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**THE APPLICATION OF A.C. IMPEDANCE SPECTROSCOPY
ON THE DURABILITY OF HYDRATED CEMENT PASTE
SUBJECTED TO VARIOUS ENVIRONMENTAL CONDITIONS**

by

Stacey Perron

A thesis
submitted under the supervision of
Dr. James J. Beaudoin

in partial fulfillment of the
requirements for the degree of
Ph.D. of Applied Science
in
Civil Engineering

**Department of Civil Engineering
University of Ottawa
Ottawa, Ontario
K1N 6N5**

June, 2001



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Examining Board:

Advisor:

Dr. J.J. Beaudoin

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ABSTRACT

Harsh Canadian winters cause many problems in reinforced concrete structures due to damaging freezing-thawing cycles which is exacerbated by the heavy use of de-icing salts on roadways. Evaluation of concrete durability with current ASTM methods may give unreliable results and are destructive to the structure. A relatively new and novel approach to evaluating the durability of concrete uses A.C. Impedance Spectroscopy (ACIS). Hydrated cement paste (hcp), mortar, brick and vycor glass were evaluated using ACIS during drying-rewetting and freezing-thawing cycles. Thermal mechanical analysis (TMA), and differential scanning calorimetry (DSC) tests were also conducted and used as references.

Results indicate that ACIS can be used to successfully evaluate the pore structure of hcp. The results from the drying-rewetting cycles are consistent with the pore coarsening theory. ACIS revealed pore structure changes consistent with the mechanical strains and pore solution chemistry. Increased pore continuity with each drying-rewetting cycle was indicated by a reduction in sample resistance.

Unique tests were conducted on hydrated cement paste, mortar, brick and vycor glass that measured the ACIS and mechanical strains simultaneously while undergoing temperature changes. The temperature was lowered from 5 °C to -80 °C and then raised to +20 °C. The ACIS results indicate that durability of the material can be assessed using the parameters R, material resistance, and phi, indicative of the frequency dispersion angle. The resistance on freezing values correlates with the amount of pore water freezing. The phi values on freezing are representative of the pore size distribution of the test sample. Resistance and phi data from freezing-thawing tests can be analyzed to assess durability of the sample. A material that is durable to freezing-thawing cycles can be described as having a high resistance at room temperature, a low freezing resistance and small changes in phi. Results were consistent among all the materials tested.

Freezing-thawing tests were also conducted on specimens resaturated with salt solutions (5%, 10%, 15%). The results of these tests indicated a lower incipient freezing temperature, increase in pore blockage temperatures, and increased mobility of the pore water during freezing (increase in the change to phi).

A series of test were conducted to evaluate the electrode polarization effects associated with the permittivity values at low frequencies. Teflon sheets were used to minimize the electrode polarization effects. It is shown that electrode polarization effects dominate over bulk polarization effects. Effects vary with the porosity of the material.

LIST OF RELATED PUBLICATIONS

J.J. Beaudoin, P. Gu, P.J. Tumidajski, and S. Perron, (1996), "Microstructural Changes on Drying and Rewetting of Hydrated Cement Paste – An A.C. Impedance Spectroscopy Study", *Concrete: from Material to Structure*, Proceedings of the RILEM International Conference, Arles, France, pp. 32-42, September 11-12.

P.J. Tumidajski, A.S. Schumacher, S. Perron, P. Gu, and J.J. Beaudoin, (1996), "On the Relationship Between Porosity and Electrical Resistivity in Cementitious Systems", *Cement and Concrete Research*, 26(4), pp. 539-544.

S. Perron, and J.J. Beaudoin, "Freezing of Water in Portland Cement Paste – An A.C. Impedance Spectroscopy Study", accepted for publication in a special issue of *Cement and Concrete Composites*.

TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS	i
ABSTRACT	ii
LIST OF RELATED PUBLICATIONS	iv
TABLE OF CONTENTS	v
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF GRAPHS	xiii
 CHAPTER 1 INTRODUCTION AND THESIS OUTLINE	
1.1 Introduction	1
1.2 Global Objectives	2
1.3 Thesis Components	2
1.4 Experimental Plan – Methodology	3
1.4.1 Drying-Rewetting	3
1.4.2 Freezing-Thawing	4
1.4.3 Ring-Disc Electrodes	5
1.4.4 Dielectric Amplification	6
1.5 Summary	7
 CHAPTER 2 LITERATURE REVIEW	
2.1 AC Impedance Spectroscopy (ACIS)	8
2.1.1 High Frequency Arc	10
2.1.2 Equivalent Circuits	11
2.1.3 Frequency Dispersion Angle	12
2.1.4 Application of ACIS to Frozen Cement Paste	13
2.1.5 Pore Solution Volume	13
2.1.6 Other Applications of Electrical Methods Applied to Concrete	14
2.1.7 Limitations on AC Impedance Spectroscopy Experiments	15
2.2 Freezing of Hydrated Cement Paste	15
2.2.1 Mechanisms of Frost Action	16
2.2.2 Freezable Water in Cement Paste	19
2.2.3 Factors Determining the Severity of the Freezing-Thawing Phenomenon	19

2.2.4	Dilation	20
2.2.5	Residual Expansion, and Degree of Saturation	20
2.2.6	Salt Scaling, De-Icers	21
2.2.7	Frost Resistance of High Performance Concrete	23
2.3	Shrinkage Mechanisms	24
2.3.1	Capillary Tension	26
2.3.2	Surface Tension	27
2.3.3	Disjoining Pressure	28
2.3.4	Movement of Interlayer Water	29
2.3.5	Cycles of Drying-Rewetting	29
2.4	Structure of Hydrated Cement Paste	30
2.4.1	Chemical Reactions of the Hydration of Cement	31
2.4.2	Plain Hydrated Cement Paste	31
2.4.3	Cement with Fly Ash	33
2.5	Dielectrics	34
2.5.1	Electrode Polarization Effects	35
2.5.2	Bulk Polarization Effects	35
2.5.3	Dielectric Amplification	35
CHAPTER 3 EXPERIMENTAL PROCEDURE, INSTRUMENTATION AND CALCULATIONS		
3.1	Introduction	37
3.2	Drying-Rewetting Experiments	37
3.2.1	Preparation of the Test Specimens	37
3.2.2	Drying-Rewetting Cycles	38
3.2.3	Rewetting Solutions	39
3.3	Freezing-Thawing Experiments	40
3.3.1	Experimental Procedure	40
3.3.2	Sample Preparation: Method 1	41
3.3.3	Sample Preparation: Method 2	42
3.4	Ring-Disc Electrode Experiments	44
3.4.1	Experimental Procedure	44
3.5	Dielectric Experiments	44
3.5.1	Sample Preparation	44
3.5.2	Testing Procedure	45
3.6	AC Impedance Spectroscopy: Instrumentation and Statistical Analysis	45
3.6.1	Solartron Setup	45

3.6.2	Initial Fitting Parameters for the Equivalent Circuit	46
3.6.3	Evaluating the Freezing-Thawing Data	48
3.6.3.1	Terms and Definitions	49
3.6.3.2	Conclusions of the Statistical Analysis	50
3.6.4	Calculating ϵ_r	50
3.6.5	Normalized Resistance	50
3.6.6	Analysis of Specimen Measurements	51
3.6.7	Measured Drying on Testing	52
3.6.8	Analysis of Resistance – Temperature Data	52
3.7	Thermal Mechanical Analysis: Instrumentation	55
3.8	Thermogravimetric Analysis: Instrumentation	55
3.9	Differential Scanning Calorimetry: Instrumentation	56
3.10	Mercury Intrusion Porosimetry: Instrumentation	56
3.11	Length Change Calculations	57
3.12	Chelsea Dielectric	57

CHAPTER 4 DYNAMIC DRYING-REWETTING OF CEMENT PASTE

4.1	Introduction	58
4.2	Results	58
4.3	Discussion	70
4.3.1	Material Characterization	70
4.3.2	Stains	71
4.3.3	Mass Changes	75
4.3.4	ACIS	78
4.3.4.1	Resaturation with Synthetic Pore Solution	81
4.3.4.2	Resaturation with Saturated Lime Solution	81
4.3.4.3	Distilled Water	84
4.3.4.4	Early Age Results – 14 Days Hydration	87
4.3.4.5	Three Months Hydration – Drying @ 100°C for 24 hours	90
4.4	Conclusions	91

CHAPTER 5 FREEZING-THAWING PHENOMENA IN HYDRATED PORTLAND CEMENT PASTE

5.1	Introduction	92
5.2	Results	92
5.2.1	Thermal Mechanical Analysis (TMA)	93
5.2.2	Differential Scanning Calorimetry (DSC)	95

5.2.3	Theoretical Discussion of the ACIS Response of Freezing Cement Paste	97
5.2.3.1	Overall Sample Resistance	97
5.2.3.2	Depression Angle and Phi of the Constant Phase Element (CPE)	98
5.2.3.3	Types of Phi Curves	100
5.2.3.4	Resistance and Phi Combined	102
5.3	W/C = 0.35 – Natural Porewater Condition	102
5.4	W.C = 0.60 – Natural Porewater Condition	107
5.5	Resaturation with Salt Solutions and Synthetic Pore Solution	108
5.5.1	W/C = 0.35 – 7 Days Hydration: Resaturation with Salt Solution and Synthetic Pore Solution	111
5.5.2	W/C = 0.35 – 28 Days: Resaturated with Salt Solution and Synthetic Pore Solution	111
5.5.3	W/C = 0.60 – 7 Days: Salt Solutions and Synthetic Pore Solutions	113
5.5.4	W/C = 0.60 – 28 Days: Salt Solutions and Synthetic Pore Solutions	116
5.6	Air Entrainment	116
5.7	Conclusions	120
 CHAPTER 6 FREEZING OF PASTES AND MORTAR WITH FLY ASH		
6.1	Introduction	122
6.2	Results	122
6.2.1	TMA	122
6.2.2	DSC	125
6.2.3	ACIS	126
6.2.3.1	HCP with Fly Ash, 9 Months Hydration	126
6.2.3.2	Mortar with Fly Ash, 9 Months Hydration	130
6.2.3.3	Cement Paste, 7 Days Hydration	132
6.2.3.3.1	Plain Reference Sample	132
6.2.3.4	Cement Paste with Fly Ash, 7 Days Hydration	133
6.2.3.5	Mortar, 7 Days Hydration	136
6.2.3.5.1	Plain Reference Specimens	136
6.2.3.5.2	Mortar with Fly Ash, 7 Days Hydration	136
6.3	Conclusions	137

CHAPTER 7	FREEZING OF MODEL POROUS SYSTEMS – BRICK AND VYCOR GLASS	
7.1	Introduction	138
7.2	Brick	138
7.2.1	Sample Preparation	138
7.2.2	Characterization of the Brick	139
7.2.3	Results	141
7.2.3.1	6000 Series Brick	143
7.2.3.2	5000 Series Brick	143
7.2.3.3	4000 Series Brick	143
7.3	Vycor Glass	146
7.3.1	Results	146
7.4	Conclusions	148
CHAPTER 8	DIELECTRIC PROPERTIES OF CEMENT PASTE AND VYCOR GLASS	150
8.1	Introduction	150
8.2	Results	150
8.3	Conclusions	157
CHAPTER 9	SUMMARY	160
9.1	Introduction	160
9.2	Dynamic Drying-Rewetting Experiments	160
9.3	Freezing-Thawing Experiments	160
9.4	Ring-Disc Electrode Experiments	161
9.5	Dielectric Amplification	162
9.6	Recommendations for Future Experiments	162
9.7	Conclusions	163
APPENDIX		164
REFERENCES		428

LIST OF TABLES

TABLE		PAGE
3.1	Drying- Rewetting Experiment Settings for Solartron	39
3.2	Resistivities of Pore Solution (Sampling Rate is 10 kHz)	39
3.3a	Mix Designs for Specimens Hydrated for 9 Months	43
3.3b	Mix Designs for Specimens Hydrated for 7 Days	43
3.4	Solartron Setups	46
3.5	Percent Error of the Equivalent Circuit Based on Initial Parameters	46
3.6	Percent Error of the Equivalent Circuit Based on Initial Parameters	47
3.7	Correlation Coefficients	53
3.8	Correlation Coefficients	54
3.9	Equations of best fit lines using least squares.	55
4.1a	Characterization of the Pastes	59
4.1b	Porosimetry Results	59
4.2a	Data on Drying-Rewetting with Synthetic Pore Solution	60
4.2b	Data on Drying-Rewetting with Calcium Hydroxide Solution	61
4.2c	Data on Drying-Rewetting with Distilled Water	63
4.2d	Data on Drying at 100°C –Rewetting with Synthetic Pore Solution	65
4.3a	Equivalent Circuits, Rewetting with Synthetic Pore Solution	66
4.3b	Equivalent Circuits, Rewetting with Saturated Calcium Hydroxide	67
4.3c	Equivalent Circuits, Resaturating with Distilled Water	68
4.3d	Equivalent Circuit, 14 Days Hydration	69
5.1	Results	94
5.2	Pore Solution Conductivity	109
6.1	TMA Results, 7 Days Hydration	123
6.2	TMA Results, 9 Months Hydration	123
6.3	DSC Results, 7 Days Hydration	125
6.4	DSC Results, 9 Months Hydration	125
6.5	Temperatures at Changes in Freezing Mechanism	127
6.6	ACIS Results, 9 Months Hydration	130
7.1	ACIS Brick Data	141

8.1	30 year hydrated cement paste in their natural condition	154
8.2	30 Year Old Cement Pastes Dried for 24 Hours at 38° C, with Teflon	154
8.3	30 Year Old Cement Pastes Dried for 24 Hours at 38° C, without Teflon	155
8.4	Vycor Glass vacuum saturated with Brine solution	156
8.5	30 year hydrated cement paste	157
8.6	Triethanolomine Summary	157
8.7	Plastiment Summary	158

LIST OF FIGURES

FIGURE		PAGE
1.1	Diagram of Ring-Disc Electrode	6
2.1	Impedance Equations	9
2.2	Nyquist Plot of Hcp	10
2.3	Schematic of the "solid-liquid interface unit cell" model	10
2.4	The equivalent circuit for an AC impedance spectrum for hcp	11
2.5	Impedance Behaviour of Hydrated Cement Paste	12
2.6	Length change of hcp on freezing and thawing	17
2.7	Heat-temperature curve of hcp	18
2.8	Freezing of HCP Saturated with salt solution	22
2.9	Shrinkage Mechanisms	24
2.10	The variation of the first shrinkage of moist cured cement paste	25
2.11	Kelvin's Equation	25
2.12	Relation between radius of curvature and vapour pressure	26
2.13	Areas of hindered adsorption	28
2.14	Schematic description of volume changes in cement paste due to alternate cycles of drying and wetting	29
3.1	Drying-Rewetting Specimen with Huggenberger Pins	37
3.2	Connecting Drying-Rewetting Specimen to Solartron	38
3.3	Specimens with Cast-in-Place Electrodes	41
3.4	Casting the Specimens	42
3.5	Attaching Electrodes with Conductive Epoxy	42
3.6	Equivalent Circuit	47
3.7	Interior Chamber of TMA Apparatus	56
5.1	Resistivity of Salt Solutions	109
7.1	Cracks in Vycor Glass on Freezing	148

LIST OF GRAPHS

GRAPH		PAGE
3.1	ACIS Parameters with Temperature Variations	49
3.2	Sections of Impedance Curves	53
4.1	Change in Resistance with W/C Ratio	71
4.2a-d	Strain vs. Drying-Rewetting Cycle	71
4.3a-d	Changes in Mass	76
4.4	Nyquist Plots from Each Drying-Rewetting Cycle	78
4.5	Resistance: 30 Years Hydration, Synthetic Pore Solution	79
4.6	Variation in Phi with Drying-Rewetting Cycles, Synthetic Pore Solution	80
4.7	30 Years Hydration, Rewetting with CaOH	82
4.8	Variation in Phi, Rewetting with CaOH	83
4.9	Resistance: 30 Years Hydration, Distilled Water	85
4.10	Variation in Phi, Distilled Water	86
4.11	14 Days Hydrations, Synthetic Pore Solution	88
4.12	Variation in Phi, 14 Days Hydration	89
5.1	ACIS Nyquist Plots at Different Temperatures	93
5.2	TMA Curves with Various Hydration Times	95
5.3	Typical DSC Curve	96
5.4	Correlation Between DSC and ACIS Results	96
5.5	Resistance-Temperature Curve	98
5.6	Phi-Temperature Curve	99
5.7	Types of Phi Curves	101
5.8	ACIS Results, w/c=0.35, Varying Hydration Times	103
5.9	Normalized Resistance, w/c=0.35	104
5.10	ACIS Curves – w/c=0.60	106
5.11	w/c=0.35, 7 Days Hydration, Salt Solutions	110
5.12	w/c=0.35, 28 Days Hydration, Salt Solutions	112
5.13	w/c=0.60, 7 Days Hydration, Salt Solutions	114
5.14	w/c=0.60, 28 Days Hydration, Salt Solutions	115

5.15	Air Entrainment Curves	118
5.16	w/c=0.35, 28 Days Hydration, 6% Air Entrainment, Salt Solutions	119
6.1	Hydrated Cement Paste, 9 Months Hydration	129
6.2	Mortar, 9 Months Hydration	131
6.3	Paste with Fly Ash, 7 Days Hydration	134
6.4	Mortar with Fly Ash, 7 Days Hydration	135
7.1	6000 Series Brick, Porosity	139
7.2	5000 Series Brick, Porosity	140
7.3	4000 Series Brick, Porosity	140
7.4	6000 Series Brick, ACIS	142
7.5	6000 Series Brick, TMA	142
7.6	5000 Series Brick, ACIS	144
7.7	5000 Series Brick, TMA	144
7.8	4000 Series Brick, ACIS	145
7.9	4000 Series Brick, TMA	145
7.10	Vycor Glass, ACIS	147
7.11	Vycor Glass, TMA	147
8.1	HCP with Triethanolomine, 1.60 mm Thick Teflon	151
8.2	HCP with Triethanolomine, 0.51 mm Thick Teflon	151
8.3	HCP with Plastiment, no Teflon Sheets	153
8.4	HCP with Plastiment, 1.6 mm Teflon Thickness	153

CHAPTER 1

INTRODUCTION AND THESIS OUTLINE

1.1 Introduction

Durability of concrete systems exposed to harsh environmental conditions has been a topic of great concern in the recent past and has received heightened interest since the advent of high performance concrete. This is especially true in northern countries such as Canada where winters are harsh and the roads are heavily salted to improve driving conditions. The combination of de-icing salts and freezing-thawing cycles during the unpredictable winter season can have disastrous effects on concrete systems. Current methods to evaluate the ability of concrete to resist the destructive mechanisms associated with freezing-thawing cycles have had varied success. Proper assessment of the insitu durability of concrete systems makes possible preventive measures to be applied to concrete elements identified to be of questionable quality and thus the extension of the service-life of the structure.

New testing procedures that address the issue of frost durability are of great interest to engineers. A novel approach to this problem includes the use of electrical methods. Electrical methods provide tools for rapid characterization of the microstructure of microporous materials. The application of these methods to concrete is relatively recent and has spawned activity in three centres (NRC, Northwestern University, and Heriott-Watt University). The techniques have special promise for the development of field and laboratory test methods in addition to providing a non-destructive means of investigating changes in basic properties of hydrated cement-based materials. This thesis is an investigation on the efficacy of electrical methods for quantitatively describing changes in the microstructure of pastes and mortars resulting from environmental effects and factors that would influence the development of new test methods for frost resistance.

1.2 Global Objectives

The three primary objectives of the work are as follows:

To innovate, develop and advance the application of electrochemical methods (with emphasis on AC impedance spectroscopy (ACIS)) to concrete durability issues pertinent to service-life prediction e.g. non-destructive evaluation of the permeability of cement systems.

To develop rapid methods for characterizing and monitoring microstructural change in hydrated cement systems due to environmental effects e.g. pore structure modification and its consequence on new/modified test methods for determination of the frost resistance of cement-based materials.

To contribute to the understanding of volume change mechanisms associated with durability issues.

1.3 Thesis Components

The thesis is comprised of the following components:

Examination of the changes to the pore structure of hydrated cement paste (hcp) subjected to drying-rewetting and freezing-thawing cycles in the presence of a variety of pore solutions using ACIS. Establishment of relationships between porosity and electrical resistivity to determine the effect of tortuosity and pore structure on behaviour.

Development of ACIS techniques as the basis of a primary tool for a non-destructive frost durability test. The work will include assessment of the effects of moisture content and salt content in the pore solution. The focus is on paste and mortar systems and the use of supplementary cementing materials. The latter, e.g. fly ash, present unique problems related to scaling effects. Supplementary work was carried out on vycor glass and brick which have contrasting pore systems to hydrated cement paste (hcp) and are used as microstructural models to verify theories developed from the hcp tests.

Investigation of dielectric amplification of hcp at low frequencies. (The significance of this relates to mass transport of ions in concrete and is important for computer modeling of mass transport phenomena (e.g. double layer effects).)

1.4 Experimental Plan - Methodology

In both drying-rewetting and freezing-thawing cycles, hcp undergoes length changes that reflect the movement of the pore water. This pore water movement creates stresses in the hcp matrix which lead to irreversible and reversible changes to the pore structure of the hcp. Analysis of hcp using ACIS and length change measurements is intended to establish:

ACIS as an effective method for evaluating pore systems of hcp.

The nature of changes to the pore network of hcp on drying and freezing.

1.4.1 Drying-Rewetting

Drying-rewetting cycles experienced by hcp cause permanent damage to the pore structure. The movement of pore water due to changes in the RH creates dimensional changes that reflect the matrix's ability to accommodate the resulting stresses on the system. ACIS tests after each cycle can be used to document the pore structure changes and correlate these with the changes that are indicated by the length-change measurements. It is hypothesized that drying-rewetting cycles will coarsen the initial pore structure due to the inability of the pore solution to re-enter some of the partially collapsed pores on drying and/or permanent compressive strains in the matrix.

Length-change measurements and ACIS tests were conducted with each cycle of drying-rewetting. A total of four drying-rewetting cycles was studied. Test specimens consisted of hcp hydrated for 14 days and 30 years. The pastes were mixed with type 10 cement and some included a calcium lignosulphate based additive. Calcium lignosulphate is an additive that is known to increase drying shrinkage. Pastes prepared using five w/c ratios were studied. These ranged from 0.25 to 1.00. All pastes were characterized using mercury intrusion porosimetry and thermogravimetric analysis.

It was anticipated that an assessment of experimental results would include new information on the following:

- the high sensitivity of hcp characteristics to changes in pore solution composition

- changes in ACIS spectral characteristics with each drying and rewetting cycle
- irreversible shrinkage due to first drying that can be easily quantified using ACIS
- pore structure opening up (coarsening) with each drying cycle as indicated by a decreasing high frequency arc (hfa) diameter and reduced shrinkage
- the dependence of the dispersion angle (a characteristic of the impedance high frequency arc) on changes in pore structure due to drying. The significance of decreases with each cycle observed will be assessed. Data will be critically reviewed in terms of evaluating the pore coarsening theory
- development of relationships between porosity and electrical resistivity

1.4.2 Freezing-Thawing

The sensitivity of ACIS to changes in temperature will provide detailed information about the changes in the hcp microstructure. In addition, the test specimens (believed to be the first of their kind) were designed to allow length-change and ACIS measurements to be obtained simultaneously. Tests measuring ACIS and length change simultaneously on hcp while undergoing freezing-thawing have (to our knowledge) never been reported before and should provide informative or useful data. Changes in ACIS spectra are extremely sensitive to freezing phenomena and may prove to be superior to volume change measurements. Paste and mortar specimens containing air entraining agents and fly ash will be examined. Air entraining agents are commonly used to give concrete increased resistance to frost action. The use of fly ash is associated with a unique salt scaling problem that affects otherwise durable concrete. It is expected that ACIS parameters will correlate with the amount of water freezing and the average pore size in which it freezes. The degree of hysteresis of the ACIS parameters will be indicative of pore structure damage.

The test specimens were carefully monitored in the temperature range of -80°C to $+20^{\circ}\text{C}$. Analysis of 1, 7, and 28 day specimens of hcp specially fabricated for measurement of length change and ACIS simultaneously were made. The specimens included pastes made with Type 10 cement, additions of fly ash, and air entraining agents. The effect of different pore solutions within the pore system of the samples was studied: natural, 5%, 10%, 15% NaCl. Thermogravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC) tests were conducted on all pastes to characterize them and determine the amount of freezable water.

The analysis included assessment, verification or discovery of the following:

- electrical measurements are highly sensitive to changes in temperature as indicated by changes in resistance (by orders of magnitude) of hcp
- the onset of freezing can be identified
- hysteresis of test parameters between freezing and thawing
- salt effects on dimensional stability of hcp
- determination of the amount of water freezing
- permanent pore structure changes
- changes of the depression angle of the high frequency arc in the impedance spectra (decreases with increased freezing)

1.4.3 Ring-Disc Electrodes

Some work (as a first-step towards field measurement) on thin layers of repair materials was attempted. In the previous sections, the ACIS tests were conducted using parallel plate electrodes. A stainless steel plate is clamped to either end of the test specimen through which the electrical signal is transmitted to the hcp. This is a convenient method of measuring ACIS in the laboratory but parallel plate electrodes would not be practical in the field for evaluating existing structures.

Ring-disc electrodes, see Figure 1.1, could be placed directly on the concrete surface. The electrical signal would be applied through the central disc. The current would travel along an elliptical path through the concrete and return through the ring. Teflon, a non-conducting material, fills the space between the disc and the ring to eliminate the possibility of the current jumping from the disc to the ring without travelling through the concrete.

A set of ring-disc electrodes were constructed with diameters ranging from 60 mm to 8 mm. The different dimensions allowed the penetration of the signal through the concrete to be varied.

Attempts were made to use the ring-disc electrodes to collect ACIS data on test samples.

Future applications include:

On new structures: periodic ACIS measurements to monitor the top layer of concrete and evaluate its effectiveness as a barrier.

On existing structures: estimation of high water/salt content.

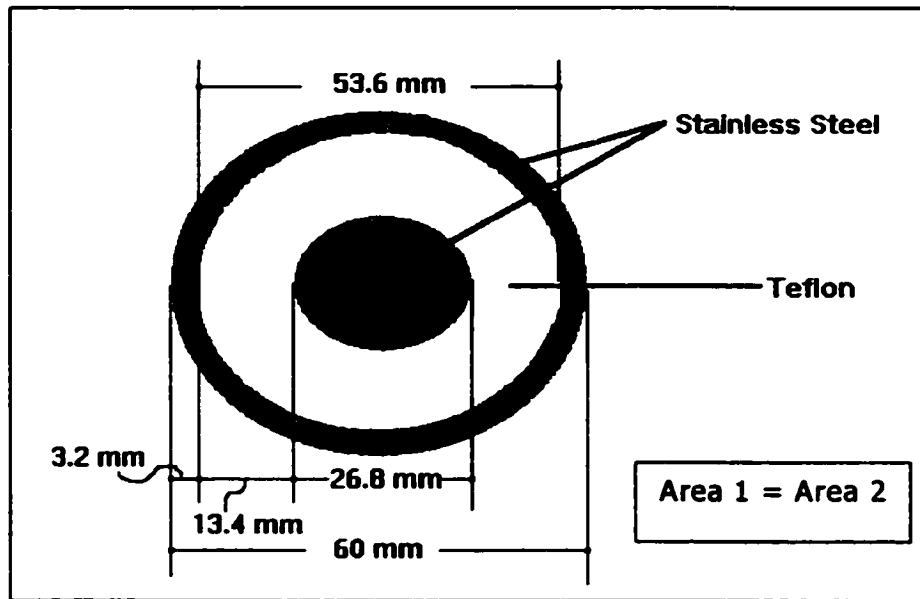


Figure 1.1: Diagram of Ring-Disc Electrode

1.4.4 Dielectric Amplification

There have been several studies on the dielectric properties of porous, liquid-filled solids that have tried to explain the extremely high permittivity values that occur at low frequencies. It is believed that these high permittivity values can arise from (i) Electrode Polarization Effects and/or (ii) Bulk Polarization Effects. This investigation included hydrated cement paste and vycor glass materials, which also exhibit extremely high permittivity values at low frequencies, in order to determine which of the above effects dominate.

