

**INVESTIGATION OF THE RESPONSE OF A CABLE-STAYED BRIDGE WITH  
DETERIORATED ORTHOTROPIC STEEL DECK**

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## ABSTRACT

The current study delves into the structural response of cable-stayed bridges, focusing on the Stonecutters Bridge, under various scenarios of deck deterioration. For one deck module, a dual-phase approach was adopted, using ANSYS v22.2, beginning with four parametric studies that investigated the impact of single and multiple rib suppression, as well as general and localized corrosion. The findings from these parametric studies yielded distinct deformation patterns and structural response of the Damaged Deck Module (DDM). Damage investigation was performed by suppressing one single rib and groups of symmetric ribs on the upper and lower surface of the inside DDM section, and three damage levels were assigned in respect to the most pronounced deformations recorded. Several general corrosion cases were also performed for the DDM, as uniform thickness reduction of the upper and lower decks steel plates, which displayed various deformation responses, underscoring the uneven impact of corrosion on different bridge components. The study of local corrosion highlighted the bridge's irregular structural reactions to varying corrosion patterns, with the severity and nature of the damage critically influencing the DDM's moment of inertia.

Furthermore, the overall behaviour of the Stonecutters Bridge Deck model was examined by implementing into its main deck several DDMs affected by different levels of damage and investigated the change in vibration modes of the bridge. Symmetric mode shapes suggested more predictable and stable behavior, while asymmetry introduced complex challenges necessitating further analysis. Three cases of static wind loadings corresponding to high wind speeds were applied to the deck and it was noticed that despite the consistent deformation in all directions pointing to structural stability in the damaged bridge, a notable insensitivity to the inflicted damage was observed. This lack of responsiveness under various damage conditions raises concerns about potential unpredicted structural behaviors.

Finally, this study provides significant insights into the structural response of a cable-stayed bridges subjected to different types and levels of deck damage. These findings are crucial for developing effective maintenance strategies and for enhancing design considerations for such structures. The research underlines the need for comprehensive understanding and proactive measures to ensure the long-term integrity and safety of cable-stayed bridges.

**Keywords:** Cable-stayed bridge behavior, Deck damage analysis, Structural deformation patterns, Vibration mode symmetry.

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## CHAPTER 1 – INTRODUCTION

### 1.1 Background

The transportation network in the United States has over 600,000 bridges, of which 39% have been in service for over five decades (Tzortzinis et al., 2021). The same situation occurs in Canada. According to the Canadian Infrastructure Report Card of 2019, approximately 40% of Canada's bridge assets are currently classified as being in fair or worse condition. Qin et al. (2024) stated that aging bridges are prone to malfunctioning expansion deck joints, mainly due to the impact loads from passing vehicles and environmental factors (Ye et al., 2023). These conditions allow water, which may contain salt and chemicals, to enter the bridge superstructure, leading to corrosion. As a result, more than 55,000 bridges in the US are structurally deficient, with the backlog of bridge rehabilitation needs estimated at \$123 billion (Tzortzinis et al., 2021). As depicted in Figures 1.1 and 1.2, incidents such as the collapse of a plate girder bridge in 2009 after approximately 28 years of usage are alarming examples of the potentially devastating consequences of inadequate corrosion prevention and maintenance (Ahn et al., 2014). Figure 1.1 shows the corrosion of a steel plate girder reported for highway bridges in Japan and the United States, which finally caused significant damages leading to the bridge's collapse.



*Figure 1- 1: Plate girder bridge in Japan experiencing structural failure (Kim et al., 2012)*

Figure 1.2 illustrates the collapse of a steel truss girder bridge in 2007 due to severe corrosion after approximately 57 years of usage (Jeon et al., 2024). This is one among several cases of corrosion-related failures of bridge members reported over the years.

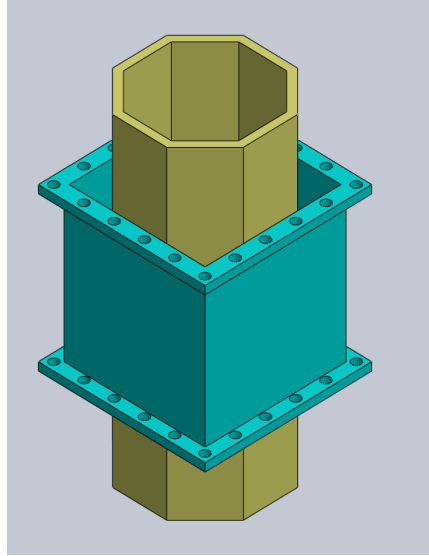


*Figure 1- 2: Steel truss bridge in Japan experiencing structural failure (Ahn et al., 2014)*

## **1.2 Causes and Consequences**

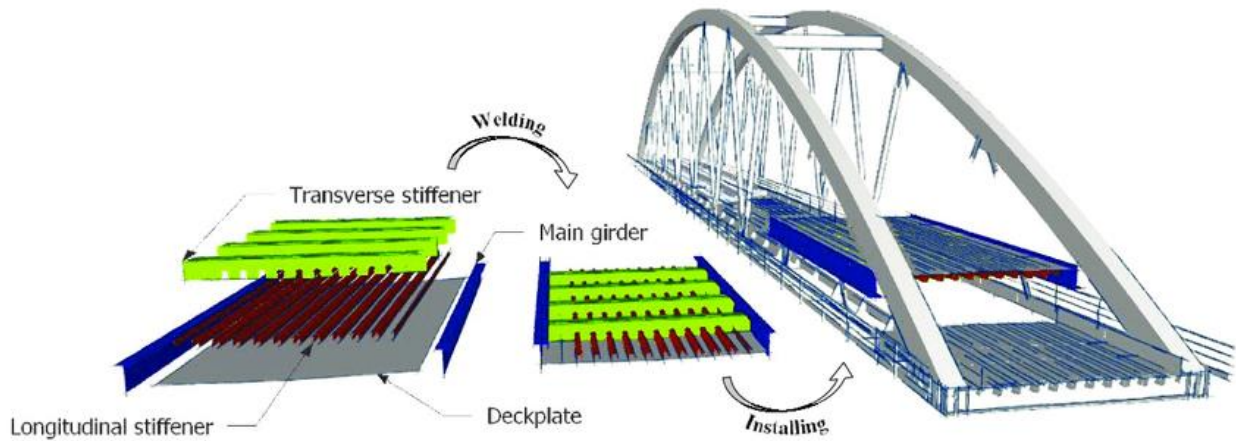
The transportation infrastructure is facing a major problem due to deteriorating steel bridges that are vulnerable to corrosion damage in harsh climates or marine environments. The end region of steel girders may show significant section loss due to runoff and chloride leaking through expansion joints (Tzortzinis et al., 2021). The conventional repair method for corroded bearing ends requires removing or cleaning the corroded region of steel and bolting or welding new steel to the girder (McMullen et al., 2018). Orthotropic steel bridge decks are prone to fatigue problems and delamination of the wearing surface. The behavior and strength of corroded members are limited as the corrosion share and form are not environmentally uniform and are affected by several factors such as temperature, relative humidity, airborne chloride ions, and time of wetness (Ahn et al., 2014). Corrosion is a common cause of steel bridge deterioration, primarily attributed to malfunctioning deck expansion joints. Aged joints fail to prevent water or de-icing mixtures from penetrating the bearing area, triggering a corrosive process that locally damages the steel beams shown in Figure 1-3.





*Figure 1-1: Steel Beam(Feroz, 2022)*

In the United States, the highway system has 614,387 bridges, of which 39% have been in service for more than five decades (Tzortzinis et al., 2021). Aging bridges are prone to malfunctioning deck expansion joints, mainly because these components are periodically subjected to impact loads by passing vehicles and environmental factors see Figure 1-4.



*Figure 1-2:Orthotropic steel bridge deck (OSBD) (Tzortzinis et al., 2021)*

Moreover, the possibility of the occurrence of orthotropic steel bridge deck corrosion damage is usually not considered in its maintenance due to the deck's anti-corrosion coating or painting. However, crack initiation at the weld root of the longitudinal fillet welding between deck plates

and closed ribs, cannot be observed by visual inspection, which might have serious implications for bridge safety (Kainuma et al., 2017). The cracks with different shape ratios propagating along the deck direction are extremely harmful to the deck-to-rib welded details in orthotropic steel decks. The proportion of fatigue damage at deck-to-rib welded details was about 20% in statistical fatigue damage cases (Zhuang et al., 2021). Numerous bridges in different countries have shown that cracks in welded details can significantly reduce the life of steel bridges. Due to special characteristics of orthotropic steel bridge deck (OSBD), fatigue cracking, and other damage types are frequently observed, severely affecting the performance of steel bridges. There is a pressing need for comprehensive research on the structural behavior of OSBD (Hoang et al., 2021). Estimating the effects of damage on steel decks is of high importance see Figure 1-5.

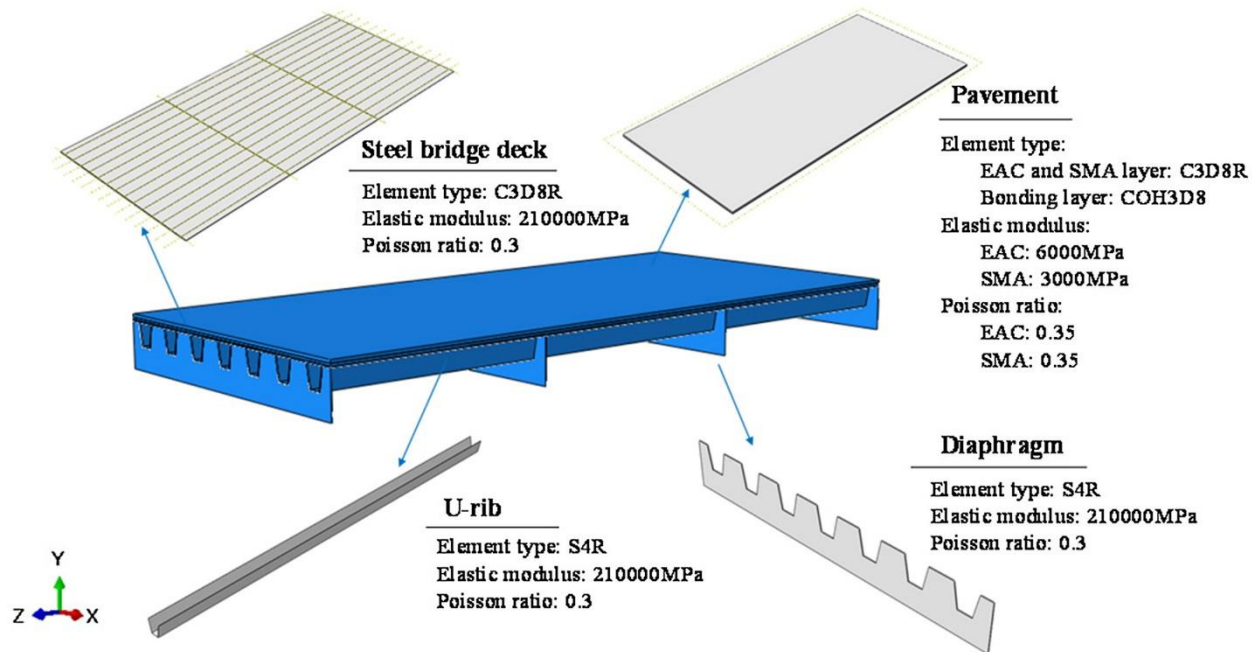


Figure 1-3: Structural behavior of OSBD: Source; (Peng et al., 2024)

In terms of the transportation network condition, out of the more than 600 000 bridges included in the National Bridge Inventory in the United States, 55 000 of them are characterized as structurally deficient. The backlog of bridge rehabilitation needs is estimated at US\$123 billion. Corrosion is a major cause of structural deficiency in highway bridges. Steel girders are prone to deterioration development at the support area, where malfunctioning expansion joints allow leaking water to penetrate the superstructure level.

### 1.3 Stonecutters Cable-stayed Bridge

The Stonecutters Cable-stayed Bridge has a special design that features a twin deck, 53 m wide, linked by cross girders at 18 m centers, providing superior aerodynamic performance due to the gap between the twin decks (Chang et al., 2023). This cable-stayed bridge is situated in Hong Kong, see Figure 1-4. As can be seen in Figure 1-3, it has 1,596 m in total length, comprising of a 1,018 m main span consisting of an orthotropic steel deck, and two back spans, built as reinforced concrete decks, each measuring 289 m. The spacing between the piers is 79.75 m, 70 m, 70 m, and 69.25 m from the tower to the end pier, respectively (Pei et al., 2023). The cross girder that connects the twin deck is 15.3 m long, and the tower top and the centerline of the road are 298 m and 78.3 m in elevation, respectively. Additionally, the spacing between the cable anchors of the main span is 18 m, and for the side spans, it is 10 m (Kaji et al., 2010).

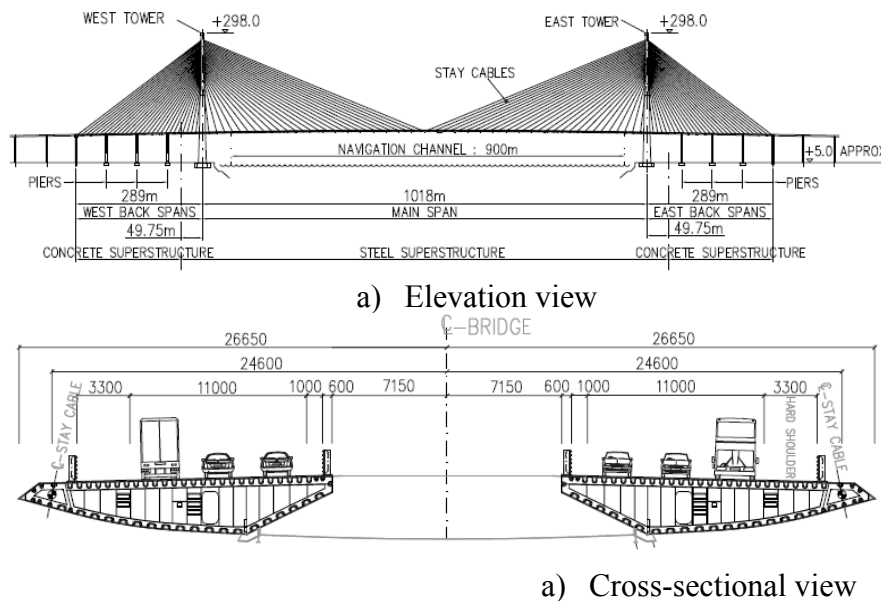


Figure 1-4: General view of Stonecutters Bridge (Kaji et al., 2010)

Figure 1-6 shows the general view of the Stonecutter Bridge, while the design is based on the Structure Design Manual for Highway and Railways (SDM) issue by HyD supplement BS54000 and other relevant codes, investigations have been conducted to establish site-specific design loads

from wind, seismic activities, and accidental ship impact to ensure safety (Falbe-Hanse et al., 2004).



*Figure 1-5: Location of Stonecutters Bridge (Kaji et al., 2010)*

Figure 1-7 shows the location of the Stonecutter Bridge, which has an orthotropic steel deck lighter than the traditional reinforced-concrete decks, is commonly used in various steel bridges due to its structural stiffness. It consists of a deck plate that is strengthened by stringers and supported by crossbeams. Steel orthotropic decks are prone to fatigue cracking due to heavy vehicle traffic (Jeong et al., 2019). Orthotropic steel decks are widely used in steel box girders of long-span suspension bridges and cable-stayed bridges because they offer several advantages such as light weight, large bearing capacity, fast construction speed, and an aesthetic structure. Although Japan constructed many orthotropic steel bridges from the 1960s-80s, damages have been reported due to the emergence of heavy-duty vehicles and increasing traffic volume (Zhuang, 2021). The Stonecutters Bridge uses a complex twin-deck orthotropic steel deck design for its main span, which provides excellent aerodynamic performance. However, to ensure safety, site-specific design loads must be considered, and the effect of fatigue cracking due to heavy vehicle traffic must be addressed. Orthotropic steel decks are widely used in long-span bridges worldwide, but they are prone to deflection and vibration caused by traffic and wind loads. Additionally, the life span used for driving comfort and safety may have a shorter service life due to high flexibility and large local deformation.

## **1.4 Problem Statement**

The Stonecutters Bridge in Hong Kong, with its unique twin-deck orthotropic steel design, faces significant challenges due to its exposure to heavy vehicle traffic and environmental factors (Wang et al., 2024). Spanning 1,596 meters with a main span of 1,018 meters, this cable-stayed bridge is structurally distinct, featuring a 53-meter-wide twin deck connected by cross girders, which enhances its aerodynamic performance. Despite its innovative design, the bridge is susceptible to fatigue cracking and other damages caused by increasing traffic volumes and heavy-duty vehicles, a common issue in orthotropic steel decks. These decks, while advantageous for their light weight and structural stiffness, often experience deflection and vibrations under traffic and wind loads, potentially reducing their service life (Ma et al., 2024). Additionally, the bridge's complex design necessitates careful consideration of site-specific design loads, including wind, seismic activities, and accidental ship impacts, to ensure safety and longevity. As such, the bridge's durability and maintenance under these stressors are a primary concern, highlighting the need for a thorough understanding of its structural behavior and the development of effective maintenance strategies. This study is therefore proposed to provide critical insights into the bridge's response to various damage scenarios, informing better-informed, proactive maintenance and design approaches that can extend the life and ensure the safety of such vital infrastructure.

## **1.5 Research Objectives**

The main goal of the current study is to comprehensively assess the impact of corrosion-induced damages on the Stonecutters Bridge, specifically focusing on how various corrosion scenarios affect the structural integrity and performance of its steel deck. Employing a dual approach with ANSYS and ABAQUS software, the study seeks to optimize finite element modeling techniques for both individual deck components and the overall bridge structure. This approach aims to enhance the understanding of the bridge's behavior under different damage scenarios, thereby guiding effective maintenance and design strategies for cable-stayed bridges.

To achieve this goal, several research objectives were identified:

1. To evaluate the impact of corrosion on the structural integrity and performance of the Stonecutters Bridge, focusing on the effects of general and localized corrosion scenarios on its steel deck.
2. To integrate and optimize the use of ANSYS and ABAQUS for detailed analysis of individual deck components and the overall bridge structure to improve modeling efficiency and cost-effectiveness.
3. To investigate the Stonecutters Bridge's response to various damage levels, particularly concerning the modular Deck Damage Model (DDM), to identify potential failure points and guide maintenance and design strategies for similar structures.

### **1.6 Research Methodology**

In the analysis of the orthotropic bridge deck of Stonecutters Bridge, a strategic approach has been employed by integrating two distinct software packages, ANSYS and ABAQUS. The selection of ANSYS, known for its adaptability and proficiency in detailed structural analysis, played a pivotal role in scrutinizing individual components of the bridge, contributing to a profound understanding of various structural aspects (Liang & Hota, 2024). Conversely, ABAQUS acknowledged for its efficacy in simulating overall structural response, was strategically employed to capture the behavior of the entire bridge system. This dual-software strategy not only aims to comprehensively assess the bridge's structural integrity but also serves as a deliberate exploration to optimize modeling costs. Fan et al. (2024) stated that ANSYS excels in many parameters, offering a detailed examination of components, it may involve a steeper learning curve and demand significant computational resources compared to ABAQUS. This research lays the groundwork for potential advancements in optimizing the use of two distinct software platforms, intending to refine integration strategies for enhanced modeling efficiency and cost-effectiveness. In the detailed analysis using ANSYS v22.2, one segment of the main deck was studied as a modular section, enabling an in-depth examination of individual components under various corrosion scenarios. This provided valuable insights into the behavior of the singular deck, identifying areas of weakness or failure for a damaged deck module (DDM), and extracting its structural properties.

Following the examination of the singular DDM deck performed with ANSYS, the second software package, ABAQUS, was employed to investigate the overall response of the twin-deck of the Stonecutters Bridge under various damage scenarios obtained from different placements of the DDM modules along the main span (Tan et al., 2023). This comprehensive evaluation, encompassing the entire deck structure and its interactions, facilitated a holistic understanding of the deck's performance and identified potential concerns not highlighted by ANSYS (Sabri, 2013). Chapters 3 and 4 provide detailed insights into the analysis, discussing the methodology, results, and implications of the study. The primary objective of this thesis is to determine the effect of corrosion-induced damages on different steel deck components on the overall structural response of the Stonecutters Bridge. The methodology involves a well-defined sequence of steps, including the utilization of two FEM models to explore the possibility of combining and reducing costs, a comprehensive literature review, pattern creation, modular deck creation in ANSYS, simulation runs for corroded ribs, worst-case scenario selection, and subsequent analysis in ABAQUS. The results obtained from both software packages are then compared, leading to conclusive insights into the impact of corrosion-induced damages on the bridge's structural behavior.

### **1.7 Thesis Overview**

This thesis is organized into 4 chapters as described below.

Chapter 1 – introduced the significance of conducting research on examining the influence of orthotropic steel deck damage on a cable-stayed bridge response; the goals and details are presented.

#### **Chapter 2 – Literature Review**

- Section 1: This section focuses on the impact of corrosion on orthotropic steel bridges. The review covers various aspects of the corrosion process, including the formation of corroded structures, thickness reduction observed, and corrosion patterns. In addition, the review presents various finite elements analysis models developed by other researchers and highlights the importance of material properties in corrosion. Previous studies' results, including the failure mode, shear capacity, deformation, and geometry imperfection of corroded deck, are also discussed in the review. The literature review provides a

comprehensive understanding of the impact of corrosion on orthotropic steel bridges, serving as the foundation for the research conducted in this thesis.

- Section 2: This section focused on documenting the cracks in orthotropic steel decks and their impact on the structural integrity of the deck. The review covers different types of cracks that can occur and their location on the deck, as well as the results of previous studies regarding the stress, fatigue, and deformation created when cracks occur. Overall, the literature review provides an in-depth understanding of the effects of cracks on orthotropic decks, which forms the foundation of the research conducted.

### Chapter 3 – Steel deck damage modelling

- The present thesis provides a comprehensive study of the Stonecutters Bridge, focusing on its overall behavior under different loading when the deck is damaged. The research involves the development of a finite element model in ANSYS, which accurately simulates the deck's structural response. The material properties of the bridge are determined, and appropriate design loading and boundary conditions are established. The thesis also investigates the effects of single and multiple corroded rib study, general corrosion, and local corrosion on the deck's performance. The thesis employs a three-tiered damage classification system, adapted from Tamakoshi et al. (2006), to quantify the extent of structural damage, ranging from visible but requiring detailed examination (Level I) to serious damage posing a hazard to traffic safety (Level III).

### Chapter 4 – Bridge deck response for different DDM damage levels

- The chapter utilizes the information found in Chapter 3, thus it starts by summarizing the DDM damage levels selected to be used in ABAQUS for the Stonecutters Bridge Model. The second section starts by importing geometry properties and making a comparison with previous studies. Values such as natural frequency are compared to validate the results obtained in *Ansys v22.2*. With the validation completed, the worst-case scenarios are selected based on the percentage of difference between the baseline values and various damages. As noted before, the primary goal of Chapter 4 is to use the structural properties found for the modular DDM in Chapter 3 and apply the damages at different locations (end, quarter and center) of the steel span of the deck. The damages are applied to the models



and the results are observed. Through numerical simulations, the research sheds light on the structural behavior of the Stonecutters Bridge, providing valuable insights by comparing the responses obtained based on the damage classification.

Chapter 5 presents the significant findings and the learning outcomes concluded from both analyses and provides recommendations for future work based on the insights gained from this research project.

## CHAPTER 2: LITERATURE REVIEW

This chapter explores two types of damages observed on orthotropic steel decks. The initial part is dedicated to corrosion, covering topics such as types, specimens, thickness reduction, patterns, and finite element analysis. The latter section of this part discusses the results obtained, encompassing failure modes, shear capacity, deformation, and other relevant factors. In section 2.2, the focus shifts to cracks, commencing with an examination that delves into various types, their locations, and the primary outcomes associated with fatigue cracks. This exploration includes considerations of stress, fatigue, and deformation.

### 2.1 Types of Corrosion

Corrosion in the steel components of orthotropic steel bridge decks plays a significant role in affecting the bridge's durability and remaining strength. This corrosion can be categorized into two primary types:

- **General Corrosion:** involves the steady and even deterioration of a steel element's surface over time. For steel bridges, this form of corrosion allows for a systematic evaluation of the bridge's residual strength by examining the uniformly corroded sections. General corrosion usually leads to a predictable thinning of the material, making it easier to assess the structural soundness of the bridge.
- **Local Corrosion:** is characterized by uneven and localized degradation at specific areas of a steel component, creating complexities in determining the extent of damage, affected area, and remaining strength. Local corrosion is particularly crucial to address in steel bridges, as it often occurs around critical areas such as bearings or supports, potentially leading to significant damage. The unpredictable patterns of local corrosion necessitate a detailed analysis, taking into account various factors like shear forces and deformation, as highlighted in previous research (e.g., Kim et al., 2012).

Corrosion-induced deterioration was observed in the field for various components of bridge decks, such as: the upper flange, u-ribs, stiffeners, end girders etc. Figure 2-1 shows the typical location of corrosion occurrence for a steel plate girder bridge in Japan (Tamakoshi et al., 2015). Most of

the severe girder corrosion is usually observed directly beneath the expansion joints of bridge decks, which are positioned over girder supports located at abutments and piers (Zmetra et al., 2018).

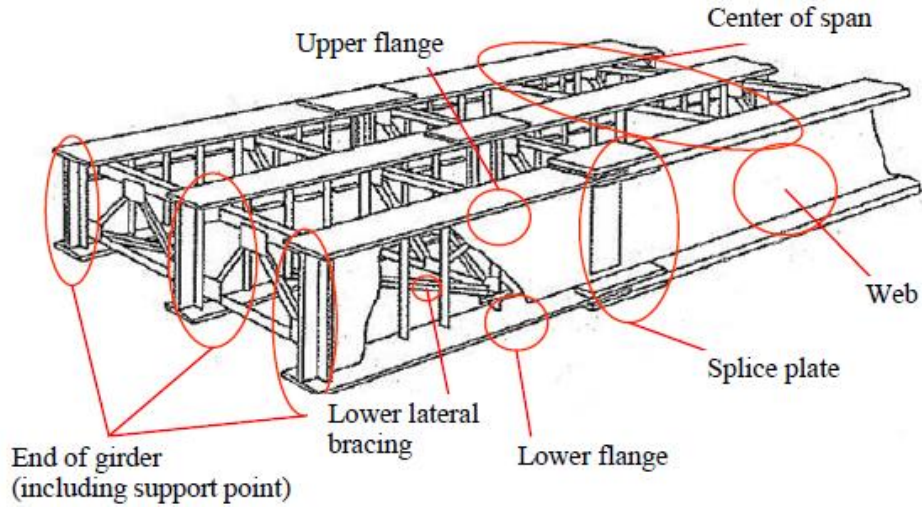


Figure 2- 1: Typical location of corrosion occurrence (Tamakoshi et al., 2015)

### 2.1.1 Corroded Steel Specimens

Obtaining naturally corroded steel beams for testing purposes is challenging, while the deterioration phenomenon in real-world conditions is non-uniform and varies significantly in topology and intensity, depending on the configuration of the bearing area. Amherst et al. (2010) conducted full-scaled experimental testing on six naturally corroded girders (designated as specimens 1 to 6 in Table 2-1) obtained from two steel bridges built in 1939 in Massachusetts, currently undergoing replacement. Specimens 1 to 3 were from the five-span Bridge A, while specimens 4 to 6 were from the simple span Bridge B.

*Table 2- 1: Summary of 6 full scale corroded girder*

| Bridge | # | Type of Beam           | Damage                                                                                                                                                                                                                               | Figure                                                                                                          |
|--------|---|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| A      | 1 | 8.43 m long<br>33WF125 | Specimen with severe section loss at the corroded end, and a notable feature of this specimen is a 152mm hole located above the bottom flange that extends along 50% of the bearing length.                                          |  <p>(Tzortzinis, 2021)</p>   |
|        | 2 | 7.29 m long<br>33WF132 | The web end of the specimen has considerable section loss along its lower part. Moreover, the maximum initial lateral web deviation, measuring 40 mm from the vertical, is 2.7 times the intact web thickness.                       |  <p>(Tzortzinis, 2021)</p>  |
|        | 3 | 8.5 m long 33WF125     | There are two holes at the end of the corroded specimen. One is located mid-height, measuring 76mm long, while the second hole begins at the outer edge of the web, extends for 457 mm, and goes beyond the bearing length by 152mm. |  <p>(Tzortzinis, 2021)</p> |

|   |   |                    |                                                                                                                                                                                                                     |                                                                                                                 |
|---|---|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| B | 4 | 6.91 m long 21WF73 | The beam has a region of extensive thickness loss at the bottom of the web, aligned parallel to the flange. Furthermore, this specimen was delivered with a bed along the web's transverse axis, near its midpoint. |  <p>(Tzortzinis, 2021)</p>   |
|   | 5 | 155 mm long 21WF73 | The corrosion has caused three web holes above the bearing, with lengths measuring 203 mm, 15 mm and 127 mm from the bottom to the top.                                                                             |  <p>(Tzortzinis, 2021)</p>   |
|   | 6 | 155 mm long 21WF59 | The beam has a single hole that extends through the web's depth and longitudinally, adjacent to both flanges.                                                                                                       |  <p>(Tzortzinis, 2021)</p> |

Table 2-1 provides a couple of examples corrosion observed in steel girders. The deterioration lead to significant section loss, such as thickness reduction and/or extensive section loss. In some cases, advanced corrosion can form holes in the structure, as seen Figure 2-2 (Tzortzinis, 2021).



*Figure 2- 2: Corroded specimen with induced holes (Tzortzinis, 2021)*

When examining images of corroded structures, it could easily be noticed that the steel has become easily breakable, an indication that the material has lost most of its strength and ductility. For instance, considering Bridge B specimen 6, it can be assumed that under the impact of a considerable load, the respective section could lose structural integrity very easy. The dimension may seem small, but they represent large portion of these members. Figure 2-3 below shows the specimen 4 of Bridge B from different angles (Tzortzinis, 2021). It appears that 99% of 6.91 meters beam length is affected by corrosion. Observing the longitudinal view, (Fig. 2-3 b), it can be noticed that the beam has a deformation of 44 mm, which is visibly impacting the thickness of the web. On the other hand, the transverse view, (Fig. 2-3 c) showcases severe deformation on the flange (undulation), with very little thickness remaining. In fact, more than half of the beam's width appears to be affected by the corrosion.





*Figure 2- 3: Bridge B, Specimen 4 (a) side elevation (b) view of the longitudinal (c) transverse view (Tzortzinis, 2021)*

In conclusion, the corrosion discussed in this section manifests as extensive, affecting various components of the bridge deck, including the flange, web, and stiffeners. Considering the widespread nature of this oxidation, it becomes imperative to address the issue and ascertain the level of corrosion-induced damage while ensuring the ongoing structural integrity. The subsequent section will provide a detailed exploration of thickness reduction resulting from corrosion.

### **2.1.2 Thickness Reduction**

Corrosion leads to various negative consequences for the affected bridge deck element, including decreased strength, structural damage, and aesthetic degradation. One common visible consequence of the steel oxidation is the reduction in the thickness of the element profile. This occurs as the material is gradually consumed by the reaction with its environment, resulting in a loss of material and a reduction in its thickness. In certain areas of the corroded deck plate, the thickness was found to have diminished to approximately 25% of its original thickness (Jeong et al., 2019). Accurately quantifying the uneven section loss in the corroded end region is a significant challenge that requires a detailed approach. Below three methods are presented to quantify the thickness reduction.

### Method 1:

To achieve precision in the thickness measurements, detailed evaluations were performed on the corroded flanges to accurately gauge the reduction in material thickness. For clarity and ease of measurement, a grid pattern was marked on each flange under examination, as recommended by Tzortzinis (2021). Measurements were taken using a high-precision thickness gauge from GE Inspection Technologies, which boasts a fine resolution of 0.025 mm. This gauge, a common tool among inspectors at the Massachusetts Department of Transportation, operates by measuring the travel time of an ultrasonic pulse through the material. To obtain dependable measurements with this device, it's essential to remove any coatings or rust from the measurement spot and to apply a couplant to facilitate the transmission of the ultrasonic signal, as stipulated in Tzortzinis's study (2021). Approximately 200 points were measured on each beam, with each point measured twice, and the average reading recorded. To assist in the analysis of the thickness loss data, a grid system was drawn at each beam as shown in Figures 2-4 and 2-5, covering the full depth of the web and extending at least two feet along the length of the beam (Tzortzinis, 2021).



*Figure 2- 4: Bridge B specimen 5 – thickness (Tzortzinis, 2021)*



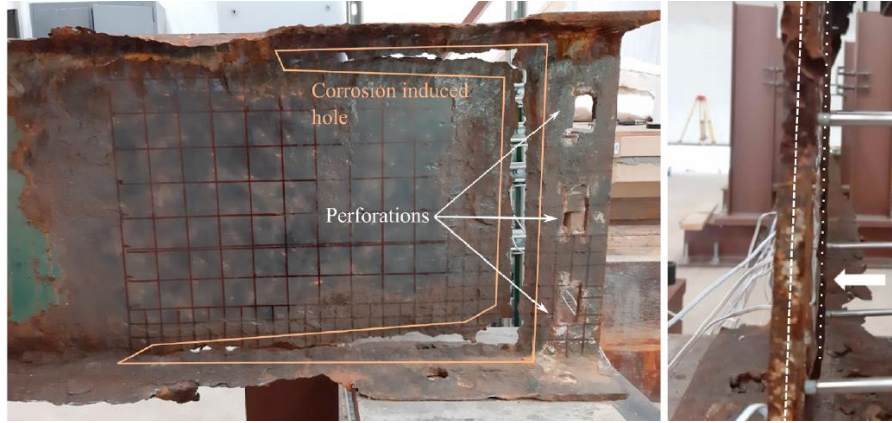


Figure 2- 5: Bridge B specimen 6 – thickness measurement (Tzortzinis, 2021)

The grid was spaced closer together near the bottom of the beam where corrosion was typically most severe. Contour maps were then created to illustrate the extent of thickness reduction for each specimen, as shown in Figure 2-6.

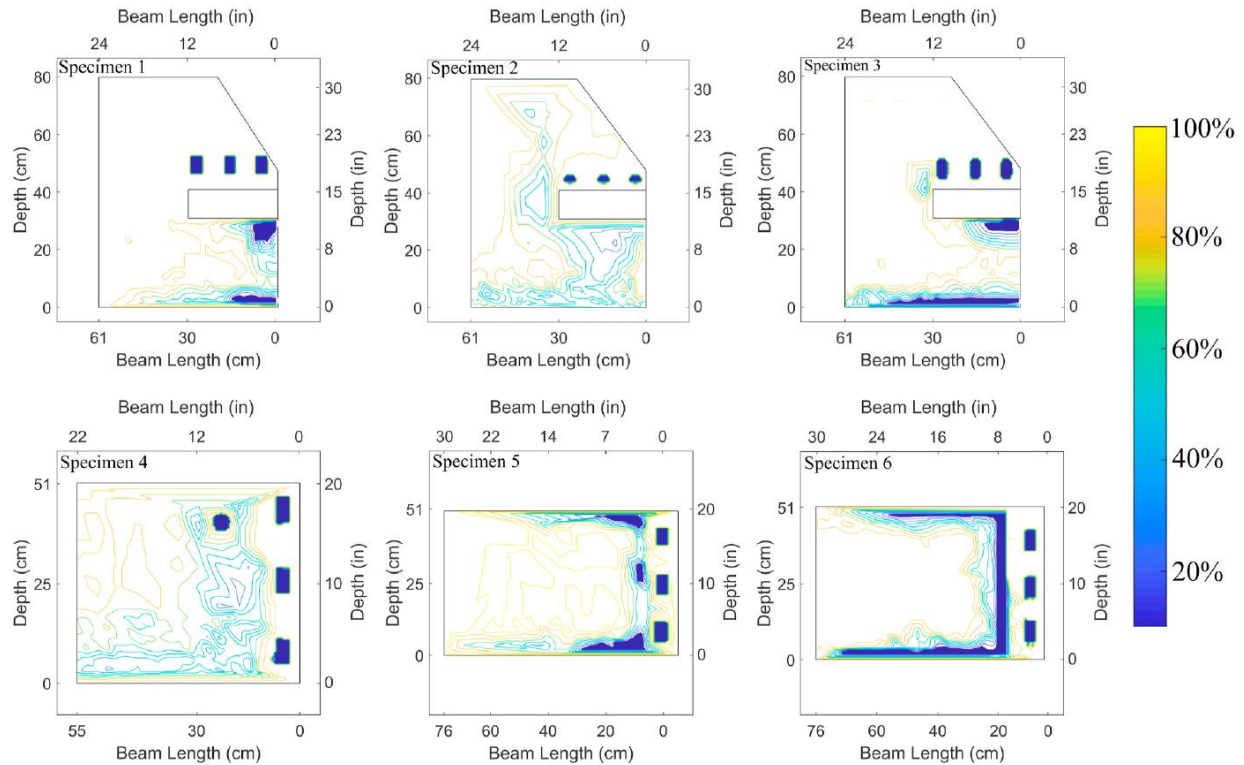


Figure 2- 6: Contour maps illustrating the remaining thickness of specimens (Tzortzinis, 2021)

With meticulous thickness measurements, it was possible to eliminate the obstacle encountered in accurately reproducing the tested specimens in 3D in the selected software. Figure 2-7 shows the

simulated section loss profile for which the areas were partitioned into the corresponding web and flange faces models.

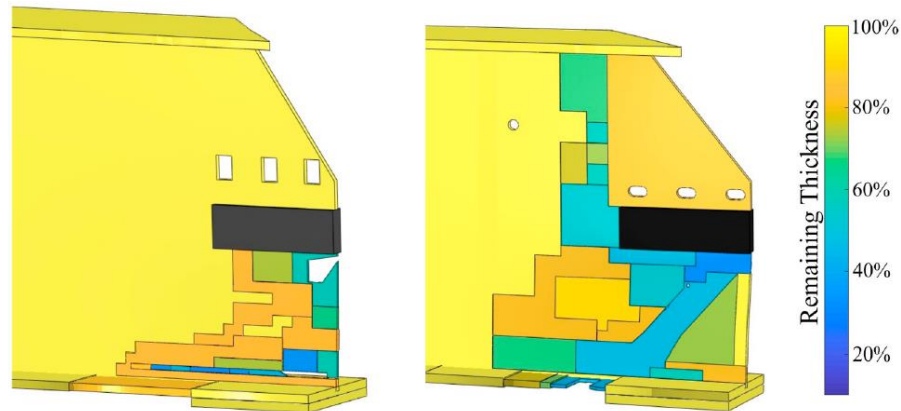


Figure 2- 7: Bridge A modeling remaining for specimens 1 and 2 (Tzortzinis, 2021)

#### Method 2:

It is not always possible to have access to testing devices and experimental facilities required for applying Method 1. In his study, Tzortzinis (2021) outlines two distinct approaches for evaluating structural elements. The first approach follows a conventional methodology, relying on specific testing equipment and experimental setups typically housed in a laboratory. This method often necessitates the physical presence of the specimens in the lab, which poses a challenge when dealing with components that are integral to larger structures or situated in remote or hard-to-reach locations.

Recognizing these constraints, Tzortzinis (2021) introduced a second method. As indicated in the Best Practice note, this second approach is tailored for greater practicality and suitability for on-site applications. It employs non-destructive testing techniques, indirect measurement methods, and computational simulations, enabling the assessment of structural elements in their actual location. This addresses the logistic and practical difficulties associated with the traditional, laboratory-based first method, thereby filling a crucial need for more accessible and adaptable structural evaluation techniques in situations where conventional methods are impractical.

It is an empirical method to account for the impact of corrosion on capacity reduction of affected structural elements. Based on field observations, Tzortzinis (2021) proposed an equation that can be used to find the average web thickness of corroded elements beams:

$$t_{average} = \frac{(N+md-H)t_w}{N+md} \quad \text{Eq. (2.1)}$$

Where:

$t_w$  : remaining web thickness

H: length of hole along length used for capacity

N: bearing length

d: beam depth

m: factor specified in Table 2-2

Table 2- 2: Proposed values of factor  $m$  (Tzortzinis, 2021)

| Imperfection Amplitude (a) | 1 $t_{web}$ | 0.1 $t_{web}$ |
|----------------------------|-------------|---------------|
| $N/d > 0.2$                | 0.2         | 0.1           |
| $N/d \leq 0.2$             | 0.1         | 0             |

Table 2-2, as outlined in Tzortzinis's 2021 study, presents suggested values for the  $m$  factor, which are based on the imperfection amplitude (a) and a normalized value (N/d). The imperfection amplitude is described in two variants:  $t_{web}$  and  $0.1t_{web}$ , where  $t_{web}$  presumably represents the web thickness of a structural component.

The table delineates two scenarios for N/d values:

- For cases where N/d exceeds 0.2, it recommends an  $m$  factor of 0.2 for an imperfection amplitude of 1  $t_{web}$ , and 0.1 for 0.1  $t_{web}$ .
- Conversely, when N/d is equal to or less than 0.2, it suggests an  $m$  factor of 0.1 for 1  $t_{web}$ , and 0 for 0.1  $t_{web}$ .

These proposed  $m$  factor values in Table 2.2, correlating with the imperfection amplitude and N/d value, imply their utility in computational models or analytical calculations that account for imperfections in the web of structural elements.

Method 3:

In recent years, new methods have been developed to quantify more accurately uneven section loss, including laser scanning of corroded members. These methods provide engineers with more accurate analysis results. Figure 2-8 displays laser-scanned images of corroded depth surfaces

taken at 0.4 mm, while the weight loss of the test specimen was measured with an electronic balance (reference). Surface morphology was characterized using laser scanning with a spot diameter of  $30\mu m$  and resolution of  $0.05\mu m$ . The measurement distance of 0.4mm was determined based on preliminary surface roughness monitoring results. The mean corrosion depth was calculated from the surface roughness profile obtained through laser measurements, with weight loss measured and distributed proportionally to the measured surface roughness relative to the intact surface level (Kainuma et al., 2015).

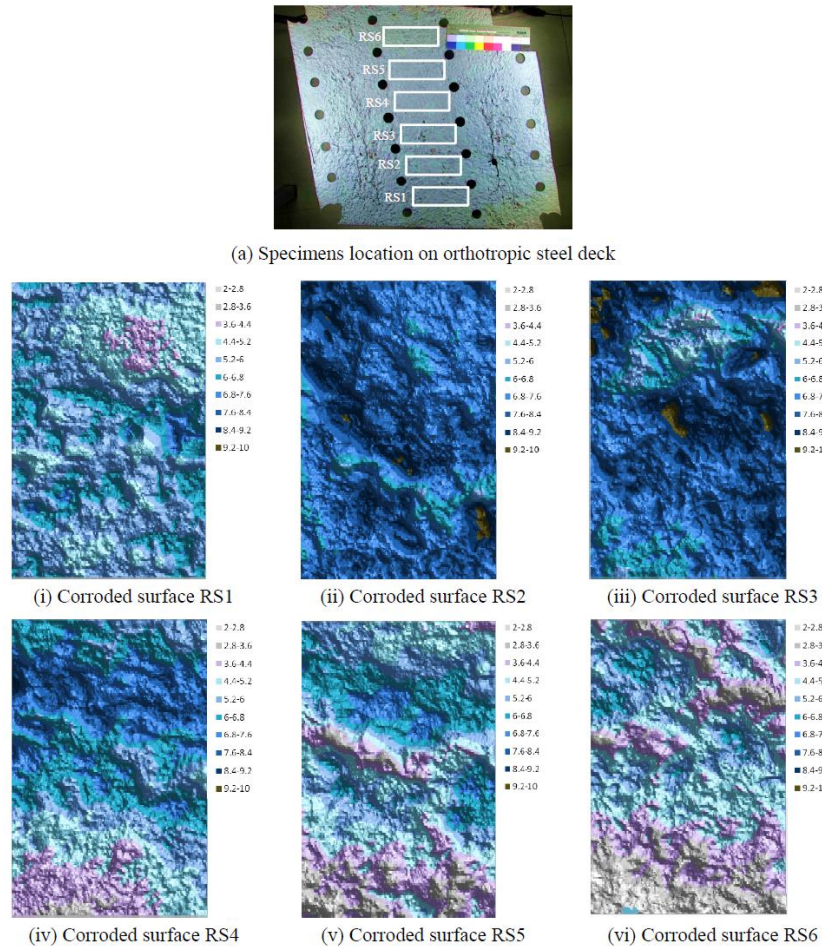


Figure 2- 8: Real corroded deck surfaces image of the cut orthotropic steel deck (Kainuma et al., 2015)

The histograms of the corroded surface models obtained from field investigations and measured by laser reading are depicted in Figure 2-9. The irregular and sharp changes in the corrosion level and distribution of the deck surface can be observed in Figure 2-8. These variations are dependent

on the deck surface area of the orthotropic steel bridge deck and exhibit a non-uniform distribution (Kainuma et al., 2015).

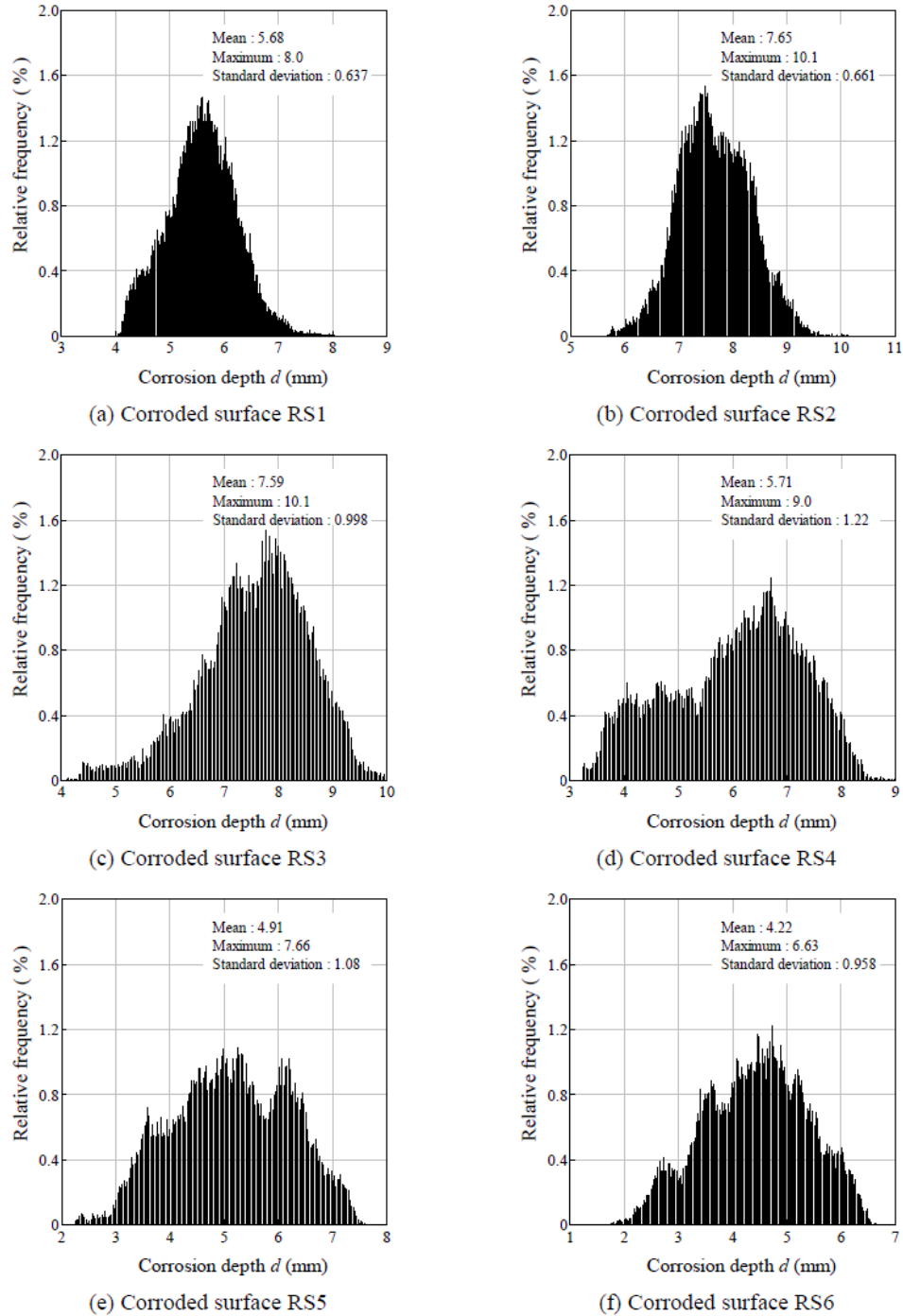


Figure 2- 9: Histogram of real corroded deck model (Kainuma et al., 2015)

The mean and maximum corrosion depths measured using laser scanning are presented in Table 2-3.



*Table 2- 3: Surface data of the corroded deck surface (unit: mm) (Kainuma et al., 2015)*

| Corroded surface | Mean corroded depth | Maximum corroded depth | Minimum corroded depth | Standard distribution |
|------------------|---------------------|------------------------|------------------------|-----------------------|
| RS1              | 5.68                | 8.0                    | 4.04                   | 0.64                  |
| RS2              | 7.65                | 10.1                   | 5.68                   | 0.66                  |
| RS3              | 7.59                | 10.1                   | 4.08                   | 1.00                  |
| RS4              | 5.71                | 9.0                    | 3.21                   | 1.22                  |
| RS5              | 4.91                | 7.66                   | 2.23                   | 1.08                  |
| RS6              | 4.22                | 6.63                   | 1.75                   | 0.96                  |
| Avg.             | 5.96                | 8.59                   | 3.50                   | 0.93                  |

It should be noted that the information above was taken from a bridge with thickness of deck plate of 12 mm and u-rib 6 mm. The corrosion has penetrated 15% to 84% of the design thickness (Kainuma et al., 2015).

### 2.1.3 Corrosion Patterns for Steel Beams

To manage the extensive data within the 93 steel bridges studied by the state of Massachusetts, distinct processes were implemented. Initially, the processing stage involved the development of raw data-driven patterns specifically addressing web corrosion and web holes, encompassing 95% of the reported cases. Each of the 808 examined corroded beam ends was categorized based on these raw data-based patterns. The resulting database comprises well-defined parameters such as thickness loss, corrosion area size, corrosion location, hole size, and location. Subsequently, the second stage involves performing statistical analysis on the recorded data, quantifying the limits of the most prevalent corrosion topologies (Tzortzinis, 2021).

Figure 2-10 presents the bounds of corrosion patterns for the second category, where patterns 1 to 5 denote areas with thickness reduction, while patterns 6 and 7 depict hole areas projected on the thickness reduction patterns that were most frequently reported based on the conducted analysis. In this study, corrosion patterns 1, 2 and 3 are employed to investigate the effect of section loss, while patterns 6 and 7 are used to examine the effect of holes on the bearing capacity.

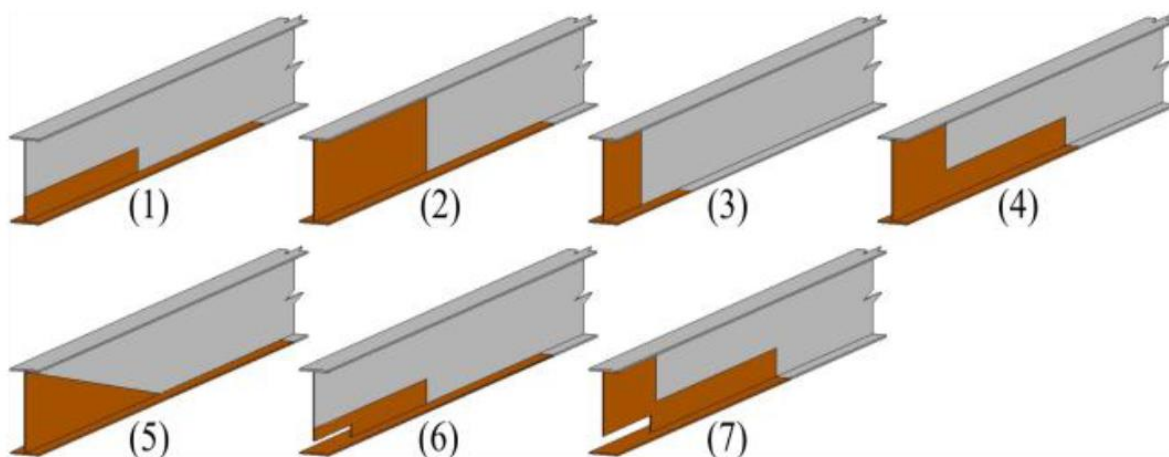


Figure 2- 10: Corrosion patterns for beam without diaphragms above bearing (Tzortzinis, 2021)

Several other studies have numerically investigated corrosion patterns in steel girders. For instance, Huang et al. (2002) closely examined the corrosion pattern of a steel girder and found that corrosion was more severe on the inner surface and lower part of the girder. In the present study, basic corrosion models were developed based on observations in the literature and were represented in Figure 2-11. Corrosion was assumed to occur on one side of the girder (Yamaguchi et al., 2013).

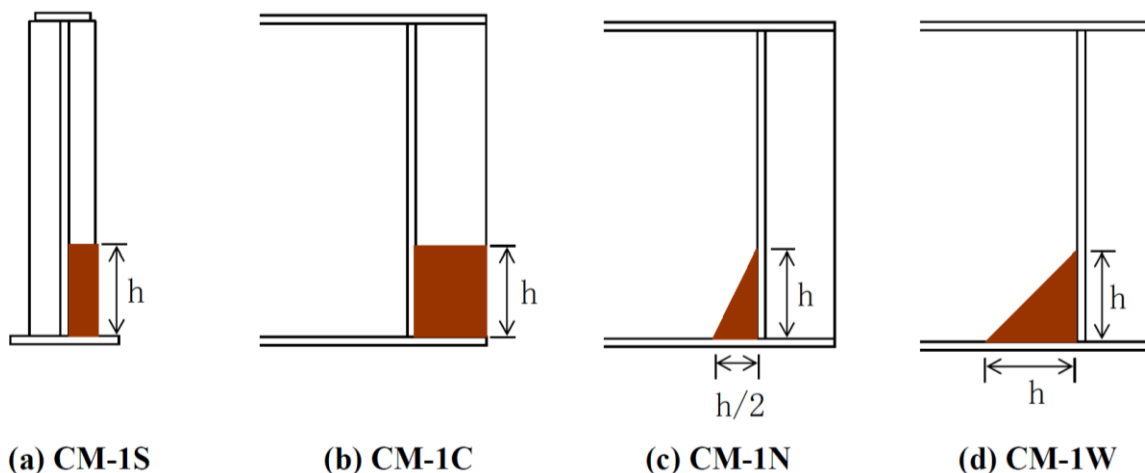


Figure 2- 11: Corrosion models (Yamaguchi et al., 2013)

The study simulated various degrees of corrosion by changing the height ( $h$ ) and plate thickness loss ( $\Delta t$ ) on one side of a plate. Values of 10%, 20%, and 40% of the web height  $h_0$  were given to  $h$ , while  $\Delta t$  took values of 2 mm, 4 mm, and 6 mm.  $\Delta t$  (representing the thickness of corrosion) was assumed to be uniform over each corroded region. Since corrosion developed on both surfaces

of the transverse stiffener, the plate-thickness loss in the transverse stiffener was twice as much as for the other corrosion models (Yamaguchi et al., 2013).

Four types of corrosion shapes were identified by Lui (2011), as shown in Figure 2-12, and three rates of thickness reduction were considered to create the corrosion models. Corrosion shapes were decided according to actual bridge inspection data. The analytical parameters investigated were the range of local corrosion  $h$  and the remaining web thickness  $t$ . Forty-five corrosion models were created with various corrosion shapes, by reducing the  $h$  values by 25%, 50%, and 75% and the  $t$  values by 25%, 50%, 75%, respectively (Liu, 2011).

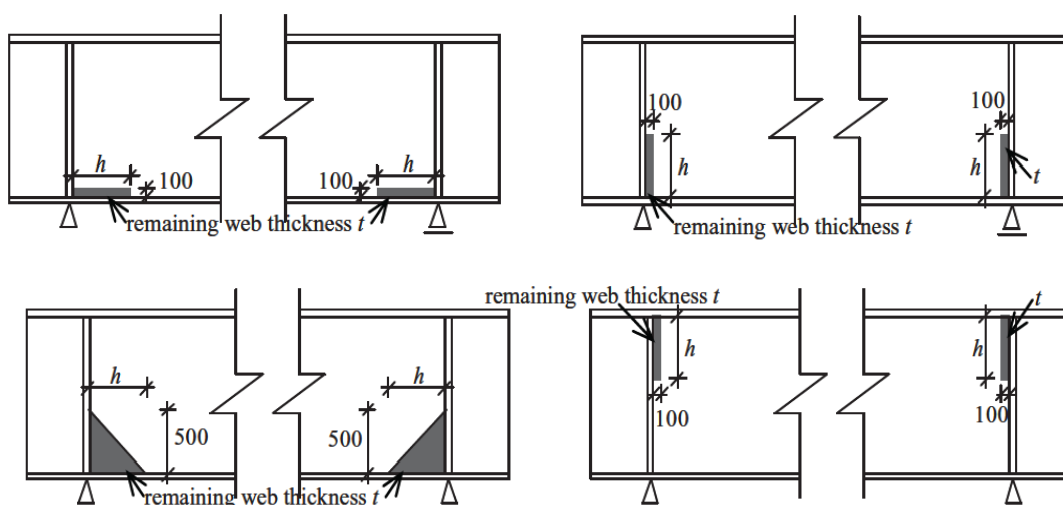


Figure 2- 12: The pattern of corrosion (Liu, 2011)

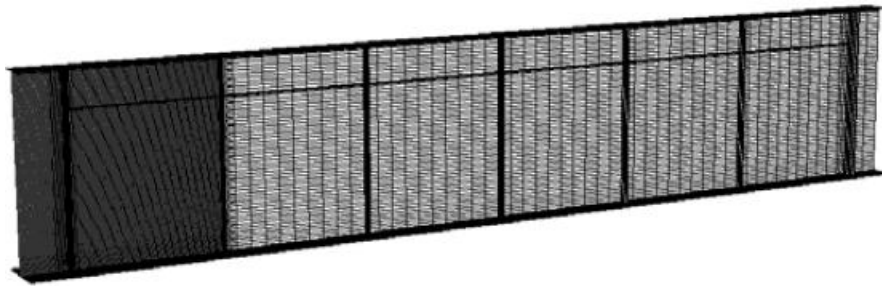
#### 2.1.4 Finite Element Analysis

Steel corrosion is a complex process that can cause significant damage to various engineering structures, and its study is critical for ensuring the safety of these structures. Finite Element Analysis (FEA) is a powerful tool that can be used to investigate the effects of corrosion on engineering structures. The use of FEA in the study of corrosion is essential because it enables the modeling of complex geometries and material properties, which are crucial in accurately predicting the behavior of corroding structures. FEA provides the ability to simulate the progression of corrosion in a structure, which is a highly nonlinear process, and evaluate the impact on the structure's mechanical properties. Overall, the use of FEA in the study of corrosion is vital for



understanding the behavior of corroding structures and predicting their remaining service life accurately. By providing a detailed analysis of the corrosion process and its effects on the structure, FEA can aid in the development of effective corrosion mitigation strategies and ensure the safety and longevity of engineering structures. The following section presents several studies which employed finite element analysis to investigate corrosion in different contexts. The studies aim to understand the behavior of corroded steel structures, predict the corrosion-induced damage, and design corrosion mitigation strategies.

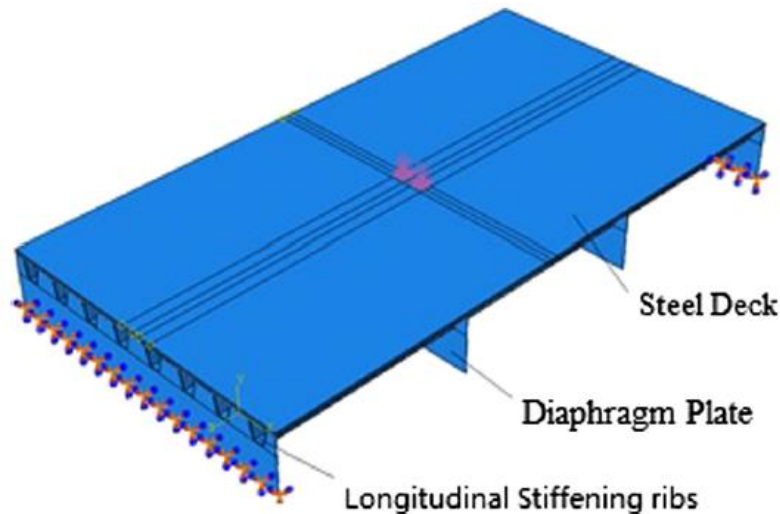
1. Yamaguchi et al. (2013) used their model to assess the load-carrying capacity of the end of the steel I-section girder, by using the ABAQUS (2006) software. The primary focus of this analysis was evaluating the load-carrying capacity of a girder end when subjected to loading above the bearing (Fig. 2-13).



*Figure 2- 13: Finite element mesh of quarter girder model (Yamaguchi et al., 2013)*

Luo et al. (2017) modelled an orthotropic steel deck section as depicted in Fig. 2-14, comprising of a steel deck, eight U-shaped stiffening ribs, and four transverse diaphragm plates using ABAQUS software. The finite element model included 12,756 elements for modelling the steel deck of 14 mm thick, 4800 mm wide, and 9000 mm long, comprising u-shaped stiffeners, steel plate, diaphragm plates etc. The goal was to investigate the deformation of the deck at 60°C under corrosion conditions. The finite element model, crafted to examine the deformation of an orthotropic steel bridge deck subjected to corrosion at 60°C, was composed of 12,756 elements. This comprehensive model represented a steel deck with dimensions of 14 mm thick, 4800 mm wide, and 9000 mm long, featuring elements like U-shaped stiffeners, a steel plate, and diaphragm plates. The investigation focused on evaluating the effects of both widespread and localized corrosion on the deck. Widespread, or general, corrosion involves a uniform deterioration of the

surface, allowing for a structured assessment of the deck's residual strength by analyzing sections with uniform corrosion. Localized corrosion, on the other hand, presents irregular and uneven decay, often occurring near bearings or supports. This type of corrosion requires meticulous analysis due to its potential to cause significant damage and the complexities involved in evaluating the impacted area and the remaining structural integrity.



*Figure 2- 14: Model of orthotropic steel deck pavement (Luo et al., 2017)*

From the vast literature reporting steel deck behaviour under corrosion conditions, two studies were useful for the current research. The first study was performed by Ahn et al. (2014) to investigate the residual shear strength of web panels with localized corrosion; plate girder shear loading tests were carried out under five corroded web conditions.

To identify the residual shear strengths and post-shear buckling behaviors of the locally corroded web panel, nonlinear finite element analyses were conducted using the finite element software MARC Mentat 2010 (Ahn et al. 2014). The study involved a combination of experimental and numerical simulations. The test specimens used in the experiment were two-panel steel webs with a flange width of 200 mm, flange thickness of 16 mm, web thickness of 6 mm, and a web aspect ratio of 1.5. The web panel had a height of 800 mm, but was used with a relatively longer web width, due to the restrictions imposed by the test system such as load capacity and frame. The FE analysis model used in this study is shown in Figure 2-15 where a four-node shell element was

used with a 10mm mesh size. The web's behavior was considered to be elastic-perfectly plastic, and the von Mises yield criterion was used for the material plasticity (Ahn et al. 2014).

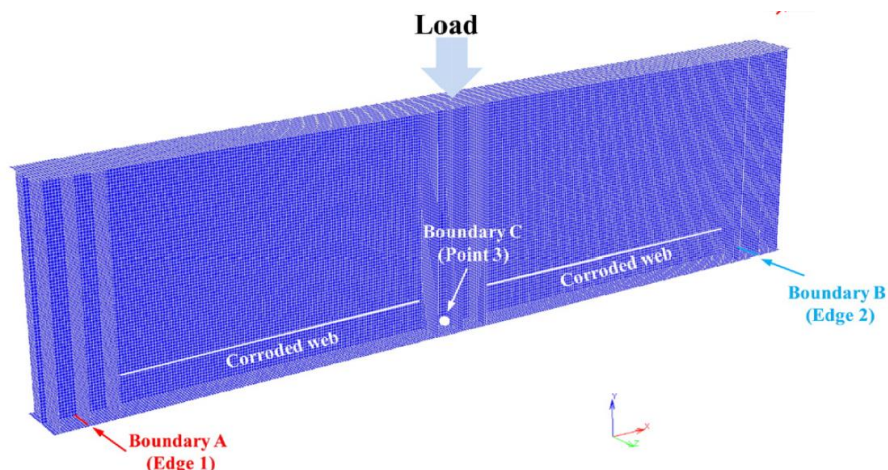


Figure 2- 15: FE analysis model of the web panel with local corrosion (Ahn et al., 2014)

To evaluate the residual shear resistant behaviors of web panels with local corrosion, the FE analyses were conducted by changing the corroded web condition, web geometry, and boundary conditions. The test specimens used for the shear loading test had a height of 800mm, a flange width of 200mm, a flange thickness of 16mm, a web thickness of 6mm, and a web aspect ratio of 1.5. The investigation into the deformation of a steel deck under corrosion involved a finite element model with 12,756 elements. This model depicted a steel deck with dimensions of 14 mm in thickness, 4800 mm in width, and 9000 mm in length. It included detailed features like U-shaped stiffeners, steel plates, and diaphragm plates. The primary aim was to study the deck's deformation at 60 degrees Celsius. To realistically simulate corrosion effects, the model altered the thickness of the left lower webs to mimic localized corrosion, instead of employing an artificially corroded material through mechanical means (Ahn et al., 2014). This method was selected to more accurately represent the impact of corrosion on the deck's structural integrity. In the FE analyses, the geometries of the models were designed based on the test specimen shown in Figure 2-16, with the fundamental dimensions remaining constant; however, the aspect ratio and web thickness were variable, while the corroded web height was changed from the lower flange based on the web panel with a height of 800mm, a width of 1200mm, and a web thickness of 6mm. The web spans were changed from 800mm to 1200mm based on the web panel with a height of 800mm and a web thickness of 6mm to evaluate the effect of the aspect ratio on the changes in the shear buckling

strengths of the corroded web panels. The thickness of the corroded web was changed from 0mm to 1mm for both webs in the entire FE analysis model.

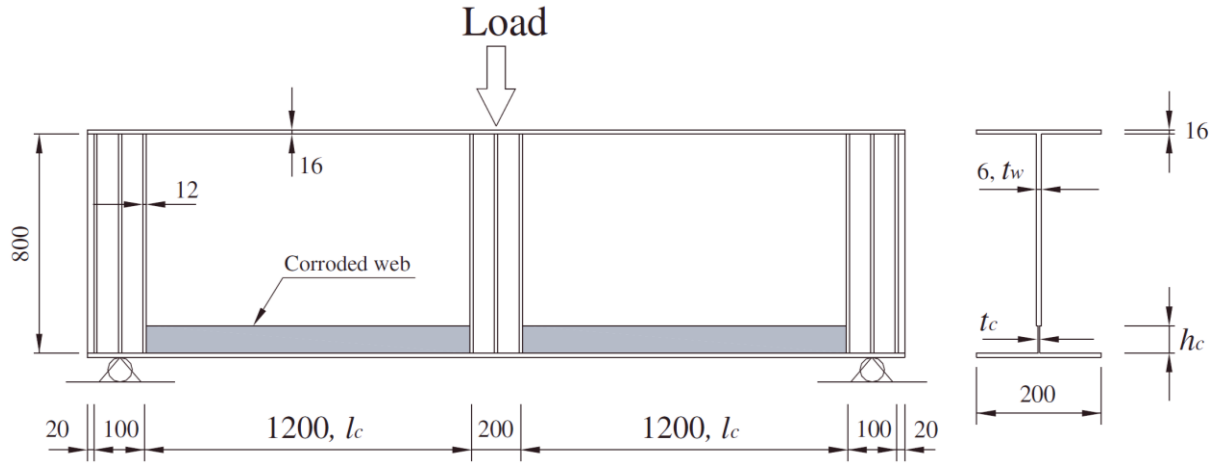


Figure 2- 16: FE analysis model (unit: mm) (Ahn et al., 2014)

The second study was conducted by Tzortzinis et al. (2021) who developed a reliable finite element model that can precisely forecast the failure load and mode of deteriorated girders. The model was calibrated using the data gathered from Specimen 1. Once calibrated, this was then utilized to simulate Specimen 2 failure and to confirm the validity of the experimentally acquired outcomes. A quasi-static analysis was conducted to replicate the applied load in the experimental setup, with the simulation concluding once instability phenomena emerged, as the study does not encompass post-buckling behavior (Tzortzinis et al., 2021). Phase II involved a parametric analysis aiming at developing a basic comprehension of how the deterioration affects the bearing capacity of the I-beams. The initial step in Phase II involved identifying the design space for the parametric analysis. Subsequently, the girder-level numerical model created was employed for various simulations within this design space, to investigate the parameters that have a substantial impact on the bearing strength of corroded rolled girders (Tzortzinis et al., 2021). The laboratory experiments were replicated through a finite element model and were analyzed using ABAQUS finite element software. To approximate the three-dimensional continuous beam with a surface at the middle of the section, shell elements were utilized (Tzortzinis et al., 2021).

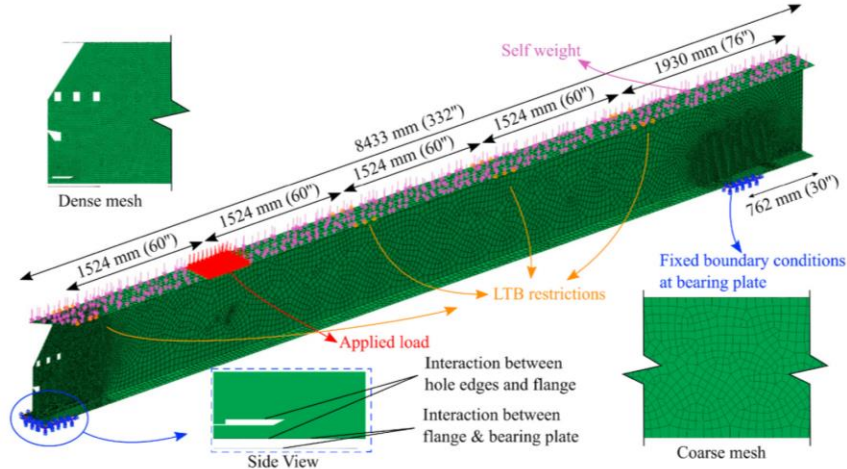


Figure 2- 17: Finite element model for experimental configuration (Tzortzinis et al., 2021)

The thickness of the actual specimen was considered and was assigned as a parameter to the corresponding elements. The two-dimensional assumption used in this study was considered valid as the thickness of the beam's components was significantly smaller compared to the other two dimensions. After conducting a sensitivity study of the mesh size, type, and section points number, the four-node linear element S4R was chosen. This element contains a unique integration point in the plane and five section points through the shell thickness, capturing bending and stretching effects. At the beam ends, where stress concentration and failure are expected to occur, a dense mesh area was defined, covering the full height of the web, with an element size of 1.3cm (0.5 in.), while at midspan, the element size was set to 5.1 cm (2 in) (Tzortzinis et al., 2021). To accurately simulate the experimentally observed behavior of the bearing area of the I-beam, strain rosettes installed near the support revealed reaction force development along the entire bearing length. The reaction was progressively concentrated towards the inner bearing edge as uplift occurred at the outer edge for increasing applied load. Both the bearing plate and girder were simulated with shell elements in contact in the finite element model (Tzortzinis et al., 2021).

### 2.1.5 Material Properties

Material properties are very important for the accurate simulation of structures' response evaluated through finite element analysis (FEA). These properties help defining how the material will behave under different types of loading, such as tension, compression, bending, and shear. Inaccurate or

incomplete material data can lead to inaccurate FEA results, resulting in designs that are not structurally sound or do not meet the desired performance criteria. Therefore, obtaining accurate and representative material properties is essential for ensuring the reliability and safety of the structures being analyzed.

There are different procedures for obtaining material properties, and the appropriate method depends on the type of material being tested and the desired properties. In the studies reported by Tzortzinis et al., (2021), the steel material properties were determined by performing tensile tests on coupons extracted from the specimens in accordance with ASTM Standard E8. For the experiment, it was ensured that the specimens were constructed during the same period, making the specimens representative. Based on the experimentally obtained stress-strain relationship for the web and flanges, simplified backbone curves were formulated (Fig. 2-18) by defining several linear branches for the deteriorated specimens (Tzortzinis et al., 2021).

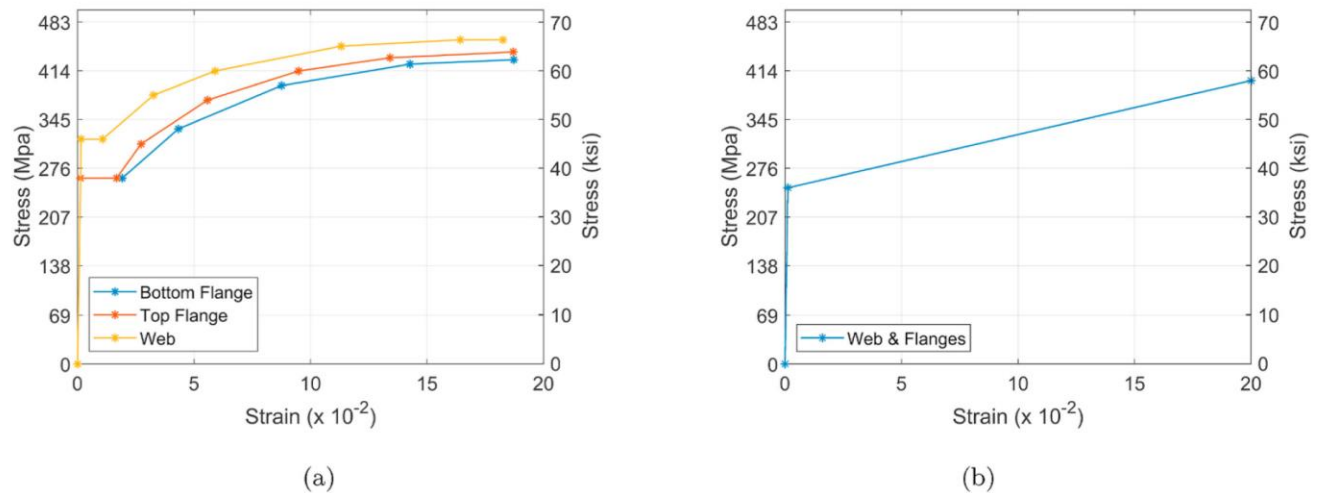


Figure 2- 18: Stress strain curves of tested coupons considered for the finite element analysis (Tzortzinis et al., 2021)

The graph in blue, labeled as "(b) Web & Flanges," represents the stress-strain relationship for combined web and flange components of a structural element. However, from the image alone, there is no explicit information provided about whether the material properties, such as stress and strain, are independent of the corrosion level. Typically, the impact of corrosion on material properties is a critical aspect of structural engineering analysis, especially for infrastructure such

as bridges. If corrosion were a factor, it could significantly affect the material's stress-strain behavior, as corrosion can reduce cross-sectional area, alter the material's ductility, and introduce stress concentrations. However, since the graph does not provide any details on corrosion or its levels, we cannot determine from this image alone whether the material properties depicted in the graph have been influenced by corrosion or if they are considered to be in a non-corroded state.

The coupon testing showed a discrepancy in the yield and ultimate stresses of the steel at the web and flange, which was attributed to the manufacturing process of the W sections at that time. However, the curves for the top and bottom flange were found to be similar, and thus the results were considered satisfactory (Tzortzinis et al., 2021). The material was modeled as an isotropic bilinear model with hardening, with a Young's Modulus of 200GPa (29.000ksi), a Poisson's ratio of 0.27, and the Von Mises yield condition applied. The yield stress was found to be 317MPa (46ksi) and 262MPa (38ksi) at 0.2% of strain for the web and flanges, respectively (Tzortzinis et al., 2021). Ahn et al., (2014) found similar properties after their tensile test. The material properties of the steel web were determined through tensile strength tests, which showed a nominal yield stress of 359MPa, Young's Modulus of 206 000MPa, and Poisson's ratio of 0.3.

Other methods, such as fatigue testing, creep testing, and hardness testing, can be used to evaluate the material's resistance to repeated loading, high-temperature deformation, and surface hardness, respectively (Luo et al., 2017). The FEA models utilized creep model parameters, which can be found in Table 2-4. Additionally, the Young's modulus and Poisson's ratio of the steel plate were 210 GPa and 0.3, respectively (Luo et al., 2017).

*Table 2- 4: Creep model properties for FEA (Luo et al., 2017)*

| Mixture | Test condition                |                  | Nonlinear creep model parameters |       |        |
|---------|-------------------------------|------------------|----------------------------------|-------|--------|
|         | Horizontal shear stress (kPa) | Temperature (°C) | $A$                              | $m$   | $n$    |
| GA      | 70, 100, 130                  | 60               | $3.26 \times 10^{PPPPPP-9}$      | 1.064 | -0.713 |
| EA      |                               |                  | $3.00 \times 10^{PPPPPP-5}$      | 0.026 | -0.815 |
| SMA     |                               |                  | $2.51 \times 10^{PPPPPP-10}$     | 1.132 | -0.763 |

### **2.1.6 Main Results from Corrosion Review**

Understanding how corrosion affects bridge steel decks is necessary in maintaining the structural integrity and safety of bridges. Corrosion can lead to a variety of failure modes, such as reduced shear capacity, increased deformation, and decreased load carrying capacity. Additionally, corrosion can create a significant effect on the geometry of the element cross-section. They can significantly impact the behavior of steel decks under load. For example, the presence of holes in the deck can create stress concentration points, leading to a localized yielding and eventually fracture, which is also introduced in this section.

#### **A. Failure Modes**

Understanding the failure modes of a structural component or system is of utmost importance in ensuring the safety of the entire bridge system. Identifying the failure modes allows engineers and designers to assess the potential consequences of structural collapse and to implement appropriate measures to prevent or mitigate them. In the presence of corrosion, understanding the failure modes is crucial to assess the impact of corrosion on the structural members. Identifying the failure mode enables us to determine how the corrosion has affected the structural members, thereby helping to assess the degree of damage caused.

The deformed shape of corroded beams is influenced primarily by the dimensions of the corroded area and the extent of thickness reduction. Based on the failure modes observed in the study reported by Tzortizinis (2021), it was concluded that damages characterized by section loss beyond 65% of the T-web tend to result in local failure at the base of the web. On the other hand, when there is increased remaining material, a half-buckling wave develops along the entire depth of the beam. The study did not clarify whether local yielding triggered instability or not. In general, the failures were classified into two categories: buckling and crippling phenomena, as presented in Figure 2-19.



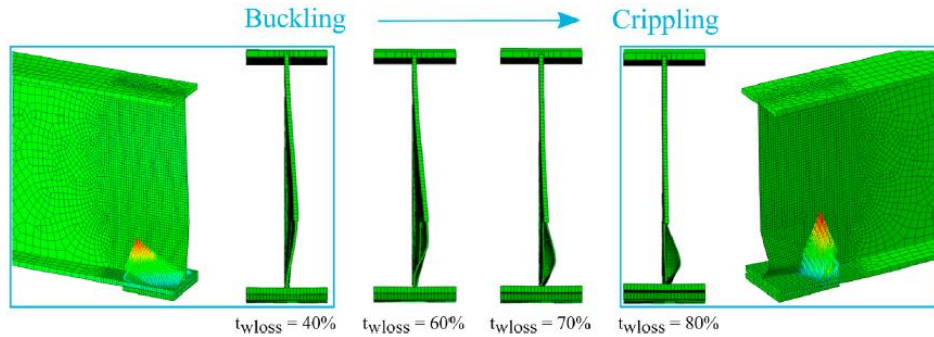


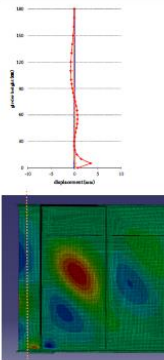
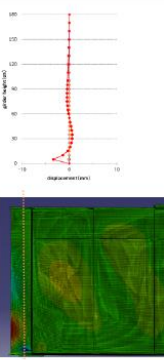
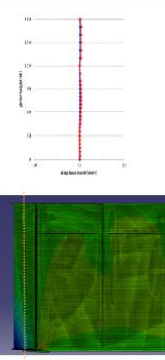
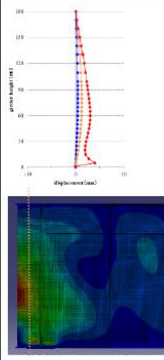
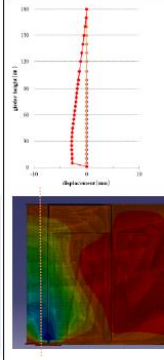
Figure 2- 19: Failure mode (buckling to crippling) (Tzortzinis, 2021)

An intriguing finding from the analysis was the apparent contradiction of increasing capacity for higher material losses, which was observed only when the corrosion length did not extend beyond the bearing length (Figure 2-19). The reduced bending stiffness in combination with the imperfect geometry leads to progressively increasing lateral displacements and uplift along the slender corroded area. This uplift resulted in the concentration of reaction forces at the inner bearing edge, where the web did not experience any loss, providing additional strength to resist loads. Finally, even when the corroded section underwent significant lateral deformation, buckling occurred only when the intact element failed.

Tzortzinis et al., (2021), conducted a study where corrosion was modeled in I-beams with two different heights, 25% and 45% of the web thickness. The findings revealed that the structural capacity of the I-beams tends to stabilize for both corrosion heights when the amplitude of imperfection is approximately equal to one time the web thickness. This phenomenon occurs specifically when the thickness reduction exceeds 60% of T-web. However, in cases with higher remaining material (thickness loss of the web at either 25% or 45% of the web thickness), imperfections emerge as the primary cause of failure load. To clarify, the "amplitude of imperfection" refers to the extent of deviation or irregularity in the beam's shape, and the study suggests that stability is reached when this imperfection reaches a certain magnitude in relation to the web thickness.

Usukara et al. (2014) performed an in-depth investigation to understand the failure modes for the girder ends affected by corrosion and they have identified five distinct types of collapse mechanisms in presence of corrosion damages (Table 2-5), as detailed below.

Table 2- 5: Collapse mechanisms for end girders (Usukura et al., 2014)

|                     | Type1                                                                             | Type2                                                                             | Type 3                                                                            | Type 4                                                                             | Type 5                                                                              |
|---------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
|                     | Coupled buckling<br>(symmetrical mode)                                            | Coupled buckling<br>(web-asymmetrical<br>mode)                                    | Local buckling                                                                    | Coupled buckling<br>(stiffener-asymmetrical<br>mode)                               | Overall buckling                                                                    |
| deformation         |  |  |  |  |  |
| Shear<br>buckling   | ○                                                                                 | ○                                                                                 | —                                                                                 | —                                                                                  | —                                                                                   |
| Local<br>buckling   | ○                                                                                 | ○                                                                                 | ○                                                                                 | ○                                                                                  | —                                                                                   |
| Overall<br>buckling | ○                                                                                 | ○                                                                                 | —                                                                                 | ○                                                                                  | ○                                                                                   |
| case                | Base model                                                                        | Web-deficient<br>• Span Side1,2, 3,4<br>• End Side1,2,3                           | Web-deficient<br>• End Side4                                                      | Stiffener-deficient<br>One side                                                    | Stiffener-deficient<br>Both sides                                                   |

When considering the base model and web-deficient cases, as presented in Table 2-5, it is noteworthy to mention that the shear buckling was initially observed at the span side web panel, followed by local buckling at the bottom of the end side web panel. As the out-of-plane deformation of the "end side web panel" increases, the column on the support, which comprises two stiffeners and the web panel, collapses with coupled buckling (Type 1 & 2). Although the base model's out-of-plane deformation occurs at the entire height of the girder, the web-deficient cases experience this deformation solely in the lower half of the girder. The greater the reduction of the web panel's cross-section, the less the deformation by shear buckling at the span side web panel was measured. Moreover, in the Type 2 category, out-of-plane deformation of the span side web panel is visible at the maximum strength level due to the out-of-plane deformation of the end side web panel. However, for the web-deficient case (end side 4), local buckling only occurs at the bottom of the end side web panel, and no shear buckling takes place. In contrast, stiffener-deficient cases experienced a different collapse mode. In this situation, out-of-plane deformation occurs on both sides of the web panel, and an overall buckling of the column on the support takes place

without a shear buckling of the web panel. For the stiffener-deficient case (one side) (Type 4), the overall buckling of the column on the support occurs with local buckling at the bottom of the web panel. Meanwhile, stiffener-deficient case (both sides) (Type 5) collapses due to overall buckling of the web panel without local buckling deformation at the bottom of the web panel (Usukura et al., 2014).

### **B. Shear Capacity**

The shear capacity of steel plate girders is significantly influenced by the extent of corrosion and the remaining thickness of the web material. Parameters such as the spread of corrosion ( $hh$ ) and the residual web thickness ( $t$ ) are crucial in determining both the shear strength and potential failure modes of the structure. When corrosion is extensive and the web thickness is substantially reduced, the shear capacity is notably compromised, leading to a shift in the failure mode from what is typically a post-buckling scenario to one dominated by shear yielding. This phenomenon has been documented in Liu's study from 2011. Further scrutiny of Figure 2-20 reveals that the degradation in shear strength due to corrosion is not uniform but rather depends on the specific shape of the corroded area and the relative amount of sectional loss experienced. This suggests that the impact of corrosion on structural integrity is multifaceted, with the pattern and severity of corrosion playing integral roles in the remaining load-bearing capacity of the girder.

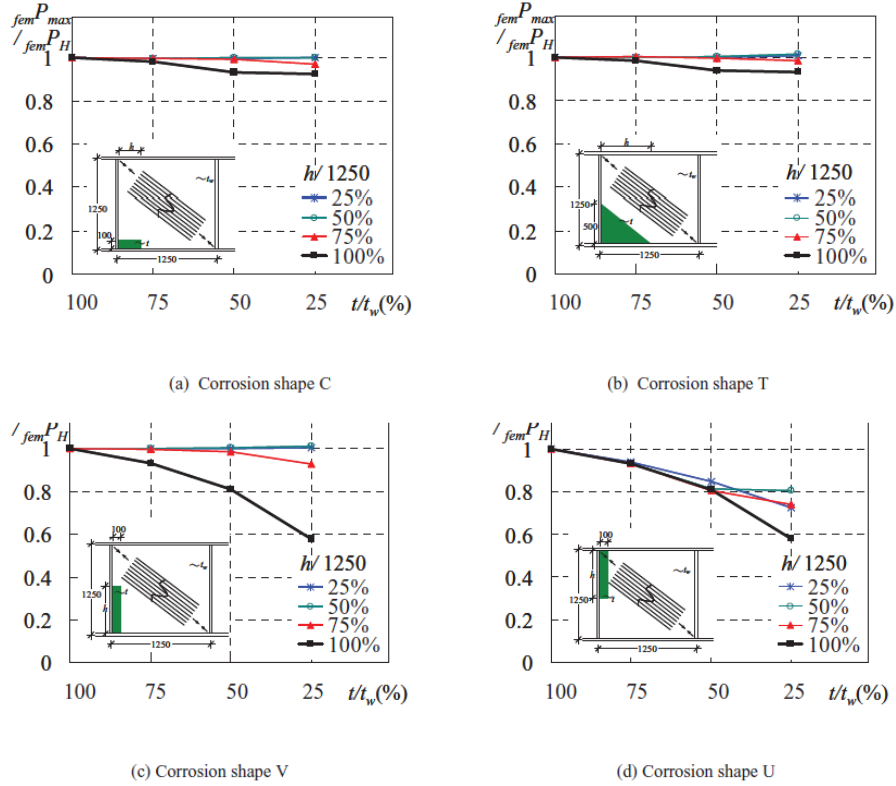


Figure 2- 20: The relationship of remaining load and rates of thickness reduction (Liu, 2011)

The critical parts of the end panels were damaged in the case of plate girders with U-shaped corrosion, Figure 2-20 (d) which led to a greater extent of decrease in shear capacity with progressing local corrosion (Liu, 2011).

Apart from the effect of local corrosion on shear capacity, the shear strength of the supporting point web plate is also an important factor to consider. Based on the analysis of Fig. 2-21, it was found that the average plate thickness reduction ratio and the shear buckling strength ratio are approximately proportional for the supporting point web plate. Therefore, by determining the average plate thickness reduction ratio, it is possible to estimate the shear strength of the supporting point web plate (Sugimoto et al., 2006).

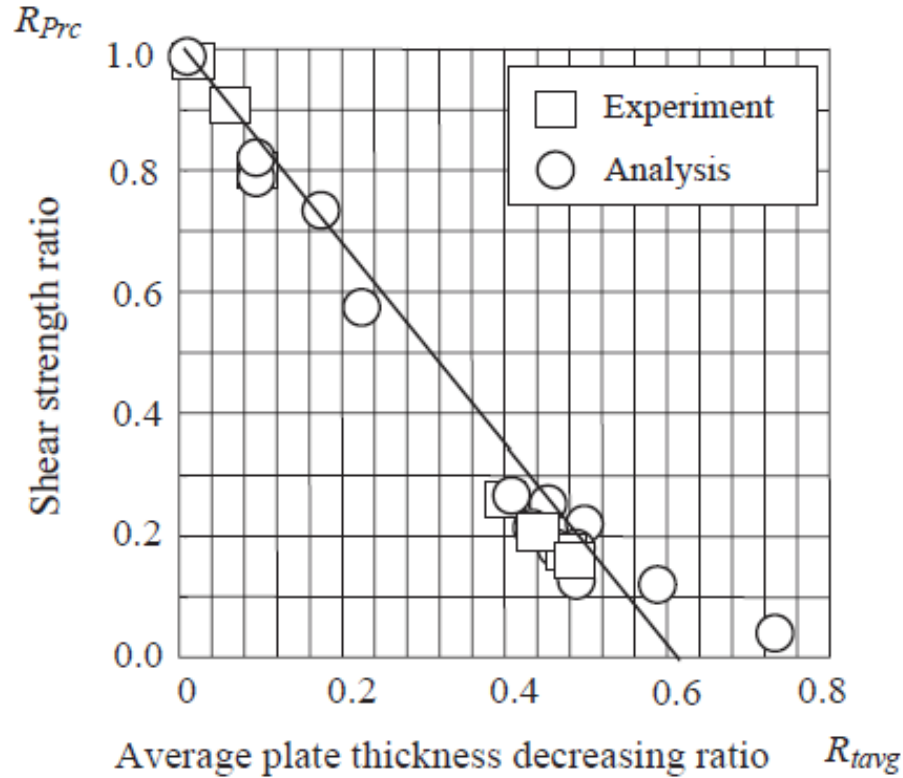


Figure 2- 21: Relation between shear buckling strength ratio and average thickness decreasing ratio (Sugimoto et al., 2006)

The deterioration of shear capacity and the underdeveloped tension field action were observed along with progressing local corrosion. For example, model Uh100t25 was unable to form tension fields in the end panels, because shear yield became dominant due to local corrosion. Similarly, for the girder with corrosion shape U, the collapse mode may be shifted to shear yield, causing shear capacity to largely deteriorate. Local corrosions not only cause the underdeveloped tension field action but also affect the shear capacity in the end panels (Liu, 2011). A pronounced shear bending shape of the corroded web section at the corroded-uncorroded section limit also appeared, and the shape became wider and larger with reducing corroded web thickness. This tendency appeared regardless of the boundary condition (Ahn et al., 2014).

In Figure 2-22, a comparison of the residual shear strength among various FE models is presented. The calculated critical shear buckling load and shear strength values consistently appeared smaller than the results obtained through FE analysis, indicating a conservative approach in the comparisons. This pattern persisted when considering the web panel with local corrosion, where

the calculated shear strength values were consistently smaller than those derived from FE analysis for the locally corroded lower web. This implies that, in the absence of local corrosion in FE models, the shear capacity might be overestimated, aligning with the principle that design equations tend to err on the conservative side (Ahn et al., 2014).

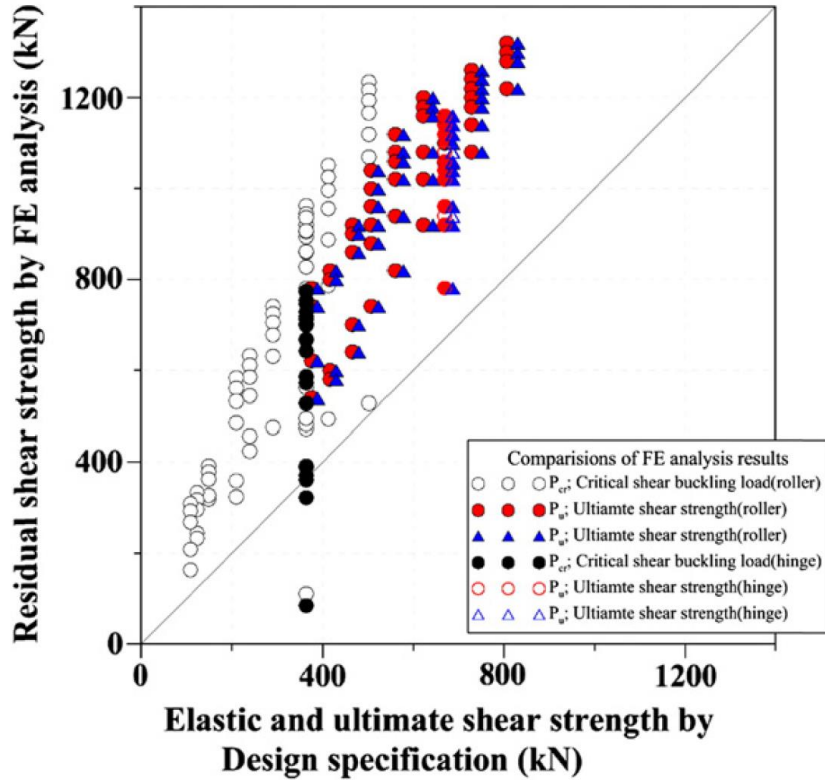


Figure 2- 22: Comparison of FE analysis results with results obtained using shear strength equations (Ahn et al., 2014)

Figure 2-22 presents a side-by-side comparison of the outcomes from finite element (FE) analysis and the shear strength equations proposed by Ahn et al. (2014). This comparison focuses on the residual shear strength of structures, considering both elastic and ultimate shear strength scenarios. The graph illustrates various conditions or types of loading, such as those involving roller or hinge supports. Additionally, it distinguishes between the critical shear buckling load and the ultimate shear strength, offering a comprehensive view of the structural capabilities under different scenarios.

Overall, the underdeveloped tension field action, the shifted collapse model, and the pronounced shear bending shape of the corroded web section all contribute to the deterioration of shear capacity due to local corrosion. Therefore, it is essential to consider these factors in assessing the safety of corroded steel girders. The comparison of the FE analysis results with the calculated critical shear buckling load and shear strength values can also help to identify the potential errors in estimating the residual shear capacity of corroded steel girders (Ahn et al., 2014).

### **C. Deformation**

Corrosion can have a significant impact on the deformation behavior of a structural member. Corrosion often leads to a reduction in the effective cross-sectional area of the member, which can result in reduced stiffness and strength. This reduction in stiffness can lead to an increase in deflection, which can cause additional stress on the member and potentially result in further deformation or failure. Additionally, corrosion can result in localized thinning of the member, which can lead to buckling or collapse under axial or bending loads.

A test on a web was performed (Sugimoto et al., 2006) and as Figure 2-23 clearly shows, the center of the web plate underwent buckling and out-of-plane deformation during the test. Also, the extent of this deformation as load was applied in the direction of the cross section can be observed in Figure 2-24. This figure demonstrates how the center of the web plate gradually shifts out of plane as the load increases (Sugimoto et al., 2006).

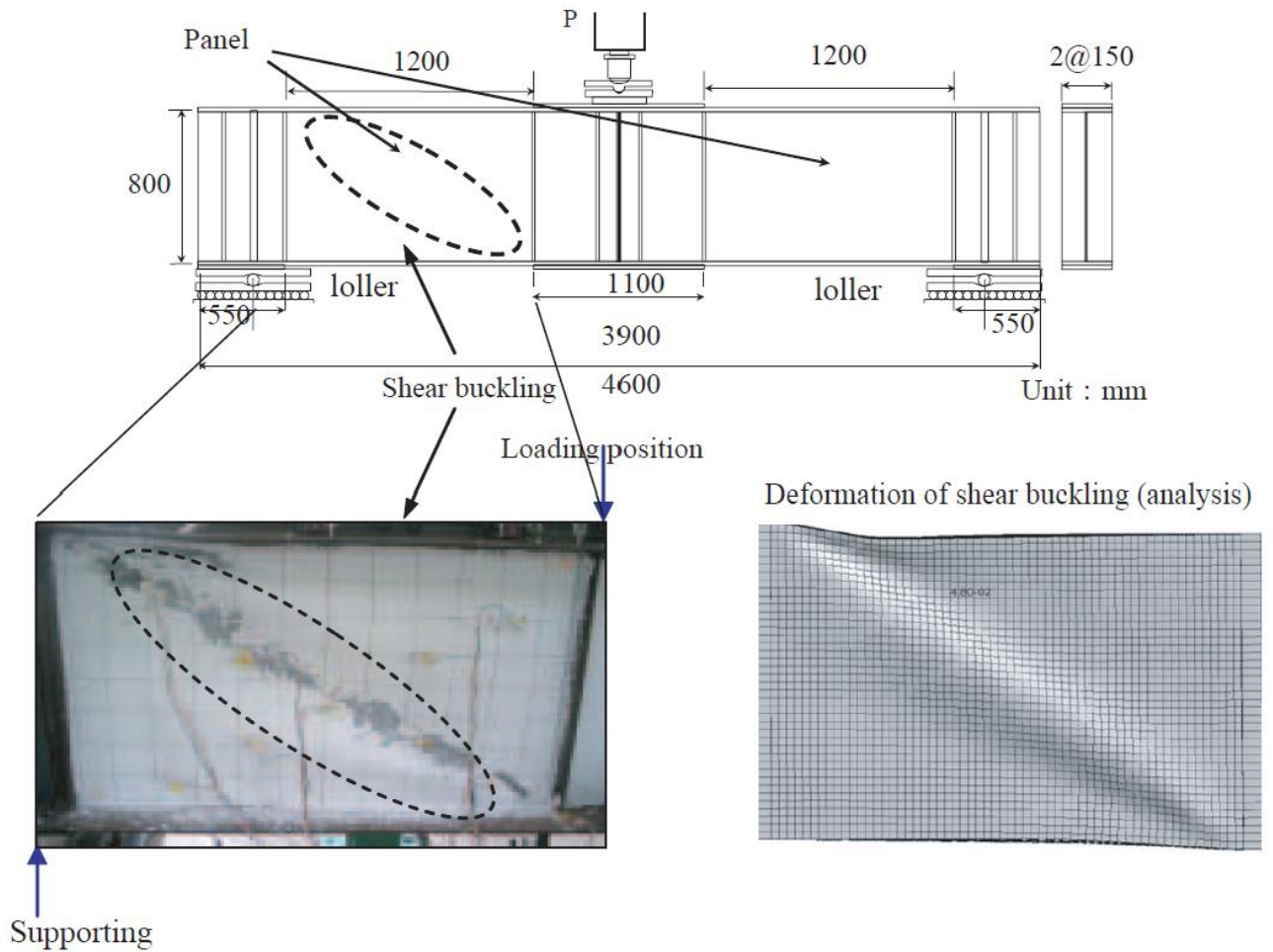


Figure 2- 23: Test specimen and result of out of plane deformation (Sugimoto et al., 2006)



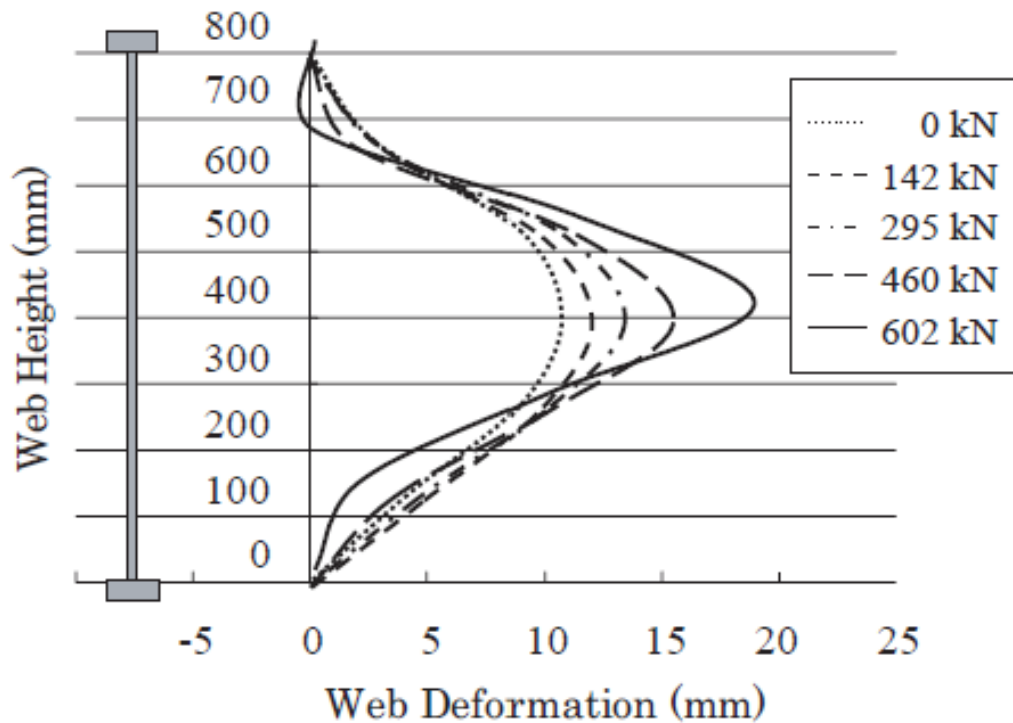


Figure 2- 24: Out of plane deformation in shear strength test (Sugimoto et al., 2006)

Kim et al., (2012), also observed that after reaching the critical shear buckling load, the lateral displacement at the center of the web panel in all specimens was greater than that at other positions. Additionally, this displacement was found to be dependent on the applied load level.

The same phenomenon is noticed when the results of a couple of the specimens (referring to section 2.1.1 corroded specimens) are analyzed (Tzortzinis, 2021):

- Specimen 1: In the case of Specimen 1, the web panel's lateral deformation was observed to concentrate near the bottom. The test was halted when the top flange was on the verge of losing contact with the lateral support, and at that point, the vertical deflection had reached nearly 50.8 mm. The failure mode was primarily influenced by the initial imperfection of the web panel. This suggests that the behavior and failure mode of the web panel are highly dependent on the initial imperfections and deformations that may exist in the panel before testing.
- Specimen 2: It is important to mention that in comparison to Specimen 1, the uplift of the bottom flange was notably higher throughout the entire experiment. The experiment was

concluded when the lateral support had reached its limit, at which point the vertical deflection was approximately 71 mm.

- Specimen 5: The failure of the specimen was mainly controlled by the extensive damage observed at the corroded end of the beam, which included corrosion and holes. As the bearing load reached 137.5 kN (30.9 kip), a brittle failure occurred at the narrow material strips with a width of 38 mm (1.5 in.) each, located at the outer web part as shown in Fig. 2-7 a). The web panel uniformly translated out of plane during the failure.

(Tzortzinis, 2021)

Regardless of the boundary condition, the tensile field shape of the corroded web tended to slope downward as the web thickness decreased. Additionally, the out-of-plane displacements of the support with corrosion, characterized by a hinge boundary condition, were more pronounced and larger compared to the support without corrosion, represented by a roller boundary condition. This phenomenon occurs because the longitudinal displacement of the web is restricted, resulting in greater out-of-plane displacement than in the roller boundary condition (Ahn et al., 2014). The behavior of web panels under loading conditions can be affected by corrosion. In the case of an uncorroded web panel, the diagonal tension field typically causes out-of-plane displacement, providing resistance against shear buckling caused by the loss of web thickness and the lack of a shear-resistant section. The web experiences deformation visible to the eyes. However, when the web panel is locally corroded with triangular corrosion, the out-of-plane displacements of all FE analysis models were found to be similar to those of the uncorroded web panel, regardless of the corrosion height and depth, and boundary conditions. This suggests that the presence of corrosion may not significantly impact the out-of-plane displacement behavior of the web panel (Ahn, 2015).

#### **D. Geometry imperfection**

Corrosion led to various forms of damage, including geometry imperfections. When a metal surface is exposed to a corrosive environment, it will gradually degrade and lose material. This loss of material results in formations of irregularities on the surfaces, such as pits, cracks, or holes. These imperfections can affect the overall geometry of the structure, making it weaker, less stable, or more prone to failure. There are two main types of geometry imperfections that can result from

corrosion: the first is the corroded area, which is a localized region on the surface that has suffered corrosion damage, resulting in a loss of material and a change in shape. Tzortzinis et al., (2021) performed a study to investigate how corrosion affects the strengths of metal I-beams. The results demonstrate a clear correlation between the extent of corrosion and the girder's residual strength.

The investigation explores how the corrosion level in a cable-stayed bridge's girder impacts its residual strength. 'Extent of corrosion' refers to both the spread of corrosion along the girder and the depth of corrosion penetration. Residual strength is the girder's reduced ability to bear loads after corrosion damage. A key finding is that when corrosion length exceeds the critical 'bearing length' by 1.1 times, further corrosion has minimal impact on the load-bearing capacity. This 'bearing length' is essential for load support, indicating that corrosion beyond this point is less critical for structural integrity.

Moreover, Tzortzinis et al., (2021) also examines the effects of corrosion on beams with an initial defect termed " $1 t_{web}$ " where  $t_{web}$  is the thickness of the flange. The research highlights that when the vertical extent of corrosion surpasses 30% of the flange simulated depth 'dn', the loss of material thickness becomes a more crucial factor than the height of corrosion in determining the beam's structural strength. This suggests that beyond the threshold of 30%, the material thickness loss due to corrosion is the predominant factor affecting the beam's capacity.

In other words, when the corrosion is in a part of the beam that's longer than the part that holds it up, it can make the beam weaker quickly. However, when the corrosion is in a part of the beam that's shorter than the part that holds it up, it can take longer to weaken the beam (Tzortzinis, 2021). The second type of imperfection is the holes, which are often caused by localized corrosion, and can weaken the structure by reducing its cross-sectional area. The same group of researchers conducted an analysis to examine the impact of the hole length and hole height on the capacity of a deteriorated beam. The analysis was performed with an imperfection amplitude of 1 T-web, and to simulate the bearing area of a deteriorated beam, a hole was introduced along with a 20% material reduction in an area with corrosion height of 30% dn and corrosion length of 2.1 times the bearing length 25.4 cm. The results, shown in Figure 2-25, reveal a significant correlation between the effect of hole height and hole length on the capacity of the beam.

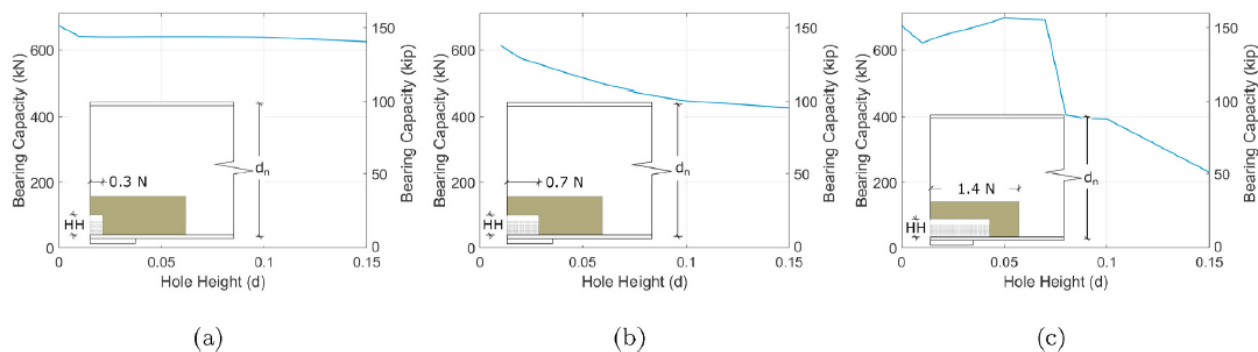


Figure 2- 25: Effect of holes' dimension to bearing capacity (Tzortzinis, 2021)

Interestingly, if an area with 100% section loss is limited above the outer edge of the bearing, it has no significant effect on the capacity regardless of its height (Fig. 2-25 a)). However, if the hole extends close to the inner bearing edge (Fig. 2-25 b)), the capacity tends to plateau. For the case where the hole extends beyond the bearing length, a counterintuitive behavior of increasing capacity for bigger holes is observed, attributed to the web bearing on the flange. Ultimately, a sudden capacity drop is observed, which is correlated to the web failure above the inner hole boundaries. It is important to note that the current procedures indicate zero nominal capacity for the scenarios presented in Figure 2-25 (c). However, the current work reveals that even in the worst-case scenario, up to a third of the capacity corresponding to the non-hole geometry can be developed. This failure mechanism can be observed under the condition of extensive downwards translation of the top flange, but it is controversial whether this condition is realistic for in-service girders due to the additional stiffness emerging from the deck and potential diaphragm existence. Moreover, even if it is realistic, extensive deformation may result in serviceability issues (Tzortzinis, 2021).

## 2.2 Cracks formed in Steel Elements

The presence of penetrating cracks in steel bridge decks poses a serious threat to their structural integrity and service life. It has been observed that cracks with flatter initial shape have a shorter fatigue life and grow faster. This underscores the importance of timely detection of cracks in orthotropic steel deck (OSD) and implementation of measures to prevent further crack propagation. Unfortunately, OSD cracks are often detected only when the fatigue cracks have

already penetrated the deck and caused damage to the waterproof layer and pavement (Zhuang et al., 2021). Fatigue cracks in orthotropic steel bridge decks typically originate from the weld root and propagate towards the deck plate, demonstrated in Fig. 2-26. Root cracks in U-rib-to-deck connections, weld toe cracks of the deck plate at the rib-to-cross beam connection, and cracks near fillet weld toes, are commonly observed damage types in orthotropic steel bridges. Partial-penetration fillet-welded connections are particularly susceptible to fatigue cracks due to the cyclic load stress caused by high volumes of vehicles (Zhuang et al., 2021).

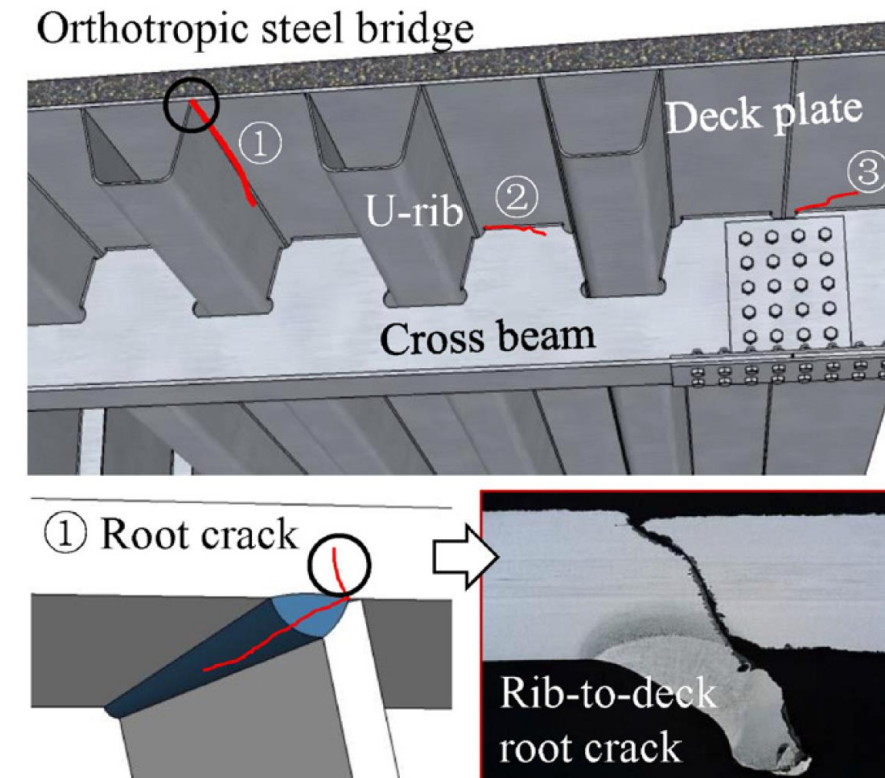


Figure 2- 26: Typical fatigue cracks in OSD (Kainumu et al., 2017)

To mitigate corrosion of orthotropic steel bridge deck members, a waterproofing layer is applied to the deck surface. However, as it can be seen in Fig. 2-27, severe corrosion can lead to decreased deck plate thickness, causing fatigue cracks at the deck-rib-welded connection (Jeong et al., 2019).

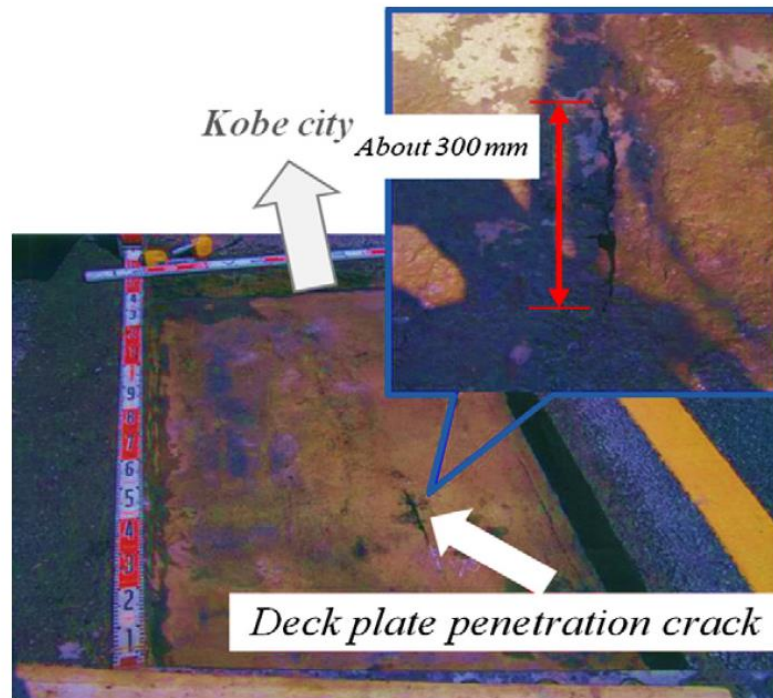


Figure 2- 27: Fatigue crack on corroded deck surface of OSD (Jeong et al., 2019)

The rib-to-deck structure, which utilizes many single-fillet weld joints due to the wide use of U-ribs, is particularly prone to root cracks between the deck plate and U-rib. This is due to inadequate welding details, residual stress from the welding process, and unfavorable weld shape (Kainuma et al., 2017).

In conclusion, detecting and preventing cracks in OSD, particularly penetrating cracks, is critical to preserving the structural integrity and service life of steel bridge decks.

### 2.2.1 Types of Cracks

In structural engineering, fatigue cracks in welded components are a common occurrence and can cause significant damage to a structure if left unchecked. Typically cracks originate from the weld root and propagate along the direction of the deck or rib. There are four types of cracks (Zhuang et al., 2021): A, B, C, and D, with quarter-elliptical and semi-elliptical cracks (A and B) from the deck corner and deck surface being particularly harmful for deck-to-rib welded details (Figs. 2-28 and 2-29).

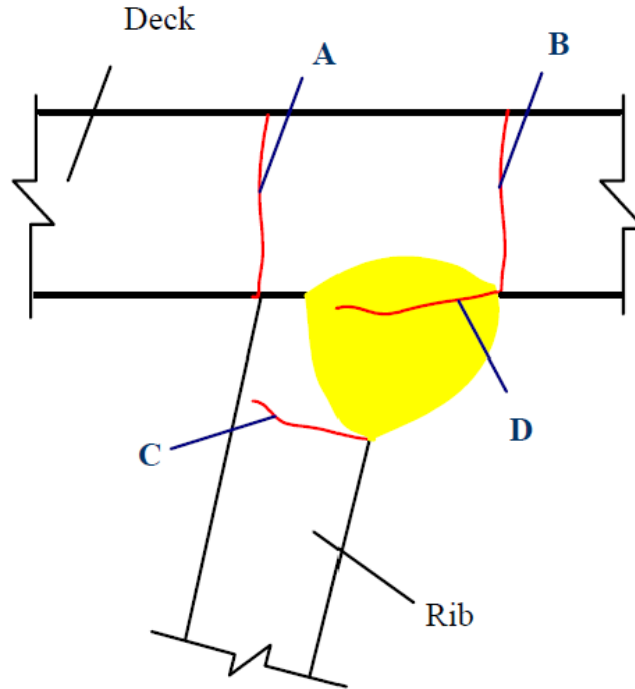


Figure 2- 28: Typical fatigue cracks (Zhuang et al., 2021)

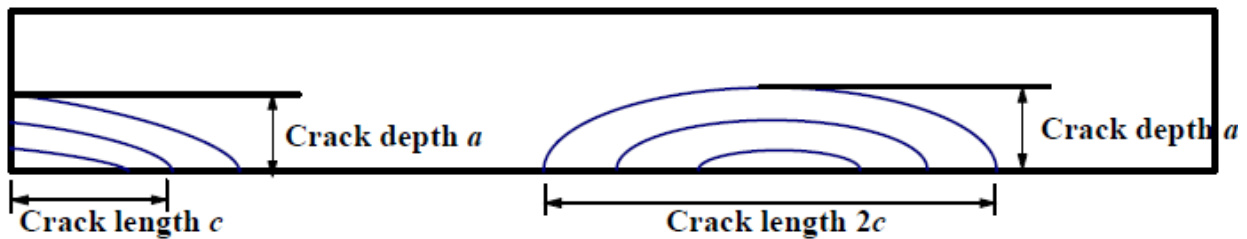


Figure 2- 29: Diagram of quarter-elliptical and elliptical (Zhuang et al., 2021)

Other researchers (Kainuma et al., 2017) have also reported the same type of cracks when conducting experiments to study the behavior of fatigue cracks in these structures; three types of cracks were identified:

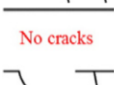
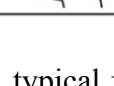
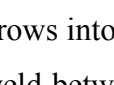
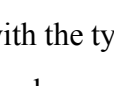
1. Only root cracks
2. Toe cracks and root cracks

These crack patterns, detailed in Table 2-6, provide insights into the correlation between stress conditions and the length of cracks in the material, different types of cracks, showing various specimens categorized by the presence and type of cracks, such as "Root crack only", "Toe and root cracks", and "No cracks". The columns under "Crack length" are labeled  $a_r$  and  $a_t$ , which stand for the root crack length and toe crack length, respectively. In more detail:

- $a_r$  is the length of the root crack, which is the part of the crack that initiates at the weld root or the point where the welding starts to penetrate the material. Root cracks often occur at the start of the weld and can propagate with stress.
- $a_t$  represent the length of the toe crack, which is the part of the crack that initiates at the "toe" of the weld, where the weld metal and the base metal meet. Toe cracks are common in welded structures and can be critical in terms of structural integrity.

The difference between these two measurements,  $a_r$  and  $a_t$  would be the location at which the crack lengths are measured.  $a_r$  measures how far the crack has penetrated from the weld root into the material, while  $a_t$  measures the crack length from the toe of the weld into the material.

*Table 2- 6: Relationship between stress and crack length (Kainuma et al., 2017)*

| Crack types                                                                                                                                                                                                                                                       | Category            | No.     | Tensile stress (MPa)                 | Stress range (MPa) | Crack length |            |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------|--------------------------------------|--------------------|--------------|------------|
|                                                                                                                                                                                                                                                                   |                     |         |                                      |                    | $a_r$ (mm)   | $a_t$ (mm) |
| <br>                                                                                         | Root crack only     | SP0-1   | 20                                   | 180                | 3.2          | –          |
|                                                                                                                                                                                                                                                                   |                     | SP0-4   | 40                                   | 180                | 5.4          |            |
|                                                                                                                                                                                                                                                                   |                     | SP75-1  | 20                                   | 180                | 1.5          |            |
|                                                                                                                                                                                                                                                                   |                     | SP75-2  | 20                                   | 120                | 2.7          |            |
|                                                                                                                                                                                                                                                                   |                     | SP100-2 | 40                                   | 180                | 6            |            |
| <br>                                                                                        | Toe and root cracks | SP100-3 | (+ 300Single)<br>40<br>(+ 600Single) | 180                | 6.1          |            |
|                                                                                                                                                                                                                                                                   |                     | SP75-3  | 40                                   | 180                | 3.2          | 4.5        |
|                                                                                                                                                                                                                                                                   |                     | SP75-5  | 40                                   | 180                | 4.6          | 5.7        |
| <br><br> | No crack            | SP100-1 | 40                                   | 180                | 2.5          | 3.5        |
|                                                                                                                                                                                                                                                                   |                     | SP0-2   | 20                                   | 120                | –            | –          |
|                                                                                                                                                                                                                                                                   |                     | SP0-3   | 20                                   | 90                 |              |            |
|                                                                                                                                                                                                                                                                   |                     | SP75-4  | 0                                    | 180                |              |            |

A typical fatigue crack initiates at the root of the weld between the deck plate and stringer and grows into the deck plate. This deck plate crack is unique in that it originates from the root of the weld between the stringer and the deck, and then spreads into the deck plate. This is in contrast with the typical fatigue cracks that grow through the weld from the root. Additionally, this type of crack occurs under bending loads, with the initiation point experiencing compression from wheel loading (Maljaars et al., 2016). While the fatigue crack paths were nearly perpendicular to the depth of deck plate, the root cracks in this study were not entirely perpendicular to the deck plate due to varying deck plate thickness and boundary conditions.



The passage describes the behavior of fatigue cracks in the context of orthotropic steel bridge decks under bending loads. According to Maljaars et al. (2016), such cracks typically initiate at points of compression due to wheel loading, which is often the top surface of the deck plate where bending moments are highest. The term "depth" here refers to the thickness of the deck plate, which is an orthogonal measure from the top surface (where vehicles travel) to the bottom surface (often facing the interior of the bridge). The observation that the fatigue crack paths were almost perpendicular to the deck plate's thickness suggests that they propagate in a direction that is mostly aligned with the height of the deck plate itself. However, Kainuma et al. (2017) found that the root cracks did not follow a perfectly perpendicular path relative to the deck plate. This deviation was attributed to variations in the deck plate thickness and specific boundary conditions, which can influence the stress distribution and, consequently, the crack trajectory.

To clarify, it's important to note that the "root cracks" mentioned initiated at the tip of the weld toe or other stress risers at the root of the welded joint. As the cracks propagate, they tend to move towards a direction that aligns with the principal stress—often vertical to the deck surface indicating that the propagation direction is dictated by the maximum principal stress experienced by the deck. In essence, the cracks start at points of high stress concentration and grow in a direction predominantly dictated by the stress state within the deck plate, which may not always be perfectly vertical due to the complex loading conditions and geometric factors influencing the bridge deck.

### **2.2.2 Cracks' Location**

A study was conducted on steel bridges located on Japan's national roads in Honshu, Skikoku, Kyushu, and other smaller islands connected to those regions. Hokkaido's bridges were not included in the study (Tamakoshi et al., 2015). During the ten-year period from 1994 to 2003, 8,230 bridges on national roads were inspected, accounting for 87.5% of all national road bridges, and 4,304 of them were steel bridges, which make up 52.3% of the inspected bridges. The study focused on the most common types of bridges, non-composite, and composite steel plate girder bridges, and collected data on corrosion, steel cracks, and concrete deck cracks that significantly impact the superstructure.

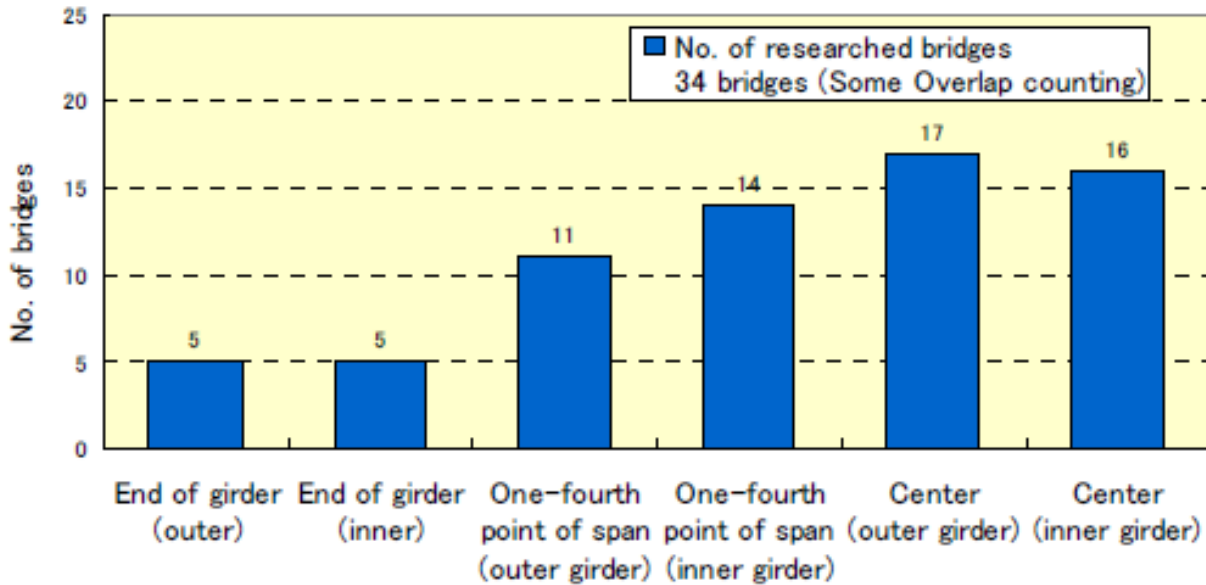


Figure 2- 30: Location of steel cracks on bridges (Tamakoshi et al., 2015)

Tamakoshi et al. (2015) concluded that most of the cracks inspected were located at the following regions of the investigated bridges:

- End of girder: towards the ends of the girders, cracks were relatively low but tended to increase progressively towards the centers of the spans. In terms of transverse cracks, a considerable proportion occurred on the interior girders, although the contrast between exterior and interior girders was not substantial.
- One-fourth point of span: there was only a marginal distinction between the incidence of exterior and interior cracks. Most of the cracks were in the fillet welding between the upper flanges of the main girders and the stiffeners at the connecting parts of the main girders and cross beams, as well as in the main girders and cross frames.
- Center: a total of 33 non-composite-type bridges were found to have cracks at the center of a girder, with 17 exhibiting exterior girder cracks and 16 exhibiting interior girder cracks. The difference between the number of cracks on exterior and interior girders was negligible. Most of these cracks were detected on the fillet welding of the upper flanges of main girders and the stiffeners of connection parts between the main girders and cross beams. The longitudinal distribution of cracks on non-composite plate girder bridges was concentrated near the center of the span, accounting for 73.5% of all cracks observed on the investigated bridges.

### 2.2.3 Main Results from Fatigue Cracks

In steel structures, the presence of cracks can have a significant impact on the performance and integrity of the material. Cracks in steel decks can create stress concentrations that can result in fatigue and deformation. This section will discuss how the presence of cracks in steel decks can lead to these types of failure and the factors that contribute to their development. It will explore the effects of crack depth, the stress created impact on the fatigue life of the structure and the deformation experienced.

#### A. Stress

Fatigue cracks on the deck are a significant concern for the structural integrity of the bridge. The initiation of fatigue cracks from the welding root and extending to the deck is caused by the high stress at the unpenetrated part of the welding root. The shape of the crack is semi-elliptical, and about 87% of the fatigue life is consumed after the crack propagation reaches approximately 75% of the deck thickness (Zhuang et al., 2021).

The local stress concentration developed by the uneven deck plate surface can cause a fatigue crack in the deck plate. Therefore, the local stress distributions of the corroded deck surface were compared based on the corrosion level of the deck surface. The principal stress distribution of the mean corroded surface model showed a uniformly arranged tensile principal stress distribution by negative moment according to the reduction of the sectional properties of the deck plate developed by corrosion. The principal stresses on the mean corroded surface model increased to 12%, 41%, and 95% of the uncorroded deck plate around the U rib and deck plate connection part due to the decrease in the thickness of the deck plate caused by corrosion (Jeong et al., 2019).

The principal stresses also increased depending on the corrosion level of the deck surface, as in the mean corrosion model. Still, its maximum principal stress sharply increased up to 19% of the mean corrosion model. The maximum principal stress was increased in proportion to the corrosion level relationships, regardless of the corroded-surface model, but the change in the corroded-surface model was shown in the regression curves below in Figure 2-31.

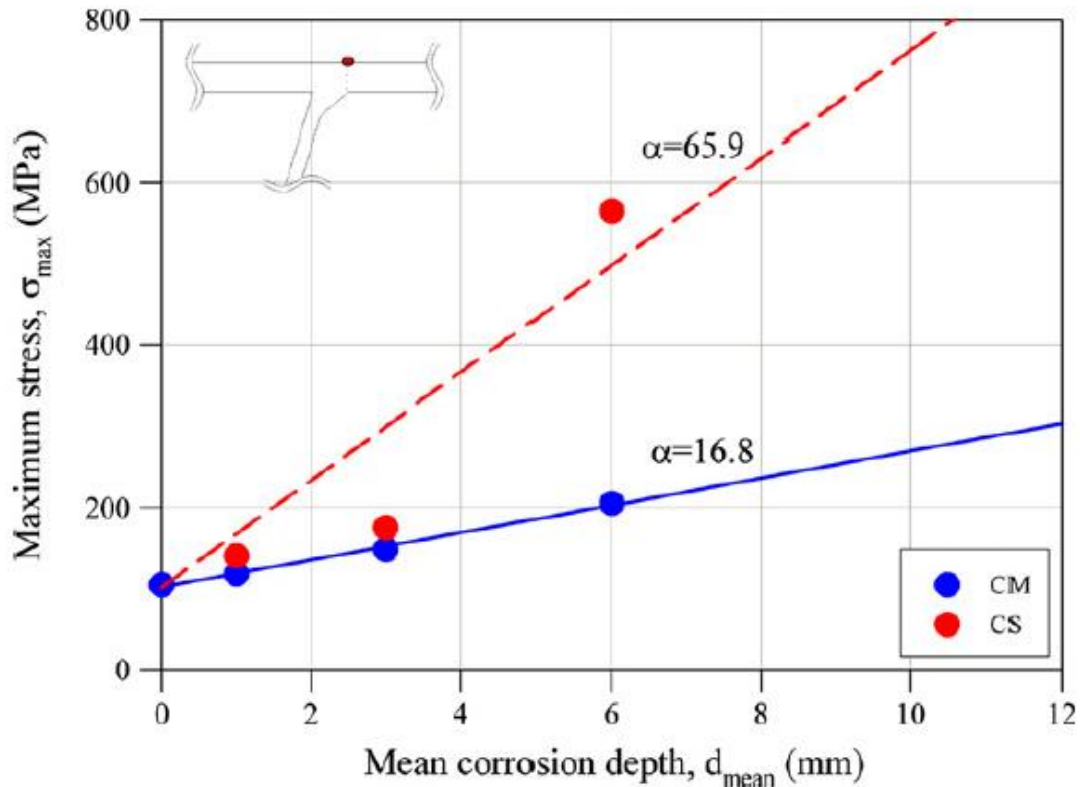


Figure 2- 31: Mean principal stress and mean corrosion depth (Jeong et al., 2019)

The legend in Fig. 2-31 indicates two different data series represented by blue and red dots, labeled CM and CS. These abbreviations stand for “Mean Corroded Surface Model” and “Corroded Surface Model” respectively and correspond to two different finite element models developed by (Jeong et al., 2019). In the case of the corroded surface model, a high stress concentration and stress distribution were shown because of the surface roughness of the corroded deck surface with reduced deck thickness. The stress level exceeded the fatigue limit of stress. Therefore, fatigue crack can occur on the deck surface due to the stress concentration as well as the displacement increased caused by the corroded sectional properties (Jeong et al., 2019).

## B. Fatigue

Overall, the study found that fatigue cracks in orthotropic steel bridge decks can be initiated from various sources, including welding roots, corrosion-induced stress concentration, and even surface

roughness. The following paragraphs will delve into the specific findings of the study, including the comparison of fatigue life calculated by 2D and 3D models, the observation of fatigue reliabilities over time, and the effects of corrosion on fatigue strength.

The fatigue cracks in orthotropic steel bridge decks, can appear due to multiple causes, such as welding roots, stress concentrations due to corrosion and surface roughness. Zhuang et al. (2021) examined the fatigue life of these structures through computational models and they observed the reliability of these decks over time, while considering the impact of corrosion on their strength to fatigue. A comparison between two-dimensional (2D) and three-dimensional (3D) models was performed by Zhuang et al. (2021) and the discrepancies in fatigue life predictions between the two models were highlighted, providing insights into the effect of corrosion on the fatigue strength of bridge components.

### **Comparison 2D and 3D models**

Zhuang et al. (2021) conducted a study to assess fatigue life in materials by comparing the predictive capabilities of two-dimensional (2D) and three-dimensional (3D) modeling approaches. The 2D plane strain model, which simplifies the specimen to a cross-sectional view and assumes zero strain in the length direction, was found to inadequately estimate the fatigue life. This model, due to its assumptions, does not account for out-of-plane stresses, potentially leading to inaccurate stress intensity factors at the crack tip. In contrast, the 3D models, which incorporate the full geometry of the specimen and consider the complex stress states, provide a more comprehensive analysis. These models can more precisely determine the crack's progression under cyclic loads and account for the three-dimensional nature of crack growth. The research indicated that the 2D model's limitation lies in its inability to fully represent the stress concentration at the crack front, leading to an underestimation of the crack growth life. For an in-depth understanding of the distinct differences between these modeling approaches, one would need to examine research, including its foundational assumptions, boundary conditions, meshing strategies, material characteristics, and loading conditions, which collectively explain the discrepancy between the 2D and 3D model outcomes.

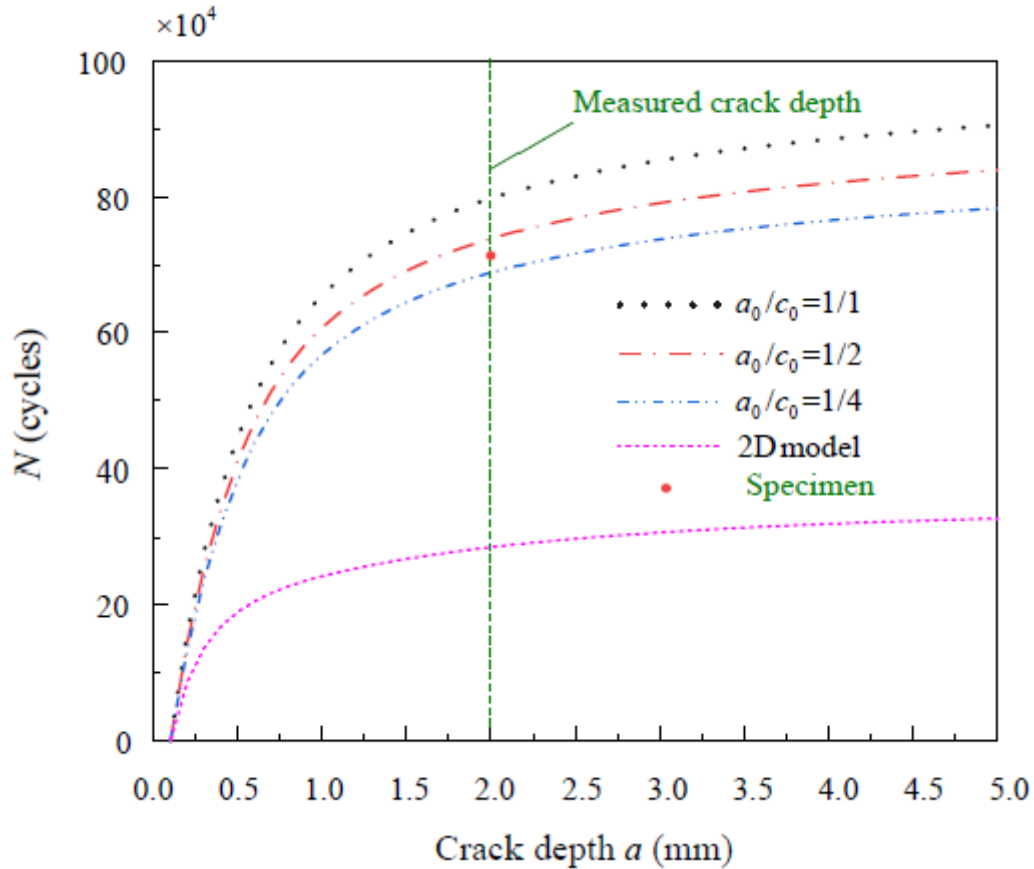


Figure 2- 32: Comparison of the fatigue life of 2D and 3D models (Zhuang et al., 2021)

The relationship between the number of cycles ( $N$ ) and the crack depth ( $a$ ) in millimeters. The ratios ( $a_0/c_0$ ) mentioned in the legend seem to refer to initial crack depth ( $a_0$ ) to some characteristic length ( $c_0$ ), possibly relating to the dimensions of the specimen or a critical structural dimension in the model.

These ratios are likely used to normalize the crack depth to allow comparison across different sizes or different conditions. For example:

$a_0/c = 1/1$  indicates that the initial crack depth is equal to the characteristic length.

$a_0/c_0 = 1/2$  suggests the initial crack depth is half the characteristic length.

$a_0/c_0 = 1/4$  implies the initial crack depth is a quarter of the characteristic length.

These comparisons are crucial for assessing the severity of the crack in relation to the size of the component being studied.

## Reliabilities

The fatigue reliabilities of three welded details were analyzed and compared (Guo et al., 2017).

The results showed that the reliabilities of Weld A decreased rapidly during the first ten to twenty years of service, and the detail was the most vulnerable one among the three details (Fig. 2-33). However, the reliabilities at different positions for the same welded detail were not the same, with details in the middle lane and outer lane having relatively lower reliabilities.

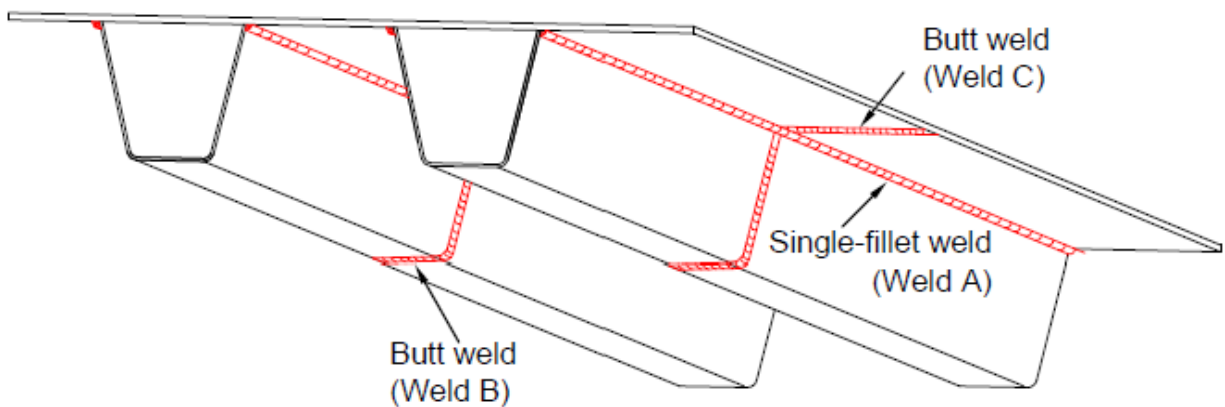


Figure 2- 33: Welded details in OSD (Guo et al., 2017)

## Effect of corrosion on fatigue strength

The full-scale tests conducted by Guo et al. (2017) for the deck plate revealed that fatigue cracks were mostly concentrated at around half of the deck plate thickness. The cracks mostly stopped propagating after reaching the neutral axis of the deck plate thickness. Furthermore, the study found that the fatigue strength of corroded steel plates decreased significantly compared to uncorroded ones due to local-stress concentration caused by uneven surface or pits on the steel surface developed by corrosion and the pit shape. The study also evaluated the stress levels of corroded deck plates using mean and surface corrosion models. The stress levels of the mean corrosion model with 1mm and 3mm corrosion depths were lower than the fatigue limit of stress, as categorized in stress category A. However, the stress level of the mean corrosion model with 6mm corrosion depth exceeded the fatigue limit of stress category A. Similarly, the stress level of the surface corrosion model with 3mm corrosion depth also exceeded the fatigue limit of stress in

category A, as did the surface corrosion model with 6mm corrosion depth. The stress concentration generated by the surface roughness of the corroded deck plate can lead to fatigue crack occurrence.

### **C. Deformation**

Based on the experimental and FE analysis results (Jeong et al., 2019), it was found that the mean corrosion depth has a significant effect on the deformation and displacement of the orthotropic steel bridge deck and the U ribs. Figure 2-34 shows that the deformation of the deck and U rib increases with the increase in the mean corrosion depth (Jeong et al., 2019).





(a) Deck plate 12mm (design depth)



(b) Deck plate 11mm ( $d_{\text{mean}}$ ; 1mm)



(c) Deck plate 9mm ( $d_{\text{mean}}$ ; 3mm)



(d) Deck plate 6mm ( $d_{\text{mean}}$ ; 6mm)

*Figure 2- 34: Deformation shape of OSD (Jeong et al., 2019)*

Furthermore, the torsional deformation of the U rib was also observed to increase due to the reduction of their sectional properties by corrosion, as illustrated in Figure 2-35. These findings suggest that corrosion not only affects the strength but also the stiffness and geometry of the affected elements (Jeong et al., 2019).

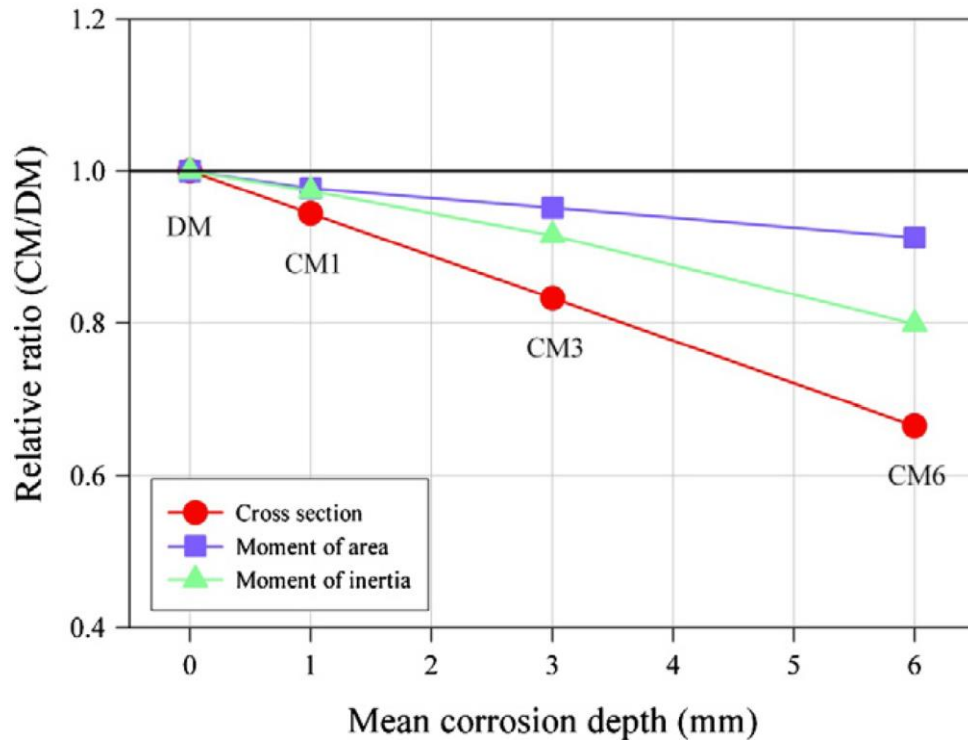


Figure 2- 35: Relative ratio of sectional properties based on uncorroded orthotropic deck (Jeong et al., 2019)

Furthermore, the results obtained from the FE analysis showed that the orthotropic steel bridge deck's displacement increased with the rise in corrosion level, leading to a slight shift towards the U rib. The reduction in the sectional properties due to corrosion was the main reason for this displacement. Additionally, the study analyzed the stress and displacement distributions on the lower surface of the deck along the transverse direction. The findings indicated that the displacement of the deck increased and shifted towards the U rib, depending on the corrosion level (Jeong et al., 2019).

The literature review conducted in Chapter 2 has laid the groundwork for an innovative exploration into the effects of steel deck deterioration on bridge span behavior. A focal point of this research is the application of the finite element method (FEA) to simulate damage scenarios where physical thickness measurements are not possible and developing a novel quantification scale for orthotropic steel deck damages, thus addressing a significant gap in current methodologies. The forthcoming parametric study performed in Chapter 3 will build on the established concept of thickness reduction to gauge the impact of damage for the entire deck of a cable-stayed bridge, a

step beyond the research previously explored in the literature. Moreover, this study will extend the current understanding of corrosion patterns reported for steel beams to the context of stiffeners. Given their design and functional resemblance, this investigation is expected to reveal critical insights into the structural vulnerabilities uniquely determined by the damaged stiffeners. Moreover, the current research will make a distinct contribution by utilizing the local and general corrosion patterns to predict and analyze potential weak points within the orthotropic steel bridge deck.

A critical element of this research will be the investigation of the fundamental damage mechanisms, such as the effect of rib-to-deck root cracks with full penetration, on deck's structural response. A detailed comprehension and quantification of the damage mechanisms, including their precise locations, will be instrumental for performing a segmented analysis of the Stonecutters Bridge main span, enabling a thorough assessment of damaged deck modules and their implications on the overall bridge structural integrity. In summary, the conducted literature review, not only synthesizes existing knowledge, but also clearly delineates the necessity and potential contributions of the current research. By advancing the state-of-the-art in FEA and its application to steel deck and stiffeners damages, this work will provide a significant leap forward in the predictive analysis and maintenance strategies for bridge spans.

## CHAPTER 3 – STEEL DECK DAMAGE MODELLING

A thorough investigation of main types of damages that can occur for bridge steel decks, such as cracks and corrosion of various elements composing the deck, was carried out in the current research, for developing a better understanding of the changes these can trigger in the structural response of the entire suspension bridge system. Through a detailed structural analysis, it is possible to determine the extent of the encountered damage and to assess the potential impact on the structural integrity of the entire bridge.

Initially a parametric study was performed for one damaged deck module (DDM), to gain more comprehensive understanding of the impact the localised structural damage can induce to one deck module, by systematically varying the input parameters and by assessing their effects on the structural response of DDM. The purpose of the parametric study conducted in Chapter 3 is to identify the most important elements of the DDM section and the critical damage levels of these elements, such that when integrated into the main span of the suspension bridge, at different locations, the entire behavior of the bridge can be studied, as presented later in Chapter 4.

The current Chapter introduces two parametric studies, conducted using *ANSYS v22.2* software, academic license, to investigate the damage caused by cracks and corrosion of steel elements on a DDM segment. The goal is to quantify the extend of the damage encountered by the DDM section, by assigning different damage levels, based on the changes in the structural response they induce. A selection of local corrosion-induced damages of the entire bridge deck will be further used in Chapter 4, where the goal is to assess the effect of the DDM damages on the entire bridge structure, using *ABAQUS* software, as it allows higher number of degrees of freedom, which is necessary for modelling the entire bridge.

The use of different software for the two types of analysis, such as *ANSYS* and *ABAQUS*, is strategic. *ANSYS* is utilized for its specific strengths in analyzing individual bridge components, leveraging its advanced features for certain structural analyses. Therefore *ANSYS*, student license, was used for modelling stiffeners and ribs local damage and general damage for one deck module. Meanwhile, *ABAQUS*, known for handling a higher number of degrees of freedom, is ideal for

modeling complex, overall structure of the Stonecutters Bridge. This complementary approach ensures a thorough and specialized analysis, capitalizing on the unique capabilities of each software for different aspects of the bridge's examination. Thus, using ABAQUS, the properties of the damaged deck modules were applied to the complex model of the Stonecutters Bridge deck, and modal properties and structural response of the bridge were investigated in Chapter 4.

Characterizing a damage classification for bridge decks is a crucial aspect for conducting a parametric study to assess the impact of the structural damage on the bridge system. Damage classification provides a systematic framework for defining different types and degrees of damage that can occur. By using a standardized damage classification, consistency of applying the same level of damage can be ensured. Additionally, a clear and detailed damage classification system can provide valuable insights into the mechanisms that underlie the damage. Overall, incorporating damage classification into a parametric study helps in selecting the critical cases for application to the entire bridge, in Chapter 4 of this study. A damage classification of steel elements, based on the research performed by Tamakoshi et al. (2006), is proposed in (Table 3.1) below. The parametric study is divided by levels I, II and III, each corresponding to the condition detailed in the table below.

*Table 3- 1: Damage classification for steel elements parametric study (adapted from Tamakoshi et al., 2006)*

| Damage classification           | Qualitative Assessment                                                                               | Quantitative Measurements                                                                                                                                                                                        |
|---------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I – Moderate Visible Damage     | Initial visual inspection to identify signs of moderate damage (e.g., minor corrosion, small cracks) | Detailed examinations using tools like ultrasonic testing, magnetic particle inspection, or dye penetrant inspection to measure the extent of damage, such as depth and length of cracks, or degree of corrosion |
| II – Substantial Visible Damage | Visual inspection to confirm significant damage (e.g., extensive corrosion, large cracks)            | Advanced structural analysis tools, such as 3D laser scanning or finite element modeling, to assess the impact on structural integrity and necessary repairs                                                     |
| III – Severe Visible Damage     | Immediate visual identification of severe damage (e.g., large deformations, major fractures)         | Urgent detailed structural assessment, possibly involving load testing or real-time monitoring systems, to determine immediate safety risks and repair requirements                                              |

To systematically assess the structural condition of the cable-stayed bridge with a deteriorated orthotropic steel deck, the following section provides insights into the quantification methods applied to each damage level:

- Level 1: Moderately Visible Damage

The quantification for Level 1 damage involved a through examination of the affected components, including but not limited to e.g., rib suppression, general and local corrosion. Quantitative measures, such as the count or extent of damaged elements, were utilized to characterize the damage as moderately visible.

- Level 2: Substantially Visible Damage

For level 2 damage, a broader range of factors was considered in the quantification process. The number and severity of damage elements was increased from level 1 to have substantially visible damage for the different type of damages.

- Level 3: Severely Visible Damage

Quantifying Level 3 damage involved an assessment of multiple parameters, including the determination of the fatigue limit. The evaluation considered the count, severity, and overall impact damage elements. ADD 75% HERE

### **3.1 Steel Deck Corrosion Background**

The main span of the Stonecutters Bridge consists of an orthotropic steel deck, of 1,080 m, made up of a steel framework with a flat steel plate deck. The Stonecutters Bridge has two parallel steel decks which are connected by 300-meter-long connecting beams, as it can be noticed in Fig. 3-1 (Janjic, 2005). The deck is supported by a series of steel box girders that run along the entire length of the main span. The two box girders are connected by crossbeams and diagonal bracing to form a rigid framework that supports the weight of the deck and traffic. These components are constructed of steel plates with a design thickness of 9 mm, while the orthotropic deck plate of 18 mm is welded to the top flanges of the girders to create smooth, continuous surface for vehicles to travel on. The deck's steel structure is protected by a special coating that helps preventing corrosion, and the design incorporates features such as stiffening ribs and cross-bracing to increase its strength and stability (Falbe-Hanse et al., 2004). The side spans of the Stonecutters Bridge consist of concrete box decks; thus, these were not considered in the current study, which focused on steel elements corrosion and crack damages.



*Figure 3- 1: One segment of Stonecutters Bridge Deck (Sabri, 2013)*

For the current study, both local and general corrosion were applied to the box deck girder elements in different arrangements. Local corrosion was defined as localized alteration of a material's surface, while general corrosion is considered as a uniform degradation of steel applied over its entire exposed surface (Wei et al., 2019). Local corrosion was simulated by applying a thickness reduction of the steel plate of the affected structural element, such as the steel ribs and vertical stiffeners. The general corrosion was modeled by applying a uniform reduction of the steel thickness over the entire DDM model. Moreover, the cracks in the welding of the ribs were simulated as corroded ribs, as reported in the literature (Zhuang et al, 2021), where it was found that once the crack reached 50% of propagation at the rib-to-deck connection, this connection was compromised. Therefore, to model the corroded ribs detaching from the deck, these were suppressed in the DDM model, for the region where the corrosion was considered. The parametric investigation of the corrosion modelling was divided into two parts: single and multiple ribs study, as detailed below. First, the section providing a summary of the finite element analysis (FEA) is introduced.

### **3.2 Bridge Deck Model**

#### **Finite Element Modeling**

The steel bridge deck of Stonecutters Bridge has a length of 1,080m (middle span) and is constructed of 56 identical bridge deck modules connected through cross beams. The FEM of the

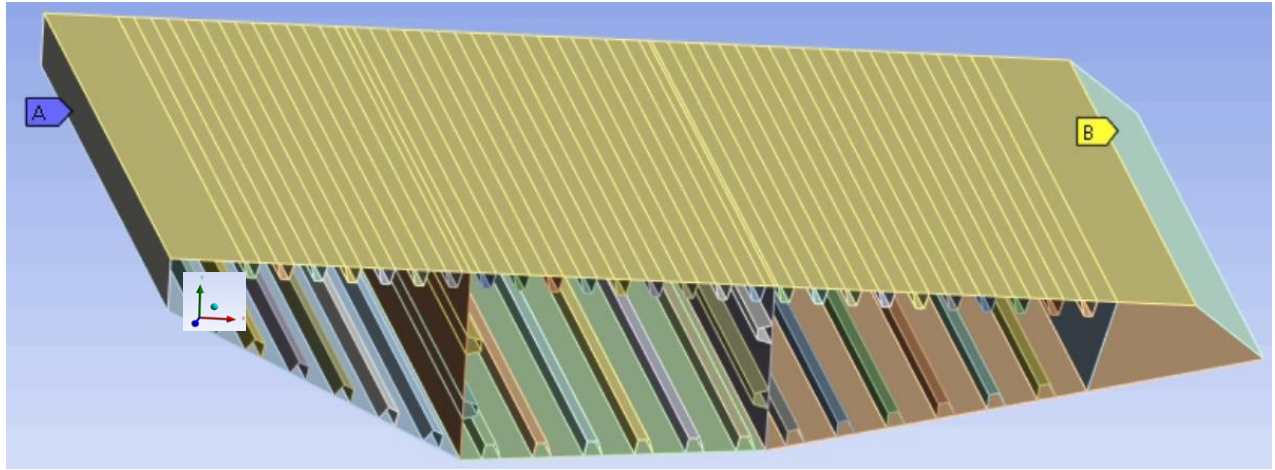


full-bridge model of Stonecutters Bridge was developed in ABAQUS by Sabri (2011) and was improved by Feng (2015) and Yang et al. (2023). The deck corrosion model is developed in the current study, by employing a 3D finite element model of one deck model (DDM) developed in *ANSYS v22.2*, for further performing the structural analysis of the deck and extracting the structural properties of the corroded deck. The DDM geometry was created in *Spaceclaim v22.2* software and was imported into *ANSYS v22.2* Workbench, following the design details presented in Falbe-Hanse et al. (2004). The orthotropic steel deck modeled has a total of 48 steel ribs along the upper surface and lower surface of the deck, and has three transversal vertical stiffeners, as shown in Figure 3.2. The components of the deck were modeled using linear elastic beam (BEAM88) elements, which included six degrees of freedom at each of their nodes, namely three translations and three rotations. This allows to place the appropriate boundary conditions, as follows (Fig. 3.2): In the analysis described:

- Face A Boundary Conditions: This face was restrained against all translations (UX, UY, UZ) and rotations (ROT X, ROT Y, ROT Z). This setup simulates the connection with the stabilizing beam between the two decks, effectively fixing Face A in space.
- Face B Boundary Conditions: Face B was restrained only in the UX direction while allowing free rotations. This constraint prevents the deck from sliding towards the second deck, but does not restrict rotational movements.
- Other Degrees of Freedom (DOF): For the current analysis, which focuses on a single Deck Damage Model (DDM) module, other DOFs were not constrained. This approach is relevant when considering the module in isolation.
- Integration into the Full Bridge Model: When this DDM module is integrated into the full bridge model, consisting of 56 modules, the current boundary conditions will be modified. In the complete model, the nodes of the DDM module will be connected to the actual stabilizing beams and adjacent deck modules of the bridge, reflecting more realistic interaction and constraints.

Regarding the question about the Cartesian coordinate system not shown in Figure 3-2 and the clarity on the restraint of Face B: It appears that for Face B, only translation in the UX direction is restrained, while rotations are not. This means that Face B is fixed against movement along the

UX axis, but it can rotate and move along other axes (UY, UZ). However, without the visual reference of Figure 3-2, this interpretation is based solely on the textual description provided.



*Figure 3- 2: Boundary conditions of deck module*

The DDM model was refined using the following modeling techniques:

Figure shows a 3D model of a deck module with labeled points A and B, which are likely to represent specific areas where boundary conditions are applied. However, without further information or a legend accompanying Figure 3-2, I cannot determine the directions of the XYZ axes within this model. Typically, in a Cartesian coordinate system:

- The X-axis runs horizontally and represents the width.
- The Y-axis runs vertically and represents the height.
- The Z-axis represents the depth or the longitudinal aspect in the context of a bridge deck.

For the dimensions and correspondence to the ribs:

The module dimensions are described as 18 meters in width and length, with the deck plate having a thickness of 18 mm and the stiffeners being 9 mm thick. This likely corresponds to the overall size of the deck module including the ribs, as ribs are usually part of the stiffening system in such structures. The ribs are usually the vertical or inclined elements that provide rigidity to the deck plate and are integral in transferring loads to the main structural elements.

The DDM (Deck Damage Model) was refined with several modeling techniques:

- Isolation of one module for damage scenarios.

- Ensuring the geometry of steel plates, ribs, and stiffeners are stitched with no gaps larger than 5 mm.
- Verification of the geometry for completeness and integrity.
- Using linear elastic beam elements for structural modeling and shell geometry created in Spaceclaim v22.2 for control over plate thickness.

Contact modeling was done using a shared topology to ensure proper interaction between components. For exact dimensions and the XYZ directions as they pertain to this specific module, one would normally refer to the detailed project drawings or annotations within the modeling software, which are not visible in the image provided. If such details are required, they would need to be included in the diagram or obtained from the modeling software used to create the figure.

Once the DDM model concluded, its structural features will be retained for application as one lumped mass for the main deck of the Stonecutters Bridge.

### Material characteristics

Steel was used as the construction material for the main span of the Stonecutters Bridge deck with the properties employed for the FEA of the box girder modelled, as provided in (Table 3-2) (Sabri, 2013), and were applied to all steel components of the model.

*Table 3- 2: Material properties of the structural steel (Sabri, 2013)*

| Property         | Units             | Value  |
|------------------|-------------------|--------|
| Density          | kg/m <sup>3</sup> | 7,850  |
| Young's Modulus  | Pa                | 2E+11  |
| Poisson's Ratio  | -                 | 0.3    |
| Tensile Yield    | Pa                | 2.5E+8 |
| Tensile Strength | MPa               | 4.6E+8 |

### Design loading

This section introduces the loads applied to the DDM model to conduct the current parametric analysis, as well as the for the entire bridge deck investigated in Chapter 4. The dead load was used through the parametric study of the damaged ribs, while for the parametric study of vertical stiffeners, the dead and wind load were used. The loading conditions include only static loads below (Fig. 3-3):

- Dead load:
  - The self-weight of the deck with all its components.
  - No additional superimposed dead loads were considered in the calculations.
  - The dead load was applied by using the option *Standard Earth Gravity in ANSYS v22.2* and it was assigned to all the elements present in the DDM model.
- Wind load:
  - The wind velocities used to determine the wind load in this investigation were 70m/s, (the closest to the design wind speed for Stonecutters Bridge which is 67.7m/s, 141m/s and 211 m/s (Feng, 2015).
  - Based on the given wind speeds, the mean drag and lift wind loadings (the drag and lift loads) on the girder were calculated (Eq.3.1) and were applied as concentrated forces to the node at the mass centre of the steel girder, for every 18m. The torsional moment was also applied as a concentrated moment at the mass center, determined as per Eq 3.1 (Scanlan, 1996):

$$D_m = \frac{1}{2}\rho\bar{U}^2C_DBL(\alpha); L_m = \frac{1}{2}\rho\bar{U}^2C_LBL(\alpha); M_m = \frac{1}{2}\rho\bar{U}^2C_MB^2L(\alpha) \quad \text{Eq. (3.1)}$$

Where,

$D_m$  is drag force

$L_m$  is the lift force

$M_m$  is moment

$\rho$  is the air density, 1.225 kg/m<sup>3</sup>

$\bar{U}$  is the mean wind velocity

$C_D, C_L, C_M$  are the drag, lift and moment coefficients

$B$  is the bridge deck width

$L$  is the bridge length

$\alpha$  represents the angle of attack of wind,  $90^\circ$  in the current investigation.

In the context of the aerodynamic forces acting on a structure, such as a bridge deck, the drag force ( $D_m$ ), lift force ( $L_m$ ), and moment ( $M_m$ ) can be defined using the following equations that consider the shape, orientation, and environmental factors affecting the structure:

Drag Force ( $D_m$ ):

$$D_m = \frac{1}{2} \rho \bar{U}^2 C_D B L(\alpha)$$

This represents the force exerted by the wind in the direction parallel to the flow of air. It is influenced by the drag coefficient ( $C_D$ ), which is a dimensionless number describing the resistance of an object in a fluid environment (in this case, air).

Lift Force ( $L_m$ ):

$$L_m = \frac{1}{2} \rho \bar{U}^2 C_L B L(\alpha)$$

This is the force exerted by the wind in a direction perpendicular to the flow of air. The lift coefficient ( $C_L$ ) is also a dimensionless number that describes the lift characteristics of the bridge deck due to the wind.

Moment ( $M_m$ ):

$$M_m = \frac{1}{2} \rho \bar{U}^2 C_M B^2 L(\alpha)$$

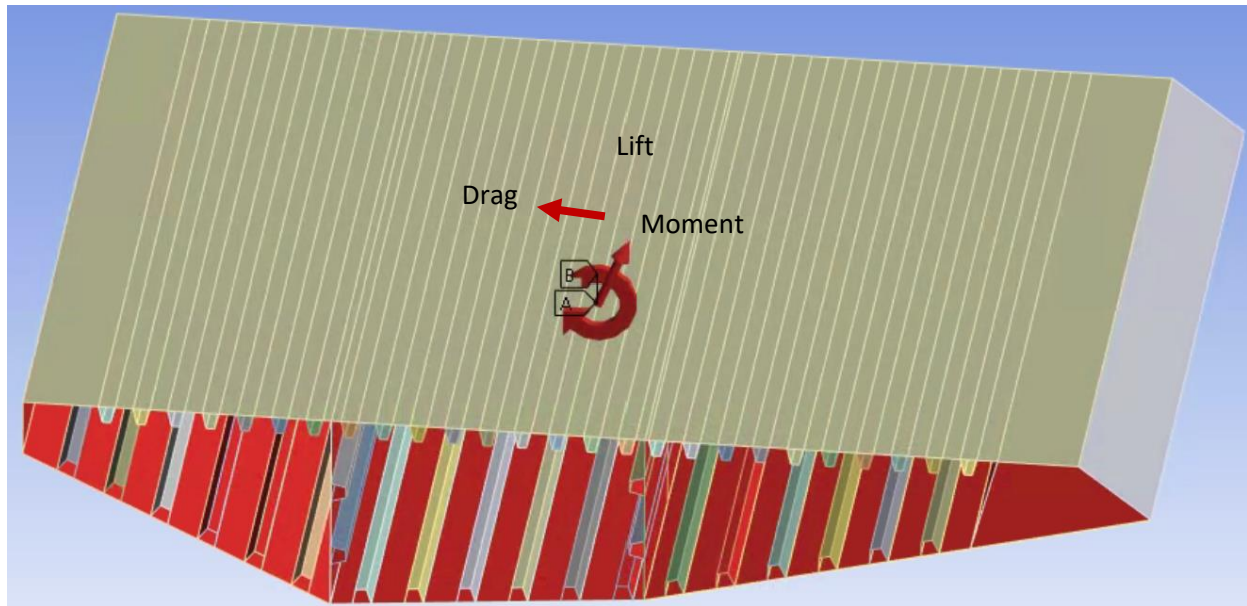
This is the turning or twisting force caused by wind acting on the bridge deck. The moment coefficient ( $C_M$ ) is a dimensionless factor that quantifies the tendency of the wind to cause rotational forces around a given point or axis.

In these equations:

- $\rho$  (rho) represents the air density, which is given as  $1.225 \text{ kg/m}^3$ .
- $U$  represents the mean wind velocity.
- $B$  is the bridge deck width.

- $L$  is the bridge length.

$\alpha$  (alpha) represents the angle of attack of the wind, which is the angle between the direction of the wind and the reference axis of the object. In this case, it is given as 90 degrees, indicating that the wind is acting perpendicular to the length of the bridge, which is a common assumption for worst-case scenarios in bridge design. These equations provide a mathematical framework for assessing the aerodynamic performance of a bridge deck under wind loads by quantifying the respective forces and moments acting upon it.



*Figure 3- 3: Static wind forces applied as concentrated forces and moments*

Different loading conditions were applied to the DDM model, depending on the type of the component being analyzed. For the single rib damage study, only dead load was applied, as the corrosion was assumed to have significantly reduced the load-carrying capacity of the ribs. To study the effect of the damaged stiffeners, under general and local corrosion scenarios, the design wind loads were applied in addition to the dead load. Live load, such as traffic, was not considered in this study, since, in practice the bridge will be closed to traffic when the wind speed would approach the design wind speed.

For the Damaged Deck Module (DDM) analysis, loading conditions were tailored to the structural component under scrutiny. In the case of single rib damage, the model accounted solely for dead loads, recognizing that corrosion would significantly impair the rib's ability to sustain additional forces. Conversely, the analysis of stiffeners, compromised by general and localized corrosion, involved both dead loads and prescribed design wind loads, acknowledging the environmental pressures these components would face. Live loads, indicative of vehicular traffic, were omitted based on the operational protocol that would halt traffic during high wind speeds events reaching design thresholds. Nonetheless, it is important to note that traffic loads can induce fatigue cracking, presenting another dimension of stress that, while not considered in this study, is relevant for comprehensive bridge evaluations.

### **3.3 Damage Model for Set of Ribs**

It is assumed that steel orthotropic bridge decks have the same mechanical properties in different directions. Ribs are used to reinforce the box deck along its surface and to provide additional support against bending and buckling. The ribs are typically placed inside the box deck, at regular intervals along the length of the deck and are welded to the steel deck plate. The ribs also help to distribute the loads from the steel deck plate to the longitudinal girders that support the deck. As introduced by Kainuma et al. (2017), the welding surrounding the ribs can have cracks induced by two mechanisms: cyclic loading stress and increase of stress concentration. For the cases where the cracks are penetrating the ribs, causing these not to perform to their full capacity, it is possible to assume the ribs damages. Removing or deteriorating ribs can have significant implications for the overall structure's stability and safety.

For modeling the damage of individual ribs, loss of contact with the main steel plate of the deck was considered. Time-dependent corrosion models and cracks propagation models were not considered in the current investigation, because the goal was to estimate the overall response of the suspension bridge after the elements damage has developed. Moreover, to simplify the study below, the damaged ribs were separated into two regions: top ribs and bottom ribs respectively, as indicated in Figure 3-4, and were assigned numbers from 1 to 36 for the upper steel plate and from 1 to 18 on the lower steel plate (Figure 3-5).

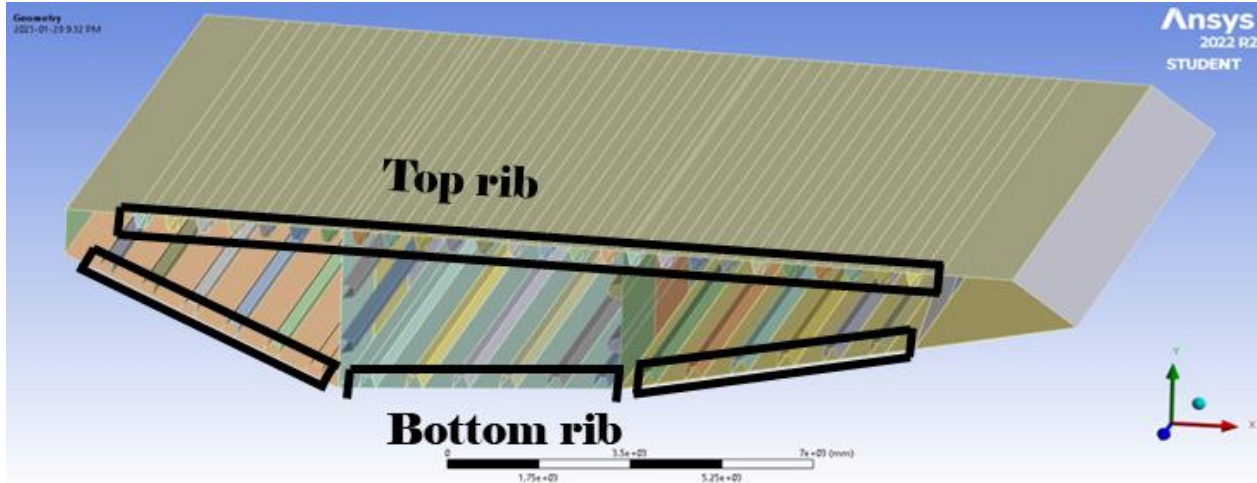


Figure 3- 4: Definition of top and bottom ribs

The goal of modelling ribs corrosion was to examine the impact of damaged ribs on the overall DDM deck response by successively suppressing sets of 3 (red rectangles), 5 (orange rectangles), 7 (yellow rectangles), 9 (green rectangles), 11 (light blue rectangles), 13 (dark blue rectangles), 15 (green rectangles) and 17 (purple rectangles) ribs simultaneously, as shown in the Fig. 3-5.

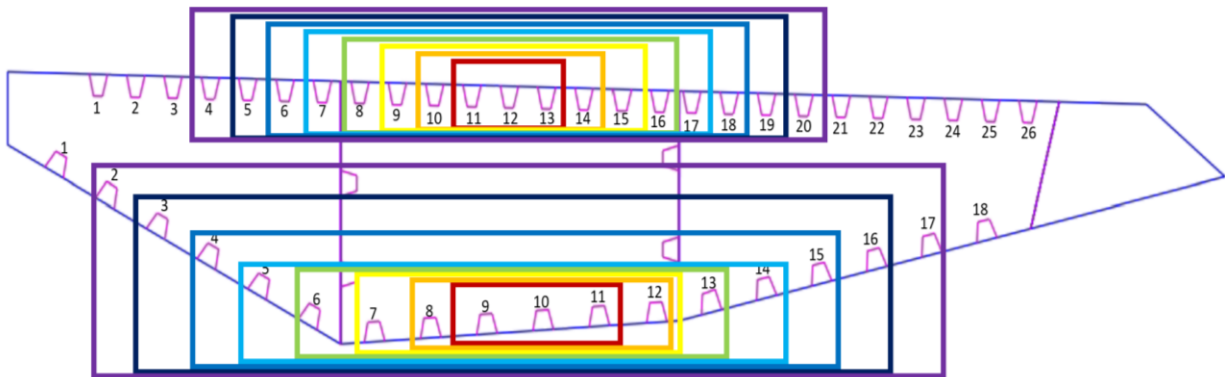


Figure 3- 5: Visual representation of suppressed ribs

In the context of Figure 3-5, which depicts the visual representation of the suppressed ribs in the DDM model, the question of whether unsymmetrical damage has been accounted for is pertinent. While the current depiction may not explicitly illustrate unsymmetrical damage, this aspect will indeed be addressed. The consideration of unsymmetrical damage scenarios, including their effects and implications on the structural integrity of the DDM, will be elaborated upon in Section 3.4.1.



This forthcoming section will provide a detailed analysis of the impact of non-uniform corrosion and its potential to compromise the bridge's load-bearing capabilities and overall safety.

This will help determine the number of corroded ribs that would drive a bigger deformation of the DDM deck segment. To accomplish this, the methodology applied was removing the damaged ribs to create the biggest deformation and determine a damage classification. The bottom of the deck has 18 ribs, while the top has 26 ribs in total. However, ribs 1, 2 and 20 to 26 are not considered in this study, as indicated in color blue in Figure 3-6, because they are located on the hard shoulder of the deck, and they experience much lower cyclic loadings, when compared to the ribs between 3 and 20 on the top surface.

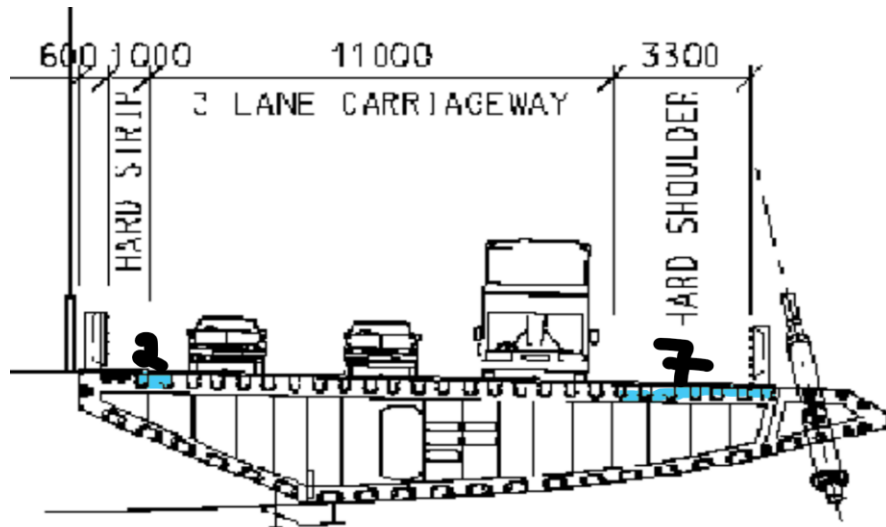


Figure 3- 6: Stonecutters Bridge deck cross-section (Ge, 2016), ribs omitted in the current study

In reference to Figure 3-6, which presents the cross-section of the Stonecutters Bridge deck with the omission of ribs as per the current study, the BP inquiry about FE (Finite Element) mesh and the elements used for modeling stiffeners and the box suggests a need for clarification on the computational modeling details. The FE mesh refers to the network of finite elements that are used to discretize the bridge deck structure for analysis in finite element software. The 'elements' are the individual shapes (such as triangles, quadrilaterals, tetrahedrons, etc.) that make up the mesh and are used to approximate the structural behavior under various loads.

For the stiffeners and the box section of the bridge deck in the finite element model, the BP is likely asking about:

- The type of finite elements used: For example, whether shell elements, beam elements, or solid elements are employed for the stiffeners and the box section.
- The density and distribution of the mesh: This includes how fine or coarse the mesh is and how it is applied over the different components of the bridge deck, which can greatly affect the accuracy of the analysis.
- The level of detail in the mesh: Specifically, whether the mesh accurately captures the geometric details necessary to simulate the structural behavior of the stiffeners and the box section effectively.

### 3.4 Results Summary for Damaged Ribs Study

Suppressing the corroded ribs and applying the dead load led to an increase in the average and maximum deformations of the DDM deck segment. The maximum deformation reported in this section was probed on the box girder and not along the ribs. As it can be noticed in Table 3-3, the maximum deformation recorded for the DDM segment when the top ribs were suppressed ranged between 7.80mm and 35.57mm under its own self-weight, while for the bottom ribs' suppression, the maximum deformation was situated between 7.82mm and 23.65mm, as summarized in Table 3-4. These findings were corroborated by the deformations plotted on middle lines on the top and bottom steel plates, along the deck's transverse direction (x-axis), as shown in Figures 3-7 and 3-8, respectively. Detailed results for all the case investigated are presented in Appendices A and B while the complete data are in Appendix E. It is important to note that the monitored line is along the X-direction, but the results plotted for the displacement are on the vertical Y-direction.

Tables 3-3 and 3-4 outline the deformation results for different sets of ribs within a DDM structure, captured in Figure 3-7 from a finite element analysis. Each set of ribs refers to a particular group or specific location of ribs on the bridge (Fig. 3-5), identified by odd numbers, indicating the specific rib identifiers. The maximum deformation column lists the most significant displacement experienced by the ribs from their original undeformed position. The average deformation column

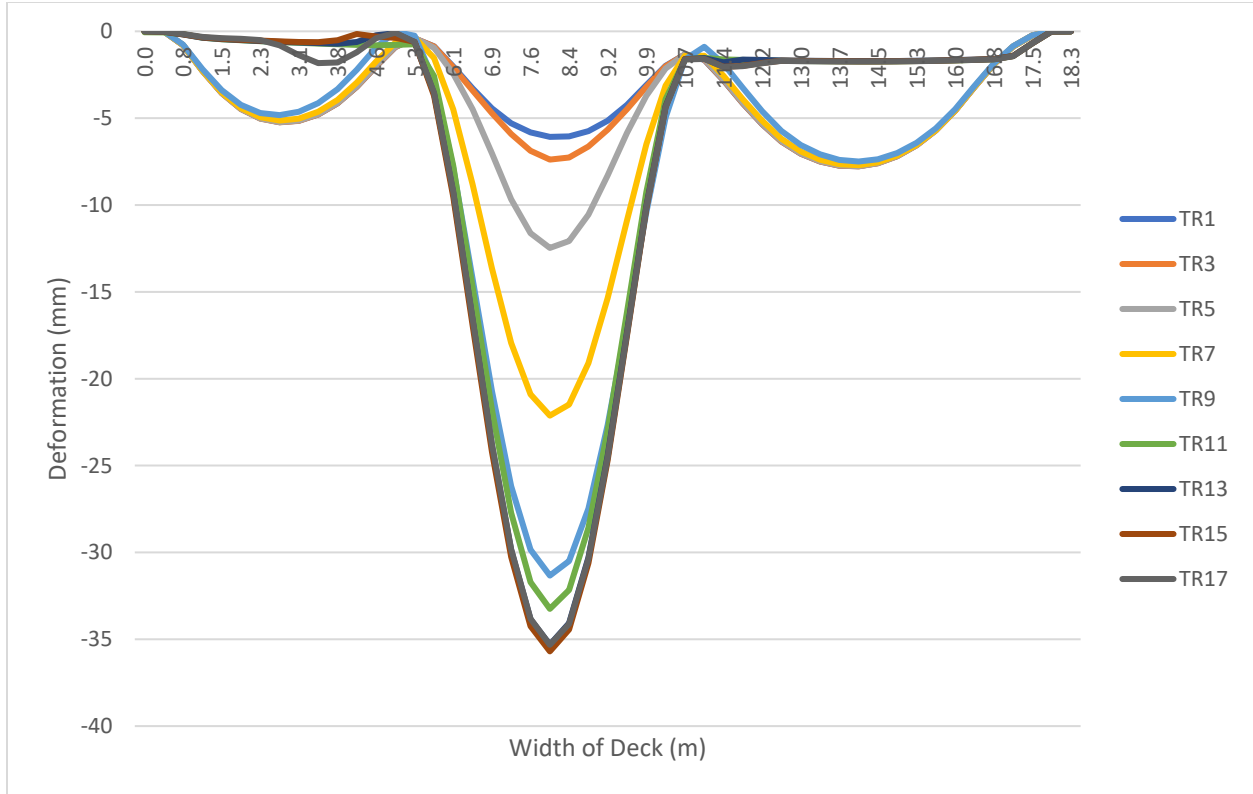
shows the mean deformation across each set of ribs, providing an insight into the general behavior of the bridge's ribs under load rather than extreme values. It helps in understanding the overall deformation pattern and is useful for assessing the distributed structural response. An increasing trend in deformations was noticed with the increase of the number of affected ribs, especially for the maximum deformation. For instance, ribs sets 11, 13, 15, and 17 show maximum deformations above 33 mm under dead load effect, while the average deformation increased more gradually, implying that while peaks in stress occur, the overall deformation remains within a certain range. Understanding this data is essential for evaluating the structural health of the DDM and for determining the need for maintenance or repairs.

