Does Corrosion Affect the Bond Between Steel and Concrete?

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Introduction:

Corrosion of reinforcing steel is one of the leading causes of reinforced concrete infrastructure deterioration in North America due to the application of de-icing salts in the winter. Among the structures most affected are highway bridges and parking structures.

Fig 1: Reinforced concrete elements affected by corrosion

Experimental evidence has shown that steel corrosion has a detrimental effect on the mechanical interaction behavior, also known as bond, between reinforcing steel and concrete. For plain reinforcing bars, this bond behavior is dependent on the frictional properties of the two materials. Furthermore, the friction coefficient is believed to be a parameter dependent on the degree of reinforcement corrosion.

Objective:

The objective of this research is to study the frictional properties of corroded steel and concrete through experimental testing. Therefore, we can understand the properties of aging structures and maintain them more efficiently.

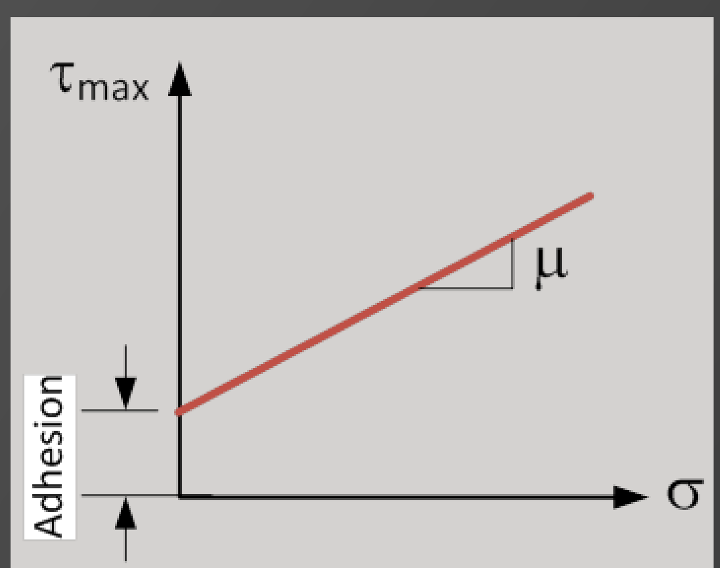

Fig. 2: Tau to sigma graph and the coefficient of friction

Methodology:

Two sets of mortar samples (85.6×85.6 mm) are cast in between two steel plates. One of the mortars is mixed with NaCl (3% by mass) to naturally induce corrosion on the steel. The two sets of steel-mortar-steel composite samples are tested mechanically to deduce the frictional properties of the interface.

Fig. 3: Casting of samples

Material	Mix M1	Mix M2
Sand (kg)	6.8	6.8
Cement (kg)	2.27	2.27
Water (L)	1.46	1.46
NaCl (g)	68	0

Table 1: Mortars mix design

Fig. 4: Cylinder samples during and after test

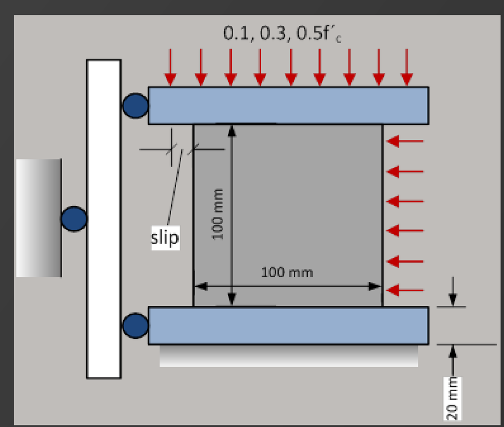

Fig. 5: Test setup

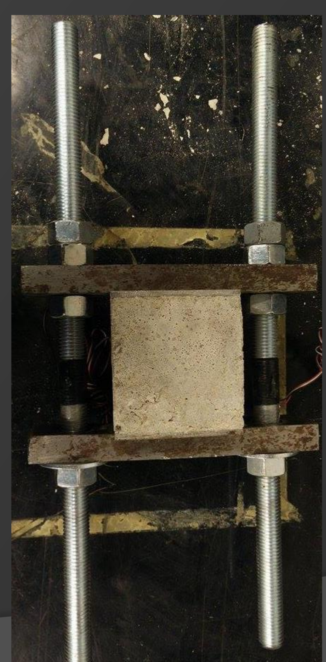

Fig. 6: Applying normal force

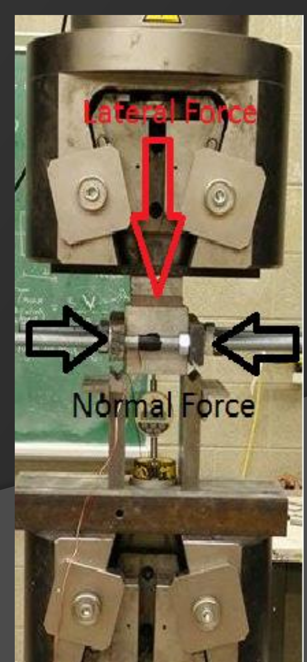

Fig. 7: Finding max lateral force

Results:

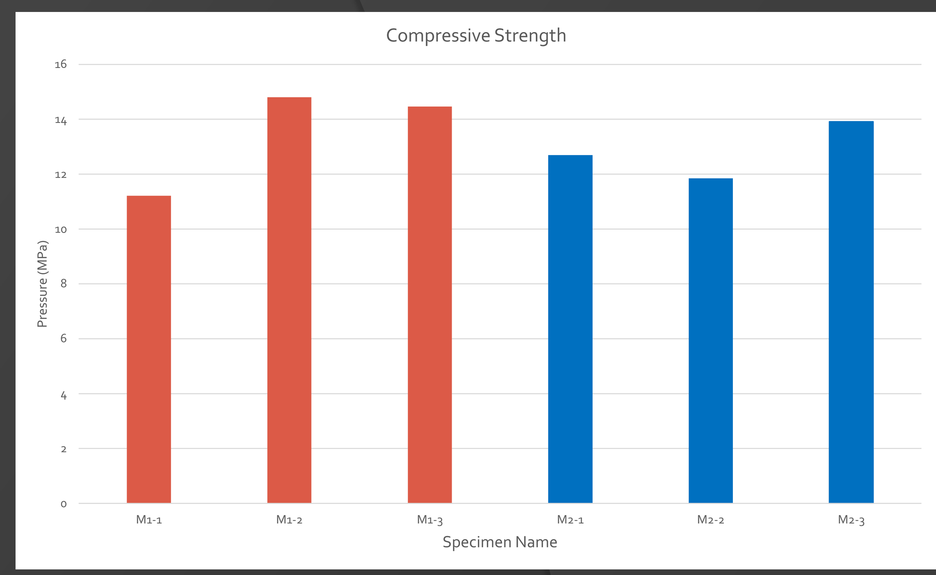

Fig. 8: Compressive strength

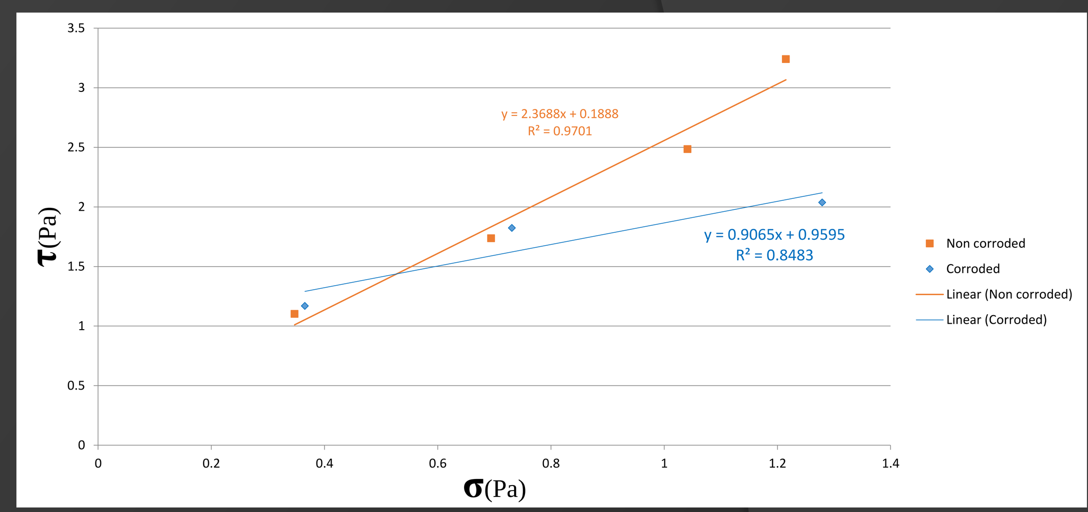

Fig. 9: Normal force versus lateral load

Conclusions:

Observations:

As seen in Fig.9 the corroded samples show a lower coefficient of friction as compared to non-corroded samples. This could be because the steel plates push the concrete away from their surfaces, due to the corrosion buildup (Fig.10) that makes the bond between mortar and steel plates weaker. Having three samples (because sample C failed) does not give us a statistically accurate answer but does mean that this phenomenon needs more research.

Future Experiments:

In future experiments, care should be exercised to not contaminate the non-corroded samples with Nacl (Fig.3) . For more accurate results more samples should be tested, especially to have a wider range for applying normal load (>50% f'_c).

Fig. 10: Steel plate for non-corroded and corroded samples

References:

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