Determination of the cause of the amplification focused on double-layer effects or bulk amplification effects. Measurement of dielectric constant of hcp involved using samples of different lengths and varying w/c ratios and varying admixtures. Tests with and without teflon sheets in between the electrodes and the sample were conducted to distinguish between double-layer effects and bulk amplification effects. Teflon simulates an ideal capacitor. The teflon sheets are non-conductive and will minimize the presence of a double-layer effect between the sample and the electrodes.

1.5 Summary

The individual components of the thesis combine to establish ACIS as an exciting and promising new testing technique for concrete systems. Through the drying-rewetting experiments, the damage to the pore structure due to the evacuation of the pore water is documented. ACIS is sensitive enough to detect changes to the composition of the pore water and to the pore structure itself. The freezing-thawing data show that the changes and movement of the pore water in cement systems due to temperature change can be observed in the changes to sample resistance and phi (depression angle parameter) and are important. The information and analysis forms the basis on which to establish ACIS as a new tool to analyze concrete systems.

CHAPTER 2

LITERATURE REVIEW

2.1 AC Impedance Spectroscopy (ACIS)

ACIS is a testing technique that has been used for several decades in the electrochemical field (MacDonald, 1987). Its use has just recently crossed over into the field of concrete science with promising results. Researchers at the National Research Council Canada (NRC) have linked ACIS parameters to hydrated cement paste (hcp) properties such as: the ionic concentration of the pore solution, pore-size distribution, and total porosity (Gu et al., 1998). Other investigations have related these parameters to microstructural characteristics of hcp (Olson et al., 1993; Christensen et al., 1993; McCarter et al., 1996). The high frequency arc which is the main ACIS characteristic results from the microstructure of the paste, i.e. solid-liquid interfaces in the hcp. The arc diameter and its intercepts with the real impedance axis can be used to describe the hydration process, e.g. the arc diameter increases with degree of hydration and finer pore sizes typical of systems containing silica fume.

Electrical resistivity is a fundamental concept in the use of electrical methods. It is the measure of the ability of a material to resist electrical conduction through it. There are two methods through which electricity can be conducted, electronic (through solid phases) and ionic (through liquid). Electrical conduction through hcp is essentially electrolytic and is carried through the motions of ions in the pore solution. The ions contained within hcp pore solution include: Na^+ , K^+ , OH^- , SO_4^{2-} , and Ca^{2+} , which are strong electrolytes that can easily act as charge carriers (Andersson et al., 1989).

In addition to electrical resistivity or its inverse, conductivity, the dielectric constant (ϵ_r) also provides important information about the test material. The dielectric constant is a material property that reflects the polarization features of the material under an external electric field. It is related to the extent of polarization and the frequency of the current. Use of an alternating current

allows for the measurement of both resistivity and the dielectric constant. An AC signal creates two electrical responses: electrical conduction and polarization. A direct current can only measure resistivity. Another advantage to using an AC signal is that it avoids problems resulting from electrochemical polarization of the electrodes.

AC impedance can be measured through analysis of the ratio of the amplitudes and phase shift between the voltage and current. A small amplitude sinusoidal voltage or current signal is applied to a system which results in the generation of a response current or potential signal that is recorded. The impedance is then calculated from the equations included in Figure 2.1 (Gu et al., 1998). The ACIS procedure involves the measurement of the impedance directly over a range of frequencies (100Hz to 5MHz). When plotted on a complex plane or Nyquist plot, a typical ACIS curve for hcp is obtained as shown in Figure 2.2. The semi-circle indicated is known as the high frequency arc (hfa) and relates to the bulk paste impedance behaviour. The tail at the end of the arc that is in the low frequency range results from a cement-electrode surface capacitance effect.

(a)

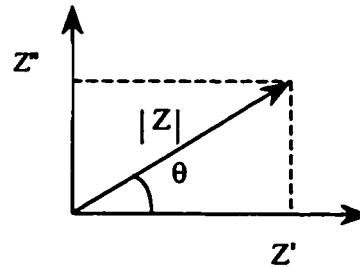
$$|Z| = \frac{V_m}{i_m}$$

$$Z'(\omega) = |Z| \cos(\theta)$$

$$Z''(\omega) = |Z| \sin(\theta)$$

$$Z(\omega) = Z'(\omega) - jZ''(\omega)$$

(b)



where Z is impedance, V is voltage, i is current, θ is the phase angle, ω is frequency.

Figure 2.1: (a) Impedance Equations and (b) Impedance Vector Plotted in Complex Plane

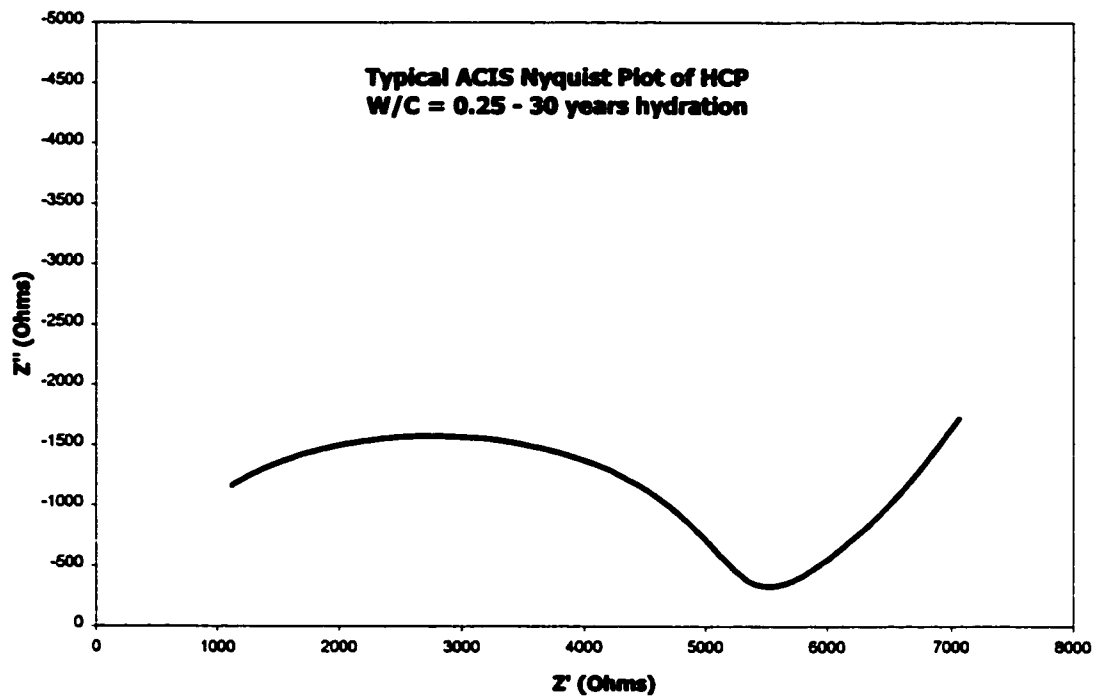


Figure 2.2: Nyquist Plot of Hcp

2.1.1 High Frequency Arc

The high frequency arc (hfa) that is part of the ACIS spectrum is essentially due to solid-liquid interface phenomena. Solid-liquid double layers create a separation of charges within the pore solution which has a capacitance effect, see Figure 2.3 (Gu et al., 1998). The hfa diameter is proportional to the number of solid-liquid interfaces in the test specimen. If the specimen thickness is smaller than its critical thickness, the hfa will not be detected due to an insufficient number of solid-liquid interfaces (Gu et al., 1998).

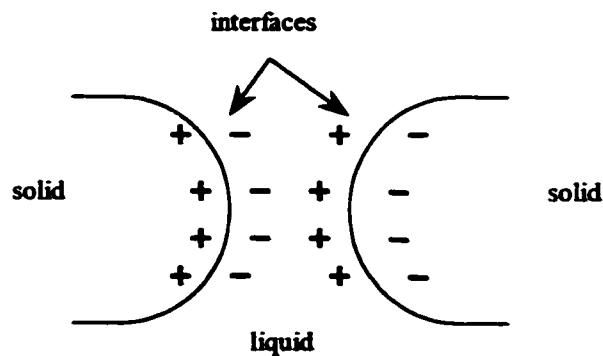


Figure 2.3: Schematic of the "solid-liquid interface unit cell" model.

2.1.2 Equivalent Circuits

The ACIS data can be evaluated and represented by an equivalent circuit. The work included in the thesis focuses primarily on the hfa and how it changes quantitatively under various test conditions and environmental changes. Therefore, equivalent circuits as shown in Figure 2.4 (Gu et al., 1998) will be used to analyze this region only. The equivalent circuit consists of a resistor connected in series to a resistor and a capacitor connected in parallel. For a perfect resistor and capacitor, the result is a perfect semi-circle. In practice, for hcp the hfa is often depressed below the real impedance axis (Gu et al., 1998; Cormack et al., 1998). This requires the use of a frequency dependent Constant Phase Element in series with the capacitor that will factor into the equivalent circuit the imperfections of the capacitor that creates the depressed arc, see Figure 2.5 (Gu et al., 1998). Φ , ϕ , represents the depression of the hfa below the axis and relates to the frequency dispersion angle, α_d , by the equation $\phi = 1 - 2\alpha_d/\pi$.

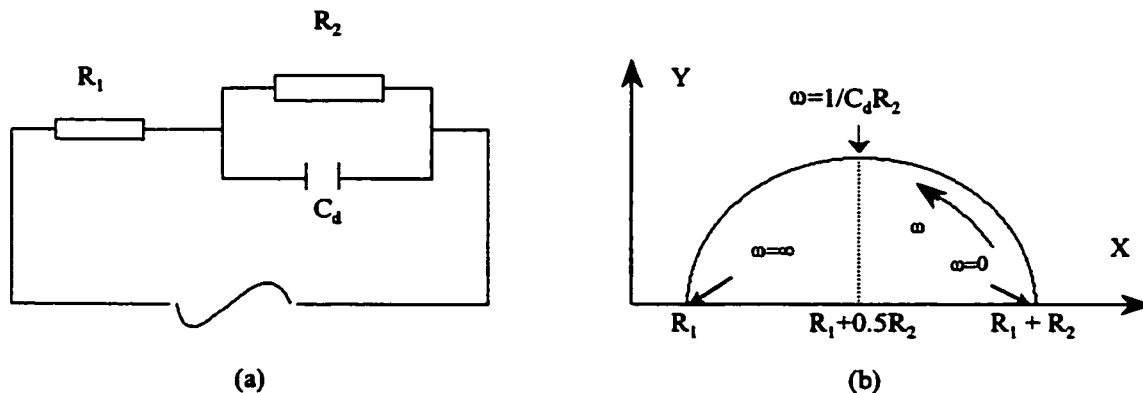


Figure 2.4: (a) The equivalent circuit for an AC impedance spectrum for hcp and (b) the corresponding high-frequency arc.

The values for the high frequency resistance, R_1 , and the high frequency arc diameter, R_2 , can be approximated directly from the Nyquist plot see Figure 2.4. R_1 can be equated to the distance from the origin to the point where the hfa intersects the real axis at the high frequency end. R_2 is equal to the diameter of the hfa. These two parameters have been studied and proven to relate to hcp properties (Gu et al., 1998):

1. R_1 is an inverse function of both porosity and ionic concentration in the pore solution.
2. R_2 is an inverse function of porosity, mean pore size, and ionic concentration of the pore solution.

3. The capacitance of the solid-liquid interface, C_1 , and depression angle are affected by the ionic concentration of the pore solution and paste microstructure.

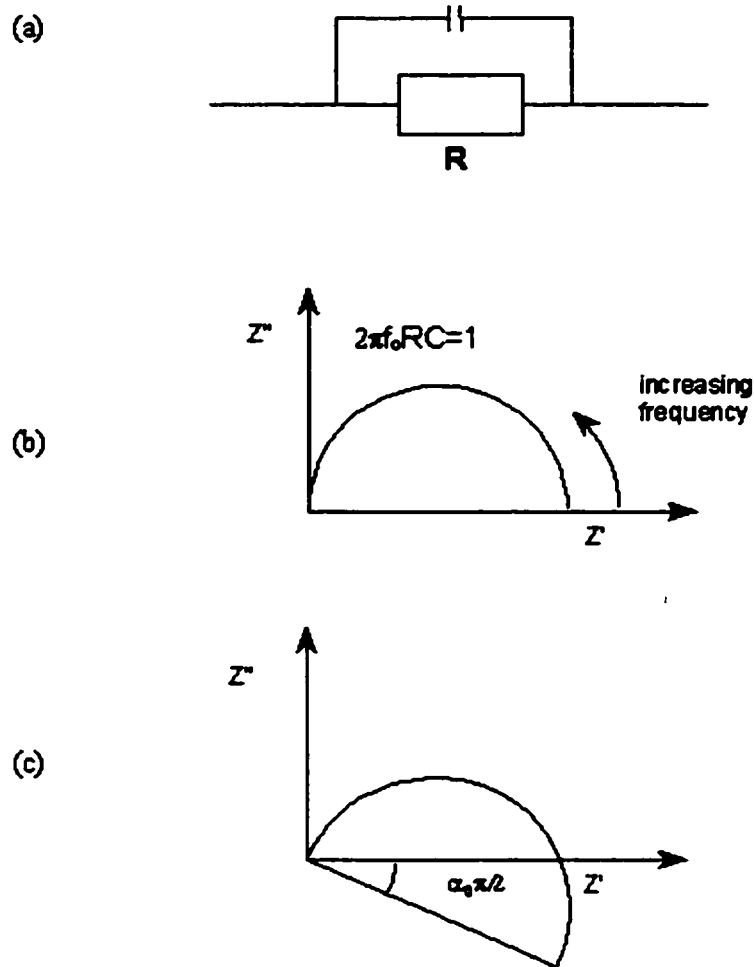


Figure 2.5: Impedance behaviour of hydrated cement paste: (a) parallel electrical circuit, (b) its corresponding impedance plotted in the complex plane, (c) impedance plot showing a semicircle are inclined at $\alpha_d \pi / 2$.

2.1.3 Frequency Dispersion Angle

The frequency dispersion angle, α_d , has been related to the pore-size distribution of the test specimen, spread of relaxation times and non-Debye behaviour (Gu et al., 1994). When an alternating signal is applied, the dipoles of ions inside the micropores orient themselves to follow

the signal. The time required for the orientation of ions, termed relaxation time, appears to be affected by the geometry of the pores and the surface chemistry of the solid. The differences of ion-ion interaction between large and small pores are expected to result in different relaxation times. This indicates that a large dispersion angle can be attributed to the numerous relaxation times inherent to a broad pore-size distribution. A narrow pore size distribution would generate significantly fewer relaxation times and a small dispersion angle on the Nyquist plot. In the literature (Gu et al., 1994), the different dispersion angles for hcp (28°), silica-fume paste (18°), and porous glass (9°) are documented. The dispersion angles decrease as the pore size distribution is reduced.

2.1.4 Application of ACIS to Frozen Cement Paste

Freezing of cement paste to temperatures of -40°C significantly reduces the dielectric constant values and conductivity (Olson, 1993). This was linked to the formation of ice in capillary pores that resulted in a discontinuity in the pore structure. This effect diminished as hydration of the specimens increased due to a naturally occurring disconnected pore structure. The contributions from the capillary pores on the ACIS parameters can be separated from those related to the C-S-H layers by freezing the cement paste.

2.1.5 Pore Solution Volume

It has been hypothesized that the decrease in resistance on drying is due to a coarsening of the pores within the hcp. As the pores become enlarged and more continuous, the volume of pore solution that transmits the electrical current increases. In work by Hao Cai and Xila Lui, 1998, it was assumed that the resistance of the concrete specimen, R_c , is equal to the resistance of the pore solution, R_s . This assumption is reasonable because the electrical current is transmitted through the concrete specimen by electrolytes in the pore solution. This results in the following relationship:

$$R_c = \frac{h_c}{\sigma_c S_c} = \frac{h_s}{\sigma_s S_s} = R_s \quad (2.1)$$

Where:

h_c is the length of concrete through which electrical current has passed

h_s is the effective length of pore solution through which electrical current has passed

S_c, S_s is the area of concrete, pore solution through which electrical current has passed

σ_c, σ_s is the electrical conductivity of concrete pore solution.

It is further assumed that $h_c = h_s$ because the electrical current will take the shortest path.

Therefore,

$$\sigma_c S_c = \sigma_s S_s \quad (2.2)$$

Multiply equation 2.2 by h ,

$$\sigma_c V_c = \sigma_s V_s \quad (2.3)$$

It is known that

$$\sigma_c = \frac{h_c}{R_c S_c} \quad (2.4)$$

$$V_c = S_c h_c \quad (2.5)$$

Substituting equations 2.4 and 2.5 into equation 2.3 and solving for V_s results in

$$V_s = \frac{h_c^2}{R_c \sigma_c} \quad (2.6)$$

2.1.6 Other Applications of Electrical Methods Applied to Concrete

Electrocuring, electromigration, and electrochemical chloride treatment are other applications of electrical methods applied to concrete. In contrast to ACIS methods, these applications involve large electric fields in excess of 100 V/m. Electrocuring (Bredenkamp, 1993) is a method of accelerated hydration with the use of ohmic heating. High early strengths of the concrete can be achieved with A.C. fields of 300-500 V/m. Electromigration uses large D.C. fields (1180 V/m) to force ions through concrete (Whiting, 1981). Conductivity/diffusivity is a function of the

amount of current passed through a standard sample in a set period of time. Electrochemical chloride removal uses a counter electrode and D.C. fields (100-1000 V/m) to remove chloride ions from concrete pore solution (Tritthart et al., 1993). The counter electrode is placed on the surface and attracts the chloride ions away from the reinforcing steel.

An undesirable effect of the use of large electric fields is the associated generation of heat. This heat can cause microcracking of the concrete. In addition, some researchers believe that microstructural changes in cement paste can be induced by the application of large electric fields (Sohn et al., 1998). Increased paste resistances resulting from the application of a 1250 V/m electric field were attributed to changes in the connectivity of the capillary pores at the location of 'bottlenecks'.

2.1.7 Limitations on A.C. Impedance Spectroscopy Experiments

Artificial effects can be incorporated into the measured values from machine limitations, stray imittances and electrode effects (Mason et al., 1998; Edwards et al., 1997). Limitations of the instrument being used to measure the specimens will restrict the type of material that can be tested. Stray imittances result from cables, leads, insulation, and sample holders should be kept to a minimum. Use of coaxial cables is important. Electrode effects in multipoint impedance spectroscopy measurements lead to unreliable data. Two-point measurements are recommended. Null corrections can be performed as a last resort to reduce the artificial effects discussed.

2.2 Freezing of Hydrated Cement Paste

The freezing of cement paste is a very complex phenomenon which often results in weakening the cement paste structure as a whole. Repeated freezing-thawing cycles continue to degrade the cement or concrete structure further. This leads to surface scaling, internal cracking, reduced modulus of elasticity and increased permeability. Unfortunately, the deleterious effects of freezing on cement paste are enhanced by de-icer salts commonly used by municipalities to keep roadways clear of ice. An excellent review of the fundamental principles of frost action is provided by Ramachandran et al., 1981.

Determining the durability of a concrete system in situ is very difficult. Many factors are involved in the frost resistance of concrete, of which the most important include: pore size

distribution (air void spacing factor), degree of saturation, and rate of temperature change. ASTM methods C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing, and C672, Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals, are normally used to estimate the frost resistance of concrete. Currently, the most common method of improving the concrete's ability to withstand freezing-thawing cycles is the use of air entrainment in the cement paste. The purpose of the entrained air is to provide relief of stress due to hydraulic pressure. The spacing of the entrained air is critical and should be less than the recommended amount.

2.2.1 Mechanisms of Frost Action

The freezing mechanisms of hydrated cement paste are intimately related to the behaviour of the pore water at the reduced temperatures (Litvan, 1988). As the temperature of paste decreases below the triple point of water, 0°C, the chemical potentials of the supercooled and adsorbed pore water are larger than for bulk water and ice. The water will migrate from the interior of the paste to the exterior in search of a lower vapour pressure. Freezing of the pore water does not occur in the paste until the temperature reaches -5°C to -10°C. The incipient freezing temperature of pore water does not occur at 0°C like that of pure water because of the increased pressure on the molecules from the confined space within the pore. This results in a decrease of water vapor tension above the convex meniscus of liquid in pores (Schneider and Rathousky, 1989). In addition, the freezing temperature is even more depressed by the presence of salts in the solution.

The initiation of freezing requires one of the following events: thermal nucleation, heterogeneous nucleation, or seeding with a piece of ice (Helmuth, 1960). Once freezing is initiated, the pore water will begin to freeze in the larger capillary pores and continue to freeze in decreasing order of pore size. The ice crystals that are forming have a lower vapour pressure than the supercooled water and will feed on the unfrozen water in the other pores. Ice formation propagates in a continuous, connected front. The continuous ice front restricts the formation of ice in the larger capillary pores. It will require relatively low pressures to freeze water in larger capillary spaces that are not connected to the existing ice network. Ice will only propagate through capillary pores large enough to contain stable ice crystals (Helmuth, 1960). Furthermore, the capillary pores that are considered to be frozen still contain on average four molecular layers of unfrozen water adsorbed to the solid surfaces of the hydrated cement (Powers and Brownyard, 1947).

There is migration of the water to the exterior surface or at least larger pores to relieve the pressure building up due to the lower temperature and the migration of water to the ice crystals that have a lower vapour pressure. The transfer of water leads to hydraulic pressures within the pore structure that lead to cracking if the system is unable to accommodate the additional stresses.

Osmotic pressures will be present as the pore water is not pure water but contains dissolved salt ions, and often de-icer salts. As the pore water freezes, the concentration of the salts in the pore water changes and produces differential pressures within the system. Seeking equilibrium, the more dilute pore water migrates to areas of higher concentration. Again, the transfer of water is stressing the system and may lead to internal cracking.

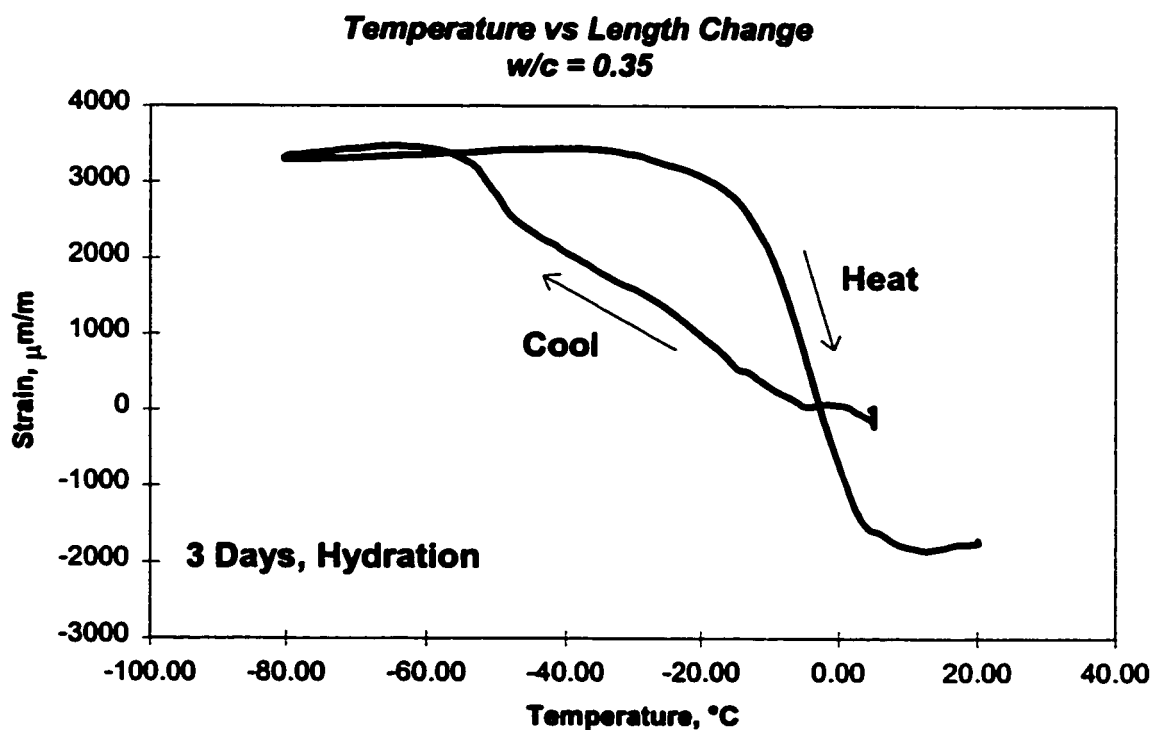


Figure 2.6: Length change of hcp on freezing and thawing.

As outlined previously, the physical rules governing the freezing of pore water in hcp are difficult to satisfy. The criteria to be met in the melting of ice crystals in hcp is less exhaustive. The melting temperature of the ice crystals in the hcp only relates to the pore size in which it is held. Therefore, melting occurs at higher temperatures than freezing. This hysteresis is apparent in the

freezing-thawing data documented in the literature (Powers, 1945) and is consistent throughout the range of tests including length change and calorimetry. The direction and rate of water movement is associated with capillary effects (Powers, 1945).

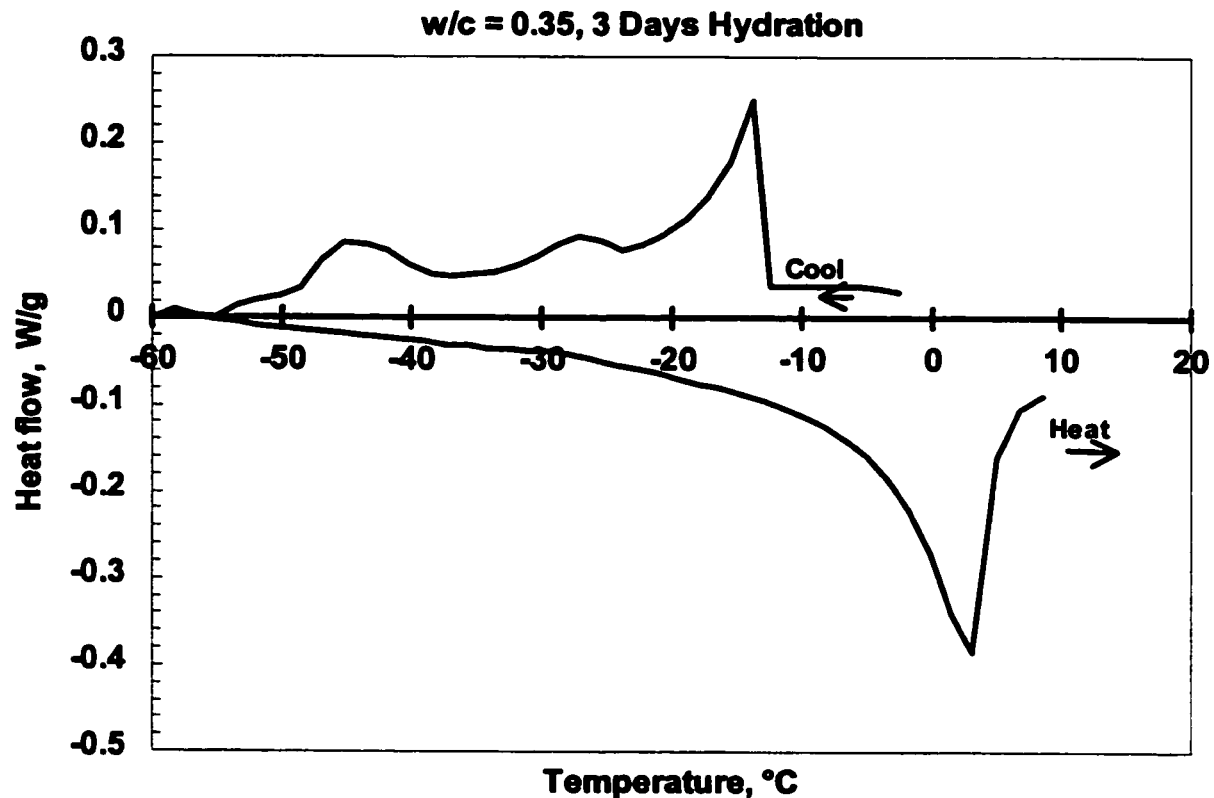


Figure 2.7: Heat-temperature curve of hcp.