*Table 3- 3: Deformation Top Plate*

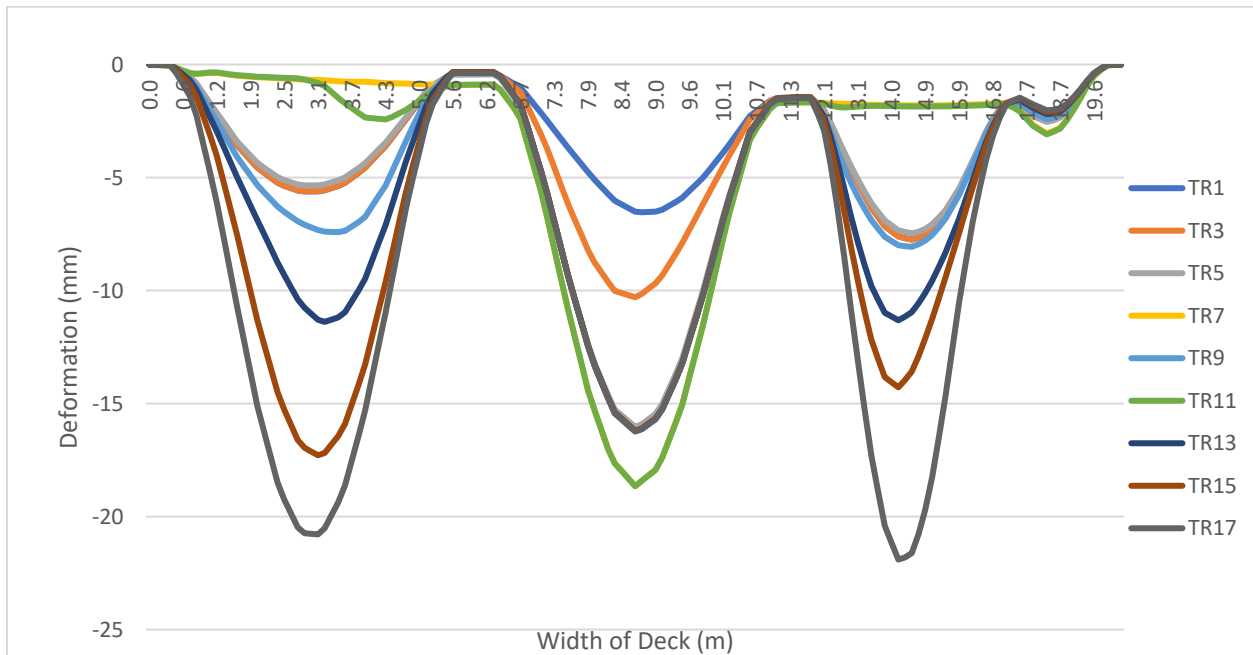
| SETS OF RIBS | Deformation (mm) |         |
|--------------|------------------|---------|
|              | Maximum          | Average |
| 1            | 7.80             | 2.27    |
| 3            | 7.80             | 2.27    |
| 5            | 12.62            | 2.32    |
| 7            | 22.34            | 2.49    |
| 9            | 31.58            | 2.71    |
| 11           | 33.52            | 2.83    |
| 13           | 35.54            | 2.93    |
| 15           | 35.93            | 3.01    |
| 17           | 35.57            | 3.04    |

*Table 3- 4: Deformation Bottom Plate*

| SETS OF RIBS | Deformation (mm) |         |
|--------------|------------------|---------|
|              | Maximum          | Average |
| 1            | 7.82             | 2.30    |
| 3            | 10.32            | 2.35    |
| 5            | 16.09            | 2.49    |
| 7            | 18.651           | 2.5579  |
| 9            | 18.67            | 2.64    |
| 11           | 18.66            | 2.70    |
| 13           | 18.63            | 2.73    |
| 15           | 18.63            | 2.92    |
| 17           | 23.65            | 3.26    |



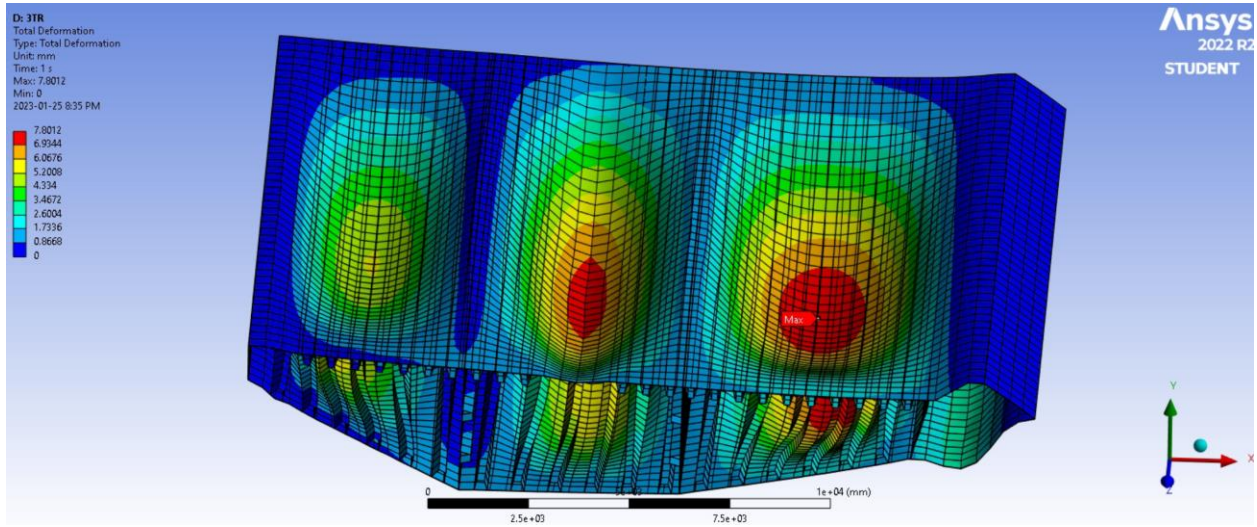
a) Top steel deck plate



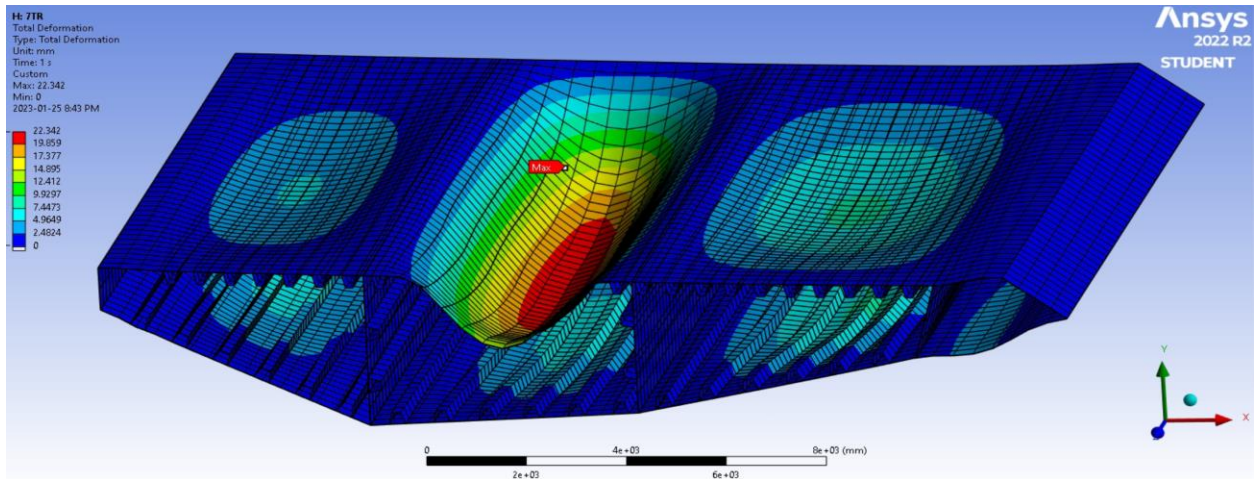
b) Bottom steel deck plate

Figure 3- 7: Deformation recorded on vertical direction (y-direction) sampled along transverses lines across the DDM

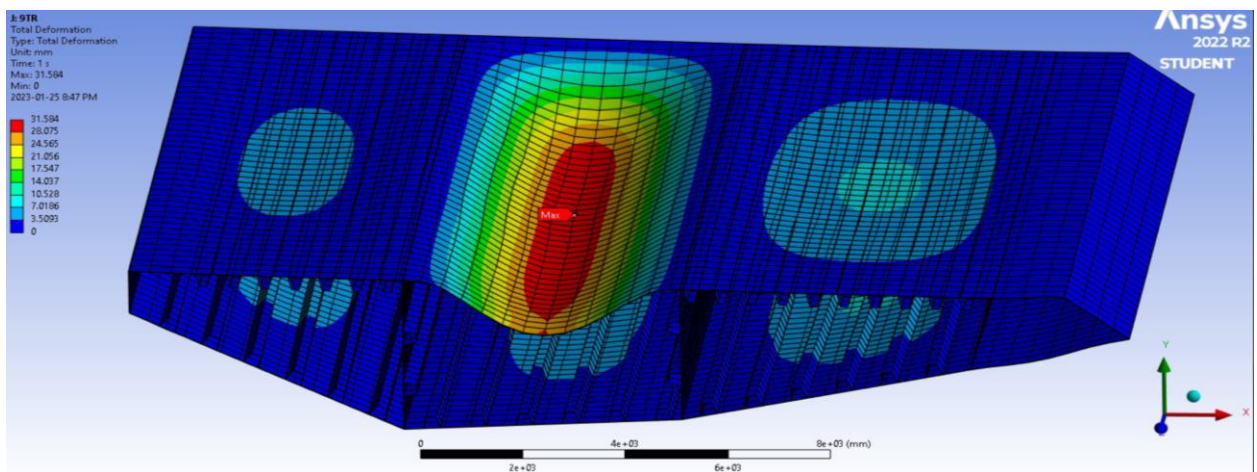
The graph in Figures 3-7 a) and b) display the deformation results for the top and bottom steel deck plates, plotting deformation on vertical y-direction, recorded on transversal lines sampled across the deck width represented on the horizontal axis. The X-direction, as mentioned here, refers to the transverse direction of the deck which is perpendicular to the longitudinal axis of the bridge (the direction along the length of the bridge). In structural engineering, the transverse direction (X-direction in this case) would typically be across the width of the bridge, running from one side to the other. This is the direction you see along the horizontal axis of the graph. The lines on the graph represent the deformation profiles for various sets of ribs, identified as TR1, TR3, and so on. The deformation values are plotted on the vertical axis in millimeters (mm), indicating the amount of vertical displacement (up or down) from the original, undeformed position, which corresponds to the Y-direction. Thus, the monitored line along the X-direction on the bridge deck provides data for deformation that is represented in the Y-direction (vertical) on the graph.



a) Set of 3 corroded ribs (TR3)



b) Set of 7 corroded ribs (TR7)



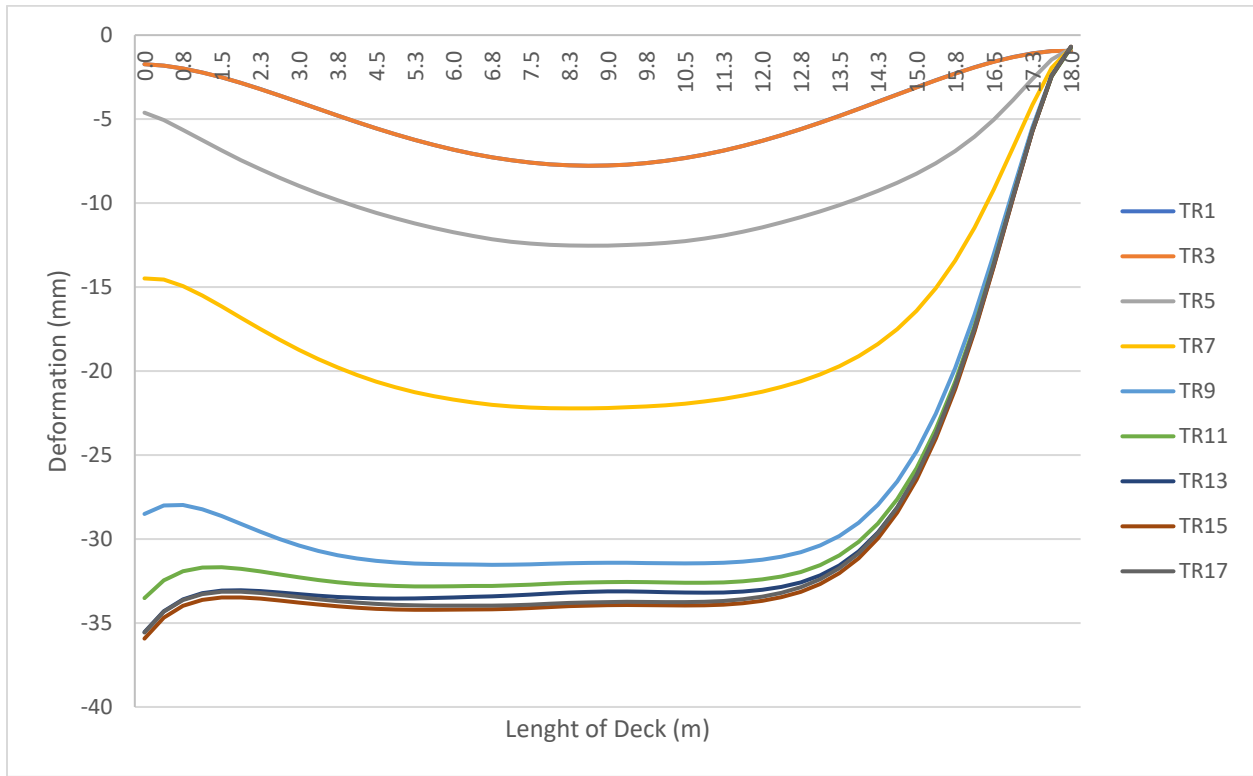
c) Set of 11 corroded ribs (TR11)

Figure 3- 8: FEA of DDM deformation with ribs corroded at top deck plate

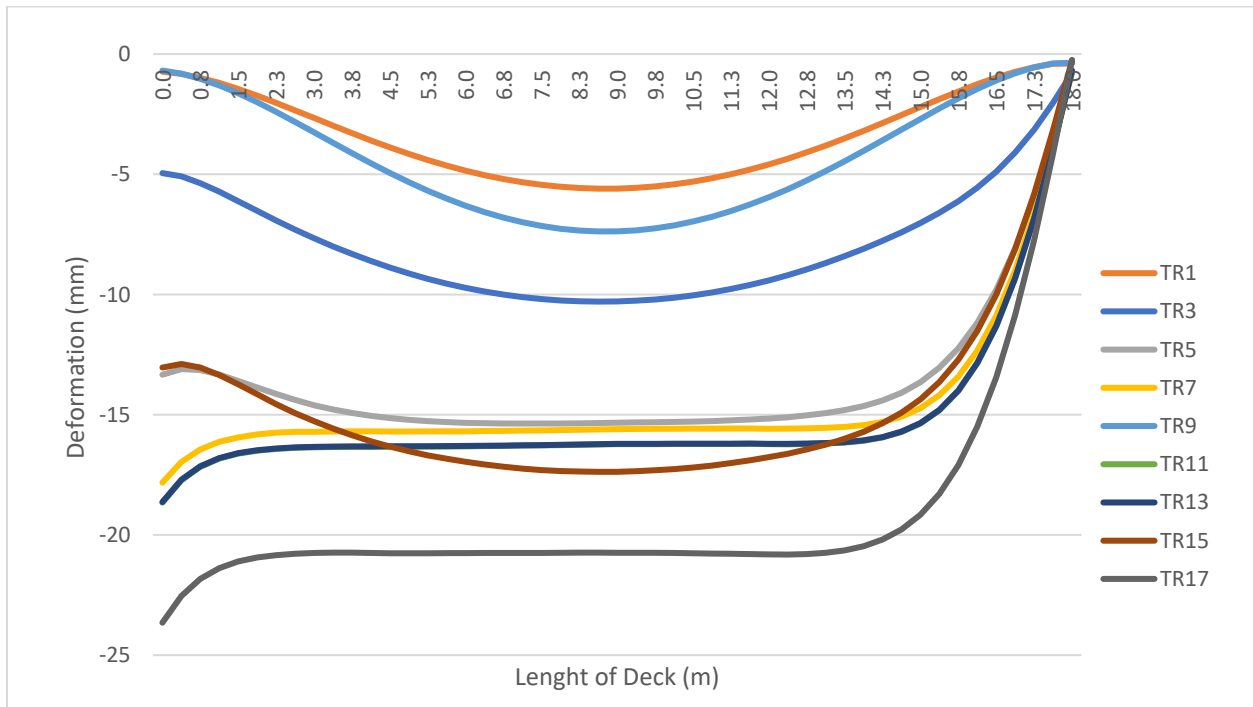
As it can be noticed in Fig. 3-7 a) above, corroding ribs simultaneously in sets of 1, 3 and 5 ribs can induce negligible deformation for the first and last 5m of the deck, and a gradually increasing deformation for the middle 5m of the deck, of up to 15mm for the set of 5 corroded ribs (TR5 in Fig. 3-7 a)). A similar pattern was noticed when corroding sets of top ribs 7, 9, 11, 13, 15 and 17, but with gradually increasing deformation, especially for the middle of the DDM deck for the affected sets of 13, 15 and 17 ribs (TR13, TR15 and TR17 in Fig. 3-7 a)), for which 35.7mm maximum deformation was noticed. A three-dimensional representation of the DDM segment with the deformation patterns are included in Figures 3-8 a) to c), where it can be noticed that as more ribs are suppressed, the maximum deformation tends to concentrate in the middle of the top steel deck plate.

This might be because the top plate is generally more prone to buckling. Under the effect of the dead load, the top steel plate is exposed to compressive forces which tend to cause the top plate to deform, resulting in the curvature observed in Figure 3.7. Also, the top plate is subjected to greater bending due to the deck's configuration, which is causing higher deformation of the top ribs. It is important to note that the top steel deck plate helps distribute the applied loads across the DDM structure.



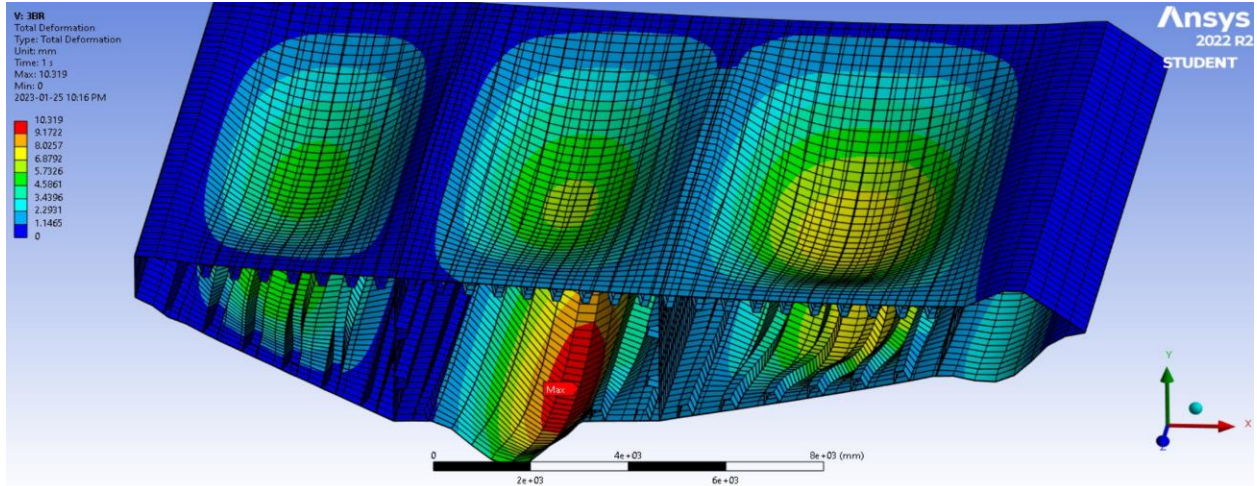


a) Top steel deck plate

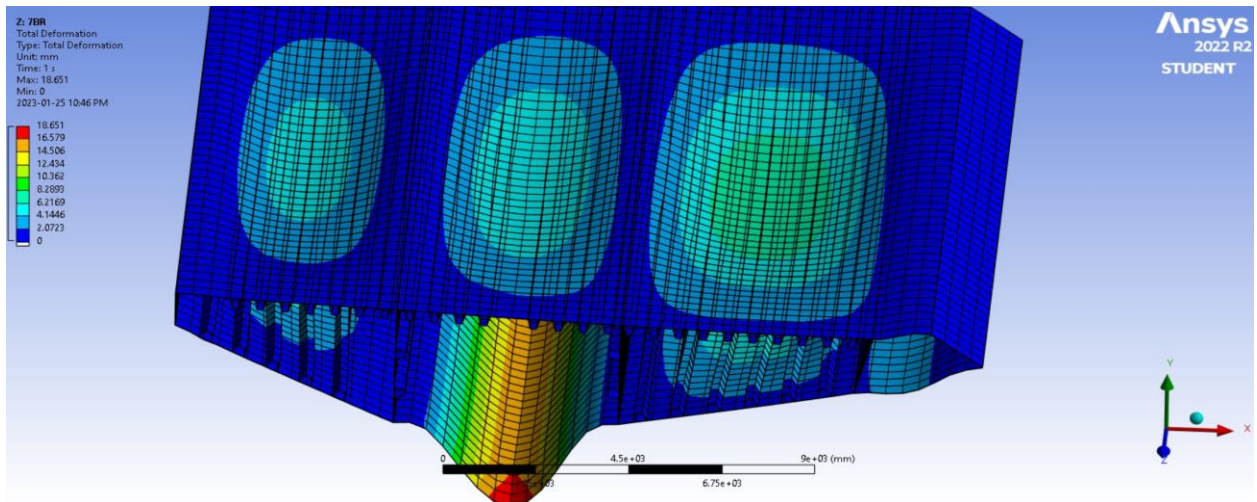


b) Bottom steel deck plate

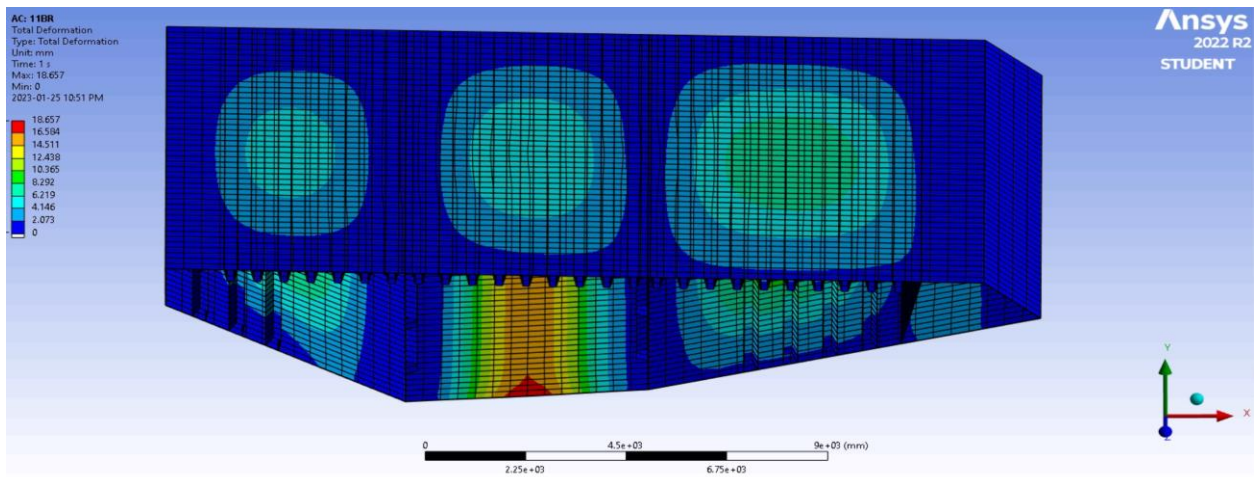
Figure 3- 9: Deformation on longitudinal direction (y-direction)



a) Set of 3 corroded ribs (BR3)



b) Set of 7 corroded ribs (BR7)



c) Set of 11 corroded ribs (BR11)

Figure 3- 10: FEA of DDM deformation with ribs corroded at bottom plate

By observing the maximum deformations presented in Figure 3-8, we can conclude that three damage effect categories are formed, as the results are summarized:

For a) top steel deck plate

- Group 1: TR1, TR5 with a maximum deformation of 12.5mm
- Group 2: TR7 with a maximum deformation of 22.2mm
- Group 3: TR9 to TR17 with a maximum deformation of 34mm

For b) bottom steel deck plate

- Group 1: BR3, BR9 with a maximum deformation of 10mm
- Group 2: BR5, BR7, BR11, BR13, BR15 with a maximum deformation of 17.8mm
- Group 3: BR17 with a maximum deformation of 21mm

It is interesting to notice that DDM deformations for the corroded ribs BR7 and BR9 are interchanged. This response can be explained by looking at Figure 3-5, which shows that the connection included in BR9 can provide support and can reduce the deformation when ribs 6 to 13 are suppressed versus the case when ribs 7 to 12 are suppressed. For the longitudinal direction, as expected, the maximum deformation is in the middle of the DDM span as seen in Fig 3-10a). It seems that in Figs. 3-10 b) and c) there are localized deformations at the tip of the DDM deck segment.

When compared to the top steel deck plate, the bottom plate deformation is much lower, for all the damaged ribs sets considered. This can be explained by the fact that the bottom steel deck plate is subjected to tensile forces, generally having less effect on the deformation, when compared to compressive forces. Tensile forces tend to elongate the material while compression pushes the member to buckle. This makes the bottom steel deck plate less prone to buckling and deformation, but not exempted from it.

This study proved to be valuable in determining the impact of damaged sets of ribs on deformations within one DDM segment. The results indicated that there was little difference in the deformation when ribs set TR1 and TR3 were suppressed, but a significant change in deformation was noticed when ribs sets TR7 to TR9 on the top plate were damaged. After the suppression of 9 ribs, the difference in deformation between ribs was not as drastic as expected. It was concluded that by

removing ribs sets of TR3, TR7, and TR11, representing each level of damage classification (Level 1, Level 2, and Level 3), the effect of each damage category could be accurately captured. This conclusion was reached by analyzing the amount of deformation caused by each damaged rib. Thus, the DDM study can progress to the next investigation step with confidence that the effects of each level of damage classification would be accurately represented.

### **3.4.1 Multiple Ribs Corrosion and Vertical Stiffeners Study**

Two distinct types of damages were considered in the analysis, each associated with specific scenarios. The first type of damage results from external factors, primarily corrosion induced by environmental elements (Kainuma et al., 2017). In this category, the affected ribs are grouped to represent the nature of the damage. For example, in the group L2-O4, ribs 3-4, 8-9, and 17-19 were entirely corroded, leading to their omission from the DDM model to simulate this particular scenario. On the other hand, the second type of damage is attributed to human error and is characterized by the individual failure of a rib, as opposed to a group of ribs affected simultaneously. This type of damage can be caused by various factors such as errors during maintenance or a lack of protective paint coating on the ribs. For instance, in the group L1-O4, ribs 5, 12, and 18 are omitted from the DDM model due to human error.

To provide further clarity, the nomenclature system employed involves using the letter "L" followed by a number to denote the damage level (as established in Table 3-1). For example, "L1" represents Level 1 damage. Subsequently, the letter "O" and a number are introduced to differentiate options within a specific level. This explicit representation aims to enhance the understanding of the damage scenarios and their classification in the subsequent analysis.

Various reasons can cause this damage, such as errors during maintenance, lack of protective paint coated on the ribs. For example, in group L1-O4, ribs 5, 12, and 18 are omitted due to human-induced errors in construction and installation on these ribs on the deck. Further notations used in Figures 3-11 and 3-12 showing the summary of patterns for the top and bottom ribs, are as follows: Top deck plate (Fig. 3-11) – ribs 3 to 19:

- Level 1 – entire removal of 3 ribs due to corrosion induced damage.

- Level 2 – entire removal of 7 ribs due to corrosion induced damage.
- Level 3 – entire removal of 11 ribs due to entire corrosion induced damage.

Bottom deck plate (Fig. 3-12) – ribs 1 to 18:

- Level 1 – entire removal of 3 ribs due to corrosion induced damage.
- Level 2 – entire removal of 7 ribs due to corrosion induced damage.
- Level 3 – entire removal of 11 ribs due to corrosion induced damage.

The classification of ribs removal levels due to corrosion induced damage, for the top and bottom deck plates, is used in Figures 3-11 and 3-12 respectively, for different options of damage involving removing a certain number of ribs at different levels.

In Table 3-1, damage levels were classified based on the severity of damage, ranging from moderate (Level I) to severe (Level III). These levels indicate the extent of deterioration and the urgency of required repairs. Based on the maximum deformation obtained for each ribs removal case corresponding levels of damage from Level 1 to Level 3 were assigned as described in Figures 3-11 and 3-12.

| Level - Option | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
|----------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| L1 - O1        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L1 - O2        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L1 - O3        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L1 - O4        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L1 - O5        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L1 - O6        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L1 - O7        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L2 - O1        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L2 - O2        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L2 - O3        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L2 - O4        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L2 - O5        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L2 - O6        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L2 - O7        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L3 - O1        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L3 - O2        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L3 - O3        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L3 - O4        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L3 - O5        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| L3 - O6        |   |   |   |   |   |   |   |   |   |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

Figure 3- 11: Summary of pattern cases for top ribs

| Level - |   |   |   |   |   | VS1 |   |   |   |    |    | VS2 |    |    |    |    |    |    |
|---------|---|---|---|---|---|-----|---|---|---|----|----|-----|----|----|----|----|----|----|
| Option  | 1 | 2 | 3 | 4 | 5 | 6   | 7 | 8 | 9 | 10 | 11 | 12  | 13 | 14 | 15 | 16 | 17 | 18 |
| L1 - O1 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L1 - O2 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L1 - O3 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L1 - O4 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L1 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L1 - O6 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L1 - O7 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L2 - O1 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L2 - O2 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L2 - O3 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L2 - O4 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L2 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L2 - O6 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L2 - O7 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L3 - O1 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L3 - O2 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L3 - O3 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L3 - O4 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L3 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |
| L3 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |

Figure 3- 12: Summary of pattern cases for bottom ribs

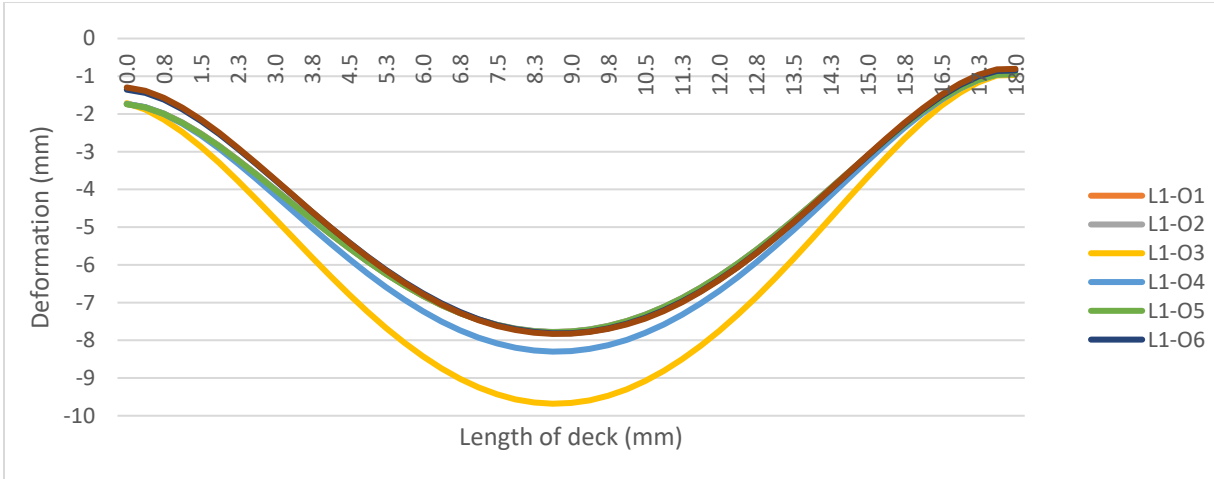
The damage levels are classified based on the severity, aligning with the categories defined in Table 3-1. Further notations used in Figures 3-11 and 3-12 illustrate the summary of patterns for the top and bottom ribs, corresponding directly to the damage levels outlined in Table 3-1. The levels of corrosion removal for individual ribs, such as entire corrosion removal of 3, 7, or 11 ribs, are indicative of the severity of damage aligned with the defined levels. This classification approach ensures a clear and consistent correspondence between the presented damage scenarios and the established damage levels in Table 3-1.

### 3.5 Results Multiple Ribs Corrosion and Vertical Stiffeners Study

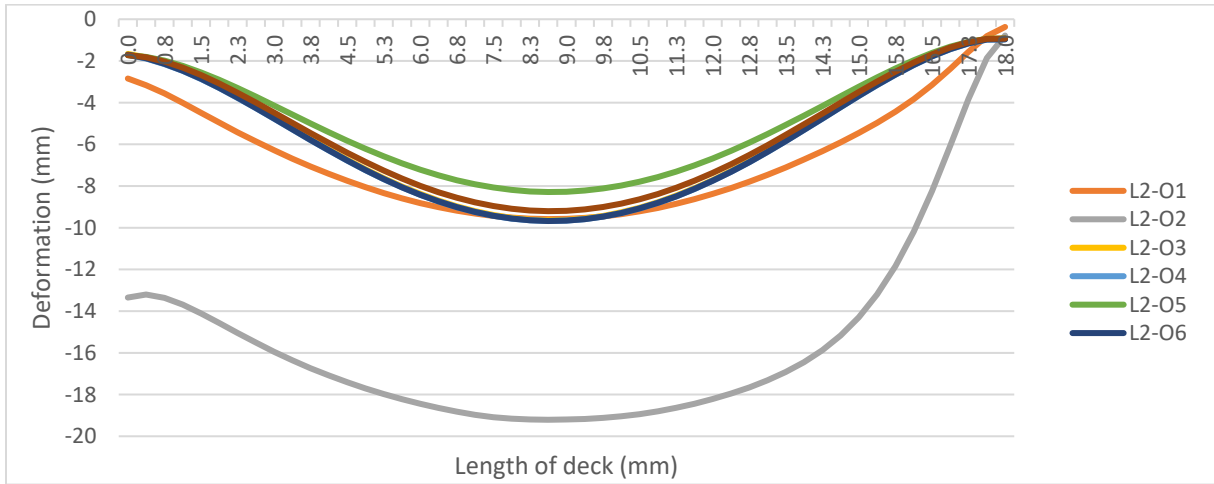
All the results extracted for the 40 case studies of the DDM with corroded ribs on the top and bottom plates, can be found in Appendices C and D. Moreover, the data for the bridge deck with no corrosion employed in this study, is in Appendix F, allowing for further observation. It is essential to highlight the values presented in this study are solely for damage levels comparison purposes, as the DDM modules were not yet added to the entire bridge deck.

The three plots in Figure 3-13 represent the deformation of the top plate of the deck, along the longitudinal direction. Notable elements include the length of the deck for Damage Level 1 (Figure 3-13 a), Damage Level 2 (Figure 3-13 b) and Damage Level 3 (Figure 3-13 c). The legend

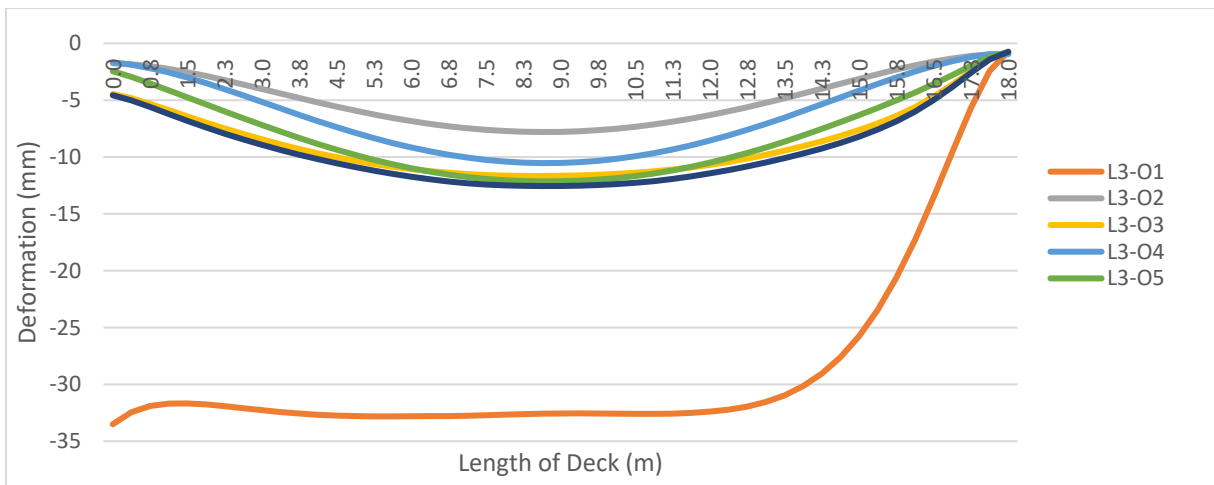
identifies the damage options presented in Figure 3-11 and 3-12. It was noticed that the emerging from the results plotted in Fig. 3-13 reveal that the deformation for Damage Levels 1 and 2, except for L2-O2, falls within 10mm. The maximum deformation of L2-O2 case is practically double, which suggests that the suppression of ribs TR 10 to 16 leads to a higher deformation, thus to higher damages. This DDM behaviour is expected as these ribs are in the middle of the deck module. The same trend is exemplified in Fig. 3-13 c) with L3-O1, where TR ribs 7 to 17 ribs are suppressed, showing a deformation of 33mm. In summary, these graphs reveal that suppressing the ribs in the middle of the DDM module will result in having a bigger deformation, compared to suppressing ribs at any other location of the DDM.



a) Damage Level 1



b) Damage Level 2

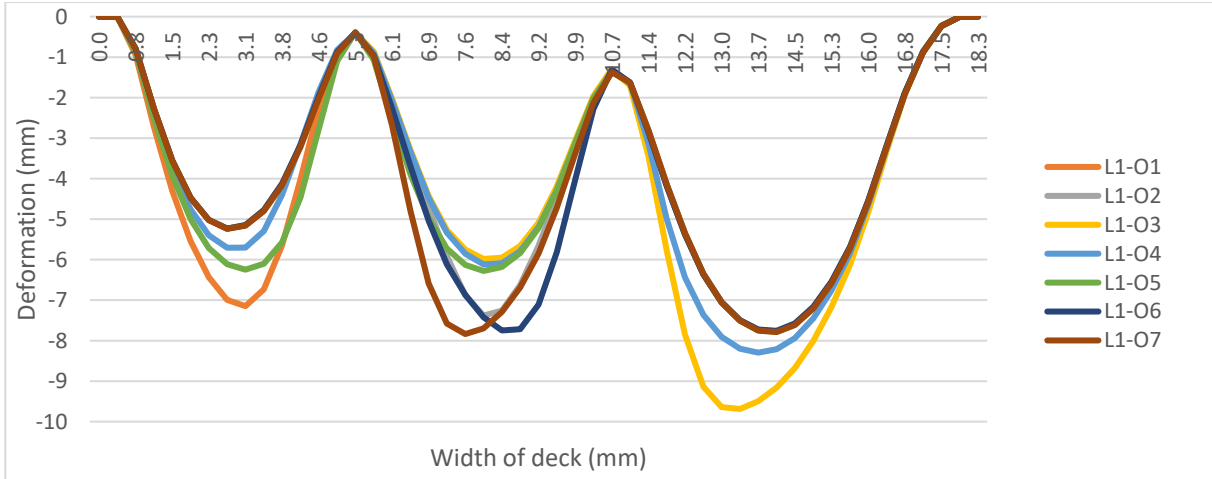


c) Damage Level 3

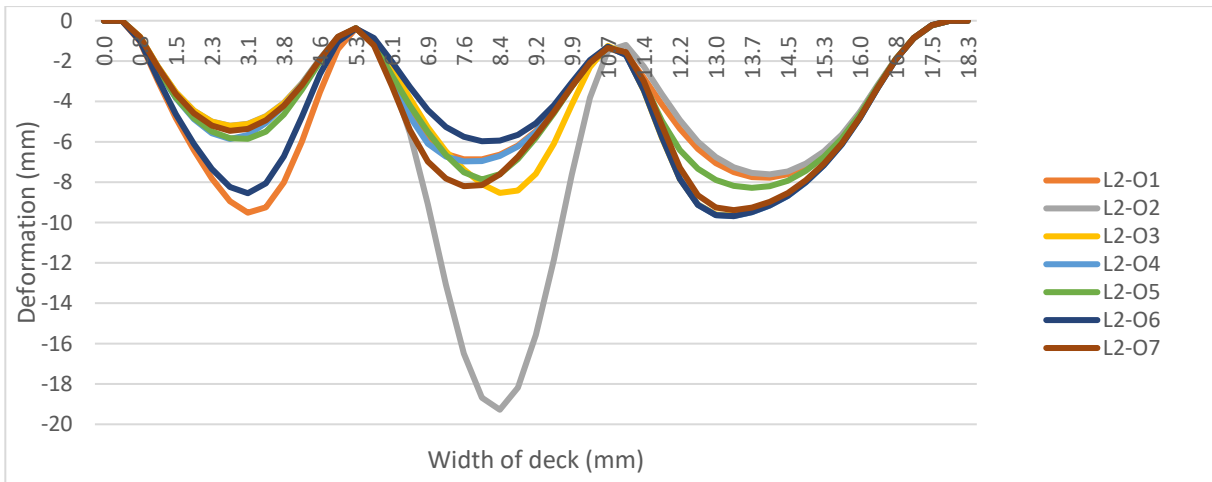
Figure 3- 13: Multiple rib study – Top rib longitudinal



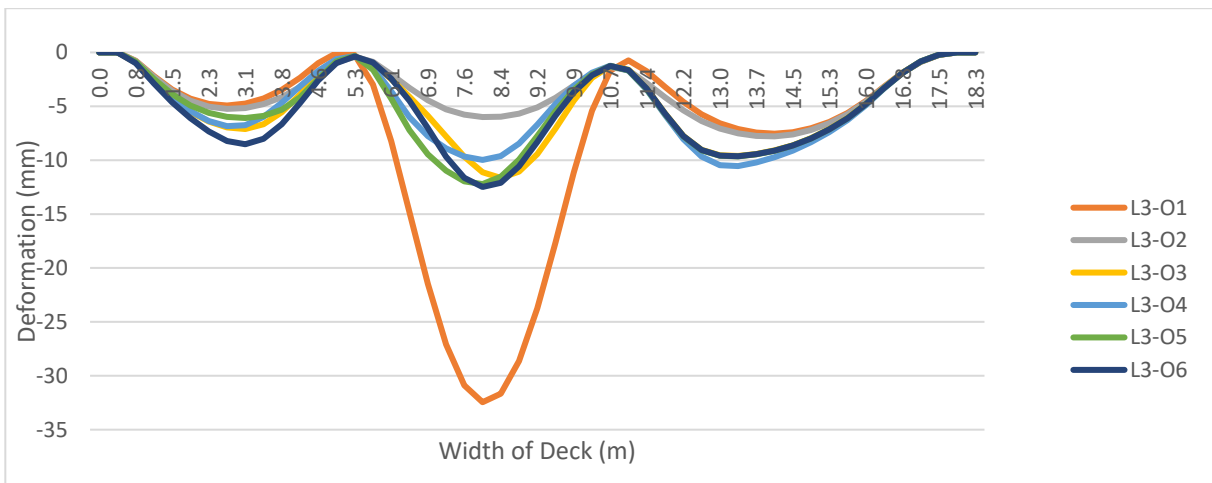
In Figure 3-14 the deformation of the top deck plate is depicted on the transversal direction. The x-axis portrays the length of the deck (18.3m), while the y-axis represents the deformation in mm. The two vertical stiffeners are located at distances 5.3mm and 10.7mm. At these locations, the deformation is 0mm, thus creating three spans on the transverse direction: between 0 and 5.3m (span 1), 5.3 to 10.7m (span 2) and finally 10.7 to 18.3m (span 3). For spans 1 and 3, the maximum deformation is approximately 10mm, while, as expected, the middle span experiences the highest deformation with L2-O2 on damage level 2 (referring to Figure 3-14b) at 20mm and L3-O1 on damage level 3 (referring to Figure 3-14c) at 33mm. These two levels experienced highest deformations compared to the others due to the deletion of the stiffeners. Their primary function is to provide additional stiffness and support to the steel deck. In L2-O2 and L3-O1, they are removed in the longest span, resulting in highest deformation.



a) Damage Level 1



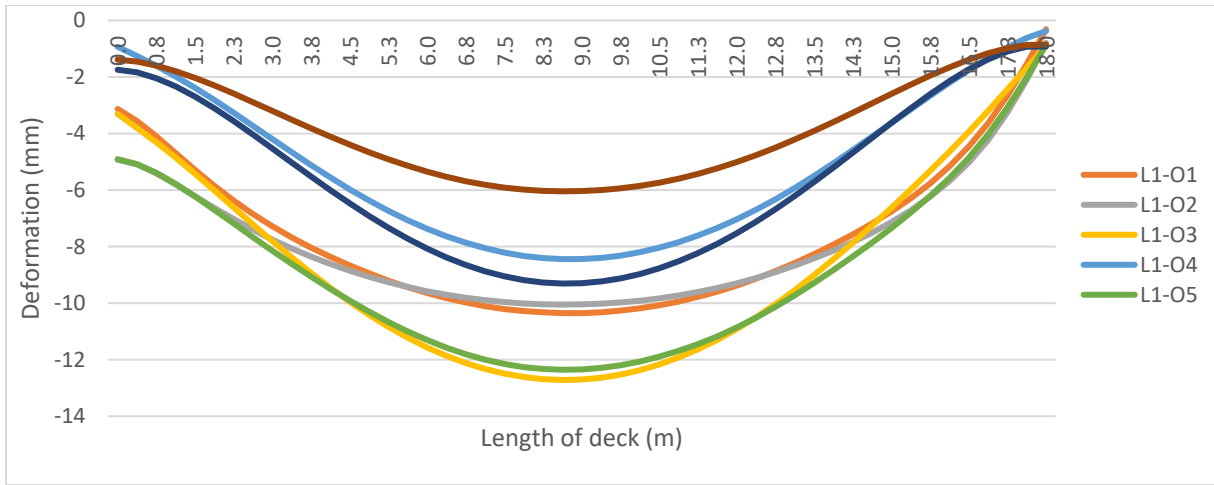
b) Damage Level 2



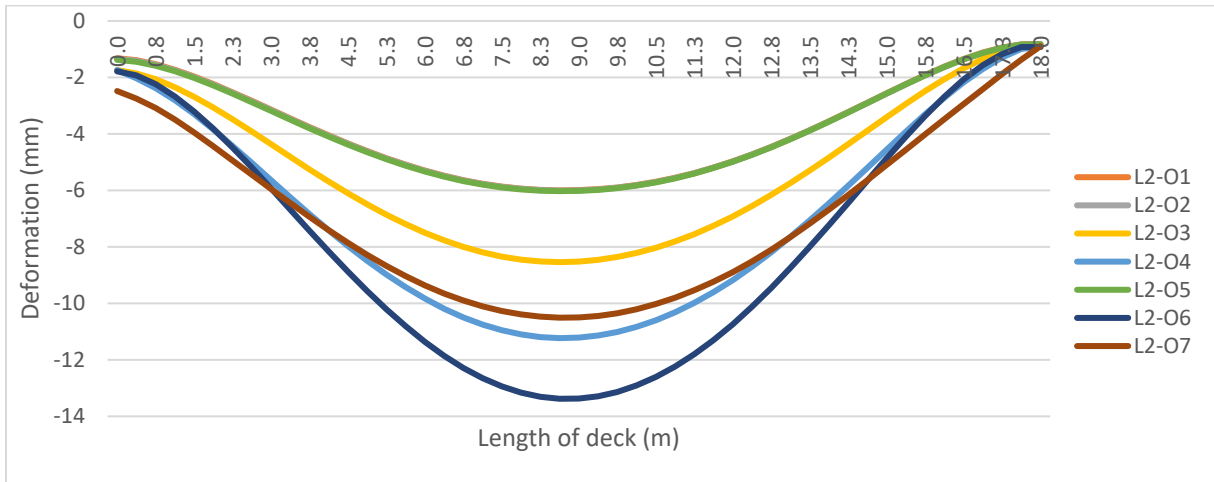
c) Damage Level 3

Figure 3- 14: Multiple ribs study – Tob ribs transversal direction

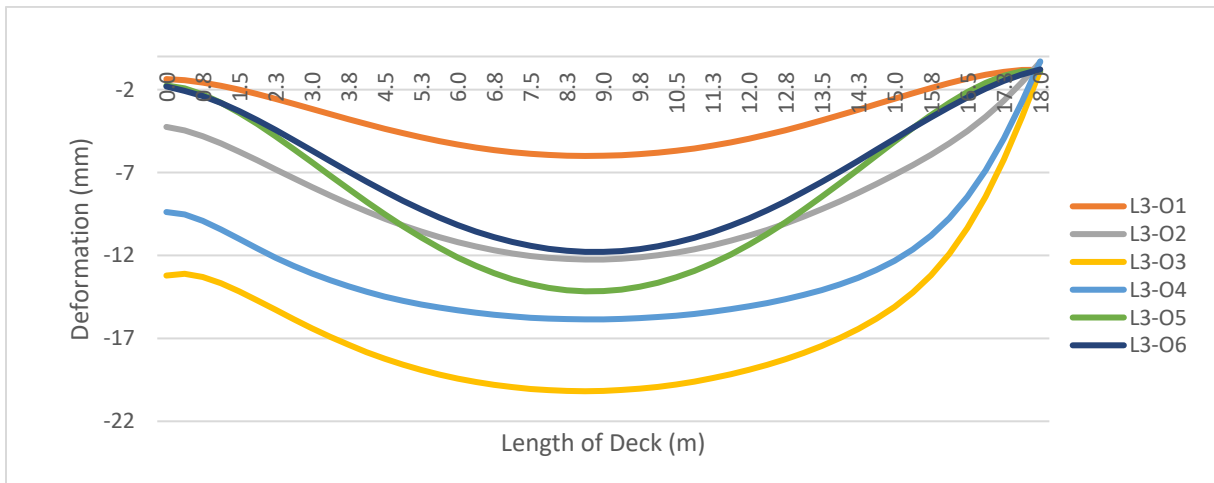
Like the top deck plate deformation reported in Fig. 3.13, three sets of graphs were prepared for representing the deformation for the bottom deck plate in the longitudinal direction (Fig. 3-14 a-c). The maximum deformation is observed in the middle of the DDM module, approximately at 9m. The deformation for Damage Levels 1, 2 and 3 (except for L3-O3 and L3-O4) are within 14mm. By examining Fig 3-15(c) for L3-O3 and L3-O4, it was noticed that the highest deformation was encountered when the ribs are suppressed on the bottom right side of the deck. The suppression of four consecutive ribs on the left side in L3-O4 did not draw the same deformation as the deletion of four ribs on the right side in L3-O3, which derived a bigger deformation. The difference between the two lies in the stress redistribution caused by these alterations. The absence of ribs on one side shifts the load-bearing dynamics, leading to higher deformation.



a) Damage Level 1



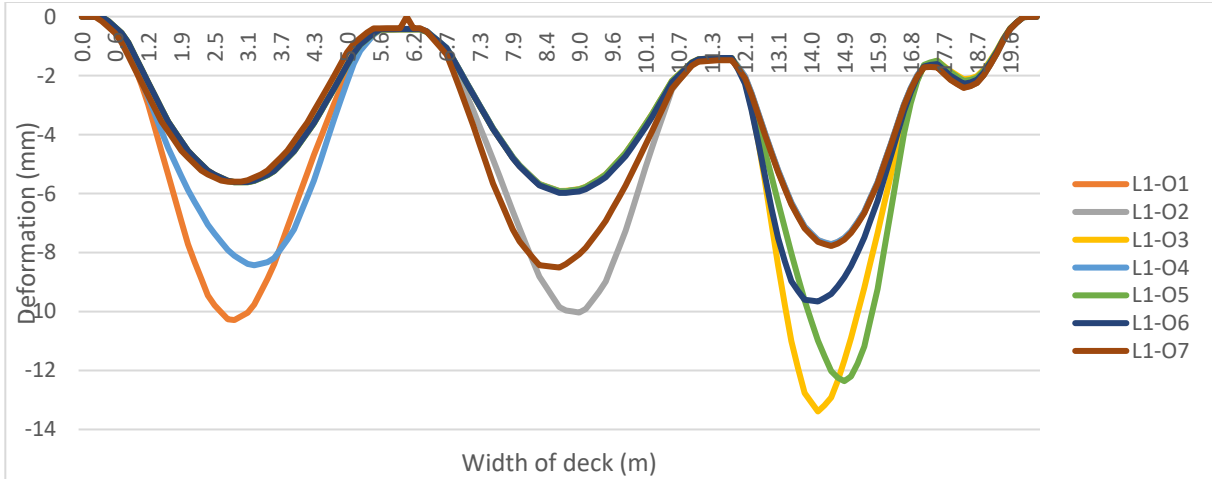
b) Damage Level 2



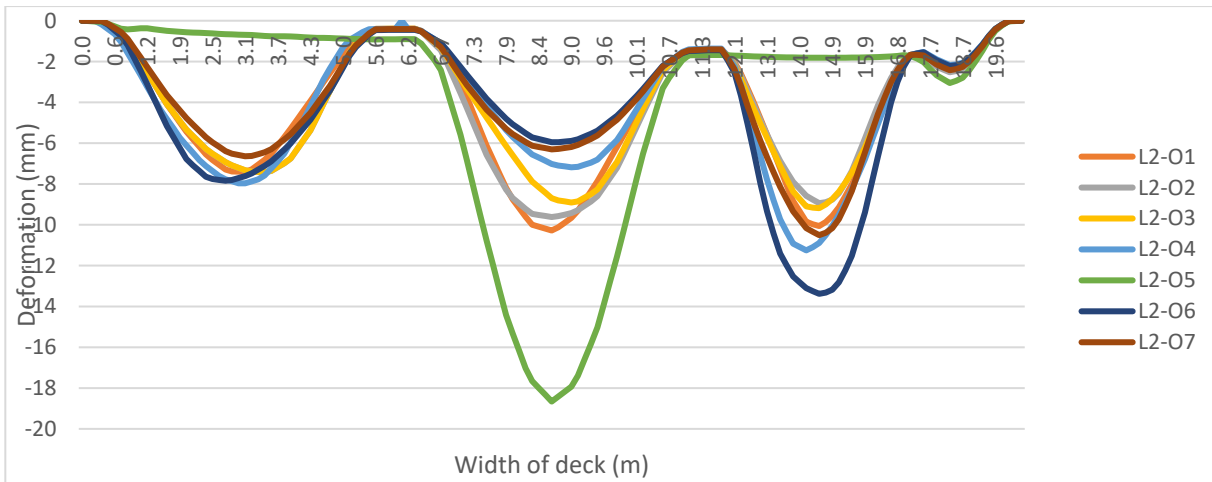
c) Damage Level 3

Figure 3- 15: Multiple ribs study – Bottom ribs longitudinal direction

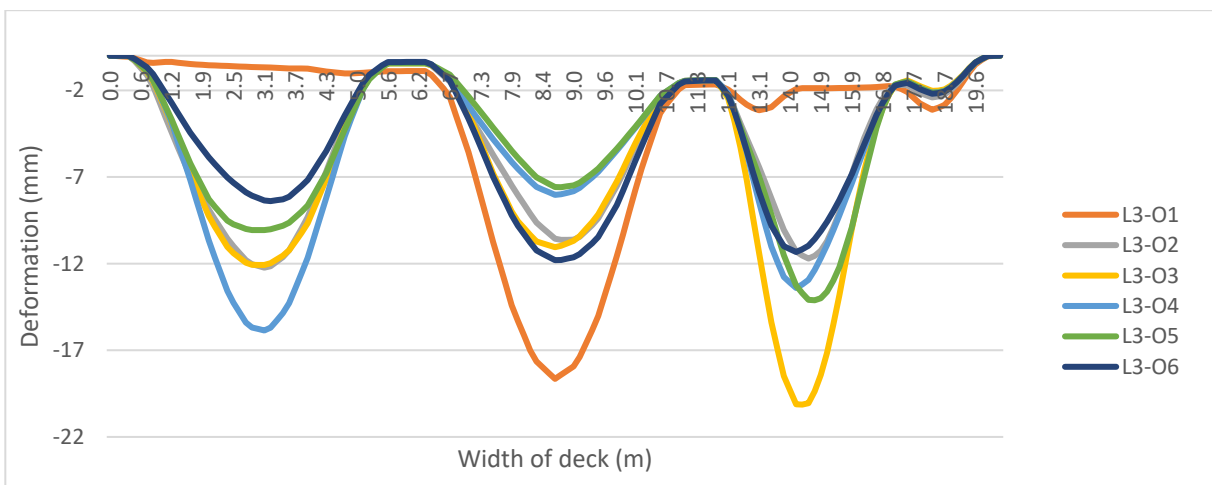
The collection of graphs in Figure 3-16 represents the deformation on the transversal direction of the bottom deck plate. The horizontal axis describes the length of the deck at 18.3m, while the vertical axis showcases the deformation in mm. Considering all the damage levels represented, the deformation in the three spans is approximately within the same range, with the exception of cases L2-O5 and L3-O1, where the deformation is significantly higher on spans 1 and 3, the deformation is at 0, and observing, it should be mentioned that there is no suppression of ribs at these locations. This illustration proves that the presence of ribs is effective in reducing the deformation of deck plates.



a) Damage Level 1



b) Damage Level 2



a) Damage Level 3

Figure 3- 16: Multiple ribs study – Bottom rib transversal direction

Representing the deformation behavior of the deck components is an important tool for identifying DDM response patterns. The deformation behavior of this deck module was analyzed in both transversal and longitudinal directions. The findings reveal that the graphs of deformation behavior in both directions have some similarities and differences.

When comparing Figure 3-13 to 3-16, it can be summarized that there is a gradual increase in deformation between different damage levels. The results were grouped as follow:

- Damage Level 1 for deformations below 14 mm (top and bottom plates)
- Damage Level 2 for deformations below 20 mm (top and bottom plates)
- Damage Level 3 for deformations below 35 mm for top ribs and 22 mm for bottom ribs

This suggests that the deformation behavior of the DDM steel deck changes as the damage level increases, indicating that the structure is reaching a potential critical point. Finally, L2-O5 and L3-O1 were identified as the two cases for which the deformation is minimal, when the vertical stiffeners are in place (not corroded). It proves that the point where the stiffeners are located is a critical location, indicating that the presence of ribs helps reducing the deformation.

### **3.5.1 General Corrosion Model**

General corrosion model is considered in this study as a form of corrosion that occurs uniformly over the surface of a metal, resulting in a reduction in material thickness. In FE modeling, this phenomenon can be simulated by reducing the thickness of the affected areas of the model. The thickness reduction can be achieved by modifying the thickness values of the elements in the affected regions to represent the amount of material loss due to corrosion. The design thicknesses for the top and bottom steel deck plates, as well as the vertical stiffeners, were 18mm. For the ribs of the Stonecutter Bridge deck, the design thickness was 9mm. The thickness reduction of the orthotropic steel deck (OSD) due to advanced corrosion can be significant, thus it was categorized into three damage levels (referring to damage classification presented in Table 3.1):

- 25% thickness reduction (damage level 1)
- 50% thickness reduction (damage level 2)
- 75% thickness reduction (damage level 3)

Here's how the thickness reduction classification relates to Table 3-1:

**Damage Level 1 (Moderate Visible Damage):**

This corresponds to a 25% reduction in thickness. At this level, while the corrosion may not be highly visible, it has begun to compromise the structural integrity to some extent. This aligns with the concept of moderate visible damage in Table 3-1, where detailed examination is needed to determine the necessity of repair.

**Damage Level 2 (Substantial Visible Damage):**

This level corresponds to a 50% reduction in thickness. At this stage, the corrosion is more apparent and has significantly weakened the affected components. It corresponds to substantial visible damage in Table 3-1, where immediate repair is deemed necessary after detailed study.

**Damage Level 3 (Severe Visible Damage):**

This level corresponds to a 75% reduction in thickness. The corrosion-induced reduction in thickness is severe, posing a significant hazard to the structural integrity and safety of the bridge. This aligns with severe visible damage in Table 3-1, which requires urgent attention and poses a hazard to traffic safety. By providing a quantitative measure of thickness reduction, this classification system complements the qualitative assessment of visible damage levels in Table 3-1, offering a more detailed understanding of the extent of corrosion-induced deterioration and its implications for the structural integrity of the bridge.

This quantification was based on the understanding that after 75% of the mean corrosion depth, the element reaches its fatigue strength. The mean corrosion depth emerged as a crucial factor influencing the deformation and displacement of orthotropic steel bridge decks and u-ribs.

### **3.6 Results of General Corrosion Model**

When considering 25%, 50% and 75% steel plate thickness reduction, while maintaining the inside ribs and stiffeners undamaged, the following deformations were recorded: for 25% reduction, the top deck displays a maximum deformation of up to 8mm, while the vertical stiffeners exhibit varying deformation based on the direction (Fig. 3-17 a)). The bottom plate of the deck experiences



a higher deformation than the top deck plate. This can be seen in Figures 3-17 a), b) and c), where the color varies from light blue to dark blue signifying that the deformation is low. The bottom of the deck is subjected to tensile forces, which can lead to greater deformation or sagging of the bottom surface, especially in this case where the steel is compromised due to corrosion. Note that 25% and 50% reduction, the maximum deformation is in the bottom plate. At the 75% level, the maximum deformation is located on first vertical stiffeners, which means this could be a localized deformation.

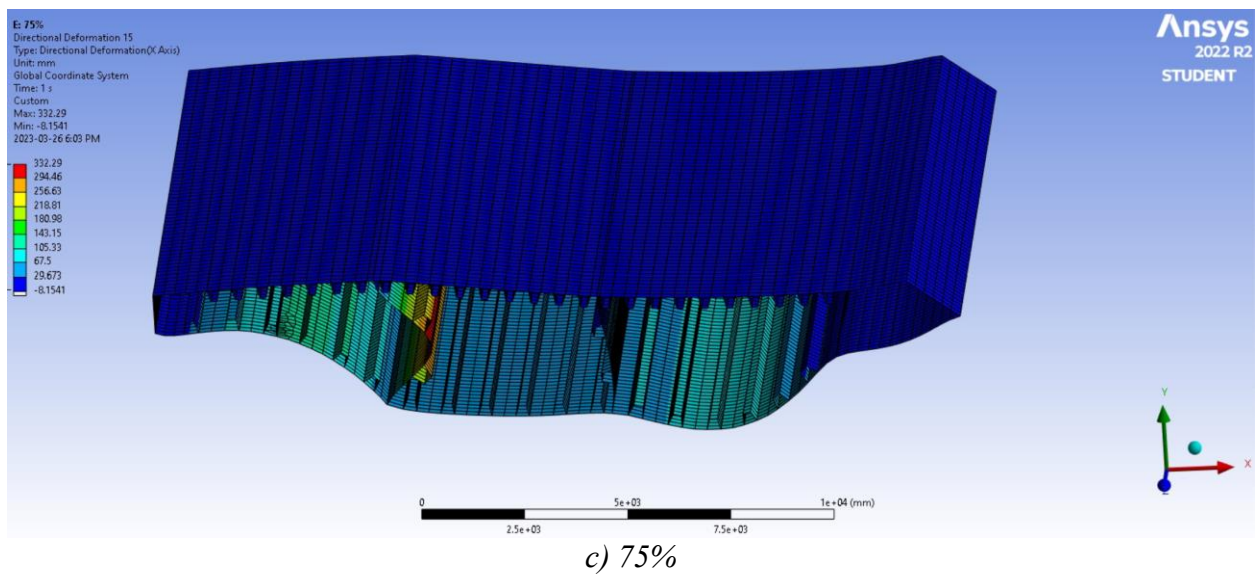
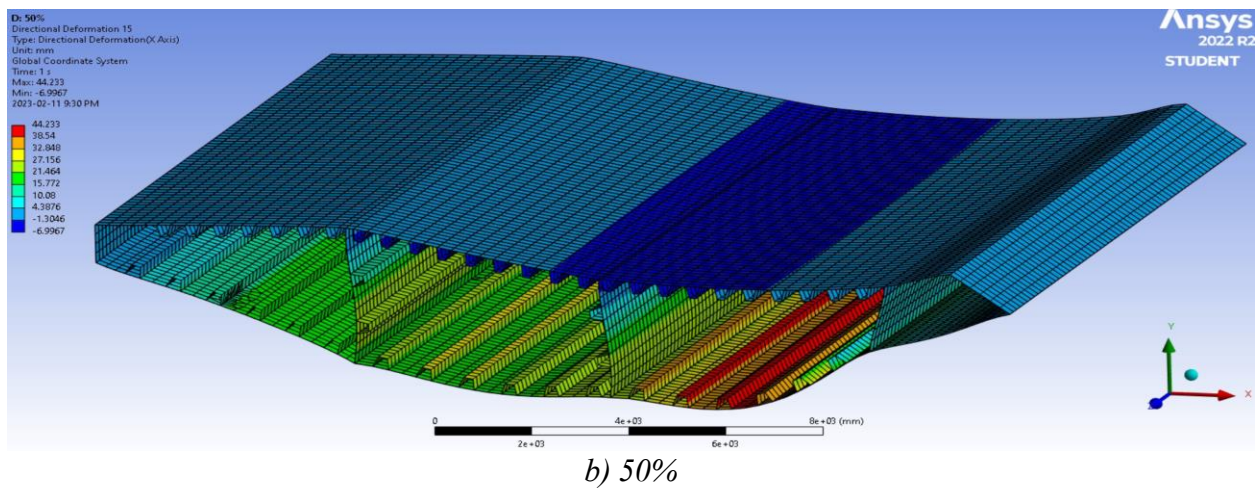
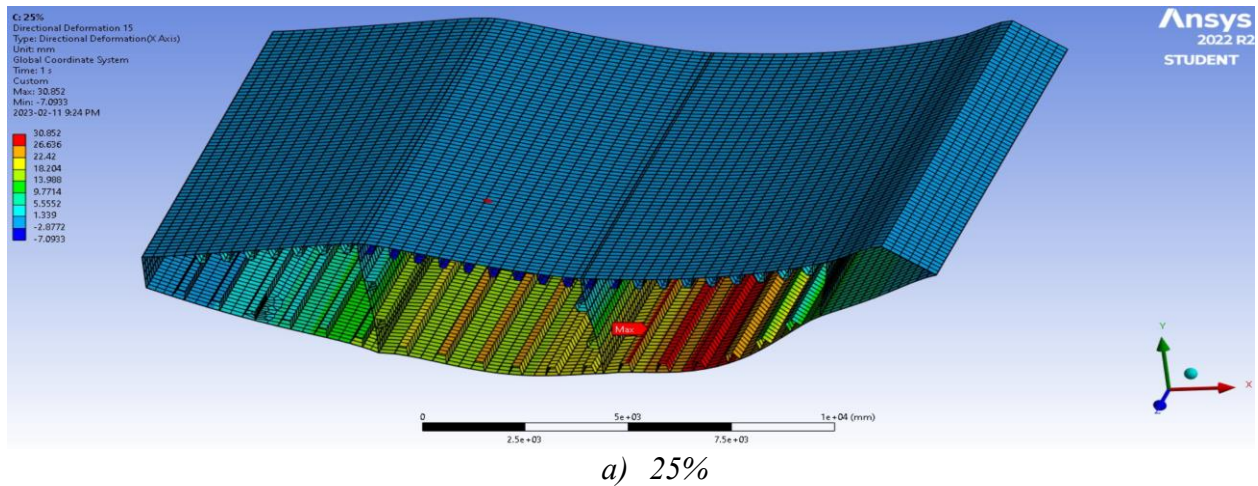


Figure 3- 17: General corrosion induced deformation of DDM segment

All the data extracted for investigating the effect of the general corrosion on the overall DDM segment can be found in Appendix G; only critical cases are presented below. As it can be noticed in Fig. 3-18, on the bottom deck plate, all three parts exhibit varying deformation on both longitudinal and transversal directions. As the thickness was reduced, the deformation increases up to three times. The highest deformation observed is below 180mm. Based on Figure 3-18, the two exteriors' parts are experiencing high deformation.

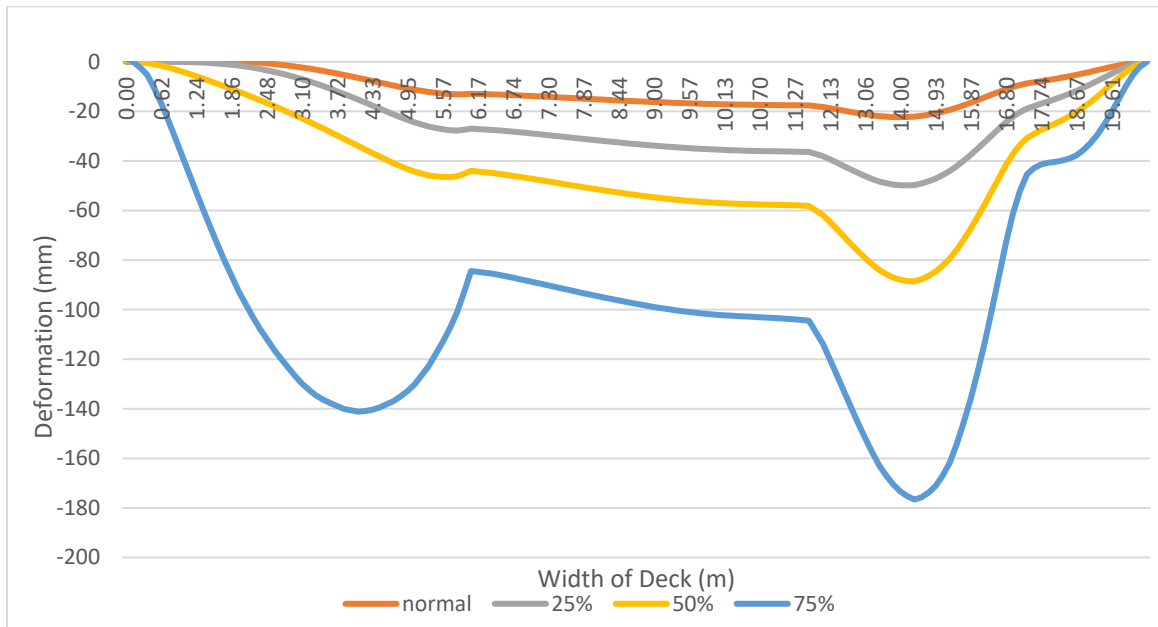
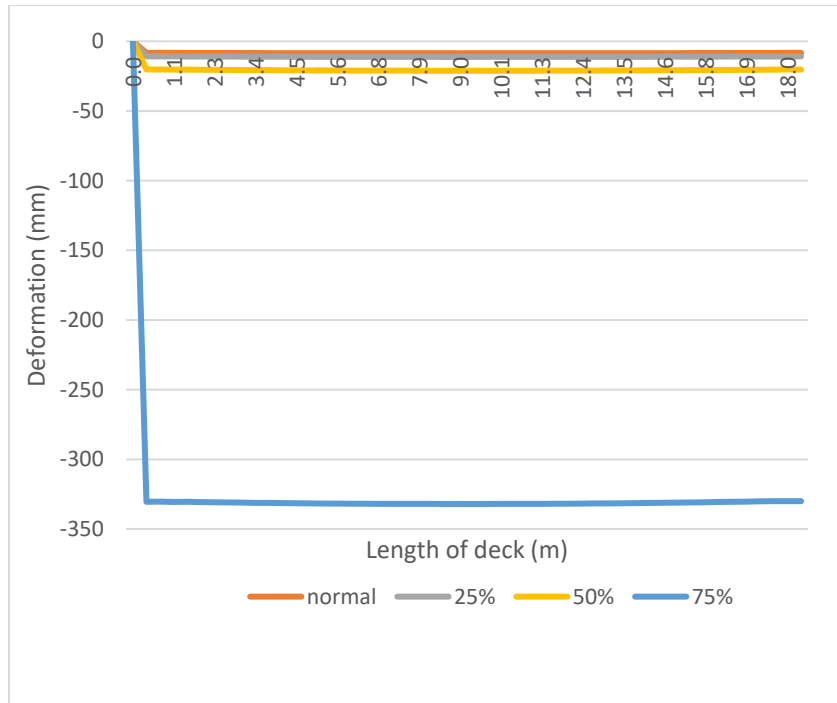
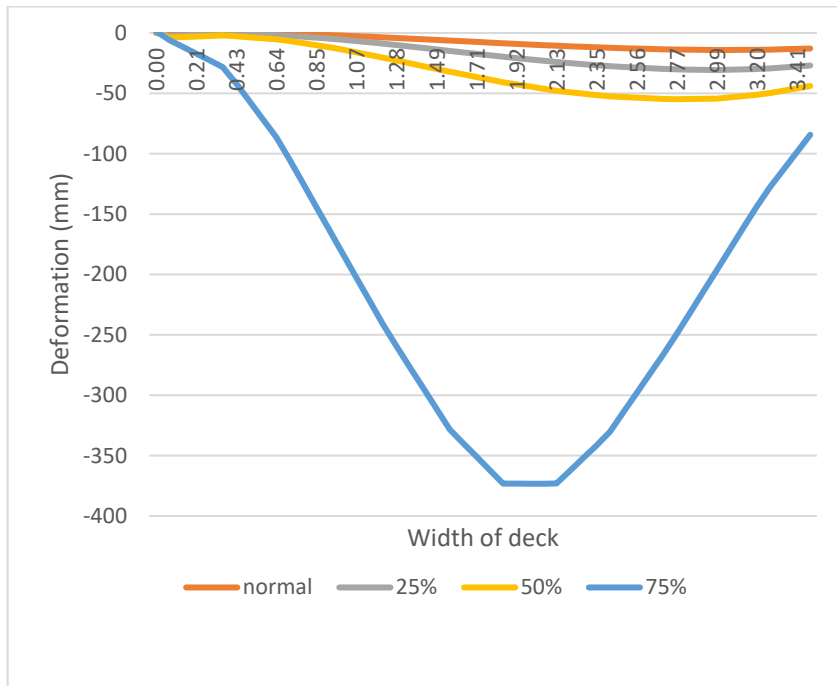


Figure 3- 18: Bottom deck plate– transversal direction

The same parametric study, of reducing the thickness (25%, 50% and 75%), was performed for the three vertical stiffeners, and the deformations were represented in Fig. 3-19. It was noticed that the stiffener 3 had the lowest amount of deformation with a maximum value of 50 mm, followed by stiffener 2 with 140 mm maximum deflection. Stiffener 1 experiencing the highest deformation, showing a difference of 8 times between design thickness and reduction of 75%, as represented in Figure 3-19. The deformation remains the same for the thickness reductions of 25% and 50%. There is a drastic change when the reduction of 75% is applied to the model, increasing the deformation by 16 times, for both longitudinal and transversal directions.



a) Longitudinal direction



b) Transversal Direction

Figure 3- 19: Deformation Stiffener 1

In conclusion, the results show that for the general corrosion case, the deformation is higher in the transversal direction compared to the longitudinal direction. Orthotropic steel decks (OSD) are

designed to be stronger and more rigid in the longitudinal direction, which is the direction of the traffic flow. In general, this is achieved by placing more and thicker longitudinal stiffeners, which provide the deck with more resistance against bending and torsion.

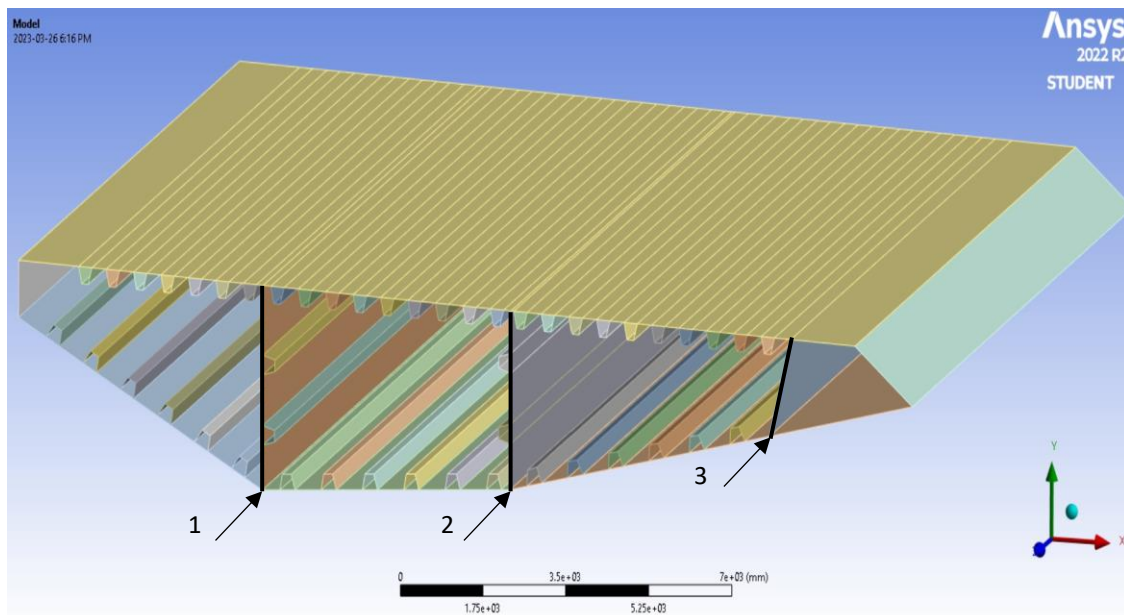
When the deck is subjected to a load, such as the traffic or live load, this is transmitted to the deck through the longitudinal direction. This results in more bending of the deck in the longitudinal direction, which causes less deformation in this direction compared to the transversal direction. However, wind loads can also contribute to the deformation, and wind is more likely to act on the bridge deck from the transverse direction. This can cause additional deformation in the transverse direction, which can be compounded by the deck's lower resistance to bending and torsion in this direction. Therefore, the combination of the bridge deck's design and loading conditions can lead to higher deformation in the transverse direction compared to the longitudinal direction, which can be aggravated by the potential damage induced by corrosion of OSD steel elements.

### **3.6.1 General Corrosion for Vertical Stiffeners**

To complete the investigation of the corrosion-induced damage for the Stonecutters Bridge box deck, finally the local corrosion is modeled for the vertical stiffeners 1, 2 and 3 as shown in Fig. 3.20.

"Local corrosion" typically refers to corrosion that occurs in specific areas or localized regions of a structure, as opposed to uniform general corrosion that affects the entire surface uniformly. In the context of the Stonecutters Bridge box deck investigation, modeling local corrosion for the vertical stiffeners 1, 2, and 3 as shown in Figure 3.20, means the modeling focuses on simulating corrosion damage in specific regions or sections of these stiffeners. Designating this as "local corrosion" suggests that the corrosion induced damage is concentrated in certain areas rather than being distributed uniformly across the entire length or surface of the stiffeners. Thus, local corrosion modeling could represent corrosion pits, localized thinning, or other forms of localized degradation that are commonly observed in real-world structures due to environmental factors or design considerations. In essence, while "local corrosion" may refer to damaged components, it specifically emphasizes the localized nature of the corrosion damage, highlighting the need to model and analyze its effects in a targeted manner. This approach allows for a more accurate

assessment of the structural integrity and performance of the stiffeners under realistic corrosion conditions. “General Corrosion” on the other hand, refers to modelling an uniform reduction of cross-section area for certain sections of the element investigated. Thus in the current section several patterns of corrosion for I-beams were identified based on the existing literature, and surface reduction was modelled for the corresponding segments of the stiffeners considered as damaged in this research.



*Figure 3- 20: Vertical stiffeners of Stonecutters bridge*

The investigation into the effect of different types of corrosion patterns on the deformation of the orthotropic deck was based on the corrosion patterns identified in the literature for a steel I-beam (Tzortzinis et al., 2021). The corrosion patterns, namely N2, N4, and N5, were selected based on their reported significant impact on DDM deformation in the study by Tzortzinis et al. (2021). The application of these corrosion patterns to the vertical stiffener of the deck was determined through a careful consideration of the literature findings and the observed influence of each pattern on structural deformation.

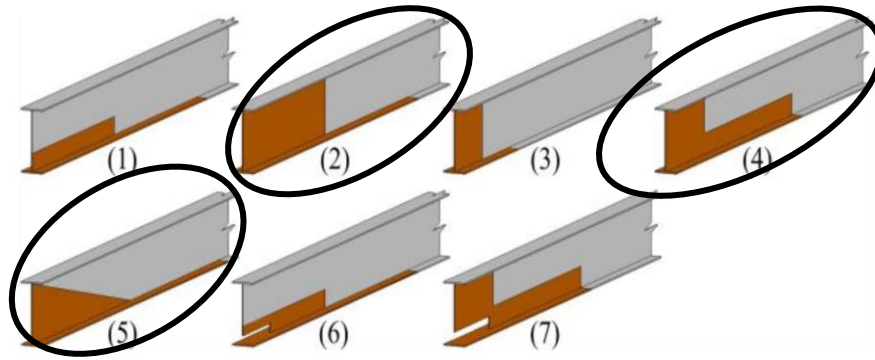


Figure 3- 21: Local corrosion pattern

Corrosion patterns 1 to 5 describe areas with thickness reduction, while patterns 6 and 7 describe holes areas projected on the thickness reduction. Also, patterns 6 and 7 are used to investigate the effect of the holes on the bearing capacity of the I-beam. Unfortunately, this model could not be run due to a lack of computing capacity and the number of CPU cores used by the *ANSYS v22.2* software. Three patterns 2, 4 and 5, (N2, N4 and N5 respectively) were applied to the vertical stiffeners of the current DDM deck and one model per each pattern was created, while within each file the model was duplicated to represent the damage classification. Levels 1, 2 and 3 had a thickness reduction of 25%, 50% and 75% respectively. Table 3-5 presents the dimensions of the thickness reduction area for each model. It should be noted that for corrosion N4, there are two values presented for the height and length of reduced area. This is to represent the two possible dimensions in the pattern. Appendices H, I and J provide more detailed information.



Table 3- 5: Dimensions of vertical stiffeners for N2, N4 and N5

| Vertical Stiffener 1 |            |            |               |            |            |               |            |            |               |
|----------------------|------------|------------|---------------|------------|------------|---------------|------------|------------|---------------|
| Corrosion Type       | Level 1    |            |               | Level 2    |            |               | Level 3    |            |               |
|                      | Height (m) | Length (m) | Thickness (m) | Height (m) | Length (m) | Thickness (m) | Height (m) | Length (m) | Thickness (m) |
| N2                   | 3.41       | 4.5        | 13.5          | 3.41       | 9          | 9             | 3.41       | 13.5       | 4.5           |
| N4                   | 3.41/0.86  | 1.1/4.5    | 1.35          | 3.41/1.71  | 2.25/9     | 9             | 3.41/2.56  | 3.38/13.5  | 4.5           |
| N5                   | 3.41       | 4.5        | 13.5          | 3.41       | 9          | 9             | 3.41       | 13.5       | 4.5           |
| Vertical Stiffener 2 |            |            |               |            |            |               |            |            |               |
| N2                   | 2.98       | 4.5        | 13.5          | 2.98       | 9          | 9             | 2.98       | 13.5       | 4.5           |
| N4                   | 2.98/0.75  | 1.13/4.5   | 13.5          | 2.98/1.49  | 2.25/9     | 9             | 2.98/2.24  | 3.38/13.5  | 4.5           |
| N5                   | 2.98       | 4.5        | 13.5          | 2.98       | 9          | 9             | 2.98       | 13.5       | 4.5           |
| Vertical Stiffener 3 |            |            |               |            |            |               |            |            |               |
| N2                   | 1.7        | 4.5        | 13.5          | 1.7        | 9          | 9             | 1.7        | 13.5       | 4.5           |
| N4                   | 1.7        | 4.5        | 13.5          | 1.7        | 9          | 9             | 1.7        | 13.5       | 4.5           |
| N5                   | 1.7/0.43   | 1.13/4.5   | 13.5          | 1.7/0.85   | 2.25/9     | 9             | 1.7/1.28   | 3.38/13.5  | 4.5           |

### 3.7 Results for Vertical Stiffeners General Corrosion

The results for the DDM deformation considering the general corrosion applied in patterns N2, N5 and N5 to the vertical stiffeners, are presented in Tables 3-6 to 3-11. The response obtained under dead load showed that for all levels of damage, the N2 corrosion pattern had the worst deformation of 56mm (Table 3-6, Level 3, two stiffeners), while N4 and N5 patterns had similar deformation values of maximum 20mm (Tables 3-8 to 3-11). It is important to note that the extent and nature of the damage can determine the degree to which the DDM moment of inertia is affected. Small or localized damage may have a relatively minor effect on the moment of inertia, while more extensive damage, or damage that is distributed throughout the component can have a more significant impact. Below is a summary and insight of each table while the detailed data is in Appendices H to I.

N2 – longitudinal direction (Table 3-6):



- The minimum deformation values generally increase as the number of stiffeners increases from level 1 to level 3.
- The maximum deformation values also tend to increase with the numbers of stiffeners, but the increase is more significant compared to the minimum values.

*Table 3- 6: Local corrosion N2 – longitudinal direction*

| Deformation | Level 1        |                 |                 | Level 2        |                 |                 | Level 3        |                 |                 |
|-------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
|             | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners |
| Min (mm)    | 0.221          | 0.233           | 5.547           | 5.022          | 4.957           | 4.894           | 5.720          | 5.570           | 5.515           |
| Max (mm)    | 2.903          | 10.414          | 10.424          | 11.587         | 11.878          | 11.982          | 54.836         | 56.061          | 50.750          |

N2 – transversal direction (Table 3-7):

- The minimum deformation values remain relatively stable across different levels and number of stiffeners. This could be due to the shape and location of the corrosion, which may cause a relatively uniform distribution of stresses and strains in the transversal direction.
- The maximum deformation values increase as the number of stiffeners increases from level 1 to level 3. Should be noted that the range of deformation values for N2 (transversal) is larger than that of N2 (longitudinal).

*Table 3- 7: Local corrosion N2 – transversal direction*

| Deformation | Level 1        |                 |                 | Level 2        |                 |                 | Level 3        |                 |                 |
|-------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
|             | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners |
| Min (mm)    | 1.230          | 1.886           | 1.884           | 1.941          | 1.951           | 1.941           | 1.892          | 1.869           | 1.105           |
| Max (mm)    | 2.700          | 18.153          | 18.193          | 18.512         | 18.721          | 18.920          | 33.273         | 34.003          | 30.735          |

N4 – longitudinal direction (Table 3-4):

- The minimum deformation values decrease as the number of stiffeners increase from level 1 to level 3.
- The maximum deformation values show a slight variation, with some fluctuations across different levels and number of stiffeners.

*Table 3- 8: Local corrosion N4 – longitudinal direction*

| Deformation | Level 1        |                 |                 | Level 2        |                 |                 | Level 3        |                 |                 |
|-------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
|             | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners |
| Min (mm)    | 5.722          | 5.696           | 5.691           | 5.174          | 5.017           | 5.030           | 2.222          | 1.457           | 1.457           |
| Max (mm)    | 9.488          | 9.491           | 9.440           | 10.062         | 10.056          | 9.965           | 18.753         | 18.875          | 18.822          |

N4 – transversal direction (Table 3-9):

- The minimum deformation values are relatively consistent across different levels and number of stiffeners. The maximum deformation values show a slight increase as the number of stiffeners increase from Level 1 to Level 3.
- The deformation is relatively small. This suggest that this type of deformation doesn't impact the deck on a larger scale.

*Table 3- 9: Local corrosion N4 – transversal direction*

| Deformation | Level 1        |                 |                 | Level 2        |                 |                 | Level 3        |                 |                 |
|-------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
|             | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners |
| Min (mm)    | 2.268          | 2.3             | 2.298           | 2.418          | 2.440           | 2.549           | 2.782          | 2.810           | 2.817           |
| Max (mm)    | 18.174         | 18.289          | 18.306          | 18.691         | 18.878          | 19.255          | 18.824         | 18.921          | 19.024          |

N5 – longitudinal direction (Table 3-10):

- The minimum deformation values decrease as the number of stiffeners increase from Level 1 to Level 3. It seems that the deformation in the longitudinal direction is constrained, leading to lower minimum deformation values.
- The maximum deformation values also decrease as the number of stiffeners increases.
- With these results, it leads us to understand that the effect of stiffeners on deformation is not linear.

*Table 3- 10: Local corrosion N5 – longitudinal direction*

| Deformation | Level 1        |                 |                 | Level 2        |                 |                 | Level 3        |                 |                 |
|-------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
|             | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners |
| Min (mm)    | 5.316          | 5.271           | 5.279           | 3.276          | 3.181           | 3.204           | 1.522          | 1.544           | 1.424           |
| Max (mm)    | 9.447          | 9.450           | 9.426           | 11.060         | 11.055          | 11.038          | 17.736         | 17.822          | 17.777          |

N5 – transversal direction (Table 3-11):

- The minimum deformation values decrease as the number of stiffeners increases from Level 1 to Level 3.
- The maximum deformation values show a slight increase with the number of stiffeners.

*Table 3- 11: Local corrosion N5 – transversal direction*

| Deformation | Level 1        |                 |                 | Level 2        |                 |                 | Level 3        |                 |                 |
|-------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------|-----------------|-----------------|
|             | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners | 1<br>Stiffener | 2<br>Stiffeners | 3<br>Stiffeners |
| Min (mm)    | 2.151          | 2.156           | 2.153           | 2.405          | 2.421           | 2.414           | 3.008          | 3.034           | 3.048           |
| Max (mm)    | 18.058         | 18.096          | 18.116          | 18.358         | 18.545          | 18.62           | 18.360         | 18.571          | 18.635          |

The results of the parametric studies obtained in Chapter 3 will be utilized to investigate the Stonecutters Bridge deck response, by applying damage to the steel deck span. The detailed damage levels quantification developed for ribs and stiffeners affected by corrosion, will be employed for determining the structural properties of one Damaged Deck Module (DDM) with further application to the steel deck of the Stonecutters Bridge, as described in the following Chapter.

## CHAPTER 4 – STONECUTTERS BRIDGE RESPONSE WITH DAMAGED DECK MODULES

Investigating the damage on a single deck module (DDM) helped quantify the damage levels for one isolated component of the Stonecutters Bridge deck. However, to clarify the structural response of the entire bridge for different levels of damage, the DDM needs to be placed on the bridge deck and a structural analysis must be completed. The current Chapter answers this problem by adding a comprehensive investigation of the Stonecutter's Bridge behaviour with different damage levels of the DDM, positioned at different locations along the bridge deck, starting with the most critical point, which is the middle of the span. Considering the parametric study conducted for the DDM module introduced in Chapter 3, the following sub-sections delve into essential aspects for determining the Stonecutter's Bridge response after considering several DDM damage scenarios.

### 4.1 Damage Modelling for The Stonecutters Bridge Deck

To understand the structural response of the entire Stonecutters Bridge for different damage levels of its deck, this Chapter transitions from the isolated investigation of a single deck module (DDM) to the comprehensive analysis of the entire bridge deck. This will help determine how the Stonecutters Bridge responds under various deck damage scenarios. The DDM damage levels are adapted for inclusion on the main deck of the Stonecutters Bridge which includes a transition from the *ANSYS v22.2* DDM investigation to the *ABAQUS* FEM of the entire Stonecutters Bridge Model. Such transition involves a simplification of the DDM model, for which the main structural properties should be transferred from *ANSYS v22.2* to the Stonecutters Bridge FEM model in *ABAQUS*. Damage modelling for segments of the entire bridge deck and the simplification between the DDM model in *Ansys v22.2* and the Stonecutters FE model in *ABAQUS* include the following steps:

#### Step 1: Incorporating damages in *ABAQUS*

To assess damage to the Stonecutters deck, different levels of deformation are considered, spanning from minimum to maximum deformation for both top and bottom ribs. This approach covers all possible scenarios between these extremes. General and local corrosion effects on the

steel span deck are also considered. Different scenarios are formulated to represent various damage levels, and these damages are applied to the bridges for evaluation of the structural response.

### Step 2: Damage model for Stonecutters Bridge deck

The second section focuses on investigating the natural frequency, vibration mode shapes and deformation patterns of the Stonecutters Bridge, exploring how they respond to the structural changes induced by the DDM modelled damage. The aim is to understand how the damages impact the natural vibration mode shapes, which can offer insight in understanding the bridge behavior in cases of corrosion.

#### 4.1.1 Selection of DDM Damage Cases

This section presents the behaviour of the entire steel deck considering corroded ribs placed at different locations along the middle span of the Stonecutters Bridge model. The deformation range for each DDM level damage, as classified in the previous Chapter, are investigated under dead and wind loads applications. By considering the minimum and maximum deformation values for both the top and bottom ribs, the analysis covers all possible cases between these extremes, ensuring a comprehensive evaluation of the structure's response to various damage scenarios. The resulting data is organized, providing a clear representation of the deformation patterns.

Furthermore, the study extends to explore the effects of DDM general corrosion and local corrosion on the orthotropic steel deck of the bridge. Separate scenarios are created for each type of corrosion, with multiple cases generated to represent different damage levels. By meticulously analyzing 56 DDM modular decks, comprising of 28 cases per level, the research uncovers the impact of varying degrees of corrosion on the structure's behaviour. Assessment is employed to refine the analysis cases, removing cases with minimal impact on the simulation and enhancing the study's accuracy and efficiency. The section also divides the Stonecutter's Bridge main deck into three parts where DDM models are successively applied, allowing to gain insight into the behaviour of different sections of the structure.

#### Corroded ribs:

To analyze the behavior of the corroded ribs, it was necessary to determine the range of deformation for each DDM level of damage classification. This was accomplished by selecting the

minimum and maximum deformation values for both the top and bottom ribs, to fully consider all possible cases between these extreme values.

The resulting deflection under dead load, for the given corroded ribs, is presented in Figure 4-1, with each column number representing a different rib, while the locations of the vertical stiffeners were denoted by the label “VS#”. Figure 4-1 introduces two options per each damage level. As mentioned in Chapter 3, stiffeners 1, 2, 20 to 26 (red cells in Figure 4-1) were not included in this study because they are located on the hard shoulder of the deck, where they experience much lower cyclic loadings, when compared to the ribs between 3 and 20 on the top surface.

The boxes filled in Figure 4-1a and b, demonstrate which ribs were suppressed due to damage. For example, for the case L3-O2, ribs 3 to 13 were suppressed (which resulted in a Level 3 damage for the DDM, Fig 3-5), while for the case L2-O3, only ribs 5-7, 9, 11, 13 and 15 were removed from the analysis, which led to a Level 2 DDM damage (Figure 3-5). The exact locations of the suppressed ribs introduced in Figure 4-1, are illustrated in Figure 4-2. It should be noted that a complete classification of the DDM damage cases was detailed in Appendix K for corroded ribs under general corrosion and local corrosion cases. This methodical approach to analyzing the deformation of corroded ribs ensures a comprehensive understanding of the deck’s behaviour under a range of damage scenarios.

| Level -<br>Option |   |   |   |   |   |   | VS1 |   |   |    |    |    |    |    |    |    | VS2 |    |    |    |    |    |    |    |    |    |
|-------------------|---|---|---|---|---|---|-----|---|---|----|----|----|----|----|----|----|-----|----|----|----|----|----|----|----|----|----|
|                   | 1 | 2 | 3 | 4 | 5 | 6 | 7   | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17  | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| L1 - O2           |   |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |    |    |    |    |    |    |    |
| L1 - O4           |   |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |    |    |    |    |    |    |    |
| L2 - O2           |   |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |    |    |    |    |    |    |    |
| L2 - O5           |   |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |    |    |    |    |    |    |    |
| L3 - O1           |   |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |    |    |    |    |    |    |    |
| L3 - O2           |   |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |    |    |    |    |    |    |    |

a) Top ribs

| Level -<br>Option |   |   |   |   | VS1 |   |   |   |   |    |    |    | VS2 |    |    |    |    |    |
|-------------------|---|---|---|---|-----|---|---|---|---|----|----|----|-----|----|----|----|----|----|
|                   | 1 | 2 | 3 | 4 | 5   | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13  | 14 | 15 | 16 | 17 | 18 |
| L1 - O4           |   |   |   |   |     |   |   |   |   |    |    |    |     |    |    |    |    |    |
| L1 - O5           |   |   |   |   |     |   |   |   |   |    |    |    |     |    |    |    |    |    |
| L2 - O3           |   |   |   |   |     |   |   |   |   |    |    |    |     |    |    |    |    |    |
| L2 - O5           |   |   |   |   |     |   |   |   |   |    |    |    |     |    |    |    |    |    |
| L3 - O3           |   |   |   |   |     |   |   |   |   |    |    |    |     |    |    |    |    |    |
| L3 - O6           |   |   |   |   |     |   |   |   |   |    |    |    |     |    |    |    |    |    |

b) Bottom ribs

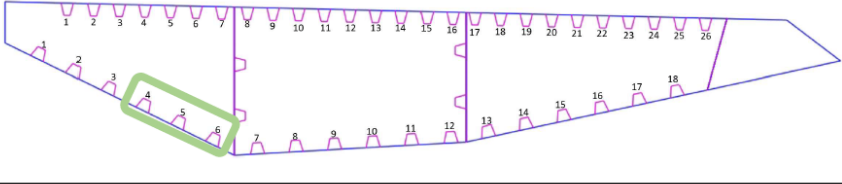
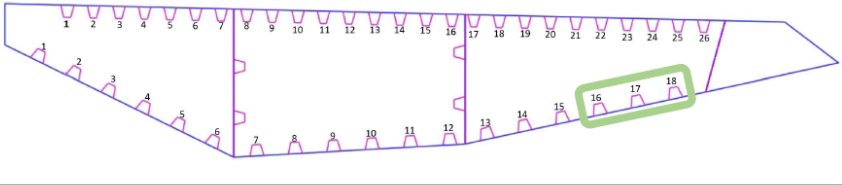
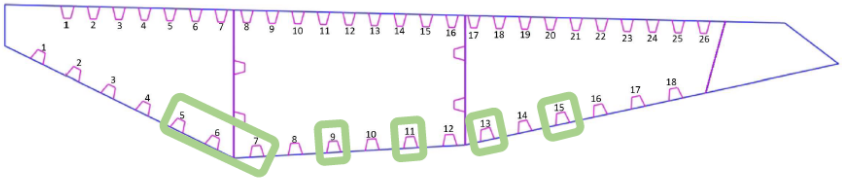
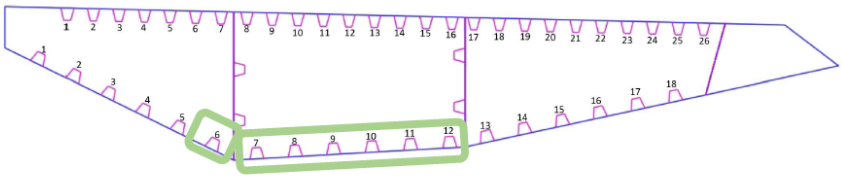
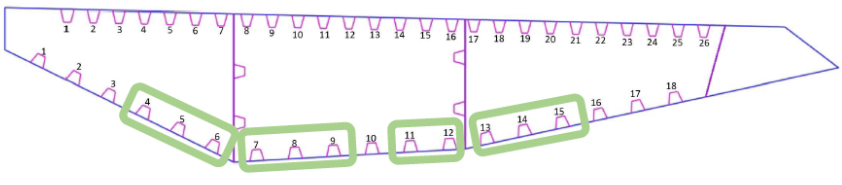
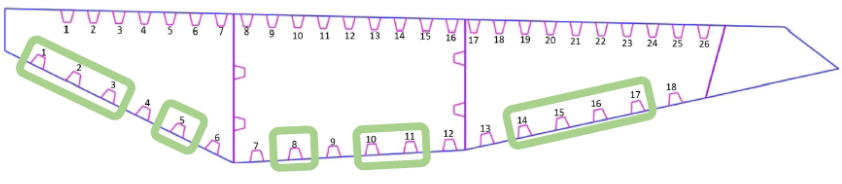
Figure 4- 1: Scenario of corroded ribs

Figure 4-2 is a visual representation of Figure 4-1. It shows the numbered ribs in the orthotropic steel deck. With the help of the green box, the damaged ribs are frames accordingly to Figure 4-1.

| Damages                | Level | Name       | Description |
|------------------------|-------|------------|-------------|
| Corroded ribs<br>(top) | 1     | L1-O2(MIN) |             |
|                        |       | L1-O4(MAX) |             |
|                        | 2     | L2-O5(MIN) |             |
|                        |       | L2-O2(MAX) |             |
|                        | 3     | L3-O2(MIN) |             |
|                        |       | L3-O1(MAX) |             |

a) top



| Damages                   | Level | Name       | Description                                                                          |
|---------------------------|-------|------------|--------------------------------------------------------------------------------------|
| Corroded ribs<br>(bottom) | 1     | L1-O4(MIN) |    |
|                           |       | L1-O5(MAX) |    |
|                           | 2     | L2-O3(MIN) |    |
|                           |       | L2-O5(MAX) |   |
|                           | 3     | L3-O6(MIN) |  |
|                           |       | L3-O3(MAX) |  |

b) bottom

Figure 4- 2: Location of corroded ribs on top and bottom ribs

For each scenario presented above, Tables 4-1 and 4-2 shows the deformation.

*Table 4- 1: Top Ribs - Deformation*

| <b>Level-Option</b> | <b>Type</b> | <b>Deformation (mm)</b> |
|---------------------|-------------|-------------------------|
| L1-O2               | Min         | 7.801                   |
| L1-O4               | Max         | 8.309                   |
| L2-O5               | Min         | 8.295                   |
| L2-O2               | Max         | 19.344                  |
| L3-O2               | Min         | 7.819                   |
| L3-O1               | Max         | 33.507                  |

The feasibility of reporting deformation to a precision of 1/1001/100 of a millimetre, or 0.01 mm, hinges on various factors. These include the precision of measurement equipment used (like high-precision callipers or laser tools), the nature and scale of the material being measured, the specific requirements of the application (critical in fields such as aerospace or microelectronics), and the consistency and error margins of the measurement process. Essentially, while such precision is achievable and necessary in certain high-precision fields, it's crucial to ensure that the measurement tools are adequately accurate and that such detail is pertinent and meaningful for the specific application.

*Table 4- 2: Bottom Ribs - Deformation*

| <b>Level-Option</b> | <b>Type</b> | <b>Deformation (mm)</b> |
|---------------------|-------------|-------------------------|
| L1-O4               | Min         | 8.458                   |
| L1-O5               | Max         | 12.420                  |
| L2-O3               | Min         | 9.190                   |
| L2-O5               | Max         | 18.659                  |
| L3-O3               | Min         | 11.844                  |
| L3-O6               | Max         | 20.201                  |

The minimum and maximum deformations, presented in Tables 4-1 and 4-2, indicate that the extent of deformation can vary significantly depending on the specific damage level and option considered. Typically, greater deformations occur at elevated damage levels. The deformation values tend to increase when suppressing both top and bottom ribs. For instance, in Table 4-1, the maximum deformation for L1-O4 is 8.309 mm, while for L2-O2, it increases to 19.344 mm. Similarly, in Table 4-2, the maximum deformation for L1-O5 is 12.420 mm, while for L3-O6, it increases to 20.201 mm. This trend suggests that, as expected, higher levels of damage result in more significant deformation in the ribs. Moreover, there are also noticeable differences in the deformation values between top and bottom rib deformations at the same level and option. For example, in Table 4-1, for L2-O5, the minimum deformation for the top rib is 8.295mm, whereas the minimum deformation for the bottom ribs is 9.190mm. Similarly, for L3-O2, the maximum deformation for the top ribs is 33.507mm, whereas the maximum deformation for the bottom ribs is 18.659mm. This disparity suggests that the behaviour of the top and bottom ribs may differ under certain damage scenarios. Understanding the differences in the deformation values induced by the damage of the top and bottom ribs, is essential for assessing the structural performance of the entire deck. The variations in deformation between the top and bottom ribs directly impact load-bearing capacity and response to structural stress. With these results, it can be concluded that the bottom ribs might have higher areas of stress.

#### Stiffeners Corrosion:

To analyze the effects of various types and levels of damage induced by corrosion on a steel bridge deck, separate scenarios were created and based on their effect, a damage classification was assigned. For each corrosion-induced damage scenario, cases were generated to represent different levels of damage. Table 4-1 shows different corrosion types identified in the literature (N2 – rectangle, N4 – L-shape and N5-triangle, which can be applied to the vertical stiffeners of the deck, due to cross-section and aspect ratio similarities. These corrosion patterns were introduced in detail in Chapter 3 (Figure 3.21), along with the scenario that produces the minimum and the maximum deformation of the DDM deck, respectively. For N2, Level 1 for example, the columns MIN indicates that [S2; S123] case had the minimum deformation; for this case, the notation before the semicolon, S2, represents the stiffeners creating the deformation, while the notation after the semicolon, S123, represents the total number of stiffeners affected.

Table 4- 3: Scenarios for stiffeners corrosion

| Corrosion | Level | Scenario   |            |            |                 |
|-----------|-------|------------|------------|------------|-----------------|
|           |       | Min        | Value (mm) | Max        | Deflection (mm) |
| N2        | 1     | [S3; S123] | 5.543      | [S2; S12]  | 18.153          |
|           | 2     | [S3; S3]   | 5.022      | [S2; S123] | 18.920          |
|           | 3     | [S3; S3]   | 5.720      | [S1;S1]    | 54.836          |
| N4        | 1     | [S3; S3]   | 5.722      | [S2;S123]  | 18.306          |
|           | 2     | [S1; S123] | 5.030      | [S2; S123] | 19.255          |
|           | 3     | [S2; S2]   | 2.222      | [S3; S23]  | 18.921          |
| N5        | 1     | [S1; S1]   | 5.316      | [S2; S123] | 18.116          |
|           | 2     | [S1; S1]   | 3.276      | [S2; S123] | 18.620          |
|           | 3     | [S2; S2]   | -3.034     | [S2; S13]  | 18.571          |

The deformation values differ across these scenarios, indicating that various combinations of localized stiffener corrosion, as presented in Table 4-3, led to diverse impacts on the structure's deflection. Notably, for case corrosion type N5 Level 3, the scenario [S2; S2] shows a negative deformation of -3.034 mm, which implies a compression of the affected area. In simpler terms, when there is a negative deformation, it means that the material is undergoing a change in shape in the opposite direction of the applied force. In this specific case, the second stiffener is being compressed, while the rest of the stiffeners are under tension. Compression refers to a force that causes the material to change shape by reducing its length or volume. On the other hand, tension refers to a force that causes the material to stretch or elongate.

Compression of stiffeners in a steel orthotropic deck can introduce certain risks that need to be taken into account. These risks include the possibility of buckling, where the stiffener may deform in an unstable manner, leading to a reduction in its load-bearing capacity. Additionally, compression can weaken the stiffeners, resulting in a reduced ability to carry loads. It can also lead to stress concentration, where the compression forces become localized in specific areas,

increasing the likelihood of damage or failure. Finally, repeated compression can contribute to material fatigue, making the stiffeners more prone to cracking or failure over time. This compression of stiffeners in a steel orthotropic deck can have several potential risks to consider, including buckling, reduced load-bearing capacity, stress concentration, material fatigue, loss of stiffness, and issues with connections and welds, among others. These risks need careful assessment, as they can significantly impact the structural integrity of the entire deck.

The case S2 appears to consistently exhibit the maximum deformation, as observed in Table 4-3. Across all the combinations studied, except for N2 Level 3 and N4 Level 3, the maximum deformations were extracted from stiffener 2. This observation suggests that the trend of higher deformation in S2 is a general pattern for the investigated orthotropic steel deck. As for the exceptions, the reason for N2 Level 3 and N4 Level 3 diverging from this trend is not straightforward and warrants further investigation. Identifying the specific factors that make these cases exceptions could provide valuable insights into the behaviour of the structure. Furthermore, it's important to note that S2's location, which is in the middle of the span of the deck. This location is usually susceptible to higher loads due to its position. This location can result in increased stresses and deformations, as the middle of a span typically experiences greater forces compared to the edges or supports. In summary, Table 4-3 presents valuable insights into the behavior of the structure under various scenarios of local corrosion. It highlights the influence of different corrosion levels, the variation in scenarios, and the possibility of negative deformation. For each damage level, 28 cases were investigated, resulting in a total of 56 cases of DDM decks analyzed (see Appendices M, N and O). Looking at the deformation obtained under dead load, it was determined that the ribs corrosion and stiffeners corrosion should be treated as separate scenarios, rather than being combined into a single scenario. In the context of deformation under the effect of the dead load, it has been determined that the corrosion of ribs and stiffeners should be treated as separate scenarios rather than being combined into a single scenario. This approach is based on the analysis of the specific case and the understanding that the corrosion of ribs and stiffeners can have distinct effects on the structural behavior. The decision to treat ribs corrosion and stiffeners corrosion as separate scenarios is realistic and supported by research. For example, an experimental study on the degradation of fatigue properties of reinforcing steel bars due to corrosion indicated that laboratory salt spray exposures for 90 days and over, can simulate the

natural corrosion damage of steel bars in reinforced concrete structures at coastal sites (Apostolopoulos et al., 2010). This suggests that the corrosion of steel bars, including ribs and stiffeners, can accumulate over the service life of the structure. Furthermore, it is important to note that the term "ribs" can have different meanings depending on the context. In the case of steel orthotropic decks, ribs refer to structural elements that provide additional stiffness and support to the deck. Therefore, investigating the deformation in the context of steel ribs, allows for a more accurate assessment of the effects of corrosion on the structural behaviour of the steel orthotropic deck. To aid in the analysis, Tables 4-4 to 4-6 were created to map out the different damage scenarios and the corresponding DDM locations on the main span steel bridge deck.

*Table 4- 4: Definition of cases – Level 1*

| <b>Case</b> | <b>Top ribs</b> | <b>Bottom ribs</b> | <b>General corrosion</b> | <b>Local corrosion</b> |
|-------------|-----------------|--------------------|--------------------------|------------------------|
| C1-1        | L1-O2MIN        | L1-04MIN           | 25%                      | N/A                    |
| C1-2        | L1-O2MIN        | L1-05MAX           | 25%                      | N/A                    |
| C1-3        | L1-O4MAX        | L1-04MIN           | 25%                      | N/A                    |
| C1-4        | L1-O4MAX        | L1-05MAX           | 25%                      | N/A                    |
| C1-8        | L1-O2MIN        | L1-05MAX           | N/A                      | N2(MAX)S2;S12 – L1     |
| C1-10       | L1-O4MAX        | L1-04MIN           | N/A                      | N2(MAX)S2;S12 – L1     |
| C1-11       | L1-O4MAX        | L1-05MAX           | N/A                      | N2(MIN)S3;S123 – L1    |
| C1-12       | L1-O4MAX        | L1-05MAX           | N/A                      | N2(MAX)S2;S12 – L1     |
| C1-16       | L1-O2MIN        | L1-05MAX           | N/A                      | N4(MAX)S2;S123 – L1    |
| C1-18       | L1-O4MAX        | L1-04MIN           | N/A                      | N4(MAX)S2;S123 – L1    |
| C1-19       | L1-O4MAX        | L1-05MAX           | N/A                      | N4(MIN)S3; S3 – L1     |
| C1-20       | L1-O4MAX        | L1-05MAX           | N/A                      | N4(MAX)S2;S123 – L1    |
| C1-24       | L1-O2MIN        | L1-05MAX           | N/A                      | N5(MAX)S2;S123 – L1    |
| C1-26       | L1-O4MAX        | L1-04MIN           | N/A                      | N5(MAX)S2;S123 – L1    |
| C1-27       | L1-O4MAX        | L1-05MAX           | N/A                      | N5(MIN)S1; S1 – L1     |
| C1-28       | L1-O4MAX        | L1-05MAX           | N/A                      | N5(MAX)S2;S123 – L1    |

Table 4- 5: Definition of cases – Level 2

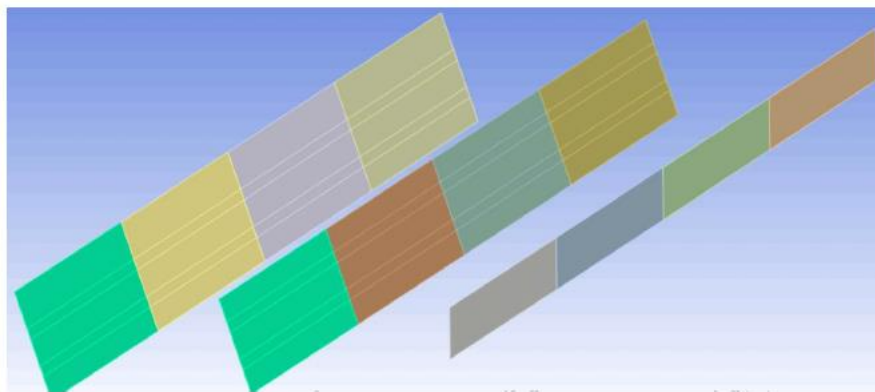
| Case  | Top ribs | Bottom ribs | General corrosion | Local corrosion     |
|-------|----------|-------------|-------------------|---------------------|
| C2-1  | L2-O5MIN | L2-O3MIN    | 50%               | N/A                 |
| C2-2  | L2-O5MIN | L2-O5MAX    | 50%               | N/A                 |
| C2-3  | L2-O2MAX | L2-O3MIN    | 50%               | N/A                 |
| C2-4  | L2-O2MAX | L2-O5MAX    | 50%               | N/A                 |
| C2-8  | L2-O5MIN | L2-O5MAX    | N/A               | N2(MAX)S2;S12 - L2  |
| C2-10 | L2-O2MAX | L2-O3MIN    | N/A               | N2(MAX)S2;S12 - L2  |
| C2-11 | L2-O2MAX | L2-O5MAX    | N/A               | N2(MIN)S3;S123 - L2 |
| C2-12 | L2-O2MAX | L2-O5MAX    | N/A               | N2(MAX)S2;S12 - L2  |
| C2-16 | L2-O5MIN | L2-O5MAX    | N/A               | N4(MAX)S2;S123 - L2 |
| C2-18 | L2-O2MAX | L2-O3MIN    | N/A               | N4(MAX)S2;S123 - L2 |
| C2-19 | L2-O2MAX | L2-O5MAX    | N/A               | N4(MIN)S3; S3 - L2  |
| C2-20 | L2-O2MAX | L2-O5MAX    | N/A               | N4(MAX)S2;S123 - L2 |
| C2-24 | L2-O5MIN | L2-O5MAX    | N/A               | N5(MAX)S2;S123 - L2 |
| C2-26 | L2-O2MAX | L2-O3MIN    | N/A               | N5(MAX)S2;S123 - L2 |
| C2-27 | L2-O2MAX | L2-O5MAX    | N/A               | N5(MIN)S1; S1 - L2  |
| C2-28 | L2-O2MAX | L2-O5MAX    | N/A               | N5(MAX)S2;S123 - L2 |

Table 4- 6: Definition of cases – Level 3

| Case  | Top ribs | Bottom ribs | General corrosion | Local corrosion     |
|-------|----------|-------------|-------------------|---------------------|
| C3-1  | L3-O2MIN | L3-O6MIN    | 75%               | N/A                 |
| C3-2  | L3-O2MIN | L3-O3MAX    | 75%               | N/A                 |
| C3-3  | L3-O1MAX | L3-O6MIN    | 75%               | N/A                 |
| C3-4  | L3-O1MAX | L3-O3MAX    | 75%               | N/A                 |
| C3-8  | L3-O2MIN | L3-O3MAX    | N/A               | N2(MAX)S2;S12 - L3  |
| C3-10 | L3-O1MAX | L3-O6MIN    | N/A               | N2(MAX)S2;S12 - L3  |
| C3-11 | L3-O1MAX | L3-O3MAX    | N/A               | N2(MIN)S3;S123 - L3 |
| C3-12 | L3-O1MAX | L3-O3MAX    | N/A               | N2(MAX)S2;S12 - L3  |
| C3-16 | L3-O2MIN | L3-O3MAX    | N/A               | N4(MAX)S2;S123 - L3 |
| C3-17 | L3-O1MAX | L3-O6MIN    | N/A               | N4(MIN)S3; S3 - L3  |
| C3-18 | L3-O1MAX | L3-O6MIN    | N/A               | N4(MAX)S2;S123 - L3 |
| C3-19 | L3-O1MAX | L3-O3MAX    | N/A               | N4(MIN)S3; S3 - L3  |
| C3-20 | L3-O1MAX | L3-O3MAX    | N/A               | N4(MAX)S2;S123 - L3 |
| C3-24 | L3-O2MIN | L3-O3MAX    | N/A               | N5(MAX)S2;S123 - L3 |
| C3-26 | L3-O1MAX | L3-O6MIN    | N/A               | N5(MAX)S2;S123 - L3 |
| C3-27 | L3-O1MAX | L3-O3MAX    | N/A               | N5(MIN)S1; S1 - L3  |
| C3-28 | L3-O1MAX | L3-O3MAX    | N/A               | N5(MAX)S2;S123 - L3 |

In Tables 4-4 to 4-6, the case number is represented by C1-XX for Level 1, C2-XX for Level 2 and finally C3-XX for Level 3. Further on, combination of top and bottom ribs corroded cases were considered as per the notation used in Figure 4-1 and Table 4-3. For example, C3-8 is a combination of:

- L3-O2MIN – top corroded rib 11 to 13 (see Figure 4.2)
- L3-O3MAX – at bottom corroded ribs with exception of 4, 6-7, 12-13 and 18 (see Figure 4.2)
- N2(MAX) S2;S12-L3 – as demonstrated in Figure 4-3 with a thickness of 4.5mm (see Appendix K part 2)



*Figure 4- 3: Visual representation of S2;S12-L3*

The cases which did not yield significant deformations were not represented in Tables 4-4, 4-5 and 4-6, thus the cases are not indicated in ascending order in these tables. For example, C3-8 is present but not C3-9, because this was eliminated from the analysis. Also, it was observed that this case represented minimum deformation and would not have a significant impact on the overall situation. Therefore, all the cases which were found to have a combination of minimum deformation were removed from the current investigation, as these are not expected to cause a noticeable damage on the bridge deck. By removing these cases, the analysis process was streamlined and focused on the cases that are most relevant and impactful for the DDM damaged cases used for parts of the Stonecutters Bridge main deck. This demonstrates a judicious approach to simulation and analysis, where unnecessary cases were identified and removed to improve the efficiency of the analysis.



To place the DDM modules on the Stonecutter's Bridge deck model, which is symmetric, several locations were identified along the deck, where the bridge could exhibit the types of damages investigated in this study. In the current study, the main span of the Stonecutters Bridge was divided into three parts, as presented below for one half of the steel span. The same information is applied to the other half of the main span.

- End of span (EOS) containing 9 modular decks.
- A quarter of span ( $\frac{1}{4}$  SPAN) containing 7 modular decks.
- Centre of span (COS) containing 12 modular decks.

The segmentation of the bridge is made due to the multiple studies showing that different sections of the bridge experience different types of damage. The segmentation of the bridge also allows easier identification and analyzation of specific damage locations. The notations above were used for the damaged levels introduced in Table 4-7, which shows the damage levels, the number of decks affected, and the type of damage selected along with the location of the DDM along the main deck.

Table 4- 7: Layout of DDM input on steel span of Stonecutter's Bridge

| Location of deck | Level 1           |                      | Level 2                           |                      | Level 3                                                                                      |                      |
|------------------|-------------------|----------------------|-----------------------------------|----------------------|----------------------------------------------------------------------------------------------|----------------------|
|                  | Damage            | No. of affected deck | Damage                            | No. of affected deck | Damage                                                                                       | No. of affected deck |
| EOS              | Local corrosion   | 2                    | Local corrosion                   | 4                    | Local corrosion & corroded ribs                                                              | 6                    |
| ¼ SPAN           | General corrosion | 1                    | General corrosion & corroded ribs | 3                    | (1) General corrosion along with corroded ribs; (2) corroded ribs along with local corrosion | 5                    |
| COS              | Corroded ribs     | 3                    | Corroded ribs                     | 6                    | Corroded ribs along with general corrosion                                                   | 9                    |

To analyze the behaviour of the main deck of the Stonecutters Bridge, 10 cases of DDM placement per level were developed based on the data presented above, and as detailed in Appendix L. However, after conducting further analysis using the moment of inertia extracted from *Ansys v22.2*, critical damage effects were considered to further refine these cases. In Appendix L, the percentage difference between the original 10 cases and the refined options was calculated. Based on this analysis, the original 10 cases were reduced to only 1 case per level, as shown in the Table 4-8. The three sections of the deck have been represented by a color, the darker the color the higher the level:

- End of girder (yellow)
- ¼ of span (grey)
- Centre span (green)

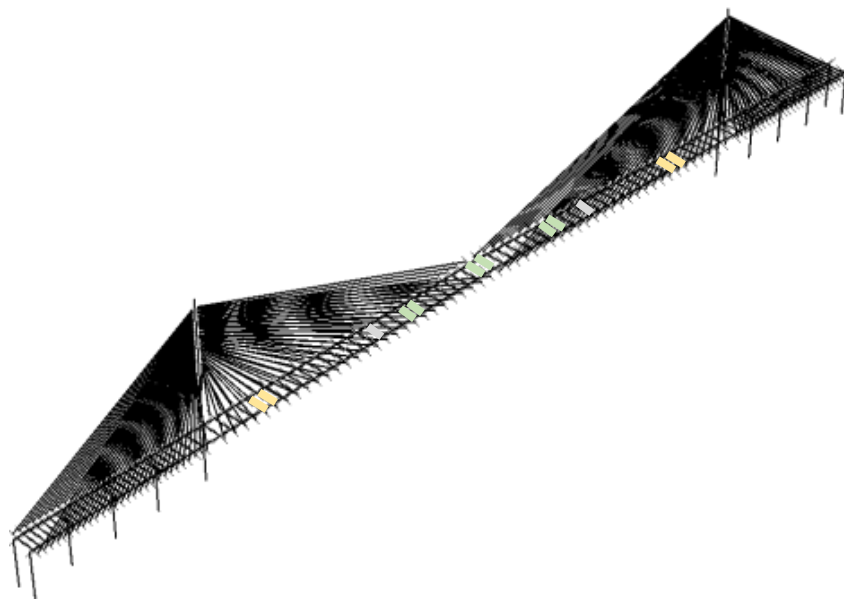
Table 4- 8: Critical cases for DDM location on main span of Stonecutter’s Bridge

| End of Girder |       |                     |                    |                     |                     |       |       |   |       |
|---------------|-------|---------------------|--------------------|---------------------|---------------------|-------|-------|---|-------|
|               | 1     | 2                   | 3                  | 4                   | 5                   | 6     | 7     | 8 | 9     |
| C1-7          |       |                     |                    |                     |                     | C1-24 | C1-11 |   |       |
| C2-5          |       | C2-12<br>W/O<br>TBR | C2-8<br>W/O<br>TBR | C2-27<br>W/O<br>TBR | C2-11<br>W/O<br>TBR |       |       |   |       |
| C3-8          | C3-26 |                     | C3-20              | C3-28               | C3-11               | C3-24 |       |   | C3-18 |

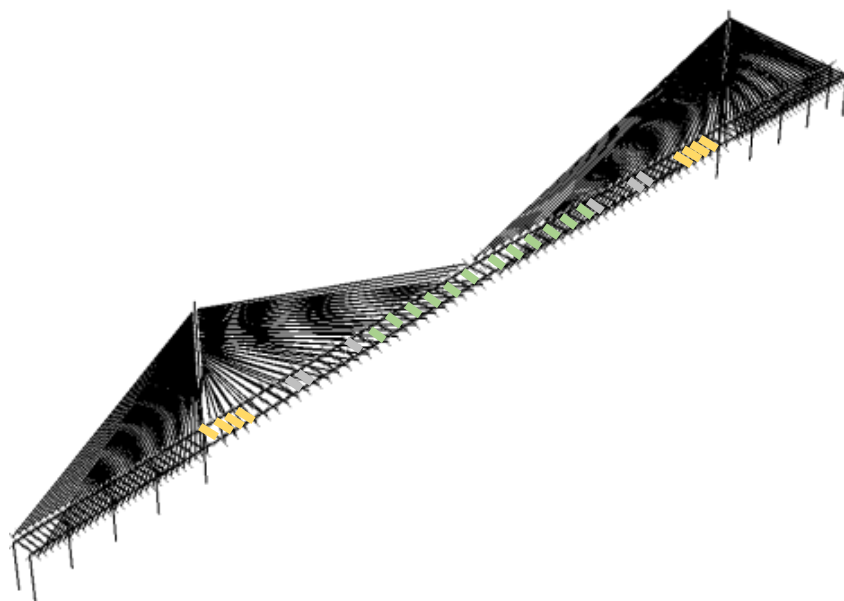
| 1/4 of span |      |       |    |      |       |    |       |
|-------------|------|-------|----|------|-------|----|-------|
|             | 10   | 11    | 12 | 13   | 14    | 15 | 16    |
| C1-7        |      |       |    |      |       |    | G25   |
| C2-5        | C2-3 | C2-2  |    |      |       |    | C2-1  |
| C3-8        | C3-4 | C3-20 |    | C3-1 | C3-10 |    | C3-12 |

| Centre of Span |                   |      |                   |                   |                   |      |                   |    |                   |      |                   |                   |
|----------------|-------------------|------|-------------------|-------------------|-------------------|------|-------------------|----|-------------------|------|-------------------|-------------------|
|                | 17                | 18   | 19                | 20                | 21                | 22   | 23                | 24 | 25                | 26   | 27                | 28                |
| C1-7           |                   |      | C1-2<br>W/O<br>GC | C1-1<br>W/O<br>GC |                   |      |                   |    |                   |      |                   | C1-4<br>W/O<br>GC |
| C2-5           | C2-4<br>W/O<br>GC |      | C2-4<br>W/O<br>GC |                   | C2-2<br>W/O<br>GC |      | C2-1<br>W/O<br>GC |    | C2-3<br>W/O<br>GC |      | C2-4<br>W/O<br>GC |                   |
| C3-8           | C3-4              | C3-1 | C3-4              |                   | C3-4              | C3-2 | C3-2              |    |                   | C3-3 | C3-4              | C3-1              |

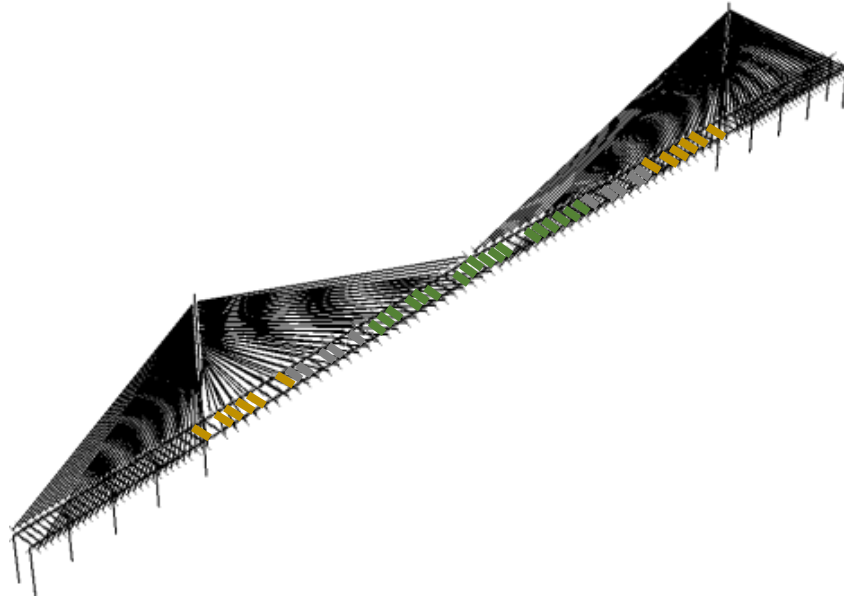
This approach of refining cases based on additional analysis demonstrates a systematic and thorough approach to engineering analysis, ensuring that the most relevant and impactful scenarios are prioritized for further study. A visual representation of the damage for these three cases is shown in Figure 4-4.



a) C1-7



b) C2-5



c) C3-8

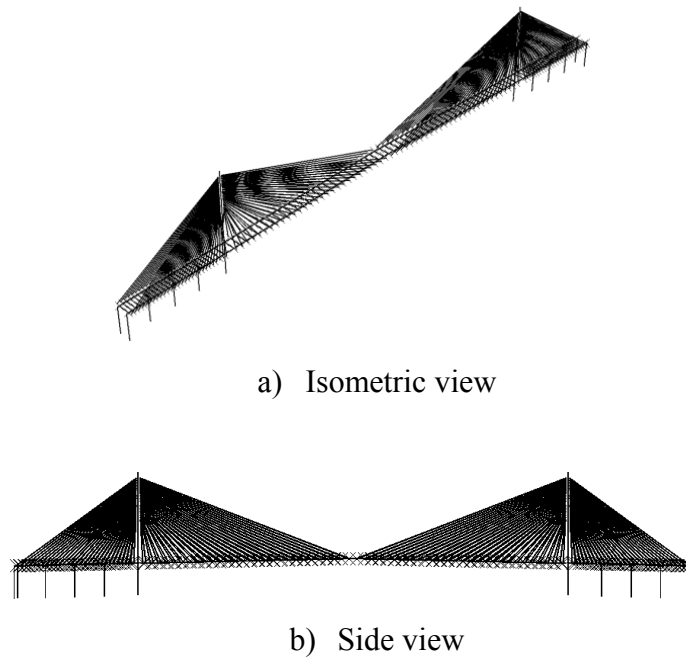
*Figure 4- 4: Visual representation of damage on Stonecutter's bridge*

#### **4.2 Stonecutters Bridge - ABAQUS Finite Element Model**

In comparison to the *Ansys v22.2* DDM model presented in Chapter 3, the *ABAQUS* model presents more comprehensive representation of the entire Stonecutters Bridge. The model consists of 56 deck modules, compared to *Ansys v22.2* only represents a modular deck. To simplify the model while still preserving the dimensions of the actual bridge, a line model was developed for the bridge. The decision to employ a line model in this study is driven by the necessity to strike a balance between computational efficiency and modelling accuracy. A detailed finite element model in this case can be highly complex and burdening computational resources. With finite computing capacities and memory constraints, utilizing a line model simplifies the structure, reducing the number of elements while capturing the essential structural behavior.

In this case, this model was simplified using truss and beam elements, which still carry the structural properties of the initial cables, towers and deck elements, providing a more efficient and effective means of simulating the bridge's behaviour. Such simplifications are necessary because a detailed model would be too complex, and the computer capacities reach their limits before finalising the structural analysis.

The current FEM model of the Stonecutters Bridge was initially developed and calibrated by Sabri, (2011), based on the specifications presented in the scientific literature by Kaji and Grady (2010), Falbe-Hansen et al. (2004) and Falbe-Hansen et al. (2017). Further on, the Stonecutters Bridge model was used by Jeong, Kainuma and Ahn (2019) for studying the effect of cable corrosion on the structural response of the bridge and by Feng (2015) for studying the flutter aerodynamic instability. As the FEM model of the Stonecutters Bridge was very well documented in the previous research projects, only the basic details are introduced below.



*Figure 4- 5: ABAQUS FEM model of Stonecutters Bridge*

The Stonecutters Bridge FEM model (*Figure 4-5*) is composed by multiple structural elements such as: cables (modelled as truss elements), towers (modelled as beam elements), side span piers (beam elements), back-span (concrete deck modelled as beam elements), and main deck longitudinal steel girder (modeled as beam elements).

#### Material characteristics

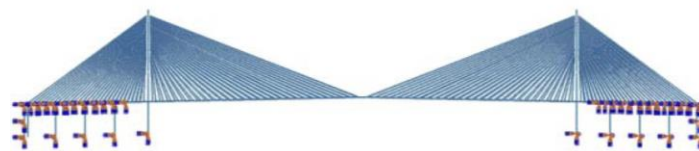
The material properties used for the FEA are provided in Table 4-9 and were applied to different structural components presented in the section.

Table 4- 9: Material properties for the bridge model (Feng, 2015)

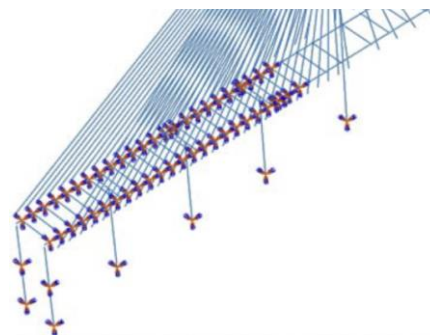
| Material                     | Structural members                           | Mass Density (kg/m <sup>3</sup> ) | Young's modulus (GPa) | Poisson's Ratio |
|------------------------------|----------------------------------------------|-----------------------------------|-----------------------|-----------------|
| Reinforced concrete          | Towers, piers, back-span, side cross girders | 2,400                             | 60                    | 0.2             |
| Steel                        | Centre deck, cross girders                   | 7,850                             | 205                   | 0.3             |
| Cable High-performance Steel | Stay cable                                   | 7,800                             | 200                   | 0.28            |

#### Boundary Conditions

The boundary conditions can be observed in Figure 4-6:



a) Elevation side view



b) Isometric view

Figure 4- 6: Boundary conditions of bridge model (Fang, 2015)

As a summary, the following are included:

- Fixed: back spans, piers and towers
  - This prevents any translation and rotational movements in all directions.

- To prevent relative motion between the deck and tower in the model, three translational movements and three rotations around different axes (longitudinal, vertical, and transverse) are connected. This connection is established through a constraint mechanism. This method is a way to link two parts in a finite element analysis to prevent relative motion between the deck and the tower 2 mechanisms were utilized:
  - Kinematic coupling constraints are defined using the *ABAQUS* interaction module.
  - Additionally, the lateral bearings are represented in the model using two transverse multi-point constraint (MPC) beam links to restrict the deck's transverse movement at the tower locations.

### Design Loadings

This section presents the load applied to the model.

- Dead Load

The weight of the bridge itself, including the weight of the deck, beams, cables, and other components was considered in the analysis. The material properties were included in the model to take this in consideration and gravitational acceleration was applied.

- Wind Load

The wind effect against the bridge, which can cause lateral movement and stress on the structure, is conventionally decomposed into three components: one along the wind direction (drag force), another perpendicular to the wind direction (lift force), and a moment around the deck axis (overturning moment) as it can be noticed in Figure 4-7. The basic formulations for calculating these components as a function of wind speed, nominal area exposed and drag, lift and moment coefficients respectively, were introduced in Chapter 3, section 3.2. The application of drag and lift loads on the girder is placed at the mass centre of the steel girder, distributed at intervals of 18 meters to correspond to one DDM module. In addition to these forces, the torsional moment is applied at the mass centre of the girder. The calculations were based on specific values for wind velocity, including the design speed of 70 m/s. Additionally, extreme scenarios were considered with wind velocities of 141 m/s and 211 m/s to assess the structural response under more severe conditions.



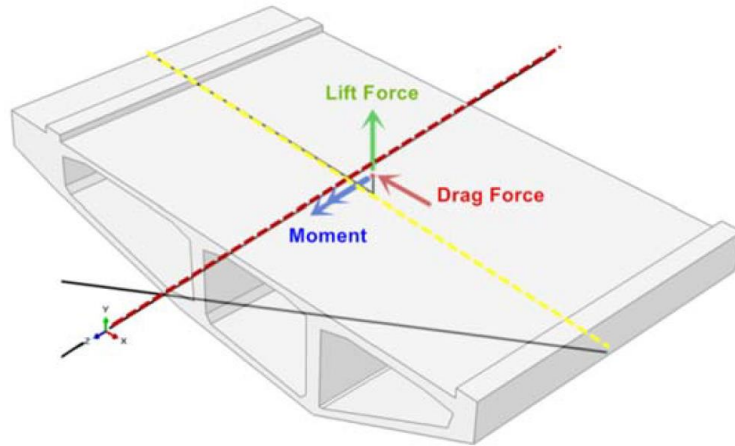


Figure 4- 7: Wind forces applied in ABAQUS (Feng, 2015)

Note that the design wind speed is high considering the normal environmental conditions at the bridge site. For this reason, loads such as live load, such as vehicles, pedestrians and other moving loads that use the bridge, were omitted, as traffic on the bridge will be stopped in case of extreme wind events.

#### 4.2.1 DDM Geometry Properties Import from Ansys v22.2 to ABAQUS

Models of damaged deck modules (DDM) with various damage levels, were generated for all the cases listed in Tables 4.4 to 4.6 and their respective properties were extracted using *Ansys v22.2* as seen in Figure 4-8.

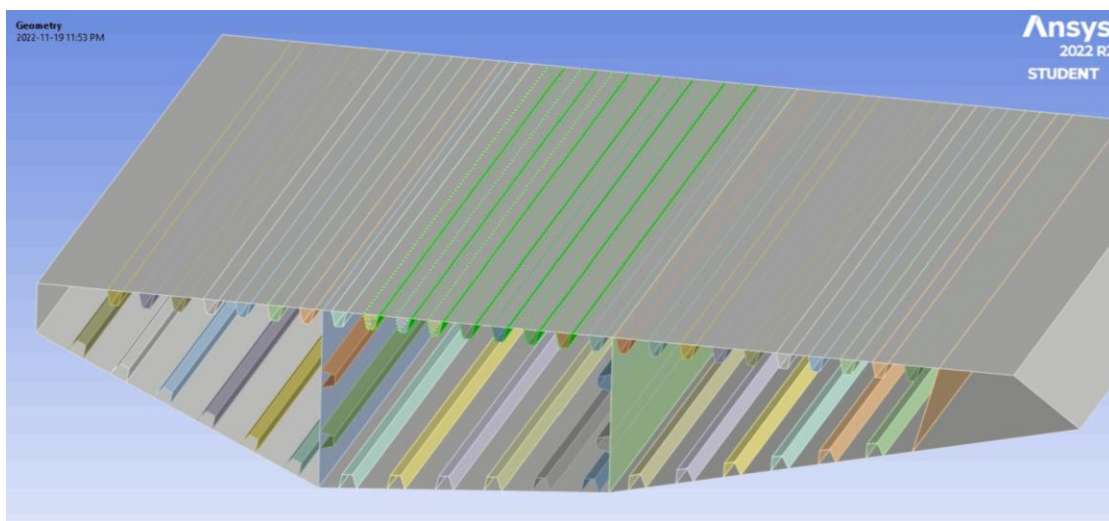


Figure 4- 8: Isometric view of steel deck shell model (Ansys v22.2)

While a comprehensive summary of all the information extracted from *Ansys v22.2* for various DDM cases can be found in Appendices M, N and O, only the main concept and the most important parameters for each case are provided in detailed in this Chapter, such as:

- Total rigid body mass matrix about origin where the 3x3 matrix for translational mass, coupled translational/rotational mass and rotational mass (inertia) can be found.
- The difference between the coupled translational/rotational mass and the rotational mass (inertia).
- The center of mass.
- Total inertia about the centre mass.
- Principal inertia.
- Orientation vectors of the inertia principal axes in the global cartesian system.

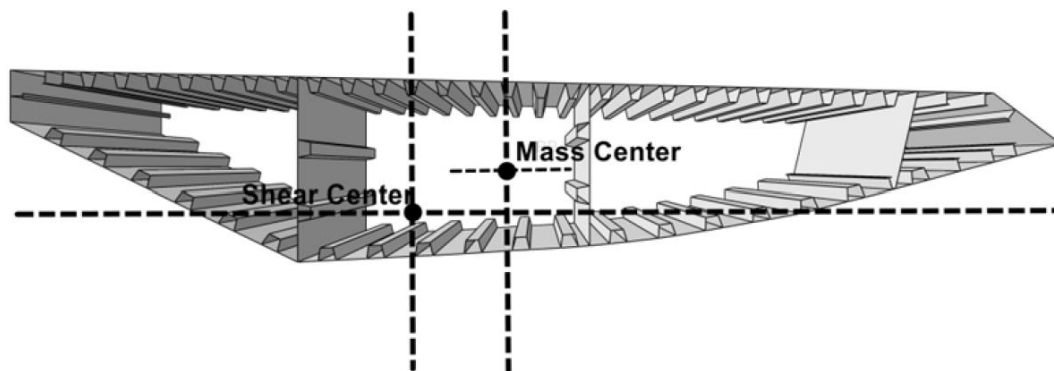


Figure 4- 9: Cross-section of steel deck shell model ABAQUS (Feng, 2015)

The “profile option” is a feature in *ABAQUS* that allows users to define the cross-sectional properties of structural elements, thus properties such as geometry/cross-sectional shape and area, material, mass and inertia and additional properties for open sections, can be defined. Through the profile option for the steel deck, the above listed properties were determined in *Ansys v22.2* for DDM modules, considering the damage types modelled as presented in Chapter 3. Thereafter these were imported into *ABAQUS*, where DDM properties were applied along the deck at every 18m as detailed below.

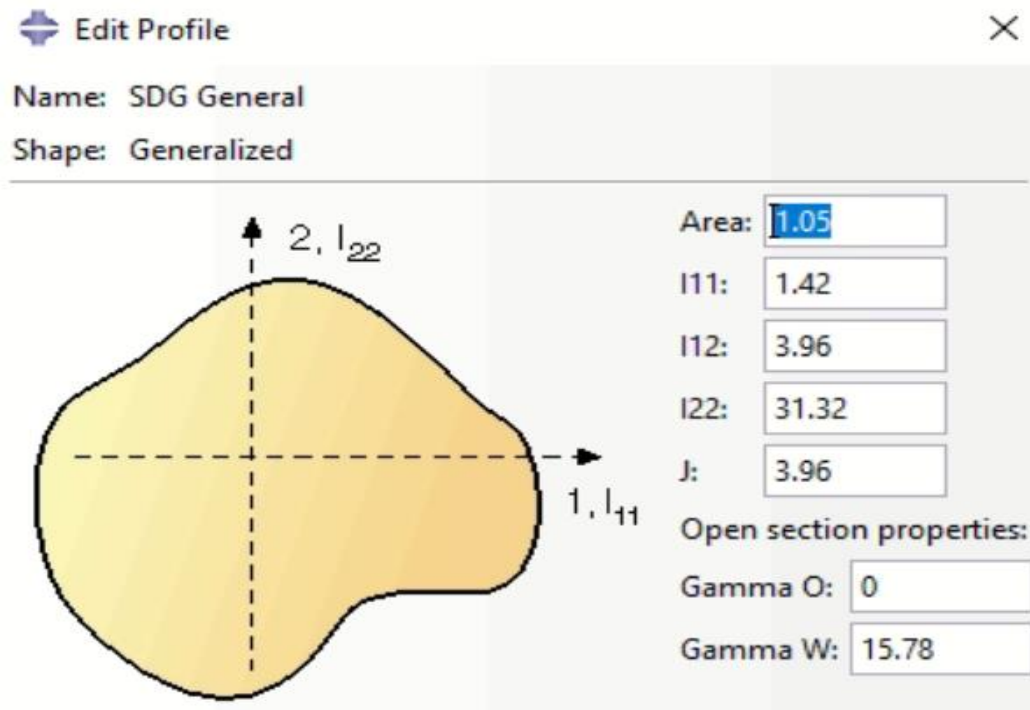


Figure 4- 10: Generalized Profile for steel deck in ABAQUS

As it can be seen in Figure 4-10, a general cross-sectional area was selected for the deck, for which the input parameters can be controlled, and the following properties must be filled based on the DDM data obtained from *Ansys v22.2* :

- Cross-sectional area
- Moment of inertia about centroidal x-axis ( $I_{11}$ )
- Torsional moment of inertia ( $I_{12}$ )
- Moment of inertia about centroidal Y-axis ( $I_{22}$ )

Since this is an open section, the following additional properties are needed:

- Gamma O
- Gamma W

Steel is generally considered to be an isotropic material, meaning that its mechanical and physical properties are the same in all directions. In its pure form, steel is isotropic because its crystal structure is cubic and symmetrical, resulting in the same properties in all directions. However, when steel is subjected to various manufacturing processes, such as rolling or forging, it can become anisotropic due to the alignment of its microstructure. In practice, the degree of anisotropy

in steel is often negligible compared to other materials such as wood or composites. Therefore, steel will be treated as an isotropic material for this engineering application. These values will remain unchanged. Treating steel as isotropic material simplifies the analysis by assuming uniform material properties in all directions, which is typically suitable for steel behaviour and helps streamline the simulation process.

#### **4.2.2 Validation of Main Geometric Properties**

In this study, a particular emphasis is placed on the validation of main geometric properties, specifically focusing on the three types of moment of inertia:

- Moment of inertia about centroidal X-axis
- Torsional moment of inertia (St. Venant, also z-axis)
- Moment of inertia about centroidal Y-axis

These properties hold significance in understanding the impact of corrosion on structural materials. The moment of inertia is a measure of an object's resistance to bending or torsional deformation about a particular axis. When corrosion occurs, it can weaken the material in specific areas, reducing the moment of inertia and the structural capacity. Understanding how corrosion impacts the moment of inertia is essential for predicting structural behaviour, as it directly influences the structure's response, such as bending stresses and deflections. Variations in moment of inertia can compromise a structure's ability to support loads and maintain its intended shape, which is why measuring changes in moment of inertia is crucial for assessing the level of structural deterioration. The importance of validating these geometric properties cannot be overstated, as it plays a pivotal role in the accuracy, reliability, optimization, and efficiency of the study. At a quick glance, it was noticed that the moments of inertia about the centroidal Y-axis extracted from *Ansys v22.2* were extremely low compared to the values found by Feng (2015) also named "category 1"; this value was approximately 23 times less than expected. A comparison study was performed to understand the source of this discrepancy, and the three categories were created:

- Category 1 includes all three types of moments of inertia obtained by Feng's study (Feng, 2015).
- Category 3 includes all three types of moments of inertia obtained in the Chapter 3 of the current study.

It should be noted that to assess the validity of these geometric properties, a threshold for acceptable values has been established, and this was set at 10% or lower difference. This threshold is chosen based on industry standards and the structural analysis context. Exceeding this threshold can have critical implications for the structural integrity of the system. Values exceeding the threshold may indicate significant deviation from the expected behavior. Note the values can be viewed in depth in Appendix P, where the moment of inertia for each case can be found. These values served as input in *ABAQUS*.

After an in-depth analysis, it was found that the moment of inertia about the centroidal x-axis, and the torsional moment of inertia, were like the values reported in the previous studies (Sabri, 2011, Feng 2015). The percentage of difference fell below 15%, which was considered within the acceptable margin. Contrary, the moment of inertia about the centroidal Y-axis obtained in the current study was much higher than the values reported by Sabri, (2011) and Feng, (2015) registering a percentage of difference decrease of approximately up 96%. A summary of the values obtained for the moments of inertia for a deck module without damage are represented in Table 4-10.

*Table 4- 10: Geometric properties of the Stonecutters steel deck section without damage*

| Properties                                          | Abbreviation | Values     |            |
|-----------------------------------------------------|--------------|------------|------------|
|                                                     |              | Category 1 | Category 3 |
| Moment of inertia about centroidal X-axis ( $m^4$ ) | $I_{11}$     | 1.42       | 1.91       |
| Torsional moment of inertia - St. Venant ( $m^4$ )  | $I_{12}$     | 3.96       | 3.27       |
| Moment of inertia about centroidal Y-axis ( $m^4$ ) | $I_{22}$     | 31.32      | 1.36       |

For the FEM model developed in *ABAQUS*, the locations of the lumped masses are derived from the geometry of the gravity centres and shear centres of the bridge deck module modelled in STAAD (Sabri, 2013), while the current study modelled the deck module in *Ansys v22.2*. Essentially the two models are intended to represent the same physical structure, however the *ANSYS v22.2* developed model allowed for further alterations when modelling the damaged DDM

cases. Even though the modelling approach, refinement of the mesh, material properties and revaluation of the boundary conditions in the *Ansys v22.2* model were all performed, the source of the discrepancy to potentially correct and ensure accurate results could not be identified. The value of the moment of inertia about the centroidal Y-axis should be similar with an acceptable percentage of difference. It is observed that the moment of inertia about the centroidal x-axis and the torsional moment of inertia (St. Venant) are similar between the two models. It may indicate that the differences in the moment of inertia about the centroidal y-axis are due to some specific aspect of the geometry or meshing in that direction. For example, it is possible that the mesh density is lower in the Y-direction, or that the geometry has some asymmetry or irregularity that is affecting the moment of inertia in that direction.

An in-depth study was performed to determine the difference between the DDM deck module models with Category 1 and Category 3 properties. The moments of inertia determined in the *Ansys v22.2* model for a non-damage deck module (NDDM) was used as the input for the general properties. Table 4-11 presents the natural frequencies of the Stonecutters Bridge as per the current study (Category 3) and the study reported by Feng (2015), which uses an identical deck module as Sabri (2013) (Category 1), along with the percentage of difference. The goal was to observe the difference in the natural frequencies to determine the accuracy of the values and to validate the current NDDM model developed for Stonecutters Bridge.

*Table 4- 11: Comparison of natural frequencies for NDDM deck module*

| Mode shape | Freq (Hz)  |            | Difference (%) |
|------------|------------|------------|----------------|
|            | Category 1 | Category 3 |                |
| 1          | 0.145      | 0.075      | 63%            |
| 2          | 0.172      | 0.089      | 63%            |
| 3          | 0.192      | 0.149      | 25%            |
| 4          | 0.253      | 0.205      | 21%            |
| 5          | 0.256      | 0.217      | 17%            |
| 6          | 0.324      | 0.249      | 26%            |
| 7          | 0.358      | 0.256      | 33%            |
| 8          | 0.387      | 0.277      | 33%            |
| 9          | 0.424      | 0.334      | 24%            |
| 10         | 0.581      | 0.354      | 48%            |
| 11         | 0.611      | 0.373      | 48%            |
| 12         | 0.701      | 0.430      | 48%            |
| 13         | 0.775      | 0.566      | 31%            |
| 14         | 0.777      | 0.567      | 31%            |
| 15         | 0.853      | 0.637      | 29%            |
| 16         | 0.895      | 0.717      | 22%            |
| 17         | 0.925      | 0.719      | 25%            |
| 18         | 0.954      | 0.769      | 21%            |
| 19         | 0.979      | 0.771      | 24%            |
| 20         | 1.135      | 0.888      | 24%            |
| 21         | 1.224      | 0.904      | 30%            |
| 22         | 1.241      | 0.915      | 30%            |
| 23         | 1.413      | 0.961      | 38%            |
| 24         | 1.442      | 0.990      | 37%            |
| 25         | 1.459      | 1.077      | 30%            |
| 26         | 1.567      | 1.099      | 35%            |
| 27         | 1.595      | 1.229      | 26%            |
| 28         | 1.677      | 1.260      | 28%            |
| 29         | 1.700      | 1.301      | 27%            |
| 30         | 1.930      | 1.408      | 31%            |

It can be seen that the percentage of difference is not consistent across all vibration modes but shows a trend of fluctuation. The first two mode shapes and the middle mode shapes, 10, 11 and 10 exhibit relatively higher percentage differences, while the others have lower differences. As we progress to higher mode shapes (from 20 and above), the percentage of difference between the two studies tends to increase. This suggests that the discrepancy between the two models becomes more pronounced for higher modes of vibration. Moreover, these values are above the threshold of acceptable values, where the threshold of acceptable percentage of difference is equal to or

below 10%. The first modes have the highest percentage of difference, which is not a good indication, especially considering that the first mode shapes represent the most fundamental frequency and hold significant importance. These values represent the frequency at which the system tends to vibrate or oscillate. It also provides insight into how the structure deforms during a dynamic loading. In this case, because the discrepancies in frequencies for NDDM modules were significant, a validation of the model could not be concluded, and the new information was inputted.

The difference in the moment of inertia between the two models can potentially lead to different results in subsequent analyses, such as calculations of bending stresses or deflections. This is because the moment of inertia is a key parameter that affects the structural behaviour of a component or system. For this reason, it was selected to maintain the moments of inertia reported by Feng (2015), for any part of the deck, which is undamaged in the Stonecutters Bridge model, as this was already validated against Luo et al. (2017). Only the damaged modules were replaced on the Stonecutters Bridge main span, by replacing the affected deck segment with the DDM modules developed in Chapter 3.

### **4.3 Effect of DDM Model on Stonecutters Bridge Response**

This section delves into the structural behaviors of the Stonecutter's bridge considering the damaged deck modules (DDM) placed at different locations along the main span. The critical DDM damage scenarios C1-7, C2-5 and C3-8 introduced in (Table 4-8) were applied to the deck, and the vibration mode shapes, frequencies, and deformation patterns, were investigated to provide comprehensive insights into how the structure responds to for different levels of damage. The first 5 vibration modes are illustrated in Figures 4-11 to 4-13, which include the deformation of the bridge, with a specific deformation scale factor applied. The significance of the first 5 mode shapes lies in their representation of the dominant and most likely modes of vibration that the bridge will experience. These modes correspond to the lowest natural frequencies and result in the largest displacements. These vibration modes represent the different ways in which the bridge can move and vibrate.



The subsequent analysis of natural frequencies, particularly the initial 30 modes, lays the foundation for understanding the relationship between the stiffness and mass distribution in the context of the applied damage. Natural frequencies represent the characteristic rates at which the structure naturally vibrates. They are a fundamental aspect of structural analysis and can help us understand how the structure responds.

The final aspect of the investigation explores structural deformations under wind loads. Displacement values (U1, U2, and U3) unveil the relationship between directional movements of the deck and their variations across damage levels. In simpler terms, these displacement values provide information about how different parts of the bridge move.

### 4.4 Vibration Mode Shapes

A mode shape characterized by vertical displacement is indicative of a vertical bending mode, revealing the structure's response to vertical loading dynamics. Conversely, the manifestation of a mode shape marked by horizontal displacement signifies the dominance of lateral bending modes, giving insight into the structure's behavioural response to horizontal forces. Additionally, the visualization of torsional mode shapes unveils twisting deformations occurring around the vertical axis, showing us the structure's torsional resistance.

Figures 4-11, 4-12 and 4-13 show visual representation of the first five vibration mode shapes for C1-7, C2-5 and C3-8. The visual representation of each case can be seen in Figure 4.4. Typically, the initial 5 to 10 vibration modes hold considerable significance, primarily due to their susceptibility to easy excitation. These figures illustrates how the structure moves and deforms. In this study, the modal behaviour of cable-stayed bridge is analyzed looking at two aspects: symmetry or asymmetry of the mode shape and the vertical, transverse directions or torsional response for each vibration mode.

Based on Figures 4-11 to 4-13, the first five mode shapes are analyzed and it is concluded:

- Mode shape 1: symmetry, horizontal deck
  - o This suggests that the structure is undergoing a vibration where both sides of the horizontal axis move in a coordinated and balances manner.

- Mode shape 2: symmetry, vertical deck
  - This implies that the structure is undergoing a vertical vibration where both sides of the structure move up and down in a synchronized manner.
- Mode shape 3: asymmetry, vertical deck
  - This mode shape breaks away from symmetry. In this case, the vibration pattern occurs along a vertical axis, but the pattern is not symmetrical about that axis. This indicates that the vibration involves different motions or amplitudes on either side of the vertical axis. Asymmetrical mode shapes can introduce complexities due to uneven motion patterns.
- Mode shape 4: symmetry, bending towers
  - The two towers bend laterally, in-phase with each other.
- Mode shape 5: asymmetry, horizontal deck
  - This mode shape introduces asymmetry in a vibration pattern occurring along a horizontal axis. This means that the motion is not balanced between the two sides of the structure along the horizontal axis. Asymmetrical mode shapes in this context could lead to uneven stress distribution and potentially undesired structural behavior.

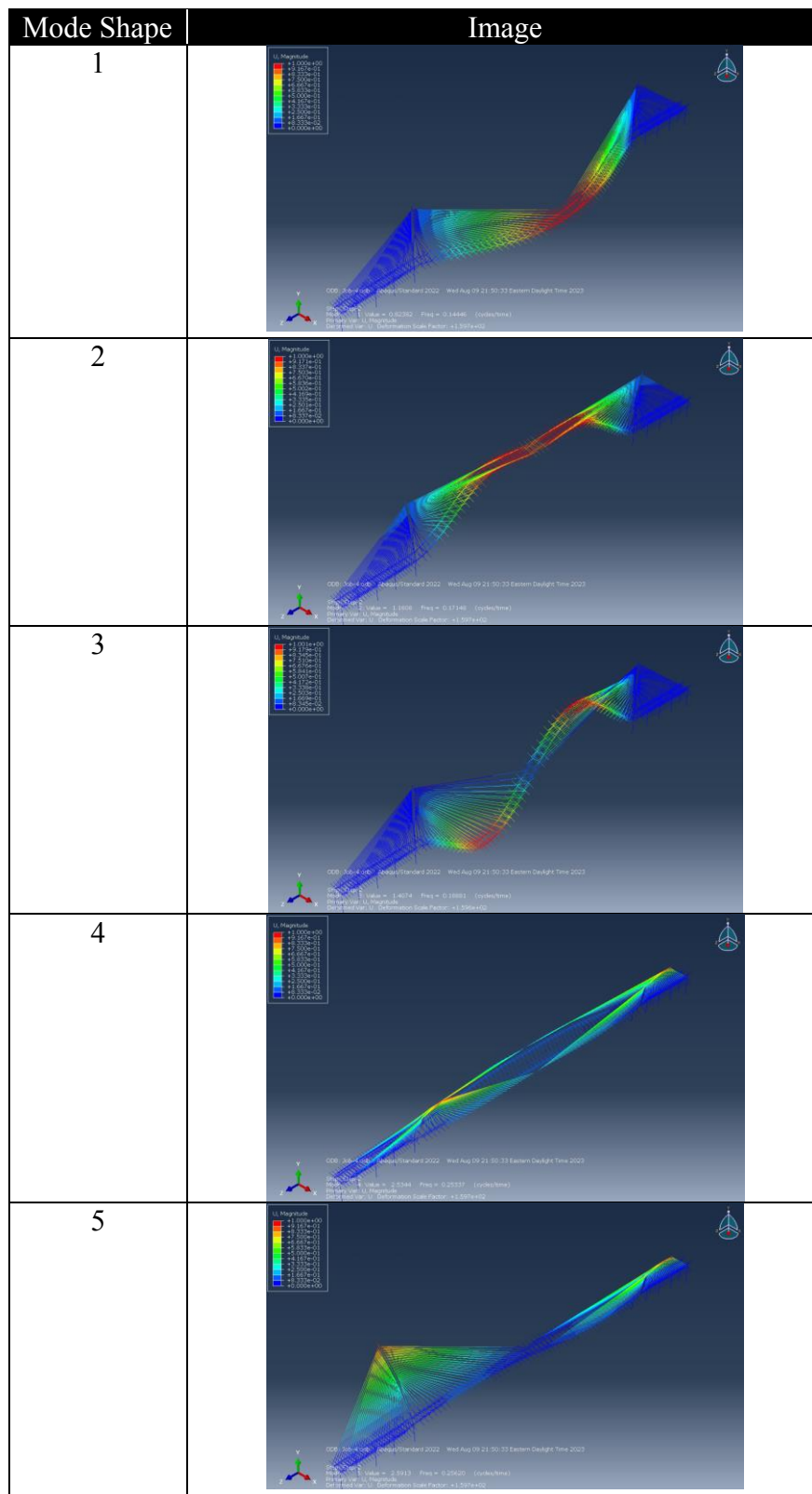


Figure 4- 11: Mode shape image for C1-7 (natural frequency)

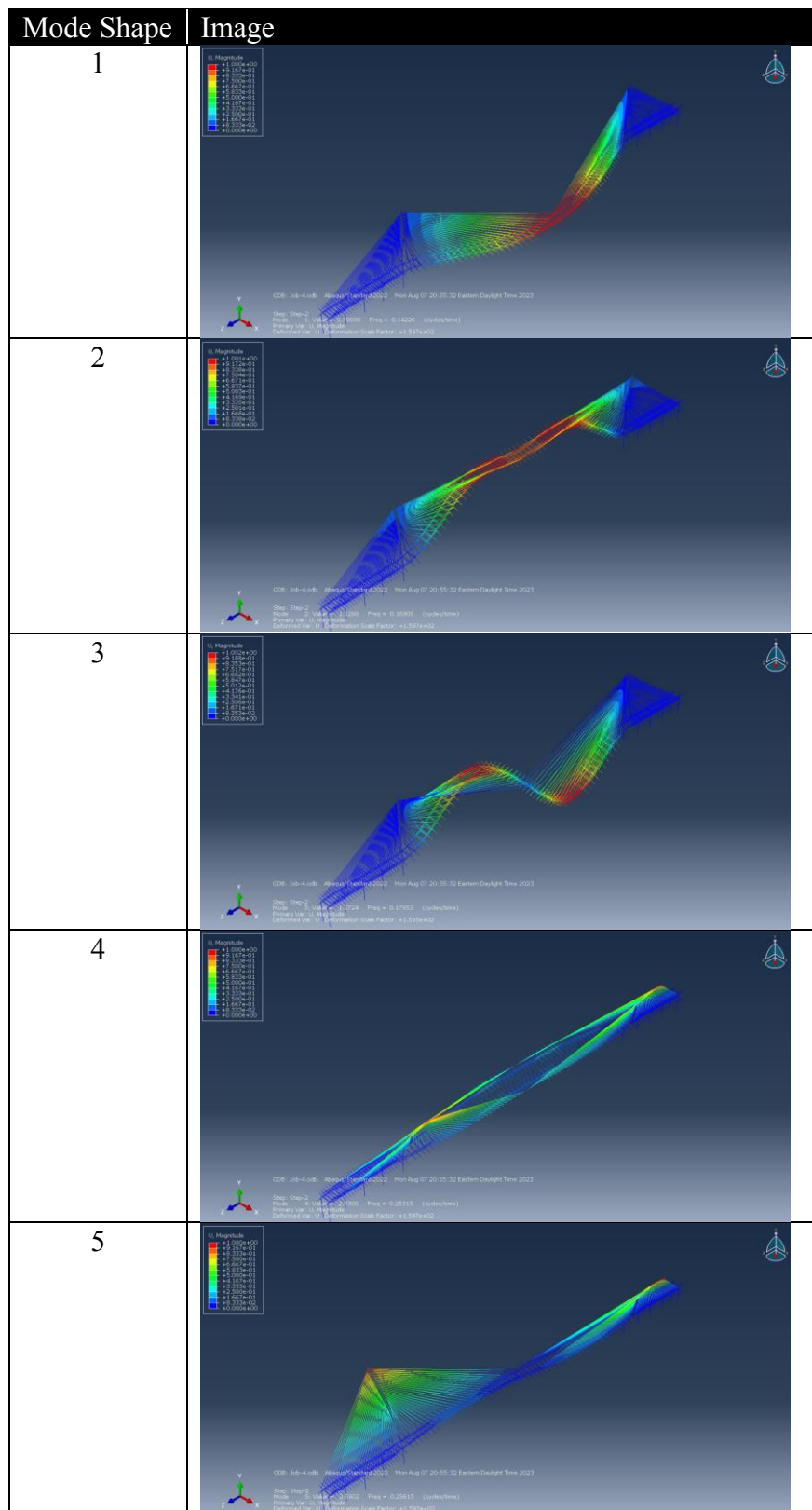


Figure 4- 12: Mode shape image for C2-5 (natural frequency)

| Mode Shape | Image                                                                                                                                                                                                                                                                                                               |
|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1          | <p>             OCB: Job-4-036 - New York Standard 2022 - Mon Aug 14 21:06:30 Eastern Daylight Time 2023<br/>             Date: 8/14/2023 14:21:06<br/>             Mode: 1<br/>             Scale = 0.22252 Freq = 0.17628 (cycles/time)<br/>             Displacement (m) = 1.1000000000000000e+03           </p> |
| 2          | <p>             OCB: Job-4-036 - New York Standard 2022 - Mon Aug 14 21:06:30 Eastern Daylight Time 2023<br/>             Date: 8/14/2023 14:21:06<br/>             Mode: 2<br/>             Scale = 0.87087 Freq = 0.14852 (cycles/time)<br/>             Displacement (m) = 1.1000000000000000e+03           </p> |
| 3          | <p>             OCB: Job-4-036 - New York Standard 2022 - Mon Aug 14 21:06:30 Eastern Daylight Time 2023<br/>             Date: 8/14/2023 14:21:06<br/>             Mode: 3<br/>             Scale = 0.15028 Freq = 0.10577 (cycles/time)<br/>             Displacement (m) = 1.1000000000000000e+03           </p> |
| 4          | <p>             OCB: Job-4-036 - New York Standard 2022 - Mon Aug 14 21:06:30 Eastern Daylight Time 2023<br/>             Date: 8/14/2023 14:21:06<br/>             Mode: 4<br/>             Scale = 2.5191 Freq = 0.25240 (cycles/time)<br/>             Displacement (m) = 1.1000000000000000e+03           </p>  |
| 5          | <p>             OCB: Job-4-036 - New York Standard 2022 - Mon Aug 14 21:06:30 Eastern Daylight Time 2023<br/>             Date: 8/14/2023 14:21:06<br/>             Mode: 5<br/>             Scale = 2.5921 Freq = 0.25274 (cycles/time)<br/>             Displacement (m) = 1.1000000000000000e+03           </p>  |

Figure 4- 13: Mode shapes for C3-8 (natural frequency)

#### 4.5 Natural Frequencies

The initial 30 frequencies of the Stonecutters Bridge finite element model were determined within the frequency range of 0.13528 to 1.91060 Hz. This range is in good agreement with the spectrum of natural frequencies documented for other cable-stayed bridges (Diana et al., 2013).

Table 4-11 presents natural frequencies for C1-7, C2-5 and C3-8 corresponding to the mode shapes 1 to 30 introduced in Figures 4-11 to 4-13. Following the first horizontal mode of the bridge deck, there are symmetric and asymmetric vertical vibration modes dominated by the bridge deck. The first vertical mode is a symmetrical shape at natural frequencies between 0.13528 Hz and 0.14446 Hz, and the second one is asymmetrical along the main span at natural frequencies between 0.14852 Hz and 0.17148 Hz. The first two vertical modes and natural frequencies are relatively close.

The fourth and the fifth modes which are horizontal vibration modes, are dominated by the bridge towers bending modes. The two towers are in symmetric mode shape at the natural frequencies between 0.2526 Hz and 0.25337 Hz, and then they move in asymmetric mode shapes at the natural frequency between 0.25574 Hz and 0.2562 Hz. The natural frequencies in these two horizontal modes characterizing the towers are relatively close and the motion of the towers always combines with the horizontal or vertical modes of the bridge deck girder.

Table 4- 12: Natural frequencies for C1-7, C2-5 and C3-8 cases

| Mode shape | Frequency (cycle/time) |         |         |         |
|------------|------------------------|---------|---------|---------|
|            | No damage              | C1-7    | C2-5    | C3-8    |
| 1          | 0.145                  | 0.14446 | 0.14226 | 0.13528 |
| 2          | 0.172                  | 0.17148 | 0.16909 | 0.14852 |
| 3          | 0.192                  | 0.18881 | 0.17953 | 0.15677 |
| 4          | 0.253                  | 0.25337 | 0.25325 | 0.2526  |
| 5          | 0.256                  | 0.25620 | 0.25615 | 0.25574 |
| 6          | 0.324                  | 0.32293 | 0.31952 | 0.31129 |
| 7          | 0.358                  | 0.35726 | 0.35089 | 0.3159  |
| 8          | 0.387                  | 0.38446 | 0.36275 | 0.3202  |
| 9          | 0.424                  | 0.42125 | 0.41355 | 0.38611 |
| 10         | 0.581                  | 0.57601 | 0.55041 | 0.4331  |
| 11         | 0.611                  | 0.60631 | 0.58980 | 0.50348 |
| 12         | 0.701                  | 0.69502 | 0.68048 | 0.60002 |
| 13         | 0.775                  | 0.77129 | 0.76244 | 0.63102 |
| 14         | 0.777                  | 0.77700 | 0.77643 | 0.70933 |
| 15         | 0.853                  | 0.84584 | 0.82536 | 0.77101 |
| 16         | 0.895                  | 0.88059 | 0.85641 | 0.80064 |
| 17         | 0.925                  | 0.91732 | 0.89198 | 0.80833 |
| 18         | 0.954                  | 0.95328 | 0.95031 | 0.8886  |
| 19         | 0.979                  | 0.97730 | 0.97312 | 0.93688 |
| 20         | 1.135                  | 1.1296  | 1.0859  | 0.95442 |
| 21         | 1.224                  | 1.2063  | 1.1690  | 0.98394 |
| 22         | 1.241                  | 1.2271  | 1.1907  | 1.0569  |
| 23         | 1.413                  | 1.4031  | 1.3396  | 1.0719  |
| 24         | 1.442                  | 1.4421  | 1.4406  | 1.1633  |
| 25         | 1.459                  | 1.4567  | 1.4446  | 1.2926  |
| 26         | 1.567                  | 1.5499  | 1.5041  | 1.3257  |
| 27         | 1.595                  | 1.5754  | 1.5298  | 1.4229  |
| 28         | 1.677                  | 1.6601  | 1.5981  | 1.4639  |
| 29         | 1.700                  | 1.6994  | 1.6977  | 1.4764  |
| 30         | 1.930                  | 1.9106  | 1.8488  | 1.5173  |

The frequencies are summarized in Figure 4-14, where the blue line represents damage Level 1, orange line represents damage Level 2 and damage Level 3 is depicted by the grey line. As it can be seen, there is similarity between damage Levels 1 and 2, but are not identical. In many cases, structural damage doesn't necessarily cause a sudden and dramatic shift in mode shapes and frequencies. Instead, it can be a gradual process where minor damage at Level 1 may slightly affect the mode shapes and frequencies. As the damage progresses to Level 2, it continues to alter the

behavior resulting in changes that are similar but not identical to Level 1. Not only that, as damage increases from Level 1 to Level 2, this coupling effect might cause similarities in the modes that are influenced by the initial damage.

A more significant difference occurs at damage Level 3 (grey line). The damage, encompassing corroded ribs, local and general corrosion, are distributed across modules, with specific modules 2, 7-8, 12, 15, 20, 24 and 25 exempt from the damage application as shown in Table 4-8. This table provides a comprehensive overview of the type, location and extent of damages applied to the bridge.

Corrosion, as it progresses, gradually weakens a material's structural integrity, leading to the development of reduction in cross-sectional area and ductility as well. Consequently, the stiffness of the material diminishes, rendering it less capable of withstanding loads. Simultaneously, the corrosion process induces uneven material loss, disrupting the original mass distribution. This shift in the centre of mass, combined with altered vibrational characteristics, significantly impacts the bridge's behaviour. It is noticeable to see the alteration of the natural frequencies at Level 3. Without damage, the natural frequency range spans from 0.145Hz to 1.930Hz. However, as damage levels increase, the natural frequency range varies between 0.135Hz to 1.517 Hz. This frequency shift provides valuable insights into how corrosion-induced changes affect the structural response.

When the stiffness decreases, the natural frequencies tend to decrease as well. With the stiffness change, there is a mass redistribution. The redistribution of mass within the bridge structure occurs due to material loss from corrosion, resulting in an uneven mass distribution. This mass redistribution can substantially impact the structure's inertia, altering its resistance to changes in motion and affecting its vibrational behaviour. The mechanics of mass redistribution involve the removal of material from corroded areas and the subsequent redistribution of this material within the structure. It's noteworthy that after mode shape 10, the frequency curves consistently fall below the natural frequency, indicating a reduction in stiffness. This reduction further emphasizes the dynamic relationship between stiffness, mass distribution, and vibrational characteristics, highlighting the effects of corrosion-induced material loss on the bridge's dynamic response.



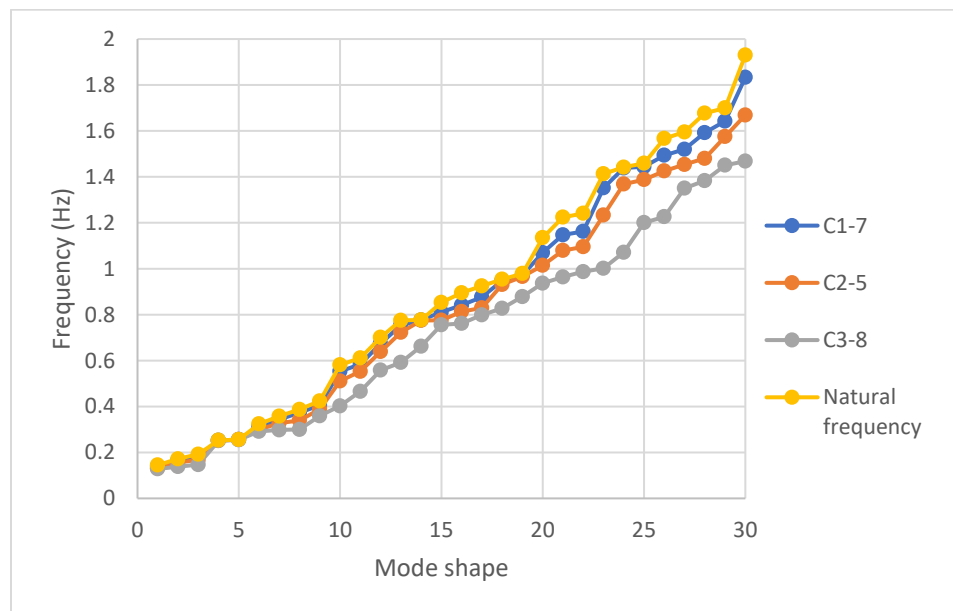


Figure 4- 14: Natural frequencies for C1-7, C2-5, C3-8 damage cases

Figure 4-14 shows the natural frequencies of the Stonecutters Bridge for different cases, plotted against the mode shapes, which range from 1 to 30. A comparison of the natural frequencies obtained for the undamaged bridge deck (represented by the yellow line labelled 'Natural frequency') with those of the damaged deck under three different scenarios (C1-7, C2-5, C3-8) was conducted. The observation that the difference is minor for lower modes indicates that the presence of damage does not significantly affect the lower natural frequencies, as compared to the undamaged case. This could imply that damage has a more impact for the higher modes frequencies, or that the damage is not severe enough to significantly alter the lower modes. For structural analysis, this could be important as it suggests that certain levels of damage may be detectable only under certain conditions or may require specific testing methods to identify them. This kind of information can be useful for engineers and professionals involved in structural health monitoring and damage assessment of cable-stayed bridges.

#### 4.6 Deformation with Damaged DDM

In structural analysis, a comprehensive understanding of deformations is essential for assessing the behaviour and integrity of structures. This section delves into a critical aspect of the

performed analysis, emphasizing the significance of understanding the displacement values denoted as U1, U2, and U3 on the deck. It is important to note the following:

- U1 – represents the displacement in the first direction, which is associated with horizontal movement (x-axis)
- U2 – represents the displacement in the second direction, which is associated with vertical movement (y-axis)
- U3 – represents the displacement in the third direction, which is lateral/transverse direction (z-axis)

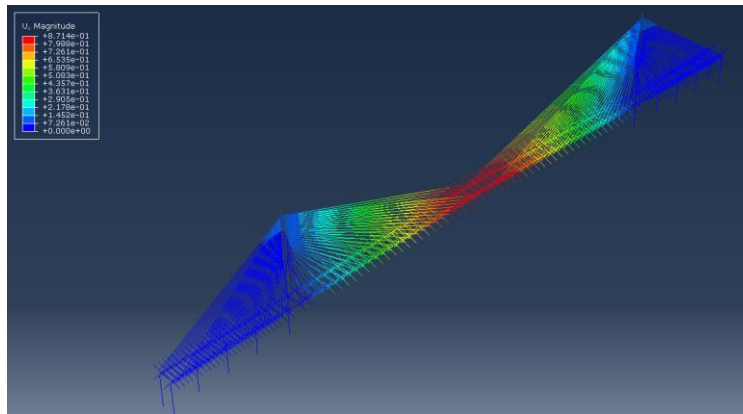
These values are measured at specific points of interest on the deck of the bridge, such as:

- Nodes: Points of the structure that are of analytical interest, which could be junctions where members are connected.
- Control Points: Specific locations where displacement values are expected to be significant or are of particular interest to engineers for monitoring.
- Section Cuts: These are specific sections of the bridge deck that are analyzed to understand the deformation under various loading conditions.

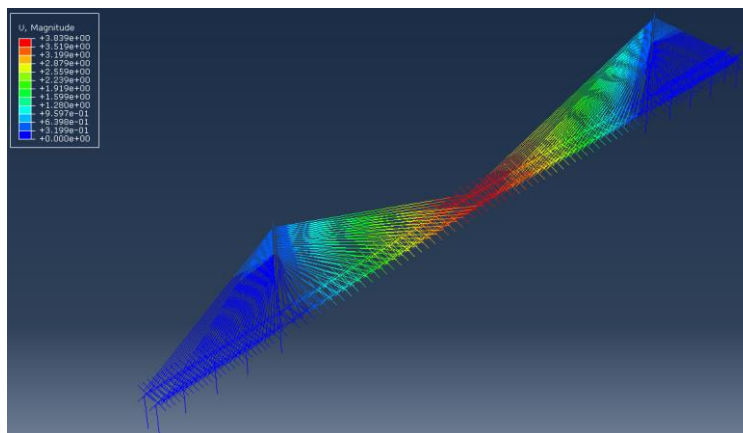
These displacement values are critical for understanding how the structure behaves under load, assessing the stress distribution, and for ensuring that deformations are within safe limits. The exact locations on the deck where U1, U2, the horizontal displacement (U1) shows some variation but generally remains in the same order of magnitude. While vertical displacement (U2) remains consistent across the levels, indicating a similar response of the bridge's vertical movement regardless of the applied damages. Finally, the lateral/transverse also exhibits some variation but remains in a similar order of magnitude across the levels.

Figures 4-15, 4-16, and 4-17 present the *ABAQUS* model showcasing structural deformation, with areas of maximum displacement highlighted in red. C1-7, C2-5 and C3-8 are respectively shown below. It becomes apparent that the most pronounced deformation is in the middle of the span. This is the case for C1-7, C2-5, and C3-8. C3-8 seems to experience the most deformation in the middle of the span considering most of the damage was applied in the middle span. See Figure 4-4. In terms of the x-axis, the maximum deformation becomes evident at a central point along the

bridge's span, particularly emphasizing the right side. Moving to the y-axis, the apex of deformation emerges at the midpoint of the span. On the z-axis, an intriguing pattern unfolds: the maximum deformation manifests on the left tower, while the right tower experiences the least displacement. This consistent throughout all levels. It shoes persistent and predictable nature of these deformation patterns amidst varying structural conditions.



*Figure 4- 15: Deformation of C1-7 (70 m/s)*



*Figure 4- 16: Deformation of C2-5 (141 m/s)*

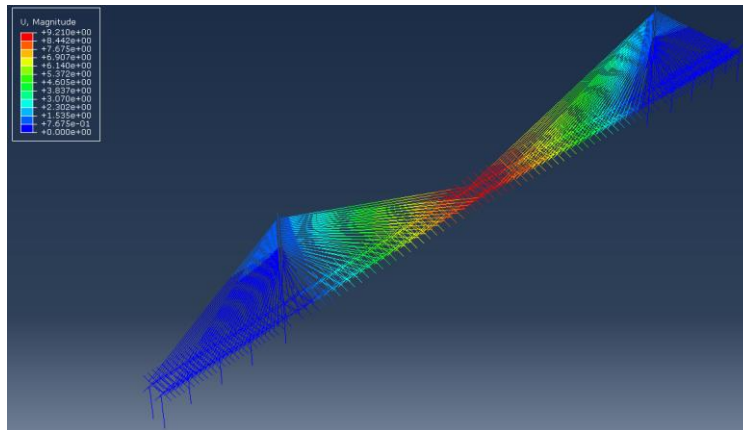


Figure 4- 17: Deformation of C3-8 (211 m/s)

Table 4-13 presents a comprehensive overview of deformation measurements in three distinct directions (U1, U2, and U3) for three levels on the deck. These measurements showcase varying levels of deformation resulting from applied damage.

Table 4-13 represents a summary of deformation results taken for different damage scenarios and different wind speeds, corresponding to Figures 4-15, 4-16 and 4-17. The deformation values are given in millimetres and are categorized into three directions: U1 (x-direction), U2 (y-direction), and U3 (z-direction), which represent horizontal, vertical, and transverse deformations respectively.

Table 4- 13: Summary of deformation on bridge deck

| Level | Deformation (mm) |            |            |
|-------|------------------|------------|------------|
|       | U1(x-dir)        | U2 (y-dir) | U3 (z-dir) |
| C1-7  | 2.873            | 521.700    | 3.158      |
| C2-5  | 2.873            | 493.500    | 3.279      |
| C3-8  | 28.750           | 521.700    | 3.158      |

Here are some insights that can be drawn from these results:

- The deformation changes with the increase in damage. For instance, in Level 1 and Level 2, the U1 deformations are somewhat similar but decrease slightly from Level 1 to Level 2. In Level 3, the U1 deformation increases significantly compared to the first two levels.
- U1 and U3 deformations appear to be more sensitive to damage changes compared to U2 deformation. U2 deformation seems relatively stable across the different damage levels.
- There seems to be an anomaly in level 3 for U1 deformation. The value (28.750) is notably higher than in the other levels (2.873). This could indicate a significant change in deformation behaviour due to a more severe level of damage.

Analysis of the data provided in the Table 4-13 reveals a notable anomaly in the U1 deformation value at Level 3 damage of the bridge deck, with a measurement of 28.750mm compared to the significantly lower values observed at other damage levels (2.873mm). This discrepancy suggests that the potential localized Level 3 damage could lead to a significant alteration in deformation behaviour of the bridge orthotropic steel deck. Such a deviation raises concerns regarding the overall structural integrity of the bridge deck, as higher deformations may compromise its stability and pose safety risks for vehicular traffic and pedestrians. Consequently, timely maintenance and repair efforts are imperative to address the observed damage and mitigate its impact on bridge safety. Based on this assessment, appropriate repairs can be recommended, while implementation of a robust monitoring plan could prove to be crucial to track the progression of deformation over time and assess the effectiveness of repair or maintenance interventions. Continuous monitoring will facilitate the identification of emerging issues and ensure the long-term safety of the bridge structure. Thus, by providing a summary of the impact of damaged deck on the structural response of the bridge, valuable insights can be gleaned into the significance of the observed deformations and their implications for bridge safety and maintenance efforts.

In summary, the extensive analysis of deck damage on the Stonecutters Cable-stayed Bridge's structural response has revealed noteworthy observations. Deformation in all directions exhibits some variation, yet it consistently maintains a similar order of magnitude, indicating a balanced response across different levels of damage. Particularly in the U2 direction (vertical), the consistency across all damage levels suggests both structural stability and a lack of sensitivity to

the applied damage. This dual aspect implies that the bridge maintains stability under the inflicted damages, showcasing an ability to handle vertical loads without significant alterations in its behaviour. Simultaneously, the observed lack of sensitivity suggests that the structure does not respond as anticipated to the applied damage, adding a layer of complexity to its behaviour.

However, the findings underscore the robustness of the Stonecutters Bridge under varying damage scenarios, emphasizing its structural stability and resilience to vertical loads. However, the nuanced lack of sensitivity to damage prompts further investigation into the intricacies of the bridge's response mechanisms. As we delve deeper into subsequent chapters, a more comprehensive understanding of these observations will be pursued, contributing to the broader knowledge of cable-stayed bridge performance, and aiding in the refinement of structural assessments under diverse conditions.

## CHAPTER 5 – CONCLUSIONS

The comprehensive analysis of the Stonecutters Cable-stayed Bridge, encompassing both corrosion-related findings and structural behaviour, has several significant observations. These observations are crucial in understanding the complexities of corrosion-induced structural changes and their influence on the bridge's response. Multiple rib corrosion led to intriguing insights into the interplay between rib location, corrosion level, and deformation. It was evident that the positioning of corroded ribs within the bridge deck, particularly those located in the center of the DDM module, such as TR 10 to 16, played a pivotal role in the deformation of the deck. This observation underscores the substantial contribution of structural elements at the deck's center to overall stiffness and deformation. The relationship between corrosion levels and deformation, with Level 3 damage resulting in the highest deformations, indicates a critical point where severe corrosion can bring the structure closer to risking its structural integrity. This finding suggests that as corrosion progresses and reaches higher levels, the deformation of the structure becomes more pronounced. It highlights the importance of addressing corrosion and implementing robust corrosion prevention measures to maintain the structural integrity of the steel deck. Furthermore, the impact of unprotected steel deck due to human error, often arising from maintenance issues or a lack of protective paint, is evident in the localized deformation observed. This emphasizes the need for effective corrosion prevention measures, such as regular maintenance and the application of protective coatings, to mitigate the detrimental effects of corrosion on the structural elements.

These observations align with the understanding that corrosion induced damage, particularly when it reaches significant levels, can lead to structural deformation and can compromise the integrity of the steel deck. It underscores the importance of proactive corrosion prevention strategies to ensure the long-term durability and safety of the bridge structure. General corrosion modeling provided valuable insights into transversal versus longitudinal deformation. Notably, deformations induced by general corrosion varied significantly between these two directions, with the transversal direction experiencing higher deformations. This divergence is attributed to the structural design, where the deck predominantly resists loads longitudinally. Furthermore, the bottom plate of the deck exhibited more deformation compared to the top plate in general corrosion

scenarios. This phenomenon stemmed from the tensile forces acting on the bottom surface, resulting in sagging, particularly when the integrity of the steel was compromised.

Local corrosion applied to vertical stiffeners highlighted the intricate relationship between deformation and corrosion patterns. Different corrosion patterns (N2, N4, N5) exhibited diverse deformation patterns, highlighting the significant impact of corrosion's nature, extent, and location on structural behaviour. Furthermore, it was observed that the relationship between the number of stiffeners and deformation was not strictly linear. As the number of stiffeners increased, deformations exhibited nuanced behaviour, implying the influence of various factors. Deformation in the longitudinal direction appeared more constrained, likely due to the shape and location of the corrosion patterns, which affected how stresses and strains were distributed along this axis.

General corrosion represents the most severe form of deterioration for this bridge structure, closely followed by local corrosion, particularly when it reaches significant damage levels. Furthermore, it is noteworthy that the most sensitive section of the deck is situated between stiffeners 1 and 2. This specific region consistently exhibits the highest deformation across parametric studies conducted. The region between stiffeners 2 and 3 subsequently display notable deformation as well. This observation aligns with corrosion typically manifesting most severely in areas with geometrical discontinuities or complex stress distributions. The spaces between adjacent stiffeners experience changes in cross-sectional shape and material properties, concentrating stresses. As a result, these sections tend to corrode at an accelerated rate compared to more uniform areas. The findings indicate general corrosion inflicts the most widespread damage. Meanwhile, localized corrosion particularly impacts sections between stiffeners when it progresses to substantial penetration levels. Overall, the results were consistent in capturing how different corrosion mechanisms preferentially affect the orthotropic steel deck's performance.

Shifting the focus to modal analysis, the first five vibration mode shapes of the Stonecutters Bridge were investigated. These shapes represented the dominant modes of vibration likely to be encountered by the bridge. The analysis revealed various modes of vibration, from symmetry in horizontal and vertical deck displacement to asymmetry introduced in mode shape 3, indicative of uneven motion patterns. Mode shapes 4 and 5 exhibited a blend of symmetry and asymmetry,



particularly in the bending towers and horizontal deck displacement. These mode shapes provided invaluable insights into the dynamic behavior of the bridge. The analysis of natural frequencies yielded significant findings. As damage levels increased, natural frequencies exhibited shifts. The natural frequency range, initially spanning from 0.145Hz to 1.930Hz without damage, varied between 0.135Hz to 1.517Hz, as damage progressed. These changes were attributed to the reduction in stiffness caused by corrosion-induced damage.

As noted in Chapter 4, the natural frequencies decrease as the damage increases. This proves that the damage was weakening the bridge. Without the damage, the bridge was stiffer and less prone to oscillations. As the level of damage increased, the Stonecutter's bridge stiffness decreased especially on the center of the span. Corrosion-induced material loss also resulted in a shift in the center of mass within the bridge structure, leading to an uneven mass distribution. This shift, combined with altered vibrational characteristics, significantly impacted the bridge's behaviour. Mass redistribution played a pivotal role in the change of natural frequencies as damage levels increased.

Deformation analysis, involving measurements in three directions (U1, U2, and U3), further emphasized the impact of applied damage. U1 and U3 deformations exhibited greater sensitivity to damage changes compared to U2 deformation. Notably, anomalies in deformation patterns, particularly for Level 3 damage, suggested significant changes in behaviour due to more severe damage.

### **5.1 Research Limitations**

Initially, a computational constraint was encountered due to the extensive demands of corrosion modeling and analysis. This constraint naturally limited the number of models that could be examined, especially in the context of intricate corrosion patterns like N2, N4, and N5. This in turn confined the scope of the study, suggesting a potential need for more comprehensive analysis of specific corrosion patterns in future research. Another constraint pertains to the simplified corrosion models employed, which suppressed the corroded element or employed an overall reduction of the steel plate surface. These models relied on simplified assumptions to ensure

practicality during the analysis. However, real-world corrosion processes are considerably more intricate, time-dependent, and multifaceted. While these models yielded valuable insights, they may not encompass the full range of effects associated with real-world corrosion scenarios. Moreover, the study identified that the influence of vertical stiffeners on deformation did not follow a strictly linear trend. This observation implies a possible necessity for more advanced and non-linear models to provide precise predictions regarding deformation under varying conditions. One of the most significant limitations uncovered was the substantial discrepancy in the moment of inertia about the centroidal Y-axis. Despite extensive efforts to address this issue, it remains a crucial constraint with wide-ranging implications. Such disparities in moment of inertia may potentially lead to varying results in subsequent analyses, particularly in calculations concerning bending stresses and deflection predictions. Addressing this limitation is paramount for enhancing the study's reliability.

Furthermore, variations in natural frequencies were observed, particularly at higher mode shapes, across different damage levels. Although it was evident that damage induced changes in natural frequencies, the absence of clear linear trends makes it challenging to predict how frequency shifts correspond to damage severity. This limitation underscores the complexities of the bridge's response to damage and emphasizes the need for more nuanced analyses and predictive models. Additionally, the corrosion models applied in this study, while comprehensive in their scope, are still simplifications of actual corrosion processes. Real-world corrosion is influenced by numerous uncontrolled variables and environmental factors that are challenging to replicate in a controlled simulation. Consequently, these models may not fully encompass the complexities of real-world corrosion behavior.

## **5.2 Recommendations for Future Work**

To address and solve some of the limitations mentioned above, this section explores several items for future investigation and improvement in our research. The future work can start with better modelling of steel as material in a finite element model:

Incorporating anisotropy into Finite Element Modeling (FEM) is advantageous for simulating the behaviour of corroded steel. To improve the accuracy of modelling the effects of corrosion on structural elements, it is recommended to utilize constitutive behaviour for corroded steel. This integration allows for a more comprehensive representation of the degradation process, going

beyond simple thickness reduction and capturing the evolving material properties as corrosion progresses. Accounting for anisotropy is crucial when dealing with corroded steel elements, as the material can exhibit varying properties in different directions due to factors such as grain orientation and microstructural changes caused by corrosion. By incorporating anisotropy into the finite element model, the directional variation in material properties can be accurately captured, enabling the simulation of non-uniform degradation and providing more realistic predictions of structural behaviour.

Utilizing constitutive behaviour for corroded steel is essential to consider the changing material properties due to degradation. By incorporating the constitutive behaviour, the model can accurately capture the evolving mechanical response of the material as corrosion progresses. This comprehensive representation of the degradation process and its impact on structural behaviour enables a more accurate simulation. By combining anisotropy and constitutive behaviour in finite element modelling, the behaviour of corroded steel can be more accurately simulated. This approach allows for a nuanced representation of the degradation process, considering the directional variations in material properties as well as the evolving mechanical response. By adopting this comprehensive approach, the accuracy of the finite element model can be enhanced, leading to more realistic predictions of the structural behaviour as corrosion progresses. Perform sensitivity analysis to understand how variations in material properties, damage severity, and environmental conditions impact the bridge's response. To solve the problem of corrosion on the deck, depending on the budget, it would be beneficial to layer steel as anisotropic material. It would allow the designer to attribute properties in different directions, which can make the top plate/u-ribs of the orthotropic steel deck more resistant to certain types of damage.

An in-depth exploration of the moment of inertia about the centroidal Y-axis ( $I_{22}$ ) to explore the discrepancy between the results obtained from the two software applications. Study the relationship between thickness (mass density) and moment of inertia for damaged steel elements. The goal of this could help determine how much we can reduce the moment of inertia based on the thickness reduction. Establish a relation between the reduction of moment inertia and natural frequency in orthotropic steel deck incorporating the damage on deck (corroded deck, general and

local corrosion). If it is possible, an equation between the two should be identified. It would help simplify the study investigation of damage on the deck.