Typical results presented in previous studies by Helmuth, 1961, and Litvan, 1975, report the depressed freezing temperature and expansive volume changes of hcp due to freezing. Typical curves are shown in Figures 2.6 and 2.7. In Figure 2.6, three distinct sections of the length change curve are at -8° , -25° , and -40°C and correlate with the freezing mechanisms of the various pore sizes. Thawing is best indicated by the resumption of the linear expansion of the system at -3°C . The heat-temperature curve of Figure 2.7 shows the exothermic peaks that correlate with freezing at -5° , -25° and -40°C . Hysteresis on thawing is also apparent at -1°C .

2.2.2 *Freezable Water in Cement Paste*

An investigation of the freezable water in cement paste through calorimetry revealed that the amount of freezable water and the temperature at incipient freezing varied with w/c ratio and history of the paste (Banthia et al., 1989). Increasing age and decreasing w/c ratio led to a decrease in the amount of freezable water and a lower temperature of incipient freezing. Freezing-thawing cycles and drying-rewetting cycles increased the amount of freezable water. This effect diminishes with repeated cycles. Samples that contained dissolved de-icer salts in the pore solution exhibited two peaks on freezing and thawing that were associated with freezing of the pure water and the eutectic solution. The temperature of incipient freezing was not affected by the de-icer salts in the pore solution.

2.2.3 *Factors Determining the Severity of the Freezing-Thawing Phenomenon*

In general, if the water content (degree of saturation) and the porosity of the cement paste are low, i.e. w/c ratio is low, freezing will cause little mechanical damage. Air entrainment provides relief of hydraulic pressure by providing closely spaced air bubbles. It is necessary that these air voids are not saturated. In some materials, e.g. brick, an open continuous pore system can permit drainage of excess water. This is generally not the case in cement systems. For a low water content, the decreased amount of water within the system may eliminate the need for air entrainment.

Cooling and warming rates are enormously important factors to consider in the freezing-thawing phenomena. Increasing the cooling and warming rates increases damage (Powers, 1945). If mass transfer does not occur at the required rate, then mechanical damage will occur. This is how entrained air improves the frost resistance of concrete. Entrained air will increase the amount of air voids within the system and reduce the spacing factor, L . There is more space for the pore water to move into; the travelling distance is also reduced. Again, it is an *a priori* condition that the air voids themselves are not saturated even though the pores in the paste are water filled.

2.2.4 Dilation

Dilation of the cement paste is an important factor to consider when evaluating the frost resistance of concrete (Helmuth, 1961; Litvan, 1975). The dilation factor (R_w) is defined here as the difference between the relative length change of the specimen over the temperature range of +20°C to 0°C (β_{AB}) and the final (stationary at -20°C) relative length change of the same specimen over the temperature range of 0°C to -20°C (β_{BC}):

$$R_w = \beta_{AB} - \beta_{BC} \text{ (}\mu\text{m/m, } 20^\circ\text{C)}$$

Dilation is an indication of how well the cement paste is able to alleviate the build up of pressure due to freezing. If the paste is frost resistant, the water will be easily transferred from the pores to the air-voids without any dilation. Cement paste that is vulnerable to frost action will dilate on freezing, because there is too much water being displaced for the available air voids in the system to accommodate. For good quality concrete the dilation factor should be below zero, but the limiting value of dilation factor is considered to be $R_w = -40 \mu\text{m/m, } 20^\circ\text{C}$. In addition, the dilation test can more accurately distinguish between good and inferior concrete when the freezing occurs in the presence of water.

2.2.5 Residual Expansion, and Degree of Saturation

Degree of saturation, S_f , and the dilation are very closely related because one depends on the other. The degree of saturation is calculated by the ratio of the volume of freezable water, W_f , to the volume of freezable water plus the volume of air filled voids, A , as follows (Vuorinen, 1964):

$$S_f = W_f / (W_f + A)$$

It gives an indication of the air voids available to withstand the mass transfer of water and its expansion. The critical degree of saturation is in the range of 0.7 to 0.8, whereas the theoretical value is 0.917. It is at the theoretical value that the hydraulic pressure due to the formation of ice causes the dilation of the concrete beyond its elastic limit. The effect that freezing has on cement paste with a critical degree of saturation is permanent expansion (referred to as residual

expansion) without apparent rupture which will escalate to complete disintegration with repeated freezing.

The cover zone of concrete is instrumental in minimizing the degree of saturation of the concrete. ACIS has been used to evaluate the sorption properties of the cover zone of concrete (McCarter et al., 1996). Depth of penetration of a water front and concentration of chloride ions from de-icing salts were estimated. The resistance ratio (resistance of paste subjected to rewetting/initial resistance of the paste) has been linked to the degree of saturation of the matrix (McCarter et al., 1995).

2.2.6 Salt Scaling, De-Icers

Salt scaling is a common problem in Northern climates where de-icing salts are used in the winter term to improve driving conditions. It is a surface effect where the covering concrete will crumble off. This problem most often affects parking garages, bridge decks and sidewalks because they are heavily treated with de-icing salts and are subjected to the freezing-thawing conditions of the environment. This is also true for apparently excellent quality concretes such as 'high volume fly ash' concrete (Pigeon and Marchand, 1996a, 1996b). In view of recent emphasis on concrete for sustainable development, this problem merits significant attention. Salt scaling is differentiated from internal cracking due to freezing-thawing cycles by the strong osmotic pressures near the surface, the increased concentration of dissolved de-icer salts and the different physical and chemical characteristics of the surface concrete compared to those of the interior.

De-icing salts have a significant effect on the freezing of concrete and cement paste. As previously mentioned, the lower vapour pressure of the salt solution allows for a higher degree of saturation of the paste at lower relative humidities. The retention of the pore solution makes it more difficult for the paste to accommodate the mass transfer of water. Salt scaling has been linked to the absorption of water into the concrete during freezing-thawing tests (Jacobsen and Sellevold, 1994). Freezing-thawing increases the absorption as compared to isothermal suction. NaCl solution increases the absorption of concrete relative to pure water during freezing-thawing tests.

In the case of relatively dilute salt solutions (< 10%), large expansions result and surface scaling is at its worst when compared to high concentrations of salt in solution or pure water (Litvan,

1972 and 1976). In the case of dilute salt solutions, a large fraction of the water component crystallizes at the end of the capillary channels leading to the external surface. This blocks the flow of the interior to the surface creating a build up of solution that results in large expansions and surface scaling.

Highly concentrated salt solutions generally do not generate significant expansions on cooling due to the highly viscous nature of concentrated salt solutions that essentially makes the whole system rigid and prevents mass redistribution. Though on warming, the built-up stresses appear due to the decreasing viscosity of the salt solution.

Freezing of salt solutions contained within hcp occurs in two steps, as can be seen in Figure 2.8 (Litvan, 1976). There are two exothermic peaks on freezing. The first peak is the crystallization of ice which is inversely related to the concentration of the salt solution. The second peak is the solidification of the eutectic mixture and relates directly to the concentration of the salt solution. Hysteresis on thawing still occurs with the presence of salts in solution. Salt solutions are believed to be absorbed more readily on thawing than pure water (Powers, 1945).

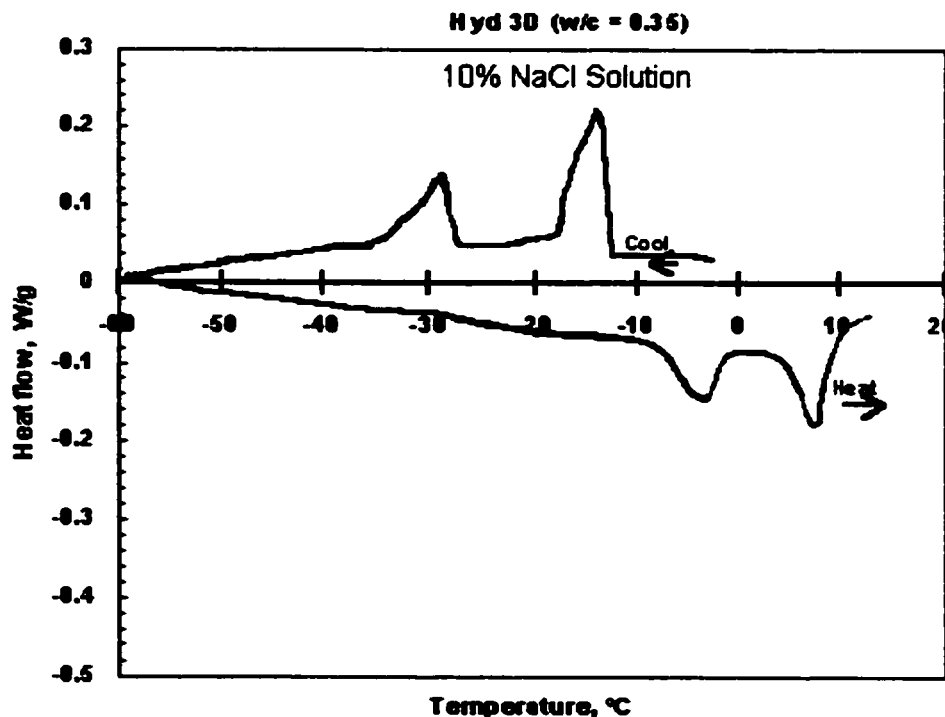


Figure 2.8: Freezing of HCP Saturated with salt solution

2.2.7 Frost Resistance of High Performance Concrete

High performance concretes usually include the addition of silica fume, fly ash or blast furnace slag that make it possible for the concrete to achieve compressive strengths upwards of 80 MPa. The pozzolans added to the mix react with the calcium hydroxide crystals to form cementitious products which significantly enhance its strength and refine the overall pore structure. Despite the increased strengths of the high performance concrete, they are still susceptible to frost action and salt scaling.

Concrete with the pozzolan, fly ash, still requires air entrainment to enhance its frost resistant qualities. Comparing plain concrete and fly ash concrete of equal strengths and air content, they will have equivalent frost resistance (Mehta, 1989). The presence of fly ash affects the amount of air entraining admixture to achieve the desired air content and air void spacing. The air-entraining admixture interacts with the fine fly ash material both physically and chemically. Usually, extra quantities of air entrainment admixture is required to achieve the desired size and spacing of the entrained air (Jacobsen et al., 1992).

Internal cracking and salt scaling are also problematic with high performance concrete. A slow cooling rate increases salt scaling, while rapid cooling increases internal cracking when the levels of internal cracking are low (Jacobsen et al., 1997). This implies that two different damage mechanisms are responsible for those problems. However, with increased internal cracking, scaling accelerates dramatically. De-icer salts enhance the scaling damage which may be due to osmotic pressures. It is believed that the primary mechanisms involved with salt scaling are of the osmotic type rather than hydraulic pressure type.

The benefit of the fly ash concrete is the reduced permeability of the outer layer of concrete and the refined pore structure reduces the number of freezing-thawing cycles. Keeping the water content and the number of freezing-thawing cycles of concrete to a minimum is significant in preventing frost damage.

2.3 Shrinkage Mechanisms

Shrinkage of hcp and ACIS parameters characteristic of hcp share many similar dependencies. As previously discussed, the factors affecting ACIS of hcp include: pore-size distribution (w/c), temperature, and moisture content (RH). These factors, in addition to cement composition and fineness, degree of hydration, equilibrium vapour pressure and air movement, all relate to the shrinkage of hcp. It is believed that shrinkage is the direct result of the removal of adsorbed surface water and the interlayer water between C-S-H sheets. ACIS techniques are sensitive to the movement and/or removal of pore water that results in shrinkage.

The proposed mechanisms that explain the shrinkage of hcp were much debated. Powers, Ishai, Feldman and Sereda, and Wittman all proposed different theories for the shrinkage mechanism of hcp, see Figure 2.9 (Soroka, 1980). They all agreed, though, that shrinkage results from a combination of mechanisms. The predominant mechanism controlling the shrinkage of hcp changes with the RH of the system. It can be seen from the graph in Figure 2.10 that the slope of the shrinkage strain vs. percent water removed curve changes two to three times. Each change in the slope indicates that a different mechanism or combination of mechanisms is occurring. The shrinkage mechanisms are: capillary tension, surface tension, disjoining pressure and movement or removal of interlayer water.

An attempt to relate the irreversible effects of shrinkage in hcp with the ACIS parameters will be made. This will be referred to later. It is therefore useful to review aspects of the mechanisms that have been described in the literature.

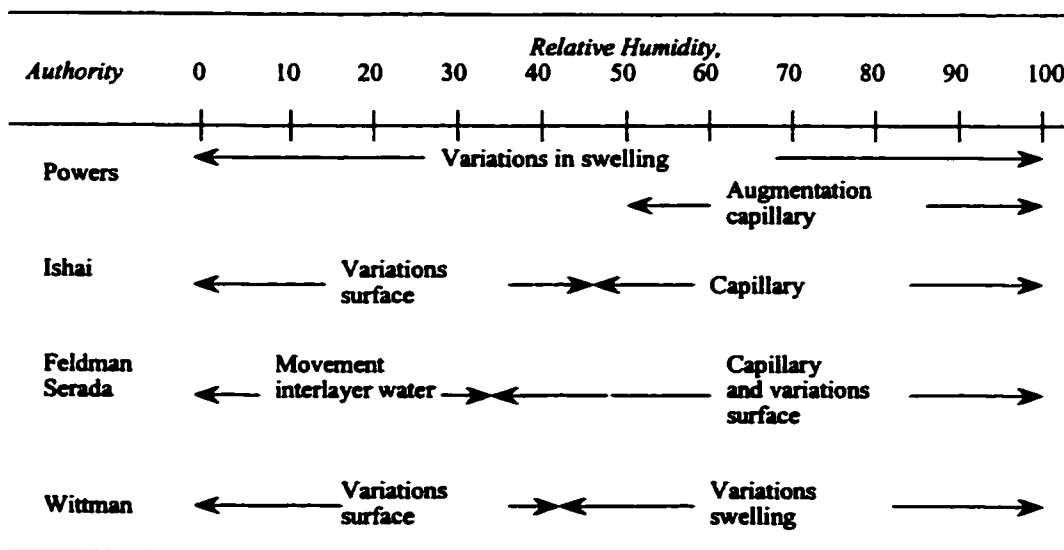


Figure 2.9 : Shrinkage Mechanisms.

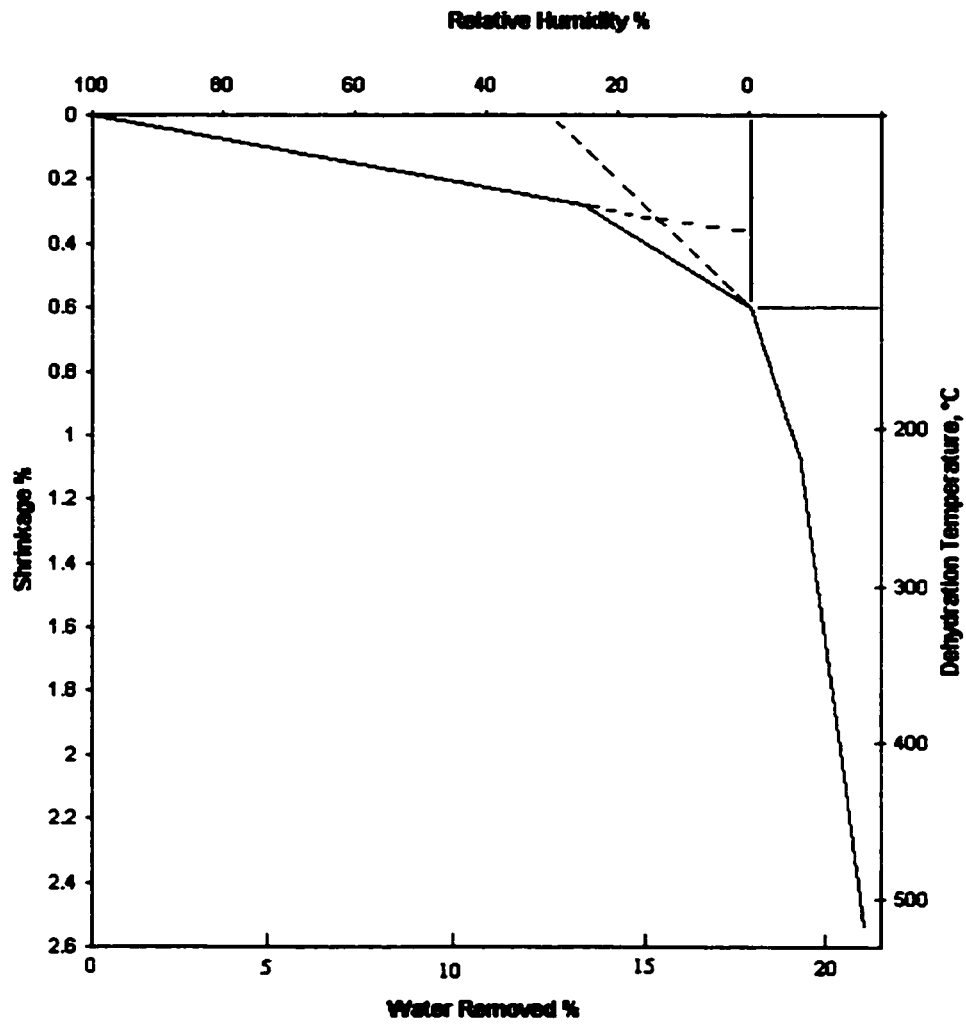


Figure 2.10: The variation of the first shrinkage of moist cured cement paste removed by drying in air and dehydration at elevated

2.3.1 Capillary Tension

Capillary tension is created in the pore water with the formation of a meniscus. This induces compressive forces to form in the cement paste causing a decrease in volume of the paste.

$$\ln\left(\frac{p}{p_0}\right) = \frac{2T}{R\theta\rho r}$$

Figure 2.11: Kelvin's Equation, where p is the vapour pressure, p_0 is the saturation vapour pressure over a plane surface, T is the surface tension of the liquid, R is the gas constant, θ is the temperature in degrees kelvin, and ρ is the density of the liquid.

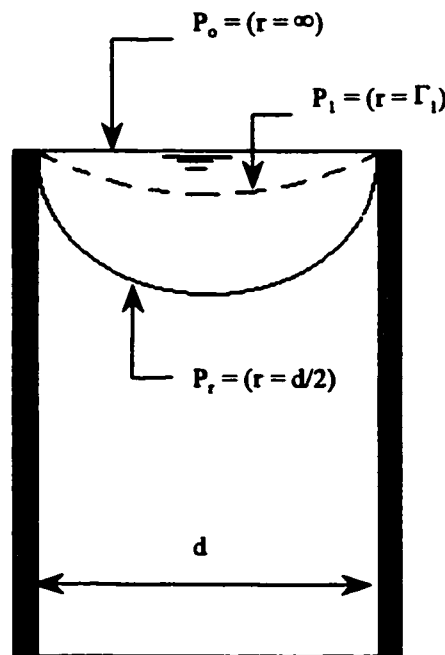


Figure 2.12: Relation between radius of curvature and vapour pressure.

A differential relative humidity between the cement paste and the environment forces water out of the cement paste. This action decreases the vapour pressure in the capillary pores, and water evaporates. Water will continue to evaporate until the vapour pressure in the capillary pore satisfies Kelvin's equation, see Figure 2.11. The action of water evaporating creates a meniscus in the water. The radius of curvature of the meniscus decreases as evaporation continues, see Figure 2.12 (Soroka, 1980). The minimum radius of curvature that would maintain the meniscus

is half the diameter of the pore. The meniscus disappears when the vapour pressure of the pore lowers below the corresponding radius of curvature and evaporation continues until the pore is empty. In accordance with Kelvin's equation, the water will evaporate from the larger pores first. The smaller the diameter of the pore, the lower the vapour pressure required for evaporation.

As the meniscus forms in the pore, tensile stresses result in the water. The tension in the water increases as the radius of curvature of the meniscus decreases. Since the water is in tension, compressive forces result in the cement paste to keep the system in equilibrium. When the meniscus disappears, there is a slight rebound in length followed by continued shortening as adsorbed water is removed. It is the compressive forces on the solid in the cement paste which cause a corresponding volume decrease, i.e. shrinkage. The modulus of elasticity of the cement paste affects the amount of shrinkage resulting from this mechanism. The higher the modulus of elasticity, the lower the amount of shrinkage.

Upon wetting, the pores refill and the stresses are relieved allowing the paste to swell. This mechanism would explain the coarsening effect that drying has on the pores of cement paste. This will be confirmed by the ACIS investigation. If the paste is in compression on all sides of the pore, the pore size would increase. Perhaps the strains enter the inelastic range of the cement paste and do not recover their original shape, leaving the pore enlarged.

This mechanism is the most prominent when the relative humidity is greater than about 40%. It explains why shrinkage is not completely described as a function of water loss. At the higher humidity ranges, the capillary pores are emptying according to size in decreasing order. There is a large amount of water loss from the large capillary pores without remarkable shrinkage. The smaller the pore, the greater the associated shrinkage.

2.3.2 *Surface Tension*

Solid surface tension in cement gel particles can induce a compressive stress of about 250 MPa. Volume changes occur when the surface tension changes. When the compressive stresses change, so does the surface tension.

Every molecule is repelled and attracted equally from all sides when it is located in the interior of a material. For a molecule located on the surface of a material, the forces of attraction and

repulsion are not symmetrical. Therefore, it is held more tightly by its neighbouring molecules. This causes the surface to naturally maintain itself in tension. When a water molecule is introduced into the system, it is adsorbed to the surface. This results in a redistribution of the forces in the surface layer of molecules. Some of the forces maintaining the surface tension are used to hold the water molecule to the surface. The reduced surface tension causes the material to swell due to elastic recovery. The reverse is also true. When a water molecule that was physically adsorbed by the surface evaporates, the surface tension increases and produces shrinkage.

This mechanism is only of secondary importance for explaining shrinkage of cement paste. Physically adsorbed water is the only water that will affect surface tension. Therefore, evaporation of the water from the pores will not induce shrinkage due to changes in surface tension until the last layer of water molecules are removed. The surface tension mechanism is only valid when $RH < 40\%$.

2.3.3 Disjoining Pressure

The disjoining pressure mechanism assumes that the thickness of an adsorbed layer varies with relative humidity. As the relative humidity increases, so does the interparticle separation. Therefore, the cement paste would shrink on drying and expand on wetting.

The maximum thickness of a layer of water molecules is about 0.35 nm. If the space between two particles of the cement paste is smaller than 0.7 nm, the width of two layers of water molecules, a disjoining pressure results. In other words, there is not enough room for water molecules to exist as they normally would, this is called hindered adsorption, see Figure 2.13 (Soroka, 1980). This pressure causes the cement paste to swell. The disjoining pressure increases with relative humidity and therefore swelling of the cement paste increases with moisture content.

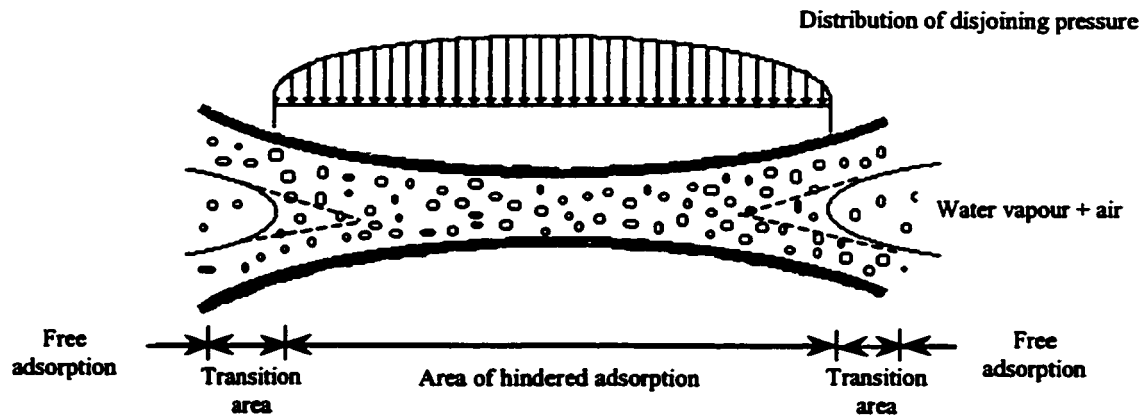


Figure 2.13: Areas of hindered adsorption.

2.3.4 Movement of Interlayer Water

It is generally agreed that the removal of interlayer water is the dominant mechanism governing shrinkage. This mechanism is predominant at relative humidities lower than 35%. It is due to the movement of interlayer water that the amount of shrinkage increases at low humidities. The amount of C-S-H also factors into this shrinkage mechanism. The more C-S-H layers existing in the paste, the more interlayer water there will be to remove, thereby increasing shrinkage. There are several conflicting theories concerning the re-entry of water into the interlayer spaces.

Some researchers believe that the total energy of the system is lowered as the particle spacing decreases when the water is removed. This means that water could not re-enter the interlayer spaces and the shrinkage would be irreversible.

Another theory proposes that water enter or exit the interlayer spaces as required. Irreversible shrinkage occurs because new bonds are formed when the gel particles approach one another. These bonds remain intact on wetting which restrict expansion.

2.3.5 Cycles of Drying-Rewetting

The behaviour of hcp subjected to cycles of drying-rewetting as indicated by shrinkage and swelling is illustrated in Figure 2.14 (Soroka, 1980). The first drying cycle results in reversible and irreversible shrinkage. Reversible shrinkage is recovered on rewetting while irreversible

shrinkage is permanent. With each subsequent cycle of drying-rewetting, the amount of shrinkage and swelling decrease. The dimensions of the hcp become increasingly stable with each cycle.

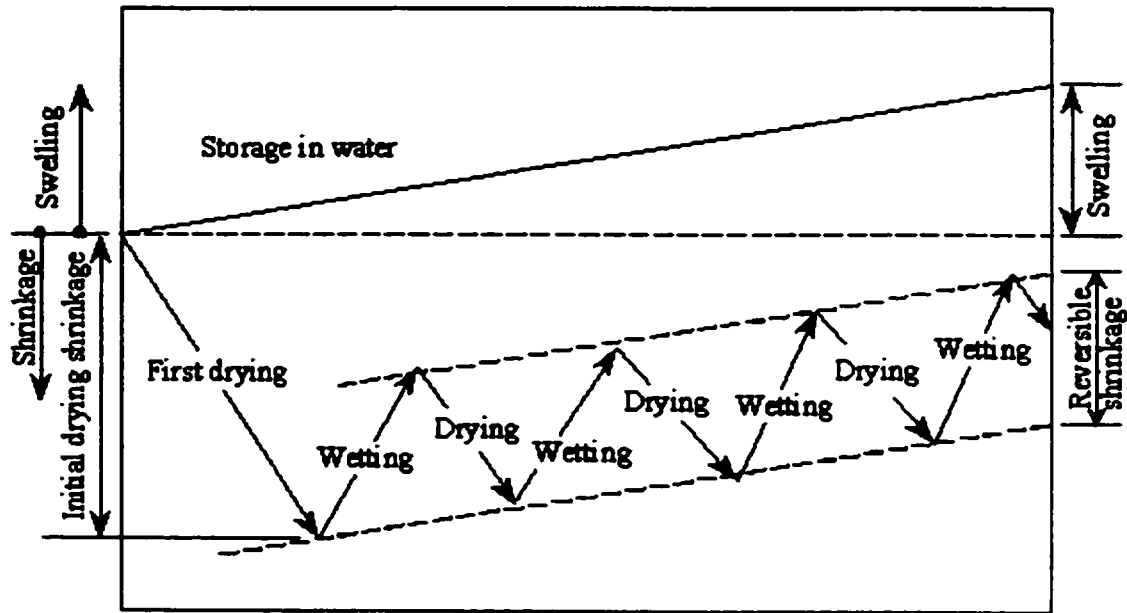


Figure 2.14: Schematic description of volume changes in cement paste due to alternate cycles of drying and wetting.

Pore coarsening resulting from drying-rewetting cycles attributed to a partial collapse of the structure resulting in the creation of larger pores (Marchand, 1993; Patel et al., 1988) has significant effects on the ice formation pattern of concrete (Miller et al., 1990). In a study of the effects of drying-rewetting cycles of the 50mm cover zone of concrete (McCarter et al., 1996), electrical methods were used to analyze the water and ionic penetration of the concrete cover zone. Results were influenced by the drying history of the concrete and the solution used for rewetting. The effects were readily apparent in the conductivity measurements.

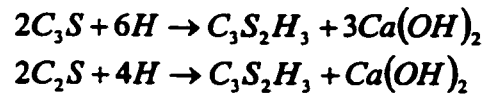
2.4 Structure of Hydrated Cement Paste

The physical structure of hydrated cement paste is very complicated. There are several theories outlined in the current literature such as: the Powers-Brunauer Model, the Feldman-Sereda

Model, and the Munich Model (Ramachandran et al., 1981). Common to all proposed models for the structure of hydrated cement paste is the importance given to the role of water in understanding the structure of hydrated cement.

2.4.1 Chemical Reactions of the Hydration of Cement

The constituents of cement clinker consist typically of about 67% CaO, 22% SiO₂, 5% Al₂O₃, 3% Fe₂O₃ and 3% other components. The cement (C₃S and C₂S are the primary cementing minerals) + water react to form hydration products, C-S-H, CH. There are lesser amounts of other hydrated phases including aluminates. The primary cement reactions are:



In the above reactions, the symbols C, S, and H (typical cement nomenclature) represent CaO, SiO₂ and H₂O respectively. The first hydration product indicated is usually referred to as C-S-H in which the dashes indicate that no particular composition is implied. It exists in a variety of compositions one of which is indicated in the reactions above. Calcium hydroxide (usually denoted as CH), the second hydration product, is usually in the form of large and brittle crystals that do not contribute to strength.

2.4.2 Plain Hydrated Cement Paste

Calcium silicate hydrate (C-S-H) is often referred to as a gel (and as tobermorite-like) due to its similarities to the mineral tobermorite. The composition of the C-S-H depends on the initial water:solid ratio and the degree of hydration. Common to all the models is the importance of the role of water in explaining the behaviour of hydrated cement. The concepts from 3 models on the structure of C-S-H are outlined below:

POWERS-BRUNAUER MODEL, (Ramachandran et al., 1981)

The Powers-Brunauer Model is based on the concept that C-S-H resembles tobermorite gel. The large surface area and closely spaced particles gives the C-S-H its strength through van der Waals' forces. Swelling and shrinkage is explained through the movement of layers of waters in and out of the structure. Other specifics include:

- Specific surface area $\sim 180\text{m}^2/\text{g}$
- Minimum porosity of 28%
- Solid to solid distance $\sim 180\text{ nm}$
- Diameter of particles $\sim 1000\text{ nm}$
- Gel pores only accessible to water, entrances $< 40\text{ nm}$
- Any space not filled with gel is capillary space
- Particles held together by van der Waals' forces
- Creep is the result of water squeezed out due to the application of stress

FELDMAN-SEREDA MODEL, (Ramachandran et al., 1981)

The C-S-H is theorized to be a poorly crystallized version of a layered silicate in the Feldman-Sereda Model. Strength is achieved through van der Waals' forces, siloxane, hydrogen and calcium-silica bonds. Water plays an intricate role in the structure of C-S-H. The interlayer water is considered a part of the structure and contributes to the rigidity of the system. Water molecules are physically adsorbed on the surface and form hydrogen bonds with the free surface. Swelling is the result of a combination of a reduction of the surface energy and menisci effects with the introduction of water to the system in addition to the penetration of water molecules between the layers. Additional information includes:

- structural water is not considered pore water
- gel pores are considered a manifestation of interlayer spaces
- surface area $\sim 40\text{-}80\text{ m}^2/\text{g}$ (equivalent to that obtained by N_2 adsorption)

Creep:

- Manifestation of aging
- Lower surface energy by aggregation of sheets due to the formation of more layers, accelerated by stress and water

- Surface area is reduced

MUNICH MODEL, (Ramachandran et al., 1981)

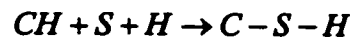
The Munich Model focuses on the explanation of mechanical properties, swelling and strength.

The main concepts include:

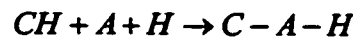
- $2\% < RH < 42\%$: volume changes are due to free surface energy changes
- $42\% RH$: volume changes are due to disjoining pressures
- decrease of strength on wetting is due to a decrease in surface energy

2.4.3 Cements with Fly Ash

Fly ash is a by-product from the generation of electricity. It is produced by the combustion of finely ground coal, injected with a stream of air into a furnace. The $1500^{\circ}C$ temperature in the furnace quickly burns the carbonaceous content of coal and melts the inorganic material, shale and clay (essentially consisting of silica, alumina, and iron oxide). Fine spherical particles form from these materials after a rapid cooling. This material is collected and called fly ash because it gets carried out of the furnace with flue gases. Consider the following reactions:



or



The CH, that results from the initial reaction between water and cement clinker, reacts with the fly ash (either S or A) and water to form a cementitious product, either C-S-H or calcium aluminate hydrate (C-A-H). The Pozzolanic reaction is lime consuming instead of lime producing. The resulting cement binder has a refined pore structure, grain size and transition zone, that leads to a reduction of permeability by 1 – 3 orders of magnitude. CH will nucleate around the smaller fly ash particles which will generate numerous smaller and less-oriented crystals of CH instead of large oriented ones. This leads to a more homogeneous microstructure and a denser transition zone with the aggregates (Gu et al., 1993; Christensen et al., 1992).

Fly ash is rated as a pozzolan through the Pozzolanic Activity Index. This index indicates a pozzolan's ability to react with CH to produce C-S-H and is a function of the crystal structure, particle size, shape and texture.

Advantages associated with the use of Fly Ash

- Lower heat of hydration
- Increased strengths
- Reduced permeability
- Decreased amount of cement (economical and environmental)
- Improved workability
- Reduced bleeding due to increased tortuosity of flow channels

Disadvantages associated with the use of Fly Ash

- Increased sensitivity to curing
- Reduction in CH lowers alkalinity of the pore water which may be a factor in the corrosion of reinforcing steel
- Increased drying shrinkage (due to more C-S-H)

2.5 Dielectrics

A material with the ability to electrically insulate is referred to as a dielectric (*substances with no free charges*). The effectiveness of a dielectric is quantified by the dielectric constant, $\kappa = C/C_0$, the ratio of the capacitance of a capacitor containing the dielectric to the capacitance of the capacitor in a vacuum. The ability of a capacitor to store opposite charges on each plate (*the capacitance*) is always increased with the presence of a dielectric. The molecules of the dielectric become polarized within the presence of the electric field which reduces the electric field and the voltage between the electrodes, which increases the capacitance.

Permittivity, ϵ , is a proportionality constant that is used to evaluate the increased capacitance that results from the presence of a dielectric material within the capacitor. The relative permittivity, or dielectric constant, of a dielectric material is directly related to its capacitance, $\epsilon_r = \epsilon/\epsilon_0 = Cd/\epsilon_0 S$, (ϵ_r : relative permittivity, ϵ_0 : permittivity of a vacuum, C: capacitance, d: thickness of the dielectric, S: surface area of the electrodes).

2.5.1 Electrode Polarization Effects

Electrode polarization effects result from the existence of an electrochemical double layer at the interface between the electrode and the sample. Oppositely charged particles attract one another and gather together at the surface of each substance and a diffuse layer of ions further out. The electrostatic attraction between the two opposite and separated charges causes an electrical field to be established across the interface. This electric field could be creating the high permittivities that are being observed.

2.5.2 Bulk Polarization Effects

Bulk polarization effects will be present if the current is stopped at the boundaries to the insulating matrix resulting in a charge build up. This causes a reduction in the electric field or a change of direction of the field parallel to the conducting channels. The amount of polarization is dependent on frequency. The lower the frequency, the more time there is for the charges to build up and reduce the electric field, the higher the permittivity. The more complex the structure, the higher the permittivity (dielectric constant).

2.5.3 Dielectric Amplification

Previous studies investigating the high permittivities of salt water saturated porous glass and natural and artificial rock samples discussed the significance of the Electrode and Bulk Polarization Effects on the high permittivities (Brouers et al., 1987; Nost et al., 1992; Nettelblad and Niklasson, 1994). These researchers all concluded that Bulk Polarization Effects were dominating the low frequency high permittivities and Electrode Polarization Effects were not significant. As well, the dielectric properties of hydrated cement paste have also been studied (Olson et al., 1995; Ford et al., 1997; Zhang et al., 1996a and 1996b). Relationships between cement hydration and w/c ratio with dielectric properties have been documented.

Brouers, Ramsamugh and Dixit, 1987, studied Al_2O_3 ceramic samples saturated with different brine solutions and observed large values of $\epsilon'(0)$ at low frequencies. The dielectric constants were found to increase with porosity but were independent of salinity. ϵ' at 10^6 Hz was greater than 10. They concluded that the high dielectric constants at low frequencies were due largely to the geometry of dead-ends and microchannels of the microstructure of the material. They

hypothesized that if the material contains pores or clusters of well interconnected pores which are connected by only a narrow neck to the backbone of pores, this can give relatively large regions of conducting phases surrounded by an insulating coating of grains.

Nettelblad and Niklasson, 1994, investigated high dielectric constants of natural and artificial rock samples. They performed tests on natural sandstones from Lemunda (low clay content and SiO_2 as the main constituent) and sand or glass beads that were glued together with epoxy (following the Grain Consolidation Model). The high permittivities were concluded to originate from bulk effects because the permittivity values did not vary with the thickness of the specimen. In addition, experimental results agreed with calculations from the Grain Consolidation Model which includes an electrochemical double-layer at the surfaces of the grains.

Nøst, Hansen and Haslund, 1992, conducted tests on salt water saturated porous glass. Their dielectric dispersion curves showed that at the lowest frequencies, ϵ increases, which was concluded to be due to the contact impedance caused by the polarization between the electrode and the electrolyte. Using the equivalent circuit of a specimen with electrode polarization, the critical frequency at which the contact impedance significantly affects the measured dispersion was determined. For the samples tested, it was determined that contact impedance was not a significant factor.

Cement paste has also been documented to exhibit large dielectric values at early ages (Olson et al., 1995; Ford et al., 1997). The large values have been attributed to dielectric amplification resulting from the microstructure of the pastes, both capillary pores and C-S-H contributing. These theories are being debated in the literature. Other researchers (Alonso et al., 1998) have reported reasonable values for the dielectric constants of saturated cement pastes. The experimental data was collected on specimens of saturated cement pastes that were insulated from the electrodes by mylar sheets. This method of testing effectively eliminates the double-layer effect at the electrode/paste interface. The observed dielectric amplification of saturated cement paste would not result from the microstructure of the paste but from the double-layer effect of the electrode/paste interface.

CHAPTER 3

EXPERIMENTAL PROCEDURE, INSTRUMENTATION AND CALCULATIONS

3.1 Introduction

This chapter will focus on the experimental procedures and processes that were used to collect and format the data presented in this thesis.

3.2 Drying-Rewetting Experiments

3.2.1 Preparation of the Test Specimens

The specimens tested in the drying-rewetting experiments consisted of hydrated cement pastes prepared with w/c ratios between 0.25 and 1.00. The pastes were mixed using Type 10 cement under a vacuum and placed in long cylindrical tubes 38 mm in diameter and 200 mm long. Stoppers were used to close each end. Demoulding took place the day following mixing.

Storage of the pastes hydrated for 30 years was in latex covers with a small amount of saturated calcium hydroxide solution. The latex encased pastes were then sealed within plastic tubes and placed in storage for over 30 years. The pastes tested after 14 days of hydration were stored in a solution of saturated calcium hydroxide for 14 days.

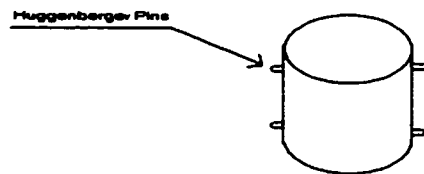


Figure 3.1: Drying-Rewetting Specimen with Huggenberger Pins

The test specimens were cut into 25 mm long segments using a precision saw and water. Then 4 holes were drilled into each segment to accommodate the Huggenberger reference pins, (for length change measurements see Figure 3.1). Non-expansive epoxy was used to solidify the pins into the drilled spaces of each specimen. The epoxy was allowed to cure in a 100% RH environment for a minimum of 72 hours.

3.2.2 *Drying-Rewetting Cycles*

Each test specimen was subjected to four cycles of drying and rewetting. The drying portion of each cycle consisted of vacuum drying the specimen at a temperature of 38°C for a period of 24 hours. This gentle drying method was chosen so that cracking would be minimized.

Rewetting of the specimen consisted of evacuating the air within the specimens in a vacuum for three hours and then completely covering the specimens in solution for 18 hours while still under a vacuum. During this time the solution was being stirred for a period of one minute per hour with a magnetic stirrer.

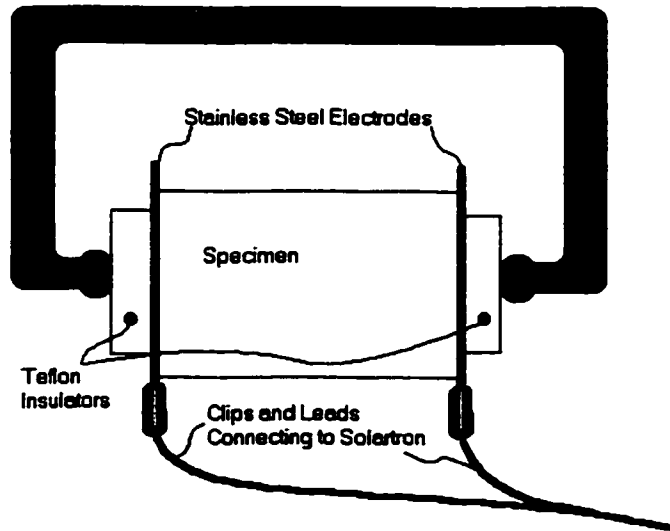


Figure 3.2: Connecting Drying-Rewetting Specimen to Solartron

Prior to beginning the drying-rewetting cycles, initial measurements were recorded. These included: mass (with an electronic scale), length and diameter (with electronic calipers), Huggenberger length change measurements (distance between the Huggenberger pins) and

impedance spectra (with a 1260 Solartron Phase-Gain Analyzer). Length change measurements and mass measurements were recorded twice per cycle, once after drying and again after the rewetting portion of the cycle. An AC Impedance spectrum was obtained after each rewetting. Stainless steel electrodes were clamped to either end of the specimen to provide a connection between the 1260 Solartron Phase-Gain Analyzer for the impedance measurements, (see Figure 3.2). The settings used for the impedance tests are in Table 3.1.

SETUP		
Experimental Type	Sweep Frequency	Control Voltage
Sweep	Initial Frequency (Ω)	5000000
	Final Frequency (Ω)	100
	Logarithmic	Step/Decade
	Type	
Generator	Interval	10
	Monitor	VI
	Generator BIAS (V)	0
	Target Amplitude (V)	0.1
	Generator Amplitude Limit (V)	3
	Error Limit (%)	10

Table 3.1: Drying- Rewetting Experiment Settings for Solartron

3.2.3 Rewetting Solutions

Three different solutions were used to resaturate the pastes on rewetting. They included: distilled water, saturated calcium hydroxide solution, and a synthetic pore solution. The synthetic pore solution was created to match the resistivity of the pastes' natural pore water. Pore water from similar pastes of each of the test specimens was expressed. The resistivity of the expressed pore water was measured using an LCR meter. Potassium chloride was added to a saturated calcium hydroxide solution until the desired resistivity was achieved for the synthetic pore solution. Table 3.2 lists the resistivities of the resaturation solutions used in the drying-rewetting experiments.

w/c	ρ (Ωcm)
0.25	19.1
0.30	25.7
0.40	31.2
0.80	46.3
1.00	55.5

Table 3.2: Resistivities of Pore Solution (Sampling Rate is 10 kHz)

3.3 Freezing-Thawing Experiments

3.3.1 *Experimental Procedure*

Hcp was carefully monitored in the temperature range of -80°C to $+20^{\circ}\text{C}$. Analyses of hcp specimens hydrated for 1, 7, and 28 days were made using specimens specially fabricated for the simultaneous measurement of length change and ACIS parameters. The specimens included: pastes made with Type 10 cement, additions of fly ash, and air entraining agents. The effects of different pore solutions contained within the samples was studied. These included: natural, 5%, 10%, 15% NaCl solutions. TGA and DSC tests were conducted on all pastes to characterize them and determine the amount of freezable water.

The test specimens were inserted into the DuPont TMA apparatus in a saturated surface dry condition. The wires connected to the electrodes were carefully placed so that they would extend outside the cold finger and yet would not interfere with it.

The following outlines the procedures and associated temperature variations of each test:

1. Isothermal at $+5^{\circ}\text{C}$ for 10 minutes. ACIS measurements were started once the sample was isothermal.
2. Decrease temperature by $2^{\circ}\text{C}/\text{minute}$ to a minimum of -80°C .
3. Isothermal at -80°C for 10 minutes.
4. Increase temperature by $2^{\circ}\text{C}/\text{minute}$ to a maximum of $+20^{\circ}\text{C}$
5. Isothermal at $+20^{\circ}\text{C}$ for 5 minutes.

Each test was 114.5 minutes in duration. Several measurements of length were taken per minute and one impedance spectrum every 50 seconds.

The raw data collected by the Solartron 1260 Gain-Phase Analyzer is then fit to an equivalent circuit using the ZView software. Each impedance spectrum is fit to a corresponding equivalent circuit in which the sample resistance and phi (the dispersion angle parameter) is obtained, refer to Appendix A for the tabulation of these values. For each test there is over 130 impedance spectra and their corresponding equivalent circuits.

3.3.2 Sample Preparation: Method 1

The test specimens were designed so that ACIS measurements as well as length change measurements could be taken simultaneously. Cement paste specimens were cast in 8 mm diameter cylinders 13 mm long. The small cylinder size was selected so that the specimens would freeze completely and would fit into the DuPont TMA apparatus. Stainless steel electrodes were cast in place at either end of the sample with approximately 2 mm cover, see Figure 3.3. Silver wires were soldered onto the electrodes and used to connect the specimen to the Solartron 1260.

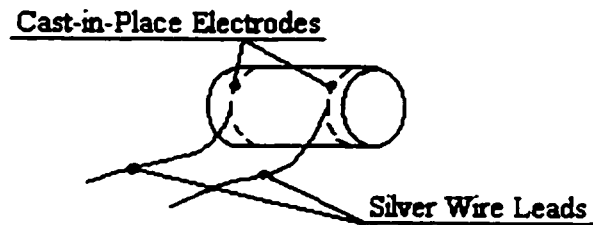


Figure 3.3: Specimens with Cast-in-Place Electrodes

The stainless steel electrodes were positioned during placement of the cement paste by notching out the ends of the cylinder and securing the electrode in place with hot wax, see Figure 3.4. The cement paste was placed into the mould in two steps. After each step the specimen was tamped many times to bring any air bubbles to the surface. The top electrode was then placed and secured with hot wax and a cover. Specimens with $w/c = 0.60$ were rolled for the first 24 hours to minimize bleeding of the water.

The specimens were demoulded the day following casting. They were wet cured in saturated calcium hydroxide solution for the desired hydration period.

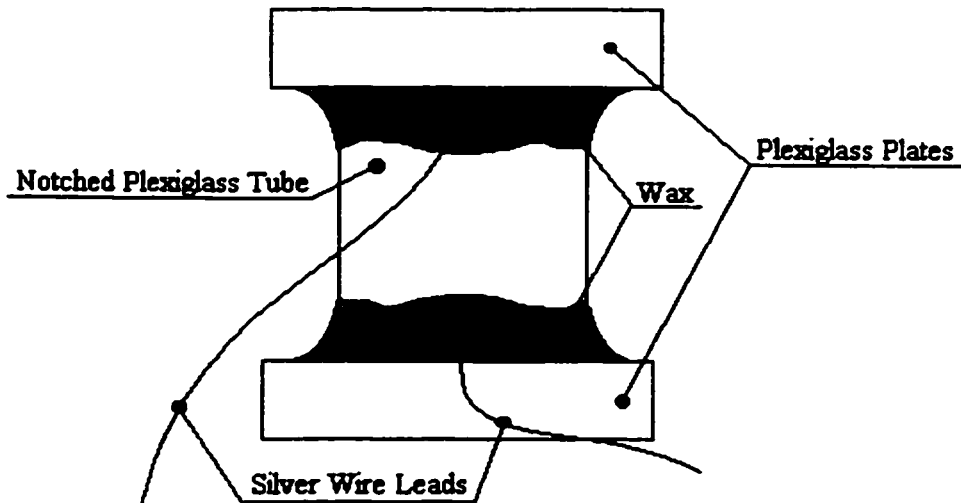


Figure 3.4: Casting the Specimens

3.3.3 Sample Preparation: Method 2

Tests were conducted on mortar and cement paste samples that contained fly ash from three different fly ash sources. The mix designs are displayed in Tables 3.3a and 3.3b. A w/c ratio of 0.40 was used for both the pastes and mortars. The samples tested after nine months hydration were prepared in batches mixed under a vacuum and cast into 4 x 8 inch cylinders. They were demoulded the next day and cured in saturated calcium hydroxide solution for nine months.

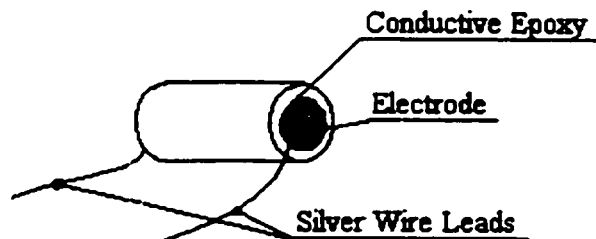


Figure 3.5: Attaching Electrodes with Conductive Epoxy

The cylinders were sliced into 13 mm thick disks with a wet saw. Then 10 mm diameter cores were drilled from the disks. Electrodes were attached to each end of the resulting cylinders using conductive epoxy, see Figure 3.5. The samples were kept at 100% humidity while the epoxy cured for a minimum of 24 hours.

Specimens Hydrated for 9 Months

	Cement (kg/m ³)	Fly Ash (kg/m ³)	Water (kg/m ³)	Sand (kg/m ³)	Water Reducer (kg/m ³)
Pastes:					
Plain	1305	0	523	0	2610
Melligan	1020	255	505	0	2040
Portage	1027	257	514	0	2054
Sundance	1000	250	500	0	2000
Mortar:					
Plain	645	0	260	1255	1290
Melligan	505	126	254	1247	1010
Portage	510	128	255	1255	1020
Sundance	503	126	252	1238	1006

Table 3.3a: Mix Designs for Specimens Hydrated for 9 Months

Specimens Hydrated for 7 Days

	Cement (kg/m ³)	Fly Ash (kg/m ³)	Water (kg/m ³)	Sand (kg/m ³)	Water Reducer (kg/m ³)
Pastes:					
Plain	1364	0	545	0	2728
Melligan	1058	265	529	0	2116
Portage	1073	268	536	0	2146
Sundance	1044	261	522	0	2088
Mortar:					
Plain	665	0	266	1330	1330
Melligan	532	133	266	1292	1064
Portage	532	133	266	1308	1064
Sundance	532	133	266	1274	1064

Table 3.3b: Mix Designs for Specimens Hydrated for 7 Days

3.4 Ring-Disc Electrode Experiments

3.4.1 *Experimental Procedure*

The use of ring-disc electrodes would allow for the evaluation of concrete surfaces in situ. A set of experiments were designed to give an indication on future applications using ring-disc electrodes as well as provide insight for developing the next phase of experiments.

Experiments were conducted on three sets of samples. The first two samples consisted of hydrated cement paste with a w/c ratio of 0.30 and mortar with a w/c ratio of 0.45. The last sample was prepared with a cement paste base (0.30 w/c ratio) with a 1 cm overlay of the 0.45 w/c ratio mortar. The specimens were box shaped with the dimensions 30 cm x 30 cm x 8 cm high. Type 10 portland cement and distilled water were used in the mixes. Demoulding occurred the day following mixing with moist curing for a minimum of 28 days.

A.C. impedance spectra were measured for all the samples using the ring-disc electrodes and the Solartron Gain-Phase Analyzer. Filter paper was cut to match the outline of the ring and disc portions of the electrodes. It was saturated with tap water and placed in between the electrode and the specimen to ensure a good contact surface between the two elements. Weights were used to keep the ring-disc electrodes in place on the surface of the specimens. Care was taken to keep the weights isolated from the electrical current.

3.5 Dielectric Experiments

3.5.1 *Sample Preparation*

The hydrated cement pastes that were tested had w/c ratios of 0.25, 0.50, 0.80 and 1.00 measured by weight. The cement used was Type 10, portland cement. Each mix was mixed under a vacuum and cast into tubes 31 mm in diameter and approximately 200 mm in length. Each end was sealed with a stopper. The 0.80 and 1.00 w/c ratio pastes were rolled for 24 hours to minimize bleeding of the mix water. The specimens were demoulded the day following casting and kept in saturated calcium hydroxide solution and allowed to hydrate for an average of 30 years.

The specimens were sliced into disks with thickness of 5, 10, and 15 mm using a wet saw. When not in use the specimens were kept at 100% RH in a dessicator.

A set of specimens were resaturated with a pore solution similar in composition to the natural pore solution of the paste but with a different conductivity. This synthetic pore solution consisted of saturated calcium hydroxide solution with enough potassium chloride added to obtain the desired conductivity of the solution. Resaturation of the pastes consisted of drying and resaturation. Drying was achieved under a vacuum at 38°C for 24 hours. The pastes were then vacuum saturated for a minimum of 18 hours.

The vycor glass samples were vacuum saturated for a minimum of 18 hours with 3 different salt solutions. NaCl was mixed with water until the following conductivities were achieved: 16.76, 6.28, 0.621 s/m.

3.5.2 Testing Procedure

Stainless steel plates were clamped to either end of each specimen and used as electrodes. The Chelsea-Dielectric was connected to the sample through the stainless steel plates. Measurements were taken at a frequency of 100 Hz with a voltage of 0.05 V applied to the specimen.

For tests including teflon, the teflon sheets were inserted between the specimen and the electrodes at either end.

3.6 A.C. Impedance Spectroscopy: Instrumentation and Statistical Analysis

3.6.1 Solartron Setup

The setup used to control the electrical current applied to each specimen for all the experiments is outlined in Table 3.4. The drying-rewetting experiments used setup B with all others using setup A.

SETUP		A	B
Experimental Type	Sweep Frequency	Control Voltage	Control Voltage
Sweep	Initial Frequency (Ω)	5000000	5000000
	Final Frequency (Ω)	100	100
	Logarithmic Type	Step/Decade	Step/Decade
	Interval	6	10
Generator	Monitor	V1	V1
	Generator BIAS (V)	0	0
	Target Amplitude (V)	0.05	0.1
	Generator Amplitude Limit (V)	3	3
	Error Limit (%)	10	10

Table 3.4 – Solartron Setups

3.6.2 Initial Fitting Parameters for the Equivalent Circuit

Included in the Z60 software program used to measure and collect the impedance spectra of the hydrated cement paste samples is an equivalent circuits option. It uses a complex nonlinear least squares immittance fitting program to find an equivalent circuit associated with the data collected. When the sample being tested has very large impedances that approach the capacity of the testing machine (Schlumberger 1260 Gain-Phase Analyzer), the Equivalent Circuits option becomes very sensitive to the initial fitting parameters selected. The errors contained in the suggested equivalent circuit by the fitting program when inappropriate initial parameters are selected can be in the order of 10^{25} .