- Most of the research needs to be performed for various damaged beams (cantilever, composite, simply supported etc). Reducing the moment of inertia could lead to a decrease in the natural frequency, indicating that stiffness of the beam decreased with a reduction in moment of inertia.
- Dynamic response of damaged steel orthotropic deck can be performed based on the outcomes presented in this thesis.

-To continue to enrich this study, it would be primordial to add all type of loads on the bridge. Here is a list of loads that could be added:

- Live load vehicles, pedestrians, and other moving loads that use the bridge.
- Seismic load: the force generated by earthquakes or other seismic events, which can cause significant stress on the bridge.
- Impact load: the sudden impact of heavy objects or vehicles, such as during a collision, if something was to hit piers and towers.
- Hydrodynamic load: since this bridge is above water, the weight and pressure of water the hydrodynamic load can be applied only on the towers, but it can cause significant stress on the bridge structure. This significant load should be taken in consideration.

To optimize modelling costs while leveraging the strengths of each tool, a strategy is proposed that involves utilizing both ANSYS and ABAQUS software applications for bridge modelling. This approach combines the benefits of accuracy and cost-effectiveness. ANSYS is chosen for conducting detailed investigations of specific bridge sections due to its advanced features and capabilities. It provides a wide range of tools and techniques to accurately represent the complex behavior of critical bridge components. The software's accuracy in simulating and predicting structural elements makes it a suitable choice for detailed investigations. ABAQUS, on the other hand, brings cost-efficiency and accessibility to the modeling process. It offers a range of modeling capabilities at a relatively lower cost compared to ANSYS, making it ideal for broader structural assessments. Additionally, ABAQUS is widely used in the engineering community, ensuring accessibility to a larger user base and a wealth of resources, tutorials, and support.

By combining the strengths of ANSYS and ABAQUS, the overall strategy aims to optimize both accuracy and cost-effectiveness in the modeling process. ANSYS is utilized for detailed investigations of specific bridge sections, taking advantage of its advanced features and accuracy. ABAQUS, on the other hand, is employed for broader structural assessments, benefiting from its cost-efficiency and accessibility. This refined strategy ensures that modelling costs are optimized while still achieving accurate representations of the bridge's behaviour. By utilizing the most suitable software for each aspect of the investigation, the study can benefit from the strengths of both ANSYS and ABAQUS, leading to a comprehensive and cost-effective analysis of the bridge structure. A time analysis with corrosion on an orthotropic deck and the cable involves modelling the behaviour over time.

Analyzing how the overall bridge reacts to corrosion in its different components over time, could be carried out. It could help predict its future behaviour and life cycle in the presence of corrosion-induced damage. The time-dependent modelling is a process itself. It would require integrating equations of motion over time to simulate the behaviour of the decks under the effect of the applied damages. Addressing uncertainties in the finite element model and potential discrepancies in moment of inertia values calls for a focus on experimental validation. To comprehensively assess the accuracy of our finite element model, a series of controlled experiments on the bridge is proposed. This involves equipping the structure with an instrumentation system for monitoring various parameters. Controlled damage scenarios, such as selectively removing ribs, will be strategically introduced to observe and measure the bridge's structural response under varying conditions. Thorough testing will be conducted under different loading scenarios, capturing empirical data for both undamaged and damaged states. The empirical data will be compared with predictions from the finite element model. This iterative process of validation and calibration aims to enhance the accuracy of the finite element model, ensuring it reliably reflects the Stonecutters Bridge's structural behaviour in real-world conditions.

However, conducting structural monitoring on the Stonecutters Bridge is highly recommended to address uncertainties in the finite element model and potential discrepancies in moment of inertia values. This field validation process aims to comprehensively assess the accuracy of the finite element model for a cable-stayed bridge with a deteriorated orthotropic steel deck. The first step

in the experimental setup involves equipping the bridge structure with an instrumentation system to monitor various parameters. Such system will capture important data related to the bridge's response under different loading conditions. The goal is to obtain empirical data that can be compared with the predictions generated by the finite element model. Controlled damage scenarios will be introduced to observe and measure the bridge's structural response under varying conditions. For example, specific ribs may be selectively removed to simulate deterioration in the orthotropic steel deck. This will provide insights into how different types and degrees of damage affect the bridge's structural behaviour.

Thorough testing will be conducted under different loading scenarios for both undamaged and damaged states of the bridge. The field monitoring data obtained from these tests will be compared with the predictions generated by the finite element model. This iterative process of validation and calibration aims to enhance the accuracy of the model, ensuring that it reliably reflects the Stonecutters Bridge's structural behaviour in real-world conditions. This would ensure that the finite element model developed in the current research, accurately represents the bridge's structural behaviour, enabling reliable predictions and assessments of the bridge's response under different conditions. Moreover, conducting structural monitoring on the Stonecutters Bridge, and comparison with the finite element model with controlled damage scenarios, would be essential for a comprehensive and accurate assessment of the bridge's response. Through this iterative process of validation and calibration, the accuracy and reliability of the finite element DDM model developed can be enhanced, ensuring it effectively reflects the Stonecutters Bridge's structural behaviour in real-world conditions.

## REFERENCES

- Ahn, J. H., Kim, I. T., Kainuma, S., & Lee, M. J. (2014). Residual shear strength of steel plate girder due to web local corrosion. *Journal of Constructional Steel Research*, 100, 108-115.
- Ahn, J.-H., Cheung, J.-H., Lee, W.-H., Oh, H., & Kim, I.-T. (2015). Shear buckling experiments of web panel with pitting and through-thickness corrosion damage. *Journal of Constructional Steel Research*, 109, 44-56.
- Ahn, J.-H., Kainuma, S., & Kim, I.-T. (2015). Shear failure behaviors of a web panel with local corrosion depending on web boundary conditions. *Journal of Constructional Steel Research*, 110, 13-21.
- Apostolopoulos, C.A., Pasialis, V.P. Effects of Corrosion and Ribs on Low Cycle Fatigue Behavior of Reinforcing Steel Bars S400. *J. of Materi Eng and Perform* **19**, 385–394 (2010). <https://doi.org/10.1007/s11665-009-9502-y>
- Chang, Y., Luo, W., Zhao, L., Zou, Y., Liu, Q., & Ge, Y. (2023). Influence of reduced drag load on stay cables on the construction cost of cable-stayed bridges: Two study cases. *Journal of Wind Engineering and Industrial Aerodynamics*, 242, 105584.
- Diana, G., Fiammenghi, G., Belloli, M., Rocchi, D. “Wind Tunnel Tests and Numerical Falbe-Hanse,K., Hauge, L. & Kite, S. (2004). Stonecutters Bridge – Detailed Design. International Association for Bridge and Structural Engineering, 19-24. DOI: 10.2749/222137804796291719,
- Dipartimento di Meccanica. (Year). *Approach for Long Span Bridges: The Messina Bridge*. Highways Department, Hong Kong Special Administrative Region. (Year). *Bridge, Hong Kong*.
- Fan, Z., Tang, X., Chen, Y., Ren, Y., Deng, C., Wang, Z., ... & Huang, Q. (2024). Review of anomaly detection in large span bridges: available methods, recent advancements and future trends. *Advances in Bridge Engineering*, 5(1), 2.
- Ge, Y. (2016). Aerodynamic challenge and limitation in long-span cable-supported bridges. Semantic Scholar.
- Guo, T., Zhu, J., & Liu, Z. (2017). Fatigue reliability assessment of orthotropic steel bridge decks based on probabilistic multi-scale finite element analysis. *International Journal of Fatigue*, 99, 48-62.
- Hoang, V. H., Nguyen, Q. T., Tran, A. T., & Tran, T. C. H. (2021). Mechanical behavior of the asphalt wearing surface on an orthotropic steel bridge deck under cyclic loading. *Construction and Building Materials*.
- Hui, M. “Full-bridge Aeroelastic Model Wind Tunnel Tests for the Stonecutters Bridge”. Civil Engineering and Development Department, Hong Kong Special Administrative Region, Civil

Engineering and Development Building, 101 Princess Margaret Road, Hong Kong, People's Republic of China. (2013). *HKIE Transactions*, 20(2), 109–123.

Hui, M., and Ding, Q. S. “Flutter Analysis of Stonecutters Bridge”. *Wind and Structures*, Vol. 9, No. 2(2006) 125-146.

Janjic, Dorian. (2005). Experience from Global Analysis of Stonecutter's Bridge and Sutong Bridge. TDV Company.

Jeon, C. H., Shim, C. S., Lee, Y. H., & Schooling, J. (2024). Prescriptive maintenance of prestressed concrete bridges considering digital twin and key performance indicator. *Engineering Structures*, 302, 117383.

Jeong, Y. S., Kainuma, S., & Ahn, J. H. (2019). Structural response of orthotropic bridge deck depending on the corroded deck surface. *Journal of Mechanical Science and Technology*, 33(3), 1419-1426.

Kainuma, S., Jeong, Y. S., & Ahn, J. H. (2015). Stress distribution on the real corrosion surface of the orthotropic steel bridge deck. *Steel and Composite Structures*, 18(6), 1479-1492. doi: 10.12989/scs.2015.18.6.1479

Kainuma, S., Yang, M., Jeong, Y.-S., Inokuchi, S., Kawabata, A., & Uchida, D. (2017). Experiment of fatigue behavior of rib-to-deck weld root in orthotropic steel deck. *Journal of Structural Engineering*.

Kaji, A., Hirai, T., O'Grady, R., Sham, R. (2010). An Introduction to Stonecutters Bridge, Hong Kong: Erection of the Steel Segments, Hydraulic Buffers and Lateral Bearings. In Amin, Okui, Bhuiyan (Eds.), *IABSE-JSCE Joint Conference on Advances in Bridge Engineering-II* (pp. xx-xx). Dhaka, Bangladesh: ISBN: 978-984-33-1893-0. Yokogawa Bridge Corporation, Tokyo, Japan; Maeda-Hitachi-Yokogawa-Hsing Chong JV, Hong Kong, China; AECOM, Hong Kong, China.

Kim, I.-T., Lee, M.-J., Ahn, J.-H., & Kainuma, S. (2012). Experimental evaluation of sheet buckling behaviors and strength of locally corroded web. *Thin-Walled Structures*, 57, 45-54.

Larose, G. L., Savage, M. G., and Lafreniere, A. “Sectional Model Experiments for  
Liang, R. R., & Hota, G. V. (2024). Infrastructure Applications of Fiber-Reinforced Polymer Composites. In *Applied Plastics Engineering Handbook* (pp. 749-781). William Andrew Publishing.

Liu, X., Miyashita, T., & Nagai, K. (2011). Analytical study on shear capacity of steel I-girders with local corrosion near by supports. *Journal of Structural Engineering*, 131(11), 1723-1730. LTR-AL-2006-0013.

Luo, S., Lu, Q., Qian, Z., Wang, H., & Huang, Y. (2017). Laboratory investigation and numerical simulation of the rutting performance of double-layer surfacing structure for steel bridge decks. *Journal of Traffic and Transportation Engineering (English Edition)*.



- Ma, L., Li, Z., Xu, H., & Cai, C. S. (2024). Numerical study on the dynamic amplification factors of highway continuous beam bridges under the action of vehicle fleets. *Engineering Structures*, 304, 117638.
- Maljaars, J., Bonet, E., & Pijpers, R. (2016). Fatigue resistance of the deck plate in steel orthotropic deck structures. *Journal of Bridge Engineering*, 21(3), 04015063.
- McMullen, K., & Zaghi, A. (2018). An accelerated repair method for steel girders with severe end corrosion damage. *Journal of Bridge Engineering*, 23(7), 04018052.
- Pei, B., Chong, A., Xia, H., & Kang, X. (2023). Design and key construction technology of steel-concrete-steel sandwich composite pylon for a large span cable-stayed bridge. *Scientific Reports*, 13(1), 6626.
- Peng, J., Liu, Y., Yang, Y., & Xie, L. (2024). Fatigue behavior of RD joint in OSBD subjected to local corrosion at top plate. *Engineering Failure Analysis*, 108091.
- Politecnica di Milano, Via La Mas, 1-Milano, Italy. *J. Wind Eng. Ind. Aerodyn.* 122 (2013)
- Qin, S., Zhong, A., Zhang, J., Wang, K., & Gao, L. (2024). Hot spot stress distribution and fatigue life evaluation of steel-UHPC deck in a long-span cable-stayed bridge. *Journal of Constructional Steel Research*, 213, 108406.
- Scanlan, R.H. & Simium, E. "Wind effects on Structures". Wiley Interscience, New York, 3 edition, 1996.
- Stroyone. (2023, March 4). Stonecutters Bridge - Stroyone.com. [stroyone.com. https://stroyone.com/bridge/stonecutters-bridge.html](https://stroyone.com/bridge/stonecutters-bridge.html)
- Sugimoto, I., Kobayashi, Y., & Ichikawa, A. (2006). Durability Evaluation based on buckling characteristics of Corroded Steel Deck Girders. *Journal of Structural and Construction Engineering (Transactions of AIJ)*.
- Tamakoshi, T., Yoshida, Y., Sakai, Y., & Fukunaga, S. (2006). Analysis of damage occurring in steel plate girder bridges on national roads in Japan. *Journal of Bridge Engineering*, 11(2), 207-215.
- Tan, X., Fang, Z., Zhu, Q., Liao, Y., Tang, S., & Zhang, F. (2023). Numerical and experimental study of a segmentally prefabricated orthotropic steel-ultra-high-performance concrete composite deck for long-span cable-stayed bridges. *Advances in Structural Engineering*, 13694332231213468.
- Tzortzinis, G., Knickle, B. T & Gerasimidis, S. (n/a). Development of an analytical framework for strength assessment of corroded steel bridges.

Tzortzinis, G., Knickle, B. T., Bardow, A., Brena, S., & Gerasimidis, S. (2021). Strength evaluation of deteriorated girder ends. II: Numerical study on corroded I-beams. *Journal of Structural Engineering*.

Tzortzinis, G., Knickle, B., Bardow, A., Brena, S., & Gerasimidis, S. (2021). Strength evaluation of deteriorated girder ends. I: Experimental study on naturally corroded I-beams. *Journal of Bridge Engineering*.

Usukura, Y., Yamaguchi, E., Suzuki, T., & Mitsugi, S. (2014). Strength evaluation for a corroded damaged steel girder end considering its collapse mechanism. *Engineering Structures*, 77, 31-40. Verification of the Aerodynamic Properties at High Reynolds Number of the Stonecutters

Wang, Y., Shao, X., Wang, S., Chen, M., Li, C., & Cui, P. (2024). Application of Lightweight Steel-Plate-Reinforced Ribbed UHPC Deck Panel in a Long-Span Suspension Bridge. *Journal of Bridge Engineering*, 29(2), 05023011.

Wei, L. & Gao, K. (2019). Understanding the general and localized corrosion mechanisms of Cr-containing steels in supercritical CO<sub>2</sub>-saturated aqueous environments. *Journal of Alloys and Compounds*.

Xiang, Y., Noel, E., Dragomirescu, E., & Martin-Perez, B. (2023). The effect of cable corrosion on dynamic response of Stonecutters Cable-Stayed Bridge model. *Canadian Journal of Civil Engineering*.

Yamaguchi, E., & Akagi, T. (2013). Degradation of load-carrying capacity of steel I-girder end due to corrosion. *Journal of Structural Engineering*.

Ye, H., Huang, A., Jiang, C., & Wang, W. (2023). Experimental Investigation on Fatigue Improvement of Orthotropic Steel Bridge Deck Using Steel Fiber Reinforced Concrete. *International Journal of Concrete Structures and Materials*, 17(1), 41.

Zhuang, M.-L., Wang, S., & Sun, C. (2021). Experiment and numerical simulation investigation for crack growth of deck-to-rib welded details in orthotropic steel bridge decks. *Journal of Constructional Steel Research*.

Zmetra, K., McMullen, K., Zaghi, A., & Wille, K. (2018). Experimental Study of UHPC Repair for Corrosion-Damaged Steel Girder Ends. *Journal of Structural Engineering*.

## **APPENDIX A – Case study of removal of single ribs on top plate**

## CHAPTER 5 - CONCLUSIONS

### TOP PLATE

| # OF RIBS | Deformation (mm) |         |
|-----------|------------------|---------|
|           | MAX              | AVERAGE |
| 1         | 7.80             | 2.27    |
| 3         | 7.80             | 2.27    |
| 5         | 12.62            | 2.32    |
| 7         | 22.34            | 2.49    |
| 9         | 31.58            | 2.71    |
| 11        | 33.52            | 2.83    |
| 13        | 35.54            | 2.93    |
| 15        | 35.93            | 3.01    |
| 17        | 35.57            | 3.04    |

#### Deformation - Y (mm) TRANSV

|      |      |       |       |       |       |       |       |       |
|------|------|-------|-------|-------|-------|-------|-------|-------|
| 1.0  | 3.0  | 5.0   | 7.0   | 9.0   | 11.0  | 13.0  | 15.0  | 17.0  |
| 0.0  | 0.0  | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |
| -5.0 | -5.0 | -5.0  | -4.9  | -4.7  | -0.6  | -0.6  | -0.5  | -0.5  |
| -0.9 | -0.9 | -0.9  | -0.7  | 0.0   | -0.8  | -0.1  | -0.4  | -0.1  |
| -5.8 | -6.9 | -11.6 | -20.9 | -29.8 | -31.7 | -33.8 | -34.2 | -33.8 |
| -2.0 | -2.0 | -2.1  | -3.1  | -5.0  | -3.9  | -4.3  | -4.4  | -4.4  |
| -7.0 | -7.0 | -7.0  | -6.9  | -6.5  | -1.7  | -1.7  | -1.7  | -1.7  |
| -5.7 | -5.7 | -5.7  | -5.7  | -5.6  | -1.7  | -1.7  | -1.7  | -1.7  |
| 0.0  | 0.0  | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   | 0.0   |

#### Deformation - Z (mm) LONGI

|      |      |       |       |       |       |       |       |       |
|------|------|-------|-------|-------|-------|-------|-------|-------|
| 1.0  | 3.0  | 5.0   | 7.0   | 9.0   | 11.0  | 13.0  | 15.0  | 17.0  |
| -1.7 | -1.7 | -4.6  | -14.5 | -28.5 | -33.5 | -35.5 | -35.9 | -35.6 |
| -3.2 | -3.2 | -8.0  | -17.5 | -29.6 | -31.9 | -33.1 | -33.5 | -33.2 |
| -5.9 | -5.9 | -10.9 | -21.0 | -31.4 | -32.8 | -33.5 | -34.2 | -33.9 |
| -7.6 | -7.6 | -12.4 | -22.2 | -31.5 | -32.7 | -33.3 | -34.1 | -33.9 |
| -7.5 | -7.5 | -12.4 | -22.0 | -31.4 | -32.6 | -33.2 | -34.0 | -33.8 |
| -5.6 | -5.6 | -10.8 | -20.6 | -30.8 | -32.0 | -32.6 | -33.1 | -32.9 |
| -2.7 | -2.7 | -7.6  | -15.1 | -22.5 | -23.5 | -23.8 | -24.0 | -23.8 |
| -0.9 | -0.9 | -0.8  | -0.8  | -0.7  | -0.8  | -0.7  | -0.7  | -0.7  |

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 1

Table A1.1: 1TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 7.80        | 2.27     |

Table A1.2: 1TR - Deformation Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.01 |
| 4.96  | -0.91 |
| 7.63  | -5.82 |
| 10.30 | -1.98 |
| 12.97 | -7.05 |
| 15.64 | -5.70 |
| 18.31 | 0.00  |

Table A1.3: 1TR - Deformation Long

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.73 |
| 2.25  | -3.21 |
| 4.88  | -5.90 |
| 7.50  | -7.59 |
| 10.13 | -7.49 |
| 12.75 | -5.60 |
| 15.38 | -2.68 |
| 18.00 | -0.94 |

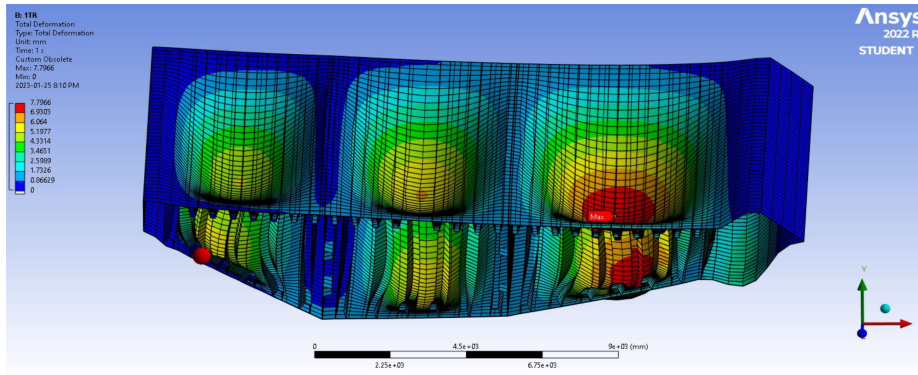


Figure A1.1: 1TR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 3

Table A1.4: 3TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 7.80        | 2.27     |

Table A1.5: 3TR - Deformation Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.02 |
| 4.96  | -0.90 |
| 7.63  | -6.88 |
| 10.30 | -2.02 |
| 12.97 | -7.04 |
| 15.64 | -5.71 |
| 18.31 | 0.00  |

Table A1.6: 3TR - Deformation Long

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.73 |
| 2.25  | -3.21 |
| 4.88  | -5.90 |
| 7.50  | -7.59 |
| 10.13 | -7.49 |
| 12.75 | -5.60 |
| 15.38 | -2.69 |
| 18.00 | -0.94 |

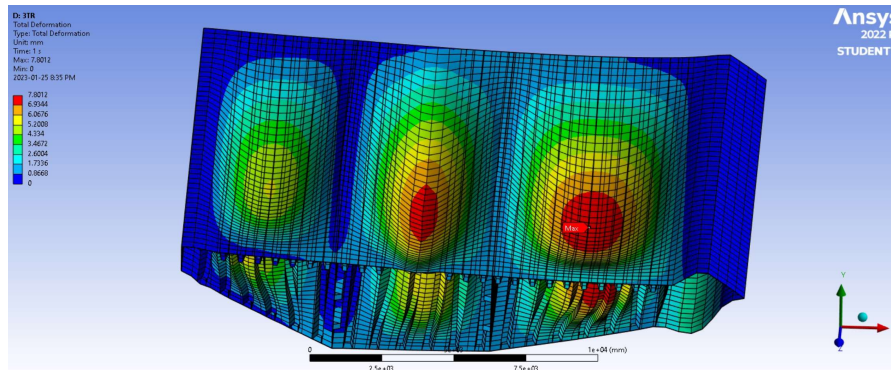


Figure A1.2: 3TR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 5

Table A1.7: 5TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 12.62       | 2.32     |

Table A1.8: 5TR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -5.01  |
| 4.96  | -0.87  |
| 7.63  | -11.62 |
| 10.30 | -2.15  |
| 12.97 | -7.02  |
| 15.64 | -5.71  |
| 18.31 | 0.00   |

Table A1.9: 5TR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -4.61  |
| 2.25  | -7.98  |
| 4.88  | -10.91 |
| 7.50  | -12.41 |
| 10.13 | -12.37 |
| 12.75 | -10.84 |
| 15.38 | -7.62  |
| 18.00 | -0.78  |

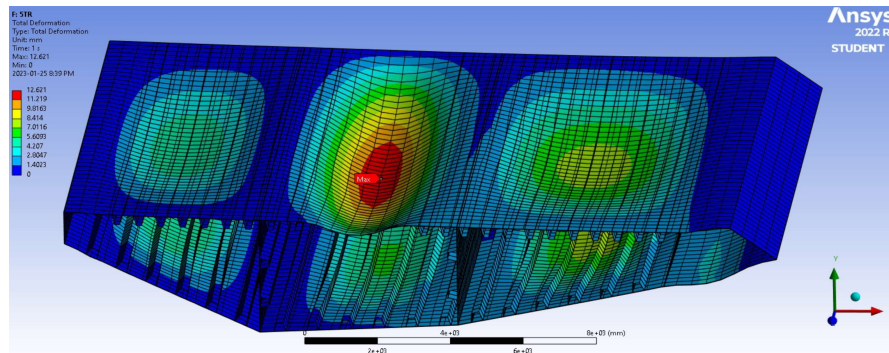


Figure A1.3: 5TR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 7

Table A1.10: 7TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 22.34       | 2.49     |

Table A1.11: 7TR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -4.95  |
| 4.96  | -0.65  |
| 7.63  | -20.90 |
| 10.30 | -3.13  |
| 12.97 | -6.92  |
| 15.64 | -5.69  |
| 18.31 | 0.00   |

Table A1.12: 7TR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -14.49 |
| 2.25  | -17.50 |
| 4.88  | -20.97 |
| 7.50  | -22.18 |
| 10.13 | -22.04 |
| 12.75 | -20.61 |
| 15.38 | -15.06 |
| 18.00 | -0.76  |

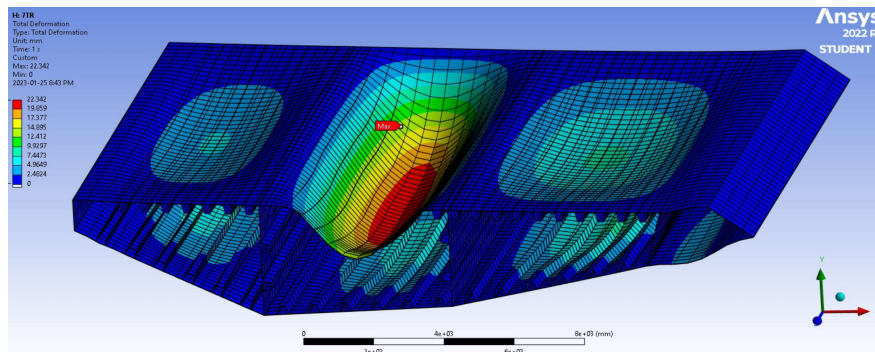


Figure A1.4: 7TR - Static Structural (deformation)



## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 9

Table A1.13: 9TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 31.58       | 2.71     |

Table A1.14: 9TR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -4.70  |
| 4.96  | -0.03  |
| 7.63  | -29.85 |
| 10.30 | -4.97  |
| 12.97 | -6.54  |
| 15.64 | -5.59  |
| 18.31 | 0.00   |

Table A1.15: 9TR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -28.51 |
| 2.25  | -29.57 |
| 4.88  | -31.40 |
| 7.50  | -31.51 |
| 10.13 | -31.45 |
| 12.75 | -30.79 |
| 15.38 | -22.55 |
| 18.00 | -0.72  |

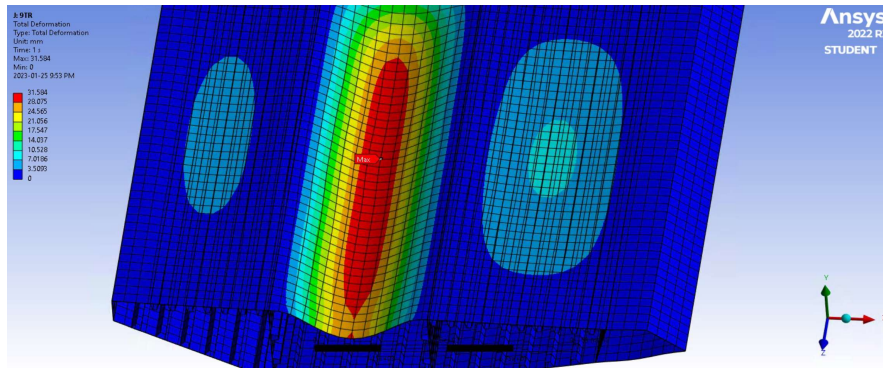


Figure A1.5: 9TR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 11

Table A1.16: 11TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 33.52       | 2.83     |

Table A1.17: 11TR - Deformation Tranverse      Table A1.19: 1TR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | -0.05  |
| 2.29  | -0.57  |
| 4.96  | -0.78  |
| 7.63  | -31.71 |
| 10.30 | -3.92  |
| 12.97 | -1.71  |
| 15.64 | -1.69  |
| 18.31 | 0.00   |

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -33.52 |
| 2.25  | -31.93 |
| 4.88  | -32.80 |
| 7.50  | -32.72 |
| 10.13 | -32.59 |
| 12.75 | -31.96 |
| 15.38 | -23.46 |
| 18.00 | -0.75  |

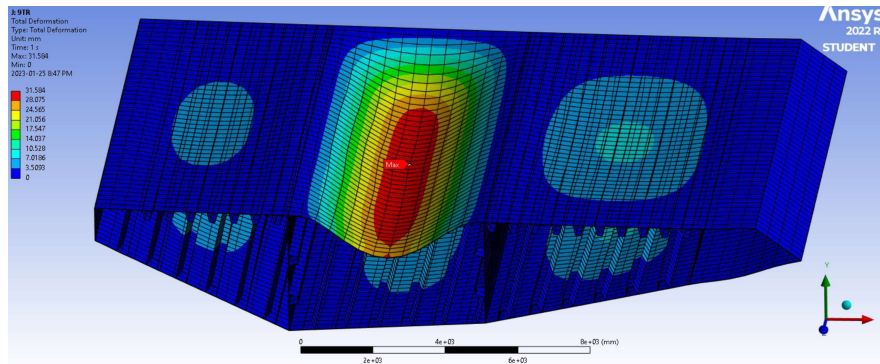


Figure A1.6: 11TR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 13

Table A1.20: 13TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 35.54       | 2.93     |

Table A1.21: 13TR - Deformation Tranverse      Table A1.22: 13TR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -0.56  |
| 4.96  | -0.10  |
| 7.63  | -33.85 |
| 10.30 | -4.31  |
| 12.97 | -1.69  |
| 15.64 | -1.68  |
| 18.31 | 0.00   |

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -35.54 |
| 2.25  | -33.10 |
| 4.88  | -33.54 |
| 7.50  | -33.31 |
| 10.13 | -33.16 |
| 12.75 | -32.58 |
| 15.38 | -23.84 |
| 18.00 | -0.70  |

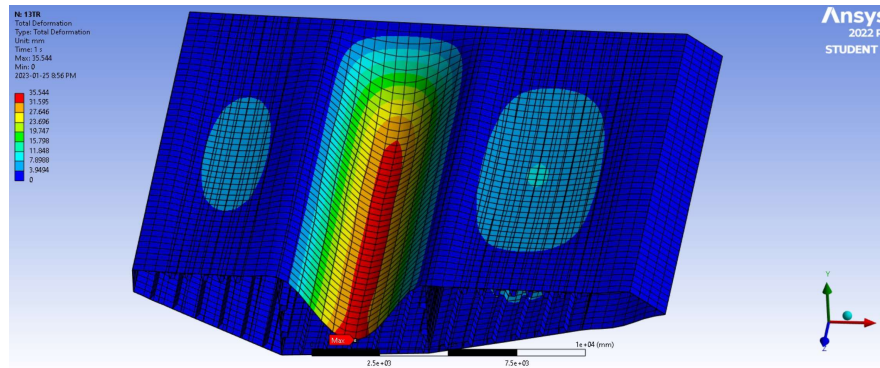


Figure A1.7: 13TR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 15

Table A1.23: 15TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 35.93       | 3.01     |

Table A1.24: 15TR - Deformation Tranverse      Table A1.25: 15TR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -0.53  |
| 4.96  | -0.37  |
| 7.63  | -34.25 |
| 10.30 | -4.37  |
| 12.97 | -1.70  |
| 15.64 | -1.69  |
| 18.31 | 0.00   |

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -35.93 |
| 2.25  | -33.55 |
| 4.88  | -34.19 |
| 7.50  | -34.11 |
| 10.13 | -33.95 |
| 12.75 | -33.15 |
| 15.38 | -24.02 |
| 18.00 | -0.69  |

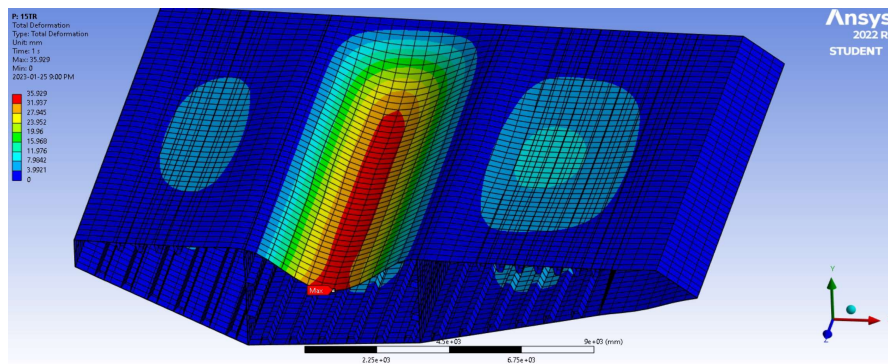


Figure A1.8: 15TR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 17

Table A1.26: 17TR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 35.57       | 3.04     |

Table A1.27: 17TR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -0.50  |
| 4.96  | -0.08  |
| 7.63  | -33.83 |
| 10.30 | -4.37  |
| 12.97 | -1.72  |
| 15.64 | -1.70  |
| 18.31 | 0.00   |

Table A1.28: 1TR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -35.57 |
| 2.25  | -33.21 |
| 4.88  | -33.92 |
| 7.50  | -33.91 |
| 10.13 | -33.76 |
| 12.75 | -32.87 |
| 15.38 | -23.77 |
| 18.00 | -0.68  |

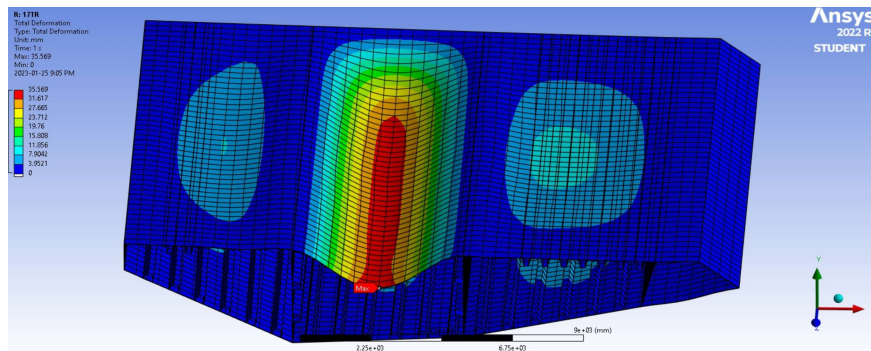


Figure A1.9: 17TR - Static Structural (deformation)

## **APPENDIX B – Case study of removal of single ribs on bottom plate**

## CHAPTER 5 - CONCLUSIONS

### BOTTOM PLATE

| # OF RIBS | Deformation (mm) |         |
|-----------|------------------|---------|
|           | MAX              | AVERAGE |
| 1         | 7.82             | 2.30    |
| 3         | 10.32            | 2.35    |
| 5         | 16.09            | 2.49    |
| 7         | 18.651           | 2.5579  |
| 9         | 18.67            | 2.64    |
| 11        | 18.66            | 2.70    |
| 13        | 18.63            | 2.73    |
| 15        | 18.63            | 2.92    |
| 17        | 23.65            | 3.26    |

#### Deformation - Y (mm)      TRANS

| 1     | 3      | 5      | 7      | 9      | 11     | 13     | 15     | 17     |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0.00  | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   |
| -5.01 | -5.00  | -4.77  | -0.59  | -5.97  | -0.56  | -8.13  | -13.44 | -17.37 |
| -2.83 | -2.82  | -2.72  | -0.84  | -4.06  | -2.16  | -5.25  | -7.00  | -7.94  |
| -0.67 | -0.75  | -1.01  | -1.51  | -0.95  | -1.50  | -0.92  | -0.92  | -0.96  |
| -6.51 | -10.30 | -16.04 | -18.65 | -16.23 | -18.66 | -16.21 | -16.21 | -16.23 |
| -1.83 | -1.90  | -2.16  | -2.36  | -2.17  | -2.39  | -2.15  | -2.14  | -2.17  |
| -6.32 | -6.33  | -6.13  | -1.78  | -6.89  | -1.82  | -9.80  | -12.17 | -17.29 |
| -2.00 | -2.01  | -2.08  | -1.68  | -2.06  | -1.73  | -2.15  | -2.17  | -2.38  |
| 0.00  | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   |

#### Deformation - Z (mm)      LONGI

| 1     | 3      | 5      | 7      | 9     | 11     | 13     | 15     | 17     |
|-------|--------|--------|--------|-------|--------|--------|--------|--------|
| -0.73 | -4.95  | -13.34 | -17.82 | -0.68 | -18.66 | -18.63 | -13.03 | -23.65 |
| -2.03 | -6.92  | -14.13 | -15.75 | -2.40 | -16.43 | -16.40 | -14.56 | -20.85 |
| -4.15 | -9.12  | -15.21 | -15.70 | -5.32 | -16.33 | -16.31 | -16.52 | -20.76 |
| -5.44 | -10.19 | -15.37 | -15.65 | -7.15 | -16.28 | -16.26 | -17.30 | -20.75 |
| -5.42 | -10.14 | -15.30 | -15.59 | -7.12 | -16.22 | -16.21 | -17.26 | -20.75 |
| -4.09 | -8.95  | -15.03 | -15.57 | -5.26 | -16.22 | -16.20 | -16.45 | -20.79 |
| -1.88 | -6.60  | -13.05 | -14.19 | -2.26 | -14.82 | -14.80 | -13.64 | -18.29 |
| -0.39 | -0.78  | -0.77  | -0.75  | -0.36 | -0.70  | -0.68  | -0.26  | -0.24  |

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 1

Table B1.1: 1BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 7.82        | 2.30     |

Table B1.2: 1BR - Deformation Tranverse

| <b>Dir</b>   | <b>Def</b> |
|--------------|------------|
| <b>Y (m)</b> | <b>mm</b>  |
| 0.00         | 0.00       |
| 2.23         | -5.01      |
| 4.58         | -2.83      |
| 6.51         | -0.67      |
| 8.66         | -6.51      |
| 10.81        | -1.83      |
| 13.44        | -6.32      |
| 16.99        | -2.00      |
| 20.36        | 0.00       |

Table B1.3: 1BR - Deformation Long

| <b>Dir</b>   | <b>Def</b> |
|--------------|------------|
| <b>Z (m)</b> | <b>mm</b>  |
| 0.00         | -0.73      |
| 2.25         | -2.03      |
| 4.88         | -4.15      |
| 7.50         | -5.44      |
| 10.13        | -5.42      |
| 12.75        | -4.09      |
| 15.38        | -1.88      |
| 18.00        | -0.39      |

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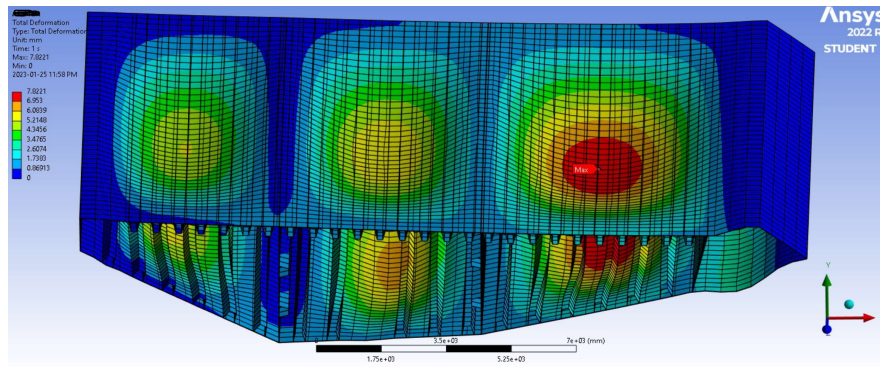


Figure B1.1: 1BR - Static Structural (deformation)



## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 3

Table B1.4: 3BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 10.32       | 2.35     |

Table B1.5: 3BR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -5.00  |
| 4.58  | -2.82  |
| 6.51  | -0.75  |
| 8.66  | -10.30 |
| 10.81 | -1.90  |
| 13.44 | -6.33  |
| 16.99 | -2.01  |
| 20.36 | 0.00   |

Table B1.6: 3BR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -4.95  |
| 2.25  | -6.92  |
| 4.88  | -9.12  |
| 7.50  | -10.19 |
| 10.13 | -10.14 |
| 12.75 | -8.95  |
| 15.38 | -6.60  |
| 18.00 | -0.78  |

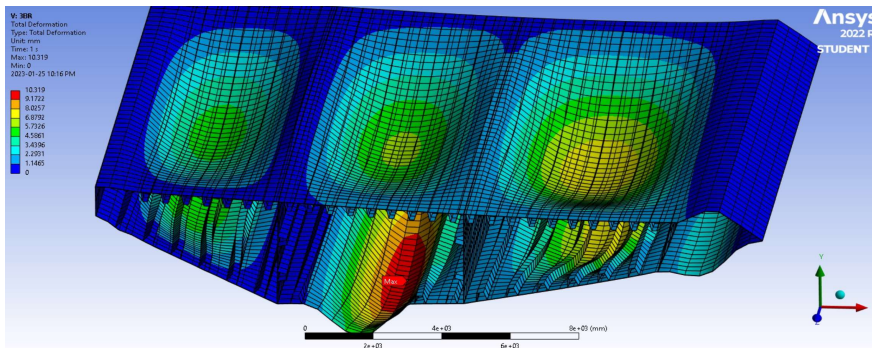


Figure B1.2: 3BR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 5

Table B1.7: 1BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 16.09       | 2.49     |

Table B1.8: 5BR - Deformation Tranverse

| <b>Dir</b>   | <b>Def</b> |
|--------------|------------|
| <b>Y (m)</b> | <b>mm</b>  |
| 0.00         | 0.00       |
| 2.23         | -4.77      |
| 4.58         | -2.72      |
| 6.51         | -1.01      |
| 8.66         | -16.04     |
| 10.81        | -2.16      |
| 13.44        | -6.13      |
| 16.99        | -2.08      |
| 20.36        | 0.00       |

Table B1.9: 5BR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -13.34 |
| 2.25  | -14.13 |
| 4.88  | -15.21 |
| 7.50  | -15.37 |
| 10.13 | -15.30 |
| 12.75 | -15.03 |
| 15.38 | -13.05 |
| 18.00 | -0.77  |

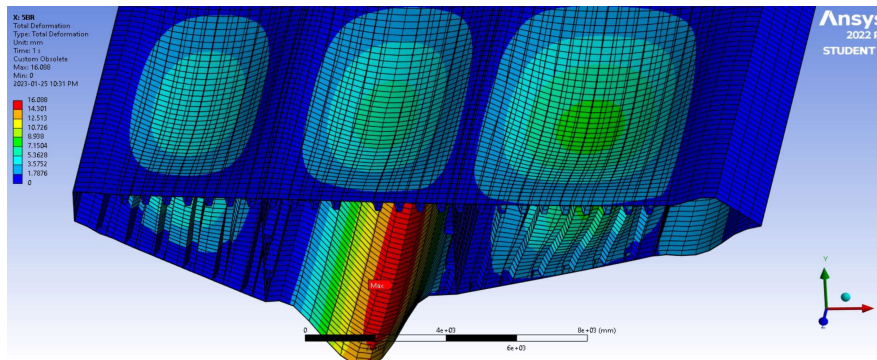


Figure B1.3: 5BR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 7

Table B1.10: 7BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 18.65       | 2.56     |

Table B1.11: 7BR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -0.59  |
| 4.58  | -0.84  |
| 6.51  | -1.51  |
| 8.66  | -18.65 |
| 10.81 | -2.36  |
| 13.44 | -1.78  |
| 16.99 | -1.68  |
| 20.36 | 0.00   |

Table B1.12: 7BR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -17.82 |
| 2.25  | -15.75 |
| 4.88  | -15.70 |
| 7.50  | -15.65 |
| 10.13 | -15.59 |
| 12.75 | -15.57 |
| 15.38 | -14.19 |
| 18.00 | -0.75  |

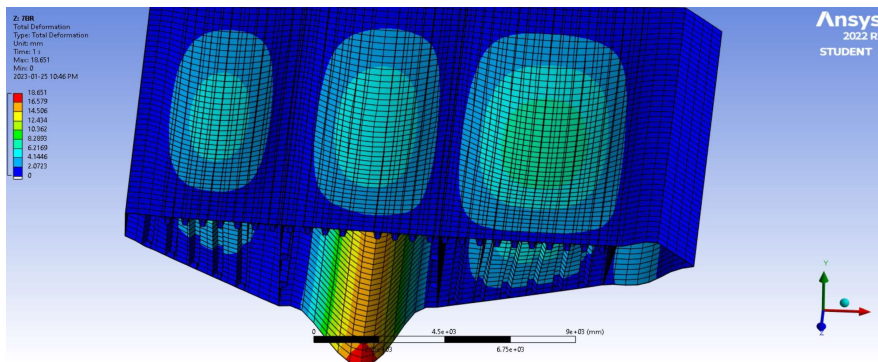


Figure B1.4: 7BR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 9

Table B1.13: 9BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 18.67       | 2.64     |

Table B1.14: 9BR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -5.97  |
| 4.58  | -4.06  |
| 6.51  | -0.95  |
| 8.66  | -16.23 |
| 10.81 | -2.17  |
| 13.44 | -6.89  |
| 16.99 | -2.06  |
| 20.36 | 0.00   |

Table B1.15: 9BR - Deformation Long

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -0.68 |
| 2.25  | -2.40 |
| 4.88  | -5.32 |
| 7.50  | -7.15 |
| 10.13 | -7.12 |
| 12.75 | -5.26 |
| 15.38 | -2.26 |
| 18.00 | -0.36 |

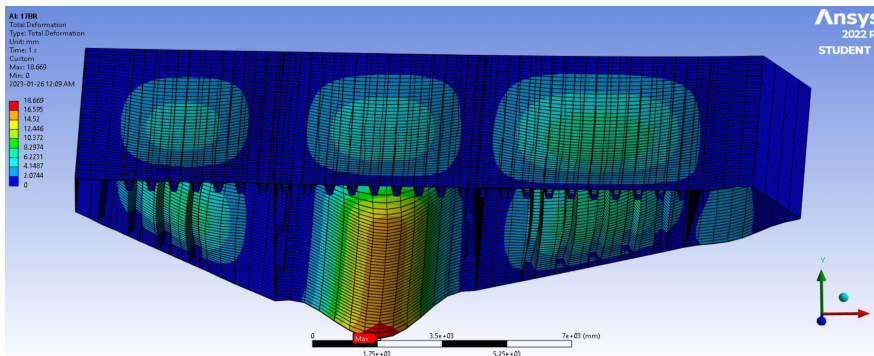


Figure B1.5: 9BR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 11

Table B1.16: 11BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 18.66       | 2.70     |

Table B1.17: 11BR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -0.56  |
| 4.58  | -2.16  |
| 6.51  | -1.50  |
| 8.66  | -18.66 |
| 10.81 | -2.39  |
| 13.44 | -1.82  |
| 16.99 | -1.73  |
| 20.36 | 0.00   |

Table B1.19: 11BR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -18.66 |
| 2.25  | -16.43 |
| 4.88  | -16.33 |
| 7.50  | -16.28 |
| 10.13 | -16.22 |
| 12.75 | -16.22 |
| 15.38 | -14.82 |
| 18.00 | -0.70  |

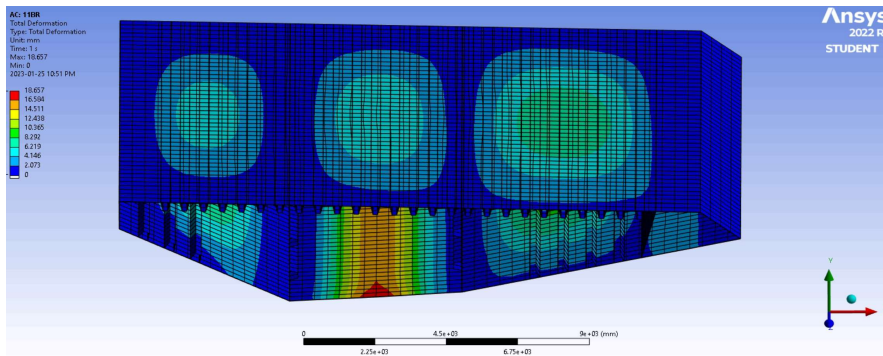


Figure B1.6: 11BR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 13

Table b1.20: 13BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 18.63       | 2.73     |

Table B1.21: 13BR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -8.13  |
| 4.58  | -5.25  |
| 6.51  | -0.92  |
| 8.66  | -16.21 |
| 10.81 | -2.15  |
| 13.44 | -9.80  |
| 16.99 | -2.15  |
| 20.36 | 0.00   |

Table B1.22: 13BR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -18.63 |
| 2.25  | -16.40 |
| 4.88  | -16.31 |
| 7.50  | -16.26 |
| 10.13 | -16.21 |
| 12.75 | -16.20 |
| 15.38 | -14.80 |
| 18.00 | -0.68  |

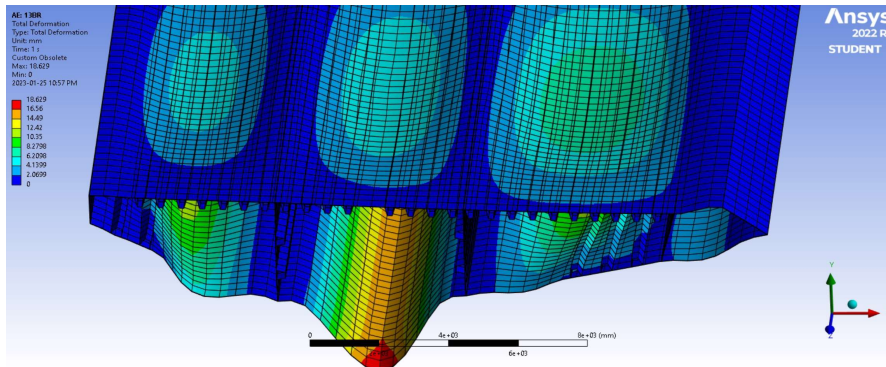


Figure B1.7: 13BR - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 15

Table B1.23: 15BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 18.63       | 2.92     |

Table B1.24: 15BR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -13.44 |
| 4.58  | -7.00  |
| 6.51  | -0.92  |
| 8.66  | -16.21 |
| 10.81 | -2.14  |
| 13.44 | -12.17 |
| 16.99 | -2.17  |
| 20.36 | 0.00   |

Table B1.25: 15BR - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -13.03 |
| 2.25  | -14.56 |
| 4.88  | -16.52 |
| 7.50  | -17.30 |
| 10.13 | -17.26 |
| 12.75 | -16.45 |
| 15.38 | -13.64 |
| 18.00 | -0.26  |

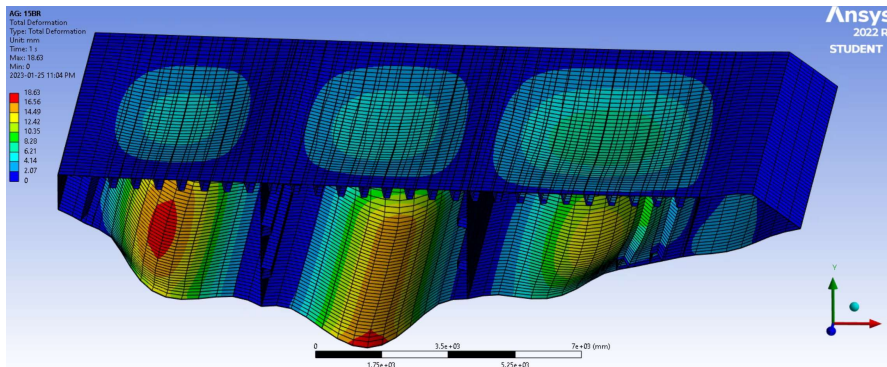


Figure B1.8: 15BR - Static Structural (deformation)



## CHAPTER 5 - CONCLUSIONS

Number of rib removed: 17

Table B1.26: 17BR - Max Deformation

| Deformation |          |
|-------------|----------|
| Max(mm)     | Avg (mm) |
| 23.65       | 3.26     |

Table B1.27: 17BR - Deformation Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -17.37 |
| 4.58  | -7.94  |
| 6.51  | -0.96  |
| 8.66  | -16.23 |
| 10.81 | -2.17  |
| 13.44 | -17.29 |
| 16.99 | -2.38  |
| 20.36 | 0.00   |

Table B1.28: 17BR - Deformation Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -23.65 |
| 2.25  | -20.85 |
| 4.88  | -20.76 |
| 7.50  | -20.75 |
| 10.13 | -20.75 |
| 12.75 | -20.79 |
| 15.38 | -18.29 |
| 18.00 | -0.24  |

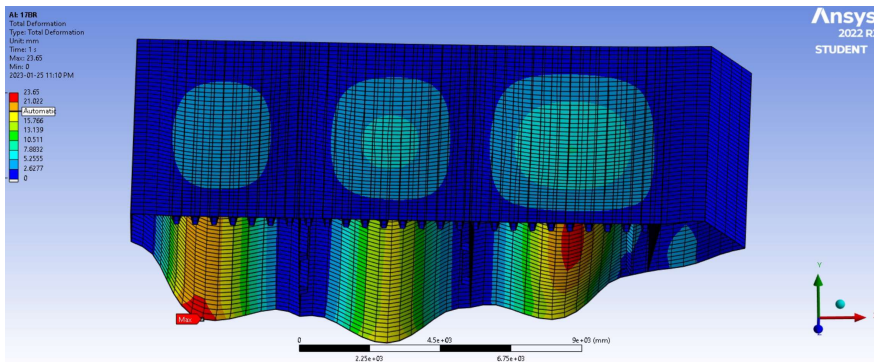


Figure B1.9: 17BR - Static Structural (deformation)



## **APPENDIX C – Case study of removal of multiple ribs on top plate**

# CHAPTER 5 - CONCLUSIONS

## TOP PLATE

**Top** - ribs 3 to 19

Level 1 - removal of 3 ribs

Level 2 - removal of 7 ribs

Level 3 - removal of 11 ribs

| Level - |                            |   |   |   |   |   | VS1 |   |   |    |    |    |    |    |    |    | VS2 |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
|---------|----------------------------|---|---|---|---|---|-----|---|---|----|----|----|----|----|----|----|-----|----|----|--------------------------------------------------------------|----|----|----|----|----|----|--|--|--|--|
| Option  | 1                          | 2 | 3 | 4 | 5 | 6 | 7   | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17  | 18 | 19 | 20                                                           | 21 | 22 | 23 | 24 | 25 | 26 |  |  |  |  |
| L1 - 01 | H<br>a<br>r<br>d           |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    | H<br>a<br>r<br>d<br><br>s<br>h<br>o<br>u<br>l<br>d<br>e<br>r |    |    |    |    |    |    |  |  |  |  |
| L1 - 02 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L1 - 03 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L1 - 04 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L1 - 05 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L1 - 06 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L1 - 07 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L2 - 01 | s<br>h<br>o<br>u<br>l<br>d |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L2 - 02 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L2 - 03 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L2 - 04 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L2 - 05 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L2 - 06 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L2 - 07 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L3 - 01 | e<br>r                     |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L3 - 02 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L3 - 03 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L3 - 04 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L3 - 05 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |
| L3 - 06 |                            |   |   |   |   |   |     |   |   |    |    |    |    |    |    |    |     |    |    |                                                              |    |    |    |    |    |    |  |  |  |  |

# CHAPTER 5 - CONCLUSIONS

| Case  | max def | average |
|-------|---------|---------|
| L1-O1 | 7.808   | 2.339   |
| L1-O2 | 7.801   | 2.267   |
| L1-O3 | 9.730   | 2.366   |
| L1-O4 | 8.309   | 2.322   |
| L1-O5 | 7.808   | 2.398   |
| L1-O6 | 7.837   | 2.337   |
| L1-O7 | 7.865   | 2.376   |
| L2-O1 | 9.645   | 2.455   |
| L2-O2 | 19.344  | 2.432   |
| L2-O3 | 9.691   | 2.394   |
| L2-O4 | 9.726   | 2.431   |
| L2-O5 | 8.295   | 2.364   |
| L2-O6 | 9.726   | 2.415   |
| L2-O7 | 9.395   | 2.391   |
| L3-O1 | 33.507  | 2.810   |
| L3-O2 | 7.819   | 2.304   |
| L3-O3 | 11.739  | 2.428   |
| L3-O4 | 10.621  | 2.420   |
| L3-O5 | 12.250  | 2.506   |
| L3-O6 | 12.635  | 2.442   |

## CHAPTER 5 - CONCLUSIONS

TR L1 - O1

Table C1.1: TR L1-O1 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 7.81        | 2.34     |

Table C1.2: TR L1-O1 - Deformation Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -6.43 |
| 4.96  | -0.89 |
| 7.63  | -5.79 |
| 10.30 | -1.99 |
| 12.97 | -7.06 |
| 15.64 | -5.71 |
| 18.31 | 0.00  |

Table C1.3: TR L1-O1 - Deformation Long

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.74 |
| 2.25  | -3.22 |
| 4.88  | -5.91 |
| 7.50  | -7.59 |
| 10.13 | -7.49 |
| 12.75 | -5.61 |
| 15.38 | -2.70 |
| 18.00 | -0.94 |

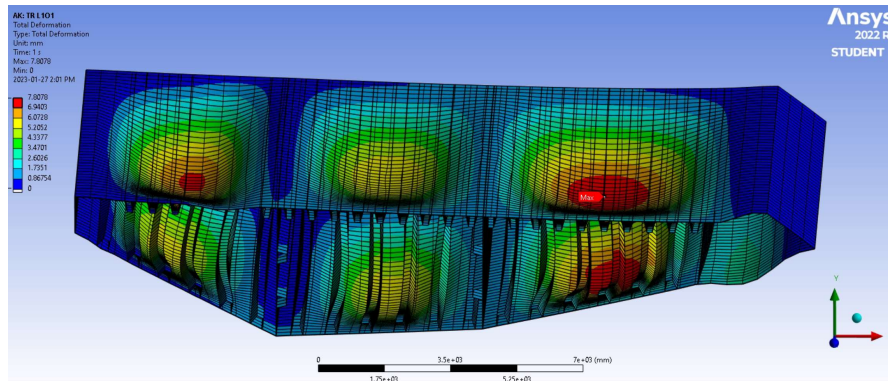


Figure C1.1: TR L1-O1 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L1 - O2

Table C1.4: TR L1-O2 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 7.80        | 2.27     |

Table C1.5: TR L1-O2 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.02 |
| 4.96  | -0.90 |
| 7.63  | -6.88 |
| 10.30 | -2.02 |
| 12.97 | -7.04 |
| 15.64 | -5.71 |
| 18.31 | 0.00  |

Table C1.6: TR L1-O2 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.73 |
| 2.25  | -3.21 |
| 4.88  | -5.90 |
| 7.50  | -7.59 |
| 10.13 | -7.49 |
| 12.75 | -5.60 |
| 15.38 | -2.69 |
| 18.00 | -0.94 |

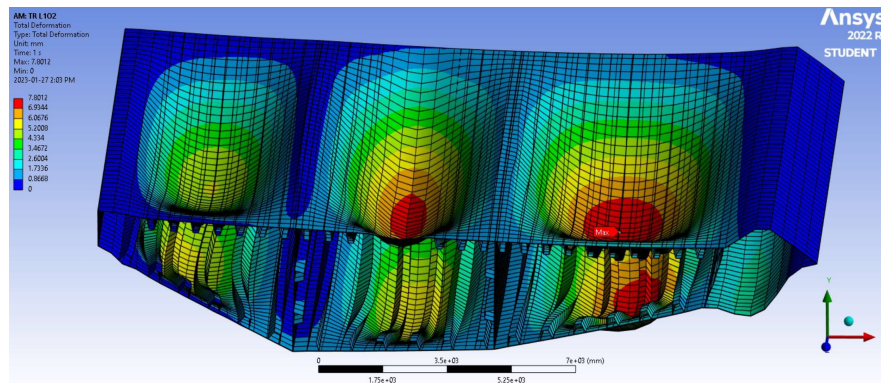


Figure C1.2: TR L1-O2 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L1 - O3

Table C1.7: TR L1-O3 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.73        | 2.37     |

Table C1.8: TR L1-O3 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.02 |
| 4.96  | -0.91 |
| 7.63  | -5.75 |
| 10.30 | -1.96 |
| 12.97 | -9.64 |
| 15.64 | -6.14 |
| 18.31 | 0.00  |

Table C1.9: TR L1-O3 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.71 |
| 2.25  | -3.77 |
| 4.88  | -7.24 |
| 7.50  | -9.43 |
| 10.13 | -9.30 |
| 12.75 | -6.86 |
| 15.38 | -3.16 |
| 18.00 | -0.97 |

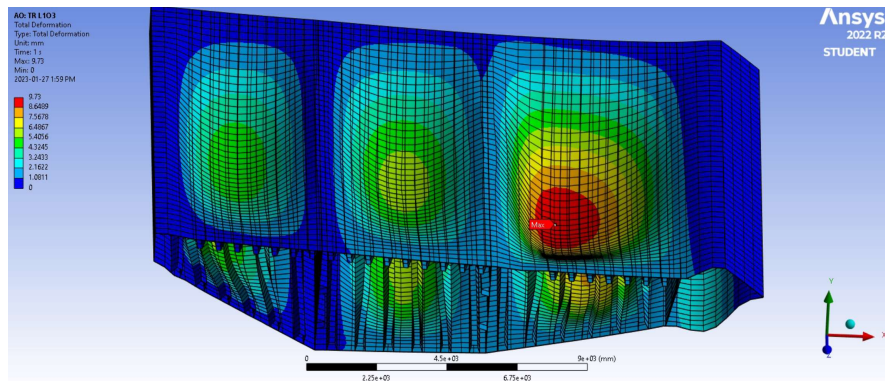


Figure C1.3: TR L1-O3 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L1 - O4

Table C1.10: TR L1-O4 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 8.31        | 2.32     |

Table C1.11: TR L1-O4 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.40 |
| 4.96  | -0.82 |
| 7.63  | -5.85 |
| 10.30 | -2.02 |
| 12.97 | -7.91 |
| 15.64 | -5.85 |
| 18.31 | 0.00  |

Table C1.12: TR L1-O4 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.73 |
| 2.25  | -3.31 |
| 4.88  | -6.23 |
| 7.50  | -8.08 |
| 10.13 | -7.99 |
| 12.75 | -5.93 |
| 15.38 | -2.80 |
| 18.00 | -0.94 |

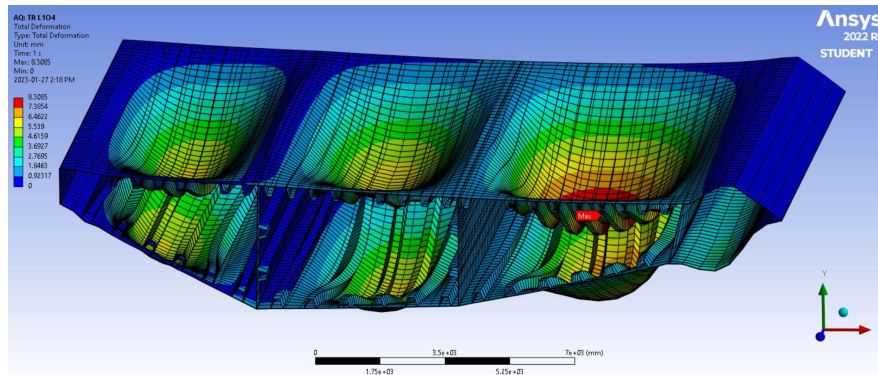


Figure C1.4: TR L1-O4 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L1 - O5

Table C1.13: TR L1-O5 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 7.81        | 2.40     |

Table C1.14: TR L1-O5 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.72 |
| 4.96  | -1.10 |
| 7.63  | -6.13 |
| 10.30 | -2.01 |
| 12.97 | -7.06 |
| 15.64 | -5.72 |
| 18.31 | 0.00  |

Table C1.15: TR L1-O5 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.74 |
| 2.25  | -3.22 |
| 4.88  | -5.91 |
| 7.50  | -7.60 |
| 10.13 | -7.49 |
| 12.75 | -5.61 |
| 15.38 | -2.70 |
| 18.00 | -0.94 |

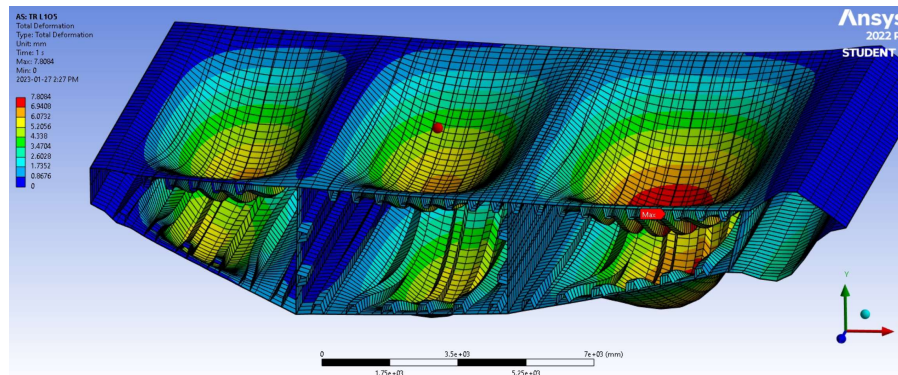


Figure C1.5: TR L1-O5 - Static Structural (deformation)



TR L1 - 06

Table C1.16: TR L1-O6 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 7.84        | 2.34     |

Table C1.17: TR L1-O6 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.02 |
| 4.96  | -0.87 |
| 7.63  | -6.87 |
| 10.30 | -2.28 |
| 12.97 | -7.05 |
| 15.64 | -5.69 |
| 18.31 | 0.00  |

Table C1.18: TR L1-O6 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.36 |
| 2.25  | -2.92 |
| 4.88  | -5.78 |
| 7.50  | -7.60 |
| 10.13 | -7.56 |
| 12.75 | -5.69 |
| 15.38 | -2.68 |
| 18.00 | -0.85 |

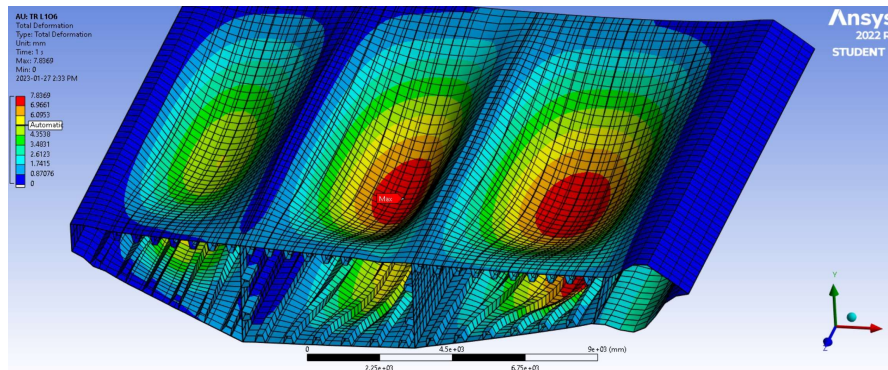


Figure C1.6: TR L1-O6 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L1 - O7

Table C1.19: TR L1-O7 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 7.86        | 2.38     |

Table C1.20: TR L1-O7 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.02 |
| 4.96  | -0.91 |
| 7.63  | -7.84 |
| 10.30 | -2.12 |
| 12.97 | -7.06 |
| 15.64 | -5.73 |
| 18.31 | 0.00  |

Table C1.21: TR L1-O7 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.30 |
| 2.25  | -2.89 |
| 4.88  | -5.79 |
| 7.50  | -7.62 |
| 10.13 | -7.58 |
| 12.75 | -5.69 |
| 15.38 | -2.66 |
| 18.00 | -0.80 |

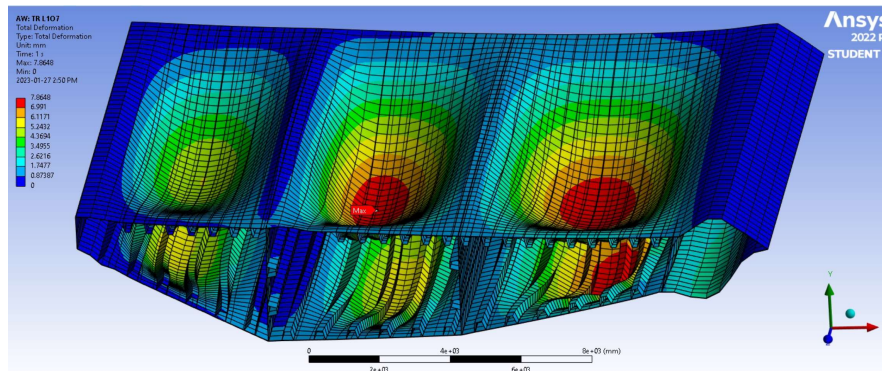


Figure C1.7: TR L1-O7 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L2 - O1

Table C1.22: TR L2-O1 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.65        | 2.46     |

Table C1.23: TR L2-O1 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -7.82 |
| 4.96  | -1.41 |
| 7.63  | -6.86 |
| 10.30 | -2.06 |
| 12.97 | -7.05 |
| 15.64 | -5.72 |
| 18.31 | 0.00  |

Table C1.24: TR L2-O1 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -2.84 |
| 2.25  | -5.42 |
| 4.88  | -8.06 |
| 7.50  | -9.43 |
| 10.13 | -9.35 |
| 12.75 | -7.79 |
| 15.38 | -4.97 |
| 18.00 | -0.37 |

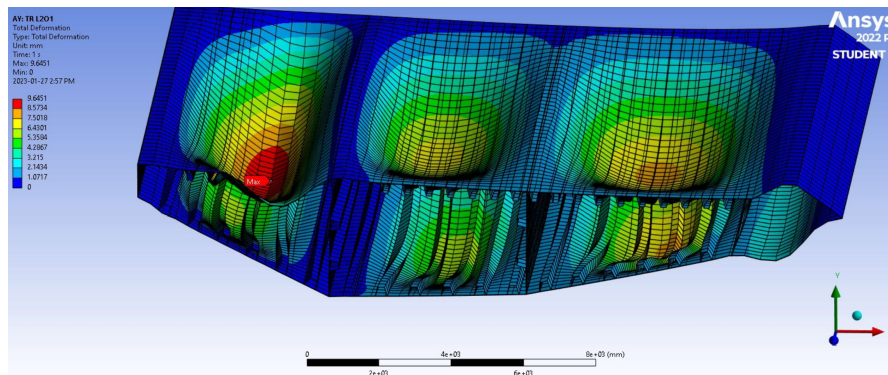


Figure C1.8: TR L2-O1 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L2 - O2

Table C1.25: TR L2-O2 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 19.34       | 2.43     |

Table C1.26: TR L2-O2 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -5.00  |
| 4.96  | -0.80  |
| 7.63  | -16.50 |
| 10.30 | -3.82  |
| 12.97 | -6.76  |
| 15.64 | -5.65  |
| 18.31 | 0.00   |

Table C1.27: TR L2-O2 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -13.35 |
| 2.25  | -15.04 |
| 4.88  | -17.71 |
| 7.50  | -19.09 |
| 10.13 | -19.04 |
| 12.75 | -17.66 |
| 15.38 | -13.19 |
| 18.00 | -0.78  |

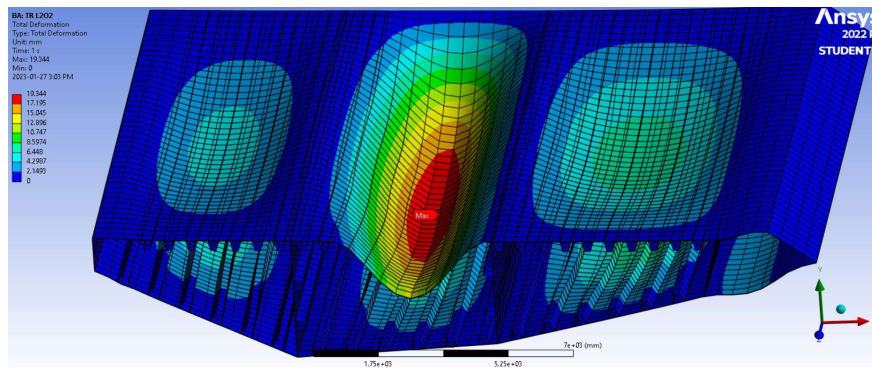


Figure C1.9: TR L2-O2 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L2 - O3

Table C1.28: TR L2-O3 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.69        | 2.39     |

Table C1.29: TR L2-O3 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.00 |
| 4.96  | -0.84 |
| 7.63  | -7.37 |
| 10.30 | -2.30 |
| 12.97 | -9.60 |
| 15.64 | -6.09 |
| 18.31 | 0.00  |

Table C1.30: TR L2-O3 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.66 |
| 2.25  | -3.72 |
| 4.88  | -7.19 |
| 7.50  | -9.39 |
| 10.13 | -9.26 |
| 12.75 | -6.82 |
| 15.38 | -3.12 |
| 18.00 | -0.93 |

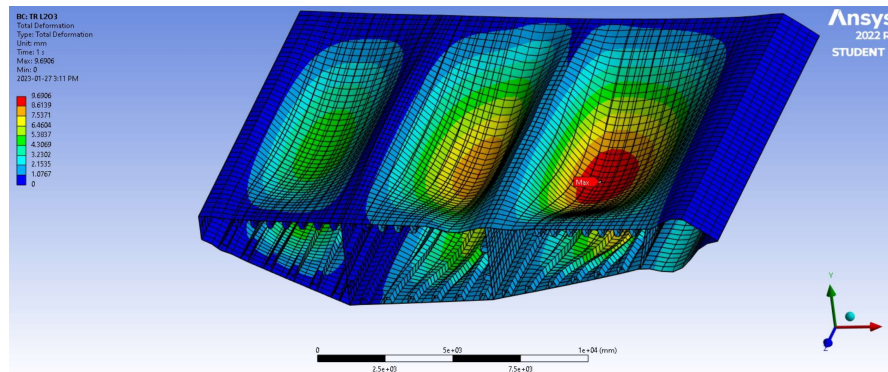


Figure C1.10: TR L2-O3 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L2 - O4

Table C1.31: TR L2-O4 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.73        | 2.43     |

Table C1.32: TR L2-O4 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.58 |
| 4.96  | -0.82 |
| 7.63  | -6.97 |
| 10.30 | -2.05 |
| 12.97 | -9.64 |
| 15.64 | -6.14 |
| 18.31 | 0.00  |

Table C1.33: TR L2-O4 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.71 |
| 2.25  | -3.77 |
| 4.88  | -7.24 |
| 7.50  | -9.43 |
| 10.13 | -9.29 |
| 12.75 | -6.85 |
| 15.38 | -3.16 |
| 18.00 | -0.97 |

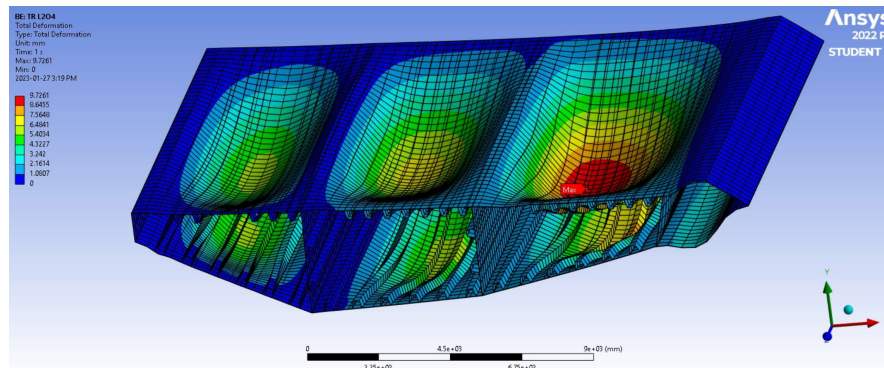


Figure C1.11: TR L2-O4 - Static Structural (deformation)



## CHAPTER 5 - CONCLUSIONS

TR L2 - O5

Table C1.34: TR L2-O5 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 8.30        | 2.36     |

Table C1.35: TR L2-O5 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.49 |
| 4.96  | -0.84 |
| 7.63  | -7.51 |
| 10.30 | -2.06 |
| 12.97 | -7.89 |
| 15.64 | -5.84 |
| 18.31 | 0.00  |

Table C1.36: TR L2-O5 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.72 |
| 2.25  | -3.30 |
| 4.88  | -6.21 |
| 7.50  | -8.07 |
| 10.13 | -7.97 |
| 12.75 | -5.92 |
| 15.38 | -2.79 |
| 18.00 | -0.93 |

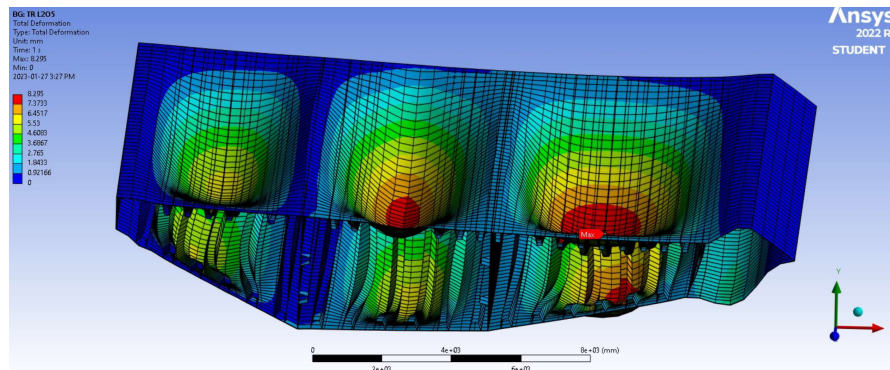


Figure C1.12: TR L2-O5 - Static Structural (deformation)

TR L2 - O6

Table C1.37: TR L2-O6 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.73        | 2.42     |

Table C1.38: TR L2-O6 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -7.34 |
| 4.96  | -1.04 |
| 7.63  | -5.75 |
| 10.30 | -1.95 |
| 12.97 | -9.64 |
| 15.64 | -6.13 |
| 18.31 | 0.00  |

Table C1.39: TR L2-O6 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.70 |
| 2.25  | -3.76 |
| 4.88  | -7.23 |
| 7.50  | -9.43 |
| 10.13 | -9.29 |
| 12.75 | -6.85 |
| 15.38 | -3.15 |
| 18.00 | -0.96 |

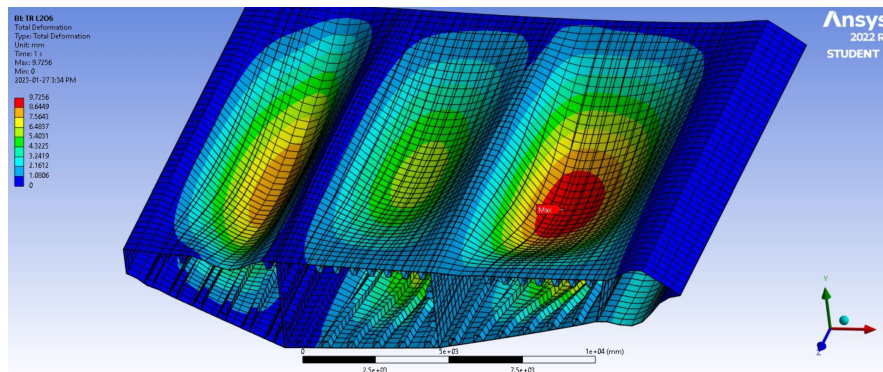


Figure C1.13: TR L2-O6 - Static Structural (deformation)



## CHAPTER 5 - CONCLUSIONS

TR L2 - O7

Table C1.40: TR L2-O7 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.39        | 2.39     |

Table C1.41: TR L2-O7 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.20 |
| 4.96  | -0.79 |
| 7.63  | -8.20 |
| 10.30 | -2.09 |
| 12.97 | -9.25 |
| 15.64 | -6.08 |
| 18.31 | 0.00  |

Table C1.42: TR L2-O7 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.73 |
| 2.25  | -3.52 |
| 4.88  | -6.84 |
| 7.50  | -8.96 |
| 10.13 | -8.85 |
| 12.75 | -6.51 |
| 15.38 | -2.99 |
| 18.00 | -0.93 |

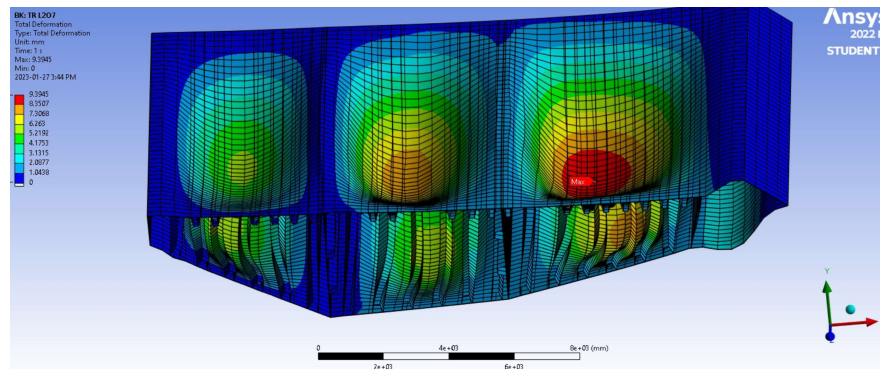


Figure C1.14: TR L2-O7 - Static Structural (deformation)

Table C1.43: TR L3-O1 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 33.51       | 2.81     |

Table C1.44: TR L3-O1 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -4.78  |
| 4.96  | -0.06  |
| 7.63  | -30.89 |
| 10.30 | -5.42  |
| 12.97 | -6.57  |
| 15.64 | -5.62  |
| 18.31 | 0.00   |

Table C1.45: TR L3-O1 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -33.51 |
| 2.25  | -31.92 |
| 4.88  | -32.79 |
| 7.50  | -32.71 |
| 10.13 | -32.59 |
| 12.75 | -31.96 |
| 15.38 | -23.44 |
| 18.00 | -0.71  |

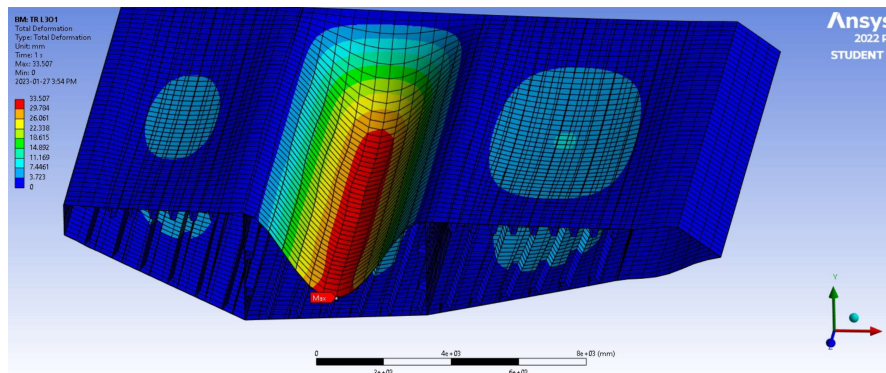


Figure C1.15: TR L3-O1 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L3 - O2

Table C1.46: TR L3-O2 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 7.82        | 2.30     |

Table C1.47: TR L3-O2 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -5.03 |
| 4.96  | -0.92 |
| 7.63  | -5.77 |
| 10.30 | -1.99 |
| 12.97 | -7.07 |
| 15.64 | -5.72 |
| 18.31 | 0.00  |

Table C1.48: TR L3-O2 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.75 |
| 2.25  | -3.23 |
| 4.88  | -5.92 |
| 7.50  | -7.61 |
| 10.13 | -7.50 |
| 12.75 | -5.62 |
| 15.38 | -2.70 |
| 18.00 | -0.95 |

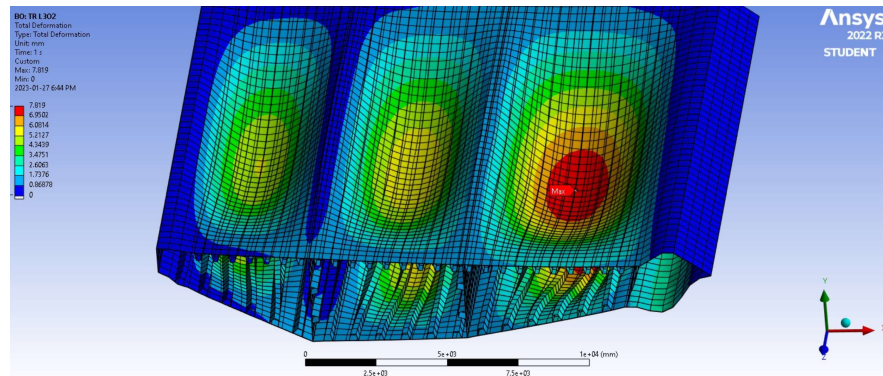


Figure C1.16: TR L3-O2 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L3 - O3

Table C1.49: TR L3-O3 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 11.74       | 2.43     |

Table C1.50: TR L3-O3 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.29  | -6.41 |
| 4.96  | -0.79 |
| 7.63  | -9.68 |
| 10.30 | -2.36 |
| 12.97 | -9.55 |
| 15.64 | -6.09 |
| 18.31 | 0.00  |

Table C1.51: TR L3-O3 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -4.45  |
| 2.25  | -7.49  |
| 4.88  | -10.33 |
| 7.50  | -11.58 |
| 10.13 | -11.48 |
| 12.75 | -10.14 |
| 15.38 | -7.04  |
| 18.00 | -0.77  |

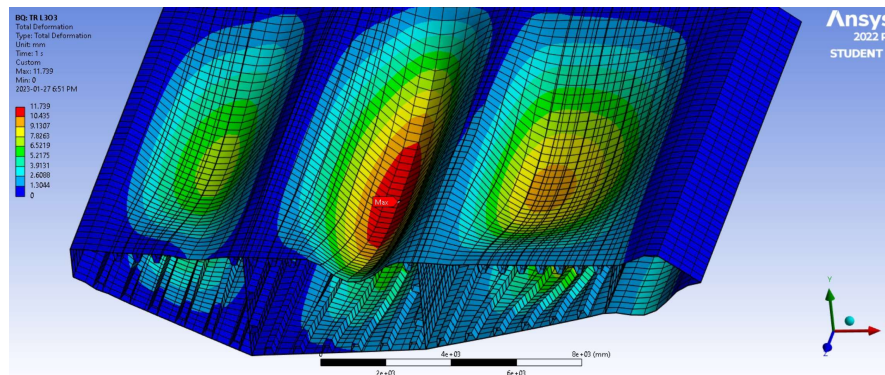


Figure C1.17: TR L3-O3 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L3 - O4

Table C1.52: TR L3-O4 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 10.62       | 2.42     |

Table C1.53: TR L3-O4 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -6.36  |
| 4.96  | -0.62  |
| 7.63  | -9.66  |
| 10.30 | -1.88  |
| 12.97 | -10.46 |
| 15.64 | -6.28  |
| 18.31 | 0.00   |

Table C1.54: TR L3-O4 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -1.66  |
| 2.25  | -4.03  |
| 4.88  | -7.87  |
| 7.50  | -10.25 |
| 10.13 | -10.16 |
| 12.75 | -7.61  |
| 15.38 | -3.57  |
| 18.00 | -0.93  |

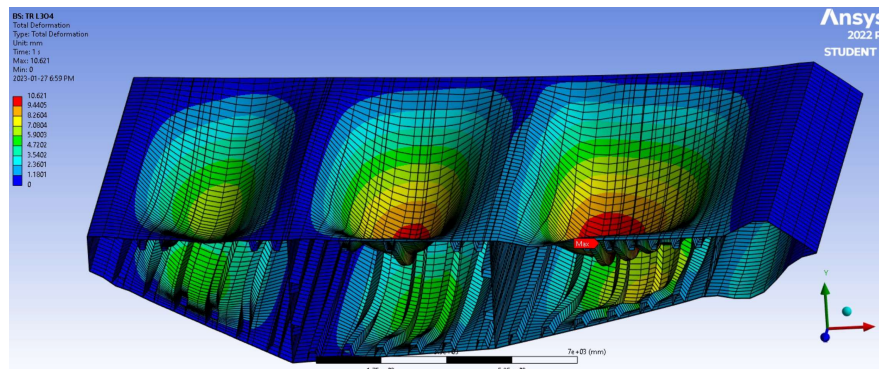


Figure C1.18: TR L3-O4 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

TR L3 - O5

Table C1.55: TR L3-O5 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 12.25       | 2.51     |

Table C1.56: TR L3-O5 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -5.61  |
| 4.96  | -0.84  |
| 7.63  | -11.96 |
| 10.30 | -2.03  |
| 12.97 | -9.59  |
| 15.64 | -6.11  |
| 18.31 | 0.00   |

Table C1.57: TR L3-O5 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -2.45  |
| 2.25  | -5.98  |
| 4.88  | -9.82  |
| 7.50  | -11.93 |
| 10.13 | -11.86 |
| 12.75 | -9.64  |
| 15.38 | -5.68  |
| 18.00 | -0.76  |

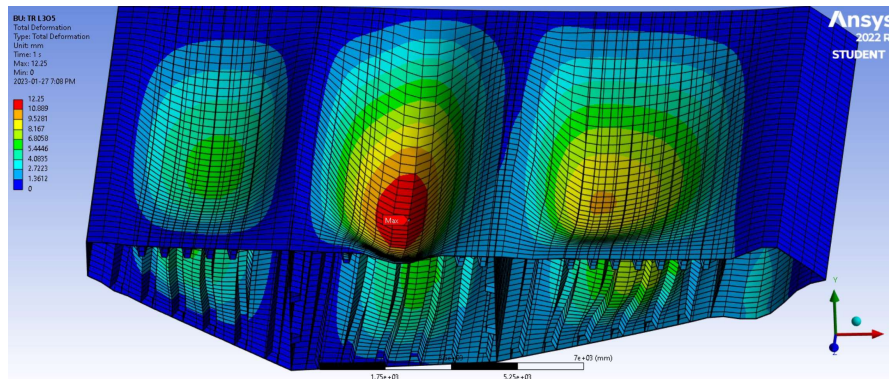


Figure C1.19: TR L3-O5 - Static Structural (deformation)



## CHAPTER 5 - CONCLUSIONS

TR L3 - O6

Table C1.58: TR L3-O6 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 12.64       | 2.44     |

Table C1.59: TR L3-O6 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.29  | -7.33  |
| 4.96  | -0.99  |
| 7.63  | -11.63 |
| 10.30 | -2.12  |
| 12.97 | -9.57  |
| 15.64 | -6.11  |
| 18.31 | 0.00   |

Table C1.60: TR L3-O6 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -4.56  |
| 2.25  | -7.94  |
| 4.88  | -10.89 |
| 7.50  | -12.42 |
| 10.13 | -12.38 |
| 12.75 | -10.83 |
| 15.38 | -7.58  |
| 18.00 | -0.75  |

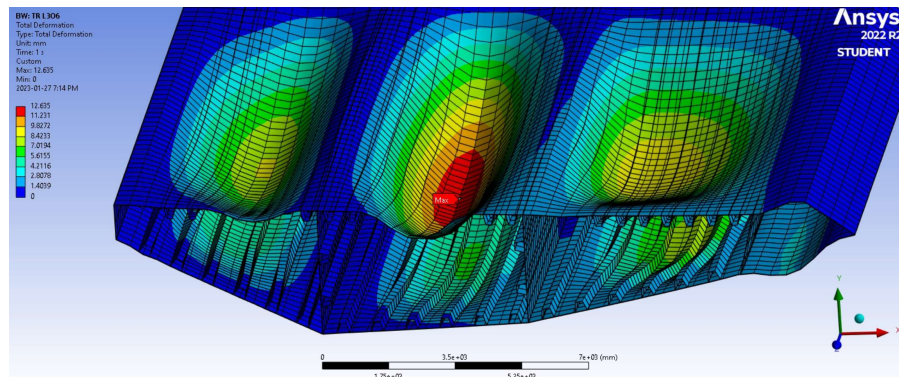


Figure C1.20: TR L3-O6 - Static Structural (deformation)

## **APPENDIX D – Case study of removal of multiple ribs on bottom plate**



## CHAPTER 5 - CONCLUSIONS

### BOTTOM PLATE

**Bottom** - ribs 1 to 18

Level 1 - removal of 3 ribs

Level 2 - removal of 7 ribs

Level 3 - removal of 11 ribs

| Level - |   |   |   |   |   | VS1 |   |   |   |    |    | VS2 |    |    |    |    |    |    |  |
|---------|---|---|---|---|---|-----|---|---|---|----|----|-----|----|----|----|----|----|----|--|
| Option  | 1 | 2 | 3 | 4 | 5 | 6   | 7 | 8 | 9 | 10 | 11 | 12  | 13 | 14 | 15 | 16 | 17 | 18 |  |
| L1 - O1 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L1 - O2 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L1 - O3 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L1 - O4 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L1 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L1 - O6 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L1 - O7 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L2 - O1 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L2 - O2 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L2 - O3 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L2 - O4 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L2 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L2 - O6 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L2 - O7 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L3 - O1 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L3 - O2 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L3 - O3 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L3 - O4 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L3 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |
| L3 - O5 |   |   |   |   |   |     |   |   |   |    |    |     |    |    |    |    |    |    |  |

## CHAPTER 5 - CONCLUSIONS

| <b>Case</b> | <b>max</b> | <b>average</b> |
|-------------|------------|----------------|
| L1-O1       | 10.361     | 2.369          |
| L1-O2       | 10.054     | 2.330          |
| L1-O3       | 13.422     | 2.333          |
| L1-O4       | 8.458      | 2.373          |
| L1-O5       | 12.420     | 2.323          |
| L1-O6       | 9.664      | 2.363          |
| L1-O7       | 8.514      | 2.375          |
| L2-O1       | 10.301     | 2.337          |
| L2-O2       | 9.631      | 2.488          |
| L2-O3       | 9.190      | 2.442          |
| L2-O4       | 11.268     | 2.420          |
| L2-O5       | 18.659     | 2.574          |
| L2-O6       | 13.419     | 2.558          |
| L2-O7       | 10.552     | 2.388          |
| L3-O1       | 18.649     | 2.687          |
| L3-O2       | 12.281     | 2.572          |
| L3-O3       | 20.201     | 2.701          |
| L3-O4       | 15.900     | 2.562          |
| L3-O5       | 14.197     | 2.580          |
| L3-O6       | 11.844     | 2.570          |

## CHAPTER 5 - CONCLUSIONS

BR L1 - O1

Table D1.1: BR L1-O1 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 10.36       | 2.37     |

Table D1.2: BR L1-O1 - Deformation Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -8.88 |
| 4.58  | -3.55 |
| 6.51  | -0.70 |
| 8.66  | -5.94 |
| 10.81 | -1.80 |
| 13.44 | -6.33 |
| 16.99 | -2.01 |
| 20.36 | 0.00  |

Table D1.3: BR L1-O1 - Deformation Long

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -3.13  |
| 2.25  | -6.37  |
| 4.88  | -8.95  |
| 7.50  | -10.21 |
| 10.13 | -10.18 |
| 12.75 | -8.87  |
| 15.38 | -6.30  |
| 18.00 | -0.31  |

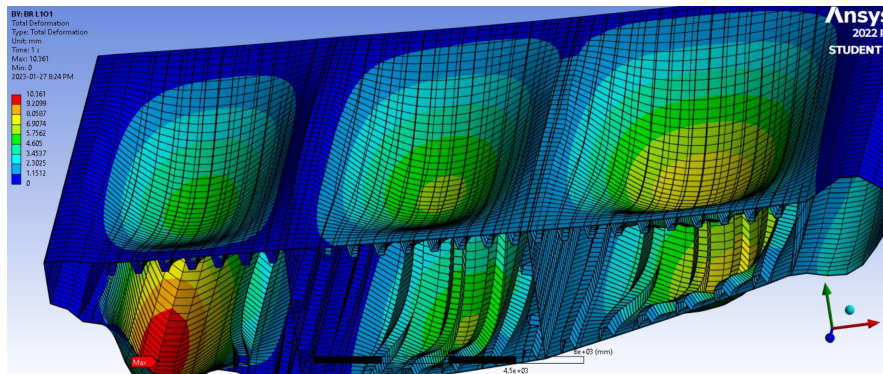


Figure D1.1: BR L1-O1 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L1 - O2

Table D1.4: BR L1-O2 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 10.05       | 2.33     |

Table D1.5: BR L1-O2 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -5.01 |
| 4.58  | -2.84 |
| 6.51  | -0.74 |
| 8.66  | -9.85 |
| 10.81 | -1.89 |
| 13.44 | -6.30 |
| 16.99 | -1.99 |
| 20.36 | 0.00  |

Table D1.6: BR L1-O2 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -4.93 |
| 2.25  | -7.03 |
| 4.88  | -9.07 |
| 7.50  | -9.97 |
| 10.13 | -9.92 |
| 12.75 | -8.90 |
| 15.38 | -6.72 |
| 18.00 | -0.80 |

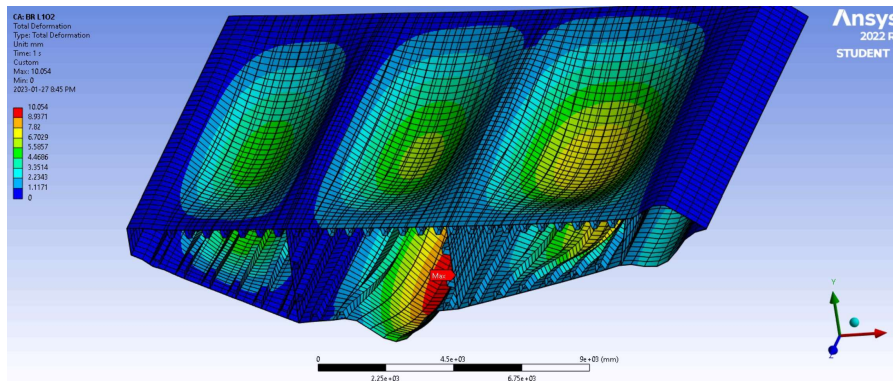


Figure D1.2: BR L1-O2 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L1 - O3

Table D1.7: BR L1-O3 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 13.42       | 2.33     |

Table D1.8: BR L1-O3 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -5.00  |
| 4.58  | -2.83  |
| 6.51  | -0.69  |
| 8.66  | -5.91  |
| 10.81 | -1.76  |
| 13.44 | -11.01 |
| 16.99 | -2.15  |
| 20.36 | 0.00   |

Table D1.9: BR L1-O3 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -3.30  |
| 2.25  | -6.62  |
| 4.88  | -10.42 |
| 7.50  | -12.49 |
| 10.13 | -12.37 |
| 12.75 | -10.04 |
| 15.38 | -5.98  |
| 18.00 | -0.89  |

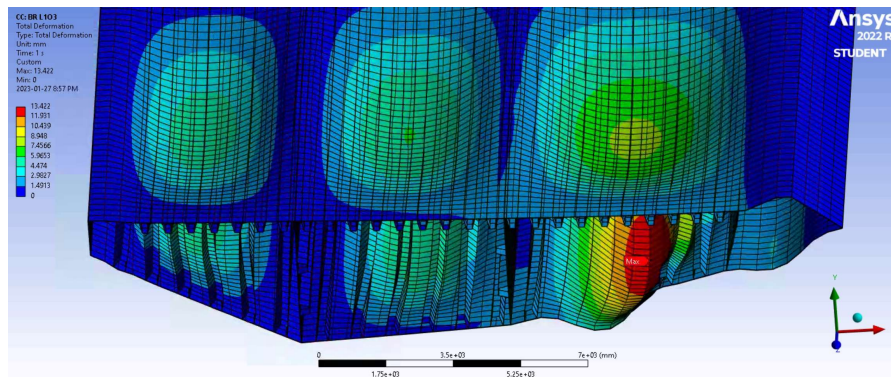


Figure D1.3: BR L1-O3 - Static Structural (deformation)

BR L1 - O4

Table D1.10: BR L1-O4 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 8.46        | 2.37     |

Table D1.11: BR L1-O4 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -6.67 |
| 4.58  | -4.18 |
| 6.51  | -0.68 |
| 8.66  | -5.92 |
| 10.81 | -1.79 |
| 13.44 | -6.32 |
| 16.99 | -1.99 |
| 20.36 | 0.00  |

Table D1.12: BR L1-O4 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -0.93 |
| 2.25  | -3.27 |
| 4.88  | -6.37 |
| 7.50  | -8.21 |
| 10.13 | -8.20 |
| 12.75 | -6.33 |
| 15.38 | -3.15 |
| 18.00 | -0.38 |

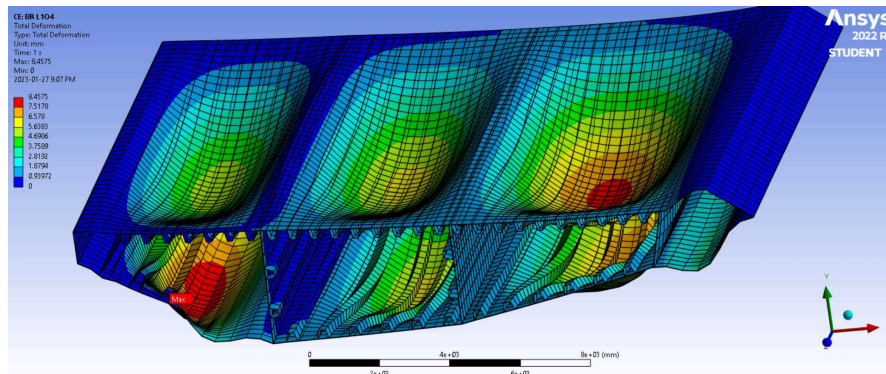


Figure D1.4: BR L1-O4 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L1 - O5

Table D1.13: BR L1-O5 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 12.42       | 2.32     |

Table D1.14: BR L1-O5 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -5.01 |
| 4.58  | -2.85 |
| 6.51  | -0.70 |
| 8.66  | -5.92 |
| 10.81 | -1.76 |
| 13.44 | -8.03 |
| 16.99 | -2.19 |
| 20.36 | 0.00  |

Table D1.15: BR L1-O5 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -4.91  |
| 2.25  | -7.18  |
| 4.88  | -10.30 |
| 7.50  | -12.15 |
| 10.13 | -12.07 |
| 12.75 | -10.14 |
| 15.38 | -6.80  |
| 18.00 | -0.86  |

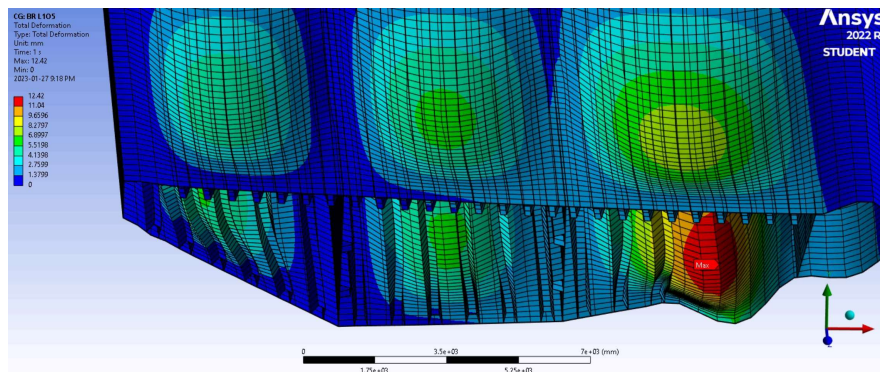


Figure D1.5: BR L1-O5 - Static Structural (deformation)



BR L1 - 06

Table D1.16: BR L1-O6 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.66        | 2.36     |

Table D1.17: BR L1-O6 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -5.00 |
| 4.58  | -2.83 |
| 6.51  | -0.69 |
| 8.66  | -5.97 |
| 10.81 | -1.78 |
| 13.44 | -8.97 |
| 16.99 | -2.06 |
| 20.36 | 0.00  |

Table D1.18: BR L1-O6 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.75 |
| 2.25  | -3.56 |
| 4.88  | -6.92 |
| 7.50  | -9.05 |
| 10.13 | -8.97 |
| 12.75 | -6.68 |
| 15.38 | -3.11 |
| 18.00 | -0.92 |

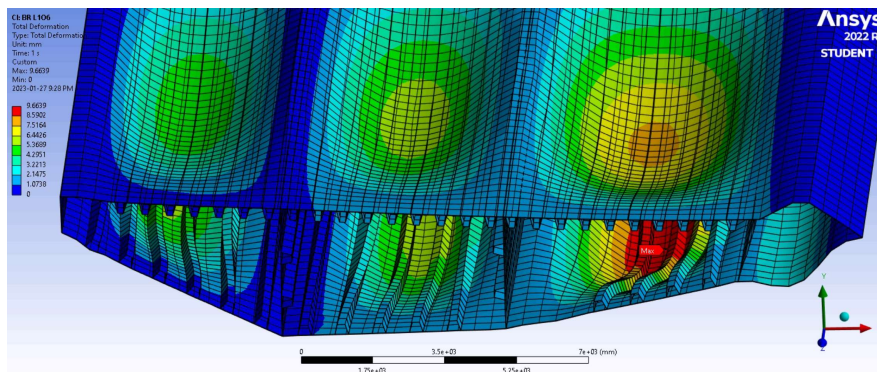


Figure D1.6: BR L1-O6 - Static Structural (deformation)



BR L1 - O7

Table D1.19: BR L1-O7 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 8.51        | 2.38     |

Table D1.20: BR L1-O7 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -5.22 |
| 4.58  | -2.42 |
| 6.51  | -0.76 |
| 8.66  | -8.51 |
| 10.81 | -1.92 |
| 13.44 | -6.36 |
| 16.99 | -2.03 |
| 20.36 | 0.00  |

Table C1.21: TR L1-O7 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.38 |
| 2.25  | -2.59 |
| 4.88  | -4.66 |
| 7.50  | -5.91 |
| 10.13 | -5.85 |
| 12.75 | -4.50 |
| 15.38 | -2.27 |
| 18.00 | -0.86 |

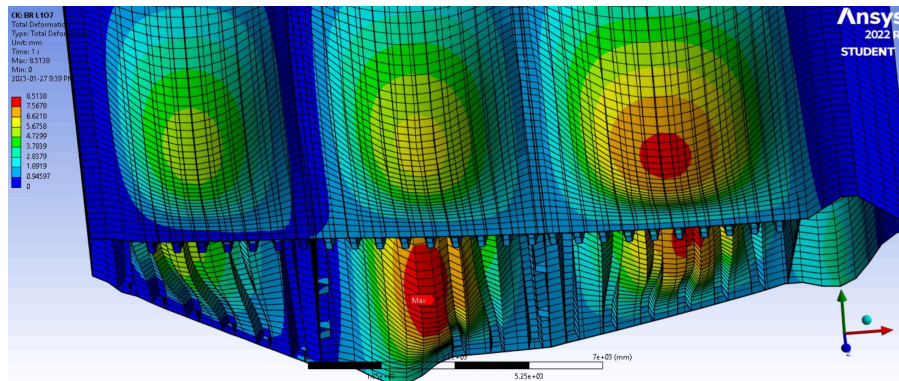


Figure D1.7: BR L1-O7 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L2 - O1

Table D1.22: BR L2-O1 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 10.30       | 2.34     |

Table D1.23: BR L2-O1 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -6.18  |
| 4.58  | -3.02  |
| 6.51  | -0.74  |
| 8.66  | -10.28 |
| 10.81 | -1.87  |
| 13.44 | -7.24  |
| 16.99 | -2.08  |
| 20.36 | 0.00   |

Table D1.24: BR L2-O1 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.32 |
| 2.25  | -2.52 |
| 4.88  | -4.61 |
| 7.50  | -5.87 |
| 10.13 | -5.81 |
| 12.75 | -4.46 |
| 15.38 | -2.23 |
| 18.00 | -0.81 |

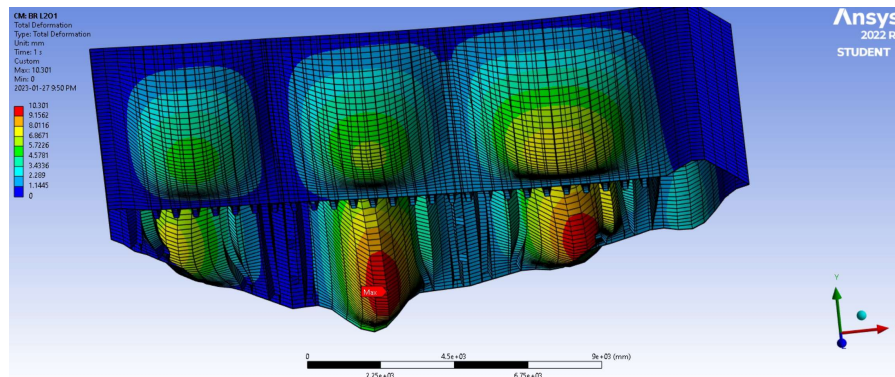


Figure D1.8: BR L2-O1 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L2 - O2

Table D1.25: BR L2-O2 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.63        | 2.49     |

Table D1.26: BR L2-O2 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -5.97 |
| 4.58  | -4.08 |
| 6.51  | -0.83 |
| 8.66  | -9.62 |
| 10.81 | -1.93 |
| 13.44 | -6.87 |
| 16.99 | -1.92 |
| 20.36 | 0.00  |

Table D1.27: BR L2-O2 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.34 |
| 2.25  | -2.54 |
| 4.88  | -4.62 |
| 7.50  | -5.87 |
| 10.13 | -5.82 |
| 12.75 | -4.47 |
| 15.38 | -2.24 |
| 18.00 | -0.83 |

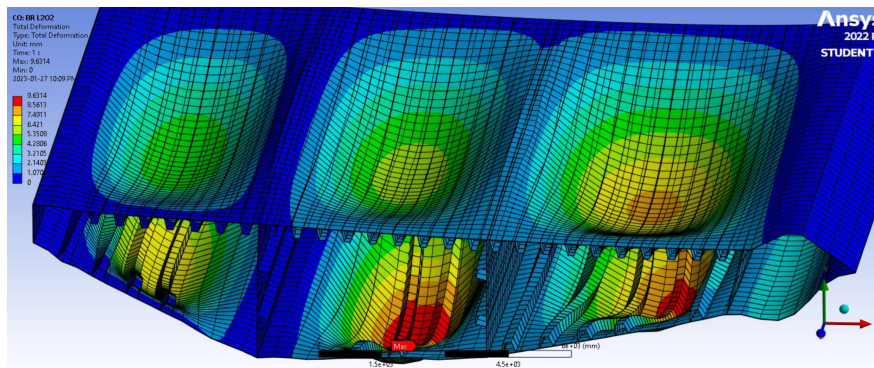


Figure D1.9: BR L2-O2 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L2 - O3

Table D1.28: BR L2-O3 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 9.19        | 2.44     |

Table D1.29: BR L2-O3 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -5.97 |
| 4.58  | -4.08 |
| 6.51  | -0.77 |
| 8.66  | -8.70 |
| 10.81 | -1.87 |
| 13.44 | -7.11 |
| 16.99 | -2.05 |
| 20.36 | 0.00  |

Table D1.30: BR L2-O3 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.74 |
| 2.25  | -3.48 |
| 4.88  | -6.49 |
| 7.50  | -8.34 |
| 10.13 | -8.21 |
| 12.75 | -6.16 |
| 15.38 | -2.94 |
| 18.00 | -0.88 |

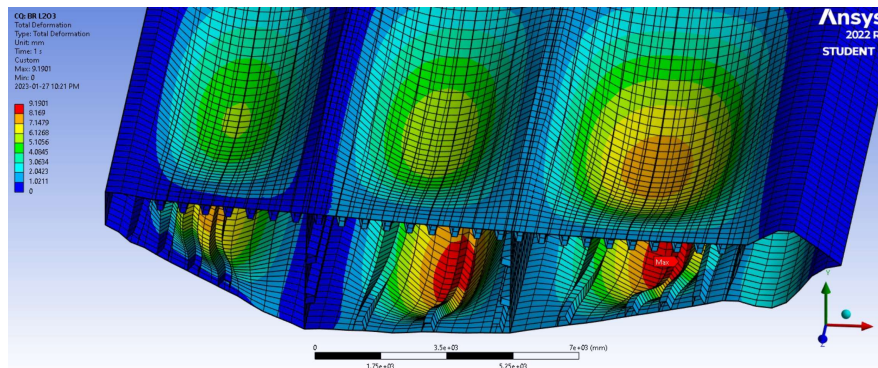


Figure D1.10: BR L2-O3 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L2 - O4

Table D1.31: BR L2-O4 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 11.27       | 2.42     |

Table D1.32: BR L2-O4 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -6.84 |
| 4.58  | -2.89 |
| 6.51  | -0.70 |
| 8.66  | -7.02 |
| 10.81 | -1.77 |
| 13.44 | -9.73 |
| 16.99 | -2.11 |
| 20.36 | 0.00  |

Table D1.33: BR L2-O4 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -1.74  |
| 2.25  | -4.42  |
| 4.88  | -8.49  |
| 7.50  | -10.95 |
| 10.13 | -10.83 |
| 12.75 | -8.19  |
| 15.38 | -3.92  |
| 18.00 | -0.92  |

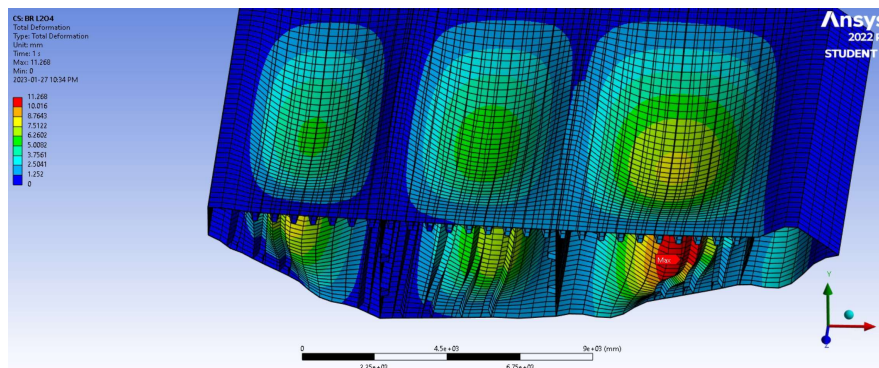


Figure D1.11: BR L2-O4 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L2 - O5

Table D1.34: BR L2-O5 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 18.66       | 2.57     |

Table D1.35: BR L2-O5 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -0.59  |
| 4.58  | -0.84  |
| 6.51  | -1.52  |
| 8.66  | -18.66 |
| 10.81 | -2.37  |
| 13.44 | -1.79  |
| 16.99 | -1.69  |
| 20.36 | 0.00   |

Table D1.36: BR L2-O5 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.37 |
| 2.25  | -2.57 |
| 4.88  | -4.65 |
| 7.50  | -5.90 |
| 10.13 | -5.83 |
| 12.75 | -4.47 |
| 15.38 | -2.25 |
| 18.00 | -0.83 |

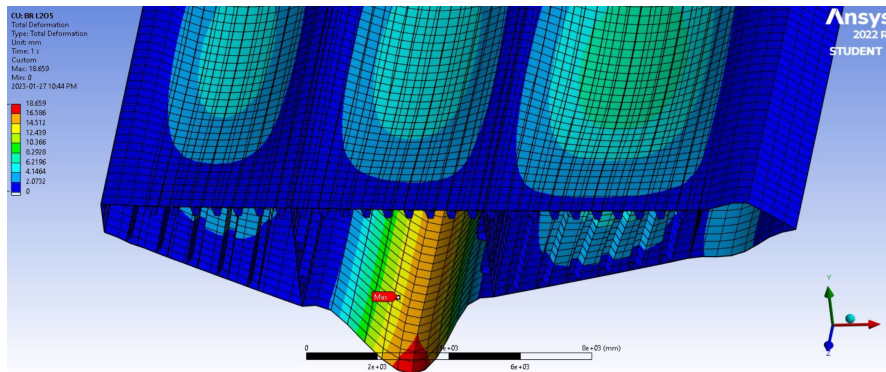


Figure D1.12: BR L2-O5 - Static Structural (deformation)



## CHAPTER 5 - CONCLUSIONS

BR L2 - O6

Table D1.37: BR L2-O6 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 13.42       | 2.56     |

Table D1.38: BR L2-O6 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -7.36  |
| 4.58  | -3.90  |
| 6.51  | -0.71  |
| 8.66  | -5.95  |
| 10.81 | -1.80  |
| 13.44 | -11.41 |
| 16.99 | -2.23  |
| 20.36 | 0.00   |

Table D1.39: BR L2-O6 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -1.78  |
| 2.25  | -4.48  |
| 4.88  | -9.56  |
| 7.50  | -12.94 |
| 10.13 | -12.91 |
| 12.75 | -9.45  |
| 15.38 | -4.10  |
| 18.00 | -0.92  |

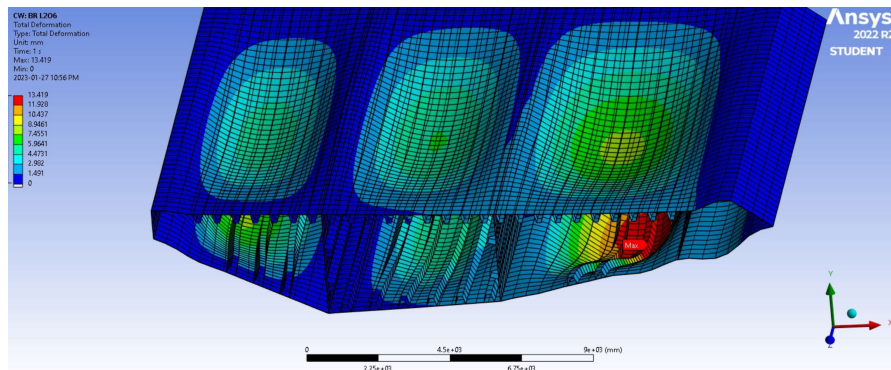


Figure D1.13: BR L2-O6 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L2 - O7

Table D1.40: BR L2-O7 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 10.55       | 2.39     |

Table D1.41: BR L2-O7 - Def Transverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -5.40 |
| 4.58  | -3.63 |
| 6.51  | -0.77 |
| 8.66  | -6.30 |
| 10.81 | -1.80 |
| 13.44 | -8.14 |
| 16.99 | -1.97 |
| 20.36 | 0.00  |

Table C1.42: TR L2-O7 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -2.48  |
| 2.25  | -4.94  |
| 4.88  | -8.28  |
| 7.50  | -10.27 |
| 10.13 | -10.21 |
| 12.75 | -8.10  |
| 15.38 | -4.56  |
| 18.00 | -0.89  |

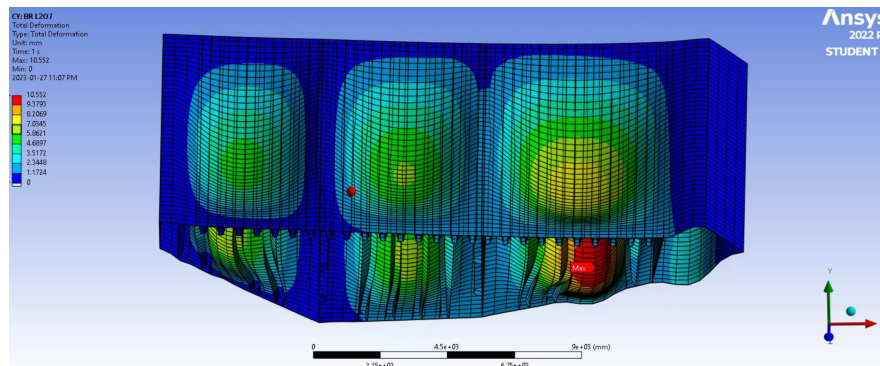


Figure D1.14: BR L2-O7 - Static Structural (deformation)



Table D1.43: BR L3-O1 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 18.65       | 2.69     |

Table D1.44: BR L3-O1 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -0.57  |
| 4.58  | -0.98  |
| 6.51  | -1.50  |
| 8.66  | -18.65 |
| 10.81 | -2.38  |
| 13.44 | -2.97  |
| 16.99 | -1.75  |
| 20.36 | 0.00   |

Table D1.45: BR L3-O1 - Def Longitudinal

| Dir   | Def   |
|-------|-------|
| Z (m) | mm    |
| 0.00  | -1.36 |
| 2.25  | -2.56 |
| 4.88  | -4.63 |
| 7.50  | -5.87 |
| 10.13 | -5.80 |
| 12.75 | -4.45 |
| 15.38 | -2.22 |
| 18.00 | -0.80 |

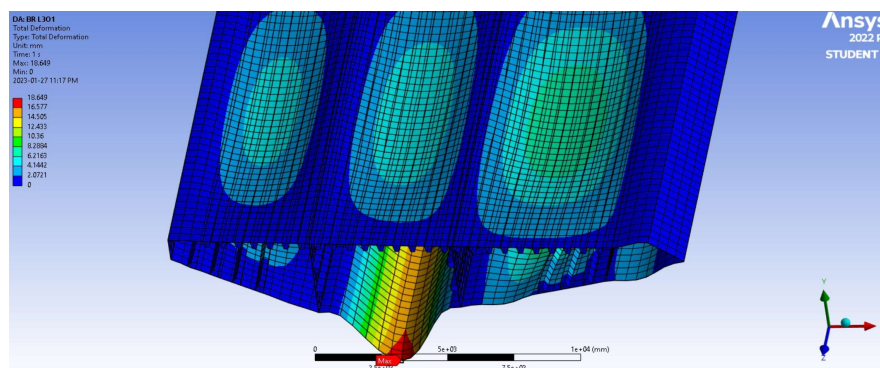


Figure D1.15: BR L3-O1 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L3 - O2

Table D1.46: TR L3-O2 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 12.28       | 2.57     |

Table D1.47: TR L3-O2 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -10.00 |
| 4.58  | -4.79  |
| 6.51  | -0.87  |
| 8.66  | -10.56 |
| 10.81 | -1.91  |
| 13.44 | -8.23  |
| 16.99 | -2.02  |
| 20.36 | 0.00   |

Table D1.48: TR L3-O2 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -4.25  |
| 2.25  | -6.81  |
| 4.88  | -10.19 |
| 7.50  | -12.03 |
| 10.13 | -11.99 |
| 12.75 | -10.07 |
| 15.38 | -6.55  |
| 18.00 | -0.34  |

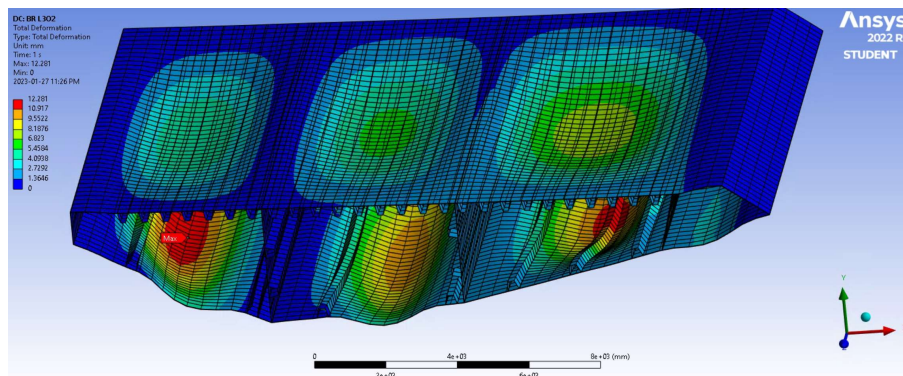


Figure D1.16: BR L3-O2 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L3 - O3

Table D1.49: BR L3-O3 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 20.20       | 2.70     |

Table D1.50: BR L3-O3 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -10.45 |
| 4.58  | -5.11  |
| 6.51  | -0.80  |
| 8.66  | -11.05 |
| 10.81 | -1.87  |
| 13.44 | -15.38 |
| 16.99 | -2.27  |
| 20.36 | 0.00   |

Table D1.51: BR L3-O3 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -13.22 |
| 2.25  | -15.28 |
| 4.88  | -18.59 |
| 7.50  | -20.05 |
| 10.13 | -19.92 |
| 12.75 | -18.26 |
| 15.38 | -14.24 |
| 18.00 | -0.84  |

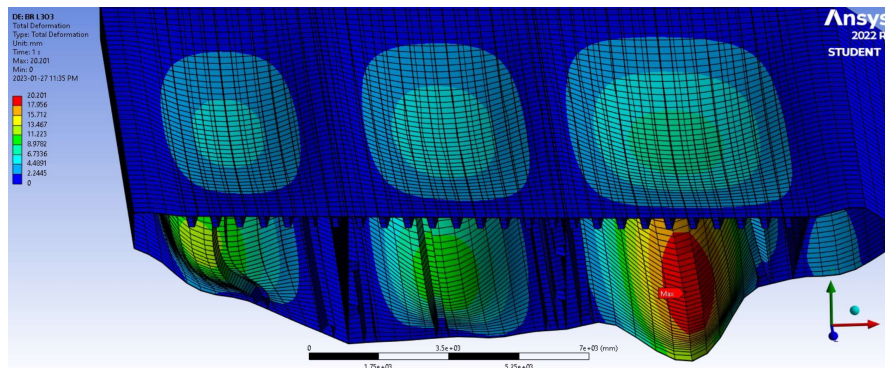


Figure D1.17: BR L3-O3 - Static Structural (deformation)

BR L3 - O4

Table D1.52: BR L3-O4 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 15.90       | 2.56     |

Table D1.53: BR L3-O4 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -12.61 |
| 4.58  | -5.82  |
| 6.51  | -0.78  |
| 8.66  | -8.03  |
| 10.81 | -1.82  |
| 13.44 | -11.01 |
| 16.99 | -2.16  |
| 20.36 | 0.00   |

Table D1.54: BR L3-O4 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -9.38  |
| 2.25  | -12.14 |
| 4.88  | -14.73 |
| 7.50  | -15.76 |
| 10.13 | -15.71 |
| 12.75 | -14.64 |
| 15.38 | -11.64 |
| 18.00 | -0.30  |

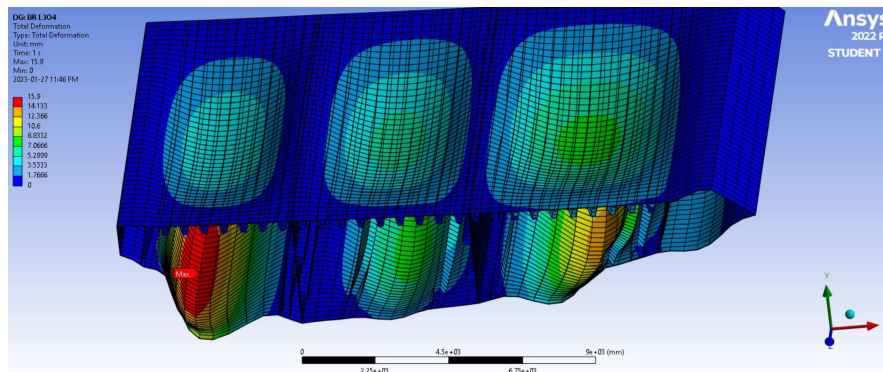


Figure D1.18: BR L3-O4 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L3 - O5

Table D1.55: BR L3-O5 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 14.20       | 2.58     |

Table D1.56: BR L3-O5 - Def Tranverse

| Dir   | Def   |
|-------|-------|
| Y (m) | mm    |
| 0.00  | 0.00  |
| 2.23  | -9.12 |
| 4.58  | -5.09 |
| 6.51  | -0.71 |
| 8.66  | -7.58 |
| 10.81 | -1.82 |
| 13.44 | -9.16 |
| 16.99 | -2.25 |
| 20.36 | 0.00  |

Table D1.57: BR L3-O5 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -1.75  |
| 2.25  | -4.81  |
| 4.88  | -10.24 |
| 7.50  | -13.74 |
| 10.13 | -13.64 |
| 12.75 | -10.00 |
| 15.38 | -4.31  |
| 18.00 | -0.90  |

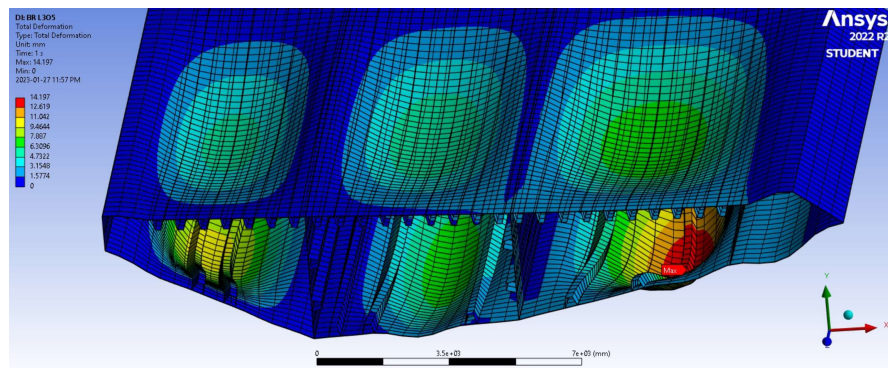


Figure D1.19: BR L3-O5 - Static Structural (deformation)

## CHAPTER 5 - CONCLUSIONS

BR L3 - O6

Table D1.58: BR L3-O6 - Max Deformation

| Deformation |          |
|-------------|----------|
| Max (mm)    | Avg (mm) |
| 11.84       | 2.57     |

Table D1.59: BR L3-O6 - Def Tranverse

| Dir   | Def    |
|-------|--------|
| Y (m) | mm     |
| 0.00  | 0.00   |
| 2.23  | -6.64  |
| 4.58  | -4.13  |
| 6.51  | -0.81  |
| 8.66  | -11.80 |
| 10.81 | -2.04  |
| 13.44 | -9.80  |
| 16.99 | -2.15  |
| 20.36 | 0.00   |

Table D1.60: BR L3-O6 - Def Longitudinal

| Dir   | Def    |
|-------|--------|
| Z (m) | mm     |
| 0.00  | -1.81  |
| 2.25  | -4.43  |
| 4.88  | -8.70  |
| 7.50  | -11.42 |
| 10.13 | -11.45 |
| 12.75 | -8.74  |
| 15.38 | -4.31  |
| 18.00 | -0.78  |

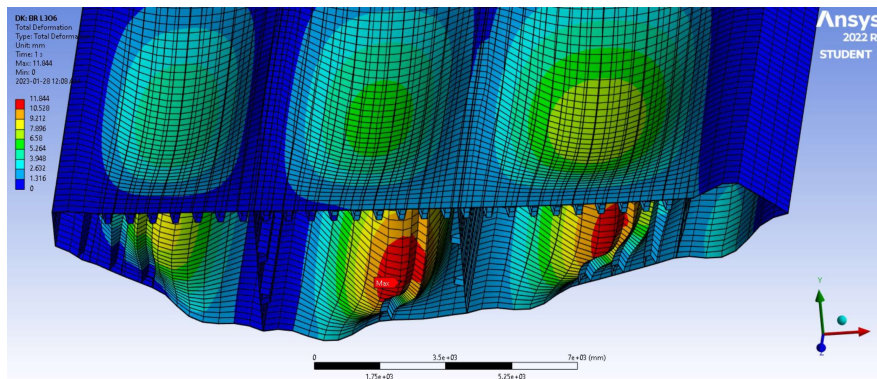


Figure D1.20: BR L3-O6 - Static Structural (deformation)

## **APPENDIX E – Raw data case study of removal of single ribs**



| TOP PLATE - LONGITUDINAL |       |      |          |          |         |         |          |          |          |          |          |
|--------------------------|-------|------|----------|----------|---------|---------|----------|----------|----------|----------|----------|
| longi                    | mm    | m    | TR1      | TR3      | TR5     | TR7     | TR9      | TR11     | TR13     | TR15     | TR17     |
| 1                        | 0     | 0.0  | -1.7345  | -1.7348  | -4.6124 | -14.486 | -28.509  | -33.519  | -35.544  | -35.929  | -35.569  |
| 2                        | 375   | 0.4  | -1.8176  | -1.8178  | -5.0593 | -14.553 | -28.005  | -32.459  | -34.298  | -34.682  | -34.329  |
| 3                        | 750   | 0.8  | -1.9869  | -1.9871  | -5.6412 | -14.943 | -27.979  | -31.92   | -33.592  | -33.979  | -33.631  |
| 4                        | 1125  | 1.1  | -2.2247  | -2.2251  | -6.2566 | -15.504 | -28.233  | -31.703  | -33.225  | -33.621  | -33.276  |
| 5                        | 1500  | 1.5  | -2.5158  | -2.5163  | -6.8653 | -16.154 | -28.636  | -31.683  | -33.072  | -33.482  | -33.139  |
| 6                        | 1875  | 1.9  | -2.8487  | -2.8493  | -7.4422 | -16.83  | -29.1    | -31.778  | -33.049  | -33.477  | -33.136  |
| 7                        | 2250  | 2.3  | -3.2117  | -3.2124  | -7.9833 | -17.499 | -29.569  | -31.931  | -33.099  | -33.549  | -33.211  |
| 8                        | 2625  | 2.6  | -3.5953  | -3.5961  | -8.4915 | -18.139 | -30.005  | -32.107  | -33.186  | -33.66   | -33.326  |
| 9                        | 3000  | 3.0  | -3.9908  | -3.9917  | -8.968  | -18.737 | -30.388  | -32.282  | -33.283  | -33.784  | -33.455  |
| 10                       | 3375  | 3.4  | -4.3903  | -4.3909  | -9.4141 | -19.288 | -30.708  | -32.441  | -33.374  | -33.903  | -33.582  |
| 11                       | 3750  | 3.8  | -4.7874  | -4.7869  | -9.8306 | -19.787 | -30.964  | -32.573  | -33.449  | -34.008  | -33.696  |
| 12                       | 4125  | 4.1  | -5.1756  | -5.1736  | -10.218 | -20.233 | -31.159  | -32.677  | -33.503  | -34.092  | -33.79   |
| 13                       | 4500  | 4.5  | -5.5487  | -5.5463  | -10.577 | -20.626 | -31.301  | -32.75   | -33.534  | -34.154  | -33.864  |
| 14                       | 4875  | 4.9  | -5.9027  | -5.9002  | -10.907 | -20.967 | -31.397  | -32.796  | -33.544  | -34.193  | -33.916  |
| 15                       | 5250  | 5.3  | -6.2345  | -6.232   | -11.211 | -21.258 | -31.458  | -32.819  | -33.535  | -34.214  | -33.949  |
| 16                       | 5625  | 5.6  | -6.5405  | -6.5381  | -11.487 | -21.5   | -31.493  | -32.823  | -33.512  | -34.217  | -33.965  |
| 17                       | 6000  | 6.0  | -6.8182  | -6.8158  | -11.735 | -21.7   | -31.51   | -32.813  | -33.478  | -34.209  | -33.968  |
| 18                       | 6375  | 6.4  | -7.0632  | -7.061   | -11.954 | -21.865 | -31.519  | -32.796  | -33.44   | -34.193  | -33.964  |
| 19                       | 6750  | 6.8  | -7.2741  | -7.272   | -12.152 | -22.012 | -31.538  | -32.792  | -33.416  | -34.189  | -33.97   |
| 20                       | 7125  | 7.1  | -7.4501  | -7.4482  | -12.302 | -22.111 | -31.529  | -32.759  | -33.365  | -34.154  | -33.945  |
| 21                       | 7500  | 7.5  | -7.589   | -7.5874  | -12.412 | -22.177 | -31.507  | -32.715  | -33.305  | -34.107  | -33.906  |
| 22                       | 7875  | 7.9  | -7.6907  | -7.6894  | -12.482 | -22.211 | -31.475  | -32.663  | -33.24   | -34.05   | -33.856  |
| 23                       | 8250  | 8.3  | -7.7537  | -7.7529  | -12.522 | -22.223 | -31.445  | -32.616  | -33.183  | -33.999  | -33.809  |
| 24                       | 8625  | 8.6  | -7.7784  | -7.778   | -12.537 | -22.22  | -31.427  | -32.585  | -33.145  | -33.963  | -33.776  |
| 25                       | 9000  | 9.0  | -7.7635  | -7.7635  | -12.529 | -22.198 | -31.417  | -32.565  | -33.123  | -33.94   | -33.753  |
| 26                       | 9375  | 9.4  | -7.7097  | -7.7102  | -12.499 | -22.158 | -31.416  | -32.558  | -33.118  | -33.929  | -33.741  |
| 27                       | 9750  | 9.8  | -7.6166  | -7.6178  | -12.448 | -22.105 | -31.428  | -32.568  | -33.134  | -33.936  | -33.745  |
| 28                       | 10125 | 10.1 | -7.4857  | -7.4874  | -12.372 | -22.036 | -31.446  | -32.588  | -33.164  | -33.952  | -33.756  |
| 29                       | 10500 | 10.5 | -7.317   | -7.3192  | -12.262 | -21.941 | -31.456  | -32.603  | -33.189  | -33.959  | -33.756  |
| 30                       | 10875 | 10.9 | -7.1117  | -7.1146  | -12.113 | -21.814 | -31.446  | -32.6    | -33.197  | -33.946  | -33.733  |
| 31                       | 11250 | 11.3 | -6.8713  | -6.8746  | -11.929 | -21.661 | -31.418  | -32.581  | -33.189  | -33.91   | -33.687  |
| 32                       | 11625 | 11.6 | -6.597   | -6.601   | -11.702 | -21.462 | -31.345  | -32.515  | -33.132  | -33.82   | -33.585  |
| 33                       | 12000 | 12.0 | -6.292   | -6.2963  | -11.443 | -21.226 | -31.229  | -32.405  | -33.027  | -33.679  | -33.431  |
| 34                       | 12375 | 12.4 | -5.9562  | -5.9612  | -11.156 | -20.946 | -31.053  | -32.231  | -32.856  | -33.466  | -33.205  |
| 35                       | 12750 | 12.8 | -5.5951  | -5.6002  | -10.84  | -20.61  | -30.785  | -31.963  | -32.584  | -33.148  | -32.874  |
| 36                       | 13125 | 13.1 | -5.2105  | -5.2161  | -10.495 | -20.204 | -30.386  | -31.558  | -32.169  | -32.683  | -32.399  |
| 37                       | 13500 | 13.5 | -4.8075  | -4.8132  | -10.122 | -19.714 | -29.818  | -30.977  | -31.571  | -32.033  | -31.74   |
| 38                       | 13875 | 13.9 | -4.3903  | -4.3963  | -9.7165 | -19.119 | -29.03   | -30.169  | -30.738  | -31.146  | -30.848  |
| 39                       | 14250 | 14.3 | -3.9632  | -3.97    | -9.2745 | -18.394 | -27.967  | -29.076  | -29.611  | -29.962  | -29.665  |
| 40                       | 14625 | 14.6 | -3.5302  | -3.5371  | -8.788  | -17.503 | -26.57   | -27.635  | -28.126  | -28.421  | -28.13   |
| 41                       | 15000 | 15.0 | -3.1017  | -3.1081  | -8.2436 | -16.408 | -24.78   | -25.782  | -26.219  | -26.46   | -26.183  |
| 42                       | 15375 | 15.4 | -2.6831  | -2.6892  | -7.6227 | -15.063 | -22.545  | -23.462  | -23.837  | -24.024  | -23.771  |
| 43                       | 15750 | 15.8 | -2.2839  | -2.2896  | -6.8995 | -13.426 | -19.832  | -20.64   | -20.945  | -21.084  | -20.862  |
| 44                       | 16125 | 16.1 | -1.914   | -1.919   | -6.044  | -11.468 | -16.646  | -17.321  | -17.551  | -17.647  | -17.464  |
| 45                       | 16500 | 16.5 | -1.5815  | -1.5863  | -5.0332 | -9.1965 | -13.055  | -13.577  | -13.731  | -13.791  | -13.651  |
| 46                       | 16875 | 16.9 | -1.3036  | -1.307   | -3.8684 | -6.6903 | -9.2275  | -9.5888  | -9.6699  | -9.7002  | -9.6058  |
| 47                       | 17250 | 17.3 | -1.0847  | -1.0884  | -2.6115 | -4.1478 | -5.4859  | -5.6948  | -5.7127  | -5.7208  | -5.6684  |
| 48                       | 17625 | 17.6 | -0.95108 | -0.95182 | -1.4534 | -1.9526 | -2.3753  | -2.4639  | -2.4352  | -2.4286  | -2.4085  |
| 49                       | 18000 | 18.0 | -0.93766 | -0.9382  | -0.7834 | -0.7554 | -0.72362 | -0.75242 | -0.70108 | -0.68829 | -0.68449 |



| TOP PLATE - TRANSVERSAL |        |      |       |       |        |        |        |        |        |        |        |
|-------------------------|--------|------|-------|-------|--------|--------|--------|--------|--------|--------|--------|
| trans                   | mm     | m    | TR1   | TR3   | TR5    | TR7    | TR9    | TR11   | TR13   | TR15   | TR17   |
| 1                       | 0      | 0.0  | 0.00  | 0.00  | 0.00   | 0.00   | 0.00   | -0.05  | 0.00   | 0.00   | 0.00   |
| 2                       | 381.37 | 0.4  | 0.00  | 0.00  | 0.00   | 0.00   | 0.00   | -0.06  | -0.02  | -0.02  | -0.02  |
| 3                       | 762.75 | 0.8  | -0.79 | -0.79 | -0.79  | -0.79  | -0.76  | -0.16  | -0.18  | -0.17  | -0.16  |
| 4                       | 1144.1 | 1.1  | -2.26 | -2.27 | -2.27  | -2.25  | -2.17  | -0.36  | -0.37  | -0.35  | -0.32  |
| 5                       | 1525.5 | 1.5  | -3.55 | -3.56 | -3.55  | -3.52  | -3.39  | -0.46  | -0.45  | -0.43  | -0.40  |
| 6                       | 1906.9 | 1.9  | -4.46 | -4.47 | -4.47  | -4.42  | -4.23  | -0.51  | -0.50  | -0.48  | -0.43  |
| 7                       | 2288.2 | 2.3  | -5.01 | -5.02 | -5.01  | -4.95  | -4.70  | -0.57  | -0.56  | -0.53  | -0.50  |
| 8                       | 2669.6 | 2.7  | -5.23 | -5.24 | -5.23  | -5.14  | -4.83  | -0.62  | -0.60  | -0.58  | -0.81  |
| 9                       | 3051   | 3.1  | -5.15 | -5.15 | -5.14  | -5.03  | -4.63  | -0.66  | -0.64  | -0.61  | -1.37  |
| 10                      | 3432.4 | 3.4  | -4.79 | -4.79 | -4.77  | -4.63  | -4.13  | -0.71  | -0.68  | -0.63  | -1.83  |
| 11                      | 3813.7 | 3.8  | -4.14 | -4.14 | -4.12  | -3.95  | -3.34  | -0.74  | -0.71  | -0.51  | -1.79  |
| 12                      | 4195.1 | 4.2  | -3.20 | -3.19 | -3.17  | -2.96  | -2.22  | -0.78  | -0.62  | -0.15  | -1.21  |
| 13                      | 4576.5 | 4.6  | -2.01 | -2.00 | -1.97  | -1.74  | -0.93  | -0.81  | -0.23  | -0.30  | -0.39  |
| 14                      | 4957.9 | 5.0  | -0.91 | -0.90 | -0.87  | -0.65  | -0.03  | -0.78  | -0.10  | -0.37  | -0.08  |
| 15                      | 5339.2 | 5.3  | -0.41 | -0.40 | -0.39  | -0.35  | -0.26  | -0.74  | -0.63  | -0.61  | -0.61  |
| 16                      | 5720.6 | 5.7  | -0.87 | -0.87 | -0.95  | -1.54  | -2.82  | -2.57  | -3.58  | -3.71  | -3.54  |
| 17                      | 6102   | 6.1  | -2.03 | -2.07 | -2.44  | -4.49  | -7.86  | -7.73  | -9.29  | -9.53  | -9.22  |
| 18                      | 6483.3 | 6.5  | -3.29 | -3.41 | -4.48  | -8.82  | -14.25 | -14.74 | -16.62 | -16.93 | -16.54 |
| 19                      | 6864.7 | 6.9  | -4.44 | -4.71 | -7.03  | -13.65 | -20.71 | -21.79 | -23.85 | -24.22 | -23.78 |
| 20                      | 7246.1 | 7.2  | -5.30 | -5.91 | -9.67  | -17.94 | -26.18 | -27.73 | -29.86 | -30.26 | -29.82 |
| 21                      | 7627.5 | 7.6  | -5.82 | -6.88 | -11.62 | -20.90 | -29.85 | -31.71 | -33.85 | -34.25 | -33.83 |
| 22                      | 8008.8 | 8.0  | -6.08 | -7.38 | -12.47 | -22.13 | -31.33 | -33.25 | -35.31 | -35.70 | -35.32 |
| 23                      | 8390.2 | 8.4  | -6.05 | -7.26 | -12.07 | -21.49 | -30.50 | -32.16 | -34.07 | -34.44 | -34.12 |
| 24                      | 8771.6 | 8.8  | -5.75 | -6.63 | -10.55 | -19.10 | -27.48 | -28.58 | -30.30 | -30.61 | -30.37 |
| 25                      | 9153   | 9.2  | -5.15 | -5.66 | -8.30  | -15.36 | -22.67 | -22.98 | -24.44 | -24.70 | -24.54 |
| 26                      | 9534.3 | 9.5  | -4.23 | -4.48 | -5.85  | -10.89 | -16.70 | -16.16 | -17.31 | -17.51 | -17.41 |
| 27                      | 9915.7 | 9.9  | -3.09 | -3.19 | -3.71  | -6.50  | -10.43 | -9.25  | -10.06 | -10.19 | -10.15 |
| 28                      | 10297  | 10.3 | -1.98 | -2.02 | -2.15  | -3.13  | -4.97  | -3.92  | -4.31  | -4.37  | -4.37  |
| 29                      | 10678  | 10.7 | -1.33 | -1.33 | -1.33  | -1.40  | -1.62  | -1.62  | -1.60  | -1.60  | -1.61  |
| 30                      | 11060  | 11.1 | -1.64 | -1.63 | -1.59  | -1.40  | -0.89  | -1.52  | -1.54  | -1.58  | -1.59  |
| 31                      | 11441  | 11.4 | -2.83 | -2.81 | -2.77  | -2.56  | -1.87  | -1.62  | -1.79  | -2.04  | -2.05  |
| 32                      | 11823  | 11.8 | -4.15 | -4.14 | -4.10  | -3.91  | -3.26  | -1.65  | -1.62  | -1.99  | -2.00  |
| 33                      | 12204  | 12.2 | -5.35 | -5.34 | -5.31  | -5.15  | -4.60  | -1.67  | -1.65  | -1.82  | -1.83  |
| 34                      | 12585  | 12.6 | -6.35 | -6.34 | -6.32  | -6.18  | -5.73  | -1.69  | -1.67  | -1.69  | -1.70  |
| 35                      | 12967  | 13.0 | -7.05 | -7.04 | -7.02  | -6.92  | -6.54  | -1.71  | -1.69  | -1.70  | -1.72  |
| 36                      | 13348  | 13.3 | -7.49 | -7.49 | -7.48  | -7.39  | -7.08  | -1.72  | -1.70  | -1.71  | -1.73  |
| 37                      | 13729  | 13.7 | -7.73 | -7.73 | -7.72  | -7.65  | -7.40  | -1.73  | -1.71  | -1.72  | -1.74  |
| 38                      | 14111  | 14.1 | -7.77 | -7.77 | -7.76  | -7.71  | -7.50  | -1.74  | -1.71  | -1.73  | -1.74  |
| 39                      | 14492  | 14.5 | -7.59 | -7.60 | -7.59  | -7.54  | -7.37  | -1.73  | -1.71  | -1.73  | -1.74  |
| 40                      | 14874  | 14.9 | -7.18 | -7.19 | -7.18  | -7.15  | -7.00  | -1.73  | -1.71  | -1.72  | -1.73  |
| 41                      | 15255  | 15.3 | -6.56 | -6.56 | -6.56  | -6.53  | -6.41  | -1.71  | -1.69  | -1.71  | -1.72  |
| 42                      | 15636  | 15.6 | -5.70 | -5.71 | -5.71  | -5.69  | -5.59  | -1.69  | -1.68  | -1.69  | -1.70  |
| 43                      | 16018  | 16.0 | -4.56 | -4.57 | -4.57  | -4.55  | -4.48  | -1.67  | -1.65  | -1.67  | -1.68  |
| 44                      | 16399  | 16.4 | -3.20 | -3.21 | -3.21  | -3.20  | -3.14  | -1.64  | -1.62  | -1.64  | -1.65  |
| 45                      | 16780  | 16.8 | -1.89 | -1.90 | -1.90  | -1.89  | -1.86  | -1.61  | -1.59  | -1.60  | -1.61  |
| 46                      | 17162  | 17.2 | -0.87 | -0.88 | -0.88  | -0.87  | -0.86  | -1.43  | -1.41  | -1.42  | -1.43  |
| 47                      | 17543  | 17.5 | -0.23 | -0.23 | -0.23  | -0.23  | -0.23  | -0.69  | -0.68  | -0.68  | -0.69  |
| 48                      | 17925  | 17.9 | 0.00  | 0.00  | 0.00   | 0.00   | -0.01  | -0.01  | -0.01  | -0.01  | -0.01  |
| 49                      | 18306  | 18.3 | 0.00  | 0.00  | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   | 0.00   |

| BOTTOM PLATE - LONGITUDINAL |       |      |          |          |          |         |          |          |          |          |          |
|-----------------------------|-------|------|----------|----------|----------|---------|----------|----------|----------|----------|----------|
| longi                       | mm    | m    | TR1      | TR3      | TR5      | TR7     | TR9      | TR11     | TR13     | TR15     | TR17     |
| 1                           | 0     | 0.0  | -0.72916 | -4.9487  | -13.335  | -17.823 | -0.68273 | -18.657  | -18.629  | -13.034  | -23.65   |
| 2                           | 375   | 0.4  | -0.82484 | -5.0848  | -13.104  | -16.963 | -0.81457 | -17.73   | -17.704  | -12.89   | -22.536  |
| 3                           | 750   | 0.8  | -0.9906  | -5.3688  | -13.144  | -16.445 | -1.0297  | -17.167  | -17.142  | -13.036  | -21.825  |
| 4                           | 1125  | 1.1  | -1.1998  | -5.7249  | -13.332  | -16.127 | -1.3029  | -16.825  | -16.801  | -13.346  | -21.38   |
| 5                           | 1500  | 1.5  | -1.4488  | -6.1191  | -13.596  | -15.943 | -1.6311  | -16.618  | -16.595  | -13.734  | -21.101  |
| 6                           | 1875  | 1.9  | -1.7281  | -6.5231  | -13.866  | -15.816 | -2.0016  | -16.497  | -16.475  | -14.15   | -20.935  |
| 7                           | 2250  | 2.3  | -2.0287  | -6.9201  | -14.133  | -15.745 | -2.4035  | -16.425  | -16.404  | -14.562  | -20.845  |
| 8                           | 2625  | 2.6  | -2.3406  | -7.3     | -14.382  | -15.713 | -2.8238  | -16.38   | -16.36   | -14.93   | -20.78   |
| 9                           | 3000  | 3.0  | -2.6581  | -7.6607  | -14.608  | -15.709 | -3.2548  | -16.357  | -16.338  | -15.269  | -20.749  |
| 10                          | 3375  | 3.4  | -2.9757  | -7.9988  | -14.783  | -15.698 | -3.6888  | -16.344  | -16.326  | -15.575  | -20.737  |
| 11                          | 3750  | 3.8  | -3.2884  | -8.3135  | -14.927  | -15.694 | -4.1187  | -16.337  | -16.319  | -15.852  | -20.739  |
| 12                          | 4125  | 4.1  | -3.5913  | -8.6066  | -15.044  | -15.694 | -4.5378  | -16.335  | -16.318  | -16.103  | -20.75   |
| 13                          | 4500  | 4.5  | -3.8813  | -8.8743  | -15.137  | -15.696 | -4.9413  | -16.329  | -16.313  | -16.327  | -20.761  |
| 14                          | 4875  | 4.9  | -4.1542  | -9.1226  | -15.212  | -15.698 | -5.3233  | -16.329  | -16.313  | -16.518  | -20.763  |
| 15                          | 5250  | 5.3  | -4.4085  | -9.347   | -15.266  | -15.695 | -5.6808  | -16.326  | -16.311  | -16.688  | -20.765  |
| 16                          | 5625  | 5.6  | -4.6412  | -9.5478  | -15.309  | -15.694 | -6.0094  | -16.322  | -16.307  | -16.829  | -20.757  |
| 17                          | 6000  | 6.0  | -4.8516  | -9.724   | -15.339  | -15.69  | -6.3084  | -16.315  | -16.3    | -16.956  | -20.753  |
| 18                          | 6375  | 6.4  | -5.0365  | -9.8745  | -15.352  | -15.678 | -6.5719  | -16.305  | -16.291  | -17.066  | -20.75   |
| 19                          | 6750  | 6.8  | -5.197   | -10.003  | -15.363  | -15.671 | -6.8006  | -16.296  | -16.282  | -17.16   | -20.748  |
| 20                          | 7125  | 7.1  | -5.3312  | -10.109  | -15.365  | -15.659 | -6.9931  | -16.286  | -16.273  | -17.239  | -20.749  |
| 21                          | 7500  | 7.5  | -5.4393  | -10.191  | -15.366  | -15.65  | -7.1484  | -16.276  | -16.263  | -17.302  | -20.75   |
| 22                          | 7875  | 7.9  | -5.5195  | -10.251  | -15.364  | -15.64  | -7.2638  | -16.266  | -16.253  | -17.34   | -20.743  |
| 23                          | 8250  | 8.3  | -5.5719  | -10.284  | -15.356  | -15.628 | -7.3399  | -16.251  | -16.239  | -17.363  | -20.736  |
| 24                          | 8625  | 8.6  | -5.5968  | -10.295  | -15.344  | -15.613 | -7.3765  | -16.237  | -16.224  | -17.375  | -20.737  |
| 25                          | 9000  | 9.0  | -5.5942  | -10.286  | -15.332  | -15.601 | -7.3737  | -16.227  | -16.214  | -17.374  | -20.742  |
| 26                          | 9375  | 9.4  | -5.5636  | -10.258  | -15.321  | -15.592 | -7.3306  | -16.223  | -16.21   | -17.352  | -20.743  |
| 27                          | 9750  | 9.8  | -5.5045  | -10.21   | -15.311  | -15.586 | -7.2469  | -16.222  | -16.209  | -17.31   | -20.742  |
| 28                          | 10125 | 10.1 | -5.4181  | -10.136  | -15.302  | -15.585 | -7.1245  | -16.219  | -16.206  | -17.259  | -20.749  |
| 29                          | 10500 | 10.5 | -5.3046  | -10.037  | -15.285  | -15.581 | -6.9636  | -16.215  | -16.202  | -17.196  | -20.763  |
| 30                          | 10875 | 10.9 | -5.1649  | -9.9166  | -15.263  | -15.577 | -6.7657  | -16.215  | -16.201  | -17.115  | -20.776  |
| 31                          | 11250 | 11.3 | -4.9979  | -9.7721  | -15.233  | -15.573 | -6.5297  | -16.216  | -16.202  | -17.009  | -20.782  |
| 32                          | 11625 | 11.6 | -4.8052  | -9.6007  | -15.198  | -15.574 | -6.2585  | -16.214  | -16.199  | -16.893  | -20.793  |
| 33                          | 12000 | 12.0 | -4.5898  | -9.4143  | -15.162  | -15.582 | -5.9562  | -16.225  | -16.21   | -16.766  | -20.806  |
| 34                          | 12375 | 12.4 | -4.35    | -9.199   | -15.107  | -15.581 | -5.6209  | -16.229  | -16.213  | -16.62   | -20.813  |
| 35                          | 12750 | 12.8 | -4.0877  | -8.9539  | -15.027  | -15.567 | -5.2562  | -16.216  | -16.2    | -16.445  | -20.794  |
| 36                          | 13125 | 13.1 | -3.806   | -8.6904  | -14.931  | -15.547 | -4.8667  | -16.197  | -16.18   | -16.241  | -20.743  |
| 37                          | 13500 | 13.5 | -3.5072  | -8.4061  | -14.805  | -15.506 | -4.4559  | -16.159  | -16.141  | -15.999  | -20.642  |
| 38                          | 13875 | 13.9 | -3.1937  | -8.1     | -14.639  | -15.434 | -4.0281  | -16.084  | -16.065  | -15.71   | -20.469  |
| 39                          | 14250 | 14.3 | -2.8693  | -7.7693  | -14.408  | -15.3   | -3.5885  | -15.947  | -15.928  | -15.354  | -20.191  |
| 40                          | 14625 | 14.6 | -2.5381  | -7.4128  | -14.091  | -15.08  | -3.1432  | -15.72   | -15.7    | -14.915  | -19.772  |
| 41                          | 15000 | 15.0 | -2.205   | -7.0275  | -13.649  | -14.724 | -2.6989  | -15.363  | -15.343  | -14.358  | -19.16   |
| 42                          | 15375 | 15.4 | -1.8751  | -6.6034  | -13.046  | -14.187 | -2.2626  | -14.82   | -14.799  | -13.641  | -18.291  |
| 43                          | 15750 | 15.8 | -1.5554  | -6.1192  | -12.24   | -13.414 | -1.8438  | -14.012  | -13.991  | -12.713  | -17.097  |
| 44                          | 16125 | 16.1 | -1.2536  | -5.5538  | -11.177  | -12.336 | -1.4519  | -12.867  | -12.846  | -11.519  | -15.502  |
| 45                          | 16500 | 16.5 | -0.97736 | -4.8894  | -9.8032  | -10.881 | -1.0974  | -11.328  | -11.308  | -10.002  | -13.441  |
| 46                          | 16875 | 16.9 | -0.74013 | -4.0952  | -8.0696  | -8.9871 | -0.79558 | -9.3326  | -9.3124  | -8.1061  | -10.851  |
| 47                          | 17250 | 17.3 | -0.54444 | -3.143   | -5.952   | -6.6241 | -0.55168 | -6.8482  | -6.8284  | -5.8126  | -7.7288  |
| 48                          | 17625 | 17.6 | -0.4075  | -2.0224  | -3.4799  | -3.8297 | -0.38682 | -3.9202  | -3.901   | -3.154   | -4.1352  |
| 49                          | 18000 | 18.0 | -0.39324 | -0.78413 | -0.77022 | -0.7512 | -0.36304 | -0.70157 | -0.68302 | -0.25982 | -0.24407 |

BOTTOM PLATE - TRANSVERSE

| trans | mm     | m       |      | TR1     | TR3     | TR5    | TR7     | TR9    | TR11    | TR13    | TR15    | TR17    |
|-------|--------|---------|------|---------|---------|--------|---------|--------|---------|---------|---------|---------|
| 1     | 0      | 0       | 0.00 | 0.00    | 0.00    | 0.00   | 0.00    | 0.00   | 0.00    | 0.00    | 0.00    | 0.00    |
| 2     | 123.84 | 0.12384 | 0.12 | 0.00    | 0.00    | 0.00   | -0.02   | 0.00   | -0.02   | 0.00    | 0.00    | 0.00    |
| 3     | 247.69 | 0.24769 | 0.25 | 0.00    | 0.00    | 0.00   | -0.04   | 0.00   | -0.04   | 0.00    | 0.00    | 0.00    |
| 4     | 371.53 | 0.37153 | 0.37 | -0.01   | -0.01   | -0.01  | -0.06   | 0.00   | -0.06   | 0.00    | 0.00    | -0.01   |
| 5     | 495.38 | 0.49538 | 0.50 | -0.15   | -0.15   | -0.15  | -0.16   | -0.17  | -0.15   | -0.19   | -0.24   | -0.38   |
| 6     | 619.22 | 0.61922 | 0.62 | -0.36   | -0.35   | -0.34  | -0.27   | -0.40  | -0.26   | -0.45   | -0.56   | -0.89   |
| 7     | 743.07 | 0.74307 | 0.74 | -0.56   | -0.56   | -0.53  | -0.39   | -0.62  | -0.37   | -0.70   | -0.88   | -1.39   |
| 8     | 866.91 | 0.86691 | 0.87 | -0.88   | -0.88   | -0.84  | -0.42   | -0.99  | -0.40   | -1.13   | -1.46   | -2.27   |
| 9     | 990.76 | 0.99076 | 0.99 | -1.33   | -1.33   | -1.28  | -0.40   | -1.50  | -0.38   | -1.73   | -2.29   | -3.52   |
| 10    | 1114.6 | 1.1146  | 1.11 | -1.79   | -1.78   | -1.71  | -0.37   | -2.01  | -0.35   | -2.34   | -3.13   | -4.77   |
| 11    | 1238.4 | 1.2384  | 1.24 | -2.23   | -2.23   | -2.14  | -0.37   | -2.53  | -0.35   | -2.96   | -4.04   | -6.09   |
| 12    | 1362.3 | 1.3623  | 1.36 | -2.68   | -2.68   | -2.56  | -0.41   | -3.05  | -0.39   | -3.63   | -5.20   | -7.63   |
| 13    | 1486.1 | 1.4861  | 1.49 | -3.12   | -3.12   | -2.98  | -0.45   | -3.57  | -0.43   | -4.30   | -6.37   | -9.17   |
| 14    | 1610   | 1.61    | 1.61 | -3.56   | -3.56   | -3.40  | -0.49   | -4.09  | -0.47   | -4.98   | -7.53   | -10.70  |
| 15    | 1733.8 | 1.7338  | 1.73 | -3.89   | -3.89   | -3.72  | -0.52   | -4.50  | -0.49   | -5.61   | -8.79   | -12.16  |
| 16    | 1857.7 | 1.8577  | 1.86 | -4.22   | -4.22   | -4.03  | -0.54   | -4.91  | -0.51   | -6.24   | -10.04  | -13.63  |
| 17    | 1981.5 | 1.9815  | 1.98 | -4.55   | -4.55   | -4.34  | -0.56   | -5.33  | -0.54   | -6.88   | -11.30  | -15.09  |
| 18    | 2105.4 | 2.1054  | 2.11 | -4.79   | -4.78   | -4.56  | -0.58   | -5.65  | -0.55   | -7.50   | -12.38  | -16.25  |
| 19    | 2229.2 | 2.2292  | 2.23 | -5.01   | -5.00   | -4.77  | -0.59   | -5.97  | -0.56   | -8.13   | -13.44  | -17.37  |
| 20    | 2353   | 2.353   | 2.35 | -5.23   | -5.22   | -4.98  | -0.60   | -6.28  | -0.58   | -8.76   | -14.50  | -18.49  |
| 21    | 2476.9 | 2.4769  | 2.48 | -5.36   | -5.36   | -5.11  | -0.62   | -6.52  | -0.59   | -9.32   | -15.27  | -19.25  |
| 22    | 2600.7 | 2.6007  | 2.60 | -5.47   | -5.46   | -5.21  | -0.64   | -6.72  | -0.60   | -9.85   | -15.94  | -19.86  |
| 23    | 2724.6 | 2.7246  | 2.72 | -5.57   | -5.56   | -5.31  | -0.65   | -6.93  | -0.61   | -10.39  | -16.61  | -20.47  |
| 24    | 2848.4 | 2.8484  | 2.85 | -5.61   | -5.60   | -5.35  | -0.67   | -7.09  | -0.66   | -10.76  | -16.96  | -20.74  |
| 25    | 2972.3 | 2.9723  | 2.97 | -5.61   | -5.60   | -5.35  | -0.67   | -7.21  | -0.74   | -11.03  | -17.12  | -20.76  |
| 26    | 3096.1 | 3.0961  | 3.10 | -5.61   | -5.60   | -5.35  | -0.68   | -7.32  | -0.81   | -11.29  | -17.29  | -20.78  |
| 27    | 3220   | 3.22    | 3.22 | -5.56   | -5.55   | -5.30  | -0.70   | -7.39  | -0.96   | -11.38  | -17.18  | -20.51  |
| 28    | 3343.8 | 3.3438  | 3.34 | -5.47   | -5.46   | -5.21  | -0.72   | -7.40  | -1.21   | -11.29  | -16.81  | -19.94  |
| 29    | 3467.6 | 3.4676  | 3.47 | -5.37   | -5.36   | -5.12  | -0.74   | -7.42  | -1.47   | -11.19  | -16.44  | -19.37  |
| 30    | 3591.5 | 3.5915  | 3.59 | -5.23   | -5.22   | -4.99  | -0.76   | -7.36  | -1.72   | -10.96  | -15.89  | -18.61  |
| 31    | 3715.3 | 3.7153  | 3.72 | -5.01   | -5.00   | -4.78  | -0.76   | -7.16  | -1.93   | -10.48  | -15.03  | -17.53  |
| 32    | 3839.2 | 3.8392  | 3.84 | -4.80   | -4.78   | -4.58  | -0.76   | -6.97  | -2.14   | -10.00  | -14.17  | -16.44  |
| 33    | 3963   | 3.963   | 3.96 | -4.56   | -4.55   | -4.36  | -0.76   | -6.74  | -2.35   | -9.47   | -13.26  | -15.29  |
| 34    | 4086.9 | 4.0869  | 4.09 | -4.24   | -4.23   | -4.06  | -0.78   | -6.28  | -2.37   | -8.68   | -12.05  | -13.85  |
| 35    | 4210.7 | 4.2107  | 4.21 | -3.93   | -3.91   | -3.75  | -0.80   | -5.81  | -2.40   | -7.90   | -10.85  | -12.41  |
| 36    | 4334.6 | 4.3346  | 4.33 | -3.61   | -3.59   | -3.45  | -0.82   | -5.35  | -2.43   | -7.11   | -9.64   | -10.98  |
| 37    | 4458.4 | 4.4584  | 4.46 | -3.22   | -3.21   | -3.09  | -0.83   | -4.71  | -2.31   | -6.18   | -8.32   | -9.46   |
| 38    | 4582.3 | 4.5823  | 4.58 | -2.83   | -2.82   | -2.72  | -0.84   | -4.06  | -2.16   | -5.25   | -7.00   | -7.94   |
| 39    | 4706.1 | 4.7061  | 4.71 | -2.45   | -2.43   | -2.35  | -0.84   | -3.41  | -2.01   | -4.32   | -5.69   | -6.42   |
| 40    | 4829.9 | 4.8299  | 4.83 | -2.05   | -2.03   | -1.97  | -0.85   | -2.78  | -1.82   | -3.47   | -4.53   | -5.11   |
| 41    | 4953.8 | 4.9538  | 4.95 | -1.64   | -1.63   | -1.59  | -0.87   | -2.16  | -1.59   | -2.66   | -3.43   | -3.86   |
| 42    | 5077.6 | 5.0776  | 5.08 | -1.24   | -1.22   | -1.20  | -0.88   | -1.54  | -1.37   | -1.84   | -2.33   | -2.62   |
| 43    | 5201.5 | 5.2015  | 5.20 | -0.94   | -0.93   | -0.93  | -0.89   | -1.10  | -1.20   | -1.27   | -1.56   | -1.75   |
| 44    | 5325.3 | 5.3253  | 5.33 | -0.76   | -0.74   | -0.75  | -0.90   | -0.83  | -1.09   | -0.92   | -1.11   | -1.25   |
| 45    | 5449.2 | 5.4492  | 5.45 | -0.57   | -0.55   | -0.57  | -0.90   | -0.56  | -0.98   | -0.58   | -0.67   | -0.75   |
| 46    | 5573   | 5.573   | 5.57 | -0.43   | -0.41   | -0.44  | -0.91   | -0.37  | -0.89   | -0.33   | -0.34   | -0.38   |
| 47    | 5696.9 | 5.6969  | 5.70 | -0.43   | -0.41   | -0.44  | -0.91   | -0.36  | -0.89   | -0.33   | -0.34   | -0.38   |
| 48    | 5820.7 | 5.8207  | 5.82 | -0.42   | -0.41   | -0.44  | -0.90   | -0.36  | -0.89   | -0.33   | -0.33   | -0.38   |
| 49    | 5944.5 | 5.9445  | 5.94 | -0.42   | -0.41   | -0.43  | -0.90   | -0.36  | -0.89   | -0.33   | -0.33   | -0.37   |
| 50    |        |         |      | 0.00    | 0.00    | 0.00   | 0.00    | 0.00   | 0.00    | 0.00    | 0.00    | 0.00    |
| 51    | mm     | m       |      | #VALUE! | #VALUE! | #####  | #VALUE! | #####  | #VALUE! | #VALUE! | #VALUE! | #VALUE! |
| 52    | 0      | 0       |      | -0.42   | -0.41   | -0.43  | -0.90   | -0.36  | -0.89   | -0.33   | -0.33   | -0.37   |
| 56    | 452.88 | 0.45288 | 6.40 | -0.50   | -0.51   | -0.61  | -1.11   | -0.54  | -1.10   | -0.51   | -0.51   | -0.55   |
| 57    | 566.09 | 0.56609 | 6.51 | -0.67   | -0.75   | -1.01  | -1.51   | -0.95  | -1.50   | -0.92   | -0.92   | -0.96   |
| 58    | 679.31 | 0.67931 | 6.62 | -0.84   | -0.98   | -1.42  | -1.91   | -1.36  | -1.90   | -1.33   | -1.33   | -1.37   |
| 59    | 792.53 | 0.79253 | 6.74 | -1.02   | -1.22   | -1.83  | -2.41   | -1.77  | -2.40   | -1.74   | -1.74   | -1.78   |
| 60    | 905.75 | 0.90575 | 6.85 | -1.37   | -1.81   | -2.75  | -3.46   | -2.70  | -3.45   | -2.67   | -2.67   | -2.71   |
| 61    | 1019   | 1.019   | 6.96 | -1.75   | -2.44   | -3.74  | -4.52   | -3.70  | -4.50   | -3.67   | -3.67   | -3.70   |
| 62    | 1132.2 | 1.1322  | 7.08 | -2.12   | -3.07   | -4.72  | -5.57   | -4.70  | -5.56   | -4.67   | -4.67   | -4.70   |
| 63    | 1245.4 | 1.2454  | 7.19 | -2.50   | -3.76   | -5.77  | -6.82   | -5.77  | -6.81   | -5.74   | -5.73   | -5.77   |
| 64    | 1358.6 | 1.3586  | 7.30 | -2.89   | -4.55   | -6.93  | -8.14   | -6.94  | -8.13   | -6.91   | -6.91   | -6.94   |
| 65    | 1471.8 | 1.4718  | 7.42 | -3.27   | -5.34   | -8.09  | -9.47   | -8.12  | -9.46   | -8.09   | -8.08   | -8.12   |
| 66    | 1585.1 | 1.5851  | 7.53 | -3.65   | -6.13   | -9.25  | -10.76  | -9.29  | -10.75  | -9.26   | -9.26   | -9.29   |
| 67    | 1698.3 | 1.6983  | 7.64 | -4.02   | -6.82   | -10.30 | -11.98  | -10.35 | -11.97  | -10.33  | -10.32  | -10.35  |
| 68    | 1811.5 | 1.8115  | 7.76 | -4.39   | -7.51   | -11.33 | -13.19  | -11.40 | -13.18  | -11.38  | -11.37  | -11.40  |
| 69    | 1924.7 | 1.9247  | 7.87 | -4.76   | -8.20   | -12.37 | -14.41  | -12.45 | -14.40  | -12.43  | -12.42  | -12.45  |
| 70    | 2037.9 | 2.0379  | 7.98 | -5.10   | -8.76   | -13.23 | -15.31  | -13.34 | -15.31  | -13.31  | -13.31  | -13.34  |

|                         |        |         |       |         |         |        |         |        |         |         |         |         |
|-------------------------|--------|---------|-------|---------|---------|--------|---------|--------|---------|---------|---------|---------|
| CHAPTER 5 - CONCLUSIONS |        |         |       |         |         |        |         |        |         |         |         |         |
| 71                      | 2151.2 | 2.1512  | 8.10  | -5.41   | -9.19   | -13.93 | -16.17  | -14.06 | -16.16  | -14.03  | -14.03  | -14.05  |
| 72                      | 2264.4 | 2.2644  | 8.21  | -5.73   | -9.62   | -14.63 | -17.02  | -14.77 | -17.02  | -14.75  | -14.75  | -14.77  |
| 73                      | 2377.6 | 2.3776  | 8.32  | -6.03   | -10.02  | -15.27 | -17.65  | -15.44 | -17.65  | -15.41  | -15.40  | -15.44  |
| 74                      | 2490.8 | 2.4908  | 8.44  | -6.19   | -10.11  | -15.53 | -17.98  | -15.71 | -17.99  | -15.68  | -15.67  | -15.70  |
| 75                      | 2604   | 2.604   | 8.55  | -6.35   | -10.20  | -15.78 | -18.32  | -15.97 | -18.32  | -15.94  | -15.94  | -15.96  |
| 76                      | 2717.3 | 2.7173  | 8.66  | -6.51   | -10.30  | -16.04 | -18.65  | -16.23 | -18.66  | -16.21  | -16.21  | -16.23  |
| 77                      | 2830.5 | 2.8305  | 8.78  | -6.54   | -10.14  | -15.91 | -18.41  | -16.13 | -18.42  | -16.11  | -16.09  | -16.13  |
| 78                      | 2943.7 | 2.9437  | 8.89  | -6.52   | -9.91   | -15.69 | -18.17  | -15.91 | -18.18  | -15.89  | -15.88  | -15.91  |
| 79                      | 3056.9 | 3.0569  | 9.00  | -6.51   | -9.68   | -15.46 | -17.93  | -15.69 | -17.94  | -15.67  | -15.66  | -15.69  |
| 80                      | 3170.1 | 3.1701  | 9.11  | -6.42   | -9.33   | -15.02 | -17.38  | -15.27 | -17.40  | -15.24  | -15.23  | -15.26  |
| 81                      | 3283.3 | 3.2833  | 9.23  | -6.25   | -8.86   | -14.36 | -16.61  | -14.61 | -16.63  | -14.58  | -14.57  | -14.60  |
| 82                      | 3396.6 | 3.3966  | 9.34  | -6.08   | -8.38   | -13.70 | -15.84  | -13.95 | -15.86  | -13.92  | -13.92  | -13.94  |
| 83                      | 3509.8 | 3.5098  | 9.45  | -5.89   | -7.89   | -12.98 | -15.01  | -13.22 | -15.04  | -13.20  | -13.19  | -13.22  |
| 84                      | 3623   | 3.623   | 9.57  | -5.60   | -7.33   | -12.00 | -13.86  | -12.24 | -13.89  | -12.22  | -12.21  | -12.23  |
| 85                      | 3736.2 | 3.7362  | 9.68  | -5.31   | -6.77   | -11.02 | -12.71  | -11.25 | -12.73  | -11.23  | -11.22  | -11.25  |
| 86                      | 3849.4 | 3.8494  | 9.79  | -5.02   | -6.20   | -10.04 | -11.56  | -10.27 | -11.58  | -10.25  | -10.24  | -10.26  |
| 87                      | 3962.7 | 3.9627  | 9.91  | -4.66   | -5.65   | -8.97  | -10.31  | -9.17  | -10.33  | -9.15   | -9.14   | -9.17   |
| 88                      | 4075.9 | 4.0759  | 10.02 | -4.28   | -5.10   | -7.87  | -9.02   | -8.05  | -9.05   | -8.03   | -8.02   | -8.05   |
| 89                      | 4189.1 | 4.1891  | 10.13 | -3.91   | -4.54   | -6.77  | -7.73   | -6.93  | -7.76   | -6.91   | -6.90   | -6.93   |
| 90                      | 4302.3 | 4.3023  | 10.25 | -3.52   | -4.00   | -5.75  | -6.50   | -5.88  | -6.54   | -5.86   | -5.85   | -5.88   |
| 91                      | 4415.5 | 4.4155  | 10.36 | -3.10   | -3.48   | -4.82  | -5.44   | -4.92  | -5.47   | -4.90   | -4.89   | -4.92   |
| 92                      | 4528.8 | 4.5288  | 10.47 | -2.69   | -2.95   | -3.89  | -4.37   | -3.96  | -4.41   | -3.93   | -3.93   | -3.96   |
| 93                      | 4642   | 4.642   | 10.59 | -2.28   | -2.43   | -2.97  | -3.31   | -3.00  | -3.34   | -3.00   | -2.97   | -3.01   |
| 94                      | 4755.2 | 4.7552  | 10.70 | -2.05   | -2.16   | -2.56  | -2.79   | -2.59  | -2.82   | -2.57   | -2.56   | -2.59   |
| 95                      | 4868.4 | 4.8684  | 10.81 | -1.83   | -1.90   | -2.16  | -2.36   | -2.17  | -2.39   | -2.15   | -2.14   | -2.17   |
| 96                      | 4981.6 | 4.9816  | 10.93 | -1.60   | -1.63   | -1.76  | -1.93   | -1.75  | -1.96   | -1.73   | -1.72   | -1.75   |
| 97                      | 5094.9 | 5.0949  | 11.04 | -1.48   | -1.49   | -1.56  | -1.69   | -1.54  | -1.71   | -1.51   | -1.51   | -1.54   |
| 98                      | 5208.1 | 5.2081  | 11.15 | -1.47   | -1.48   | -1.54  | -1.68   | -1.52  | -1.70   | -1.49   | -1.49   | -1.53   |
| 99                      | 5321.3 | 5.3213  | 11.27 | -1.45   | -1.46   | -1.53  | -1.67   | -1.50  | -1.69   | -1.48   | -1.47   | -1.51   |
| 100                     | 5434.5 | 5.4345  | 11.38 | -1.44   | -1.45   | -1.51  | -1.67   | -1.48  | -1.68   | -1.46   | -1.45   | -1.49   |
| 101                     |        |         |       | 0.00    | 0.00    | 0.00   | 0.00    | 0.00   | 0.00    | 0.00    | 0.00    | 0.00    |
| 102                     | mm     | m       |       | #VALUE! | #VALUE! | #####  | #VALUE! | #####  | #VALUE! | #VALUE! | #VALUE! | #VALUE! |
| 103                     | 0      | 0       |       | -1.44   | -1.45   | -1.51  | -1.67   | -1.48  | -1.68   | -1.46   | -1.45   | -1.49   |
| 107                     | 748.15 | 0.74815 | 12.13 | -2.04   | -2.05   | -2.08  | -1.70   | -2.31  | -1.75   | -2.31   | -2.51   | -2.92   |
| 108                     | 935.19 | 0.93519 | 12.31 | -2.61   | -2.62   | -2.61  | -1.71   | -3.01  | -1.81   | -3.21   | -3.63   | -4.48   |
| 109                     | 1122.2 | 1.1222  | 12.50 | -3.29   | -3.30   | -3.25  | -1.73   | -3.83  | -1.87   | -4.31   | -5.00   | -6.39   |
| 110                     | 1309.3 | 1.3093  | 12.69 | -3.95   | -3.96   | -3.88  | -1.74   | -4.57  | -1.90   | -5.48   | -6.49   | -8.52   |
| 111                     | 1496.3 | 1.4963  | 12.88 | -4.60   | -4.61   | -4.50  | -1.75   | -5.23  | -1.88   | -6.71   | -8.07   | -10.84  |
| 112                     | 1683.3 | 1.6833  | 13.06 | -5.22   | -5.23   | -5.08  | -1.76   | -5.85  | -1.86   | -7.86   | -9.57   | -13.10  |
| 113                     | 1870.4 | 1.8704  | 13.25 | -5.79   | -5.80   | -5.62  | -1.77   | -6.39  | -1.84   | -8.87   | -10.93  | -15.26  |
| 114                     | 2057.4 | 2.0574  | 13.44 | -6.32   | -6.33   | -6.13  | -1.78   | -6.89  | -1.82   | -9.80   | -12.17  | -17.29  |
| 115                     | 2244.5 | 2.2445  | 13.62 | -6.74   | -6.75   | -6.52  | -1.79   | -7.26  | -1.83   | -10.40  | -13.02  | -18.88  |
| 116                     | 2431.5 | 2.4315  | 13.81 | -7.14   | -7.15   | -6.90  | -1.79   | -7.62  | -1.84   | -10.98  | -13.83  | -20.40  |
| 117                     | 2618.5 | 2.6185  | 14.00 | -7.37   | -7.38   | -7.12  | -1.80   | -7.81  | -1.84   | -11.15  | -14.05  | -21.15  |
| 118                     | 2805.6 | 2.8056  | 14.18 | -7.60   | -7.61   | -7.33  | -1.80   | -8.00  | -1.85   | -11.31  | -14.28  | -21.90  |
| 119                     | 2992.6 | 2.9926  | 14.37 | -7.68   | -7.69   | -7.41  | -1.81   | -8.04  | -1.85   | -11.15  | -13.96  | -21.81  |
| 120                     | 3179.7 | 3.1797  | 14.56 | -7.74   | -7.75   | -7.47  | -1.81   | -8.07  | -1.85   | -10.95  | -13.58  | -21.62  |
| 121                     | 3366.7 | 3.3667  | 14.75 | -7.66   | -7.67   | -7.40  | -1.81   | -7.95  | -1.85   | -10.56  | -12.90  | -20.78  |
| 122                     | 3553.7 | 3.5537  | 14.93 | -7.52   | -7.53   | -7.27  | -1.81   | -7.79  | -1.85   | -10.10  | -12.12  | -19.70  |
| 123                     | 3740.8 | 3.7408  | 15.12 | -7.30   | -7.31   | -7.07  | -1.81   | -7.54  | -1.85   | -9.57   | -11.26  | -18.27  |
| 124                     | 3927.8 | 3.9278  | 15.31 | -6.99   | -7.00   | -6.77  | -1.80   | -7.20  | -1.85   | -8.96   | -10.34  | -16.50  |
| 125                     | 4114.8 | 4.1148  | 15.49 | -6.63   | -6.64   | -6.44  | -1.80   | -6.82  | -1.85   | -8.31   | -9.41   | -14.66  |
| 126                     | 4301.9 | 4.3019  | 15.68 | -6.13   | -6.14   | -5.97  | -1.79   | -6.30  | -1.84   | -7.57   | -8.44   | -12.60  |
| 127                     | 4488.9 | 4.4889  | 15.87 | -5.63   | -5.64   | -5.49  | -1.79   | -5.78  | -1.83   | -6.83   | -7.47   | -10.55  |
| 128                     | 4676   | 4.676   | 16.06 | -4.98   | -4.99   | -4.88  | -1.78   | -5.11  | -1.82   | -5.97   | -6.46   | -8.76   |
| 129                     | 4863   | 4.863   | 16.24 | -4.33   | -4.34   | -4.26  | -1.77   | -4.44  | -1.82   | -5.12   | -5.45   | -6.98   |
| 130                     | 5050   | 5.05    | 16.43 | -3.66   | -3.67   | -3.64  | -1.76   | -3.76  | -1.80   | -4.27   | -4.50   | -5.54   |
| 131                     | 5237.1 | 5.2371  | 16.62 | -2.99   | -3.00   | -3.00  | -1.75   | -3.07  | -1.79   | -3.43   | -3.57   | -4.23   |
| 132                     | 5424.1 | 5.4241  | 16.80 | -2.44   | -2.45   | -2.48  | -1.72   | -2.50  | -1.76   | -2.73   | -2.80   | -3.18   |
| 133                     | 5611.2 | 5.6112  | 16.99 | -2.00   | -2.01   | -2.08  | -1.68   | -2.06  | -1.73   | -2.15   | -2.17   | -2.38   |
| 134                     | 5798.2 | 5.7982  | 17.18 | -1.69   | -1.70   | -1.79  | -1.72   | -1.74  | -1.76   | -1.73   | -1.71   | -1.78   |
| 135                     | 5985.2 | 5.9852  | 17.36 | -1.68   | -1.69   | -1.81  | -1.85   | -1.72  | -1.89   | -1.63   | -1.58   | -1.61   |
| 136                     | 6172.3 | 6.1723  | 17.55 | -1.70   | -1.71   | -1.85  | -2.03   | -1.72  | -2.07   | -1.56   | -1.49   | -1.47   |
| 137                     | 6359.3 | 6.3593  | 17.74 | -1.91   | -1.92   | -2.07  | -2.36   | -1.93  | -2.40   | -1.74   | -1.66   | -1.61   |
| 138                     | 6546.3 | 6.5463  | 17.93 | -2.13   | -2.14   | -2.29  | -2.67   | -2.14  | -2.72   | -1.92   | -1.83   | -1.76   |
| 139                     | 6733.4 | 6.7334  | 18.11 | -2.27   | -2.28   | -2.42  | -2.86   | -2.28  | -2.90   | -2.06   | -1.97   | -1.89   |
| 140                     | 6920.4 | 6.9204  | 18.30 | -2.40   | -2.41   | -2.54  | -3.05   | -2.41  | -3.09   | -2.19   | -2.11   | -2.02   |
| 141                     | 7107.5 | 7.1075  | 18.49 | -2.35   | -2.35   | -2.47  | -2.93   | -2.35  | -2.97   | -2.16   | -2.08   | -2.00   |
| 142                     | 7294.5 | 7.2945  | 18.67 | -2.24   | -2.24   | -2.34  | -2.79   | -2.24  | -2.82   | -2.07   | -2.00   | -1.93   |
| 143                     | 7481.5 | 7.4815  | 18.86 | -1.98   | -1.98   | -2.06  | -2.42   | -1.98  | -2.45   | -1.84   | -1.79   | -1.73   |
| 144                     | 7668.6 | 7.6686  | 19.05 | -1.63   | -1.63   | -1.69  | -1.97   | -1.63  | -1.99   | -1.52   | -1.48   | -1.43   |

|     |        |        |       |       |       |       |       |       |       |       |       |       |
|-----|--------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 145 | 7855.6 | 7.8556 | 19.23 | -1.23 | -1.24 | -1.28 | -1.47 | -1.23 | -1.49 | -1.16 | -1.13 | -1.09 |
| 146 | 8042.7 | 8.0427 | 19.42 | -0.79 | -0.79 | -0.82 | -0.93 | -0.79 | -0.94 | -0.74 | -0.73 | -0.71 |
| 147 | 8229.7 | 8.2297 | 19.61 | -0.42 | -0.42 | -0.43 | -0.50 | -0.42 | -0.50 | -0.40 | -0.39 | -0.38 |
| 148 | 8416.7 | 8.4167 | 19.80 | -0.20 | -0.20 | -0.21 | -0.24 | -0.20 | -0.24 | -0.19 | -0.18 | -0.18 |
| 149 | 8603.8 | 8.6038 | 19.98 | -0.02 | -0.02 | -0.02 | -0.03 | -0.02 | -0.03 | -0.01 | -0.01 | -0.01 |
| 150 | 8790.8 | 8.7908 | 20.17 | -0.01 | -0.01 | -0.01 | -0.02 | -0.01 | -0.02 | -0.01 | -0.01 | -0.01 |
| 151 | 8977.8 | 8.9778 | 20.36 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |

## **APPENDIX F – Raw data case study of removal of multiple ribs**

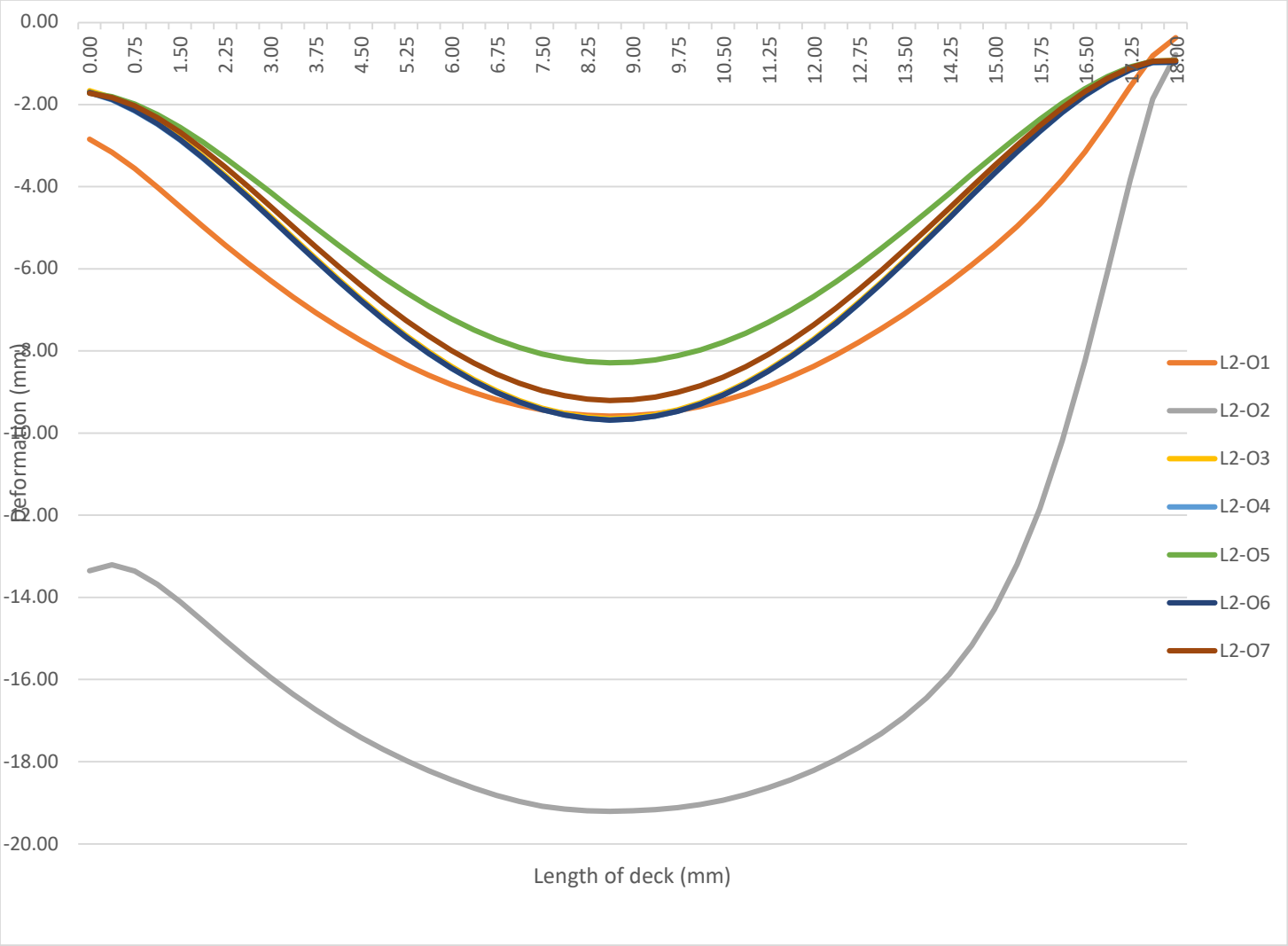
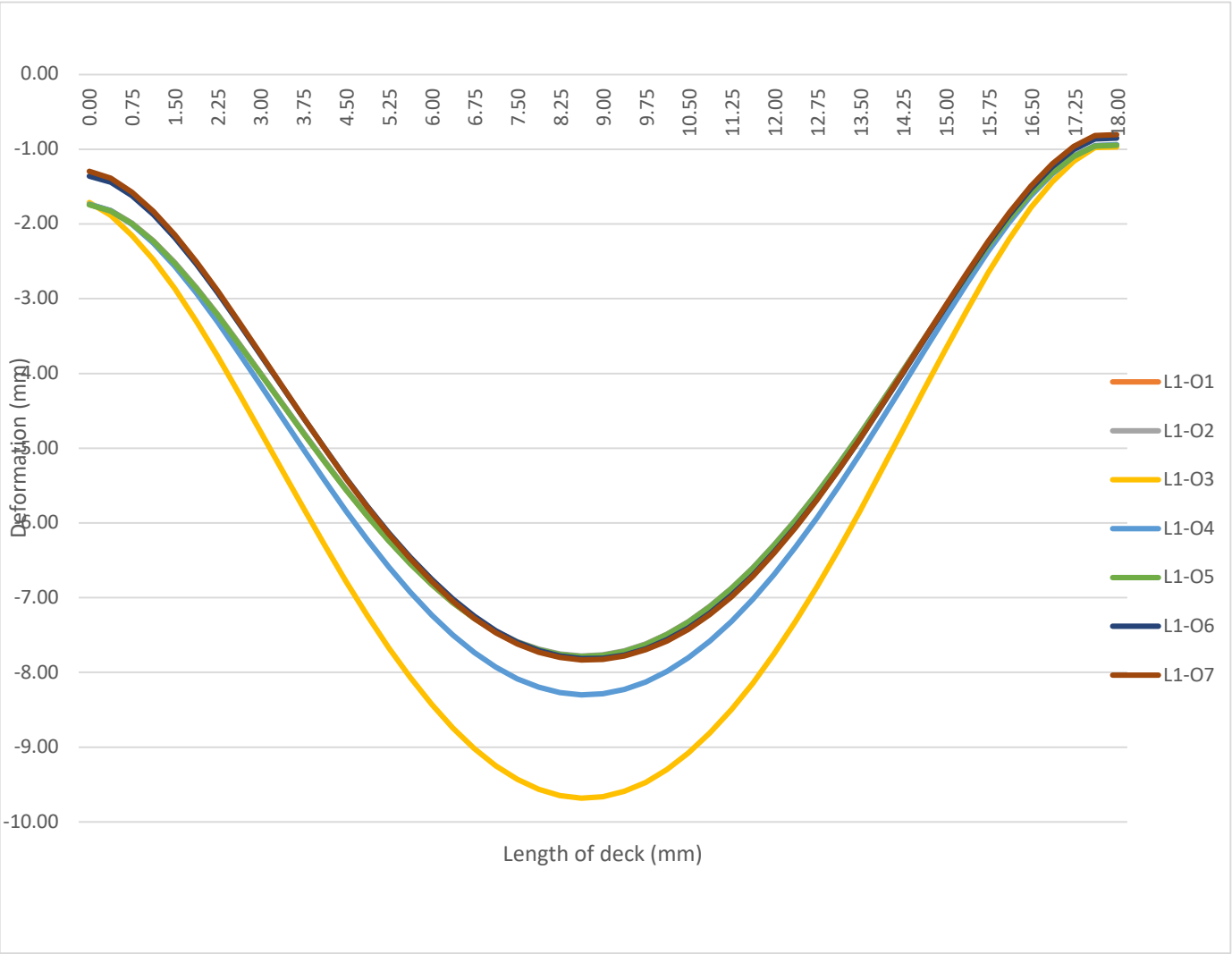


CHAPTER 5 - CONCLUSIONS

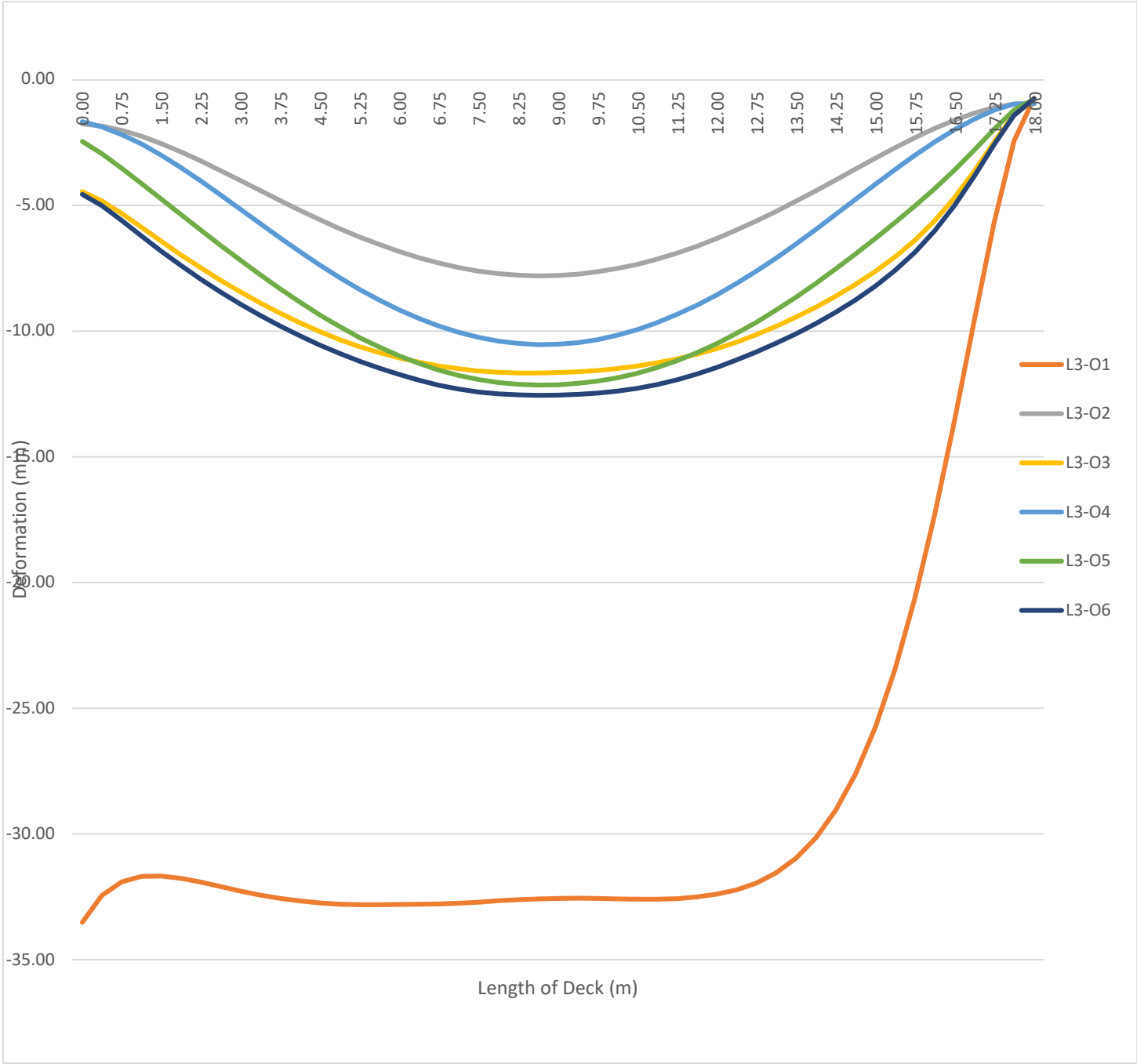
TOP PLATE - LONGITUDINAL

|    | mm    | m     | L1-O1 | L1-O2 | L1-O3 | L1-O4 | L1-O5 | L1-O6 | L1-O7 | L2-O1 | L2-O2  | L2-O3 | L2-O4 | L2-O5 | L2-O6 | L2-O7 | L3-O1  | L3-O2 | L3-O3  | L3-O4  | L3-O5  | L3-O6  |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|--------|-------|--------|--------|--------|--------|
| 1  | 0     | 0.00  | -1.74 | -1.73 | -1.71 | -1.73 | -1.74 | -1.36 | -1.30 | -2.84 | -13.35 | -1.66 | -1.71 | -1.72 | -1.70 | -1.73 | -33.51 | -1.75 | -4.45  | -1.66  | -2.45  | -4.56  |
| 2  | 375   | 0.38  | -1.82 | -1.82 | -1.88 | -1.82 | -1.83 | -1.44 | -1.39 | -3.16 | -13.20 | -1.83 | -1.88 | -1.81 | -1.87 | -1.83 | -32.45 | -1.84 | -4.82  | -1.87  | -2.94  | -5.01  |
| 3  | 750   | 0.75  | -1.99 | -1.99 | -2.15 | -2.00 | -2.00 | -1.62 | -1.57 | -3.55 | -13.36 | -2.10 | -2.15 | -1.99 | -2.14 | -2.03 | -31.91 | -2.01 | -5.32  | -2.18  | -3.52  | -5.59  |
| 4  | 1125  | 1.13  | -2.23 | -2.23 | -2.48 | -2.25 | -2.23 | -1.87 | -1.83 | -4.01 | -13.69 | -2.42 | -2.47 | -2.24 | -2.46 | -2.32 | -31.69 | -2.24 | -5.87  | -2.55  | -4.13  | -6.21  |
| 5  | 1500  | 1.50  | -2.52 | -2.52 | -2.87 | -2.57 | -2.53 | -2.18 | -2.14 | -4.48 | -14.11 | -2.81 | -2.86 | -2.55 | -2.85 | -2.67 | -31.67 | -2.54 | -6.43  | -3.00  | -4.75  | -6.82  |
| 6  | 1875  | 1.88  | -2.85 | -2.85 | -3.30 | -2.92 | -2.86 | -2.54 | -2.50 | -4.95 | -14.57 | -3.25 | -3.30 | -2.91 | -3.29 | -3.08 | -31.77 | -2.87 | -6.97  | -3.50  | -5.37  | -7.40  |
| 7  | 2250  | 2.25  | -3.22 | -3.21 | -3.77 | -3.31 | -3.22 | -2.92 | -2.89 | -5.42 | -15.04 | -3.72 | -3.77 | -3.30 | -3.76 | -3.52 | -31.92 | -3.23 | -7.49  | -4.03  | -5.98  | -7.94  |
| 8  | 2625  | 2.63  | -3.60 | -3.60 | -4.27 | -3.72 | -3.61 | -3.33 | -3.31 | -5.86 | -15.51 | -4.21 | -4.26 | -3.71 | -4.25 | -3.99 | -32.10 | -3.62 | -7.98  | -4.58  | -6.59  | -8.45  |
| 9  | 3000  | 3.00  | -4.00 | -3.99 | -4.77 | -4.15 | -4.00 | -3.75 | -3.73 | -6.28 | -15.95 | -4.72 | -4.77 | -4.14 | -4.76 | -4.48 | -32.27 | -4.01 | -8.44  | -5.15  | -7.18  | -8.93  |
| 10 | 3375  | 3.38  | -4.40 | -4.39 | -5.29 | -4.58 | -4.40 | -4.17 | -4.16 | -6.68 | -16.36 | -5.24 | -5.29 | -4.57 | -5.28 | -4.97 | -32.43 | -4.41 | -8.88  | -5.72  | -7.76  | -9.38  |
| 11 | 3750  | 3.75  | -4.79 | -4.79 | -5.80 | -5.01 | -4.80 | -4.59 | -4.59 | -7.06 | -16.74 | -5.75 | -5.80 | -5.00 | -5.79 | -5.46 | -32.57 | -4.81 | -9.29  | -6.29  | -8.32  | -9.80  |
| 12 | 4125  | 4.13  | -5.18 | -5.17 | -6.30 | -5.43 | -5.18 | -5.00 | -5.00 | -7.42 | -17.09 | -6.25 | -6.30 | -5.42 | -6.29 | -5.94 | -32.67 | -5.19 | -9.67  | -6.84  | -8.85  | -10.19 |
| 13 | 4500  | 4.50  | -5.55 | -5.55 | -6.78 | -5.84 | -5.56 | -5.40 | -5.41 | -7.75 | -17.41 | -6.73 | -6.78 | -5.83 | -6.77 | -6.40 | -32.74 | -5.57 | -10.02 | -7.37  | -9.35  | -10.55 |
| 14 | 4875  | 4.88  | -5.91 | -5.90 | -7.24 | -6.23 | -5.91 | -5.78 | -5.79 | -8.06 | -17.71 | -7.19 | -7.24 | -6.21 | -7.23 | -6.84 | -32.79 | -5.92 | -10.33 | -7.87  | -9.82  | -10.89 |
| 15 | 5250  | 5.25  | -6.24 | -6.23 | -7.67 | -6.59 | -6.24 | -6.13 | -6.15 | -8.34 | -17.98 | -7.62 | -7.67 | -6.58 | -7.66 | -7.26 | -32.81 | -6.25 | -10.61 | -8.34  | -10.25 | -11.19 |
| 16 | 5625  | 5.63  | -6.54 | -6.54 | -8.07 | -6.93 | -6.55 | -6.46 | -6.48 | -8.59 | -18.22 | -8.02 | -8.06 | -6.91 | -8.06 | -7.64 | -32.82 | -6.56 | -10.86 | -8.77  | -10.64 | -11.47 |
| 17 | 6000  | 6.00  | -6.82 | -6.82 | -8.43 | -7.23 | -6.82 | -6.76 | -6.78 | -8.82 | -18.44 | -8.38 | -8.42 | -7.22 | -8.42 | -7.99 | -32.81 | -6.83 | -11.07 | -9.15  | -10.98 | -11.73 |
| 18 | 6375  | 6.38  | -7.07 | -7.06 | -8.74 | -7.50 | -7.07 | -7.02 | -7.05 | -9.01 | -18.64 | -8.70 | -8.74 | -7.49 | -8.74 | -8.30 | -32.79 | -7.08 | -11.24 | -9.50  | -11.28 | -11.95 |
| 19 | 6750  | 6.75  | -7.28 | -7.27 | -9.02 | -7.73 | -7.28 | -7.25 | -7.28 | -9.18 | -18.82 | -8.97 | -9.01 | -7.72 | -9.01 | -8.56 | -32.79 | -7.29 | -11.38 | -9.79  | -11.55 | -12.15 |
| 20 | 7125  | 7.13  | -7.46 | -7.45 | -9.25 | -7.93 | -7.46 | -7.44 | -7.47 | -9.32 | -18.97 | -9.21 | -9.24 | -7.92 | -9.24 | -8.78 | -32.76 | -7.47 | -11.50 | -10.05 | -11.76 | -12.31 |
| 21 | 7500  | 7.50  | -7.59 | -7.59 | -9.43 | -8.08 | -7.60 | -7.60 | -7.62 | -9.43 | -19.09 | -9.39 | -9.43 | -8.07 | -9.43 | -8.96 | -32.71 | -7.61 | -11.58 | -10.25 | -11.93 | -12.42 |
| 22 | 7875  | 7.88  | -7.70 | -7.69 | -9.57 | -8.20 | -7.70 | -7.71 | -7.73 | -9.51 | -19.16 | -9.52 | -9.56 | -8.18 | -9.56 | -9.09 | -32.66 | -7.71 | -11.63 | -10.40 | -12.04 | -12.49 |
| 23 | 8250  | 8.25  | -7.76 | -7.75 | -9.65 | -8.27 | -7.76 | -7.78 | -7.80 | -9.56 | -19.20 | -9.61 | -9.64 | -8.26 | -9.64 | -9.17 | -32.61 | -7.77 | -11.66 | -10.49 | -12.11 | -12.53 |
| 24 | 8625  | 8.63  | -7.78 | -7.78 | -9.68 | -8.30 | -7.79 | -7.81 | -7.83 | -9.58 | -19.21 | -9.64 | -9.68 | -8.29 | -9.68 | -9.20 | -32.58 | -7.80 | -11.66 | -10.53 | -12.14 | -12.55 |
| 25 | 9000  | 9.00  | -7.77 | -7.76 | -9.66 | -8.29 | -7.77 | -7.81 | -7.82 | -9.57 | -19.20 | -9.62 | -9.66 | -8.27 | -9.66 | -9.19 | -32.56 | -7.78 | -11.65 | -10.52 | -12.13 | -12.54 |
| 26 | 9375  | 9.38  | -7.72 | -7.71 | -9.59 | -8.23 | -7.72 | -7.77 | -7.78 | -9.53 | -19.17 | -9.55 | -9.59 | -8.22 | -9.59 | -9.12 | -32.56 | -7.73 | -11.61 | -10.45 | -12.08 | -12.51 |
| 27 | 9750  | 9.75  | -7.62 | -7.62 | -9.47 | -8.13 | -7.63 | -7.68 | -7.70 | -9.45 | -19.12 | -9.43 | -9.47 | -8.12 | -9.47 | -9.01 | -32.57 | -7.64 | -11.56 | -10.33 | -11.99 | -12.46 |
| 28 | 10125 | 10.13 | -7.49 | -7.49 | -9.30 | -7.99 | -7.49 | -7.56 | -7.58 | -9.35 | -19.04 | -9.26 | -9.29 | -7.97 | -9.29 | -8.85 | -32.59 | -7.50 | -11.48 | -10.16 | -11.86 | -12.38 |
| 29 | 10500 | 10.50 | -7.33 | -7.32 | -9.08 | -7.80 | -7.33 | -7.40 | -7.42 | -9.21 | -18.94 | -9.04 | -9.07 | -7.79 | -9.07 | -8.64 | -32.60 | -7.34 | -11.38 | -9.93  | -11.68 | -12.27 |
| 30 | 10875 | 10.88 | -7.12 | -7.11 | -8.81 | -7.58 | -7.12 | -7.21 | -7.23 | -9.05 | -18.80 | -8.77 | -8.81 | -7.57 | -8.81 | -8.38 | -32.60 | -7.13 | -11.26 | -9.65  | -11.45 | -12.12 |
| 31 | 11250 | 11.25 | -6.88 | -6.87 | -8.50 | -7.32 | -6.88 | -6.97 | -6.99 | -8.85 | -18.64 | -8.46 | -8.50 | -7.31 | -8.49 | -8.08 | -32.58 | -6.89 | -11.10 | -9.33  | -11.18 | -11.93 |
| 32 | 11625 | 11.63 | -6.61 | -6.60 | -8.15 | -7.02 | -6.61 | -6.70 | -6.72 | -8.63 | -18.44 | -8.11 | -8.14 | -7.01 | -8.14 | -7.75 | -32.51 | -6.62 | -10.91 | -8.96  | -10.86 | -11.70 |
| 33 | 12000 | 12.00 | -6.30 | -6.30 | -7.75 | -6.69 | -6.30 | -6.39 | -6.41 | -8.38 | -18.21 | -7.71 | -7.75 | -6.68 | -7.75 | -7.37 | -32.40 | -6.31 | -10.69 | -8.56  | -10.49 | -11.44 |
| 34 | 12375 | 12.38 | -5.97 | -5.96 | -7.32 | -6.33 | -5.97 | -6.05 | -6.06 | -8.10 | -17.95 | -7.28 | -7.32 | -6.31 | -7.32 | -6.95 | -32.23 | -5.98 | -10.43 | -8.10  | -10.09 | -11.15 |
| 35 | 12750 | 12.75 | -5.61 | -5.60 | -6.86 | -5.93 | -5.61 | -5.69 | -5.69 | -7.79 | -17.66 | -6.82 | -6.85 | -5.92 | -6.85 | -6.51 | -31.96 | -5.62 | -10.14 | -7.61  | -9.64  | -10.83 |
| 36 | 13125 | 13.13 | -5.22 | -5.22 | -6.36 | -5.52 | -5.22 | -5.29 | -5.30 | -7.46 | -17.32 | -6.32 | -6.36 | -5.51 | -6.36 | -6.04 | -31.55 | -5.23 | -9.81  | -7.09  | -9.16  | -10.48 |
| 37 | 13500 | 13.50 | -4.82 | -4.81 | -5.85 | -5.08 | -4.82 | -4.88 | -4.88 | -7.11 | -16.92 | -5.81 | -5.85 | -5.07 | -5.84 | -5.55 | -30.97 | -4.83 | -9.44  | -6.53  | -8.64  | -10.10 |
| 38 | 13875 | 13.88 | -4.40 | -4.40 | -5.31 | -4.63 | -4.40 | -4.45 | -4.44 | -6.73 | -16.45 | -5.27 | -5.31 | -4.62 | -5.31 | -5.04 | -30.16 | -4.41 | -9.04  | -5.95  | -8.10  | -9.69  |
| 39 | 14250 | 14.25 | -3.98 | -3.97 | -4.77 | -4.17 | -3.98 | -4.01 | -4.00 | -6.33 | -15.87 | -4.73 | -4.77 | -4.16 | -4.76 | -4.52 | -29.06 | -3.98 | -8.61  | -5.36  | -7.52  | -9.25  |
| 40 | 14625 | 14.63 | -3.54 | -3.54 | -4.22 | -3.71 | -3.54 | -3.56 | -3.55 | -5.91 | -15.17 | -4.18 | -4.22 | -3.70 | -4.21 | -4.00 | -27.62 | -3.55 | -8.14  | -4.75  | -6.93  | -8.75  |

|    |       |       |       |       |       |       |       |       |       |       |        |       |       |       |       |       |        |       |       |       |       |       |
|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|
| 41 | 15000 | 15.00 | -3.11 | -3.11 | -3.68 | -3.25 | -3.12 | -3.12 | -3.10 | -5.45 | -14.29 | -3.64 | -3.68 | -3.24 | -3.67 | -3.49 | -25.77 | -3.12 | -7.62 | -4.16 | -6.31 | -8.21 |
| 42 | 15375 | 15.38 | -2.70 | -2.69 | -3.16 | -2.80 | -2.70 | -2.68 | -2.66 | -4.97 | -13.19 | -3.12 | -3.16 | -2.79 | -3.15 | -2.99 | -23.44 | -2.70 | -7.04 | -3.57 | -5.68 | -7.58 |
| 43 | 15750 | 15.75 | -2.30 | -2.29 | -2.66 | -2.37 | -2.30 | -2.26 | -2.24 | -4.43 | -11.84 | -2.62 | -2.66 | -2.36 | -2.65 | -2.51 | -20.62 | -2.30 | -6.38 | -3.00 | -5.02 | -6.86 |
| 44 | 16125 | 16.13 | -1.92 | -1.92 | -2.20 | -1.98 | -1.93 | -1.88 | -1.85 | -3.83 | -10.19 | -2.16 | -2.20 | -1.97 | -2.19 | -2.07 | -17.30 | -1.93 | -5.60 | -2.47 | -4.33 | -6.00 |
| 45 | 16500 | 16.50 | -1.59 | -1.59 | -1.78 | -1.62 | -1.59 | -1.53 | -1.49 | -3.15 | -8.24  | -1.74 | -1.78 | -1.61 | -1.77 | -1.68 | -13.55 | -1.60 | -4.68 | -1.98 | -3.59 | -4.99 |
| 46 | 16875 | 16.88 | -1.31 | -1.31 | -1.44 | -1.33 | -1.31 | -1.23 | -1.20 | -2.38 | -6.07  | -1.40 | -1.43 | -1.32 | -1.43 | -1.36 | -9.56  | -1.32 | -3.62 | -1.56 | -2.79 | -3.83 |
| 47 | 17250 | 17.25 | -1.09 | -1.09 | -1.16 | -1.10 | -1.10 | -1.00 | -0.96 | -1.56 | -3.82  | -1.12 | -1.16 | -1.09 | -1.15 | -1.10 | -5.66  | -1.10 | -2.47 | -1.21 | -1.96 | -2.57 |
| 48 | 17625 | 17.63 | -0.96 | -0.95 | -0.98 | -0.95 | -0.96 | -0.86 | -0.82 | -0.81 | -1.86  | -0.94 | -0.98 | -0.94 | -0.97 | -0.94 | -2.43  | -0.97 | -1.40 | -0.96 | -1.20 | -1.42 |
| 49 | 18000 | 18.00 | -0.94 | -0.94 | -0.97 | -0.94 | -0.94 | -0.85 | -0.80 | -0.37 | -0.78  | -0.93 | -0.97 | -0.93 | -0.96 | -0.93 | -0.71  | -0.95 | -0.77 | -0.93 | -0.76 | -0.75 |



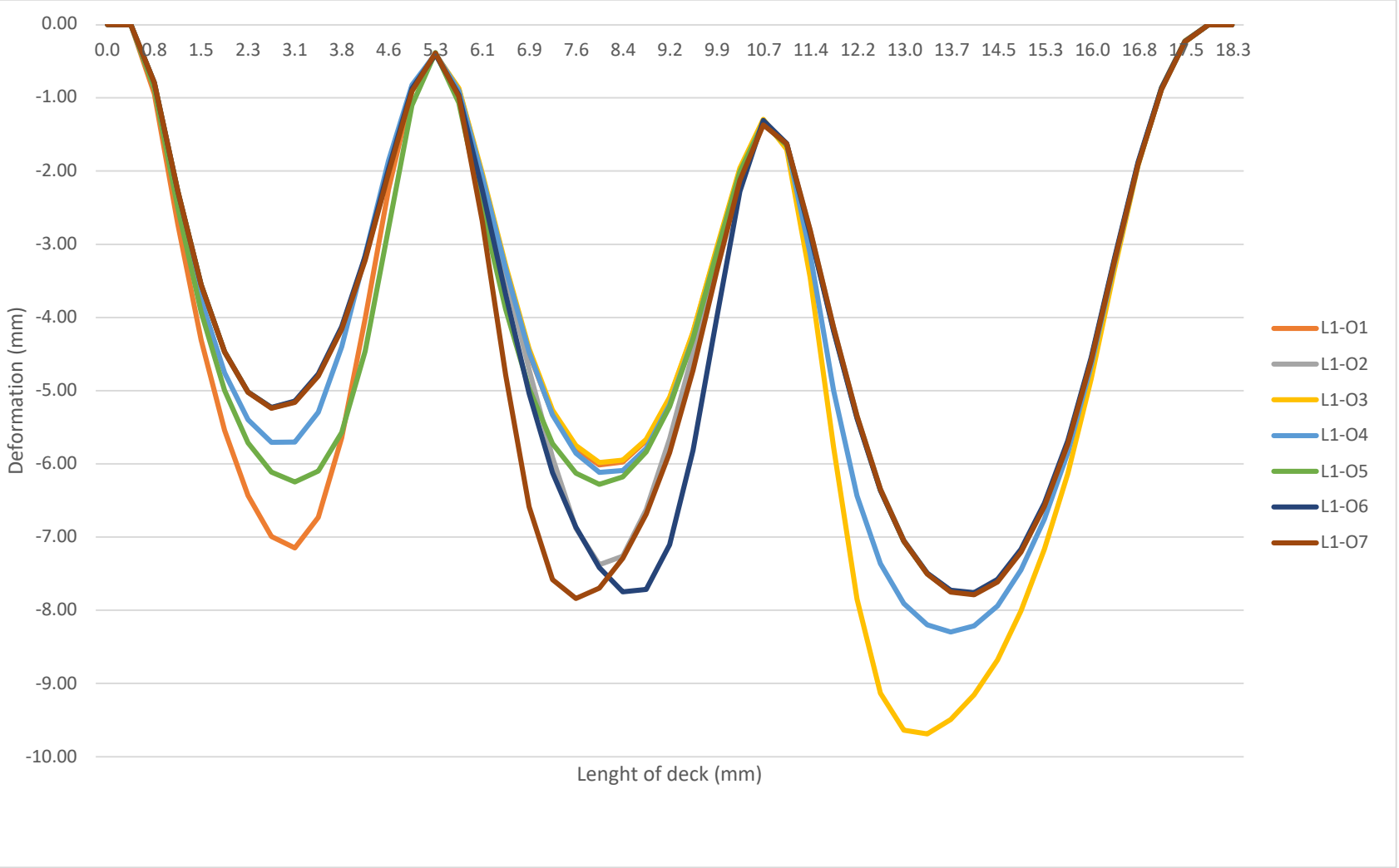


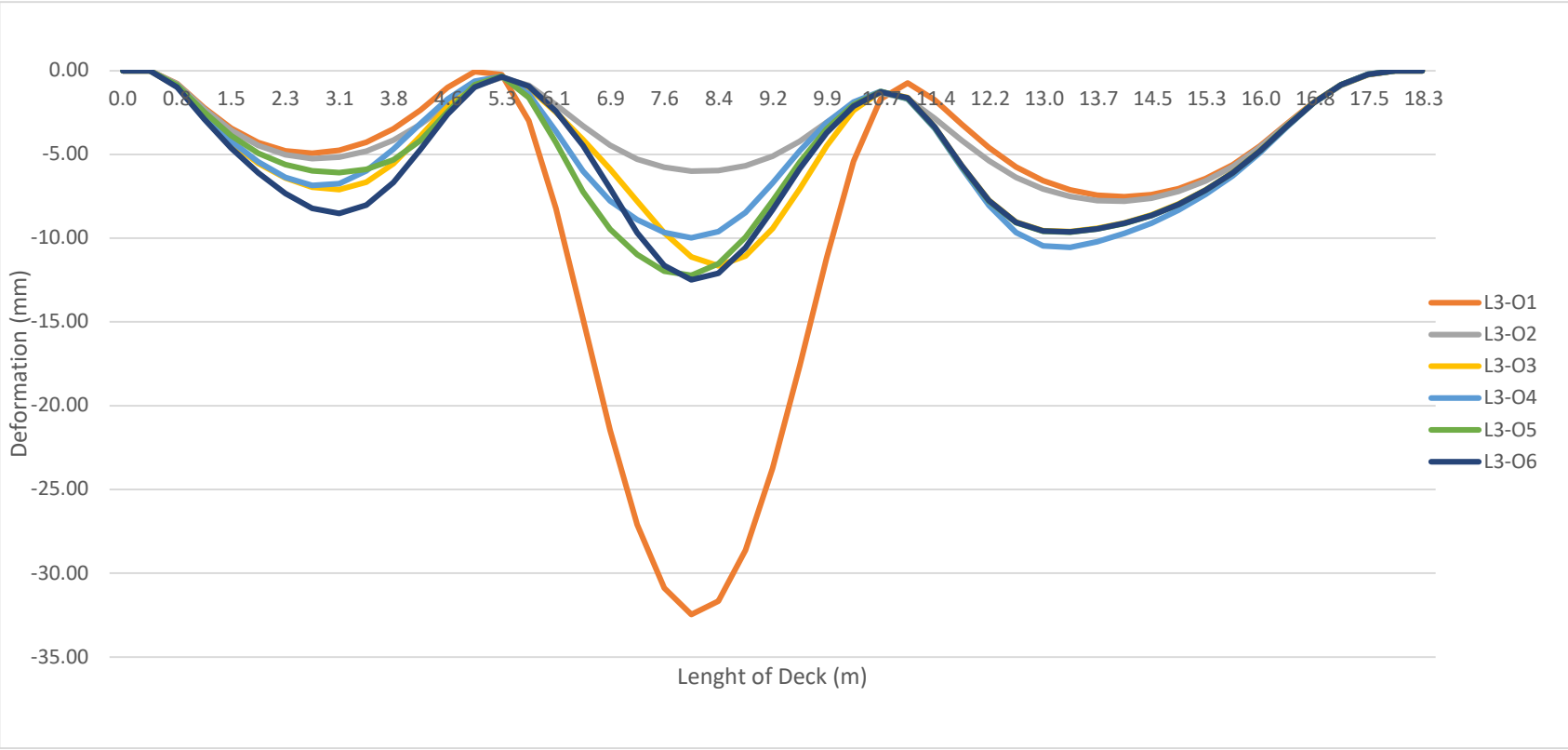
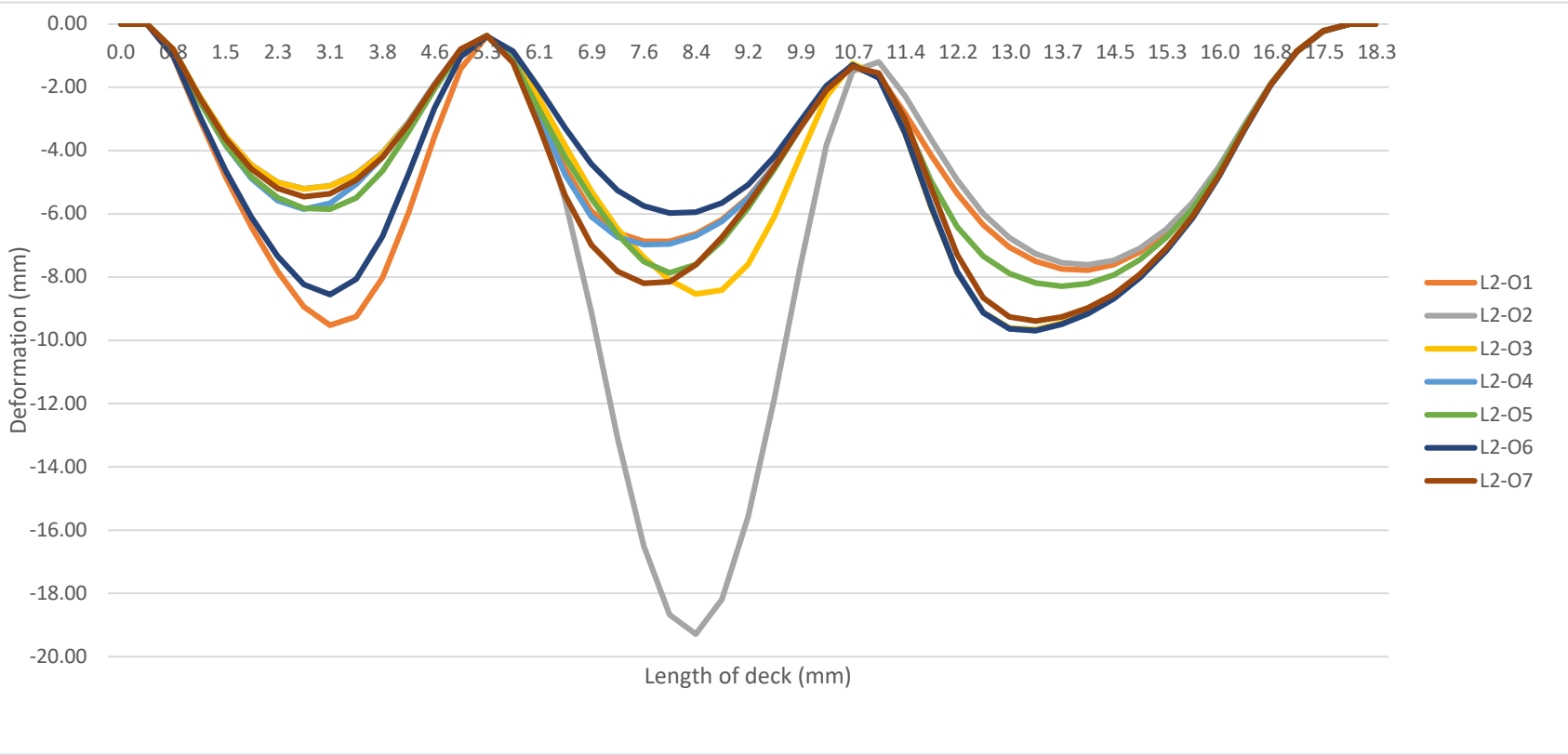


TOP PLATE - TRANSVERSE

|    | mm     | m    | L1-O1 | L1-O2 | L1-O3 | L1-O4 | L1-O5 | L1-O6 | L1-O7 | L2-O1 | L2-O2  | L2-O3 | L2-O4 | L2-O5 | L2-O6 | L2-O7 | L3-O1  | L3-O2 | L3-O3  | L3-O4  | L3-O5  | L3-O6  |
|----|--------|------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|--------|-------|--------|--------|--------|--------|
| 1  | 0      | 0.0  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00   | 0.00  | 0.00   | 0.00   | 0.00   | 0.00   |
| 2  | 381.37 | 0.4  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00   | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00   | 0.00  | 0.00   | 0.00   | 0.00   | 0.00   |
| 3  | 762.75 | 0.8  | -0.95 | -0.79 | -0.79 | -0.84 | -0.87 | -0.79 | -0.79 | -1.03 | -0.79  | -0.79 | -0.84 | -0.85 | -0.99 | -0.80 | -0.77  | -0.79 | -0.94  | -0.92  | -0.86  | -0.99  |
| 4  | 1144.1 | 1.1  | -2.72 | -2.27 | -2.27 | -2.39 | -2.50 | -2.27 | -2.27 | -2.99 | -2.27  | -2.27 | -2.42 | -2.42 | -2.88 | -2.30 | -2.20  | -2.27 | -2.72  | -2.64  | -2.47  | -2.88  |
| 5  | 1525.5 | 1.5  | -4.31 | -3.56 | -3.56 | -3.76 | -3.93 | -3.55 | -3.56 | -4.82 | -3.54  | -3.55 | -3.83 | -3.81 | -4.63 | -3.62 | -3.44  | -3.56 | -4.30  | -4.21  | -3.88  | -4.63  |
| 6  | 1906.9 | 1.9  | -5.54 | -4.47 | -4.47 | -4.76 | -5.00 | -4.47 | -4.47 | -6.41 | -4.45  | -4.46 | -4.88 | -4.83 | -6.10 | -4.58 | -4.30  | -4.48 | -5.53  | -5.45  | -4.92  | -6.10  |
| 7  | 2288.2 | 2.3  | -6.43 | -5.02 | -5.02 | -5.40 | -5.72 | -5.02 | -5.02 | -7.82 | -5.00  | -5.00 | -5.58 | -5.49 | -7.34 | -5.20 | -4.78  | -5.03 | -6.41  | -6.36  | -5.61  | -7.33  |
| 8  | 2669.6 | 2.7  | -6.99 | -5.24 | -5.23 | -5.71 | -6.11 | -5.23 | -5.24 | -8.94 | -5.20  | -5.21 | -5.86 | -5.82 | -8.24 | -5.46 | -4.93  | -5.24 | -6.96  | -6.85  | -5.99  | -8.22  |
| 9  | 3051   | 3.1  | -7.15 | -5.15 | -5.15 | -5.70 | -6.25 | -5.14 | -5.16 | -9.51 | -5.11  | -5.12 | -5.66 | -5.86 | -8.55 | -5.36 | -4.75  | -5.16 | -7.10  | -6.75  | -6.08  | -8.52  |
| 10 | 3432.4 | 3.4  | -6.73 | -4.79 | -4.79 | -5.30 | -6.10 | -4.77 | -4.80 | -9.25 | -4.73  | -4.75 | -5.07 | -5.49 | -8.06 | -4.93 | -4.27  | -4.80 | -6.66  | -5.98  | -5.90  | -8.02  |
| 11 | 3813.7 | 3.8  | -5.65 | -4.14 | -4.14 | -4.40 | -5.57 | -4.12 | -4.16 | -8.02 | -4.07  | -4.10 | -4.21 | -4.64 | -6.72 | -4.21 | -3.48  | -4.16 | -5.55  | -4.68  | -5.32  | -6.67  |
| 12 | 4195.1 | 4.2  | -4.02 | -3.19 | -3.20 | -3.15 | -4.46 | -3.17 | -3.22 | -5.99 | -3.10  | -3.14 | -3.15 | -3.42 | -4.76 | -3.18 | -2.35  | -3.21 | -3.91  | -3.15  | -4.17  | -4.70  |
| 13 | 4576.5 | 4.6  | -2.25 | -2.00 | -2.01 | -1.86 | -2.78 | -1.97 | -2.03 | -3.55 | -1.89  | -1.94 | -1.93 | -2.05 | -2.65 | -1.93 | -1.00  | -2.02 | -2.13  | -1.70  | -2.46  | -2.60  |
| 14 | 4957.9 | 5.0  | -0.89 | -0.90 | -0.91 | -0.82 | -1.10 | -0.87 | -0.91 | -1.41 | -0.80  | -0.84 | -0.82 | -0.84 | -1.04 | -0.79 | -0.06  | -0.92 | -0.79  | -0.62  | -0.84  | -0.99  |
| 15 | 5339.2 | 5.3  | -0.40 | -0.40 | -0.41 | -0.40 | -0.38 | -0.41 | -0.39 | -0.38 | -0.37  | -0.39 | -0.37 | -0.36 | -0.39 | -0.37 | -0.24  | -0.41 | -0.36  | -0.34  | -0.33  | -0.36  |
| 16 | 5720.6 | 5.7  | -0.92 | -0.87 | -0.87 | -0.90 | -1.07 | -0.96 | -0.98 | -0.92 | -1.09  | -0.98 | -1.09 | -1.14 | -0.86 | -1.22 | -2.99  | -0.88 | -1.04  | -1.39  | -1.60  | -0.93  |
| 17 | 6102   | 6.1  | -2.11 | -2.07 | -2.03 | -2.07 | -2.53 | -2.26 | -2.68 | -2.64 | -2.93  | -2.34 | -2.85 | -2.70 | -2.03 | -3.23 | -8.22  | -2.04 | -2.47  | -3.61  | -4.29  | -2.43  |
| 18 | 6483.3 | 6.5  | -3.36 | -3.41 | -3.29 | -3.33 | -3.89 | -3.69 | -4.79 | -4.55 | -5.57  | -3.84 | -4.76 | -4.21 | -3.28 | -5.42 | -14.81 | -3.30 | -4.11  | -6.00  | -7.21  | -4.48  |
| 19 | 6864.7 | 6.9  | -4.49 | -4.71 | -4.43 | -4.48 | -4.97 | -5.04 | -6.59 | -5.91 | -9.10  | -5.28 | -6.09 | -5.51 | -4.43 | -6.98 | -21.47 | -4.44 | -5.88  | -7.77  | -9.46  | -7.02  |
| 20 | 7246.1 | 7.2  | -5.32 | -5.91 | -5.27 | -5.33 | -5.73 | -6.12 | -7.58 | -6.60 | -13.09 | -6.47 | -6.73 | -6.66 | -5.26 | -7.82 | -27.10 | -5.28 | -7.79  | -8.90  | -10.97 | -9.67  |
| 21 | 7627.5 | 7.6  | -5.79 | -6.88 | -5.75 | -5.85 | -6.13 | -6.87 | -7.84 | -6.86 | -16.50 | -7.37 | -6.97 | -7.51 | -5.75 | -8.20 | -30.89 | -5.77 | -9.68  | -9.66  | -11.96 | -11.63 |
| 22 | 8008.8 | 8.0  | -6.01 | -7.38 | -5.98 | -6.12 | -6.28 | -7.42 | -7.70 | -6.87 | -18.68 | -8.10 | -6.95 | -7.87 | -5.97 | -8.15 | -32.45 | -6.00 | -11.12 | -9.97  | -12.22 | -12.48 |
| 23 | 8390.2 | 8.4  | -5.98 | -7.26 | -5.95 | -6.09 | -6.18 | -7.75 | -7.29 | -6.64 | -19.28 | -8.53 | -6.70 | -7.60 | -5.94 | -7.61 | -31.66 | -5.97 | -11.65 | -9.61  | -11.53 | -12.09 |
| 24 | 8771.6 | 8.8  | -5.68 | -6.63 | -5.66 | -5.79 | -5.84 | -7.72 | -6.69 | -6.18 | -18.19 | -8.41 | -6.24 | -6.85 | -5.66 | -6.74 | -28.63 | -5.68 | -11.06 | -8.47  | -9.95  | -10.57 |
| 25 | 9153   | 9.2  | -5.11 | -5.66 | -5.09 | -5.19 | -5.22 | -7.11 | -5.85 | -5.48 | -15.57 | -7.59 | -5.52 | -5.81 | -5.08 | -5.69 | -23.75 | -5.10 | -9.43  | -6.72  | -7.77  | -8.31  |
| 26 | 9534.3 | 9.5  | -4.21 | -4.48 | -4.20 | -4.29 | -4.29 | -5.82 | -4.72 | -4.47 | -11.84 | -6.09 | -4.49 | -4.58 | -4.19 | -4.52 | -17.64 | -4.21 | -7.07  | -4.79  | -5.47  | -5.86  |
| 27 | 9915.7 | 9.9  | -3.08 | -3.19 | -3.06 | -3.14 | -3.13 | -4.03 | -3.38 | -3.23 | -7.62  | -4.16 | -3.24 | -3.27 | -3.06 | -3.26 | -11.15 | -3.09 | -4.49  | -3.10  | -3.48  | -3.70  |
| 28 | 10297  | 10.3 | -1.99 | -2.02 | -1.96 | -2.02 | -2.01 | -2.28 | -2.12 | -2.06 | -3.82  | -2.30 | -2.05 | -2.06 | -1.95 | -2.09 | -5.42  | -1.99 | -2.36  | -1.88  | -2.03  | -2.12  |
| 29 | 10678  | 10.7 | -1.34 | -1.33 | -1.29 | -1.34 | -1.35 | -1.31 | -1.37 | -1.36 | -1.49  | -1.24 | -1.31 | -1.33 | -1.29 | -1.35 | -1.70  | -1.35 | -1.26  | -1.24  | -1.26  | -1.27  |
| 30 | 11060  | 11.1 | -1.65 | -1.63 | -1.71 | -1.63 | -1.65 | -1.62 | -1.63 | -1.64 | -1.20  | -1.65 | -1.68 | -1.60 | -1.70 | -1.56 | -0.74  | -1.66 | -1.60  | -1.69  | -1.66  | -1.63  |
| 31 | 11441  | 11.4 | -2.84 | -2.81 | -3.45 | -3.13 | -2.84 | -2.85 | -2.80 | -2.82 | -2.27  | -3.47 | -3.40 | -3.10 | -3.45 | -3.00 | -1.74  | -2.85 | -3.36  | -3.46  | -3.41  | -3.36  |
| 32 | 11823  | 11.8 | -4.16 | -4.14 | -5.77 | -5.00 | -4.16 | -4.18 | -4.14 | -4.15 | -3.64  | -5.80 | -5.73 | -4.96 | -5.77 | -5.19 | -3.21  | -4.18 | -5.68  | -5.82  | -5.72  | -5.68  |
| 33 | 12204  | 12.2 | -5.36 | -5.34 | -7.85 | -6.44 | -5.36 | -5.38 | -5.34 | -5.35 | -4.92  | -7.84 | -7.82 | -6.41 | -7.84 | -7.28 | -4.59  | -5.37 | -7.74  | -8.05  | -7.79  | -7.76  |
| 34 | 12585  | 12.6 | -6.36 | -6.34 | -9.13 | -7.36 | -6.36 | -6.36 | -6.35 | -6.35 | -6.00  | -9.10 | -9.12 | -7.34 | -9.13 | -8.65 | -5.75  | -6.37 | -9.03  | -9.66  | -9.08  | -9.05  |
| 35 | 12967  | 13.0 | -7.06 | -7.04 | -9.64 | -7.91 | -7.06 | -7.05 | -7.06 | -7.05 | -6.76  | -9.60 | -9.64 | -7.89 | -9.64 | -9.25 | -6.57  | -7.07 | -9.55  | -10.46 | -9.59  | -9.57  |
| 36 | 13348  | 13.3 | -7.50 | -7.49 | -9.69 | -8.20 | -7.50 | -7.49 | -7.51 | -7.50 | -7.26  | -9.65 | -9.69 | -8.18 | -9.68 | -9.39 | -7.12  | -7.51 | -9.60  | -10.55 | -9.64  | -9.63  |
| 37 | 13729  | 13.7 | -7.74 | -7.73 | -9.49 | -8.30 | -7.74 | -7.73 | -7.75 | -7.74 | -7.54  | -9.45 | -9.49 | -8.28 | -9.49 | -9.26 | -7.43  | -7.75 | -9.42  | -10.22 | -9.45  | -9.45  |
| 38 | 14111  | 14.1 | -7.78 | -7.77 | -9.16 | -8.21 | -7.78 | -7.76 | -7.79 | -7.78 | -7.62  | -9.11 | -9.16 | -8.20 | -9.15 | -8.98 | -7.53  | -7.79 | -9.09  | -9.72  | -9.12  | -9.12  |
| 39 | 14492  | 14.5 | -7.60 | -7.60 | -8.68 | -7.94 | -7.60 | -7.58 | -7.61 | -7.60 | -7.47  | -8.63 | -8.68 | -7.93 | -8.67 | -8.54 | -7.41  | -7.61 | -8.62  | -9.11  | -8.64  | -8.64  |

|    |       |      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |
|----|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 40 | 14874 | 14.9 | -7.19 | -7.19 | -8.01 | -7.45 | -7.19 | -7.17 | -7.21 | -7.20 | -7.08 | -7.97 | -8.02 | -7.44 | -8.01 | -7.91 | -7.04 | -7.20 | -7.95 | -8.33 | -7.98 | -7.98 |
| 41 | 15255 | 15.3 | -6.57 | -6.56 | -7.17 | -6.76 | -6.57 | -6.54 | -6.58 | -6.57 | -6.48 | -7.12 | -7.17 | -6.75 | -7.16 | -7.09 | -6.45 | -6.58 | -7.12 | -7.39 | -7.14 | -7.14 |
| 42 | 15636 | 15.6 | -5.71 | -5.71 | -6.14 | -5.85 | -5.72 | -5.69 | -5.73 | -5.72 | -5.65 | -6.09 | -6.14 | -5.84 | -6.13 | -6.08 | -5.62 | -5.72 | -6.09 | -6.28 | -6.11 | -6.11 |
| 43 | 16018 | 16.0 | -4.57 | -4.57 | -4.84 | -4.66 | -4.57 | -4.55 | -4.59 | -4.58 | -4.52 | -4.79 | -4.84 | -4.65 | -4.83 | -4.80 | -4.51 | -4.58 | -4.79 | -4.92 | -4.81 | -4.81 |
| 44 | 16399 | 16.4 | -3.21 | -3.21 | -3.33 | -3.25 | -3.21 | -3.19 | -3.23 | -3.22 | -3.17 | -3.29 | -3.34 | -3.24 | -3.33 | -3.32 | -3.17 | -3.22 | -3.30 | -3.36 | -3.31 | -3.31 |
| 45 | 16780 | 16.8 | -1.90 | -1.90 | -1.92 | -1.91 | -1.90 | -1.88 | -1.91 | -1.90 | -1.88 | -1.89 | -1.93 | -1.90 | -1.92 | -1.92 | -1.88 | -1.91 | -1.90 | -1.91 | -1.91 | -1.91 |
| 46 | 17162 | 17.2 | -0.88 | -0.88 | -0.86 | -0.87 | -0.88 | -0.86 | -0.89 | -0.88 | -0.87 | -0.84 | -0.86 | -0.87 | -0.86 | -0.86 | -0.87 | -0.88 | -0.84 | -0.84 | -0.85 | -0.85 |
| 47 | 17543 | 17.5 | -0.23 | -0.23 | -0.22 | -0.23 | -0.23 | -0.23 | -0.24 | -0.23 | -0.23 | -0.21 | -0.22 | -0.23 | -0.22 | -0.22 | -0.23 | -0.24 | -0.21 | -0.21 | -0.22 | -0.22 |
| 48 | 17925 | 17.9 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |
| 49 | 18306 | 18.3 | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  | 0.00  |

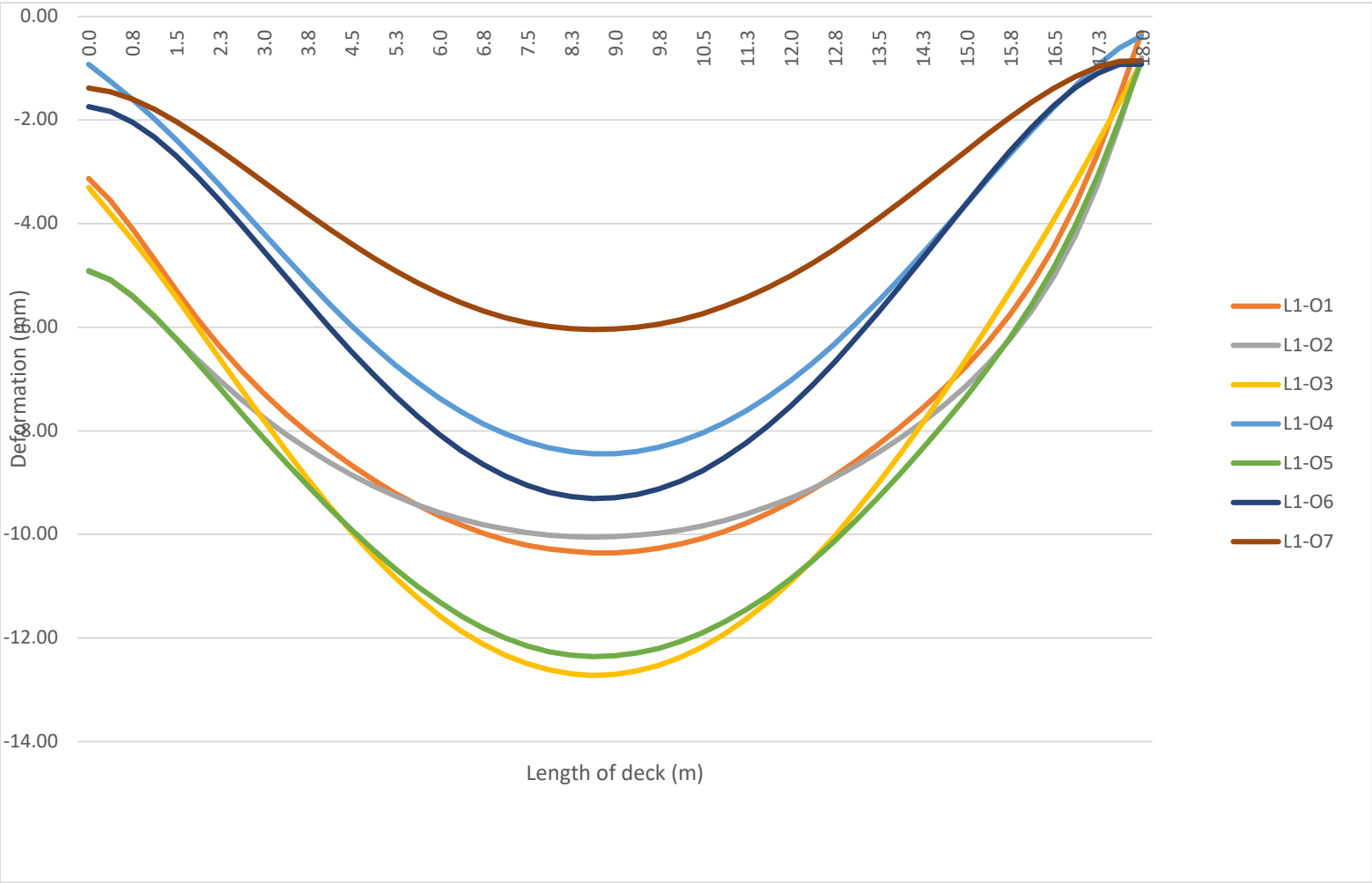




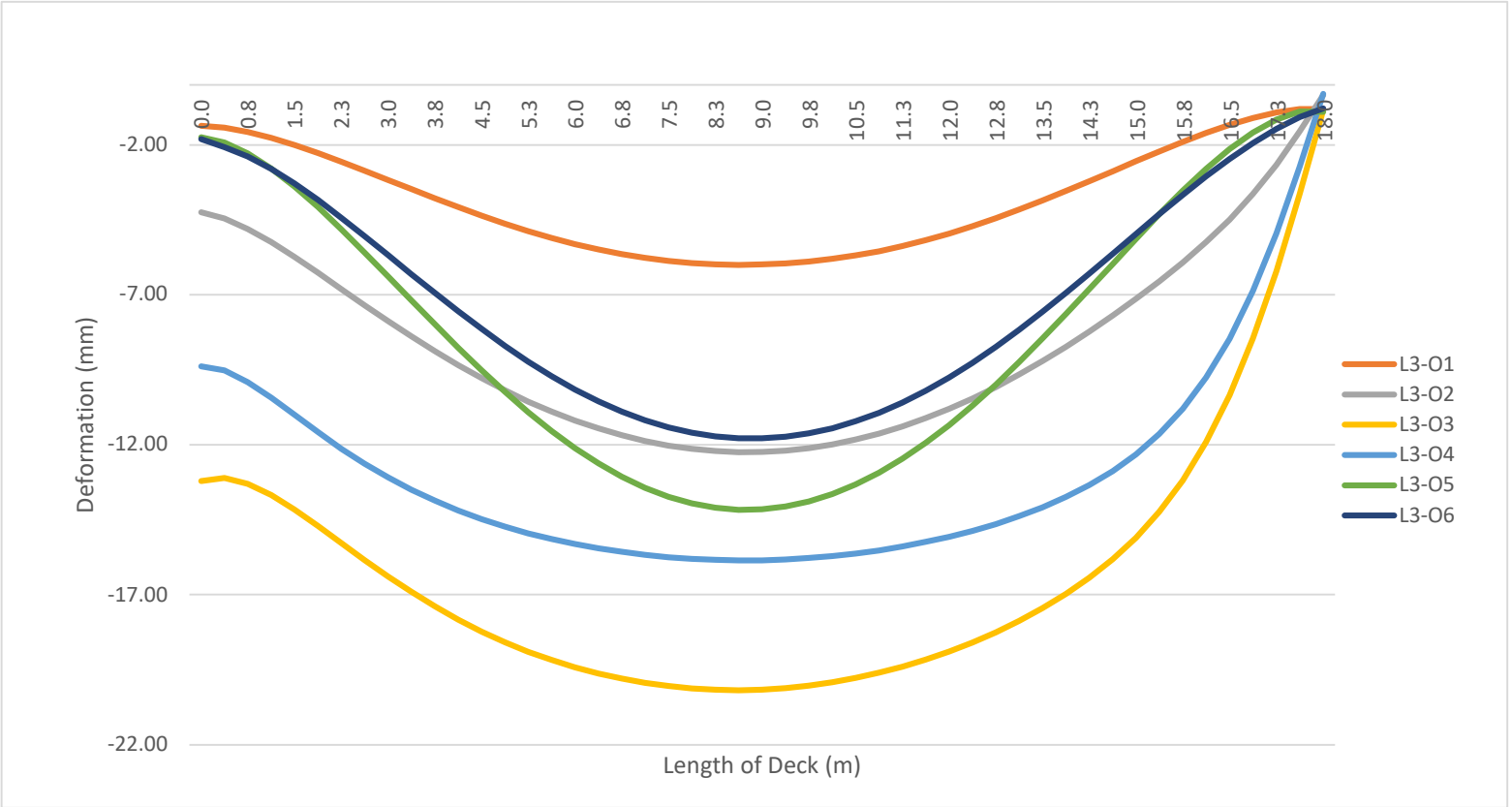
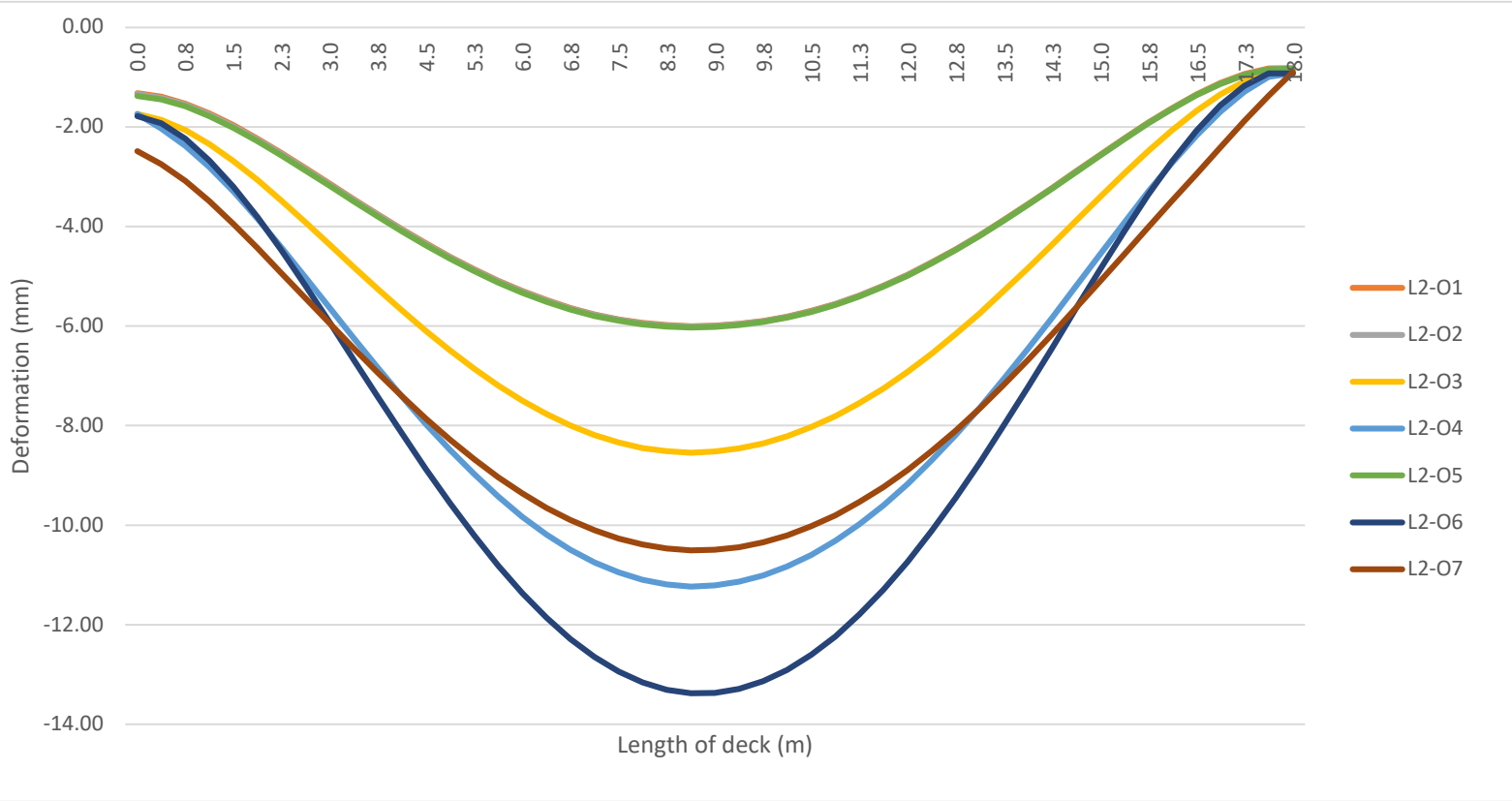
BOTTOM PLATE - LONGITUDINAL

|    | mm    | m    | L1-O1  | L1-O2  | L1-O3  | L1-O4 | L1-O5  | L1-O6 | L1-O7 | L2-O1 | L2-O2 | L2-O3 | L2-O4  | L2-O5 | L2-O6  | L2-O7  | L3-O1 | L3-O2  | L3-O3  | L3-O4  | L3-O5  | L3-O6  |
|----|-------|------|--------|--------|--------|-------|--------|-------|-------|-------|-------|-------|--------|-------|--------|--------|-------|--------|--------|--------|--------|--------|
| 1  | 0     | 0.0  | -3.13  | -4.93  | -3.30  | -0.93 | -4.91  | -1.75 | -1.38 | -1.32 | -1.34 | -1.74 | -1.74  | -1.37 | -1.78  | -2.48  | -1.36 | -4.25  | -13.22 | -9.38  | -1.75  | -1.81  |
| 2  | 375   | 0.4  | -3.55  | -5.09  | -3.81  | -1.26 | -5.08  | -1.84 | -1.46 | -1.39 | -1.41 | -1.86 | -2.03  | -1.45 | -1.93  | -2.75  | -1.43 | -4.46  | -13.11 | -9.53  | -1.92  | -2.08  |
| 3  | 750   | 0.8  | -4.10  | -5.41  | -4.31  | -1.60 | -5.39  | -2.04 | -1.60 | -1.53 | -1.55 | -2.06 | -2.38  | -1.59 | -2.24  | -3.08  | -1.57 | -4.81  | -13.30 | -9.91  | -2.29  | -2.39  |
| 4  | 1125  | 1.1  | -4.69  | -5.80  | -4.85  | -1.98 | -5.78  | -2.33 | -1.79 | -1.73 | -1.75 | -2.34 | -2.80  | -1.78 | -2.67  | -3.49  | -1.77 | -5.25  | -13.68 | -10.43 | -2.79  | -2.80  |
| 5  | 1500  | 1.5  | -5.29  | -6.22  | -5.42  | -2.38 | -6.23  | -2.69 | -2.03 | -1.97 | -1.99 | -2.68 | -3.30  | -2.02 | -3.20  | -3.95  | -2.00 | -5.74  | -14.17 | -11.00 | -3.40  | -3.29  |
| 6  | 1875  | 1.9  | -5.85  | -6.63  | -6.02  | -2.81 | -6.70  | -3.11 | -2.30 | -2.23 | -2.25 | -3.07 | -3.84  | -2.29 | -3.81  | -4.44  | -2.27 | -6.27  | -14.71 | -11.58 | -4.08  | -3.84  |
| 7  | 2250  | 2.3  | -6.37  | -7.03  | -6.62  | -3.27 | -7.18  | -3.56 | -2.59 | -2.52 | -2.54 | -3.48 | -4.42  | -2.57 | -4.48  | -4.94  | -2.56 | -6.81  | -15.28 | -12.14 | -4.81  | -4.43  |
| 8  | 2625  | 2.6  | -6.85  | -7.40  | -7.21  | -3.73 | -7.67  | -4.04 | -2.89 | -2.83 | -2.85 | -3.92 | -5.03  | -2.88 | -5.19  | -5.44  | -2.86 | -7.35  | -15.85 | -12.64 | -5.59  | -5.05  |
| 9  | 3000  | 3.0  | -7.28  | -7.75  | -7.80  | -4.20 | -8.15  | -4.53 | -3.20 | -3.14 | -3.16 | -4.36 | -5.64  | -3.19 | -5.93  | -5.95  | -3.17 | -7.87  | -16.39 | -13.09 | -6.38  | -5.68  |
| 10 | 3375  | 3.4  | -7.67  | -8.07  | -8.38  | -4.66 | -8.61  | -5.03 | -3.51 | -3.45 | -3.47 | -4.81 | -6.24  | -3.50 | -6.68  | -6.45  | -3.48 | -8.38  | -16.90 | -13.50 | -7.19  | -6.31  |
| 11 | 3750  | 3.8  | -8.04  | -8.35  | -8.93  | -5.12 | -9.06  | -5.52 | -3.81 | -3.76 | -3.77 | -5.26 | -6.84  | -3.80 | -7.42  | -6.94  | -3.78 | -8.88  | -17.38 | -13.86 | -7.98  | -6.94  |
| 12 | 4125  | 4.1  | -8.36  | -8.61  | -9.46  | -5.55 | -9.50  | -6.01 | -4.11 | -4.05 | -4.07 | -5.69 | -7.42  | -4.10 | -8.16  | -7.41  | -4.08 | -9.34  | -17.83 | -14.19 | -8.77  | -7.55  |
| 13 | 4500  | 4.5  | -8.67  | -8.85  | -9.95  | -5.97 | -9.91  | -6.47 | -4.39 | -4.34 | -4.35 | -6.10 | -7.97  | -4.38 | -8.88  | -7.86  | -4.36 | -9.78  | -18.23 | -14.48 | -9.52  | -8.14  |
| 14 | 4875  | 4.9  | -8.95  | -9.07  | -10.42 | -6.37 | -10.30 | -6.92 | -4.66 | -4.61 | -4.62 | -6.49 | -8.49  | -4.65 | -9.56  | -8.28  | -4.63 | -10.19 | -18.59 | -14.73 | -10.24 | -8.70  |
| 15 | 5250  | 5.3  | -9.21  | -9.26  | -10.84 | -6.73 | -10.67 | -7.33 | -4.91 | -4.86 | -4.87 | -6.86 | -8.98  | -4.90 | -10.21 | -8.68  | -4.88 | -10.56 | -18.91 | -14.95 | -10.92 | -9.23  |
| 16 | 5625  | 5.6  | -9.44  | -9.43  | -11.22 | -7.07 | -11.00 | -7.72 | -5.14 | -5.09 | -5.10 | -7.20 | -9.42  | -5.13 | -10.81 | -9.04  | -5.10 | -10.89 | -19.18 | -15.14 | -11.54 | -9.72  |
| 17 | 6000  | 6.0  | -9.64  | -9.58  | -11.57 | -7.37 | -11.31 | -8.07 | -5.35 | -5.30 | -5.31 | -7.50 | -9.83  | -5.33 | -11.37 | -9.36  | -5.31 | -11.19 | -19.43 | -15.31 | -12.12 | -10.16 |
| 18 | 6375  | 6.4  | -9.82  | -9.70  | -11.87 | -7.64 | -11.58 | -8.38 | -5.53 | -5.48 | -5.49 | -7.77 | -10.19 | -5.51 | -11.86 | -9.65  | -5.49 | -11.46 | -19.63 | -15.45 | -12.63 | -10.55 |
| 19 | 6750  | 6.8  | -9.97  | -9.81  | -12.12 | -7.86 | -11.81 | -8.65 | -5.69 | -5.64 | -5.65 | -8.00 | -10.50 | -5.67 | -12.29 | -9.90  | -5.65 | -11.69 | -19.80 | -15.57 | -13.07 | -10.90 |
| 20 | 7125  | 7.1  | -10.11 | -9.90  | -12.33 | -8.06 | -12.00 | -8.87 | -5.81 | -5.77 | -5.77 | -8.19 | -10.75 | -5.80 | -12.65 | -10.11 | -5.77 | -11.88 | -19.94 | -15.67 | -13.44 | -11.18 |
| 21 | 7500  | 7.5  | -10.21 | -9.97  | -12.49 | -8.21 | -12.15 | -9.05 | -5.91 | -5.87 | -5.87 | -8.34 | -10.95 | -5.90 | -12.94 | -10.27 | -5.87 | -12.03 | -20.05 | -15.76 | -13.74 | -11.42 |
| 22 | 7875  | 7.9  | -10.28 | -10.01 | -12.61 | -8.33 | -12.27 | -9.19 | -5.98 | -5.94 | -5.95 | -8.45 | -11.10 | -5.97 | -13.16 | -10.39 | -5.94 | -12.14 | -20.12 | -15.81 | -13.96 | -11.60 |
| 23 | 8250  | 8.3  | -10.33 | -10.04 | -12.69 | -8.41 | -12.33 | -9.27 | -6.03 | -5.98 | -5.99 | -8.52 | -11.19 | -6.01 | -13.31 | -10.47 | -5.98 | -12.21 | -20.17 | -15.84 | -14.10 | -11.72 |
| 24 | 8625  | 8.6  | -10.35 | -10.05 | -12.72 | -8.44 | -12.36 | -9.31 | -6.04 | -6.00 | -6.01 | -8.54 | -11.23 | -6.03 | -13.38 | -10.51 | -6.00 | -12.25 | -20.19 | -15.85 | -14.16 | -11.78 |
| 25 | 9000  | 9.0  | -10.35 | -10.04 | -12.70 | -8.44 | -12.34 | -9.29 | -6.04 | -5.99 | -6.00 | -8.52 | -11.21 | -6.02 | -13.37 | -10.50 | -5.99 | -12.24 | -20.17 | -15.85 | -14.15 | -11.78 |
| 26 | 9375  | 9.4  | -10.32 | -10.02 | -12.64 | -8.40 | -12.29 | -9.23 | -6.00 | -5.96 | -5.96 | -8.46 | -11.14 | -5.98 | -13.29 | -10.44 | -5.95 | -12.20 | -20.11 | -15.83 | -14.06 | -11.73 |
| 27 | 9750  | 9.8  | -10.26 | -9.97  | -12.53 | -8.32 | -12.20 | -9.13 | -5.94 | -5.90 | -5.90 | -8.36 | -11.01 | -5.92 | -13.14 | -10.35 | -5.89 | -12.11 | -20.04 | -15.78 | -13.89 | -11.62 |
| 28 | 10125 | 10.1 | -10.18 | -9.92  | -12.37 | -8.20 | -12.07 | -8.97 | -5.85 | -5.81 | -5.82 | -8.21 | -10.83 | -5.83 | -12.91 | -10.21 | -5.80 | -11.99 | -19.92 | -15.71 | -13.64 | -11.45 |
| 29 | 10500 | 10.5 | -10.08 | -9.83  | -12.17 | -8.04 | -11.90 | -8.77 | -5.74 | -5.70 | -5.70 | -8.03 | -10.60 | -5.72 | -12.61 | -10.02 | -5.69 | -11.83 | -19.78 | -15.63 | -13.32 | -11.22 |
| 30 | 10875 | 10.9 | -9.94  | -9.73  | -11.92 | -7.85 | -11.69 | -8.52 | -5.60 | -5.55 | -5.56 | -7.81 | -10.32 | -5.57 | -12.24 | -9.80  | -5.55 | -11.63 | -19.61 | -15.52 | -12.93 | -10.93 |
| 31 | 11250 | 11.3 | -9.78  | -9.61  | -11.63 | -7.61 | -11.45 | -8.23 | -5.43 | -5.39 | -5.39 | -7.55 | -9.98  | -5.41 | -11.80 | -9.54  | -5.38 | -11.39 | -19.40 | -15.39 | -12.47 | -10.60 |
| 32 | 11625 | 11.6 | -9.59  | -9.46  | -11.30 | -7.34 | -11.18 | -7.90 | -5.23 | -5.19 | -5.20 | -7.25 | -9.60  | -5.21 | -11.30 | -9.24  | -5.18 | -11.11 | -19.17 | -15.24 | -11.94 | -10.20 |
| 33 | 12000 | 12.0 | -9.38  | -9.30  | -10.92 | -7.04 | -10.87 | -7.53 | -5.01 | -4.97 | -4.98 | -6.92 | -9.18  | -4.99 | -10.74 | -8.89  | -4.96 | -10.80 | -18.90 | -15.07 | -11.35 | -9.76  |
| 34 | 12375 | 12.4 | -9.14  | -9.12  | -10.50 | -6.70 | -10.52 | -7.12 | -4.77 | -4.72 | -4.73 | -6.56 | -8.70  | -4.74 | -10.12 | -8.51  | -4.71 | -10.46 | -18.60 | -14.87 | -10.70 | -9.27  |
| 35 | 12750 | 12.8 | -8.87  | -8.90  | -10.04 | -6.33 | -10.14 | -6.68 | -4.50 | -4.46 | -4.47 | -6.16 | -8.19  | -4.47 | -9.45  | -8.10  | -4.45 | -10.07 | -18.26 | -14.64 | -10.00 | -8.74  |
| 36 | 13125 | 13.1 | -8.58  | -8.67  | -9.54  | -5.93 | -9.73  | -6.21 | -4.21 | -4.17 | -4.18 | -5.74 | -7.64  | -4.19 | -8.74  | -7.65  | -4.16 | -9.66  | -17.88 | -14.38 | -9.25  | -8.17  |
| 37 | 13500 | 13.5 | -8.27  | -8.42  | -9.01  | -5.50 | -9.29  | -5.72 | -3.91 | -3.87 | -3.88 | -5.30 | -7.06  | -3.88 | -8.00  | -7.18  | -3.86 | -9.21  | -17.45 | -14.09 | -8.46  | -7.57  |
| 38 | 13875 | 13.9 | -7.93  | -8.14  | -8.45  | -5.05 | -8.83  | -5.21 | -3.59 | -3.55 | -3.56 | -4.84 | -6.46  | -3.57 | -7.23  | -6.68  | -3.54 | -8.73  | -16.98 | -13.74 | -7.64  | -6.94  |
| 39 | 14250 | 14.3 | -7.58  | -7.84  | -7.87  | -4.59 | -8.35  | -4.68 | -3.27 | -3.23 | -3.24 | -4.36 | -5.84  | -3.24 | -6.44  | -6.17  | -3.21 | -8.22  | -16.44 | -13.34 | -6.81  | -6.29  |

|    |       |      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |        |        |       |       |
|----|-------|------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|-------|-------|
| 40 | 14625 | 14.6 | -7.18 | -7.51 | -7.26 | -4.11 | -7.86 | -4.15 | -2.93 | -2.89 | -2.90 | -3.89 | -5.20 | -2.91 | -5.65 | -5.64 | -2.88 | -7.69 | -15.82 | -12.88 | -5.97 | -5.63 |
| 41 | 15000 | 15.0 | -6.76 | -7.14 | -6.63 | -3.63 | -7.35 | -3.63 | -2.60 | -2.56 | -2.57 | -3.41 | -4.56 | -2.57 | -4.87 | -5.10 | -2.55 | -7.14 | -15.10 | -12.32 | -5.13 | -4.97 |
| 42 | 15375 | 15.4 | -6.30 | -6.72 | -5.98 | -3.15 | -6.80 | -3.11 | -2.27 | -2.23 | -2.24 | -2.94 | -3.92 | -2.25 | -4.10 | -4.56 | -2.22 | -6.55 | -14.24 | -11.64 | -4.31 | -4.31 |
| 43 | 15750 | 15.8 | -5.77 | -6.24 | -5.32 | -2.67 | -6.21 | -2.61 | -1.96 | -1.91 | -1.93 | -2.48 | -3.30 | -1.93 | -3.36 | -4.02 | -1.90 | -5.92 | -13.19 | -10.80 | -3.53 | -3.67 |
| 44 | 16125 | 16.1 | -5.16 | -5.69 | -4.64 | -2.20 | -5.57 | -2.15 | -1.66 | -1.62 | -1.63 | -2.06 | -2.72 | -1.63 | -2.68 | -3.48 | -1.60 | -5.25 | -11.91 | -9.76  | -2.80 | -3.05 |
| 45 | 16500 | 16.5 | -4.46 | -5.03 | -3.94 | -1.76 | -4.85 | -1.73 | -1.39 | -1.35 | -1.36 | -1.68 | -2.18 | -1.36 | -2.08 | -2.94 | -1.33 | -4.49 | -10.34 | -8.47  | -2.14 | -2.47 |
| 46 | 16875 | 16.9 | -3.63 | -4.23 | -3.20 | -1.34 | -4.03 | -1.37 | -1.16 | -1.12 | -1.13 | -1.35 | -1.70 | -1.13 | -1.56 | -2.41 | -1.10 | -3.64 | -8.46  | -6.87  | -1.59 | -1.94 |
| 47 | 17250 | 17.3 | -2.66 | -3.26 | -2.44 | -0.95 | -3.08 | -1.10 | -0.98 | -0.94 | -0.95 | -1.09 | -1.29 | -0.95 | -1.17 | -1.88 | -0.92 | -2.67 | -6.22  | -4.95  | -1.16 | -1.47 |
| 48 | 17625 | 17.6 | -1.54 | -2.10 | -1.67 | -0.62 | -2.02 | -0.93 | -0.87 | -0.82 | -0.84 | -0.92 | -0.99 | -0.84 | -0.92 | -1.37 | -0.81 | -1.55 | -3.64  | -2.73  | -0.89 | -1.08 |
| 49 | 18000 | 18.0 | -0.31 | -0.80 | -0.89 | -0.38 | -0.86 | -0.92 | -0.86 | -0.81 | -0.83 | -0.88 | -0.92 | -0.83 | -0.92 | -0.89 | -0.80 | -0.34 | -0.84  | -0.30  | -0.90 | -0.78 |









BOTTOM PLATE - TRANSVERSE

| mm   | m       | m   | L1-O1    | L1-O2   | L1-O3    | L1-O4  | L1-O5   | L1-O6   | L1-O7    | L2-O1   | L2-O2   | L2-O3   | L2-O4    | L2-O5    | L2-O6    | L2-O7   | L3-O1   | L3-O2    | L3-O3  | L3-O4     | L3-O5     | L3-O6     |
|------|---------|-----|----------|---------|----------|--------|---------|---------|----------|---------|---------|---------|----------|----------|----------|---------|---------|----------|--------|-----------|-----------|-----------|
| 0    | 0       | 0.0 | -9.1E-05 | -9E-05  | -9E-05   | -9E-05 | -9E-05  | -9E-05  | -0.00171 | -9E-05  | -9E-05  | -8E-05  | -0.00158 | -0.0011  | -9.7E-05 | -9E-05  | -0.0011 | -9.3E-05 | -9E-05 | -8.65E-05 | -9.3E-05  | -8.34E-05 |
| 124  | 0.12384 | 0.1 | -0.00171 | -0.0017 | -0.0017  | -0.002 | -0.0017 | -0.0017 | -0.0035  | -0.0016 | -0.0016 | -0.0016 | -0.00325 | -0.01902 | -0.00184 | -0.0016 | -0.0186 | -0.00173 | -0.002 | -0.001616 | -0.001753 | -0.001552 |
| 248  | 0.24769 | 0.2 | -0.00351 | -0.0034 | -0.0035  | -0.003 | -0.0035 | -0.0035 | -0.0053  | -0.0033 | -0.0033 | -0.0032 | -0.00492 | -0.03914 | -0.00378 | -0.0034 | -0.0383 | -0.00356 | -0.004 | -0.003318 | -0.003599 | -0.003186 |
| 372  | 0.37153 | 0.4 | -0.00531 | -0.0051 | -0.00529 | -0.005 | -0.0053 | -0.0053 | -0.15296 | -0.005  | -0.005  | -0.0049 | -0.17961 | -0.05926 | -0.00571 | -0.0051 | -0.058  | -0.00539 | -0.006 | -0.00502  | -0.005444 | -0.004821 |
| 495  | 0.49538 | 0.5 | -0.18523 | -0.1534 | -0.15321 | -0.183 | -0.1534 | -0.1532 | -0.35433 | -0.1684 | -0.1708 | -0.1707 | -0.4163  | -0.15718 | -0.20526 | -0.1544 | -0.1532 | -0.30496 | -0.254 | -0.23307  | -0.23995  | -0.18211  |
| 619  | 0.61922 | 0.6 | -0.42987 | -0.3553 | -0.35488 | -0.424 | -0.3553 | -0.3548 | -0.55574 | -0.3903 | -0.3957 | -0.3957 | -0.65301 | -0.27563 | -0.47694 | -0.3578 | -0.2685 | -0.70889 | -0.59  | -0.54135  | -0.55781  | -0.42214  |
| 743  | 0.74307 | 0.7 | -0.67454 | -0.5572 | -0.55659 | -0.665 | -0.5573 | -0.5564 | -0.87989 | -0.6123 | -0.6207 | -0.6206 | -1.0409  | -0.39427 | -0.74864 | -0.5613 | -0.384  | -1.1128  | -0.927 | -0.84965  | -0.87568  | -0.66218  |
| 867  | 0.86691 | 0.9 | -1.0995  | -0.8822 | -0.8812  | -1.06  | -0.8823 | -0.881  | -1.3307  | -0.975  | -0.9875 | -0.9874 | -1.5848  | -0.42531 | -1.1973  | -0.8899 | -0.4139 | -1.7571  | -1.495 | -1.3987   | -1.4064   | -1.0563   |
| 991  | 0.99076 | 1.0 | -1.7105  | -1.3341 | -1.3326  | -1.615 | -1.3343 | -1.3323 | -1.7814  | -1.4829 | -1.5007 | -1.5004 | -2.1286  | -0.398   | -1.8286  | -1.3476 | -0.3869 | -2.6493  | -2.302 | -2.1961   | -2.1565   | -1.6095   |
| 1115 | 1.1146  | 1.1 | -2.3214  | -1.7861 | -1.784   | -2.17  | -1.7862 | -1.7836 | -2.2304  | -1.9907 | -2.0138 | -2.0134 | -2.6765  | -0.37081 | -2.4598  | -1.8053 | -0.36   | -3.5415  | -3.109 | -2.9936   | -2.9067   | -2.1626   |
| 1238 | 1.2384  | 1.2 | -2.9762  | -2.2361 | -2.2336  | -2.73  | -2.2364 | -2.233  | -2.6734  | -2.5042 | -2.5288 | -2.5283 | -3.2373  | -0.37155 | -3.1043  | -2.2641 | -0.3605 | -4.4221  | -3.947 | -3.8626   | -3.6787   | -2.7205   |
| 1362 | 1.3623  | 1.4 | -3.7709  | -2.6803 | -2.6772  | -3.306 | -2.6806 | -2.6766 | -3.1164  | -3.0356 | -3.0499 | -3.0491 | -3.7981  | -0.41406 | -3.7911  | -2.7264 | -0.4018 | -5.2658  | -4.886 | -4.9604   | -4.5203   | -3.2939   |
| 1486 | 1.4861  | 1.5 | -4.5655  | -3.1244 | -3.1209  | -3.881 | -3.1249 | -3.1201 | -3.5559  | -3.567  | -3.5709 | -3.5699 | -4.3557  | -0.45662 | -4.4779  | -3.1887 | -0.4431 | -6.1094  | -5.824 | -6.0582   | -5.362    | -3.8672   |
| 1610 | 1.61    | 1.6 | -5.36    | -3.5651 | -3.5611  | -4.453 | -3.5657 | -3.5602 | -3.8856  | -4.0958 | -4.0886 | -4.0874 | -4.8141  | -0.49543 | -5.1602  | -3.6483 | -0.4808 | -6.9469  | -6.759 | -7.1581   | -6.1991   | -4.4375   |
| 1734 | 1.7338  | 1.7 | -6.1455  | -3.8957 | -3.8913  | -4.929 | -3.8965 | -3.8903 | -4.2152  | -4.5407 | -4.5026 | -4.5011 | -5.2725  | -0.51908 | -5.6986  | -4.0211 | -0.5036 | -7.5902  | -7.59  | -8.3255   | -6.8927   | -4.9113   |
| 1858 | 1.8577  | 1.9 | -6.9311  | -4.2264 | -4.2215  | -5.405 | -4.2274 | -4.2205 | -4.5449  | -4.9857 | -4.9167 | -4.9148 | -5.7309  | -0.54279 | -6.237   | -4.3939 | -0.5264 | -8.2334  | -8.421 | -9.4929   | -7.5863   | -5.3851   |
| 1982 | 1.9815  | 2.0 | -7.7167  | -4.557  | -4.5518  | -5.881 | -4.5582 | -4.5506 | -4.7778  | -5.4307 | -5.3307 | -5.3285 | -6.1074  | -0.56654 | -6.7754  | -4.7667 | -0.5493 | -8.8766  | -9.252 | -10.66    | -8.2798   | -5.8588   |
| 2105 | 2.1054  | 2.1 | -8.3141  | -4.7908 | -4.7852  | -6.279 | -4.7923 | -4.784  | -4.9965  | -5.8099 | -5.6571 | -5.6544 | -6.4718  | -0.5792  | -7.0868  | -5.0867 | -0.5615 | -9.4417  | -9.865 | -11.648   | -8.7165   | -6.2556   |
| 2229 | 2.2292  | 2.2 | -8.8837  | -5.0103 | -5.0044  | -6.667 | -5.0121 | -5.0032 | -5.2154  | -6.1794 | -5.9706 | -5.9674 | -6.8365  | -0.59193 | -7.3648  | -5.3989 | -0.5739 | -9.9953  | -10.45 | -12.609   | -9.1154   | -6.6411   |
| 2353 | 2.353   | 2.4 | -9.4535  | -5.23   | -5.2238  | -7.054 | -5.232  | -5.2225 | -5.3519  | -6.5491 | -6.2842 | -6.2807 | -7.1168  | -0.60472 | -7.643   | -5.7113 | -0.5864 | -10.549  | -11.03 | -13.571   | -9.5145   | -7.0268   |
| 2477 | 2.4769  | 2.5 | -9.7877  | -5.3671 | -5.3607  | -7.362 | -5.3694 | -5.3593 | -5.4544  | -6.8223 | -6.5219 | -6.5179 | -7.3624  | -0.62196 | -7.7549  | -5.9564 | -0.603  | -10.995  | -11.39 | -14.255   | -9.7271   | -7.3329   |
| 2601 | 2.6007  | 2.6 | -10.025  | -5.4703 | -5.4636  | -7.637 | -5.4729 | -5.4622 | -5.557   | -7.0559 | -6.7284 | -6.7238 | -7.608   | -0.64031 | -7.7984  | -6.1739 | -0.6206 | -11.397  | -11.67 | -14.826   | -9.8631   | -7.6063   |
| 2725 | 2.7246  | 2.7 | -10.262  | -5.5735 | -5.5666  | -7.912 | -5.5764 | -5.5652 | -5.5992  | -7.2896 | -6.9349 | -6.9298 | -7.7684  | -0.65865 | -7.842   | -6.3913 | -0.6382 | -11.798  | -11.95 | -15.397   | -9.999    | -7.8798   |
| 2848 | 2.8484  | 2.8 | -10.289  | -5.6162 | -5.6093  | -8.108 | -5.6195 | -5.6078 | -5.5983  | -7.3899 | -7.0909 | -7.0854 | -7.8678  | -0.67104 | -7.8052  | -6.5186 | -0.6507 | -12.025  | -12.07 | -15.685   | -10.058   | -8.0742   |
| 2972 | 2.9723  | 3.0 | -10.165  | -5.6158 | -5.6088  | -8.248 | -5.6195 | -5.6073 | -5.5974  | -7.3949 | -7.2109 | -7.2048 | -7.9672  | -0.67946 | -7.7111  | -6.5811 | -0.6599 | -12.128  | -12.07 | -15.771   | -10.061   | -8.212    |
| 3096 | 3.0961  | 3.1 | -10.041  | -5.6154 | -5.6083  | -8.387 | -5.6194 | -5.6069 | -5.5488  | -7.3999 | -7.3309 | -7.3243 | -7.9679  | -0.6879  | -7.6169  | -6.6437 | -0.6691 | -12.23   | -12.08 | -15.857   | -10.064   | -8.3499   |
| 3220 | 3.22    | 3.2 | -9.7612  | -5.5672 | -5.5601  | -8.431 | -5.5716 | -5.5587 | -5.452   | -7.2851 | -7.3979 | -7.3908 | -7.8691  | -0.70136 | -7.4786  | -6.6291 | -0.6818 | -12.149  | -11.97 | -15.692   | -10.015   | -8.3924   |
| 3344 | 3.3438  | 3.3 | -9.3249  | -5.4707 | -5.4638  | -8.379 | -5.4757 | -5.4623 | -5.3552  | -7.0492 | -7.4114 | -7.4038 | -7.7702  | -0.72236 | -7.2959  | -6.5365 | -0.6997 | -11.884  | -11.76 | -15.275   | -9.9136   | -8.3385   |
| 3468 | 3.4676  | 3.5 | -8.8887  | -5.3743 | -5.3674  | -8.327 | -5.3797 | -5.366  | -5.2153  | -6.8133 | -7.425  | -7.4169 | -7.5843  | -0.74339 | -7.1131  | -6.4439 | -0.7176 | -11.619  | -11.54 | -14.857   | -9.8121   | -8.2846   |
| 3592 | 3.5915  | 3.6 | -8.3885  | -5.2349 | -5.2281  | -8.184 | -5.2408 | -5.2267 | -4.9966  | -6.5168 | -7.3666 | -7.3582 | -7.2387  | -0.76066 | -6.8926  | -6.2987 | -0.7326 | -11.228  | -11.22 | -14.284   | -9.636    | -8.1401   |
| 3715 | 3.7153  | 3.7 | -7.7709  | -5.0167 | -5.0101  | -7.874 | -5.0231 | -5.0087 | -4.7778  | -6.1092 | -7.1765 | -7.168  | -6.8931  | -0.76284 | -6.6029  | -6.0572 | -0.7356 | -10.606  | -10.72 | -13.423   | -9.3229   | -7.8293   |
| 3839 | 3.8392  | 3.8 | -7.1534  | -4.7984 | -4.792   | -7.565 | -4.8054 | -4.7908 | -4.5423  | -5.7015 | -6.9864 | -6.9777 | -6.5117  | -0.76503 | -6.3132  | -5.8156 | -0.7386 | -9.9834  | -10.22 | -12.563   | -9.0099   | -7.5184   |
| 3963 | 3.963   | 4.0 | -6.5362  | -4.5634 | -4.5573  | -7.215 | -4.571  | -4.5561 | -4.2237  | -5.2867 | -6.7511 | -6.7425 | -5.9528  | -0.76724 | -6.0074  | -5.5563 | -0.7417 | -9.3177  | -9.666 | -11.655   | -8.644    | -7.1669   |
| 4087 | 4.0869  | 4.1 | -5.9208  | -4.2456 | -4.2399  | -6.663 | -4.2539 | -4.2387 | -3.9052  | -4.8362 | -6.2927 | -6.2845 | -5.394   | -0.78705 | -5.6219  | -5.2088 | -0.7968 | -8.4379  | -8.819 | -10.505   | -8.0166   | -6.6142   |
| 4211 | 4.2107  | 4.2 | -5.3055  | -3.9278 | -3.9225  | -6.112 | -3.9368 | -3.9214 | -3.5866  | -4.3857 | -5.8342 | -5.8266 | -4.8352  | -0.80688 | -5.2364  | -4.8614 | -0.8519 | -7.5581  | -7.972 | -9.3555   | -7.3893   | -6.0615   |
| 4335 | 4.3346  | 4.3 | -4.6902  | -3.6101 | -3.6051  | -5.56  | -3.6197 | -3.6041 | -3.1988  | -3.9353 | -5.3758 | -5.3687 | -4.1882  | -0.82671 | -4.851   | -4.5139 | -0.907  | -6.6783  | -7.125 | -8.206    | -6.762    | -5.5089   |
| 4458 | 4.4584  | 4.5 | -4.1172  | -3.2232 | -3.2187  | -4.874 | -3.2335 | -3.2177 | -2.8097  | -3.4779 | -4.7312 | -4.7251 | -3.5394  | -0.83637 | -4.3762  | -4.0733 | -0.9465 | -5.7347  | -6.12  | -7.0144   | -5.9256   | -4.8214   |
| 4582 | 4.5823  | 4.6 | -3.5451  | -2.8351 | -2.8309  | -4.185 | -2.846  | -2.8301 | -2.4207  | -3.0203 | -4.083  | -4.0778 | -2.8908  | -0.84349 | -3.8997  | -3.6309 | -0.982  | -4.7899  | -5.111 | -5.8219   | -5.085    | -4.1314   |
| 4706 | 4.7061  | 4.7 | -2.9732  | -2.447  | -2.4432  | -3.495 | -2.4586 | -2.4425 | -2.0197  | -2.5629 | -3.4348 | -3.4305 | -2.3399  | -0.85063 | -3.4232  | -3.1885 | -1.0175 | -3.8452  | -4.103 | -4.6295   | -4.2445   | -3.4413   |



## CHAPTER 5 - CONCLUSIONS

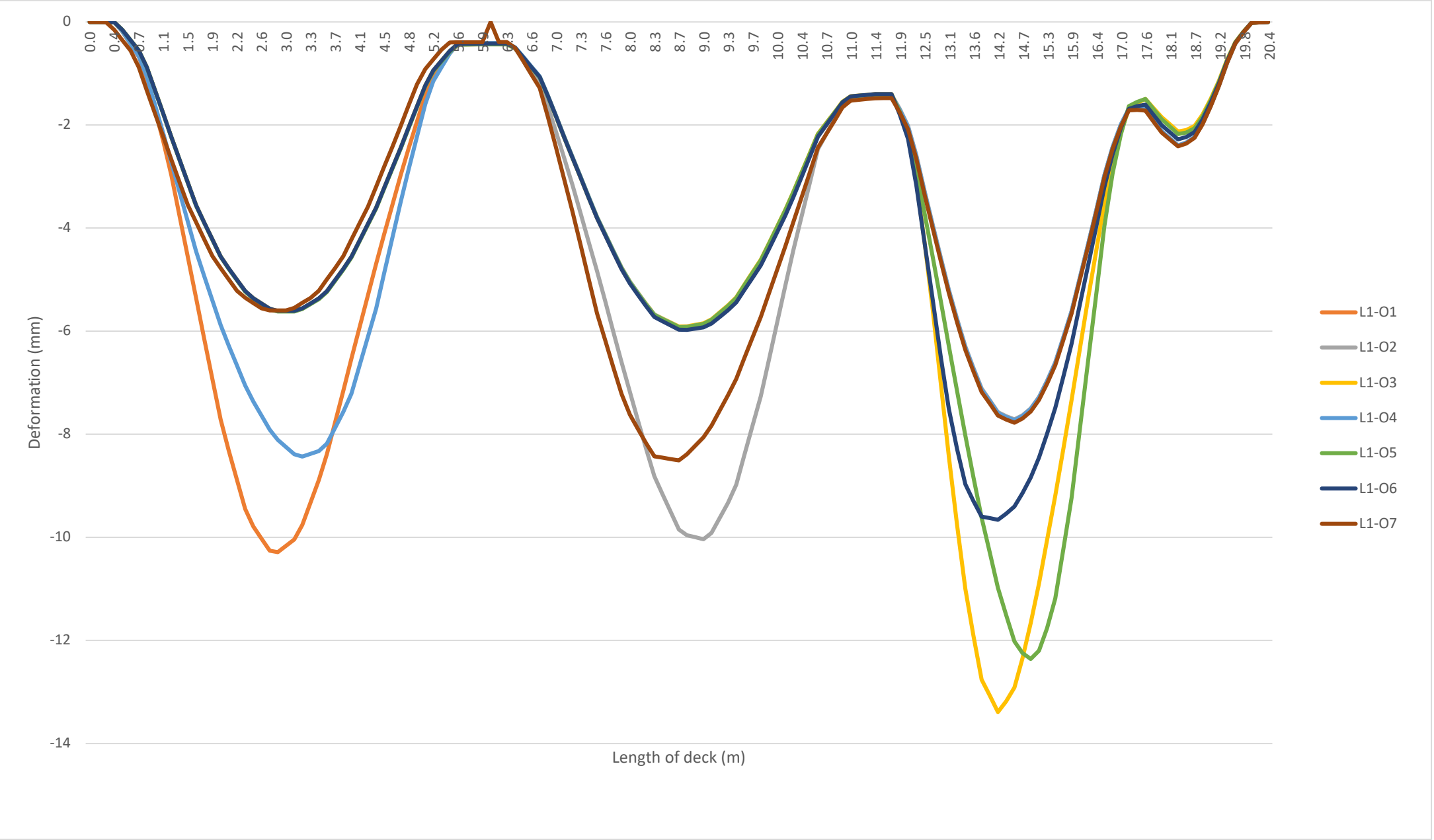
|      |         |     |          |         |          |        |         |         |          |         |         |         |          |          |          |         |         |          |        |          |          |          |
|------|---------|-----|----------|---------|----------|--------|---------|---------|----------|---------|---------|---------|----------|----------|----------|---------|---------|----------|--------|----------|----------|----------|
| 4830 | 4.8299  | 4.8 | -2.4458  | -2.047  | -2.0436  | -2.853 | -2.0591 | -2.0429 | -1.6152  | -2.122  | -2.8092 | -2.8058 | -1.8198  | -0.86101 | -2.8722  | -2.6741 | -1.0197 | -3.0711  | -3.27  | -3.6662  | -3.4528  | -2.798   |
| 4954 | 4.9538  | 5.0 | -1.9326  | -1.6435 | -1.6404  | -2.224 | -1.656  | -1.6398 | -1.2113  | -1.6864 | -2.1907 | -2.1883 | -1.3003  | -0.87359 | -2.2981  | -2.1373 | -0.9999 | -2.3506  | -2.493 | -2.7747  | -2.6765  | -2.1693  |
| 5078 | 5.0776  | 5.1 | -1.42    | -1.2404 | -1.2377  | -1.596 | -1.2534 | -1.2372 | -0.916   | -1.2515 | -1.5728 | -1.5713 | -0.94562 | -0.88623 | -1.7244  | -1.601  | -0.9801 | -1.6307  | -1.717 | -1.8838  | -1.9007  | -1.5412  |
| 5202 | 5.2015  | 5.2 | -1.0531  | -0.9458 | -0.94329 | -1.151 | -0.959  | -0.9429 | -0.72591 | -0.9375 | -1.1319 | -1.1311 | -0.75038 | -0.89653 | -1.2869  | -1.1922 | -0.9589 | -1.1431  | -1.194 | -1.281   | -1.3497  | -1.0955  |
| 5325 | 5.3253  | 5.3 | -0.82723 | -0.7562 | -0.7537  | -0.882 | -0.7693 | -0.7533 | -0.53748 | -0.7405 | -0.8626 | -0.8623 | -0.55653 | -0.9033  | -0.9814  | -0.9072 | -0.9353 | -0.8802  | -0.918 | -0.95744 | -1.0165  | -0.82668 |
| 5449 | 5.4492  | 5.4 | -0.60305 | -0.5679 | -0.56556 | -0.614 | -0.581  | -0.5652 | -0.39891 | -0.5452 | -0.595  | -0.5952 | -0.41362 | -0.91011 | -0.67791 | -0.6239 | -0.9118 | -0.61916 | -0.643 | -0.63581 | -0.68529 | -0.55976 |
| 5573 | 5.573   | 5.6 | -0.43799 | -0.4289 | -0.42684 | -0.417 | -0.4418 | -0.4266 | -0.3972  | -0.4014 | -0.3982 | -0.3986 | -0.41229 | -0.91513 | -0.45473 | -0.4154 | -0.8928 | -0.42716 | -0.441 | -0.39946 | -0.44155 | -0.36408 |
| 5697 | 5.6969  | 5.7 | -0.43621 | -0.4273 | -0.42518 | -0.416 | -0.4401 | -0.4249 | -0.39554 | -0.3998 | -0.3967 | -0.3972 | -0.41099 | -0.9129  | -0.45278 | -0.4136 | -0.8907 | -0.4256  | -0.44  | -0.39747 | -0.43987 | -0.36274 |
| 5821 | 5.8207  | 5.8 | -0.43448 | -0.4257 | -0.42357 | -0.414 | -0.4384 | -0.4233 | -0.39395 | -0.3982 | -0.3952 | -0.3959 | -0.40975 | -0.91069 | -0.45088 | -0.4118 | -0.8886 | -0.42408 | -0.438 | -0.39552 | -0.43822 | -0.36145 |
| 5945 | 5.9445  | 5.9 | -0.43282 | -0.4242 | -0.42202 | -0.413 | -0.4368 | -0.4218 | -0.39345 | -0.3967 | -0.3938 | -0.3946 | -0.40943 | -0.9086  | -0.44905 | -0.41   | -0.8866 | -0.42262 | -0.437 | -0.39364 | -0.43664 | -0.36022 |
| 113  | 0.11322 | 6.1 | -0.43243 | -0.4238 | -0.42159 | -0.413 | -0.4363 | -0.4214 | #REF!    | -0.3964 | -0.3934 | -0.3942 | #REF!    | -0.9056  | -0.4486  | -0.4096 | -0.884  | -0.4224  | -0.436 | -0.39326 | -0.43623 | -0.35989 |
| 226  | 0.22644 | 6.2 | -0.43206 | -0.4235 | -0.42119 | -0.412 | -0.4359 | -0.421  | -0.39297 | -0.396  | -0.393  | -0.3939 | -0.40913 | -0.90261 | -0.44817 | -0.4092 | -0.8815 | -0.4222  | -0.436 | -0.3929  | -0.43584 | -0.35958 |
| 340  | 0.33966 | 6.3 | -0.43171 | -0.4232 | -0.42081 | -0.412 | -0.4355 | -0.4206 | -0.39252 | -0.3957 | -0.3926 | -0.3936 | -0.40886 | -0.89966 | -0.44776 | -0.4088 | -0.879  | -0.42203 | -0.436 | -0.39257 | -0.43548 | -0.35931 |
| 453  | 0.45288 | 6.4 | -0.51273 | -0.5182 | -0.5017  | -0.493 | -0.5162 | -0.5019 | -0.5048  | -0.4987 | -0.5252 | -0.5089 | -0.49784 | -1.1215  | -0.52845 | -0.5192 | -1.1014 | -0.55643 | -0.546 | -0.50935 | -0.51873 | -0.49537 |
| 566  | 0.56609 | 6.5 | -0.69908 | -0.7371 | -0.68783 | -0.679 | -0.7023 | -0.6891 | -0.76309 | -0.7357 | -0.8309 | -0.7746 | -0.70271 | -1.5184  | -0.71423 | -0.7733 | -1.4986 | -0.86626 | -0.8   | -0.77814 | -0.71061 | -0.80841 |
| 679  | 0.67931 | 6.6 | -0.88684 | -0.9577 | -0.87539 | -0.867 | -0.8898 | -0.8776 | -1.023   | -0.9743 | -1.1385 | -1.0422 | -0.90922 | -1.9192  | -0.90153 | -1.0292 | -1.8994 | -1.1784  | -1.057 | -1.0487  | -0.9042  | -1.1232  |
| 793  | 0.79253 | 6.7 | -1.0753  | -1.1791 | -1.0636  | -1.055 | -1.078  | -1.0668 | -1.2835  | -1.2135 | -1.4469 | -1.3106 | -1.1165  | -2.4144  | -1.0896  | -1.2858 | -2.3946 | -1.4914  | -1.314 | -1.3199  | -1.0986  | -1.4386  |
| 906  | 0.90575 | 6.9 | -1.4483  | -1.6448 | -1.4359  | -1.428 | -1.4504 | -1.4413 | -1.847   | -1.7969 | -2.1126 | -1.7981 | -1.5294  | -3.4682  | -1.4625  | -1.7411 | -3.4484 | -2.0771  | -1.963 | -1.8183  | -1.4981  | -2.1357  |
| 1019 | 1.019   | 7.0 | -1.8468  | -2.144  | -1.8334  | -1.827 | -1.8481 | -1.8411 | -2.4518  | -2.4272 | -2.8269 | -2.3155 | -1.9704  | -4.5241  | -1.8608  | -2.2236 | -4.5041 | -2.7     | -2.665 | -2.3475  | -1.9258  | -2.8845  |
| 1132 | 1.1322  | 7.1 | -2.2455  | -2.6435 | -2.2312  | -2.225 | -2.2461 | -2.2412 | -3.0567  | -3.0577 | -3.5414 | -2.8332 | -2.4118  | -5.581   | -2.2595  | -2.7062 | -5.5608 | -3.3232  | -3.368 | -2.8769  | -2.3539  | -3.6335  |
| 1245 | 1.2454  | 7.2 | -2.64    | -3.1658 | -2.6247  | -2.62  | -2.6399 | -2.6373 | -3.6826  | -3.7509 | -4.276  | -3.3319 | -2.853   | -6.8283  | -2.654   | -3.1559 | -6.8082 | -3.935   | -4.144 | -3.386   | -2.7916  | -4.4246  |
| 1359 | 1.3586  | 7.3 | -3.0282  | -3.7225 | -3.0116  | -3.008 | -3.027  | -3.0271 | -4.3399  | -4.5388 | -5.041  | -3.8019 | -3.2939  | -8.1519  | -3.0421  | -3.5556 | -8.1322 | -4.5297  | -5.031 | -3.8642  | -3.2436  | -5.2793  |
| 1472 | 1.4718  | 7.4 | -3.4165  | -4.2792 | -3.3986  | -3.396 | -3.4142 | -3.417  | -4.9973  | -5.3266 | -5.8061 | -4.2719 | -3.7349  | -9.4758  | -3.4303  | -3.9553 | -9.4564 | -5.1245  | -5.917 | -4.3424  | -3.6956  | -6.1341  |
| 1585 | 1.5851  | 7.5 | -3.8048  | -4.836  | -3.7856  | -3.785 | -3.8015 | -3.807  | -5.6547  | -6.1145 | -6.5712 | -4.7419 | -4.1759  | -10.769  | -3.8185  | -4.3551 | -10.75  | -5.7193  | -6.804 | -4.8206  | -4.1477  | -6.9889  |
| 1698 | 1.6983  | 7.6 | -4.1358  | -5.4234 | -4.1153  | -4.116 | -4.1312 | -4.1404 | -6.1828  | -6.8111 | -7.1476 | -5.2079 | -4.5712  | -11.984  | -4.1492  | -4.6724 | -11.966 | -6.309   | -7.54  | -5.2597  | -4.5924  | -7.733   |
| 1812 | 1.8115  | 7.8 | -4.4624  | -6.0132 | -4.4405  | -4.442 | -4.4564 | -4.4693 | -6.7008  | -7.5004 | -7.7092 | -5.6737 | -4.9631  | -13.2    | -4.4754  | -4.9832 | -13.182 | -6.8983  | -8.264 | -5.6956  | -5.0366  | -8.4684  |
| 1925 | 1.9247  | 7.9 | -4.7889  | -6.603  | -4.7658  | -4.769 | -4.7816 | -4.7983 | -7.2188  | -8.1898 | -8.2708 | -6.1394 | -5.3549  | -14.416  | -4.8016  | -5.294  | -14.399 | -7.4876  | -8.988 | -6.1316  | -5.4808  | -9.2038  |
| 2038 | 2.0379  | 8.0 | -5.0622  | -7.1752 | -5.0377  | -5.042 | -5.0535 | -5.0743 | -7.6192  | -8.7506 | -8.6873 | -6.59   | -5.6964  | -15.321  | -5.0745  | -5.5489 | -15.305 | -8.0494  | -9.552 | -6.5271  | -5.8931  | -9.8155  |
| 2151 | 2.1512  | 8.1 | -5.2801  | -7.729  | -5.2544  | -5.26  | -5.2701 | -5.2952 | -7.8975  | -9.178  | -8.9534 | -7.025  | -5.9856  | -16.175  | -5.2919  | -5.7456 | -16.159 | -8.5828  | -9.951 | -6.8807  | -6.2723  | -10.299  |
| 2264 | 2.2644  | 8.2 | -5.498   | -8.2829 | -5.4712  | -5.478 | -5.4867 | -5.5162 | -8.1759  | -9.6055 | -9.2195 | -7.46   | -6.2749  | -17.028  | -5.5094  | -5.9424 | -17.014 | -9.1162  | -10.35 | -7.2342  | -6.6516  | -10.782  |
| 2378 | 2.3776  | 8.3 | -5.7028  | -8.8168 | -5.6748  | -5.683 | -5.6901 | -5.724  | -8.4302  | -10.001 | -9.4651 | -7.8795 | -6.5516  | -17.659  | -5.7137  | -6.126  | -17.645 | -9.6283  | -10.72 | -7.5688  | -7.0128  | -11.237  |
| 2491 | 2.4908  | 8.4 | -5.7824  | -9.161  | -5.7532  | -5.762 | -5.7683 | -5.8073 | -8.4559  | -10.093 | -9.5163 | -8.1519 | -6.7081  | -17.992  | -5.7926  | -6.1844 | -17.98  | -9.9381  | -10.83 | -7.7216  | -7.2016  | -11.424  |
| 2604 | 2.604   | 8.5 | -5.8619  | -9.5053 | -5.8316  | -5.842 | -5.8464 | -5.8905 | -8.4816  | -10.186 | -9.5675 | -8.4243 | -6.8647  | -18.325  | -5.8715  | -6.2428 | -18.314 | -10.248  | -10.94 | -7.8745  | -7.3904  | -11.611  |
| 2717 | 2.7173  | 8.7 | -5.9415  | -9.8495 | -5.91    | -5.922 | -5.9246 | -5.9738 | -8.5073  | -10.278 | -9.6186 | -8.6967 | -7.0212  | -18.659  | -5.9505  | -6.3011 | -18.649 | -10.558  | -11.05 | -8.0274  | -7.5792  | -11.798  |
| 2831 | 2.8305  | 8.8 | -5.9398  | -9.9623 | -5.9073  | -5.92  | -5.9215 | -5.9762 | -8.3902  | -10.125 | -9.5753 | -8.8029 | -7.0933  | -18.417  | -5.9481  | -6.2797 | -18.409 | -10.629  | -10.97 | -7.997   | -7.5874  | -11.786  |
| 2944 | 2.9437  | 8.9 | -5.9114  | -9.9988 | -5.8779  | -5.892 | -5.8916 | -5.952  | -8.2261  | -9.8924 | -9.5008 | -8.8542 | -7.1375  | -18.176  | -5.919   | -6.2321 | -18.168 | -10.623  | -10.83 | -7.9063  | -7.536   | -11.71   |
| 3057 | 3.0569  | 9.0 | -5.883   | -10.035 | -5.8484  | -5.864 | -5.8617 | -5.9279 | -8.062   | -9.6594 | -9.4263 | -8.9056 | -7.1817  | -17.934  | -5.8898  | -6.1844 | -17.928 | -10.616  | -10.68 | -7.8155  | -7.4847  | -11.633  |
| 3170 | 3.1701  | 9.1 | -5.8045  | -9.9151 | -5.769   | -5.785 | -5.7819 | -5.8535 | -7.8352  | -9.311  | -9.2855 | -8.8491 | -7.1565  | -17.39   | -5.8107  | -6.0885 | -17.385 | -10.451  | -10.42 | -7.6243  | -7.3313  | -11.446  |
| 3283 | 3.2833  | 9.2 | -5.6711  | -9.623  | -5.6347  | -5.652 | -5.6474 | -5.724  | -7.5395  | -8.836  | -9.0719 | -8.6742 | -7.0551  | -16.619  | -5.6766  | -5.9399 | -16.616 | -10.113  | -10.01 | -7.3226  | -7.0661  | -11.137  |
| 3397 | 3.3966  | 9.3 | -5.5377  | -9.331  | -5.5005  | -5.519 | -5.5128 | -5.5946 | -7.2439  | -8.3609 | -8.8584 | -8.4993 | -6.9537  | -15.848  | -5.5426  | -5.7912 | -15.846 | -9.7745  | -9.606 | -7.021   | -6.8008  | -10.829  |
| 3510 | 3.5098  | 9.5 | -5.3815  | -8.9801 | -5.3435  | -5.363 | -5.3554 | -5.4422 | -6.9263  | -7.8675 | -8.5931 | -8.2672 | -6.8066  | -15.023  | -5.3857  | -5.6199 | -15.022 | -9.3774  | -9.154 | -6.6971  | -6.5113  | -10.456  |
| 3623 | 3.623   | 9.6 | -5.1397  | -8.4081 | -5.1008  | -5.122 | -5.1123 | -5.2036 | -6.5261  | -7.3047 | -8.1334 | -7.8201 | -6.4882  | -13.87   | -5.143   | -5.364  | -13.87  | -8.7605  | -8.524 | -6.2898  | -6.1308  | -9.8436  |
| 3736 | 3.7362  | 9.7 | -4.8977  | -7.836  | -4.858   | -4.88  | -4.869  | -4.965  | -6.1258  | -6.7418 | -7.6735 | -7.3727 | -6.1696  | -12.717  | -4.9002  | -5.1079 | -12.718 | -8.1436  | -7.893 | -5.8824  | -5.7501  | -9.2306  |

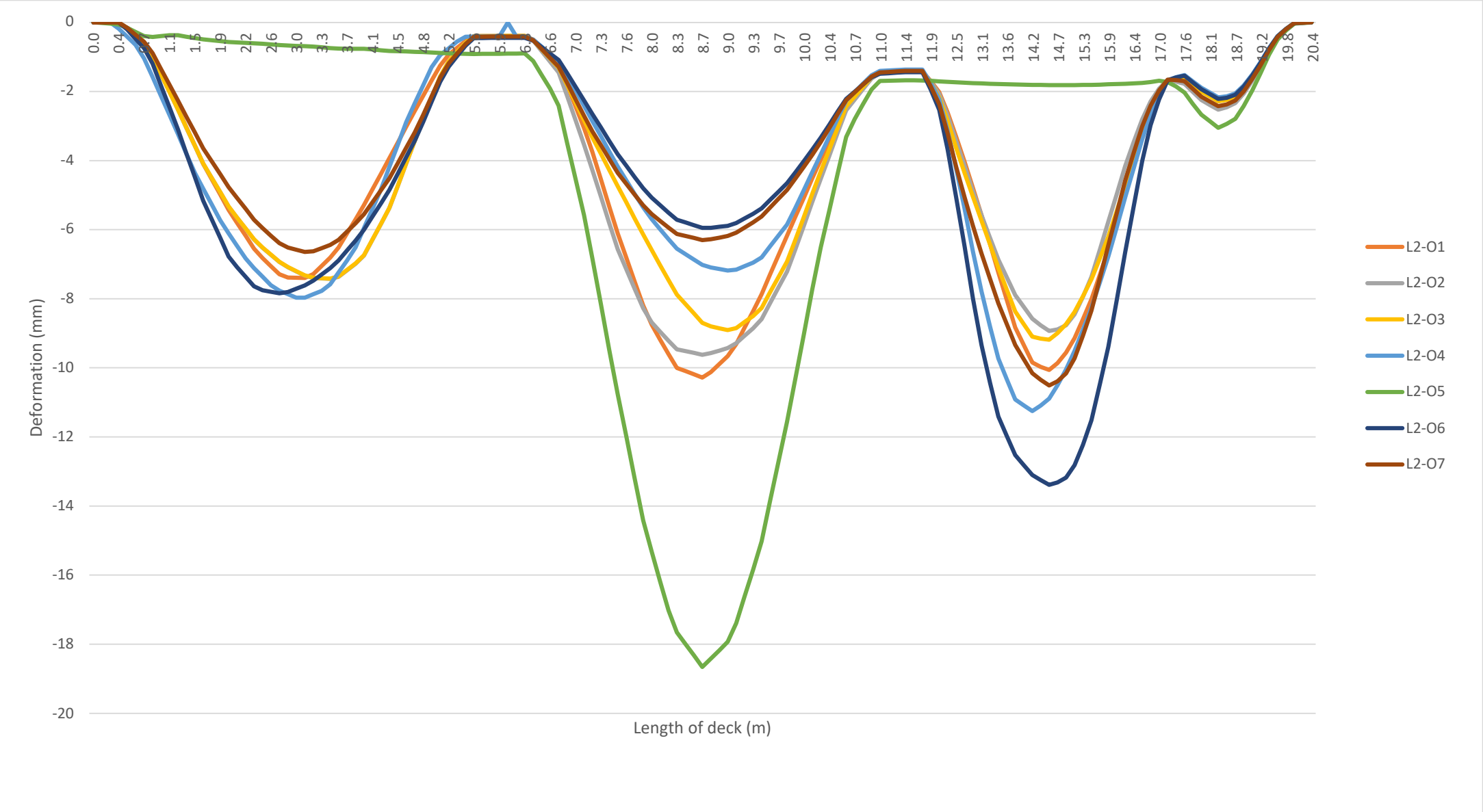
## CHAPTER 5 - CONCLUSIONS

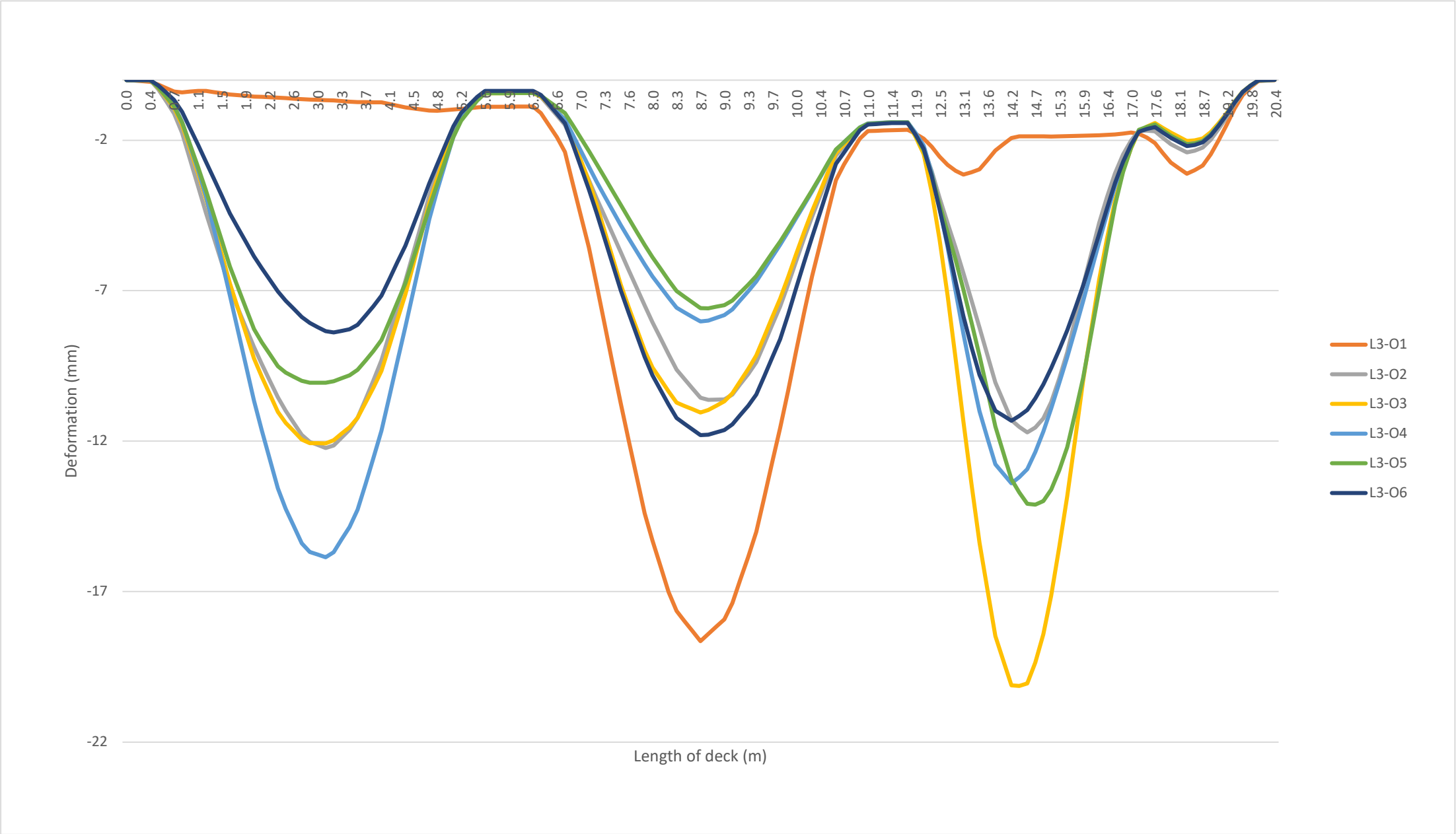
|      |         |      |         |         |         |        |         |         |         |         |         |         |         |         |         |         |         |         |        |         |         |         |
|------|---------|------|---------|---------|---------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------|---------|---------|---------|
| 3849 | 3.8494  | 9.8  | -4.6558 | -7.264  | -4.6153 | -4.639 | -4.6259 | -4.7265 | -5.7256 | -6.179  | -7.2138 | -6.9256 | -5.8512 | -11.564 | -4.6575 | -4.8519 | -11.567 | -7.5267 | -7.263 | -5.4752 | -5.3696 | -8.6178 |
| 3963 | 3.9627  | 9.9  | -4.3422 | -6.5653 | -4.301  | -4.325 | -4.311  | -4.4125 | -5.2748 | -5.6242 | -6.567  | -6.2947 | -5.3686 | -10.314 | -4.3431 | -4.5224 | -10.318 | -6.7889 | -6.54  | -5.0395 | -4.9517 | -7.7943 |
| 4076 | 4.0759  | 10.0 | -4.015  | -5.8426 | -3.9731 | -3.999 | -3.9826 | -4.0842 | -4.8146 | -5.071  | -5.8849 | -5.629  | -4.8549 | -9.0261 | -4.015  | -4.1791 | -9.031  | -6.0283 | -5.799 | -4.5985 | -4.5268 | -6.931  |
| 4189 | 4.1891  | 10.1 | -3.6878 | -5.12   | -3.6452 | -3.672 | -3.6543 | -3.7559 | -4.3543 | -4.5177 | -5.2028 | -4.9633 | -4.3412 | -7.7379 | -3.6869 | -3.8357 | -7.7438 | -5.2677 | -5.059 | -4.1575 | -4.1019 | -6.0677 |
| 4302 | 4.3023  | 10.2 | -3.3396 | -4.4275 | -3.2964 | -3.324 | -3.305  | -3.3998 | -3.8842 | -3.9765 | -4.5286 | -4.3131 | -3.8241 | -6.5135 | -3.338  | -3.4655 | -6.5204 | -4.5427 | -4.36  | -3.7068 | -3.6648 | -5.2247 |
| 4416 | 4.4155  | 10.4 | -2.9644 | -3.7737 | -2.9208 | -2.949 | -2.9289 | -3.0083 | -3.4015 | -3.4507 | -3.8646 | -3.6829 | -3.3026 | -5.4485 | -2.9623 | -3.0608 | -5.4564 | -3.8635 | -3.714 | -3.2437 | -3.2123 | -4.4078 |
| 4529 | 4.5288  | 10.5 | -2.5893 | -3.1199 | -2.5453 | -2.575 | -2.5529 | -2.6168 | -2.9188 | -2.925  | -3.2006 | -3.0528 | -2.7812 | -4.3837 | -2.5867 | -2.6562 | -4.3926 | -3.1842 | -3.068 | -2.7807 | -2.7598 | -3.5909 |
| 4642 | 4.642   | 10.6 | -2.2173 | -2.4727 | -2.1728 | -2.203 | -2.1799 | -2.2284 | -2.4402 | -2.404  | -2.5431 | -2.429  | -2.2648 | -3.3195 | -2.2141 | -2.2548 | -3.3293 | -2.5119 | -2.429 | -2.3215 | -2.3112 | -2.7822 |
| 4755 | 4.7552  | 10.7 | -2.0094 | -2.1824 | -1.9648 | -1.995 | -1.9718 | -2.0054 | -2.1804 | -2.1372 | -2.2369 | -2.1479 | -2.0194 | -2.7994 | -2.0066 | -2.0254 | -2.8085 | -2.2129 | -2.149 | -2.0726 | -2.0676 | -2.4108 |
| 4868 | 4.8684  | 10.8 | -1.8015 | -1.892  | -1.7569 | -1.788 | -1.7637 | -1.7825 | -1.9206 | -1.8704 | -1.9307 | -1.8669 | -1.774  | -2.3702 | -1.7992 | -1.796  | -2.3783 | -1.9138 | -1.869 | -1.8237 | -1.8241 | -2.0395 |
| 4982 | 4.9816  | 10.9 | -1.5936 | -1.6017 | -1.549  | -1.58  | -1.5557 | -1.5596 | -1.6609 | -1.6037 | -1.6246 | -1.5859 | -1.5286 | -1.9415 | -1.5918 | -1.5667 | -1.9486 | -1.6149 | -1.589 | -1.5748 | -1.5807 | -1.6682 |
| 5095 | 5.0949  | 11.0 | -1.4865 | -1.4547 | -1.4418 | -1.473 | -1.4486 | -1.4445 | -1.5276 | -1.4672 | -1.4695 | -1.4438 | -1.404  | -1.6945 | -1.4849 | -1.4485 | -1.699  | -1.4636 | -1.448 | -1.447  | -1.4557 | -1.4803 |
| 5208 | 5.2081  | 11.2 | -1.4734 | -1.441  | -1.4286 | -1.46  | -1.4355 | -1.4301 | -1.512  | -1.4521 | -1.4551 | -1.4311 | -1.3917 | -1.689  | -1.4717 | -1.4339 | -1.6887 | -1.4497 | -1.435 | -1.432  | -1.441  | -1.4631 |
| 5321 | 5.3213  | 11.3 | -1.4603 | -1.4274 | -1.4154 | -1.447 | -1.4225 | -1.4157 | -1.4965 | -1.437  | -1.4408 | -1.4185 | -1.3795 | -1.6835 | -1.4585 | -1.4194 | -1.6785 | -1.4358 | -1.423 | -1.4171 | -1.4264 | -1.446  |
| 5435 | 5.4345  | 11.4 | -1.4472 | -1.4138 | -1.4022 | -1.434 | -1.4095 | -1.4013 | -1.481  | -1.4219 | -1.4264 | -1.4058 | -1.3673 | -1.678  | -1.4453 | -1.4049 | -1.6684 | -1.422  | -1.411 | -1.4021 | -1.4119 | -1.4289 |
| 187  | 0.18704 | 11.6 | -1.4471 | -1.4137 | -1.402  | -1.434 | -1.4096 | -1.4008 | -1.4808 | -1.4217 | -1.4262 | -1.4057 | -1.3669 | -1.6794 | -1.4452 | -1.4048 | -1.6613 | -1.422  | -1.411 | -1.4018 | -1.4119 | -1.4281 |
| 374  | 0.37408 | 11.8 | -1.447  | -1.4136 | -1.4017 | -1.433 | -1.4098 | -1.4002 | -1.4806 | -1.4215 | -1.4261 | -1.4056 | -1.3664 | -1.6809 | -1.4451 | -1.4048 | -1.6543 | -1.422  | -1.411 | -1.4015 | -1.4119 | -1.4274 |
| 561  | 0.56112 | 11.9 | -1.7232 | -1.689  | -1.7579 | -1.709 | -1.7444 | -1.7977 | -1.7565 | -1.6953 | -1.7232 | -1.7587 | -1.7597 | -1.6931 | -1.9426 | -1.8462 | -1.7862 | -1.8145 | -1.892 | -1.7573 | -1.8368 | -1.8202 |
| 748  | 0.74815 | 12.1 | -2.0509 | -2.0158 | -2.1805 | -2.037 | -2.1415 | -2.2695 | -2.0838 | -2.0199 | -2.0756 | -2.1777 | -2.2266 | -1.7078 | -2.5333 | -2.3699 | -1.9502 | -2.2803 | -2.463 | -2.1795 | -2.3412 | -2.2862 |
| 935  | 0.93519 | 12.3 | -2.619  | -2.5832 | -3.0976 | -2.605 | -2.845  | -3.1659 | -2.6517 | -2.6056 | -2.692  | -2.8482 | -3.1316 | -1.7213 | -3.67   | -3.2021 | -2.2184 | -3.0335 | -3.724 | -3.097  | -3.162  | -3.1919 |
| 1122 | 1.1222  | 12.5 | -3.2954 | -3.2589 | -4.237  | -3.281 | -3.6864 | -4.2531 | -3.3279 | -3.3087 | -3.4271 | -3.6319 | -4.2336 | -1.7342 | -5.052  | -4.1729 | -2.5471 | -3.9158 | -5.296 | -4.2369 | -4.1249 | -4.2949 |
| 1309 | 1.3093  | 12.7 | -3.9589 | -3.9222 | -5.5521 | -3.944 | -4.545  | -5.3679 | -3.9913 | -4.0409 | -4.1571 | -4.3637 | -5.4058 | -1.7463 | -6.4961 | -5.0667 | -2.8183 | -4.7614 | -7.158 | -5.553  | -5.0646 | -5.4687 |
| 1496 | 1.4963  | 12.9 | -4.6112 | -4.5747 | -7.0188 | -4.596 | -5.4181 | -6.5065 | -4.6435 | -4.7981 | -4.8826 | -5.0505 | -6.6384 | -1.7575 | -7.9936 | -5.8939 | -3.0195 | -5.5752 | -9.269 | -7.0209 | -5.9842 | -6.7034 |
| 1683 | 1.6833  | 13.1 | -5.2313 | -5.195  | -8.4351 | -5.216 | -6.2924 | -7.5092 | -5.2636 | -5.5837 | -5.5826 | -5.7389 | -7.7887 | -1.7682 | -9.3377 | -6.6876 | -3.1449 | -6.4225 | -11.36 | -8.4387 | -6.9679 | -7.8558 |
| 1870 | 1.8704  | 13.2 | -5.7993 | -5.7632 | -9.7697 | -5.783 | -7.1682 | -8.2922 | -5.8316 | -6.4152 | -6.2412 | -6.4298 | -8.8056 | -1.7772 | -10.433 | -7.4271 | -3.0673 | -7.3239 | -13.43 | -9.7749 | -8.0552 | -8.875  |
| 2057 | 2.0574  | 13.4 | -6.3326 | -6.2968 | -11.005 | -6.316 | -8.0275 | -8.971  | -6.3648 | -7.2412 | -6.8679 | -7.1091 | -9.7301 | -1.786  | -11.409 | -8.1369 | -2.9684 | -8.2303 | -15.38 | -11.012 | -9.1647 | -9.8018 |
| 2245 | 2.2445  | 13.6 | -6.7479 | -6.7126 | -11.905 | -6.731 | -8.8308 | -9.2958 | -6.78   | -8.0482 | -7.3865 | -7.7492 | -10.341 | -1.7931 | -11.979 | -8.7458 | -2.6567 | -9.1537 | -16.96 | -11.914 | -10.35  | -10.414 |
| 2432 | 2.4315  | 13.8 | -7.1495 | -7.1148 | -12.762 | -7.133 | -9.6251 | -9.5992 | -7.1816 | -8.8334 | -7.8924 | -8.3692 | -10.919 | -1.8002 | -12.528 | -9.3402 | -2.3456 | -10.055 | -18.48 | -12.772 | -11.512 | -10.994 |
| 2619 | 2.6185  | 14.0 | -7.3771 | -7.3432 | -13.075 | -7.36  | -10.304 | -9.6297 | -7.4091 | -9.3399 | -8.2367 | -8.7336 | -11.085 | -1.8054 | -12.816 | -9.7495 | -2.1325 | -10.679 | -19.3  | -13.088 | -12.39  | -11.16  |
| 2806 | 2.8056  | 14.2 | -7.6047 | -7.5715 | -13.389 | -7.588 | -10.984 | -9.6602 | -7.6365 | -9.8464 | -8.581  | -9.098  | -11.251 | -1.8105 | -13.104 | -10.159 | -1.93   | -11.303 | -20.12 | -13.403 | -13.269 | -11.326 |
| 2993 | 2.9926  | 14.4 | -7.6834 | -7.6511 | -13.182 | -7.667 | -11.511 | -9.5409 | -7.7149 | -9.9746 | -8.7672 | -9.1578 | -11.091 | -1.8132 | -13.251 | -10.345 | -1.8727 | -11.529 | -20.13 | -13.198 | -13.704 | -11.166 |
| 3180 | 3.1797  | 14.6 | -7.7449 | -7.7136 | -12.915 | -7.728 | -12.021 | -9.4042 | -7.7762 | -10.059 | -8.9352 | -9.1825 | -10.894 | -1.8149 | -13.382 | -10.506 | -1.8697 | -11.71  | -20.06 | -12.932 | -14.088 | -10.967 |
| 3367 | 3.3667  | 14.7 | -7.6646 | -7.6343 | -12.348 | -7.648 | -12.246 | -9.1456 | -7.6954 | -9.8647 | -8.8915 | -8.9993 | -10.507 | -1.8158 | -13.318 | -10.389 | -1.8708 | -11.547 | -19.36 | -12.365 | -14.112 | -10.578 |
| 3554 | 3.5537  | 14.9 | -7.529  | -7.4999 | -11.663 | -7.513 | -12.361 | -8.8395 | -7.5594 | -9.5614 | -8.7655 | -8.735  | -10.046 | -1.816  | -13.177 | -10.163 | -1.8752 | -11.25  | -18.42 | -11.681 | -13.995 | -10.115 |
| 3741 | 3.7408  | 15.1 | -7.3052 | -7.2774 | -10.9   | -7.289 | -12.202 | -8.4564 | -7.3351 | -9.14   | -8.4513 | -8.3792 | -9.5117 | -1.815  | -12.816 | -9.7245 | -1.8763 | -10.71  | -17.14 | -10.919 | -13.617 | -9.5782 |
| 3928 | 3.9278  | 15.3 | -6.9931 | -6.9665 | -10.059 | -6.977 | -11.767 | -7.9962 | -7.0224 | -8.6    | -7.9486 | -7.9315 | -8.9042 | -1.8117 | -12.233 | -9.0735 | -1.8711 | -9.9249 | -15.53 | -10.077 | -12.978 | -8.9682 |
| 4115 | 4.1148  | 15.5 | -6.6309 | -6.6055 | -9.1941 | -6.615 | -11.187 | -7.4921 | -6.6595 | -8.0123 | -7.3665 | -7.4385 | -8.261  | -1.8079 | -11.521 | -8.3432 | -1.8657 | -9.0524 | -13.83 | -9.2123 | -12.202 | -8.3225 |
| 4302 | 4.3019  | 15.7 | -6.1324 | -6.1084 | -8.2661 | -6.117 | -10.212 | -6.8689 | -6.1602 | -7.295  | -6.5687 | -6.8225 | -7.521  | -1.8011 | -10.458 | -7.3978 | -1.8595 | -7.9411 | -11.92 | -8.2837 | -11.055 | -7.58   |
| 4489 | 4.4889  | 15.9 | -5.6339 | -5.6112 | -7.3381 | -5.619 | -9.2373 | -6.2456 | -5.6609 | -6.5777 | -5.771  | -6.2065 | -6.781  | -1.7943 | -9.3957 | -6.4524 | -1.8534 | -6.8299 | -9.999 | -7.355  | -9.9069 | -6.8374 |
| 4676 | 4.676   | 16.1 | -4.9835 | -4.9622 | -6.3528 | -4.969 | -7.911  | -5.4868 | -5.0096 | -5.7447 | -4.9647 | -5.453  | -5.9242 | -1.7863 | -8.0282 | -5.5165 | -1.8453 | -5.7901 | -8.316 | -6.369  | -8.4447 | -5.978  |
| 4863 | 4.863   | 16.2 | -4.3331 | -4.3131 | -5.3673 | -4.319 | -6.5851 | -4.7279 | -4.3583 | -4.9116 | -4.1584 | -4.6994 | -5.0674 | -1.7784 | -6.6608 | -4.5804 | -1.8373 | -4.7501 | -6.633 | -5.3828 | -6.9828 | -5.1186 |
| 5050 | 5.05    | 16.4 | -3.6668 | -3.6481 | -4.4334 | -3.654 | -5.2733 | -3.9668 | -3.691  | -4.0965 | -3.4619 | -3.9429 | -4.2217 | -1.7659 | -5.3294 | -3.7726 | -1.8244 | -3.8922 | -5.269 | -4.4481 | -5.5644 | -4.2706 |
| 5237 | 5.2371  | 16.6 | -2.9948 | -2.9775 | -3.5178 | -2.982 | -3.9666 | -3.2048 | -3.0181 | -3.2878 | -2.8045 | -3.1854 | -3.3801 | -1.7524 | -4.0108 | -3.0103 | -1.8105 | -3.0987 | -4.019 | -3.5317 | -4.1615 | -3.4265 |

CHAPTER 5 - CONCLUSIONS

|      |        |      |          |         |          |        |         |         |          |         |         |         |          |          |          |         |         |          |        |           |           |           |
|------|--------|------|----------|---------|----------|--------|---------|---------|----------|---------|---------|---------|----------|----------|----------|---------|---------|----------|--------|-----------|-----------|-----------|
| 5424 | 5.4241 | 16.8 | -2.4422  | -2.4259 | -2.7568  | -2.43  | -2.9404 | -2.5714 | -2.4647  | -2.6185 | -2.2915 | -2.5565 | -2.6763  | -1.725   | -2.9794  | -2.4102 | -1.7825 | -2.4749  | -3.021 | -2.7699   | -3.061    | -2.7206   |
| 5611 | 5.6112 | 17.0 | -2.0053  | -1.9899 | -2.1457  | -1.994 | -2.1861 | -2.0625 | -2.0271  | -2.0841 | -1.9185 | -2.0525 | -2.1062  | -1.6896  | -2.2264  | -1.9672 | -1.7465 | -2.0155  | -2.269 | -2.1581   | -2.2535   | -2.1487   |
| 5798 | 5.7982 | 17.2 | -1.6969  | -1.6823 | -1.6853  | -1.686 | -1.6336 | -1.69   | -1.7179  | -1.691  | -1.6705 | -1.6847 | -1.6799  | -1.727   | -1.6758  | -1.6601 | -1.7849 | -1.692   | -1.698 | -1.697    | -1.6574   | -1.7206   |
| 5985 | 5.9852 | 17.4 | -1.6878  | -1.6738 | -1.5761  | -1.677 | -1.5513 | -1.6356 | -1.708   | -1.6269 | -1.7137 | -1.6345 | -1.5889  | -1.8524  | -1.5965  | -1.6695 | -1.913  | -1.6857  | -1.547 | -1.5869   | -1.5533   | -1.6275   |
| 6172 | 6.1723 | 17.6 | -1.7017  | -1.6883 | -1.496   | -1.691 | -1.4972 | -1.6069 | -1.7208  | -1.5891 | -1.7767 | -1.6098 | -1.5259  | -2.033   | -1.5451  | -1.7009 | -2.0967 | -1.702   | -1.428 | -1.506    | -1.4788   | -1.5624   |
| 6359 | 6.3593 | 17.7 | -1.9168  | -1.9045 | -1.6722  | -1.907 | -1.6922 | -1.8046 | -1.9344  | -1.7827 | -2.0137 | -1.8094 | -1.7097  | -2.3599  | -1.7402  | -1.9254 | -2.4275 | -1.9185  | -1.589 | -1.6811   | -1.6655   | -1.7431   |
| 6546 | 6.5463 | 17.9 | -2.1321  | -2.1208 | -1.8485  | -2.123 | -1.8874 | -2.0025 | -2.1481  | -1.9764 | -2.2509 | -2.0091 | -1.8936  | -2.6747  | -1.9354  | -2.1501 | -2.7456 | -2.135   | -1.749 | -1.8563   | -1.8522   | -1.9238   |
| 6733 | 6.7334 | 18.1 | -2.2708  | -2.2606 | -1.9888  | -2.263 | -2.0336 | -2.1421 | -2.2847  | -2.1156 | -2.3911 | -2.149  | -2.0343  | -2.8622  | -2.0786  | -2.2915 | -2.9303 | -2.2737  | -1.889 | -1.9954   | -1.9973   | -2.0607   |
| 6920 | 6.9204 | 18.3 | -2.4034  | -2.3945 | -2.1262  | -2.396 | -2.176  | -2.2771 | -2.4153  | -2.2507 | -2.5237 | -2.2842 | -2.1716  | -3.0498  | -2.2178  | -2.4263 | -3.1152 | -2.4062  | -2.027 | -2.1316   | -2.1391   | -2.1943   |
| 7108 | 7.1075 | 18.5 | -2.3495  | -2.3419 | -2.098   | -2.344 | -2.1463 | -2.235  | -2.3593  | -2.2106 | -2.4595 | -2.2416 | -2.1395  | -2.9372  | -2.1829  | -2.3714 | -2.9952 | -2.3519  | -2.007 | -2.1023   | -2.1121   | -2.1582   |
| 7295 | 7.2945 | 18.7 | -2.2407  | -2.2344 | -2.021   | -2.236 | -2.0658 | -2.1407 | -2.2484  | -2.1191 | -2.3373 | -2.1465 | -2.0575  | -2.7946  | -2.0968  | -2.2606 | -2.8447 | -2.2425  | -1.941 | -2.0241   | -2.0354   | -2.0723   |
| 7482 | 7.4815 | 18.9 | -1.9815  | -1.9764 | -1.8003  | -1.978 | -1.839  | -1.899  | -1.9872  | -1.8809 | -2.0613 | -1.9037 | -1.8304  | -2.4258  | -1.864   | -1.9982 | -2.4666 | -1.9827  | -1.734 | -1.8024   | -1.8136   | -1.8416   |
| 7669 | 7.6686 | 19.0 | -1.6293  | -1.6254 | -1.4907  | -1.626 | -1.5218 | -1.5662 | -1.6331  | -1.552  | -1.6902 | -1.5696 | -1.5137  | -1.9723  | -1.5404  | -1.6421 | -2.0033 | -1.6298  | -1.44  | -1.4919   | -1.502    | -1.5215   |
| 7856 | 7.8556 | 19.2 | -1.2358  | -1.233  | -1.1374  | -1.234 | -1.1607 | -1.1909 | -1.2381  | -1.1806 | -1.2788 | -1.1933 | -1.1537  | -1.4726  | -1.1736  | -1.2449 | -1.4947 | -1.2358  | -1.102 | -1.1379   | -1.1464   | -1.1586   |
| 8043 | 8.0427 | 19.4 | -0.79462 | -0.7927 | -0.73356 | -0.793 | -0.7489 | -0.7667 | -0.79563 | -0.7599 | -0.8209 | -0.7679 | -0.74353 | -0.93445 | -0.75679 | -0.7999 | -0.9485 | -0.7942  | -0.712 | -0.7335   | -0.73984  | -0.74605  |
| 8230 | 8.2297 | 19.6 | -0.42155 | -0.4204 | -0.39119 | -0.421 | -0.3999 | -0.4075 | -0.42161 | -0.4038 | -0.4341 | -0.408  | -0.39598 | -0.49808 | -0.40359 | -0.4238 | -0.5058 | -0.42086 | -0.381 | -0.39075  | -0.3951   | -0.39669  |
| 8417 | 8.4167 | 19.8 | -0.20068 | -0.2    | -0.18617 | -0.2   | -0.1908 | -0.1939 | -0.20049 | -0.192  | -0.2064 | -0.194  | -0.18837 | -0.23938 | -0.19254 | -0.2015 | -0.2436 | -0.20007 | -0.181 | -0.18575  | -0.18843  | -0.18845  |
| 8604 | 8.6038 | 20.0 | -0.01642 | -0.0161 | -0.01511 | -0.016 | -0.0166 | -0.0157 | -0.01592 | -0.0151 | -0.0163 | -0.0154 | -0.0151  | -0.03413 | -0.01664 | -0.016  | -0.0356 | -0.01577 | -0.015 | -0.014614 | -0.016156 | -0.014557 |
| 8791 | 8.7908 | 20.2 | -0.00821 | -0.0081 | -0.00755 | -0.008 | -0.0083 | -0.0078 | -0.00796 | -0.0075 | -0.0081 | -0.0077 | -0.00755 | -0.01706 | -0.00832 | -0.008  | -0.0178 | -0.00789 | -0.008 | -0.007307 | -0.008078 | -0.007278 |







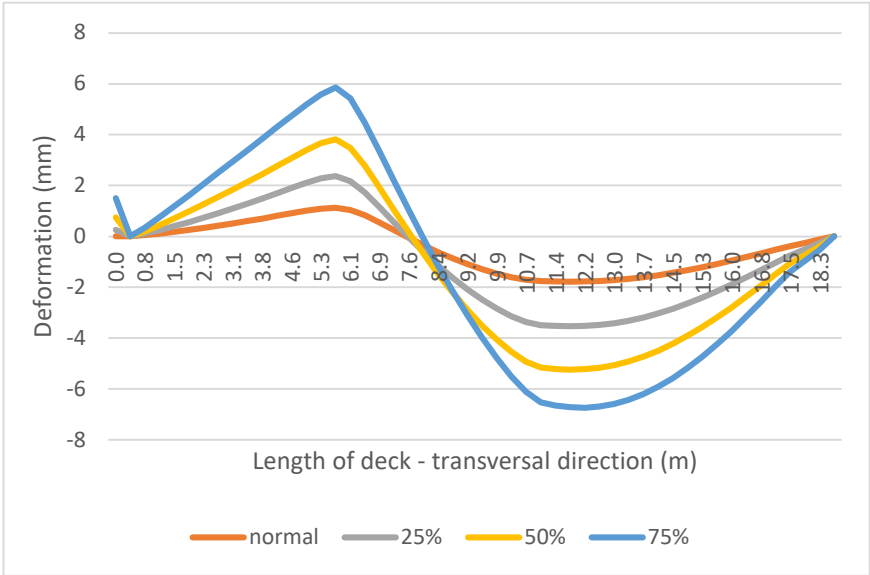
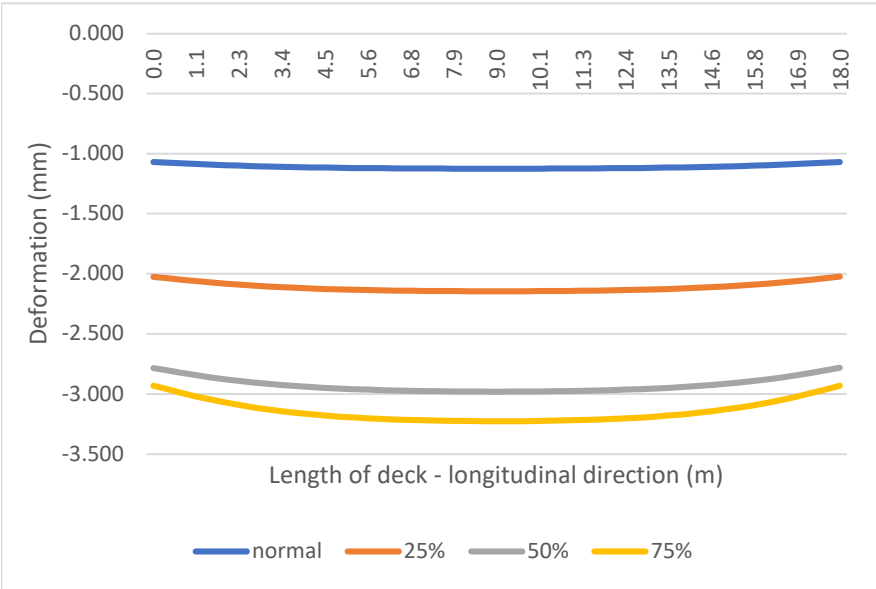


## **APPENDIX G – Raw data case study for general corrosion**



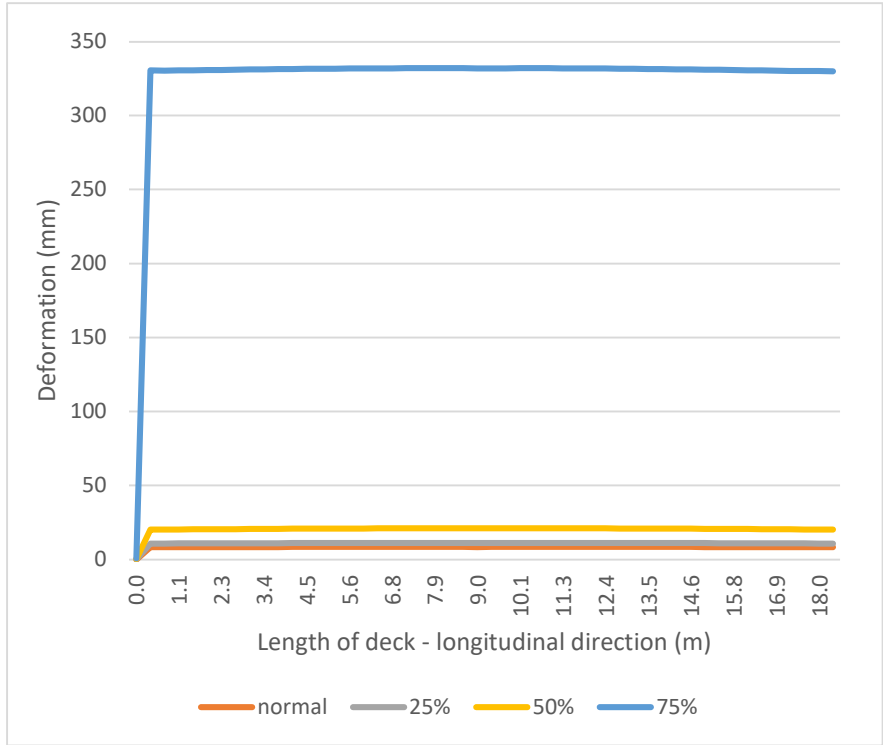
| Top deck longi |      |        |        |        |        |
|----------------|------|--------|--------|--------|--------|
| mm             | m    | normal | 25%    | 50%    | 75%    |
| 0              | 0.0  | -1.069 | -0.955 | -0.759 | -0.148 |
| 375            | 0.4  | -1.075 | -0.962 | -0.767 | -0.158 |
| 750            | 0.8  | -1.081 | -0.969 | -0.775 | -0.168 |
| 1125           | 1.1  | -1.086 | -0.975 | -0.782 | -0.177 |
| 1500           | 1.5  | -1.091 | -0.981 | -0.789 | -0.186 |
| 1875           | 1.9  | -1.096 | -0.986 | -0.795 | -0.194 |
| 2250           | 2.3  | -1.100 | -0.991 | -0.801 | -0.201 |
| 2625           | 2.6  | -1.104 | -0.995 | -0.806 | -0.208 |
| 3000           | 3.0  | -1.107 | -0.999 | -0.810 | -0.213 |
| 3375           | 3.4  | -1.110 | -1.002 | -0.814 | -0.219 |
| 3750           | 3.8  | -1.112 | -1.005 | -0.818 | -0.223 |
| 4125           | 4.1  | -1.115 | -1.008 | -0.821 | -0.227 |
| 4500           | 4.5  | -1.117 | -1.010 | -0.823 | -0.231 |
| 4875           | 4.9  | -1.118 | -1.012 | -0.825 | -0.234 |
| 5250           | 5.3  | -1.120 | -1.013 | -0.827 | -0.236 |
| 5625           | 5.6  | -1.121 | -1.015 | -0.829 | -0.239 |
| 6000           | 6.0  | -1.122 | -1.016 | -0.830 | -0.240 |
| 6375           | 6.4  | -1.123 | -1.017 | -0.832 | -0.242 |
| 6750           | 6.8  | -1.124 | -1.018 | -0.832 | -0.243 |
| 7125           | 7.1  | -1.124 | -1.019 | -0.833 | -0.244 |
| 7500           | 7.5  | -1.125 | -1.019 | -0.834 | -0.245 |
| 7875           | 7.9  | -1.125 | -1.019 | -0.834 | -0.246 |
| 8250           | 8.3  | -1.125 | -1.020 | -0.835 | -0.246 |
| 8625           | 8.6  | -1.125 | -1.020 | -0.835 | -0.247 |
| 9000           | 9.0  | -1.125 | -1.020 | -0.835 | -0.247 |
| 9375           | 9.4  | -1.125 | -1.020 | -0.835 | -0.247 |
| 9750           | 9.8  | -1.125 | -1.020 | -0.835 | -0.246 |
| 10125          | 10.1 | -1.125 | -1.019 | -0.834 | -0.246 |
| 10500          | 10.5 | -1.125 | -1.019 | -0.834 | -0.245 |
| 10875          | 10.9 | -1.124 | -1.019 | -0.833 | -0.244 |
| 11250          | 11.3 | -1.124 | -1.018 | -0.833 | -0.243 |
| 11625          | 11.6 | -1.123 | -1.017 | -0.832 | -0.242 |
| 12000          | 12.0 | -1.122 | -1.016 | -0.830 | -0.240 |
| 12375          | 12.4 | -1.121 | -1.015 | -0.829 | -0.239 |
| 12750          | 12.8 | -1.120 | -1.014 | -0.827 | -0.236 |
| 13125          | 13.1 | -1.118 | -1.012 | -0.825 | -0.234 |
| 13500          | 13.5 | -1.117 | -1.010 | -0.823 | -0.231 |
| 13875          | 13.9 | -1.115 | -1.008 | -0.821 | -0.227 |
| 14250          | 14.3 | -1.112 | -1.005 | -0.818 | -0.223 |
| 14625          | 14.6 | -1.110 | -1.002 | -0.814 | -0.219 |
| 15000          | 15.0 | -1.107 | -0.999 | -0.810 | -0.213 |
| 15375          | 15.4 | -1.104 | -0.995 | -0.806 | -0.208 |
| 15750          | 15.8 | -1.100 | -0.991 | -0.801 | -0.201 |
| 16125          | 16.1 | -1.096 | -0.986 | -0.795 | -0.194 |
| 16500          | 16.5 | -1.091 | -0.981 | -0.789 | -0.186 |
| 16875          | 16.9 | -1.086 | -0.975 | -0.782 | -0.178 |
| 17250          | 17.3 | -1.081 | -0.969 | -0.775 | -0.168 |
| 17625          | 17.6 | -1.075 | -0.962 | -0.767 | -0.158 |
| 18000          | 18.0 | -1.069 | -0.955 | -0.759 | -0.148 |

| Top deck trans |      |        |        |        |              |
|----------------|------|--------|--------|--------|--------------|
| mm             | m    | normal | 25%    | 50%    | 75%          |
| 0              | 0.0  | 0.000  | 0.000  | 0.000  | <b>0.000</b> |
| 381.37         | 0.4  | 0.049  | 0.061  | 0.085  | 0.149        |
| 762.75         | 0.8  | 0.108  | 0.137  | 0.193  | 0.314        |
| 1144.1         | 1.1  | 0.177  | 0.222  | 0.305  | 0.478        |
| 1525.5         | 1.5  | 0.251  | 0.310  | 0.417  | 0.641        |
| 1906.9         | 1.9  | 0.331  | 0.401  | 0.528  | 0.800        |
| 2288.2         | 2.3  | 0.416  | 0.494  | 0.637  | 0.955        |
| 2669.6         | 2.7  | 0.506  | 0.590  | 0.746  | 1.106        |
| 3051           | 3.1  | 0.601  | 0.688  | 0.853  | 1.252        |
| 3432.4         | 3.4  | 0.700  | 0.788  | 0.961  | 1.393        |
| 3813.7         | 3.8  | 0.802  | 0.891  | 1.068  | 1.529        |
| 4195.1         | 4.2  | 0.905  | 0.995  | 1.175  | 1.661        |
| 4576.5         | 4.6  | 1.005  | 1.099  | 1.282  | 1.788        |
| 4957.9         | 5.0  | 1.089  | 1.189  | 1.382  | 1.913        |
| 5339.2         | 5.3  | 1.133  | 1.241  | 1.449  | 2.044        |
| 5720.6         | 5.7  | 1.037  | 1.127  | 1.312  | 1.947        |
| 6102           | 6.1  | 0.828  | 0.896  | 1.058  | 1.694        |
| 6483.3         | 6.5  | 0.545  | 0.604  | 0.766  | 1.423        |
| 6864.7         | 6.9  | 0.241  | 0.304  | 0.477  | 1.149        |
| 7246.1         | 7.2  | -0.062 | 0.012  | 0.196  | 0.873        |
| 7627.5         | 7.6  | -0.353 | -0.267 | -0.074 | 0.596        |
| 8008.8         | 8.0  | -0.624 | -0.527 | -0.332 | 0.322        |
| 8390.2         | 8.4  | -0.872 | -0.769 | -0.576 | 0.051        |
| 8771.6         | 8.8  | -1.099 | -0.993 | -0.807 | -0.215       |
| 9153           | 9.2  | -1.299 | -1.197 | -1.023 | -0.473       |
| 9534.3         | 9.5  | -1.469 | -1.378 | -1.222 | -0.721       |
| 9915.7         | 9.9  | -1.609 | -1.535 | -1.404 | -0.960       |
| 10297          | 10.3 | -1.712 | -1.659 | -1.560 | -1.184       |
| 10678          | 10.7 | -1.765 | -1.731 | -1.666 | -1.375       |
| 11060          | 11.1 | -1.775 | -1.748 | -1.695 | -1.436       |
| 11441          | 11.4 | -1.780 | -1.755 | -1.706 | -1.480       |
| 11823          | 11.8 | -1.775 | -1.749 | -1.702 | -1.509       |
| 12204          | 12.2 | -1.757 | -1.730 | -1.684 | -1.525       |
| 12585          | 12.6 | -1.724 | -1.696 | -1.652 | -1.524       |
| 12967          | 13.0 | -1.675 | -1.646 | -1.605 | -1.507       |
| 13348          | 13.3 | -1.609 | -1.581 | -1.543 | -1.472       |
| 13729          | 13.7 | -1.530 | -1.503 | -1.467 | -1.421       |
| 14111          | 14.1 | -1.437 | -1.413 | -1.379 | -1.354       |
| 14492          | 14.5 | -1.332 | -1.309 | -1.277 | -1.270       |
| 14874          | 14.9 | -1.215 | -1.195 | -1.163 | -1.170       |
| 15255          | 15.3 | -1.090 | -1.071 | -1.040 | -1.056       |
| 15636          | 15.6 | -0.958 | -0.939 | -0.907 | -0.928       |
| 16018          | 16.0 | -0.819 | -0.799 | -0.765 | -0.787       |
| 16399          | 16.4 | -0.677 | -0.655 | -0.617 | -0.638       |
| 16780          | 16.8 | -0.532 | -0.506 | -0.463 | -0.475       |
| 17162          | 17.2 | -0.388 | -0.361 | -0.318 | -0.324       |
| 17543          | 17.5 | -0.261 | -0.252 | -0.228 | -0.224       |
| 17925          | 17.9 | -0.128 | -0.136 | -0.140 | -0.139       |
| 18306          | 18.3 | 0.000  | 0.000  | 0.000  | 0.000        |

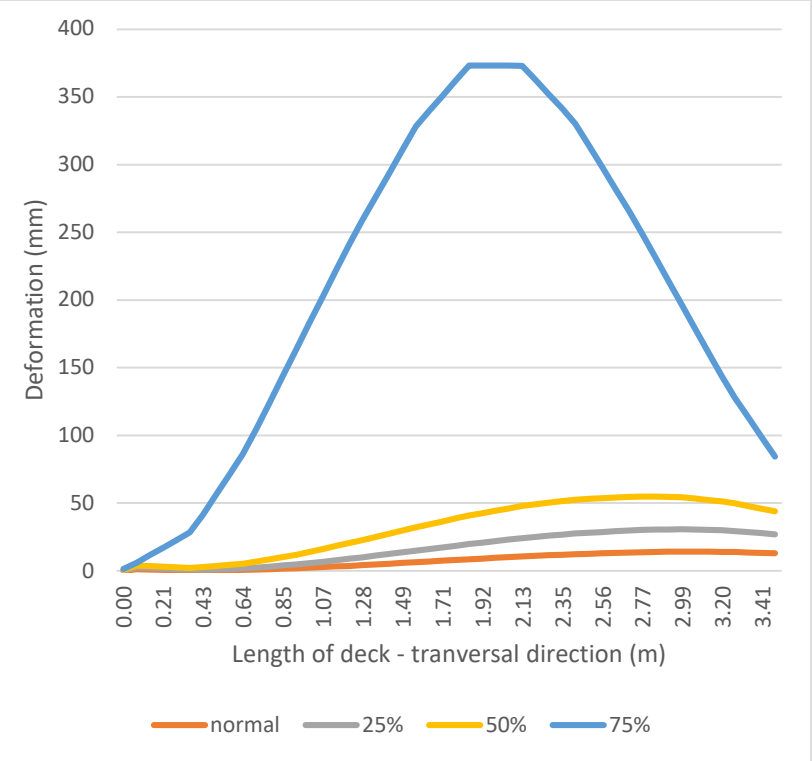




| S1 longi |      |        |        |        |         |
|----------|------|--------|--------|--------|---------|
| mm       | m    | normal | 25%    | 50%    | 75%     |
| 0        | 0.0  | 8.272  | 10.785 | 20.222 | 330.530 |
| 375      | 0.4  | 8.279  | 10.787 | 20.190 | 330.410 |
| 750      | 0.8  | 8.301  | 10.823 | 20.272 | 330.560 |
| 1125     | 1.1  | 8.319  | 10.852 | 20.337 | 330.540 |
| 1500     | 1.5  | 8.337  | 10.882 | 20.405 | 330.770 |
| 1875     | 1.9  | 8.356  | 10.912 | 20.470 | 330.870 |
| 2250     | 2.3  | 8.374  | 10.941 | 20.532 | 331.000 |
| 2625     | 2.6  | 8.391  | 10.969 | 20.593 | 331.120 |
| 3000     | 3.0  | 8.408  | 10.996 | 20.650 | 331.240 |
| 3375     | 3.4  | 8.423  | 11.021 | 20.704 | 331.350 |
| 3750     | 3.8  | 8.437  | 11.044 | 20.755 | 331.450 |
| 4125     | 4.1  | 8.449  | 11.064 | 20.802 | 331.540 |
| 4500     | 4.5  | 8.460  | 11.083 | 20.845 | 331.630 |
| 4875     | 4.9  | 8.469  | 11.100 | 20.885 | 331.710 |
| 5250     | 5.3  | 8.477  | 11.115 | 20.921 | 331.780 |
| 5625     | 5.6  | 8.484  | 11.127 | 20.953 | 331.840 |
| 6000     | 6.0  | 8.490  | 11.138 | 20.981 | 331.890 |
| 6375     | 6.4  | 8.495  | 11.148 | 21.006 | 331.930 |
| 6750     | 6.8  | 8.499  | 11.156 | 21.027 | 331.970 |
| 7125     | 7.1  | 8.502  | 11.162 | 21.045 | 332.000 |
| 7500     | 7.5  | 8.504  | 11.167 | 21.059 | 332.020 |
| 7875     | 7.9  | 8.505  | 11.171 | 21.070 | 332.040 |
| 8250     | 8.3  | 8.506  | 11.173 | 21.078 | 332.050 |
| 8625     | 8.6  | 8.507  | 11.174 | 21.083 | 332.060 |
| 9000     | 9.0  | 8.506  | 11.174 | 21.083 | 332.060 |
| 9375     | 9.4  | 8.505  | 11.172 | 21.081 | 332.060 |
| 9750     | 9.8  | 8.503  | 11.170 | 21.076 | 332.040 |
| 10125    | 10.1 | 8.502  | 11.167 | 21.068 | 332.020 |
| 10500    | 10.5 | 8.500  | 11.163 | 21.057 | 331.990 |
| 10875    | 10.9 | 8.497  | 11.158 | 21.043 | 331.940 |
| 11250    | 11.3 | 8.494  | 11.151 | 21.026 | 331.890 |
| 11625    | 11.6 | 8.491  | 11.144 | 21.005 | 331.830 |
| 12000    | 12.0 | 8.486  | 11.135 | 20.981 | 331.760 |
| 12375    | 12.4 | 8.481  | 11.125 | 20.954 | 331.690 |
| 12750    | 12.8 | 8.474  | 11.112 | 20.922 | 331.600 |
| 13125    | 13.1 | 8.467  | 11.098 | 20.888 | 331.510 |
| 13500    | 13.5 | 8.458  | 11.083 | 20.850 | 331.410 |
| 13875    | 13.9 | 8.448  | 11.065 | 20.808 | 331.300 |
| 14250    | 14.3 | 8.436  | 11.045 | 20.762 | 331.180 |
| 14625    | 14.6 | 8.423  | 11.024 | 20.713 | 331.060 |
| 15000    | 15.0 | 8.409  | 11.000 | 20.661 | 330.920 |
| 15375    | 15.4 | 8.394  | 10.975 | 20.605 | 330.790 |
| 15750    | 15.8 | 8.377  | 10.948 | 20.547 | 330.640 |
| 16125    | 16.1 | 8.360  | 10.921 | 20.486 | 330.480 |
| 16500    | 16.5 | 8.343  | 10.893 | 20.423 | 330.340 |
| 16875    | 16.9 | 8.327  | 10.865 | 20.360 | 330.200 |
| 17250    | 17.3 | 8.310  | 10.837 | 20.294 | 330.020 |
| 17625    | 17.6 | 8.291  | 10.806 | 20.220 | 330.020 |
| 18000    | 18.0 | 8.285  | 10.806 | 20.253 | 330.000 |

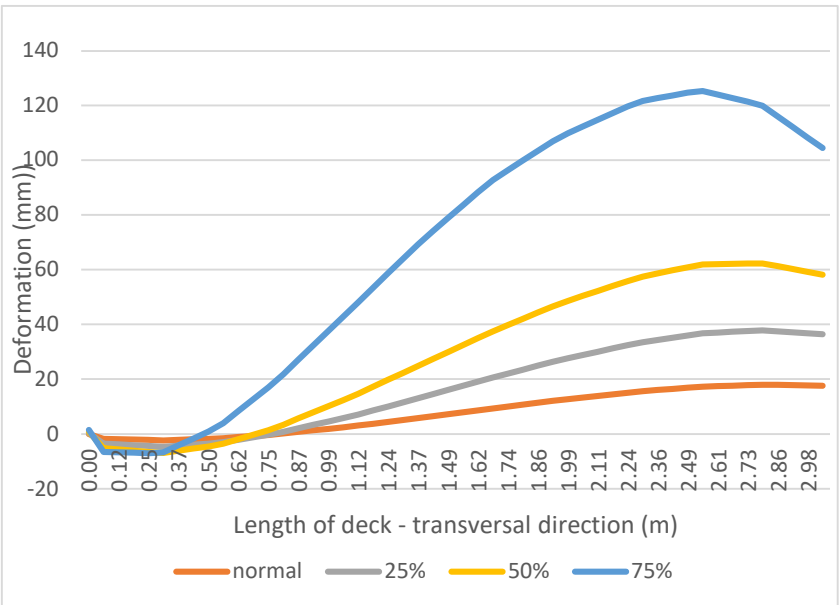
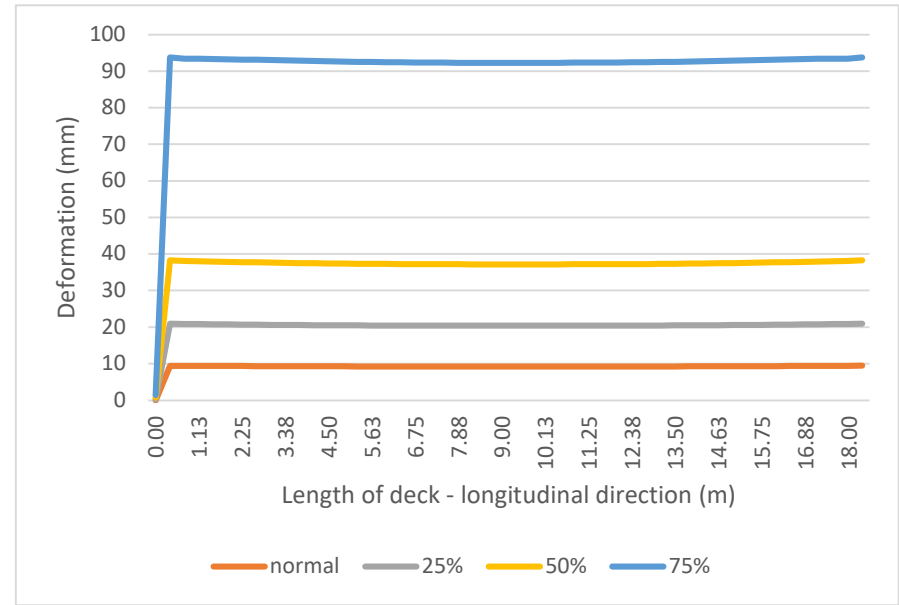


| S1 trans |      |        |        |        |         |
|----------|------|--------|--------|--------|---------|
| mm       | m    | normal | 25%    | 50%    | 75%     |
| 0        | 0.00 | 1.134  | 1.242  | 1.451  | 2.051   |
| 71.08    | 0.07 | 0.930  | 1.054  | 1.417  | 8.073   |
| 142.16   | 0.14 | 0.726  | 0.865  | 1.384  | 14.095  |
| 213.24   | 0.21 | 0.521  | 0.677  | 1.350  | 20.117  |
| 284.32   | 0.28 | 0.317  | 0.488  | 1.316  | 26.138  |
| 355.4    | 0.36 | 0.361  | 0.608  | 1.790  | 38.906  |
| 426.48   | 0.43 | 0.451  | 0.785  | 2.358  | 52.921  |
| 497.56   | 0.50 | 0.541  | 0.963  | 2.926  | 66.936  |
| 568.64   | 0.57 | 0.631  | 1.140  | 3.494  | 80.952  |
| 639.72   | 0.64 | 0.889  | 1.517  | 4.352  | 97.920  |
| 710.8    | 0.71 | 1.202  | 1.958  | 5.305  | 115.850 |
| 781.88   | 0.78 | 1.514  | 2.400  | 6.258  | 133.770 |
| 852.96   | 0.85 | 1.826  | 2.841  | 7.210  | 151.700 |
| 924.04   | 0.92 | 2.239  | 3.392  | 8.276  | 169.140 |
| 995.12   | 1.00 | 2.702  | 3.999  | 9.400  | 186.340 |
| 1066.2   | 1.07 | 3.166  | 4.605  | 10.523 | 203.540 |
| 1137.3   | 1.14 | 3.629  | 5.211  | 11.647 | 220.730 |
| 1208.4   | 1.21 | 4.142  | 5.861  | 12.769 | 236.480 |
| 1279.4   | 1.28 | 4.683  | 6.535  | 13.892 | 251.420 |
| 1350.5   | 1.35 | 5.223  | 7.209  | 15.014 | 266.350 |
| 1421.6   | 1.42 | 5.763  | 7.883  | 16.136 | 281.290 |
| 1492.7   | 1.49 | 6.305  | 8.558  | 17.261 | 296.260 |
| 1563.8   | 1.56 | 6.860  | 9.218  | 18.224 | 305.280 |
| 1634.8   | 1.63 | 7.416  | 9.879  | 19.190 | 314.330 |
| 1705.9   | 1.71 | 7.972  | 10.540 | 20.155 | 323.370 |
| 1777     | 1.78 | 8.528  | 11.200 | 21.117 | 332.260 |
| 1848.1   | 1.85 | 9.048  | 11.780 | 21.789 | 330.550 |
| 1919.2   | 1.92 | 9.569  | 12.360 | 22.461 | 328.830 |
| 1990.2   | 1.99 | 10.089 | 12.940 | 23.133 | 327.120 |
| 2061.3   | 2.06 | 10.606 | 13.516 | 23.794 | 325.090 |
| 2132.4   | 2.13 | 11.036 | 13.952 | 24.099 | 313.410 |
| 2203.5   | 2.20 | 11.465 | 14.388 | 24.405 | 301.720 |
| 2274.6   | 2.27 | 11.894 | 14.824 | 24.710 | 290.040 |
| 2345.6   | 2.35 | 12.308 | 15.238 | 24.975 | 277.750 |
| 2416.7   | 2.42 | 12.613 | 15.497 | 24.951 | 261.170 |
| 2487.8   | 2.49 | 12.918 | 15.756 | 24.927 | 244.600 |
| 2558.9   | 2.56 | 13.223 | 16.015 | 24.904 | 228.020 |
| 2630     | 2.63 | 13.528 | 16.274 | 24.880 | 211.440 |
| 2701     | 2.70 | 13.755 | 16.430 | 24.693 | 194.440 |
| 2772.1   | 2.77 | 13.898 | 16.475 | 24.328 | 177.000 |
| 2843.2   | 2.84 | 14.041 | 16.519 | 23.964 | 159.550 |
| 2914.3   | 2.91 | 14.184 | 16.564 | 23.599 | 142.100 |
| 2985.4   | 2.99 | 14.124 | 16.353 | 22.846 | 125.520 |
| 3056.4   | 3.06 | 14.057 | 16.135 | 22.080 | 108.970 |
| 3127.5   | 3.13 | 13.991 | 15.917 | 21.314 | 92.419  |
| 3198.6   | 3.20 | 13.813 | 15.567 | 20.385 | 77.759  |
| 3269.7   | 3.27 | 13.505 | 15.063 | 19.265 | 65.313  |
| 3340.8   | 3.34 | 13.197 | 14.560 | 18.145 | 52.866  |
| 3411.8   | 3.41 | 12.888 | 14.056 | 17.025 | 40.420  |

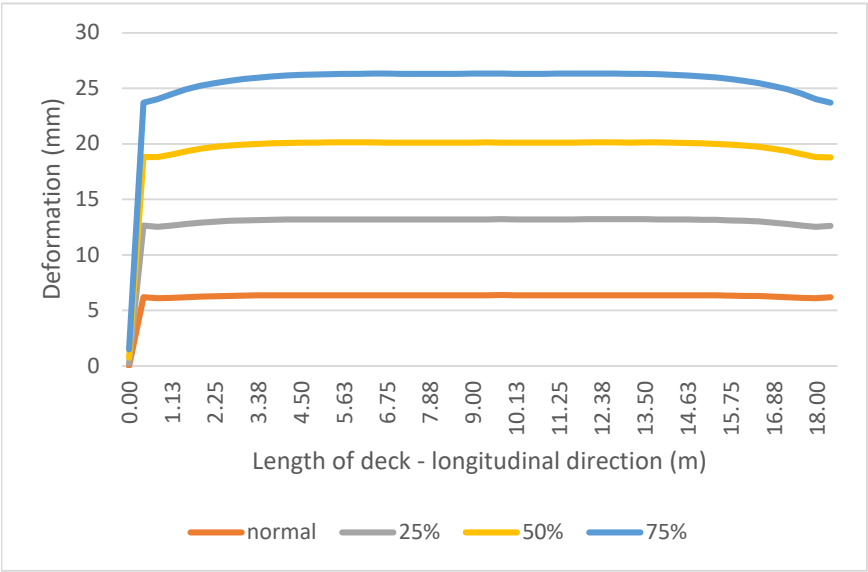


| S2 longi |       |        |        |        |        |
|----------|-------|--------|--------|--------|--------|
| mm       | m     | normal | 25%    | 50%    | 75%    |
| 0        | 0.00  | 9.460  | 11.500 | 17.304 | 55.467 |
| 375      | 0.38  | 9.425  | 11.445 | 17.201 | 55.270 |
| 750      | 0.75  | 9.407  | 11.423 | 17.178 | 55.377 |
| 1125     | 1.13  | 9.387  | 11.398 | 17.143 | 55.397 |
| 1500     | 1.50  | 9.368  | 11.373 | 17.108 | 55.399 |
| 1875     | 1.88  | 9.350  | 11.349 | 17.074 | 55.390 |
| 2250     | 2.25  | 9.334  | 11.327 | 17.042 | 55.377 |
| 2625     | 2.63  | 9.318  | 11.306 | 17.011 | 55.364 |
| 3000     | 3.00  | 9.303  | 11.286 | 16.980 | 55.337 |
| 3375     | 3.38  | 9.290  | 11.268 | 16.950 | 55.309 |
| 3750     | 3.75  | 9.279  | 11.251 | 16.923 | 55.281 |
| 4125     | 4.13  | 9.269  | 11.236 | 16.898 | 55.256 |
| 4500     | 4.50  | 9.260  | 11.223 | 16.875 | 55.233 |
| 4875     | 4.88  | 9.253  | 11.212 | 16.854 | 55.211 |
| 5250     | 5.25  | 9.248  | 11.203 | 16.836 | 55.192 |
| 5625     | 5.63  | 9.243  | 11.195 | 16.820 | 55.174 |
| 6000     | 6.00  | 9.240  | 11.188 | 16.806 | 55.159 |
| 6375     | 6.38  | 9.237  | 11.183 | 16.794 | 55.145 |
| 6750     | 6.75  | 9.235  | 11.178 | 16.783 | 55.134 |
| 7125     | 7.13  | 9.233  | 11.175 | 16.775 | 55.124 |
| 7500     | 7.50  | 9.232  | 11.172 | 16.768 | 55.116 |
| 7875     | 7.88  | 9.231  | 11.170 | 16.763 | 55.111 |
| 8250     | 8.25  | 9.231  | 11.169 | 16.759 | 55.107 |
| 8625     | 8.63  | 9.230  | 11.168 | 16.757 | 55.105 |
| 9000     | 9.00  | 9.230  | 11.168 | 16.756 | 55.105 |
| 9375     | 9.38  | 9.230  | 11.168 | 16.756 | 55.107 |
| 9750     | 9.75  | 9.230  | 11.169 | 16.759 | 55.111 |
| 10125    | 10.13 | 9.231  | 11.170 | 16.762 | 55.116 |
| 10500    | 10.50 | 9.231  | 11.172 | 16.767 | 55.124 |
| 10875    | 10.88 | 9.232  | 11.174 | 16.774 | 55.133 |
| 11250    | 11.25 | 9.234  | 11.177 | 16.782 | 55.144 |
| 11625    | 11.63 | 9.236  | 11.182 | 16.792 | 55.157 |
| 12000    | 12.00 | 9.239  | 11.187 | 16.804 | 55.172 |
| 12375    | 12.38 | 9.242  | 11.193 | 16.817 | 55.189 |
| 12750    | 12.75 | 9.246  | 11.201 | 16.833 | 55.208 |
| 13125    | 13.13 | 9.252  | 11.210 | 16.851 | 55.229 |
| 13500    | 13.50 | 9.259  | 11.221 | 16.872 | 55.253 |
| 13875    | 13.88 | 9.267  | 11.234 | 16.894 | 55.278 |
| 14250    | 14.25 | 9.277  | 11.248 | 16.919 | 55.305 |
| 14625    | 14.63 | 9.288  | 11.265 | 16.946 | 55.333 |
| 15000    | 15.00 | 9.301  | 11.283 | 16.976 | 55.363 |
| 15375    | 15.38 | 9.316  | 11.303 | 17.007 | 55.393 |
| 15750    | 15.75 | 9.332  | 11.325 | 17.039 | 55.419 |
| 16125    | 16.13 | 9.349  | 11.348 | 17.073 | 55.441 |
| 16500    | 16.50 | 9.367  | 11.371 | 17.106 | 55.448 |
| 16875    | 16.88 | 9.385  | 11.395 | 17.139 | 55.438 |
| 17250    | 17.25 | 9.404  | 11.418 | 17.168 | 55.389 |
| 17625    | 17.63 | 9.423  | 11.442 | 17.196 | 55.311 |
| 18000    | 18.00 | 9.458  | 11.496 | 17.298 | 55.507 |