R_1	R_2	C_1	Percent Error (A)	Percent Error (B)
1	1	1	$6.00 * 10^4$	679
1	2	3	$9.58 * 10^5$	$1.07 * 10^9$
1	3	2	17 $\Leftarrow$	16.8 $\Leftarrow$
2	1	2	$1.80 * 10^5$	$3.03 * 10^5$
2	2	1	$3.05 * 10^4$	4645
2	3	3	$8.80 * 10^5$	$1.20 * 10^9$
3	1	3	$8.70 * 10^{25}$	$3.51 * 10^4$
3	2	2	17 $\Leftarrow$	16.8 $\Leftarrow$
3	3	1	17 $\Leftarrow$	16.8 $\Leftarrow$

Table 3.5: Percent Error of the Equivalent Circuit Based on Initial Parameters.

To better understand the effect of the initial fitting parameters on the equivalent circuit being output, a fraction factorial experiment was conducted. Three levels of each parameter were tested in the combinations listed in Table 3.5. Level 1 represents low values for the parameters (default settings), level 2 were the 'real' settings, and level 3 tested high settings (1000 times the real values). The variables listed in Table 3.5 represent the circuit illustrated in Figure 3.6.

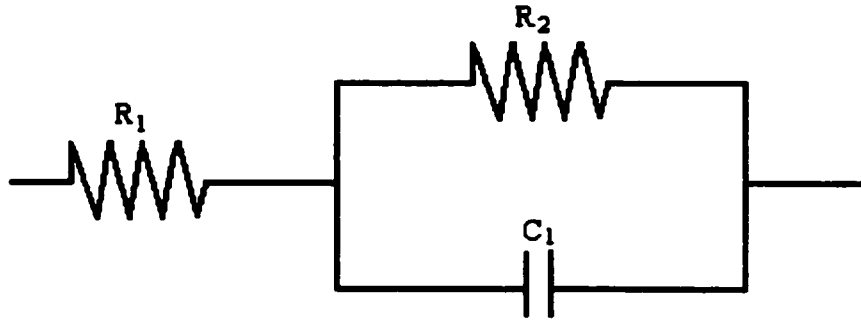


Figure 3.6: Equivalent Circuit

R_1	R_2	C_1	Percent Error (A)	Percent Error (B)
1	3	1	17	16.8
2	3	1	17	16.8
1	2	2	17	16.8
2	3	2	17	16.8
3	3	2	17	16.8

Table 3.6: Percent Error of the Equivalent Circuit Based on Initial Parameters.

The analysis of the results from the tests conducted changing the initial parameters was straight forward. Because there is not a linear relationship between the percent errors and the initial parameters an optimization procedure could not be employed. As well, means and variances of the results were not calculated because the percent errors were either very large or the actual accepted values meaning the equivalent circuit was either right or wrong. It is apparent that the parameter combinations marked with an arrow in Table 3.5 result in the 'real' equivalent circuit. It can also be noticed that the parameter R_1 has no significant effect on the resulting percent error. Not one of the three combinations where R_1 has the 'real' values selected, level 2, does the

program produce the 'real' equivalent circuit. It would appear that large values for the parameters give accurate results. To further test this theory, an other set of tests were run with different interactions between parameters with emphasis on the level 2 and level 3 settings, see Table 3.6.

The results in Table 3.6 support the assumption stated above that the value of R_1 in the initial parameter values does influence the equivalent circuit outcome and that the initial values of R_2 and C_1 should be assumed to be relatively large to make the fitting of the equivalent circuit more efficient.

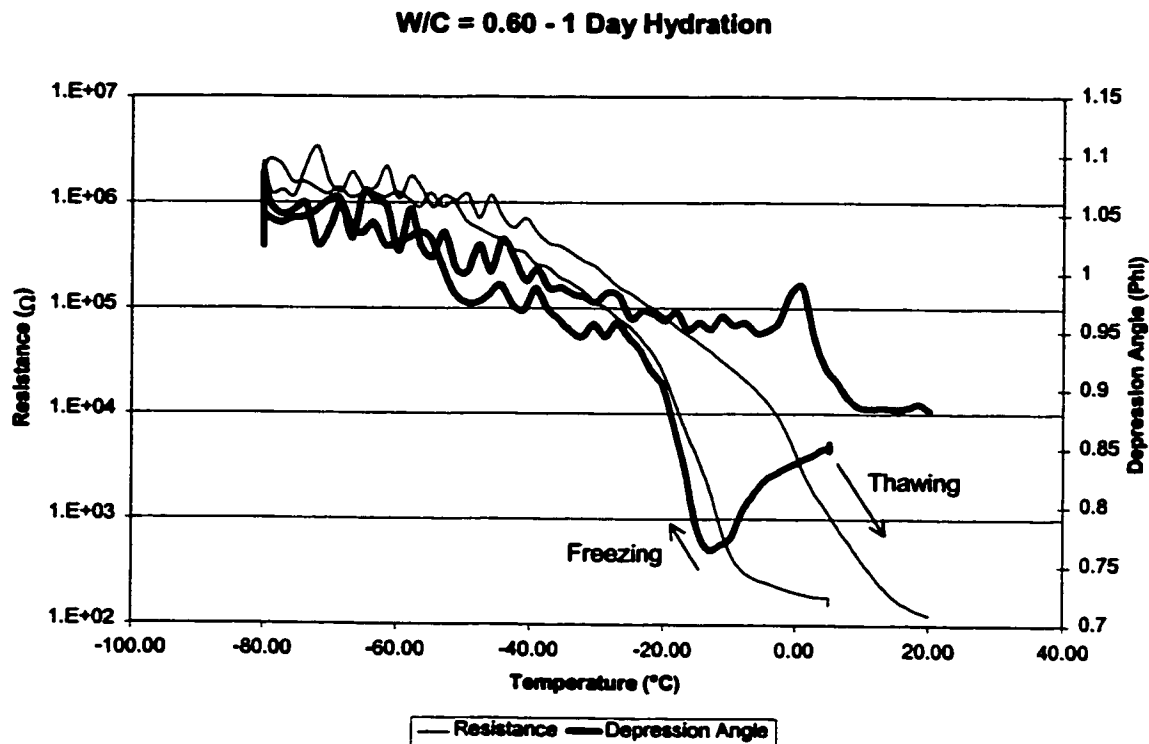
3.6.3 *Evaluating the Freezing-Thawing Data*

The raw data that was collected from the Solartron 1260 Gain/Phase Analyzer was fit to an equivalent circuit using ZView software as previously discussed. The allowed error used for fitting the electrical variables was 20%. The individual error of the resistance values and the phi value of the constant phase element was usually within 10%. It was the error for the capacitance values that could be as high as 30% that increased the overall percent error for the entire circuit. Due to the nature of electrochemical tests, a 20% error is within the accepted limits for these types of tests. The fitted circuits obtained are consistent and do correlate with the results from the other more established tests for cement paste such as TMA and DSC. It is felt that the ACIS results are reliable.

A graphical representation of the data was acquired by plotting the temperature in ° Celsius on the x-axis and the resistance, R_2 , on the y-axis, see Graph 3.1. In general, the resistance increases with decreasing temperature and decreases with increasing temperature. Because the resistance of the cement paste on freezing goes through several decades, it is best represented on a semi-log graph, as previously discussed. Temperature versus resistance has a linear relationship when plotted on a semi-log graph. As freezing progresses, the slope of the curve changes. The greater the effect on freezing, the greater the slope of the resistance-temperature curve. Hysteresis is also apparent between the freezing and thawing curves. It is caused by damage to the pore structure and pore water thawing at a higher temperature than it freezes.

In combination with the resistance-temperature curve, the phi (ϕ)-temperature curve supplements the information that can be acquired from ACIS. Plotting phi versus temperature on a secondary

axis of the resistance graph gives more information on the behaviour of the pore water on freezing, see Graph 3.1. In general, on freezing ϕ decreases to a minimum value and then increases to approach one as freezing continues. On thawing it follows the shape of the freezing curve with a hysteresis effect. The movement of the pore water on freezing can be followed with the ϕ -temperature curve.



Graph 3.1: ACIS Parameters with Temperature Variations

Evaluation of both the resistance and ϕ curves in unison gives a more complete picture of the behaviour of the specimen on freezing. An increase in the slope of the resistance-temperature curve on freezing corresponds with a decrease in the ϕ -temperature slope. Thawing has the reverse effect on the two curves.

3.6.3.1 Terms and Definitions

Many terms will be used throughout the discussion of the results. The definitions of these terms are as follows:

- Effective Freezing Resistance, R_{ef} : $R_{@ -40^{\circ}\text{C}} - R_{if}$
- Blocking Temperature, T_b : Temperature at which ϕ reaches a minimum on freezing.

- Incipient Freezing Temperature, T_{if} : Temperature at which freezing of the pore water begins
- Incipient Freezing Resistance, R_{if} : Resistance at T_{if} .

3.6.3.2 Conclusions of the Statistical Analysis

Assume large values for the initial parameters when fitting an equivalent circuit. There is a definite relationship between L_1 and d_{be} though the exact function is uncertain. Variation of d_{be} is within acceptable limits and correction of resistance values is not necessary. There is a strong semi-lognormal relationship between resistance and low temperatures of cement paste which varies depending on the freezing process of the paste (range of temperature).

3.6.4 *Calculating ϵ_r*

The chelsea dielectric testing apparatus measures the relative permittivity of a material directly, with the cross sectional area and the material thickness given. Experiments using the teflon sheets in between the sample and the electrodes requires a calculation to quantify the permittivity of the test material alone. The following equation was used to do this:

$$\epsilon_g = \frac{d_g \epsilon_T \epsilon_t}{d_T \epsilon_t - d_t \epsilon_T}$$

ϵ : relative permittivity

d : thickness of material

subscripts

T: teflon + material

t: teflon alone

g: test material

3.6.5 *Normalized Resistance*

In order to accurately assess the behaviour of the hcp on environmental changes, the data was frequently normalized. This also aided in comparing different pore structures between w/c ratios and to bring values to a base level. Normalized data in this thesis was calculated by dividing the R_2 (from the equivalent circuit) of the sample throughout the environmental changes, by the initial R_2 value before testing.

3.6.6 Analysis of Specimen Measurements

It is very important to know the distance between the electrodes when taking impedance measurements. This distance is directly related to impedance and comparisons of impedance results as an indicator of pore structure is only valid when the distance between the electrodes, d_{be} , is the same. To directly measure the d_{be} of the cement samples used in the experiment, it was necessary to break open the specimen. This method was very cumbersome so it was desired to find a relationship between the total length of the specimen (L_t) and the d_{be} . The measurement L_t was much easier to take directly, and using that value the d_{be} could be estimated.

Total length and the distance between the electrodes were measured for 43 different samples. The normal distribution is most often used to explain the errors of measurement. Both sets of data collected, L_t and d_{be} , followed a normal distribution with normal probability plot correlations of 0.996 and 0.969 respectively. No other types of distributions were considered given the nature of the data (measurements) and the high correlation of normal probability plots.

Using the method of least squares, a straight line was fit to the data for L_t and d_{be} . With a coefficient of correlation of 0.563, the equation of the line was calculated to be $d_{be}=0.80*L_t-0.21$. Using the Fisher Z transformation, and the null hypothesis of $\rho=0$, a relationship was found between L_t and d_{be} . With a 95% confidence interval of $0.319<\rho<0.738$. This being such a large interval and the low coefficient of correlation, a check for outliers was conducted. No outliers were detected for either of the two sets of data.

Four outliers were identified, however, for the set of data representing the combined depth of the two electrodes within the sample, d . These numbers were calculated by $L_t - d_{be}$. Eliminating the four sets of data from the regression analysis yielded a stronger value for the coefficient of correlation, 0.744 with a sample size of 39. The equation of the best fit line was determined to be $d_{be}=0.963*L_t-2.527$. Again the null hypothesis of $\rho=0$ was rejected using the Fisher Z transformation and the 95% confidence interval was calculated to be $0.560<\rho<0.858$.

Considering the basis for eliminating the outliers as described above, it is not assured that outliers will be detected in the future. Therefore, both of the relationships determined between L_t and d_{be} give accurate information. Though a better estimate for the population correlation would be

0.560 < ρ < 0.738. The lower boundary calculated without the outliers and the upper boundary calculated with outliers.

The coefficient of variation was calculated to be 3.4% and 6.1% for L_t and d_{be} respectively. Therefore, no correction of impedance values to account for a variance in d_{be} between samples is necessary.

3.6.7 Measured Drying on Testing

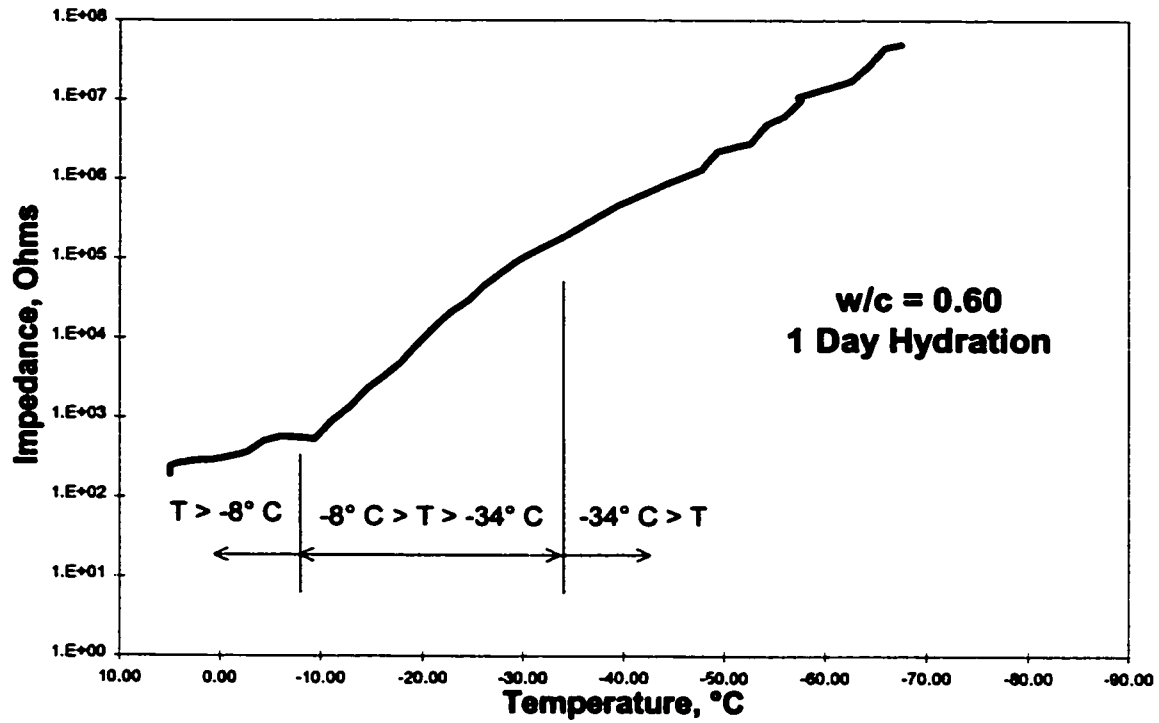
Drying of the test specimen subjected to freezing-thawing was evaluated. The mass prior to testing and immediately following the completion of the test was measured. As well, the electrodes were removed from the specimen to obtain their mass. The average loss of mass of the paste was 3.2% and 2.2% for the 0.60 and 0.35 w/c ratios respectively. This loss of mass is due to a small amount of pore water evaporating from the paste. This could not be prevented and was estimated to represent less than 10% of the evaporable water content of the samples which was deemed acceptable.

3.6.8 Analysis of Resistance – Temperature Data

As explained in one of the earlier sections, hydrated cement paste samples were prepared with stainless steel electrodes inserted at either end of the sample. The temperature of each specimen was then lowered, at a rate of 2° C/min, from room temperature (20° C) down to –80° C and then back up to 20° C. Length change measurements and impedance spectra were collected continuously as the temperature was being lowered. The measurement of the impedance spectra provides valuable information on the changes happening within the pore structure of the cement paste as it is very sensitive to changes within the pore structure. Graph 3.2 illustrates how the resistance of the cement paste increases with a decrease in temperature.

It can be seen in Graph 3.2 that temperature and resistance appear to have a very strong correlation when plotted as a semi-lognormal plot. It is apparent that the relationship between the two variables changes with the temperature. There are three distinct sections of the curve:

- 1) $T > -8^\circ \text{C}$
- 2) $-8^\circ \text{C} \geq T \geq -34^\circ \text{C}$
- 3) $-34^\circ \text{C} > T$



Graph 3.2: Sections of Impedance Curve

These sections were selected based on a visual inspection of the two sets of data displayed in Graph 3.2, which are supported by the known freezing processes of cement paste at -8°C and -40°C .

Section - w/c = 0.60: 1 day	r (normal)	r (semi-lognormal)
1) $T > -8^{\circ}\text{C}$	0.926	0.956
2) $-8^{\circ}\text{C} \geq T \geq -34^{\circ}\text{C}$	0.869	0.998
3) $-34^{\circ}\text{C} > T$	0.805	0.995

Table 3.7: Correlation Coefficients

Section - w/c = 0.60: 7 days	r (normal)	r (semi-lognormal)
1) $T > -8^{\circ}\text{C}$	0.997	0.999
2) $-8^{\circ}\text{C} \geq T \geq -34^{\circ}\text{C}$		0.968
3) $-34^{\circ}\text{C} > T$		0.997

Table 3.8: Correlation Coefficients

Tables 3.7 and 3.8 show that there is a strong semi-lognormal relationship between the resistance of hydrated cement paste and temperature.

Section 1 $T > -8^{\circ}\text{C}$

The regression results for Section 1, hydrated for 1 day, show that a semi-lognormal distribution fits better than a normal distribution. Though when analyzing both of the Residual plots for the two different distributions, each shows a pattern within the residuals which could mean that another distribution might better reflect the temperature-resistance phenomenon. The data for the specimen hydrated for 7 days shows an almost perfect semi-lognormal correlation, $r = 0.999$. This supports the original conclusion that Section 1 is semi-lognormally distributed.

Section 2 $-8^{\circ}\text{C} \geq T \geq -34^{\circ}\text{C}$

Again, both hydration times for Section 2 exhibit a semi-lognormal distribution. Though, in the Residual Plot for 7 days of hydration, a pattern can be noticed. Once again, based on the data for 1 day of hydration and the other sections, a semi-lognormal distribution is selected.

Section 3 $-34^{\circ}\text{C} > T$

After reviewing the coefficients of correlation, Residual and Normal Probability Plots for the two hydration times there was no doubt that the distribution is semi-lognormal. Both Residual Plots have scattered points where no pattern is noticeable and the data have nearly perfect semi-lognormal correlation.

The method of least squares was used to fit an equation to the data within each section and the results are included in Table 3.9.

1) $T > -8^{\circ}\text{C}$	1 day of hydration	$\log(Z) = 2.53 - 0.032 \cdot T$
	7 days of hydration	$\log(Z) = 2.97 - 0.025 \cdot T$
2) $-8^{\circ}\text{C} \geq T \geq -34^{\circ}\text{C}$	1 day of hydration	$\log(Z) = 1.74 - 0.111 \cdot T$
	7 days of hydration	$\log(Z) = 2.93 - 0.066 \cdot T$
3) $-34^{\circ}\text{C} > T$	1 day of hydration	$\log(Z) = 2.70 - 0.074 \cdot T$
	7 days of hydration	$\log(Z) = 2.70 - 0.064 \cdot T$

Table 3.9: Equations of best fit lines using least squares.

The variation in the functions between the sections of temperature are a direct result of the different freezing processes occurring within the hydrated cement paste samples.

3.7 Thermal Mechanical Analysis: Instrumentation

The DuPont Thermo Mechanical Analyzer 2940 apparatus was used to control the temperature variations as well as measure the changes in length of the specimen, see Figure 3.7. Length change was measured through the movement of the probe. Liquid nitrogen was kept in the cold finger that lowered to enclose the specimen. The apparatus is equipped with a furnace to control the temperature variations at the desired rates.

3.8 Thermogravimetric Analysis: Instrumentation

The instrument used to provide data on thermo gravimetric analysis (TGA) was a DuPont 951. This test involves monitoring the mass changes during heating. A 40 mg to 50 mg sample was sealed within a furnace and then heated to 105°C for 3 hours. The mass lost during this interval is due to the loss of evaporable water within the hcp pore structure. The sample was then heated to 1000°C and the mass loss is from combined water in the pore structure. It is also expected that a small amount of the matrix is also lost on ignition.

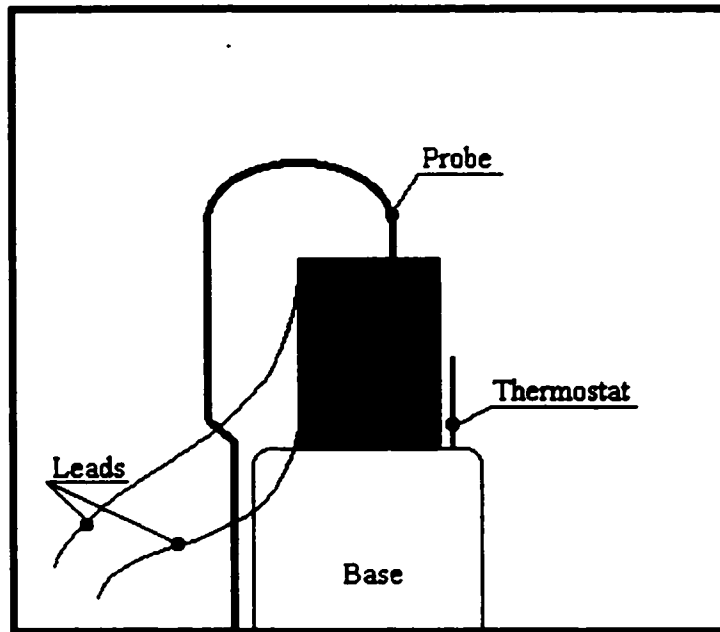


Figure 3.7: Interior Chamber of TMA Apparatus

3.9 Differential Scanning Calorimetry: Instrumentation

Differential Scanning Calorimetry (DSC) was used to measure the amount of pore water freezing in the hcp. A DuPont 2910 was used for these tests. It measures the amount of energy required to lower the temperature in the test cell. 15 mg to 25 mg samples were sealed in aluminum lidded pans for the tests. The rate of cooling matched the rate described in the freezing-thawing tests previously mentioned. Integrating the energy-temperature curve indicates the amount of water freezing.

3.10 Mercury Intrusion Porosimetry: Instrumentation

The porosity of the cementitious specimens was measured using an American Instrument Porosimeter. Since mercury is a non-compressible liquid it can be used to approximate the porosity of the sample. The sample is dried for 3 hours at 105°C in a vacuum prior to testing. Then using the instrument, pressures of up to 60000 pounds per square inch were applied to the sample and the mercury. The volume of mercury entering the pore system is measured at regular intervals of applied pressure and is indicative of porosity. Pore diameter is inversely related to the pressure applied.

3.11 Length Change Calculations

The strain of the specimens was calculated using the length change measurements and the following equation:

$$\varepsilon = \frac{\Delta l}{l}$$

3.12 Chelsea Dielectric

The Chelsea Dielectric instrument was used to measure the dielectric properties of specimens directly. All connections and settings used are similar to those described in the section on Solartron for the Drying-Rewetting experiments.

CHAPTER 4

DYNAMIC DRYING – REWETTING OF CEMENT PASTE

4.1 Introduction

Drying-rewetting cycles applied to hcp cause permanent change to the pore structure. The transport of pore water due to changes in the relative humidity (RH) results in dimensional changes that reflect the matrix's ability to accommodate the resulting stresses on the system. The application of AC Impedance Spectroscopy (ACIS) methods after each cycle is intended to document the pore structure changes and establish their correspondence with the length-change measurements. It is hypothesized that drying-rewetting cycles will coarsen the initial pore structure due to the collapse of pore boundaries on drying and/or permanent compressive strains in the matrix.

It is important to realize that the drying-rewetting of cement paste in the context of this thesis is a dynamic process. This implies that equilibrium with respect to water adsorption, intercalation and transport is not achieved. Equilibrium in the cement paste-water system generally takes several days/months to achieve. Dynamic processes generally occur for structural concrete subjected to environmental forces associated with drying-rewetting. In practice it is the capillary pores that contribute most to the dynamics of the transport process. The gentle drying process in the experiments described below was intended to simulate practical conditions.

4.2 Results

The data collected from the drying-rewetting experiments is displayed in Tables 4.1, 4.2 and 4.3. Table 4.1 contains the data that describes the composition of the hydrated cement pastes used in the experiments. This information was obtained from Thermal Gravimetric Analysis (TGA) and Mercury Intrusion Porosimetry (MIP). TGA measures the change in mass with temperature and is related to the water content of the hcp. MIP measures the porosity of a cement sample by measuring the volume of mercury that penetrates into the pore system. Thirty years of hydration

is apparent in the TGA and MIP data. The older pastes have larger volumes of hydration products as compared to younger pastes of similar w/c ratios. Porosity and the average pore diameter decreases with increased hydration.

w/c ratio	Hydration Time	w _n (%)	%CH	CH/ignited wt. (%)
0.25	30 yrs	13.71		16.7
0.30	30 yrs	16.42		17.3
0.40	30 yrs	16.50		20.2
0.50	30 yrs	17.15		21.8
0.80	30 yrs	18.24		29.0
1.00	30 yrs	18.09		27.5
0.25	14 days	14.92	8.556	10.3
0.30	14 days	14.82	9.270	11.2
0.30	14 days	15.15	11.000	13.3
0.40	14 days	18.62	12.360	15.3
0.50	14 days	20.54	14.050	17.8
0.80	14 days	21.29	17.710	22.7

Table 4.1a: Characterization of the Pastes

w/c Ratio	Hydration Time	Total Porosity (%)	Mean Pore Size, r ₀ (μm)	Threshold Diameter (μm)
0.25	30 yrs	12	0.055	0.088
0.30	30 yrs	12	0.059	0.088
0.40	30 yrs	26	0.030	0.088
0.50	30 yrs	31	0.031	0.101
0.80	30 yrs	53	0.077	0.114
1.00	30 yrs	58	0.105	0.120

Table 4.1b: Porosimetry Results

Dimensional properties are tabulated in Table 4.2. This information outlines the original dimensions of the test specimens and the changes that each specimen underwent due to each treatment of drying and rewetting. Strain calculations use this data. In addition, the changes of mass were monitored and included in Table 4.2.

POREWATER TESTS

*Rewetting with Approximated Pore Solutions that Simulate Conductivity
- using Calcium Hydroxide and Potassium Chloride Crystals*

<i>Initial Measurements</i>						
Sample	w/c	Length, mm	Diameter, mm	Mass, g	L - 0, mm	R - 0, mm
P25A	0.25	25.59	31.59	44.9684	3.734	3.874
P25B	0.25	25.62	30.34	40.9786	3.978	3.870
P30A	0.30	26.19	32.52	44.9889	3.683	3.659
P30B	0.30	25.43	32.33	45.0269	4.104	4.446
P50A	0.50	25.13	31.26	36.6507	3.656	3.748
P50B	0.50	25.62	31.41	37.4826	3.715	3.826
P80A	0.80	25.68	31.40	32.7042	4.173	4.163
P80B	0.80	25.13	30.86	30.7893	4.536	4.050
P100A	1.00	25.69	31.64	31.5582	4.521	4.083
P100B	1.00	25.73	31.38	30.8919	4.091	4.311

<i>First Cycle</i>								
Sample	Mass - 1D, g	Moisture Lost	L - 1D, mm	R - 1D, mm	Mass - 1W, g	Moisture Gained	L - 1W, mm	R - 1W, mm
P25A	43.0301	1.9383	3.714	3.841	45.0387	2.0086	3.760	3.890
P25B	39.3240	1.6546	3.952	3.847	41.0460	1.7220	3.980	3.875
P30A	42.4029	2.5860	3.646	3.632	45.1001	2.6972	3.722	3.690
P30B	42.5809	2.4460	4.065	4.422	45.0969	2.5160	4.124	4.475
P50A	30.8343	5.8164	3.599	3.700	36.7698	5.9355	3.655	3.743
P50B	31.9961	5.4865	3.682	3.775	37.7063	5.7102	3.734	3.835
P80A	23.7470	8.9572	4.161	4.077	33.1274	9.3804	4.201	4.169
P80B	22.4156	8.3737	4.431	3.974	31.3206	8.9050	4.528	4.091
P100A	20.9576	10.6006	4.451	4.024	31.7686	10.8110	4.517	4.080
P100B	19.9177	10.9742	4.011	4.243	31.1022	11.1845	4.078	4.313

<i>Second Cycle</i>								
Sample	Mass - 2D, g	Moisture Lost	L - 2D, mm	R - 2D, mm	Mass - 2W, g	Moisture Gained	L - 2W, mm	R - 2W, mm
P25A	43.2539	1.7848	3.762	3.841	45.1109	1.8570	3.790	3.909
P25B	39.4926	1.5534	3.968	3.860	41.1182	1.6256	3.986	3.894
P30A	42.2173	2.8828	3.656	3.650	45.1338	2.9165	3.738	3.704
P30B	42.4968	2.6001	4.092	4.434	45.1425	2.6457	4.143	4.474
P50A	30.9907	5.7791	3.604	3.707	36.8143	5.8236	3.664	3.747
P50B	32.2164	5.4899	3.692	3.777	37.7641	5.5477	3.741	3.832
P80A	23.8741	9.2533	4.186	4.105	33.1520	9.2779	4.238	4.182
P80B	22.3306	8.9900	4.442	4.047	31.3527	9.0221	4.528	4.114
P100A	21.5286	10.2400	4.460	4.031	31.8162	10.2876	4.518	4.081
P100B	21.1402	9.9620	4.032	4.292	31.1947	10.0545	4.080	4.327

Table 4.2a: Data on Drying-Rewetting with Synthetic Pore Solution

<i>Third Cycle</i>								
Sample	Mass - 3D, g	Moisture Lost	L - 3D, mm	R - 3D, mm	Mass - 3W, g	Moisture Gained	L - 3W, mm	R - 3W, mm
P25A	43.3244	1.7865	3.781	3.865	45.1344	1.8100	3.807	3.918
P25B	39.7144	1.4038	3.988	3.872	41.1334	1.4190	4.000	3.908
P30A	41.9054	3.2284	3.672	3.659	45.2445	3.3391	3.762	3.723
P30B	42.0852	3.0573	4.112	4.413	45.2284	3.1432	4.163	4.519
P50A	30.8428	5.9715	3.608	3.698	36.8516	6.0088	3.662	3.744
P50B	32.0048	5.7593	3.701	3.785	37.8183	5.8135	3.742	3.832
P80A	23.5406	9.6114	4.195	4.081	33.1616	9.6210	4.228	4.192
P80B	22.3746	8.9781	4.460	4.050	31.3707	8.9961	4.531	4.111
P100A	22.4025	9.4137	4.482	4.045	31.8247	9.4222	4.520	4.087
P100B	22.2358	8.9589	4.059	4.315	31.2012	8.9654	4.079	4.322

<i>Fourth Cycle</i>								
Sample	Mass - 4D, g	Moisture Lost	L - 4D, mm	R - 4D, mm	Mass - 4W, g	Moisture Gained	L - 4W, mm	R - 4W, mm
P25A	43.4584	1.6760	3.796	3.873	45.2382	1.7798	3.818	3.925
P25B	39.6180	1.5154	3.986	3.874	41.1992	1.5812	4.012	3.914
P30A	42.8295	2.4150	3.700	3.701	45.4504	2.6209	3.768	3.741
P30B	42.7696	2.4588	4.149	4.454	45.4070	2.6374	4.183	4.495
P50A	31.3042	5.5474	3.623	3.705	36.9825	5.6783	3.662	3.742
P50B	32.4819	5.3364	3.721	3.807	37.9955	5.5136	3.755	3.857
P80A								
P80B	22.8846	8.4861	4.473	4.063	31.3801	8.4955	4.543	4.095
P100A	23.8201	8.0046	4.501	4.064	31.8652	8.0451	4.519	4.076
P100B	23.9389	7.2623	4.069	4.324	31.2268	7.2879	4.077	4.322

Table 4.2a (Cont'd): Data on Drying-Rewetting with Synthetic Pore Solution

LIME SOLUTION

Cement Paste Hydrated for 30 Years

Rewetting with saturated Calcium Hydroxide Solution

<i>Initial Measurements</i>						
Sample	w/c	Length, mm	Diameter, mm	Mass, g	L - 0, mm	R - 0, mm
S25A	0.25	25.69	30.46	42.0658	4.325	4.225
S25B	0.25	25.93	30.40	41.4152	4.083	4.513
S30A	0.30	27.10	32.23	47.1897	4.254	3.860
S30B	0.30	25.62	32.37	45.3917	4.292	4.538
S50A	0.50	25.52	31.33	37.3917	4.029	3.741
S50B	0.50	25.71	31.31	37.6527	3.784	3.934
S80A	0.80	26.29	30.91	32.8204	3.942	4.292
S80B	0.80	25.70	30.91	32.2262	4.029	4.309
S100A	1.00	26.45	31.34	31.7602	3.817	3.803
S100B	1.00	25.76	31.32	31.0921	3.621	3.632

Table 4.2b: Data on Drying-Rewetting with Calcium Hydroxide Solution

<i>First Cycle</i>								
Sample	Mass - 1D, g	Moisture Lost	L - 1D, mm	R - 1D, mm	Mass - 1W, g	Moisture Gained	L - 1W, mm	R - 1W, mm
S25A	40.8615	1.2043	4.145	4.308	42.0958	1.2343	4.242	4.322
S25B	40.2606	1.1546	4.170	4.415	41.4151	1.1545	4.100	4.526
S30A	45.2725	1.9172	4.138	3.833	47.2925	2.0200	4.263	3.883
S30B	43.8080	1.5837	4.253	4.482	45.4828	1.6748	4.297	4.572
S50A	32.2974	5.0943	3.996	3.666	37.3767	5.0793	4.021	3.748
S50B	32.4560	5.1967	3.728	3.910	37.6602	5.2042	3.825	3.940
S80A	23.7653	9.0551	3.888	4.235	32.8478	9.0825	3.952	4.286
S80B	23.6924	8.5338	3.986	4.252	32.2742	8.5818	4.027	4.307
S100A	20.4813	11.2789	3.742	3.721	31.7438	11.2625	3.808	3.788
S100B	20.1658	10.9263	3.543	3.572	31.0611	10.8953	3.610	3.627

<i>Second Cycle</i>								
Sample	Mass - 2D, g	Moisture Lost	L - 2D, mm	R - 2D, mm	Mass - 2W, g	Moisture Gained	L - 2W, mm	R - 2W, mm
S25A	40.7311	1.3647	4.086	4.397	42.1488	1.4177	4.212	4.311
S25B	40.2464	1.1687	4.080	4.447	41.4300	1.1836	4.098	4.519
S30A	44.9409	2.3516	4.149	3.839	47.2802	2.3393	4.253	3.887
S30B	43.5730	1.9098	4.272	4.513	45.4720	1.8990	4.305	4.552
S50A	31.4729	5.9038	3.971	3.658	37.3588	5.8859	4.057	3.731
S50B	31.7328	5.9274	3.718	3.922	37.6465	5.9137	3.809	3.948
S80A	23.5997	9.2481	3.892	4.235	32.8338	9.2341	3.946	4.290
S80B	23.8726	8.4016	3.986	4.261	32.2468	8.3742	4.027	4.320
S100A	21.2149	10.5289	3.764	3.736	31.7325	10.5176	3.804	3.778
S100B	20.6668	10.3943	3.573	3.596	31.0327	10.3659	3.618	3.639

<i>Third Cycle</i>								
Sample	Mass - 3D, g	Moisture Lost	L - 3D, mm	R - 3D, mm	Mass - 3W, g	Moisture Gained	L - 3W, mm	R - 3W, mm
S25A	40.6468	1.5020	4.104	4.298	42.1119	1.4651	4.228	4.330
S25B	40.0793	1.3507	4.068	4.444	41.4047	1.3254	4.089	4.514
S30A	44.6503	2.6299	4.148	3.843	47.2949	2.6446	4.246	3.894
S30B	43.2455	2.2265	4.279	4.510	45.4824	2.2369	4.313	4.575
S50A	31.7577	5.6011	3.977	3.659	37.3557	5.5980	3.990	3.719
S50B	31.9221	5.7244	3.715	3.936	37.6442	5.7221	3.767	3.949
S80A	23.7935	9.0403	3.904	4.244	32.8360	9.0425	3.948	4.286
S80B	23.9211	8.3257	3.993	4.278	32.2594	8.3383	4.026	4.317
S100A	22.2568	9.4757	3.795	3.767	31.7464	9.4896	3.806	3.780
S100B	21.7843	9.2484	3.604	3.629	31.0580	9.2737	3.616	3.645

Table 4.2b (Cont'd): Data on Drying-Rewetting with Calcium Hydroxide Solution

Fourth Cycle								
Sample	Mass - 4D, g	Moisture Lost	L - 4D, mm	R - 4D, mm	Mass - 4W, g	Moisture Gained	L - 4W, mm	R - 4W, mm
S25A	40.5630	1.5489	4.095	4.298	42.1610	1.5980	4.236	4.349
S25B	39.9920	1.4127	4.079	4.442	41.4300	1.4380	4.086	4.511
S30A	44.9493	2.3456	4.164	3.870	47.3239	2.3746	4.230	3.910
S30B	43.2235	2.2589	4.288	4.514	45.5042	2.2807	4.327	4.580
S50A	31.7874	5.5683	3.968	3.657	37.3519	5.5645	3.999	3.707
S50B	31.9453	5.6989	3.694	3.928	37.6371	5.6918	3.766	3.957
S80A	23.8291	9.0069	3.909	4.250	32.8366	9.0075	3.947	4.279
S80B	24.6624	7.5970	4.006	4.295	32.2632	7.6008	4.018	4.324
S100A	23.6947	8.0517	3.798	3.769	31.7567	8.0620	3.803	3.776
S100B	22.4122	8.6458	3.609	3.641	31.0680	8.6558	3.618	3.644

Table 4.2b: Data on Drying-Rewetting with Calcium Hydroxide Solution

Distilled Water

Cement Paste Hydrated for 30 Years

Rewetting with Distilled Water

Initial Measurements				
Sample	w/c	Length, mm	Diameter, mm	Mass, g
100A	1	25.56	31.93	31.8775
100B	1	26.34	31.94	32.7879
25A	0.25	25.68	31.52	44.0252
25B	0.25	26.16	31.45	45.2024
25C	0.25	25.69	31.43	45.1597
30A	0.3	25.81	31.78	43.4018
30B	0.3	25.73	31.69	43.5973
30C	0.3	25.63	31.61	43.4895
40A	0.4	26.17	31.84	41.1579
40B	0.4	25.54	31.85	40.3876
50A	0.5	18.69	31.72	27.5383
50B	0.5	18.93	31.71	28.1583
80A	0.8	25.91	31.86	33.8927
80B	0.8	25.7	31.95	34.0775

Table 4.2c: Data on Drying-Rewetting with Distilled Water

First Cycle					Second Cycle				
Sample	Mass - 1D, g	Moisture Lost	Mass - 1W, g	Moisture Gained	Sample	Mass - 2D, g	Moisture Lost	Mass - 2W, g	Moisture Gained
100A	18.8717	13.0058	31.6919	12.8202	100A	20.1382	11.5537	31.6186	11.4804
100B	19.4396	13.3483	32.6154	13.1758	100B	20.5483	12.0671	32.5652	12.0169
25A	39.6747	4.3505	43.7248	4.0501	25A	42.0806	1.6442	43.7421	1.6615
25B	40.8111	4.3913	44.9033	4.0922	25B	43.2989	1.6044	44.8647	1.5658
25C	39.8039	5.3558	43.8587	4.0548	25C	42.2183	1.6404	43.8223	1.6040
30A	38.4384	4.9634	43.1765	4.7381	30A	41.0556	2.1209	43.1932	2.1376
30B	38.7056	4.8917	43.3847	4.6791	30B	41.3998	1.9849	43.4078	2.0080
30C	38.6437	4.8458	43.2408	4.5971	30C	41.3426	1.8982	43.2555	1.9129
40A	34.3219	6.8360	40.9365	6.6146	40A	36.2773	4.6592	40.9744	4.6971
40B	33.6204	6.7672	40.208	6.5876	40B	35.5736	4.6344	40.2289	4.6553
50A	21.4238	6.1145	27.4048	5.9810	50A	22.6019	4.8029	27.4137	4.8118
50B	22.0103	6.1480	28.0073	5.9970	50B	23.4204	4.5869	28.0140	4.5936
80A	22.3202	11.5725	33.797	11.4768	80A	23.7102	10.0868	33.7433	10.0331
80B	22.4328	11.6447	33.9643	11.5315	80B	23.7311	10.2332	33.918	10.1869

Third Cycle					Fourth Cycle				
Sample	Mass - 3D, g	Moisture Lost	Mass - 3W, g	Moisture Gained	Sample	Mass - 4D, g	Moisture Lost	Mass - 4W, g	Moisture Gained
100A	21.4863	10.1323	31.596	10.1097	100A	20.0839	11.5121	31.6466	11.5627
100B	22.3522	10.2130	32.4844	10.1322	100B	20.5426	11.9418	—	—
25A	42.7798	0.9623	43.8091	1.0293	25A	42.6061	1.2030	43.7832	1.1771
25B	43.9426	0.9221	44.922	0.9794	25B	43.7607	1.1613	44.8863	1.1256
25C	42.8934	0.9289	43.879	0.9856	25C	42.6809	1.1981	43.8544	1.1735
30A	42.1397	1.0535	43.2386	1.0989	30A	41.6277	1.6109	43.2212	1.5935
30B	42.3519	1.0559	43.4713	1.1194	30B	41.7463	1.7250	43.4475	1.7012
30C	42.1917	1.0638	43.3005	1.1088	30C	41.6330	1.6675	43.2758	1.6428
40A	37.4189	3.5555	41.0132	3.5943	40A	36.3733	4.6399	41.0322	4.6589
40B	36.5886	3.6403	40.2773	3.6887	40B	35.5836	4.6937	40.2778	4.6942
50A	23.2887	4.1250	27.4158	4.1271	50A	22.7837	4.6321	27.4253	4.6416
50B	24.2218	3.7922	28.0214	3.7996	50B	23.4476	4.5738	28.0241	4.5765
80A	25.2063	8.5370	33.6562	8.4499	80A	23.6392	10.0170	33.6925	10.0533
80B	24.9556	8.9624	33.8444	8.8888	80B	23.7700	10.0744	—	—

Table 4.2c (Cont'd): Data on Drying-Rewetting with Distilled Water

After each rewetting portion of the cycle, an AC Impedance Spectrum (ACIS) was obtained. The equivalent circuit for each spectrum was fit to the measured data and is presented in Table 4.3. The information provided by ACIS contains descriptors of the pore system of the hcp specimens used in the experiments.

Drying at 100° C for 24 hours
3 Months Hydration

Rewetting with Approximated Pore Solutions that Simulate Conductivity
- using Calcium Hydroxide and Potassium Chloride Crystals

<i>Initial Measurements</i>						
Sample	w/c	Length, mm	Diameter, mm	Mass, g	L - 0, mm	R - 0, mm
H25A	0.25	26.20	32.12	47.2006	3.628	3.804
H25B	0.25	26.34	31.85	46.7278	2.660	4.103
H30A	0.30	26.06	31.94	45.7330	3.364	4.186
H30B	0.30	25.68	31.58	43.9401	3.890	3.695
H40A	0.50	25.87	31.86	41.8196	3.661	3.715
H40B	0.50	25.82	31.97	41.8561	3.632	3.554
H50A	0.80	25.83	31.78	39.3598	3.792	3.655
H50B	0.80	25.67	31.63	38.7240	3.603	3.869
H80A	1.00	25.61	31.74	34.2367	3.671	3.130
H80B	1.00	25.69	31.45	32.7878	4.259	3.465

<i>First Cycle</i>								
Sample	Mass - 1D, g	Moisture Lost	L - 1D, mm	R - 1D, mm	Mass - 1W, g	Moisture Gained	L - 1W, mm	R - 1W, mm
H25A	41.6580	5.5426	3.543	3.717	46.8865	5.2285	3.634	3.801
H25B	41.2978	5.4300	2.574	4.057	46.4280	5.1302	2.665	4.104
H30A	39.5439	6.1891	3.268	4.072	45.5250	5.9811	3.375	4.169
H30B	37.8256	6.1145	3.767	3.597	43.7123	5.8867	3.871	3.694
H40A	33.8265	7.9931	3.548	3.599	41.6903	7.8638	3.675	3.690
H40B	33.9544	7.9017	3.526	3.427	41.6529	7.6985	3.648	3.539
H50A	30.5181	8.8417	3.654	3.545	39.2800	8.7619	3.782	3.652
H50B	29.9135	8.8105	3.477	3.741	38.6649	8.7514	3.617	3.844
H80A	22.5046	16.2194	3.576	2.993	34.0676	11.5630	3.675	3.108
H80B	20.7155	13.5212	4.137	3.343	32.7808	12.0653	4.243	3.453

<i>Second Cycle</i>								
Sample	Mass - 2D, g	Moisture Lost	L - 2D, mm	R - 2D, mm	Mass - 2W, g	Moisture Gained	L - 2W, mm	R - 2W, mm
H25A	41.5161	5.3704	3.555	3.721	47.1031	5.5870	3.641	3.798
H25B	41.1079	5.3201	2.581	4.063	46.6468	5.5389	2.669	4.112
H30A	39.3432	6.1818	3.286	4.082	45.5530	6.2098	3.378	4.184
H30B	37.7228	5.9895	3.849	3.618	43.7519	6.0291	3.879	3.712
H40A	33.8130	7.8773	3.594	3.608	41.8279	8.0149	3.707	3.745
H40B	33.7040	7.9489	3.541	3.439	41.7611	8.0571	3.682	3.552
H50A	30.3595	8.9205	3.670	3.569	39.3078	8.9483	3.808	3.676
H50B	29.6995	8.9654	3.490	3.742	38.6920	8.9925	3.602	3.853
H80A	22.4362	11.6314	3.578	3.009	34.0899	11.6537	3.687	3.116
H80B	20.6110	12.1698	4.122	3.341	32.8140	12.2030	4.237	3.576

Table 4.2d: Data on Drying at 100°C –Rewetting with Synthetic Pore Solution

<i>Third Cycle</i>								
Sample	Mass - 3D, g	Moisture Lost	L - 3D, mm	R - 3D, mm	Mass - 3W, g	Moisture Gained	L - 3W, mm	R - 3W, mm
H25A	42.0245	5.0786	3.583	3.744	47.1966	5.1721	3.650	3.813
H25B	41.5364	5.1104	2.607	4.082	46.7170	5.1806	2.667	4.114
H30A	39.7970	5.7560	3.317	4.114	45.5941	5.7971	3.390	4.196
H30B	38.1569	5.5950	3.799	3.640	43.7744	5.6175	3.888	3.718
H40A	34.1654	7.6625	3.629	3.659	41.8370	7.6716	3.724	3.749
H40B	34.1829	7.5782	3.583	3.469	41.7740	7.5911	3.722	3.556
H50A	30.6857	8.6221	3.708	3.607	39.2897	8.6040	3.809	3.691
H50B	29.9616	8.7304	3.508	3.764	38.6892	8.7276	3.619	3.858
H80A	22.6852	11.4047	3.612	3.036	34.0664	11.3812	3.680	3.117
H80B	20.8180	11.9960	4.153	3.348	32.7545	11.9365	4.232	3.422

<i>Fourth Cycle</i>				
Sample	Mass - 4D, g	Moisture Lost	L - 4D, mm	R - 4D, mm
H25A	42.1124	5.0842	3.589	3.748
H25B	41.7555	4.9615	2.617	4.079
H30A	39.9699	5.6242	3.327	4.127
H30B	38.3311	5.4433	3.869	3.650
H40A	34.4194	7.4176	3.654	3.658
H40B	34.3145	7.4595	3.605	3.470
H50A	30.8310	8.4587	3.7060	3.6160
H50B	30.1001	8.5891	3.518	3.768
H80A	22.7716	11.2948	3.568	3.039
H80B	20.9920	11.7625	4.156	3.353

Table 4.2d (Cont'd): Data on Drying at 100°C – Rewetting with Synthetic Pore Solution

**Drying-Rewetting with Synthetic Pore Solution
Equivalent Circuits**

Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ	Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ
P25A-0	0	5594.9	5.40E-09	0.662	P25B-0	-46.4	8362	7.39E-09	0.639
P25A-1	196.91	2052.2	4.21E-09	0.700	P25B-1	61.82	2793	4.89E-09	0.674
P25A-2	156.71	1662.4	5.99E-09	0.683	P25B-2	-125.9	2133	1.79E-08	0.590
P25A-3	78.685	1801.1	1.13E-08	0.640	P25B-3	22.81	1772	1.19E-08	0.624
P25A-4	32.598	1306.8	2.68E-08	0.592	P25B-4	-121.9	1618	3.80E-08	0.549
P30A-0	1.74E-09	4077.8	9.88E-09	0.642	P30B-0	119.7	3192	3.51E-09	0.708
P30A-1	109.92	1860.6	8.14E-09	0.667	P30B-1	205	2107	5.15E-09	0.703
P30A-2	110.19	1238.5	5.71E-09	0.692	P30B-2	141.7	1314	5.68E-09	0.694
P30A-3	327.13	566.52	6.89E-10	0.897	P30B-3				
P30A-4	54.72	951.01	5.48E-08	0.568	P30B-4	161.8	737.5	1.87E-08	0.649

Table 4.3a: Equivalent Circuits, Rewetting with Synthetic Pore Solution

Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ	Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ
P40A-0	1.74E-09	1150.4	1.60E-07	0.541	P40B-0	108.9	758.9	2.19E-08	0.661
P40A-1	83.566	286.95	5.41E-08	0.617	P40B-1	56.6	373.2	2.06E-08	0.651
P40A-2	51.839	367.7	9.30E-08	0.589	P40B-2	78.23	483.9	2.48E-08	0.657
					P40B-3	79.14	319.9	6.55E-08	0.619
					P40B-4	78.51	264.4	8.03E-08	0.609
P50A-0	1.74E-09	659.3	9.24E-06	0.336	P50B-0	163.4	767.6	9.08E-06	0.385
P50A-1	23.4	331.39	7.00E-07	0.482	P50B-1	-224.8	600	2.23E-07	0.448
P50A-2	-57.5	295.22	3.85E-06	0.343	P50B-2	118.7	203.7	2.02E-08	0.715
P50A-3	16.636	185.17	1.96E-06	0.426	P50B-3	106.9	182.8	2.16E-08	0.715
P50A-4					P50B-4	92.62	94.26	7.61E-08	0.680
P80A-0	1.74E-09	319.71	5.81E-07	0.496	P80B-0	16.86	318.9	5.67E-07	0.503
P80A-1	70.647	52.026	1.19E-07	0.669	P80B-1	72.66	58.3	2.15E-08	0.763
P80A-2	48.691	80.258	2.68E-06	0.460	P80B-2	58.25	63.86	2.44E-07	0.614
P80A-3	51.305	78.965	3.24E-07	0.578	P80B-3	34.76	84.42	9.29E-07	0.500
					P80B-4	-446.8		3.32E-07	0.331
P100A-0	10.492	203.19	3.52E-07	0.528	P100B-0	51.06	103.5	5.15E-08	0.676
P100A-1	1.74E-09	165.74	8.66E-06	0.346	P100B-1	73.39	29.86	5.97E-08	0.784
P100A-2	1.74E-09	142.62	2.05E-05	0.313	P100B-2	54.22	78.78	2.81E-06	0.515
P100A-3	67.329	69.707	5.36E-07	0.625	P100B-3	58.81	56.81	1.73E-06	0.556
P100A-4	57.936	101.2	1.80E-06	0.540	P100B-4	42.09	50.4	9.48E-06	0.435

Table 4.3a (Cont'd): Equivalent Circuits, Rewetting with Synthetic Pore Solution

**Drying-Rewetting with Saturated Calcium Hydroxide
Equivalent Circuits**

Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ	Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ
S25A-0	-310.1	10221	2.13E-08	0.569	S25B-0	-1186	22810	6.47E-07	0.359
S25A-1	103.3	8637	3.64E-09	0.685	S25B-1	13.74	6645	5.07E-09	0.664
S25A-2	31.68	6068	6.81E-09	0.649	S25B-2	-2.456	4124	4.60E-09	0.670
S25A-3	21.63	8263	1.24E-08	0.616	S25B-3	-81.12	5151	1.39E-08	0.604
S25A-4	52.76	5277	5.94E-10	0.844	S25B-4	-42.68	3932	5.21E-09	0.661
S30A-0	-9.55E+02	4674	1.81E-07	0.428	S30B-0	-433	7603	2.75E-07	0.435
S30A-1	-72.45	2922	1.41E-08	0.617	S30B-1	-141.9	2866	1.46E-08	0.610
S30A-2	-25.97	2627	1.22E-08	0.626	S30B-2	61.09	2378	4.51E-09	0.688
S30A-3	-144.6	2707	2.50E-08	0.578	S30B-3	-125.7	2902	2.30E-08	0.585
S30A-4	26.36	2219	7.01E-09	0.662	S30B-4	55.92	2227	4.43E-09	0.691

Table 4.3b: Equivalent Circuits, Rewetting with Saturated Calcium Hydroxide

Sample	R ₁ (Ω)	R ₂ (Ω)	C ₂ (F)	φ	Sample	R ₁ (Ω)	R ₂ (Ω)	C ₂ (F)	φ
S50A-0	6.80E+01	400.4	7.51E-07	0.494	S50B-0	37.9	533.6	2.69E-06	0.414
S50A-1	15.06	383.8	2.10E-07	0.519	S50B-1	70.56	323	1.28E-07	0.568
S50A-2	20.31	345.2	1.16E-07	0.552	S50B-2	35.68	396.3	2.79E-07	0.512
S50A-3	-6.158	456	2.03E-07	0.512	S50B-3	0.43326	479.1	2.41E-07	0.506
S50A-4	-194.3	697.3	6.11E-07	0.406	S50B-4	14.36	506.6	2.33E-07	0.511
S80A-0	6.14E+01	209.6	1.39E-07	0.608	S80B-0	57.23	168.1	5.44E-08	0.656
S80A-1	107	128.9	9.67E-09	0.769	S80B-1	141.1	154	2.51E-08	0.734
S80A-2	57.84	210.9	3.39E-08	0.651	S80B-2	154.8	195.8	5.30E-08	0.694
S80A-3	25.04	248.6	3.53E-08	0.624	S80B-3	120.4	514.6	3.45E-07	0.560
S80A-4	31.82	248.7	4.61E-08	0.610	S80B-4	99.68	349.7	7.49E-07	0.505
S100A-0	68.15	92.73	1.28E-08	0.775	S100B-0	68.59	60.2	3.23E-08	0.751
S100A-1	1.17E+02	91.71	6.32E-08	0.722	S100B-1	103.8	67.01	1.33E-08	0.792
S100A-2	1.02E+02	146.7	1.76E-07	0.628	S100B-2	99.22	94.09	9.18E-08	0.668
S100A-3	58.66	236.1	1.27E-06	0.479	S100B-3	86.29	206.5	3.54E-07	0.563
S100A-4	94.76	121.8	4.59E-07	0.560	S100B-4	73.71	120.7	1.94E-07	0.582

Table 4.3b (Cont'd): Equivalent Circuit, Resaturating with Saturated Calcium Hydroxide