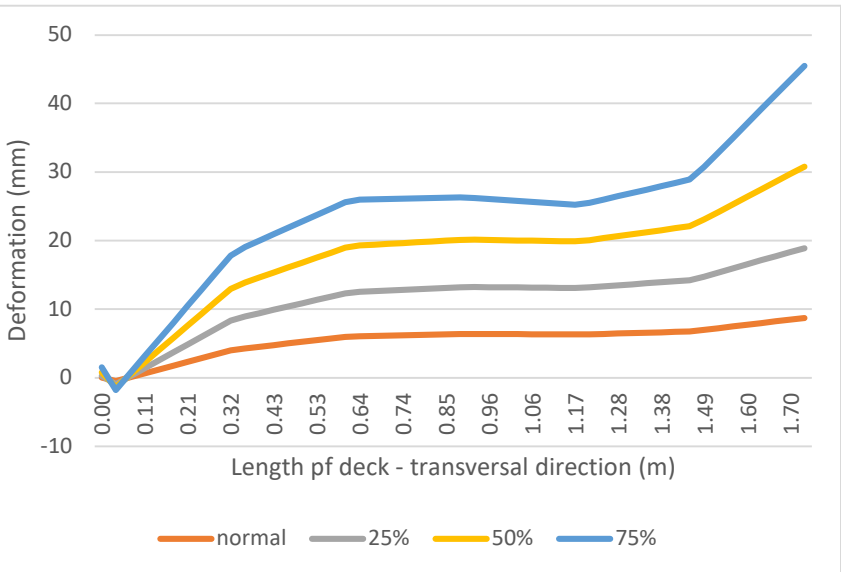
| S2 trans |      |        |        |        |        |
|----------|------|--------|--------|--------|--------|
| mm       | m    | normal | 25%    | 50%    | 75%    |
| 0        | 0.00 | -1.770 | -1.740 | -1.681 | -1.405 |
| 62.126   | 0.06 | -1.910 | -1.904 | -1.838 | -1.082 |
| 124.25   | 0.12 | -2.050 | -2.068 | -1.995 | -0.760 |
| 186.38   | 0.19 | -2.190 | -2.233 | -2.152 | -0.438 |
| 248.5    | 0.25 | -2.281 | -2.339 | -2.225 | 0.118  |
| 310.63   | 0.31 | -2.120 | -2.137 | -1.851 | 1.911  |
| 372.75   | 0.37 | -1.958 | -1.935 | -1.478 | 3.704  |
| 434.88   | 0.43 | -1.796 | -1.733 | -1.104 | 5.497  |
| 497      | 0.50 | -1.557 | -1.441 | -0.605 | 7.571  |
| 559.13   | 0.56 | -1.154 | -0.952 | 0.164  | 10.250 |
| 621.26   | 0.62 | -0.750 | -0.463 | 0.933  | 12.929 |
| 683.38   | 0.68 | -0.346 | 0.026  | 1.703  | 15.608 |
| 745.51   | 0.75 | 0.152  | 0.624  | 2.597  | 18.465 |
| 807.63   | 0.81 | 0.726  | 1.309  | 3.591  | 21.465 |
| 869.76   | 0.87 | 1.300  | 1.993  | 4.585  | 24.465 |
| 931.88   | 0.93 | 1.875  | 2.677  | 5.580  | 27.465 |
| 994.01   | 0.99 | 2.449  | 3.362  | 6.574  | 30.465 |
| 1056.1   | 1.06 | 3.048  | 4.072  | 7.585  | 33.409 |
| 1118.3   | 1.12 | 3.727  | 4.863  | 8.646  | 36.178 |
| 1180.4   | 1.18 | 4.405  | 5.653  | 9.708  | 38.947 |
| 1242.5   | 1.24 | 5.083  | 6.443  | 10.770 | 41.716 |
| 1304.6   | 1.30 | 5.761  | 7.234  | 11.832 | 44.486 |
| 1366.8   | 1.37 | 6.467  | 8.040  | 12.861 | 46.841 |
| 1428.9   | 1.43 | 7.185  | 8.853  | 13.874 | 48.990 |
| 1491     | 1.49 | 7.904  | 9.666  | 14.887 | 51.139 |
| 1553.1   | 1.55 | 8.622  | 10.480 | 15.900 | 53.289 |
| 1615.3   | 1.62 | 9.336  | 11.284 | 16.889 | 55.315 |
| 1677.4   | 1.68 | 10.020 | 12.031 | 17.728 | 56.578 |
| 1739.5   | 1.74 | 10.705 | 12.777 | 18.568 | 57.842 |
| 1801.6   | 1.80 | 11.389 | 13.524 | 19.408 | 59.105 |
| 1863.8   | 1.86 | 12.073 | 14.270 | 20.248 | 60.368 |
| 1925.9   | 1.93 | 12.700 | 14.935 | 20.954 | 61.247 |
| 1988     | 1.99 | 13.291 | 15.547 | 21.575 | 61.881 |
| 2050.1   | 2.05 | 13.881 | 16.159 | 22.195 | 62.515 |
| 2112.3   | 2.11 | 14.471 | 16.771 | 22.816 | 63.149 |
| 2174.4   | 2.17 | 15.061 | 17.383 | 23.436 | 63.783 |
| 2236.5   | 2.24 | 15.602 | 17.932 | 23.964 | 64.186 |
| 2298.6   | 2.30 | 16.029 | 18.330 | 24.271 | 64.047 |
| 2360.8   | 2.36 | 16.455 | 18.728 | 24.578 | 63.907 |
| 2422.9   | 2.42 | 16.881 | 19.127 | 24.886 | 63.768 |
| 2485     | 2.49 | 17.272 | 19.481 | 25.125 | 63.434 |
| 2547.2   | 2.55 | 17.461 | 19.578 | 24.976 | 61.984 |
| 2609.3   | 2.61 | 17.650 | 19.676 | 24.827 | 60.534 |
| 2671.4   | 2.67 | 17.839 | 19.774 | 24.678 | 59.083 |
| 2733.5   | 2.73 | 18.006 | 19.845 | 24.489 | 57.533 |
| 2795.7   | 2.80 | 17.901 | 19.579 | 23.811 | 54.726 |
| 2857.8   | 2.86 | 17.796 | 19.313 | 23.133 | 51.919 |
| 2919.9   | 2.92 | 17.692 | 19.047 | 22.455 | 49.112 |
| 2982     | 2.98 | 17.587 | 18.781 | 21.777 | 46.305 |



| S3 longi |       |        |       |       |       |
|----------|-------|--------|-------|-------|-------|
| mm       | m     | normal | 25%   | 50%   | 75%   |
| 0        | 0.00  | 6.183  | 6.446 | 6.165 | 4.922 |
| 375      | 0.38  | 6.100  | 6.427 | 6.276 | 5.204 |
| 750      | 0.75  | 6.130  | 6.498 | 6.420 | 5.442 |
| 1125     | 1.13  | 6.193  | 6.585 | 6.546 | 5.583 |
| 1500     | 1.50  | 6.249  | 6.657 | 6.643 | 5.670 |
| 1875     | 1.88  | 6.290  | 6.710 | 6.717 | 5.745 |
| 2250     | 2.25  | 6.316  | 6.746 | 6.772 | 5.822 |
| 2625     | 2.63  | 6.336  | 6.774 | 6.817 | 5.899 |
| 3000     | 3.00  | 6.350  | 6.794 | 6.850 | 5.968 |
| 3375     | 3.38  | 6.359  | 6.808 | 6.875 | 6.026 |
| 3750     | 3.75  | 6.365  | 6.817 | 6.893 | 6.074 |
| 4125     | 4.13  | 6.369  | 6.823 | 6.905 | 6.111 |
| 4500     | 4.50  | 6.372  | 6.827 | 6.913 | 6.140 |
| 4875     | 4.88  | 6.373  | 6.829 | 6.917 | 6.161 |
| 5250     | 5.25  | 6.374  | 6.830 | 6.919 | 6.176 |
| 5625     | 5.63  | 6.373  | 6.829 | 6.919 | 6.186 |
| 6000     | 6.00  | 6.373  | 6.828 | 6.917 | 6.193 |
| 6375     | 6.38  | 6.372  | 6.827 | 6.915 | 6.197 |
| 6750     | 6.75  | 6.372  | 6.825 | 6.912 | 6.199 |
| 7125     | 7.13  | 6.372  | 6.825 | 6.910 | 6.200 |
| 7500     | 7.50  | 6.372  | 6.824 | 6.908 | 6.201 |
| 7875     | 7.88  | 6.372  | 6.824 | 6.907 | 6.202 |
| 8250     | 8.25  | 6.373  | 6.825 | 6.907 | 6.204 |
| 8625     | 8.63  | 6.376  | 6.827 | 6.909 | 6.208 |
| 9000     | 9.00  | 6.380  | 6.830 | 6.912 | 6.210 |
| 9375     | 9.38  | 6.379  | 6.829 | 6.908 | 6.204 |
| 9750     | 9.75  | 6.372  | 6.822 | 6.903 | 6.196 |
| 10125    | 10.13 | 6.370  | 6.821 | 6.903 | 6.195 |
| 10500    | 10.50 | 6.373  | 6.825 | 6.909 | 6.200 |
| 10875    | 10.88 | 6.373  | 6.826 | 6.912 | 6.201 |
| 11250    | 11.25 | 6.374  | 6.827 | 6.915 | 6.201 |
| 11625    | 11.63 | 6.375  | 6.829 | 6.918 | 6.200 |
| 12000    | 12.00 | 6.375  | 6.831 | 6.921 | 6.196 |
| 12375    | 12.38 | 6.375  | 6.831 | 6.922 | 6.188 |
| 12750    | 12.75 | 6.376  | 6.832 | 6.922 | 6.178 |
| 13125    | 13.13 | 6.375  | 6.831 | 6.921 | 6.163 |
| 13500    | 13.50 | 6.373  | 6.829 | 6.916 | 6.141 |
| 13875    | 13.88 | 6.371  | 6.826 | 6.909 | 6.113 |
| 14250    | 14.25 | 6.367  | 6.820 | 6.896 | 6.076 |
| 14625    | 14.63 | 6.360  | 6.810 | 6.878 | 6.027 |
| 15000    | 15.00 | 6.352  | 6.796 | 6.853 | 5.969 |
| 15375    | 15.38 | 6.336  | 6.774 | 6.817 | 5.896 |
| 15750    | 15.75 | 6.318  | 6.748 | 6.774 | 5.821 |
| 16125    | 16.13 | 6.292  | 6.712 | 6.718 | 5.743 |
| 16500    | 16.50 | 6.249  | 6.656 | 6.640 | 5.662 |
| 16875    | 16.88 | 6.201  | 6.592 | 6.551 | 5.583 |
| 17250    | 17.25 | 6.133  | 6.503 | 6.428 | 5.447 |
| 17625    | 17.63 | 6.101  | 6.430 | 6.283 | 5.209 |
| 18000    | 18.00 | 6.181  | 6.444 | 6.163 | 4.916 |

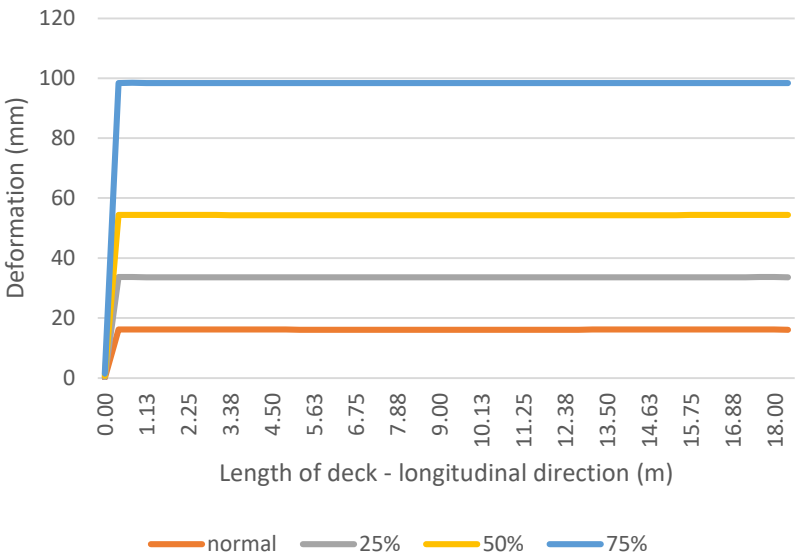
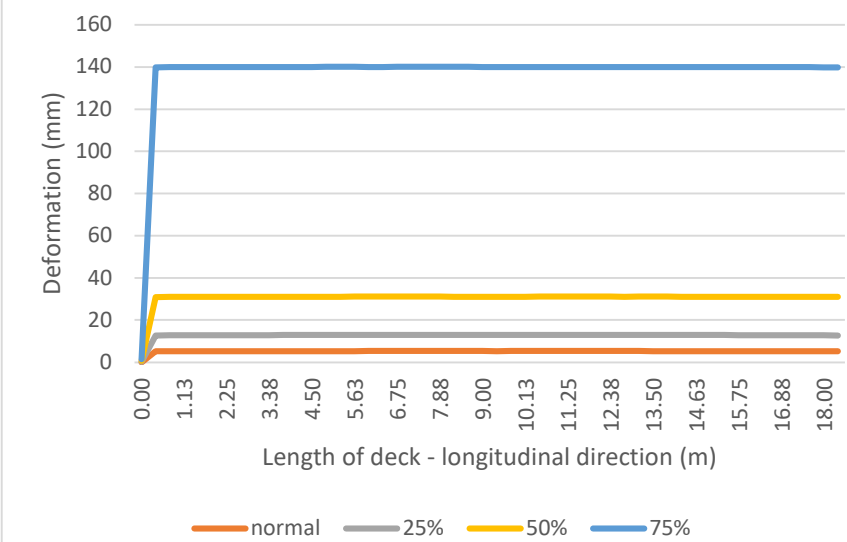


| S3 trans |      |        |        |        |        |
|----------|------|--------|--------|--------|--------|
| mm       | m    | normal | 25%    | 50%    | 75%    |
| 0        | 0.00 | -0.485 | -0.458 | -0.412 | -0.421 |
| 35.449   | 0.04 | 0.072  | 0.140  | 0.219  | 0.240  |
| 70.897   | 0.07 | 0.630  | 0.739  | 0.851  | 0.901  |
| 106.35   | 0.11 | 1.187  | 1.337  | 1.483  | 1.561  |
| 141.79   | 0.14 | 1.745  | 1.935  | 2.114  | 2.222  |
| 177.24   | 0.18 | 2.302  | 2.533  | 2.746  | 2.883  |
| 212.69   | 0.21 | 2.859  | 3.131  | 3.377  | 3.543  |
| 248.14   | 0.25 | 3.417  | 3.730  | 4.009  | 4.204  |
| 283.59   | 0.28 | 3.974  | 4.328  | 4.641  | 4.865  |
| 319.04   | 0.32 | 4.277  | 4.648  | 4.962  | 5.169  |
| 354.49   | 0.35 | 4.513  | 4.896  | 5.203  | 5.381  |
| 389.93   | 0.39 | 4.749  | 5.143  | 5.443  | 5.593  |
| 425.38   | 0.43 | 4.985  | 5.391  | 5.684  | 5.804  |
| 460.83   | 0.46 | 5.221  | 5.639  | 5.924  | 6.016  |
| 496.28   | 0.50 | 5.457  | 5.886  | 6.165  | 6.227  |
| 531.73   | 0.53 | 5.693  | 6.134  | 6.405  | 6.439  |
| 567.18   | 0.57 | 5.929  | 6.381  | 6.646  | 6.651  |
| 602.63   | 0.60 | 6.040  | 6.495  | 6.742  | 6.676  |
| 638.08   | 0.64 | 6.087  | 6.542  | 6.764  | 6.607  |
| 673.52   | 0.67 | 6.134  | 6.588  | 6.787  | 6.538  |
| 708.97   | 0.71 | 6.181  | 6.634  | 6.810  | 6.468  |
| 744.42   | 0.74 | 6.228  | 6.681  | 6.832  | 6.399  |
| 779.87   | 0.78 | 6.275  | 6.727  | 6.855  | 6.330  |
| 815.32   | 0.82 | 6.322  | 6.773  | 6.878  | 6.261  |
| 850.77   | 0.85 | 6.369  | 6.819  | 6.901  | 6.192  |
| 886.22   | 0.89 | 6.378  | 6.832  | 6.900  | 6.098  |
| 921.66   | 0.92 | 6.366  | 6.826  | 6.886  | 5.990  |
| 957.11   | 0.96 | 6.354  | 6.820  | 6.871  | 5.882  |
| 992.56   | 0.99 | 6.342  | 6.814  | 6.857  | 5.774  |
| 1028     | 1.03 | 6.330  | 6.808  | 6.843  | 5.666  |
| 1063.5   | 1.06 | 6.318  | 6.802  | 6.829  | 5.558  |
| 1098.9   | 1.10 | 6.306  | 6.795  | 6.815  | 5.451  |
| 1134.4   | 1.13 | 6.294  | 6.789  | 6.801  | 5.343  |
| 1169.8   | 1.17 | 6.326  | 6.846  | 6.886  | 5.431  |
| 1205.3   | 1.21 | 6.383  | 6.937  | 7.027  | 5.629  |
| 1240.7   | 1.24 | 6.440  | 7.028  | 7.168  | 5.827  |
| 1276.2   | 1.28 | 6.497  | 7.119  | 7.309  | 6.024  |
| 1311.6   | 1.31 | 6.555  | 7.210  | 7.450  | 6.222  |
| 1347     | 1.35 | 6.612  | 7.301  | 7.591  | 6.419  |
| 1382.5   | 1.38 | 6.669  | 7.392  | 7.732  | 6.617  |
| 1417.9   | 1.42 | 6.726  | 7.483  | 7.873  | 6.815  |
| 1453.4   | 1.45 | 6.948  | 7.783  | 8.320  | 7.685  |
| 1488.8   | 1.49 | 7.204  | 8.126  | 8.827  | 8.688  |
| 1524.3   | 1.52 | 7.459  | 8.468  | 9.335  | 9.692  |
| 1559.7   | 1.56 | 7.714  | 8.811  | 9.842  | 10.696 |
| 1595.2   | 1.60 | 7.970  | 9.153  | 10.350 | 11.699 |
| 1630.6   | 1.63 | 8.225  | 9.496  | 10.857 | 12.703 |
| 1666.1   | 1.67 | 8.481  | 9.838  | 11.365 | 13.707 |
| 1701.5   | 1.70 | 8.736  | 10.181 | 11.872 | 14.710 |

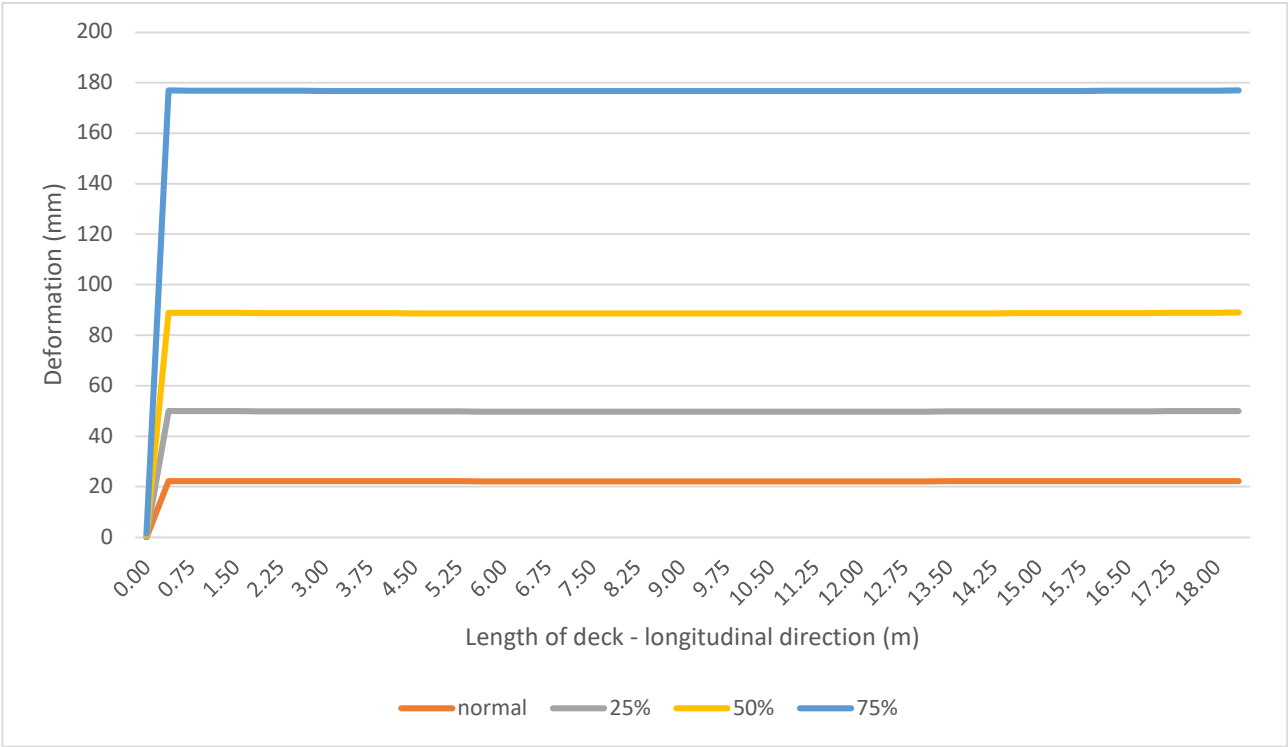


| B1 longi |       |        |       |        |         |
|----------|-------|--------|-------|--------|---------|
| mm       | m     | normal | 25%   | 50%    | 75%     |
| 0        | 0.00  | 5.135  | 7.544 | 18.228 | 108.970 |
| 375      | 0.38  | 5.150  | 7.556 | 18.226 | 108.970 |
| 750      | 0.75  | 5.164  | 7.567 | 18.223 | 108.970 |
| 1125     | 1.13  | 5.177  | 7.577 | 18.220 | 108.980 |
| 1500     | 1.50  | 5.188  | 7.587 | 18.216 | 108.980 |
| 1875     | 1.88  | 5.199  | 7.595 | 18.212 | 108.980 |
| 2250     | 2.25  | 5.208  | 7.603 | 18.207 | 108.980 |
| 2625     | 2.63  | 5.217  | 7.610 | 18.202 | 108.980 |
| 3000     | 3.00  | 5.224  | 7.616 | 18.197 | 108.980 |
| 3375     | 3.38  | 5.231  | 7.622 | 18.192 | 108.980 |
| 3750     | 3.75  | 5.237  | 7.627 | 18.186 | 108.980 |
| 4125     | 4.13  | 5.243  | 7.631 | 18.181 | 108.980 |
| 4500     | 4.50  | 5.248  | 7.635 | 18.175 | 108.980 |
| 4875     | 4.88  | 5.252  | 7.638 | 18.169 | 108.980 |
| 5250     | 5.25  | 5.256  | 7.641 | 18.164 | 108.980 |
| 5625     | 5.63  | 5.259  | 7.644 | 18.159 | 108.980 |
| 6000     | 6.00  | 5.262  | 7.646 | 18.154 | 108.980 |
| 6375     | 6.38  | 5.264  | 7.648 | 18.149 | 108.980 |
| 6750     | 6.75  | 5.266  | 7.649 | 18.145 | 108.980 |
| 7125     | 7.13  | 5.268  | 7.650 | 18.142 | 108.980 |
| 7500     | 7.50  | 5.269  | 7.651 | 18.139 | 108.980 |
| 7875     | 7.88  | 5.271  | 7.652 | 18.136 | 108.980 |
| 8250     | 8.25  | 5.271  | 7.653 | 18.135 | 108.980 |
| 8625     | 8.63  | 5.272  | 7.653 | 18.133 | 108.970 |
| 9000     | 9.00  | 5.272  | 7.653 | 18.133 | 108.970 |
| 9375     | 9.38  | 5.272  | 7.653 | 18.133 | 108.970 |
| 9750     | 9.75  | 5.272  | 7.653 | 18.134 | 108.970 |
| 10125    | 10.13 | 5.271  | 7.653 | 18.136 | 108.970 |
| 10500    | 10.50 | 5.270  | 7.652 | 18.138 | 108.970 |
| 10875    | 10.88 | 5.269  | 7.651 | 18.141 | 108.970 |
| 11250    | 11.25 | 5.267  | 7.650 | 18.144 | 108.960 |
| 11625    | 11.63 | 5.265  | 7.648 | 18.148 | 108.960 |
| 12000    | 12.00 | 5.263  | 7.647 | 18.153 | 108.960 |
| 12375    | 12.38 | 5.260  | 7.645 | 18.158 | 108.960 |
| 12750    | 12.75 | 5.257  | 7.643 | 18.163 | 108.950 |
| 13125    | 13.13 | 5.253  | 7.640 | 18.168 | 108.950 |
| 13500    | 13.50 | 5.249  | 7.637 | 18.174 | 108.950 |
| 13875    | 13.88 | 5.245  | 7.633 | 18.180 | 108.950 |
| 14250    | 14.25 | 5.239  | 7.629 | 18.186 | 108.950 |
| 14625    | 14.63 | 5.234  | 7.625 | 18.192 | 108.940 |
| 15000    | 15.00 | 5.227  | 7.620 | 18.197 | 108.940 |
| 15375    | 15.38 | 5.220  | 7.614 | 18.203 | 108.940 |
| 15750    | 15.75 | 5.211  | 7.607 | 18.208 | 108.940 |
| 16125    | 16.13 | 5.202  | 7.600 | 18.213 | 108.940 |
| 16500    | 16.50 | 5.192  | 7.592 | 18.218 | 108.940 |
| 16875    | 16.88 | 5.181  | 7.583 | 18.222 | 108.930 |
| 17250    | 17.25 | 5.168  | 7.573 | 18.225 | 108.930 |
| 17625    | 17.63 | 5.154  | 7.562 | 18.229 | 108.930 |
| 18000    | 18.00 | 5.139  | 7.551 | 18.232 | 108.920 |

| B2 longi |       |        |        |        |        |
|----------|-------|--------|--------|--------|--------|
| mm       | m     | normal | 25%    | 50%    | 75%    |
| 0        | 0.00  | 16.109 | 17.503 | 20.761 | 44.080 |
| 375      | 0.38  | 16.106 | 17.500 | 20.758 | 44.080 |
| 750      | 0.75  | 16.105 | 17.499 | 20.756 | 44.082 |
| 1125     | 1.13  | 16.103 | 17.497 | 20.754 | 44.084 |
| 1500     | 1.50  | 16.101 | 17.495 | 20.752 | 44.086 |
| 1875     | 1.88  | 16.099 | 17.493 | 20.749 | 44.088 |
| 2250     | 2.25  | 16.097 | 17.490 | 20.747 | 44.089 |
| 2625     | 2.63  | 16.096 | 17.488 | 20.744 | 44.091 |
| 3000     | 3.00  | 16.094 | 17.486 | 20.742 | 44.093 |
| 3375     | 3.38  | 16.092 | 17.484 | 20.739 | 44.094 |
| 3750     | 3.75  | 16.091 | 17.482 | 20.737 | 44.095 |
| 4125     | 4.13  | 16.089 | 17.480 | 20.735 | 44.097 |
| 4500     | 4.50  | 16.088 | 17.479 | 20.733 | 44.098 |
| 4875     | 4.88  | 16.086 | 17.477 | 20.731 | 44.099 |
| 5250     | 5.25  | 16.085 | 17.475 | 20.729 | 44.100 |
| 5625     | 5.63  | 16.084 | 17.474 | 20.727 | 44.101 |
| 6000     | 6.00  | 16.083 | 17.473 | 20.726 | 44.101 |
| 6375     | 6.38  | 16.083 | 17.472 | 20.725 | 44.102 |
| 6750     | 6.75  | 16.082 | 17.471 | 20.723 | 44.102 |
| 7125     | 7.13  | 16.081 | 17.470 | 20.723 | 44.103 |
| 7500     | 7.50  | 16.081 | 17.470 | 20.722 | 44.103 |
| 7875     | 7.88  | 16.081 | 17.469 | 20.721 | 44.102 |
| 8250     | 8.25  | 16.080 | 17.469 | 20.721 | 44.102 |
| 8625     | 8.63  | 16.080 | 17.469 | 20.721 | 44.101 |
| 9000     | 9.00  | 16.080 | 17.469 | 20.721 | 44.100 |
| 9375     | 9.38  | 16.080 | 17.469 | 20.721 | 44.098 |
| 9750     | 9.75  | 16.081 | 17.469 | 20.721 | 44.097 |
| 10125    | 10.13 | 16.081 | 17.470 | 20.722 | 44.095 |
| 10500    | 10.50 | 16.081 | 17.470 | 20.722 | 44.094 |
| 10875    | 10.88 | 16.082 | 17.471 | 20.723 | 44.092 |
| 11250    | 11.25 | 16.083 | 17.472 | 20.724 | 44.091 |
| 11625    | 11.63 | 16.084 | 17.473 | 20.725 | 44.090 |
| 12000    | 12.00 | 16.084 | 17.474 | 20.727 | 44.088 |
| 12375    | 12.38 | 16.085 | 17.475 | 20.728 | 44.087 |
| 12750    | 12.75 | 16.087 | 17.477 | 20.730 | 44.085 |
| 13125    | 13.13 | 16.088 | 17.478 | 20.732 | 44.083 |
| 13500    | 13.50 | 16.089 | 17.480 | 20.734 | 44.081 |
| 13875    | 13.88 | 16.090 | 17.482 | 20.736 | 44.079 |
| 14250    | 14.25 | 16.092 | 17.484 | 20.739 | 44.077 |
| 14625    | 14.63 | 16.094 | 17.486 | 20.741 | 44.075 |
| 15000    | 15.00 | 16.095 | 17.488 | 20.744 | 44.072 |
| 15375    | 15.38 | 16.097 | 17.490 | 20.746 | 44.070 |
| 15750    | 15.75 | 16.099 | 17.492 | 20.749 | 44.068 |
| 16125    | 16.13 | 16.100 | 17.494 | 20.751 | 44.065 |
| 16500    | 16.50 | 16.102 | 17.496 | 20.754 | 44.063 |
| 16875    | 16.88 | 16.104 | 17.498 | 20.756 | 44.060 |
| 17250    | 17.25 | 16.106 | 17.500 | 20.759 | 44.058 |
| 17625    | 17.63 | 16.107 | 17.502 | 20.760 | 44.055 |
| 18000    | 18.00 | 16.110 | 17.505 | 20.764 | 44.053 |



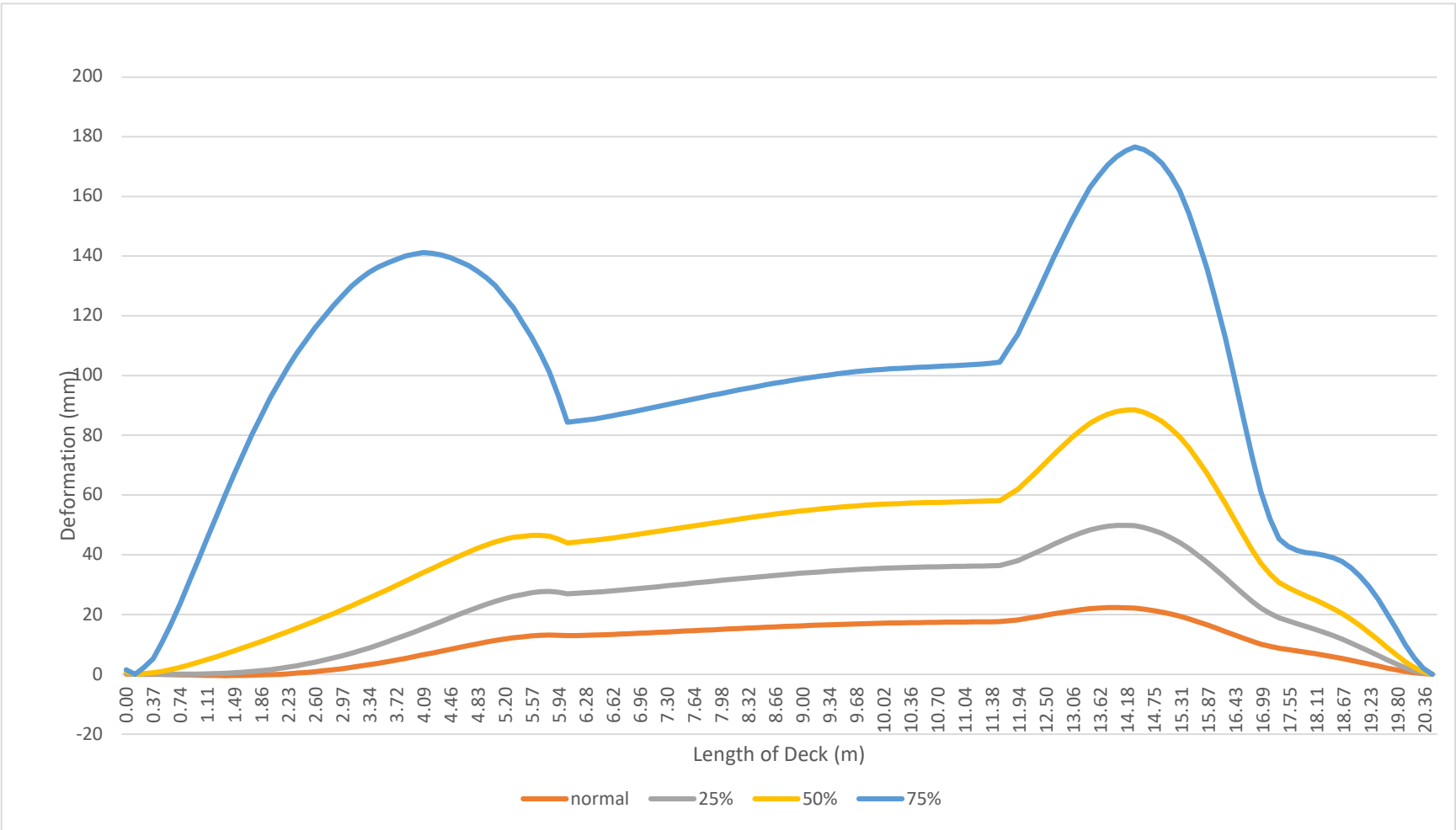
| B3 longi |       |        |        |        |        |
|----------|-------|--------|--------|--------|--------|
| mm       | m     | normal | 25%    | 50%    | 75%    |
| 0        | 0.00  | 22.245 | 27.746 | 38.972 | 88.032 |
| 375      | 0.38  | 22.221 | 27.717 | 38.937 | 88.001 |
| 750      | 0.75  | 22.213 | 27.711 | 38.935 | 88.01  |
| 1125     | 1.13  | 22.202 | 27.7   | 38.926 | 88.013 |
| 1500     | 1.50  | 22.193 | 27.691 | 38.919 | 88.015 |
| 1875     | 1.88  | 22.185 | 27.683 | 38.913 | 88.017 |
| 2250     | 2.25  | 22.177 | 27.675 | 38.906 | 88.02  |
| 2625     | 2.63  | 22.17  | 27.667 | 38.901 | 88.023 |
| 3000     | 3.00  | 22.164 | 27.661 | 38.895 | 88.026 |
| 3375     | 3.38  | 22.158 | 27.654 | 38.89  | 88.029 |
| 3750     | 3.75  | 22.153 | 27.649 | 38.886 | 88.032 |
| 4125     | 4.13  | 22.148 | 27.643 | 38.882 | 88.035 |
| 4500     | 4.50  | 22.144 | 27.638 | 38.878 | 88.037 |
| 4875     | 4.88  | 22.14  | 27.634 | 38.874 | 88.04  |
| 5250     | 5.25  | 22.136 | 27.63  | 38.871 | 88.043 |
| 5625     | 5.63  | 22.133 | 27.626 | 38.868 | 88.045 |
| 6000     | 6.00  | 22.13  | 27.623 | 38.865 | 88.047 |
| 6375     | 6.38  | 22.128 | 27.62  | 38.863 | 88.049 |
| 6750     | 6.75  | 22.126 | 27.618 | 38.861 | 88.051 |
| 7125     | 7.13  | 22.124 | 27.616 | 38.859 | 88.053 |
| 7500     | 7.50  | 22.123 | 27.614 | 38.858 | 88.054 |
| 7875     | 7.88  | 22.122 | 27.613 | 38.857 | 88.055 |
| 8250     | 8.25  | 22.121 | 27.612 | 38.856 | 88.055 |
| 8625     | 8.63  | 22.12  | 27.611 | 38.855 | 88.056 |
| 9000     | 9.00  | 22.12  | 27.611 | 38.855 | 88.056 |
| 9375     | 9.38  | 22.12  | 27.611 | 38.855 | 88.055 |
| 9750     | 9.75  | 22.121 | 27.612 | 38.855 | 88.055 |
| 10125    | 10.13 | 22.121 | 27.613 | 38.856 | 88.054 |
| 10500    | 10.50 | 22.122 | 27.614 | 38.857 | 88.053 |
| 10875    | 10.88 | 22.124 | 27.615 | 38.858 | 88.051 |
| 11250    | 11.25 | 22.126 | 27.617 | 38.859 | 88.05  |
| 11625    | 11.63 | 22.127 | 27.62  | 38.861 | 88.048 |
| 12000    | 12.00 | 22.13  | 27.622 | 38.863 | 88.046 |
| 12375    | 12.38 | 22.132 | 27.625 | 38.866 | 88.043 |
| 12750    | 12.75 | 22.136 | 27.629 | 38.869 | 88.041 |
| 13125    | 13.13 | 22.139 | 27.633 | 38.872 | 88.038 |
| 13500    | 13.50 | 22.143 | 27.637 | 38.875 | 88.035 |
| 13875    | 13.88 | 22.147 | 27.642 | 38.879 | 88.032 |
| 14250    | 14.25 | 22.152 | 27.647 | 38.883 | 88.029 |
| 14625    | 14.63 | 22.157 | 27.653 | 38.887 | 88.026 |
| 15000    | 15.00 | 22.163 | 27.659 | 38.892 | 88.022 |
| 15375    | 15.38 | 22.169 | 27.666 | 38.897 | 88.019 |
| 15750    | 15.75 | 22.176 | 27.673 | 38.903 | 88.016 |
| 16125    | 16.13 | 22.184 | 27.681 | 38.909 | 88.013 |
| 16500    | 16.50 | 22.192 | 27.689 | 38.916 | 88.01  |
| 16875    | 16.88 | 22.201 | 27.698 | 38.922 | 88.008 |
| 17250    | 17.25 | 22.212 | 27.709 | 38.931 | 88.005 |
| 17625    | 17.63 | 22.22  | 27.715 | 38.933 | 87.995 |
| 18000    | 18.00 | 22.243 | 27.744 | 38.967 | 88.026 |





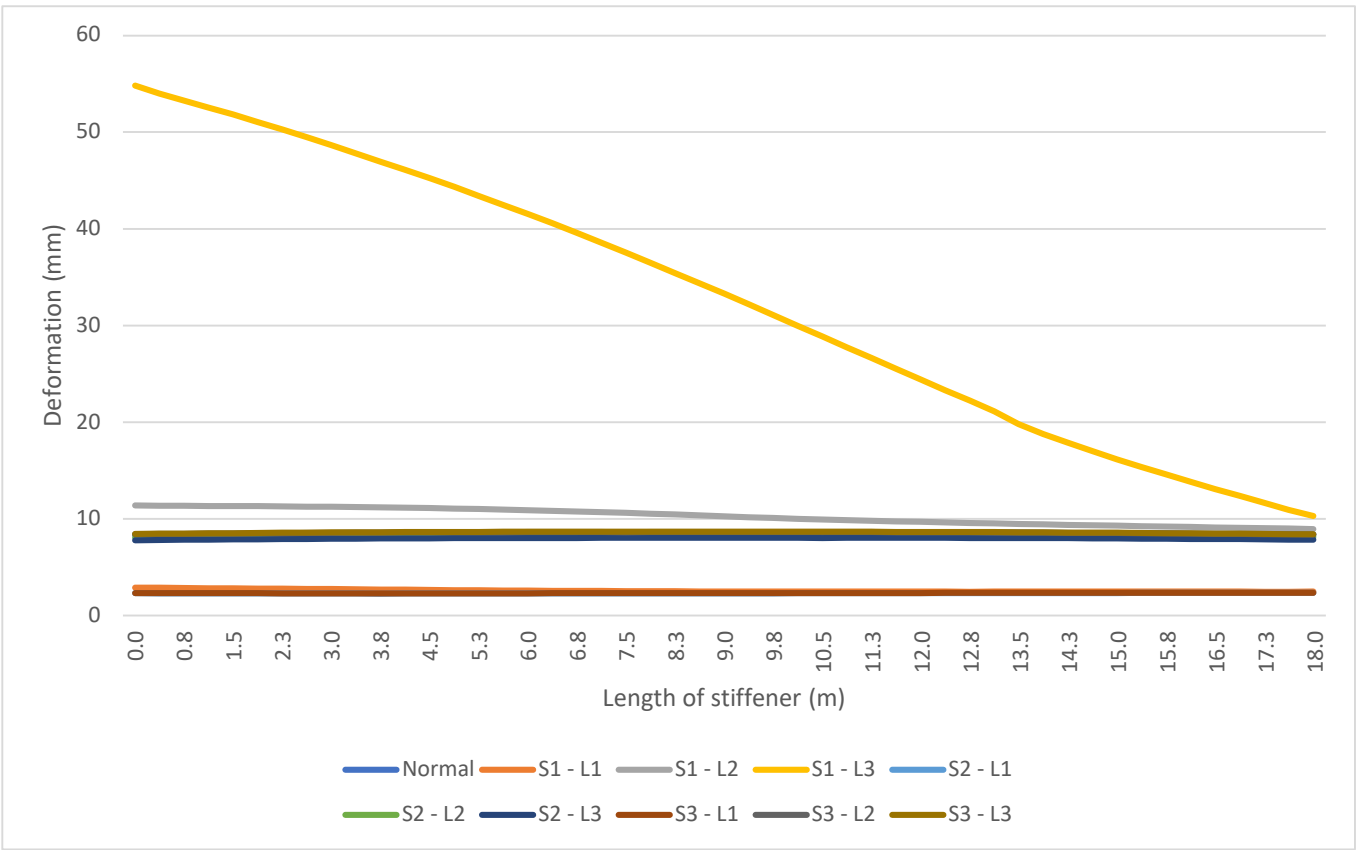
| B1 trans |         |      |        |        |        |         |
|----------|---------|------|--------|--------|--------|---------|
| mm       |         | m    | normal | 25%    | 50%    | 75%     |
| 0        | 0       | 0.00 | 0.000  | 0.000  | 0.000  | 0.000   |
| 123.84   | 123.84  | 0.12 | -0.019 | 0.016  | 0.202  | 2.097   |
| 247.69   | 247.69  | 0.25 | -0.044 | 0.037  | 0.467  | 4.745   |
| 371.53   | 371.53  | 0.37 | -0.094 | 0.080  | 0.993  | 9.667   |
| 495.38   | 495.38  | 0.50 | -0.150 | 0.134  | 1.603  | 15.111  |
| 619.22   | 619.22  | 0.62 | -0.213 | 0.203  | 2.325  | 21.261  |
| 743.07   | 743.07  | 0.74 | -0.271 | 0.289  | 3.114  | 27.632  |
| 866.91   | 866.91  | 0.87 | -0.327 | 0.385  | 3.937  | 34.119  |
| 990.76   | 990.76  | 0.99 | -0.377 | 0.488  | 4.768  | 40.567  |
| 1114.6   | 1114.6  | 1.11 | -0.404 | 0.619  | 5.625  | 46.866  |
| 1238.4   | 1238.4  | 1.24 | -0.430 | 0.749  | 6.482  | 53.165  |
| 1362.3   | 1362.3  | 1.36 | -0.420 | 0.910  | 7.326  | 59.092  |
| 1486.1   | 1486.1  | 1.49 | -0.397 | 1.081  | 8.165  | 64.902  |
| 1610     | 1610    | 1.61 | -0.352 | 1.267  | 8.982  | 70.441  |
| 1733.8   | 1733.8  | 1.73 | -0.265 | 1.481  | 9.757  | 75.457  |
| 1857.7   | 1857.7  | 1.86 | -0.177 | 1.695  | 10.531 | 80.474  |
| 1981.5   | 1981.5  | 1.98 | -0.018 | 1.955  | 11.227 | 84.613  |
| 2105.4   | 2105.4  | 2.11 | 0.147  | 2.218  | 11.917 | 88.675  |
| 2229.2   | 2229.2  | 2.23 | 0.355  | 2.510  | 12.566 | 92.226  |
| 2353     | 2353    | 2.35 | 0.607  | 2.832  | 13.173 | 95.262  |
| 2476.9   | 2476.9  | 2.48 | 0.860  | 3.155  | 13.778 | 98.278  |
| 2600.7   | 2600.7  | 2.60 | 1.175  | 3.519  | 14.331 | 100.690 |
| 2724.6   | 2724.6  | 2.72 | 1.514  | 3.899  | 14.867 | 103.030 |
| 2848.4   | 2848.4  | 2.85 | 1.878  | 4.296  | 15.381 | 105.150 |
| 2972.3   | 2972.3  | 2.97 | 2.270  | 4.712  | 15.869 | 107.000 |
| 3096.1   | 3096.1  | 3.10 | 2.707  | 5.159  | 16.314 | 108.220 |
| 3220     | 3220    | 3.22 | 3.168  | 5.622  | 16.736 | 109.100 |
| 3343.8   | 3343.8  | 3.34 | 3.668  | 6.113  | 17.122 | 109.410 |
| 3467.6   | 3467.6  | 3.47 | 4.202  | 6.629  | 17.475 | 109.360 |
| 3591.5   | 3591.5  | 3.59 | 4.751  | 7.154  | 17.816 | 109.160 |
| 3715.3   | 3715.3  | 3.72 | 5.302  | 7.682  | 18.153 | 108.920 |
| 3839.2   | 3839.2  | 3.84 | 5.894  | 8.237  | 18.439 | 108.050 |
| 3963     | 3963    | 3.96 | 6.486  | 8.793  | 18.725 | 107.180 |
| 4086.9   | 4086.9  | 4.09 | 7.100  | 9.362  | 18.961 | 105.500 |
| 4210.7   | 4210.7  | 4.21 | 7.721  | 9.936  | 19.178 | 103.520 |
| 4334.6   | 4334.6  | 4.33 | 8.341  | 10.508 | 19.370 | 101.270 |
| 4458.4   | 4458.4  | 4.46 | 8.962  | 11.076 | 19.526 | 98.630  |
| 4582.3   | 4582.3  | 4.58 | 9.582  | 11.644 | 19.682 | 95.989  |
| 4706.1   | 4706.1  | 4.71 | 10.168 | 12.174 | 19.777 | 92.865  |
| 4829.9   | 4829.9  | 4.83 | 10.741 | 12.690 | 19.850 | 89.570  |
| 4953.8   | 4953.8  | 4.95 | 11.270 | 13.159 | 19.863 | 85.800  |
| 5077.6   | 5077.6  | 5.08 | 11.736 | 13.562 | 19.793 | 81.361  |
| 5201.5   | 5201.5  | 5.20 | 12.188 | 13.950 | 19.708 | 76.854  |
| 5325.3   | 5325.3  | 5.33 | 12.500 | 14.187 | 19.478 | 71.672  |
| 5449.2   | 5449.2  | 5.45 | 12.812 | 14.424 | 19.247 | 66.490  |
| 5573     | 5573    | 5.57 | 13.037 | 14.564 | 18.926 | 60.971  |
| 5696.9   | 5696.9  | 5.70 | 13.144 | 14.574 | 18.482 | 55.001  |
| 5820.7   | 5820.7  | 5.82 | 13.057 | 14.361 | 17.802 | 47.938  |
| 5944.5   | 5944.5  | 5.94 | 12.891 | 14.059 | 17.028 | 40.437  |
| 113.22   | 6057.72 | 6.06 | 12.966 | 14.151 | 17.154 | 40.489  |
| 226.44   | 6170.94 | 6.17 | 13.041 | 14.244 | 17.282 | 40.552  |
| 339.66   | 6284.16 | 6.28 | 13.116 | 14.337 | 17.409 | 40.616  |
| 452.88   | 6397.38 | 6.40 | 13.217 | 14.454 | 17.553 | 40.749  |
| 566.09   | 6510.59 | 6.51 | 13.334 | 14.587 | 17.708 | 40.923  |
| 679.31   | 6623.81 | 6.62 | 13.451 | 14.720 | 17.862 | 41.098  |
| 792.53   | 6737.03 | 6.74 | 13.579 | 14.863 | 18.022 | 41.275  |
| 905.75   | 6850.25 | 6.85 | 13.713 | 15.009 | 18.183 | 41.453  |
| 1019     | 6963.5  | 6.96 | 13.848 | 15.157 | 18.344 | 41.629  |
| 1132.2   | 7076.7  | 7.08 | 13.991 | 15.311 | 18.508 | 41.798  |
| 1245.4   | 7189.9  | 7.19 | 14.134 | 15.464 | 18.672 | 41.967  |
| 1358.6   | 7303.1  | 7.30 | 14.280 | 15.619 | 18.835 | 42.133  |
| 1471.8   | 7416.3  | 7.42 | 14.427 | 15.774 | 18.998 | 42.296  |
| 1585.1   | 7529.6  | 7.53 | 14.574 | 15.930 | 19.161 | 42.460  |
| 1698.3   | 7642.8  | 7.64 | 14.720 | 16.083 | 19.321 | 42.621  |
| 1811.5   | 7756    | 7.76 | 14.867 | 16.236 | 19.480 | 42.780  |
| 1924.7   | 7869.2  | 7.87 | 15.013 | 16.388 | 19.637 | 42.939  |
| 2037.9   | 7982.4  | 7.98 | 15.155 | 16.535 | 19.787 | 43.093  |
| 2151.2   | 8095.7  | 8.10 | 15.298 | 16.682 | 19.936 | 43.247  |
| 2264.4   | 8208.9  | 8.21 | 15.438 | 16.825 | 20.080 | 43.398  |
| 2377.6   | 8322.1  | 8.32 | 15.575 | 16.964 | 20.220 | 43.547  |
| 2490.8   | 8435.3  | 8.44 | 15.713 | 17.103 | 20.360 | 43.696  |
| 2604     | 8548.5  | 8.55 | 15.845 | 17.235 | 20.491 | 43.841  |
| 2717.3   | 8661.8  | 8.66 | 15.974 | 17.363 | 20.617 | 43.984  |
| 2830.5   | 8775    | 8.78 | 16.101 | 17.489 | 20.740 | 44.124  |

|        |          |       |        |        |        |        |
|--------|----------|-------|--------|--------|--------|--------|
| 2943.7 | 8888.2   | 8.89  | 16.218 | 17.602 | 20.845 | 44.251 |
| 3056.9 | 9001.4   | 9.00  | 16.335 | 17.715 | 20.950 | 44.379 |
| 3170.1 | 9114.6   | 9.11  | 16.445 | 17.818 | 21.042 | 44.499 |
| 3283.3 | 9227.8   | 9.23  | 16.549 | 17.914 | 21.127 | 44.614 |
| 3396.6 | 9341.1   | 9.34  | 16.654 | 18.011 | 21.212 | 44.730 |
| 3509.8 | 9454.3   | 9.45  | 16.749 | 18.096 | 21.282 | 44.834 |
| 3623   | 9567.5   | 9.57  | 16.839 | 18.175 | 21.345 | 44.935 |
| 3736.2 | 9680.7   | 9.68  | 16.927 | 18.251 | 21.404 | 45.030 |
| 3849.4 | 9793.9   | 9.79  | 17.000 | 18.309 | 21.440 | 45.102 |
| 3962.7 | 9907.2   | 9.91  | 17.073 | 18.368 | 21.476 | 45.173 |
| 4075.9 | 10020.4  | 10.02 | 17.137 | 18.416 | 21.499 | 45.234 |
| 4189.1 | 10133.6  | 10.13 | 17.195 | 18.458 | 21.515 | 45.288 |
| 4302.3 | 10246.8  | 10.25 | 17.253 | 18.499 | 21.531 | 45.342 |
| 4415.5 | 10360    | 10.36 | 17.302 | 18.532 | 21.541 | 45.395 |
| 4528.8 | 10473.3  | 10.47 | 17.346 | 18.562 | 21.548 | 45.449 |
| 4642   | 10586.5  | 10.59 | 17.389 | 18.590 | 21.556 | 45.507 |
| 4755.2 | 10699.7  | 10.70 | 17.421 | 18.612 | 21.567 | 45.587 |
| 4868.4 | 10812.9  | 10.81 | 17.454 | 18.635 | 21.578 | 45.667 |
| 4981.6 | 10926.1  | 10.93 | 17.483 | 18.659 | 21.600 | 45.767 |
| 5094.9 | 11039.4  | 11.04 | 17.509 | 18.685 | 21.630 | 45.879 |
| 5208.1 | 11152.6  | 11.15 | 17.535 | 18.710 | 21.659 | 45.990 |
| 5321.3 | 11265.8  | 11.27 | 17.561 | 18.744 | 21.713 | 46.139 |
| 5434.5 | 11379    | 11.38 | 17.588 | 18.782 | 21.778 | 46.303 |
| 187.04 | 11566.04 | 11.57 | 17.897 | 19.308 | 22.801 | 49.129 |
| 374.08 | 11753.08 | 11.75 | 18.208 | 19.838 | 23.832 | 51.961 |
| 561.12 | 11940.12 | 11.94 | 18.692 | 20.655 | 25.342 | 55.482 |
| 748.15 | 12127.15 | 12.13 | 19.186 | 21.492 | 26.876 | 59.007 |
| 935.19 | 12314.19 | 12.31 | 19.711 | 22.384 | 28.478 | 62.547 |
| 1122.2 | 12501.2  | 12.50 | 20.225 | 23.269 | 30.060 | 66.010 |
| 1309.3 | 12688.3  | 12.69 | 20.724 | 24.139 | 31.615 | 69.417 |
| 1496.3 | 12875.3  | 12.88 | 21.174 | 24.948 | 33.083 | 72.703 |
| 1683.3 | 13062.3  | 13.06 | 21.581 | 25.700 | 34.467 | 75.873 |
| 1870.4 | 13249.4  | 13.25 | 21.925 | 26.368 | 35.730 | 78.874 |
| 2057.4 | 13436.4  | 13.44 | 22.137 | 26.857 | 36.708 | 81.318 |
| 2244.5 | 13623.5  | 13.62 | 22.279 | 27.250 | 37.542 | 83.513 |
| 2431.5 | 13810.5  | 13.81 | 22.316 | 27.498 | 38.170 | 85.370 |
| 2618.5 | 13997.5  | 14.00 | 22.255 | 27.609 | 38.595 | 86.867 |
| 2805.6 | 14184.6  | 14.18 | 22.113 | 27.605 | 38.850 | 88.053 |
| 2992.6 | 14371.6  | 14.37 | 21.767 | 27.310 | 38.616 | 87.978 |
| 3179.7 | 14558.7  | 14.56 | 21.332 | 26.884 | 38.175 | 87.458 |
| 3366.7 | 14745.7  | 14.75 | 20.801 | 26.318 | 37.517 | 86.463 |
| 3553.7 | 14932.7  | 14.93 | 20.143 | 25.560 | 36.547 | 84.724 |
| 3740.8 | 15119.8  | 15.12 | 19.404 | 24.676 | 35.358 | 82.350 |
| 3927.8 | 15306.8  | 15.31 | 18.515 | 23.559 | 33.722 | 78.417 |
| 4114.8 | 15493.8  | 15.49 | 17.541 | 22.300 | 31.825 | 73.687 |
| 4301.9 | 15680.9  | 15.68 | 16.519 | 20.963 | 29.783 | 68.515 |
| 4488.9 | 15867.9  | 15.87 | 15.426 | 19.494 | 27.475 | 62.392 |
| 4676   | 16055    | 16.06 | 14.313 | 17.981 | 25.047 | 55.627 |
| 4863   | 16242    | 16.24 | 13.181 | 16.414 | 22.457 | 47.871 |
| 5050   | 16429    | 16.43 | 12.086 | 14.877 | 19.847 | 39.629 |
| 5237.1 | 16616.1  | 16.62 | 11.006 | 13.355 | 17.244 | 31.301 |
| 5424.1 | 16803.1  | 16.80 | 10.080 | 12.046 | 14.980 | 23.946 |
| 5611.2 | 16990.2  | 16.99 | 9.319  | 10.983 | 13.186 | 18.440 |
| 5798.2 | 17177.2  | 17.18 | 8.704  | 10.141 | 11.823 | 14.651 |
| 5985.2 | 17364.2  | 17.36 | 8.260  | 9.598  | 11.133 | 13.814 |
| 6172.3 | 17551.3  | 17.55 | 7.813  | 9.095  | 10.621 | 13.870 |
| 6359.3 | 17738.3  | 17.74 | 7.359  | 8.615  | 10.225 | 14.506 |
| 6546.3 | 17925.3  | 17.93 | 6.881  | 8.134  | 9.893  | 15.458 |
| 6733.4 | 18112.4  | 18.11 | 6.368  | 7.616  | 9.526  | 16.324 |
| 6920.4 | 18299.4  | 18.30 | 5.828  | 7.063  | 9.101  | 17.005 |
| 7107.5 | 18486.5  | 18.49 | 5.256  | 6.465  | 8.597  | 17.416 |
| 7294.5 | 18673.5  | 18.67 | 4.640  | 5.791  | 7.929  | 17.207 |
| 7481.5 | 18860.5  | 18.86 | 4.005  | 5.074  | 7.155  | 16.550 |
| 7668.6 | 19047.6  | 19.05 | 3.355  | 4.319  | 6.276  | 15.423 |
| 7855.6 | 19234.6  | 19.23 | 2.699  | 3.526  | 5.260  | 13.599 |
| 8042.7 | 19421.7  | 19.42 | 2.064  | 2.733  | 4.178  | 11.278 |
| 8229.7 | 19608.7  | 19.61 | 1.460  | 1.962  | 3.076  | 8.654  |
| 8416.7 | 19795.7  | 19.80 | 0.913  | 1.244  | 1.993  | 5.777  |
| 8603.8 | 19982.8  | 19.98 | 0.489  | 0.671  | 1.087  | 3.168  |
| 8790.8 | 20169.8  | 20.17 | 0.181  | 0.251  | 0.411  | 1.191  |
| 8977.8 | 20356.8  | 20.36 | 0.000  | 0.000  | 0.000  | 0.000  |

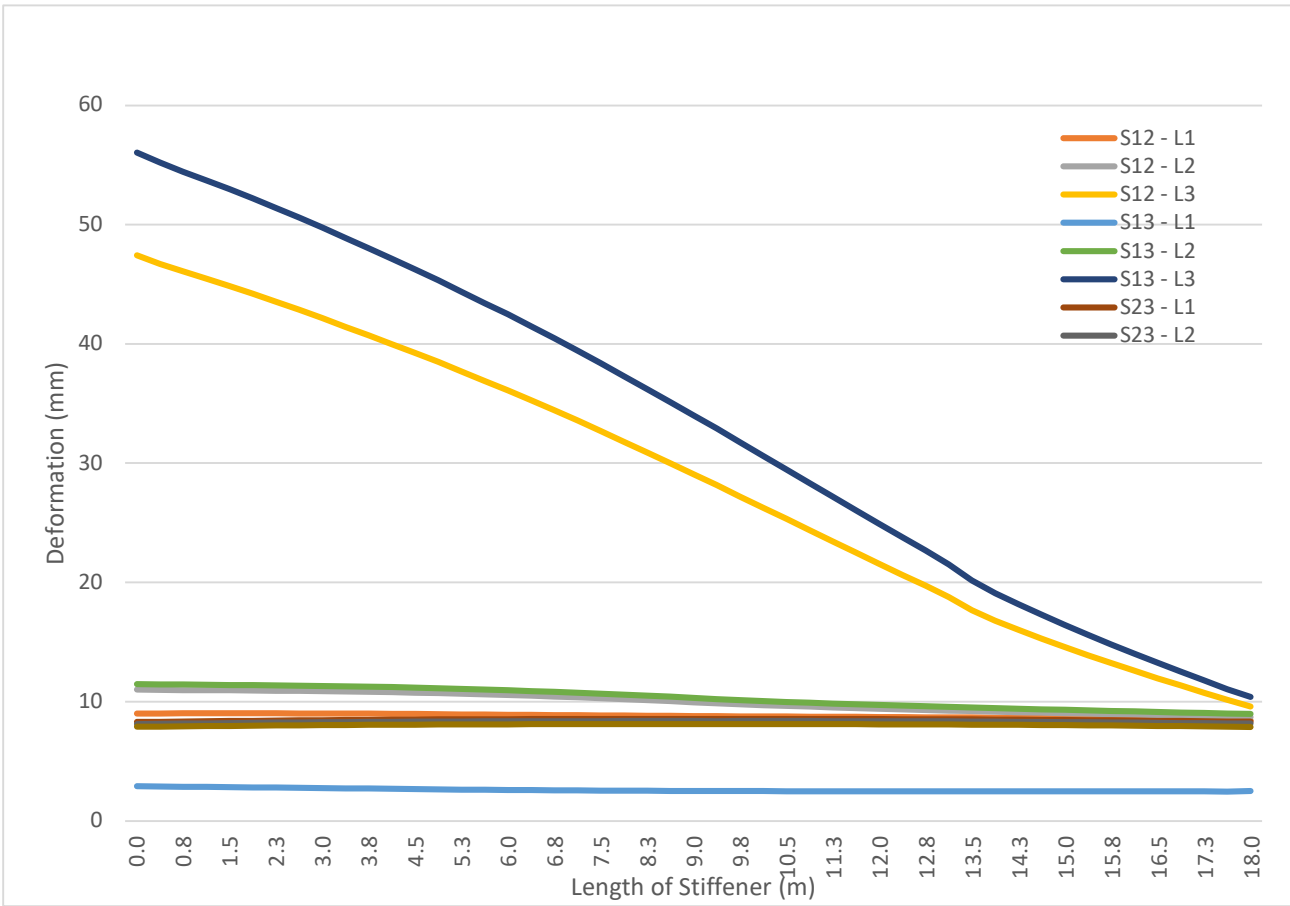




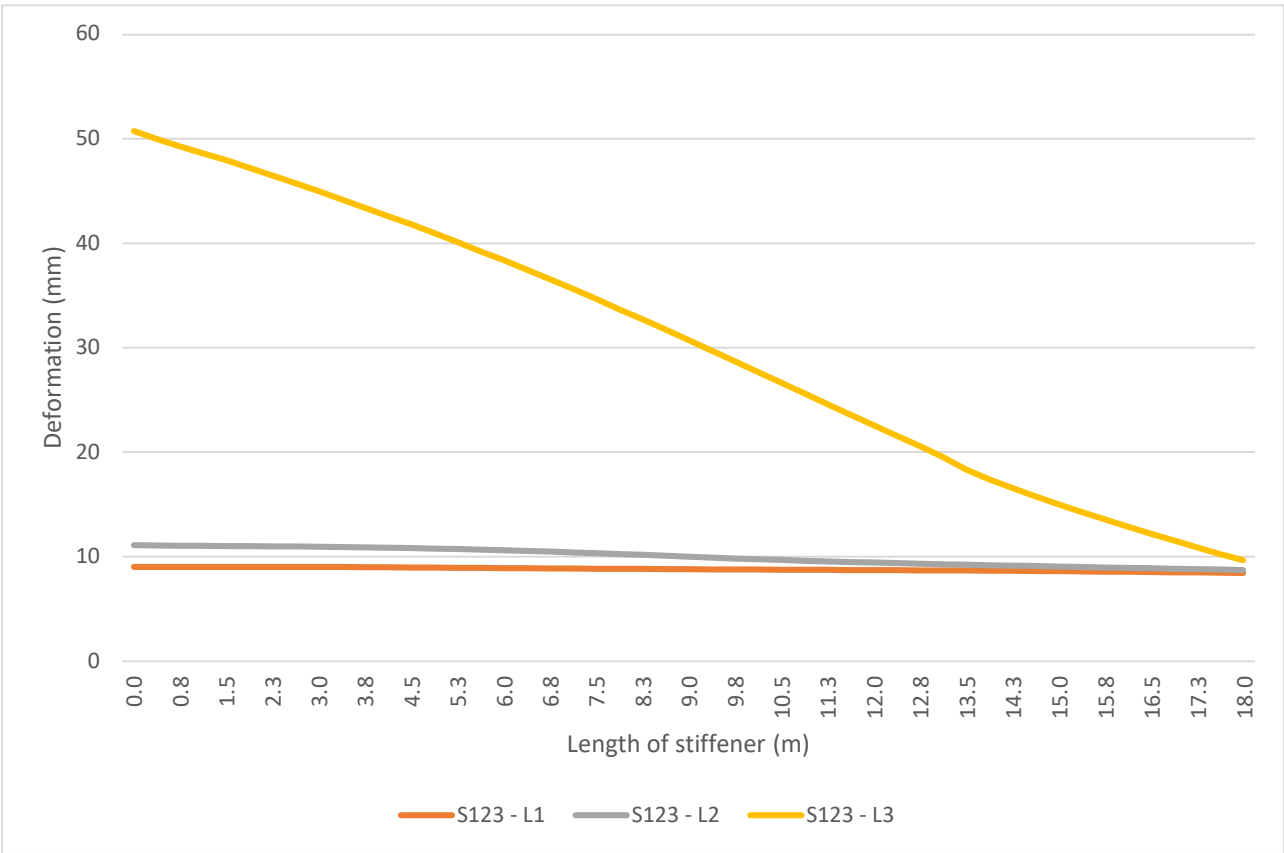
## **APPENDIX H – Raw data case study for corrosion type N2 longitudinal (Part 1)**



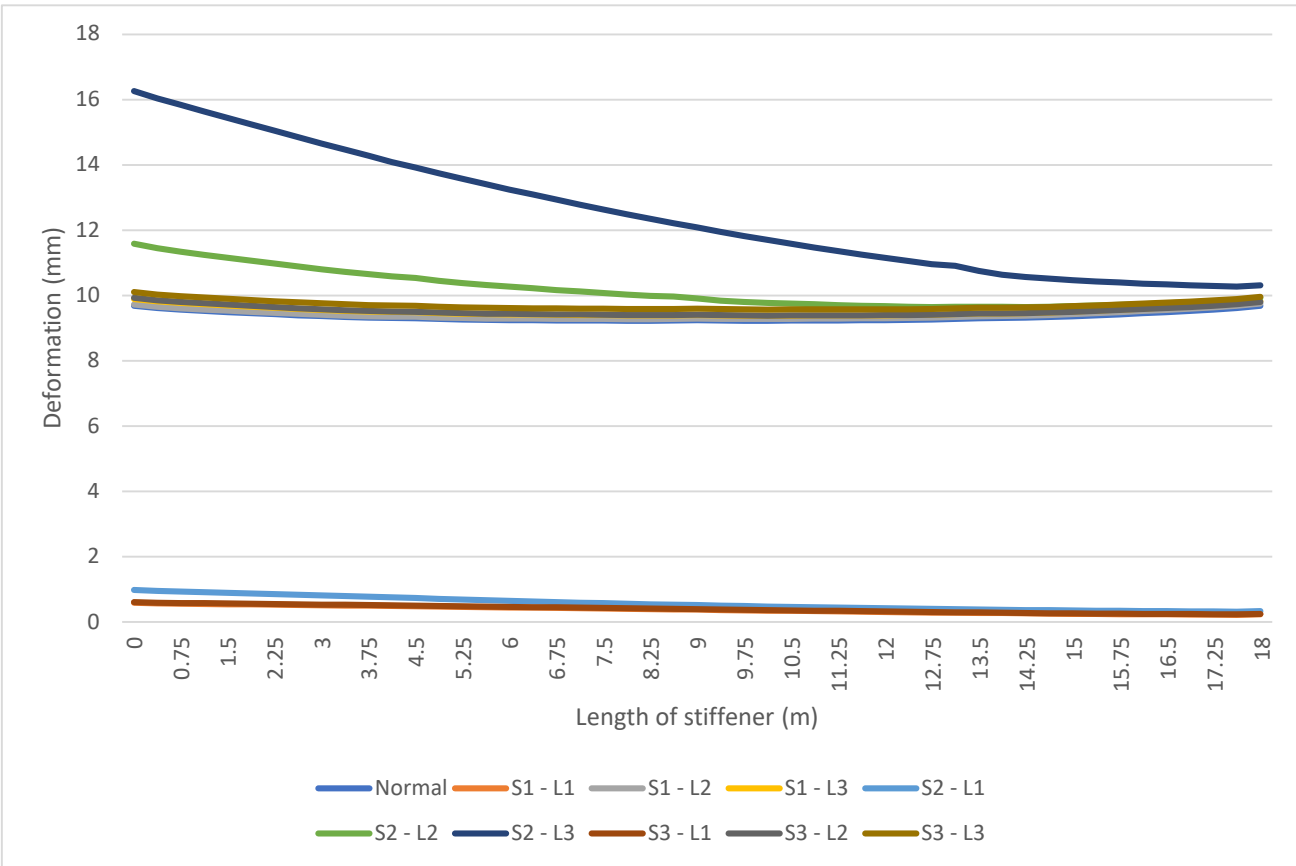
| STIFFENER 1 - Longitudinal direction |      |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m    | Normal | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.0  | 8.370  | 2.903   | 11.405  | 54.836  | 2.304   | 8.077   | 7.800   | 2.324   | 8.419   | 8.453   |
| 375                                  | 0.4  | 8.377  | 2.863   | 11.357  | 54.002  | 2.283   | 8.086   | 7.809   | 2.303   | 8.426   | 8.460   |
| 750                                  | 0.8  | 8.398  | 2.845   | 11.347  | 53.256  | 2.281   | 8.107   | 7.829   | 2.301   | 8.446   | 8.481   |
| 1125                                 | 1.1  | 8.417  | 2.826   | 11.332  | 52.522  | 2.280   | 8.126   | 7.846   | 2.300   | 8.464   | 8.499   |
| 1500                                 | 1.5  | 8.436  | 2.809   | 11.319  | 51.825  | 2.280   | 8.146   | 7.864   | 2.299   | 8.483   | 8.518   |
| 1875                                 | 1.9  | 8.454  | 2.789   | 11.303  | 51.055  | 2.278   | 8.165   | 7.882   | 2.298   | 8.501   | 8.536   |
| 2250                                 | 2.3  | 8.472  | 2.770   | 11.285  | 50.273  | 2.277   | 8.184   | 7.900   | 2.296   | 8.518   | 8.554   |
| 2625                                 | 2.6  | 8.489  | 2.750   | 11.265  | 49.475  | 2.276   | 8.202   | 7.916   | 2.295   | 8.535   | 8.571   |
| 3000                                 | 3.0  | 8.506  | 2.730   | 11.241  | 48.664  | 2.275   | 8.219   | 7.932   | 2.294   | 8.551   | 8.587   |
| 3375                                 | 3.4  | 8.520  | 2.708   | 11.211  | 47.789  | 2.273   | 8.234   | 7.946   | 2.292   | 8.564   | 8.600   |
| 3750                                 | 3.8  | 8.533  | 2.689   | 11.180  | 46.951  | 2.273   | 8.249   | 7.959   | 2.292   | 8.577   | 8.614   |
| 4125                                 | 4.1  | 8.546  | 2.670   | 11.144  | 46.097  | 2.274   | 8.262   | 7.971   | 2.292   | 8.589   | 8.625   |
| 4500                                 | 4.5  | 8.557  | 2.644   | 11.104  | 45.241  | 2.275   | 8.274   | 7.982   | 2.293   | 8.599   | 8.636   |
| 4875                                 | 4.9  | 8.566  | 2.618   | 11.059  | 44.348  | 2.275   | 8.285   | 7.991   | 2.294   | 8.608   | 8.645   |
| 5250                                 | 5.3  | 8.573  | 2.599   | 11.006  | 43.399  | 2.275   | 8.293   | 7.998   | 2.293   | 8.614   | 8.651   |
| 5625                                 | 5.6  | 8.580  | 2.583   | 10.951  | 42.460  | 2.275   | 8.301   | 8.005   | 2.294   | 8.620   | 8.657   |
| 6000                                 | 6.0  | 8.586  | 2.570   | 10.893  | 41.545  | 2.278   | 8.308   | 8.012   | 2.296   | 8.625   | 8.663   |
| 6375                                 | 6.4  | 8.591  | 2.556   | 10.829  | 40.571  | 2.279   | 8.314   | 8.017   | 2.297   | 8.629   | 8.666   |
| 6750                                 | 6.8  | 8.595  | 2.543   | 10.761  | 39.581  | 2.281   | 8.319   | 8.021   | 2.299   | 8.632   | 8.669   |
| 7125                                 | 7.1  | 8.598  | 2.532   | 10.688  | 38.572  | 2.282   | 8.324   | 8.025   | 2.300   | 8.634   | 8.671   |
| 7500                                 | 7.5  | 8.600  | 2.521   | 10.613  | 37.548  | 2.284   | 8.327   | 8.027   | 2.302   | 8.635   | 8.672   |
| 7875                                 | 7.9  | 8.601  | 2.510   | 10.532  | 36.476  | 2.284   | 8.329   | 8.029   | 2.302   | 8.635   | 8.672   |
| 8250                                 | 8.3  | 8.602  | 2.502   | 10.453  | 35.424  | 2.287   | 8.332   | 8.031   | 2.304   | 8.635   | 8.672   |
| 8625                                 | 8.6  | 8.603  | 2.495   | 10.364  | 34.358  | 2.289   | 8.335   | 8.033   | 2.307   | 8.635   | 8.672   |
| 9000                                 | 9.0  | 8.603  | 2.490   | 10.259  | 33.289  | 2.292   | 8.337   | 8.035   | 2.310   | 8.634   | 8.672   |
| 9375                                 | 9.4  | 8.603  | 2.485   | 10.159  | 32.198  | 2.295   | 8.338   | 8.036   | 2.312   | 8.634   | 8.671   |
| 9750                                 | 9.8  | 8.602  | 2.478   | 10.080  | 31.073  | 2.296   | 8.338   | 8.036   | 2.313   | 8.631   | 8.668   |
| 10125                                | 10.1 | 8.601  | 2.474   | 10.006  | 29.960  | 2.298   | 8.339   | 8.036   | 2.315   | 8.629   | 8.666   |
| 10500                                | 10.5 | 8.600  | 2.473   | 9.936   | 28.868  | 2.302   | 8.340   | 8.037   | 2.319   | 8.627   | 8.664   |
| 10875                                | 10.9 | 8.598  | 2.470   | 9.869   | 27.751  | 2.305   | 8.339   | 8.036   | 2.322   | 8.624   | 8.660   |
| 11250                                | 11.3 | 8.595  | 2.468   | 9.804   | 26.636  | 2.307   | 8.338   | 8.035   | 2.324   | 8.620   | 8.656   |
| 11625                                | 11.6 | 8.591  | 2.467   | 9.743   | 25.526  | 2.310   | 8.336   | 8.033   | 2.327   | 8.615   | 8.651   |
| 12000                                | 12.0 | 8.586  | 2.465   | 9.685   | 24.422  | 2.313   | 8.333   | 8.030   | 2.329   | 8.610   | 8.646   |
| 12375                                | 12.4 | 8.580  | 2.463   | 9.627   | 23.315  | 2.314   | 8.328   | 8.026   | 2.330   | 8.602   | 8.638   |
| 12750                                | 12.8 | 8.573  | 2.462   | 9.574   | 22.244  | 2.316   | 8.323   | 8.021   | 2.333   | 8.595   | 8.630   |
| 13125                                | 13.1 | 8.566  | 2.463   | 9.524   | 21.100  | 2.319   | 8.317   | 8.016   | 2.336   | 8.586   | 8.621   |
| 13500                                | 13.5 | 8.557  | 2.463   | 9.475   | 19.799  | 2.322   | 8.310   | 8.009   | 2.339   | 8.577   | 8.611   |
| 13875                                | 13.9 | 8.546  | 2.463   | 9.427   | 18.762  | 2.324   | 8.301   | 8.000   | 2.341   | 8.565   | 8.599   |
| 14250                                | 14.3 | 8.534  | 2.464   | 9.381   | 17.868  | 2.327   | 8.291   | 7.991   | 2.343   | 8.553   | 8.586   |
| 14625                                | 14.6 | 8.520  | 2.463   | 9.333   | 17.001  | 2.328   | 8.278   | 7.979   | 2.344   | 8.538   | 8.571   |
| 15000                                | 15.0 | 8.505  | 2.463   | 9.287   | 16.160  | 2.330   | 8.265   | 7.967   | 2.346   | 8.522   | 8.554   |
| 15375                                | 15.4 | 8.489  | 2.463   | 9.243   | 15.357  | 2.332   | 8.250   | 7.953   | 2.348   | 8.505   | 8.537   |
| 15750                                | 15.8 | 8.472  | 2.465   | 9.200   | 14.580  | 2.335   | 8.235   | 7.939   | 2.350   | 8.488   | 8.519   |
| 16125                                | 16.1 | 8.454  | 2.465   | 9.156   | 13.823  | 2.336   | 8.219   | 7.923   | 2.351   | 8.469   | 8.500   |
| 16500                                | 16.5 | 8.436  | 2.464   | 9.113   | 13.083  | 2.337   | 8.202   | 7.907   | 2.352   | 8.450   | 8.480   |
| 16875                                | 16.9 | 8.418  | 2.464   | 9.072   | 12.361  | 2.337   | 8.186   | 7.892   | 2.353   | 8.431   | 8.461   |
| 17250                                | 17.3 | 8.398  | 2.461   | 9.028   | 11.643  | 2.335   | 8.168   | 7.875   | 2.351   | 8.410   | 8.440   |
| 17625                                | 17.6 | 8.377  | 2.457   | 8.984   | 10.930  | 2.333   | 8.148   | 7.856   | 2.348   | 8.388   | 8.417   |
| 18000                                | 18.0 | 8.370  | 2.477   | 8.964   | 10.302  | 2.353   | 8.142   | 7.850   | 2.368   | 8.381   | 8.409   |



| STIFFENER 1 in S## - Longitudinal direction |      |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m    | Normal | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.0  | 8.370  | 9.019    | 11.016   | 47.439   | 2.914    | 11.486   | 56.061   | 8.301    | 8.127    | 7.890    |
| 375                                         | 0.4  | 8.377  | 9.004    | 10.972   | 46.723   | 2.873    | 11.437   | 55.212   | 8.309    | 8.136    | 7.898    |
| 750                                         | 0.8  | 8.398  | 9.008    | 10.963   | 46.090   | 2.855    | 11.425   | 54.452   | 8.330    | 8.157    | 7.918    |
| 1125                                        | 1.1  | 8.417  | 9.008    | 10.951   | 45.464   | 2.836    | 11.409   | 53.703   | 8.349    | 8.175    | 7.935    |
| 1500                                        | 1.5  | 8.436  | 9.009    | 10.940   | 44.868   | 2.819    | 11.394   | 52.992   | 8.368    | 8.194    | 7.953    |
| 1875                                        | 1.9  | 8.454  | 9.009    | 10.926   | 44.210   | 2.799    | 11.377   | 52.206   | 8.387    | 8.213    | 7.970    |
| 2250                                        | 2.3  | 8.472  | 9.008    | 10.911   | 43.543   | 2.780    | 11.358   | 51.407   | 8.406    | 8.231    | 7.987    |
| 2625                                        | 2.6  | 8.489  | 9.006    | 10.893   | 42.862   | 2.760    | 11.336   | 50.592   | 8.423    | 8.248    | 8.004    |
| 3000                                        | 3.0  | 8.506  | 9.001    | 10.871   | 42.171   | 2.740    | 11.311   | 49.764   | 8.440    | 8.265    | 8.019    |
| 3375                                        | 3.4  | 8.520  | 8.993    | 10.844   | 41.426   | 2.718    | 11.279   | 48.871   | 8.454    | 8.279    | 8.032    |
| 3750                                        | 3.8  | 8.533  | 8.984    | 10.815   | 40.711   | 2.699    | 11.247   | 48.014   | 8.468    | 8.293    | 8.045    |
| 4125                                        | 4.1  | 8.546  | 8.973    | 10.782   | 39.983   | 2.681    | 11.209   | 47.141   | 8.481    | 8.305    | 8.056    |
| 4500                                        | 4.5  | 8.557  | 8.956    | 10.746   | 39.253   | 2.654    | 11.168   | 46.265   | 8.492    | 8.317    | 8.066    |
| 4875                                        | 4.9  | 8.566  | 8.936    | 10.703   | 38.492   | 2.628    | 11.121   | 45.351   | 8.502    | 8.326    | 8.075    |
| 5250                                        | 5.3  | 8.573  | 8.920    | 10.654   | 37.685   | 2.609    | 11.067   | 44.381   | 8.510    | 8.334    | 8.082    |
| 5625                                        | 5.6  | 8.580  | 8.905    | 10.602   | 36.886   | 2.593    | 11.009   | 43.420   | 8.516    | 8.341    | 8.087    |
| 6000                                        | 6.0  | 8.586  | 8.892    | 10.548   | 36.105   | 2.580    | 10.950   | 42.483   | 8.523    | 8.347    | 8.093    |
| 6375                                        | 6.4  | 8.591  | 8.877    | 10.487   | 35.276   | 2.566    | 10.884   | 41.485   | 8.528    | 8.352    | 8.097    |
| 6750                                        | 6.8  | 8.595  | 8.862    | 10.423   | 34.434   | 2.553    | 10.814   | 40.472   | 8.532    | 8.356    | 8.100    |
| 7125                                        | 7.1  | 8.598  | 8.848    | 10.354   | 33.575   | 2.542    | 10.740   | 39.438   | 8.536    | 8.360    | 8.103    |
| 7500                                        | 7.5  | 8.600  | 8.834    | 10.282   | 32.705   | 2.531    | 10.662   | 38.388   | 8.538    | 8.362    | 8.105    |
| 7875                                        | 7.9  | 8.601  | 8.820    | 10.206   | 31.793   | 2.520    | 10.580   | 37.289   | 8.539    | 8.363    | 8.105    |
| 8250                                        | 8.3  | 8.602  | 8.808    | 10.130   | 30.899   | 2.512    | 10.498   | 36.210   | 8.541    | 8.365    | 8.106    |
| 8625                                        | 8.6  | 8.603  | 8.796    | 10.046   | 29.993   | 2.505    | 10.408   | 35.117   | 8.542    | 8.366    | 8.107    |
| 9000                                        | 9.0  | 8.603  | 8.785    | 9.946    | 29.085   | 2.500    | 10.301   | 34.020   | 8.543    | 8.367    | 8.107    |
| 9375                                        | 9.4  | 8.603  | 8.775    | 9.850    | 28.158   | 2.495    | 10.199   | 32.900   | 8.543    | 8.368    | 8.108    |
| 9750                                        | 9.8  | 8.602  | 8.764    | 9.775    | 27.204   | 2.488    | 10.119   | 31.746   | 8.542    | 8.367    | 8.106    |
| 10125                                       | 10.1 | 8.601  | 8.754    | 9.705    | 26.260   | 2.484    | 10.043   | 30.604   | 8.541    | 8.366    | 8.105    |
| 10500                                       | 10.5 | 8.600  | 8.745    | 9.639    | 25.332   | 2.483    | 9.972    | 29.482   | 8.541    | 8.366    | 8.104    |
| 10875                                       | 10.9 | 8.598  | 8.736    | 9.575    | 24.385   | 2.480    | 9.903    | 28.335   | 8.539    | 8.365    | 8.102    |
| 11250                                       | 11.3 | 8.595  | 8.727    | 9.514    | 23.440   | 2.478    | 9.837    | 27.189   | 8.536    | 8.362    | 8.100    |
| 11625                                       | 11.6 | 8.591  | 8.717    | 9.456    | 22.499   | 2.477    | 9.774    | 26.049   | 8.533    | 8.359    | 8.097    |
| 12000                                       | 12.0 | 8.586  | 8.707    | 9.400    | 21.564   | 2.475    | 9.714    | 24.914   | 8.528    | 8.355    | 8.092    |
| 12375                                       | 12.4 | 8.580  | 8.696    | 9.346    | 20.627   | 2.473    | 9.655    | 23.777   | 8.522    | 8.350    | 8.087    |
| 12750                                       | 12.8 | 8.573  | 8.685    | 9.296    | 19.721   | 2.472    | 9.601    | 22.675   | 8.516    | 8.344    | 8.081    |
| 13125                                       | 13.1 | 8.566  | 8.674    | 9.249    | 18.753   | 2.473    | 9.549    | 21.499   | 8.508    | 8.337    | 8.074    |
| 13500                                       | 13.5 | 8.557  | 8.661    | 9.203    | 17.652   | 2.473    | 9.500    | 20.162   | 8.500    | 8.329    | 8.066    |
| 13875                                       | 13.9 | 8.546  | 8.647    | 9.158    | 16.772   | 2.473    | 9.450    | 19.097   | 8.489    | 8.319    | 8.056    |
| 14250                                       | 14.3 | 8.534  | 8.633    | 9.114    | 16.014   | 2.474    | 9.403    | 18.177   | 8.478    | 8.308    | 8.045    |
| 14625                                       | 14.6 | 8.520  | 8.616    | 9.070    | 15.279   | 2.473    | 9.355    | 17.285   | 8.464    | 8.295    | 8.032    |
| 15000                                       | 15.0 | 8.505  | 8.599    | 9.027    | 14.567   | 2.473    | 9.308    | 16.421   | 8.449    | 8.280    | 8.018    |
| 15375                                       | 15.4 | 8.489  | 8.580    | 8.985    | 13.886   | 2.473    | 9.263    | 15.595   | 8.433    | 8.265    | 8.003    |
| 15750                                       | 15.8 | 8.472  | 8.562    | 8.944    | 13.228   | 2.475    | 9.219    | 14.796   | 8.417    | 8.250    | 7.987    |
| 16125                                       | 16.1 | 8.454  | 8.542    | 8.903    | 12.587   | 2.475    | 9.174    | 14.017   | 8.399    | 8.232    | 7.970    |
| 16500                                       | 16.5 | 8.436  | 8.522    | 8.862    | 11.960   | 2.474    | 9.130    | 13.256   | 8.381    | 8.215    | 7.953    |
| 16875                                       | 16.9 | 8.418  | 8.503    | 8.823    | 11.348   | 2.474    | 9.088    | 12.513   | 8.363    | 8.198    | 7.936    |
| 17250                                       | 17.3 | 8.398  | 8.482    | 8.783    | 10.740   | 2.471    | 9.044    | 11.775   | 8.344    | 8.179    | 7.918    |
| 17625                                       | 17.6 | 8.377  | 8.459    | 8.741    | 10.137   | 2.467    | 8.999    | 11.042   | 8.323    | 8.158    | 7.897    |
| 18000                                       | 18.0 | 8.370  | 8.452    | 8.721    | 9.605    | 2.487    | 8.977    | 10.395   | 8.316    | 8.151    | 7.889    |

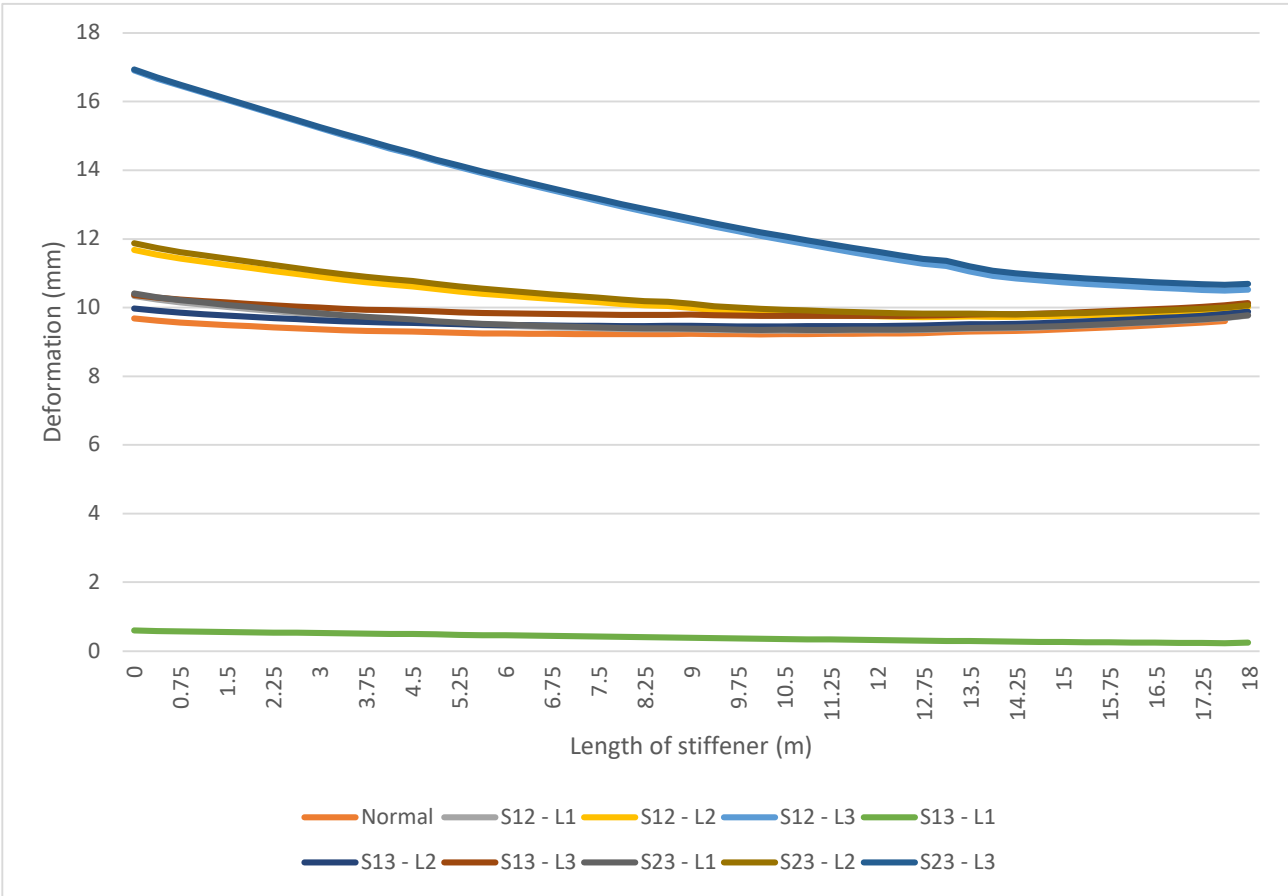


| STIFFENER 1 in S1,2 & 3 - Longitudinal direction |      |        |           |           |           |
|--------------------------------------------------|------|--------|-----------|-----------|-----------|
| mm                                               | m    | Normal | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.0  | 8.370  | 9.035     | 11.097    | 50.750    |
| 375                                              | 0.4  | 8.377  | 9.020     | 11.052    | 49.973    |
| 750                                              | 0.8  | 8.398  | 9.023     | 11.042    | 49.280    |
| 1125                                             | 1.1  | 8.417  | 9.023     | 11.028    | 48.596    |
| 1500                                             | 1.5  | 8.436  | 9.024     | 11.015    | 47.945    |
| 1875                                             | 1.9  | 8.454  | 9.023     | 11.000    | 47.227    |
| 2250                                             | 2.3  | 8.472  | 9.022     | 10.984    | 46.498    |
| 2625                                             | 2.6  | 8.489  | 9.019     | 10.964    | 45.754    |
| 3000                                             | 3.0  | 8.506  | 9.014     | 10.941    | 44.999    |
| 3375                                             | 3.4  | 8.520  | 9.006     | 10.912    | 44.186    |
| 3750                                             | 3.8  | 8.533  | 8.997     | 10.882    | 43.406    |
| 4125                                             | 4.1  | 8.546  | 8.985     | 10.848    | 42.612    |
| 4500                                             | 4.5  | 8.557  | 8.967     | 10.809    | 41.816    |
| 4875                                             | 4.9  | 8.566  | 8.947     | 10.765    | 40.986    |
| 5250                                             | 5.3  | 8.573  | 8.931     | 10.714    | 40.106    |
| 5625                                             | 5.6  | 8.580  | 8.916     | 10.660    | 39.234    |
| 6000                                             | 6.0  | 8.586  | 8.902     | 10.604    | 38.385    |
| 6375                                             | 6.4  | 8.591  | 8.886     | 10.541    | 37.482    |
| 6750                                             | 6.8  | 8.595  | 8.872     | 10.475    | 36.565    |
| 7125                                             | 7.1  | 8.598  | 8.857     | 10.405    | 35.631    |
| 7500                                             | 7.5  | 8.600  | 8.843     | 10.331    | 34.683    |
| 7875                                             | 7.9  | 8.601  | 8.828     | 10.252    | 33.692    |
| 8250                                             | 8.3  | 8.602  | 8.815     | 10.175    | 32.720    |
| 8625                                             | 8.6  | 8.603  | 8.803     | 10.089    | 31.736    |
| 9000                                             | 9.0  | 8.603  | 8.792     | 9.987     | 30.749    |
| 9375                                             | 9.4  | 8.603  | 8.782     | 9.889     | 29.742    |
| 9750                                             | 9.8  | 8.602  | 8.770     | 9.813     | 28.706    |
| 10125                                            | 10.1 | 8.601  | 8.760     | 9.741     | 27.681    |
| 10500                                            | 10.5 | 8.600  | 8.751     | 9.673     | 26.675    |
| 10875                                            | 10.9 | 8.598  | 8.741     | 9.607     | 25.648    |
| 11250                                            | 11.3 | 8.595  | 8.732     | 9.544     | 24.622    |
| 11625                                            | 11.6 | 8.591  | 8.722     | 9.485     | 23.603    |
| 12000                                            | 12.0 | 8.586  | 8.712     | 9.429     | 22.589    |
| 12375                                            | 12.4 | 8.580  | 8.700     | 9.373     | 21.575    |
| 12750                                            | 12.8 | 8.573  | 8.689     | 9.322     | 20.594    |
| 13125                                            | 13.1 | 8.566  | 8.677     | 9.273     | 19.547    |
| 13500                                            | 13.5 | 8.557  | 8.665     | 9.226     | 18.358    |
| 13875                                            | 13.9 | 8.546  | 8.651     | 9.180     | 17.409    |
| 14250                                            | 14.3 | 8.534  | 8.636     | 9.135     | 16.589    |
| 14625                                            | 14.6 | 8.520  | 8.619     | 9.090     | 15.795    |
| 15000                                            | 15.0 | 8.505  | 8.601     | 9.046     | 15.025    |
| 15375                                            | 15.4 | 8.489  | 8.583     | 9.003     | 14.290    |
| 15750                                            | 15.8 | 8.472  | 8.565     | 8.961     | 13.579    |
| 16125                                            | 16.1 | 8.454  | 8.544     | 8.919     | 12.886    |
| 16500                                            | 16.5 | 8.436  | 8.524     | 8.878     | 12.209    |
| 16875                                            | 16.9 | 8.418  | 8.504     | 8.838     | 11.549    |
| 17250                                            | 17.3 | 8.398  | 8.483     | 8.796     | 10.892    |
| 17625                                            | 17.6 | 8.377  | 8.460     | 8.754     | 10.240    |
| 18000                                            | 18.0 | 8.370  | 8.453     | 8.733     | 9.664     |

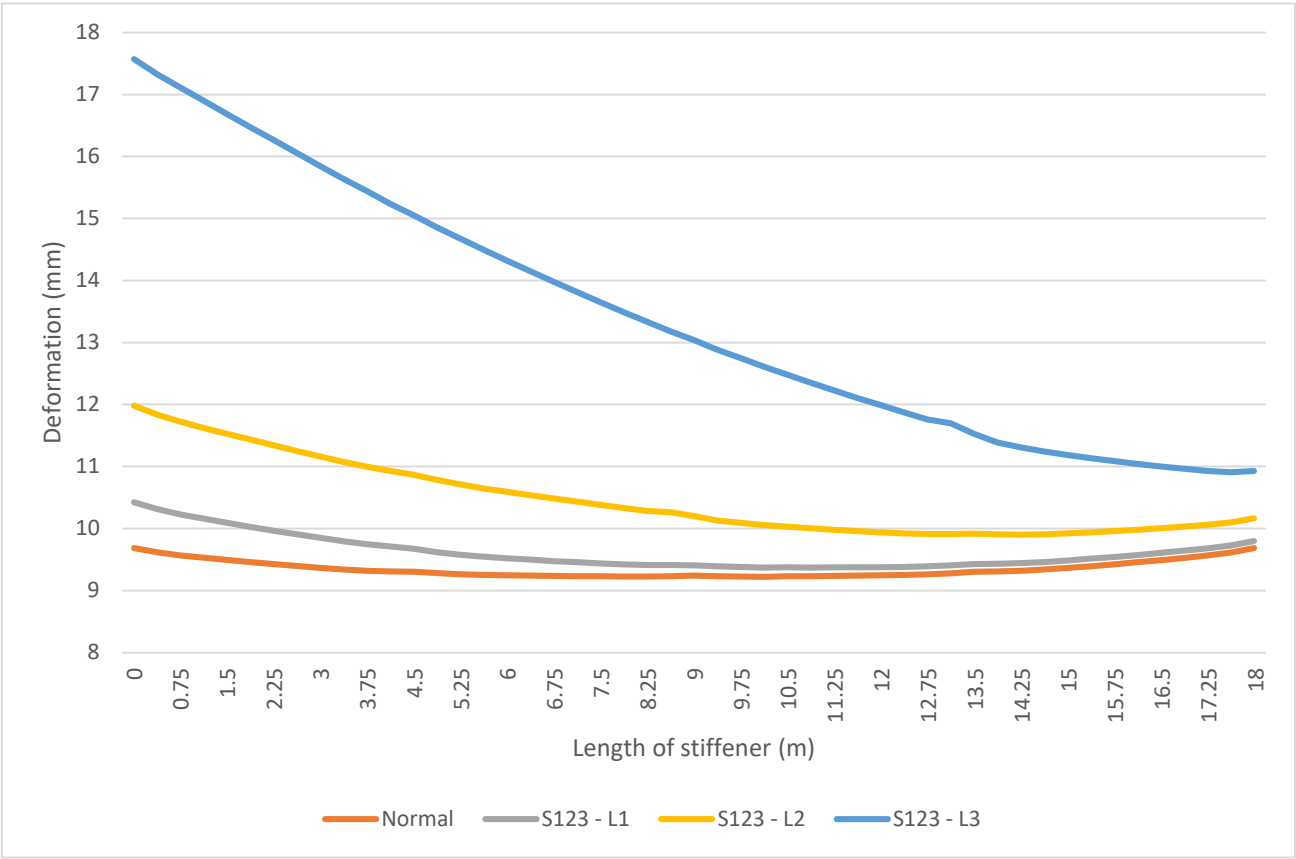


| STIFFENER 2 - Longitudinal direction |      |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m    | Normal | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.0  | 8.370  | 0.589   | 9.724   | 9.897   | 0.986   | 11.587  | 16.270  | 0.612   | 9.931   | 10.108  |
| 375                                  | 0.4  | 8.377  | 0.566   | 9.655   | 9.825   | 0.949   | 11.449  | 16.040  | 0.589   | 9.854   | 10.031  |
| 750                                  | 0.8  | 8.398  | 0.557   | 9.606   | 9.773   | 0.929   | 11.339  | 15.838  | 0.580   | 9.801   | 9.978   |
| 1125                                 | 1.1  | 8.417  | 0.549   | 9.567   | 9.732   | 0.911   | 11.243  | 15.639  | 0.572   | 9.758   | 9.935   |
| 1500                                 | 1.5  | 8.436  | 0.542   | 9.532   | 9.695   | 0.893   | 11.152  | 15.440  | 0.564   | 9.719   | 9.897   |
| 1875                                 | 1.9  | 8.454  | 0.534   | 9.498   | 9.658   | 0.874   | 11.064  | 15.243  | 0.556   | 9.680   | 9.859   |
| 2250                                 | 2.3  | 8.472  | 0.527   | 9.466   | 9.623   | 0.855   | 10.976  | 15.046  | 0.548   | 9.644   | 9.823   |
| 2625                                 | 2.6  | 8.489  | 0.519   | 9.436   | 9.590   | 0.836   | 10.890  | 14.851  | 0.540   | 9.610   | 9.789   |
| 3000                                 | 3.0  | 8.506  | 0.511   | 9.408   | 9.560   | 0.816   | 10.805  | 14.655  | 0.532   | 9.578   | 9.758   |
| 3375                                 | 3.4  | 8.520  | 0.502   | 9.382   | 9.531   | 0.795   | 10.723  | 14.464  | 0.523   | 9.548   | 9.728   |
| 3750                                 | 3.8  | 8.533  | 0.494   | 9.363   | 9.509   | 0.775   | 10.652  | 14.280  | 0.515   | 9.526   | 9.706   |
| 4125                                 | 4.1  | 8.546  | 0.487   | 9.352   | 9.495   | 0.756   | 10.585  | 14.090  | 0.508   | 9.512   | 9.692   |
| 4500                                 | 4.5  | 8.557  | 0.482   | 9.346   | 9.486   | 0.732   | 10.532  | 13.923  | 0.502   | 9.502   | 9.683   |
| 4875                                 | 4.9  | 8.566  | 0.471   | 9.325   | 9.463   | 0.703   | 10.453  | 13.738  | 0.491   | 9.477   | 9.659   |
| 5250                                 | 5.3  | 8.573  | 0.460   | 9.308   | 9.443   | 0.681   | 10.384  | 13.574  | 0.480   | 9.456   | 9.638   |
| 5625                                 | 5.6  | 8.580  | 0.451   | 9.297   | 9.429   | 0.660   | 10.321  | 13.406  | 0.470   | 9.442   | 9.624   |
| 6000                                 | 6.0  | 8.586  | 0.443   | 9.293   | 9.422   | 0.643   | 10.270  | 13.247  | 0.462   | 9.435   | 9.617   |
| 6375                                 | 6.4  | 8.591  | 0.434   | 9.289   | 9.415   | 0.624   | 10.219  | 13.091  | 0.453   | 9.428   | 9.610   |
| 6750                                 | 6.8  | 8.595  | 0.425   | 9.285   | 9.409   | 0.606   | 10.169  | 12.937  | 0.444   | 9.421   | 9.603   |
| 7125                                 | 7.1  | 8.598  | 0.416   | 9.282   | 9.403   | 0.589   | 10.121  | 12.785  | 0.435   | 9.414   | 9.597   |
| 7500                                 | 7.5  | 8.600  | 0.407   | 9.279   | 9.397   | 0.572   | 10.073  | 12.636  | 0.426   | 9.408   | 9.592   |
| 7875                                 | 7.9  | 8.601  | 0.397   | 9.274   | 9.390   | 0.555   | 10.024  | 12.488  | 0.415   | 9.401   | 9.584   |
| 8250                                 | 8.3  | 8.602  | 0.389   | 9.276   | 9.389   | 0.540   | 9.983   | 12.349  | 0.407   | 9.399   | 9.583   |
| 8625                                 | 8.6  | 8.603  | 0.382   | 9.284   | 9.394   | 0.528   | 9.966   | 12.212  | 0.400   | 9.404   | 9.588   |
| 9000                                 | 9.0  | 8.603  | 0.376   | 9.293   | 9.401   | 0.517   | 9.910   | 12.084  | 0.393   | 9.410   | 9.594   |
| 9375                                 | 9.4  | 8.603  | 0.365   | 9.285   | 9.391   | 0.501   | 9.843   | 11.946  | 0.382   | 9.399   | 9.582   |
| 9750                                 | 9.8  | 8.602  | 0.354   | 9.279   | 9.383   | 0.486   | 9.805   | 11.822  | 0.371   | 9.390   | 9.573   |
| 10125                                | 10.1 | 8.601  | 0.345   | 9.278   | 9.380   | 0.473   | 9.775   | 11.699  | 0.362   | 9.386   | 9.569   |
| 10500                                | 10.5 | 8.600  | 0.338   | 9.284   | 9.383   | 0.462   | 9.752   | 11.585  | 0.354   | 9.389   | 9.572   |
| 10875                                | 10.9 | 8.598  | 0.329   | 9.288   | 9.385   | 0.451   | 9.728   | 11.472  | 0.346   | 9.390   | 9.573   |
| 11250                                | 11.3 | 8.595  | 0.321   | 9.293   | 9.387   | 0.440   | 9.707   | 11.362  | 0.337   | 9.392   | 9.574   |
| 11625                                | 11.6 | 8.591  | 0.312   | 9.298   | 9.390   | 0.429   | 9.688   | 11.256  | 0.328   | 9.394   | 9.575   |
| 12000                                | 12.0 | 8.586  | 0.304   | 9.303   | 9.394   | 0.418   | 9.671   | 11.156  | 0.320   | 9.397   | 9.578   |
| 12375                                | 12.4 | 8.580  | 0.294   | 9.308   | 9.397   | 0.407   | 9.654   | 11.053  | 0.310   | 9.399   | 9.578   |
| 12750                                | 12.8 | 8.573  | 0.287   | 9.320   | 9.407   | 0.398   | 9.647   | 10.956  | 0.302   | 9.408   | 9.587   |
| 13125                                | 13.1 | 8.566  | 0.281   | 9.340   | 9.425   | 0.391   | 9.651   | 10.905  | 0.297   | 9.425   | 9.603   |
| 13500                                | 13.5 | 8.557  | 0.277   | 9.362   | 9.446   | 0.384   | 9.657   | 10.757  | 0.292   | 9.444   | 9.621   |
| 13875                                | 13.9 | 8.546  | 0.268   | 9.370   | 9.452   | 0.375   | 9.650   | 10.634  | 0.283   | 9.449   | 9.624   |
| 14250                                | 14.3 | 8.534  | 0.259   | 9.382   | 9.463   | 0.365   | 9.649   | 10.568  | 0.274   | 9.458   | 9.632   |
| 14625                                | 14.6 | 8.520  | 0.252   | 9.402   | 9.482   | 0.356   | 9.656   | 10.515  | 0.267   | 9.474   | 9.647   |
| 15000                                | 15.0 | 8.505  | 0.247   | 9.429   | 9.508   | 0.350   | 9.673   | 10.472  | 0.262   | 9.499   | 9.670   |
| 15375                                | 15.4 | 8.489  | 0.242   | 9.458   | 9.536   | 0.344   | 9.691   | 10.432  | 0.256   | 9.525   | 9.695   |
| 15750                                | 15.8 | 8.472  | 0.237   | 9.489   | 9.566   | 0.339   | 9.713   | 10.396  | 0.252   | 9.553   | 9.721   |
| 16125                                | 16.1 | 8.454  | 0.233   | 9.523   | 9.599   | 0.334   | 9.737   | 10.365  | 0.247   | 9.583   | 9.750   |
| 16500                                | 16.5 | 8.436  | 0.229   | 9.559   | 9.634   | 0.329   | 9.764   | 10.337  | 0.243   | 9.615   | 9.781   |
| 16875                                | 16.9 | 8.418  | 0.226   | 9.595   | 9.669   | 0.325   | 9.791   | 10.311  | 0.239   | 9.648   | 9.812   |
| 17250                                | 17.3 | 8.398  | 0.222   | 9.634   | 9.709   | 0.321   | 9.821   | 10.288  | 0.236   | 9.684   | 9.846   |
| 17625                                | 17.6 | 8.377  | 0.221   | 9.686   | 9.759   | 0.319   | 9.864   | 10.279  | 0.234   | 9.732   | 9.892   |
| 18000                                | 18.0 | 8.370  | 0.233   | 9.758   | 9.831   | 0.331   | 9.932   | 10.307  | 0.247   | 9.802   | 9.961   |

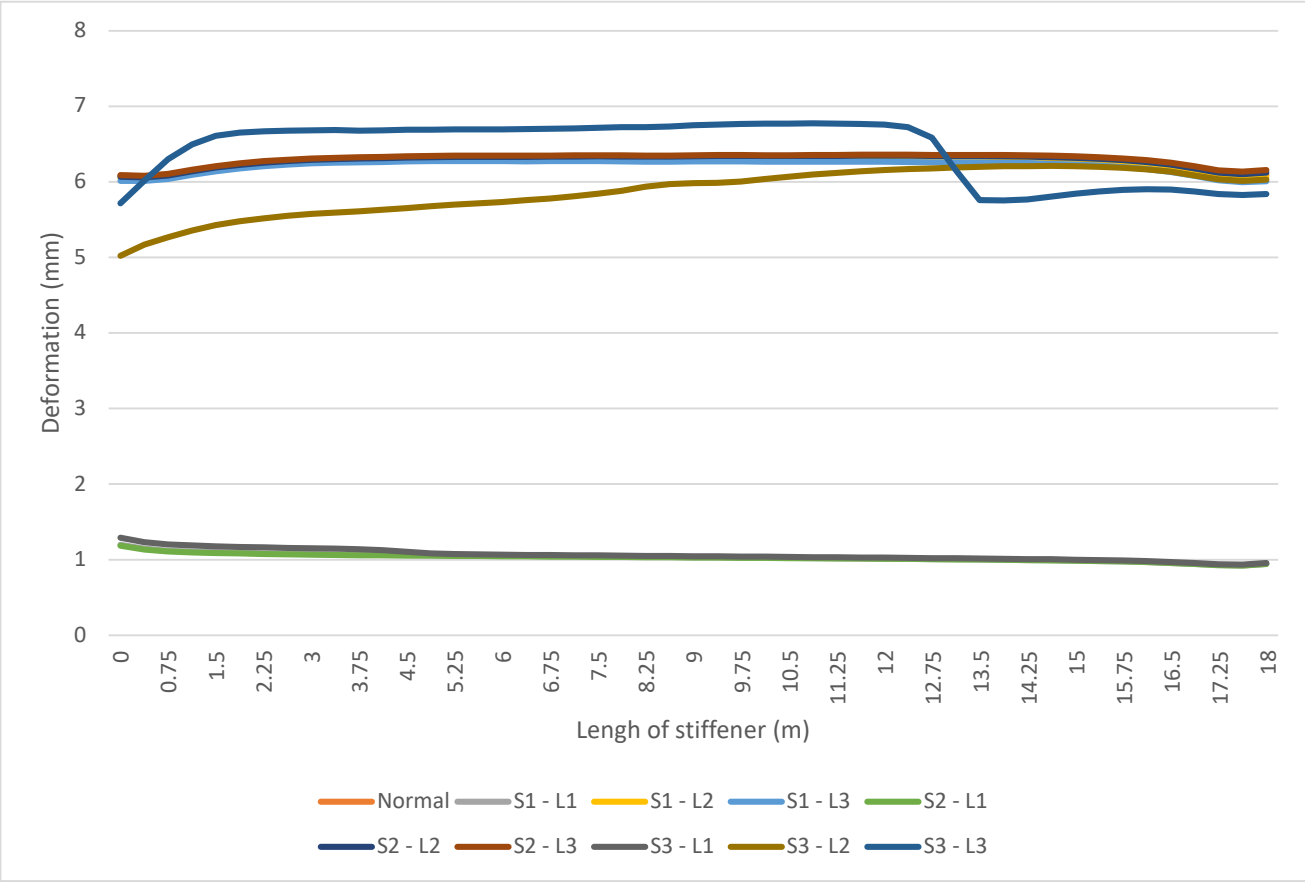




| STIFFENER 2 in S## - Longitudinal direction |      |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m    | Normal | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.0  | 8.370  | 10.343   | 11.679   | 16.909   | 0.599    | 9.980    | 10.368   | 10.414   | 11.878   | 16.939   |
| 375                                         | 0.4  | 8.377  | 10.234   | 11.541   | 16.670   | 0.576    | 9.904    | 10.289   | 10.302   | 11.733   | 16.699   |
| 750                                         | 0.8  | 8.398  | 10.151   | 11.430   | 16.460   | 0.567    | 9.851    | 10.233   | 10.216   | 11.618   | 16.490   |
| 1125                                        | 1.1  | 8.417  | 10.083   | 11.334   | 16.253   | 0.559    | 9.809    | 10.188   | 10.146   | 11.518   | 16.283   |
| 1500                                        | 1.5  | 8.436  | 10.020   | 11.242   | 16.047   | 0.552    | 9.770    | 10.146   | 10.080   | 11.423   | 16.077   |
| 1875                                        | 1.9  | 8.454  | 9.958    | 11.153   | 15.842   | 0.544    | 9.732    | 10.106   | 10.016   | 11.330   | 15.872   |
| 2250                                        | 2.3  | 8.472  | 9.898    | 11.065   | 15.637   | 0.537    | 9.696    | 10.067   | 9.953    | 11.238   | 15.668   |
| 2625                                        | 2.6  | 8.489  | 9.840    | 10.979   | 15.433   | 0.529    | 9.663    | 10.031   | 9.893    | 11.148   | 15.465   |
| 3000                                        | 3.0  | 8.506  | 9.785    | 10.894   | 15.229   | 0.521    | 9.632    | 9.997    | 9.835    | 11.059   | 15.262   |
| 3375                                        | 3.4  | 8.520  | 9.731    | 10.811   | 15.029   | 0.512    | 9.602    | 9.965    | 9.779    | 10.973   | 15.064   |
| 3750                                        | 3.8  | 8.533  | 9.687    | 10.740   | 14.837   | 0.504    | 9.580    | 9.940    | 9.732    | 10.898   | 14.873   |
| 4125                                        | 4.1  | 8.546  | 9.654    | 10.672   | 14.637   | 0.498    | 9.566    | 9.923    | 9.698    | 10.828   | 14.676   |
| 4500                                        | 4.5  | 8.557  | 9.616    | 10.618   | 14.463   | 0.492    | 9.557    | 9.912    | 9.658    | 10.771   | 14.502   |
| 4875                                        | 4.9  | 8.566  | 9.562    | 10.539   | 14.270   | 0.481    | 9.533    | 9.885    | 9.601    | 10.688   | 14.311   |
| 5250                                        | 5.3  | 8.573  | 9.523    | 10.471   | 14.097   | 0.471    | 9.513    | 9.862    | 9.561    | 10.616   | 14.140   |
| 5625                                        | 5.6  | 8.580  | 9.492    | 10.406   | 13.919   | 0.461    | 9.499    | 9.845    | 9.528    | 10.550   | 13.966   |
| 6000                                        | 6.0  | 8.586  | 9.470    | 10.355   | 13.751   | 0.454    | 9.493    | 9.836    | 9.504    | 10.496   | 13.802   |
| 6375                                        | 6.4  | 8.591  | 9.448    | 10.303   | 13.585   | 0.445    | 9.486    | 9.826    | 9.481    | 10.441   | 13.639   |
| 6750                                        | 6.8  | 8.595  | 9.427    | 10.253   | 13.421   | 0.436    | 9.480    | 9.817    | 9.459    | 10.388   | 13.480   |
| 7125                                        | 7.1  | 8.598  | 9.410    | 10.204   | 13.260   | 0.427    | 9.474    | 9.809    | 9.440    | 10.337   | 13.322   |
| 7500                                        | 7.5  | 8.600  | 9.393    | 10.156   | 13.101   | 0.418    | 9.469    | 9.800    | 9.422    | 10.287   | 13.168   |
| 7875                                        | 7.9  | 8.601  | 9.376    | 10.107   | 12.943   | 0.408    | 9.462    | 9.790    | 9.404    | 10.235   | 13.014   |
| 8250                                        | 8.3  | 8.602  | 9.367    | 10.065   | 12.795   | 0.400    | 9.461    | 9.787    | 9.394    | 10.191   | 12.870   |
| 8625                                        | 8.6  | 8.603  | 9.366    | 10.047   | 12.645   | 0.393    | 9.466    | 9.789    | 9.391    | 10.171   | 12.728   |
| 9000                                        | 9.0  | 8.603  | 9.366    | 9.992    | 12.508   | 0.387    | 9.473    | 9.793    | 9.390    | 10.111   | 12.595   |
| 9375                                        | 9.4  | 8.603  | 9.351    | 9.924    | 12.360   | 0.376    | 9.462    | 9.780    | 9.374    | 10.039   | 12.451   |
| 9750                                        | 9.8  | 8.602  | 9.338    | 9.886    | 12.226   | 0.366    | 9.454    | 9.769    | 9.360    | 9.998    | 12.323   |
| 10125                                       | 10.1 | 8.601  | 9.332    | 9.856    | 12.092   | 0.357    | 9.451    | 9.763    | 9.354    | 9.966    | 12.194   |
| 10500                                       | 10.5 | 8.600  | 9.333    | 9.832    | 11.967   | 0.349    | 9.455    | 9.763    | 9.354    | 9.940    | 12.076   |
| 10875                                       | 10.9 | 8.598  | 9.333    | 9.809    | 11.843   | 0.341    | 9.456    | 9.762    | 9.353    | 9.914    | 11.958   |
| 11250                                       | 11.3 | 8.595  | 9.334    | 9.787    | 11.722   | 0.332    | 9.458    | 9.761    | 9.353    | 9.890    | 11.843   |
| 11625                                       | 11.6 | 8.591  | 9.336    | 9.768    | 11.606   | 0.324    | 9.461    | 9.761    | 9.355    | 9.868    | 11.733   |
| 12000                                       | 12.0 | 8.586  | 9.339    | 9.751    | 11.496   | 0.316    | 9.465    | 9.761    | 9.357    | 9.849    | 11.628   |
| 12375                                       | 12.4 | 8.580  | 9.342    | 9.734    | 11.383   | 0.306    | 9.467    | 9.760    | 9.358    | 9.830    | 11.520   |
| 12750                                       | 12.8 | 8.573  | 9.352    | 9.728    | 11.275   | 0.299    | 9.477    | 9.767    | 9.368    | 9.821    | 11.418   |
| 13125                                       | 13.1 | 8.566  | 9.370    | 9.731    | 11.213   | 0.293    | 9.495    | 9.782    | 9.385    | 9.822    | 11.363   |
| 13500                                       | 13.5 | 8.557  | 9.390    | 9.738    | 11.056   | 0.289    | 9.514    | 9.799    | 9.405    | 9.826    | 11.205   |
| 13875                                       | 13.9 | 8.546  | 9.396    | 9.732    | 10.926   | 0.280    | 9.520    | 9.801    | 9.410    | 9.816    | 11.073   |
| 14250                                       | 14.3 | 8.534  | 9.407    | 9.730    | 10.851   | 0.271    | 9.530    | 9.808    | 9.420    | 9.812    | 11.001   |
| 14625                                       | 14.6 | 8.520  | 9.425    | 9.738    | 10.791   | 0.264    | 9.547    | 9.822    | 9.438    | 9.817    | 10.944   |
| 15000                                       | 15.0 | 8.505  | 9.452    | 9.755    | 10.740   | 0.259    | 9.573    | 9.845    | 9.464    | 9.831    | 10.895   |
| 15375                                       | 15.4 | 8.489  | 9.479    | 9.774    | 10.693   | 0.254    | 9.599    | 9.868    | 9.490    | 9.847    | 10.850   |
| 15750                                       | 15.8 | 8.472  | 9.509    | 9.796    | 10.651   | 0.250    | 9.628    | 9.894    | 9.520    | 9.866    | 10.808   |
| 16125                                       | 16.1 | 8.454  | 9.541    | 9.821    | 10.613   | 0.246    | 9.660    | 9.923    | 9.551    | 9.888    | 10.772   |
| 16500                                       | 16.5 | 8.436  | 9.575    | 9.848    | 10.579   | 0.242    | 9.693    | 9.953    | 9.585    | 9.912    | 10.739   |
| 16875                                       | 16.9 | 8.418  | 9.610    | 9.876    | 10.547   | 0.238    | 9.726    | 9.984    | 9.619    | 9.937    | 10.707   |
| 17250                                       | 17.3 | 8.398  | 9.648    | 9.907    | 10.518   | 0.235    | 9.763    | 10.018   | 9.656    | 9.965    | 10.679   |
| 17625                                       | 17.6 | 8.377  | 9.697    | 9.951    | 10.503   | 0.233    | 9.812    | 10.064   | 9.705    | 10.004   | 10.663   |
| 18000                                       | 18.0 | 8.370  | 9.769    | 10.020   | 10.527   | 0.245    | 9.883    | 10.134   | 9.776    | 10.071   | 10.689   |

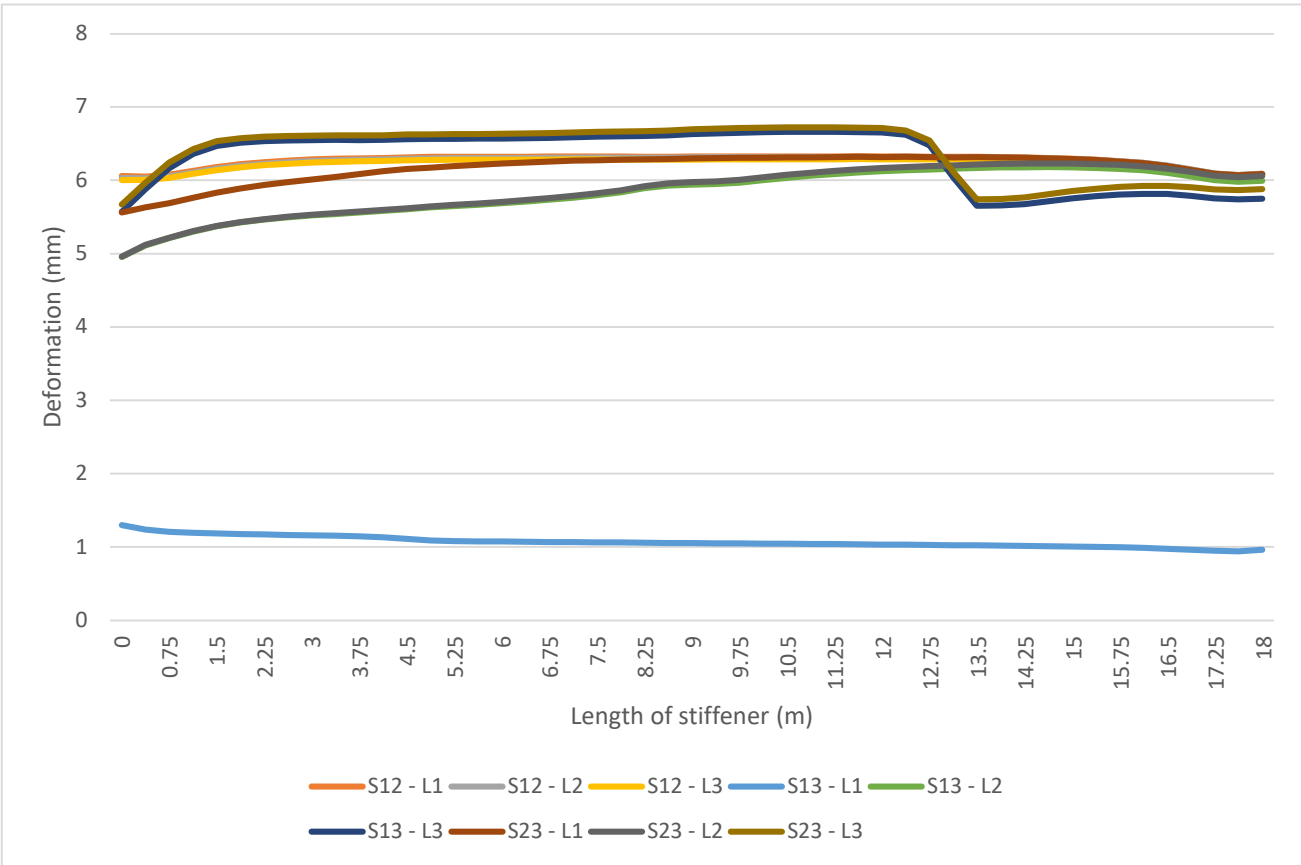


| STIFFENER 2 in S1,2 & 3 - Longitudinal direction |      |        |           |           |           |
|--------------------------------------------------|------|--------|-----------|-----------|-----------|
| mm                                               | m    | Normal | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.0  | 8.370  | 10.424    | 11.982    | 17.574    |
| 375                                              | 0.4  | 8.377  | 10.312    | 11.837    | 17.327    |
| 750                                              | 0.8  | 8.398  | 10.227    | 11.722    | 17.111    |
| 1125                                             | 1.1  | 8.417  | 10.157    | 11.621    | 16.898    |
| 1500                                             | 1.5  | 8.436  | 10.091    | 11.525    | 16.686    |
| 1875                                             | 1.9  | 8.454  | 10.027    | 11.432    | 16.474    |
| 2250                                             | 2.3  | 8.472  | 9.965     | 11.340    | 16.263    |
| 2625                                             | 2.6  | 8.489  | 9.905     | 11.249    | 16.053    |
| 3000                                             | 3.0  | 8.506  | 9.848     | 11.160    | 15.842    |
| 3375                                             | 3.4  | 8.520  | 9.792     | 11.073    | 15.637    |
| 3750                                             | 3.8  | 8.533  | 9.746     | 10.997    | 15.439    |
| 4125                                             | 4.1  | 8.546  | 9.712     | 10.926    | 15.232    |
| 4500                                             | 4.5  | 8.557  | 9.672     | 10.869    | 15.053    |
| 4875                                             | 4.9  | 8.566  | 9.616     | 10.786    | 14.854    |
| 5250                                             | 5.3  | 8.573  | 9.576     | 10.714    | 14.676    |
| 5625                                             | 5.6  | 8.580  | 9.543     | 10.646    | 14.493    |
| 6000                                             | 6.0  | 8.586  | 9.520     | 10.592    | 14.320    |
| 6375                                             | 6.4  | 8.591  | 9.497     | 10.537    | 14.149    |
| 6750                                             | 6.8  | 8.595  | 9.475     | 10.483    | 13.981    |
| 7125                                             | 7.1  | 8.598  | 9.456     | 10.431    | 13.815    |
| 7500                                             | 7.5  | 8.600  | 9.439     | 10.381    | 13.651    |
| 7875                                             | 7.9  | 8.601  | 9.421     | 10.328    | 13.488    |
| 8250                                             | 8.3  | 8.602  | 9.411     | 10.283    | 13.335    |
| 8625                                             | 8.6  | 8.603  | 9.409     | 10.263    | 13.181    |
| 9000                                             | 9.0  | 8.603  | 9.408     | 10.203    | 13.040    |
| 9375                                             | 9.4  | 8.603  | 9.392     | 10.131    | 12.886    |
| 9750                                             | 9.8  | 8.602  | 9.379     | 10.090    | 12.748    |
| 10125                                            | 10.1 | 8.601  | 9.372     | 10.057    | 12.610    |
| 10500                                            | 10.5 | 8.600  | 9.373     | 10.031    | 12.481    |
| 10875                                            | 10.9 | 8.598  | 9.372     | 10.005    | 12.353    |
| 11250                                            | 11.3 | 8.595  | 9.372     | 9.980     | 12.227    |
| 11625                                            | 11.6 | 8.591  | 9.374     | 9.958     | 12.107    |
| 12000                                            | 12.0 | 8.586  | 9.376     | 9.939     | 11.992    |
| 12375                                            | 12.4 | 8.580  | 9.378     | 9.919     | 11.873    |
| 12750                                            | 12.8 | 8.573  | 9.388     | 9.910     | 11.761    |
| 13125                                            | 13.1 | 8.566  | 9.406     | 9.911     | 11.695    |
| 13500                                            | 13.5 | 8.557  | 9.425     | 9.916     | 11.528    |
| 13875                                            | 13.9 | 8.546  | 9.431     | 9.906     | 11.388    |
| 14250                                            | 14.3 | 8.534  | 9.441     | 9.902     | 11.308    |
| 14625                                            | 14.6 | 8.520  | 9.459     | 9.908     | 11.243    |
| 15000                                            | 15.0 | 8.505  | 9.485     | 9.922     | 11.187    |
| 15375                                            | 15.4 | 8.489  | 9.512     | 9.939     | 11.134    |
| 15750                                            | 15.8 | 8.472  | 9.541     | 9.958     | 11.086    |
| 16125                                            | 16.1 | 8.454  | 9.573     | 9.981     | 11.043    |
| 16500                                            | 16.5 | 8.436  | 9.607     | 10.005    | 11.003    |
| 16875                                            | 16.9 | 8.418  | 9.641     | 10.030    | 10.964    |
| 17250                                            | 17.3 | 8.398  | 9.678     | 10.059    | 10.930    |
| 17625                                            | 17.6 | 8.377  | 9.728     | 10.099    | 10.909    |
| 18000                                            | 18.0 | 8.370  | 9.799     | 10.167    | 10.930    |

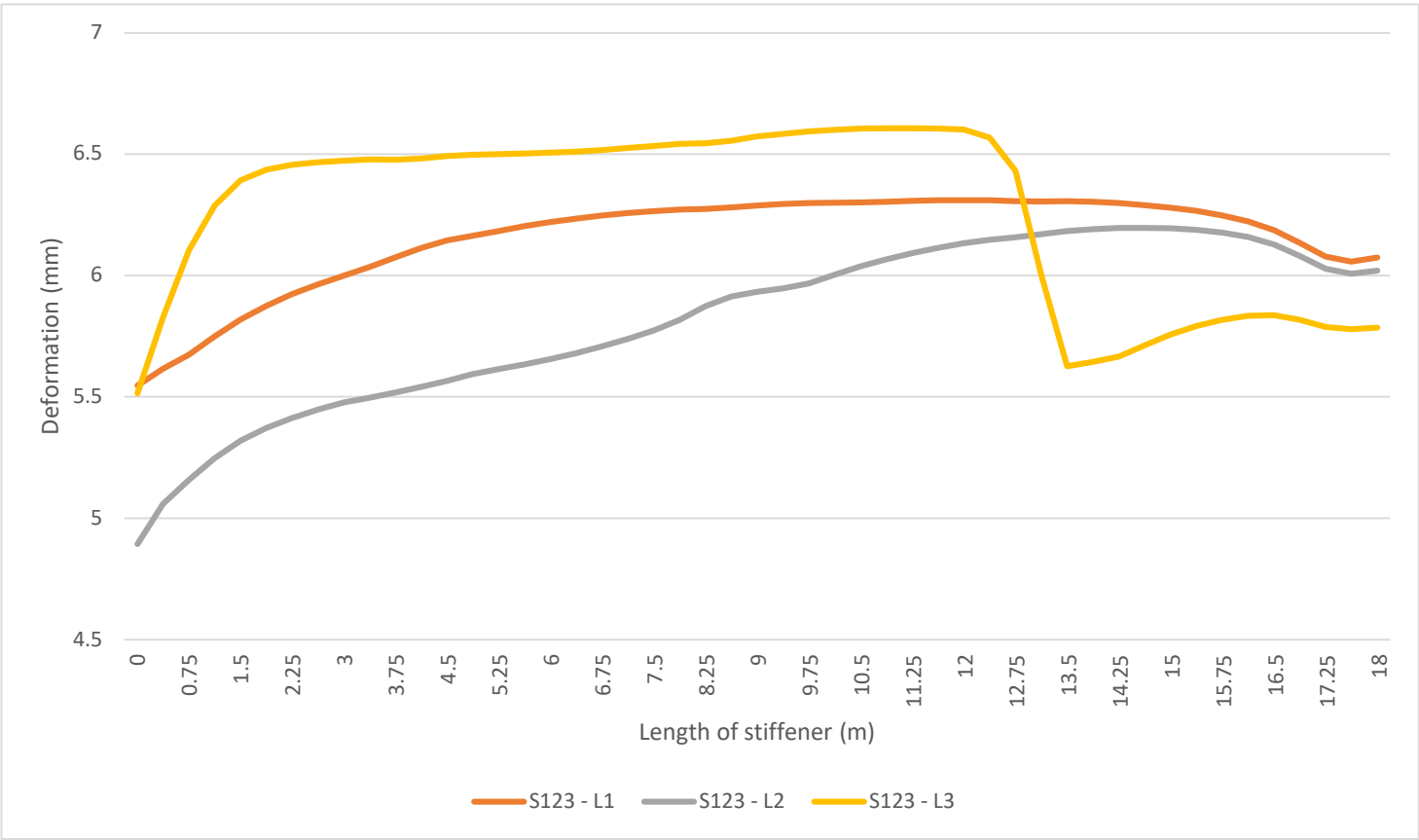


| STIFFENER 3 - Longitudinal direction |      |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m    | Normal | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.0  | 8.370  | 1.198   | 6.049   | 6.014   | 1.185   | 6.069   | 6.089   | 1.291   | 5.022   | 5.720   |
| 375                                  | 0.4  | 8.377  | 1.145   | 6.042   | 6.012   | 1.133   | 6.063   | 6.084   | 1.230   | 5.172   | 6.017   |
| 750                                  | 0.8  | 8.398  | 1.119   | 6.066   | 6.037   | 1.108   | 6.086   | 6.107   | 1.201   | 5.268   | 6.299   |
| 1125                                 | 1.1  | 8.417  | 1.107   | 6.119   | 6.091   | 1.097   | 6.139   | 6.159   | 1.187   | 5.357   | 6.495   |
| 1500                                 | 1.5  | 8.436  | 1.099   | 6.169   | 6.142   | 1.089   | 6.188   | 6.208   | 1.178   | 5.428   | 6.608   |
| 1875                                 | 1.9  | 8.454  | 1.091   | 6.206   | 6.179   | 1.082   | 6.226   | 6.245   | 1.169   | 5.479   | 6.652   |
| 2250                                 | 2.3  | 8.472  | 1.085   | 6.235   | 6.208   | 1.076   | 6.255   | 6.273   | 1.162   | 5.518   | 6.671   |
| 2625                                 | 2.6  | 8.489  | 1.079   | 6.255   | 6.229   | 1.071   | 6.276   | 6.294   | 1.156   | 5.549   | 6.678   |
| 3000                                 | 3.0  | 8.506  | 1.074   | 6.269   | 6.244   | 1.067   | 6.292   | 6.309   | 1.150   | 5.575   | 6.681   |
| 3375                                 | 3.4  | 8.520  | 1.071   | 6.278   | 6.253   | 1.063   | 6.302   | 6.319   | 1.145   | 5.593   | 6.684   |
| 3750                                 | 3.8  | 8.533  | 1.066   | 6.283   | 6.258   | 1.059   | 6.308   | 6.324   | 1.138   | 5.612   | 6.679   |
| 4125                                 | 4.1  | 8.546  | 1.063   | 6.288   | 6.263   | 1.056   | 6.314   | 6.330   | 1.126   | 5.632   | 6.681   |
| 4500                                 | 4.5  | 8.557  | 1.061   | 6.295   | 6.270   | 1.055   | 6.322   | 6.338   | 1.105   | 5.655   | 6.690   |
| 4875                                 | 4.9  | 8.566  | 1.058   | 6.300   | 6.274   | 1.052   | 6.328   | 6.344   | 1.083   | 5.679   | 6.691   |
| 5250                                 | 5.3  | 8.573  | 1.055   | 6.301   | 6.275   | 1.050   | 6.330   | 6.345   | 1.073   | 5.698   | 6.692   |
| 5625                                 | 5.6  | 8.580  | 1.053   | 6.300   | 6.274   | 1.048   | 6.330   | 6.345   | 1.069   | 5.715   | 6.693   |
| 6000                                 | 6.0  | 8.586  | 1.051   | 6.300   | 6.273   | 1.046   | 6.331   | 6.345   | 1.067   | 5.734   | 6.695   |
| 6375                                 | 6.4  | 8.591  | 1.048   | 6.300   | 6.273   | 1.044   | 6.332   | 6.346   | 1.064   | 5.757   | 6.698   |
| 6750                                 | 6.8  | 8.595  | 1.046   | 6.302   | 6.274   | 1.042   | 6.334   | 6.348   | 1.061   | 5.781   | 6.702   |
| 7125                                 | 7.1  | 8.598  | 1.044   | 6.303   | 6.274   | 1.040   | 6.336   | 6.350   | 1.059   | 5.810   | 6.708   |
| 7500                                 | 7.5  | 8.600  | 1.042   | 6.303   | 6.274   | 1.038   | 6.337   | 6.351   | 1.056   | 5.842   | 6.715   |
| 7875                                 | 7.9  | 8.601  | 1.040   | 6.301   | 6.272   | 1.036   | 6.336   | 6.350   | 1.054   | 5.882   | 6.722   |
| 8250                                 | 8.3  | 8.602  | 1.037   | 6.298   | 6.268   | 1.033   | 6.334   | 6.347   | 1.050   | 5.935   | 6.723   |
| 8625                                 | 8.6  | 8.603  | 1.035   | 6.298   | 6.267   | 1.031   | 6.335   | 6.347   | 1.048   | 5.970   | 6.731   |
| 9000                                 | 9.0  | 8.603  | 1.033   | 6.301   | 6.270   | 1.030   | 6.339   | 6.351   | 1.046   | 5.982   | 6.748   |
| 9375                                 | 9.4  | 8.603  | 1.030   | 6.303   | 6.271   | 1.027   | 6.341   | 6.354   | 1.044   | 5.987   | 6.757   |
| 9750                                 | 9.8  | 8.602  | 1.028   | 6.302   | 6.270   | 1.025   | 6.342   | 6.354   | 1.041   | 6.004   | 6.765   |
| 10125                                | 10.1 | 8.601  | 1.026   | 6.301   | 6.268   | 1.023   | 6.341   | 6.353   | 1.039   | 6.036   | 6.771   |
| 10500                                | 10.5 | 8.600  | 1.024   | 6.300   | 6.266   | 1.021   | 6.341   | 6.353   | 1.037   | 6.069   | 6.775   |
| 10875                                | 10.9 | 8.598  | 1.021   | 6.300   | 6.266   | 1.019   | 6.342   | 6.354   | 1.034   | 6.095   | 6.774   |
| 11250                                | 11.3 | 8.595  | 1.019   | 6.302   | 6.267   | 1.016   | 6.344   | 6.356   | 1.032   | 6.119   | 6.771   |
| 11625                                | 11.6 | 8.591  | 1.016   | 6.303   | 6.267   | 1.014   | 6.346   | 6.359   | 1.029   | 6.139   | 6.766   |
| 12000                                | 12.0 | 8.586  | 1.014   | 6.303   | 6.267   | 1.011   | 6.347   | 6.360   | 1.027   | 6.156   | 6.759   |
| 12375                                | 12.4 | 8.580  | 1.012   | 6.301   | 6.264   | 1.009   | 6.346   | 6.359   | 1.024   | 6.168   | 6.723   |
| 12750                                | 12.8 | 8.573  | 1.008   | 6.297   | 6.260   | 1.006   | 6.342   | 6.356   | 1.021   | 6.178   | 6.583   |
| 13125                                | 13.1 | 8.566  | 1.006   | 6.295   | 6.257   | 1.003   | 6.341   | 6.356   | 1.018   | 6.189   | 6.150   |
| 13500                                | 13.5 | 8.557  | 1.004   | 6.296   | 6.257   | 1.001   | 6.342   | 6.358   | 1.016   | 6.200   | 5.760   |
| 13875                                | 13.9 | 8.546  | 1.000   | 6.293   | 6.254   | 0.998   | 6.340   | 6.357   | 1.012   | 6.208   | 5.755   |
| 14250                                | 14.3 | 8.534  | 0.996   | 6.287   | 6.248   | 0.994   | 6.336   | 6.353   | 1.009   | 6.211   | 5.767   |
| 14625                                | 14.6 | 8.520  | 0.992   | 6.279   | 6.239   | 0.991   | 6.328   | 6.346   | 1.005   | 6.210   | 5.806   |
| 15000                                | 15.0 | 8.505  | 0.988   | 6.268   | 6.228   | 0.987   | 6.319   | 6.338   | 1.000   | 6.207   | 5.845   |
| 15375                                | 15.4 | 8.489  | 0.983   | 6.254   | 6.214   | 0.981   | 6.306   | 6.327   | 0.995   | 6.199   | 5.874   |
| 15750                                | 15.8 | 8.472  | 0.977   | 6.235   | 6.194   | 0.975   | 6.288   | 6.310   | 0.989   | 6.186   | 5.893   |
| 16125                                | 16.1 | 8.454  | 0.968   | 6.209   | 6.169   | 0.967   | 6.264   | 6.288   | 0.980   | 6.166   | 5.902   |
| 16500                                | 16.5 | 8.436  | 0.957   | 6.172   | 6.132   | 0.957   | 6.229   | 6.254   | 0.970   | 6.134   | 5.898   |
| 16875                                | 16.9 | 8.418  | 0.944   | 6.120   | 6.079   | 0.943   | 6.178   | 6.206   | 0.956   | 6.086   | 5.873   |
| 17250                                | 17.3 | 8.398  | 0.929   | 6.063   | 6.021   | 0.928   | 6.123   | 6.153   | 0.940   | 6.032   | 5.838   |
| 17625                                | 17.6 | 8.377  | 0.924   | 6.041   | 5.997   | 0.923   | 6.103   | 6.135   | 0.936   | 6.011   | 5.827   |
| 18000                                | 18.0 | 8.370  | 0.942   | 6.058   | 6.010   | 0.941   | 6.124   | 6.157   | 0.954   | 6.028   | 5.841   |



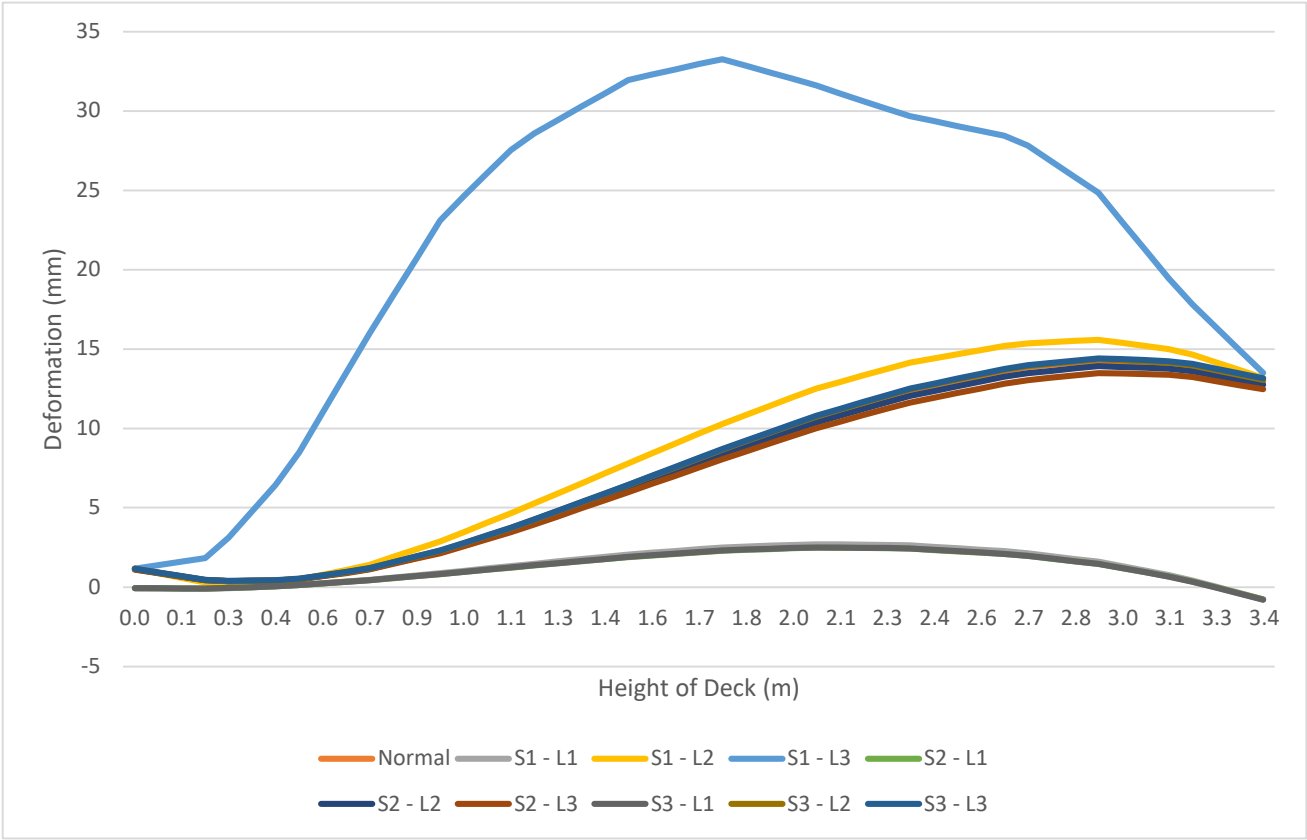


| STIFFENER 3 in S## - Longitudinal direction |      |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m    | Normal | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.0  | 8.370  | 6.060    | 6.033    | 6.003    | 1.299    | 4.957    | 5.570    | 5.562    | 4.962    | 5.670    |
| 375                                         | 0.4  | 8.377  | 6.053    | 6.030    | 6.007    | 1.237    | 5.112    | 5.880    | 5.629    | 5.120    | 5.969    |
| 750                                         | 0.8  | 8.398  | 6.076    | 6.055    | 6.034    | 1.208    | 5.211    | 6.163    | 5.686    | 5.218    | 6.241    |
| 1125                                        | 1.1  | 8.417  | 6.130    | 6.109    | 6.087    | 1.194    | 5.301    | 6.358    | 5.761    | 5.306    | 6.427    |
| 1500                                        | 1.5  | 8.436  | 6.180    | 6.159    | 6.137    | 1.185    | 5.373    | 6.469    | 5.831    | 5.377    | 6.532    |
| 1875                                        | 1.9  | 8.454  | 6.218    | 6.197    | 6.175    | 1.176    | 5.424    | 6.514    | 5.888    | 5.429    | 6.575    |
| 2250                                        | 2.3  | 8.472  | 6.247    | 6.226    | 6.205    | 1.169    | 5.464    | 6.534    | 5.935    | 5.470    | 6.595    |
| 2625                                        | 2.6  | 8.489  | 6.268    | 6.248    | 6.226    | 1.162    | 5.496    | 6.543    | 5.975    | 5.504    | 6.603    |
| 3000                                        | 3.0  | 8.506  | 6.284    | 6.264    | 6.243    | 1.157    | 5.523    | 6.548    | 6.011    | 5.532    | 6.609    |
| 3375                                        | 3.4  | 8.520  | 6.293    | 6.274    | 6.252    | 1.152    | 5.541    | 6.552    | 6.046    | 5.552    | 6.613    |
| 3750                                        | 3.8  | 8.533  | 6.299    | 6.280    | 6.258    | 1.145    | 5.560    | 6.548    | 6.086    | 5.573    | 6.611    |
| 4125                                        | 4.1  | 8.546  | 6.305    | 6.286    | 6.264    | 1.133    | 5.581    | 6.551    | 6.125    | 5.595    | 6.614    |
| 4500                                        | 4.5  | 8.557  | 6.313    | 6.294    | 6.272    | 1.111    | 5.604    | 6.561    | 6.155    | 5.619    | 6.625    |
| 4875                                        | 4.9  | 8.566  | 6.318    | 6.300    | 6.278    | 1.089    | 5.629    | 6.564    | 6.173    | 5.646    | 6.628    |
| 5250                                        | 5.3  | 8.573  | 6.320    | 6.302    | 6.280    | 1.079    | 5.649    | 6.566    | 6.192    | 5.667    | 6.630    |
| 5625                                        | 5.6  | 8.580  | 6.320    | 6.303    | 6.279    | 1.076    | 5.666    | 6.567    | 6.212    | 5.685    | 6.632    |
| 6000                                        | 6.0  | 8.586  | 6.320    | 6.303    | 6.280    | 1.073    | 5.686    | 6.570    | 6.230    | 5.706    | 6.635    |
| 6375                                        | 6.4  | 8.591  | 6.321    | 6.304    | 6.280    | 1.070    | 5.709    | 6.573    | 6.244    | 5.730    | 6.638    |
| 6750                                        | 6.8  | 8.595  | 6.323    | 6.307    | 6.282    | 1.068    | 5.734    | 6.579    | 6.256    | 5.757    | 6.644    |
| 7125                                        | 7.1  | 8.598  | 6.324    | 6.309    | 6.284    | 1.065    | 5.764    | 6.586    | 6.266    | 5.788    | 6.651    |
| 7500                                        | 7.5  | 8.600  | 6.325    | 6.310    | 6.284    | 1.062    | 5.796    | 6.594    | 6.274    | 5.822    | 6.659    |
| 7875                                        | 7.9  | 8.601  | 6.323    | 6.309    | 6.282    | 1.060    | 5.837    | 6.602    | 6.280    | 5.864    | 6.667    |
| 8250                                        | 8.3  | 8.602  | 6.320    | 6.307    | 6.280    | 1.057    | 5.891    | 6.604    | 6.283    | 5.919    | 6.668    |
| 8625                                        | 8.6  | 8.603  | 6.320    | 6.307    | 6.280    | 1.054    | 5.928    | 6.613    | 6.289    | 5.958    | 6.678    |
| 9000                                        | 9.0  | 8.603  | 6.324    | 6.311    | 6.283    | 1.053    | 5.942    | 6.630    | 6.297    | 5.975    | 6.695    |
| 9375                                        | 9.4  | 8.603  | 6.326    | 6.314    | 6.285    | 1.050    | 5.950    | 6.641    | 6.304    | 5.986    | 6.704    |
| 9750                                        | 9.8  | 8.602  | 6.326    | 6.314    | 6.285    | 1.047    | 5.968    | 6.650    | 6.307    | 6.005    | 6.713    |
| 10125                                       | 10.1 | 8.601  | 6.324    | 6.314    | 6.284    | 1.045    | 6.001    | 6.657    | 6.308    | 6.040    | 6.719    |
| 10500                                       | 10.5 | 8.600  | 6.324    | 6.314    | 6.283    | 1.043    | 6.034    | 6.662    | 6.310    | 6.074    | 6.724    |
| 10875                                       | 10.9 | 8.598  | 6.324    | 6.315    | 6.284    | 1.041    | 6.061    | 6.662    | 6.313    | 6.102    | 6.724    |
| 11250                                       | 11.3 | 8.595  | 6.325    | 6.317    | 6.286    | 1.038    | 6.085    | 6.661    | 6.316    | 6.127    | 6.722    |
| 11625                                       | 11.6 | 8.591  | 6.327    | 6.319    | 6.288    | 1.035    | 6.106    | 6.658    | 6.318    | 6.148    | 6.718    |
| 12000                                       | 12.0 | 8.586  | 6.327    | 6.320    | 6.289    | 1.033    | 6.123    | 6.654    | 6.320    | 6.167    | 6.712    |
| 12375                                       | 12.4 | 8.580  | 6.325    | 6.318    | 6.287    | 1.031    | 6.136    | 6.620    | 6.318    | 6.180    | 6.678    |
| 12750                                       | 12.8 | 8.573  | 6.321    | 6.315    | 6.284    | 1.027    | 6.146    | 6.479    | 6.315    | 6.192    | 6.541    |
| 13125                                       | 13.1 | 8.566  | 6.319    | 6.314    | 6.283    | 1.024    | 6.157    | 6.042    | 6.313    | 6.203    | 6.116    |
| 13500                                       | 13.5 | 8.557  | 6.320    | 6.315    | 6.285    | 1.022    | 6.169    | 5.654    | 6.314    | 6.216    | 5.739    |
| 13875                                       | 13.9 | 8.546  | 6.317    | 6.313    | 6.284    | 1.019    | 6.176    | 5.657    | 6.312    | 6.224    | 5.746    |
| 14250                                       | 14.3 | 8.534  | 6.312    | 6.308    | 6.280    | 1.015    | 6.180    | 5.673    | 6.307    | 6.229    | 5.765    |
| 14625                                       | 14.6 | 8.520  | 6.303    | 6.301    | 6.273    | 1.011    | 6.179    | 5.714    | 6.298    | 6.229    | 5.809    |
| 15000                                       | 15.0 | 8.505  | 6.293    | 6.291    | 6.265    | 1.007    | 6.176    | 5.754    | 6.288    | 6.227    | 5.851    |
| 15375                                       | 15.4 | 8.489  | 6.280    | 6.278    | 6.253    | 1.001    | 6.168    | 5.785    | 6.275    | 6.221    | 5.885    |
| 15750                                       | 15.8 | 8.472  | 6.261    | 6.260    | 6.237    | 0.995    | 6.155    | 5.805    | 6.256    | 6.209    | 5.909    |
| 16125                                       | 16.1 | 8.454  | 6.235    | 6.236    | 6.214    | 0.986    | 6.135    | 5.816    | 6.231    | 6.191    | 5.923    |
| 16500                                       | 16.5 | 8.436  | 6.199    | 6.201    | 6.181    | 0.976    | 6.103    | 5.813    | 6.195    | 6.160    | 5.924    |
| 16875                                       | 16.9 | 8.418  | 6.147    | 6.150    | 6.132    | 0.962    | 6.055    | 5.789    | 6.144    | 6.114    | 5.904    |
| 17250                                       | 17.3 | 8.398  | 6.091    | 6.094    | 6.077    | 0.946    | 6.000    | 5.754    | 6.087    | 6.061    | 5.874    |
| 17625                                       | 17.6 | 8.377  | 6.070    | 6.073    | 6.057    | 0.942    | 5.978    | 5.741    | 6.066    | 6.041    | 5.867    |
| 18000                                       | 18.0 | 8.370  | 6.089    | 6.091    | 6.071    | 0.961    | 5.992    | 5.747    | 6.085    | 6.057    | 5.880    |

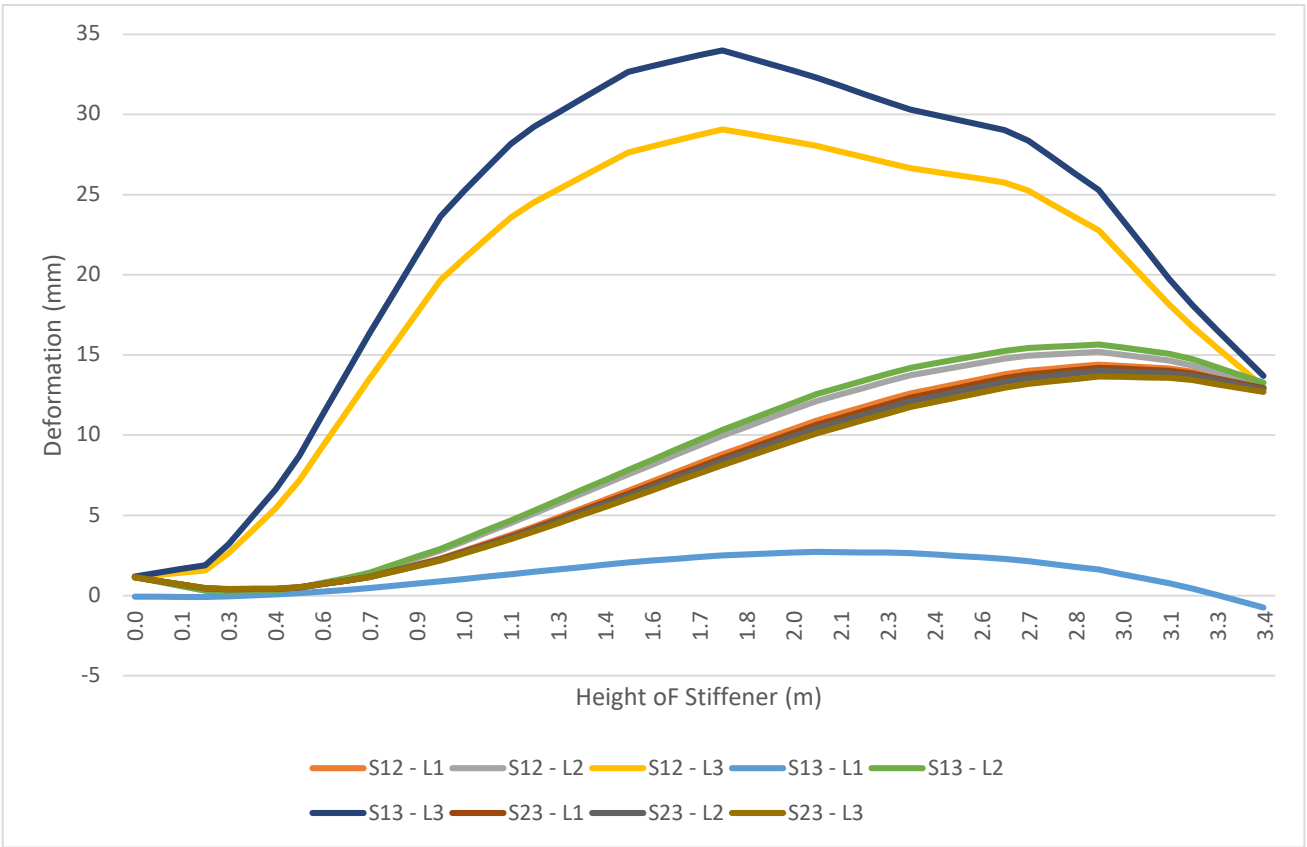


| STIFFENER 3 in S1,2 & 3 - Longitudinal direction |      |        |           |           |           |
|--------------------------------------------------|------|--------|-----------|-----------|-----------|
| mm                                               | m    | Normal | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.0  | 8.370  | 5.547     | 4.894     | 5.515     |
| 375                                              | 0.4  | 8.377  | 5.616     | 5.058     | 5.828     |
| 750                                              | 0.8  | 8.398  | 5.673     | 5.158     | 6.104     |
| 1125                                             | 1.1  | 8.417  | 5.749     | 5.247     | 6.288     |
| 1500                                             | 1.5  | 8.436  | 5.819     | 5.320     | 6.393     |
| 1875                                             | 1.9  | 8.454  | 5.876     | 5.372     | 6.436     |
| 2250                                             | 2.3  | 8.472  | 5.923     | 5.414     | 6.456     |
| 2625                                             | 2.6  | 8.489  | 5.964     | 5.448     | 6.466     |
| 3000                                             | 3.0  | 8.506  | 6.000     | 5.477     | 6.474     |
| 3375                                             | 3.4  | 8.520  | 6.035     | 5.497     | 6.479     |
| 3750                                             | 3.8  | 8.533  | 6.075     | 5.519     | 6.478     |
| 4125                                             | 4.1  | 8.546  | 6.114     | 5.541     | 6.482     |
| 4500                                             | 4.5  | 8.557  | 6.145     | 5.566     | 6.493     |
| 4875                                             | 4.9  | 8.566  | 6.164     | 5.594     | 6.497     |
| 5250                                             | 5.3  | 8.573  | 6.183     | 5.615     | 6.500     |
| 5625                                             | 5.6  | 8.580  | 6.203     | 5.634     | 6.503     |
| 6000                                             | 6.0  | 8.586  | 6.221     | 5.656     | 6.506     |
| 6375                                             | 6.4  | 8.591  | 6.235     | 5.681     | 6.511     |
| 6750                                             | 6.8  | 8.595  | 6.247     | 5.708     | 6.517     |
| 7125                                             | 7.1  | 8.598  | 6.257     | 5.740     | 6.525     |
| 7500                                             | 7.5  | 8.600  | 6.266     | 5.774     | 6.534     |
| 7875                                             | 7.9  | 8.601  | 6.271     | 5.817     | 6.542     |
| 8250                                             | 8.3  | 8.602  | 6.275     | 5.873     | 6.545     |
| 8625                                             | 8.6  | 8.603  | 6.280     | 5.914     | 6.555     |
| 9000                                             | 9.0  | 8.603  | 6.289     | 5.933     | 6.573     |
| 9375                                             | 9.4  | 8.603  | 6.295     | 5.947     | 6.584     |
| 9750                                             | 9.8  | 8.602  | 6.299     | 5.968     | 6.593     |
| 10125                                            | 10.1 | 8.601  | 6.300     | 6.003     | 6.601     |
| 10500                                            | 10.5 | 8.600  | 6.302     | 6.038     | 6.606     |
| 10875                                            | 10.9 | 8.598  | 6.304     | 6.067     | 6.608     |
| 11250                                            | 11.3 | 8.595  | 6.307     | 6.092     | 6.607     |
| 11625                                            | 11.6 | 8.591  | 6.310     | 6.114     | 6.606     |
| 12000                                            | 12.0 | 8.586  | 6.311     | 6.133     | 6.602     |
| 12375                                            | 12.4 | 8.580  | 6.310     | 6.147     | 6.569     |
| 12750                                            | 12.8 | 8.573  | 6.307     | 6.158     | 6.432     |
| 13125                                            | 13.1 | 8.566  | 6.305     | 6.170     | 6.002     |
| 13500                                            | 13.5 | 8.557  | 6.306     | 6.183     | 5.627     |
| 13875                                            | 13.9 | 8.546  | 6.304     | 6.192     | 5.644     |
| 14250                                            | 14.3 | 8.534  | 6.298     | 6.196     | 5.666     |
| 14625                                            | 14.6 | 8.520  | 6.290     | 6.197     | 5.712     |
| 15000                                            | 15.0 | 8.505  | 6.280     | 6.195     | 5.757     |
| 15375                                            | 15.4 | 8.489  | 6.267     | 6.189     | 5.792     |
| 15750                                            | 15.8 | 8.472  | 6.248     | 6.177     | 5.818     |
| 16125                                            | 16.1 | 8.454  | 6.223     | 6.158     | 5.834     |
| 16500                                            | 16.5 | 8.436  | 6.187     | 6.128     | 5.836     |
| 16875                                            | 16.9 | 8.418  | 6.135     | 6.081     | 5.818     |
| 17250                                            | 17.3 | 8.398  | 6.078     | 6.028     | 5.788     |
| 17625                                            | 17.6 | 8.377  | 6.057     | 6.007     | 5.779     |
| 18000                                            | 18.0 | 8.370  | 6.075     | 6.020     | 5.785     |

## **APPENDIX H – Raw data case study for corrosion type N2 transversal (Part 2)**

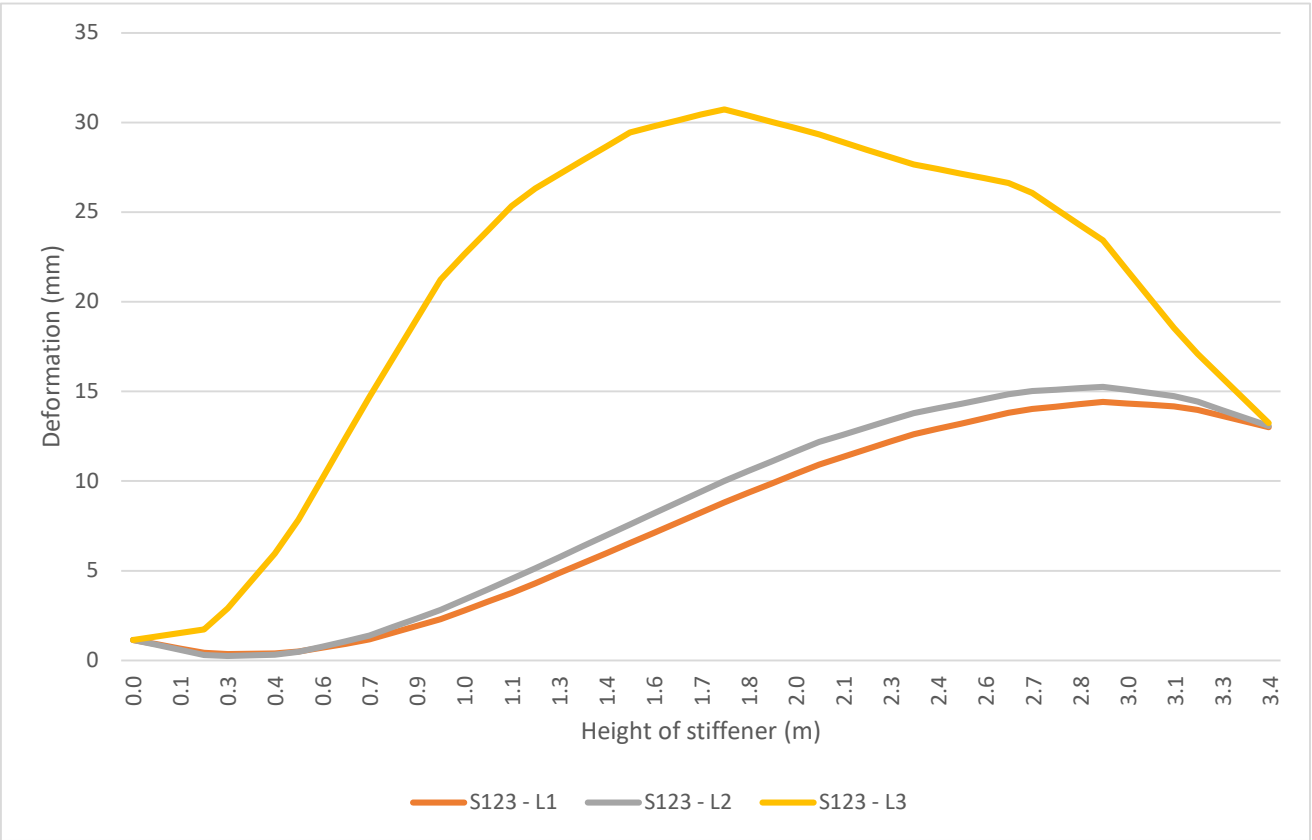


| STIFFENER 1 - Transversal direction |       |        |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | Normal | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S1 - L4 | S3 - L3 |
| 0.000                               | 0.000 | 1.138  | -0.074  | 1.153   | 1.164   | -0.073  | 1.119   | 1.092   | -0.074  | 0.592   | 1.157   |
| 71.080                              | 0.071 | 0.903  | -0.084  | 0.866   | 1.386   | -0.082  | 0.890   | 0.872   | -0.082  | 0.470   | 0.922   |
| 142.160                             | 0.142 | 0.669  | -0.094  | 0.578   | 1.608   | -0.091  | 0.662   | 0.652   | -0.091  | 0.679   | 0.688   |
| 213.240                             | 0.213 | 0.435  | -0.104  | 0.291   | 1.830   | -0.100  | 0.434   | 0.432   | -0.100  | 0.445   | 0.454   |
| 284.320                             | 0.284 | 0.380  | -0.064  | 0.239   | 3.107   | -0.063  | 0.379   | 0.379   | -0.062  | 0.389   | 0.399   |
| 355.400                             | 0.355 | 0.391  | -0.006  | 0.274   | 4.778   | -0.007  | 0.389   | 0.388   | -0.006  | 0.401   | 0.410   |
| 426.480                             | 0.426 | 0.402  | 0.052   | 0.310   | 6.450   | 0.048   | 0.398   | 0.397   | 0.050   | 0.412   | 0.422   |
| 497.560                             | 0.498 | 0.505  | 0.133   | 0.467   | 8.502   | 0.123   | 0.497   | 0.492   | 0.126   | 0.515   | 0.526   |
| 568.640                             | 0.569 | 0.717  | 0.239   | 0.768   | 11.009  | 0.223   | 0.702   | 0.689   | 0.227   | 0.728   | 0.739   |
| 639.720                             | 0.640 | 0.929  | 0.346   | 1.069   | 13.515  | 0.324   | 0.906   | 0.885   | 0.328   | 0.940   | 0.953   |
| 710.800                             | 0.711 | 1.170  | 0.459   | 1.405   | 15.996  | 0.429   | 1.139   | 1.109   | 0.434   | 1.182   | 1.195   |
| 781.880                             | 0.782 | 1.539  | 0.596   | 1.896   | 18.362  | 0.556   | 1.495   | 1.451   | 0.563   | 1.551   | 1.566   |
| 852.960                             | 0.853 | 1.907  | 0.733   | 2.386   | 20.727  | 0.684   | 1.851   | 1.793   | 0.691   | 1.920   | 1.936   |
| 924.040                             | 0.924 | 2.275  | 0.870   | 2.876   | 23.093  | 0.811   | 2.207   | 2.135   | 0.820   | 2.290   | 2.307   |
| 995.120                             | 0.995 | 2.745  | 1.020   | 3.463   | 24.625  | 0.949   | 2.661   | 2.572   | 0.958   | 2.760   | 2.779   |
| 1066.200                            | 1.066 | 3.224  | 1.171   | 4.058   | 26.077  | 1.088   | 3.125   | 3.018   | 1.098   | 3.241   | 3.261   |
| 1137.300                            | 1.137 | 3.704  | 1.321   | 4.654   | 27.529  | 1.226   | 3.589   | 3.464   | 1.238   | 3.721   | 3.742   |
| 1208.400                            | 1.208 | 4.223  | 1.468   | 5.271   | 28.589  | 1.361   | 4.092   | 3.948   | 1.373   | 4.242   | 4.265   |
| 1279.400                            | 1.279 | 4.766  | 1.613   | 5.900   | 29.430  | 1.493   | 4.617   | 4.454   | 1.506   | 4.786   | 4.811   |
| 1350.500                            | 1.351 | 5.309  | 1.758   | 6.529   | 30.270  | 1.625   | 5.143   | 4.960   | 1.639   | 5.330   | 5.357   |
| 1421.600                            | 1.422 | 5.851  | 1.903   | 7.158   | 31.111  | 1.757   | 5.668   | 5.465   | 1.772   | 5.874   | 5.902   |
| 1492.700                            | 1.493 | 6.395  | 2.048   | 7.789   | 31.953  | 1.890   | 6.195   | 5.972   | 1.905   | 6.420   | 6.449   |
| 1563.800                            | 1.564 | 6.952  | 2.160   | 8.412   | 32.290  | 1.991   | 6.735   | 6.492   | 2.007   | 6.978   | 7.010   |
| 1634.800                            | 1.635 | 7.510  | 2.271   | 9.036   | 32.628  | 2.093   | 7.276   | 7.013   | 2.109   | 7.538   | 7.571   |
| 1705.900                            | 1.706 | 8.068  | 2.383   | 9.660   | 32.965  | 2.194   | 7.817   | 7.534   | 2.211   | 8.097   | 8.133   |
| 1777.000                            | 1.777 | 8.624  | 2.492   | 10.281  | 33.273  | 2.294   | 8.357   | 8.054   | 2.312   | 8.655   | 8.693   |
| 1848.100                            | 1.848 | 9.146  | 2.546   | 10.840  | 32.858  | 2.344   | 8.865   | 8.545   | 2.362   | 9.179   | 9.219   |
| 1919.200                            | 1.919 | 9.668  | 2.601   | 11.399  | 32.443  | 2.394   | 9.372   | 9.035   | 2.412   | 9.703   | 9.745   |
| 1990.200                            | 1.990 | 10.189 | 2.656   | 11.958  | 32.028  | 2.445   | 9.880   | 9.525   | 2.462   | 10.226  | 10.271  |
| 2061.300                            | 2.061 | 10.704 | 2.705   | 12.505  | 31.607  | 2.489   | 10.381  | 10.009  | 2.507   | 10.743  | 10.789  |
| 2132.400                            | 2.132 | 11.134 | 2.688   | 12.920  | 31.116  | 2.475   | 10.802  | 10.418  | 2.492   | 11.175  | 11.224  |
| 2203.500                            | 2.204 | 11.565 | 2.672   | 13.335  | 30.625  | 2.460   | 11.224  | 10.828  | 2.476   | 11.608  | 11.660  |
| 2274.600                            | 2.275 | 11.996 | 2.655   | 13.751  | 30.134  | 2.445   | 11.645  | 11.237  | 2.461   | 12.041  | 12.095  |
| 2345.600                            | 2.346 | 12.411 | 2.630   | 14.147  | 29.666  | 2.421   | 12.052  | 11.632  | 2.437   | 12.458  | 12.515  |
| 2416.700                            | 2.417 | 12.715 | 2.537   | 14.409  | 29.362  | 2.336   | 12.354  | 11.929  | 2.350   | 12.765  | 12.824  |
| 2487.800                            | 2.488 | 13.020 | 2.445   | 14.670  | 29.057  | 2.251   | 12.655  | 12.225  | 2.264   | 13.072  | 13.133  |
| 2558.900                            | 2.559 | 13.324 | 2.353   | 14.932  | 28.752  | 2.166   | 12.957  | 12.521  | 2.178   | 13.379  | 13.443  |
| 2630.000                            | 2.630 | 13.629 | 2.261   | 15.194  | 28.448  | 2.081   | 13.259  | 12.817  | 2.091   | 13.686  | 13.752  |
| 2701.000                            | 2.701 | 13.854 | 2.127   | 15.365  | 27.813  | 1.957   | 13.485  | 13.043  | 1.965   | 13.914  | 13.983  |
| 2772.100                            | 2.772 | 13.995 | 1.948   | 15.438  | 26.823  | 1.790   | 13.631  | 13.192  | 1.797   | 14.057  | 14.129  |
| 2843.200                            | 2.843 | 14.136 | 1.770   | 15.510  | 25.833  | 1.624   | 13.777  | 13.340  | 1.628   | 14.201  | 14.274  |
| 2914.300                            | 2.914 | 14.280 | 1.593   | 15.587  | 24.853  | 1.458   | 13.925  | 13.492  | 1.461   | 14.347  | 14.423  |
| 2985.400                            | 2.985 | 14.212 | 1.311   | 15.389  | 23.049  | 1.194   | 13.872  | 13.452  | 1.194   | 14.281  | 14.360  |
| 3056.400                            | 3.056 | 14.144 | 1.030   | 15.191  | 21.245  | 0.930   | 13.818  | 13.413  | 0.927   | 14.216  | 14.298  |
| 3127.500                            | 3.128 | 14.076 | 0.749   | 14.994  | 19.441  | 0.666   | 13.765  | 13.374  | 0.660   | 14.151  | 14.235  |
| 3198.600                            | 3.199 | 13.891 | 0.413   | 14.652  | 17.817  | 0.350   | 13.600  | 13.229  | 0.340   | 13.969  | 14.055  |
| 3269.700                            | 3.270 | 13.586 | 0.020   | 14.164  | 16.378  | -0.020  | 13.320  | 12.975  | -0.034  | 13.666  | 13.755  |
| 3340.800                            | 3.341 | 13.280 | -0.373  | 13.675  | 14.939  | -0.391  | 13.040  | 12.722  | -0.409  | 13.364  | 13.455  |
| 3411.800                            | 3.412 | 12.975 | -0.765  | 13.186  | 13.500  | -0.761  | 12.760  | 12.468  | -0.783  | 13.061  | 13.156  |

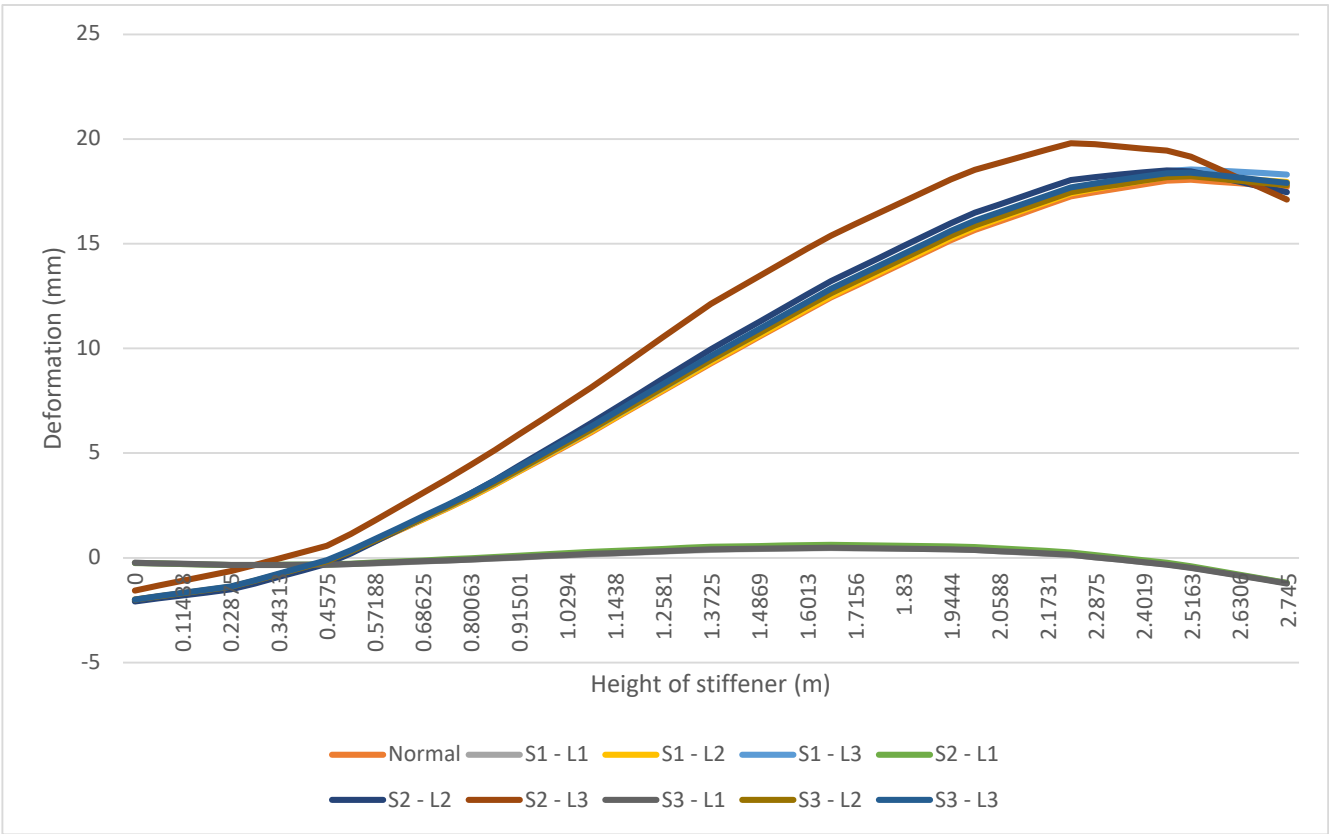


| STIFFENER 1 in S## - Transversal direction |       |        |          |          |          |          |          |          |          |          |          |
|--------------------------------------------|-------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                         | m     | Normal | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0.000                                      | 0.000 | 1.138  | 1.138    | 1.134    | 1.121    | -0.072   | 1.163    | 1.183    | 1.136    | 1.130    | 1.115    |
| 71.080                                     | 0.071 | 0.903  | 0.899    | 0.854    | 1.270    | -0.083   | 0.876    | 1.417    | 0.903    | 0.901    | 0.895    |
| 142.160                                    | 0.142 | 0.669  | 0.660    | 0.574    | 1.419    | -0.093   | 0.589    | 1.651    | 0.670    | 0.673    | 0.675    |
| 213.240                                    | 0.213 | 0.435  | 0.421    | 0.294    | 1.568    | -0.103   | 0.302    | 1.885    | 0.437    | 0.445    | 0.455    |
| 284.320                                    | 0.284 | 0.380  | 0.364    | 0.242    | 2.629    | -0.063   | 0.251    | 3.193    | 0.382    | 0.390    | 0.402    |
| 355.400                                    | 0.355 | 0.391  | 0.375    | 0.275    | 4.031    | -0.005   | 0.287    | 4.902    | 0.392    | 0.399    | 0.411    |
| 426.480                                    | 0.426 | 0.402  | 0.385    | 0.309    | 5.433    | 0.053    | 0.324    | 6.611    | 0.403    | 0.409    | 0.421    |
| 497.560                                    | 0.498 | 0.505  | 0.490    | 0.460    | 7.166    | 0.134    | 0.481    | 8.710    | 0.505    | 0.508    | 0.516    |
| 568.640                                    | 0.569 | 0.717  | 0.706    | 0.751    | 9.295    | 0.241    | 0.784    | 11.275   | 0.715    | 0.713    | 0.714    |
| 639.720                                    | 0.640 | 0.929  | 0.921    | 1.043    | 11.424   | 0.348    | 1.086    | 13.840   | 0.926    | 0.918    | 0.912    |
| 710.800                                    | 0.711 | 1.170  | 1.167    | 1.368    | 13.537   | 0.461    | 1.424    | 16.378   | 1.165    | 1.151    | 1.137    |
| 781.880                                    | 0.782 | 1.539  | 1.544    | 1.842    | 15.576   | 0.598    | 1.916    | 18.800   | 1.530    | 1.508    | 1.481    |
| 852.960                                    | 0.853 | 1.907  | 1.921    | 2.317    | 17.616   | 0.736    | 2.407    | 21.222   | 1.895    | 1.864    | 1.825    |
| 924.040                                    | 0.924 | 2.275  | 2.297    | 2.792    | 19.656   | 0.873    | 2.899    | 23.644   | 2.261    | 2.221    | 2.169    |
| 995.120                                    | 0.995 | 2.745  | 2.780    | 3.360    | 21.009   | 1.024    | 3.487    | 25.209   | 2.727    | 2.676    | 2.608    |
| 1066.200                                   | 1.066 | 3.224  | 3.272    | 3.937    | 22.295   | 1.175    | 4.084    | 26.691   | 3.202    | 3.141    | 3.057    |
| 1137.300                                   | 1.137 | 3.704  | 3.765    | 4.514    | 23.582   | 1.326    | 4.682    | 28.173   | 3.678    | 3.606    | 3.505    |
| 1208.400                                   | 1.208 | 4.223  | 4.299    | 5.111    | 24.540   | 1.474    | 5.300    | 29.252   | 4.194    | 4.110    | 3.993    |
| 1279.400                                   | 1.279 | 4.766  | 4.857    | 5.721    | 25.314   | 1.619    | 5.931    | 30.104   | 4.733    | 4.637    | 4.501    |
| 1350.500                                   | 1.351 | 5.309  | 5.415    | 6.330    | 26.087   | 1.765    | 6.562    | 30.957   | 5.271    | 5.164    | 5.010    |
| 1421.600                                   | 1.422 | 5.851  | 5.973    | 6.940    | 26.860   | 1.910    | 7.192    | 31.809   | 5.810    | 5.691    | 5.519    |
| 1492.700                                   | 1.493 | 6.395  | 6.532    | 7.551    | 27.635   | 2.056    | 7.824    | 32.664   | 6.350    | 6.219    | 6.029    |
| 1563.800                                   | 1.564 | 6.952  | 7.100    | 8.155    | 28.001   | 2.168    | 8.449    | 33.006   | 6.903    | 6.761    | 6.553    |
| 1634.800                                   | 1.635 | 7.510  | 7.669    | 8.760    | 28.367   | 2.280    | 9.075    | 33.348   | 7.457    | 7.303    | 7.078    |
| 1705.900                                   | 1.706 | 8.068  | 8.239    | 9.365    | 28.733   | 2.392    | 9.700    | 33.691   | 8.011    | 7.846    | 7.603    |
| 1777.000                                   | 1.777 | 8.624  | 8.806    | 9.967    | 29.074   | 2.502    | 10.324   | 34.003   | 8.564    | 8.388    | 8.127    |
| 1848.100                                   | 1.848 | 9.146  | 9.332    | 10.510   | 28.818   | 2.557    | 10.884   | 33.580   | 9.082    | 8.898    | 8.622    |
| 1919.200                                   | 1.919 | 9.668  | 9.859    | 11.053   | 28.562   | 2.612    | 11.445   | 33.156   | 9.601    | 9.407    | 9.118    |
| 1990.200                                   | 1.990 | 10.189 | 10.385   | 11.596   | 28.306   | 2.668    | 12.005   | 32.732   | 10.120   | 9.917    | 9.613    |
| 2061.300                                   | 2.061 | 10.704 | 10.903   | 12.127   | 28.042   | 2.717    | 12.554   | 32.302   | 10.632   | 10.420   | 10.102   |
| 2132.400                                   | 2.132 | 11.134 | 11.332   | 12.534   | 27.689   | 2.701    | 12.971   | 31.795   | 11.061   | 10.844   | 10.517   |
| 2203.500                                   | 2.204 | 11.565 | 11.761   | 12.940   | 27.337   | 2.685    | 13.388   | 31.289   | 11.490   | 11.268   | 10.932   |
| 2274.600                                   | 2.275 | 11.996 | 12.190   | 13.346   | 26.985   | 2.669    | 13.805   | 30.782   | 11.919   | 11.692   | 11.347   |
| 2345.600                                   | 2.346 | 12.411 | 12.603   | 13.735   | 26.649   | 2.644    | 14.203   | 30.299   | 12.332   | 12.101   | 11.748   |
| 2416.700                                   | 2.417 | 12.715 | 12.900   | 13.995   | 26.426   | 2.552    | 14.467   | 29.980   | 12.637   | 12.405   | 12.051   |
| 2487.800                                   | 2.488 | 13.020 | 13.198   | 14.255   | 26.203   | 2.460    | 14.730   | 29.661   | 12.941   | 12.710   | 12.353   |
| 2558.900                                   | 2.559 | 13.324 | 13.496   | 14.515   | 25.980   | 2.368    | 14.994   | 29.342   | 13.246   | 13.014   | 12.656   |
| 2630.000                                   | 2.630 | 13.629 | 13.793   | 14.775   | 25.757   | 2.277    | 15.257   | 29.022   | 13.551   | 13.319   | 12.959   |
| 2701.000                                   | 2.701 | 13.854 | 14.010   | 14.948   | 25.244   | 2.143    | 15.430   | 28.364   | 13.777   | 13.548   | 13.191   |
| 2772.100                                   | 2.772 | 13.995 | 14.139   | 15.028   | 24.421   | 1.965    | 15.504   | 27.339   | 13.920   | 13.697   | 13.347   |
| 2843.200                                   | 2.843 | 14.136 | 14.268   | 15.108   | 23.597   | 1.787    | 15.579   | 26.314   | 14.063   | 13.846   | 13.503   |
| 2914.300                                   | 2.914 | 14.280 | 14.400   | 15.191   | 22.782   | 1.610    | 15.657   | 25.300   | 14.208   | 13.997   | 13.661   |
| 2985.400                                   | 2.985 | 14.212 | 14.317   | 15.013   | 21.237   | 1.329    | 15.461   | 23.445   | 14.145   | 13.947   | 13.630   |
| 3056.400                                   | 3.056 | 14.144 | 14.233   | 14.834   | 19.691   | 1.047    | 15.266   | 21.590   | 14.082   | 13.897   | 13.598   |
| 3127.500                                   | 3.128 | 14.076 | 14.150   | 14.656   | 18.146   | 0.766    | 15.070   | 19.735   | 14.018   | 13.847   | 13.567   |
| 3198.600                                   | 3.199 | 13.891 | 13.948   | 14.341   | 16.746   | 0.430    | 14.731   | 18.076   | 13.839   | 13.685   | 13.430   |
| 3269.700                                   | 3.270 | 13.586 | 13.625   | 13.885   | 15.495   | 0.037    | 14.246   | 16.616   | 13.541   | 13.409   | 13.185   |
| 3340.800                                   | 3.341 | 13.280 | 13.302   | 13.429   | 14.244   | -0.356   | 13.760   | 15.156   | 13.243   | 13.132   | 12.940   |
| 3411.800                                   | 3.412 | 12.975 | 12.979   | 12.973   | 12.993   | -0.749   | 13.274   | 13.696   | 12.944   | 12.856   | 12.695   |