Drying-Rewetting with Distilled Water
Equivalent Circuits

Sample	R ₁ (Ω)	R ₂ (Ω)	C ₂ (F)	φ	Sample	R ₁ (Ω)	R ₂ (Ω)	C ₂ (F)	φ
25A-0	224.1	4627	5.01E-10	0.802	25B-0	103.6	7476	1.46E-09	0.736
25A-1	78.36	7235	2.26E-09	0.711	25B-1	124.6	6107	1.92E-09	0.726
25A-2	92.4	10863	1.69E-09	0.724	25B-2	104.2	6604	2.19E-09	0.717
25A-3	101.3	8387	1.32E-09	0.739	25B-3	71.89	6965	2.44E-09	0.709
25A-4	53.57	16033	1.58E-09	0.725	25B-4	-68.91	8116	5.16E-09	0.662
30A-0	4.58E+02	1053	5.97E-12	1.102	30B-0	129.5	2606	7.23E-10	0.799
30A-1	130.3	3376	3.52E-09	0.707	30B-1	104.7	2909	3.49E-09	0.706
30A-2	132.4	4010	3.15E-09	0.710	30B-2	106.7	3459	3.00E-09	0.711
30A-3	113.1	3691	2.71E-09	0.718	30B-3	99.26	3591	2.90E-09	0.713
30A-4	-6.649	4702	6.19E-09	0.665	30B-4	-10.69	4342	7.31E-09	0.655
40A-0	1.74E+02	345	1.33E-09	0.835	40B-0	176.9	326.9	1.60E-09	0.826
40A-1	149.1	472.9	1.52E-08	0.688	40B-1	120.5	589.5	2.25E-08	0.658
40A-2	136.1	575.7	1.25E-08	0.686	40B-2	134.9	622.7	1.60E-08	0.673
40A-3	120.9	780.5	1.55E-08	0.665	40B-3	129.3	659.7	1.41E-08	0.674
40A-4	85.69	823.6	1.83E-08	0.648	40B-4	89.06	887	5.27E-08	0.589
50A-0	9.97E+01	216.6	2.54E-09	0.828	50B-0	112.2	199.1	3.43E-09	0.817
50A-1	140.4	298.8	5.26E-09	0.796	50B-1	110.6	313.8	8.63E-09	0.750
50A-2	116.3	264.1	1.12E-08	0.738	50B-2	117.7	326.1	4.62E-08	0.655
50A-3	102.4	327.6	1.26E-08	0.718	50B-3	115.6	435.9	3.16E-08	0.666
50A-4	73.35	380	1.1E-08	0.712	50B-4	51.13	642.1	1.51E-07	0.560

Table 4.3c: Equivalent Circuits, Resaturating with Distilled Water

Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ	Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ
80A-0	9.41E+01	49.34	8.98E-10	0.973	80B-0	88.76	48.39	7.93E-10	0.974
80A-1	89.6	72.77	7.56E-09	0.814	80B-1	90.83	78.32	6.85E-09	0.815
80A-2	99.81	116.5	7.82E-09	0.783	80B-2	104.1	125.4	6.28E-09	0.792
80A-3	108.6	150	5.29E-09	0.789	80B-3	115.3	152.7	4.64E-09	0.799
80A-4	89.47	206.6	1.19E-08	0.721					
100A-0	76.47	44.17	4.11E-09	0.885	100B-0	100.8	51.08	2.11E-08	0.809
100A-1	9.96E+01	55.81	2.49E-08	0.797	100B-1	98.48	65.22	1.31E-08	0.799
100A-2	1.04E+02	84.23	2.39E-08	0.753	100B-2	119.7	61.38	9.35E-09	0.836
100A-3	99.62	96.06	4.67E-09	0.825	100B-3	126.4	111.4	2.50E-09	0.853
100A-4	105.6	127.4	2.01E-08	0.735	100B-4	131.9	104.1	3.34E-09	0.848

Table 4.3c (Cont'd): Equivalent Circuits, Resaturating with Distilled Water

14 Days Hydration

Drying-Rewetting with Synthetic Pore Solution

Equivalent Circuits

Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ	Sample	$R_1 (\Omega)$	$R_2 (\Omega)$	$C_2 (F)$	ϕ
F25A-0	781.6	1097	3.88E-09	0.754	F25B-0	636.1	1345	1.23E-08	0.674
F25A-1	389.6	786.2	2.59E-08	0.639	F25B-1	355.7	762.9	3.89E-08	0.610
F25A-2	313.3	806.5	4.69E-08	0.604	F25B-2	308.3	1000	5.84E-08	0.586
F25A-3	50.68	973.1	1.09E-08	0.664	F25B-3	95.7	888	1.13E-08	0.670
F25A-4	134.3	857.6	1.34E-08	0.680	F25B-4	137.2	834.6	9.85E-09	0.694
F25C-0	1003	2372	1.37E-09	0.781					
F25C-1	442.8	1998	1.42E-08	0.625					
F25C-2	526.2	1581	1.17E-08	0.661					
F25C-3	102	1918	2.08E-09	0.751					
F25C-4	19.17	1542	4.09E-09	0.707					
F30A-0	4.64E+02	1085	2.35E-08	0.651	F30B-0	373.7	1019	1.28E-08	0.674
F30A-1	287.9	581.7	3.28E-08	0.642	F30B-1	283	624.8	2.44E-08	0.654
F30A-2	268.8	810	3.09E-08	0.643	F30B-2	240.3	892.5	2.08E-08	0.656
F30A-3	115.1	725.3	1.09E-08	0.689	F30B-3	105	1089	5.11E-09	0.726
F30A-4	110	738.9	1.86E-08	0.671	F30B-4	121.6	694.3	1.12E-08	0.702
F30C-0	5.23E+02	895.6	2.30E-08	0.647	F30D-0	601.1	805.9	2.67E-09	0.779
F30C-1	232.2	751.7	3.81E-08	0.607	F30D-1	367	502.2	1.59E-08	0.693
F30C-2	209.1	691.5	6.56E-08	0.584	F30D-2	159.8	1058	2.52E-08	0.624
F30C-3	115.1	700.5	1.23E-08	0.680	F30D-3	113.7	1126	2.88E-09	0.758
F30C-4	105.8	606.1	1.52E-08	0.676	F30D-4	113.9	739.8	4.01E-09	0.752

Table 4.3d: Equivalent Circuit, 14 Days Hydration

Sample	$R_1(\Omega)$	$R_2(\Omega)$	$C_2(F)$	ϕ	Sample	$R_1(\Omega)$	$R_2(\Omega)$	$C_2(F)$	ϕ
F40A-0	1.50E+02	1326	1.44E-07	0.549	F40B-0	184.7	802.8	2.51E-08	0.649
F40A-1	162.2	291.4	9.51E-08	0.613	F40B-1	88.41	443.1	1.33E-07	0.555
F40A-2	43.45	625.2	3.32E-07	0.501	F40B-2	100.3	453.5	2.19E-07	0.539
F40A-3	34.76	434.5	5.33E-08	0.610	F40B-3	43.14	401.7	5.50E-08	0.611
F40A-4	73.86	360.8	4.65E-08	0.638	F40B-4	51.8	385	3.64E-08	0.643
F40C-0	2.24E+02	656.3	1.17E-08	0.693	F40D-0	200.2	442.8	5.33E-09	0.735
F40C-1	64.48	364.8	2.59E-07	0.503	F40D-1	148.8	278.9	9.32E-08	0.601
F40C-2	92.26	440.7	1.86E-07	0.530	F40D-2	84.99	474.2	1.78E-07	0.528
F40C-3	97.45	399.8	1.42E-08	0.695	F40D-3	72.17	368.8	2.61E-08	0.657
F40C-4	69.02	299.8	3.96E-08	0.639	F40D-4	54.21	374	3.73E-08	0.631
F50A-0	1.70E+02	336.6	3.68E-09	0.781	F50B-0	124	440.6	8.13E-09	0.722
F50A-1	152.1	261.8	1.13E-08	0.741	F50B-1	142.6	266.6	6.86E-09	0.763
F50A-2	116.8	251.1	3.80E-09	0.804	F50B-2	100.2	294.6	5.05E-09	0.779
F50A-3	121.8	300.9	6.47E-09	0.776					
F50C-0	1.18E+02	270	4.08E-09	0.775	F50D-0	156.9	366.6	2.71E-09	0.789
F50C-1	149.3	268.7	3.71E-09	0.807	F50D-1	171.3	257.4	4.49E-09	0.795
F50C-2	103.4	138.4	5.64E-09	0.816	F50D-2	117	271.8	2.51E-09	0.821
F50C-3	82.85	184.9	1.04E-08	0.757	F50D-3	112.6	259.9	4.63E-09	0.788
F80A-0	1.00E+02	195.4	5.06E-09	0.787	F80B-0	111.9	86.1	5.98E-09	0.843
F80A-1	125.9	56.17	3.48E-09	0.928	F80B-1	88.86	46.41	3.14E-08	0.777
F80A-2	77.23	61.57	1.70E-08	0.796	F80B-2	76.34	54.43	1.22E-08	0.823
F80A-3	83	50.3	1.39E-08	0.836	F80B-3	79.13	50.43	1.29E-08	0.830
F80C-0	9.69E+01	189.4	6.81E-09	0.765	F80D-0	95	82.13	7.34E-09	0.817
F80C-1	104.1	87.49	1.93E-08	0.762	F80D-1	100.5	35.25	9.94E-09	0.879
F80C-2	85.3	65.3	7.85E-09	0.839	F80D-2	73.64	38.78	1.47E-08	0.838
F80C-3	86.88	55.06	9.08E-09	0.851	F80D-3	78.14	34.93	6.65E-09	0.906

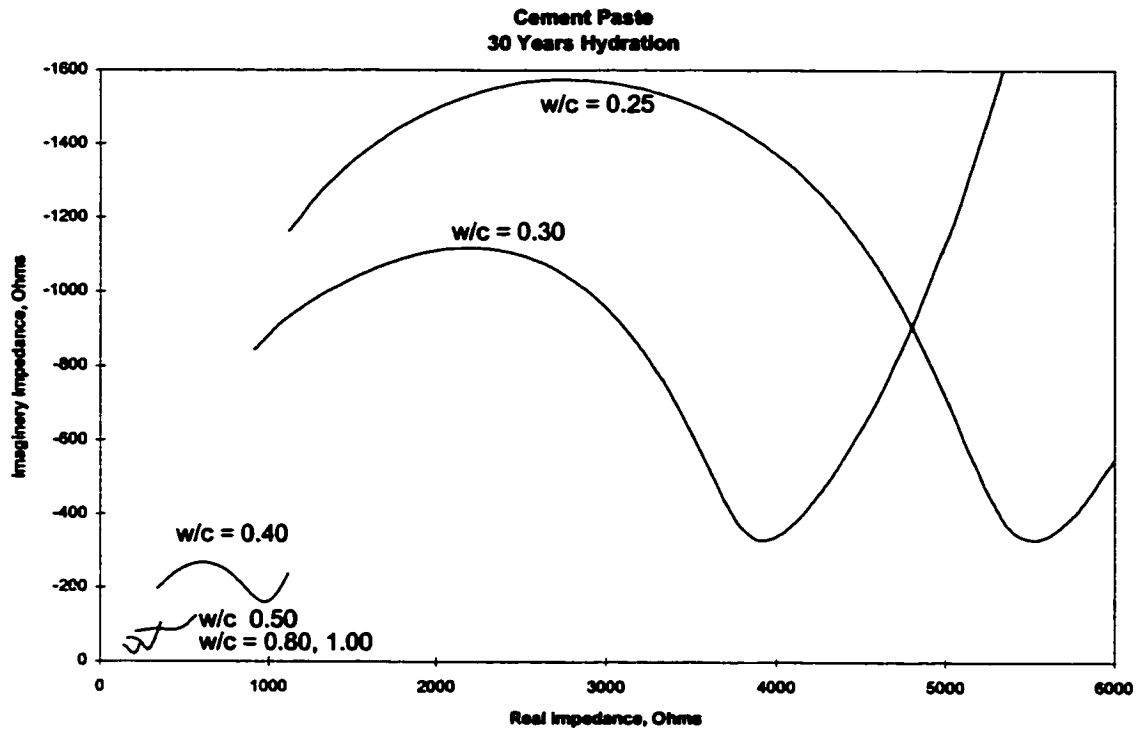
Table 4.3d (Cont'd): Equivalent Circuits, 14 Days Hydration

4.3 Discussion

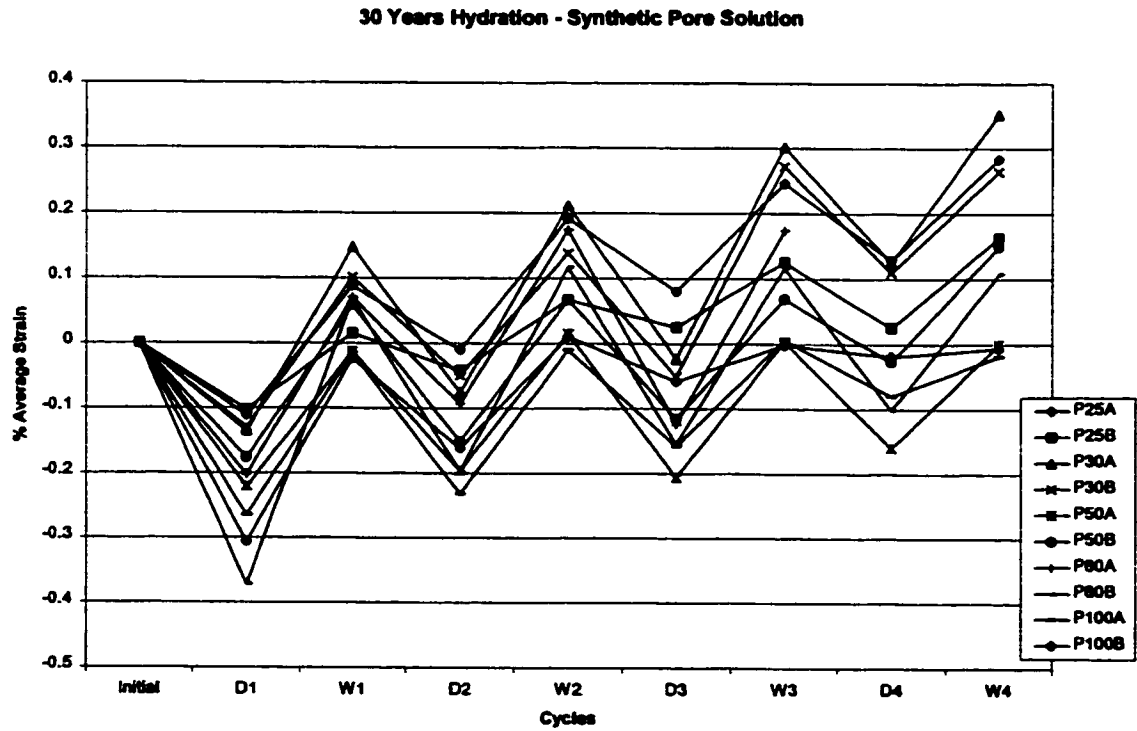
4.3.1 Material Characterization

Table 4.1 shows the difference in the hydration parameters between the w/c ratios studied. This information was calculated from the TGA data. The non-evaporable water content, w_n , increases with w/c ratio. Percent of CH/ignited weight increases with w/c ratio and hydration time. Porosity and threshold diameter increase with w/c ratio.

There is in agreement between the material characterization data in Table 4.1 and the resistance of the specimens as measured using ACIS. Graph 4.1 illustrates the increase in resistance with a decrease in w/c ratio, i.e. decreased porosity.



Graph 4.1: Nyquist Plots of HCP, Varying w/c ratios

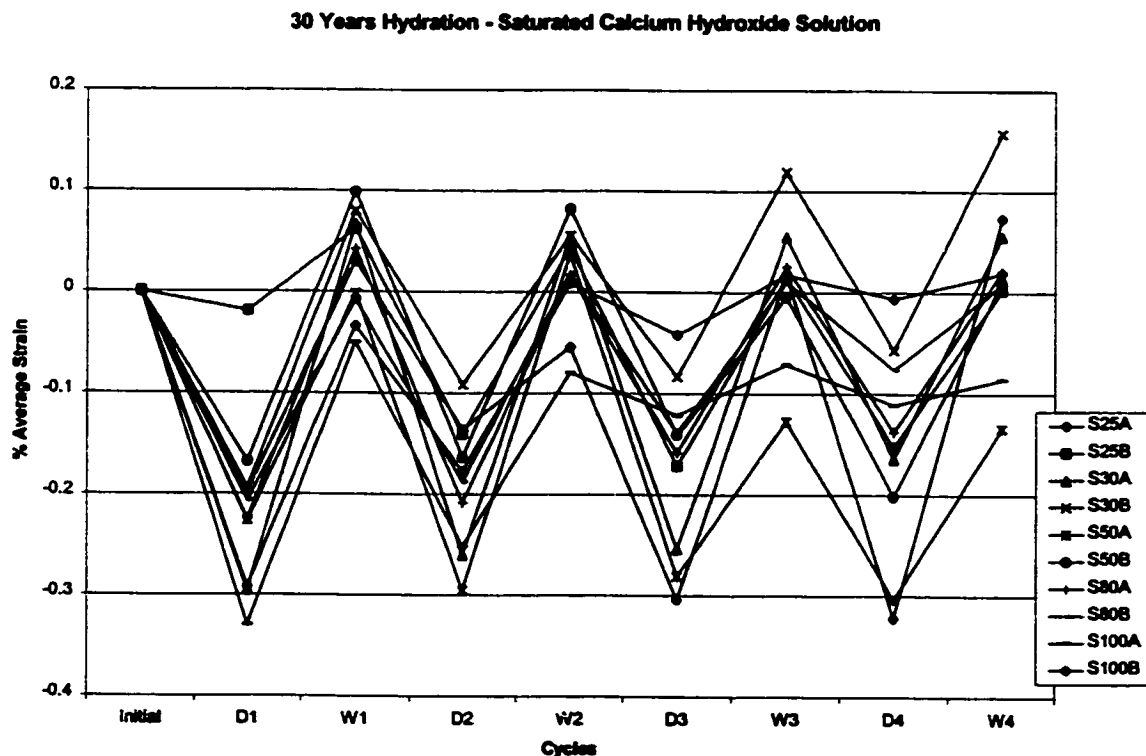


Graph 4.2a: Strain vs. Drying-Rewetting Cycle

4.3.2 Strains

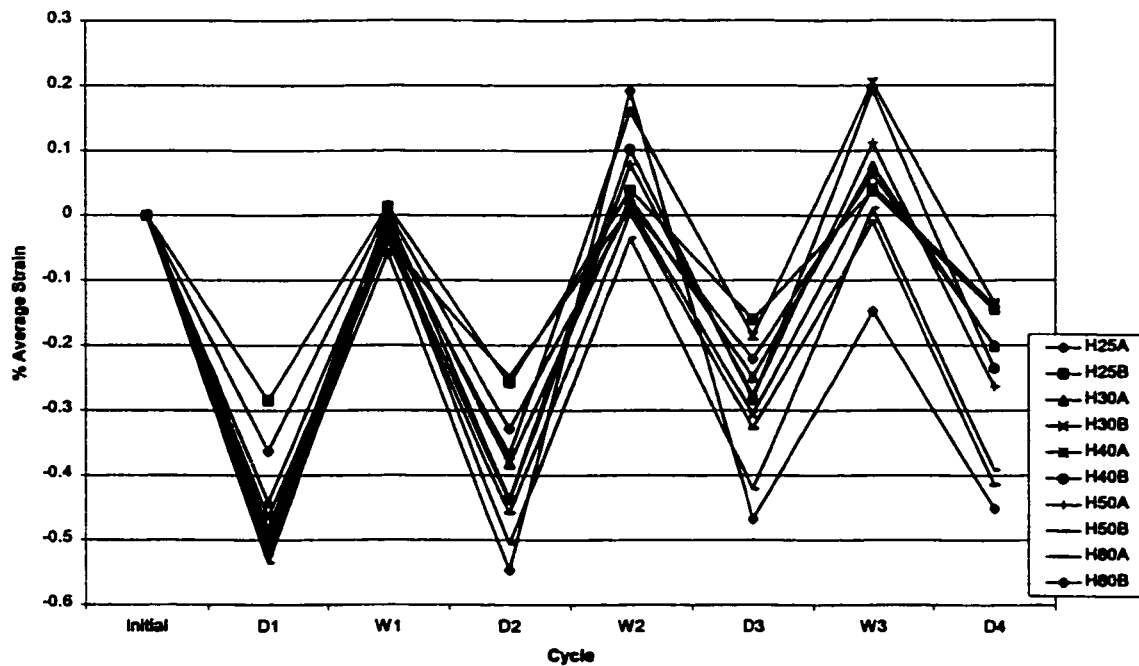
The calculated strain results show the same trend for the various test groups of hcp. The strain results are plotted versus the drying-rewetting cycle in Graph 4.2. Every specimen exhibits the greatest amount of shrinkage after first drying. The amount of shrinkage increases with w/c ratio. This relates to the greater porosity and relatively open pore structure of the high w/c ratio pastes.

After one complete cycle of drying and rewetting the samples expanded from the dried state. Most of the samples recovered all the shrinkage from drying and even expanded beyond their original dimensions. This result was unexpected due to data published by a variety of authors documenting irreversible shrinkage (Sohn and Mason, 1998; Litvan, 1988). It is however noted that the cited data were generally obtained under equilibrium conditions and the data are not representative of dynamic behaviour. Very few specimens experienced irreversible shrinkage in these tests.



Graph 4.2b: Strain vs. Drying-Rewetting Cycle

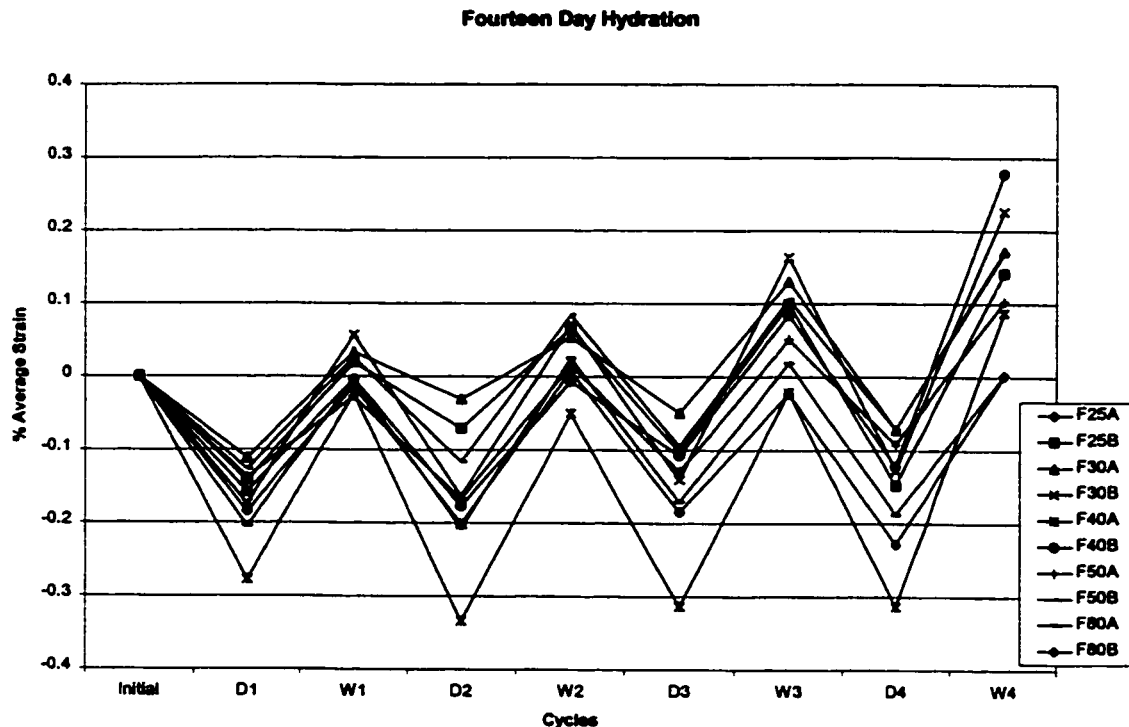
3 Months Hydration - 100°C Drying



Graph 4.2c: Strain Vs. Drying-Rewetting Cycle

The absence of any irreversible shrinkage may be due to the fact that the specimens were not completely dried. This is likely as the drying regime was gentle and the specimens relatively thick (25 mm). It is also possible that some microcracking occurred although no visible signs of cracking were observed. The very small micropores and interlayer space that are emptied below 30% RH and primarily responsible for irreversible shrinkage were probably not emptied. The shrinkage strains that did manifest were due primarily to the larger capillary pores being emptied. The higher w/c ratios have a larger number and size of capillary pores in addition to a lower stiffness of the matrix; they will exhibit larger shrinkage strains. Expansion on rewetting that creates the positive strains may be due in part to some microcracking. Pore coarsening on first drying increases the number of capillaries. Therefore, on rewetting the volume of water in the larger pores increases and the rebound effect from the formation and disappearance of a meniscus could account for the swelling. A more plausible mechanism would appear to be associated with the dynamic and delayed exit and entry of interlayer water into the C-S-H structure. It is suggested that each successive cycle of wetting and drying results in the entry of an increasing amount of interlayer water into the structure. The non-equilibrium cycling of wetting and drying does not remove all the interlayer water and subsequent wetting adds to the increased amount present.

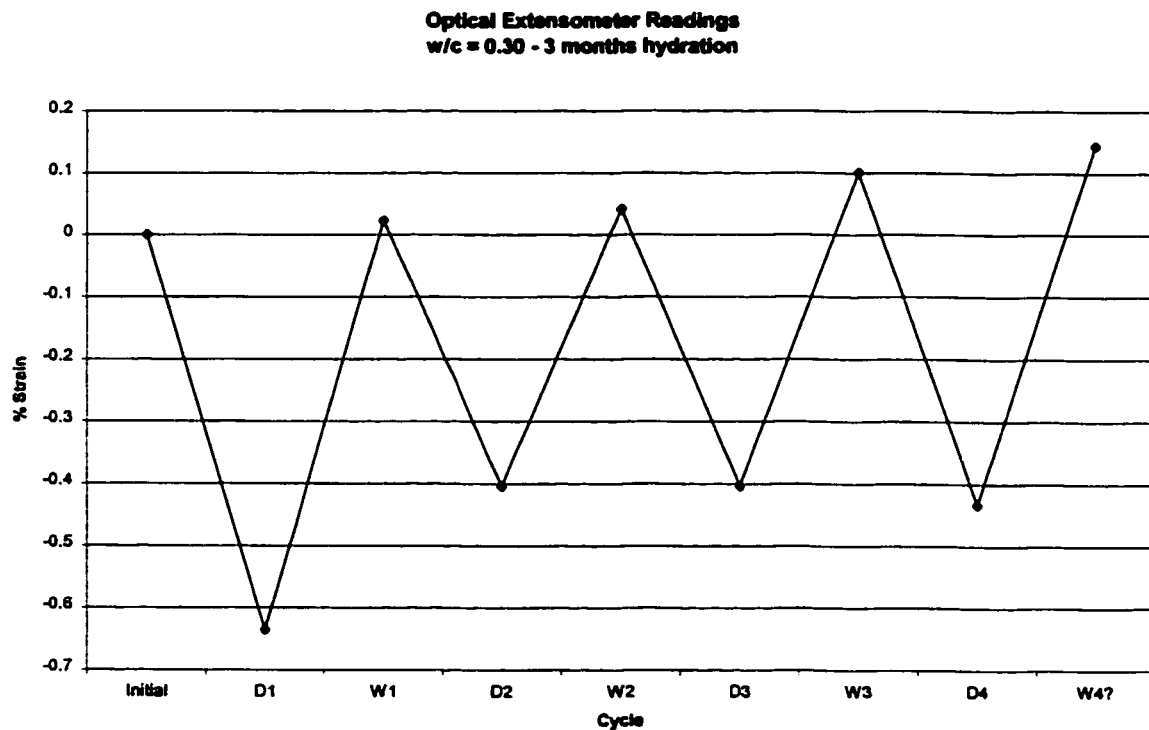
Subsequent cycles of drying and rewetting indicate that shrinkage decreases with each cycle while expansion increases. The low w/c ratio specimens experience the largest amount of cyclic expansion. This result implies that the high w/c ratio pastes were not experiencing the same degree of drying as the low w/c ratio pastes. The low w/c ratio pastes likely contained more residual water. The gentle drying could not completely remove water from the fine pore structure of the low w/c ratio pastes.