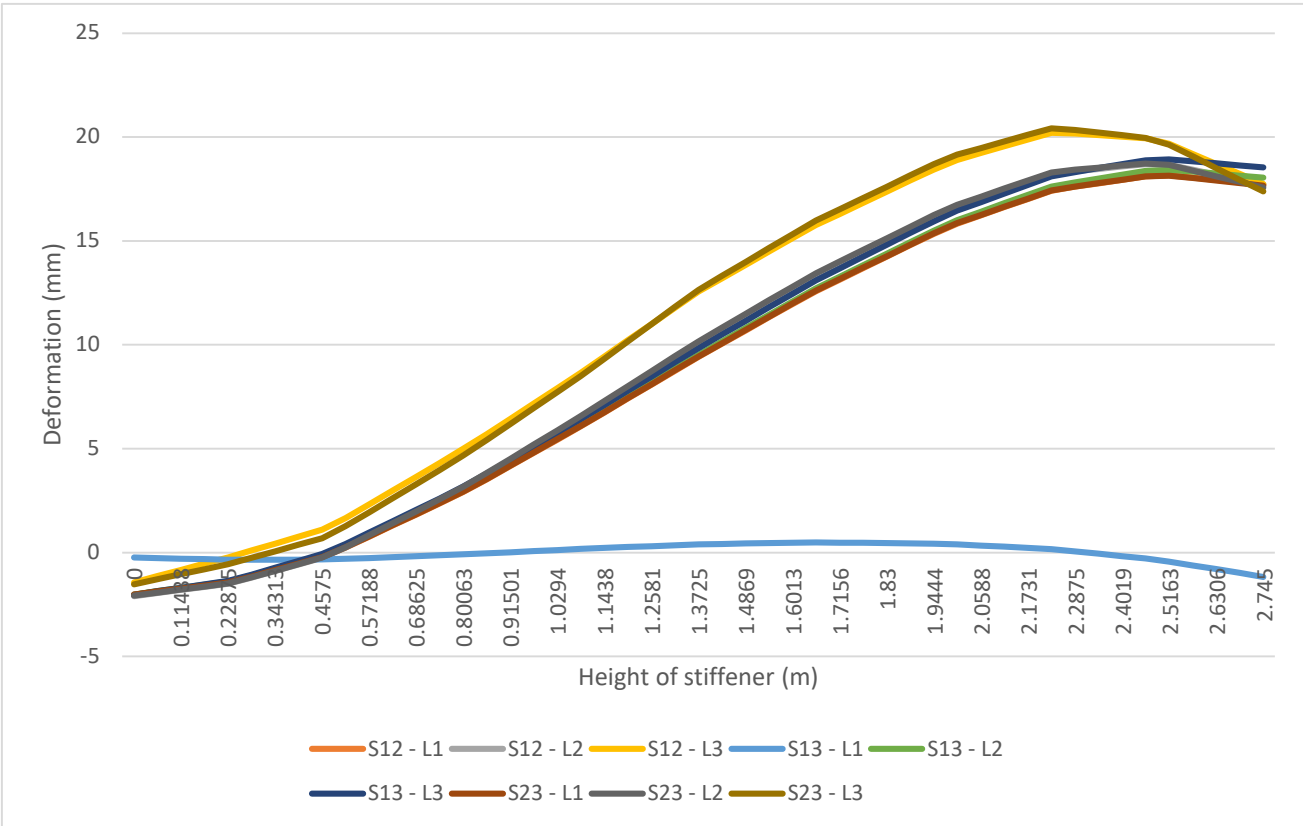




| STIFFENER 1 in S1,2 & 3 - Transversal direction |       |        |           |           |           |
|-------------------------------------------------|-------|--------|-----------|-----------|-----------|
| mm                                              | m     | Normal | S123 - L1 | S123 - L2 | S123 - L3 |
| 0.000                                           | 0.000 | 1.138  | 1.140     | 1.145     | 1.142     |
| 71.080                                          | 0.071 | 0.903  | 0.902     | 0.865     | 1.339     |
| 142.160                                         | 0.142 | 0.669  | 0.663     | 0.586     | 1.536     |
| 213.240                                         | 0.213 | 0.435  | 0.424     | 0.306     | 1.733     |
| 284.320                                         | 0.284 | 0.380  | 0.367     | 0.255     | 2.901     |
| 355.400                                         | 0.355 | 0.391  | 0.377     | 0.289     | 4.431     |
| 426.480                                         | 0.426 | 0.402  | 0.388     | 0.323     | 5.962     |
| 497.560                                         | 0.498 | 0.505  | 0.492     | 0.475     | 7.841     |
| 568.640                                         | 0.569 | 0.717  | 0.708     | 0.768     | 10.136    |
| 639.720                                         | 0.640 | 0.929  | 0.924     | 1.060     | 12.431    |
| 710.800                                         | 0.711 | 1.170  | 1.170     | 1.387     | 14.704    |
| 781.880                                         | 0.782 | 1.539  | 1.547     | 1.863     | 16.878    |
| 852.960                                         | 0.853 | 1.907  | 1.924     | 2.339     | 19.052    |
| 924.040                                         | 0.924 | 2.275  | 2.301     | 2.815     | 21.226    |
| 995.120                                         | 0.995 | 2.745  | 2.783     | 3.384     | 22.642    |
| 1066.200                                        | 1.066 | 3.224  | 3.276     | 3.962     | 23.986    |
| 1137.300                                        | 1.137 | 3.704  | 3.769     | 4.541     | 25.329    |
| 1208.400                                        | 1.208 | 4.223  | 4.303     | 5.140     | 26.313    |
| 1279.400                                        | 1.279 | 4.766  | 4.862     | 5.751     | 27.096    |
| 1350.500                                        | 1.351 | 5.309  | 5.420     | 6.362     | 27.879    |
| 1421.600                                        | 1.422 | 5.851  | 5.978     | 6.973     | 28.662    |
| 1492.700                                        | 1.493 | 6.395  | 6.538     | 7.586     | 29.446    |
| 1563.800                                        | 1.564 | 6.952  | 7.106     | 8.191     | 29.775    |
| 1634.800                                        | 1.635 | 7.510  | 7.676     | 8.798     | 30.104    |
| 1705.900                                        | 1.706 | 8.068  | 8.245     | 9.404     | 30.433    |
| 1777.000                                        | 1.777 | 8.624  | 8.813     | 10.008    | 30.735    |
| 1848.100                                        | 1.848 | 9.146  | 9.340     | 10.553    | 30.384    |
| 1919.200                                        | 1.919 | 9.668  | 9.867     | 11.098    | 30.034    |
| 1990.200                                        | 1.990 | 10.189 | 10.393    | 11.642    | 29.683    |
| 2061.300                                        | 2.061 | 10.704 | 10.912    | 12.176    | 29.327    |
| 2132.400                                        | 2.132 | 11.134 | 11.341    | 12.584    | 28.904    |
| 2203.500                                        | 2.204 | 11.565 | 11.771    | 12.993    | 28.482    |
| 2274.600                                        | 2.275 | 11.996 | 12.200    | 13.401    | 28.059    |
| 2345.600                                        | 2.346 | 12.411 | 12.613    | 13.791    | 27.657    |
| 2416.700                                        | 2.417 | 12.715 | 12.912    | 14.053    | 27.399    |
| 2487.800                                        | 2.488 | 13.020 | 13.210    | 14.315    | 27.141    |
| 2558.900                                        | 2.559 | 13.324 | 13.508    | 14.577    | 26.884    |
| 2630.000                                        | 2.630 | 13.629 | 13.806    | 14.840    | 26.626    |
| 2701.000                                        | 2.701 | 13.854 | 14.024    | 15.015    | 26.066    |
| 2772.100                                        | 2.772 | 13.995 | 14.154    | 15.097    | 25.180    |
| 2843.200                                        | 2.843 | 14.136 | 14.284    | 15.180    | 24.295    |
| 2914.300                                        | 2.914 | 14.280 | 14.416    | 15.265    | 23.419    |
| 2985.400                                        | 2.985 | 14.212 | 14.333    | 15.090    | 21.792    |
| 3056.400                                        | 3.056 | 14.144 | 14.251    | 14.914    | 20.166    |
| 3127.500                                        | 3.128 | 14.076 | 14.168    | 14.739    | 18.540    |
| 3198.600                                        | 3.199 | 13.891 | 13.967    | 14.427    | 17.084    |
| 3269.700                                        | 3.270 | 13.586 | 13.645    | 13.975    | 15.801    |
| 3340.800                                        | 3.341 | 13.280 | 13.323    | 13.523    | 14.518    |
| 3411.800                                        | 3.412 | 12.975 | 13.000    | 13.070    | 13.235    |

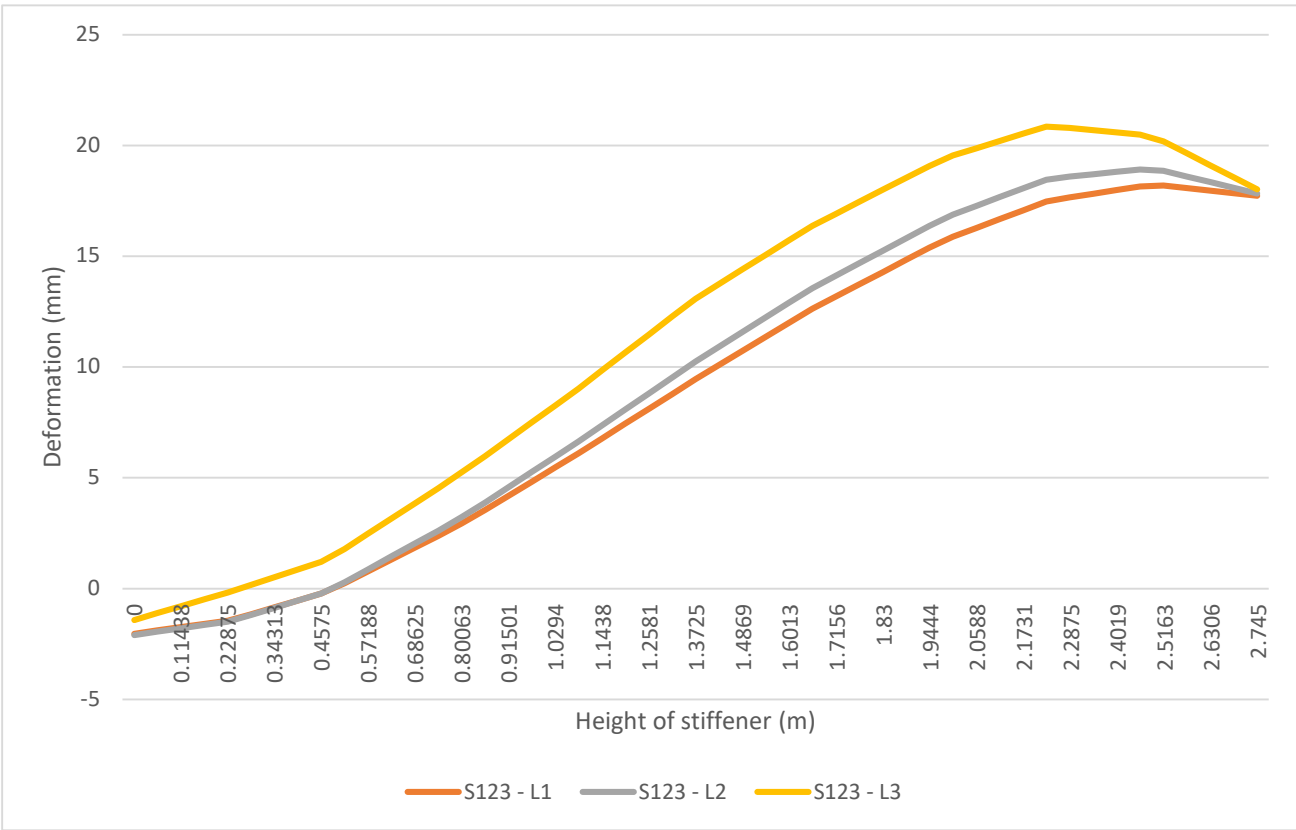


| STIFFENER 2 - Transversal direction |       |        |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | Normal | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0.000                               | 0.000 | -2.000 | -0.244  | -2.023  | -2.049  | -0.250  | -2.083  | -1.566  | -0.239  | -1.995  | -1.988  |
| 57.188                              | 0.057 | -1.853 | -0.271  | -1.872  | -1.892  | -0.275  | -1.941  | -1.334  | -0.266  | -1.844  | -1.834  |
| 114.380                             | 0.114 | -1.705 | -0.298  | -1.721  | -1.735  | -0.301  | -1.799  | -1.102  | -0.293  | -1.694  | -1.680  |
| 171.560                             | 0.172 | -1.558 | -0.325  | -1.570  | -1.579  | -0.326  | -1.657  | -0.870  | -0.319  | -1.543  | -1.526  |
| 228.750                             | 0.229 | -1.410 | -0.351  | -1.419  | -1.422  | -0.351  | -1.515  | -0.638  | -0.346  | -1.393  | -1.372  |
| 285.940                             | 0.286 | -1.125 | -0.352  | -1.130  | -1.128  | -0.347  | -1.228  | -0.343  | -0.346  | -1.102  | -1.076  |
| 343.130                             | 0.343 | -0.816 | -0.348  | -0.818  | -0.810  | -0.339  | -0.916  | -0.038  | -0.342  | -0.789  | -0.756  |
| 400.320                             | 0.400 | -0.508 | -0.345  | -0.506  | -0.493  | -0.330  | -0.604  | 0.268   | -0.338  | -0.475  | -0.437  |
| 457.500                             | 0.458 | -0.199 | -0.341  | -0.194  | -0.175  | -0.322  | -0.292  | 0.574   | -0.333  | -0.161  | -0.117  |
| 514.690                             | 0.515 | 0.260  | -0.310  | 0.268   | 0.293   | -0.283  | 0.201   | 1.127   | -0.301  | 0.306   | 0.357   |
| 571.880                             | 0.572 | 0.781  | -0.267  | 0.792   | 0.821   | -0.232  | 0.769   | 1.781   | -0.258  | 0.834   | 0.894   |
| 629.070                             | 0.629 | 1.301  | -0.225  | 1.315   | 1.350   | -0.181  | 1.336   | 2.435   | -0.215  | 1.363   | 1.431   |
| 686.250                             | 0.686 | 1.821  | -0.183  | 1.838   | 1.879   | -0.130  | 1.904   | 3.089   | -0.172  | 1.891   | 1.968   |
| 743.440                             | 0.743 | 2.342  | -0.140  | 2.361   | 2.408   | -0.079  | 2.471   | 3.743   | -0.129  | 2.420   | 2.505   |
| 800.630                             | 0.801 | 2.891  | -0.095  | 2.914   | 2.966   | -0.026  | 3.070   | 4.434   | -0.083  | 2.977   | 3.072   |
| 857.820                             | 0.858 | 3.482  | -0.046  | 3.507   | 3.564   | 0.032   | 3.709   | 5.136   | -0.033  | 3.577   | 3.680   |
| 915.010                             | 0.915 | 4.108  | 0.006   | 4.136   | 4.198   | 0.093   | 4.385   | 5.881   | 0.020   | 4.211   | 4.324   |
| 972.190                             | 0.972 | 4.734  | 0.059   | 4.765   | 4.833   | 0.153   | 5.062   | 6.625   | 0.073   | 4.846   | 4.968   |
| 1029.400                            | 1.029 | 5.360  | 0.111   | 5.393   | 5.467   | 0.214   | 5.738   | 7.370   | 0.126   | 5.481   | 5.613   |
| 1086.600                            | 1.087 | 5.986  | 0.163   | 6.022   | 6.101   | 0.275   | 6.415   | 8.114   | 0.179   | 6.116   | 6.257   |
| 1143.800                            | 1.144 | 6.645  | 0.206   | 6.685   | 6.770   | 0.324   | 7.124   | 8.919   | 0.222   | 6.784   | 6.933   |
| 1200.900                            | 1.201 | 7.305  | 0.249   | 7.348   | 7.439   | 0.373   | 7.832   | 9.724   | 0.266   | 7.451   | 7.610   |
| 1258.100                            | 1.258 | 7.964  | 0.293   | 8.011   | 8.108   | 0.422   | 8.541   | 10.528  | 0.309   | 8.119   | 8.286   |
| 1315.300                            | 1.315 | 8.624  | 0.336   | 8.674   | 8.777   | 0.471   | 9.249   | 11.333  | 0.353   | 8.787   | 8.962   |
| 1372.500                            | 1.373 | 9.282  | 0.377   | 9.335   | 9.444   | 0.518   | 9.954   | 12.128  | 0.395   | 9.452   | 9.636   |
| 1429.700                            | 1.430 | 9.912  | 0.396   | 9.970   | 10.085  | 0.539   | 10.607  | 12.783  | 0.413   | 10.088  | 10.279  |
| 1486.900                            | 1.487 | 10.542 | 0.415   | 10.604  | 10.727  | 0.561   | 11.260  | 13.438  | 0.432   | 10.725  | 10.921  |
| 1544.100                            | 1.544 | 11.172 | 0.434   | 11.239  | 11.369  | 0.582   | 11.912  | 14.093  | 0.450   | 11.361  | 11.563  |
| 1601.300                            | 1.601 | 11.803 | 0.453   | 11.873  | 12.010  | 0.603   | 12.565  | 14.748  | 0.469   | 11.997  | 12.206  |
| 1658.400                            | 1.658 | 12.422 | 0.467   | 12.498  | 12.642  | 0.620   | 13.205  | 15.387  | 0.483   | 12.622  | 12.837  |
| 1715.600                            | 1.716 | 12.970 | 0.453   | 13.051  | 13.204  | 0.604   | 13.760  | 15.923  | 0.468   | 13.173  | 13.390  |
| 1772.800                            | 1.773 | 13.518 | 0.439   | 13.605  | 13.766  | 0.589   | 14.315  | 16.458  | 0.453   | 13.723  | 13.943  |
| 1830.000                            | 1.830 | 14.066 | 0.425   | 14.159  | 14.329  | 0.573   | 14.870  | 16.993  | 0.438   | 14.274  | 14.497  |
| 1887.200                            | 1.887 | 14.614 | 0.410   | 14.713  | 14.891  | 0.557   | 15.426  | 17.529  | 0.422   | 14.825  | 15.050  |
| 1944.400                            | 1.944 | 15.162 | 0.396   | 15.267  | 15.453  | 0.542   | 15.981  | 18.064  | 0.407   | 15.376  | 15.603  |
| 2001.600                            | 2.002 | 15.657 | 0.366   | 15.768  | 15.963  | 0.509   | 16.477  | 18.523  | 0.376   | 15.871  | 16.100  |
| 2058.800                            | 2.059 | 16.057 | 0.308   | 16.176  | 16.381  | 0.445   | 16.869  | 18.844  | 0.316   | 16.269  | 16.496  |
| 2116.000                            | 2.116 | 16.457 | 0.250   | 16.583  | 16.799  | 0.381   | 17.262  | 19.164  | 0.256   | 16.667  | 16.892  |
| 2173.100                            | 2.173 | 16.857 | 0.192   | 16.991  | 17.217  | 0.317   | 17.654  | 19.485  | 0.196   | 17.065  | 17.288  |
| 2230.300                            | 2.230 | 17.256 | 0.134   | 17.399  | 17.635  | 0.253   | 18.046  | 19.806  | 0.136   | 17.463  | 17.684  |
| 2287.500                            | 2.288 | 17.459 | 0.024   | 17.611  | 17.860  | 0.133   | 18.182  | 19.745  | 0.022   | 17.658  | 17.871  |
| 2344.700                            | 2.345 | 17.640 | -0.092  | 17.803  | 18.065  | 0.006   | 18.292  | 19.644  | -0.096  | 17.831  | 18.036  |
| 2401.900                            | 2.402 | 17.822 | -0.207  | 17.995  | 18.269  | -0.120  | 18.402  | 19.543  | -0.215  | 18.005  | 18.201  |
| 2459.100                            | 2.459 | 18.004 | -0.322  | 18.187  | 18.474  | -0.247  | 18.512  | 19.441  | -0.333  | 18.179  | 18.367  |
| 2516.300                            | 2.516 | 18.062 | -0.468  | 18.257  | 18.558  | -0.406  | 18.458  | 19.155  | -0.483  | 18.225  | 18.401  |
| 2573.500                            | 2.574 | 17.970 | -0.650  | 18.178  | 18.495  | -0.605  | 18.209  | 18.644  | -0.669  | 18.118  | 18.278  |
| 2630.600                            | 2.631 | 17.879 | -0.832  | 18.100  | 18.432  | -0.804  | 17.959  | 18.133  | -0.856  | 18.011  | 18.154  |
| 2687.800                            | 2.688 | 17.787 | -1.014  | 18.021  | 18.369  | -1.003  | 17.709  | 17.622  | -1.043  | 17.904  | 18.031  |
| 2745.000                            | 2.745 | 17.696 | -1.196  | 17.943  | 18.306  | -1.202  | 17.459  | 17.111  | -1.230  | 17.796  | 17.907  |

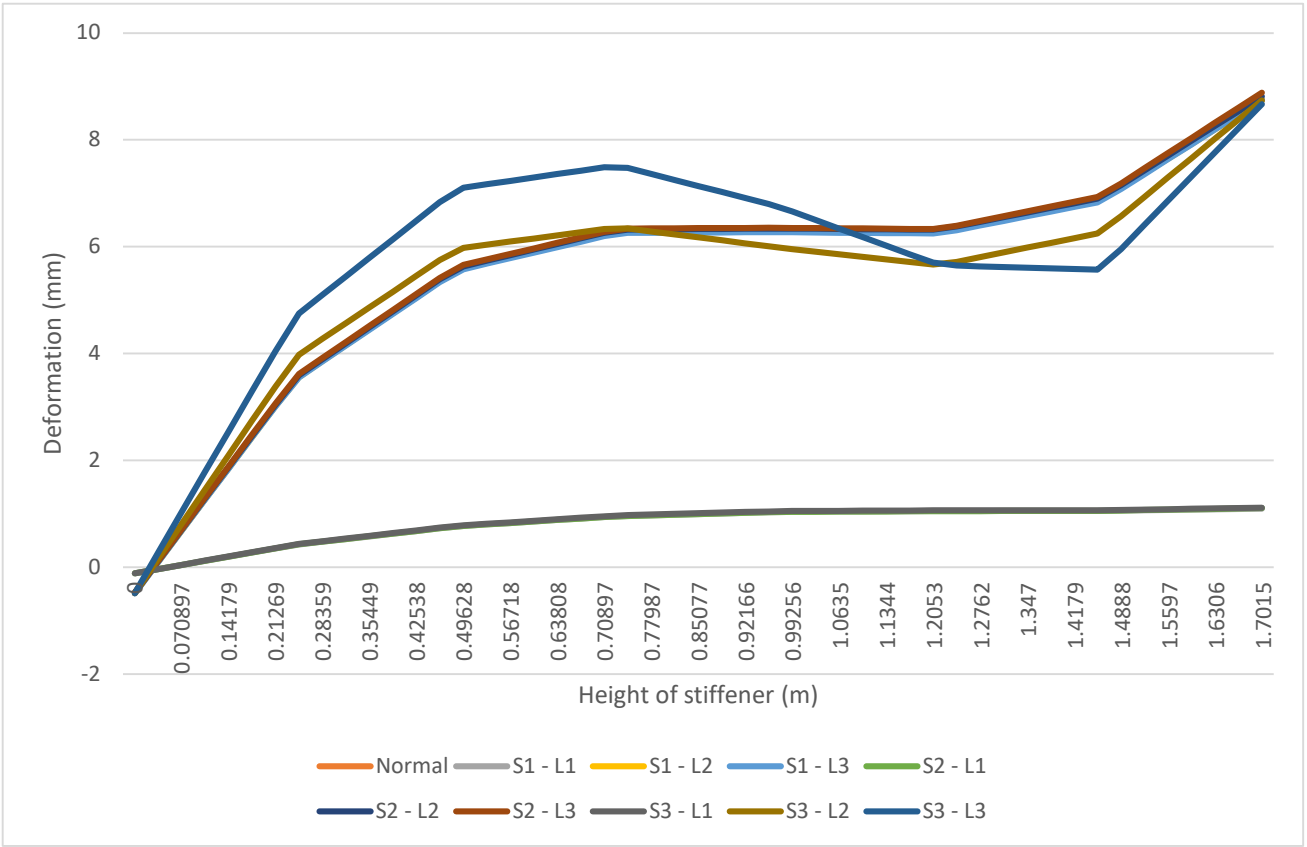


| STIFFENER 2 in S## - Transveral direction |       |        |          |          |          |          |          |          |          |          |          |
|-------------------------------------------|-------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                        | m     | Normal | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0.000                                     | 0.000 | -2.000 | -2.030   | -2.099   | -1.441   | -0.248   | -2.017   | -2.033   | -2.023   | -2.078   | -1.537   |
| 57.188                                    | 0.057 | -1.853 | -1.886   | -1.951   | -1.141   | -0.274   | -1.862   | -1.869   | -1.879   | -1.932   | -1.295   |
| 114.380                                   | 0.114 | -1.705 | -1.742   | -1.803   | -0.841   | -0.301   | -1.708   | -1.704   | -1.736   | -1.787   | -1.053   |
| 171.560                                   | 0.172 | -1.558 | -1.599   | -1.655   | -0.541   | -0.328   | -1.553   | -1.540   | -1.592   | -1.642   | -0.810   |
| 228.750                                   | 0.229 | -1.410 | -1.455   | -1.507   | -0.241   | -0.355   | -1.399   | -1.375   | -1.449   | -1.497   | -0.568   |
| 285.940                                   | 0.286 | -1.125 | -1.168   | -1.214   | 0.088    | -0.356   | -1.105   | -1.069   | -1.161   | -1.204   | -0.262   |
| 343.130                                   | 0.343 | -0.816 | -0.856   | -0.897   | 0.422    | -0.352   | -0.787   | -0.739   | -0.850   | -0.886   | 0.054    |
| 400.320                                   | 0.400 | -0.508 | -0.545   | -0.580   | 0.755    | -0.348   | -0.470   | -0.410   | -0.538   | -0.569   | 0.371    |
| 457.500                                   | 0.458 | -0.199 | -0.234   | -0.263   | 1.089    | -0.344   | -0.152   | -0.080   | -0.227   | -0.251   | 0.688    |
| 514.690                                   | 0.515 | 0.260  | 0.234    | 0.235    | 1.655    | -0.312   | 0.318    | 0.405    | 0.242    | 0.251    | 1.260    |
| 571.880                                   | 0.572 | 0.781  | 0.764    | 0.806    | 2.317    | -0.269   | 0.850    | 0.952    | 0.774    | 0.828    | 1.935    |
| 629.070                                   | 0.629 | 1.301  | 1.295    | 1.378    | 2.978    | -0.226   | 1.381    | 1.499    | 1.306    | 1.405    | 2.611    |
| 686.250                                   | 0.686 | 1.821  | 1.826    | 1.949    | 3.639    | -0.183   | 1.913    | 2.046    | 1.838    | 1.982    | 3.287    |
| 743.440                                   | 0.743 | 2.342  | 2.357    | 2.520    | 4.301    | -0.140   | 2.445    | 2.592    | 2.370    | 2.558    | 3.963    |
| 800.630                                   | 0.801 | 2.891  | 2.917    | 3.124    | 4.999    | -0.094   | 3.006    | 3.170    | 2.931    | 3.167    | 4.676    |
| 857.820                                   | 0.858 | 3.482  | 3.519    | 3.765    | 5.694    | -0.044   | 3.609    | 3.787    | 3.534    | 3.816    | 5.404    |
| 915.010                                   | 0.915 | 4.108  | 4.156    | 4.444    | 6.431    | 0.009    | 4.247    | 4.441    | 4.173    | 4.503    | 6.174    |
| 972.190                                   | 0.972 | 4.734  | 4.794    | 5.124    | 7.167    | 0.063    | 4.885    | 5.096    | 4.811    | 5.191    | 6.945    |
| 1029.400                                  | 1.029 | 5.360  | 5.431    | 5.803    | 7.904    | 0.116    | 5.523    | 5.750    | 5.450    | 5.878    | 7.716    |
| 1086.600                                  | 1.087 | 5.986  | 6.069    | 6.483    | 8.641    | 0.169    | 6.161    | 6.404    | 6.089    | 6.566    | 8.486    |
| 1143.800                                  | 1.144 | 6.645  | 6.737    | 7.194    | 9.425    | 0.213    | 6.832    | 7.091    | 6.758    | 7.284    | 9.319    |
| 1200.900                                  | 1.201 | 7.305  | 7.405    | 7.906    | 10.209   | 0.258    | 7.504    | 7.778    | 7.427    | 8.003    | 10.152   |
| 1258.100                                  | 1.258 | 7.964  | 8.074    | 8.617    | 10.993   | 0.302    | 8.175    | 8.465    | 8.097    | 8.722    | 10.985   |
| 1315.300                                  | 1.315 | 8.624  | 8.742    | 9.328    | 11.777   | 0.346    | 8.846    | 9.152    | 8.766    | 9.441    | 11.817   |
| 1372.500                                  | 1.373 | 9.282  | 9.409    | 10.036   | 12.551   | 0.389    | 9.516    | 9.837    | 9.433    | 10.156   | 12.639   |
| 1429.700                                  | 1.430 | 9.912  | 10.045   | 10.692   | 13.195   | 0.408    | 10.156   | 10.491   | 10.070   | 10.815   | 13.310   |
| 1486.900                                  | 1.487 | 10.542 | 10.682   | 11.348   | 13.839   | 0.428    | 10.797   | 11.146   | 10.707   | 11.475   | 13.981   |
| 1544.100                                  | 1.544 | 11.172 | 11.319   | 12.004   | 14.483   | 0.448    | 11.438   | 11.801   | 11.344   | 12.135   | 14.652   |
| 1601.300                                  | 1.601 | 11.803 | 11.956   | 12.661   | 15.127   | 0.468    | 12.078   | 12.455   | 11.981   | 12.795   | 15.323   |
| 1658.400                                  | 1.658 | 12.422 | 12.581   | 13.304   | 15.757   | 0.484    | 12.708   | 13.098   | 12.606   | 13.442   | 15.977   |
| 1715.600                                  | 1.716 | 12.970 | 13.132   | 13.864   | 16.292   | 0.471    | 13.265   | 13.666   | 13.156   | 14.000   | 16.518   |
| 1772.800                                  | 1.773 | 13.518 | 13.683   | 14.424   | 16.828   | 0.457    | 13.821   | 14.234   | 13.706   | 14.559   | 17.060   |
| 1830.000                                  | 1.830 | 14.066 | 14.234   | 14.983   | 17.364   | 0.444    | 14.378   | 14.802   | 14.256   | 15.117   | 17.601   |
| 1887.200                                  | 1.887 | 14.614 | 14.785   | 15.543   | 17.900   | 0.431    | 14.934   | 15.370   | 14.806   | 15.675   | 18.143   |
| 1944.400                                  | 1.944 | 15.162 | 15.336   | 16.103   | 18.435   | 0.418    | 15.491   | 15.937   | 15.356   | 16.234   | 18.684   |
| 2001.600                                  | 2.002 | 15.657 | 15.831   | 16.605   | 18.897   | 0.388    | 15.993   | 16.450   | 15.850   | 16.732   | 19.146   |
| 2058.800                                  | 2.059 | 16.057 | 16.226   | 17.004   | 19.225   | 0.331    | 16.398   | 16.863   | 16.243   | 17.122   | 19.464   |
| 2116.000                                  | 2.116 | 16.457 | 16.622   | 17.402   | 19.554   | 0.274    | 16.804   | 17.277   | 16.637   | 17.513   | 19.782   |
| 2173.100                                  | 2.173 | 16.857 | 17.018   | 17.801   | 19.883   | 0.216    | 17.209   | 17.690   | 17.030   | 17.904   | 20.101   |
| 2230.300                                  | 2.230 | 17.256 | 17.414   | 18.200   | 20.212   | 0.159    | 17.615   | 18.103   | 17.423   | 18.294   | 20.419   |
| 2287.500                                  | 2.288 | 17.459 | 17.604   | 18.345   | 20.171   | 0.049    | 17.819   | 18.311   | 17.610   | 18.421   | 20.335   |
| 2344.700                                  | 2.345 | 17.640 | 17.773   | 18.464   | 20.092   | -0.066   | 18.002   | 18.498   | 17.774   | 18.521   | 20.210   |
| 2401.900                                  | 2.402 | 17.822 | 17.942   | 18.583   | 20.013   | -0.181   | 18.186   | 18.684   | 17.939   | 18.621   | 20.085   |
| 2459.100                                  | 2.459 | 18.004 | 18.111   | 18.703   | 19.934   | -0.296   | 18.369   | 18.871   | 18.104   | 18.721   | 19.960   |
| 2516.300                                  | 2.516 | 18.062 | 18.153   | 18.660   | 19.672   | -0.442   | 18.426   | 18.928   | 18.140   | 18.653   | 19.635   |
| 2573.500                                  | 2.574 | 17.970 | 18.041   | 18.423   | 19.189   | -0.624   | 18.331   | 18.830   | 18.021   | 18.383   | 19.071   |
| 2630.600                                  | 2.631 | 17.879 | 17.929   | 18.186   | 18.706   | -0.806   | 18.236   | 18.732   | 17.902   | 18.112   | 18.506   |
| 2687.800                                  | 2.688 | 17.787 | 17.817   | 17.949   | 18.222   | -0.989   | 18.141   | 18.634   | 17.783   | 17.842   | 17.941   |
| 2745.000                                  | 2.745 | 17.696 | 17.705   | 17.712   | 17.739   | -1.171   | 18.046   | 18.536   | 17.664   | 17.572   | 17.376   |

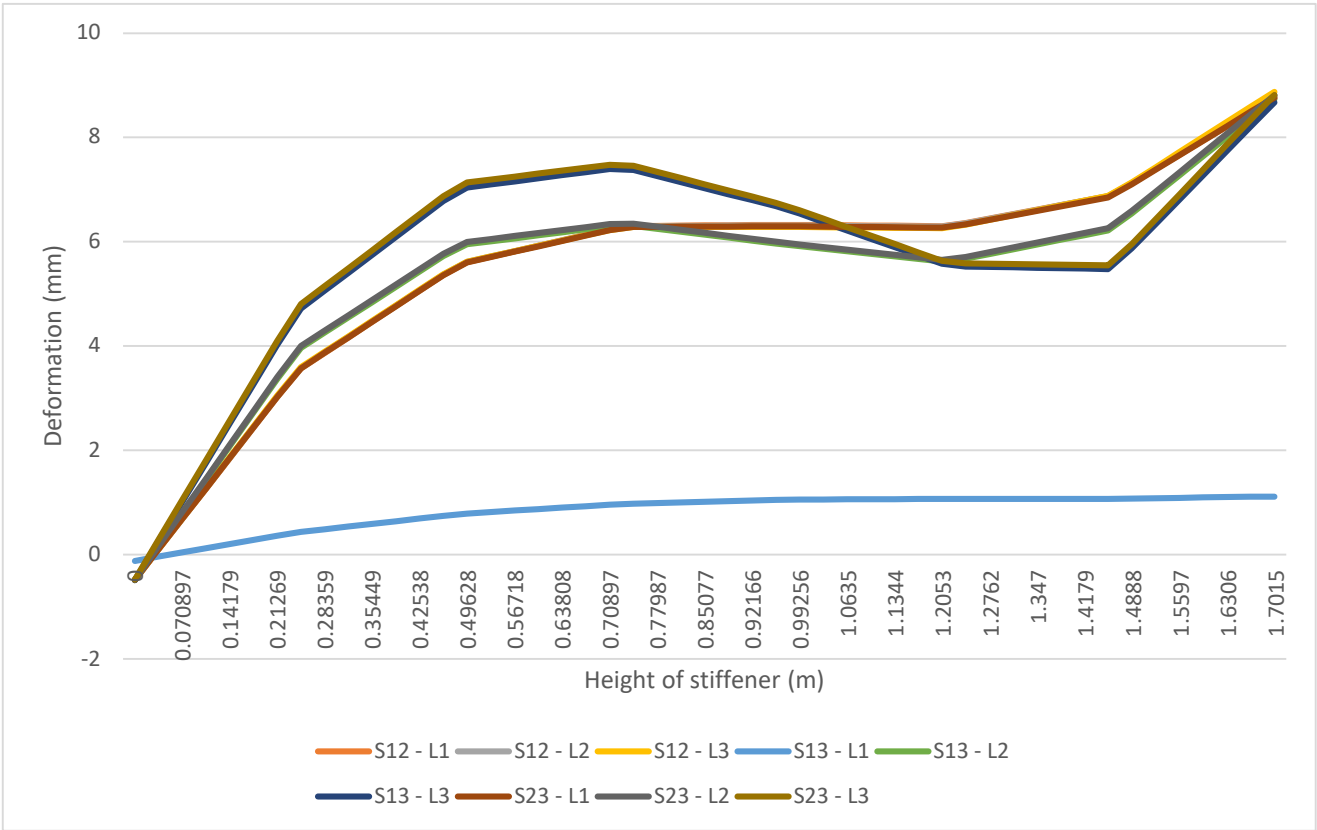




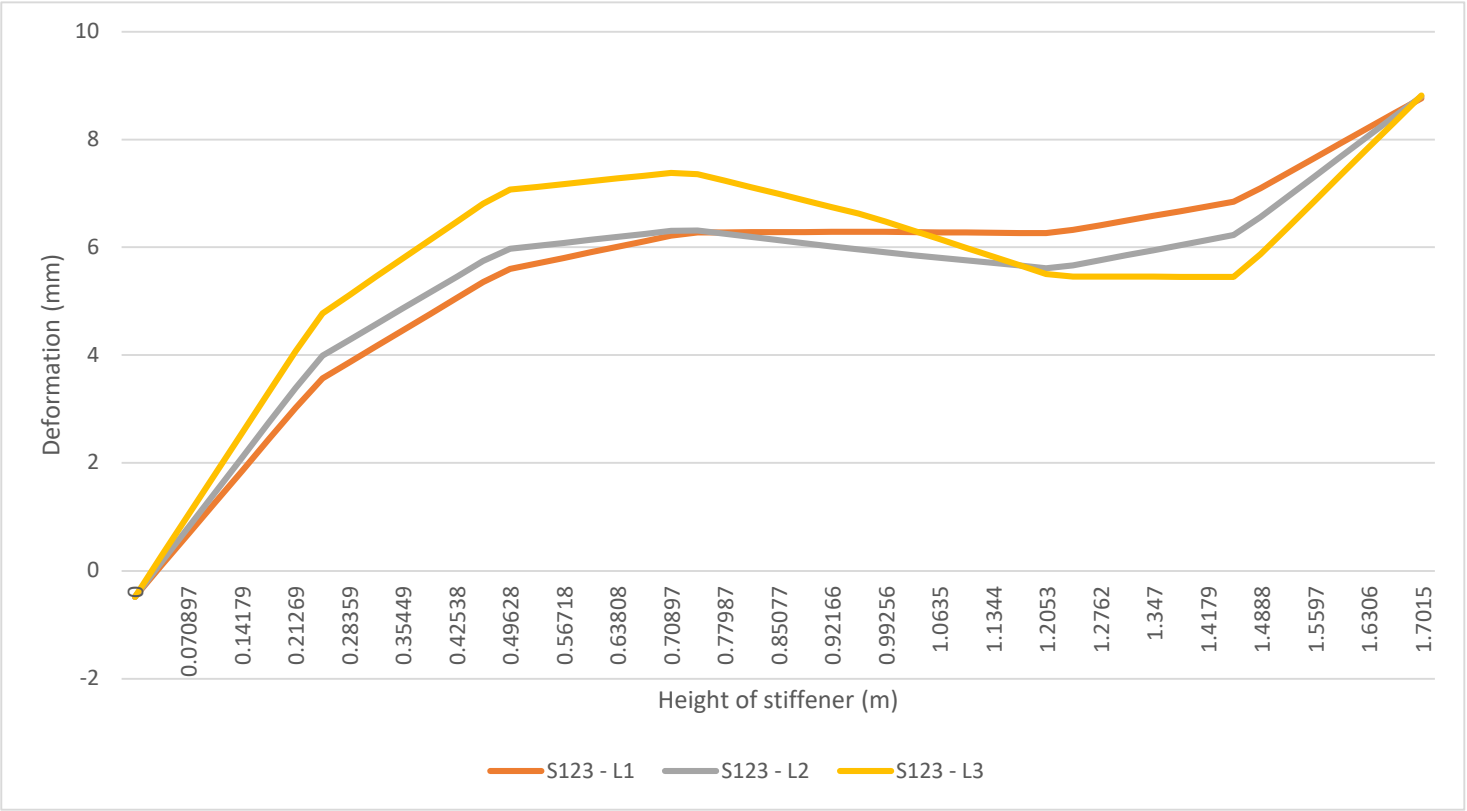
| STIFFENER 2 in S1,2 & 3 - Transversal direction |       |        |           |           |           |
|-------------------------------------------------|-------|--------|-----------|-----------|-----------|
| mm                                              | m     | Normal | S123 - L1 | S123 - L2 | S123 - L3 |
| 0.000                                           | 0.000 | -2.000 | -2.028    | -2.093    | -1.415    |
| 57.188                                          | 0.057 | -1.853 | -1.884    | -1.941    | -1.105    |
| 114.380                                         | 0.114 | -1.705 | -1.739    | -1.790    | -0.794    |
| 171.560                                         | 0.172 | -1.558 | -1.595    | -1.638    | -0.483    |
| 228.750                                         | 0.229 | -1.410 | -1.450    | -1.486    | -0.173    |
| 285.940                                         | 0.286 | -1.125 | -1.162    | -1.188    | 0.168     |
| 343.130                                         | 0.343 | -0.816 | -0.849    | -0.865    | 0.514     |
| 400.320                                         | 0.400 | -0.508 | -0.536    | -0.542    | 0.860     |
| 457.500                                         | 0.458 | -0.199 | -0.224    | -0.219    | 1.206     |
| 514.690                                         | 0.515 | 0.260  | 0.246     | 0.288     | 1.792     |
| 571.880                                         | 0.572 | 0.781  | 0.779     | 0.869     | 2.476     |
| 629.070                                         | 0.629 | 1.301  | 1.312     | 1.451     | 3.160     |
| 686.250                                         | 0.686 | 1.821  | 1.845     | 2.032     | 3.844     |
| 743.440                                         | 0.743 | 2.342  | 2.377     | 2.613     | 4.528     |
| 800.630                                         | 0.801 | 2.891  | 2.940     | 3.227     | 5.250     |
| 857.820                                         | 0.858 | 3.482  | 3.544     | 3.879     | 5.971     |
| 915.010                                         | 0.915 | 4.108  | 4.183     | 4.570     | 6.735     |
| 972.190                                         | 0.972 | 4.734  | 4.823     | 5.260     | 7.499     |
| 1029.400                                        | 1.029 | 5.360  | 5.462     | 5.951     | 8.263     |
| 1086.600                                        | 1.087 | 5.986  | 6.102     | 6.642     | 9.027     |
| 1143.800                                        | 1.144 | 6.645  | 6.772     | 7.364     | 9.840     |
| 1200.900                                        | 1.201 | 7.305  | 7.442     | 8.086     | 10.653    |
| 1258.100                                        | 1.258 | 7.964  | 8.113     | 8.808     | 11.467    |
| 1315.300                                        | 1.315 | 8.624  | 8.783     | 9.530     | 12.280    |
| 1372.500                                        | 1.373 | 9.282  | 9.451     | 10.248    | 13.084    |
| 1429.700                                        | 1.430 | 9.912  | 10.089    | 10.911    | 13.744    |
| 1486.900                                        | 1.487 | 10.542 | 10.727    | 11.575    | 14.405    |
| 1544.100                                        | 1.544 | 11.172 | 11.365    | 12.238    | 15.065    |
| 1601.300                                        | 1.601 | 11.803 | 12.003    | 12.902    | 15.726    |
| 1658.400                                        | 1.658 | 12.422 | 12.630    | 13.552    | 16.371    |
| 1715.600                                        | 1.716 | 12.970 | 13.182    | 14.115    | 16.913    |
| 1772.800                                        | 1.773 | 13.518 | 13.733    | 14.678    | 17.455    |
| 1830.000                                        | 1.830 | 14.066 | 14.285    | 15.241    | 17.997    |
| 1887.200                                        | 1.887 | 14.614 | 14.836    | 15.804    | 18.539    |
| 1944.400                                        | 1.944 | 15.162 | 15.388    | 16.368    | 19.080    |
| 2001.600                                        | 2.002 | 15.657 | 15.883    | 16.871    | 19.545    |
| 2058.800                                        | 2.059 | 16.057 | 16.278    | 17.268    | 19.872    |
| 2116.000                                        | 2.116 | 16.457 | 16.674    | 17.665    | 20.199    |
| 2173.100                                        | 2.173 | 16.857 | 17.069    | 18.062    | 20.526    |
| 2230.300                                        | 2.230 | 17.256 | 17.464    | 18.458    | 20.853    |
| 2287.500                                        | 2.288 | 17.459 | 17.653    | 18.594    | 20.791    |
| 2344.700                                        | 2.345 | 17.640 | 17.820    | 18.703    | 20.689    |
| 2401.900                                        | 2.402 | 17.822 | 17.987    | 18.811    | 20.586    |
| 2459.100                                        | 2.459 | 18.004 | 18.154    | 18.920    | 20.484    |
| 2516.300                                        | 2.516 | 18.062 | 18.193    | 18.862    | 20.183    |
| 2573.500                                        | 2.574 | 17.970 | 18.077    | 18.603    | 19.644    |
| 2630.600                                        | 2.631 | 17.879 | 17.961    | 18.345    | 19.104    |
| 2687.800                                        | 2.688 | 17.787 | 17.845    | 18.086    | 18.565    |
| 2745.000                                        | 2.745 | 17.696 | 17.730    | 17.827    | 18.025    |



| STIFFENER 3 - Transversal direction |       |        |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | Normal | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0.000                               | 0.000 | -0.484 | -0.116  | -0.487  | -0.490  | -0.117  | -0.480  | -0.474  | -0.118  | -0.484  | -0.484  |
| 35.449                              | 0.035 | 0.100  | -0.039  | 0.096   | 0.093   | -0.039  | 0.107   | 0.115   | -0.039  | 0.160   | 0.271   |
| 70.897                              | 0.071 | 0.685  | 0.039   | 0.680   | 0.676   | 0.039   | 0.694   | 0.705   | 0.040   | 0.804   | 1.026   |
| 106.350                             | 0.106 | 1.269  | 0.117   | 1.263   | 1.259   | 0.117   | 1.281   | 1.295   | 0.119   | 1.449   | 1.782   |
| 141.790                             | 0.142 | 1.853  | 0.194   | 1.847   | 1.843   | 0.195   | 1.868   | 1.884   | 0.198   | 2.093   | 2.537   |
| 177.240                             | 0.177 | 2.438  | 0.272   | 2.430   | 2.426   | 0.273   | 2.455   | 2.474   | 0.277   | 2.738   | 3.292   |
| 212.690                             | 0.213 | 3.022  | 0.350   | 3.014   | 3.009   | 0.351   | 3.042   | 3.063   | 0.356   | 3.382   | 4.047   |
| 248.140                             | 0.248 | 3.566  | 0.423   | 3.557   | 3.551   | 0.425   | 3.588   | 3.612   | 0.431   | 3.976   | 4.745   |
| 283.590                             | 0.284 | 3.865  | 0.473   | 3.855   | 3.848   | 0.475   | 3.888   | 3.912   | 0.482   | 4.272   | 5.093   |
| 319.040                             | 0.319 | 4.165  | 0.524   | 4.153   | 4.145   | 0.525   | 4.187   | 4.211   | 0.533   | 4.567   | 5.441   |
| 354.490                             | 0.354 | 4.464  | 0.574   | 4.452   | 4.442   | 0.575   | 4.487   | 4.511   | 0.584   | 4.862   | 5.789   |
| 389.930                             | 0.390 | 4.763  | 0.624   | 4.750   | 4.739   | 0.625   | 4.787   | 4.811   | 0.635   | 5.157   | 6.138   |
| 425.380                             | 0.425 | 5.063  | 0.674   | 5.048   | 5.037   | 0.675   | 5.086   | 5.111   | 0.685   | 5.452   | 6.486   |
| 460.830                             | 0.461 | 5.362  | 0.725   | 5.347   | 5.334   | 0.726   | 5.386   | 5.411   | 0.736   | 5.747   | 6.834   |
| 496.280                             | 0.496 | 5.606  | 0.769   | 5.590   | 5.575   | 0.769   | 5.630   | 5.655   | 0.781   | 5.974   | 7.101   |
| 531.730                             | 0.532 | 5.711  | 0.797   | 5.694   | 5.678   | 0.797   | 5.734   | 5.758   | 0.809   | 6.033   | 7.165   |
| 567.180                             | 0.567 | 5.817  | 0.825   | 5.799   | 5.782   | 0.825   | 5.839   | 5.862   | 0.837   | 6.092   | 7.229   |
| 602.630                             | 0.603 | 5.922  | 0.853   | 5.904   | 5.885   | 0.852   | 5.944   | 5.966   | 0.865   | 6.151   | 7.293   |
| 638.080                             | 0.638 | 6.028  | 0.881   | 6.008   | 5.988   | 0.880   | 6.048   | 6.070   | 0.894   | 6.210   | 7.356   |
| 673.520                             | 0.674 | 6.133  | 0.909   | 6.113   | 6.091   | 0.908   | 6.153   | 6.173   | 0.922   | 6.269   | 7.420   |
| 708.970                             | 0.709 | 6.239  | 0.937   | 6.218   | 6.194   | 0.935   | 6.258   | 6.277   | 0.950   | 6.328   | 7.484   |
| 744.420                             | 0.744 | 6.301  | 0.958   | 6.279   | 6.254   | 0.956   | 6.319   | 6.337   | 0.971   | 6.338   | 7.472   |
| 779.870                             | 0.780 | 6.305  | 0.969   | 6.282   | 6.257   | 0.968   | 6.322   | 6.339   | 0.983   | 6.283   | 7.359   |
| 815.320                             | 0.815 | 6.309  | 0.981   | 6.286   | 6.259   | 0.979   | 6.325   | 6.342   | 0.995   | 6.227   | 7.247   |
| 850.770                             | 0.851 | 6.313  | 0.993   | 6.289   | 6.261   | 0.990   | 6.328   | 6.344   | 1.006   | 6.172   | 7.134   |
| 886.220                             | 0.886 | 6.317  | 1.005   | 6.293   | 6.264   | 1.002   | 6.331   | 6.346   | 1.018   | 6.116   | 7.022   |
| 921.660                             | 0.922 | 6.321  | 1.016   | 6.296   | 6.266   | 1.013   | 6.334   | 6.348   | 1.030   | 6.061   | 6.909   |
| 957.110                             | 0.957 | 6.325  | 1.028   | 6.300   | 6.269   | 1.025   | 6.337   | 6.350   | 1.041   | 6.005   | 6.796   |
| 992.560                             | 0.993 | 6.324  | 1.034   | 6.299   | 6.267   | 1.031   | 6.337   | 6.349   | 1.048   | 5.954   | 6.657   |
| 1028.000                            | 1.028 | 6.321  | 1.037   | 6.295   | 6.263   | 1.033   | 6.333   | 6.345   | 1.050   | 5.905   | 6.497   |
| 1063.500                            | 1.064 | 6.317  | 1.039   | 6.291   | 6.259   | 1.036   | 6.329   | 6.342   | 1.052   | 5.857   | 6.337   |
| 1098.900                            | 1.099 | 6.313  | 1.041   | 6.287   | 6.256   | 1.038   | 6.325   | 6.338   | 1.054   | 5.808   | 6.177   |
| 1134.400                            | 1.134 | 6.309  | 1.043   | 6.283   | 6.252   | 1.040   | 6.322   | 6.335   | 1.056   | 5.760   | 6.018   |
| 1169.800                            | 1.170 | 6.305  | 1.046   | 6.279   | 6.248   | 1.043   | 6.318   | 6.331   | 1.059   | 5.712   | 5.858   |
| 1205.300                            | 1.205 | 6.301  | 1.048   | 6.275   | 6.244   | 1.045   | 6.314   | 6.327   | 1.061   | 5.663   | 5.698   |
| 1240.700                            | 1.241 | 6.360  | 1.049   | 6.335   | 6.305   | 1.046   | 6.375   | 6.390   | 1.062   | 5.713   | 5.643   |
| 1276.200                            | 1.276 | 6.445  | 1.049   | 6.421   | 6.392   | 1.047   | 6.462   | 6.479   | 1.062   | 5.801   | 5.630   |
| 1311.600                            | 1.312 | 6.529  | 1.049   | 6.506   | 6.479   | 1.048   | 6.549   | 6.569   | 1.062   | 5.890   | 5.617   |
| 1347.000                            | 1.347 | 6.614  | 1.050   | 6.591   | 6.566   | 1.049   | 6.636   | 6.658   | 1.063   | 5.979   | 5.604   |
| 1382.500                            | 1.383 | 6.698  | 1.050   | 6.677   | 6.653   | 1.049   | 6.723   | 6.747   | 1.063   | 6.068   | 5.591   |
| 1417.900                            | 1.418 | 6.783  | 1.050   | 6.762   | 6.740   | 1.050   | 6.809   | 6.836   | 1.063   | 6.156   | 5.578   |
| 1453.400                            | 1.453 | 6.867  | 1.050   | 6.847   | 6.827   | 1.051   | 6.896   | 6.925   | 1.064   | 6.245   | 5.565   |
| 1488.800                            | 1.489 | 7.113  | 1.056   | 7.094   | 7.077   | 1.058   | 7.147   | 7.181   | 1.070   | 6.568   | 5.951   |
| 1524.300                            | 1.524 | 7.385  | 1.062   | 7.368   | 7.355   | 1.066   | 7.425   | 7.465   | 1.076   | 6.930   | 6.404   |
| 1559.700                            | 1.560 | 7.657  | 1.069   | 7.642   | 7.633   | 1.073   | 7.702   | 7.748   | 1.083   | 7.292   | 6.857   |
| 1595.200                            | 1.595 | 7.929  | 1.075   | 7.916   | 7.911   | 1.081   | 7.980   | 8.032   | 1.090   | 7.654   | 7.309   |
| 1630.600                            | 1.631 | 8.201  | 1.081   | 8.189   | 8.189   | 1.089   | 8.258   | 8.315   | 1.097   | 8.015   | 7.762   |
| 1666.100                            | 1.666 | 8.473  | 1.088   | 8.463   | 8.467   | 1.097   | 8.536   | 8.598   | 1.104   | 8.377   | 8.214   |
| 1701.500                            | 1.702 | 8.745  | 1.094   | 8.737   | 8.745   | 1.104   | 8.813   | 8.882   | 1.111   | 8.739   | 8.667   |



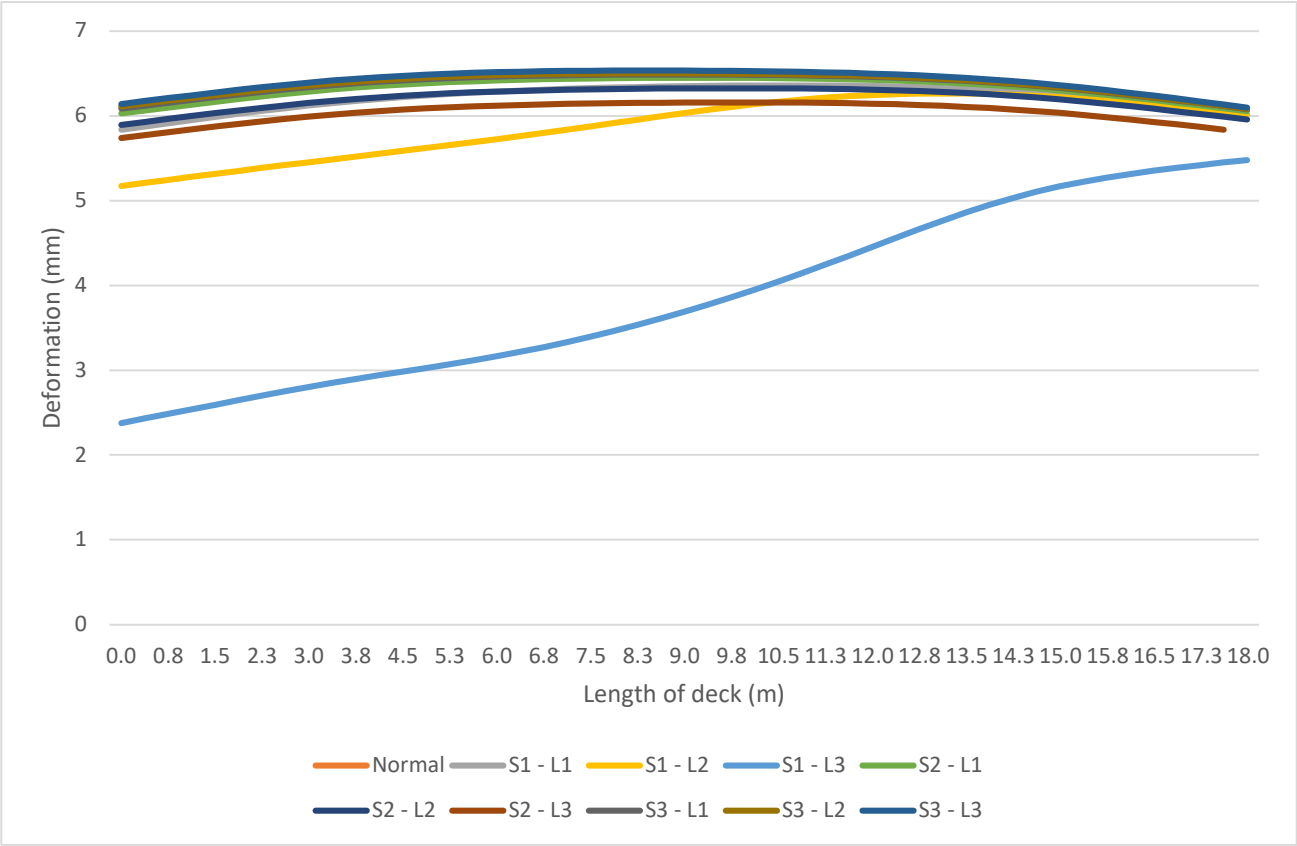
| STIFFENER 3 in S## - Longitudinal direction |       |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|-------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m     | Normal | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0.000                                       | 0.000 | -0.484 | -0.484   | -0.483   | -0.480   | -0.118   | -0.487   | -0.490   | -0.483   | -0.480   | -0.474   |
| 35.449                                      | 0.035 | 0.100  | 0.101    | 0.103    | 0.108    | -0.039   | 0.156    | 0.262    | 0.102    | 0.167    | 0.288    |
| 70.897                                      | 0.071 | 0.685  | 0.686    | 0.689    | 0.696    | 0.041    | 0.799    | 1.015    | 0.687    | 0.815    | 1.051    |
| 106.350                                     | 0.106 | 1.269  | 1.271    | 1.275    | 1.283    | 0.121    | 1.442    | 1.768    | 1.272    | 1.462    | 1.813    |
| 141.790                                     | 0.142 | 1.853  | 1.856    | 1.862    | 1.871    | 0.200    | 2.085    | 2.520    | 1.857    | 2.110    | 2.576    |
| 177.240                                     | 0.177 | 2.438  | 2.440    | 2.448    | 2.459    | 0.280    | 2.728    | 3.273    | 2.442    | 2.757    | 3.338    |
| 212.690                                     | 0.213 | 3.022  | 3.025    | 3.034    | 3.047    | 0.359    | 3.371    | 4.025    | 3.027    | 3.405    | 4.101    |
| 248.140                                     | 0.248 | 3.566  | 3.569    | 3.579    | 3.593    | 0.435    | 3.964    | 4.719    | 3.571    | 4.002    | 4.803    |
| 283.590                                     | 0.284 | 3.865  | 3.868    | 3.877    | 3.890    | 0.486    | 4.257    | 5.062    | 3.869    | 4.296    | 5.148    |
| 319.040                                     | 0.319 | 4.165  | 4.168    | 4.176    | 4.187    | 0.537    | 4.551    | 5.405    | 4.167    | 4.591    | 5.493    |
| 354.490                                     | 0.354 | 4.464  | 4.467    | 4.474    | 4.484    | 0.588    | 4.844    | 5.749    | 4.465    | 4.885    | 5.838    |
| 389.930                                     | 0.390 | 4.763  | 4.766    | 4.773    | 4.781    | 0.640    | 5.138    | 6.092    | 4.763    | 5.180    | 6.183    |
| 425.380                                     | 0.425 | 5.063  | 5.065    | 5.071    | 5.078    | 0.691    | 5.431    | 6.435    | 5.061    | 5.475    | 6.527    |
| 460.830                                     | 0.461 | 5.362  | 5.364    | 5.370    | 5.376    | 0.742    | 5.724    | 6.778    | 5.359    | 5.769    | 6.872    |
| 496.280                                     | 0.496 | 5.606  | 5.608    | 5.612    | 5.617    | 0.787    | 5.950    | 7.040    | 5.602    | 5.996    | 7.135    |
| 531.730                                     | 0.532 | 5.711  | 5.713    | 5.716    | 5.718    | 0.815    | 6.008    | 7.099    | 5.705    | 6.053    | 7.192    |
| 567.180                                     | 0.567 | 5.817  | 5.818    | 5.820    | 5.819    | 0.843    | 6.065    | 7.158    | 5.809    | 6.110    | 7.248    |
| 602.630                                     | 0.603 | 5.922  | 5.923    | 5.924    | 5.920    | 0.872    | 6.123    | 7.216    | 5.912    | 6.166    | 7.305    |
| 638.080                                     | 0.638 | 6.028  | 6.028    | 6.027    | 6.021    | 0.900    | 6.180    | 7.275    | 6.016    | 6.223    | 7.362    |
| 673.520                                     | 0.674 | 6.133  | 6.134    | 6.131    | 6.122    | 0.928    | 6.238    | 7.334    | 6.119    | 6.280    | 7.419    |
| 708.970                                     | 0.709 | 6.239  | 6.239    | 6.235    | 6.223    | 0.956    | 6.295    | 7.393    | 6.223    | 6.337    | 7.476    |
| 744.420                                     | 0.744 | 6.301  | 6.300    | 6.295    | 6.281    | 0.978    | 6.304    | 7.377    | 6.283    | 6.345    | 7.458    |
| 779.870                                     | 0.780 | 6.305  | 6.304    | 6.298    | 6.281    | 0.989    | 6.248    | 7.261    | 6.285    | 6.287    | 7.339    |
| 815.320                                     | 0.815 | 6.309  | 6.308    | 6.300    | 6.281    | 1.001    | 6.191    | 7.145    | 6.287    | 6.230    | 7.220    |
| 850.770                                     | 0.851 | 6.313  | 6.311    | 6.303    | 6.282    | 1.013    | 6.135    | 7.028    | 6.289    | 6.172    | 7.102    |
| 886.220                                     | 0.886 | 6.317  | 6.315    | 6.305    | 6.282    | 1.024    | 6.079    | 6.912    | 6.292    | 6.115    | 6.983    |
| 921.660                                     | 0.922 | 6.321  | 6.319    | 6.308    | 6.282    | 1.036    | 6.022    | 6.796    | 6.294    | 6.057    | 6.864    |
| 957.110                                     | 0.957 | 6.325  | 6.322    | 6.310    | 6.283    | 1.048    | 5.966    | 6.680    | 6.296    | 6.000    | 6.745    |
| 992.560                                     | 0.993 | 6.324  | 6.322    | 6.309    | 6.281    | 1.054    | 5.914    | 6.539    | 6.295    | 5.947    | 6.602    |
| 1028.000                                    | 1.028 | 6.321  | 6.318    | 6.305    | 6.277    | 1.056    | 5.866    | 6.379    | 6.291    | 5.898    | 6.440    |
| 1063.500                                    | 1.064 | 6.317  | 6.314    | 6.302    | 6.274    | 1.058    | 5.817    | 6.218    | 6.286    | 5.850    | 6.279    |
| 1098.900                                    | 1.099 | 6.313  | 6.310    | 6.298    | 6.270    | 1.060    | 5.769    | 6.058    | 6.282    | 5.801    | 6.117    |
| 1134.400                                    | 1.134 | 6.309  | 6.306    | 6.294    | 6.267    | 1.062    | 5.720    | 5.898    | 6.278    | 5.752    | 5.955    |
| 1169.800                                    | 1.170 | 6.305  | 6.302    | 6.291    | 6.263    | 1.064    | 5.672    | 5.737    | 6.274    | 5.703    | 5.793    |
| 1205.300                                    | 1.205 | 6.301  | 6.299    | 6.287    | 6.259    | 1.066    | 5.624    | 5.577    | 6.269    | 5.654    | 5.632    |
| 1240.700                                    | 1.241 | 6.360  | 6.359    | 6.348    | 6.324    | 1.067    | 5.674    | 5.525    | 6.330    | 5.706    | 5.581    |
| 1276.200                                    | 1.276 | 6.445  | 6.444    | 6.436    | 6.416    | 1.067    | 5.764    | 5.517    | 6.417    | 5.798    | 5.575    |
| 1311.600                                    | 1.312 | 6.529  | 6.529    | 6.524    | 6.508    | 1.068    | 5.855    | 5.508    | 6.504    | 5.890    | 5.569    |
| 1347.000                                    | 1.347 | 6.614  | 6.615    | 6.612    | 6.600    | 1.068    | 5.945    | 5.500    | 6.590    | 5.982    | 5.563    |
| 1382.500                                    | 1.383 | 6.698  | 6.700    | 6.699    | 6.692    | 1.068    | 6.035    | 5.491    | 6.677    | 6.074    | 5.556    |
| 1417.900                                    | 1.418 | 6.783  | 6.785    | 6.787    | 6.784    | 1.068    | 6.125    | 5.483    | 6.764    | 6.166    | 5.550    |
| 1453.400                                    | 1.453 | 6.867  | 6.871    | 6.875    | 6.876    | 1.069    | 6.215    | 5.474    | 6.851    | 6.257    | 5.544    |
| 1488.800                                    | 1.489 | 7.113  | 7.118    | 7.127    | 7.138    | 1.074    | 6.541    | 5.873    | 7.101    | 6.588    | 5.952    |
| 1524.300                                    | 1.524 | 7.385  | 7.392    | 7.407    | 7.428    | 1.081    | 6.907    | 6.340    | 7.379    | 6.958    | 6.429    |
| 1559.700                                    | 1.560 | 7.657  | 7.666    | 7.686    | 7.718    | 1.088    | 7.272    | 6.807    | 7.657    | 7.329    | 6.906    |
| 1595.200                                    | 1.595 | 7.929  | 7.940    | 7.966    | 8.008    | 1.095    | 7.637    | 7.273    | 7.935    | 7.699    | 7.382    |
| 1630.600                                    | 1.631 | 8.201  | 8.213    | 8.246    | 8.298    | 1.102    | 8.002    | 7.740    | 8.213    | 8.069    | 7.859    |
| 1666.100                                    | 1.666 | 8.473  | 8.487    | 8.525    | 8.588    | 1.109    | 8.368    | 8.207    | 8.490    | 8.440    | 8.336    |
| 1701.500                                    | 1.702 | 8.745  | 8.761    | 8.805    | 8.878    | 1.115    | 8.733    | 8.674    | 8.768    | 8.810    | 8.813    |



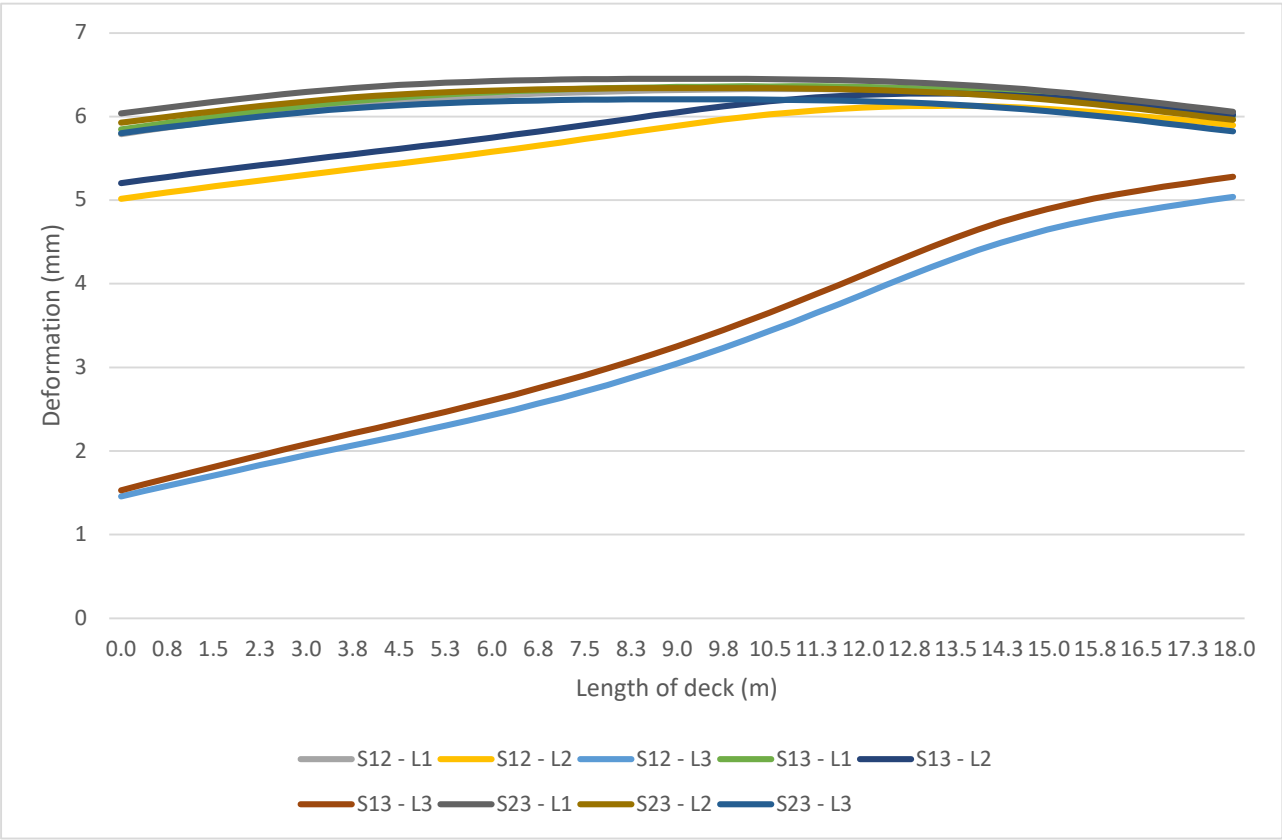
| STIFFENER 3 in S1,2 & 3 - Longitudinal direction |       |        |           |           |           |
|--------------------------------------------------|-------|--------|-----------|-----------|-----------|
| mm                                               | m     | Normal | S123 - L1 | S123 - L2 | S123 - L3 |
| 0.000                                            | 0.000 | -0.484 | -0.484    | -0.483    | -0.480    |
| 35.449                                           | 0.035 | 0.100  | 0.101     | 0.163     | 0.280     |
| 70.897                                           | 0.071 | 0.685  | 0.685     | 0.809     | 1.039     |
| 106.350                                          | 0.106 | 1.269  | 1.270     | 1.455     | 1.798     |
| 141.790                                          | 0.142 | 1.853  | 1.855     | 2.101     | 2.558     |
| 177.240                                          | 0.177 | 2.438  | 2.440     | 2.747     | 3.317     |
| 212.690                                          | 0.213 | 3.022  | 3.024     | 3.393     | 4.076     |
| 248.140                                          | 0.248 | 3.566  | 3.568     | 3.989     | 4.775     |
| 283.590                                          | 0.284 | 3.865  | 3.866     | 4.282     | 5.115     |
| 319.040                                          | 0.319 | 4.165  | 4.164     | 4.574     | 5.454     |
| 354.490                                          | 0.354 | 4.464  | 4.461     | 4.867     | 5.794     |
| 389.930                                          | 0.390 | 4.763  | 4.759     | 5.160     | 6.133     |
| 425.380                                          | 0.425 | 5.063  | 5.057     | 5.453     | 6.473     |
| 460.830                                          | 0.461 | 5.362  | 5.354     | 5.746     | 6.812     |
| 496.280                                          | 0.496 | 5.606  | 5.597     | 5.971     | 7.070     |
| 531.730                                          | 0.532 | 5.711  | 5.700     | 6.026     | 7.121     |
| 567.180                                          | 0.567 | 5.817  | 5.803     | 6.081     | 7.173     |
| 602.630                                          | 0.603 | 5.922  | 5.906     | 6.137     | 7.225     |
| 638.080                                          | 0.638 | 6.028  | 6.009     | 6.192     | 7.277     |
| 673.520                                          | 0.674 | 6.133  | 6.112     | 6.247     | 7.329     |
| 708.970                                          | 0.709 | 6.239  | 6.216     | 6.303     | 7.381     |
| 744.420                                          | 0.744 | 6.301  | 6.275     | 6.309     | 7.358     |
| 779.870                                          | 0.780 | 6.305  | 6.277     | 6.251     | 7.236     |
| 815.320                                          | 0.815 | 6.309  | 6.280     | 6.192     | 7.114     |
| 850.770                                          | 0.851 | 6.313  | 6.282     | 6.134     | 6.992     |
| 886.220                                          | 0.886 | 6.317  | 6.284     | 6.075     | 6.869     |
| 921.660                                          | 0.922 | 6.321  | 6.286     | 6.017     | 6.747     |
| 957.110                                          | 0.957 | 6.325  | 6.288     | 5.958     | 6.625     |
| 992.560                                          | 0.993 | 6.324  | 6.286     | 5.905     | 6.480     |
| 1028.000                                         | 1.028 | 6.321  | 6.282     | 5.857     | 6.318     |
| 1063.500                                         | 1.064 | 6.317  | 6.278     | 5.808     | 6.156     |
| 1098.900                                         | 1.099 | 6.313  | 6.274     | 5.759     | 5.993     |
| 1134.400                                         | 1.134 | 6.309  | 6.270     | 5.711     | 5.831     |
| 1169.800                                         | 1.170 | 6.305  | 6.265     | 5.662     | 5.669     |
| 1205.300                                         | 1.205 | 6.301  | 6.261     | 5.613     | 5.507     |
| 1240.700                                         | 1.241 | 6.360  | 6.322     | 5.666     | 5.459     |
| 1276.200                                         | 1.276 | 6.445  | 6.409     | 5.759     | 5.457     |
| 1311.600                                         | 1.312 | 6.529  | 6.496     | 5.853     | 5.456     |
| 1347.000                                         | 1.347 | 6.614  | 6.583     | 5.946     | 5.454     |
| 1382.500                                         | 1.383 | 6.698  | 6.670     | 6.040     | 5.452     |
| 1417.900                                         | 1.418 | 6.783  | 6.757     | 6.133     | 5.451     |
| 1453.400                                         | 1.453 | 6.867  | 6.844     | 6.227     | 5.449     |
| 1488.800                                         | 1.489 | 7.113  | 7.095     | 6.560     | 5.870     |
| 1524.300                                         | 1.524 | 7.385  | 7.374     | 6.934     | 6.361     |
| 1559.700                                         | 1.560 | 7.657  | 7.652     | 7.308     | 6.852     |
| 1595.200                                         | 1.595 | 7.929  | 7.931     | 7.682     | 7.343     |
| 1630.600                                         | 1.631 | 8.201  | 8.209     | 8.056     | 7.835     |
| 1666.100                                         | 1.666 | 8.473  | 8.488     | 8.429     | 8.326     |
| 1701.500                                         | 1.702 | 8.745  | 8.766     | 8.803     | 8.817     |

## **APPENDIX I – Raw data case study for corrosion type N4**

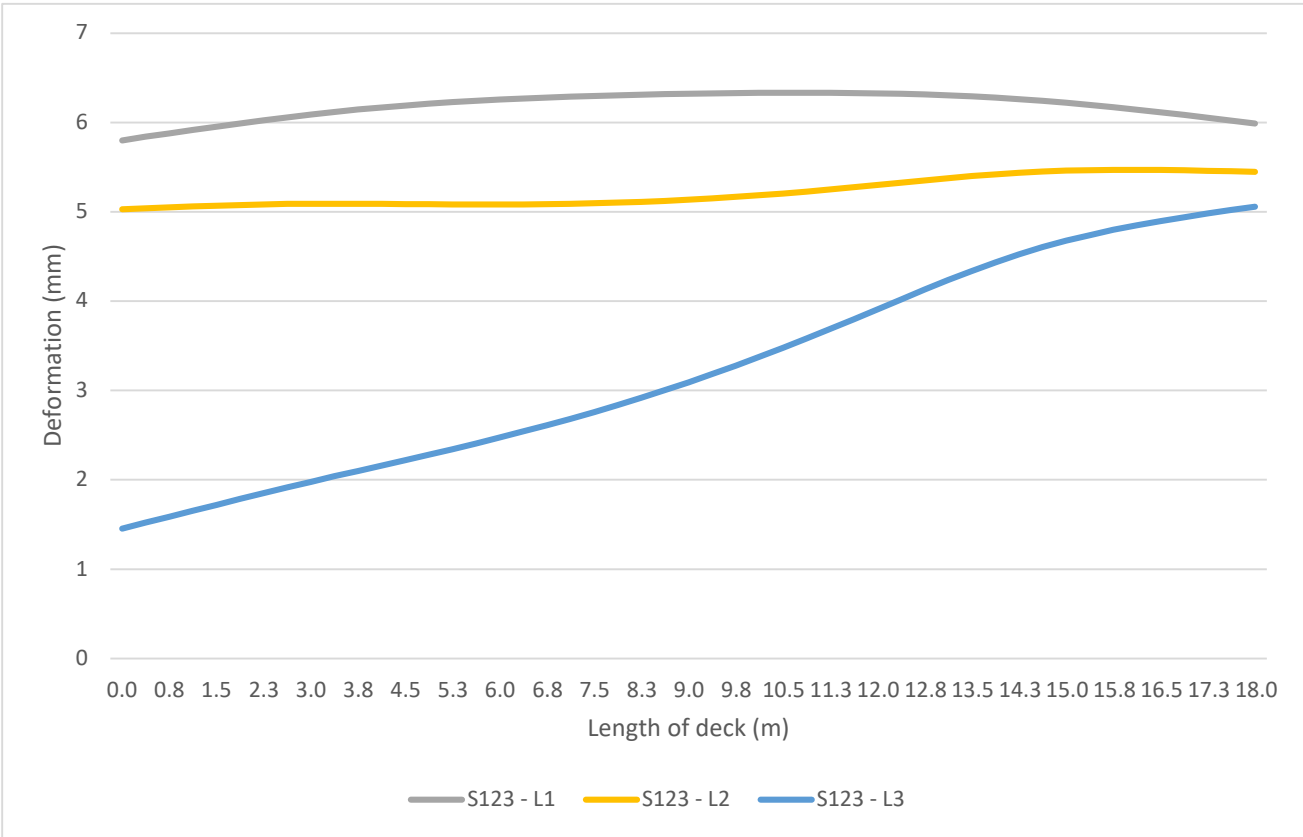




| STIFFENER 1 - Longitudinal direction |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m      | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.000  | 5.838   | 5.174   | 2.378   | 6.029   | 5.894   | 5.739   | 6.087   | 6.111   | 6.141   |
| 375                                  | 0.375  | 5.876   | 5.210   | 2.431   | 6.064   | 5.929   | 5.774   | 6.122   | 6.145   | 6.175   |
| 750                                  | 0.750  | 5.914   | 5.246   | 2.484   | 6.099   | 5.964   | 5.808   | 6.155   | 6.179   | 6.209   |
| 1125                                 | 1.125  | 5.951   | 5.282   | 2.538   | 6.133   | 5.998   | 5.841   | 6.189   | 6.211   | 6.243   |
| 1500                                 | 1.500  | 5.988   | 5.317   | 2.592   | 6.166   | 6.031   | 5.873   | 6.221   | 6.244   | 6.275   |
| 1875                                 | 1.875  | 6.024   | 5.352   | 2.646   | 6.199   | 6.064   | 5.905   | 6.253   | 6.275   | 6.307   |
| 2250                                 | 2.250  | 6.059   | 5.386   | 2.699   | 6.230   | 6.095   | 5.936   | 6.283   | 6.305   | 6.338   |
| 2625                                 | 2.625  | 6.092   | 5.420   | 2.752   | 6.259   | 6.125   | 5.964   | 6.312   | 6.333   | 6.366   |
| 3000                                 | 3.000  | 6.122   | 5.454   | 2.803   | 6.286   | 6.152   | 5.991   | 6.338   | 6.359   | 6.393   |
| 3375                                 | 3.375  | 6.151   | 5.487   | 2.852   | 6.311   | 6.177   | 6.015   | 6.362   | 6.383   | 6.417   |
| 3750                                 | 3.750  | 6.177   | 5.520   | 2.898   | 6.333   | 6.200   | 6.037   | 6.383   | 6.404   | 6.438   |
| 4125                                 | 4.125  | 6.201   | 5.554   | 2.942   | 6.353   | 6.220   | 6.056   | 6.402   | 6.423   | 6.456   |
| 4500                                 | 4.500  | 6.222   | 5.587   | 2.985   | 6.370   | 6.238   | 6.074   | 6.419   | 6.439   | 6.473   |
| 4875                                 | 4.875  | 6.241   | 5.620   | 3.026   | 6.385   | 6.253   | 6.088   | 6.432   | 6.452   | 6.486   |
| 5250                                 | 5.250  | 6.258   | 5.654   | 3.069   | 6.398   | 6.266   | 6.101   | 6.444   | 6.464   | 6.498   |
| 5625                                 | 5.625  | 6.273   | 5.689   | 3.115   | 6.409   | 6.277   | 6.112   | 6.454   | 6.473   | 6.508   |
| 6000                                 | 6.000  | 6.287   | 5.724   | 3.164   | 6.418   | 6.287   | 6.121   | 6.463   | 6.481   | 6.515   |
| 6375                                 | 6.375  | 6.299   | 5.761   | 3.216   | 6.425   | 6.295   | 6.129   | 6.470   | 6.488   | 6.522   |
| 6750                                 | 6.750  | 6.309   | 5.798   | 3.272   | 6.432   | 6.303   | 6.136   | 6.475   | 6.493   | 6.527   |
| 7125                                 | 7.125  | 6.319   | 5.836   | 3.332   | 6.437   | 6.308   | 6.142   | 6.479   | 6.496   | 6.530   |
| 7500                                 | 7.500  | 6.327   | 5.876   | 3.395   | 6.441   | 6.313   | 6.146   | 6.483   | 6.499   | 6.533   |
| 7875                                 | 7.875  | 6.334   | 5.915   | 3.462   | 6.444   | 6.317   | 6.150   | 6.485   | 6.501   | 6.535   |
| 8250                                 | 8.250  | 6.340   | 5.956   | 3.534   | 6.447   | 6.320   | 6.153   | 6.487   | 6.502   | 6.535   |
| 8625                                 | 8.625  | 6.345   | 5.995   | 3.609   | 6.448   | 6.323   | 6.155   | 6.487   | 6.502   | 6.535   |
| 9000                                 | 9.000  | 6.350   | 6.034   | 3.689   | 6.449   | 6.324   | 6.157   | 6.487   | 6.502   | 6.534   |
| 9375                                 | 9.375  | 6.354   | 6.071   | 3.772   | 6.449   | 6.325   | 6.158   | 6.487   | 6.501   | 6.533   |
| 9750                                 | 9.750  | 6.357   | 6.106   | 3.859   | 6.449   | 6.326   | 6.159   | 6.486   | 6.499   | 6.531   |
| 10125                                | 10.125 | 6.359   | 6.139   | 3.950   | 6.447   | 6.325   | 6.159   | 6.484   | 6.497   | 6.528   |
| 10500                                | 10.500 | 6.360   | 6.167   | 4.045   | 6.445   | 6.324   | 6.158   | 6.481   | 6.493   | 6.524   |
| 10875                                | 10.875 | 6.360   | 6.193   | 4.143   | 6.442   | 6.322   | 6.156   | 6.477   | 6.489   | 6.520   |
| 11250                                | 11.250 | 6.359   | 6.214   | 4.244   | 6.438   | 6.319   | 6.153   | 6.473   | 6.484   | 6.514   |
| 11625                                | 11.625 | 6.356   | 6.232   | 4.348   | 6.433   | 6.315   | 6.149   | 6.467   | 6.477   | 6.507   |
| 12000                                | 12.000 | 6.352   | 6.246   | 4.452   | 6.426   | 6.309   | 6.144   | 6.459   | 6.470   | 6.499   |
| 12375                                | 12.375 | 6.347   | 6.257   | 4.557   | 6.418   | 6.302   | 6.137   | 6.451   | 6.460   | 6.489   |
| 12750                                | 12.750 | 6.339   | 6.263   | 4.661   | 6.408   | 6.293   | 6.129   | 6.440   | 6.449   | 6.477   |
| 13125                                | 13.125 | 6.329   | 6.265   | 4.763   | 6.396   | 6.282   | 6.119   | 6.427   | 6.436   | 6.463   |
| 13500                                | 13.500 | 6.318   | 6.264   | 4.860   | 6.382   | 6.269   | 6.107   | 6.413   | 6.422   | 6.448   |
| 13875                                | 13.875 | 6.303   | 6.258   | 4.949   | 6.365   | 6.254   | 6.092   | 6.396   | 6.404   | 6.430   |
| 14250                                | 14.250 | 6.287   | 6.249   | 5.031   | 6.347   | 6.237   | 6.076   | 6.377   | 6.385   | 6.409   |
| 14625                                | 14.625 | 6.267   | 6.237   | 5.104   | 6.326   | 6.217   | 6.057   | 6.355   | 6.363   | 6.387   |
| 15000                                | 15.000 | 6.246   | 6.220   | 5.167   | 6.302   | 6.194   | 6.035   | 6.331   | 6.338   | 6.361   |
| 15375                                | 15.375 | 6.221   | 6.201   | 5.223   | 6.276   | 6.170   | 6.011   | 6.305   | 6.311   | 6.334   |
| 15750                                | 15.750 | 6.195   | 6.179   | 5.272   | 6.248   | 6.143   | 5.986   | 6.277   | 6.283   | 6.304   |
| 16125                                | 16.125 | 6.167   | 6.155   | 5.314   | 6.218   | 6.115   | 5.958   | 6.246   | 6.252   | 6.272   |
| 16500                                | 16.500 | 6.137   | 6.128   | 5.352   | 6.187   | 6.085   | 5.929   | 6.215   | 6.220   | 6.240   |
| 16875                                | 16.875 | 6.106   | 6.101   | 5.387   | 6.155   | 6.054   | 5.900   | 6.182   | 6.187   | 6.206   |
| 17250                                | 17.250 | 6.075   | 6.073   | 5.419   | 6.122   | 6.022   | 5.869   | 6.149   | 6.153   | 6.171   |
| 17625                                | 17.625 | 6.043   | 6.044   | 5.451   | 6.089   | 5.990   | 5.838   | 6.115   | 6.119   | 6.136   |
| 18000                                | 18.000 | 6.010   | 6.015   | 5.481   | 6.055   | 5.958   |         | 6.080   | 6.084   | 6.100   |

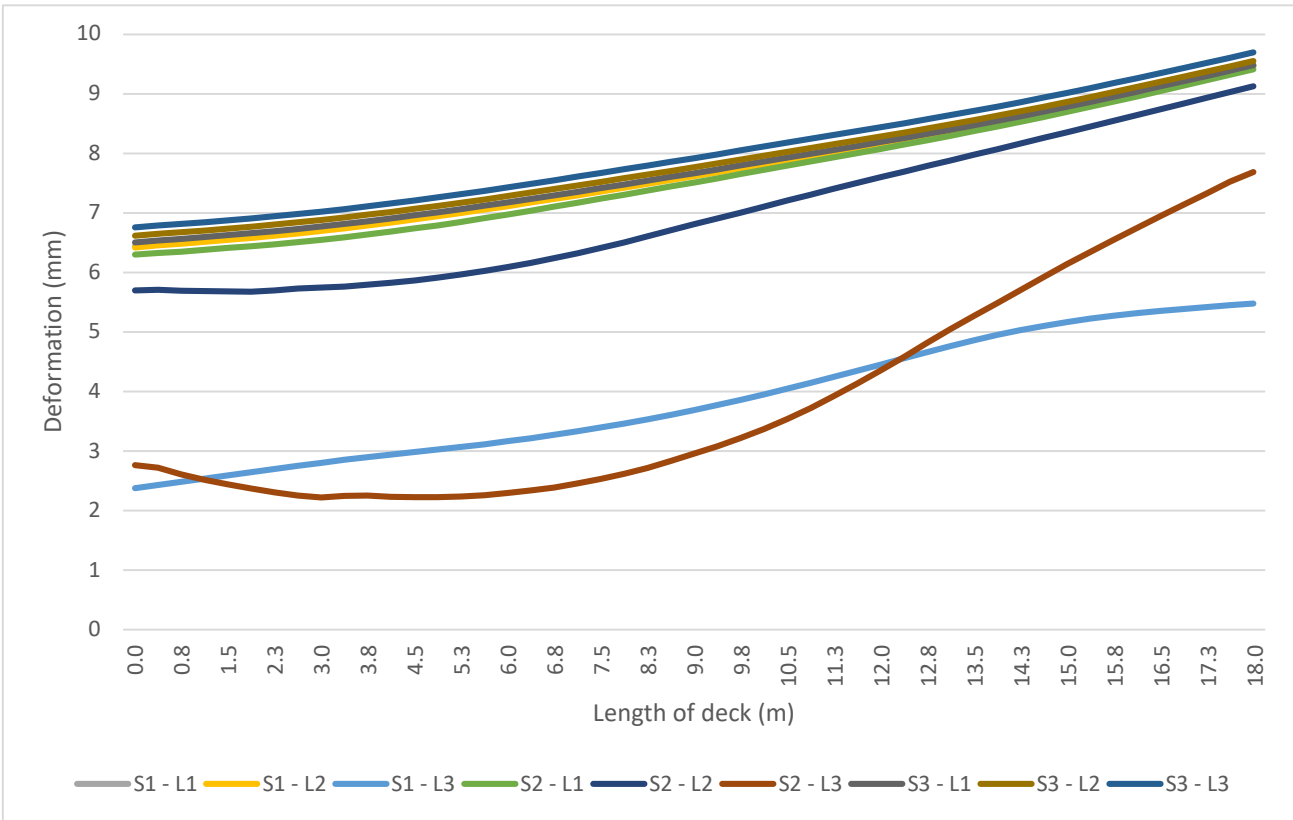


| STIFFENER 1 in S## - Longitudinal direction |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m      | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.000  | 5.792    | 5.017    | 1.457    | 5.847    | 5.206    | 1.531    | 6.039    | 5.927    | 5.804    |
| 375                                         | 0.375  | 5.831    | 5.054    | 1.519    | 5.885    | 5.242    | 1.599    | 6.074    | 5.962    | 5.838    |
| 750                                         | 0.750  | 5.870    | 5.091    | 1.580    | 5.923    | 5.278    | 1.668    | 6.108    | 5.996    | 5.872    |
| 1125                                        | 1.125  | 5.907    | 5.127    | 1.642    | 5.960    | 5.313    | 1.737    | 6.142    | 6.030    | 5.905    |
| 1500                                        | 1.500  | 5.945    | 5.163    | 1.705    | 5.997    | 5.348    | 1.807    | 6.175    | 6.062    | 5.937    |
| 1875                                        | 1.875  | 5.981    | 5.199    | 1.767    | 6.032    | 5.382    | 1.877    | 6.207    | 6.095    | 5.969    |
| 2250                                        | 2.250  | 6.016    | 5.234    | 1.829    | 6.067    | 5.416    | 1.946    | 6.238    | 6.125    | 6.000    |
| 2625                                        | 2.625  | 6.050    | 5.268    | 1.890    | 6.099    | 5.450    | 2.014    | 6.267    | 6.154    | 6.028    |
| 3000                                        | 3.000  | 6.081    | 5.303    | 1.949    | 6.130    | 5.483    | 2.080    | 6.294    | 6.181    | 6.054    |
| 3375                                        | 3.375  | 6.110    | 5.337    | 2.008    | 6.158    | 5.516    | 2.145    | 6.319    | 6.206    | 6.078    |
| 3750                                        | 3.750  | 6.137    | 5.371    | 2.064    | 6.184    | 5.548    | 2.208    | 6.340    | 6.228    | 6.100    |
| 4125                                        | 4.125  | 6.161    | 5.405    | 2.122    | 6.208    | 5.581    | 2.271    | 6.360    | 6.247    | 6.119    |
| 4500                                        | 4.500  | 6.183    | 5.438    | 2.180    | 6.229    | 5.614    | 2.335    | 6.377    | 6.264    | 6.135    |
| 4875                                        | 4.875  | 6.203    | 5.473    | 2.240    | 6.247    | 5.646    | 2.400    | 6.391    | 6.279    | 6.149    |
| 5250                                        | 5.250  | 6.220    | 5.507    | 2.301    | 6.264    | 5.680    | 2.466    | 6.404    | 6.291    | 6.161    |
| 5625                                        | 5.625  | 6.236    | 5.542    | 2.363    | 6.279    | 5.713    | 2.534    | 6.415    | 6.302    | 6.172    |
| 6000                                        | 6.000  | 6.250    | 5.578    | 2.428    | 6.292    | 5.748    | 2.603    | 6.423    | 6.311    | 6.180    |
| 6375                                        | 6.375  | 6.262    | 5.615    | 2.495    | 6.304    | 5.783    | 2.675    | 6.431    | 6.318    | 6.187    |
| 6750                                        | 6.750  | 6.274    | 5.653    | 2.564    | 6.314    | 5.820    | 2.748    | 6.437    | 6.325    | 6.193    |
| 7125                                        | 7.125  | 6.283    | 5.691    | 2.636    | 6.323    | 5.858    | 2.825    | 6.442    | 6.330    | 6.197    |
| 7500                                        | 7.500  | 6.292    | 5.731    | 2.712    | 6.331    | 5.896    | 2.904    | 6.446    | 6.334    | 6.201    |
| 7875                                        | 7.875  | 6.300    | 5.771    | 2.790    | 6.338    | 5.935    | 2.986    | 6.449    | 6.337    | 6.204    |
| 8250                                        | 8.250  | 6.307    | 5.811    | 2.872    | 6.344    | 5.974    | 3.072    | 6.451    | 6.339    | 6.206    |
| 8625                                        | 8.625  | 6.312    | 5.851    | 2.957    | 6.349    | 6.013    | 3.160    | 6.452    | 6.341    | 6.207    |
| 9000                                        | 9.000  | 6.317    | 5.890    | 3.046    | 6.354    | 6.051    | 3.253    | 6.453    | 6.342    | 6.207    |
| 9375                                        | 9.375  | 6.322    | 5.928    | 3.137    | 6.357    | 6.088    | 3.348    | 6.453    | 6.342    | 6.207    |
| 9750                                        | 9.750  | 6.325    | 5.963    | 3.233    | 6.360    | 6.122    | 3.447    | 6.452    | 6.342    | 6.207    |
| 10125                                       | 10.125 | 6.328    | 5.996    | 3.331    | 6.362    | 6.154    | 3.549    | 6.451    | 6.341    | 6.205    |
| 10500                                       | 10.500 | 6.329    | 6.025    | 3.434    | 6.363    | 6.182    | 3.655    | 6.448    | 6.339    | 6.203    |
| 10875                                       | 10.875 | 6.330    | 6.051    | 3.539    | 6.363    | 6.207    | 3.763    | 6.445    | 6.336    | 6.200    |
| 11250                                       | 11.250 | 6.329    | 6.073    | 3.647    | 6.362    | 6.228    | 3.874    | 6.441    | 6.332    | 6.196    |
| 11625                                       | 11.625 | 6.327    | 6.092    | 3.758    | 6.359    | 6.245    | 3.988    | 6.435    | 6.327    | 6.190    |
| 12000                                       | 12.000 | 6.323    | 6.107    | 3.869    | 6.355    | 6.259    | 4.102    | 6.428    | 6.321    | 6.184    |
| 12375                                       | 12.375 | 6.318    | 6.118    | 3.981    | 6.349    | 6.269    | 4.217    | 6.420    | 6.313    | 6.176    |
| 12750                                       | 12.750 | 6.311    | 6.125    | 4.092    | 6.341    | 6.274    | 4.331    | 6.410    | 6.303    | 6.166    |
| 13125                                       | 13.125 | 6.301    | 6.129    | 4.200    | 6.331    | 6.276    | 4.442    | 6.398    | 6.292    | 6.155    |
| 13500                                       | 13.500 | 6.290    | 6.129    | 4.304    | 6.320    | 6.275    | 4.549    | 6.384    | 6.279    | 6.141    |
| 13875                                       | 13.875 | 6.276    | 6.125    | 4.402    | 6.305    | 6.269    | 4.648    | 6.367    | 6.263    | 6.125    |
| 14250                                       | 14.250 | 6.260    | 6.117    | 4.492    | 6.288    | 6.259    | 4.739    | 6.348    | 6.245    | 6.107    |
| 14625                                       | 14.625 | 6.241    | 6.106    | 4.574    | 6.269    | 6.246    | 4.822    | 6.327    | 6.225    | 6.087    |
| 15000                                       | 15.000 | 6.219    | 6.091    | 4.646    | 6.247    | 6.229    | 4.895    | 6.303    | 6.202    | 6.064    |
| 15375                                       | 15.375 | 6.196    | 6.073    | 4.712    | 6.223    | 6.210    | 4.960    | 6.278    | 6.176    | 6.039    |
| 15750                                       | 15.750 | 6.170    | 6.052    | 4.771    | 6.196    | 6.187    | 5.018    | 6.250    | 6.149    | 6.012    |
| 16125                                       | 16.125 | 6.142    | 6.029    | 4.823    | 6.168    | 6.162    | 5.070    | 6.220    | 6.120    | 5.983    |
| 16500                                       | 16.500 | 6.112    | 6.005    | 4.872    | 6.138    | 6.136    | 5.116    | 6.188    | 6.090    | 5.952    |
| 16875                                       | 16.875 | 6.082    | 5.979    | 4.917    | 6.107    | 6.108    | 5.160    | 6.156    | 6.058    | 5.921    |
| 17250                                       | 17.250 | 6.051    | 5.952    | 4.959    | 6.076    | 6.080    | 5.201    | 6.123    | 6.026    | 5.889    |
| 17625                                       | 17.625 | 6.019    | 5.925    | 5.001    | 6.044    | 6.051    | 5.241    | 6.090    | 5.994    | 5.856    |
| 18000                                       | 18.000 | 5.987    | 5.897    | 5.041    | 6.011    | 6.021    | 5.280    | 6.056    | 5.960    | 5.822    |

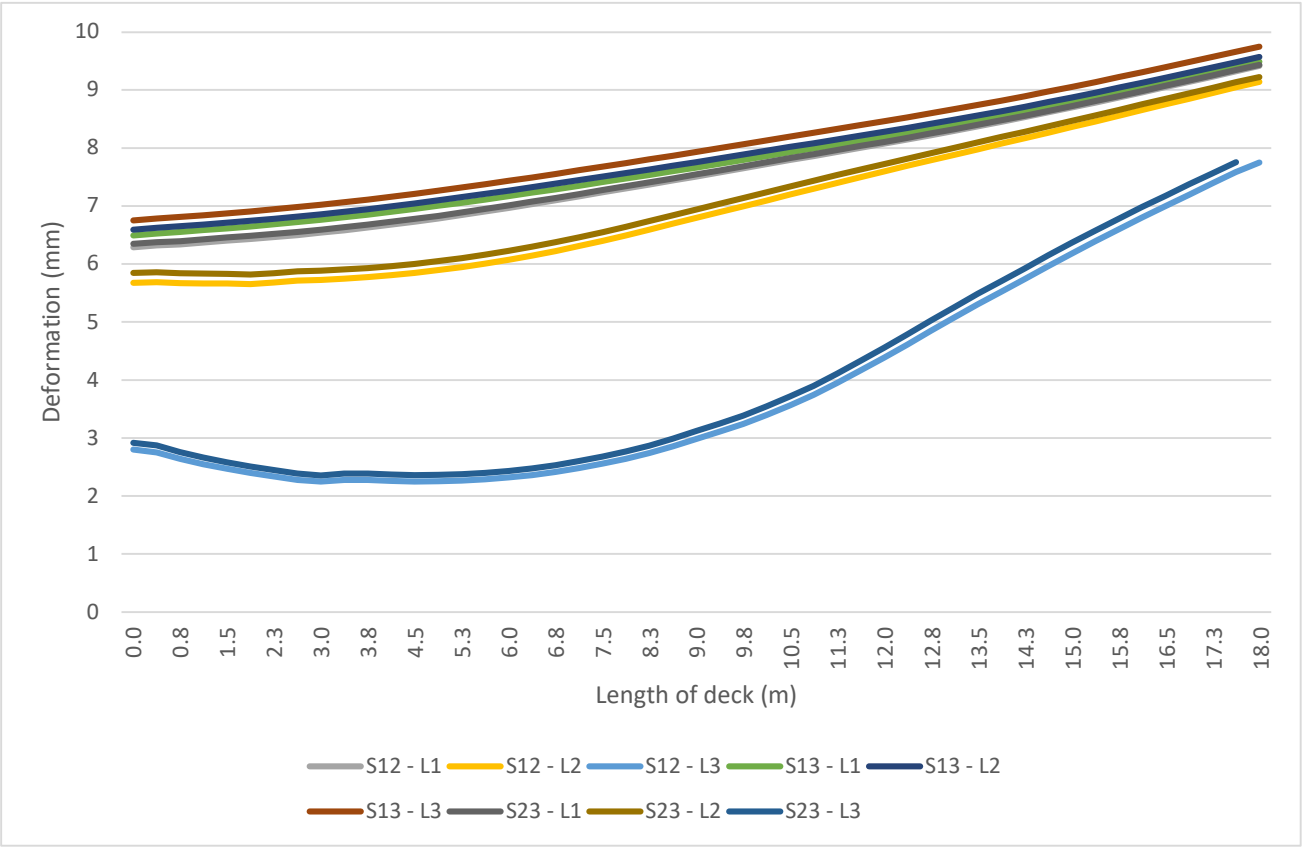


| STIFFENER 1 in S1,2 & 3 - Longitudinal direction |        |           |           |           |
|--------------------------------------------------|--------|-----------|-----------|-----------|
| mm                                               | m      | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.000  | 1.154     | 1.164     | 1.170     |
| 375                                              | 0.375  | 0.940     | 0.898     | 0.832     |
| 750                                              | 0.750  | 0.726     | 0.632     | 0.494     |
| 1125                                             | 1.125  | 0.512     | 0.366     | 0.155     |
| 1500                                             | 1.500  | 0.298     | 0.100     | -0.183    |
| 1875                                             | 1.875  | 0.370     | 0.102     | -0.303    |
| 2250                                             | 2.250  | 0.450     | 0.110     | -0.418    |
| 2625                                             | 2.625  | 0.529     | 0.119     | -0.533    |
| 3000                                             | 3.000  | 0.608     | 0.128     | -0.647    |
| 3375                                             | 3.375  | 0.899     | 0.348     | -0.575    |
| 3750                                             | 3.750  | 1.202     | 0.578     | -0.493    |
| 4125                                             | 4.125  | 1.504     | 0.809     | -0.412    |
| 4500                                             | 4.500  | 1.806     | 1.040     | -0.330    |
| 4875                                             | 4.875  | 2.261     | 1.442     | -0.076    |
| 5250                                             | 5.250  | 2.720     | 1.847     | 0.182     |
| 5625                                             | 5.625  | 3.178     | 2.252     | 0.439     |
| 6000                                             | 6.000  | 3.637     | 2.657     | 0.696     |
| 6375                                             | 6.375  | 4.138     | 3.117     | 1.014     |
| 6750                                             | 6.750  | 4.665     | 3.608     | 1.365     |
| 7125                                             | 7.125  | 5.191     | 4.099     | 1.717     |
| 7500                                             | 7.500  | 5.717     | 4.590     | 2.068     |
| 7875                                             | 7.875  | 6.244     | 5.082     | 2.420     |
| 8250                                             | 8.250  | 6.775     | 5.598     | 2.791     |
| 8625                                             | 8.625  | 7.306     | 6.116     | 3.163     |
| 9000                                             | 9.000  | 7.837     | 6.633     | 3.535     |
| 9375                                             | 9.375  | 8.354     | 7.232     | 4.380     |
| 9750                                             | 9.750  | 8.871     | 7.832     | 5.231     |
| 10125                                            | 10.125 | 9.387     | 8.431     | 6.082     |
| 10500                                            | 10.500 | 9.861     | 9.076     | 7.391     |
| 10875                                            | 10.875 | 10.332    | 9.722     | 8.714     |
| 11250                                            | 11.250 | 10.801    | 10.365    | 10.033    |
| 11625                                            | 11.625 | 11.200    | 10.903    | 10.951    |
| 12000                                            | 12.000 | 11.599    | 11.440    | 11.873    |
| 12375                                            | 12.375 | 11.951    | 11.914    | 12.688    |
| 12750                                            | 12.750 | 12.338    | 12.404    | 13.220    |
| 13125                                            | 13.125 | 12.684    | 12.843    | 13.698    |
| 13500                                            | 13.500 | 13.030    | 13.282    | 14.176    |
| 13875                                            | 13.875 | 13.356    | 13.716    | 14.650    |
| 14250                                            | 14.250 | 13.622    | 14.082    | 15.038    |
| 14625                                            | 14.625 | 13.825    | 14.375    | 15.335    |
| 15000                                            | 15.000 | 14.029    | 14.668    | 15.631    |
| 15375                                            | 15.375 | 14.232    | 14.961    | 15.928    |
| 15750                                            | 15.750 | 14.211    | 14.936    | 15.788    |
| 16125                                            | 16.125 | 14.178    | 14.896    | 15.625    |
| 16500                                            | 16.500 | 14.145    | 14.855    | 15.462    |
| 16875                                            | 16.875 | 13.986    | 14.615    | 15.092    |
| 17250                                            | 17.250 | 13.688    | 14.154    | 14.492    |
| 17625                                            | 17.625 | 13.389    | 13.693    | 13.893    |
| 18000                                            | 18.000 | 13.091    |           |           |

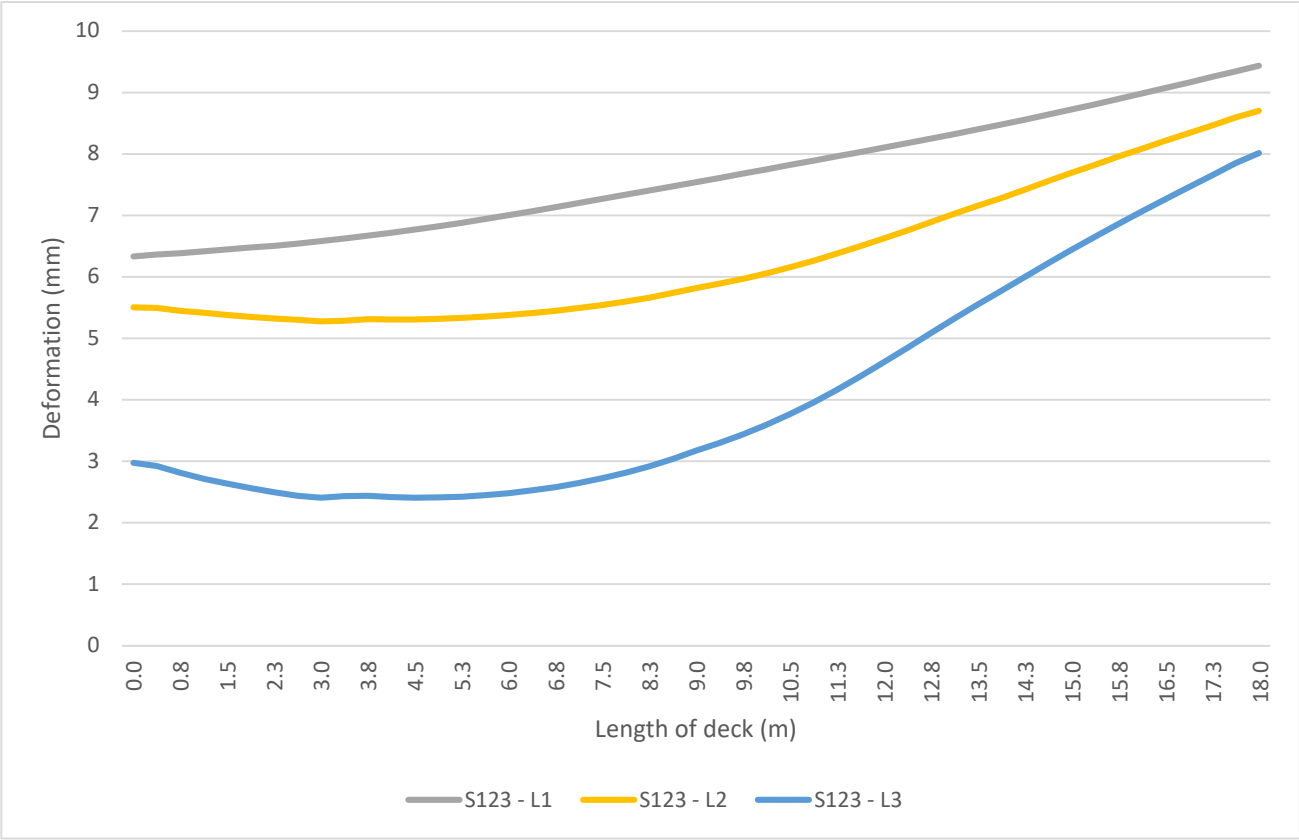




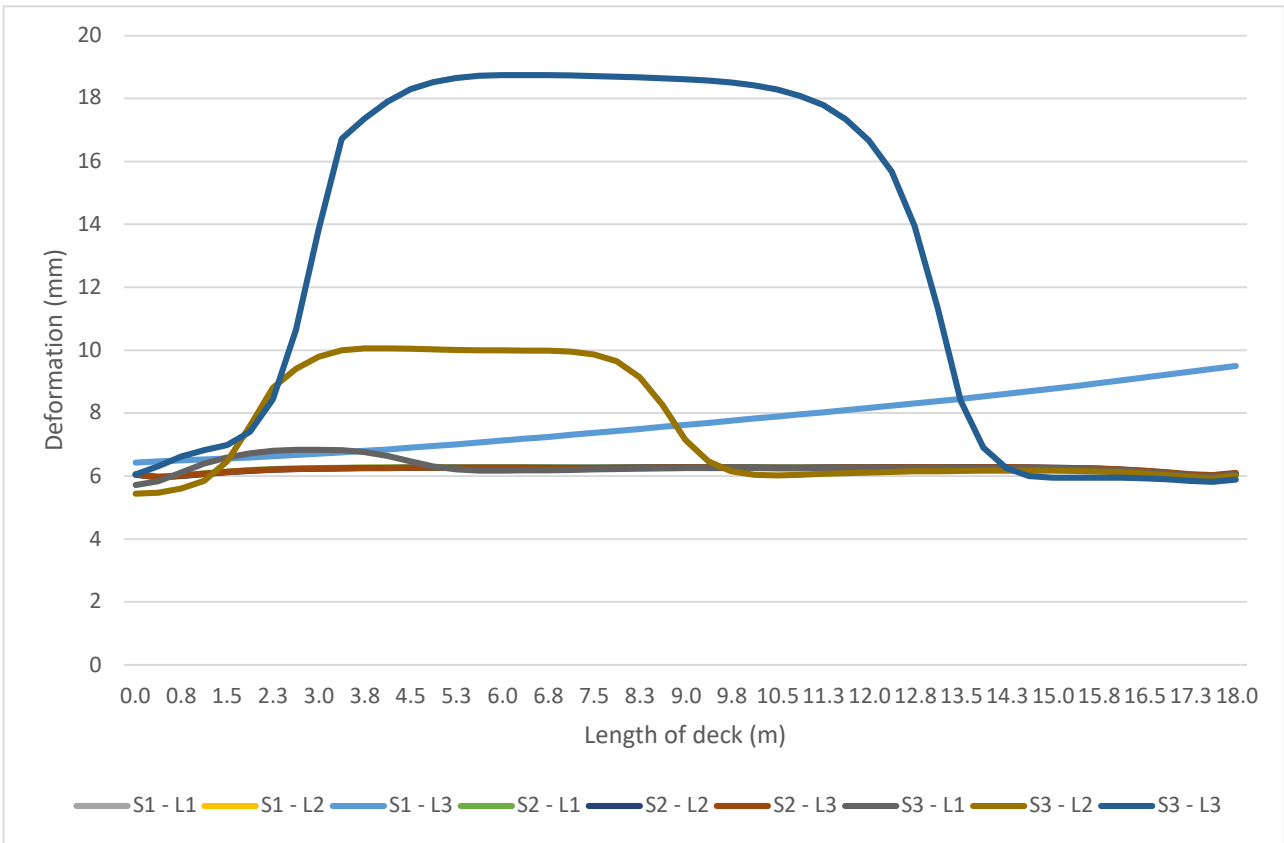
| STIFFENER 2 - Longitudinal direction |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m      | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.000  | -1.815  | -1.834  | -1.864  | 1.150   | -1.774  | -1.727  | -1.810  | -1.808  | -1.794  |
| 375                                  | 0.375  | -1.943  | -1.962  | -1.991  | 0.946   | -1.951  | -1.993  | -1.938  | -1.935  | -1.925  |
| 750                                  | 0.750  | -2.072  | -2.090  | -2.118  | 0.743   | -2.128  | -2.259  | -2.066  | -2.063  | -2.055  |
| 1125                                 | 1.125  | -2.200  | -2.219  | -2.245  | 0.539   | -2.305  | -2.525  | -2.193  | -2.190  | -2.185  |
| 1500                                 | 1.500  | -2.263  | -2.282  | -2.307  | 0.336   | -2.418  | -2.738  | -2.256  | -2.252  | -2.248  |
| 1875                                 | 1.875  | -2.082  | -2.101  | -2.126  | 0.420   | -2.297  | -2.752  | -2.073  | -2.066  | -2.059  |
| 2250                                 | 2.250  | -1.901  | -1.921  | -1.944  | 0.511   | -2.175  | -2.767  | -1.891  | -1.880  | -1.871  |
| 2625                                 | 2.625  | -1.720  | -1.740  | -1.762  | 0.603   | -2.054  | -2.782  | -1.709  | -1.695  | -1.683  |
| 3000                                 | 3.000  | -1.430  | -1.450  | -1.471  | 0.694   | -1.821  | -2.699  | -1.417  | -1.399  | -1.382  |
| 3375                                 | 3.375  | -0.990  | -1.011  | -1.029  | 0.996   | -1.436  | -2.484  | -0.975  | -0.952  | -0.928  |
| 3750                                 | 3.750  | -0.550  | -0.571  | -0.588  | 1.309   | -1.051  | -2.268  | -0.533  | -0.505  | -0.474  |
| 4125                                 | 4.125  | -0.110  | -0.131  | -0.147  | 1.622   | -0.666  | -2.052  | -0.091  | -0.057  | -0.020  |
| 4500                                 | 4.500  | 0.398   | 0.376   | 0.362   | 1.935   | -0.210  | -1.772  | 0.419   | 0.459   | 0.504   |
| 4875                                 | 4.875  | 0.980   | 0.959   | 0.946   | 2.397   | 0.326   | -1.423  | 1.004   | 1.050   | 1.105   |
| 5250                                 | 5.250  | 1.564   | 1.542   | 1.531   | 2.861   | 0.863   | -1.074  | 1.590   | 1.642   | 1.706   |
| 5625                                 | 5.625  | 2.147   | 2.126   | 2.116   | 3.326   | 1.399   | -0.724  | 2.176   | 2.234   | 2.306   |
| 6000                                 | 6.000  | 2.730   | 2.709   | 2.701   | 3.791   | 1.936   | -0.375  | 2.762   | 2.825   | 2.907   |
| 6375                                 | 6.375  | 3.326   | 3.304   | 3.299   | 4.296   | 2.486   | -0.018  | 3.360   | 3.430   | 3.521   |
| 6750                                 | 6.750  | 3.960   | 3.939   | 3.936   | 4.824   | 3.079   | 0.365   | 3.996   | 4.073   | 4.173   |
| 7125                                 | 7.125  | 4.595   | 4.574   | 4.573   | 5.353   | 3.673   | 0.748   | 4.633   | 4.716   | 4.826   |
| 7500                                 | 7.500  | 5.229   | 5.209   | 5.210   | 5.881   | 4.266   | 1.130   | 5.270   | 5.359   | 5.478   |
| 7875                                 | 7.875  | 5.893   | 5.873   | 5.877   | 6.411   | 4.899   | 1.534   | 5.935   | 6.030   | 6.159   |
| 8250                                 | 8.250  | 6.574   | 6.555   | 6.563   | 6.940   | 5.557   | 1.952   | 6.618   | 6.719   | 6.857   |
| 8625                                 | 8.625  | 7.255   | 7.238   | 7.248   | 7.470   | 6.215   | 2.370   | 7.301   | 7.408   | 7.556   |
| 9000                                 | 9.000  | 7.936   | 7.920   | 7.934   | 8.001   | 6.872   | 2.787   | 7.984   | 8.097   | 8.254   |
| 9375                                 | 9.375  | 8.591   | 8.577   | 8.596   | 8.511   | 7.569   | 3.458   | 8.639   | 8.756   | 8.919   |
| 9750                                 | 9.750  | 9.244   | 9.234   | 9.257   | 9.021   | 8.266   | 4.134   | 9.293   | 9.414   | 9.584   |
| 10125                                | 10.125 | 9.898   | 9.890   | 9.919   | 9.531   | 8.963   | 4.809   | 9.947   | 10.072  | 10.249  |
| 10500                                | 10.500 | 10.552  | 10.546  | 10.580  | 9.991   | 9.660   | 5.485   | 10.602  | 10.730  | 10.913  |
| 10875                                | 10.875 | 11.205  | 11.203  | 11.241  | 10.449  | 10.357  | 6.161   | 11.256  | 11.388  | 11.578  |
| 11250                                | 11.250 | 11.859  | 11.859  | 11.903  | 10.904  | 11.055  | 6.836   | 11.910  | 12.046  | 12.243  |
| 11625                                | 11.625 | 12.478  | 12.482  | 12.531  | 11.281  | 11.759  | 7.661   | 12.529  | 12.668  | 12.869  |
| 12000                                | 12.000 | 13.075  | 13.083  | 13.139  | 11.657  | 12.469  | 8.581   | 13.126  | 13.266  | 13.471  |
| 12375                                | 12.375 | 13.672  | 13.684  | 13.746  | 11.989  | 13.179  | 9.500   | 13.722  | 13.865  | 14.072  |
| 12750                                | 12.750 | 14.270  | 14.285  | 14.354  | 12.343  | 13.888  | 10.420  | 14.319  | 14.463  | 14.674  |
| 13125                                | 13.125 | 14.867  | 14.886  | 14.961  | 12.661  | 14.598  | 11.340  | 14.916  | 15.062  | 15.276  |
| 13500                                | 13.500 | 15.456  | 15.480  | 15.561  | 12.978  | 15.306  | 12.264  | 15.505  | 15.652  | 15.870  |
| 13875                                | 13.875 | 15.914  | 15.943  | 16.033  | 13.276  | 15.890  | 13.183  | 15.960  | 16.107  | 16.323  |
| 14250                                | 14.250 | 16.371  | 16.406  | 16.503  | 13.520  | 16.474  | 14.103  | 16.415  | 16.560  | 16.776  |
| 14625                                | 14.625 | 16.828  | 16.868  | 16.974  | 13.706  | 17.057  | 15.022  | 16.870  | 17.014  | 17.229  |
| 15000                                | 15.000 | 17.285  | 17.331  | 17.444  | 13.893  | 17.641  | 15.942  | 17.325  | 17.468  | 17.681  |
| 15375                                | 15.375 | 17.510  | 17.564  | 17.688  | 14.080  | 17.915  | 16.557  | 17.546  | 17.683  | 17.888  |
| 15750                                | 15.750 | 17.724  | 17.786  | 17.921  | 14.062  | 18.174  | 17.156  | 17.755  | 17.886  | 18.083  |
| 16125                                | 16.125 | 17.938  | 18.008  | 18.153  | 14.033  | 18.433  | 17.756  | 17.964  | 18.089  | 18.278  |
| 16500                                | 16.500 | 18.152  | 18.231  | 18.386  | 14.004  | 18.691  | 18.355  | 18.174  | 18.292  | 18.472  |
| 16875                                | 16.875 | 18.079  | 18.168  | 18.337  | 13.860  | 18.452  | 18.160  | 18.093  | 18.200  | 18.362  |
| 17250                                | 17.250 | 17.999  | 18.099  | 18.281  | 13.588  | 18.200  | 17.945  | 18.006  | 18.100  | 18.245  |
| 17625                                | 17.625 | 17.919  | 18.029  | 18.224  | 13.316  | 17.948  | 17.730  | 17.918  | 18.001  | 18.128  |
| 18000                                | 18.000 | 17.839  | 17.960  | 18.168  | 13.044  | 17.695  | 17.515  | 17.830  | 17.901  | 18.011  |



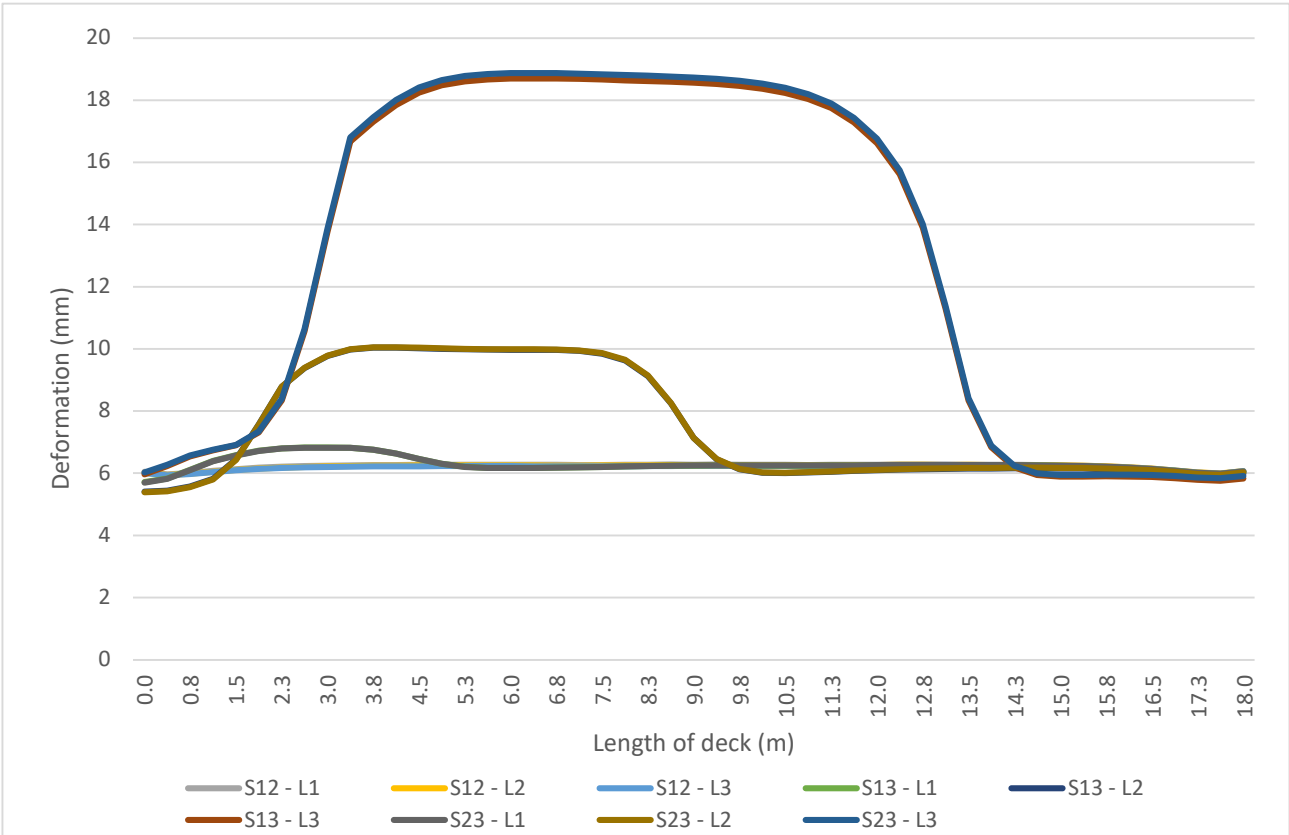
| STIFFENER 2 in S## - Longitudinal direction |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m      | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.000  | -1.809   | -1.798   | -1.779   | -1.815   | -1.831   | -1.845   | -1.804   | -1.772   | -1.710   |
| 375                                         | 0.375  | -1.948   | -1.974   | -2.041   | -1.943   | -1.958   | -1.974   | -1.943   | -1.949   | -1.983   |
| 750                                         | 0.750  | -2.087   | -2.150   | -2.304   | -2.070   | -2.086   | -2.103   | -2.081   | -2.125   | -2.256   |
| 1125                                        | 1.125  | -2.226   | -2.327   | -2.567   | -2.198   | -2.213   | -2.232   | -2.220   | -2.302   | -2.529   |
| 1500                                        | 1.500  | -2.300   | -2.440   | -2.777   | -2.261   | -2.275   | -2.293   | -2.294   | -2.416   | -2.748   |
| 1875                                        | 1.875  | -2.131   | -2.318   | -2.788   | -2.079   | -2.090   | -2.104   | -2.123   | -2.291   | -2.762   |
| 2250                                        | 2.250  | -1.962   | -2.196   | -2.799   | -1.896   | -1.904   | -1.914   | -1.953   | -2.166   | -2.777   |
| 2625                                        | 2.625  | -1.792   | -2.075   | -2.810   | -1.714   | -1.719   | -1.724   | -1.782   | -2.041   | -2.792   |
| 3000                                        | 3.000  | -1.513   | -1.842   | -2.724   | -1.423   | -1.423   | -1.422   | -1.501   | -1.803   | -2.707   |
| 3375                                        | 3.375  | -1.082   | -1.456   | -2.505   | -0.981   | -0.976   | -0.966   | -1.069   | -1.412   | -2.485   |
| 3750                                        | 3.750  | -0.652   | -1.071   | -2.286   | -0.539   | -0.529   | -0.510   | -0.636   | -1.021   | -2.263   |
| 4125                                        | 4.125  | -0.221   | -0.686   | -2.067   | -0.097   | -0.082   | -0.054   | -0.204   | -0.630   | -2.041   |
| 4500                                        | 4.500  | 0.278    | -0.229   | -1.784   | 0.413    | 0.434    | 0.472    | 0.298    | -0.166   | -1.753   |
| 4875                                        | 4.875  | 0.854    | 0.307    | -1.431   | 0.997    | 1.025    | 1.074    | 0.876    | 0.378    | -1.393   |
| 5250                                        | 5.250  | 1.431    | 0.843    | -1.079   | 1.583    | 1.617    | 1.678    | 1.455    | 0.922    | -1.034   |
| 5625                                        | 5.625  | 2.007    | 1.380    | -0.726   | 2.168    | 2.209    | 2.281    | 2.034    | 1.466    | -0.674   |
| 6000                                        | 6.000  | 2.584    | 1.917    | -0.373   | 2.754    | 2.801    | 2.884    | 2.613    | 2.010    | -0.315   |
| 6375                                        | 6.375  | 3.173    | 2.467    | -0.012   | 3.352    | 3.405    | 3.500    | 3.204    | 2.569    | 0.053    |
| 6750                                        | 6.750  | 3.804    | 3.061    | 0.374    | 3.988    | 4.049    | 4.156    | 3.837    | 3.171    | 0.447    |
| 7125                                        | 7.125  | 4.434    | 3.655    | 0.760    | 4.625    | 4.692    | 4.812    | 4.469    | 3.773    | 0.841    |
| 7500                                        | 7.500  | 5.064    | 4.248    | 1.146    | 5.261    | 5.336    | 5.468    | 5.102    | 4.375    | 1.235    |
| 7875                                        | 7.875  | 5.727    | 4.882    | 1.554    | 5.927    | 6.008    | 6.153    | 5.767    | 5.017    | 1.651    |
| 8250                                        | 8.250  | 6.410    | 5.540    | 1.975    | 6.610    | 6.698    | 6.857    | 6.452    | 5.684    | 2.082    |
| 8625                                        | 8.625  | 7.093    | 6.198    | 2.396    | 7.293    | 7.389    | 7.560    | 7.136    | 6.351    | 2.512    |
| 9000                                        | 9.000  | 7.777    | 6.856    | 2.817    | 7.976    | 8.080    | 8.264    | 7.821    | 7.018    | 2.942    |
| 9375                                        | 9.375  | 8.446    | 7.555    | 3.493    | 8.631    | 8.742    | 8.937    | 8.492    | 7.721    | 3.628    |
| 9750                                        | 9.750  | 9.116    | 8.255    | 4.173    | 9.286    | 9.403    | 9.610    | 9.162    | 8.425    | 4.318    |
| 10125                                       | 10.125 | 9.785    | 8.954    | 4.854    | 9.941    | 10.065   | 10.283   | 9.833    | 9.129    | 5.008    |
| 10500                                       | 10.500 | 10.455   | 9.654    | 5.534    | 10.596   | 10.726   | 10.956   | 10.503   | 9.833    | 5.698    |
| 10875                                       | 10.875 | 11.125   | 10.353   | 6.215    | 11.251   | 11.388   | 11.629   | 11.174   | 10.538   | 6.388    |
| 11250                                       | 11.250 | 11.794   | 11.053   | 6.895    | 11.906   | 12.050   | 12.302   | 11.844   | 11.242   | 7.078    |
| 11625                                       | 11.625 | 12.436   | 11.761   | 7.725    | 12.526   | 12.676   | 12.939   | 12.486   | 11.952   | 7.918    |
| 12000                                       | 12.000 | 13.059   | 12.475   | 8.651    | 13.123   | 13.279   | 13.552   | 13.109   | 12.666   | 8.853    |
| 12375                                       | 12.375 | 13.682   | 13.188   | 9.577    | 13.721   | 13.882   | 14.165   | 13.732   | 13.380   | 9.788    |
| 12750                                       | 12.750 | 14.305   | 13.902   | 10.503   | 14.319   | 14.486   | 14.777   | 14.355   | 14.094   | 10.724   |
| 13125                                       | 13.125 | 14.929   | 14.616   | 11.429   | 14.916   | 15.089   | 15.390   | 14.978   | 14.808   | 11.659   |
| 13500                                       | 13.500 | 15.544   | 15.328   | 12.358   | 15.506   | 15.685   | 15.995   | 15.594   | 15.520   | 12.598   |
| 13875                                       | 13.875 | 16.016   | 15.919   | 13.289   | 15.964   | 16.147   | 16.463   | 16.064   | 16.105   | 13.535   |
| 14250                                       | 14.250 | 16.487   | 16.509   | 14.219   | 16.420   | 16.607   | 16.930   | 16.533   | 16.690   | 14.472   |
| 14625                                       | 14.625 | 16.957   | 17.099   | 15.149   | 16.876   | 17.068   | 17.397   | 17.001   | 17.274   | 15.409   |
| 15000                                       | 15.000 | 17.428   | 17.689   | 16.079   | 17.333   | 17.528   | 17.863   | 17.470   | 17.859   | 16.345   |
| 15375                                       | 15.375 | 17.647   | 17.973   | 16.716   | 17.556   | 17.753   | 18.089   | 17.685   | 18.126   | 16.963   |
| 15750                                       | 15.750 | 17.853   | 18.243   | 17.338   | 17.768   | 17.967   | 18.303   | 17.886   | 18.377   | 17.564   |
| 16125                                       | 16.125 | 18.059   | 18.512   | 17.960   | 17.980   | 18.180   | 18.517   | 18.087   | 18.628   | 18.165   |
| 16500                                       | 16.500 | 18.265   | 18.782   | 18.582   | 18.191   | 18.393   | 18.730   | 18.289   | 18.878   | 18.765   |
| 16875                                       | 16.875 | 18.162   | 18.558   | 18.416   | 18.114   | 18.314   | 18.644   | 18.178   | 18.618   | 18.528   |
| 17250                                       | 17.250 | 18.052   | 18.322   | 18.232   | 18.030   | 18.228   | 18.551   | 18.060   | 18.345   | 18.270   |
| 17625                                       | 17.625 | 17.941   | 18.085   | 18.047   | 17.946   | 18.142   | 18.458   | 17.941   | 18.071   | 18.012   |
| 18000                                       | 18.000 | 17.830   | 17.849   | 17.863   | 17.861   | 18.055   | 18.365   | 17.822   | 17.798   | 17.754   |



| STIFFENER 2 in S1,2 & 3 - Longitudinal direction |        |           |           |           |
|--------------------------------------------------|--------|-----------|-----------|-----------|
| mm                                               | m      | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.000  | -1.808    | -1.788    | -1.762    |
| 375                                              | 0.375  | -1.947    | -1.994    | -2.031    |
| 750                                              | 0.750  | -2.086    | -2.200    | -2.301    |
| 1125                                             | 1.125  | -2.225    | -2.405    | -2.570    |
| 1500                                             | 1.500  | -2.298    | -2.549    | -2.785    |
| 1875                                             | 1.875  | -2.128    | -2.460    | -2.796    |
| 2250                                             | 2.250  | -1.957    | -2.372    | -2.806    |
| 2625                                             | 2.625  | -1.787    | -2.283    | -2.817    |
| 3000                                             | 3.000  | -1.506    | -2.084    | -2.728    |
| 3375                                             | 3.375  | -1.074    | -1.733    | -2.501    |
| 3750                                             | 3.750  | -0.642    | -1.382    | -2.275    |
| 4125                                             | 4.125  | -0.210    | -1.031    | -2.048    |
| 4500                                             | 4.500  | 0.292     | -0.608    | -1.756    |
| 4875                                             | 4.875  | 0.870     | -0.106    | -1.392    |
| 5250                                             | 5.250  | 1.449     | 0.397     | -1.028    |
| 5625                                             | 5.625  | 2.027     | 0.900     | -0.664    |
| 6000                                             | 6.000  | 2.606     | 1.403     | -0.299    |
| 6375                                             | 6.375  | 3.198     | 1.920     | 0.073     |
| 6750                                             | 6.750  | 3.830     | 2.483     | 0.472     |
| 7125                                             | 7.125  | 4.462     | 3.046     | 0.870     |
| 7500                                             | 7.500  | 5.095     | 3.609     | 1.269     |
| 7875                                             | 7.875  | 5.760     | 4.216     | 1.690     |
| 8250                                             | 8.250  | 6.445     | 4.849     | 2.126     |
| 8625                                             | 8.625  | 7.130     | 5.483     | 2.561     |
| 9000                                             | 9.000  | 7.815     | 6.117     | 2.996     |
| 9375                                             | 9.375  | 8.486     | 6.855     | 3.688     |
| 9750                                             | 9.750  | 9.157     | 7.595     | 4.383     |
| 10125                                            | 10.125 | 9.828     | 8.335     | 5.079     |
| 10500                                            | 10.500 | 10.499    | 9.076     | 5.775     |
| 10875                                            | 10.875 | 11.170    | 9.816     | 6.471     |
| 11250                                            | 11.250 | 11.841    | 10.557    | 7.167     |
| 11625                                            | 11.625 | 12.483    | 11.344    | 8.012     |
| 12000                                            | 12.000 | 13.107    | 12.160    | 8.954     |
| 12375                                            | 12.375 | 13.731    | 12.977    | 9.896     |
| 12750                                            | 12.750 | 14.355    | 13.794    | 10.839    |
| 13125                                            | 13.125 | 14.979    | 14.610    | 11.781    |
| 13500                                            | 13.500 | 15.596    | 15.425    | 12.726    |
| 13875                                            | 13.875 | 16.067    | 16.093    | 13.674    |
| 14250                                            | 14.250 | 16.537    | 16.760    | 14.623    |
| 14625                                            | 14.625 | 17.008    | 17.427    | 15.571    |
| 15000                                            | 15.000 | 17.478    | 18.094    | 16.518    |
| 15375                                            | 15.375 | 17.695    | 18.398    | 17.157    |
| 15750                                            | 15.750 | 17.898    | 18.684    | 17.779    |
| 16125                                            | 16.125 | 18.102    | 18.970    | 18.402    |
| 16500                                            | 16.500 | 18.306    | 19.255    | 19.024    |
| 16875                                            | 16.875 | 18.199    | 18.964    | 18.813    |
| 17250                                            | 17.250 | 18.084    | 18.660    | 18.582    |
| 17625                                            | 17.625 | 17.969    | 18.354    | 18.350    |
| 18000                                            | 18.000 | 17.853    |           | 18.119    |

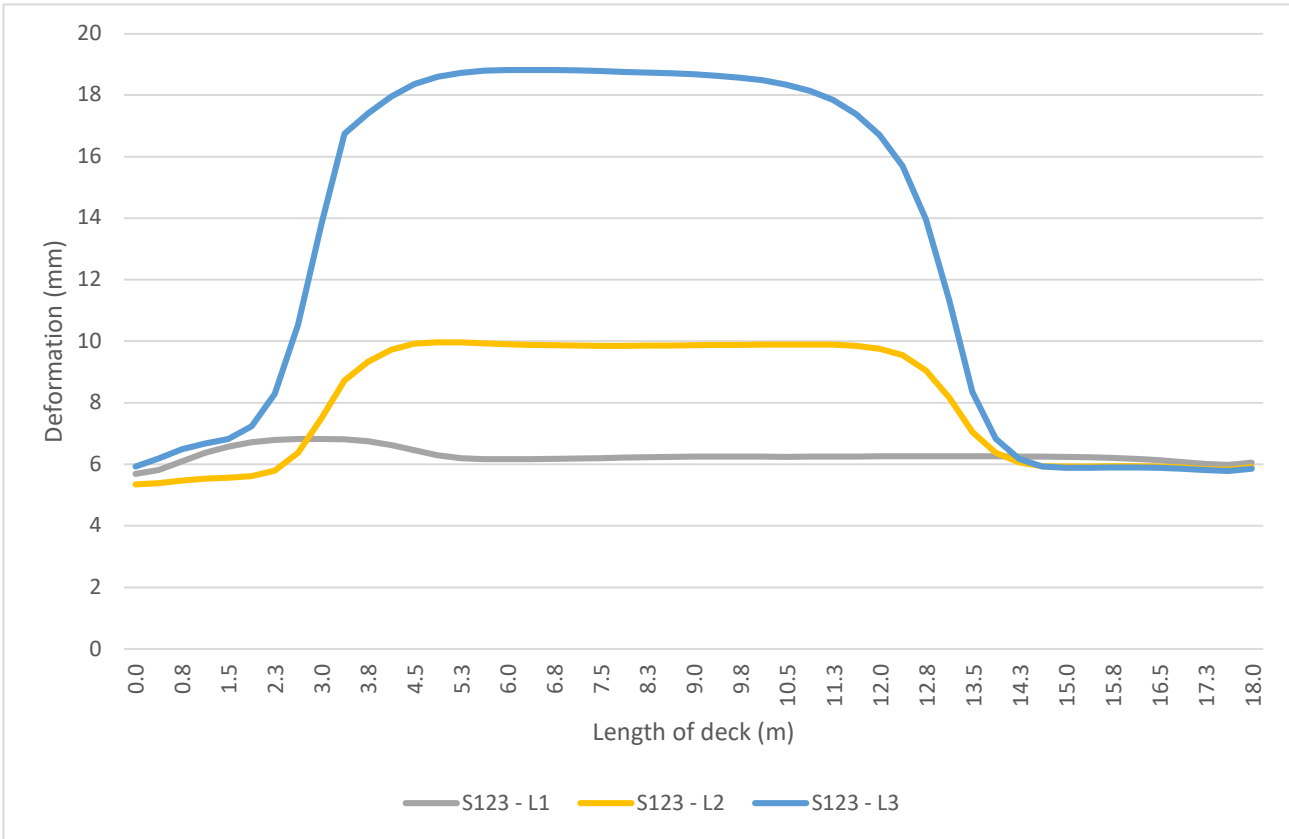


| STIFFENER 3 - Longitudinal direction |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m      | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.000  | 6.062   | 6.049   | 6.435   | 6.047   | 6.036   | 6.047   | 5.722   | 5.447   | 6.055   |
| 375                                  | 0.375  | 5.986   | 5.974   | 6.468   | 5.973   | 5.963   | 5.973   | 5.837   | 5.474   | 6.311   |
| 750                                  | 0.750  | 6.021   | 6.009   | 6.495   | 6.009   | 5.998   | 6.008   | 6.114   | 5.603   | 6.617   |
| 1125                                 | 1.125  | 6.088   | 6.077   | 6.526   | 6.077   | 6.065   | 6.073   | 6.398   | 5.851   | 6.820   |
| 1500                                 | 1.500  | 6.146   | 6.135   | 6.558   | 6.136   | 6.123   | 6.129   | 6.585   | 6.471   | 6.984   |
| 1875                                 | 1.875  | 6.189   | 6.178   | 6.592   | 6.179   | 6.167   | 6.171   | 6.726   | 7.591   | 7.402   |
| 2250                                 | 2.250  | 6.219   | 6.209   | 6.628   | 6.211   | 6.198   | 6.201   | 6.803   | 8.804   | 8.438   |
| 2625                                 | 2.625  | 6.239   | 6.228   | 6.667   | 6.231   | 6.218   | 6.221   | 6.830   | 9.403   | 10.650  |
| 3000                                 | 3.000  | 6.253   | 6.243   | 6.709   | 6.246   | 6.233   | 6.235   | 6.834   | 9.794   | 13.845  |
| 3375                                 | 3.375  | 6.263   | 6.252   | 6.753   | 6.257   | 6.244   | 6.246   | 6.819   | 10.000  | 16.722  |
| 3750                                 | 3.750  | 6.269   | 6.259   | 6.799   | 6.264   | 6.251   | 6.252   | 6.759   | 10.058  | 17.358  |
| 4125                                 | 4.125  | 6.274   | 6.263   | 6.849   | 6.269   | 6.257   | 6.257   | 6.638   | 10.062  | 17.897  |
| 4500                                 | 4.500  | 6.276   | 6.266   | 6.900   | 6.273   | 6.261   | 6.260   | 6.464   | 10.044  | 18.298  |
| 4875                                 | 4.875  | 6.278   | 6.268   | 6.954   | 6.275   | 6.263   | 6.263   | 6.305   | 10.024  | 18.526  |
| 5250                                 | 5.250  | 6.279   | 6.269   | 7.009   | 6.277   | 6.265   | 6.264   | 6.210   | 10.008  | 18.655  |
| 5625                                 | 5.625  | 6.279   | 6.268   | 7.066   | 6.277   | 6.266   | 6.264   | 6.173   | 9.997   | 18.721  |
| 6000                                 | 6.000  | 6.277   | 6.266   | 7.124   | 6.276   | 6.265   | 6.262   | 6.171   | 9.992   | 18.745  |
| 6375                                 | 6.375  | 6.273   | 6.263   | 7.184   | 6.273   | 6.263   | 6.260   | 6.177   | 9.990   | 18.753  |
| 6750                                 | 6.750  | 6.270   | 6.260   | 7.245   | 6.270   | 6.260   | 6.257   | 6.187   | 9.985   | 18.749  |
| 7125                                 | 7.125  | 6.269   | 6.258   | 7.307   | 6.269   | 6.260   | 6.256   | 6.197   | 9.952   | 18.735  |
| 7500                                 | 7.500  | 6.269   | 6.259   | 7.370   | 6.270   | 6.261   | 6.257   | 6.208   | 9.861   | 18.715  |
| 7875                                 | 7.875  | 6.271   | 6.261   | 7.434   | 6.272   | 6.264   | 6.260   | 6.219   | 9.651   | 18.692  |
| 8250                                 | 8.250  | 6.276   | 6.266   | 7.498   | 6.278   | 6.270   | 6.265   | 6.232   | 9.147   | 18.670  |
| 8625                                 | 8.625  | 6.280   | 6.270   | 7.562   | 6.283   | 6.276   | 6.271   | 6.243   | 8.263   | 18.645  |
| 9000                                 | 9.000  | 6.282   | 6.272   | 7.626   | 6.284   | 6.278   | 6.273   | 6.250   | 7.152   | 18.615  |
| 9375                                 | 9.375  | 6.279   | 6.269   | 7.692   | 6.282   | 6.277   | 6.272   | 6.251   | 6.466   | 18.572  |
| 9750                                 | 9.750  | 6.275   | 6.265   | 7.760   | 6.278   | 6.273   | 6.268   | 6.250   | 6.152   | 18.510  |
| 10125                                | 10.125 | 6.271   | 6.261   | 7.826   | 6.274   | 6.270   | 6.265   | 6.249   | 6.035   | 18.423  |
| 10500                                | 10.500 | 6.267   | 6.257   | 7.894   | 6.271   | 6.268   | 6.263   | 6.248   | 6.024   | 18.287  |
| 10875                                | 10.875 | 6.266   | 6.256   | 7.961   | 6.270   | 6.267   | 6.262   | 6.248   | 6.041   | 18.088  |
| 11250                                | 11.250 | 6.267   | 6.257   | 8.028   | 6.271   | 6.269   | 6.265   | 6.251   | 6.067   | 17.798  |
| 11625                                | 11.625 | 6.271   | 6.261   | 8.095   | 6.275   | 6.274   | 6.270   | 6.256   | 6.093   | 17.341  |
| 12000                                | 12.000 | 6.275   | 6.265   | 8.164   | 6.279   | 6.279   | 6.275   | 6.260   | 6.116   | 16.672  |
| 12375                                | 12.375 | 6.278   | 6.267   | 8.234   | 6.282   | 6.282   | 6.279   | 6.264   | 6.134   | 15.670  |
| 12750                                | 12.750 | 6.278   | 6.268   | 8.306   | 6.282   | 6.283   | 6.281   | 6.265   | 6.147   | 13.953  |
| 13125                                | 13.125 | 6.277   | 6.267   | 8.379   | 6.282   | 6.284   | 6.282   | 6.264   | 6.157   | 11.357  |
| 13500                                | 13.500 | 6.276   | 6.266   | 8.454   | 6.280   | 6.283   | 6.283   | 6.263   | 6.165   | 8.405   |
| 13875                                | 13.875 | 6.273   | 6.263   | 8.531   | 6.278   | 6.281   | 6.282   | 6.261   | 6.170   | 6.900   |
| 14250                                | 14.250 | 6.268   | 6.258   | 8.611   | 6.273   | 6.278   | 6.280   | 6.257   | 6.174   | 6.252   |
| 14625                                | 14.625 | 6.262   | 6.252   | 8.692   | 6.267   | 6.272   | 6.276   | 6.250   | 6.174   | 6.001   |
| 15000                                | 15.000 | 6.252   | 6.242   | 8.776   | 6.258   | 6.264   | 6.269   | 6.241   | 6.170   | 5.950   |
| 15375                                | 15.375 | 6.238   | 6.228   | 8.862   | 6.244   | 6.251   | 6.258   | 6.227   | 6.161   | 5.947   |
| 15750                                | 15.750 | 6.219   | 6.208   | 8.949   | 6.224   | 6.232   | 6.241   | 6.208   | 6.146   | 5.953   |
| 16125                                | 16.125 | 6.188   | 6.178   | 9.038   | 6.194   | 6.204   | 6.214   | 6.178   | 6.121   | 5.949   |
| 16500                                | 16.500 | 6.145   | 6.135   | 9.128   | 6.152   | 6.162   | 6.175   | 6.135   | 6.082   | 5.930   |
| 16875                                | 16.875 | 6.087   | 6.077   | 9.219   | 6.094   | 6.106   | 6.121   | 6.078   | 6.028   | 5.894   |
| 17250                                | 17.250 | 6.020   | 6.009   | 9.311   | 6.027   | 6.041   | 6.058   | 6.011   | 5.965   | 5.843   |
| 17625                                | 17.625 | 5.985   | 5.973   | 9.404   | 5.992   | 6.007   | 6.027   | 5.976   | 5.931   | 5.816   |
| 18000                                | 18.000 | 6.060   | 6.047   | 9.500   | 6.068   | 6.084   | 6.106   | 6.051   | 6.005   | 5.887   |

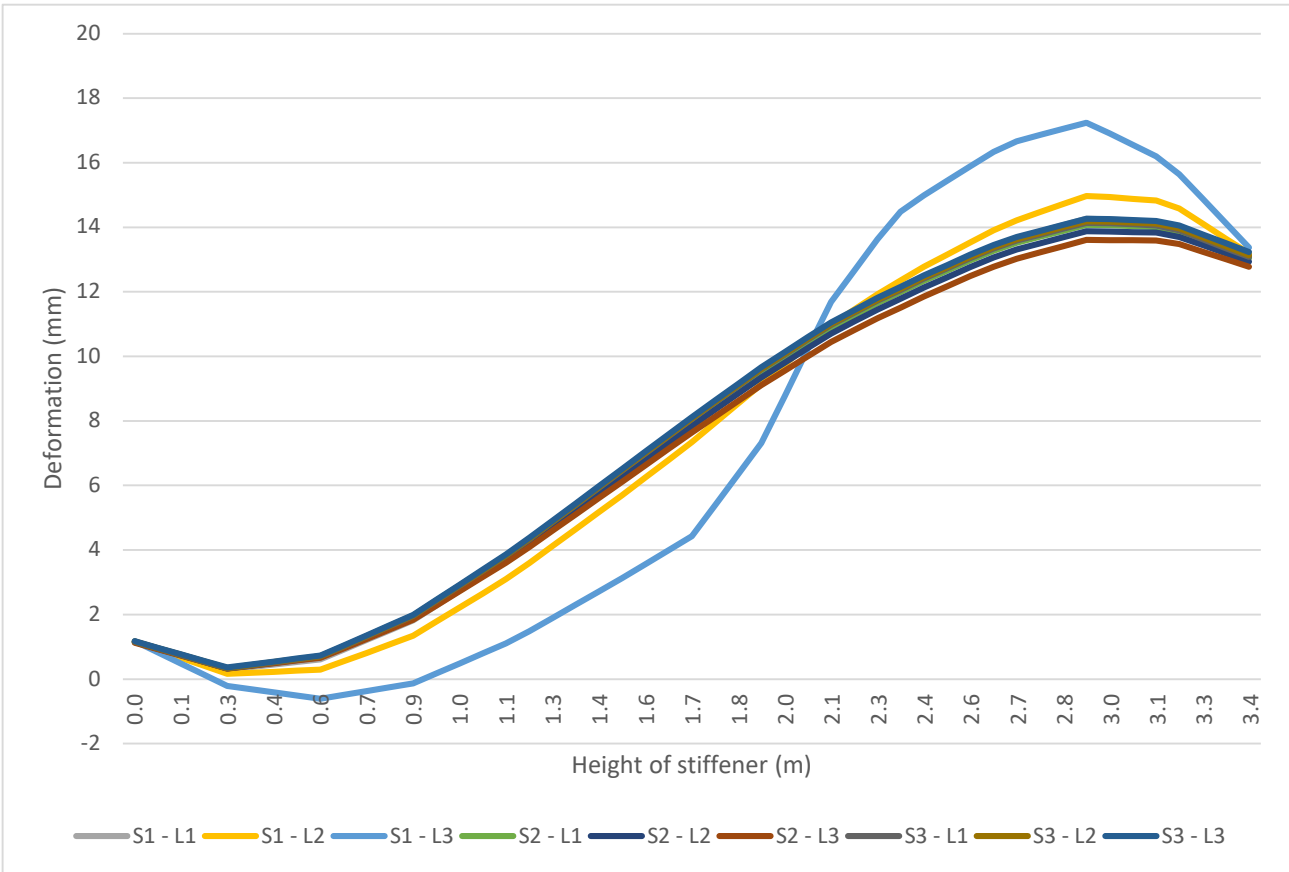


| STIFFENER 3 in S## - Longitudinal direction |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m      | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.000  | 6.043    | 6.017    | 6.001    | 5.717    | 5.412    | 5.966    | 5.696    | 5.387    | 6.024    |
| 375                                         | 0.375  | 5.969    | 5.946    | 5.933    | 5.832    | 5.442    | 6.229    | 5.815    | 5.419    | 6.274    |
| 750                                         | 0.750  | 6.005    | 5.983    | 5.969    | 6.110    | 5.573    | 6.537    | 6.096    | 5.548    | 6.568    |
| 1125                                        | 1.125  | 6.073    | 6.050    | 6.035    | 6.395    | 5.821    | 6.737    | 6.384    | 5.797    | 6.757    |
| 1500                                        | 1.500  | 6.132    | 6.109    | 6.092    | 6.582    | 6.443    | 6.895    | 6.574    | 6.423    | 6.915    |
| 1875                                        | 1.875  | 6.176    | 6.152    | 6.135    | 6.723    | 7.565    | 7.307    | 6.716    | 7.555    | 7.338    |
| 2250                                        | 2.250  | 6.207    | 6.183    | 6.165    | 6.800    | 8.780    | 8.340    | 6.795    | 8.781    | 8.391    |
| 2625                                        | 2.625  | 6.228    | 6.204    | 6.186    | 6.826    | 9.380    | 10.564   | 6.822    | 9.388    | 10.637   |
| 3000                                        | 3.000  | 6.243    | 6.219    | 6.200    | 6.831    | 9.771    | 13.777   | 6.827    | 9.783    | 13.877   |
| 3375                                        | 3.375  | 6.254    | 6.230    | 6.210    | 6.816    | 9.978    | 16.669   | 6.813    | 9.992    | 16.801   |
| 3750                                        | 3.750  | 6.261    | 6.238    | 6.217    | 6.756    | 10.037   | 17.307   | 6.753    | 10.052   | 17.452   |
| 4125                                        | 4.125  | 6.266    | 6.243    | 6.222    | 6.635    | 10.040   | 17.847   | 6.632    | 10.056   | 18.003   |
| 4500                                        | 4.500  | 6.270    | 6.247    | 6.225    | 6.461    | 10.023   | 18.248   | 6.458    | 10.038   | 18.412   |
| 4875                                        | 4.875  | 6.272    | 6.249    | 6.228    | 6.302    | 10.003   | 18.476   | 6.299    | 10.018   | 18.644   |
| 5250                                        | 5.250  | 6.274    | 6.251    | 6.229    | 6.207    | 9.987    | 18.605   | 6.204    | 10.003   | 18.775   |
| 5625                                        | 5.625  | 6.274    | 6.252    | 6.229    | 6.170    | 9.976    | 18.670   | 6.167    | 9.992    | 18.842   |
| 6000                                        | 6.000  | 6.272    | 6.251    | 6.227    | 6.167    | 9.972    | 18.694   | 6.166    | 9.989    | 18.868   |
| 6375                                        | 6.375  | 6.270    | 6.249    | 6.225    | 6.174    | 9.970    | 18.702   | 6.173    | 9.988    | 18.875   |
| 6750                                        | 6.750  | 6.267    | 6.247    | 6.222    | 6.184    | 9.965    | 18.698   | 6.183    | 9.983    | 18.871   |
| 7125                                        | 7.125  | 6.266    | 6.246    | 6.221    | 6.194    | 9.933    | 18.683   | 6.194    | 9.951    | 18.856   |
| 7500                                        | 7.500  | 6.266    | 6.247    | 6.222    | 6.205    | 9.842    | 18.663   | 6.205    | 9.861    | 18.835   |
| 7875                                        | 7.875  | 6.269    | 6.250    | 6.225    | 6.216    | 9.632    | 18.640   | 6.217    | 9.650    | 18.811   |
| 8250                                        | 8.250  | 6.274    | 6.256    | 6.230    | 6.228    | 9.128    | 18.617   | 6.230    | 9.144    | 18.787   |
| 8625                                        | 8.625  | 6.279    | 6.262    | 6.236    | 6.239    | 8.244    | 18.593   | 6.241    | 8.257    | 18.761   |
| 9000                                        | 9.000  | 6.281    | 6.265    | 6.238    | 6.246    | 7.132    | 18.563   | 6.248    | 7.141    | 18.730   |
| 9375                                        | 9.375  | 6.279    | 6.263    | 6.237    | 6.248    | 6.447    | 18.519   | 6.250    | 6.454    | 18.685   |
| 9750                                        | 9.750  | 6.274    | 6.259    | 6.233    | 6.247    | 6.133    | 18.458   | 6.250    | 6.139    | 18.622   |
| 10125                                       | 10.125 | 6.270    | 6.256    | 6.230    | 6.245    | 6.016    | 18.371   | 6.248    | 6.023    | 18.533   |
| 10500                                       | 10.500 | 6.267    | 6.254    | 6.227    | 6.244    | 6.005    | 18.236   | 6.248    | 6.014    | 18.394   |
| 10875                                       | 10.875 | 6.266    | 6.253    | 6.227    | 6.245    | 6.023    | 18.037   | 6.248    | 6.032    | 18.192   |
| 11250                                       | 11.250 | 6.268    | 6.255    | 6.230    | 6.248    | 6.049    | 17.747   | 6.251    | 6.060    | 17.897   |
| 11625                                       | 11.625 | 6.271    | 6.260    | 6.234    | 6.252    | 6.075    | 17.291   | 6.256    | 6.087    | 17.434   |
| 12000                                       | 12.000 | 6.275    | 6.265    | 6.240    | 6.257    | 6.098    | 16.622   | 6.261    | 6.111    | 16.758   |
| 12375                                       | 12.375 | 6.278    | 6.268    | 6.244    | 6.260    | 6.116    | 15.619   | 6.264    | 6.130    | 15.745   |
| 12750                                       | 12.750 | 6.279    | 6.269    | 6.246    | 6.261    | 6.129    | 13.900   | 6.265    | 6.144    | 14.012   |
| 13125                                       | 13.125 | 6.278    | 6.269    | 6.247    | 6.261    | 6.139    | 11.301   | 6.265    | 6.155    | 11.390   |
| 13500                                       | 13.500 | 6.277    | 6.269    | 6.247    | 6.260    | 6.147    | 8.345    | 6.264    | 6.165    | 8.409    |
| 13875                                       | 13.875 | 6.274    | 6.267    | 6.246    | 6.257    | 6.153    | 6.841    | 6.262    | 6.171    | 6.893    |
| 14250                                       | 14.250 | 6.270    | 6.264    | 6.244    | 6.253    | 6.156    | 6.194    | 6.258    | 6.176    | 6.242    |
| 14625                                       | 14.625 | 6.264    | 6.258    | 6.240    | 6.247    | 6.156    | 5.944    | 6.252    | 6.177    | 5.991    |
| 15000                                       | 15.000 | 6.254    | 6.249    | 6.233    | 6.237    | 6.153    | 5.894    | 6.242    | 6.174    | 5.943    |
| 15375                                       | 15.375 | 6.240    | 6.237    | 6.222    | 6.223    | 6.144    | 5.892    | 6.229    | 6.167    | 5.944    |
| 15750                                       | 15.750 | 6.221    | 6.218    | 6.205    | 6.204    | 6.129    | 5.899    | 6.210    | 6.154    | 5.954    |
| 16125                                       | 16.125 | 6.190    | 6.189    | 6.178    | 6.174    | 6.103    | 5.895    | 6.180    | 6.130    | 5.955    |
| 16500                                       | 16.500 | 6.148    | 6.148    | 6.138    | 6.131    | 6.065    | 5.877    | 6.138    | 6.093    | 5.941    |
| 16875                                       | 16.875 | 6.090    | 6.091    | 6.084    | 6.074    | 6.010    | 5.841    | 6.080    | 6.041    | 5.910    |
| 17250                                       | 17.250 | 6.023    | 6.025    | 6.020    | 6.007    | 5.946    | 5.789    | 6.014    | 5.979    | 5.864    |
| 17625                                       | 17.625 | 5.988    | 5.991    | 5.987    | 5.972    | 5.911    | 5.761    | 5.979    | 5.947    | 5.842    |
| 18000                                       | 18.000 | 6.063    | 6.066    | 6.061    | 6.046    | 5.983    | 5.827    | 6.054    | 6.021    | 5.915    |

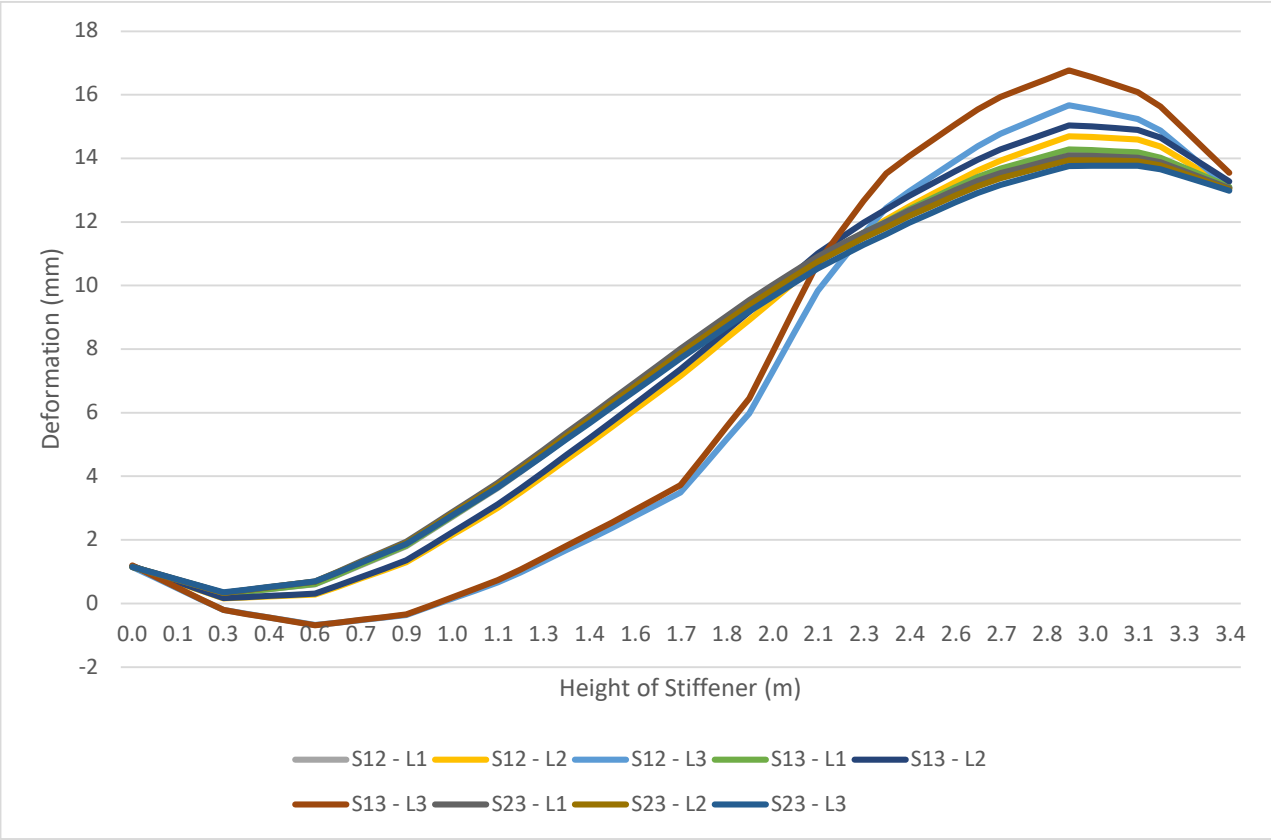




| STIFFENER 3 in S1,2 & 3 - Longitudinal direction |        |           |           |           |
|--------------------------------------------------|--------|-----------|-----------|-----------|
| mm                                               | m      | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.000  | 5.691     | 5.353     | 5.931     |
| 375                                              | 0.375  | 5.811     | 5.384     | 6.189     |
| 750                                              | 0.750  | 6.091     | 5.467     | 6.485     |
| 1125                                             | 1.125  | 6.380     | 5.530     | 6.671     |
| 1500                                             | 1.500  | 6.570     | 5.559     | 6.823     |
| 1875                                             | 1.875  | 6.713     | 5.611     | 7.239     |
| 2250                                             | 2.250  | 6.792     | 5.787     | 8.290     |
| 2625                                             | 2.625  | 6.819     | 6.379     | 10.547    |
| 3000                                             | 3.000  | 6.824     | 7.501     | 13.807    |
| 3375                                             | 3.375  | 6.810     | 8.729     | 16.746    |
| 3750                                             | 3.750  | 6.750     | 9.332     | 17.399    |
| 4125                                             | 4.125  | 6.629     | 9.719     | 17.951    |
| 4500                                             | 4.500  | 6.455     | 9.917     | 18.360    |
| 4875                                             | 4.875  | 6.295     | 9.965     | 18.593    |
| 5250                                             | 5.250  | 6.201     | 9.958     | 18.723    |
| 5625                                             | 5.625  | 6.164     | 9.932     | 18.790    |
| 6000                                             | 6.000  | 6.162     | 9.904     | 18.815    |
| 6375                                             | 6.375  | 6.170     | 9.882     | 18.822    |
| 6750                                             | 6.750  | 6.180     | 9.866     | 18.817    |
| 7125                                             | 7.125  | 6.191     | 9.857     | 18.802    |
| 7500                                             | 7.500  | 6.202     | 9.852     | 18.781    |
| 7875                                             | 7.875  | 6.214     | 9.851     | 18.757    |
| 8250                                             | 8.250  | 6.226     | 9.856     | 18.732    |
| 8625                                             | 8.625  | 6.238     | 9.863     | 18.707    |
| 9000                                             | 9.000  | 6.245     | 9.871     | 18.676    |
| 9375                                             | 9.375  | 6.247     | 9.876     | 18.631    |
| 9750                                             | 9.750  | 6.246     | 9.881     | 18.568    |
| 10125                                            | 10.125 | 6.245     | 9.886     | 18.479    |
| 10500                                            | 10.500 | 6.244     | 9.891     | 18.341    |
| 10875                                            | 10.875 | 6.245     | 9.893     | 18.139    |
| 11250                                            | 11.250 | 6.248     | 9.887     | 17.844    |
| 11625                                            | 11.625 | 6.252     | 9.852     | 17.382    |
| 12000                                            | 12.000 | 6.257     | 9.758     | 16.706    |
| 12375                                            | 12.375 | 6.261     | 9.547     | 15.693    |
| 12750                                            | 12.750 | 6.262     | 9.043     | 13.956    |
| 13125                                            | 13.125 | 6.261     | 8.161     | 11.330    |
| 13500                                            | 13.500 | 6.260     | 7.053     | 8.347     |
| 13875                                            | 13.875 | 6.258     | 6.373     | 6.831     |
| 14250                                            | 14.250 | 6.254     | 6.060     | 6.180     |
| 14625                                            | 14.625 | 6.248     | 5.940     | 5.930     |
| 15000                                            | 15.000 | 6.239     | 5.923     | 5.883     |
| 15375                                            | 15.375 | 6.225     | 5.931     | 5.885     |
| 15750                                            | 15.750 | 6.206     | 5.941     | 5.897     |
| 16125                                            | 16.125 | 6.176     | 5.940     | 5.898     |
| 16500                                            | 16.500 | 6.134     | 5.926     | 5.885     |
| 16875                                            | 16.875 | 6.077     | 5.894     | 5.854     |
| 17250                                            | 17.250 | 6.010     | 5.848     | 5.808     |
| 17625                                            | 17.625 | 5.975     | 5.827     | 5.784     |
| 18000                                            | 18.000 | 6.049     | 5.903     | 5.852     |

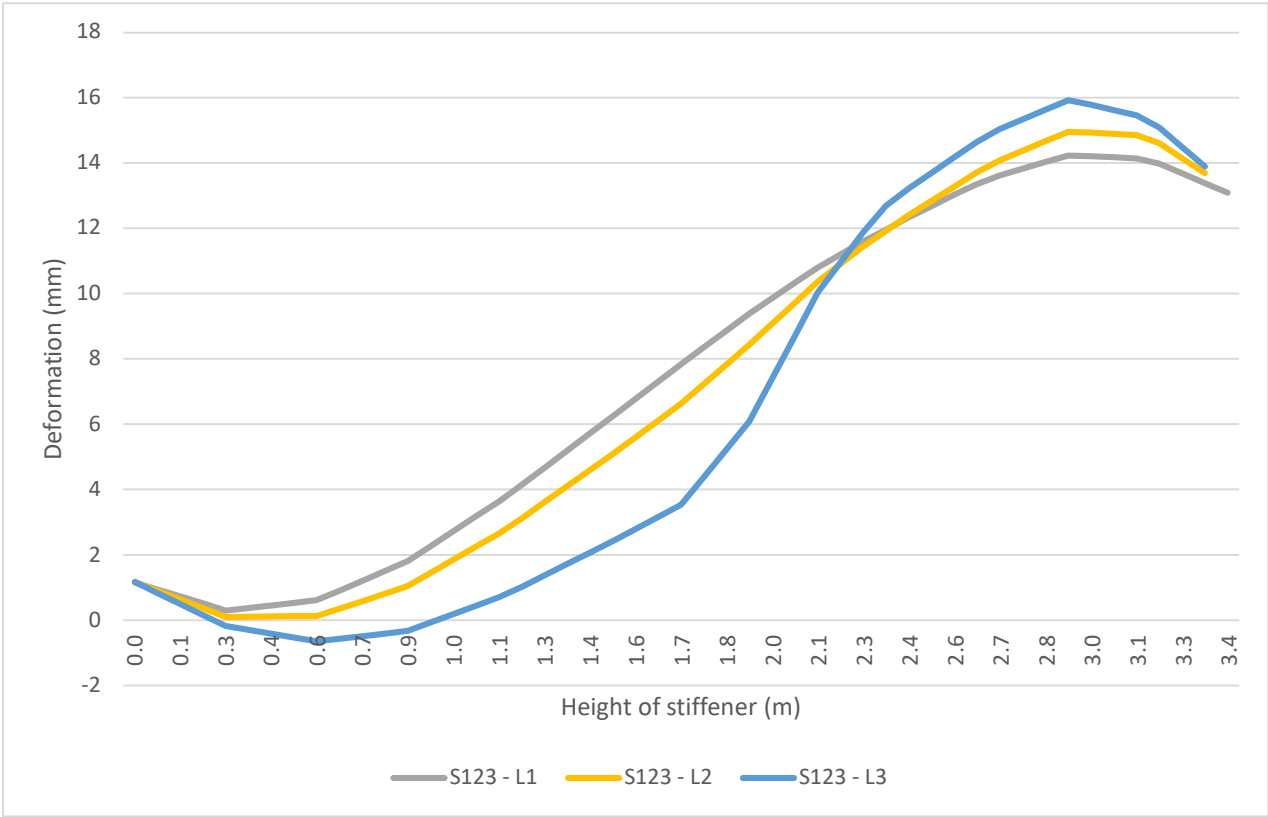


| STIFFENER 1 - Transversal direction |       |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                   | 0.000 | 1.154   | 1.162   | 1.174   | 1.150   | 1.141   | 1.126   | 1.154   | 1.160   | 1.173   |
| 71.08                               | 0.071 | 0.940   | 0.912   | 0.826   | 0.946   | 0.938   | 0.926   | 0.950   | 0.956   | 0.969   |
| 142.16                              | 0.142 | 0.726   | 0.662   | 0.479   | 0.743   | 0.735   | 0.727   | 0.746   | 0.753   | 0.766   |
| 213.24                              | 0.213 | 0.512   | 0.412   | 0.131   | 0.539   | 0.533   | 0.528   | 0.543   | 0.549   | 0.563   |
| 284.32                              | 0.284 | 0.298   | 0.161   | -0.216  | 0.336   | 0.330   | 0.329   | 0.339   | 0.346   | 0.359   |
| 355.4                               | 0.355 | 0.371   | 0.189   | -0.319  | 0.420   | 0.411   | 0.406   | 0.425   | 0.432   | 0.446   |
| 426.48                              | 0.426 | 0.451   | 0.224   | -0.415  | 0.511   | 0.499   | 0.490   | 0.518   | 0.525   | 0.540   |
| 497.56                              | 0.498 | 0.531   | 0.259   | -0.512  | 0.603   | 0.587   | 0.574   | 0.611   | 0.618   | 0.634   |
| 568.64                              | 0.569 | 0.612   | 0.294   | -0.608  | 0.694   | 0.674   | 0.658   | 0.703   | 0.711   | 0.728   |
| 639.72                              | 0.640 | 0.905   | 0.546   | -0.498  | 0.996   | 0.970   | 0.945   | 1.008   | 1.017   | 1.035   |
| 710.8                               | 0.711 | 1.209   | 0.810   | -0.377  | 1.309   | 1.276   | 1.242   | 1.323   | 1.333   | 1.352   |
| 781.88                              | 0.782 | 1.513   | 1.074   | -0.256  | 1.622   | 1.582   | 1.539   | 1.639   | 1.649   | 1.669   |
| 852.96                              | 0.853 | 1.817   | 1.337   | -0.135  | 1.935   | 1.888   | 1.837   | 1.954   | 1.965   | 1.986   |
| 924.04                              | 0.924 | 2.274   | 1.774   | 0.172   | 2.397   | 2.340   | 2.277   | 2.419   | 2.430   | 2.453   |
| 995.12                              | 0.995 | 2.735   | 2.214   | 0.483   | 2.861   | 2.796   | 2.721   | 2.886   | 2.899   | 2.923   |
| 1066.2                              | 1.066 | 3.196   | 2.655   | 0.794   | 3.326   | 3.252   | 3.164   | 3.354   | 3.367   | 3.392   |
| 1137.3                              | 1.137 | 3.656   | 3.095   | 1.105   | 3.791   | 3.707   | 3.608   | 3.821   | 3.835   | 3.862   |
| 1208.4                              | 1.208 | 4.160   | 3.590   | 1.480   | 4.296   | 4.203   | 4.091   | 4.330   | 4.345   | 4.373   |
| 1279.4                              | 1.279 | 4.689   | 4.116   | 1.891   | 4.824   | 4.722   | 4.596   | 4.861   | 4.877   | 4.907   |
| 1350.5                              | 1.351 | 5.218   | 4.643   | 2.302   | 5.353   | 5.241   | 5.102   | 5.392   | 5.409   | 5.440   |
| 1421.6                              | 1.422 | 5.746   | 5.169   | 2.713   | 5.881   | 5.759   | 5.607   | 5.924   | 5.941   | 5.974   |
| 1492.7                              | 1.493 | 6.276   | 5.696   | 3.125   | 6.411   | 6.279   | 6.114   | 6.456   | 6.475   | 6.509   |
| 1563.8                              | 1.564 | 6.808   | 6.242   | 3.558   | 6.940   | 6.800   | 6.621   | 6.988   | 7.008   | 7.044   |
| 1634.8                              | 1.635 | 7.342   | 6.790   | 3.991   | 7.470   | 7.321   | 7.130   | 7.521   | 7.542   | 7.580   |
| 1705.9                              | 1.706 | 7.875   | 7.338   | 4.425   | 8.001   | 7.842   | 7.638   | 8.055   | 8.077   | 8.116   |
| 1777                                | 1.777 | 8.394   | 7.939   | 5.383   | 8.511   | 8.345   | 8.130   | 8.568   | 8.591   | 8.632   |
| 1848.1                              | 1.848 | 8.912   | 8.540   | 6.347   | 9.021   | 8.847   | 8.621   | 9.080   | 9.105   | 9.147   |
| 1919.2                              | 1.919 | 9.430   | 9.141   | 7.312   | 9.531   | 9.349   | 9.111   | 9.592   | 9.618   | 9.662   |
| 1990.2                              | 1.990 | 9.904   | 9.749   | 8.761   | 9.991   | 9.803   | 9.557   | 10.054  | 10.081  | 10.128  |
| 2061.3                              | 2.061 | 10.377  | 10.358  | 10.226  | 10.449  | 10.255  | 10.001  | 10.513  | 10.542  | 10.591  |
| 2132.4                              | 2.132 | 10.847  | 10.963  | 11.684  | 10.904  | 10.705  | 10.442  | 10.970  | 11.000  | 11.051  |
| 2203.5                              | 2.204 | 11.246  | 11.445  | 12.653  | 11.281  | 11.079  | 10.811  | 11.348  | 11.379  | 11.432  |
| 2274.6                              | 2.275 | 11.645  | 11.927  | 13.627  | 11.657  | 11.452  | 11.180  | 11.725  | 11.758  | 11.813  |
| 2345.6                              | 2.346 | 11.997  | 12.352  | 14.488  | 11.989  | 11.781  | 11.505  | 12.057  | 12.092  | 12.149  |
| 2416.7                              | 2.417 | 12.383  | 12.774  | 14.992  | 12.343  | 12.135  | 11.856  | 12.412  | 12.448  | 12.508  |
| 2487.8                              | 2.488 | 12.729  | 13.153  | 15.443  | 12.661  | 12.452  | 12.171  | 12.730  | 12.767  | 12.829  |
| 2558.9                              | 2.559 | 13.075  | 13.532  | 15.895  | 12.978  | 12.769  | 12.485  | 13.047  | 13.087  | 13.151  |
| 2630                                | 2.630 | 13.400  | 13.905  | 16.343  | 13.276  | 13.066  | 12.781  | 13.345  | 13.385  | 13.452  |
| 2701                                | 2.701 | 13.665  | 14.220  | 16.668  | 13.520  | 13.311  | 13.027  | 13.588  | 13.630  | 13.699  |
| 2772.1                              | 2.772 | 13.866  | 14.472  | 16.861  | 13.706  | 13.501  | 13.220  | 13.773  | 13.817  | 13.889  |
| 2843.2                              | 2.843 | 14.067  | 14.724  | 17.054  | 13.893  | 13.691  | 13.413  | 13.959  | 14.004  | 14.078  |
| 2914.3                              | 2.914 | 14.268  | 14.976  | 17.246  | 14.080  | 13.881  | 13.606  | 14.145  | 14.192  | 14.268  |
| 2985.4                              | 2.985 | 14.243  | 14.937  | 16.914  | 14.062  | 13.872  | 13.608  | 14.123  | 14.172  | 14.251  |
| 3056.4                              | 3.056 | 14.206  | 14.883  | 16.554  | 14.033  | 13.853  | 13.601  | 14.092  | 14.142  | 14.223  |
| 3127.5                              | 3.128 | 14.168  | 14.830  | 16.195  | 14.004  | 13.834  | 13.594  | 14.060  | 14.112  | 14.196  |
| 3198.6                              | 3.199 | 14.004  | 14.581  | 15.647  | 13.860  | 13.703  | 13.479  | 13.912  | 13.966  | 14.052  |
| 3269.7                              | 3.270 | 13.698  | 14.118  | 14.890  | 13.588  | 13.449  | 13.245  | 13.634  | 13.690  | 13.779  |
| 3340.8                              | 3.341 | 13.393  | 13.655  | 14.133  | 13.316  | 13.194  | 13.011  | 13.357  | 13.415  | 13.507  |
| 3411.8                              | 3.412 | 13.087  | 13.192  | 13.377  | 13.044  | 12.939  | 12.777  | 13.080  | 13.139  | 13.234  |

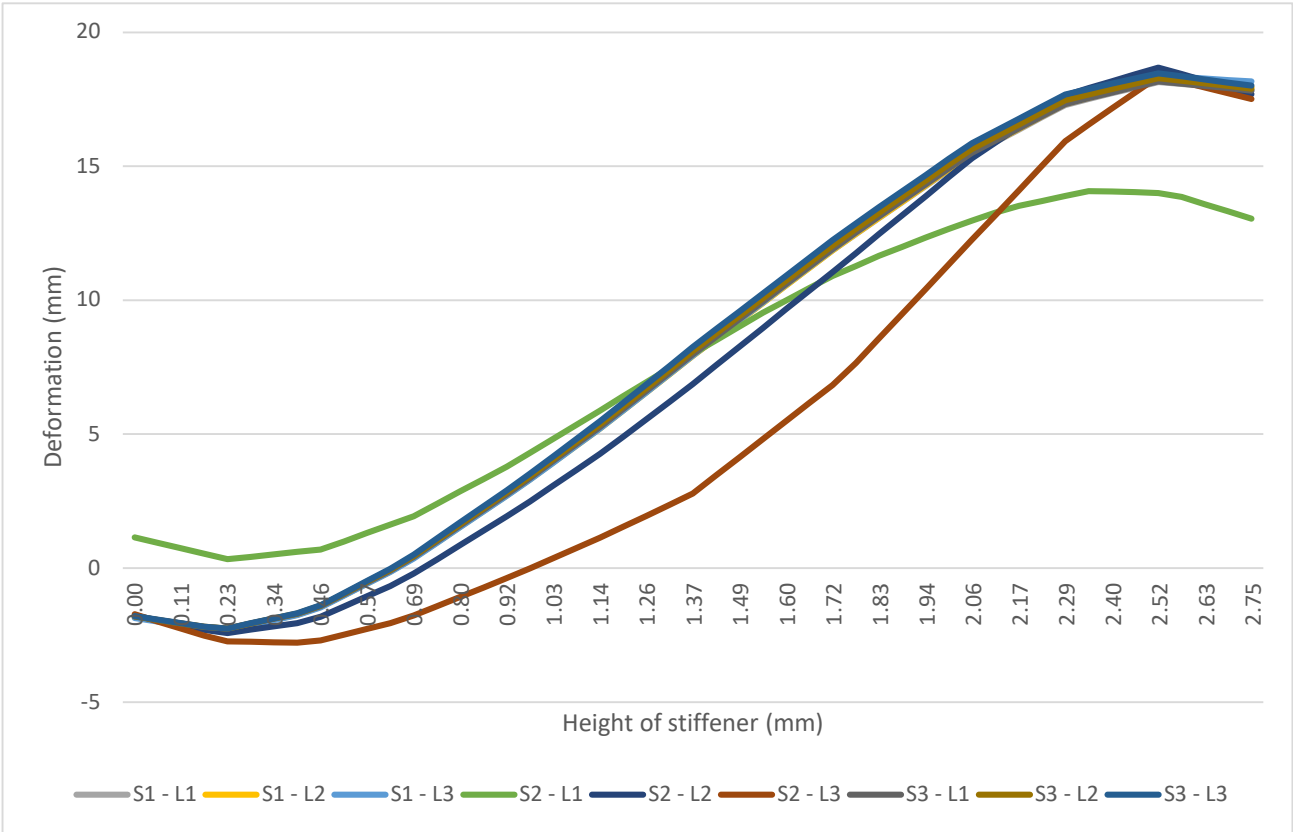


| STIFFENER 1 in S## - Transversal direction |       |          |          |          |          |          |          |          |          |          |
|--------------------------------------------|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                         | m     | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                          | 0.000 | 1.152    | 1.151    | 1.147    | 1.156    | 1.170    | 1.194    | 1.152    | 1.150    | 1.149    |
| 71.08                                      | 0.071 | 0.938    | 0.903    | 0.808    | 0.942    | 0.920    | 0.844    | 0.949    | 0.947    | 0.950    |
| 142.16                                     | 0.142 | 0.724    | 0.655    | 0.469    | 0.728    | 0.670    | 0.493    | 0.745    | 0.744    | 0.751    |
| 213.24                                     | 0.213 | 0.510    | 0.407    | 0.131    | 0.514    | 0.420    | 0.143    | 0.541    | 0.542    | 0.552    |
| 284.32                                     | 0.284 | 0.296    | 0.160    | -0.208   | 0.300    | 0.170    | -0.207   | 0.338    | 0.339    | 0.353    |
| 355.4                                      | 0.355 | 0.368    | 0.185    | -0.329   | 0.373    | 0.199    | -0.331   | 0.422    | 0.420    | 0.431    |
| 426.48                                     | 0.426 | 0.447    | 0.216    | -0.444   | 0.453    | 0.234    | -0.449   | 0.513    | 0.509    | 0.517    |
| 497.56                                     | 0.498 | 0.526    | 0.248    | -0.560   | 0.534    | 0.270    | -0.567   | 0.605    | 0.597    | 0.602    |
| 568.64                                     | 0.569 | 0.606    | 0.280    | -0.675   | 0.614    | 0.306    | -0.685   | 0.696    | 0.685    | 0.687    |
| 639.72                                     | 0.640 | 0.897    | 0.525    | -0.604   | 0.907    | 0.559    | -0.608   | 0.999    | 0.981    | 0.976    |
| 710.8                                      | 0.711 | 1.199    | 0.781    | -0.523   | 1.212    | 0.823    | -0.521   | 1.312    | 1.288    | 1.275    |
| 781.88                                     | 0.782 | 1.501    | 1.037    | -0.442   | 1.516    | 1.088    | -0.434   | 1.625    | 1.595    | 1.574    |
| 852.96                                     | 0.853 | 1.803    | 1.293    | -0.361   | 1.820    | 1.352    | -0.346   | 1.939    | 1.902    | 1.873    |
| 924.04                                     | 0.924 | 2.258    | 1.719    | -0.108   | 2.278    | 1.790    | -0.079   | 2.401    | 2.356    | 2.316    |
| 995.12                                     | 0.995 | 2.716    | 2.149    | 0.148    | 2.739    | 2.231    | 0.192    | 2.865    | 2.812    | 2.762    |
| 1066.2                                     | 1.066 | 3.174    | 2.579    | 0.404    | 3.200    | 2.673    | 0.463    | 3.330    | 3.269    | 3.208    |
| 1137.3                                     | 1.137 | 3.632    | 3.008    | 0.660    | 3.661    | 3.114    | 0.734    | 3.795    | 3.726    | 3.654    |
| 1208.4                                     | 1.208 | 4.134    | 3.492    | 0.976    | 4.165    | 3.611    | 1.068    | 4.301    | 4.223    | 4.140    |
| 1279.4                                     | 1.279 | 4.660    | 4.006    | 1.326    | 4.694    | 4.138    | 1.438    | 4.829    | 4.743    | 4.648    |
| 1350.5                                     | 1.351 | 5.186    | 4.520    | 1.676    | 5.223    | 4.665    | 1.807    | 5.358    | 5.263    | 5.156    |
| 1421.6                                     | 1.422 | 5.712    | 5.034    | 2.025    | 5.752    | 5.192    | 2.177    | 5.887    | 5.783    | 5.664    |
| 1492.7                                     | 1.493 | 6.239    | 5.549    | 2.376    | 6.282    | 5.720    | 2.547    | 6.416    | 6.304    | 6.173    |
| 1563.8                                     | 1.564 | 6.769    | 6.083    | 2.745    | 6.814    | 6.268    | 2.938    | 6.946    | 6.825    | 6.684    |
| 1634.8                                     | 1.635 | 7.300    | 6.619    | 3.115    | 7.348    | 6.817    | 3.330    | 7.477    | 7.348    | 7.195    |
| 1705.9                                     | 1.706 | 7.831    | 7.154    | 3.486    | 7.882    | 7.366    | 3.722    | 8.007    | 7.871    | 7.707    |
| 1777                                       | 1.777 | 8.347    | 7.741    | 4.313    | 8.401    | 7.968    | 4.628    | 8.518    | 8.375    | 8.202    |
| 1848.1                                     | 1.848 | 8.863    | 8.329    | 5.146    | 8.919    | 8.571    | 5.540    | 9.029    | 8.879    | 8.697    |
| 1919.2                                     | 1.919 | 9.379    | 8.916    | 5.980    | 9.438    | 9.174    | 6.453    | 9.539    | 9.383    | 9.192    |
| 1990.2                                     | 1.990 | 9.852    | 9.512    | 7.257    | 9.913    | 9.785    | 7.861    | 9.999    | 9.839    | 9.642    |
| 2061.3                                     | 2.061 | 10.324   | 10.109   | 8.547    | 10.386   | 10.396   | 9.284    | 10.458   | 10.293   | 10.091   |
| 2132.4                                     | 2.132 | 10.792   | 10.702   | 9.833    | 10.856   | 11.004   | 10.703   | 10.913   | 10.744   | 10.536   |
| 2203.5                                     | 2.204 | 11.191   | 11.177   | 10.732   | 11.256   | 11.487   | 11.678   | 11.291   | 11.121   | 10.910   |
| 2274.6                                     | 2.275 | 11.589   | 11.652   | 11.635   | 11.655   | 11.971   | 12.658   | 11.667   | 11.496   | 11.284   |
| 2345.6                                     | 2.346 | 11.941   | 12.071   | 12.433   | 12.008   | 12.398   | 13.524   | 12.000   | 11.828   | 11.614   |
| 2416.7                                     | 2.417 | 12.327   | 12.491   | 12.963   | 12.394   | 12.823   | 14.072   | 12.355   | 12.184   | 11.971   |
| 2487.8                                     | 2.488 | 12.672   | 12.867   | 13.437   | 12.740   | 13.203   | 14.563   | 12.673   | 12.503   | 12.290   |
| 2558.9                                     | 2.559 | 13.018   | 13.244   | 13.912   | 13.087   | 13.583   | 15.055   | 12.991   | 12.822   | 12.610   |
| 2630                                       | 2.630 | 13.343   | 13.615   | 14.383   | 13.412   | 13.959   | 15.542   | 13.289   | 13.121   | 12.911   |
| 2701                                       | 2.701 | 13.609   | 13.930   | 14.772   | 13.678   | 14.275   | 15.929   | 13.533   | 13.369   | 13.163   |
| 2772.1                                     | 2.772 | 13.812   | 14.185   | 15.072   | 13.879   | 14.529   | 16.209   | 13.720   | 13.561   | 13.362   |
| 2843.2                                     | 2.843 | 14.015   | 14.440   | 15.372   | 14.081   | 14.783   | 16.489   | 13.908   | 13.754   | 13.561   |
| 2914.3                                     | 2.914 | 14.217   | 14.695   | 15.672   | 14.283   | 15.037   | 16.768   | 14.095   | 13.946   | 13.759   |
| 2985.4                                     | 2.985 | 14.195   | 14.670   | 15.542   | 14.258   | 15.001   | 16.557   | 14.077   | 13.940   | 13.769   |
| 3056.4                                     | 3.056 | 14.162   | 14.632   | 15.389   | 14.221   | 14.950   | 16.320   | 14.049   | 13.924   | 13.768   |
| 3127.5                                     | 3.128 | 14.128   | 14.594   | 15.237   | 14.185   | 14.898   | 16.083   | 14.021   | 13.908   | 13.768   |
| 3198.6                                     | 3.199 | 13.969   | 14.368   | 14.872   | 14.021   | 14.653   | 15.629   | 13.878   | 13.781   | 13.660   |
| 3269.7                                     | 3.270 | 13.669   | 13.935   | 14.273   | 13.716   | 14.193   | 14.935   | 13.607   | 13.529   | 13.434   |
| 3340.8                                     | 3.341 | 13.370   | 13.502   | 13.673   | 13.411   | 13.733   | 14.240   | 13.335   | 13.277   | 13.209   |
| 3411.8                                     | 3.412 | 13.071   | 13.069   | 13.073   | 13.107   | 13.273   | 13.546   | 13.064   | 13.026   | 12.983   |

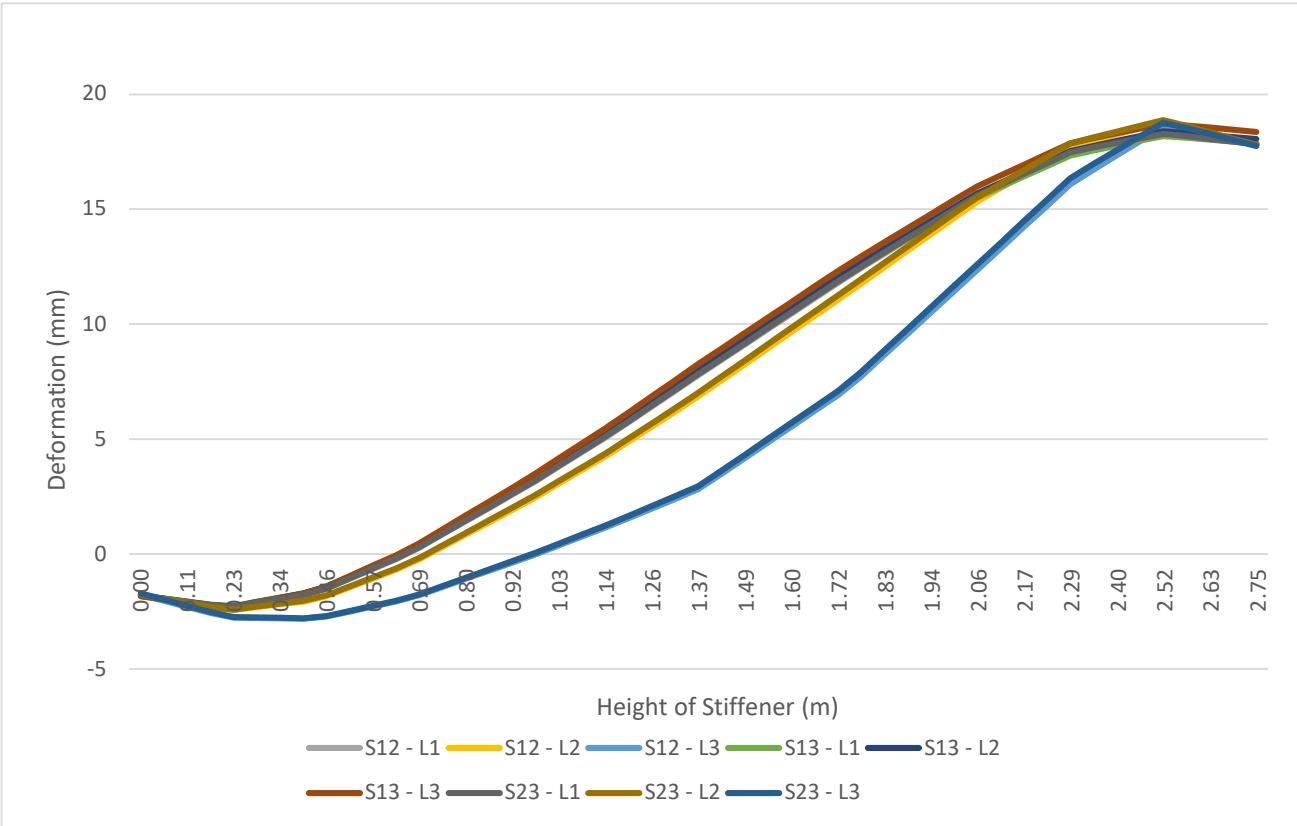




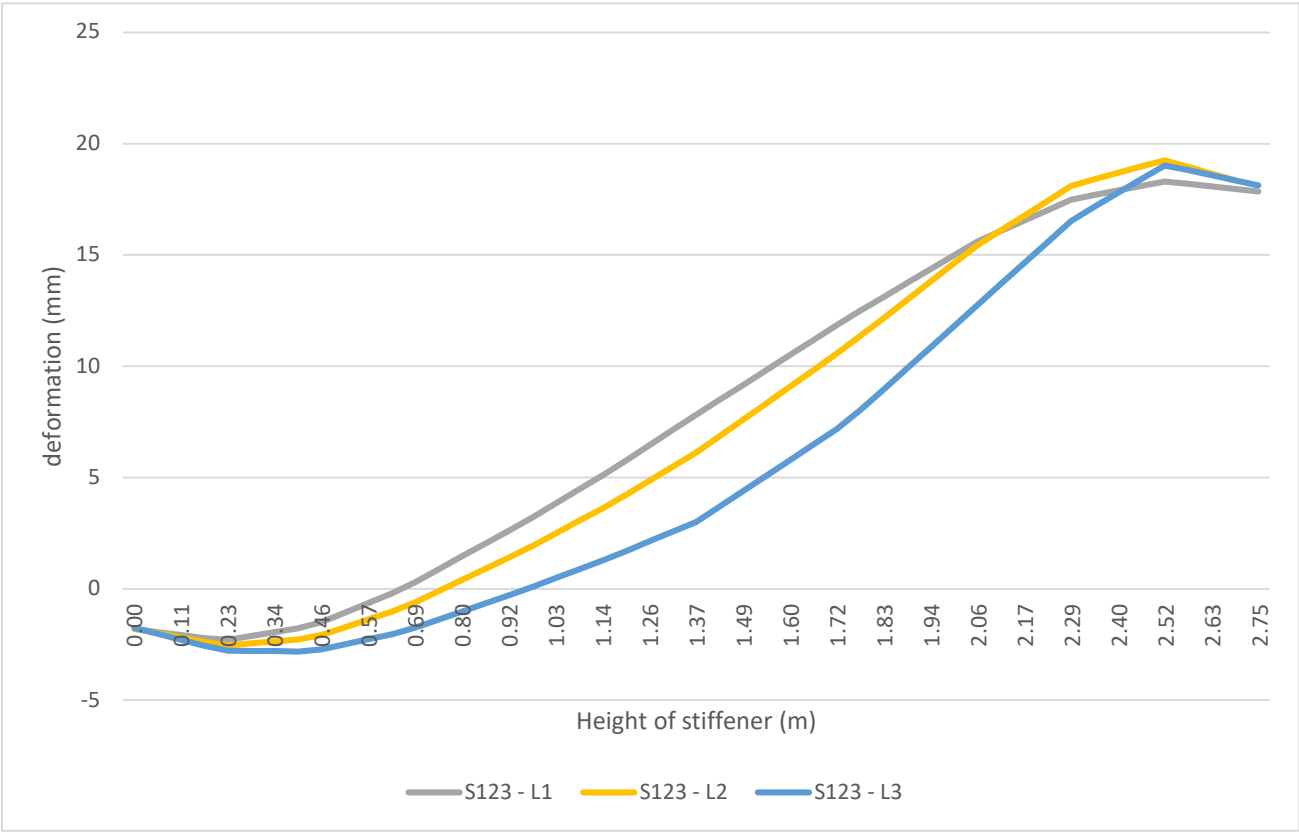
| STIFFENER 1 in S1,2 & 3 - Transversal direction |       |           |           |           |
|-------------------------------------------------|-------|-----------|-----------|-----------|
| mm                                              | m     | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                               | 0.000 | 1.154     | 1.164     | 1.170     |
| 71.08                                           | 0.071 | 0.940     | 0.898     | 0.832     |
| 142.16                                          | 0.142 | 0.726     | 0.632     | 0.494     |
| 213.24                                          | 0.213 | 0.512     | 0.366     | 0.155     |
| 284.32                                          | 0.284 | 0.298     | 0.100     | -0.183    |
| 355.4                                           | 0.355 | 0.370     | 0.102     | -0.303    |
| 426.48                                          | 0.426 | 0.450     | 0.110     | -0.418    |
| 497.56                                          | 0.498 | 0.529     | 0.119     | -0.533    |
| 568.64                                          | 0.569 | 0.608     | 0.128     | -0.647    |
| 639.72                                          | 0.640 | 0.899     | 0.348     | -0.575    |
| 710.8                                           | 0.711 | 1.202     | 0.578     | -0.493    |
| 781.88                                          | 0.782 | 1.504     | 0.809     | -0.412    |
| 852.96                                          | 0.853 | 1.806     | 1.040     | -0.330    |
| 924.04                                          | 0.924 | 2.261     | 1.442     | -0.076    |
| 995.12                                          | 0.995 | 2.720     | 1.847     | 0.182     |
| 1066.2                                          | 1.066 | 3.178     | 2.252     | 0.439     |
| 1137.3                                          | 1.137 | 3.637     | 2.657     | 0.696     |
| 1208.4                                          | 1.208 | 4.138     | 3.117     | 1.014     |
| 1279.4                                          | 1.279 | 4.665     | 3.608     | 1.365     |
| 1350.5                                          | 1.351 | 5.191     | 4.099     | 1.717     |
| 1421.6                                          | 1.422 | 5.717     | 4.590     | 2.068     |
| 1492.7                                          | 1.493 | 6.244     | 5.082     | 2.420     |
| 1563.8                                          | 1.564 | 6.775     | 5.598     | 2.791     |
| 1634.8                                          | 1.635 | 7.306     | 6.116     | 3.163     |
| 1705.9                                          | 1.706 | 7.837     | 6.633     | 3.535     |
| 1777                                            | 1.777 | 8.354     | 7.232     | 4.380     |
| 1848.1                                          | 1.848 | 8.871     | 7.832     | 5.231     |
| 1919.2                                          | 1.919 | 9.387     | 8.431     | 6.082     |
| 1990.2                                          | 1.990 | 9.861     | 9.076     | 7.391     |
| 2061.3                                          | 2.061 | 10.332    | 9.722     | 8.714     |
| 2132.4                                          | 2.132 | 10.801    | 10.365    | 10.033    |
| 2203.5                                          | 2.204 | 11.200    | 10.903    | 10.951    |
| 2274.6                                          | 2.275 | 11.599    | 11.440    | 11.873    |
| 2345.6                                          | 2.346 | 11.951    | 11.914    | 12.688    |
| 2416.7                                          | 2.417 | 12.338    | 12.404    | 13.220    |
| 2487.8                                          | 2.488 | 12.684    | 12.843    | 13.698    |
| 2558.9                                          | 2.559 | 13.030    | 13.282    | 14.176    |
| 2630                                            | 2.630 | 13.356    | 13.716    | 14.650    |
| 2701                                            | 2.701 | 13.622    | 14.082    | 15.038    |
| 2772.1                                          | 2.772 | 13.825    | 14.375    | 15.335    |
| 2843.2                                          | 2.843 | 14.029    | 14.668    | 15.631    |
| 2914.3                                          | 2.914 | 14.232    | 14.961    | 15.928    |
| 2985.4                                          | 2.985 | 14.211    | 14.936    | 15.788    |
| 3056.4                                          | 3.056 | 14.178    | 14.896    | 15.625    |
| 3127.5                                          | 3.128 | 14.145    | 14.855    | 15.462    |
| 3198.6                                          | 3.199 | 13.986    | 14.615    | 15.092    |
| 3269.7                                          | 3.270 | 13.688    | 14.154    | 14.492    |
| 3340.8                                          | 3.341 | 13.389    | 13.693    | 13.893    |
| 3411.8                                          | 3.412 | 13.091    |           |           |



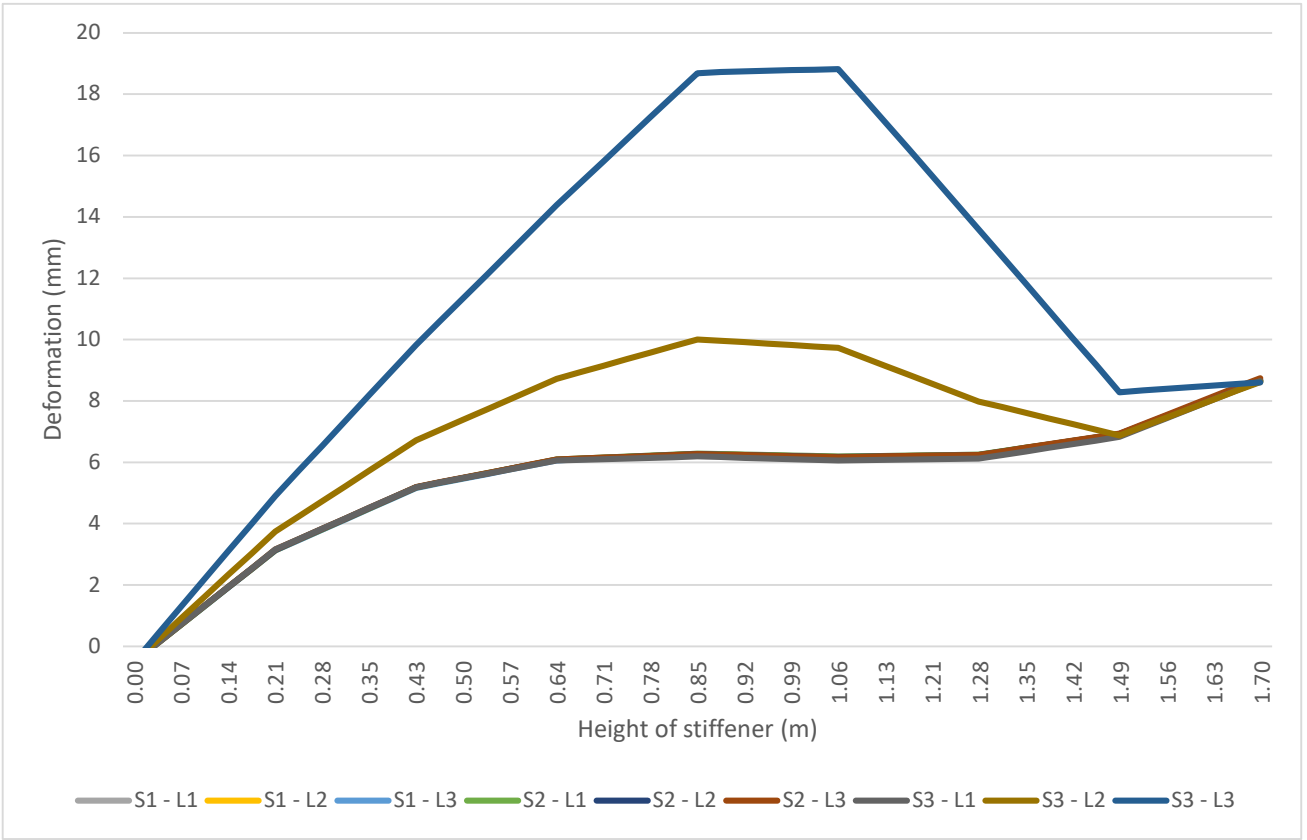
| STIFFENER 2 - Transversal direction |       |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                   | 0.000 | -1.815  | -1.834  | -1.864  | 1.150   | -1.774  | -1.727  | -1.810  | -1.808  | -1.794  |
| 57.188                              | 0.057 | -1.943  | -1.962  | -1.991  | 0.946   | -1.951  | -1.993  | -1.938  | -1.935  | -1.925  |
| 114.38                              | 0.114 | -2.072  | -2.090  | -2.118  | 0.743   | -2.128  | -2.259  | -2.066  | -2.063  | -2.055  |
| 171.56                              | 0.172 | -2.200  | -2.219  | -2.245  | 0.539   | -2.305  | -2.525  | -2.193  | -2.190  | -2.185  |
| 228.75                              | 0.229 | -2.263  | -2.282  | -2.307  | 0.336   | -2.418  | -2.738  | -2.256  | -2.252  | -2.248  |
| 285.94                              | 0.286 | -2.082  | -2.101  | -2.126  | 0.420   | -2.297  | -2.752  | -2.073  | -2.066  | -2.059  |
| 343.13                              | 0.343 | -1.901  | -1.921  | -1.944  | 0.511   | -2.175  | -2.767  | -1.891  | -1.880  | -1.871  |
| 400.32                              | 0.400 | -1.720  | -1.740  | -1.762  | 0.603   | -2.054  | -2.782  | -1.709  | -1.695  | -1.683  |
| 457.5                               | 0.458 | -1.430  | -1.450  | -1.471  | 0.694   | -1.821  | -2.699  | -1.417  | -1.399  | -1.382  |
| 514.69                              | 0.515 | -0.990  | -1.011  | -1.029  | 0.996   | -1.436  | -2.484  | -0.975  | -0.952  | -0.928  |
| 571.88                              | 0.572 | -0.550  | -0.571  | -0.588  | 1.309   | -1.051  | -2.268  | -0.533  | -0.505  | -0.474  |
| 629.07                              | 0.629 | -0.110  | -0.131  | -0.147  | 1.622   | -0.666  | -2.052  | -0.091  | -0.057  | -0.020  |
| 686.25                              | 0.686 | 0.398   | 0.376   | 0.362   | 1.935   | -0.210  | -1.772  | 0.419   | 0.459   | 0.504   |
| 743.44                              | 0.743 | 0.980   | 0.959   | 0.946   | 2.397   | 0.326   | -1.423  | 1.004   | 1.050   | 1.105   |
| 800.63                              | 0.801 | 1.564   | 1.542   | 1.531   | 2.861   | 0.863   | -1.074  | 1.590   | 1.642   | 1.706   |
| 857.82                              | 0.858 | 2.147   | 2.126   | 2.116   | 3.326   | 1.399   | -0.724  | 2.176   | 2.234   | 2.306   |
| 915.01                              | 0.915 | 2.730   | 2.709   | 2.701   | 3.791   | 1.936   | -0.375  | 2.762   | 2.825   | 2.907   |
| 972.19                              | 0.972 | 3.326   | 3.304   | 3.299   | 4.296   | 2.486   | -0.018  | 3.360   | 3.430   | 3.521   |
| 1029.4                              | 1.029 | 3.960   | 3.939   | 3.936   | 4.824   | 3.079   | 0.365   | 3.996   | 4.073   | 4.173   |
| 1086.6                              | 1.087 | 4.595   | 4.574   | 4.573   | 5.353   | 3.673   | 0.748   | 4.633   | 4.716   | 4.826   |
| 1143.8                              | 1.144 | 5.229   | 5.209   | 5.210   | 5.881   | 4.266   | 1.130   | 5.270   | 5.359   | 5.478   |
| 1200.9                              | 1.201 | 5.893   | 5.873   | 5.877   | 6.411   | 4.899   | 1.534   | 5.935   | 6.030   | 6.159   |
| 1258.1                              | 1.258 | 6.574   | 6.555   | 6.563   | 6.940   | 5.557   | 1.952   | 6.618   | 6.719   | 6.857   |
| 1315.3                              | 1.315 | 7.255   | 7.238   | 7.248   | 7.470   | 6.215   | 2.370   | 7.301   | 7.408   | 7.556   |
| 1372.5                              | 1.373 | 7.936   | 7.920   | 7.934   | 8.001   | 6.872   | 2.787   | 7.984   | 8.097   | 8.254   |
| 1429.7                              | 1.430 | 8.591   | 8.577   | 8.596   | 8.511   | 7.569   | 3.458   | 8.639   | 8.756   | 8.919   |
| 1486.9                              | 1.487 | 9.244   | 9.234   | 9.257   | 9.021   | 8.266   | 4.134   | 9.293   | 9.414   | 9.584   |
| 1544.1                              | 1.544 | 9.898   | 9.890   | 9.919   | 9.531   | 8.963   | 4.809   | 9.947   | 10.072  | 10.249  |
| 1601.3                              | 1.601 | 10.552  | 10.546  | 10.580  | 9.991   | 9.660   | 5.485   | 10.602  | 10.730  | 10.913  |
| 1658.4                              | 1.658 | 11.205  | 11.203  | 11.241  | 10.449  | 10.357  | 6.161   | 11.256  | 11.388  | 11.578  |
| 1715.6                              | 1.716 | 11.859  | 11.859  | 11.903  | 10.904  | 11.055  | 6.836   | 11.910  | 12.046  | 12.243  |
| 1772.8                              | 1.773 | 12.478  | 12.482  | 12.531  | 11.281  | 11.759  | 7.661   | 12.529  | 12.668  | 12.869  |
| 1830                                | 1.830 | 13.075  | 13.083  | 13.139  | 11.657  | 12.469  | 8.581   | 13.126  | 13.266  | 13.471  |
| 1887.2                              | 1.887 | 13.672  | 13.684  | 13.746  | 11.989  | 13.179  | 9.500   | 13.722  | 13.865  | 14.072  |
| 1944.4                              | 1.944 | 14.270  | 14.285  | 14.354  | 12.343  | 13.888  | 10.420  | 14.319  | 14.463  | 14.674  |
| 2001.6                              | 2.002 | 14.867  | 14.886  | 14.961  | 12.661  | 14.598  | 11.340  | 14.916  | 15.062  | 15.276  |
| 2058.8                              | 2.059 | 15.456  | 15.480  | 15.561  | 12.978  | 15.306  | 12.264  | 15.505  | 15.652  | 15.870  |
| 2116                                | 2.116 | 15.914  | 15.943  | 16.033  | 13.276  | 15.890  | 13.183  | 15.960  | 16.107  | 16.323  |
| 2173.1                              | 2.173 | 16.371  | 16.406  | 16.503  | 13.520  | 16.474  | 14.103  | 16.415  | 16.560  | 16.776  |
| 2230.3                              | 2.230 | 16.828  | 16.868  | 16.974  | 13.706  | 17.057  | 15.022  | 16.870  | 17.014  | 17.229  |
| 2287.5                              | 2.288 | 17.285  | 17.331  | 17.444  | 13.893  | 17.641  | 15.942  | 17.325  | 17.468  | 17.681  |
| 2344.7                              | 2.345 | 17.510  | 17.564  | 17.688  | 14.080  | 17.915  | 16.557  | 17.546  | 17.683  | 17.888  |
| 2401.9                              | 2.402 | 17.724  | 17.786  | 17.921  | 14.062  | 18.174  | 17.156  | 17.755  | 17.886  | 18.083  |
| 2459.1                              | 2.459 | 17.938  | 18.008  | 18.153  | 14.033  | 18.433  | 17.756  | 17.964  | 18.089  | 18.278  |
| 2516.3                              | 2.516 | 18.152  | 18.231  | 18.386  | 14.004  | 18.691  | 18.355  | 18.174  | 18.292  | 18.472  |
| 2573.5                              | 2.574 | 18.079  | 18.168  | 18.337  | 13.860  | 18.452  | 18.160  | 18.093  | 18.200  | 18.362  |
| 2630.6                              | 2.631 | 17.999  | 18.099  | 18.281  | 13.588  | 18.200  | 17.945  | 18.006  | 18.100  | 18.245  |
| 2687.8                              | 2.688 | 17.919  | 18.029  | 18.224  | 13.316  | 17.948  | 17.730  | 17.918  | 18.001  | 18.128  |
| 2745                                | 2.745 | 17.839  | 17.960  | 18.168  | 13.044  | 17.695  | 17.515  | 17.830  | 17.901  | 18.011  |



| STIFFENER 2 in S## - Transversal direction |       |          |          |          |          |          |          |          |          |          |
|--------------------------------------------|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                         | m     | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                          | 0.000 | -1.809   | -1.798   | -1.779   | -1.815   | -1.831   | -1.845   | -1.804   | -1.772   | -1.710   |
| 57.188                                     | 0.057 | -1.948   | -1.974   | -2.041   | -1.943   | -1.958   | -1.974   | -1.943   | -1.949   | -1.983   |
| 114.38                                     | 0.114 | -2.087   | -2.150   | -2.304   | -2.070   | -2.086   | -2.103   | -2.081   | -2.125   | -2.256   |
| 171.56                                     | 0.172 | -2.226   | -2.327   | -2.567   | -2.198   | -2.213   | -2.232   | -2.220   | -2.302   | -2.529   |
| 228.75                                     | 0.229 | -2.300   | -2.440   | -2.777   | -2.261   | -2.275   | -2.293   | -2.294   | -2.416   | -2.748   |
| 285.94                                     | 0.286 | -2.131   | -2.318   | -2.788   | -2.079   | -2.090   | -2.104   | -2.123   | -2.291   | -2.762   |
| 343.13                                     | 0.343 | -1.962   | -2.196   | -2.799   | -1.896   | -1.904   | -1.914   | -1.953   | -2.166   | -2.777   |
| 400.32                                     | 0.400 | -1.792   | -2.075   | -2.810   | -1.714   | -1.719   | -1.724   | -1.782   | -2.041   | -2.792   |
| 457.5                                      | 0.458 | -1.513   | -1.842   | -2.724   | -1.423   | -1.423   | -1.422   | -1.501   | -1.803   | -2.707   |
| 514.69                                     | 0.515 | -1.082   | -1.456   | -2.505   | -0.981   | -0.976   | -0.966   | -1.069   | -1.412   | -2.485   |
| 571.88                                     | 0.572 | -0.652   | -1.071   | -2.286   | -0.539   | -0.529   | -0.510   | -0.636   | -1.021   | -2.263   |
| 629.07                                     | 0.629 | -0.221   | -0.686   | -2.067   | -0.097   | -0.082   | -0.054   | -0.204   | -0.630   | -2.041   |
| 686.25                                     | 0.686 | 0.278    | -0.229   | -1.784   | 0.413    | 0.434    | 0.472    | 0.298    | -0.166   | -1.753   |
| 743.44                                     | 0.743 | 0.854    | 0.307    | -1.431   | 0.997    | 1.025    | 1.074    | 0.876    | 0.378    | -1.393   |
| 800.63                                     | 0.801 | 1.431    | 0.843    | -1.079   | 1.583    | 1.617    | 1.678    | 1.455    | 0.922    | -1.034   |
| 857.82                                     | 0.858 | 2.007    | 1.380    | -0.726   | 2.168    | 2.209    | 2.281    | 2.034    | 1.466    | -0.674   |
| 915.01                                     | 0.915 | 2.584    | 1.917    | -0.373   | 2.754    | 2.801    | 2.884    | 2.613    | 2.010    | -0.315   |
| 972.19                                     | 0.972 | 3.173    | 2.467    | -0.012   | 3.352    | 3.405    | 3.500    | 3.204    | 2.569    | 0.053    |
| 1029.4                                     | 1.029 | 3.804    | 3.061    | 0.374    | 3.988    | 4.049    | 4.156    | 3.837    | 3.171    | 0.447    |
| 1086.6                                     | 1.087 | 4.434    | 3.655    | 0.760    | 4.625    | 4.692    | 4.812    | 4.469    | 3.773    | 0.841    |
| 1143.8                                     | 1.144 | 5.064    | 4.248    | 1.146    | 5.261    | 5.336    | 5.468    | 5.102    | 4.375    | 1.235    |
| 1200.9                                     | 1.201 | 5.727    | 4.882    | 1.554    | 5.927    | 6.008    | 6.153    | 5.767    | 5.017    | 1.651    |
| 1258.1                                     | 1.258 | 6.410    | 5.540    | 1.975    | 6.610    | 6.698    | 6.857    | 6.452    | 5.684    | 2.082    |
| 1315.3                                     | 1.315 | 7.093    | 6.198    | 2.396    | 7.293    | 7.389    | 7.560    | 7.136    | 6.351    | 2.512    |
| 1372.5                                     | 1.373 | 7.777    | 6.856    | 2.817    | 7.976    | 8.080    | 8.264    | 7.821    | 7.018    | 2.942    |
| 1429.7                                     | 1.430 | 8.446    | 7.555    | 3.493    | 8.631    | 8.742    | 8.937    | 8.492    | 7.721    | 3.628    |
| 1486.9                                     | 1.487 | 9.116    | 8.255    | 4.173    | 9.286    | 9.403    | 9.610    | 9.162    | 8.425    | 4.318    |
| 1544.1                                     | 1.544 | 9.785    | 8.954    | 4.854    | 9.941    | 10.065   | 10.283   | 9.833    | 9.129    | 5.008    |
| 1601.3                                     | 1.601 | 10.455   | 9.654    | 5.534    | 10.596   | 10.726   | 10.956   | 10.503   | 9.833    | 5.698    |
| 1658.4                                     | 1.658 | 11.125   | 10.353   | 6.215    | 11.251   | 11.388   | 11.629   | 11.174   | 10.538   | 6.388    |
| 1715.6                                     | 1.716 | 11.794   | 11.053   | 6.895    | 11.906   | 12.050   | 12.302   | 11.844   | 11.242   | 7.078    |
| 1772.8                                     | 1.773 | 12.436   | 11.761   | 7.725    | 12.526   | 12.676   | 12.939   | 12.486   | 11.952   | 7.918    |
| 1830                                       | 1.830 | 13.059   | 12.475   | 8.651    | 13.123   | 13.279   | 13.552   | 13.109   | 12.666   | 8.853    |
| 1887.2                                     | 1.887 | 13.682   | 13.188   | 9.577    | 13.721   | 13.882   | 14.165   | 13.732   | 13.380   | 9.788    |
| 1944.4                                     | 1.944 | 14.305   | 13.902   | 10.503   | 14.319   | 14.486   | 14.777   | 14.355   | 14.094   | 10.724   |
| 2001.6                                     | 2.002 | 14.929   | 14.616   | 11.429   | 14.916   | 15.089   | 15.390   | 14.978   | 14.808   | 11.659   |
| 2058.8                                     | 2.059 | 15.544   | 15.328   | 12.358   | 15.506   | 15.685   | 15.995   | 15.594   | 15.520   | 12.598   |
| 2116                                       | 2.116 | 16.016   | 15.919   | 13.289   | 15.964   | 16.147   | 16.463   | 16.064   | 16.105   | 13.535   |
| 2173.1                                     | 2.173 | 16.487   | 16.509   | 14.219   | 16.420   | 16.607   | 16.930   | 16.533   | 16.690   | 14.472   |
| 2230.3                                     | 2.230 | 16.957   | 17.099   | 15.149   | 16.876   | 17.068   | 17.397   | 17.001   | 17.274   | 15.409   |
| 2287.5                                     | 2.288 | 17.428   | 17.689   | 16.079   | 17.333   | 17.528   | 17.863   | 17.470   | 17.859   | 16.345   |
| 2344.7                                     | 2.345 | 17.647   | 17.973   | 16.716   | 17.556   | 17.753   | 18.089   | 17.685   | 18.126   | 16.963   |
| 2401.9                                     | 2.402 | 17.853   | 18.243   | 17.338   | 17.768   | 17.967   | 18.303   | 17.886   | 18.377   | 17.564   |
| 2459.1                                     | 2.459 | 18.059   | 18.512   | 17.960   | 17.980   | 18.180   | 18.517   | 18.087   | 18.628   | 18.165   |
| 2516.3                                     | 2.516 | 18.265   | 18.782   | 18.582   | 18.191   | 18.393   | 18.730   | 18.289   | 18.878   | 18.765   |
| 2573.5                                     | 2.574 | 18.162   | 18.558   | 18.416   | 18.114   | 18.314   | 18.644   | 18.178   | 18.618   | 18.528   |
| 2630.6                                     | 2.631 | 18.052   | 18.322   | 18.232   | 18.030   | 18.228   | 18.551   | 18.060   | 18.345   | 18.270   |
| 2687.8                                     | 2.688 | 17.941   | 18.085   | 18.047   | 17.946   | 18.142   | 18.458   | 17.941   | 18.071   | 18.012   |
| 2745                                       | 2.745 | 17.830   | 17.849   | 17.863   | 17.861   | 18.055   | 18.365   | 17.822   | 17.798   | 17.754   |

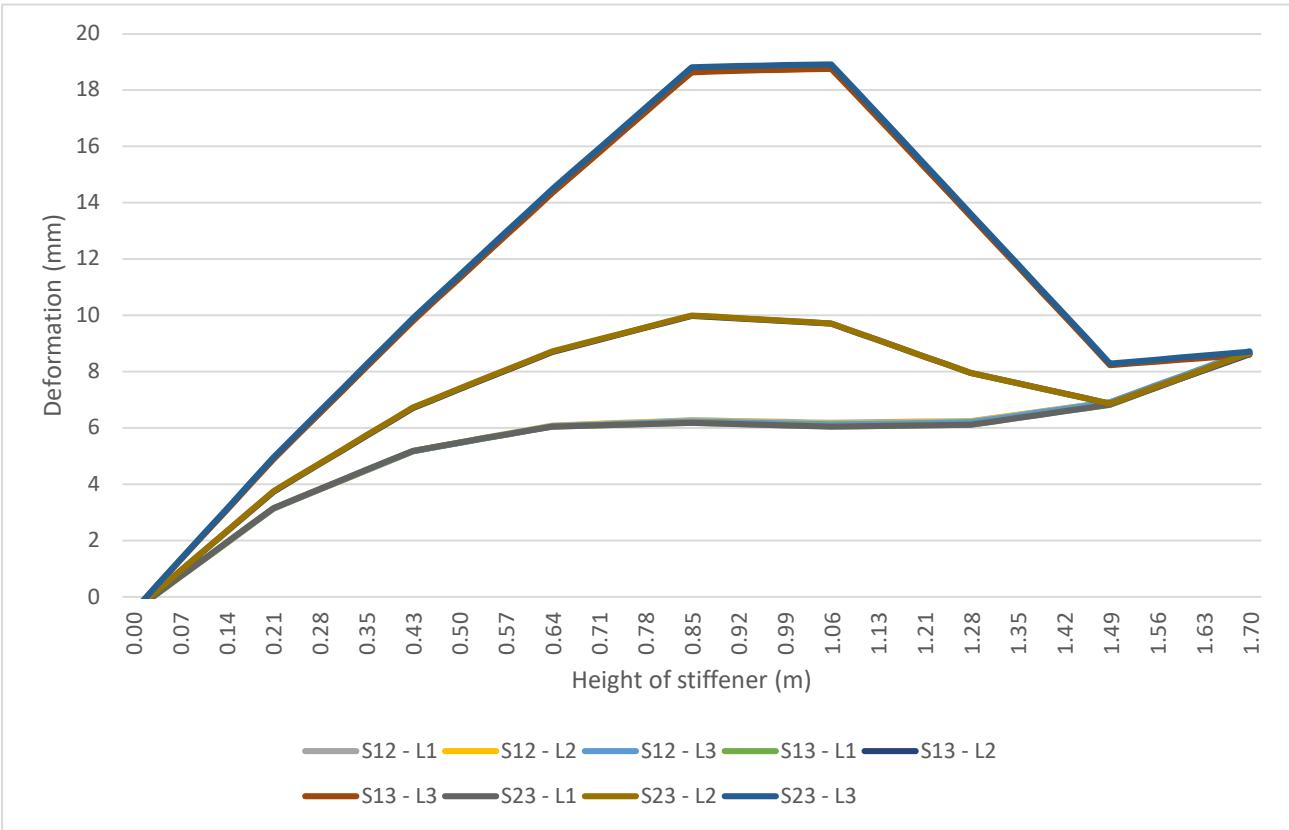


| STIFFENER 2 in S1,2 & 3 - Transversal direction |       |           |           |           |
|-------------------------------------------------|-------|-----------|-----------|-----------|
| mm                                              | m     | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                               | 0.000 | -1.808    | -1.788    | -1.762    |
| 57.188                                          | 0.057 | -1.947    | -1.994    | -2.031    |
| 114.38                                          | 0.114 | -2.086    | -2.200    | -2.301    |
| 171.56                                          | 0.172 | -2.225    | -2.405    | -2.570    |
| 228.75                                          | 0.229 | -2.298    | -2.549    | -2.785    |
| 285.94                                          | 0.286 | -2.128    | -2.460    | -2.796    |
| 343.13                                          | 0.343 | -1.957    | -2.372    | -2.806    |
| 400.32                                          | 0.400 | -1.787    | -2.283    | -2.817    |
| 457.5                                           | 0.458 | -1.506    | -2.084    | -2.728    |
| 514.69                                          | 0.515 | -1.074    | -1.733    | -2.501    |
| 571.88                                          | 0.572 | -0.642    | -1.382    | -2.275    |
| 629.07                                          | 0.629 | -0.210    | -1.031    | -2.048    |
| 686.25                                          | 0.686 | 0.292     | -0.608    | -1.756    |
| 743.44                                          | 0.743 | 0.870     | -0.106    | -1.392    |
| 800.63                                          | 0.801 | 1.449     | 0.397     | -1.028    |
| 857.82                                          | 0.858 | 2.027     | 0.900     | -0.664    |
| 915.01                                          | 0.915 | 2.606     | 1.403     | -0.299    |
| 972.19                                          | 0.972 | 3.198     | 1.920     | 0.073     |
| 1029.4                                          | 1.029 | 3.830     | 2.483     | 0.472     |
| 1086.6                                          | 1.087 | 4.462     | 3.046     | 0.870     |
| 1143.8                                          | 1.144 | 5.095     | 3.609     | 1.269     |
| 1200.9                                          | 1.201 | 5.760     | 4.216     | 1.690     |
| 1258.1                                          | 1.258 | 6.445     | 4.849     | 2.126     |
| 1315.3                                          | 1.315 | 7.130     | 5.483     | 2.561     |
| 1372.5                                          | 1.373 | 7.815     | 6.117     | 2.996     |
| 1429.7                                          | 1.430 | 8.486     | 6.855     | 3.688     |
| 1486.9                                          | 1.487 | 9.157     | 7.595     | 4.383     |
| 1544.1                                          | 1.544 | 9.828     | 8.335     | 5.079     |
| 1601.3                                          | 1.601 | 10.499    | 9.076     | 5.775     |
| 1658.4                                          | 1.658 | 11.170    | 9.816     | 6.471     |
| 1715.6                                          | 1.716 | 11.841    | 10.557    | 7.167     |
| 1772.8                                          | 1.773 | 12.483    | 11.344    | 8.012     |
| 1830                                            | 1.830 | 13.107    | 12.160    | 8.954     |
| 1887.2                                          | 1.887 | 13.731    | 12.977    | 9.896     |
| 1944.4                                          | 1.944 | 14.355    | 13.794    | 10.839    |
| 2001.6                                          | 2.002 | 14.979    | 14.610    | 11.781    |
| 2058.8                                          | 2.059 | 15.596    | 15.425    | 12.726    |
| 2116                                            | 2.116 | 16.067    | 16.093    | 13.674    |
| 2173.1                                          | 2.173 | 16.537    | 16.760    | 14.623    |
| 2230.3                                          | 2.230 | 17.008    | 17.427    | 15.571    |
| 2287.5                                          | 2.288 | 17.478    | 18.094    | 16.518    |
| 2344.7                                          | 2.345 | 17.695    | 18.398    | 17.157    |
| 2401.9                                          | 2.402 | 17.898    | 18.684    | 17.779    |
| 2459.1                                          | 2.459 | 18.102    | 18.970    | 18.402    |
| 2516.3                                          | 2.516 | 18.306    | 19.255    | 19.024    |
| 2573.5                                          | 2.574 | 18.199    | 18.964    | 18.813    |
| 2630.6                                          | 2.631 | 18.084    | 18.660    | 18.582    |
| 2687.8                                          | 2.688 | 17.969    | 18.354    | 18.350    |
| 2745                                            | 2.745 | 17.853    |           | 18.119    |

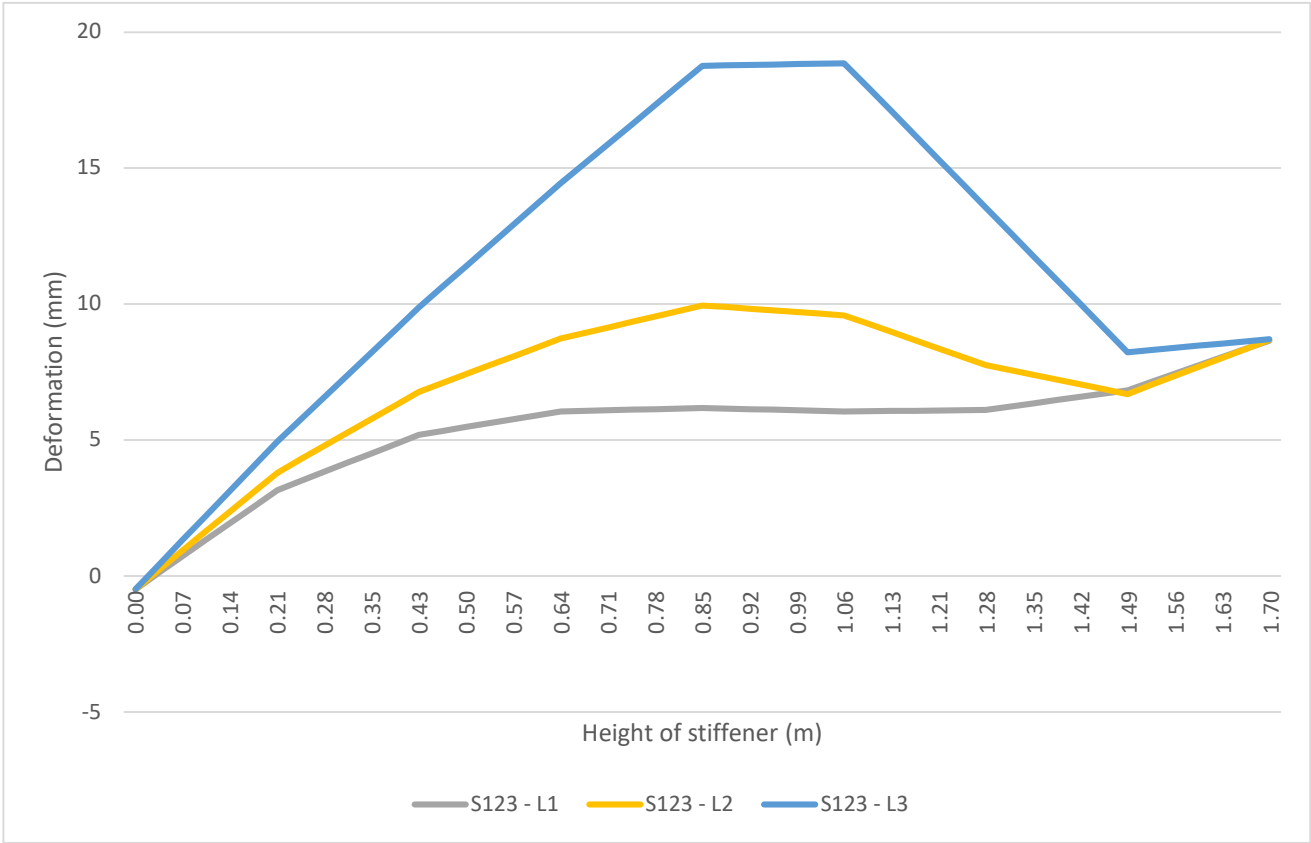


| STIFFENER 3 - Transversal direction |       |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                   | 0.000 | -0.488  | -0.489  | -0.491  | -0.487  | -0.485  | -0.481  | -0.487  | -0.488  | -0.486  |
| 35.449                              | 0.035 | 0.117   | 0.115   | 0.112   | 0.118   | 0.121   | 0.126   | 0.122   | 0.219   | 0.414   |
| 70.897                              | 0.071 | 0.719   | 0.717   | 0.713   | 0.720   | 0.724   | 0.730   | 0.728   | 0.923   | 1.311   |
| 106.35                              | 0.106 | 1.321   | 1.319   | 1.315   | 1.323   | 1.327   | 1.335   | 1.334   | 1.626   | 2.209   |
| 141.79                              | 0.142 | 1.924   | 1.921   | 1.916   | 1.926   | 1.930   | 1.940   | 1.939   | 2.330   | 3.107   |
| 177.24                              | 0.177 | 2.526   | 2.523   | 2.517   | 2.528   | 2.534   | 2.544   | 2.544   | 3.033   | 4.005   |
| 212.69                              | 0.213 | 3.132   | 3.128   | 3.122   | 3.135   | 3.141   | 3.153   | 3.152   | 3.739   | 4.905   |
| 248.14                              | 0.248 | 3.473   | 3.469   | 3.462   | 3.475   | 3.481   | 3.493   | 3.493   | 4.235   | 5.723   |
| 283.59                              | 0.284 | 3.814   | 3.809   | 3.801   | 3.816   | 3.821   | 3.833   | 3.833   | 4.731   | 6.542   |
| 319.04                              | 0.319 | 4.155   | 4.150   | 4.141   | 4.157   | 4.161   | 4.173   | 4.172   | 5.227   | 7.362   |
| 354.49                              | 0.354 | 4.495   | 4.490   | 4.480   | 4.498   | 4.501   | 4.513   | 4.510   | 5.723   | 8.182   |
| 389.93                              | 0.390 | 4.836   | 4.830   | 4.820   | 4.838   | 4.841   | 4.853   | 4.848   | 6.219   | 9.003   |
| 425.38                              | 0.425 | 5.177   | 5.171   | 5.159   | 5.179   | 5.181   | 5.192   | 5.186   | 6.715   | 9.824   |
| 460.83                              | 0.461 | 5.333   | 5.327   | 5.315   | 5.335   | 5.336   | 5.346   | 5.337   | 7.053   | 10.584  |
| 496.28                              | 0.496 | 5.484   | 5.477   | 5.464   | 5.485   | 5.485   | 5.494   | 5.481   | 7.386   | 11.342  |
| 531.73                              | 0.532 | 5.634   | 5.627   | 5.613   | 5.635   | 5.634   | 5.642   | 5.625   | 7.718   | 12.101  |
| 567.18                              | 0.567 | 5.785   | 5.777   | 5.762   | 5.786   | 5.783   | 5.790   | 5.768   | 8.051   | 12.861  |
| 602.63                              | 0.603 | 5.935   | 5.927   | 5.912   | 5.936   | 5.932   | 5.939   | 5.911   | 8.384   | 13.622  |
| 638.08                              | 0.638 | 6.086   | 6.077   | 6.061   | 6.086   | 6.081   | 6.087   | 6.053   | 8.716   | 14.383  |
| 673.52                              | 0.674 | 6.121   | 6.112   | 6.095   | 6.121   | 6.115   | 6.119   | 6.078   | 8.933   | 15.100  |
| 708.97                              | 0.709 | 6.152   | 6.143   | 6.125   | 6.152   | 6.145   | 6.148   | 6.099   | 9.147   | 15.817  |
| 744.42                              | 0.744 | 6.184   | 6.175   | 6.156   | 6.183   | 6.175   | 6.177   | 6.121   | 9.360   | 16.535  |
| 779.87                              | 0.780 | 6.216   | 6.206   | 6.187   | 6.215   | 6.205   | 6.206   | 6.142   | 9.574   | 17.253  |
| 815.32                              | 0.815 | 6.247   | 6.237   | 6.217   | 6.246   | 6.235   | 6.235   | 6.166   | 9.788   | 17.970  |
| 850.77                              | 0.851 | 6.279   | 6.269   | 6.248   | 6.277   | 6.266   | 6.264   | 6.190   | 10.002  | 18.687  |
| 886.22                              | 0.886 | 6.264   | 6.254   | 6.233   | 6.263   | 6.250   | 6.248   | 6.168   | 9.961   | 18.722  |
| 921.66                              | 0.922 | 6.249   | 6.239   | 6.217   | 6.247   | 6.234   | 6.232   | 6.146   | 9.914   | 18.742  |
| 957.11                              | 0.957 | 6.233   | 6.223   | 6.201   | 6.231   | 6.218   | 6.215   | 6.124   | 9.867   | 18.762  |
| 992.56                              | 0.993 | 6.218   | 6.207   | 6.185   | 6.216   | 6.202   | 6.198   | 6.102   | 9.821   | 18.783  |
| 1028                                | 1.028 | 6.203   | 6.192   | 6.170   | 6.200   | 6.186   | 6.182   | 6.080   | 9.775   | 18.803  |
| 1063.5                              | 1.064 | 6.187   | 6.176   | 6.154   | 6.185   | 6.170   | 6.165   | 6.059   | 9.729   | 18.824  |
| 1098.9                              | 1.099 | 6.197   | 6.186   | 6.164   | 6.195   | 6.181   | 6.177   | 6.067   | 9.440   | 17.967  |
| 1134.4                              | 1.134 | 6.208   | 6.197   | 6.175   | 6.206   | 6.192   | 6.189   | 6.076   | 9.148   | 17.093  |
| 1169.8                              | 1.170 | 6.218   | 6.208   | 6.186   | 6.216   | 6.204   | 6.201   | 6.086   | 8.855   | 16.219  |
| 1205.3                              | 1.205 | 6.229   | 6.218   | 6.197   | 6.227   | 6.215   | 6.213   | 6.097   | 8.563   | 15.343  |
| 1240.7                              | 1.241 | 6.239   | 6.229   | 6.208   | 6.238   | 6.227   | 6.225   | 6.108   | 8.272   | 14.467  |
| 1276.2                              | 1.276 | 6.250   | 6.240   | 6.219   | 6.249   | 6.238   | 6.237   | 6.119   | 7.980   | 13.591  |
| 1311.6                              | 1.312 | 6.360   | 6.350   | 6.330   | 6.360   | 6.351   | 6.353   | 6.236   | 7.796   | 12.708  |
| 1347                                | 1.347 | 6.471   | 6.462   | 6.443   | 6.472   | 6.466   | 6.470   | 6.354   | 7.612   | 11.825  |
| 1382.5                              | 1.383 | 6.582   | 6.573   | 6.556   | 6.584   | 6.581   | 6.588   | 6.473   | 7.429   | 10.942  |
| 1417.9                              | 1.418 | 6.694   | 6.685   | 6.669   | 6.696   | 6.695   | 6.705   | 6.591   | 7.246   | 10.059  |
| 1453.4                              | 1.453 | 6.805   | 6.797   | 6.781   | 6.808   | 6.810   | 6.822   | 6.710   | 7.063   | 9.176   |
| 1488.8                              | 1.489 | 6.915   | 6.907   | 6.893   | 6.919   | 6.923   | 6.938   | 6.827   | 6.877   | 8.284   |
| 1524.3                              | 1.524 | 7.204   | 7.197   | 7.185   | 7.209   | 7.218   | 7.239   | 7.131   | 7.168   | 8.339   |
| 1559.7                              | 1.560 | 7.493   | 7.487   | 7.477   | 7.500   | 7.514   | 7.540   | 7.435   | 7.459   | 8.393   |
| 1595.2                              | 1.595 | 7.783   | 7.777   | 7.769   | 7.790   | 7.809   | 7.841   | 7.739   | 7.749   | 8.447   |
| 1630.6                              | 1.631 | 8.072   | 8.067   | 8.061   | 8.081   | 8.104   | 8.142   | 8.042   | 8.040   | 8.501   |
| 1666.1                              | 1.666 | 8.361   | 8.357   | 8.352   | 8.371   | 8.400   | 8.442   | 8.345   | 8.329   | 8.555   |
| 1701.5                              | 1.702 | 8.650   | 8.646   | 8.644   | 8.662   | 8.694   | 8.743   | 8.648   | 8.618   | 8.606   |





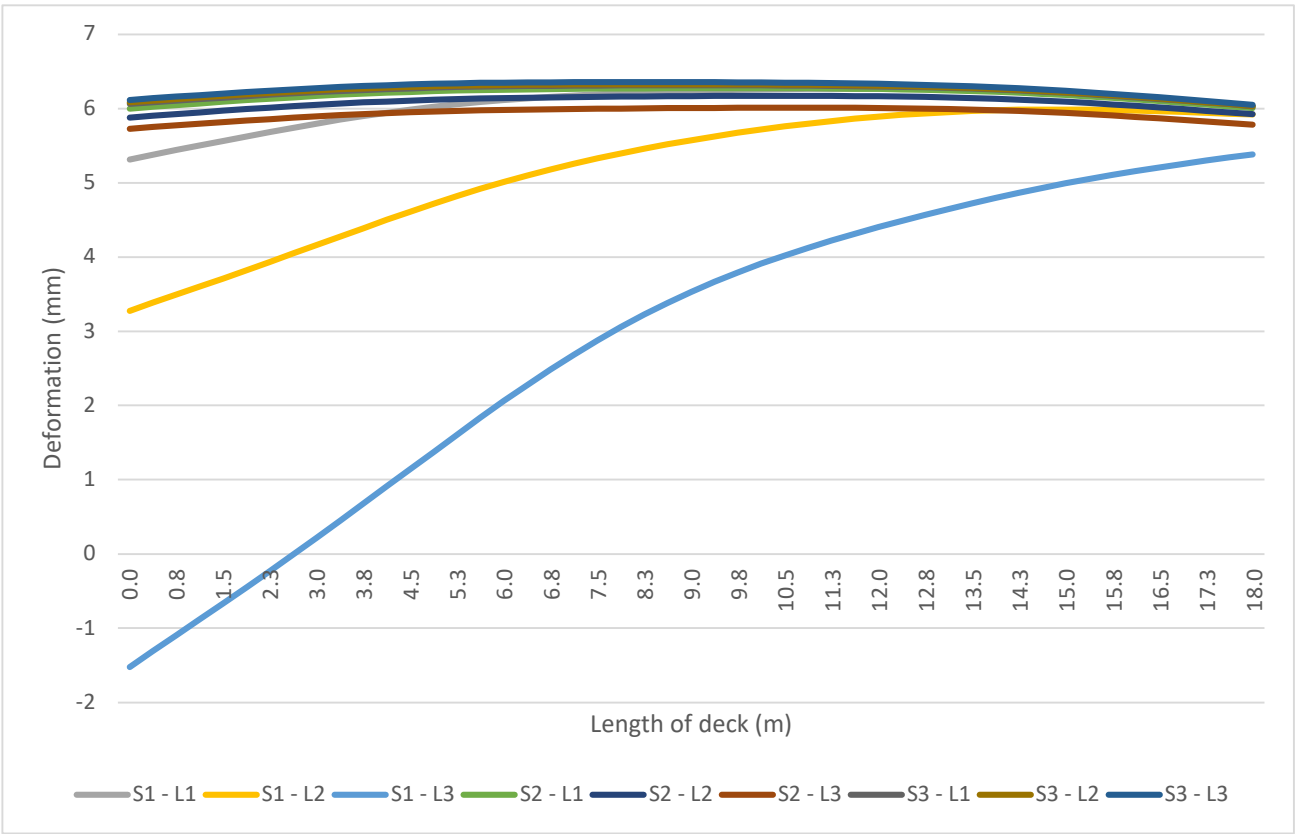
| STIFFENER 3 in S## - Transversal direction |       |          |          |          |          |          |          |          |          |          |
|--------------------------------------------|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                         | m     | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                          | 0.000 | -0.487   | -0.486   | -0.485   | -0.488   | -0.489   | -0.490   | -0.487   | -0.485   | -0.480   |
| 35.449                                     | 0.035 | 0.117    | 0.118    | 0.121    | 0.121    | 0.216    | 0.408    | 0.122    | 0.223    | 0.427    |
| 70.897                                     | 0.071 | 0.720    | 0.721    | 0.724    | 0.727    | 0.920    | 1.304    | 0.729    | 0.929    | 1.331    |
| 106.35                                     | 0.106 | 1.322    | 1.324    | 1.328    | 1.333    | 1.623    | 2.200    | 1.335    | 1.634    | 2.236    |
| 141.79                                     | 0.142 | 1.925    | 1.927    | 1.931    | 1.939    | 2.325    | 3.096    | 1.941    | 2.339    | 3.140    |
| 177.24                                     | 0.177 | 2.527    | 2.529    | 2.534    | 2.543    | 3.028    | 3.993    | 2.546    | 3.043    | 4.045    |
| 212.69                                     | 0.213 | 3.134    | 3.136    | 3.142    | 3.151    | 3.733    | 4.891    | 3.154    | 3.751    | 4.952    |
| 248.14                                     | 0.248 | 3.474    | 3.475    | 3.480    | 3.492    | 4.228    | 5.707    | 3.494    | 4.247    | 5.775    |
| 283.59                                     | 0.284 | 3.815    | 3.815    | 3.819    | 3.831    | 4.724    | 6.524    | 3.834    | 4.743    | 6.599    |
| 319.04                                     | 0.319 | 4.155    | 4.154    | 4.157    | 4.170    | 5.219    | 7.342    | 4.173    | 5.239    | 7.424    |
| 354.49                                     | 0.354 | 4.496    | 4.494    | 4.495    | 4.508    | 5.714    | 8.161    | 4.510    | 5.735    | 8.250    |
| 389.93                                     | 0.390 | 4.836    | 4.833    | 4.834    | 4.846    | 6.209    | 8.980    | 4.848    | 6.231    | 9.076    |
| 425.38                                     | 0.425 | 5.177    | 5.173    | 5.172    | 5.184    | 6.704    | 9.799    | 5.186    | 6.727    | 9.902    |
| 460.83                                     | 0.461 | 5.333    | 5.327    | 5.325    | 5.334    | 7.041    | 10.556   | 5.336    | 7.064    | 10.665   |
| 496.28                                     | 0.496 | 5.483    | 5.476    | 5.472    | 5.479    | 7.373    | 11.313   | 5.480    | 7.395    | 11.428   |
| 531.73                                     | 0.532 | 5.633    | 5.624    | 5.618    | 5.622    | 7.705    | 12.070   | 5.623    | 7.727    | 12.191   |
| 567.18                                     | 0.567 | 5.783    | 5.773    | 5.765    | 5.765    | 8.037    | 12.828   | 5.766    | 8.059    | 12.955   |
| 602.63                                     | 0.603 | 5.933    | 5.921    | 5.911    | 5.908    | 8.369    | 13.586   | 5.908    | 8.390    | 13.719   |
| 638.08                                     | 0.638 | 6.083    | 6.070    | 6.058    | 6.051    | 8.701    | 14.345   | 6.050    | 8.722    | 14.484   |
| 673.52                                     | 0.674 | 6.118    | 6.103    | 6.089    | 6.075    | 8.917    | 15.060   | 6.074    | 8.937    | 15.205   |
| 708.97                                     | 0.709 | 6.149    | 6.132    | 6.117    | 6.096    | 9.129    | 15.775   | 6.095    | 9.149    | 15.925   |
| 744.42                                     | 0.744 | 6.180    | 6.162    | 6.145    | 6.118    | 9.342    | 16.491   | 6.116    | 9.361    | 16.646   |
| 779.87                                     | 0.780 | 6.212    | 6.192    | 6.173    | 6.139    | 9.555    | 17.207   | 6.137    | 9.573    | 17.367   |
| 815.32                                     | 0.815 | 6.243    | 6.222    | 6.201    | 6.163    | 9.768    | 17.921   | 6.161    | 9.785    | 18.087   |
| 850.77                                     | 0.851 | 6.274    | 6.252    | 6.229    | 6.186    | 9.981    | 18.636   | 6.184    | 9.998    | 18.808   |
| 886.22                                     | 0.886 | 6.259    | 6.236    | 6.213    | 6.165    | 9.940    | 18.669   | 6.162    | 9.954    | 18.839   |
| 921.66                                     | 0.922 | 6.244    | 6.220    | 6.196    | 6.142    | 9.892    | 18.687   | 6.139    | 9.905    | 18.855   |
| 957.11                                     | 0.957 | 6.228    | 6.204    | 6.178    | 6.120    | 9.845    | 18.706   | 6.117    | 9.856    | 18.871   |
| 992.56                                     | 0.993 | 6.212    | 6.188    | 6.161    | 6.098    | 9.798    | 18.724   | 6.095    | 9.807    | 18.888   |
| 1028                                       | 1.028 | 6.197    | 6.171    | 6.144    | 6.077    | 9.751    | 18.742   | 6.073    | 9.759    | 18.904   |
| 1063.5                                     | 1.064 | 6.181    | 6.155    | 6.127    | 6.055    | 9.704    | 18.761   | 6.052    | 9.711    | 18.921   |
| 1098.9                                     | 1.099 | 6.191    | 6.166    | 6.139    | 6.064    | 9.416    | 17.903   | 6.060    | 9.421    | 18.052   |
| 1134.4                                     | 1.134 | 6.202    | 6.178    | 6.152    | 6.073    | 9.123    | 17.028   | 6.070    | 9.127    | 17.168   |
| 1169.8                                     | 1.170 | 6.213    | 6.189    | 6.164    | 6.082    | 8.831    | 16.154   | 6.080    | 8.833    | 16.283   |
| 1205.3                                     | 1.205 | 6.224    | 6.201    | 6.177    | 6.093    | 8.539    | 15.277   | 6.091    | 8.540    | 15.396   |
| 1240.7                                     | 1.241 | 6.235    | 6.213    | 6.189    | 6.104    | 8.247    | 14.400   | 6.102    | 8.247    | 14.509   |
| 1276.2                                     | 1.276 | 6.245    | 6.224    | 6.202    | 6.115    | 7.956    | 13.522   | 6.113    | 7.955    | 13.622   |
| 1311.6                                     | 1.312 | 6.356    | 6.338    | 6.319    | 6.232    | 7.773    | 12.642   | 6.231    | 7.772    | 12.734   |
| 1347                                       | 1.347 | 6.469    | 6.453    | 6.438    | 6.351    | 7.590    | 11.762   | 6.351    | 7.592    | 11.847   |
| 1382.5                                     | 1.383 | 6.581    | 6.568    | 6.557    | 6.470    | 7.408    | 10.881   | 6.470    | 7.411    | 10.959   |
| 1417.9                                     | 1.418 | 6.693    | 6.683    | 6.676    | 6.588    | 7.226    | 10.000   | 6.590    | 7.231    | 10.071   |
| 1453.4                                     | 1.453 | 6.805    | 6.798    | 6.795    | 6.707    | 7.045    | 9.119    | 6.709    | 7.050    | 9.183    |
| 1488.8                                     | 1.489 | 6.916    | 6.912    | 6.912    | 6.824    | 6.859    | 8.230    | 6.827    | 6.866    | 8.286    |
| 1524.3                                     | 1.524 | 7.207    | 7.208    | 7.216    | 7.129    | 7.152    | 8.293    | 7.133    | 7.167    | 8.357    |
| 1559.7                                     | 1.560 | 7.498    | 7.505    | 7.520    | 7.433    | 7.446    | 8.356    | 7.439    | 7.467    | 8.428    |
| 1595.2                                     | 1.595 | 7.789    | 7.801    | 7.824    | 7.737    | 7.739    | 8.419    | 7.745    | 7.767    | 8.498    |
| 1630.6                                     | 1.631 | 8.079    | 8.098    | 8.128    | 8.041    | 8.032    | 8.481    | 8.050    | 8.067    | 8.568    |
| 1666.1                                     | 1.666 | 8.370    | 8.394    | 8.432    | 8.344    | 8.324    | 8.543    | 8.355    | 8.366    | 8.638    |
| 1701.5                                     | 1.702 | 8.661    | 8.690    | 8.735    | 8.647    | 8.615    | 8.603    | 8.659    | 8.664    | 8.706    |



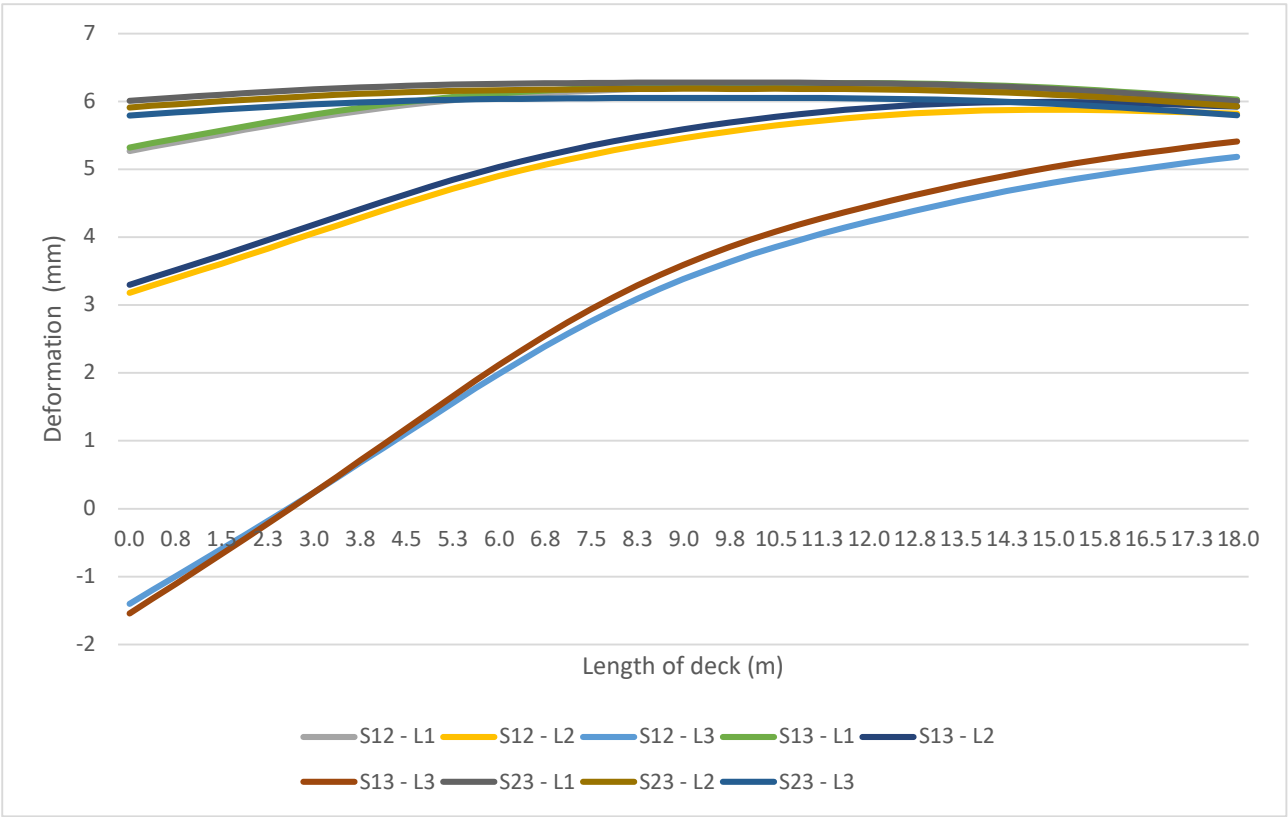
| STIFFENER 3 in S1,2 & 3 - Transversal direction |       |           |           |           |
|-------------------------------------------------|-------|-----------|-----------|-----------|
| mm                                              | m     | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                               | 0.000 | -0.487    | -0.487    | -0.484    |
| 35.449                                          | 0.035 | 0.122     | 0.229     | 0.421     |
| 70.897                                          | 0.071 | 0.728     | 0.942     | 1.324     |
| 106.35                                          | 0.106 | 1.334     | 1.654     | 2.227     |
| 141.79                                          | 0.142 | 1.940     | 2.367     | 3.130     |
| 177.24                                          | 0.177 | 2.545     | 3.078     | 4.033     |
| 212.69                                          | 0.213 | 3.153     | 3.793     | 4.938     |
| 248.14                                          | 0.248 | 3.493     | 4.288     | 5.759     |
| 283.59                                          | 0.284 | 3.833     | 4.784     | 6.581     |
| 319.04                                          | 0.319 | 4.171     | 5.280     | 7.404     |
| 354.49                                          | 0.354 | 4.509     | 5.776     | 8.228     |
| 389.93                                          | 0.390 | 4.846     | 6.271     | 9.052     |
| 425.38                                          | 0.425 | 5.184     | 6.766     | 9.876     |
| 460.83                                          | 0.461 | 5.334     | 7.098     | 10.637    |
| 496.28                                          | 0.496 | 5.477     | 7.423     | 11.397    |
| 531.73                                          | 0.532 | 5.621     | 7.749     | 12.158    |
| 567.18                                          | 0.567 | 5.763     | 8.075     | 12.920    |
| 602.63                                          | 0.603 | 5.906     | 8.401     | 13.682    |
| 638.08                                          | 0.638 | 6.047     | 8.727     | 14.446    |
| 673.52                                          | 0.674 | 6.072     | 8.933     | 15.164    |
| 708.97                                          | 0.709 | 6.092     | 9.136     | 15.882    |
| 744.42                                          | 0.744 | 6.113     | 9.340     | 16.600    |
| 779.87                                          | 0.780 | 6.134     | 9.543     | 17.320    |
| 815.32                                          | 0.815 | 6.157     | 9.746     | 18.037    |
| 850.77                                          | 0.851 | 6.180     | 9.949     | 18.756    |
| 886.22                                          | 0.886 | 6.158     | 9.893     | 18.785    |
| 921.66                                          | 0.922 | 6.136     | 9.831     | 18.798    |
| 957.11                                          | 0.957 | 6.114     | 9.769     | 18.812    |
| 992.56                                          | 0.993 | 6.091     | 9.707     | 18.826    |
| 1028                                            | 1.028 | 6.070     | 9.646     | 18.841    |
| 1063.5                                          | 1.064 | 6.048     | 9.584     | 18.855    |
| 1098.9                                          | 1.099 | 6.057     | 9.283     | 17.986    |
| 1134.4                                          | 1.134 | 6.066     | 8.977     | 17.100    |
| 1169.8                                          | 1.170 | 6.076     | 8.672     | 16.214    |
| 1205.3                                          | 1.205 | 6.087     | 8.367     | 15.327    |
| 1240.7                                          | 1.241 | 6.098     | 8.062     | 14.438    |
| 1276.2                                          | 1.276 | 6.110     | 7.758     | 13.550    |
| 1311.6                                          | 1.312 | 6.228     | 7.578     | 12.665    |
| 1347                                            | 1.347 | 6.348     | 7.400     | 11.780    |
| 1382.5                                          | 1.383 | 6.467     | 7.222     | 10.894    |
| 1417.9                                          | 1.418 | 6.587     | 7.045     | 10.009    |
| 1453.4                                          | 1.453 | 6.706     | 6.868     | 9.123     |
| 1488.8                                          | 1.489 | 6.825     | 6.687     | 8.229     |
| 1524.3                                          | 1.524 | 7.131     | 7.019     | 8.309     |
| 1559.7                                          | 1.560 | 7.437     | 7.352     | 8.389     |
| 1595.2                                          | 1.595 | 7.743     | 7.684     | 8.469     |
| 1630.6                                          | 1.631 | 8.048     | 8.017     | 8.548     |
| 1666.1                                          | 1.666 | 8.354     | 8.349     | 8.627     |
| 1701.5                                          | 1.702 | 8.658     | 8.680     | 8.703     |

## **APPENDIX J – Raw data case study for corrosion type N5**

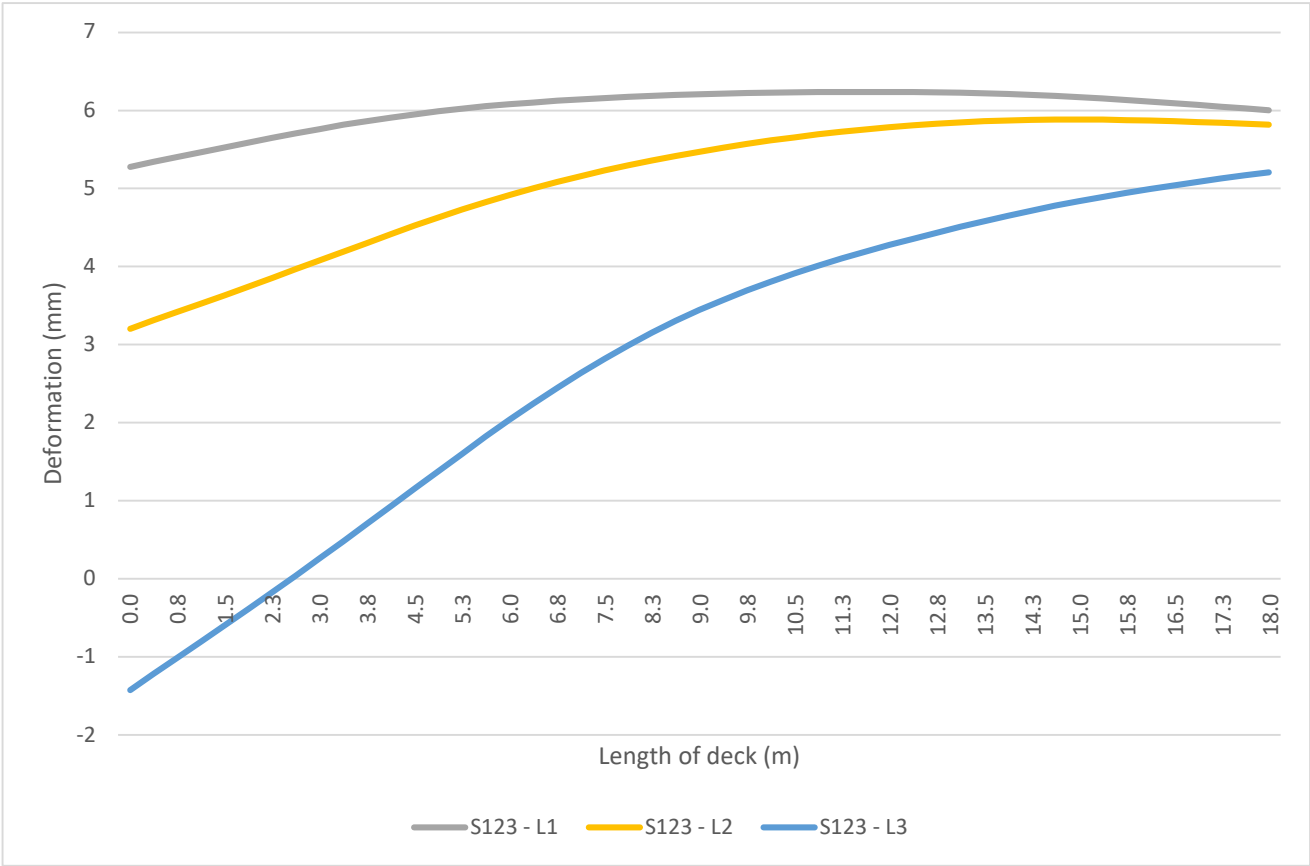




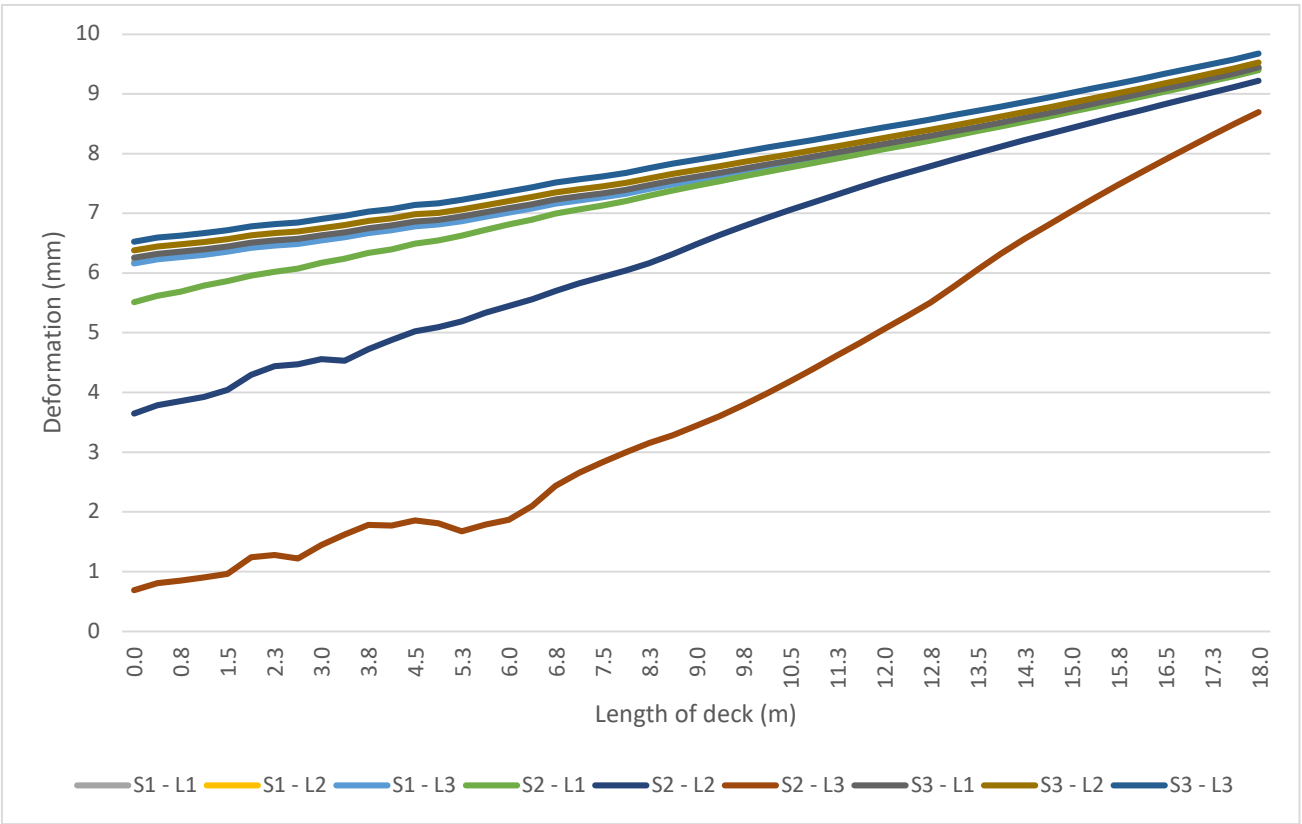
| STIFFENER 1 - Longitudinal direction |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m      | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.000  | 5.316   | 3.276   | -1.522  | 6.002   | 5.880   | 5.728   | 6.062   | 6.087   | 6.117   |
| 375                                  | 0.375  | 5.379   | 3.385   | -1.309  | 6.025   | 5.903   | 5.751   | 6.084   | 6.108   | 6.139   |
| 750                                  | 0.750  | 5.441   | 3.493   | -1.097  | 6.048   | 5.926   | 5.773   | 6.105   | 6.130   | 6.161   |
| 1125                                 | 1.125  | 5.502   | 3.601   | -0.883  | 6.070   | 5.948   | 5.795   | 6.126   | 6.150   | 6.181   |
| 1500                                 | 1.500  | 5.563   | 3.710   | -0.668  | 6.092   | 5.971   | 5.817   | 6.147   | 6.171   | 6.202   |
| 1875                                 | 1.875  | 5.625   | 3.820   | -0.451  | 6.114   | 5.994   | 5.839   | 6.168   | 6.192   | 6.223   |
| 2250                                 | 2.250  | 5.684   | 3.933   | -0.232  | 6.133   | 6.013   | 5.858   | 6.187   | 6.210   | 6.241   |
| 2625                                 | 2.625  | 5.742   | 4.050   | -0.009  | 6.151   | 6.032   | 5.877   | 6.204   | 6.227   | 6.259   |
| 3000                                 | 3.000  | 5.798   | 4.163   | 0.216   | 6.169   | 6.051   | 5.895   | 6.222   | 6.244   | 6.276   |
| 3375                                 | 3.375  | 5.852   | 4.273   | 0.445   | 6.187   | 6.069   | 5.912   | 6.238   | 6.260   | 6.291   |
| 3750                                 | 3.750  | 5.900   | 4.387   | 0.676   | 6.200   | 6.083   | 5.926   | 6.251   | 6.272   | 6.304   |
| 4125                                 | 4.125  | 5.944   | 4.501   | 0.910   | 6.212   | 6.096   | 5.938   | 6.262   | 6.283   | 6.315   |
| 4500                                 | 4.500  | 5.986   | 4.612   | 1.143   | 6.224   | 6.108   | 5.949   | 6.272   | 6.293   | 6.325   |
| 4875                                 | 4.875  | 6.024   | 4.719   | 1.374   | 6.234   | 6.119   | 5.960   | 6.282   | 6.302   | 6.334   |
| 5250                                 | 5.250  | 6.058   | 4.822   | 1.606   | 6.243   | 6.128   | 5.969   | 6.290   | 6.310   | 6.341   |
| 5625                                 | 5.625  | 6.088   | 4.919   | 1.838   | 6.250   | 6.136   | 5.976   | 6.296   | 6.315   | 6.346   |
| 6000                                 | 6.000  | 6.114   | 5.011   | 2.061   | 6.255   | 6.142   | 5.982   | 6.300   | 6.319   | 6.350   |
| 6375                                 | 6.375  | 6.136   | 5.098   | 2.275   | 6.259   | 6.146   | 5.986   | 6.303   | 6.321   | 6.352   |
| 6750                                 | 6.750  | 6.157   | 5.180   | 2.484   | 6.262   | 6.150   | 5.990   | 6.306   | 6.324   | 6.354   |
| 7125                                 | 7.125  | 6.175   | 5.257   | 2.685   | 6.265   | 6.154   | 5.994   | 6.308   | 6.326   | 6.356   |
| 7500                                 | 7.500  | 6.191   | 5.329   | 2.877   | 6.268   | 6.158   | 5.998   | 6.310   | 6.327   | 6.357   |
| 7875                                 | 7.875  | 6.206   | 5.396   | 3.057   | 6.270   | 6.161   | 6.001   | 6.311   | 6.328   | 6.357   |
| 8250                                 | 8.250  | 6.218   | 5.459   | 3.226   | 6.272   | 6.164   | 6.003   | 6.312   | 6.328   | 6.357   |
| 8625                                 | 8.625  | 6.229   | 5.518   | 3.384   | 6.274   | 6.166   | 6.006   | 6.313   | 6.329   | 6.357   |
| 9000                                 | 9.000  | 6.238   | 5.573   | 3.529   | 6.275   | 6.168   | 6.008   | 6.313   | 6.328   | 6.357   |
| 9375                                 | 9.375  | 6.246   | 5.625   | 3.665   | 6.275   | 6.169   | 6.009   | 6.313   | 6.328   | 6.356   |
| 9750                                 | 9.750  | 6.253   | 5.674   | 3.793   | 6.275   | 6.171   | 6.011   | 6.313   | 6.327   | 6.354   |
| 10125                                | 10.125 | 6.258   | 5.719   | 3.911   | 6.275   | 6.171   | 6.012   | 6.312   | 6.325   | 6.352   |
| 10500                                | 10.500 | 6.263   | 5.760   | 4.021   | 6.274   | 6.171   | 6.012   | 6.310   | 6.323   | 6.350   |
| 10875                                | 10.875 | 6.265   | 5.798   | 4.125   | 6.273   | 6.171   | 6.012   | 6.308   | 6.321   | 6.347   |
| 11250                                | 11.250 | 6.267   | 5.833   | 4.222   | 6.271   | 6.170   | 6.012   | 6.306   | 6.317   | 6.343   |
| 11625                                | 11.625 | 6.268   | 5.864   | 4.314   | 6.268   | 6.168   | 6.010   | 6.302   | 6.314   | 6.339   |
| 12000                                | 12.000 | 6.267   | 5.891   | 4.402   | 6.264   | 6.165   | 6.008   | 6.298   | 6.309   | 6.333   |
| 12375                                | 12.375 | 6.264   | 5.915   | 4.486   | 6.259   | 6.161   | 6.005   | 6.292   | 6.303   | 6.327   |
| 12750                                | 12.750 | 6.260   | 5.936   | 4.568   | 6.253   | 6.156   | 6.000   | 6.286   | 6.296   | 6.319   |
| 13125                                | 13.125 | 6.255   | 5.953   | 4.647   | 6.245   | 6.150   | 5.995   | 6.278   | 6.287   | 6.310   |
| 13500                                | 13.500 | 6.248   | 5.967   | 4.723   | 6.236   | 6.142   | 5.987   | 6.268   | 6.277   | 6.300   |
| 13875                                | 13.875 | 6.238   | 5.977   | 4.795   | 6.226   | 6.132   | 5.979   | 6.257   | 6.266   | 6.287   |
| 14250                                | 14.250 | 6.227   | 5.984   | 4.865   | 6.213   | 6.121   | 5.968   | 6.244   | 6.252   | 6.273   |
| 14625                                | 14.625 | 6.214   | 5.987   | 4.930   | 6.199   | 6.107   | 5.955   | 6.229   | 6.237   | 6.257   |
| 15000                                | 15.000 | 6.198   | 5.988   | 4.992   | 6.182   | 6.092   | 5.941   | 6.212   | 6.220   | 6.239   |
| 15375                                | 15.375 | 6.181   | 5.985   | 5.050   | 6.164   | 6.075   | 5.925   | 6.194   | 6.201   | 6.220   |
| 15750                                | 15.750 | 6.162   | 5.980   | 5.105   | 6.144   | 6.056   | 5.907   | 6.173   | 6.180   | 6.198   |
| 16125                                | 16.125 | 6.141   | 5.972   | 5.156   | 6.123   | 6.036   | 5.888   | 6.152   | 6.158   | 6.175   |
| 16500                                | 16.500 | 6.120   | 5.964   | 5.206   | 6.101   | 6.015   | 5.868   | 6.129   | 6.135   | 6.152   |
| 16875                                | 16.875 | 6.097   | 5.953   | 5.253   | 6.078   | 5.993   | 5.847   | 6.105   | 6.111   | 6.127   |
| 17250                                | 17.250 | 6.074   | 5.943   | 5.298   | 6.054   | 5.971   | 5.825   | 6.082   | 6.087   | 6.102   |
| 17625                                | 17.625 | 6.051   | 5.931   | 5.343   | 6.030   | 5.948   | 5.804   | 6.057   | 6.062   | 6.077   |
| 18000                                | 18.000 | 6.027   | 5.919   | 5.385   | 6.006   | 5.924   | 5.781   | 6.033   | 6.037   | 6.051   |



| STIFFENER 1 in S## - Longitudinal direction |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m      | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.000  | 5.271    | 3.181    | -1.398   | 5.323    | 3.299    | -1.544   | 6.010    | 5.912    | 5.792    |
| 375                                         | 0.375  | 5.335    | 3.289    | -1.198   | 5.386    | 3.408    | -1.326   | 6.033    | 5.935    | 5.815    |
| 750                                         | 0.750  | 5.397    | 3.396    | -0.998   | 5.448    | 3.516    | -1.109   | 6.055    | 5.958    | 5.836    |
| 1125                                        | 1.125  | 5.458    | 3.503    | -0.797   | 5.509    | 3.624    | -0.890   | 6.077    | 5.979    | 5.858    |
| 1500                                        | 1.500  | 5.520    | 3.611    | -0.594   | 5.570    | 3.732    | -0.669   | 6.099    | 6.001    | 5.879    |
| 1875                                        | 1.875  | 5.582    | 3.720    | -0.389   | 5.631    | 3.842    | -0.447   | 6.120    | 6.023    | 5.900    |
| 2250                                        | 2.250  | 5.642    | 3.832    | -0.182   | 5.691    | 3.956    | -0.221   | 6.140    | 6.043    | 5.919    |
| 2625                                        | 2.625  | 5.700    | 3.947    | 0.027    | 5.748    | 4.072    | 0.007    | 6.158    | 6.061    | 5.937    |
| 3000                                        | 3.000  | 5.756    | 4.059    | 0.240    | 5.804    | 4.185    | 0.237    | 6.176    | 6.079    | 5.955    |
| 3375                                        | 3.375  | 5.811    | 4.168    | 0.456    | 5.858    | 4.295    | 0.471    | 6.193    | 6.096    | 5.971    |
| 3750                                        | 3.750  | 5.859    | 4.281    | 0.674    | 5.906    | 4.408    | 0.708    | 6.206    | 6.110    | 5.985    |
| 4125                                        | 4.125  | 5.904    | 4.394    | 0.895    | 5.950    | 4.522    | 0.946    | 6.218    | 6.122    | 5.996    |
| 4500                                        | 4.500  | 5.946    | 4.504    | 1.115    | 5.991    | 4.633    | 1.183    | 6.229    | 6.133    | 6.007    |
| 4875                                        | 4.875  | 5.984    | 4.610    | 1.334    | 6.029    | 4.739    | 1.418    | 6.240    | 6.144    | 6.017    |
| 5250                                        | 5.250  | 6.019    | 4.711    | 1.554    | 6.063    | 4.842    | 1.653    | 6.248    | 6.153    | 6.025    |
| 5625                                        | 5.625  | 6.049    | 4.807    | 1.773    | 6.093    | 4.939    | 1.888    | 6.255    | 6.159    | 6.031    |
| 6000                                        | 6.000  | 6.075    | 4.899    | 1.984    | 6.118    | 5.030    | 2.114    | 6.260    | 6.165    | 6.036    |
| 6375                                        | 6.375  | 6.098    | 4.984    | 2.187    | 6.140    | 5.116    | 2.330    | 6.263    | 6.168    | 6.039    |
| 6750                                        | 6.750  | 6.120    | 5.066    | 2.385    | 6.161    | 5.198    | 2.541    | 6.266    | 6.172    | 6.042    |
| 7125                                        | 7.125  | 6.138    | 5.143    | 2.576    | 6.179    | 5.275    | 2.744    | 6.269    | 6.175    | 6.045    |
| 7500                                        | 7.500  | 6.155    | 5.214    | 2.759    | 6.195    | 5.346    | 2.938    | 6.272    | 6.178    | 6.047    |
| 7875                                        | 7.875  | 6.170    | 5.280    | 2.931    | 6.209    | 5.412    | 3.119    | 6.274    | 6.180    | 6.049    |
| 8250                                        | 8.250  | 6.183    | 5.343    | 3.092    | 6.221    | 5.475    | 3.288    | 6.276    | 6.182    | 6.051    |
| 8625                                        | 8.625  | 6.194    | 5.402    | 3.242    | 6.232    | 5.533    | 3.446    | 6.277    | 6.184    | 6.052    |
| 9000                                        | 9.000  | 6.204    | 5.457    | 3.382    | 6.241    | 5.588    | 3.592    | 6.278    | 6.185    | 6.053    |
| 9375                                        | 9.375  | 6.212    | 5.509    | 3.512    | 6.249    | 5.639    | 3.727    | 6.278    | 6.186    | 6.053    |
| 9750                                        | 9.750  | 6.219    | 5.558    | 3.634    | 6.256    | 5.687    | 3.853    | 6.278    | 6.186    | 6.053    |
| 10125                                       | 10.125 | 6.225    | 5.603    | 3.749    | 6.261    | 5.732    | 3.971    | 6.278    | 6.186    | 6.053    |
| 10500                                       | 10.500 | 6.230    | 5.645    | 3.855    | 6.265    | 5.773    | 4.080    | 6.277    | 6.186    | 6.052    |
| 10875                                       | 10.875 | 6.233    | 5.683    | 3.955    | 6.268    | 5.810    | 4.182    | 6.275    | 6.185    | 6.051    |
| 11250                                       | 11.250 | 6.235    | 5.717    | 4.050    | 6.269    | 5.844    | 4.278    | 6.273    | 6.183    | 6.049    |
| 11625                                       | 11.625 | 6.236    | 5.749    | 4.139    | 6.270    | 5.874    | 4.368    | 6.270    | 6.181    | 6.046    |
| 12000                                       | 12.000 | 6.236    | 5.777    | 4.225    | 6.269    | 5.901    | 4.455    | 6.266    | 6.177    | 6.043    |
| 12375                                       | 12.375 | 6.234    | 5.801    | 4.307    | 6.266    | 5.925    | 4.537    | 6.261    | 6.173    | 6.038    |
| 12750                                       | 12.750 | 6.230    | 5.823    | 4.387    | 6.262    | 5.945    | 4.616    | 6.255    | 6.167    | 6.033    |
| 13125                                       | 13.125 | 6.225    | 5.841    | 4.464    | 6.257    | 5.962    | 4.694    | 6.247    | 6.160    | 6.026    |
| 13500                                       | 13.500 | 6.218    | 5.855    | 4.538    | 6.249    | 5.975    | 4.768    | 6.238    | 6.152    | 6.018    |
| 13875                                       | 13.875 | 6.209    | 5.866    | 4.609    | 6.240    | 5.984    | 4.839    | 6.227    | 6.141    | 6.007    |
| 14250                                       | 14.250 | 6.198    | 5.873    | 4.677    | 6.228    | 5.991    | 4.907    | 6.214    | 6.129    | 5.996    |
| 14625                                       | 14.625 | 6.185    | 5.878    | 4.741    | 6.215    | 5.994    | 4.971    | 6.200    | 6.116    | 5.982    |
| 15000                                       | 15.000 | 6.170    | 5.879    | 4.801    | 6.200    | 5.994    | 5.031    | 6.183    | 6.100    | 5.966    |
| 15375                                       | 15.375 | 6.153    | 5.877    | 4.858    | 6.182    | 5.991    | 5.087    | 6.165    | 6.082    | 5.949    |
| 15750                                       | 15.750 | 6.134    | 5.873    | 4.912    | 6.163    | 5.985    | 5.141    | 6.145    | 6.063    | 5.930    |
| 16125                                       | 16.125 | 6.114    | 5.867    | 4.962    | 6.142    | 5.977    | 5.191    | 6.124    | 6.042    | 5.909    |
| 16500                                       | 16.500 | 6.093    | 5.859    | 5.010    | 6.121    | 5.968    | 5.239    | 6.102    | 6.021    | 5.888    |
| 16875                                       | 16.875 | 6.071    | 5.850    | 5.057    | 6.098    | 5.958    | 5.284    | 6.079    | 5.998    | 5.866    |
| 17250                                       | 17.250 | 6.048    | 5.840    | 5.101    | 6.075    | 5.946    | 5.329    | 6.055    | 5.976    | 5.843    |
| 17625                                       | 17.625 | 6.025    | 5.829    | 5.145    | 6.052    | 5.934    | 5.371    | 6.031    | 5.952    | 5.820    |
| 18000                                       | 18.000 | 6.002    | 5.818    | 5.186    | 6.028    | 5.922    | 5.412    | 6.007    | 5.928    | 5.796    |

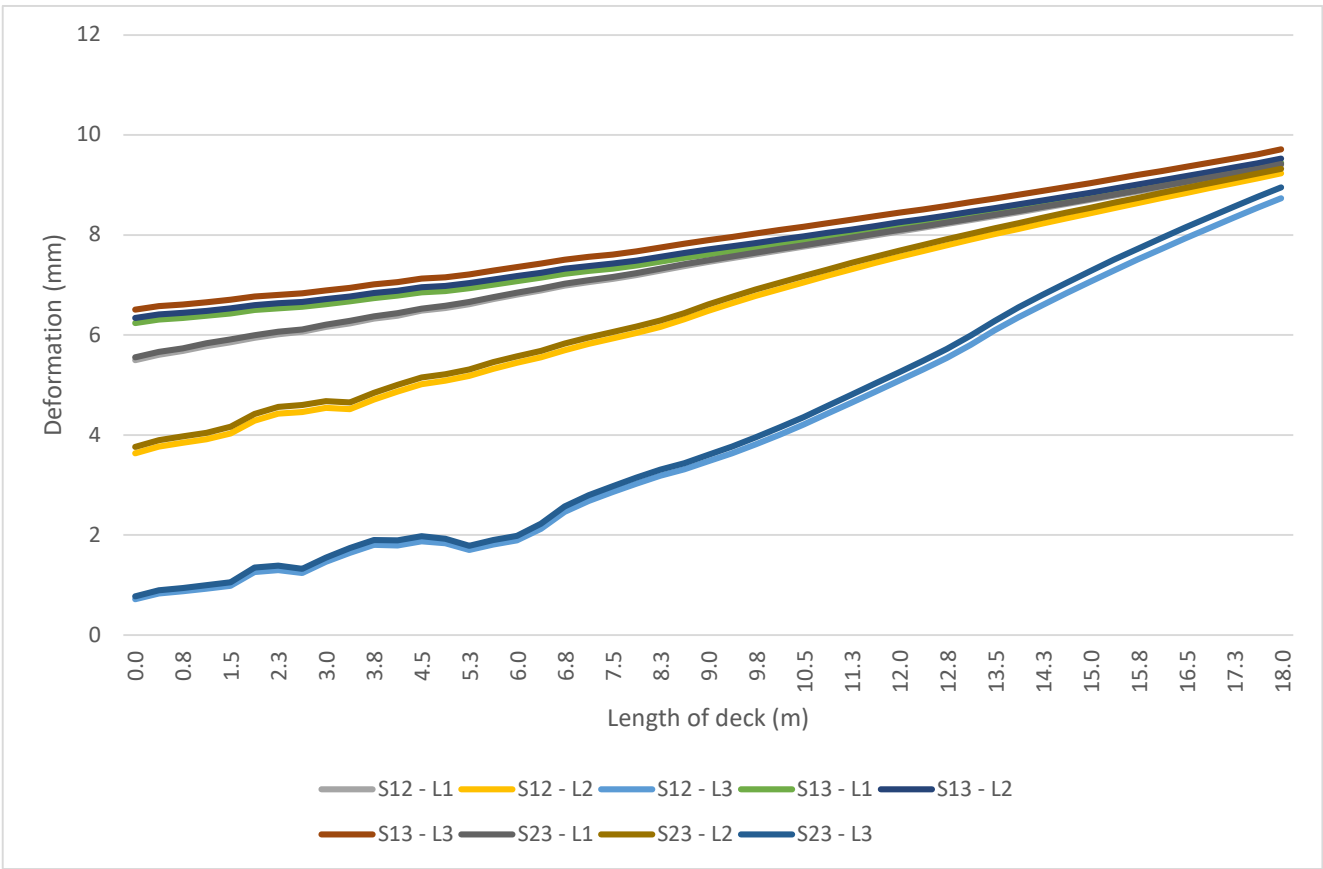


| STIFFENER 1 in S1,2 & 3 - Longitudinal direction |        |           |           |           |
|--------------------------------------------------|--------|-----------|-----------|-----------|
| mm                                               | m      | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.000  | 5.279     | 3.204     | -1.424    |
| 375                                              | 0.375  | 5.342     | 3.312     | -1.218    |
| 750                                              | 0.750  | 5.404     | 3.419     | -1.012    |
| 1125                                             | 1.125  | 5.465     | 3.525     | -0.805    |
| 1500                                             | 1.500  | 5.527     | 3.633     | -0.597    |
| 1875                                             | 1.875  | 5.588     | 3.742     | -0.387    |
| 2250                                             | 2.250  | 5.648     | 3.854     | -0.174    |
| 2625                                             | 2.625  | 5.706     | 3.969     | 0.042     |
| 3000                                             | 3.000  | 5.762     | 4.081     | 0.260     |
| 3375                                             | 3.375  | 5.817     | 4.190     | 0.481     |
| 3750                                             | 3.750  | 5.865     | 4.302     | 0.705     |
| 4125                                             | 4.125  | 5.909     | 4.415     | 0.930     |
| 4500                                             | 4.500  | 5.951     | 4.524     | 1.155     |
| 4875                                             | 4.875  | 5.989     | 4.630     | 1.377     |
| 5250                                             | 5.250  | 6.023     | 4.731     | 1.600     |
| 5625                                             | 5.625  | 6.054     | 4.827     | 1.822     |
| 6000                                             | 6.000  | 6.080     | 4.917     | 2.036     |
| 6375                                             | 6.375  | 6.103     | 5.002     | 2.241     |
| 6750                                             | 6.750  | 6.124     | 5.084     | 2.441     |
| 7125                                             | 7.125  | 6.142     | 5.160     | 2.634     |
| 7500                                             | 7.500  | 6.159     | 5.230     | 2.818     |
| 7875                                             | 7.875  | 6.173     | 5.296     | 2.991     |
| 8250                                             | 8.250  | 6.186     | 5.358     | 3.152     |
| 8625                                             | 8.625  | 6.197     | 5.416     | 3.303     |
| 9000                                             | 9.000  | 6.207     | 5.471     | 3.442     |
| 9375                                             | 9.375  | 6.215     | 5.522     | 3.571     |
| 9750                                             | 9.750  | 6.222     | 5.570     | 3.693     |
| 10125                                            | 10.125 | 6.228     | 5.615     | 3.806     |
| 10500                                            | 10.500 | 6.232     | 5.656     | 3.911     |
| 10875                                            | 10.875 | 6.235     | 5.693     | 4.010     |
| 11250                                            | 11.250 | 6.237     | 5.727     | 4.103     |
| 11625                                            | 11.625 | 6.238     | 5.758     | 4.191     |
| 12000                                            | 12.000 | 6.238     | 5.786     | 4.275     |
| 12375                                            | 12.375 | 6.235     | 5.810     | 4.355     |
| 12750                                            | 12.750 | 6.232     | 5.830     | 4.433     |
| 13125                                            | 13.125 | 6.227     | 5.848     | 4.508     |
| 13500                                            | 13.500 | 6.220     | 5.862     | 4.581     |
| 13875                                            | 13.875 | 6.210     | 5.872     | 4.650     |
| 14250                                            | 14.250 | 6.199     | 5.879     | 4.716     |
| 14625                                            | 14.625 | 6.186     | 5.883     | 4.779     |
| 15000                                            | 15.000 | 6.171     | 5.884     | 4.837     |
| 15375                                            | 15.375 | 6.154     | 5.882     | 4.893     |
| 15750                                            | 15.750 | 6.135     | 5.877     | 4.945     |
| 16125                                            | 16.125 | 6.115     | 5.870     | 4.994     |
| 16500                                            | 16.500 | 6.094     | 5.862     | 5.041     |
| 16875                                            | 16.875 | 6.072     | 5.853     | 5.085     |
| 17250                                            | 17.250 | 6.049     | 5.842     | 5.128     |
| 17625                                            | 17.625 | 6.026     | 5.831     | 5.170     |
| 18000                                            | 18.000 | 6.002     | 5.819     | 5.210     |

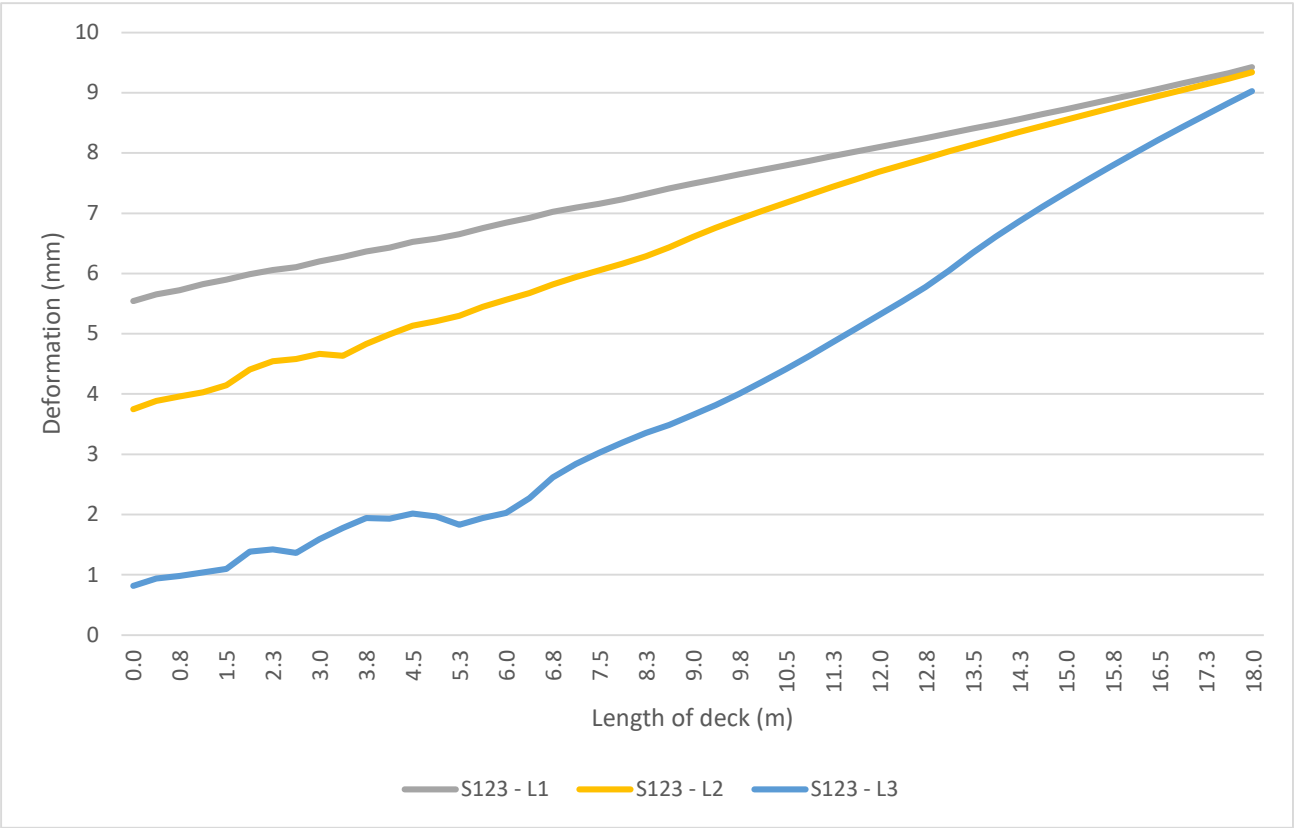


| STIFFENER 2 - Longitudinal direction |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m      | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.000  | 6.195   | 6.175   | 6.165   | 5.513   | 3.647   | 0.688   | 6.257   | 6.381   | 6.528   |
| 375                                  | 0.375  | 6.261   | 6.241   | 6.231   | 5.619   | 3.783   | 0.804   | 6.322   | 6.446   | 6.592   |
| 750                                  | 0.750  | 6.296   | 6.277   | 6.267   | 5.689   | 3.857   | 0.847   | 6.356   | 6.481   | 6.628   |
| 1125                                 | 1.125  | 6.337   | 6.318   | 6.307   | 5.791   | 3.926   | 0.903   | 6.395   | 6.519   | 6.667   |
| 1500                                 | 1.500  | 6.388   | 6.369   | 6.357   | 5.868   | 4.044   | 0.959   | 6.446   | 6.570   | 6.719   |
| 1875                                 | 1.875  | 6.453   | 6.434   | 6.423   | 5.957   | 4.297   | 1.240   | 6.509   | 6.633   | 6.783   |
| 2250                                 | 2.250  | 6.488   | 6.470   | 6.458   | 6.023   | 4.438   | 1.277   | 6.544   | 6.667   | 6.818   |
| 2625                                 | 2.625  | 6.519   | 6.500   | 6.488   | 6.073   | 4.474   | 1.217   | 6.573   | 6.696   | 6.848   |
| 3000                                 | 3.000  | 6.577   | 6.559   | 6.546   | 6.170   | 4.557   | 1.442   | 6.630   | 6.752   | 6.904   |
| 3375                                 | 3.375  | 6.630   | 6.612   | 6.598   | 6.243   | 4.530   | 1.622   | 6.681   | 6.804   | 6.958   |
| 3750                                 | 3.750  | 6.700   | 6.682   | 6.669   | 6.335   | 4.722   | 1.780   | 6.750   | 6.873   | 7.027   |
| 4125                                 | 4.125  | 6.747   | 6.730   | 6.716   | 6.397   | 4.881   | 1.771   | 6.796   | 6.918   | 7.074   |
| 4500                                 | 4.500  | 6.815   | 6.798   | 6.785   | 6.494   | 5.024   | 1.854   | 6.862   | 6.984   | 7.141   |
| 4875                                 | 4.875  | 6.843   | 6.826   | 6.812   | 6.547   | 5.095   | 1.807   | 6.889   | 7.010   | 7.168   |
| 5250                                 | 5.250  | 6.901   | 6.885   | 6.870   | 6.626   | 5.189   | 1.675   | 6.946   | 7.068   | 7.227   |
| 5625                                 | 5.625  | 6.974   | 6.958   | 6.944   | 6.723   | 5.332   | 1.786   | 7.017   | 7.138   | 7.298   |
| 6000                                 | 6.000  | 7.043   | 7.028   | 7.013   | 6.812   | 5.450   | 1.865   | 7.085   | 7.205   | 7.367   |
| 6375                                 | 6.375  | 7.111   | 7.096   | 7.081   | 6.896   | 5.559   | 2.099   | 7.153   | 7.273   | 7.436   |
| 6750                                 | 6.750  | 7.192   | 7.177   | 7.162   | 6.994   | 5.701   | 2.436   | 7.232   | 7.351   | 7.516   |
| 7125                                 | 7.125  | 7.247   | 7.233   | 7.218   | 7.066   | 5.825   | 2.655   | 7.286   | 7.404   | 7.569   |
| 7500                                 | 7.500  | 7.295   | 7.283   | 7.268   | 7.130   | 5.936   | 2.834   | 7.333   | 7.450   | 7.617   |
| 7875                                 | 7.875  | 7.358   | 7.346   | 7.331   | 7.206   | 6.044   | 3.000   | 7.395   | 7.512   | 7.679   |
| 8250                                 | 8.250  | 7.435   | 7.423   | 7.408   | 7.295   | 6.167   | 3.156   | 7.471   | 7.587   | 7.756   |
| 8625                                 | 8.625  | 7.512   | 7.501   | 7.486   | 7.384   | 6.315   | 3.283   | 7.547   | 7.662   | 7.832   |
| 9000                                 | 9.000  | 7.580   | 7.570   | 7.556   | 7.464   | 6.484   | 3.443   | 7.614   | 7.728   | 7.899   |
| 9375                                 | 9.375  | 7.647   | 7.637   | 7.623   | 7.540   | 6.637   | 3.605   | 7.680   | 7.792   | 7.964   |
| 9750                                 | 9.750  | 7.715   | 7.706   | 7.692   | 7.617   | 6.782   | 3.785   | 7.747   | 7.859   | 8.031   |
| 10125                                | 10.125 | 7.784   | 7.775   | 7.761   | 7.693   | 6.920   | 3.977   | 7.815   | 7.925   | 8.098   |
| 10500                                | 10.500 | 7.851   | 7.843   | 7.829   | 7.768   | 7.053   | 4.180   | 7.881   | 7.990   | 8.164   |
| 10875                                | 10.875 | 7.919   | 7.912   | 7.899   | 7.843   | 7.185   | 4.394   | 7.949   | 8.057   | 8.230   |
| 11250                                | 11.250 | 7.989   | 7.983   | 7.970   | 7.919   | 7.314   | 4.615   | 8.018   | 8.125   | 8.299   |
| 11625                                | 11.625 | 8.060   | 8.055   | 8.042   | 7.996   | 7.440   | 4.833   | 8.088   | 8.194   | 8.368   |
| 12000                                | 12.000 | 8.133   | 8.128   | 8.115   | 8.073   | 7.563   | 5.054   | 8.160   | 8.264   | 8.438   |
| 12375                                | 12.375 | 8.201   | 8.197   | 8.185   | 8.145   | 7.677   | 5.277   | 8.227   | 8.330   | 8.504   |
| 12750                                | 12.750 | 8.271   | 8.268   | 8.257   | 8.220   | 7.789   | 5.508   | 8.297   | 8.399   | 8.572   |
| 13125                                | 13.125 | 8.347   | 8.344   | 8.333   | 8.299   | 7.903   | 5.772   | 8.372   | 8.472   | 8.645   |
| 13500                                | 13.500 | 8.421   | 8.420   | 8.409   | 8.377   | 8.012   | 6.055   | 8.446   | 8.545   | 8.717   |
| 13875                                | 13.875 | 8.496   | 8.495   | 8.486   | 8.455   | 8.117   | 6.319   | 8.520   | 8.618   | 8.789   |
| 14250                                | 14.250 | 8.574   | 8.574   | 8.565   | 8.535   | 8.222   | 6.566   | 8.598   | 8.694   | 8.863   |
| 14625                                | 14.625 | 8.653   | 8.654   | 8.646   | 8.616   | 8.325   | 6.801   | 8.676   | 8.771   | 8.939   |
| 15000                                | 15.000 | 8.734   | 8.735   | 8.728   | 8.699   | 8.428   | 7.031   | 8.756   | 8.850   | 9.016   |
| 15375                                | 15.375 | 8.816   | 8.818   | 8.812   | 8.783   | 8.529   | 7.256   | 8.838   | 8.930   | 9.095   |
| 15750                                | 15.750 | 8.900   | 8.903   | 8.897   | 8.868   | 8.630   | 7.475   | 8.921   | 9.011   | 9.175   |
| 16125                                | 16.125 | 8.984   | 8.988   | 8.983   | 8.954   | 8.729   | 7.689   | 9.005   | 9.094   | 9.256   |
| 16500                                | 16.500 | 9.070   | 9.074   | 9.070   | 9.040   | 8.828   | 7.898   | 9.090   | 9.177   | 9.337   |
| 16875                                | 16.875 | 9.155   | 9.161   | 9.157   | 9.126   | 8.926   | 8.101   | 9.175   | 9.261   | 9.418   |
| 17250                                | 17.250 | 9.242   | 9.248   | 9.246   | 9.213   | 9.023   | 8.303   | 9.261   | 9.345   | 9.500   |
| 17625                                | 17.625 | 9.327   | 9.334   | 9.333   | 9.299   | 9.119   | 8.504   | 9.345   | 9.427   | 9.580   |
| 18000                                | 18.000 | 9.429   | 9.436   | 9.435   | 9.401   | 9.225   | 8.697   | 9.447   | 9.528   | 9.680   |

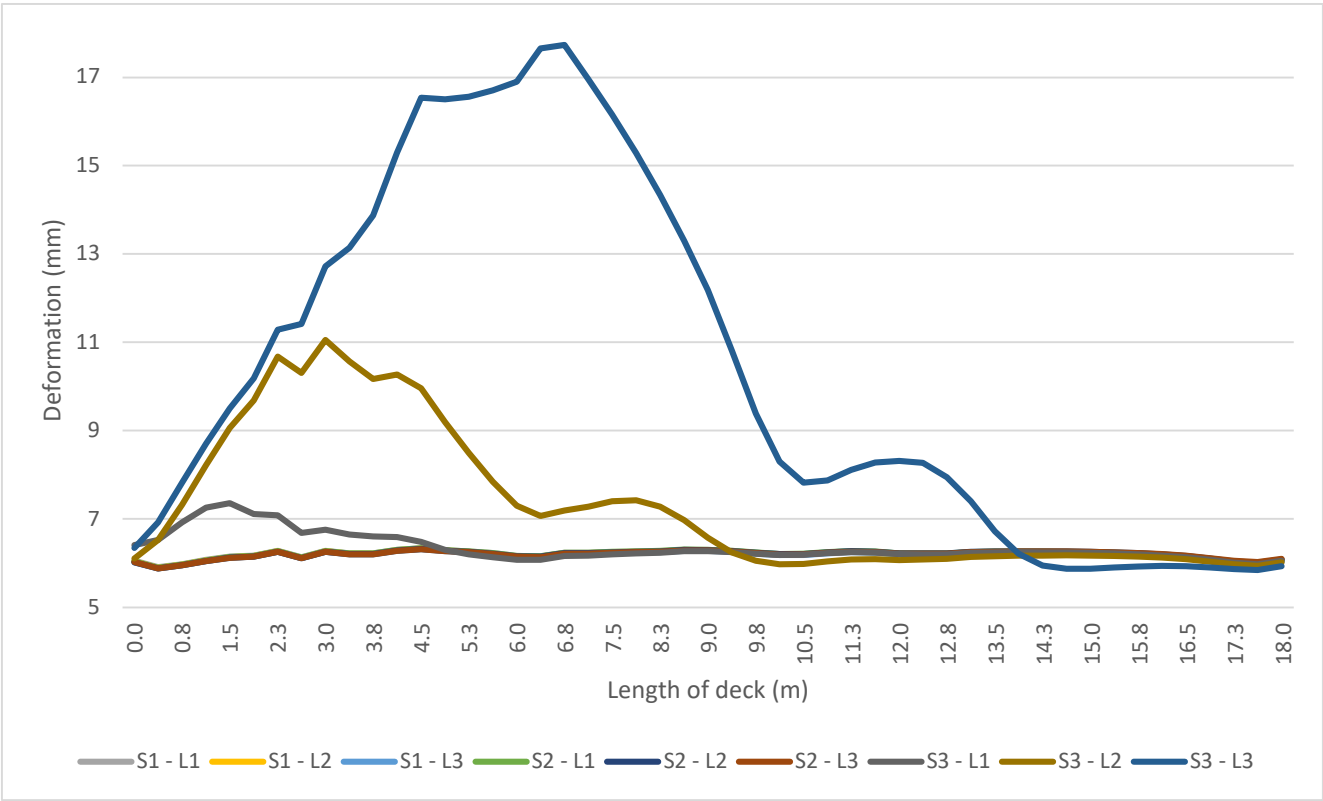




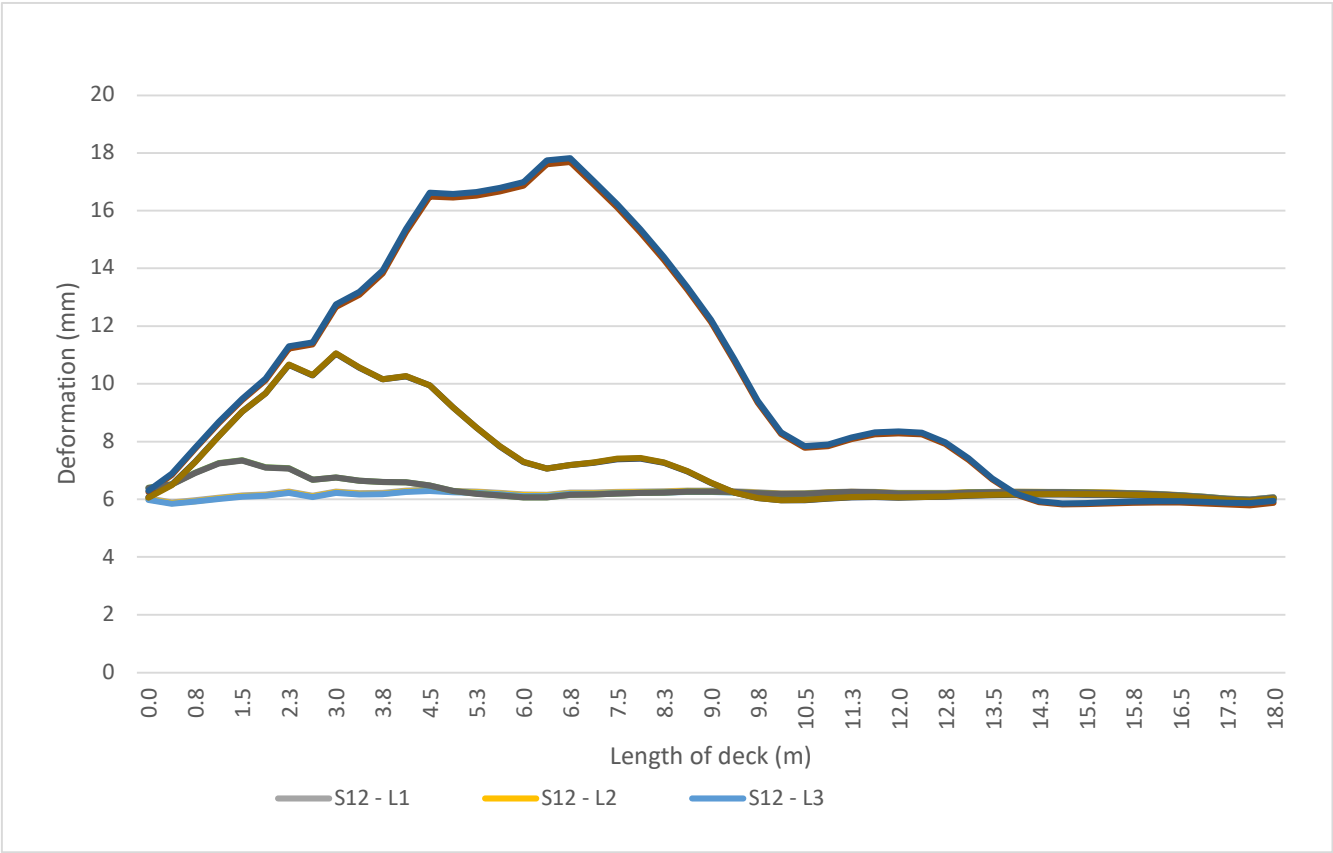
| STIFFENER 2 in S## - Longitudinal direction |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m      | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.000  | 5.503    | 3.636    | 0.717    | 6.245    | 6.345    | 6.513    | 5.557    | 3.763    | 0.777    |
| 375                                         | 0.375  | 5.609    | 3.772    | 0.832    | 6.310    | 6.410    | 6.578    | 5.663    | 3.900    | 0.895    |
| 750                                         | 0.750  | 5.680    | 3.845    | 0.875    | 6.345    | 6.445    | 6.613    | 5.733    | 3.974    | 0.940    |
| 1125                                        | 1.125  | 5.782    | 3.914    | 0.930    | 6.384    | 6.484    | 6.653    | 5.834    | 4.044    | 0.997    |
| 1500                                        | 1.500  | 5.858    | 4.032    | 0.985    | 6.435    | 6.535    | 6.704    | 5.910    | 4.164    | 1.056    |
| 1875                                        | 1.875  | 5.948    | 4.285    | 1.262    | 6.499    | 6.599    | 6.769    | 5.999    | 4.420    | 1.348    |
| 2250                                        | 2.250  | 6.014    | 4.426    | 1.300    | 6.533    | 6.634    | 6.804    | 6.064    | 4.563    | 1.386    |
| 2625                                        | 2.625  | 6.065    | 4.463    | 1.241    | 6.563    | 6.663    | 6.833    | 6.113    | 4.598    | 1.322    |
| 3000                                        | 3.000  | 6.162    | 4.546    | 1.466    | 6.620    | 6.720    | 6.891    | 6.210    | 4.680    | 1.551    |
| 3375                                        | 3.375  | 6.235    | 4.519    | 1.647    | 6.672    | 6.772    | 6.944    | 6.282    | 4.651    | 1.738    |
| 3750                                        | 3.750  | 6.327    | 4.712    | 1.802    | 6.741    | 6.841    | 7.014    | 6.373    | 4.846    | 1.903    |
| 4125                                        | 4.125  | 6.390    | 4.871    | 1.793    | 6.787    | 6.887    | 7.061    | 6.435    | 5.006    | 1.894    |
| 4500                                        | 4.500  | 6.487    | 5.015    | 1.878    | 6.854    | 6.954    | 7.129    | 6.531    | 5.149    | 1.976    |
| 4875                                        | 4.875  | 6.540    | 5.087    | 1.834    | 6.881    | 6.980    | 7.156    | 6.583    | 5.218    | 1.925    |
| 5250                                        | 5.250  | 6.619    | 5.182    | 1.702    | 6.939    | 7.038    | 7.215    | 6.661    | 5.312    | 1.788    |
| 5625                                        | 5.625  | 6.717    | 5.326    | 1.812    | 7.010    | 7.110    | 7.288    | 6.758    | 5.456    | 1.902    |
| 6000                                        | 6.000  | 6.807    | 5.443    | 1.892    | 7.079    | 7.178    | 7.357    | 6.847    | 5.574    | 1.984    |
| 6375                                        | 6.375  | 6.890    | 5.552    | 2.126    | 7.147    | 7.246    | 7.427    | 6.929    | 5.684    | 2.226    |
| 6750                                        | 6.750  | 6.989    | 5.695    | 2.463    | 7.226    | 7.326    | 7.508    | 7.027    | 5.827    | 2.573    |
| 7125                                        | 7.125  | 7.061    | 5.820    | 2.682    | 7.280    | 7.379    | 7.562    | 7.099    | 5.951    | 2.796    |
| 7500                                        | 7.500  | 7.126    | 5.931    | 2.862    | 7.328    | 7.427    | 7.611    | 7.162    | 6.061    | 2.978    |
| 7875                                        | 7.875  | 7.202    | 6.041    | 3.029    | 7.391    | 7.489    | 7.674    | 7.237    | 6.169    | 3.147    |
| 8250                                        | 8.250  | 7.291    | 6.164    | 3.186    | 7.467    | 7.565    | 7.751    | 7.325    | 6.291    | 3.307    |
| 8625                                        | 8.625  | 7.381    | 6.313    | 3.313    | 7.544    | 7.641    | 7.829    | 7.414    | 6.441    | 3.438    |
| 9000                                        | 9.000  | 7.461    | 6.482    | 3.473    | 7.611    | 7.708    | 7.897    | 7.494    | 6.610    | 3.603    |
| 9375                                        | 9.375  | 7.538    | 6.635    | 3.635    | 7.677    | 7.774    | 7.963    | 7.570    | 6.763    | 3.769    |
| 9750                                        | 9.750  | 7.615    | 6.782    | 3.816    | 7.745    | 7.841    | 8.032    | 7.646    | 6.909    | 3.954    |
| 10125                                       | 10.125 | 7.691    | 6.920    | 4.009    | 7.812    | 7.909    | 8.100    | 7.722    | 7.047    | 4.152    |
| 10500                                       | 10.500 | 7.766    | 7.054    | 4.212    | 7.879    | 7.975    | 8.167    | 7.796    | 7.180    | 4.360    |
| 10875                                       | 10.875 | 7.842    | 7.186    | 4.426    | 7.947    | 8.042    | 8.235    | 7.871    | 7.311    | 4.580    |
| 11250                                       | 11.250 | 7.918    | 7.315    | 4.647    | 8.017    | 8.111    | 8.304    | 7.946    | 7.440    | 4.806    |
| 11625                                       | 11.625 | 7.995    | 7.442    | 4.866    | 8.087    | 8.181    | 8.375    | 8.022    | 7.566    | 5.029    |
| 12000                                       | 12.000 | 8.072    | 7.566    | 5.088    | 8.159    | 8.253    | 8.446    | 8.099    | 7.689    | 5.255    |
| 12375                                       | 12.375 | 8.145    | 7.681    | 5.311    | 8.227    | 8.319    | 8.513    | 8.171    | 7.802    | 5.483    |
| 12750                                       | 12.750 | 8.220    | 7.794    | 5.543    | 8.297    | 8.389    | 8.583    | 8.246    | 7.914    | 5.720    |
| 13125                                       | 13.125 | 8.299    | 7.908    | 5.807    | 8.372    | 8.464    | 8.658    | 8.325    | 8.026    | 5.991    |
| 13500                                       | 13.500 | 8.377    | 8.018    | 6.090    | 8.446    | 8.537    | 8.731    | 8.402    | 8.134    | 6.281    |
| 13875                                       | 13.875 | 8.456    | 8.124    | 6.353    | 8.521    | 8.611    | 8.805    | 8.480    | 8.239    | 6.551    |
| 14250                                       | 14.250 | 8.536    | 8.229    | 6.601    | 8.598    | 8.688    | 8.881    | 8.559    | 8.342    | 6.803    |
| 14625                                       | 14.625 | 8.618    | 8.333    | 6.836    | 8.677    | 8.766    | 8.959    | 8.641    | 8.445    | 7.042    |
| 15000                                       | 15.000 | 8.700    | 8.436    | 7.067    | 8.758    | 8.846    | 9.037    | 8.723    | 8.546    | 7.276    |
| 15375                                       | 15.375 | 8.785    | 8.539    | 7.292    | 8.840    | 8.927    | 9.118    | 8.806    | 8.646    | 7.504    |
| 15750                                       | 15.750 | 8.870    | 8.640    | 7.512    | 8.923    | 9.010    | 9.200    | 8.891    | 8.745    | 7.726    |
| 16125                                       | 16.125 | 8.956    | 8.740    | 7.726    | 9.007    | 9.093    | 9.282    | 8.977    | 8.843    | 7.942    |
| 16500                                       | 16.500 | 9.043    | 8.840    | 7.936    | 9.093    | 9.177    | 9.365    | 9.063    | 8.940    | 8.153    |
| 16875                                       | 16.875 | 9.129    | 8.939    | 8.141    | 9.178    | 9.262    | 9.448    | 9.149    | 9.036    | 8.359    |
| 17250                                       | 17.250 | 9.216    | 9.037    | 8.343    | 9.264    | 9.347    | 9.532    | 9.235    | 9.131    | 8.561    |
| 17625                                       | 17.625 | 9.302    | 9.134    | 8.545    | 9.348    | 9.431    | 9.614    | 9.321    | 9.225    | 8.763    |
| 18000                                       | 18.000 | 9.404    | 9.240    | 8.739    | 9.450    | 9.532    | 9.714    | 9.422    | 9.330    | 8.958    |



| STIFFENER 2 in S1,2 & 3 - Longitudinal direction |        |           |           |           |
|--------------------------------------------------|--------|-----------|-----------|-----------|
| mm                                               | m      | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.000  | 5.547     | 3.748     | 0.820     |
| 375                                              | 0.375  | 5.653     | 3.885     | 0.938     |
| 750                                              | 0.750  | 5.723     | 3.959     | 0.982     |
| 1125                                             | 1.125  | 5.824     | 4.029     | 1.038     |
| 1500                                             | 1.500  | 5.901     | 4.148     | 1.096     |
| 1875                                             | 1.875  | 5.990     | 4.404     | 1.385     |
| 2250                                             | 2.250  | 6.055     | 4.547     | 1.424     |
| 2625                                             | 2.625  | 6.105     | 4.583     | 1.361     |
| 3000                                             | 3.000  | 6.202     | 4.666     | 1.591     |
| 3375                                             | 3.375  | 6.274     | 4.637     | 1.778     |
| 3750                                             | 3.750  | 6.366     | 4.832     | 1.942     |
| 4125                                             | 4.125  | 6.428     | 4.992     | 1.932     |
| 4500                                             | 4.500  | 6.524     | 5.136     | 2.016     |
| 4875                                             | 4.875  | 6.577     | 5.207     | 1.968     |
| 5250                                             | 5.250  | 6.655     | 5.300     | 1.831     |
| 5625                                             | 5.625  | 6.752     | 5.445     | 1.945     |
| 6000                                             | 6.000  | 6.841     | 5.563     | 2.027     |
| 6375                                             | 6.375  | 6.924     | 5.673     | 2.269     |
| 6750                                             | 6.750  | 7.022     | 5.817     | 2.616     |
| 7125                                             | 7.125  | 7.094     | 5.942     | 2.840     |
| 7500                                             | 7.500  | 7.158     | 6.052     | 3.023     |
| 7875                                             | 7.875  | 7.234     | 6.161     | 3.193     |
| 8250                                             | 8.250  | 7.322     | 6.284     | 3.354     |
| 8625                                             | 8.625  | 7.411     | 6.434     | 3.486     |
| 9000                                             | 9.000  | 7.491     | 6.603     | 3.651     |
| 9375                                             | 9.375  | 7.567     | 6.757     | 3.818     |
| 9750                                             | 9.750  | 7.644     | 6.903     | 4.004     |
| 10125                                            | 10.125 | 7.720     | 7.042     | 4.202     |
| 10500                                            | 10.500 | 7.795     | 7.175     | 4.411     |
| 10875                                            | 10.875 | 7.869     | 7.307     | 4.631     |
| 11250                                            | 11.250 | 7.945     | 7.436     | 4.858     |
| 11625                                            | 11.625 | 8.022     | 7.563     | 5.083     |
| 12000                                            | 12.000 | 8.099     | 7.686     | 5.309     |
| 12375                                            | 12.375 | 8.171     | 7.800     | 5.538     |
| 12750                                            | 12.750 | 8.246     | 7.912     | 5.776     |
| 13125                                            | 13.125 | 8.325     | 8.026     | 6.047     |
| 13500                                            | 13.500 | 8.403     | 8.134     | 6.338     |
| 13875                                            | 13.875 | 8.481     | 8.240     | 6.609     |
| 14250                                            | 14.250 | 8.561     | 8.344     | 6.862     |
| 14625                                            | 14.625 | 8.642     | 8.447     | 7.102     |
| 15000                                            | 15.000 | 8.725     | 8.549     | 7.337     |
| 15375                                            | 15.375 | 8.808     | 8.649     | 7.566     |
| 15750                                            | 15.750 | 8.893     | 8.749     | 7.789     |
| 16125                                            | 16.125 | 8.979     | 8.848     | 8.006     |
| 16500                                            | 16.500 | 9.065     | 8.946     | 8.218     |
| 16875                                            | 16.875 | 9.152     | 9.043     | 8.424     |
| 17250                                            | 17.250 | 9.238     | 9.139     | 8.628     |
| 17625                                            | 17.625 | 9.324     | 9.234     | 8.831     |
| 18000                                            | 18.000 | 9.426     | 9.339     | 9.027     |

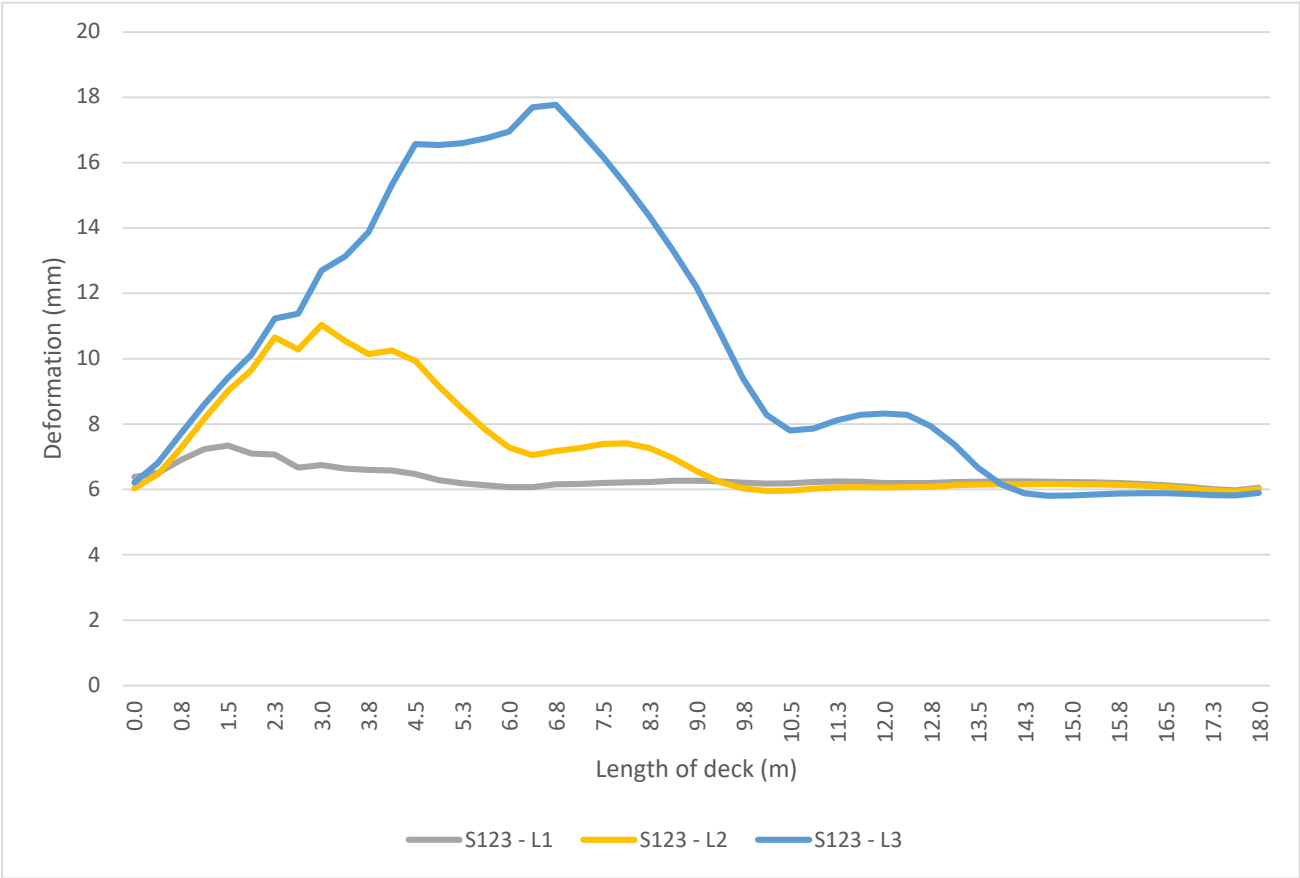


| STIFFENER 3 - Longitudinal direction |        |         |         |         |         |         |         |         |         |         |
|--------------------------------------|--------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                   | m      | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                    | 0.000  | 6.051   | 6.037   | 6.019   | 6.037   | 6.020   | 6.022   | 6.409   | 6.106   | 6.343   |
| 375                                  | 0.375  | 5.911   | 5.898   | 5.883   | 5.900   | 5.885   | 5.887   | 6.525   | 6.528   | 6.921   |
| 750                                  | 0.750  | 5.978   | 5.965   | 5.951   | 5.967   | 5.953   | 5.954   | 6.925   | 7.320   | 7.821   |
| 1125                                 | 1.125  | 6.074   | 6.062   | 6.048   | 6.064   | 6.049   | 6.049   | 7.260   | 8.219   | 8.709   |
| 1500                                 | 1.500  | 6.149   | 6.137   | 6.123   | 6.140   | 6.125   | 6.123   | 7.363   | 9.060   | 9.503   |
| 1875                                 | 1.875  | 6.173   | 6.161   | 6.148   | 6.165   | 6.151   | 6.149   | 7.115   | 9.681   | 10.187  |
| 2250                                 | 2.250  | 6.280   | 6.268   | 6.255   | 6.273   | 6.258   | 6.254   | 7.080   | 10.677  | 11.287  |
| 2625                                 | 2.625  | 6.134   | 6.123   | 6.111   | 6.129   | 6.114   | 6.111   | 6.683   | 10.308  | 11.416  |
| 3000                                 | 3.000  | 6.280   | 6.269   | 6.256   | 6.275   | 6.260   | 6.256   | 6.757   | 11.060  | 12.718  |
| 3375                                 | 3.375  | 6.222   | 6.211   | 6.199   | 6.218   | 6.204   | 6.199   | 6.645   | 10.570  | 13.140  |
| 3750                                 | 3.750  | 6.223   | 6.212   | 6.200   | 6.220   | 6.207   | 6.202   | 6.605   | 10.169  | 13.873  |
| 4125                                 | 4.125  | 6.303   | 6.292   | 6.280   | 6.301   | 6.287   | 6.281   | 6.590   | 10.273  | 15.301  |
| 4500                                 | 4.500  | 6.344   | 6.333   | 6.320   | 6.342   | 6.328   | 6.321   | 6.479   | 9.957   | 16.536  |
| 4875                                 | 4.875  | 6.294   | 6.283   | 6.271   | 6.293   | 6.280   | 6.273   | 6.298   | 9.191   | 16.498  |
| 5250                                 | 5.250  | 6.267   | 6.256   | 6.244   | 6.267   | 6.254   | 6.248   | 6.199   | 8.493   | 16.562  |
| 5625                                 | 5.625  | 6.225   | 6.214   | 6.202   | 6.225   | 6.213   | 6.206   | 6.132   | 7.845   | 16.706  |
| 6000                                 | 6.000  | 6.166   | 6.155   | 6.143   | 6.166   | 6.154   | 6.145   | 6.074   | 7.303   | 16.903  |
| 6375                                 | 6.375  | 6.157   | 6.146   | 6.134   | 6.158   | 6.146   | 6.135   | 6.074   | 7.071   | 17.651  |
| 6750                                 | 6.750  | 6.236   | 6.225   | 6.213   | 6.238   | 6.226   | 6.215   | 6.163   | 7.192   | 17.736  |
| 7125                                 | 7.125  | 6.236   | 6.225   | 6.213   | 6.238   | 6.227   | 6.217   | 6.174   | 7.277   | 16.951  |
| 7500                                 | 7.500  | 6.253   | 6.242   | 6.230   | 6.256   | 6.246   | 6.236   | 6.200   | 7.400   | 16.154  |
| 7875                                 | 7.875  | 6.265   | 6.254   | 6.242   | 6.268   | 6.260   | 6.250   | 6.220   | 7.422   | 15.281  |
| 8250                                 | 8.250  | 6.272   | 6.262   | 6.250   | 6.276   | 6.268   | 6.259   | 6.234   | 7.275   | 14.334  |
| 8625                                 | 8.625  | 6.302   | 6.291   | 6.279   | 6.305   | 6.298   | 6.288   | 6.268   | 6.973   | 13.301  |
| 9000                                 | 9.000  | 6.299   | 6.288   | 6.276   | 6.303   | 6.296   | 6.285   | 6.269   | 6.579   | 12.180  |
| 9375                                 | 9.375  | 6.277   | 6.266   | 6.254   | 6.281   | 6.275   | 6.264   | 6.251   | 6.245   | 10.816  |
| 9750                                 | 9.750  | 6.239   | 6.228   | 6.216   | 6.243   | 6.237   | 6.226   | 6.216   | 6.057   | 9.389   |
| 10125                                | 10.125 | 6.204   | 6.194   | 6.182   | 6.209   | 6.204   | 6.193   | 6.184   | 5.978   | 8.300   |
| 10500                                | 10.500 | 6.208   | 6.197   | 6.185   | 6.212   | 6.208   | 6.197   | 6.189   | 5.984   | 7.819   |
| 10875                                | 10.875 | 6.245   | 6.234   | 6.222   | 6.250   | 6.246   | 6.236   | 6.228   | 6.038   | 7.873   |
| 11250                                | 11.250 | 6.270   | 6.259   | 6.247   | 6.275   | 6.272   | 6.261   | 6.253   | 6.082   | 8.113   |
| 11625                                | 11.625 | 6.257   | 6.246   | 6.233   | 6.262   | 6.259   | 6.249   | 6.241   | 6.090   | 8.277   |
| 12000                                | 12.000 | 6.219   | 6.208   | 6.196   | 6.224   | 6.223   | 6.214   | 6.204   | 6.072   | 8.311   |
| 12375                                | 12.375 | 6.217   | 6.206   | 6.194   | 6.222   | 6.221   | 6.213   | 6.203   | 6.084   | 8.272   |
| 12750                                | 12.750 | 6.216   | 6.205   | 6.193   | 6.221   | 6.221   | 6.214   | 6.202   | 6.097   | 7.942   |
| 13125                                | 13.125 | 6.248   | 6.237   | 6.225   | 6.253   | 6.254   | 6.248   | 6.234   | 6.138   | 7.403   |
| 13500                                | 13.500 | 6.257   | 6.246   | 6.233   | 6.262   | 6.263   | 6.258   | 6.243   | 6.156   | 6.723   |
| 13875                                | 13.875 | 6.260   | 6.249   | 6.236   | 6.266   | 6.267   | 6.263   | 6.247   | 6.167   | 6.214   |
| 14250                                | 14.250 | 6.258   | 6.247   | 6.235   | 6.264   | 6.266   | 6.264   | 6.245   | 6.172   | 5.946   |
| 14625                                | 14.625 | 6.254   | 6.243   | 6.231   | 6.260   | 6.263   | 6.262   | 6.241   | 6.174   | 5.872   |
| 15000                                | 15.000 | 6.246   | 6.235   | 6.222   | 6.252   | 6.256   | 6.256   | 6.233   | 6.171   | 5.876   |
| 15375                                | 15.375 | 6.233   | 6.221   | 6.209   | 6.239   | 6.243   | 6.245   | 6.220   | 6.163   | 5.904   |
| 15750                                | 15.750 | 6.214   | 6.202   | 6.189   | 6.220   | 6.225   | 6.229   | 6.201   | 6.148   | 5.925   |
| 16125                                | 16.125 | 6.186   | 6.174   | 6.161   | 6.192   | 6.199   | 6.204   | 6.173   | 6.124   | 5.935   |
| 16500                                | 16.500 | 6.146   | 6.134   | 6.121   | 6.153   | 6.160   | 6.168   | 6.134   | 6.088   | 5.930   |
| 16875                                | 16.875 | 6.089   | 6.077   | 6.063   | 6.096   | 6.105   | 6.115   | 6.077   | 6.035   | 5.903   |
| 17250                                | 17.250 | 6.023   | 6.011   | 5.997   | 6.031   | 6.041   | 6.053   | 6.012   | 5.972   | 5.864   |
| 17625                                | 17.625 | 5.989   | 5.976   | 5.961   | 5.997   | 6.008   | 6.022   | 5.978   | 5.940   | 5.847   |
| 18000                                | 18.000 | 6.066   | 6.052   | 6.035   | 6.075   | 6.086   | 6.101   | 6.054   | 6.015   | 5.929   |

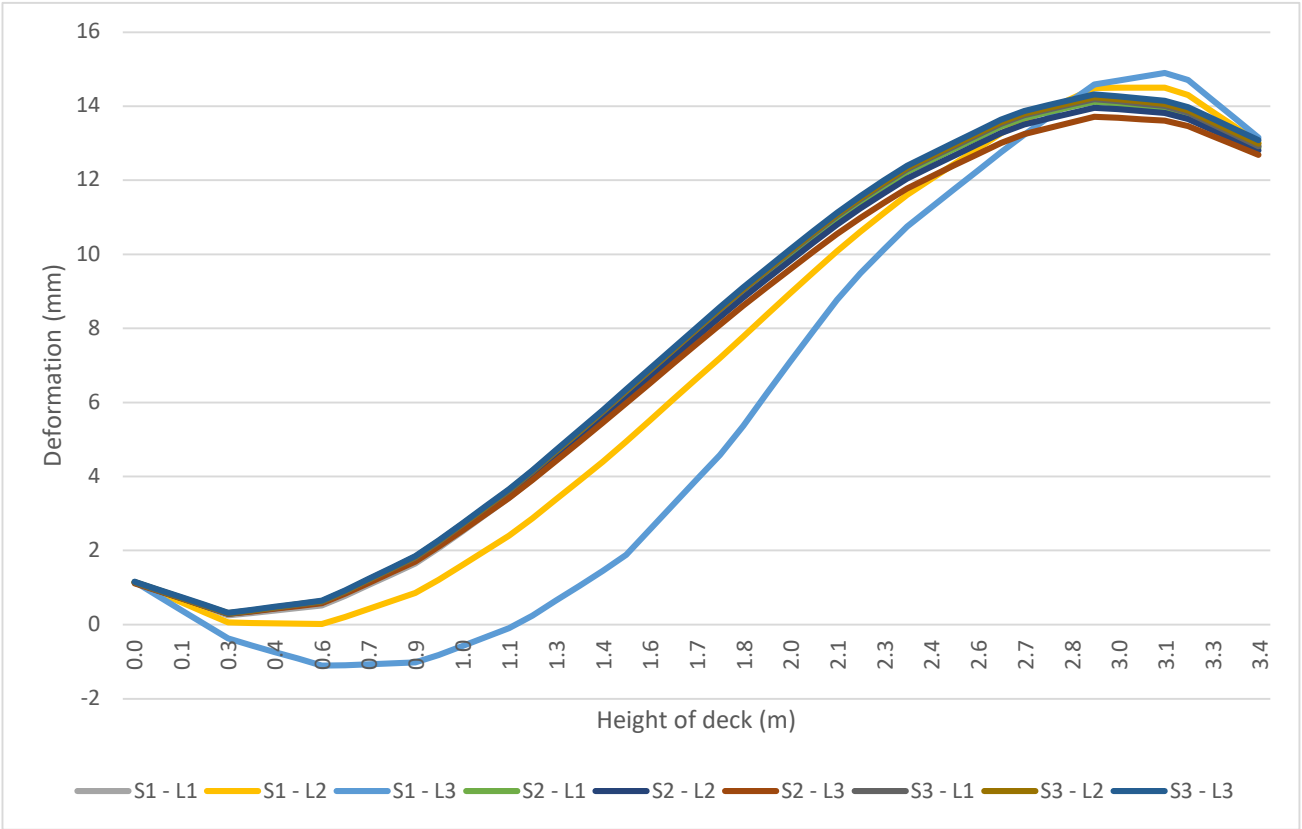


| STIFFENER 3 in S## - Longitudinal direction |        |          |          |          |          |          |          |          |          |          |
|---------------------------------------------|--------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                          | m      | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                           | 0.000  | 6.033    | 6.001    | 5.983    | 6.403    | 6.082    | 6.257    | 6.387    | 6.051    | 6.300    |
| 375                                         | 0.375  | 5.895    | 5.868    | 5.852    | 6.520    | 6.507    | 6.845    | 6.507    | 6.484    | 6.886    |
| 750                                         | 0.750  | 5.963    | 5.936    | 5.921    | 6.921    | 7.300    | 7.750    | 6.910    | 7.284    | 7.790    |
| 1125                                        | 1.125  | 6.061    | 6.033    | 6.016    | 7.255    | 8.200    | 8.641    | 7.245    | 8.188    | 8.681    |
| 1500                                        | 1.500  | 6.136    | 6.109    | 6.092    | 7.358    | 9.042    | 9.438    | 7.350    | 9.037    | 9.482    |
| 1875                                        | 1.875  | 6.162    | 6.136    | 6.119    | 7.111    | 9.664    | 10.126   | 7.103    | 9.666    | 10.181   |
| 2250                                        | 2.250  | 6.269    | 6.242    | 6.224    | 7.076    | 10.661   | 11.227   | 7.070    | 10.669   | 11.297   |
| 2625                                        | 2.625  | 6.125    | 6.099    | 6.081    | 6.679    | 10.292   | 11.361   | 6.674    | 10.299   | 11.435   |
| 3000                                        | 3.000  | 6.272    | 6.245    | 6.226    | 6.753    | 11.044   | 12.664   | 6.749    | 11.055   | 12.750   |
| 3375                                        | 3.375  | 6.215    | 6.189    | 6.170    | 6.641    | 10.554   | 13.088   | 6.639    | 10.563   | 13.181   |
| 3750                                        | 3.750  | 6.217    | 6.192    | 6.173    | 6.602    | 10.155   | 13.824   | 6.600    | 10.162   | 13.926   |
| 4125                                        | 4.125  | 6.297    | 6.272    | 6.252    | 6.586    | 10.259   | 15.253   | 6.585    | 10.266   | 15.369   |
| 4500                                        | 4.500  | 6.338    | 6.313    | 6.292    | 6.475    | 9.943    | 16.489   | 6.473    | 9.950    | 16.617   |
| 4875                                        | 4.875  | 6.289    | 6.265    | 6.244    | 6.294    | 9.177    | 16.452   | 6.293    | 9.182    | 16.579   |
| 5250                                        | 5.250  | 6.263    | 6.240    | 6.219    | 6.195    | 8.480    | 16.517   | 6.194    | 8.484    | 16.643   |
| 5625                                        | 5.625  | 6.222    | 6.199    | 6.178    | 6.129    | 7.832    | 16.664   | 6.128    | 7.835    | 16.789   |
| 6000                                        | 6.000  | 6.163    | 6.139    | 6.117    | 6.071    | 7.291    | 16.861   | 6.071    | 7.294    | 16.987   |
| 6375                                        | 6.375  | 6.155    | 6.131    | 6.106    | 6.070    | 7.060    | 17.608   | 6.070    | 7.064    | 17.739   |
| 6750                                        | 6.750  | 6.234    | 6.211    | 6.186    | 6.159    | 7.181    | 17.692   | 6.160    | 7.189    | 17.822   |
| 7125                                        | 7.125  | 6.234    | 6.212    | 6.188    | 6.170    | 7.267    | 16.907   | 6.172    | 7.278    | 17.028   |
| 7500                                        | 7.500  | 6.252    | 6.231    | 6.208    | 6.197    | 7.391    | 16.112   | 6.199    | 7.404    | 16.223   |
| 7875                                        | 7.875  | 6.265    | 6.245    | 6.222    | 6.217    | 7.412    | 15.240   | 6.219    | 7.426    | 15.344   |
| 8250                                        | 8.250  | 6.272    | 6.254    | 6.231    | 6.230    | 7.266    | 14.295   | 6.233    | 7.279    | 14.391   |
| 8625                                        | 8.625  | 6.302    | 6.283    | 6.259    | 6.265    | 6.962    | 13.263   | 6.268    | 6.971    | 13.352   |
| 9000                                        | 9.000  | 6.299    | 6.281    | 6.256    | 6.266    | 6.568    | 12.142   | 6.269    | 6.573    | 12.224   |
| 9375                                        | 9.375  | 6.278    | 6.260    | 6.235    | 6.247    | 6.234    | 10.779   | 6.251    | 6.236    | 10.851   |
| 9750                                        | 9.750  | 6.239    | 6.223    | 6.198    | 6.212    | 6.046    | 9.352    | 6.216    | 6.047    | 9.414    |
| 10125                                       | 10.125 | 6.205    | 6.189    | 6.165    | 6.180    | 5.966    | 8.265    | 6.184    | 5.968    | 8.320    |
| 10500                                       | 10.500 | 6.209    | 6.193    | 6.169    | 6.185    | 5.972    | 7.785    | 6.189    | 5.975    | 7.838    |
| 10875                                       | 10.875 | 6.246    | 6.231    | 6.207    | 6.224    | 6.026    | 7.842    | 6.228    | 6.030    | 7.897    |
| 11250                                       | 11.250 | 6.271    | 6.257    | 6.232    | 6.250    | 6.071    | 8.084    | 6.254    | 6.075    | 8.143    |
| 11625                                       | 11.625 | 6.258    | 6.244    | 6.221    | 6.237    | 6.079    | 8.251    | 6.242    | 6.085    | 8.313    |
| 12000                                       | 12.000 | 6.221    | 6.208    | 6.185    | 6.201    | 6.061    | 8.286    | 6.205    | 6.068    | 8.350    |
| 12375                                       | 12.375 | 6.218    | 6.207    | 6.185    | 6.199    | 6.074    | 8.246    | 6.204    | 6.082    | 8.310    |
| 12750                                       | 12.750 | 6.217    | 6.206    | 6.186    | 6.198    | 6.086    | 7.913    | 6.203    | 6.095    | 7.972    |
| 13125                                       | 13.125 | 6.250    | 6.239    | 6.219    | 6.231    | 6.128    | 7.369    | 6.236    | 6.137    | 7.420    |
| 13500                                       | 13.500 | 6.258    | 6.248    | 6.229    | 6.239    | 6.145    | 6.682    | 6.245    | 6.156    | 6.722    |
| 13875                                       | 13.875 | 6.262    | 6.252    | 6.234    | 6.243    | 6.156    | 6.169    | 6.248    | 6.168    | 6.202    |
| 14250                                       | 14.250 | 6.260    | 6.251    | 6.235    | 6.241    | 6.161    | 5.899    | 6.247    | 6.174    | 5.930    |
| 14625                                       | 14.625 | 6.256    | 6.248    | 6.233    | 6.237    | 6.163    | 5.825    | 6.243    | 6.177    | 5.856    |
| 15000                                       | 15.000 | 6.248    | 6.241    | 6.227    | 6.229    | 6.160    | 5.830    | 6.235    | 6.175    | 5.864    |
| 15375                                       | 15.375 | 6.235    | 6.228    | 6.216    | 6.216    | 6.152    | 5.858    | 6.222    | 6.167    | 5.895    |
| 15750                                       | 15.750 | 6.216    | 6.210    | 6.199    | 6.197    | 6.137    | 5.879    | 6.203    | 6.153    | 5.921    |
| 16125                                       | 16.125 | 6.188    | 6.183    | 6.174    | 6.169    | 6.113    | 5.889    | 6.176    | 6.131    | 5.935    |
| 16500                                       | 16.500 | 6.149    | 6.144    | 6.137    | 6.130    | 6.077    | 5.885    | 6.137    | 6.096    | 5.935    |
| 16875                                       | 16.875 | 6.092    | 6.088    | 6.084    | 6.073    | 6.023    | 5.858    | 6.080    | 6.044    | 5.913    |
| 17250                                       | 17.250 | 6.027    | 6.024    | 6.021    | 6.008    | 5.960    | 5.818    | 6.016    | 5.984    | 5.878    |
| 17625                                       | 17.625 | 5.993    | 5.990    | 5.988    | 5.974    | 5.927    | 5.799    | 5.982    | 5.952    | 5.865    |
| 18000                                       | 18.000 | 6.070    | 6.067    | 6.065    | 6.050    | 6.001    | 5.877    | 6.058    | 6.028    | 5.948    |

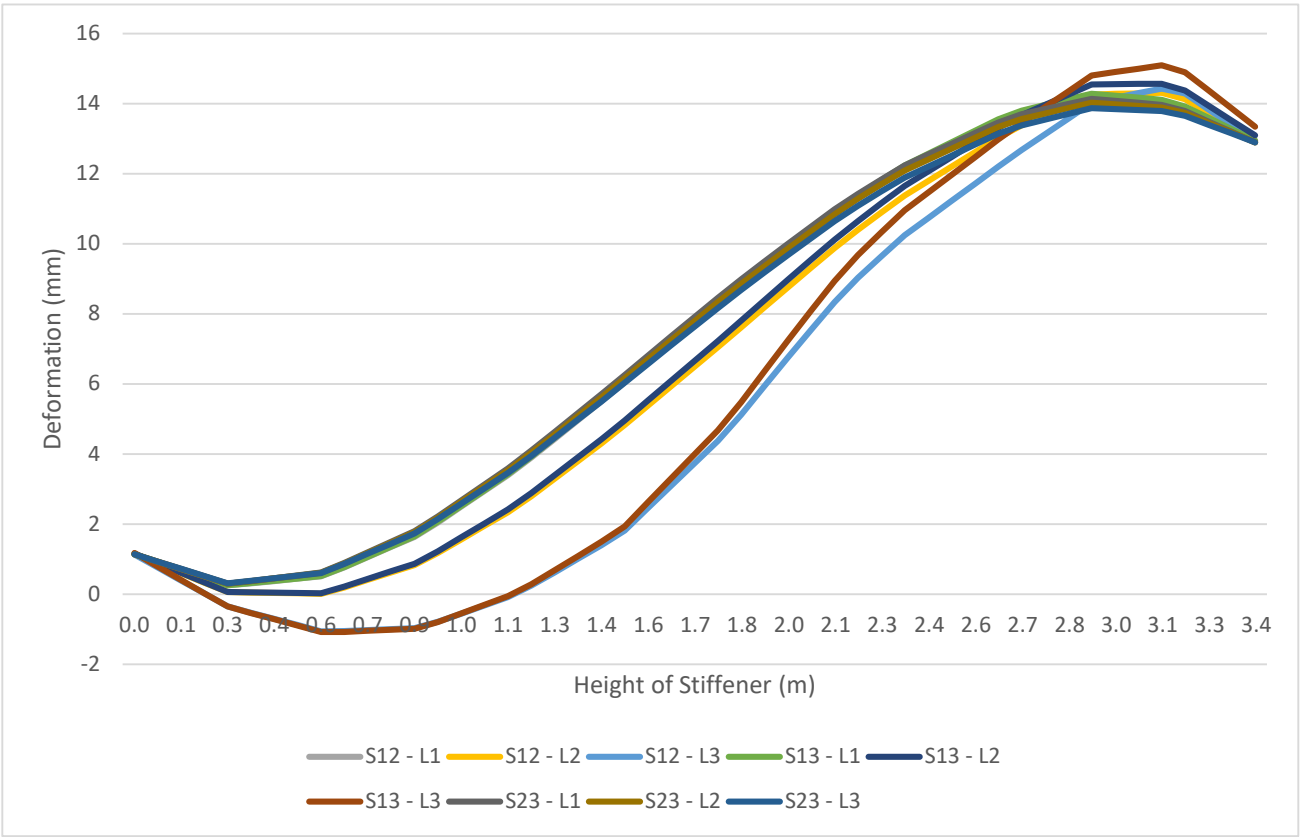




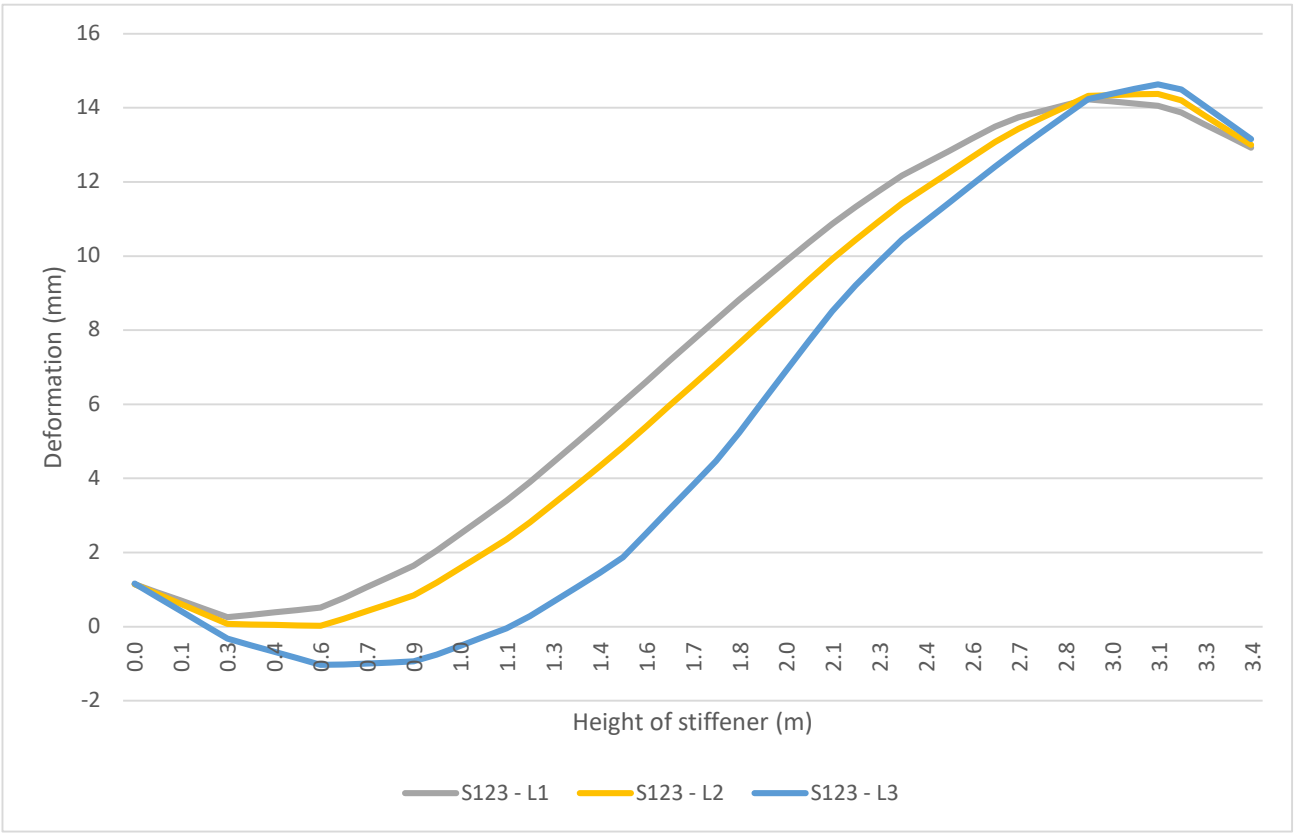
| STIFFENER 3 in S1,2 & 3 - Longitudinal direction |        |           |           |           |
|--------------------------------------------------|--------|-----------|-----------|-----------|
| mm                                               | m      | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                                | 0.000  | 6.381     | 6.027     | 6.210     |
| 375                                              | 0.375  | 6.502     | 6.462     | 6.808     |
| 750                                              | 0.750  | 6.905     | 7.263     | 7.718     |
| 1125                                             | 1.125  | 7.240     | 8.169     | 8.611     |
| 1500                                             | 1.500  | 7.345     | 9.019     | 9.415     |
| 1875                                             | 1.875  | 7.099     | 9.649     | 10.119    |
| 2250                                             | 2.250  | 7.066     | 10.652    | 11.235    |
| 2625                                             | 2.625  | 6.670     | 10.283    | 11.378    |
| 3000                                             | 3.000  | 6.746     | 11.038    | 12.695    |
| 3375                                             | 3.375  | 6.635     | 10.547    | 13.128    |
| 3750                                             | 3.750  | 6.597     | 10.146    | 13.875    |
| 4125                                             | 4.125  | 6.581     | 10.251    | 15.320    |
| 4500                                             | 4.500  | 6.470     | 9.935     | 16.568    |
| 4875                                             | 4.875  | 6.289     | 9.168     | 16.532    |
| 5250                                             | 5.250  | 6.190     | 8.471     | 16.598    |
| 5625                                             | 5.625  | 6.125     | 7.822     | 16.745    |
| 6000                                             | 6.000  | 6.067     | 7.282     | 16.945    |
| 6375                                             | 6.375  | 6.067     | 7.052     | 17.695    |
| 6750                                             | 6.750  | 6.156     | 7.178     | 17.777    |
| 7125                                             | 7.125  | 6.168     | 7.267     | 16.983    |
| 7500                                             | 7.500  | 6.195     | 7.394     | 16.180    |
| 7875                                             | 7.875  | 6.216     | 7.416     | 15.302    |
| 8250                                             | 8.250  | 6.230     | 7.269     | 14.351    |
| 8625                                             | 8.625  | 6.264     | 6.961     | 13.312    |
| 9000                                             | 9.000  | 6.265     | 6.562     | 12.185    |
| 9375                                             | 9.375  | 6.247     | 6.224     | 10.812    |
| 9750                                             | 9.750  | 6.212     | 6.035     | 9.376     |
| 10125                                            | 10.125 | 6.181     | 5.957     | 8.283     |
| 10500                                            | 10.500 | 6.186     | 5.964     | 7.804     |
| 10875                                            | 10.875 | 6.225     | 6.018     | 7.865     |
| 11250                                            | 11.250 | 6.250     | 6.064     | 8.114     |
| 11625                                            | 11.625 | 6.238     | 6.073     | 8.286     |
| 12000                                            | 12.000 | 6.202     | 6.056     | 8.324     |
| 12375                                            | 12.375 | 6.200     | 6.070     | 8.283     |
| 12750                                            | 12.750 | 6.199     | 6.084     | 7.943     |
| 13125                                            | 13.125 | 6.232     | 6.126     | 7.384     |
| 13500                                            | 13.500 | 6.241     | 6.144     | 6.680     |
| 13875                                            | 13.875 | 6.244     | 6.156     | 6.155     |
| 14250                                            | 14.250 | 6.243     | 6.162     | 5.881     |
| 14625                                            | 14.625 | 6.239     | 6.165     | 5.807     |
| 15000                                            | 15.000 | 6.231     | 6.163     | 5.815     |
| 15375                                            | 15.375 | 6.218     | 6.156     | 5.847     |
| 15750                                            | 15.750 | 6.199     | 6.142     | 5.873     |
| 16125                                            | 16.125 | 6.172     | 6.119     | 5.887     |
| 16500                                            | 16.500 | 6.133     | 6.085     | 5.887     |
| 16875                                            | 16.875 | 6.076     | 6.032     | 5.865     |
| 17250                                            | 17.250 | 6.012     | 5.971     | 5.830     |
| 17625                                            | 17.625 | 5.977     | 5.939     | 5.815     |
| 18000                                            | 18.000 | 6.053     | 6.014     | 5.894     |



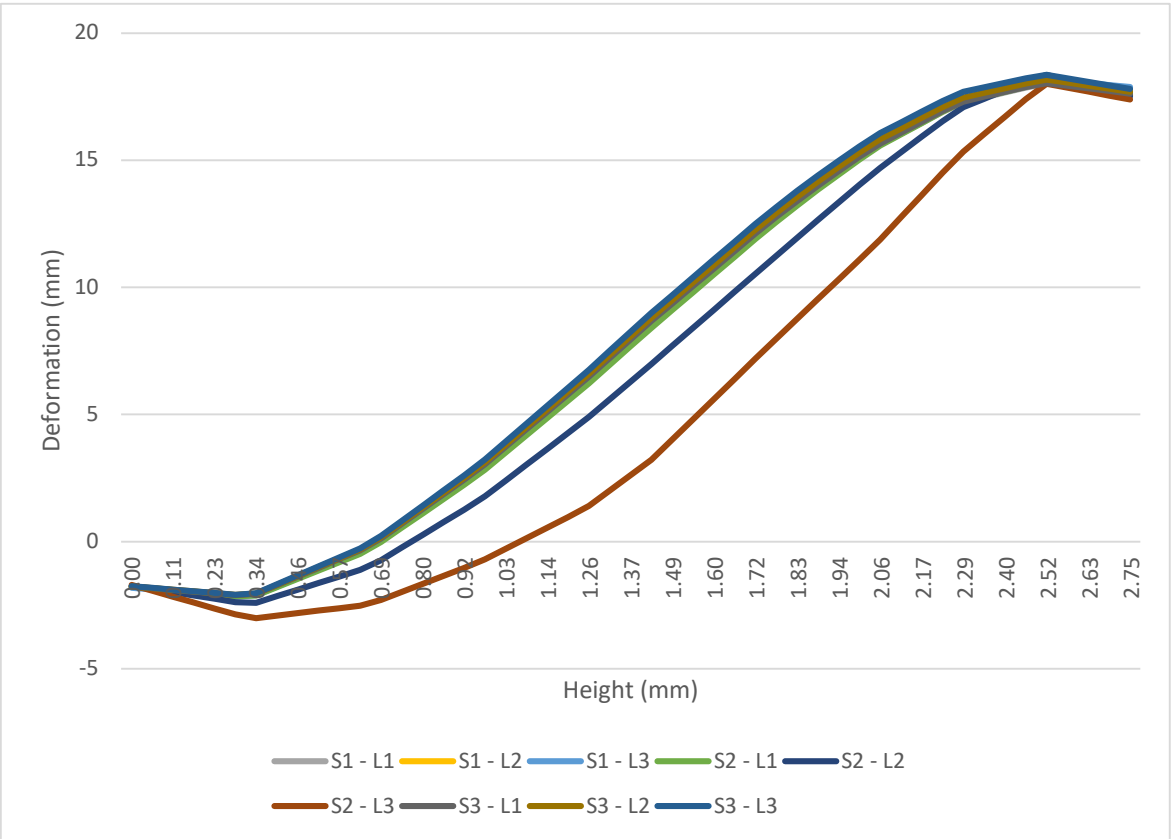
| STIFFENER 1 - Transversal direction |       |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                   | 0.000 | 1.139   | 1.145   | 1.154   | 1.134   | 1.128   | 1.117   | 1.138   | 1.145   | 1.157   |
| 71.08                               | 0.071 | 0.918   | 0.873   | 0.772   | 0.925   | 0.920   | 0.911   | 0.929   | 0.936   | 0.948   |
| 142.16                              | 0.142 | 0.697   | 0.601   | 0.390   | 0.717   | 0.711   | 0.704   | 0.720   | 0.727   | 0.739   |
| 213.24                              | 0.213 | 0.476   | 0.330   | 0.008   | 0.508   | 0.503   | 0.498   | 0.511   | 0.518   | 0.530   |
| 284.32                              | 0.284 | 0.256   | 0.057   | -0.375  | 0.299   | 0.295   | 0.292   | 0.302   | 0.309   | 0.321   |
| 355.4                               | 0.355 | 0.313   | 0.042   | -0.561  | 0.370   | 0.363   | 0.356   | 0.375   | 0.382   | 0.395   |
| 426.48                              | 0.426 | 0.380   | 0.035   | -0.741  | 0.451   | 0.440   | 0.429   | 0.457   | 0.465   | 0.478   |
| 497.56                              | 0.498 | 0.446   | 0.027   | -0.922  | 0.532   | 0.518   | 0.503   | 0.539   | 0.547   | 0.561   |
| 568.64                              | 0.569 | 0.513   | 0.020   | -1.103  | 0.613   | 0.595   | 0.576   | 0.621   | 0.630   | 0.644   |
| 639.72                              | 0.640 | 0.775   | 0.207   | -1.102  | 0.887   | 0.863   | 0.836   | 0.898   | 0.907   | 0.922   |
| 710.8                               | 0.711 | 1.067   | 0.423   | -1.074  | 1.191   | 1.161   | 1.125   | 1.204   | 1.214   | 1.230   |
| 781.88                              | 0.782 | 1.359   | 0.640   | -1.045  | 1.494   | 1.459   | 1.414   | 1.510   | 1.520   | 1.538   |
| 852.96                              | 0.853 | 1.651   | 0.856   | -1.018  | 1.798   | 1.756   | 1.703   | 1.816   | 1.827   | 1.846   |
| 924.04                              | 0.924 | 2.064   | 1.209   | -0.826  | 2.218   | 2.169   | 2.105   | 2.239   | 2.251   | 2.270   |
| 995.12                              | 0.995 | 2.516   | 1.606   | -0.583  | 2.675   | 2.618   | 2.543   | 2.699   | 2.711   | 2.732   |
| 1066.2                              | 1.066 | 2.967   | 2.003   | -0.340  | 3.131   | 3.066   | 2.980   | 3.158   | 3.172   | 3.194   |
| 1137.3                              | 1.137 | 3.419   | 2.399   | -0.096  | 3.588   | 3.515   | 3.418   | 3.618   | 3.632   | 3.656   |
| 1208.4                              | 1.208 | 3.925   | 2.867   | 0.244   | 4.094   | 4.013   | 3.904   | 4.127   | 4.143   | 4.167   |
| 1279.4                              | 1.279 | 4.462   | 3.376   | 0.642   | 4.629   | 4.540   | 4.418   | 4.665   | 4.681   | 4.708   |
| 1350.5                              | 1.351 | 5.000   | 3.887   | 1.043   | 5.164   | 5.067   | 4.932   | 5.204   | 5.221   | 5.249   |
| 1421.6                              | 1.422 | 5.539   | 4.401   | 1.448   | 5.701   | 5.596   | 5.448   | 5.744   | 5.762   | 5.792   |
| 1492.7                              | 1.493 | 6.093   | 4.938   | 1.883   | 6.251   | 6.137   | 5.977   | 6.297   | 6.316   | 6.347   |
| 1563.8                              | 1.564 | 6.650   | 5.504   | 2.553   | 6.800   | 6.678   | 6.507   | 6.849   | 6.869   | 6.902   |
| 1634.8                              | 1.635 | 7.208   | 6.070   | 3.227   | 7.350   | 7.220   | 7.038   | 7.401   | 7.423   | 7.458   |
| 1705.9                              | 1.706 | 7.766   | 6.636   | 3.903   | 7.899   | 7.763   | 7.568   | 7.954   | 7.977   | 8.014   |
| 1777                                | 1.777 | 8.323   | 7.201   | 4.581   | 8.449   | 8.305   | 8.099   | 8.507   | 8.531   | 8.569   |
| 1848.1                              | 1.848 | 8.864   | 7.778   | 5.365   | 8.979   | 8.828   | 8.612   | 9.039   | 9.065   | 9.105   |
| 1919.2                              | 1.919 | 9.387   | 8.362   | 6.238   | 9.487   | 9.330   | 9.105   | 9.549   | 9.577   | 9.620   |
| 1990.2                              | 1.990 | 9.904   | 8.942   | 7.095   | 9.990   | 9.828   | 9.594   | 10.054  | 10.083  | 10.128  |
| 2061.3                              | 2.061 | 10.413  | 9.515   | 7.936   | 10.485  | 10.318  | 10.076  | 10.552  | 10.582  | 10.629  |
| 2132.4                              | 2.132 | 10.917  | 10.083  | 8.767   | 10.974  | 10.802  | 10.553  | 11.043  | 11.075  | 11.125  |
| 2203.5                              | 2.204 | 11.378  | 10.612  | 9.487   | 11.417  | 11.241  | 10.986  | 11.488  | 11.521  | 11.573  |
| 2274.6                              | 2.275 | 11.810  | 11.115  | 10.131  | 11.829  | 11.651  | 11.391  | 11.901  | 11.936  | 11.990  |
| 2345.6                              | 2.346 | 12.228  | 11.606  | 10.751  | 12.227  | 12.046  | 11.782  | 12.299  | 12.336  | 12.393  |
| 2416.7                              | 2.417 | 12.557  | 12.019  | 11.252  | 12.533  | 12.353  | 12.089  | 12.606  | 12.645  | 12.704  |
| 2487.8                              | 2.488 | 12.885  | 12.433  | 11.753  | 12.840  | 12.660  | 12.396  | 12.913  | 12.953  | 13.015  |
| 2558.9                              | 2.559 | 13.214  | 12.847  | 12.254  | 13.147  | 12.967  | 12.703  | 13.220  | 13.262  | 13.326  |
| 2630                                | 2.630 | 13.542  | 13.261  | 12.755  | 13.453  | 13.274  | 13.009  | 13.527  | 13.570  | 13.637  |
| 2701                                | 2.701 | 13.791  | 13.616  | 13.232  | 13.683  | 13.507  | 13.245  | 13.757  | 13.801  | 13.871  |
| 2772.1                              | 2.772 | 13.953  | 13.907  | 13.682  | 13.831  | 13.659  | 13.403  | 13.903  | 13.949  | 14.022  |
| 2843.2                              | 2.843 | 14.115  | 14.198  | 14.134  | 13.978  | 13.811  | 13.561  | 14.049  | 14.097  | 14.172  |
| 2914.3                              | 2.914 | 14.277  | 14.489  | 14.586  | 14.126  | 13.963  | 13.719  | 14.195  | 14.245  | 14.323  |
| 2985.4                              | 2.985 | 14.218  | 14.499  | 14.694  | 14.069  | 13.917  | 13.686  | 14.136  | 14.188  | 14.268  |
| 3056.4                              | 3.056 | 14.154  | 14.502  | 14.796  | 14.008  | 13.866  | 13.648  | 14.072  | 14.125  | 14.209  |
| 3127.5                              | 3.128 | 14.090  | 14.505  | 14.900  | 13.947  | 13.815  | 13.611  | 14.007  | 14.063  | 14.149  |
| 3198.6                              | 3.199 | 13.902  | 14.301  | 14.706  | 13.772  | 13.653  | 13.467  | 13.829  | 13.887  | 13.976  |
| 3269.7                              | 3.270 | 13.578  | 13.872  | 14.188  | 13.474  | 13.371  | 13.207  | 13.526  | 13.586  | 13.678  |
| 3340.8                              | 3.341 | 13.254  | 13.443  | 13.670  | 13.176  | 13.090  | 12.948  | 13.223  | 13.285  | 13.380  |
| 3411.8                              | 3.412 | 12.930  | 13.015  | 13.153  | 12.878  | 12.808  | 12.688  | 12.920  | 12.984  | 13.082  |



| STIFFENER 1 in S## - Transversal direction |       |          |          |          |          |          |          |          |          |          |
|--------------------------------------------|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                         | m     | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                          | 0.000 | 1.137    | 1.136    | 1.134    | 1.140    | 1.153    | 1.174    | 1.136    | 1.137    | 1.139    |
| 71.08                                      | 0.071 | 0.916    | 0.867    | 0.764    | 0.920    | 0.881    | 0.793    | 0.927    | 0.928    | 0.933    |
| 142.16                                     | 0.142 | 0.695    | 0.597    | 0.393    | 0.699    | 0.610    | 0.411    | 0.718    | 0.720    | 0.727    |
| 213.24                                     | 0.213 | 0.475    | 0.328    | 0.022    | 0.478    | 0.338    | 0.029    | 0.509    | 0.512    | 0.520    |
| 284.32                                     | 0.284 | 0.254    | 0.058    | -0.349   | 0.257    | 0.065    | -0.354   | 0.300    | 0.303    | 0.314    |
| 355.4                                      | 0.355 | 0.310    | 0.040    | -0.529   | 0.315    | 0.050    | -0.540   | 0.372    | 0.372    | 0.379    |
| 426.48                                     | 0.426 | 0.376    | 0.031    | -0.704   | 0.382    | 0.043    | -0.719   | 0.453    | 0.450    | 0.453    |
| 497.56                                     | 0.498 | 0.442    | 0.022    | -0.879   | 0.448    | 0.036    | -0.900   | 0.534    | 0.528    | 0.528    |
| 568.64                                     | 0.569 | 0.507    | 0.012    | -1.055   | 0.515    | 0.029    | -1.080   | 0.614    | 0.605    | 0.602    |
| 639.72                                     | 0.640 | 0.767    | 0.194    | -1.054   | 0.777    | 0.216    | -1.078   | 0.889    | 0.874    | 0.864    |
| 710.8                                      | 0.711 | 1.057    | 0.405    | -1.027   | 1.069    | 0.434    | -1.048   | 1.193    | 1.173    | 1.155    |
| 781.88                                     | 0.782 | 1.347    | 0.616    | -1.000   | 1.361    | 0.651    | -1.019   | 1.497    | 1.471    | 1.445    |
| 852.96                                     | 0.853 | 1.637    | 0.826    | -0.974   | 1.653    | 0.867    | -0.990   | 1.801    | 1.770    | 1.736    |
| 924.04                                     | 0.924 | 2.048    | 1.172    | -0.789   | 2.067    | 1.222    | -0.797   | 2.221    | 2.183    | 2.140    |
| 995.12                                     | 0.995 | 2.497    | 1.560    | -0.555   | 2.519    | 1.619    | -0.551   | 2.678    | 2.633    | 2.579    |
| 1066.2                                     | 1.066 | 2.946    | 1.949    | -0.321   | 2.971    | 2.016    | -0.306   | 3.134    | 3.083    | 3.019    |
| 1137.3                                     | 1.137 | 3.394    | 2.337    | -0.088   | 3.422    | 2.414    | -0.060   | 3.591    | 3.533    | 3.459    |
| 1208.4                                     | 1.208 | 3.897    | 2.795    | 0.240    | 3.928    | 2.882    | 0.283    | 4.098    | 4.032    | 3.947    |
| 1279.4                                     | 1.279 | 4.432    | 3.295    | 0.623    | 4.466    | 3.393    | 0.684    | 4.633    | 4.560    | 4.464    |
| 1350.5                                     | 1.351 | 4.967    | 3.796    | 1.008    | 5.004    | 3.904    | 1.088    | 5.169    | 5.088    | 4.981    |
| 1421.6                                     | 1.422 | 5.503    | 4.299    | 1.397    | 5.543    | 4.419    | 1.495    | 5.706    | 5.618    | 5.500    |
| 1492.7                                     | 1.493 | 6.055    | 4.826    | 1.815    | 6.098    | 4.957    | 1.933    | 6.256    | 6.160    | 6.032    |
| 1563.8                                     | 1.564 | 6.609    | 5.381    | 2.452    | 6.655    | 5.525    | 2.615    | 6.805    | 6.703    | 6.565    |
| 1634.8                                     | 1.635 | 7.164    | 5.937    | 3.092    | 7.213    | 6.093    | 3.300    | 7.355    | 7.247    | 7.099    |
| 1705.9                                     | 1.706 | 7.719    | 6.493    | 3.733    | 7.772    | 6.660    | 3.987    | 7.905    | 7.791    | 7.634    |
| 1777                                       | 1.777 | 8.274    | 7.047    | 4.376    | 8.330    | 7.227    | 4.676    | 8.455    | 8.335    | 8.168    |
| 1848.1                                     | 1.848 | 8.813    | 7.614    | 5.119    | 8.871    | 7.805    | 5.475    | 8.985    | 8.860    | 8.685    |
| 1919.2                                     | 1.919 | 9.334    | 8.188    | 5.944    | 9.394    | 8.392    | 6.365    | 9.494    | 9.364    | 9.183    |
| 1990.2                                     | 1.990 | 9.849    | 8.758    | 6.755    | 9.911    | 8.974    | 7.239    | 9.997    | 9.863    | 9.676    |
| 2061.3                                     | 2.061 | 10.356   | 9.321    | 7.551    | 10.421   | 9.549    | 8.096    | 10.493   | 10.356   | 10.163   |
| 2132.4                                     | 2.132 | 10.859   | 9.880    | 8.339    | 10.926   | 10.119   | 8.943    | 10.983   | 10.842   | 10.644   |
| 2203.5                                     | 2.204 | 11.318   | 10.401   | 9.027    | 11.387   | 10.650   | 9.675    | 11.426   | 11.283   | 11.082   |
| 2274.6                                     | 2.275 | 11.749   | 10.898   | 9.646    | 11.819   | 11.155   | 10.329   | 11.838   | 11.695   | 11.493   |
| 2345.6                                     | 2.346 | 12.166   | 11.382   | 10.242   | 12.238   | 11.648   | 10.956   | 12.236   | 12.093   | 11.889   |
| 2416.7                                     | 2.417 | 12.495   | 11.793   | 10.732   | 12.567   | 12.063   | 11.460   | 12.543   | 12.402   | 12.202   |
| 2487.8                                     | 2.488 | 12.823   | 12.204   | 11.222   | 12.896   | 12.479   | 11.964   | 12.851   | 12.711   | 12.514   |
| 2558.9                                     | 2.559 | 13.152   | 12.615   | 11.711   | 13.225   | 12.895   | 12.468   | 13.158   | 13.021   | 12.827   |
| 2630                                       | 2.630 | 13.480   | 13.026   | 12.201   | 13.554   | 13.310   | 12.973   | 13.465   | 13.330   | 13.139   |
| 2701                                       | 2.701 | 13.729   | 13.380   | 12.671   | 13.803   | 13.668   | 13.450   | 13.695   | 13.565   | 13.381   |
| 2772.1                                     | 2.772 | 13.893   | 13.674   | 13.121   | 13.965   | 13.961   | 13.900   | 13.843   | 13.720   | 13.545   |
| 2843.2                                     | 2.843 | 14.057   | 13.967   | 13.572   | 14.128   | 14.254   | 14.350   | 13.991   | 13.875   | 13.709   |
| 2914.3                                     | 2.914 | 14.220   | 14.260   | 14.023   | 14.290   | 14.547   | 14.801   | 14.139   | 14.030   | 13.874   |
| 2985.4                                     | 2.985 | 14.165   | 14.281   | 14.164   | 14.232   | 14.559   | 14.904   | 14.084   | 13.986   | 13.848   |
| 3056.4                                     | 3.056 | 14.105   | 14.296   | 14.298   | 14.169   | 14.565   | 14.999   | 14.023   | 13.938   | 13.818   |
| 3127.5                                     | 3.128 | 14.044   | 14.312   | 14.434   | 14.106   | 14.570   | 15.096   | 13.962   | 13.890   | 13.788   |
| 3198.6                                     | 3.199 | 13.860   | 14.127   | 14.290   | 13.918   | 14.370   | 14.899   | 13.788   | 13.732   | 13.652   |
| 3269.7                                     | 3.270 | 13.542   | 13.724   | 13.838   | 13.594   | 13.944   | 14.380   | 13.491   | 13.453   | 13.400   |
| 3340.8                                     | 3.341 | 13.224   | 13.321   | 13.387   | 13.271   | 13.519   | 13.863   | 13.194   | 13.175   | 13.149   |
| 3411.8                                     | 3.412 | 12.906   | 12.919   | 12.936   | 12.948   | 13.094   | 13.346   | 12.897   | 12.896   | 12.898   |

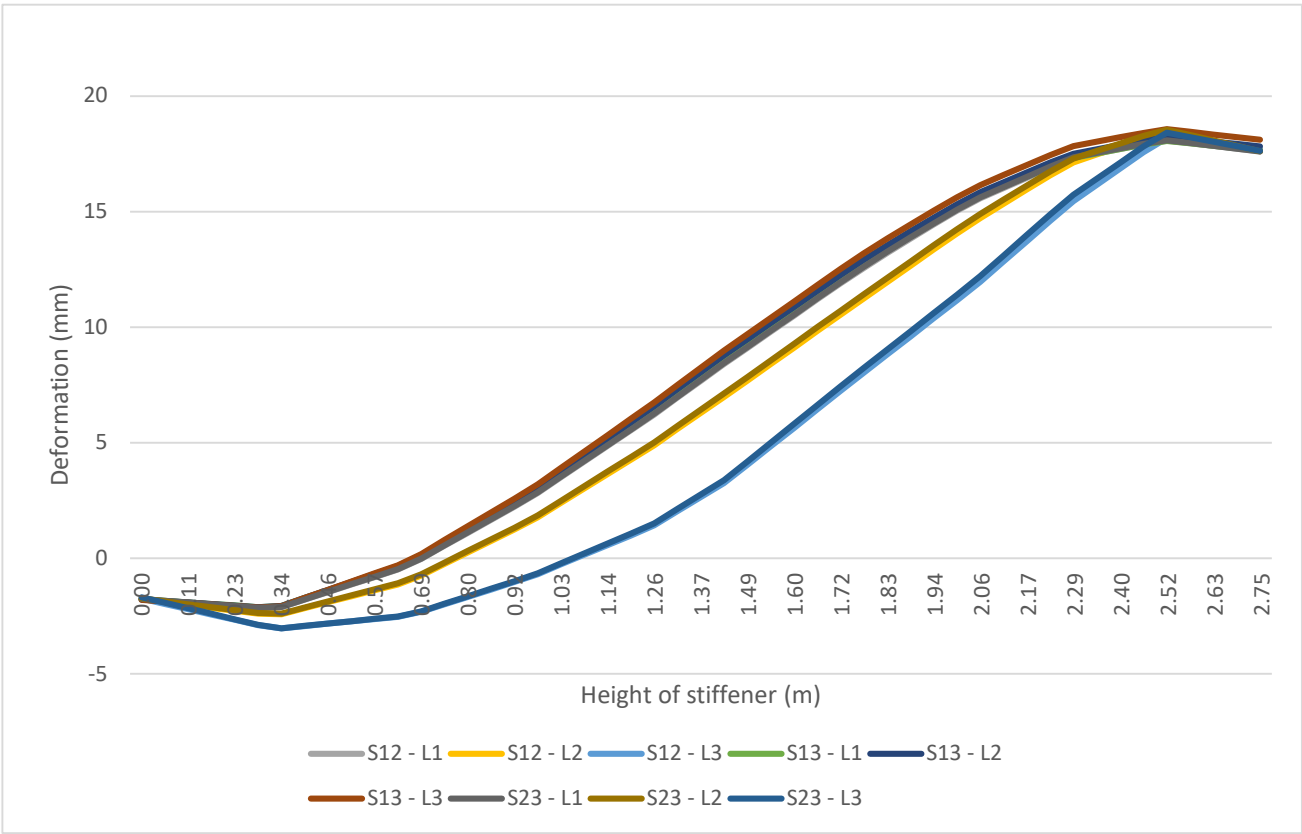


| STIFFENER 1 in S1,2 & 3 - Transversal direction |       |           |           |           |
|-------------------------------------------------|-------|-----------|-----------|-----------|
| mm                                              | m     | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                               | 0.000 | 1.138     | 1.145     | 1.156     |
| 71.08                                           | 0.071 | 0.918     | 0.875     | 0.786     |
| 142.16                                          | 0.142 | 0.697     | 0.606     | 0.416     |
| 213.24                                          | 0.213 | 0.476     | 0.336     | 0.046     |
| 284.32                                          | 0.284 | 0.256     | 0.066     | -0.325    |
| 355.4                                           | 0.355 | 0.312     | 0.049     | -0.505    |
| 426.48                                          | 0.426 | 0.378     | 0.040     | -0.679    |
| 497.56                                          | 0.498 | 0.443     | 0.031     | -0.854    |
| 568.64                                          | 0.569 | 0.509     | 0.021     | -1.029    |
| 639.72                                          | 0.640 | 0.769     | 0.204     | -1.028    |
| 710.8                                           | 0.711 | 1.059     | 0.415     | -0.999    |
| 781.88                                          | 0.782 | 1.349     | 0.627     | -0.971    |
| 852.96                                          | 0.853 | 1.639     | 0.838     | -0.944    |
| 924.04                                          | 0.924 | 2.050     | 1.184     | -0.758    |
| 995.12                                          | 0.995 | 2.499     | 1.573     | -0.522    |
| 1066.2                                          | 1.066 | 2.949     | 1.962     | -0.286    |
| 1137.3                                          | 1.137 | 3.398     | 2.351     | -0.051    |
| 1208.4                                          | 1.208 | 3.901     | 2.811     | 0.279     |
| 1279.4                                          | 1.279 | 4.435     | 3.311     | 0.664     |
| 1350.5                                          | 1.351 | 4.971     | 3.813     | 1.053     |
| 1421.6                                          | 1.422 | 5.508     | 4.317     | 1.445     |
| 1492.7                                          | 1.493 | 6.059     | 4.845     | 1.865     |
| 1563.8                                          | 1.564 | 6.614     | 5.402     | 2.512     |
| 1634.8                                          | 1.635 | 7.169     | 5.960     | 3.162     |
| 1705.9                                          | 1.706 | 7.725     | 6.517     | 3.814     |
| 1777                                            | 1.777 | 8.280     | 7.073     | 4.467     |
| 1848.1                                          | 1.848 | 8.819     | 7.641     | 5.224     |
| 1919.2                                          | 1.919 | 9.340     | 8.218     | 6.066     |
| 1990.2                                          | 1.990 | 9.856     | 8.789     | 6.894     |
| 2061.3                                          | 2.061 | 10.364    | 9.355     | 7.705     |
| 2132.4                                          | 2.132 | 10.867    | 9.916     | 8.509     |
| 2203.5                                          | 2.204 | 11.326    | 10.439    | 9.209     |
| 2274.6                                          | 2.275 | 11.758    | 10.938    | 9.837     |
| 2345.6                                          | 2.346 | 12.176    | 11.425    | 10.441    |
| 2416.7                                          | 2.417 | 12.504    | 11.838    | 10.934    |
| 2487.8                                          | 2.488 | 12.833    | 12.251    | 11.427    |
| 2558.9                                          | 2.559 | 13.162    | 12.664    | 11.920    |
| 2630                                            | 2.630 | 13.492    | 13.077    | 12.413    |
| 2701                                            | 2.701 | 13.741    | 13.433    | 12.886    |
| 2772.1                                          | 2.772 | 13.906    | 13.729    | 13.336    |
| 2843.2                                          | 2.843 | 14.070    | 14.025    | 13.788    |
| 2914.3                                          | 2.914 | 14.233    | 14.320    | 14.240    |
| 2985.4                                          | 2.985 | 14.179    | 14.345    | 14.378    |
| 3056.4                                          | 3.056 | 14.120    | 14.363    | 14.510    |
| 3127.5                                          | 3.128 | 14.060    | 14.381    | 14.643    |
| 3198.6                                          | 3.199 | 13.877    | 14.200    | 14.499    |
| 3269.7                                          | 3.270 | 13.559    | 13.801    | 14.052    |
| 3340.8                                          | 3.341 | 13.242    | 13.403    | 13.605    |
| 3411.8                                          | 3.412 | 12.925    | 13.005    | 13.159    |

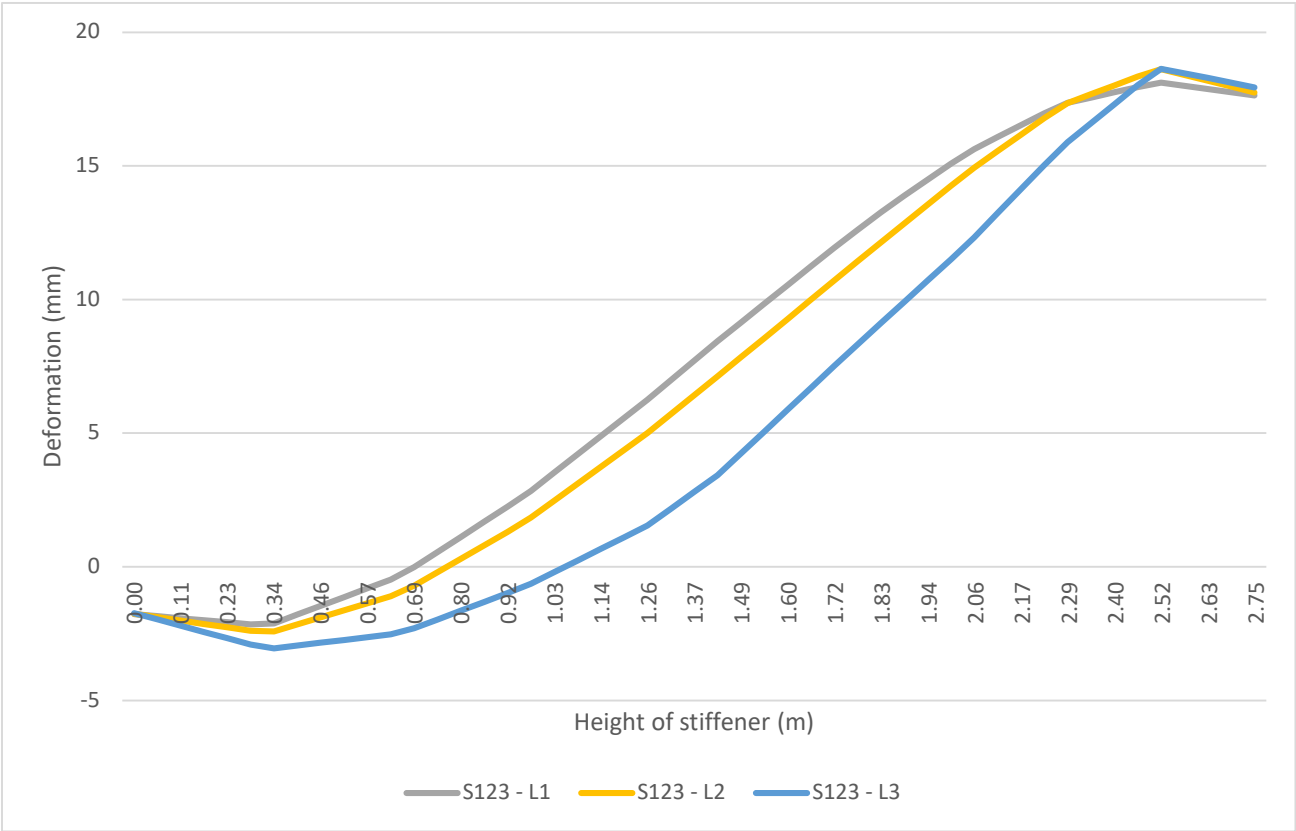


| STIFFENER 2 - Transversal direction |       |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                   | 0.000 | -1.778  | -1.792  | -1.816  | -1.766  | -1.744  | -1.706  | -1.773  | -1.770  | -1.760  |
| 57.188                              | 0.057 | -1.845  | -1.860  | -1.883  | -1.843  | -1.871  | -1.938  | -1.839  | -1.835  | -1.826  |
| 114.38                              | 0.114 | -1.912  | -1.927  | -1.950  | -1.920  | -1.999  | -2.170  | -1.906  | -1.900  | -1.891  |
| 171.56                              | 0.172 | -1.979  | -1.994  | -2.017  | -1.997  | -2.127  | -2.402  | -1.972  | -1.966  | -1.956  |
| 228.75                              | 0.229 | -2.046  | -2.061  | -2.084  | -2.074  | -2.254  | -2.634  | -2.039  | -2.031  | -2.022  |
| 285.94                              | 0.286 | -2.114  | -2.128  | -2.150  | -2.151  | -2.382  | -2.866  | -2.105  | -2.096  | -2.087  |
| 343.13                              | 0.343 | -2.069  | -2.084  | -2.106  | -2.117  | -2.405  | -3.008  | -2.060  | -2.049  | -2.038  |
| 400.32                              | 0.400 | -1.730  | -1.745  | -1.766  | -1.791  | -2.148  | -2.911  | -1.719  | -1.702  | -1.685  |
| 457.5                               | 0.458 | -1.390  | -1.405  | -1.427  | -1.464  | -1.892  | -2.815  | -1.377  | -1.355  | -1.332  |
| 514.69                              | 0.515 | -1.050  | -1.066  | -1.087  | -1.137  | -1.635  | -2.718  | -1.035  | -1.009  | -0.978  |
| 571.88                              | 0.572 | -0.710  | -0.726  | -0.748  | -0.810  | -1.379  | -2.621  | -0.694  | -0.662  | -0.625  |
| 629.07                              | 0.629 | -0.370  | -0.387  | -0.408  | -0.483  | -1.122  | -2.524  | -0.352  | -0.315  | -0.272  |
| 686.25                              | 0.686 | 0.101   | 0.085   | 0.063   | -0.025  | -0.733  | -2.306  | 0.121   | 0.164   | 0.216   |
| 743.44                              | 0.743 | 0.678   | 0.662   | 0.640   | 0.540   | -0.237  | -1.989  | 0.701   | 0.751   | 0.812   |
| 800.63                              | 0.801 | 1.255   | 1.239   | 1.218   | 1.104   | 0.258   | -1.672  | 1.280   | 1.337   | 1.408   |
| 857.82                              | 0.858 | 1.833   | 1.816   | 1.795   | 1.668   | 0.754   | -1.356  | 1.859   | 1.923   | 2.004   |
| 915.01                              | 0.915 | 2.410   | 2.393   | 2.372   | 2.233   | 1.249   | -1.039  | 2.439   | 2.509   | 2.600   |
| 972.19                              | 0.972 | 3.013   | 2.996   | 2.976   | 2.825   | 1.775   | -0.699  | 3.044   | 3.122   | 3.223   |
| 1029.4                              | 1.029 | 3.699   | 3.682   | 3.663   | 3.503   | 2.399   | -0.283  | 3.732   | 3.817   | 3.928   |
| 1086.6                              | 1.087 | 4.385   | 4.368   | 4.349   | 4.182   | 3.022   | 0.133   | 4.420   | 4.512   | 4.634   |
| 1143.8                              | 1.144 | 5.071   | 5.054   | 5.036   | 4.860   | 3.645   | 0.549   | 5.108   | 5.207   | 5.340   |
| 1200.9                              | 1.201 | 5.757   | 5.741   | 5.723   | 5.539   | 4.268   | 0.965   | 5.796   | 5.903   | 6.046   |
| 1258.1                              | 1.258 | 6.446   | 6.430   | 6.414   | 6.222   | 4.897   | 1.398   | 6.487   | 6.601   | 6.755   |
| 1315.3                              | 1.315 | 7.174   | 7.159   | 7.144   | 6.950   | 5.592   | 2.003   | 7.216   | 7.337   | 7.501   |
| 1372.5                              | 1.373 | 7.902   | 7.888   | 7.875   | 7.678   | 6.287   | 2.607   | 7.945   | 8.073   | 8.247   |
| 1429.7                              | 1.430 | 8.628   | 8.615   | 8.604   | 8.405   | 6.983   | 3.219   | 8.673   | 8.807   | 8.991   |
| 1486.9                              | 1.487 | 9.315   | 9.303   | 9.296   | 9.103   | 7.691   | 4.009   | 9.360   | 9.499   | 9.691   |
| 1544.1                              | 1.544 | 10.001  | 9.992   | 9.988   | 9.801   | 8.400   | 4.802   | 10.048  | 10.191  | 10.390  |
| 1601.3                              | 1.601 | 10.688  | 10.681  | 10.680  | 10.499  | 9.109   | 5.596   | 10.735  | 10.884  | 11.090  |
| 1658.4                              | 1.658 | 11.376  | 11.370  | 11.372  | 11.198  | 9.819   | 6.392   | 11.423  | 11.576  | 11.790  |
| 1715.6                              | 1.716 | 12.064  | 12.060  | 12.065  | 11.897  | 10.530  | 7.190   | 12.112  | 12.269  | 12.490  |
| 1772.8                              | 1.773 | 12.715  | 12.714  | 12.723  | 12.566  | 11.238  | 7.974   | 12.763  | 12.924  | 13.151  |
| 1830                                | 1.830 | 13.342  | 13.344  | 13.357  | 13.214  | 11.942  | 8.750   | 13.389  | 13.554  | 13.784  |
| 1887.2                              | 1.887 | 13.943  | 13.948  | 13.967  | 13.838  | 12.642  | 9.529   | 13.991  | 14.157  | 14.390  |
| 1944.4                              | 1.944 | 14.517  | 14.525  | 14.549  | 14.435  | 13.337  | 10.306  | 14.563  | 14.731  | 14.967  |
| 2001.6                              | 2.002 | 15.087  | 15.099  | 15.128  | 15.028  | 14.030  | 11.079  | 15.132  | 15.301  | 15.539  |
| 2058.8                              | 2.059 | 15.612  | 15.628  | 15.663  | 15.574  | 14.699  | 11.879  | 15.656  | 15.824  | 16.064  |
| 2116                                | 2.116 | 16.039  | 16.060  | 16.102  | 16.018  | 15.311  | 12.753  | 16.081  | 16.247  | 16.484  |
| 2173.1                              | 2.173 | 16.467  | 16.492  | 16.542  | 16.462  | 15.923  | 13.627  | 16.506  | 16.670  | 16.905  |
| 2230.3                              | 2.230 | 16.894  | 16.924  | 16.981  | 16.907  | 16.535  | 14.501  | 16.931  | 17.093  | 17.325  |
| 2287.5                              | 2.288 | 17.274  | 17.309  | 17.373  | 17.300  | 17.089  | 15.337  | 17.307  | 17.466  | 17.695  |
| 2344.7                              | 2.345 | 17.469  | 17.511  | 17.585  | 17.498  | 17.420  | 16.026  | 17.498  | 17.650  | 17.869  |
| 2401.9                              | 2.402 | 17.665  | 17.713  | 17.798  | 17.695  | 17.751  | 16.715  | 17.690  | 17.834  | 18.043  |
| 2459.1                              | 2.459 | 17.860  | 17.915  | 18.010  | 17.893  | 18.082  | 17.405  | 17.881  | 18.018  | 18.217  |
| 2516.3                              | 2.516 | 18.026  | 18.088  | 18.192  | 18.058  | 18.358  | 18.010  | 18.042  | 18.171  | 18.360  |
| 2573.5                              | 2.574 | 17.927  | 17.998  | 18.115  | 17.938  | 18.147  | 17.855  | 17.936  | 18.052  | 18.222  |
| 2630.6                              | 2.631 | 17.828  | 17.907  | 18.037  | 17.817  | 17.937  | 17.700  | 17.830  | 17.932  | 18.084  |
| 2687.8                              | 2.688 | 17.729  | 17.817  | 17.960  | 17.697  | 17.726  | 17.545  | 17.724  | 17.813  | 17.946  |
| 2745                                | 2.745 | 17.630  | 17.727  | 17.883  | 17.577  | 17.515  | 17.390  | 17.618  | 17.693  | 17.808  |

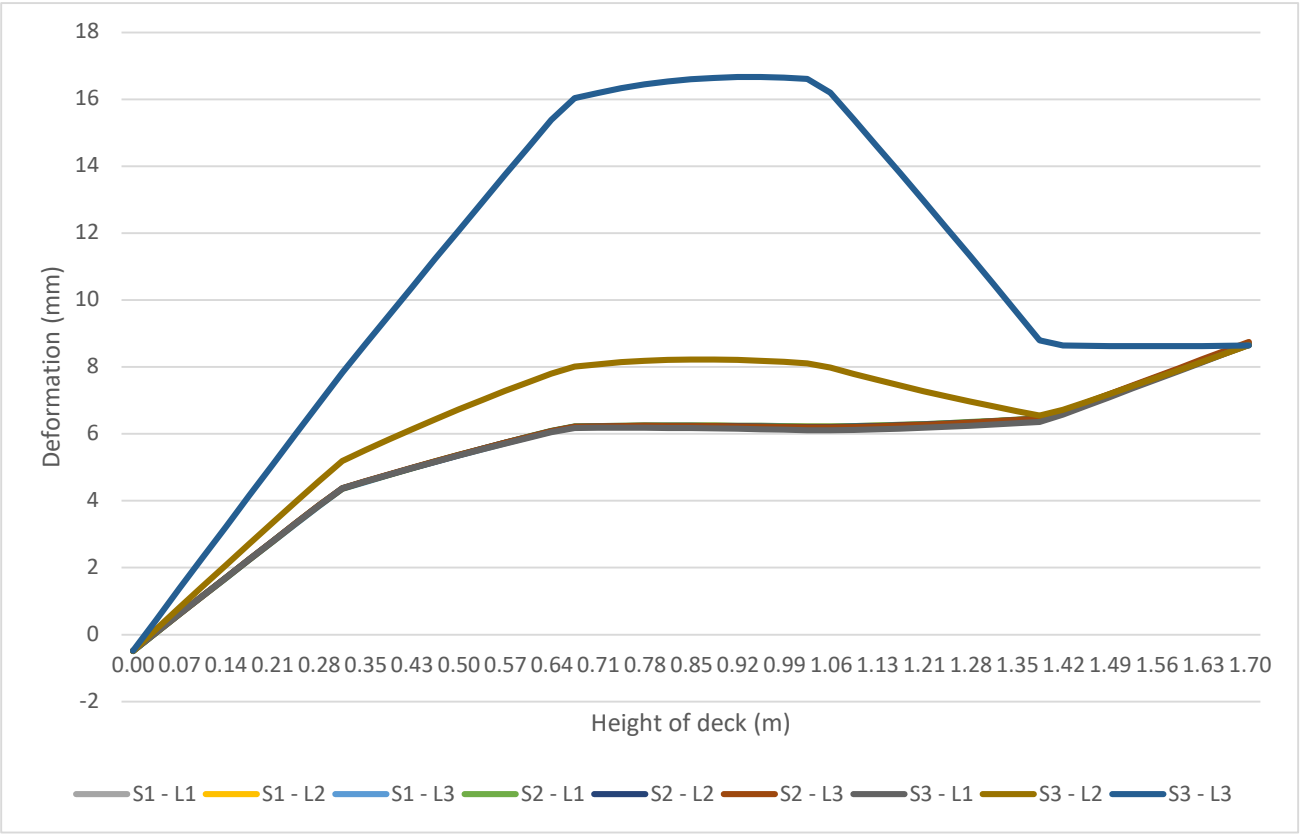




| STIFFENER 2 in S## - Transversal direction |       |          |          |          |          |          |          |          |          |          |
|--------------------------------------------|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                         | m     | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                          | 0.000 | -1.770   | -1.763   | -1.750   | -1.778   | -1.790   | -1.803   | -1.766   | -1.741   | -1.693   |
| 57.188                                     | 0.057 | -1.848   | -1.890   | -1.979   | -1.844   | -1.855   | -1.868   | -1.842   | -1.868   | -1.930   |
| 114.38                                     | 0.114 | -1.925   | -2.018   | -2.208   | -1.911   | -1.921   | -1.932   | -1.919   | -1.995   | -2.167   |
| 171.56                                     | 0.172 | -2.002   | -2.145   | -2.437   | -1.977   | -1.986   | -1.997   | -1.995   | -2.122   | -2.404   |
| 228.75                                     | 0.229 | -2.079   | -2.272   | -2.666   | -2.044   | -2.051   | -2.061   | -2.072   | -2.249   | -2.642   |
| 285.94                                     | 0.286 | -2.156   | -2.399   | -2.895   | -2.110   | -2.117   | -2.125   | -2.148   | -2.376   | -2.879   |
| 343.13                                     | 0.343 | -2.122   | -2.421   | -3.034   | -2.065   | -2.070   | -2.075   | -2.114   | -2.397   | -3.024   |
| 400.32                                     | 0.400 | -1.796   | -2.164   | -2.934   | -1.724   | -1.724   | -1.721   | -1.786   | -2.136   | -2.924   |
| 457.5                                      | 0.458 | -1.469   | -1.907   | -2.835   | -1.383   | -1.378   | -1.368   | -1.457   | -1.874   | -2.824   |
| 514.69                                     | 0.515 | -1.142   | -1.650   | -2.735   | -1.041   | -1.032   | -1.014   | -1.129   | -1.613   | -2.725   |
| 571.88                                     | 0.572 | -0.816   | -1.393   | -2.635   | -0.700   | -0.686   | -0.660   | -0.801   | -1.351   | -2.625   |
| 629.07                                     | 0.629 | -0.489   | -1.136   | -2.535   | -0.358   | -0.340   | -0.306   | -0.472   | -1.090   | -2.525   |
| 686.25                                     | 0.686 | -0.030   | -0.747   | -2.313   | 0.115    | 0.139    | 0.183    | -0.012   | -0.694   | -2.300   |
| 743.44                                     | 0.743 | 0.534    | -0.251   | -1.993   | 0.694    | 0.725    | 0.781    | 0.554    | -0.191   | -1.975   |
| 800.63                                     | 0.801 | 1.098    | 0.245    | -1.673   | 1.273    | 1.310    | 1.378    | 1.121    | 0.311    | -1.650   |
| 857.82                                     | 0.858 | 1.662    | 0.741    | -1.353   | 1.853    | 1.896    | 1.975    | 1.687    | 0.814    | -1.325   |
| 915.01                                     | 0.915 | 2.227    | 1.237    | -1.034   | 2.432    | 2.482    | 2.573    | 2.253    | 1.317    | -1.000   |
| 972.19                                     | 0.972 | 2.819    | 1.764    | -0.690   | 3.037    | 3.094    | 3.197    | 2.848    | 1.851    | -0.650   |
| 1029.4                                     | 1.029 | 3.497    | 2.388    | -0.271   | 3.725    | 3.789    | 3.905    | 3.528    | 2.482    | -0.223   |
| 1086.6                                     | 1.087 | 4.176    | 3.012    | 0.148    | 4.413    | 4.484    | 4.613    | 4.208    | 3.114    | 0.204    |
| 1143.8                                     | 1.144 | 4.854    | 3.636    | 0.567    | 5.101    | 5.180    | 5.322    | 4.889    | 3.746    | 0.632    |
| 1200.9                                     | 1.201 | 5.533    | 4.260    | 0.986    | 5.789    | 5.875    | 6.030    | 5.570    | 4.377    | 1.059    |
| 1258.1                                     | 1.258 | 6.216    | 4.890    | 1.422    | 6.480    | 6.574    | 6.742    | 6.254    | 5.015    | 1.504    |
| 1315.3                                     | 1.315 | 6.944    | 5.586    | 2.030    | 7.210    | 7.310    | 7.492    | 6.984    | 5.718    | 2.126    |
| 1372.5                                     | 1.373 | 7.673    | 6.282    | 2.638    | 7.939    | 8.047    | 8.242    | 7.714    | 6.422    | 2.747    |
| 1429.7                                     | 1.430 | 8.400    | 6.979    | 3.251    | 8.667    | 8.783    | 8.991    | 8.443    | 7.126    | 3.375    |
| 1486.9                                     | 1.487 | 9.099    | 7.689    | 4.046    | 9.355    | 9.477    | 9.696    | 9.142    | 7.841    | 4.184    |
| 1544.1                                     | 1.544 | 9.797    | 8.400    | 4.843    | 10.043   | 10.171   | 10.402   | 9.842    | 8.557    | 4.995    |
| 1601.3                                     | 1.601 | 10.496   | 9.112    | 5.641    | 10.731   | 10.866   | 11.108   | 10.541   | 9.273    | 5.807    |
| 1658.4                                     | 1.658 | 11.196   | 9.825    | 6.441    | 11.420   | 11.561   | 11.815   | 11.242   | 9.991    | 6.622    |
| 1715.6                                     | 1.716 | 11.895   | 10.538   | 7.242    | 12.109   | 12.257   | 12.522   | 11.942   | 10.709   | 7.438    |
| 1772.8                                     | 1.773 | 12.565   | 11.248   | 8.031    | 12.761   | 12.915   | 13.190   | 12.612   | 11.422   | 8.238    |
| 1830                                       | 1.830 | 13.214   | 11.954   | 8.813    | 13.389   | 13.548   | 13.832   | 13.261   | 12.131   | 9.028    |
| 1887.2                                     | 1.887 | 13.839   | 12.658   | 9.597    | 13.991   | 14.155   | 14.448   | 13.885   | 12.836   | 9.821    |
| 1944.4                                     | 1.944 | 14.437   | 13.357   | 10.379   | 14.565   | 14.734   | 15.034   | 14.483   | 13.536   | 10.611   |
| 2001.6                                     | 2.002 | 15.031   | 14.054   | 11.157   | 15.135   | 15.309   | 15.617   | 15.076   | 14.235   | 11.397   |
| 2058.8                                     | 2.059 | 15.578   | 14.726   | 11.964   | 15.660   | 15.837   | 16.152   | 15.622   | 14.906   | 12.212   |
| 2116                                       | 2.116 | 16.024   | 15.343   | 12.845   | 16.086   | 16.267   | 16.586   | 16.066   | 15.520   | 13.103   |
| 2173.1                                     | 2.173 | 16.470   | 15.960   | 13.727   | 16.513   | 16.696   | 17.019   | 16.510   | 16.134   | 13.994   |
| 2230.3                                     | 2.230 | 16.916   | 16.577   | 14.609   | 16.940   | 17.126   | 17.453   | 16.953   | 16.748   | 14.885   |
| 2287.5                                     | 2.288 | 17.311   | 17.136   | 15.454   | 17.318   | 17.506   | 17.836   | 17.346   | 17.302   | 15.735   |
| 2344.7                                     | 2.345 | 17.511   | 17.475   | 16.160   | 17.512   | 17.699   | 18.027   | 17.541   | 17.627   | 16.428   |
| 2401.9                                     | 2.402 | 17.711   | 17.814   | 16.866   | 17.705   | 17.892   | 18.219   | 17.737   | 17.951   | 17.122   |
| 2459.1                                     | 2.459 | 17.910   | 18.153   | 17.572   | 17.898   | 18.086   | 18.410   | 17.932   | 18.276   | 17.816   |
| 2516.3                                     | 2.516 | 18.078   | 18.438   | 18.194   | 18.062   | 18.248   | 18.571   | 18.096   | 18.545   | 18.421   |
| 2573.5                                     | 2.574 | 17.961   | 18.240   | 18.066   | 17.959   | 18.141   | 18.454   | 17.971   | 18.314   | 18.224   |
| 2630.6                                     | 2.631 | 17.844   | 18.042   | 17.937   | 17.856   | 18.034   | 18.338   | 17.847   | 18.082   | 18.027   |
| 2687.8                                     | 2.688 | 17.726   | 17.843   | 17.809   | 17.754   | 17.927   | 18.222   | 17.722   | 17.851   | 17.831   |
| 2745                                       | 2.745 | 17.609   | 17.645   | 17.680   | 17.651   | 17.820   | 18.106   | 17.598   | 17.619   | 17.634   |

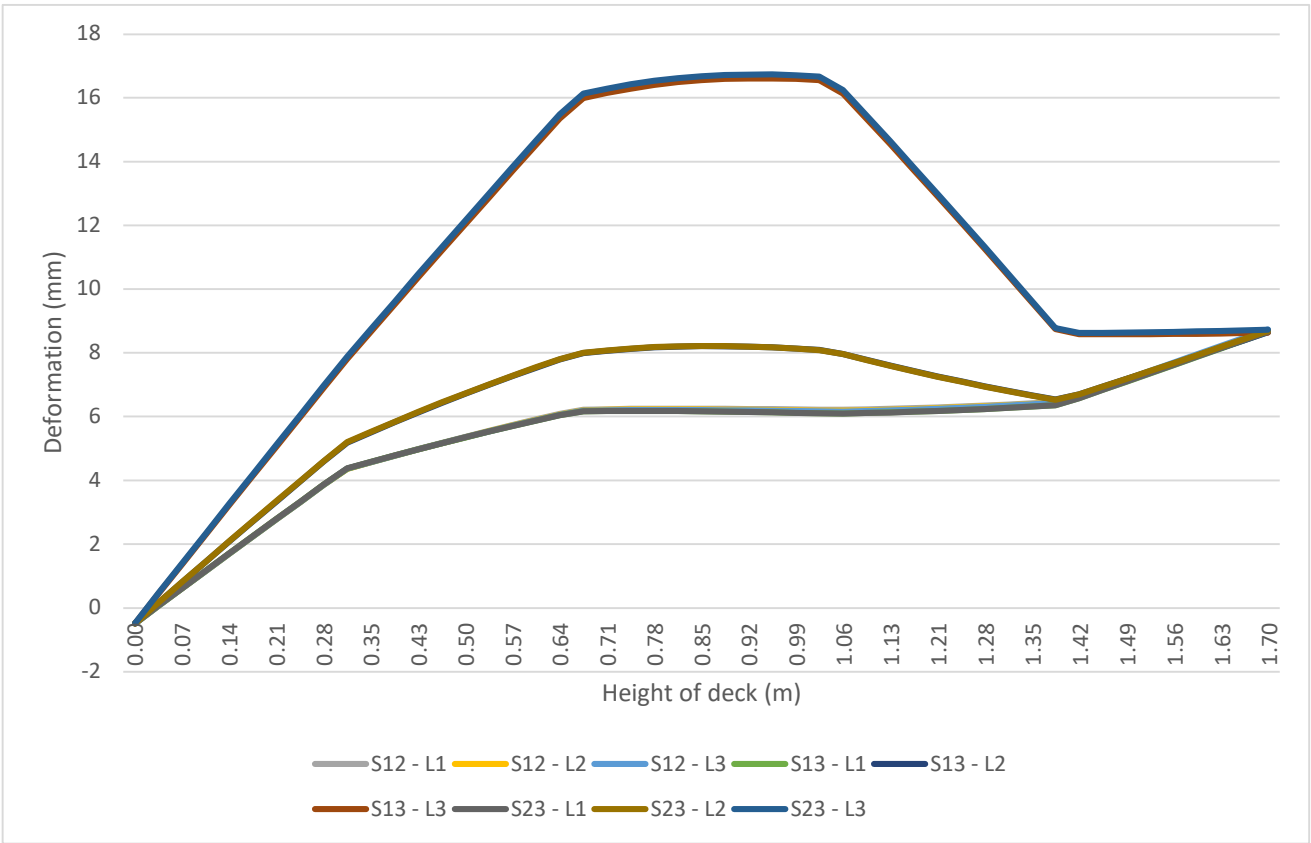


| STIFFENER 2 in S1,2 & 3 - Transversal direction |       |           |           |           |
|-------------------------------------------------|-------|-----------|-----------|-----------|
| mm                                              | m     | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                               | 0.000 | -1.770    | -1.760    | -1.736    |
| 57.188                                          | 0.057 | -1.847    | -1.887    | -1.970    |
| 114.38                                          | 0.114 | -1.923    | -2.014    | -2.204    |
| 171.56                                          | 0.172 | -2.000    | -2.141    | -2.438    |
| 228.75                                          | 0.229 | -2.077    | -2.267    | -2.672    |
| 285.94                                          | 0.286 | -2.153    | -2.394    | -2.906    |
| 343.13                                          | 0.343 | -2.119    | -2.414    | -3.048    |
| 400.32                                          | 0.400 | -1.791    | -2.153    | -2.944    |
| 457.5                                           | 0.458 | -1.463    | -1.891    | -2.841    |
| 514.69                                          | 0.515 | -1.134    | -1.629    | -2.737    |
| 571.88                                          | 0.572 | -0.806    | -1.368    | -2.634    |
| 629.07                                          | 0.629 | -0.478    | -1.106    | -2.531    |
| 686.25                                          | 0.686 | -0.018    | -0.710    | -2.302    |
| 743.44                                          | 0.743 | 0.549     | -0.207    | -1.972    |
| 800.63                                          | 0.801 | 1.115     | 0.296     | -1.643    |
| 857.82                                          | 0.858 | 1.681     | 0.799     | -1.314    |
| 915.01                                          | 0.915 | 2.247     | 1.302     | -0.985    |
| 972.19                                          | 0.972 | 2.841     | 1.836     | -0.631    |
| 1029.4                                          | 1.029 | 3.522     | 2.469     | -0.200    |
| 1086.6                                          | 1.087 | 4.203     | 3.101     | 0.232     |
| 1143.8                                          | 1.144 | 4.883     | 3.733     | 0.663     |
| 1200.9                                          | 1.201 | 5.564     | 4.365     | 1.095     |
| 1258.1                                          | 1.258 | 6.249     | 5.003     | 1.544     |
| 1315.3                                          | 1.315 | 6.979     | 5.708     | 2.169     |
| 1372.5                                          | 1.373 | 7.709     | 6.412     | 2.795     |
| 1429.7                                          | 1.430 | 8.438     | 7.117     | 3.427     |
| 1486.9                                          | 1.487 | 9.138     | 7.835     | 4.241     |
| 1544.1                                          | 1.544 | 9.838     | 8.552     | 5.056     |
| 1601.3                                          | 1.601 | 10.538    | 9.271     | 5.874     |
| 1658.4                                          | 1.658 | 11.239    | 9.991     | 6.693     |
| 1715.6                                          | 1.716 | 11.940    | 10.711    | 7.514     |
| 1772.8                                          | 1.773 | 12.611    | 11.427    | 8.320     |
| 1830                                            | 1.830 | 13.261    | 12.139    | 9.116     |
| 1887.2                                          | 1.887 | 13.886    | 12.847    | 9.914     |
| 1944.4                                          | 1.944 | 14.485    | 13.551    | 10.710    |
| 2001.6                                          | 2.002 | 15.079    | 14.252    | 11.503    |
| 2058.8                                          | 2.059 | 15.626    | 14.928    | 12.324    |
| 2116                                            | 2.116 | 16.072    | 15.547    | 13.224    |
| 2173.1                                          | 2.173 | 16.517    | 16.165    | 14.123    |
| 2230.3                                          | 2.230 | 16.962    | 16.784    | 15.022    |
| 2287.5                                          | 2.288 | 17.357    | 17.344    | 15.883    |
| 2344.7                                          | 2.345 | 17.554    | 17.677    | 16.593    |
| 2401.9                                          | 2.402 | 17.752    | 18.010    | 17.303    |
| 2459.1                                          | 2.459 | 17.950    | 18.343    | 18.013    |
| 2516.3                                          | 2.516 | 18.116    | 18.620    | 18.635    |
| 2573.5                                          | 2.574 | 17.994    | 18.402    | 18.461    |
| 2630.6                                          | 2.631 | 17.873    | 18.183    | 18.287    |
| 2687.8                                          | 2.688 | 17.752    | 17.965    | 18.113    |
| 2745                                            | 2.745 | 17.630    | 17.746    | 17.939    |

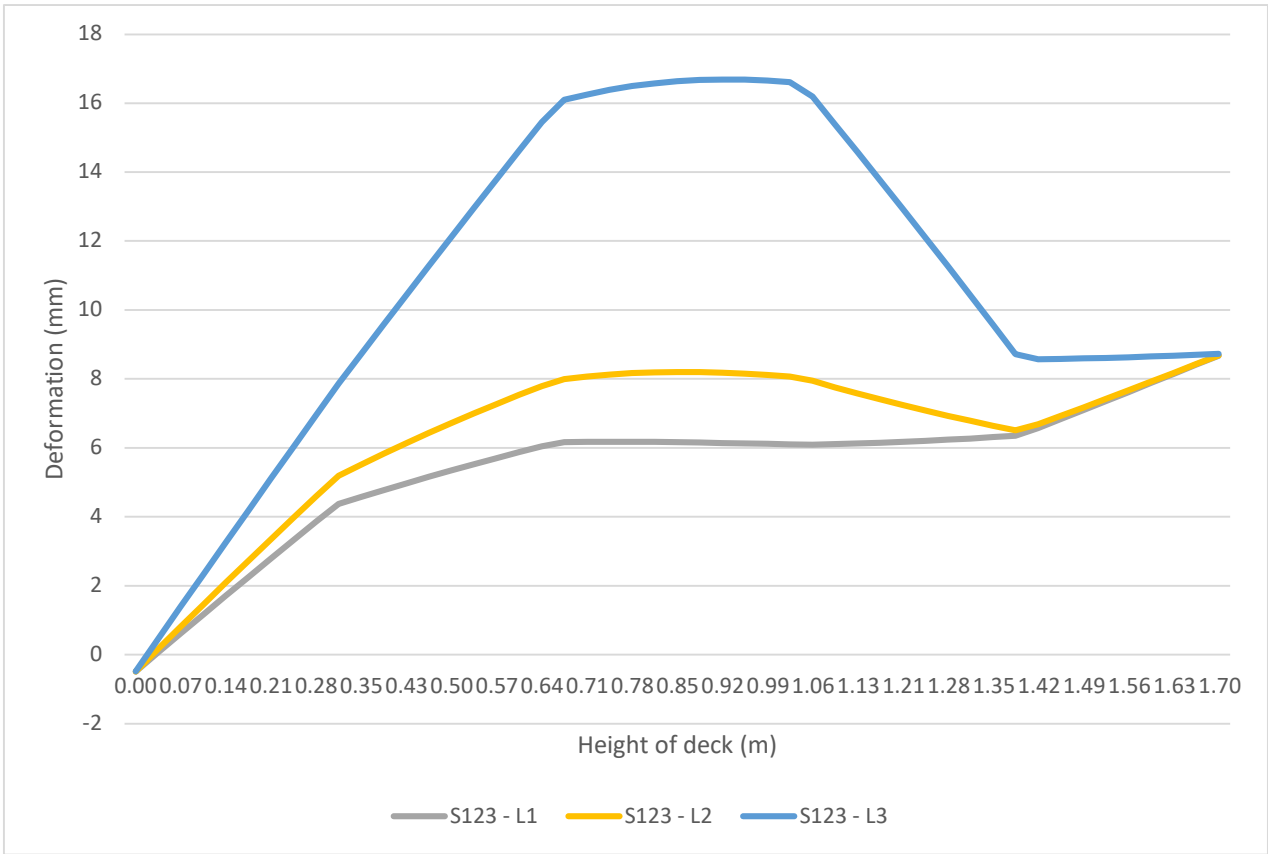


| STIFFENER 3 - Transversal direction |       |         |         |         |         |         |         |         |         |         |
|-------------------------------------|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| mm                                  | m     | S1 - L1 | S1 - L2 | S1 - L3 | S2 - L1 | S2 - L2 | S2 - L3 | S3 - L1 | S3 - L2 | S3 - L3 |
| 0                                   | 0.000 | -0.485  | -0.486  | -0.488  | -0.484  | -0.482  | -0.479  | -0.485  | -0.484  | -0.482  |
| 35.449                              | 0.035 | 0.064   | 0.062   | 0.060   | 0.065   | 0.067   | 0.070   | 0.067   | 0.163   | 0.449   |
| 70.897                              | 0.071 | 0.611   | 0.609   | 0.606   | 0.612   | 0.614   | 0.618   | 0.616   | 0.806   | 1.378   |
| 106.35                              | 0.106 | 1.156   | 1.153   | 1.150   | 1.157   | 1.159   | 1.164   | 1.163   | 1.446   | 2.305   |
| 141.79                              | 0.142 | 1.699   | 1.696   | 1.692   | 1.700   | 1.703   | 1.708   | 1.707   | 2.082   | 3.230   |
| 177.24                              | 0.177 | 2.240   | 2.236   | 2.232   | 2.242   | 2.244   | 2.251   | 2.250   | 2.715   | 4.154   |
| 212.69                              | 0.213 | 2.779   | 2.775   | 2.771   | 2.781   | 2.784   | 2.791   | 2.790   | 3.343   | 5.075   |
| 248.14                              | 0.248 | 3.317   | 3.313   | 3.308   | 3.319   | 3.322   | 3.330   | 3.327   | 3.969   | 5.995   |
| 283.59                              | 0.284 | 3.853   | 3.848   | 3.843   | 3.855   | 3.858   | 3.867   | 3.863   | 4.590   | 6.913   |
| 319.04                              | 0.319 | 4.364   | 4.359   | 4.353   | 4.367   | 4.370   | 4.379   | 4.374   | 5.188   | 7.825   |
| 354.49                              | 0.354 | 4.572   | 4.567   | 4.560   | 4.574   | 4.577   | 4.585   | 4.578   | 5.512   | 8.682   |
| 389.93                              | 0.390 | 4.777   | 4.771   | 4.764   | 4.779   | 4.780   | 4.787   | 4.778   | 5.828   | 9.535   |
| 425.38                              | 0.425 | 4.977   | 4.971   | 4.964   | 4.979   | 4.979   | 4.986   | 4.973   | 6.137   | 10.385  |
| 460.83                              | 0.461 | 5.173   | 5.166   | 5.158   | 5.175   | 5.174   | 5.179   | 5.164   | 6.436   | 11.229  |
| 496.28                              | 0.496 | 5.364   | 5.356   | 5.348   | 5.365   | 5.363   | 5.367   | 5.349   | 6.725   | 12.068  |
| 531.73                              | 0.532 | 5.551   | 5.543   | 5.534   | 5.552   | 5.549   | 5.552   | 5.531   | 7.007   | 12.903  |
| 567.18                              | 0.567 | 5.734   | 5.725   | 5.716   | 5.735   | 5.731   | 5.733   | 5.708   | 7.280   | 13.735  |
| 602.63                              | 0.603 | 5.913   | 5.904   | 5.894   | 5.914   | 5.908   | 5.909   | 5.881   | 7.545   | 14.562  |
| 638.08                              | 0.638 | 6.088   | 6.078   | 6.068   | 6.089   | 6.082   | 6.082   | 6.050   | 7.802   | 15.385  |
| 673.52                              | 0.674 | 6.218   | 6.208   | 6.197   | 6.218   | 6.211   | 6.210   | 6.173   | 8.007   | 16.030  |
| 708.97                              | 0.709 | 6.232   | 6.222   | 6.211   | 6.233   | 6.224   | 6.222   | 6.180   | 8.079   | 16.188  |
| 744.42                              | 0.744 | 6.244   | 6.234   | 6.223   | 6.244   | 6.235   | 6.231   | 6.184   | 8.139   | 16.329  |
| 779.87                              | 0.780 | 6.252   | 6.242   | 6.230   | 6.252   | 6.242   | 6.237   | 6.183   | 8.186   | 16.449  |
| 815.32                              | 0.815 | 6.253   | 6.242   | 6.230   | 6.253   | 6.241   | 6.235   | 6.177   | 8.210   | 16.534  |
| 850.77                              | 0.851 | 6.251   | 6.240   | 6.228   | 6.251   | 6.239   | 6.232   | 6.170   | 8.222   | 16.598  |
| 886.22                              | 0.886 | 6.249   | 6.237   | 6.225   | 6.248   | 6.235   | 6.227   | 6.161   | 8.222   | 16.641  |
| 921.66                              | 0.922 | 6.244   | 6.233   | 6.220   | 6.244   | 6.230   | 6.221   | 6.150   | 8.210   | 16.663  |
| 957.11                              | 0.957 | 6.238   | 6.227   | 6.214   | 6.238   | 6.223   | 6.213   | 6.137   | 8.186   | 16.665  |
| 992.56                              | 0.993 | 6.231   | 6.219   | 6.206   | 6.230   | 6.215   | 6.204   | 6.123   | 8.151   | 16.647  |
| 1028                                | 1.028 | 6.222   | 6.210   | 6.197   | 6.221   | 6.205   | 6.193   | 6.108   | 8.105   | 16.610  |
| 1063.5                              | 1.064 | 6.220   | 6.208   | 6.195   | 6.219   | 6.203   | 6.191   | 6.104   | 7.980   | 16.193  |
| 1098.9                              | 1.099 | 6.232   | 6.220   | 6.207   | 6.232   | 6.216   | 6.205   | 6.117   | 7.794   | 15.402  |
| 1134.4                              | 1.134 | 6.248   | 6.237   | 6.224   | 6.248   | 6.234   | 6.223   | 6.135   | 7.615   | 14.601  |
| 1169.8                              | 1.170 | 6.268   | 6.257   | 6.244   | 6.269   | 6.255   | 6.246   | 6.156   | 7.443   | 13.793  |
| 1205.3                              | 1.205 | 6.292   | 6.281   | 6.268   | 6.292   | 6.280   | 6.272   | 6.181   | 7.278   | 12.978  |
| 1240.7                              | 1.241 | 6.319   | 6.308   | 6.296   | 6.320   | 6.308   | 6.301   | 6.210   | 7.119   | 12.155  |
| 1276.2                              | 1.276 | 6.350   | 6.339   | 6.327   | 6.350   | 6.340   | 6.334   | 6.242   | 6.967   | 11.325  |
| 1311.6                              | 1.312 | 6.383   | 6.372   | 6.361   | 6.384   | 6.375   | 6.370   | 6.278   | 6.821   | 10.489  |
| 1347                                | 1.347 | 6.419   | 6.409   | 6.398   | 6.421   | 6.413   | 6.409   | 6.317   | 6.681   | 9.646   |
| 1382.5                              | 1.383 | 6.459   | 6.449   | 6.437   | 6.461   | 6.453   | 6.452   | 6.359   | 6.546   | 8.798   |
| 1417.9                              | 1.418 | 6.669   | 6.660   | 6.649   | 6.672   | 6.668   | 6.671   | 6.579   | 6.714   | 8.639   |
| 1453.4                              | 1.453 | 6.917   | 6.908   | 6.899   | 6.921   | 6.921   | 6.929   | 6.837   | 6.949   | 8.631   |
| 1488.8                              | 1.489 | 7.165   | 7.157   | 7.148   | 7.170   | 7.174   | 7.187   | 7.096   | 7.185   | 8.626   |
| 1524.3                              | 1.524 | 7.414   | 7.407   | 7.399   | 7.420   | 7.428   | 7.446   | 7.355   | 7.424   | 8.622   |
| 1559.7                              | 1.560 | 7.664   | 7.658   | 7.650   | 7.670   | 7.682   | 7.705   | 7.615   | 7.665   | 8.621   |
| 1595.2                              | 1.595 | 7.914   | 7.909   | 7.902   | 7.921   | 7.937   | 7.966   | 7.876   | 7.909   | 8.622   |
| 1630.6                              | 1.631 | 8.165   | 8.161   | 8.155   | 8.173   | 8.193   | 8.227   | 8.138   | 8.155   | 8.625   |
| 1666.1                              | 1.666 | 8.417   | 8.413   | 8.408   | 8.426   | 8.450   | 8.489   | 8.400   | 8.403   | 8.630   |
| 1701.5                              | 1.702 | 8.669   | 8.667   | 8.662   | 8.680   | 8.708   | 8.751   | 8.663   | 8.654   | 8.638   |





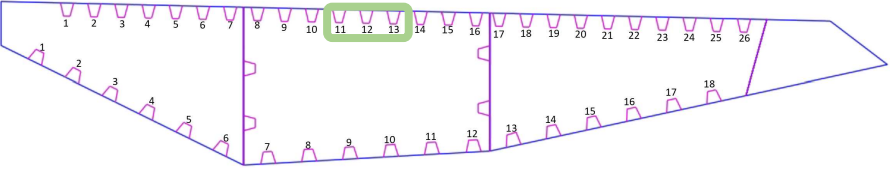
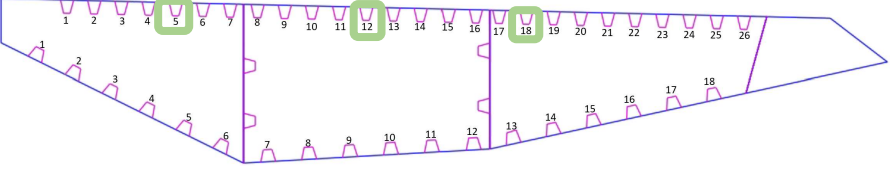
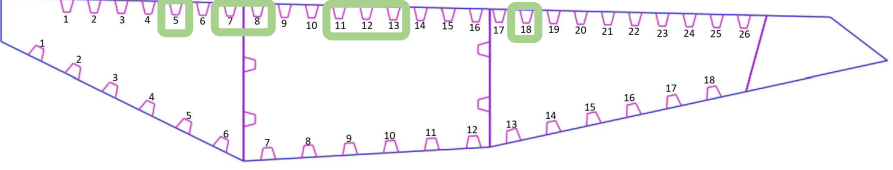
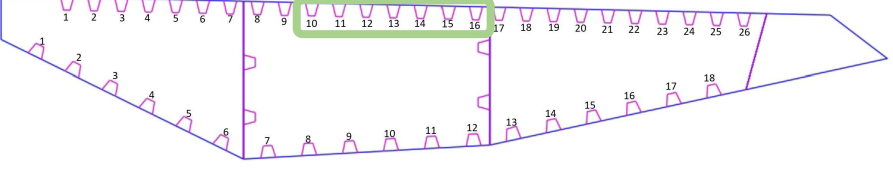
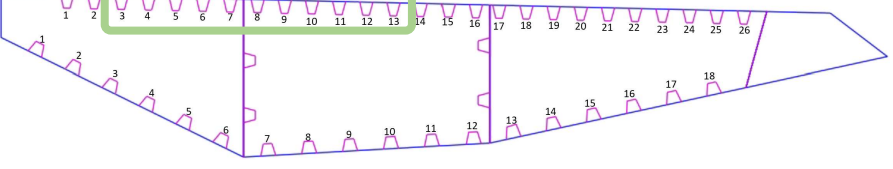
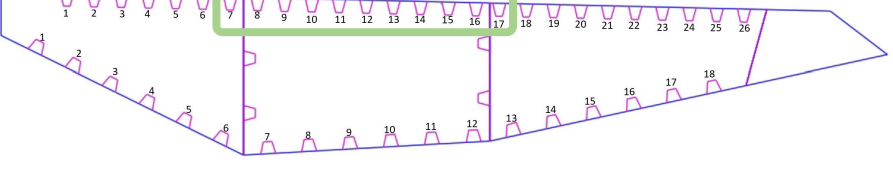
| STIFFENER 3 in S## - Transversal direction |       |          |          |          |          |          |          |          |          |          |
|--------------------------------------------|-------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| mm                                         | m     | S12 - L1 | S12 - L2 | S12 - L3 | S13 - L1 | S13 - L2 | S13 - L3 | S23 - L1 | S23 - L2 | S23 - L3 |
| 0                                          | 0.000 | -0.484   | -0.484   | -0.483   | -0.485   | -0.486   | -0.486   | -0.484   | -0.482   | -0.478   |
| 35.449                                     | 0.035 | 0.065    | 0.065    | 0.066    | 0.066    | 0.161    | 0.444    | 0.068    | 0.166    | 0.460    |
| 70.897                                     | 0.071 | 0.611    | 0.611    | 0.613    | 0.615    | 0.804    | 1.372    | 0.617    | 0.811    | 1.395    |
| 106.35                                     | 0.106 | 1.156    | 1.156    | 1.158    | 1.162    | 1.443    | 2.297    | 1.164    | 1.451    | 2.328    |
| 141.79                                     | 0.142 | 1.699    | 1.699    | 1.701    | 1.706    | 2.079    | 3.221    | 1.708    | 2.088    | 3.260    |
| 177.24                                     | 0.177 | 2.241    | 2.240    | 2.242    | 2.248    | 2.711    | 4.143    | 2.250    | 2.722    | 4.189    |
| 212.69                                     | 0.213 | 2.780    | 2.779    | 2.781    | 2.788    | 3.339    | 5.063    | 2.790    | 3.351    | 5.117    |
| 248.14                                     | 0.248 | 3.318    | 3.316    | 3.319    | 3.326    | 3.964    | 5.981    | 3.328    | 3.978    | 6.043    |
| 283.59                                     | 0.284 | 3.854    | 3.852    | 3.855    | 3.862    | 4.585    | 6.898    | 3.864    | 4.600    | 6.967    |
| 319.04                                     | 0.319 | 4.365    | 4.363    | 4.366    | 4.372    | 5.182    | 7.808    | 4.375    | 5.199    | 7.885    |
| 354.49                                     | 0.354 | 4.573    | 4.569    | 4.570    | 4.576    | 5.506    | 8.663    | 4.578    | 5.522    | 8.746    |
| 389.93                                     | 0.390 | 4.777    | 4.772    | 4.771    | 4.776    | 5.821    | 9.515    | 4.778    | 5.837    | 9.604    |
| 425.38                                     | 0.425 | 4.977    | 4.971    | 4.969    | 4.971    | 6.130    | 10.363   | 4.973    | 6.145    | 10.458   |
| 460.83                                     | 0.461 | 5.173    | 5.165    | 5.161    | 5.161    | 6.428    | 11.205   | 5.163    | 6.443    | 11.307   |
| 496.28                                     | 0.496 | 5.363    | 5.354    | 5.348    | 5.347    | 6.717    | 12.043   | 5.349    | 6.731    | 12.150   |
| 531.73                                     | 0.532 | 5.550    | 5.539    | 5.532    | 5.528    | 6.998    | 12.876   | 5.530    | 7.012    | 12.989   |
| 567.18                                     | 0.567 | 5.732    | 5.720    | 5.711    | 5.706    | 7.271    | 13.706   | 5.707    | 7.284    | 13.825   |
| 602.63                                     | 0.603 | 5.911    | 5.897    | 5.887    | 5.878    | 7.535    | 14.531   | 5.879    | 7.548    | 14.656   |
| 638.08                                     | 0.638 | 6.086    | 6.070    | 6.058    | 6.047    | 7.792    | 15.352   | 6.048    | 7.804    | 15.483   |
| 673.52                                     | 0.674 | 6.215    | 6.198    | 6.185    | 6.170    | 7.996    | 15.996   | 6.171    | 8.007    | 16.131   |
| 708.97                                     | 0.709 | 6.230    | 6.211    | 6.196    | 6.177    | 8.068    | 16.152   | 6.177    | 8.078    | 16.285   |
| 744.42                                     | 0.744 | 6.241    | 6.222    | 6.205    | 6.180    | 8.128    | 16.290   | 6.180    | 8.136    | 16.422   |
| 779.87                                     | 0.780 | 6.249    | 6.228    | 6.210    | 6.180    | 8.174    | 16.409   | 6.179    | 8.181    | 16.539   |
| 815.32                                     | 0.815 | 6.249    | 6.227    | 6.208    | 6.174    | 8.198    | 16.492   | 6.173    | 8.203    | 16.620   |
| 850.77                                     | 0.851 | 6.248    | 6.225    | 6.204    | 6.166    | 8.209    | 16.554   | 6.166    | 8.213    | 16.680   |
| 886.22                                     | 0.886 | 6.245    | 6.221    | 6.198    | 6.157    | 8.209    | 16.595   | 6.156    | 8.210    | 16.718   |
| 921.66                                     | 0.922 | 6.240    | 6.215    | 6.191    | 6.146    | 8.196    | 16.616   | 6.145    | 8.196    | 16.736   |
| 957.11                                     | 0.957 | 6.234    | 6.208    | 6.183    | 6.134    | 8.172    | 16.616   | 6.132    | 8.171    | 16.733   |
| 992.56                                     | 0.993 | 6.226    | 6.199    | 6.173    | 6.119    | 8.137    | 16.596   | 6.118    | 8.134    | 16.710   |
| 1028                                       | 1.028 | 6.217    | 6.189    | 6.162    | 6.104    | 8.091    | 16.557   | 6.102    | 8.086    | 16.668   |
| 1063.5                                     | 1.064 | 6.215    | 6.187    | 6.160    | 6.100    | 7.966    | 16.139   | 6.099    | 7.960    | 16.244   |
| 1098.9                                     | 1.099 | 6.228    | 6.201    | 6.175    | 6.113    | 7.779    | 15.347   | 6.112    | 7.772    | 15.444   |
| 1134.4                                     | 1.134 | 6.245    | 6.218    | 6.193    | 6.131    | 7.600    | 14.547   | 6.130    | 7.592    | 14.635   |
| 1169.8                                     | 1.170 | 6.265    | 6.240    | 6.216    | 6.152    | 7.428    | 13.738   | 6.151    | 7.420    | 13.818   |
| 1205.3                                     | 1.205 | 6.289    | 6.265    | 6.242    | 6.177    | 7.263    | 12.922   | 6.177    | 7.255    | 12.994   |
| 1240.7                                     | 1.241 | 6.316    | 6.293    | 6.272    | 6.206    | 7.105    | 12.099   | 6.206    | 7.096    | 12.163   |
| 1276.2                                     | 1.276 | 6.347    | 6.325    | 6.306    | 6.239    | 6.953    | 11.269   | 6.239    | 6.944    | 11.325   |
| 1311.6                                     | 1.312 | 6.381    | 6.360    | 6.342    | 6.275    | 6.807    | 10.433   | 6.275    | 6.798    | 10.480   |
| 1347                                       | 1.347 | 6.418    | 6.399    | 6.382    | 6.314    | 6.667    | 9.590    | 6.315    | 6.657    | 9.629    |
| 1382.5                                     | 1.383 | 6.457    | 6.440    | 6.425    | 6.356    | 6.532    | 8.741    | 6.357    | 6.522    | 8.773    |
| 1417.9                                     | 1.418 | 6.669    | 6.656    | 6.646    | 6.576    | 6.701    | 8.587    | 6.578    | 6.696    | 8.623    |
| 1453.4                                     | 1.453 | 6.918    | 6.909    | 6.906    | 6.834    | 6.937    | 8.586    | 6.837    | 6.938    | 8.628    |
| 1488.8                                     | 1.489 | 7.167    | 7.164    | 7.166    | 7.093    | 7.175    | 8.586    | 7.097    | 7.182    | 8.636    |
| 1524.3                                     | 1.524 | 7.417    | 7.418    | 7.427    | 7.353    | 7.415    | 8.589    | 7.358    | 7.428    | 8.645    |
| 1559.7                                     | 1.560 | 7.668    | 7.674    | 7.689    | 7.613    | 7.657    | 8.593    | 7.620    | 7.676    | 8.657    |
| 1595.2                                     | 1.595 | 7.920    | 7.930    | 7.951    | 7.874    | 7.902    | 8.600    | 7.882    | 7.927    | 8.671    |
| 1630.6                                     | 1.631 | 8.172    | 8.188    | 8.214    | 8.136    | 8.149    | 8.609    | 8.145    | 8.180    | 8.687    |
| 1666.1                                     | 1.666 | 8.425    | 8.445    | 8.478    | 8.399    | 8.398    | 8.621    | 8.408    | 8.435    | 8.706    |
| 1701.5                                     | 1.702 | 8.679    | 8.704    | 8.743    | 8.662    | 8.650    | 8.635    | 8.673    | 8.694    | 8.727    |



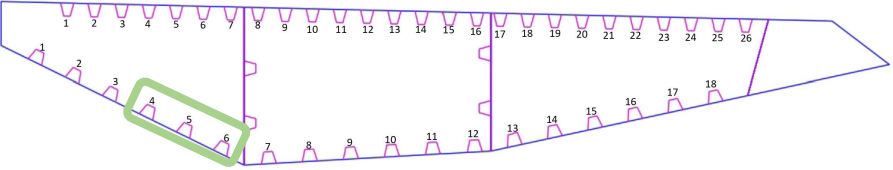
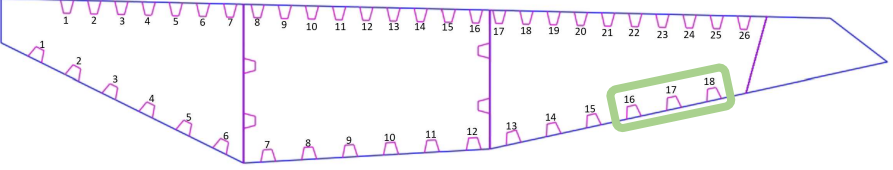
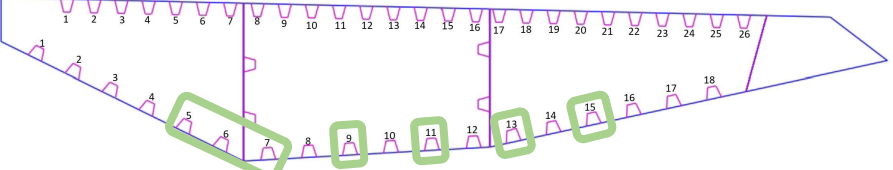
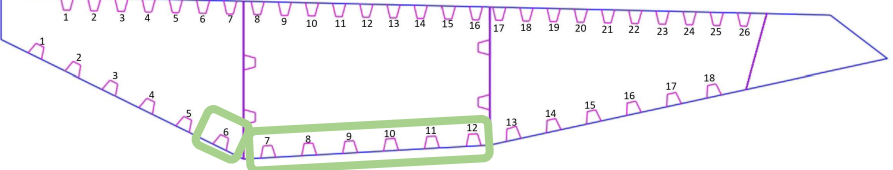
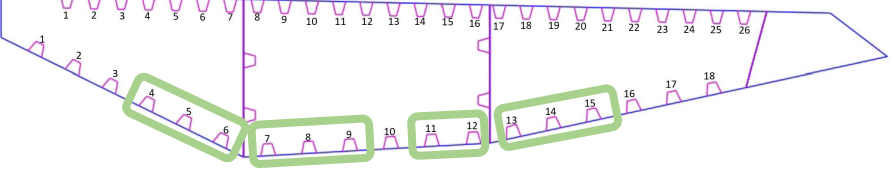
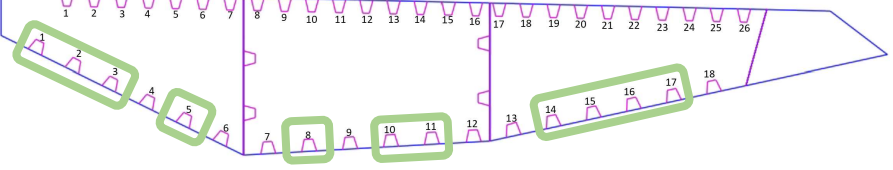
| STIFFENER 3 in S1,2 & 3 - Transversal direction |       |           |           |           |
|-------------------------------------------------|-------|-----------|-----------|-----------|
| mm                                              | m     | S123 - L1 | S123 - L2 | S123 - L3 |
| 0                                               | 0.000 | -0.484    | -0.484    | -0.481    |
| 35.449                                          | 0.035 | 0.067     | 0.164     | 0.455     |
| 70.897                                          | 0.071 | 0.616     | 0.808     | 1.389     |
| 106.35                                          | 0.106 | 1.163     | 1.448     | 2.321     |
| 141.79                                          | 0.142 | 1.707     | 2.085     | 3.251     |
| 177.24                                          | 0.177 | 2.249     | 2.718     | 4.179     |
| 212.69                                          | 0.213 | 2.789     | 3.347     | 5.105     |
| 248.14                                          | 0.248 | 3.327     | 3.972     | 6.029     |
| 283.59                                          | 0.284 | 3.862     | 4.595     | 6.951     |
| 319.04                                          | 0.319 | 4.373     | 5.193     | 7.868     |
| 354.49                                          | 0.354 | 4.577     | 5.515     | 8.727     |
| 389.93                                          | 0.390 | 4.776     | 5.830     | 9.583     |
| 425.38                                          | 0.425 | 4.971     | 6.138     | 10.436    |
| 460.83                                          | 0.461 | 5.161     | 6.435     | 11.282    |
| 496.28                                          | 0.496 | 5.346     | 6.723     | 12.124    |
| 531.73                                          | 0.532 | 5.527     | 7.003     | 12.962    |
| 567.18                                          | 0.567 | 5.704     | 7.274     | 13.795    |
| 602.63                                          | 0.603 | 5.876     | 7.538     | 14.625    |
| 638.08                                          | 0.638 | 6.045     | 7.794     | 15.450    |
| 673.52                                          | 0.674 | 6.167     | 7.996     | 16.096    |
| 708.97                                          | 0.709 | 6.174     | 8.066     | 16.248    |
| 744.42                                          | 0.744 | 6.177     | 8.124     | 16.383    |
| 779.87                                          | 0.780 | 6.176     | 8.169     | 16.498    |
| 815.32                                          | 0.815 | 6.170     | 8.190     | 16.577    |
| 850.77                                          | 0.851 | 6.162     | 8.200     | 16.635    |
| 886.22                                          | 0.886 | 6.152     | 8.197     | 16.671    |
| 921.66                                          | 0.922 | 6.141     | 8.182     | 16.687    |
| 957.11                                          | 0.957 | 6.129     | 8.156     | 16.682    |
| 992.56                                          | 0.993 | 6.114     | 8.119     | 16.658    |
| 1028                                            | 1.028 | 6.098     | 8.071     | 16.614    |
| 1063.5                                          | 1.064 | 6.095     | 7.944     | 16.189    |
| 1098.9                                          | 1.099 | 6.108     | 7.757     | 15.388    |
| 1134.4                                          | 1.134 | 6.126     | 7.577     | 14.578    |
| 1169.8                                          | 1.170 | 6.148     | 7.405     | 13.761    |
| 1205.3                                          | 1.205 | 6.173     | 7.240     | 12.937    |
| 1240.7                                          | 1.241 | 6.203     | 7.081     | 12.105    |
| 1276.2                                          | 1.276 | 6.235     | 6.929     | 11.267    |
| 1311.6                                          | 1.312 | 6.272     | 6.783     | 10.422    |
| 1347                                            | 1.347 | 6.311     | 6.643     | 9.571     |
| 1382.5                                          | 1.383 | 6.354     | 6.508     | 8.714     |
| 1417.9                                          | 1.418 | 6.575     | 6.683     | 8.569     |
| 1453.4                                          | 1.453 | 6.834     | 6.926     | 8.581     |
| 1488.8                                          | 1.489 | 7.095     | 7.171     | 8.594     |
| 1524.3                                          | 1.524 | 7.356     | 7.418     | 8.610     |
| 1559.7                                          | 1.560 | 7.618     | 7.667     | 8.628     |
| 1595.2                                          | 1.595 | 7.880     | 7.919     | 8.648     |
| 1630.6                                          | 1.631 | 8.143     | 8.173     | 8.671     |
| 1666.1                                          | 1.666 | 8.407     | 8.430     | 8.696     |
| 1701.5                                          | 1.702 | 8.672     | 8.689     | 8.724     |

## **APPENDIX K – Definition of cases – corroded ribs & general corrosion (part 1)**

# CHAPTER 5 - CONCLUSIONS

| Damages                | Level | Name       | Description                                                                          |
|------------------------|-------|------------|--------------------------------------------------------------------------------------|
| Corroded ribs<br>(top) | 1     | L1-O2(MIN) |    |
|                        |       | L1-O4(MAX) |    |
|                        | 2     | L2-O5(MIN) |    |
|                        |       | L2-O2(MAX) |   |
|                        | 3     | L3-O2(MIN) |  |
|                        |       | L3-O1(MAX) |  |

# CHAPTER 5 - CONCLUSIONS

| Damages                   | Level | Name       | Description                                                                          |
|---------------------------|-------|------------|--------------------------------------------------------------------------------------|
| Corroded ribs<br>(bottom) | 1     | L1-O4(MIN) |    |
|                           |       | L1-O5(MAX) |    |
|                           | 2     | L2-O3(MIN) |    |
|                           |       | L2-O5(MAX) |   |
|                           | 3     | L3-O6(MIN) |  |
|                           |       | L3-O3(MAX) |  |

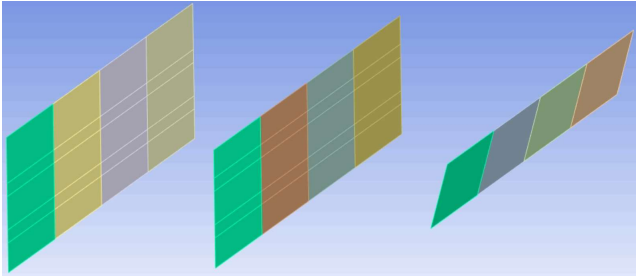
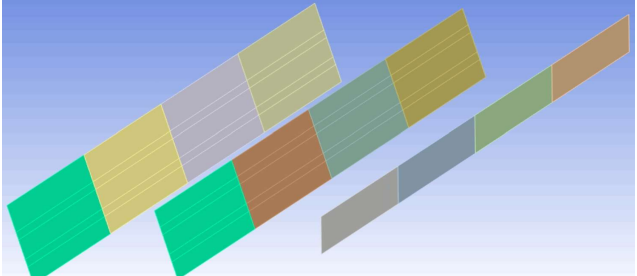
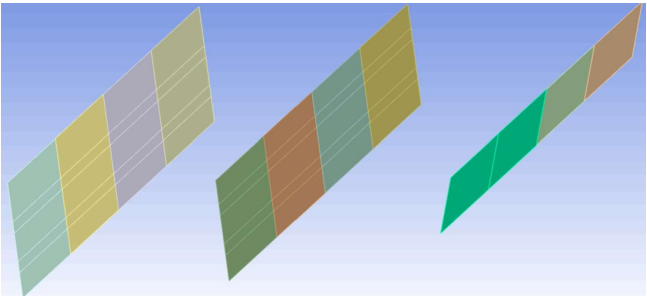
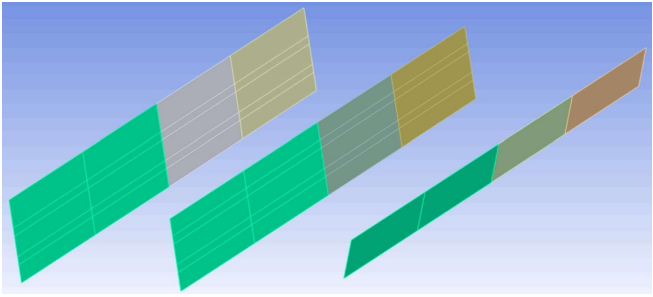
## General Corrosion

| <b>Reduction</b> | <b>Thickness (mm)</b> |                               |
|------------------|-----------------------|-------------------------------|
|                  | <b>Uribs</b>          | <b>Plate &amp; Stiffeners</b> |
| 0                | 9                     | 18                            |
| 25%              | 6.75                  | 13.5                          |
| 50%              | 3.375                 | 9                             |
| 75%              | 2.25                  | 4.5                           |

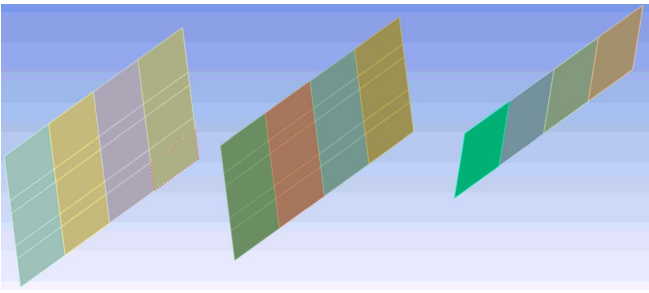
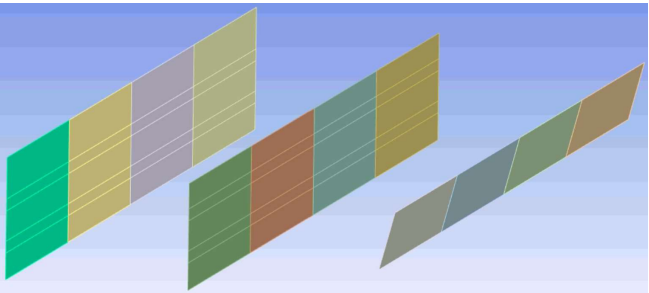
## **APPENDIX K – Definition of cases – local corrosion (part 2)**

CHAPTER 5 - CONCLUSIONS

| Level | Thickness | Length |
|-------|-----------|--------|
| 1     | 13.5      | 4.5    |
| 2     | 9         | 9      |
| 3     | 4.5       | 13.5   |

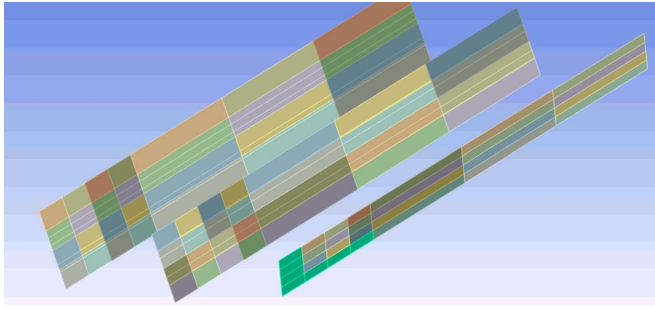
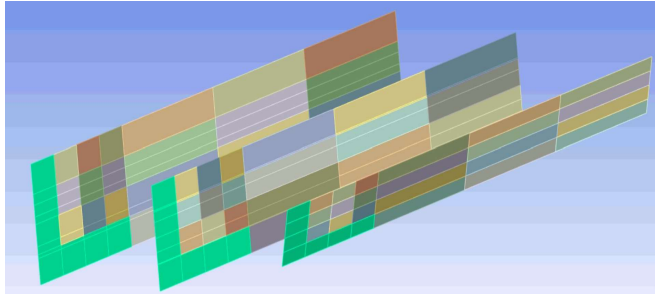
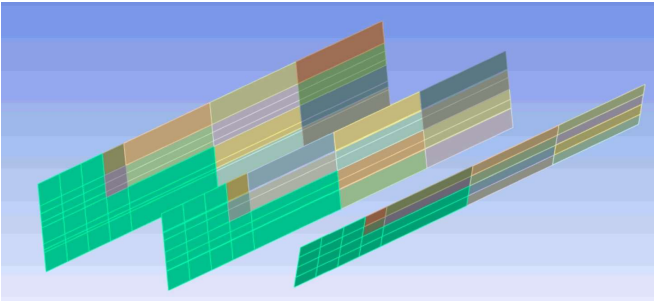
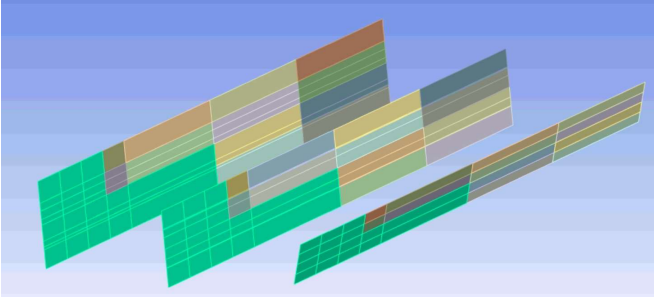
| Damages                 | Level | Name          | Description                                                                          |
|-------------------------|-------|---------------|--------------------------------------------------------------------------------------|
| Local Corrosion<br>(N2) | 1     | S3;S123 (MIN) |    |
|                         |       | S2;S12 (MAX)  |   |
|                         | 2     | S3;S3 (MIN)   |  |
|                         |       | S2;S123 (MAX) |  |

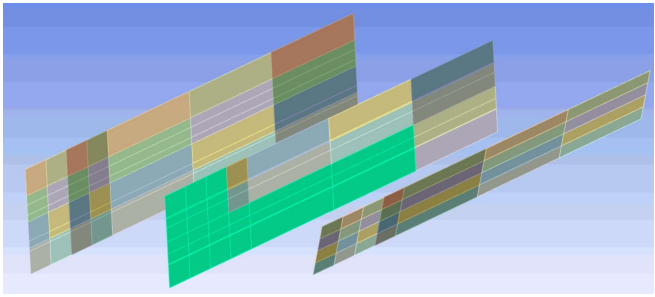
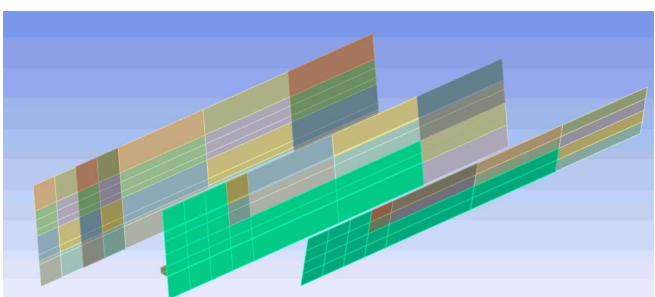


|  |   |             |                                                                                    |
|--|---|-------------|------------------------------------------------------------------------------------|
|  | 3 | S3;S3 (MIN) |  |
|  |   | S1;S1 (MAX) |  |

CHAPTER 5 - CONCLUSIONS

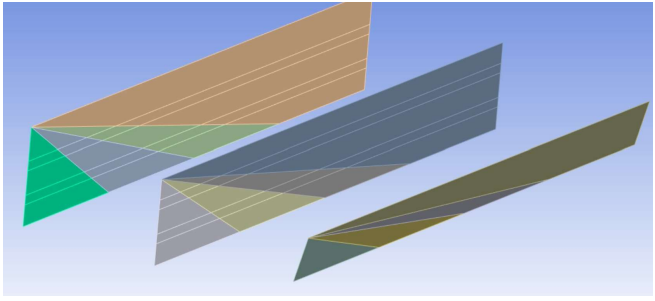
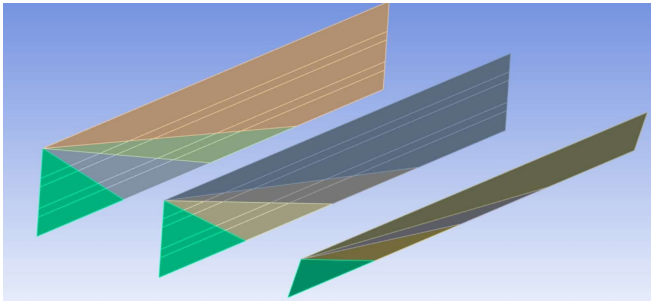
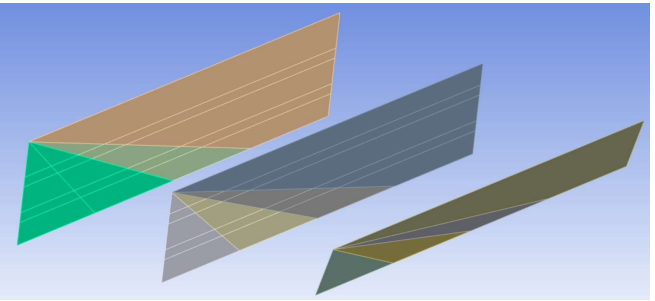
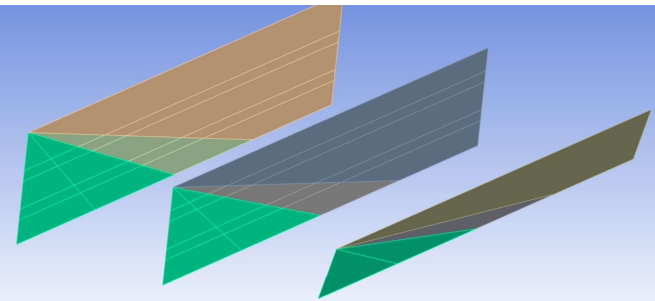
| Level | Thickness | Length |
|-------|-----------|--------|
| 1     | 13.5      | 4.5    |
| 2     | 9         | 9      |
| 3     | 4.5       | 13.5   |

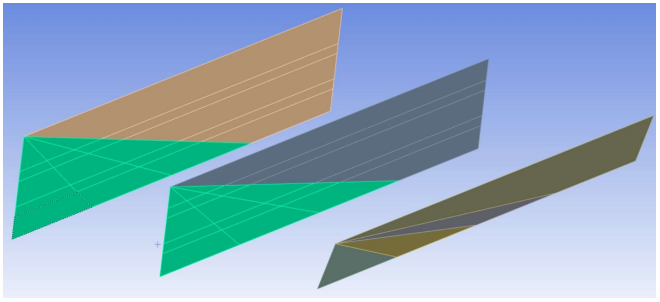
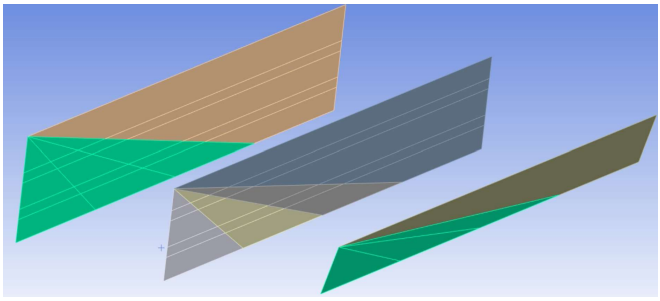
| Damages                 | Level | Name               | Description                                                                          |
|-------------------------|-------|--------------------|--------------------------------------------------------------------------------------|
| Local Corrosion<br>(N4) | 1     | S3; S3 - L1 (MIN)  |    |
|                         |       | 2;S123 - L1 (MAX)  |   |
|                         | 2     | S1;S123 - L2 (MIN) |  |
|                         |       | 2;S123 - L2 (MAX)  |  |

|   |                   |                                                                                    |
|---|-------------------|------------------------------------------------------------------------------------|
| 3 | S2;S2 - L3 (MIN)  |  |
|   | S3;S23 - L3 (MAX) |  |

CHAPTER 5 - CONCLUSIONS

| Level | Thickness | Length |
|-------|-----------|--------|
| 1     | 13.5      | 4.5    |
| 2     | 9         | 9      |
| 3     | 4.5       | 13.5   |

| Damages                 | Level | Name              | Description                                                                          |
|-------------------------|-------|-------------------|--------------------------------------------------------------------------------------|
| Local Corrosion<br>(N5) | 1     | S1; S1 - L1 (MIN) |    |
|                         |       | 2;S123 - L1 (MAX) |   |
|                         | 2     | S1;S1 - L2 (MIN)  |  |
|                         |       | 2;S123 - L2 (MAX) |  |

|   |                   |                                                                                    |
|---|-------------------|------------------------------------------------------------------------------------|
| 3 | S2;S12 - L3 (MIN) |  |
|   | S2;S13 - L3 (MAX) |  |

## **APPENDIX L – Cases definition**

PART 1

|       | End of Girder |   |   |   |   |   |   |   |   | 1/4 of span |    |    |    |    |    |    | Center of Span |    |    |    |    |    |    |    |    |    |    |    |
|-------|---------------|---|---|---|---|---|---|---|---|-------------|----|----|----|----|----|----|----------------|----|----|----|----|----|----|----|----|----|----|----|
|       | 1             | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10          | 11 | 12 | 13 | 14 | 15 | 16 | 17             | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
| P1-1  |               | X |   | X |   |   |   |   |   | X           |    |    |    |    |    |    | X              | X  | X  |    |    |    |    |    |    |    |    |    |
| P1-2  |               |   |   |   |   |   |   | X | X |             | X  |    |    |    |    |    |                |    |    | X  | X  | X  |    |    |    |    |    |    |
| P1-3  |               |   |   |   | X |   |   | X |   |             |    | X  |    |    |    |    |                |    |    |    |    |    | X  | X  | X  |    |    |    |
| P1-4  |               |   |   | X | X |   |   |   |   |             |    |    | X  |    |    |    |                |    |    |    |    |    |    |    |    | X  | X  | X  |
| P1-5  |               |   | X |   |   |   |   |   | X |             |    |    |    | X  |    |    | X              |    |    |    |    | X  |    |    |    |    |    | X  |
| P1-6  |               | X | X |   |   |   |   |   |   |             |    |    |    |    | X  |    |                |    |    |    | X  | X  | X  |    |    |    |    |    |
| P1-7  |               |   |   |   |   | X | X |   |   |             |    |    |    |    |    | X  |                |    | X  | X  |    |    |    |    |    |    |    | X  |
| P1-8  | X             |   |   |   |   | X |   |   |   | X           |    |    |    |    |    |    |                | X  |    |    |    |    |    |    | X  | X  |    |    |
| P1-9  |               |   |   |   |   |   | X | X |   |             |    |    | X  |    |    |    |                | X  |    | X  | X  |    |    |    |    |    |    |    |
| P1-10 | X             | X |   |   |   |   |   |   |   |             |    |    |    |    |    | X  |                |    | X  |    |    |    |    | X  |    |    | X  |    |
| P2-1  | X             | X | X | X |   |   |   |   |   | X           | X  | X  |    |    |    |    | X              | X  | X  | X  | X  | X  |    |    |    |    |    |    |
| P2-2  | X             | X | X |   |   |   |   | X |   |             |    | X  | X  | X  |    |    |                |    |    | X  | X  | X  | X  | X  | X  |    |    |    |
| P2-3  |               |   | X | X | X | X |   |   |   | X           |    |    | X  |    |    | X  | X              | X  |    |    | X  | X  |    |    |    |    | X  | X  |
| P2-4  |               | X | X |   |   |   | X |   | X | X           |    | X  |    | X  |    |    |                |    |    | X  | X  | X  | X  | X  | X  |    |    |    |
| P2-5  |               | X | X | X | X |   |   |   |   | X           | X  |    |    |    |    | X  | X              |    | X  |    | X  |    | X  |    | X  |    | X  |    |
| P2-6  |               |   |   | X | X | X | X |   |   |             |    |    | X  | X  | X  |    | X              | X  | X  |    | X  |    |    | X  |    | X  |    |    |
| P2-7  | X             |   | X |   |   |   |   | X | X |             |    | X  |    | X  |    | X  |                | X  |    | X  | X  | X  | X  |    | X  |    |    |    |
| P2-8  |               |   |   |   | X | X | X | X |   | X           |    | X  | X  |    | X  |    |                |    | X  | X  |    |    | X  | X  |    |    | X  | X  |
| P2-9  |               | X |   | X |   | X | X |   |   |             | X  | X  | X  |    |    |    | X              | X  | X  |    |    |    |    |    |    | X  | X  | X  |
| P2-10 |               |   |   |   |   | X | X | X | X |             |    |    |    | X  | X  | X  |                |    |    |    |    |    | X  | X  | X  | X  | X  | X  |
| P3-1  | X             | X | X | X | X | X |   |   |   |             |    | X  | X  | X  | X  | X  | X              | X  | X  | X  | X  | X  | X  | X  | X  |    |    |    |
| P3-2  | X             | X |   |   | X |   | X | X | X | X           | X  | X  |    | X  | X  |    |                | X  | X  | X  | X  | X  | X  | X  | X  | X  |    |    |
| P3-3  |               |   | X | X | X | X | X | X |   |             | X  | X  | X  | X  | X  |    |                | X  | X  | X  |    | X  | X  |    | X  | X  | X  | X  |
| P3-4  |               | X | X | X |   | X | X | X |   | X           |    | X  | X  | X  |    | X  | X              | X  | X  |    | X  | X  | X  | X  | X  | X  |    |    |
| P3-5  | X             |   |   |   | X | X | X | X | X | X           | X  | X  |    |    | X  | X  |                | X  | X  | X  | X  |    | X  | X  | X  |    | X  | X  |
| P3-6  | X             |   | X |   | X | X |   | X | X | X           |    | X  | X  | X  | X  |    | X              | X  | X  |    | X  | X  | X  |    | X  | X  | X  |    |
| P3-7  |               | X |   | X | X | X | X |   | X | X           |    | X  | X  |    | X  | X  | X              | X  | X  | X  | X  |    |    |    | X  | X  | X  | X  |
| P3-8  | X             |   | X | X | X | X |   |   | X | X           | X  |    | X  | X  |    | X  | X              | X  | X  |    | X  | X  | X  |    |    | X  | X  | X  |
| P3-9  | X             |   | X |   | X | X |   | X | X | X           |    |    | X  | X  | X  | X  | X              | X  |    | X  | X  |    | X  | X  |    | X  | X  | X  |
| P3-10 |               |   |   | X | X | X | X | X | X | X           | X  | X  | X  | X  |    |    |                |    |    | X  | X  | X  | X  | X  | X  | X  | X  | X  |

PART 2

|       | End of Girder       |                     |                     |                     |                     |                     |                     |       |       | 1/4 of span |       |       |       |       |       |       | Center of Span    |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |                   |
|-------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|-------|-------|-------------|-------|-------|-------|-------|-------|-------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
|       | 1                   | 2                   | 3                   | 4                   | 5                   | 6                   | 7                   | 8     | 9     | 10          | 11    | 12    | 13    | 14    | 15    | 16    | 17                | 18                | 19                | 20                | 21                | 22                | 23                | 24                | 25                | 26                | 27                | 28                |
| P1-2  |                     |                     |                     |                     |                     |                     |                     | C1-26 | C1-20 |             | G25   |       |       |       |       |       |                   |                   |                   | C1-4<br>W/O<br>GC | C1-1<br>W/O<br>GC | C1-2<br>W/O<br>GC |                   |                   |                   |                   |                   |                   |
| P1-7  |                     |                     |                     |                     |                     | C1-24               | C1-11               |       |       |             |       |       |       |       |       | G25   |                   |                   | C1-2<br>W/O<br>GC | C1-1<br>W/O<br>GC |                   |                   |                   |                   |                   |                   |                   | C1-4<br>W/O<br>GC |
| P1-10 | C1-26               | C1-20               |                     |                     |                     |                     |                     |       |       |             |       |       |       |       |       | G25   |                   |                   | C1-2<br>W/O<br>GC |                   |                   |                   |                   | C1-4<br>W/O<br>GC |                   |                   | C1-1<br>W/O<br>GC |                   |
| P2-1  | C2-20<br>W/O<br>TBR | C2-24<br>W/O<br>TBR | C2-28<br>W/O<br>TBR | C2-16<br>W/O<br>TBR |                     |                     |                     |       |       | C2-4        | C2-2  | C2-3  |       |       |       |       | C2-3<br>W/O<br>GC | C2-4<br>W/O<br>GC | C2-1<br>W/O<br>GC | C2-2<br>W/O<br>GC | C2-4<br>W/O<br>GC | C2-3<br>W/O<br>GC |                   |                   |                   |                   |                   |                   |
| P2-5  |                     | C2-12<br>W/O<br>TBR | C2-8<br>W/O<br>TBR  | C2-27<br>W/O<br>TBR | C2-11<br>W/O<br>TBR |                     |                     |       |       | C2-3        | C2-2  |       |       |       |       | C2-1  | C2-4<br>W/O<br>GC |                   | C2-4<br>W/O<br>GC |                   | C2-2<br>W/O<br>GC |                   | C2-1<br>W/O<br>GC |                   | C2-3<br>W/O<br>GC |                   | C2-4<br>W/O<br>GC |                   |
| P2-6  |                     |                     |                     | C2-12<br>W/O<br>TBR | C2-19<br>W/O<br>TBR | C2-16<br>W/O<br>TBR | C2-16<br>W/O<br>TBR |       |       |             |       |       | C2-1  | C2-3  | C2-2  |       | C2-3<br>W/O<br>GC | C2-4<br>W/O<br>GC | C2-3<br>W/O<br>GC |                   | C2-1<br>W/O<br>GC |                   |                   | C2-2<br>W/O<br>GC |                   | C2-4<br>W/O<br>GC |                   |                   |
| P3-4  |                     | C3-18               | C3-20               | C3-10               |                     | C3-26               | C3-24               | C3-16 |       | C3-12       |       | C3-20 | C3-27 | C3-16 |       | C3-11 | C3-1              | C3-2              | C3-3              |                   | C3-4              | C3-2              | C3-3              | C3-3              | C3-3              | C3-3              | C3-4              |                   |
| P3-6  | C3-11               |                     | C3-24               |                     | C3-19               | C3-20               |                     | C3-27 | C3-8  | C3-11       |       | C3-1  | C3-4  | C3-16 | C3-26 |       | C3-2              | C3-1              | C3-3              |                   | C3-4              | C3-3              | C3-4              |                   | C3-2              | C3-2              | C3-1              |                   |
| P3-8  | C3-26               |                     | C3-20               | C3-28               | C3-11               | C3-24               |                     |       | C3-18 | C3-4        | C3-20 |       | C3-1  | C3-10 |       | C3-12 | C3-4              | C3-1              | C3-4              |                   | C3-4              | C3-2              | C3-2              |                   |                   | C3-3              | C3-4              | C3-1              |



## **APPENDIX M – Mass summary Level 1**

C1-1

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 123.35             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.11102E+07 0.17523E+06  |
| 0.0000             | 123.35 | 0.0000 |                                       | -0.11102E+07              | 0.0000 0.20445E+07       |
| 0.0000             | 0.0000 | 123.35 |                                       | -0.17523E+06              | -0.20445E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.13749E+11               | 0.29266E+10 -0.18401E+11 |
|                    |        |        |                                       | 0.29266E+10               | 0.50783E+11 0.15770E+10  |
|                    |        |        |                                       | -0.18401E+11              | 0.15770E+10 0.37888E+11  |

TOTAL MASS = 123.35

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16575. -1420.6 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.35086E+10 0.22292E+08 66.256  
0.22292E+08 0.69036E+10 6.4516  
66.256 6.4516 0.37512E+10

PRINCIPAL INERTIAS = 0.35085E+10 0.69038E+10 0.37512E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.007,-0.000) ( 0.007, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C1-2

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 123.35             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.11102E+07 0.17634E+06  |
| 0.0000             | 123.35 | 0.0000 |                                       | -0.11102E+07              | 0.0000 0.20220E+07       |
| 0.0000             | 0.0000 | 123.35 |                                       | -0.17634E+06              | -0.20220E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.13755E+11               | 0.28902E+10 -0.18198E+11 |
|                    |        |        |                                       | 0.28902E+10               | 0.50036E+11 0.15871E+10  |
|                    |        |        |                                       | -0.18198E+11              | 0.15871E+10 0.37146E+11  |

TOTAL MASS = 123.35

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16392. -1429.6 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.35111E+10 -0.45812E+06 64.578  
-0.45812E+06 0.68983E+10 6.3685  
64.578 6.3685 0.37484E+10

The inertia principal axes coincide with the global Cartesian axes

### C1-3

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 123.35             | 0.0000 | 0.0000 |  | 0.0000                                | 0.11102E+07  | 0.17524E+06  |
| 0.0000             | 123.35 | 0.0000 |  | -0.11102E+07                          | 0.0000       | 0.20450E+07  |
| 0.0000             | 0.0000 | 123.35 |  | -0.17524E+06                          | -0.20450E+07 | 0.0000       |
| -----              |        |        |  | -----                                 |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.13749E+11                           | 0.29265E+10  | -0.18405E+11 |
|                    |        |        |  | 0.29265E+10                           | 0.50777E+11  | 0.15771E+10  |
|                    |        |        |  | -0.18405E+11                          | 0.15771E+10  | 0.37882E+11  |

TOTAL MASS = 123.35

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16579. -1420.6 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.35086E+10 0.21290E+08 66.292  
0.21290E+08 0.68818E+10 6.4508  
66.292 6.4508 0.37294E+10

PRINCIPAL INERTIAS = 0.35084E+10 0.68820E+10 0.37294E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.006,-0.000) ( 0.006, 1.000, 0.000) ( 0.000,-0.000, 1.000)

### C1-4

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |  | Coupled translational/rotational mass |
|--------------------|--|---------------------------------------|
|--------------------|--|---------------------------------------|

## CHAPTER 5 - CONCLUSIONS

|        |        |        |  |                           |              |              |
|--------|--------|--------|--|---------------------------|--------------|--------------|
| 123.35 | 0.0000 | 0.0000 |  | 0.0000                    | 0.11102E+07  | 0.17635E+06  |
| 0.0000 | 123.35 | 0.0000 |  | -0.11102E+07              | 0.0000       | 0.20225E+07  |
| 0.0000 | 0.0000 | 123.35 |  | -0.17635E+06              | -0.20225E+07 | 0.0000       |
| -----  |        |        |  | -----                     |              |              |
|        |        |        |  | Rotational mass (inertia) |              |              |
|        |        |        |  | 0.13755E+11               | 0.28901E+10  | -0.18203E+11 |
|        |        |        |  | 0.28901E+10               | 0.50030E+11  | 0.15872E+10  |
|        |        |        |  | -0.18203E+11              | 0.15872E+10  | 0.37141E+11  |

TOTAL MASS = 123.35

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16396.    -1429.7    9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|              |              |             |
|--------------|--------------|-------------|
| 0.35111E+10  | -0.14617E+07 | 64.614      |
| -0.14617E+07 | 0.68767E+10  | 6.3677      |
| 64.614       | 6.3677       | 0.37268E+10 |

The inertia principal axes coincide with the global Cartesian axes

### C1-1 W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 164.47             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14802E+07  | 0.23364E+06  |
| 0.0000             | 164.47 | 0.0000 |  | -0.14802E+07                          | 0.0000       | 0.27260E+07  |
| 0.0000             | 0.0000 | 164.47 |  | -0.23364E+06                          | -0.27260E+07 | 0.0000       |
| -----              |        |        |  | -----                                 |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.18332E+11                           | 0.39022E+10  | -0.24534E+11 |
|                    |        |        |  | 0.39022E+10                           | 0.67710E+11  | 0.21027E+10  |
|                    |        |        |  | -0.24534E+11                          | 0.21027E+10  | 0.50517E+11  |

TOTAL MASS = 164.47

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16575.    -1420.6    9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|             |             |             |
|-------------|-------------|-------------|
| 0.46782E+10 | 0.29722E+08 | 88.343      |
| 0.29722E+08 | 0.92048E+10 | 8.6021      |
| 88.343      | 8.6021      | 0.50016E+10 |

## CHAPTER 5 - CONCLUSIONS

PRINCIPAL INERTIAS = 0.46780E+10 0.92050E+10 0.50016E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.007,-0.000) ( 0.007, 1.000, 0.000) ( 0.000,-0.000, 1.000)

### C1-2 W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 164.47             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14802E+07 0.23512E+06  |
| 0.0000             | 164.47 | 0.0000 |                                       | -0.14802E+07              | 0.0000 0.26960E+07       |
| 0.0000             | 0.0000 | 164.47 |                                       | -0.23512E+06              | -0.26960E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.18340E+11               | 0.38536E+10 -0.24264E+11 |
|                    |        |        |                                       | 0.38536E+10               | 0.66714E+11 0.21161E+10  |
|                    |        |        |                                       | -0.24264E+11              | 0.21161E+10 0.49528E+11  |

TOTAL MASS = 164.47

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16392. -1429.6 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.46815E+10 -0.61083E+06 86.106  
-0.61083E+06 0.91977E+10 8.4913  
86.106 8.4913 0.49979E+10

The inertia principal axes coincide with the global Cartesian axes

### C1-3 W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 164.47             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14802E+07 0.23365E+06  |
| 0.0000             | 164.47 | 0.0000 |                                       | -0.14802E+07              | 0.0000 0.27267E+07       |
| 0.0000             | 0.0000 | 164.47 |                                       | -0.23365E+06              | -0.27267E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.18332E+11               | 0.39020E+10 -0.24540E+11 |
|                    |        |        |                                       | 0.39020E+10               | 0.67702E+11 0.21029E+10  |
|                    |        |        |                                       | -0.24540E+11              | 0.21029E+10 0.50509E+11  |

## CHAPTER 5 - CONCLUSIONS

TOTAL MASS = 164.47

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16579.    -1420.6    9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|             |             |             |
|-------------|-------------|-------------|
| 0.46781E+10 | 0.28387E+08 | 88.391      |
| 0.28387E+08 | 0.91758E+10 | 8.6010      |
| 88.391      | 8.6010      | 0.49726E+10 |

PRINCIPAL INERTIAS = 0.46779E+10 0.91759E+10 0.49726E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 1.000,-0.006,-0.000) ( 0.006, 1.000, 0.000) ( 0.000,-0.000, 1.000)

### C1-4 W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 164.47             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14802E+07  | 0.23514E+06  |
| 0.0000             | 164.47 | 0.0000 |  | -0.14802E+07                          | 0.0000       | 0.26967E+07  |
| 0.0000             | 0.0000 | 164.47 |  | -0.23514E+06                          | -0.26967E+07 | 0.0000       |
|                    |        |        |  |                                       |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.18340E+11                           | 0.38534E+10  | -0.24270E+11 |
|                    |        |        |  | 0.38534E+10                           | 0.66706E+11  | 0.21162E+10  |
|                    |        |        |  | -0.24270E+11                          | 0.21162E+10  | 0.49521E+11  |

TOTAL MASS = 164.47

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16396.    -1429.7    9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|              |              |             |
|--------------|--------------|-------------|
| 0.46814E+10  | -0.19489E+07 | 86.153      |
| -0.19489E+07 | 0.91689E+10  | 8.4902      |
| 86.153       | 8.4902       | 0.49691E+10 |

The inertia principal axes coincide with the global Cartesian axes

G25

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 127.54             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.11478E+07 0.18171E+06  |
| 0.0000             | 127.54 | 0.0000 |                                       | -0.11478E+07              | 0.0000 0.20999E+07       |
| 0.0000             | 0.0000 | 127.54 |                                       | -0.18171E+06              | -0.20999E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.14217E+11               | 0.30029E+10 -0.18899E+11 |
|                    |        |        |                                       | 0.30029E+10               | 0.51984E+11 0.16354E+10  |
|                    |        |        |                                       | -0.18899E+11              | 0.16354E+10 0.38654E+11  |

TOTAL MASS = 127.54

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16465. -1424.8 9000.0

## TOTAL INERTIA ABOUT CENTER OF MASS

0.36279E+10 0.11076E+08 65.244  
0.11076E+08 0.70803E+10 6.4127  
65.244 6.4127 0.38211E+10

PRINCIPAL INERTIAS = 0.36279E+10 0.70803E+10 0.38211E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.003,-0.000) ( 0.003, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C1-8

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 163.45             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14642E+07 0.23330E+06  |
| 0.0000             | 163.45 | 0.0000 |                                       | -0.14642E+07              | 0.0000 0.26808E+07       |
| 0.0000             | 0.0000 | 163.45 |                                       | -0.23330E+06              | -0.26808E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.18082E+11               | 0.38264E+10 -0.24024E+11 |
|                    |        |        |                                       | 0.38264E+10               | 0.66226E+11 0.20874E+10  |
|                    |        |        |                                       | -0.24024E+11              | 0.20874E+10 0.49290E+11  |

TOTAL MASS = 163.45

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16401. -1427.3 8958.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.46322E+10 -21505. -0.93467E+07  
 -21505. 0.91401E+10 -0.24766E+07  
 -0.93467E+07 -0.24766E+07 0.49876E+10

The inertia principal axes coincide with the global Cartesian axes

**C1-10**

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 163.45             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14642E+07  | 0.23183E+06  |
| 0.0000             | 163.45 | 0.0000 |  | -0.14642E+07                          | 0.0000       | 0.27115E+07  |
| 0.0000             | 0.0000 | 163.45 |  | -0.23183E+06                          | -0.27115E+07 | 0.0000       |
|                    |        |        |  |                                       |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.18074E+11                           | 0.38748E+10  | -0.24300E+11 |
|                    |        |        |  | 0.38748E+10                           | 0.67214E+11  | 0.20742E+10  |
|                    |        |        |  | -0.24300E+11                          | 0.20742E+10  | 0.50270E+11  |

TOTAL MASS = 163.45

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16589. -1418.3 8958.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.46288E+10 0.29061E+08 -0.10633E+08  
 0.29061E+08 0.91176E+10 -0.25383E+07  
 -0.10633E+08 -0.25383E+07 0.49616E+10

PRINCIPAL INERTIAS = 0.46283E+10 0.91178E+10 0.49620E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 0.999,-0.006, 0.032) ( 0.006, 1.000,-0.001) (-0.032, 0.001, 0.999)



C1-11

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 163.18             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14600E+07  | 0.23299E+06  |
| 0.0000             | 163.18 | 0.0000 |                                       | -0.14600E+07              | 0.0000       | 0.26750E+07  |
| 0.0000             | 0.0000 | 163.18 |                                       | -0.23299E+06              | -0.26750E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.18014E+11               | 0.38184E+10  | -0.23929E+11 |
|                    |        |        |                                       | 0.38184E+10               | 0.65997E+11  | 0.20824E+10  |
|                    |        |        |                                       | -0.23929E+11              | 0.20824E+10  | 0.49128E+11  |

TOTAL MASS = 163.18

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16393. -1427.8 8946.8

## TOTAL INERTIA ABOUT CENTER OF MASS

0.46191E+10 -0.90675E+06 0.42689E+07  
-0.90675E+06 0.90835E+10 -0.20778E+07  
0.42689E+07 -0.20778E+07 0.49437E+10

The inertia principal axes coincide with the global Cartesian axes

C1-12

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 163.45             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14642E+07  | 0.23332E+06  |
| 0.0000             | 163.45 | 0.0000 |                                       | -0.14642E+07              | 0.0000       | 0.26815E+07  |
| 0.0000             | 0.0000 | 163.45 |                                       | -0.23332E+06              | -0.26815E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.18082E+11               | 0.38262E+10  | -0.24030E+11 |
|                    |        |        |                                       | 0.38262E+10               | 0.66218E+11  | 0.20876E+10  |
|                    |        |        |                                       | -0.24030E+11              | 0.20876E+10  | 0.49282E+11  |

TOTAL MASS = 163.45

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16405. -1427.4 8958.0

## CHAPTER 5 - CONCLUSIONS

### TOTAL INERTIA ABOUT CENTER OF MASS

0.46322E+10 -0.13583E+07 -0.93736E+07  
 -0.13583E+07 0.91113E+10 -0.24759E+07  
 -0.93736E+07 -0.24759E+07 0.49587E+10

The inertia principal axes coincide with the global Cartesian axes

**C1-16**

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

### TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 167.63             | 0.0000 | 0.0000 |  | 0.0000                                | 0.15045E+07  | 0.24092E+06  |
| 0.0000             | 167.63 | 0.0000 |  | -0.15045E+07                          | 0.0000       | 0.27432E+07  |
| 0.0000             | 0.0000 | 167.63 |  | -0.24092E+06                          | -0.27432E+07 | 0.0000       |
|                    |        |        |  |                                       |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.18600E+11                           | 0.39390E+10  | -0.24618E+11 |
|                    |        |        |  | 0.39390E+10                           | 0.67679E+11  | 0.21596E+10  |
|                    |        |        |  | -0.24618E+11                          | 0.21596E+10  | 0.50257E+11  |

TOTAL MASS = 167.63

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16365.    -1437.2    8974.9

### TOTAL INERTIA ABOUT CENTER OF MASS

0.47510E+10 -0.34810E+07 0.21203E+07  
 -0.34810E+07 0.92846E+10 -0.25796E+07  
 0.21203E+07 -0.25796E+07 0.50181E+10

The inertia principal axes coincide with the global Cartesian axes

**C1-18**

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

### TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 160.96             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14250E+07  | 0.22545E+06  |
| 0.0000             | 160.96 | 0.0000 |  | -0.14250E+07                          | 0.0000       | 0.26613E+07  |
| 0.0000             | 0.0000 | 160.96 |  | -0.22545E+06                          | -0.26613E+07 | 0.0000       |
|                    |        |        |  |                                       |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.17505E+11                           | 0.37604E+10  | -0.23553E+11 |

## CHAPTER 5 - CONCLUSIONS

|              |             |             |
|--------------|-------------|-------------|
| 0.37604E+10  | 0.65593E+11 | 0.19879E+10 |
| -0.23553E+11 | 0.19879E+10 | 0.49182E+11 |

TOTAL MASS = 160.96

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16534.    -1400.7    8853.3

TOTAL INERTIA ABOUT CENTER OF MASS

|             |              |              |
|-------------|--------------|--------------|
| 0.45733E+10 | 0.32745E+08  | 0.81469E+07  |
| 0.32745E+08 | 0.89740E+10  | -0.80520E+07 |
| 0.81469E+07 | -0.80520E+07 | 0.48638E+10  |

PRINCIPAL INERTIAS = 0.45729E+10 0.89742E+10 0.48640E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 1.000,-0.007,-0.028) ( 0.007, 1.000,-0.002) ( 0.028, 0.002, 1.000)

**C1-19**

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 168.08             | 0.0000 | 0.0000 |  | 0.0000                                | 0.15118E+07  | 0.24195E+06  |
| 0.0000             | 168.08 | 0.0000 |  | -0.15118E+07                          | 0.0000       | 0.27506E+07  |
| 0.0000             | 0.0000 | 168.08 |  | -0.24195E+06                          | -0.27506E+07 | 0.0000       |
| -----              |        |        |  | -----                                 |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.18724E+11                           | 0.39542E+10  | -0.24734E+11 |
|                    |        |        |  | 0.39542E+10                           | 0.67897E+11  | 0.21763E+10  |
|                    |        |        |  | -0.24734E+11                          | 0.21763E+10  | 0.50355E+11  |

TOTAL MASS = 168.08

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16365.    -1439.6    8994.7

TOTAL INERTIA ABOUT CENTER OF MASS

|              |              |             |
|--------------|--------------|-------------|
| 0.47774E+10  | -0.54311E+07 | 0.65359E+07 |
| -0.54311E+07 | 0.92855E+10  | 9315.5      |
| 0.65359E+07  | 9315.5       | 0.49940E+10 |

The inertia principal axes coincide with the global Cartesian axes

C1-20

## \*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 167.63             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.15045E+07 0.24093E+06 |
| 0.0000             | 167.63 | 0.0000 |                                       | -0.15045E+07 | 0.0000 0.27439E+07      |
| 0.0000             | 0.0000 | 167.63 |                                       | -0.24093E+06 | -0.27439E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.18600E+11 0.39388E+10 -0.24624E+11  |              |                         |
|                    |        |        | 0.39388E+10 0.67672E+11 0.21597E+10   |              |                         |
|                    |        |        | -0.24624E+11 0.21597E+10 0.50249E+11  |              |                         |

TOTAL MASS = 167.63

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16369. -1437.3 8974.9

## TOTAL INERTIA ABOUT CENTER OF MASS

0.47509E+10 -0.48236E+07 0.21042E+07  
-0.48236E+07 0.92558E+10 -0.25792E+07  
0.21042E+07 -0.25792E+07 0.49893E+10

The inertia principal axes coincide with the global Cartesian axes

C1-24

## \*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 163.83             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.14696E+07 0.23374E+06 |
| 0.0000             | 163.83 | 0.0000 |                                       | -0.14696E+07 | 0.0000 0.26852E+07      |
| 0.0000             | 0.0000 | 163.83 |                                       | -0.23374E+06 | -0.26852E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.18160E+11 0.38312E+10 -0.24085E+11  |              |                         |
|                    |        |        | 0.38312E+10 0.66343E+11 0.20935E+10   |              |                         |
|                    |        |        | -0.24085E+11 0.20935E+10 0.49330E+11  |              |                         |

TOTAL MASS = 163.83

The mass principal axes coincide with the global Cartesian axes

## CHAPTER 5 - CONCLUSIONS

CENTER OF MASS (X,Y,Z)= 16391. -1426.8 8970.5

TOTAL INERTIA ABOUT CENTER OF MASS

0.46437E+10 66287. 0.23008E+07  
 66287. 0.91487E+10 -0.32454E+07  
 0.23008E+07 -0.32454E+07 0.49852E+10

The inertia principal axes coincide with the global Cartesian axes

C1-26

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 163.83             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14696E+07  | 0.23227E+06  |
| 0.0000             | 163.83 | 0.0000 |  | -0.14696E+07                          | 0.0000       | 0.27158E+07  |
| 0.0000             | 0.0000 | 163.83 |  | -0.23227E+06                          | -0.27158E+07 | 0.0000       |
|                    |        |        |  |                                       |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.18153E+11                           | 0.38796E+10  | -0.24361E+11 |
|                    |        |        |  | 0.38796E+10                           | 0.67332E+11  | 0.20803E+10  |
|                    |        |        |  | -0.24361E+11                          | 0.20803E+10  | 0.50311E+11  |

TOTAL MASS = 163.83

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16578. -1417.8 8970.5

TOTAL INERTIA ABOUT CENTER OF MASS

0.46403E+10 0.29149E+08 0.13983E+07  
 0.29149E+08 0.91268E+10 -0.32887E+07  
 0.13983E+07 -0.32887E+07 0.49599E+10

PRINCIPAL INERTIAS = 0.46401E+10 0.91270E+10 0.49599E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 1.000,-0.006,-0.004) ( 0.006, 1.000,-0.001) ( 0.004, 0.001, 1.000)

C1-27

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |             |             |
|--------------------|--------|--------|--|---------------------------------------|-------------|-------------|
| 164.20             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14757E+07 | 0.23449E+06 |
| 0.0000             | 164.20 | 0.0000 |  | -0.14757E+07                          | 0.0000      | 0.26933E+07 |

## CHAPTER 5 - CONCLUSIONS

|        |        |        |  |                           |              |              |
|--------|--------|--------|--|---------------------------|--------------|--------------|
| 0.0000 | 0.0000 | 164.20 |  | -0.23449E+06              | -0.26933E+07 | 0.0000       |
| -----  |        |        |  | -----                     |              |              |
|        |        |        |  | Rotational mass (inertia) |              |              |
|        |        |        |  | 0.18264E+11               | 0.38453E+10  | -0.24214E+11 |
|        |        |        |  | 0.38453E+10               | 0.66590E+11  | 0.21056E+10  |
|        |        |        |  | -0.24214E+11              | 0.21056E+10  | 0.49477E+11  |

TOTAL MASS = 164.20

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16403.    -1428.1    8987.6

TOTAL INERTIA ABOUT CENTER OF MASS

0.46654E+10 -0.92492E+06 -0.79273E+07  
-0.92492E+06 0.91492E+10 -0.18585E+07  
-0.79273E+07 -0.18585E+07 0.49645E+10

The inertia principal axes coincide with the global Cartesian axes

C1-28

### \*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 163.83             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14696E+07  | 0.23376E+06  |
| 0.0000             | 163.83 | 0.0000 |  | -0.14696E+07                          | 0.0000       | 0.26858E+07  |
| 0.0000             | 0.0000 | 163.83 |  | -0.23376E+06                          | -0.26858E+07 | 0.0000       |
| -----              |        |        |  | -----                                 |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.18160E+11                           | 0.38310E+10  | -0.24091E+11 |
|                    |        |        |  | 0.38310E+10                           | 0.66336E+11  | 0.20937E+10  |
|                    |        |        |  | -0.24091E+11                          | 0.20937E+10  | 0.49322E+11  |

TOTAL MASS = 163.83

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16394.    -1426.9    8970.5

TOTAL INERTIA ABOUT CENTER OF MASS

0.46437E+10 -0.12700E+07 0.22819E+07  
-0.12700E+07 0.91199E+10 -0.32449E+07  
0.22819E+07 -0.32449E+07 0.49564E+10

The inertia principal axes coincide with the global Cartesian axes

NORMAL

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 170.05             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.15305E+07 0.24228E+06 |
| 0.0000             | 170.05 | 0.0000 |                                       | -0.15305E+07 0.0000       | 0.27998E+07             |
| 0.0000             | 0.0000 | 170.05 |                                       | -0.24228E+06 -0.27998E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.18956E+11 0.40039E+10 -0.25198E+11  |                           |                         |
|                    |        |        | 0.40039E+10 0.69312E+11 0.21806E+10   |                           |                         |
|                    |        |        | -0.25198E+11 0.21806E+10 0.51538E+11  |                           |                         |

TOTAL MASS = 170.05

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16465. -1424.8 9000.0

483.72 5810000

TOTAL INERTIA ABOUT CENTER OF MASS

0.48372E+10 0.14768E+08 86.992  
0.14768E+08 0.94404E+10 8.5502 kg mm2  
86.992 8.5502 0.50949E+10

PRINCIPAL INERTIAS = 0.48371E+10 0.94404E+10 0.50949E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.003,-0.000) ( 0.003, 1.000, 0.000) ( 0.000,-0.000, 1.000)

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 170.05             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.15305E+07 0.24228E+06 |
| 0.0000             | 170.05 | 0.0000 |                                       | -0.15305E+07 0.0000       | 0.27998E+07             |
| 0.0000             | 0.0000 | 170.05 |                                       | -0.24228E+06 -0.27998E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.18956E+11 0.40039E+10 -0.25198E+11  |                           |                         |
|                    |        |        | 0.40039E+10 0.69312E+11 0.21806E+10   |                           |                         |
|                    |        |        | -0.25198E+11 0.21806E+10 0.51538E+11  |                           |                         |

## CHAPTER 5 - CONCLUSIONS

TOTAL MASS = 170.05

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16465. -1424.8 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.48372E+10 0.14768E+08 86.992

0.14768E+08 0.94404E+10 8.5503

86.992 8.5503 0.50949E+10

PRINCIPAL INERTIAS = 0.48371E+10 0.94404E+10 0.50949E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.003,-0.000) ( 0.003, 1.000, 0.000) ( 0.000,-0.000, 1.000)



## **APPENDIX N – Mass summary Level 2**

C2-1

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 78.492             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.70643E+06 0.11015E+06 |
| 0.0000             | 78.492 | 0.0000 |                                       | -0.70643E+06 | 0.0000 0.13033E+07      |
| 0.0000             | 0.0000 | 78.492 |                                       | -0.11015E+06 | -0.13033E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.87421E+10 0.18361E+10 -0.11730E+11  |              |                         |
|                    |        |        | 0.18361E+10 0.32470E+11 0.99131E+09   |              |                         |
|                    |        |        | -0.11730E+11 0.99131E+09 0.24258E+11  |              |                         |

TOTAL MASS = 78.492

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16604. -1403.3 9000.0

## TOTAL INERTIA ABOUT CENTER OF MASS

0.22297E+10 0.71892E+07 44.352  
0.71892E+07 0.44719E+10 4.4070  
44.352 4.4070 0.24631E+10

PRINCIPAL INERTIAS = 0.22297E+10 0.44720E+10 0.24631E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.003,-0.000) ( 0.003, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C2-2

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 78.514             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.70662E+06 0.10961E+06 |
| 0.0000             | 78.514 | 0.0000 |                                       | -0.70662E+06 | 0.0000 0.13049E+07      |
| 0.0000             | 0.0000 | 78.514 |                                       | -0.10961E+06 | -0.13049E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.87411E+10 0.18312E+10 -0.11744E+11  |              |                         |
|                    |        |        | 0.18312E+10 0.32537E+11 0.98647E+09   |              |                         |
|                    |        |        | -0.11744E+11 0.98647E+09 0.24319E+11  |              |                         |

TOTAL MASS = 78.514

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16620.    -1396.0    9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|             |             |             |
|-------------|-------------|-------------|
| 0.22285E+10 | 0.94928E+07 | 44.449      |
| 0.94928E+07 | 0.44895E+10 | 4.4515      |
| 44.449      | 4.4515      | 0.24783E+10 |

PRINCIPAL INERTIAS = 0.22284E+10 0.44896E+10 0.24783E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.004,-0.000) ( 0.004, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C2-3

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass      |
|--------------------|--------|--------|--------------------------------------------|
| 78.493             | 0.0000 | 0.0000 | 0.0000    0.70643E+06    0.11004E+06       |
| 0.0000             | 78.493 | 0.0000 | -0.70643E+06    0.0000    0.12985E+07      |
| 0.0000             | 0.0000 | 78.493 | -0.11004E+06    -0.12985E+07    0.0000     |
|                    |        |        |                                            |
|                    |        |        | Rotational mass (inertia)                  |
|                    |        |        | 0.87421E+10    0.18330E+10    -0.11687E+11 |
|                    |        |        | 0.18330E+10    0.32340E+11    0.99032E+09  |
|                    |        |        | -0.11687E+11    0.99032E+09    0.24128E+11 |

TOTAL MASS = 78.493

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16543.    -1401.9    9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|             |             |             |
|-------------|-------------|-------------|
| 0.22300E+10 | 0.12700E+08 | 43.978      |
| 0.12700E+08 | 0.45003E+10 | 4.4157      |
| 43.978      | 4.4157      | 0.24917E+10 |

PRINCIPAL INERTIAS = 0.22299E+10 0.45004E+10 0.24917E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.006,-0.000) ( 0.006, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C2-4

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 78.515             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.70663E+06 0.10950E+06 |
| 0.0000             | 78.515 | 0.0000 |                                       | -0.70663E+06 | 0.0000 0.13001E+07      |
| 0.0000             | 0.0000 | 78.515 |                                       | -0.10950E+06 | -0.13001E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.87411E+10 0.18281E+10 -0.11701E+11  |              |                         |
|                    |        |        | 0.18281E+10 0.32407E+11 0.98547E+09   |              |                         |
|                    |        |        | -0.11701E+11 0.98547E+09 0.24189E+11  |              |                         |

TOTAL MASS = 78.515

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16559. -1394.6 9000.0

## TOTAL INERTIA ABOUT CENTER OF MASS

0.22287E+10 0.14971E+08 44.075  
0.14971E+08 0.45180E+10 4.4602  
44.075 4.4602 0.25070E+10

PRINCIPAL INERTIAS = 0.22286E+10 0.45181E+10 0.25070E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.007,-0.000) ( 0.007, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C2-1W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 156.98             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.14129E+07 0.22029E+06 |
| 0.0000             | 156.98 | 0.0000 |                                       | -0.14129E+07 | 0.0000 0.26066E+07      |
| 0.0000             | 0.0000 | 156.98 |                                       | -0.22029E+06 | -0.26066E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.17484E+11 0.36721E+10 -0.23459E+11  |              |                         |
|                    |        |        | 0.36721E+10 0.64940E+11 0.19826E+10   |              |                         |
|                    |        |        | -0.23459E+11 0.19826E+10 0.48516E+11  |              |                         |

TOTAL MASS = 156.98

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16604. -1403.3 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|             |             |             |
|-------------|-------------|-------------|
| 0.44594E+10 | 0.14378E+08 | 88.704      |
| 0.14378E+08 | 0.89439E+10 | 8.8140      |
| 88.704      | 8.8140      | 0.49262E+10 |

PRINCIPAL INERTIAS = 0.44594E+10 0.89439E+10 0.49262E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.003,-0.000) ( 0.003, 1.000, 0.000) ( 0.000,-0.000, 1.000)

### C2-2 W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |             |
|--------------------|--------|--------|--|---------------------------------------|--------------|-------------|
| 157.03             | 0.0000 | 0.0000 |  | 0.0000                                | 0.14132E+07  | 0.21921E+06 |
| 0.0000             | 157.03 | 0.0000 |  | -0.14132E+07                          | 0.0000       | 0.26098E+07 |
| 0.0000             | 0.0000 | 157.03 |  | -0.21921E+06                          | -0.26098E+07 | 0.0000      |
| -----              |        |        |  | -----                                 |              |             |
|                    |        |        |  | Rotational mass (inertia)             |              |             |
|                    |        |        |  | 0.17482E+11 0.36623E+10 -0.23488E+11  |              |             |
|                    |        |        |  | 0.36623E+10 0.65073E+11 0.19729E+10   |              |             |
|                    |        |        |  | -0.23488E+11 0.19729E+10 0.48638E+11  |              |             |

TOTAL MASS = 157.03

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16620. -1396.0 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|             |             |             |
|-------------|-------------|-------------|
| 0.44570E+10 | 0.18986E+08 | 88.898      |
| 0.18986E+08 | 0.89791E+10 | 8.9029      |
| 88.898      | 8.9029      | 0.49566E+10 |

PRINCIPAL INERTIAS = 0.44569E+10 0.89792E+10 0.49566E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.004,-0.000) ( 0.004, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C2-3 W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 156.99             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14129E+07  | 0.22007E+06  |
| 0.0000             | 156.99 | 0.0000 |                                       | -0.14129E+07              | 0.0000       | 0.25970E+07  |
| 0.0000             | 0.0000 | 156.99 |                                       | -0.22007E+06              | -0.25970E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.17484E+11               | 0.36661E+10  | -0.23373E+11 |
|                    |        |        |                                       | 0.36661E+10               | 0.64680E+11  | 0.19806E+10  |
|                    |        |        |                                       | -0.23373E+11              | 0.19806E+10  | 0.48255E+11  |

TOTAL MASS = 156.99

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16543. -1401.9 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.44600E+10 0.25400E+08 87.956  
0.25400E+08 0.90006E+10 8.8314  
87.956 8.8314 0.49834E+10

PRINCIPAL INERTIAS = 0.44598E+10 0.90007E+10 0.49834E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.006,-0.000) ( 0.006, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C2-4 W/O GC

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 157.03             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14133E+07  | 0.21899E+06  |
| 0.0000             | 157.03 | 0.0000 |                                       | -0.14133E+07              | 0.0000       | 0.26003E+07  |
| 0.0000             | 0.0000 | 157.03 |                                       | -0.21899E+06              | -0.26003E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.17482E+11               | 0.36563E+10  | -0.23402E+11 |
|                    |        |        |                                       | 0.36563E+10               | 0.64813E+11  | 0.19709E+10  |
|                    |        |        |                                       | -0.23402E+11              | 0.19709E+10  | 0.48377E+11  |

TOTAL MASS = 157.03

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16559.    -1394.6    9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

|             |             |             |
|-------------|-------------|-------------|
| 0.44575E+10 | 0.29942E+08 | 88.150      |
| 0.29942E+08 | 0.90361E+10 | 8.9203      |
| 88.150      | 8.9203      | 0.50140E+10 |

PRINCIPAL INERTIAS = 0.44573E+10 0.90363E+10 0.50140E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.007,-0.000) ( 0.007, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C2-8

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass      |
|--------------------|--------|--------|--------------------------------------------|
| 152.96             | 0.0000 | 0.0000 | 0.0000    0.13584E+07    0.21190E+06       |
| 0.0000             | 152.96 | 0.0000 | -0.13584E+07    0.0000    0.25471E+07      |
| 0.0000             | 0.0000 | 152.96 | -0.21190E+06    -0.25471E+07    0.0000     |
|                    |        |        |                                            |
|                    |        |        | Rotational mass (inertia)                  |
|                    |        |        | 0.16697E+11    0.35523E+10    -0.22648E+11 |
|                    |        |        | 0.35523E+10    0.63306E+11    0.18744E+10  |
|                    |        |        | -0.22648E+11    0.18744E+10    0.47622E+11 |

TOTAL MASS = 152.96

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16652.    -1385.3    8880.4

TOTAL INERTIA ABOUT CENTER OF MASS

|              |              |              |
|--------------|--------------|--------------|
| 0.43410E+10  | 0.23807E+08  | -0.29506E+08 |
| 0.23807E+08  | 0.88306E+10  | -0.73730E+07 |
| -0.29506E+08 | -0.73730E+07 | 0.49160E+10  |

PRINCIPAL INERTIAS = 0.43393E+10 0.88308E+10 0.49175E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.999,-0.005, 0.051) ( 0.005, 1.000,-0.002) (-0.051, 0.002, 0.999)

C2-10

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 152.92             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13580E+07  | 0.21280E+06  |
| 0.0000             | 152.92 | 0.0000 |                                       | -0.13580E+07              | 0.0000       | 0.25360E+07  |
| 0.0000             | 0.0000 | 152.92 |                                       | -0.21280E+06              | -0.25360E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.16699E+11               | 0.35572E+10  | -0.22549E+11 |
|                    |        |        |                                       | 0.35572E+10               | 0.62964E+11  | 0.18824E+10  |
|                    |        |        |                                       | -0.22549E+11              | 0.18824E+10  | 0.47292E+11  |

TOTAL MASS = 152.92

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16584. -1391.5 8880.3

TOTAL INERTIA ABOUT CENTER OF MASS

0.43439E+10 0.28304E+08 -0.28263E+08  
0.28304E+08 0.88493E+10 -0.72588E+07  
-0.28263E+08 -0.72588E+07 0.49399E+10

PRINCIPAL INERTIAS = 0.43424E+10 0.88495E+10 0.49412E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.999,-0.006, 0.047) ( 0.006, 1.000,-0.002) (-0.047, 0.002, 0.999)

C2-11

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 151.88             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13438E+07  | 0.21041E+06  |
| 0.0000             | 151.88 | 0.0000 |                                       | -0.13438E+07              | 0.0000       | 0.25134E+07  |
| 0.0000             | 0.0000 | 151.88 |                                       | -0.21041E+06              | -0.25134E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.16491E+11               | 0.35163E+10  | -0.22230E+11 |
|                    |        |        |                                       | 0.35163E+10               | 0.62280E+11  | 0.18550E+10  |
|                    |        |        |                                       | -0.22230E+11              | 0.18550E+10  | 0.46798E+11  |

TOTAL MASS = 151.88



## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16549. -1385.3 8847.5

TOTAL INERTIA ABOUT CENTER OF MASS

0.43106E+10 0.34346E+08 0.77773E+07  
 0.34346E+08 0.87973E+10 -0.65240E+07  
 0.77773E+07 -0.65240E+07 0.49132E+10

PRINCIPAL INERTIAS = 0.43102E+10 0.87975E+10 0.49133E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 1.000,-0.008,-0.013) ( 0.008, 1.000,-0.002) ( 0.013, 0.002, 1.000)

C2-12

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |
|--------------------|--------|--------|---------------------------------------|
| 152.96             | 0.0000 | 0.0000 | 0.0000 0.13584E+07 0.21172E+06        |
| 0.0000             | 152.96 | 0.0000 | -0.13584E+07 0.0000 0.25392E+07       |
| 0.0000             | 0.0000 | 152.96 | -0.21172E+06 -0.25392E+07 0.0000      |
|                    |        |        |                                       |
|                    |        |        | Rotational mass (inertia)             |
|                    |        |        | 0.16697E+11 0.35474E+10 -0.22578E+11  |
|                    |        |        | 0.35474E+10 0.63098E+11 0.18727E+10   |
|                    |        |        | -0.22578E+11 0.18727E+10 0.47414E+11  |

TOTAL MASS = 152.96

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16600. -1384.1 8880.4

TOTAL INERTIA ABOUT CENTER OF MASS

0.43414E+10 0.32917E+08 -0.28561E+08  
 0.32917E+08 0.88846E+10 -0.73950E+07  
 -0.28561E+08 -0.73950E+07 0.49703E+10

PRINCIPAL INERTIAS = 0.43399E+10 0.88849E+10 0.49716E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 0.999,-0.007, 0.045) ( 0.007, 1.000,-0.002) (-0.045, 0.002, 0.999)

C2-16

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 155.93             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13876E+07  | 0.21608E+06  |
| 0.0000             | 155.93 | 0.0000 |                                       | -0.13876E+07              | 0.0000       | 0.25851E+07  |
| 0.0000             | 0.0000 | 155.93 |                                       | -0.21608E+06              | -0.25851E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.17070E+11               | 0.36029E+10  | -0.23000E+11 |
|                    |        |        |                                       | 0.36029E+10               | 0.64097E+11  | 0.19173E+10  |
|                    |        |        |                                       | -0.23000E+11              | 0.19173E+10  | 0.48054E+11  |

TOTAL MASS = 155.93

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16579. -1385.7 8899.0

## TOTAL INERTIA ABOUT CENTER OF MASS

0.44221E+10 0.20543E+08 0.47279E+07  
0.20543E+08 0.88896E+10 -0.56031E+07  
0.47279E+07 -0.56031E+07 0.48956E+10

PRINCIPAL INERTIAS = 0.44219E+10 0.88897E+10 0.48956E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.005,-0.010) ( 0.005, 1.000,-0.001) ( 0.010, 0.001, 1.000)

C2-18

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 155.89             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13872E+07  | 0.21694E+06  |
| 0.0000             | 155.89 | 0.0000 |                                       | -0.13872E+07              | 0.0000       | 0.25724E+07  |
| 0.0000             | 0.0000 | 155.89 |                                       | -0.21694E+06              | -0.25724E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.17072E+11               | 0.36066E+10  | -0.22886E+11 |
|                    |        |        |                                       | 0.36066E+10               | 0.63703E+11  | 0.19250E+10  |
|                    |        |        |                                       | -0.22886E+11              | 0.19250E+10  | 0.47671E+11  |

TOTAL MASS = 155.89

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16501.    -1391.6    8899.0

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.44251E+10  0.26872E+08  0.59462E+07
0.26872E+08  0.89102E+10 -0.55107E+07
0.59462E+07 -0.55107E+07  0.49214E+10
```

PRINCIPAL INERTIAS = 0.44248E+10 0.89103E+10 0.49215E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.006,-0.012) ( 0.006, 1.000,-0.001) ( 0.012, 0.001, 1.000)

C2-19

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass      |
|--------------------|--------|--------|--------------------------------------------|
| 160.08             | 0.0000 | 0.0000 | 0.0000    0.14372E+07    0.22500E+06       |
| 0.0000             | 160.08 | 0.0000 | -0.14372E+07    0.0000    0.26409E+07      |
| 0.0000             | 0.0000 | 160.08 | -0.22500E+06    -0.26409E+07    0.0000     |
|                    |        |        |                                            |
|                    |        |        | Rotational mass (inertia)                  |
|                    |        |        | 0.17757E+11    0.37378E+10    -0.23685E+11 |
|                    |        |        | 0.37378E+10    0.65581E+11    0.20202E+10  |
|                    |        |        | -0.23685E+11    0.20202E+10    0.48896E+11 |

TOTAL MASS = 160.08

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16497.    -1405.6    8978.1

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.45371E+10  0.25828E+08  0.25454E+08
0.25828E+08  0.91089E+10  0.11949E+06
0.25454E+08  0.11949E+06  0.50115E+10
```

PRINCIPAL INERTIAS = 0.45356E+10 0.91091E+10 0.50129E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.999,-0.006,-0.053) ( 0.006, 1.000, 0.000) ( 0.053,-0.000, 0.999)

C2-20

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 155.93             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13876E+07  | 0.21586E+06  |
| 0.0000             | 155.93 | 0.0000 |                                       | -0.13876E+07              | 0.0000       | 0.25756E+07  |
| 0.0000             | 0.0000 | 155.93 |                                       | -0.21586E+06              | -0.25756E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.17070E+11               | 0.35968E+10  | -0.22915E+11 |
|                    |        |        |                                       | 0.35968E+10               | 0.63837E+11  | 0.19153E+10  |
|                    |        |        |                                       | -0.22915E+11              | 0.19153E+10  | 0.47793E+11  |

TOTAL MASS = 155.93

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16517. -1384.3 8899.0

## TOTAL INERTIA ABOUT CENTER OF MASS

0.44226E+10 0.31391E+08 0.56945E+07  
 0.31391E+08 0.89459E+10 -0.56257E+07  
 0.56945E+07 -0.56257E+07 0.49522E+10

PRINCIPAL INERTIAS = 0.44223E+10 0.89461E+10 0.49523E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.007,-0.011) ( 0.007, 1.000,-0.001) ( 0.011, 0.001, 1.000)

C2-24

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 154.45             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13746E+07  | 0.21369E+06  |
| 0.0000             | 154.45 | 0.0000 |                                       | -0.13746E+07              | 0.0000       | 0.25664E+07  |
| 0.0000             | 0.0000 | 154.45 |                                       | -0.21369E+06              | -0.25664E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.16878E+11               | 0.35727E+10  | -0.22837E+11 |
|                    |        |        |                                       | 0.35727E+10               | 0.63703E+11  | 0.18919E+10  |
|                    |        |        |                                       | -0.22837E+11              | 0.18919E+10  | 0.47845E+11  |

TOTAL MASS = 154.45

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16616.    -1383.5    8900.0

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.43482E+10  0.22090E+08  0.39188E+07
0.22090E+08  0.88258E+10 -0.99410E+07
0.39188E+07 -0.99410E+07  0.49061E+10
```

PRINCIPAL INERTIAS = 0.43480E+10 0.88260E+10 0.49061E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.005,-0.007) ( 0.005, 1.000,-0.003) ( 0.007, 0.002, 1.000)

C2-26

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass      |
|--------------------|--------|--------|--------------------------------------------|
| 154.41             | 0.0000 | 0.0000 | 0.0000    0.13743E+07    0.21454E+06       |
| 0.0000             | 154.41 | 0.0000 | -0.13743E+07    0.0000    0.25536E+07      |
| 0.0000             | 0.0000 | 154.41 | -0.21454E+06    -0.25536E+07    0.0000     |
|                    |        |        |                                            |
|                    |        |        | Rotational mass (inertia)                  |
|                    |        |        | 0.16880E+11    0.35764E+10    -0.22722E+11 |
|                    |        |        | 0.35764E+10    0.63310E+11    0.18996E+10  |
|                    |        |        | -0.22722E+11    0.18996E+10    0.47462E+11 |

TOTAL MASS = 154.41

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16538.    -1389.4    8900.0

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.43512E+10  0.28358E+08  0.51251E+07
0.28358E+08  0.88472E+10 -0.98495E+07
0.51251E+07 -0.98495E+07  0.49328E+10
```

PRINCIPAL INERTIAS = 0.43509E+10 0.88475E+10 0.49328E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.006,-0.009) ( 0.006, 1.000,-0.003) ( 0.009, 0.002, 1.000)

C2-27

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 155.94             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13970E+07 0.21639E+06 |
| 0.0000             | 155.94 | 0.0000 |                                       | -0.13970E+07 0.0000       | 0.25867E+07             |
| 0.0000             | 0.0000 | 155.94 |                                       | -0.21639E+06 -0.25867E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.17226E+11 0.36237E+10 -0.23199E+11  |                           |                         |
|                    |        |        | 0.36237E+10 0.64395E+11 0.19328E+10   |                           |                         |
|                    |        |        | -0.23199E+11 0.19328E+10 0.48201E+11  |                           |                         |

TOTAL MASS = 155.94

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16587. -1387.6 8958.3

## TOTAL INERTIA ABOUT CENTER OF MASS

0.44115E+10 0.34388E+08 -0.26568E+08  
0.34388E+08 0.89739E+10 -0.56553E+07  
-0.26568E+08 -0.56553E+07 0.49943E+10

PRINCIPAL INERTIAS = 0.44100E+10 0.89742E+10 0.49955E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.999,-0.007, 0.045) ( 0.008, 1.000,-0.001) (-0.045, 0.002, 0.999)

C2-28

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 154.46             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.13747E+07 0.21347E+06 |
| 0.0000             | 154.46 | 0.0000 |                                       | -0.13747E+07 0.0000       | 0.25568E+07             |
| 0.0000             | 0.0000 | 154.46 |                                       | -0.21347E+06 -0.25568E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.16878E+11 0.35666E+10 -0.22751E+11  |                           |                         |
|                    |        |        | 0.35666E+10 0.63443E+11 0.18899E+10   |                           |                         |
|                    |        |        | -0.22751E+11 0.18899E+10 0.47584E+11  |                           |                         |

TOTAL MASS = 154.46

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16554.    -1382.1    8900.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.43487E+10   0.32925E+08   0.48760E+07  
 0.32925E+08   0.88828E+10   -0.99633E+07  
 0.48760E+07   -0.99633E+07   0.49634E+10

PRINCIPAL INERTIAS = 0.43484E+10   0.88830E+10   0.49634E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 1.000,-0.007,-0.008) ( 0.007, 1.000,-0.003) ( 0.008, 0.002, 1.000)

### C2-8 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass    |
|--------------------|--------|--------|------------------------------------------|
| 165.99             | 0.0000 | 0.0000 | 0.0000   0.14756E+07   0.23501E+06       |
| 0.0000             | 165.99 | 0.0000 | -0.14756E+07   0.0000   0.27388E+07      |
| 0.0000             | 0.0000 | 165.99 | -0.23501E+06   -0.27388E+07   0.0000     |
|                    |        |        |                                          |
|                    |        |        | Rotational mass (inertia)                |
|                    |        |        | 0.18171E+11   0.38950E+10   -0.24374E+11 |
|                    |        |        | 0.38950E+10   0.67597E+11   0.20823E+10  |
|                    |        |        | -0.24374E+11   0.20823E+10   0.50575E+11 |

TOTAL MASS = 165.99

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16500.    -1415.8    8889.7

TOTAL INERTIA ABOUT CENTER OF MASS

0.47213E+10   0.17401E+08   -0.26733E+08  
 0.17401E+08   0.92903E+10   -0.68142E+07  
 -0.26733E+08   -0.68142E+07   0.50525E+10

PRINCIPAL INERTIAS = 0.47191E+10   0.92904E+10   0.50546E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
 ( 0.997,-0.004, 0.080) ( 0.004, 1.000,-0.002) (-0.080, 0.002, 0.997)

C2-10 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 165.99             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.14756E+07 0.23501E+06 |
| 0.0000             | 165.99 | 0.0000 |                                       | -0.14756E+07 | 0.0000 0.27388E+07      |
| 0.0000             | 0.0000 | 165.99 |                                       | -0.23501E+06 | -0.27388E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.18171E+11 0.38950E+10 -0.24374E+11  |              |                         |
|                    |        |        | 0.38950E+10 0.67597E+11 0.20823E+10   |              |                         |
|                    |        |        | -0.24374E+11 0.20823E+10 0.50575E+11  |              |                         |

TOTAL MASS = 165.99

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16500. -1415.8 8889.7

TOTAL INERTIA ABOUT CENTER OF MASS

0.47213E+10 0.17401E+08 -0.26733E+08  
0.17401E+08 0.92903E+10 -0.68142E+07  
-0.26733E+08 -0.68142E+07 0.50525E+10

PRINCIPAL INERTIAS = 0.47191E+10 0.92904E+10 0.50546E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.997,-0.004, 0.080) ( 0.004, 1.000,-0.002) (-0.080, 0.002, 0.997)

C2-11 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 164.90             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.14610E+07 0.23370E+06 |
| 0.0000             | 164.90 | 0.0000 |                                       | -0.14610E+07 | 0.0000 0.27130E+07      |
| 0.0000             | 0.0000 | 164.90 |                                       | -0.23370E+06 | -0.27130E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.17965E+11 0.38639E+10 -0.24026E+11  |              |                         |
|                    |        |        | 0.38639E+10 0.66779E+11 0.20647E+10   |              |                         |
|                    |        |        | -0.24026E+11 0.20647E+10 0.49959E+11  |              |                         |

TOTAL MASS = 164.90



## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16452.    -1417.2    8859.5

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.46906E+10  0.19101E+08  0.10013E+08
0.19101E+08  0.92015E+10 -0.57861E+07
0.10013E+08 -0.57861E+07  0.49938E+10
```

PRINCIPAL INERTIAS = 0.46902E+10 0.92016E+10 0.49941E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.999,-0.004,-0.033) ( 0.004, 1.000,-0.001) ( 0.033, 0.001, 0.999)

### C2-12 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass      |
|--------------------|--------|--------|--------------------------------------------|
| 165.99             | 0.0000 | 0.0000 | 0.0000    0.14756E+07    0.23501E+06       |
| 0.0000             | 165.99 | 0.0000 | -0.14756E+07    0.0000    0.27388E+07      |
| 0.0000             | 0.0000 | 165.99 | -0.23501E+06    -0.27388E+07    0.0000     |
|                    |        |        |                                            |
|                    |        |        | Rotational mass (inertia)                  |
|                    |        |        | 0.18171E+11    0.38950E+10    -0.24374E+11 |
|                    |        |        | 0.38950E+10    0.67597E+11    0.20823E+10  |
|                    |        |        | -0.24374E+11    0.20823E+10    0.50575E+11 |

TOTAL MASS = 165.99

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16500.    -1415.8    8889.7

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.47213E+10  0.17401E+08 -0.26733E+08
0.17401E+08  0.92903E+10 -0.68142E+07
-0.26733E+08 -0.68142E+07  0.50525E+10
```

PRINCIPAL INERTIAS = 0.47191E+10 0.92904E+10 0.50546E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.997,-0.004, 0.080) ( 0.004, 1.000,-0.002) (-0.080, 0.002, 0.997)

C2-16 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 168.95             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.15048E+07 0.23915E+06  |
| 0.0000             | 168.95 | 0.0000 |                                       | -0.15048E+07              | 0.0000 0.27751E+07       |
| 0.0000             | 0.0000 | 168.95 |                                       | -0.23915E+06              | -0.27751E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.18544E+11               | 0.39444E+10 -0.24711E+11 |
|                    |        |        |                                       | 0.39444E+10               | 0.68336E+11 0.21249E+10  |
|                    |        |        |                                       | -0.24711E+11              | 0.21249E+10 0.50954E+11  |

TOTAL MASS = 168.95

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16426. -1415.5 8906.8

TOTAL INERTIA ABOUT CENTER OF MASS

0.48025E+10 0.16270E+08 0.71397E+07  
0.16270E+08 0.93491E+10 -0.51351E+07  
0.71397E+07 -0.51351E+07 0.50320E+10

PRINCIPAL INERTIAS = 0.48022E+10 0.93491E+10 0.50322E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.004,-0.031) ( 0.004, 1.000,-0.001) ( 0.031, 0.001, 1.000)

C2-18 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 168.95             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.15048E+07 0.23915E+06  |
| 0.0000             | 168.95 | 0.0000 |                                       | -0.15048E+07              | 0.0000 0.27751E+07       |
| 0.0000             | 0.0000 | 168.95 |                                       | -0.23915E+06              | -0.27751E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.18544E+11               | 0.39444E+10 -0.24711E+11 |
|                    |        |        |                                       | 0.39444E+10               | 0.68336E+11 0.21249E+10  |
|                    |        |        |                                       | -0.24711E+11              | 0.21249E+10 0.50954E+11  |

TOTAL MASS = 168.95

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16426.    -1415.5    8906.8

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.48025E+10  0.16270E+08  0.71397E+07
0.16270E+08  0.93491E+10 -0.51351E+07
0.71397E+07 -0.51351E+07  0.50320E+10
```

PRINCIPAL INERTIAS = 0.48022E+10 0.93491E+10 0.50322E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.004,-0.031) ( 0.004, 1.000,-0.001) ( 0.031, 0.001, 1.000)

### C2-19 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 173.10             | 0.0000 | 0.0000 |  | 0.0000                                | 0.15544E+07  | 0.24829E+06  |
| 0.0000             | 173.10 | 0.0000 |  | -0.15544E+07                          | 0.0000       | 0.28405E+07  |
| 0.0000             | 0.0000 | 173.10 |  | -0.24829E+06                          | -0.28405E+07 | 0.0000       |
|                    |        |        |  |                                       |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.19231E+11                           | 0.40854E+10  | -0.25481E+11 |
|                    |        |        |  | 0.40854E+10                           | 0.70080E+11  | 0.22298E+10  |
|                    |        |        |  | -0.25481E+11                          | 0.22298E+10  | 0.52057E+11  |

TOTAL MASS = 173.10

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16409.    -1434.4    8979.8

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.49167E+10  0.11092E+08  0.25762E+08
0.11092E+08  0.95115E+10  0.22030E+06
0.25762E+08  0.22030E+06  0.50905E+10
```

PRINCIPAL INERTIAS = 0.49130E+10 0.95115E+10 0.50943E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 0.990,-0.002,-0.144) ( 0.002, 1.000, 0.000) ( 0.144,-0.000, 0.990)

## C2-20 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 168.95             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.15048E+07 0.23915E+06 |
| 0.0000             | 168.95 | 0.0000 |                                       | -0.15048E+07 0.0000       | 0.27751E+07             |
| 0.0000             | 0.0000 | 168.95 |                                       | -0.23915E+06 -0.27751E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.18544E+11 0.39444E+10 -0.24711E+11  |                           |                         |
|                    |        |        | 0.39444E+10 0.68336E+11 0.21249E+10   |                           |                         |
|                    |        |        | -0.24711E+11 0.21249E+10 0.50954E+11  |                           |                         |

TOTAL MASS = 168.95

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16426. -1415.5 8906.8

## TOTAL INERTIA ABOUT CENTER OF MASS

0.48025E+10 0.16270E+08 0.71397E+07  
0.16270E+08 0.93491E+10 -0.51351E+07  
0.71397E+07 -0.51351E+07 0.50320E+10

PRINCIPAL INERTIAS = 0.48022E+10 0.93491E+10 0.50322E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 1.000,-0.004,-0.031) ( 0.004, 1.000,-0.001) ( 0.031, 0.001, 1.000)

## C2-24 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 167.48             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14918E+07 0.23676E+06 |
| 0.0000             | 167.48 | 0.0000 |                                       | -0.14918E+07 0.0000       | 0.27564E+07             |
| 0.0000             | 0.0000 | 167.48 |                                       | -0.23676E+06 -0.27564E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.18352E+11 0.39143E+10 -0.24547E+11  |                           |                         |
|                    |        |        | 0.39143E+10 0.67942E+11 0.20995E+10   |                           |                         |
|                    |        |        | -0.24547E+11 0.20995E+10 0.50745E+11  |                           |                         |

TOTAL MASS = 167.48

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16459.    -1413.7    8907.8

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.47286E+10  0.17597E+08  0.63499E+07
0.17597E+08  0.92870E+10 -0.94751E+07
0.63499E+07 -0.94751E+07  0.50442E+10
```

PRINCIPAL INERTIAS = 0.47284E+10 0.92871E+10 0.50443E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.004,-0.020) ( 0.004, 1.000,-0.002) ( 0.020, 0.002, 1.000)

### C2-26 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass      |
|--------------------|--------|--------|--------------------------------------------|
| 167.48             | 0.0000 | 0.0000 | 0.0000    0.14918E+07    0.23676E+06       |
| 0.0000             | 167.48 | 0.0000 | -0.14918E+07    0.0000    0.27564E+07      |
| 0.0000             | 0.0000 | 167.48 | -0.23676E+06    -0.27564E+07    0.0000     |
|                    |        |        |                                            |
|                    |        |        | Rotational mass (inertia)                  |
|                    |        |        | 0.18352E+11    0.39143E+10    -0.24547E+11 |
|                    |        |        | 0.39143E+10    0.67942E+11    0.20995E+10  |
|                    |        |        | -0.24547E+11    0.20995E+10    0.50745E+11 |

TOTAL MASS = 167.48

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16459.    -1413.7    8907.8

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.47286E+10  0.17597E+08  0.63499E+07
0.17597E+08  0.92870E+10 -0.94751E+07
0.63499E+07 -0.94751E+07  0.50442E+10
```

PRINCIPAL INERTIAS = 0.47284E+10 0.92871E+10 0.50443E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.004,-0.020) ( 0.004, 1.000,-0.002) ( 0.020, 0.002, 1.000)

## C2-27 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 168.97             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.15142E+07 0.23968E+06  |
| 0.0000             | 168.97 | 0.0000 |                                       | -0.15142E+07              | 0.0000 0.27863E+07       |
| 0.0000             | 0.0000 | 168.97 |                                       | -0.23968E+06              | -0.27863E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.18701E+11               | 0.39713E+10 -0.24995E+11 |
|                    |        |        |                                       | 0.39713E+10               | 0.68894E+11 0.21424E+10  |
|                    |        |        |                                       | -0.24995E+11              | 0.21424E+10 0.51362E+11  |

TOTAL MASS = 168.97

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16490. -1418.5 8961.5

## TOTAL INERTIA ABOUT CENTER OF MASS

0.47913E+10 0.18977E+08 -0.25936E+08  
0.18977E+08 0.93791E+10 -0.54542E+07  
-0.25936E+08 -0.54542E+07 0.50760E+10

PRINCIPAL INERTIAS = 0.47888E+10 0.93792E+10 0.50783E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN  
( 0.996,-0.004, 0.090) ( 0.004, 1.000,-0.001) (-0.090, 0.002, 0.996)

## C2-28 W/T TBR

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 167.48             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.14918E+07 0.23676E+06  |
| 0.0000             | 167.48 | 0.0000 |                                       | -0.14918E+07              | 0.0000 0.27564E+07       |
| 0.0000             | 0.0000 | 167.48 |                                       | -0.23676E+06              | -0.27564E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.18352E+11               | 0.39143E+10 -0.24547E+11 |
|                    |        |        |                                       | 0.39143E+10               | 0.67942E+11 0.20995E+10  |
|                    |        |        |                                       | -0.24547E+11              | 0.20995E+10 0.50745E+11  |

TOTAL MASS = 167.48

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16459. -1413.7 8907.8

TOTAL INERTIA ABOUT CENTER OF MASS

0.47286E+10 0.17597E+08 0.63499E+07

0.17597E+08 0.92870E+10 -0.94751E+07

0.63499E+07 -0.94751E+07 0.50442E+10

PRINCIPAL INERTIAS = 0.47284E+10 0.92871E+10 0.50443E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIAN

( 1.000,-0.004,-0.020) ( 0.004, 1.000,-0.002) ( 0.020, 0.002, 1.000)

## **APPENDIX O – Mass summary Level 3**



C3-1

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 44.182             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.39764E+06 59627.       |
| 0.0000             | 44.182 | 0.0000 |                                       | -0.39764E+06              | 0.0000 0.74460E+06       |
| 0.0000             | 0.0000 | 44.182 |                                       | -59627.                   | -0.74460E+06 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.49097E+10               | 0.99912E+09 -0.67014E+10 |
|                    |        |        |                                       | 0.99912E+09               | 0.18619E+11 0.53664E+09  |
|                    |        |        |                                       | -0.67014E+10              | 0.53664E+09 0.13986E+11  |

TOTAL MASS = 44.182

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16853. -1349.6 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

0.12505E+10 -0.57626E+07 48.344  
-0.57626E+07 0.24921E+10 4.7638  
48.344 4.7638 0.13567E+10

PRINCIPAL INERTIAS = 0.12505E+10 0.24921E+10 0.13567E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000, 0.005,-0.000) (-0.005, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C3-2

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 44.206             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.39786E+06 62482.       |
| 0.0000             | 44.206 | 0.0000 |                                       | -0.39786E+06              | 0.0000 0.74563E+06       |
| 0.0000             | 0.0000 | 44.206 |                                       | -62482.                   | -0.74563E+06 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.49258E+10               | 0.10358E+10 -0.67106E+10 |
|                    |        |        |                                       | 0.10358E+10               | 0.18573E+11 0.56233E+09  |
|                    |        |        |                                       | -0.67106E+10              | 0.56233E+09 0.13950E+11  |

TOTAL MASS = 44.206

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16867. -1413.4 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.12568E+10 -0.18095E+08 0.34494
-0.18095E+08 0.24157E+10 0.23562
0.34494 0.23562 0.12854E+10
```

PRINCIPAL INERTIAS = 0.12565E+10 0.24160E+10 0.12854E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000, 0.016,-0.000) (-0.016, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C3-3

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |
|--------------------|--------|--------|---------------------------------------|
| 44.183             | 0.0000 | 0.0000 | 0.0000 0.39765E+06 59326.             |
| 0.0000             | 44.183 | 0.0000 | -0.39765E+06 0.0000 0.73160E+06       |
| 0.0000             | 0.0000 | 44.183 | -59326. -0.73160E+06 0.0000           |
|                    |        |        |                                       |
|                    |        |        | Rotational mass (inertia)             |
|                    |        |        | 0.49096E+10 0.99063E+09 -0.65844E+10  |
|                    |        |        | 0.99063E+09 0.18256E+11 0.53393E+09   |
|                    |        |        | -0.65844E+10 0.53393E+09 0.13622E+11  |

TOTAL MASS = 44.183

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16558. -1342.7 9000.0

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.12511E+10 0.82859E+07 46.437
0.82859E+07 0.25625E+10 4.8081
46.437 4.8081 0.14278E+10
```

PRINCIPAL INERTIAS = 0.12511E+10 0.25626E+10 0.14278E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000,-0.006,-0.000) ( 0.006, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C3-4

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 44.207             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.39787E+06 62180.       |
| 0.0000             | 44.207 | 0.0000 |                                       | -0.39787E+06              | 0.0000 0.73263E+06       |
| 0.0000             | 0.0000 | 44.207 |                                       | -62180.                   | -0.73263E+06 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.49257E+10               | 0.10273E+10 -0.65937E+10 |
|                    |        |        |                                       | 0.10273E+10               | 0.18209E+11 0.55962E+09  |
|                    |        |        |                                       | -0.65937E+10              | 0.55962E+09 0.13586E+11  |

TOTAL MASS = 44.207

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16573. -1406.6 9000.0

## TOTAL INERTIA ABOUT CENTER OF MASS

0.12574E+10 -0.32116E+07 0.33521  
-0.32116E+07 0.24865E+10 0.23585  
0.33521 0.23585 0.13568E+10

PRINCIPAL INERTIAS = 0.12574E+10 0.24865E+10 0.13568E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000, 0.003,-0.000) (-0.003, 1.000, 0.000) ( 0.000,-0.000, 1.000)

C3-8

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 140.44             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.12434E+07 0.19771E+06  |
| 0.0000             | 140.44 | 0.0000 |                                       | -0.12434E+07              | 0.0000 0.23764E+07       |
| 0.0000             | 0.0000 | 140.44 |                                       | -0.19771E+06              | -0.23764E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.15345E+11               | 0.33225E+10 -0.21078E+11 |
|                    |        |        |                                       | 0.33225E+10               | 0.59362E+11 0.17426E+10  |
|                    |        |        |                                       | -0.21078E+11              | 0.17426E+10 0.44990E+11  |

TOTAL MASS = 140.44

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16921.    -1407.8    8853.4

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.40590E+10 -0.22988E+08 -0.38736E+08
-0.22988E+08 0.81447E+10 -0.78314E+07
-0.38736E+08 -0.78314E+07 0.45024E+10
```

PRINCIPAL INERTIAS = 0.40555E+10 0.81448E+10 0.45058E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA  
( 0.996, 0.006, 0.086) (-0.006, 1.000,-0.002) (-0.086, 0.002, 0.996)

C3-10

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 140.39             | 0.0000 | 0.0000 |  | 0.0000                                | 0.12430E+07  | 0.19176E+06  |
| 0.0000             | 140.39 | 0.0000 |  | -0.12430E+07                          | 0.0000       | 0.23499E+07  |
| 0.0000             | 0.0000 | 140.39 |  | -0.19176E+06                          | -0.23499E+07 | 0.0000       |
| -----              |        |        |  | -----                                 |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.15315E+11                           | 0.32374E+10  | -0.20840E+11 |
|                    |        |        |  | 0.32374E+10                           | 0.58764E+11  | 0.16891E+10  |
|                    |        |        |  | -0.20840E+11                          | 0.16891E+10  | 0.44372E+11  |

TOTAL MASS = 140.39

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16738.    -1365.9    8853.4

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.40484E+10 0.27612E+08 -0.34976E+08
0.27612E+08 0.84268E+10 -0.86940E+07
-0.34976E+08 -0.86940E+07 0.47765E+10
```

PRINCIPAL INERTIAS = 0.40465E+10 0.84270E+10 0.47781E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA  
( 0.999,-0.006, 0.048) ( 0.006, 1.000,-0.002) (-0.048, 0.003, 0.999)

C3-11

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 138.01             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.12160E+07 0.19420E+06 |
| 0.0000             | 138.01 | 0.0000 |                                       | -0.12160E+07 0.0000       | 0.22939E+07             |
| 0.0000             | 0.0000 | 138.01 |                                       | -0.19420E+06 -0.22939E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.14996E+11 0.32364E+10 -0.20205E+11  |                           |                         |
|                    |        |        | 0.32364E+10 0.56951E+11 0.17043E+10   |                           |                         |
|                    |        |        | -0.20205E+11 0.17043E+10 0.42919E+11  |                           |                         |

TOTAL MASS = 138.01

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 1662. -1407.2 8811.1

## TOTAL INERTIA ABOUT CENTER OF MASS

0.40084E+10 0.85249E+07 0.68446E+07  
0.85249E+07 0.81084E+10 -0.67708E+07  
0.68446E+07 -0.67708E+07 0.45179E+10

PRINCIPAL INERTIAS = 0.40083E+10 0.81084E+10 0.45180E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000,-0.002,-0.013) ( 0.002, 1.000,-0.002) ( 0.013, 0.002, 1.000)

C3-12

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                         |
|--------------------|--------|--------|---------------------------------------|---------------------------|-------------------------|
| 144.16             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.12768E+07 0.19838E+06 |
| 0.0000             | 144.16 | 0.0000 |                                       | -0.12768E+07 0.0000       | 0.24045E+07             |
| 0.0000             | 0.0000 | 144.16 |                                       | -0.19838E+06 -0.24045E+07 | 0.0000                  |
| -----              |        |        | -----                                 |                           |                         |
|                    |        |        | Rotational mass (inertia)             |                           |                         |
|                    |        |        | 0.15747E+11 0.33244E+10 -0.21331E+11  |                           |                         |
|                    |        |        | 0.33244E+10 0.59843E+11 0.17486E+10   |                           |                         |
|                    |        |        | -0.21331E+11 0.17486E+10 0.45069E+11  |                           |                         |

TOTAL MASS = 144.16

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16679. -1376.1 8857.2

TOTAL INERTIA ABOUT CENTER OF MASS

0.41649E+10 0.15578E+08 -0.33762E+08  
 0.15578E+08 0.84291E+10 -0.84837E+07  
 -0.33762E+08 -0.84837E+07 0.46917E+10

PRINCIPAL INERTIAS = 0.41627E+10 0.84291E+10 0.46939E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA  
 ( 0.998,-0.004, 0.064) ( 0.004, 1.000,-0.002) (-0.064, 0.003, 0.998)

C3-16

### \*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 146.08             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.12911E+07 0.20587E+06 |
| 0.0000             | 146.08 | 0.0000 |                                       | -0.12911E+07 | 0.0000 0.24485E+07      |
| 0.0000             | 0.0000 | 146.08 |                                       | -0.20587E+06 | -0.24485E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.15852E+11 0.34257E+10 -0.21638E+11  |              |                         |
|                    |        |        | 0.34257E+10 0.60683E+11 0.18117E+10   |              |                         |
|                    |        |        | -0.21638E+11 0.18117E+10 0.45835E+11  |              |                         |

TOTAL MASS = 146.08

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16762. -1409.4 8838.3

TOTAL INERTIA ABOUT CENTER OF MASS

0.41513E+10 -0.25075E+08 0.27730E+07  
 -0.25075E+08 0.82313E+10 -0.78472E+07  
 0.27730E+07 -0.78472E+07 0.45035E+10

PRINCIPAL INERTIAS = 0.41511E+10 0.82315E+10 0.45035E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA  
 ( 1.000, 0.006,-0.008) (-0.006, 1.000,-0.002) ( 0.008, 0.002, 1.000)

C3-18

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 146.03             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.12907E+07 0.19993E+06 |
| 0.0000             | 146.03 | 0.0000 |                                       | -0.12907E+07 | 0.0000 0.24221E+07      |
| 0.0000             | 0.0000 | 146.03 |                                       | -0.19993E+06 | -0.24221E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.15822E+11 0.33407E+10 -0.21400E+11  |              |                         |
|                    |        |        | 0.33407E+10 0.60086E+11 0.17582E+10   |              |                         |
|                    |        |        | -0.21400E+11 0.17582E+10 0.45216E+11  |              |                         |

TOTAL MASS = 146.03

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16586. -1369.1 8838.3

## TOTAL INERTIA ABOUT CENTER OF MASS

0.41408E+10 0.24654E+08 0.69240E+07  
0.24654E+08 0.85057E+10 -0.87980E+07  
0.69240E+07 -0.87980E+07 0.47697E+10

PRINCIPAL INERTIAS = 0.41406E+10 0.85058E+10 0.47698E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000,-0.006,-0.011) ( 0.006, 1.000,-0.002) ( 0.011, 0.002, 1.000)

C3-19

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |              |                         |
|--------------------|--------|--------|---------------------------------------|--------------|-------------------------|
| 151.79             | 0.0000 | 0.0000 |                                       | 0.0000       | 0.13612E+07 0.21828E+06 |
| 0.0000             | 151.79 | 0.0000 |                                       | -0.13612E+07 | 0.0000 0.25099E+07      |
| 0.0000             | 0.0000 | 151.79 |                                       | -0.21828E+06 | -0.25099E+07 0.0000     |
| -----              |        |        | -----                                 |              |                         |
|                    |        |        | Rotational mass (inertia)             |              |                         |
|                    |        |        | 0.16839E+11 0.36036E+10 -0.22471E+11  |              |                         |
|                    |        |        | 0.36036E+10 0.62285E+11 0.19583E+10   |              |                         |
|                    |        |        | -0.22471E+11 0.19583E+10 0.46516E+11  |              |                         |

TOTAL MASS = 151.79

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16535.    -1438.0    8967.3

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.43188E+10 -0.57386E+07 0.36091E+08
-0.57386E+07 0.85763E+10 0.91615E+06
0.36091E+08 0.91615E+06 0.46989E+10
```

PRINCIPAL INERTIAS = 0.43154E+10 0.85763E+10 0.47023E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA  
( 0.996, 0.001,-0.094) (-0.001, 1.000, 0.000) ( 0.094,-0.000, 0.996)

C3-20

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass      |
|--------------------|--------|--------|--------------------------------------------|
| 146.08             | 0.0000 | 0.0000 | 0.0000    0.12911E+07    0.20531E+06       |
| 0.0000             | 146.08 | 0.0000 | -0.12911E+07    0.0000    0.24240E+07      |
| 0.0000             | 0.0000 | 146.08 | -0.20531E+06    -0.24240E+07    0.0000     |
|                    |        |        |                                            |
|                    |        |        | Rotational mass (inertia)                  |
|                    |        |        | 0.15852E+11    0.34097E+10    -0.21418E+11 |
|                    |        |        | 0.34097E+10    0.59998E+11    0.18066E+10  |
|                    |        |        | -0.21418E+11    0.18066E+10    0.45149E+11 |

TOTAL MASS = 146.08

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16594.    -1405.5    8838.3

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.41526E+10 0.28609E+07 0.67321E+07
0.28609E+07 0.83626E+10 -0.79392E+07
0.67321E+07 -0.79392E+07 0.46359E+10
```

PRINCIPAL INERTIAS = 0.41525E+10 0.83626E+10 0.46360E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA  
( 1.000,-0.001,-0.014) ( 0.001, 1.000,-0.002) ( 0.014, 0.002, 1.000)



C3-24

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 143.79             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.12681E+07 0.20164E+06  |
| 0.0000             | 143.79 | 0.0000 |                                       | -0.12681E+07              | 0.0000 0.24162E+07       |
| 0.0000             | 0.0000 | 143.79 |                                       | -0.20164E+06              | -0.24162E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.15535E+11               | 0.33657E+10 -0.21306E+11 |
|                    |        |        |                                       | 0.33657E+10               | 0.59925E+11 0.17650E+10  |
|                    |        |        |                                       | -0.21306E+11              | 0.17650E+10 0.45377E+11  |

TOTAL MASS = 143.79

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16803. -1402.3 8818.8

## TOTAL INERTIA ABOUT CENTER OF MASS

0.40691E+10 -0.22421E+08 0.18460E+07  
-0.22421E+08 0.81433E+10 -0.13159E+08  
0.18460E+07 -0.13159E+08 0.44960E+10

PRINCIPAL INERTIAS = 0.40690E+10 0.81435E+10 0.44960E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000, 0.005,-0.004) (-0.006, 1.000,-0.004) ( 0.004, 0.004, 1.000)

C3-26

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |                          |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------------------|
| 143.75             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.12677E+07 0.19570E+06  |
| 0.0000             | 143.75 | 0.0000 |                                       | -0.12677E+07              | 0.0000 0.23898E+07       |
| 0.0000             | 0.0000 | 143.75 |                                       | -0.19570E+06              | -0.23898E+07 0.0000      |
| -----              |        |        | -----                                 |                           |                          |
|                    |        |        |                                       | Rotational mass (inertia) |                          |
|                    |        |        |                                       | 0.15504E+11               | 0.32807E+10 -0.21068E+11 |
|                    |        |        |                                       | 0.32807E+10               | 0.59327E+11 0.17116E+10  |
|                    |        |        |                                       | -0.21068E+11              | 0.17116E+10 0.44759E+11  |

TOTAL MASS = 143.75

## CHAPTER 5 - CONCLUSIONS

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16624.    -1361.4    8818.7

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.40585E+10  0.27351E+08  0.64990E+07
0.27351E+08  0.84197E+10 -0.14225E+08
0.64990E+07 -0.14225E+08  0.47642E+10
```

PRINCIPAL INERTIAS = 0.40583E+10 0.84200E+10 0.47643E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000,-0.006,-0.009) ( 0.006, 1.000,-0.004) ( 0.009, 0.004, 1.000)

C3-27

\*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        |  | Coupled translational/rotational mass |              |              |
|--------------------|--------|--------|--|---------------------------------------|--------------|--------------|
| 147.15             | 0.0000 | 0.0000 |  | 0.0000                                | 0.13133E+07  | 0.20765E+06  |
| 0.0000             | 147.15 | 0.0000 |  | -0.13133E+07                          | 0.0000       | 0.24588E+07  |
| 0.0000             | 0.0000 | 147.15 |  | -0.20765E+06                          | -0.24588E+07 | 0.0000       |
| -----              |        |        |  | -----                                 |              |              |
|                    |        |        |  | Rotational mass (inertia)             |              |              |
|                    |        |        |  | 0.16194E+11                           | 0.34781E+10  | -0.21992E+11 |
|                    |        |        |  | 0.34781E+10                           | 0.61256E+11  | 0.18456E+10  |
|                    |        |        |  | -0.21992E+11                          | 0.18456E+10  | 0.46078E+11  |

TOTAL MASS = 147.15

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16710.    -1411.2    8925.4

TOTAL INERTIA ABOUT CENTER OF MASS

```
0.41788E+10  0.82334E+07 -0.46184E+08
0.82334E+07  0.84464E+10 -0.77233E+07
-0.46184E+08 -0.77233E+07  0.46974E+10
```

PRINCIPAL INERTIAS = 0.41747E+10 0.84465E+10 0.47015E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 0.996,-0.002, 0.088) ( 0.002, 1.000,-0.002) (-0.088, 0.002, 0.996)

C3-28

## \*\*\*\*\* PRECISE MASS SUMMARY \*\*\*\*\*

## TOTAL RIGID BODY MASS MATRIX ABOUT ORIGIN

| Translational mass |        |        | Coupled translational/rotational mass |                           |              |              |
|--------------------|--------|--------|---------------------------------------|---------------------------|--------------|--------------|
| 143.80             | 0.0000 | 0.0000 |                                       | 0.0000                    | 0.12681E+07  | 0.20107E+06  |
| 0.0000             | 143.80 | 0.0000 |                                       | -0.12681E+07              | 0.0000       | 0.23917E+07  |
| 0.0000             | 0.0000 | 143.80 |                                       | -0.20107E+06              | -0.23917E+07 | 0.0000       |
| -----              |        |        | -----                                 |                           |              |              |
|                    |        |        |                                       | Rotational mass (inertia) |              |              |
|                    |        |        |                                       | 0.15535E+11               | 0.33497E+10  | -0.21086E+11 |
|                    |        |        |                                       | 0.33497E+10               | 0.59240E+11  | 0.17599E+10  |
|                    |        |        |                                       | -0.21086E+11              | 0.17599E+10  | 0.44692E+11  |

TOTAL MASS = 143.80

The mass principal axes coincide with the global Cartesian axes

CENTER OF MASS (X,Y,Z)= 16633.    -1398.3    8818.8

## TOTAL INERTIA ABOUT CENTER OF MASS

0.40704E+10   0.53627E+07   0.62844E+07  
0.53627E+07   0.82765E+10   -0.13262E+08  
0.62844E+07   -0.13262E+08   0.46304E+10

PRINCIPAL INERTIAS = 0.40703E+10   0.82766E+10   0.46305E+10

ORIENTATION VECTORS OF THE INERTIA PRINCIPAL AXES IN GLOBAL CARTESIA

( 1.000,-0.001,-0.011) ( 0.001, 1.000,-0.004) ( 0.011, 0.004, 1.000)

## **APPENDIX P – Data input for *ABAQUS***

|                                           |              |        |               |                | C1-1<br>W/O GC | C1-2<br>W/O GC | C1-4<br>W/O GC | G25       | C1-11     | C1-20     | C1-24     | C1-26     |
|-------------------------------------------|--------------|--------|---------------|----------------|----------------|----------------|----------------|-----------|-----------|-----------|-----------|-----------|
| Properties                                | Abbreviation | Units  | Normal (Feng) | normal (ansys) |                |                |                |           |           |           |           |           |
| Cross sectional area                      | A            | m2     | 1.05          | 1.05           | 1.05           | 1.05           | 1.05           | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      |
| Moment of inertia about centroidal x-axis | I11          | kg*m^2 | 1.45          | 1.91E+06       | 1.714E+06      | 1.715E+06      | 1.715E+06      | 1.330E+06 | 1.693E+06 | 1.745E+06 | 1.703E+06 | 1.702E+06 |
| Moment of inertia about centroidal y-axis | I22          | kg*m^2 | 31.32         | 1.36E+06       | 1.246E+06      | 1.216E+06      | 1.217E+06      | 9.521E+05 | 1.215E+06 | 1.239E+06 | 1.216E+06 | 1.246E+06 |
| Torsional moment of inertia (St Venant)   | I12, J       | kg*m^2 | 3.96          | -3.27E+06      | 2.960E+06      | 2.931E+06      | 2.932E+06      | 2.282E+06 | 2.908E+06 | 2.985E+06 | 2.919E+06 | 2.948E+06 |

INPUT VALUE FOR ABAQUS (CATEGORY 1)

|                                           |        |     | normal (ansys) | C1-1<br>W/O GC | C1-2<br>W/O GC | C1-4<br>W/O GC | G25    | C1-11  | C1-20  | C1-24  | C1-26  |
|-------------------------------------------|--------|-----|----------------|----------------|----------------|----------------|--------|--------|--------|--------|--------|
| Moment of inertia about centroidal x-axis | I11    | m^4 | 1.420          | 1.275          | 1.276          | 1.276          | 0.989  | 1.260  | 1.299  | 1.268  | 1.266  |
| Moment of inertia about centroidal y-axis | I22    | m^4 | 31.320         | 28.652         | 27.962         | 27.978         | 21.897 | 27.944 | 28.505 | 27.958 | 28.661 |
| Torsional moment of inertia (St Venant)   | I12, J | m^4 | 3.960          | 3.584          | 3.550          | 3.550          | 2.763  | 3.522  | 3.615  | 3.535  | 3.570  |

|     |      |        |       |
|-----|------|--------|-------|
|     | I11  | I12    | I12   |
| MAX | 1.31 | 28.687 | 3.624 |
| MIN | 0.99 | 21.90  | 2.76  |

INPUT VALUE FOR ABAQUS (CATEGORY 3)

|                                           |        |     | normal (ansys) | C1-1<br>W/O GC | C1-2<br>W/O GC | C1-4<br>W/O GC | G25   | C1-11 | C1-20 | C1-24 | C1-26 |
|-------------------------------------------|--------|-----|----------------|----------------|----------------|----------------|-------|-------|-------|-------|-------|
| Moment of inertia about centroidal x-axis | I11    | m^4 | 1.908          | 1.714          | 1.715          | 1.715          | 1.329 | 1.693 | 1.745 | 1.703 | 1.702 |
| Moment of inertia about centroidal y-axis | I22    | m^4 | 1.362          | 1.246          | 1.216          | 1.217          | 0.952 | 1.215 | 1.240 | 1.216 | 1.246 |
| Torsional moment of inertia (St Venant)   | I12, J | m^4 | 3.270          | 2.960          | 2.931          | 2.932          | 2.282 | 2.908 | 2.985 | 2.919 | 2.948 |

|     |      |       |       |
|-----|------|-------|-------|
|     | I11  | I12   | I12   |
| MAX | 1.75 | 1.247 | 2.993 |
| MIN | 1.33 | 0.95  | 2.282 |

| C2-1      | C2-2      | C2-3      | C2-4      | C2-1<br>W/O GC | C2-2<br>W/O GC | C2-3<br>W/O GC | C2-4<br>W/O GC | C2-8<br>W/O TBR | C2-11<br>W/O TBR | C2-12<br>W/O TBR | C2-16<br>W/O TBR | C2-19<br>W/O TBR | C2-20<br>W/O TBR | C2-24<br>W/O TBR | C2-27<br>W/O TBR | C2-28<br>W/O TBR |
|-----------|-----------|-----------|-----------|----------------|----------------|----------------|----------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| 1.05      | 1.05      | 1.05      | 1.05      | 1.05           | 1.05           | 1.05           | 1.05           | 1.05            | 1.05             | 1.05             | 1.05             | 1.05             | 1.05             | 1.05             | 1.05             | 1.05             |
| 8.166E+05 | 8.162E+05 | 8.165E+05 | 8.161E+05 | 1.633E+06      | 1.632E+06      | 1.633E+06      | 1.632E+06      | 1.711E+06       | 1.695E+06        | 1.711E+06        | 1.744E+06        | 1.803E+06        | 1.744E+06        | 1.729E+06        | 1.754E+06        | 1.729E+06        |
| 5.969E+05 | 5.983E+05 | 5.921E+05 | 5.935E+05 | 1.194E+06      | 1.197E+06      | 1.184E+06      | 1.187E+06      | 1.263E+06       | 1.252E+06        | 1.263E+06        | 1.270E+06        | 1.286E+06        | 1.270E+06        | 1.265E+06        | 1.272E+06        | 1.265E+06        |
| 1.413E+06 | 1.415E+06 | 1.409E+06 | 1.410E+06 | 2.827E+06      | 2.829E+06      | 2.817E+06      | 2.819E+06      | 2.974E+06       | 2.947E+06        | 2.974E+06        | 3.014E+06        | 3.089E+06        | 3.014E+06        | 2.993E+06        | 3.026E+06        | 2.993E+06        |

| C2-1   | C2-2   | C2-3   | C2-4   | C2-1<br>W/O GC | C2-2<br>W/O GC | C2-3<br>W/O GC | C2-4<br>W/O GC | C2-8<br>W/O TBR | C2-11<br>W/O TBR | C2-12<br>W/O TBR | C2-16<br>W/O TBR | C2-19<br>W/O TBR | C2-20<br>W/O TBR | C2-24<br>W/O TBR | C2-27<br>W/O TBR | C2-28<br>W/O TBR |
|--------|--------|--------|--------|----------------|----------------|----------------|----------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| 0.608  | 0.607  | 0.608  | 0.607  | 1.215          | 1.215          | 1.215          | 1.215          | 1.273           | 1.261            | 1.275            | 1.298            | 1.341            | 1.298            | 1.286            | 1.305            | 1.286            |
| 13.727 | 13.760 | 13.617 | 13.649 | 27.454         | 27.521         | 27.233         | 27.300         | 29.052          | 28.795           | 29.052           | 29.216           | 29.579           | 29.216           | 29.084           | 29.257           | 29.084           |
| 1.712  | 1.713  | 1.706  | 1.707  | 3.423          | 3.426          | 3.411          | 3.414          | 3.601           | 3.568            | 3.601            | 3.650            | 3.741            | 3.650            | 3.625            | 3.664            | 3.625            |

|     |      |        |       |
|-----|------|--------|-------|
|     | I11  | I22    | I12   |
| MAX | 1.34 | 29.579 | 3.741 |
| MIN | 0.61 | 13.62  | 1.71  |

| C2-1  | C2-2  | C2-3  | C2-4  | C2-1<br>W/O GC | C2-2<br>W/O GC | C2-3<br>W/O GC | C2-4<br>W/O GC | C2-8<br>W/O TBR | C2-11<br>W/O TBR | C2-12<br>W/O TBR | C2-16<br>W/O TBR | C2-19<br>W/O TBR | C2-20<br>W/O TBR | C2-24<br>W/O TBR | C2-27<br>W/O TBR | C2-28<br>W/O TBR |
|-------|-------|-------|-------|----------------|----------------|----------------|----------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| 0.816 | 0.816 | 0.816 | 0.816 | 1.633          | 1.632          | 1.633          | 1.632          | 1.710           | 1.695            | 1.710            | 1.744            | 1.802            | 1.744            | 1.728            | 1.754            | 1.728            |
| 0.597 | 0.598 | 0.592 | 0.594 | 1.194          | 1.197          | 1.184          | 1.187          | 1.263           | 1.252            | 1.263            | 1.270            | 1.286            | 1.270            | 1.265            | 1.272            | 1.265            |
| 1.413 | 1.415 | 1.409 | 1.410 | 2.827          | 2.829          | 2.817          | 2.819          | 2.974           | 2.947            | 2.974            | 3.014            | 3.089            | 3.014            | 2.993            | 3.026            | 2.993            |

|     |      |       |       |
|-----|------|-------|-------|
|     | I11  | I22   | I12   |
| MAX | 1.71 | 1.263 | 2.974 |
| MIN | 0.82 | 0.59  | 1.41  |

| C3-1      | C3-2      | C3-3      | C3-4      | C3-8      | C3-10     | C3-11     | C3-12     | C3-16     | C3-18     | C3-19     | C3-20     | C3-24     | C3-26     | C3-27     | C3-28     |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      | 1.05      |
| 4.573E+05 | 4.603E+05 | 4.570E+05 | 4.601E+05 | 1.441E+06 | 1.435E+06 | 1.410E+06 | 1.475E+06 | 1.497E+06 | 1.491E+06 | 1.579E+06 | 1.496E+06 | 1.470E+06 | 1.463E+06 | 1.521E+06 | 1.469E+06 |
| 3.470E+05 | 3.478E+05 | 3.340E+05 | 3.348E+05 | 1.133E+06 | 1.107E+06 | 1.078E+06 | 1.128E+06 | 1.157E+06 | 1.131E+06 | 1.149E+06 | 1.133E+06 | 1.148E+06 | 1.122E+06 | 1.146E+06 | 1.124E+06 |
| 8.042E+05 | 8.081E+05 | 7.909E+05 | 7.948E+05 | 2.574E+06 | 2.542E+06 | 2.488E+06 | 2.603E+06 | 2.654E+06 | 2.622E+06 | 2.728E+06 | 2.629E+06 | 2.618E+06 | 2.586E+06 | 2.666E+06 | 2.593E+06 |

| C3-1  | C3-2  | C3-3  | C3-4  | C3-8   | C3-10  | C3-11  | C3-12  | C3-16  | C3-18  | C3-19  | C3-20  | C3-24  | C3-26  | C3-27  | C3-28  |
|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0.340 | 0.343 | 0.340 | 0.342 | 1.072  | 1.068  | 1.049  | 1.098  | 1.114  | 1.109  | 1.175  | 1.114  | 1.094  | 1.089  | 1.132  | 1.093  |
| 7.980 | 7.998 | 7.681 | 7.699 | 26.058 | 25.458 | 24.791 | 25.926 | 26.619 | 26.021 | 26.419 | 26.056 | 26.405 | 25.807 | 26.345 | 25.842 |
| 0.974 | 0.979 | 0.958 | 0.963 | 3.117  | 3.078  | 3.013  | 3.152  | 3.214  | 3.175  | 3.304  | 3.184  | 3.170  | 3.131  | 3.229  | 3.140  |

|     |      |        |       |
|-----|------|--------|-------|
|     | I11  | I22    | I12   |
| MAX | 1.18 | 26.619 | 3.304 |
| MIN | 0.34 | 7.68   | 0.96  |

| C3-1  | C3-2  | C3-3  | C3-4  | C3-8  | C3-10 | C3-11 | C3-12 | C3-16 | C3-18 | C3-19 | C3-20 | C3-24 | C3-26 | C3-27 | C3-28 |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 0.457 | 0.460 | 0.457 | 0.460 | 1.441 | 1.435 | 1.410 | 1.475 | 1.497 | 1.490 | 1.579 | 1.496 | 1.470 | 1.463 | 1.521 | 1.469 |
| 0.347 | 0.348 | 0.334 | 0.335 | 1.133 | 1.107 | 1.078 | 1.128 | 1.158 | 1.132 | 1.149 | 1.133 | 1.148 | 1.122 | 1.146 | 1.124 |
| 0.804 | 0.808 | 0.791 | 0.795 | 2.574 | 2.542 | 2.488 | 2.603 | 2.654 | 2.622 | 2.728 | 2.629 | 2.618 | 2.585 | 2.666 | 2.593 |

|     |      |       |       |
|-----|------|-------|-------|
|     | I11  | I22   | I12   |
| MAX | 1.58 | 1.158 | 2.728 |
| MIN | 0.46 | 0.33  | 0.79  |