Graph 4.2d: Strain Vs. Drying-Rewetting Cycle

Other tests were conducted to verify the accuracy of the strain results measured with Huggenberger pins. Length change was measured on much thinner samples with an optical extensometer, see Graph 4.2e. The hcp tested was hydrated for 30 years and had a w/c ratio of 0.30. The specimen was 1.60 mm thick and 17.35 mm long. Drying-rewetting cycles were conducted as usual with synthetic pore solution used for resaturation. The same strain trends were recorded using the optical extensometer. The sample expanded beyond its original dimensions with each rewetting. This result confirms the validity of the Huggenberger strain results and suggests that the swelling effect is real and not an artifact due to significant microcracking.

Specimens were also dried at 100°C for 24 hours to confirm that the gentle drying did not remove all the water and to determine if the cyclic length change behaviour was correct. The specimens dried at 100°C for 24 hours exhibited the same swelling trends indicated with drying at 38°C. This suggests that the expansive mechanism is similar following treatment under both drying regimes. However, the strain values are larger for all the specimens indicating a higher degree of mass loss on drying.



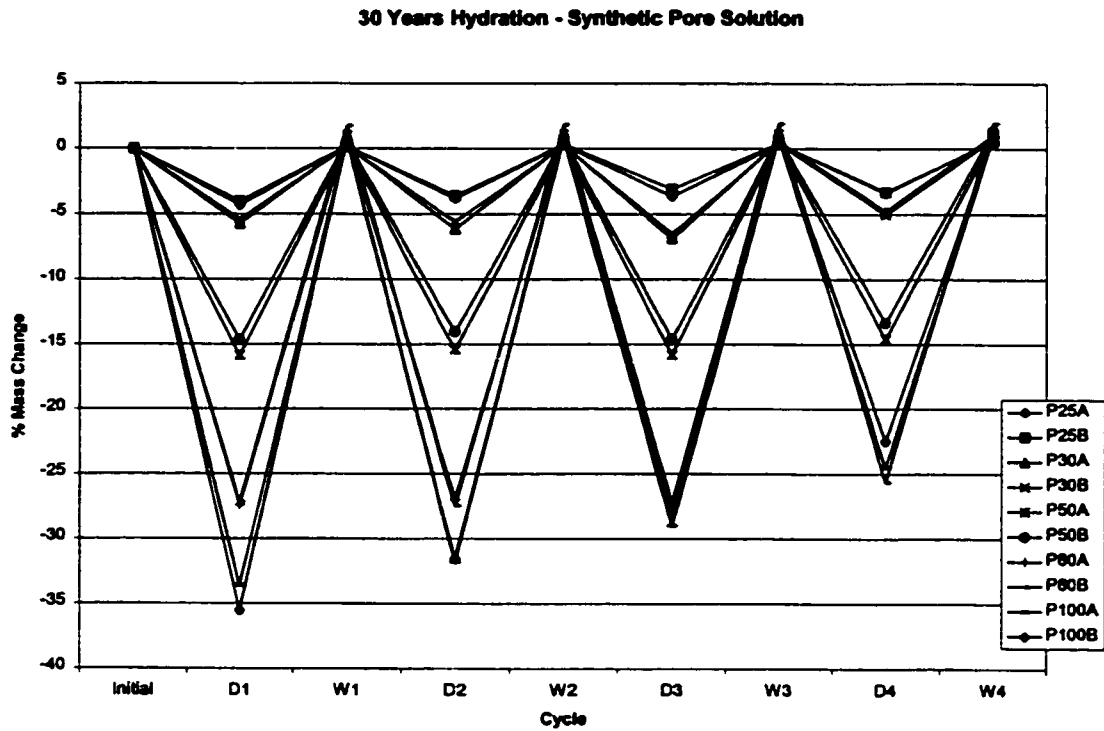
Graph 4.2e: Extensometer Results

4.3.3 Mass Changes

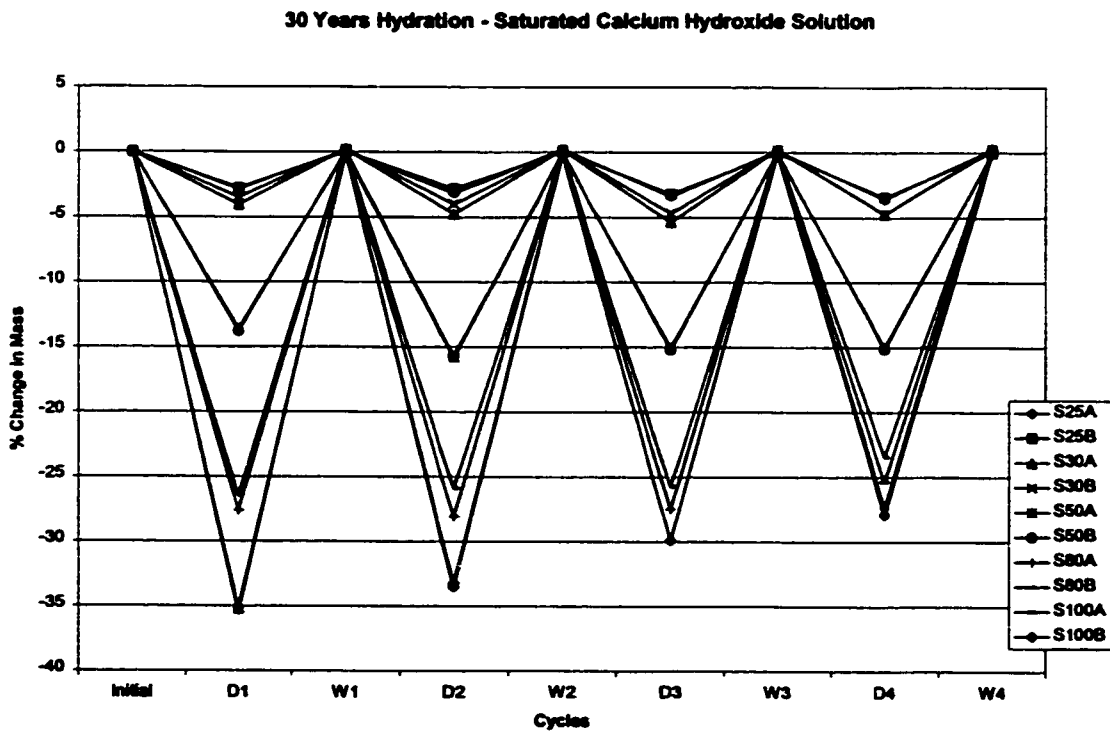
Changes to the mass of each specimen throughout the cycles are in agreement with the recorded dimensional changes, see Graph 4.3. The amount of mass lost on drying increases with w/c ratio. Mass increases with rewetting and each cycle. Swelling beyond the initial length is also noted.

Drying at 100°C for 24 hours caused different trends to the change in mass of the specimens than the specimens dried at 38°C for 24 hours. The harder drying causes a more extensive collapse of the C-S-H structure and delays the re-entry of interlayer water into the structure. The majority of

the samples never recovered their original mass. Most samples recovered all of the shrinkage but never regained its original mass. Again the non-equilibrium conditions permit the length change recovery.

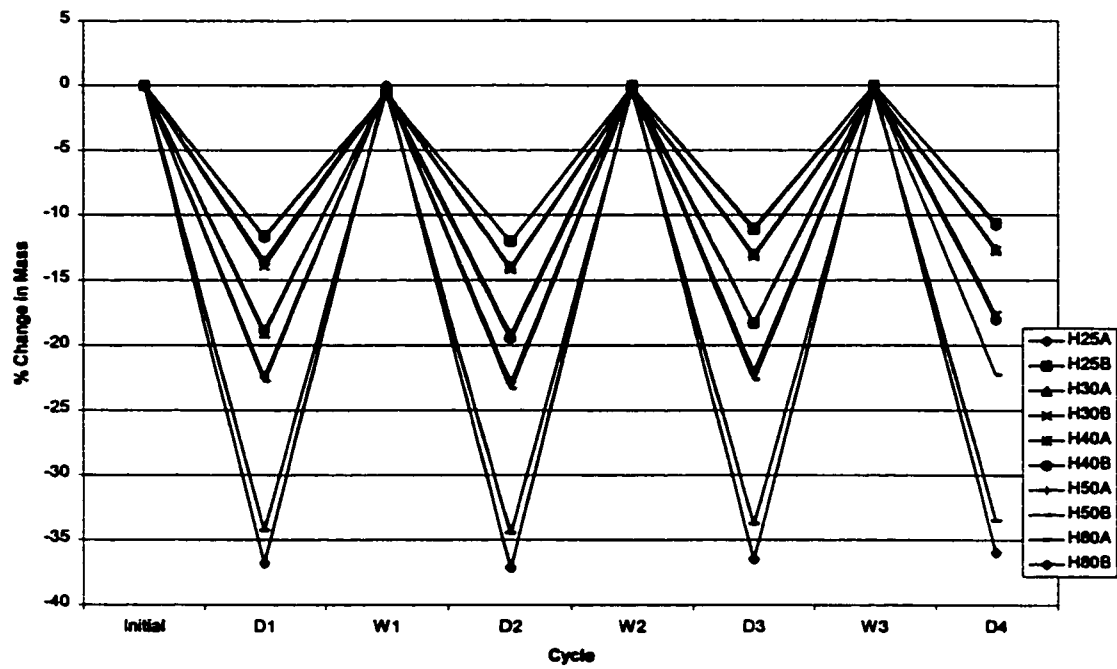


Graph 4.3a: Changes in Mass, Rewetting with Synthetic Pore Solution



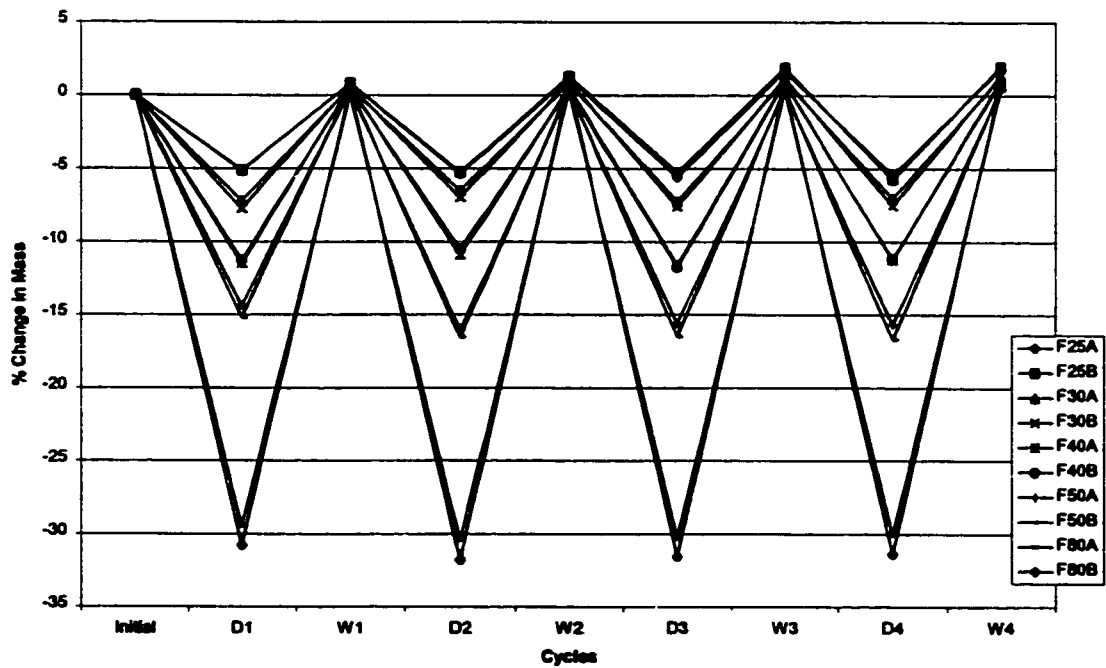
Graph 4.3b: Changes in Mass, Rewetting with Saturated Calcium Hydroxide

3 Months Hydration, 100°C Drying



Graph 4.3c: Changes in Mass, 100°C Drying

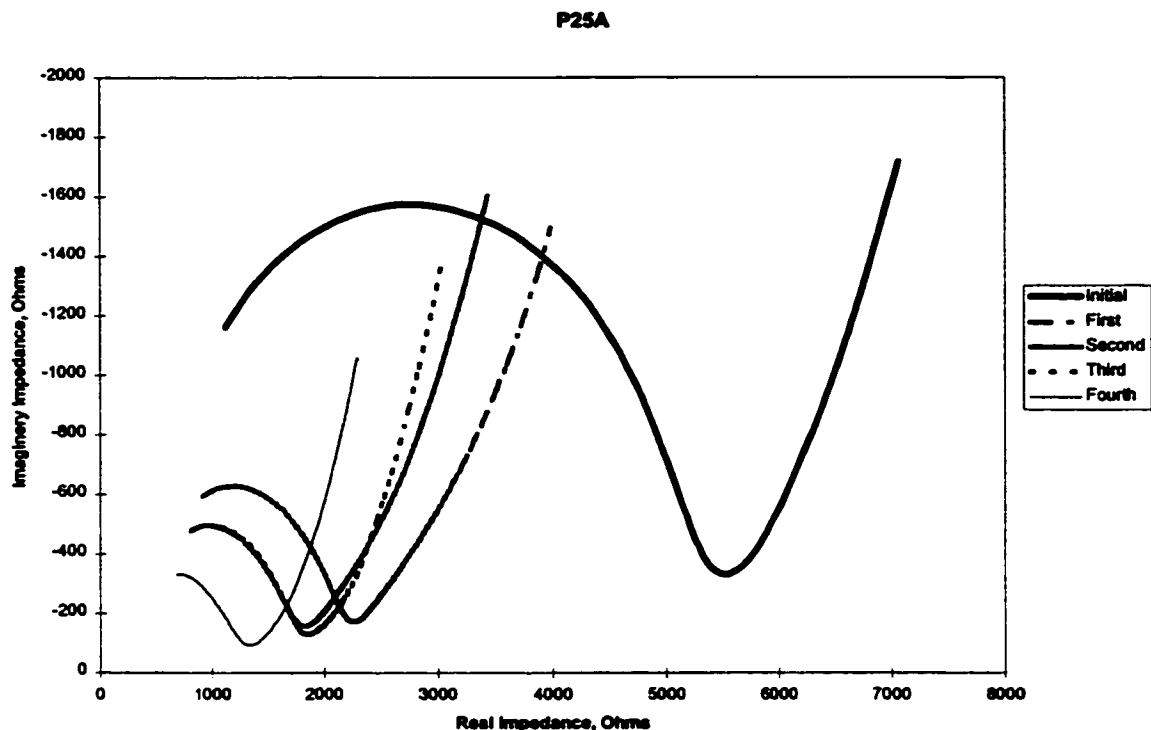
14 Days Hydration- Synthetic Pore Solution



Graph 4.3d: Changes in Mass, 14 Days Hydration

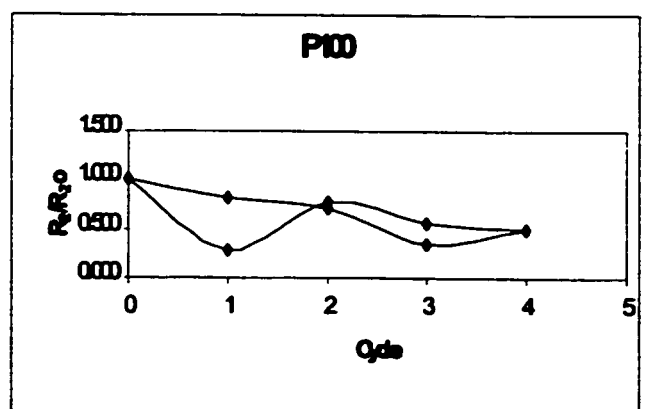
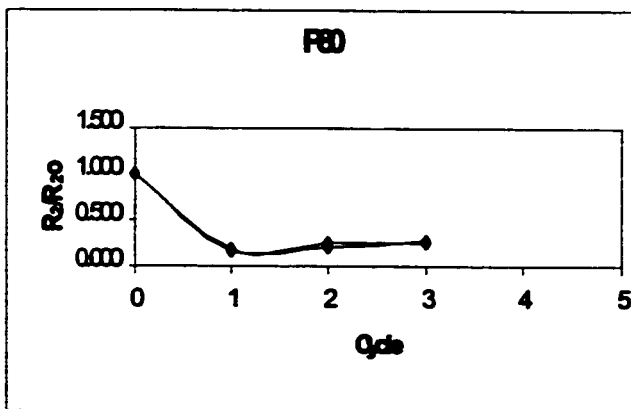
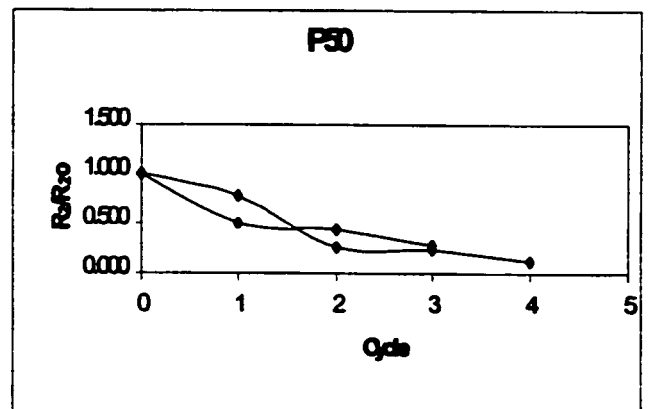
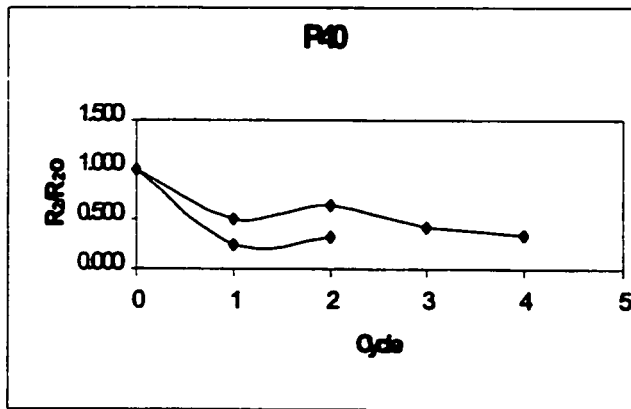
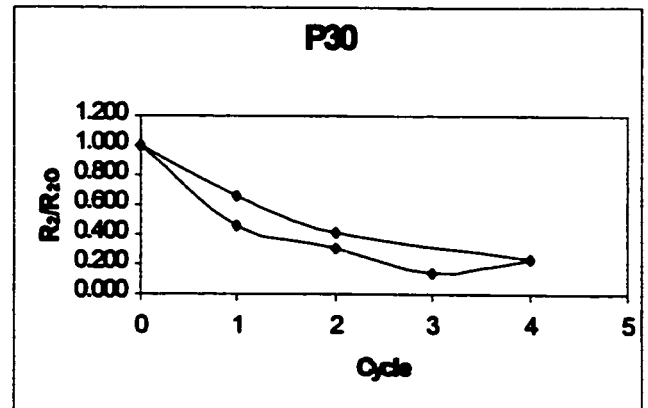
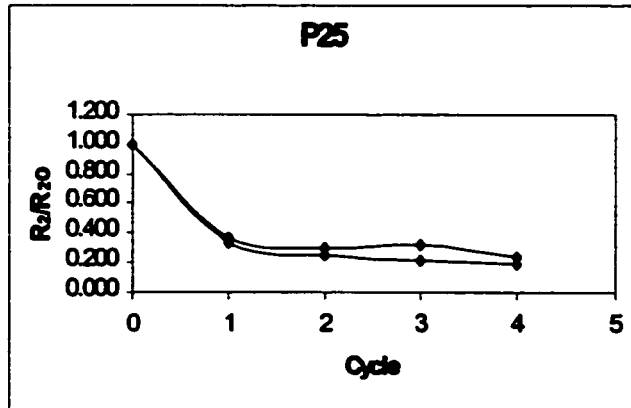
4.3.4 ACIS

The Nyquist plots of the ACIS data for Specimen P25A (30 years hydration, $w/c = 0.25$) can be seen in Graph 4.4. This graph is indicative of data collected. It illustrates the changes that are occurring to the resistance of the hcp on drying and rewetting cycles. All measurements are made in the saturated state. Resaturation is made with pore solution (equivalent conductivity).

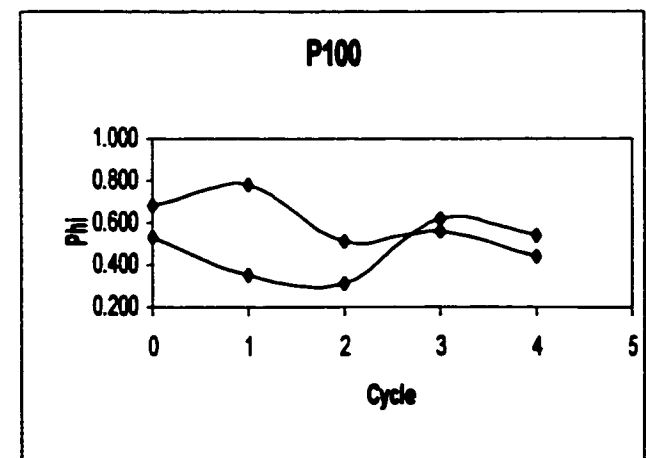
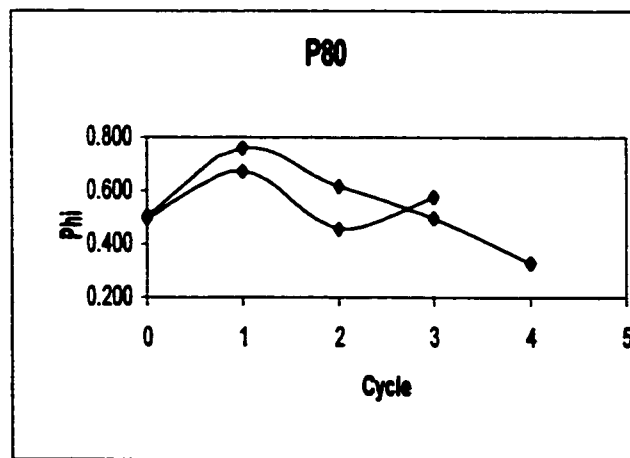
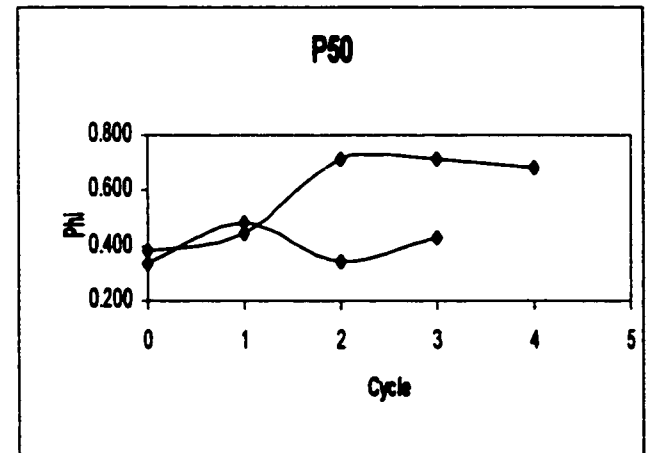
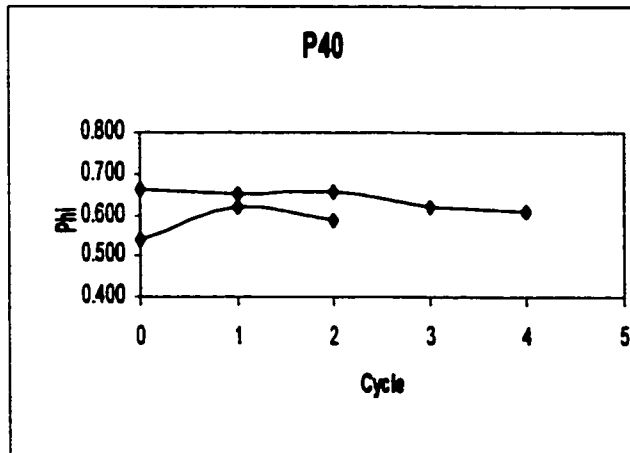
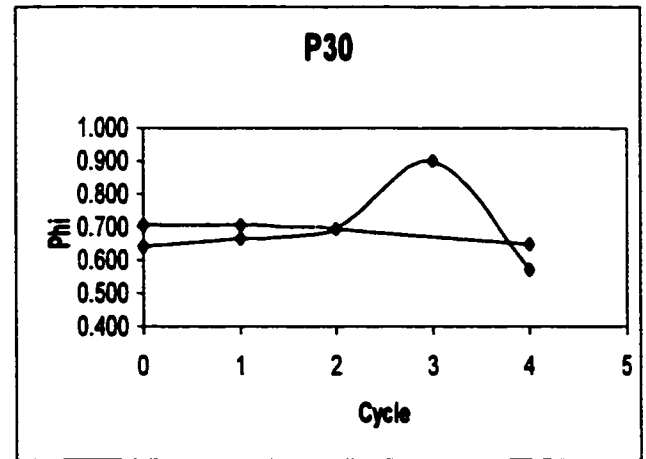
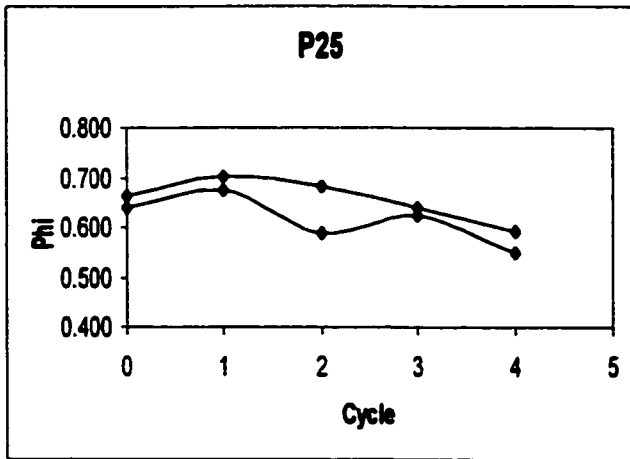


Graph 4.4: Nyquist Plots from Each Drying-Rewetting Cycle

The diameter of the high frequency arc (hfa) decreases with each cycle of drying and rewetting. This is an indication of pore coarsening in itself as increased conductivity would produce this result. The hfa is the largest for each specimen in its natural state before any drying has occurred. The pore structure of the paste at this stage is undamaged and 30 years of hydration has produced highly discontinuous pore systems in the lower w/c ratio pastes. It can be seen that the hfa increases with decreasing w/c ratio. This is due to the fact that the electrical signal is transmitted through the paste by the electrolytes in the pore solution. The larger the pores and the more connected the pores (of a saturated paste) the smaller the hfa. The properties of the hfa change due to changes to the pore structure.



Graph 4.5: 30 Years Hydration, Synthetic Pore Solution



Graph 4.6: Variation in Phi with Drying Rewetting Cycles, Synthetic Pore Solution

The change of the hfa is the greatest between the initial measurement and the first drying-rewetting cycle. Each subsequent cycle brings about changes to the pore structure but with decreasing intensity. The hcp microstructure tends toward stabilization and the changes to the hfa with each cycle decrease, reflecting this stabilization of the hcp pore structure.

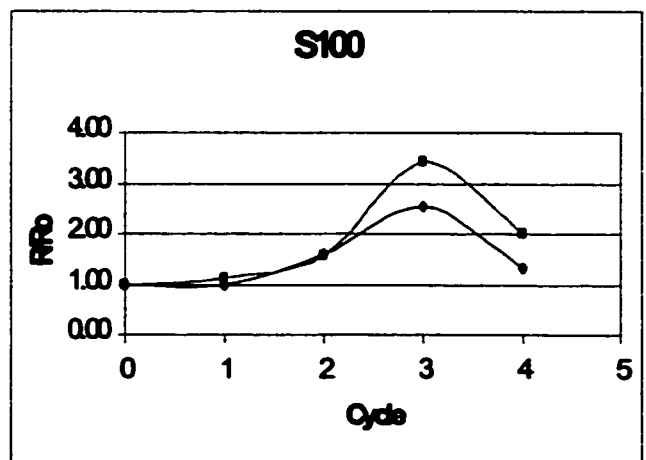
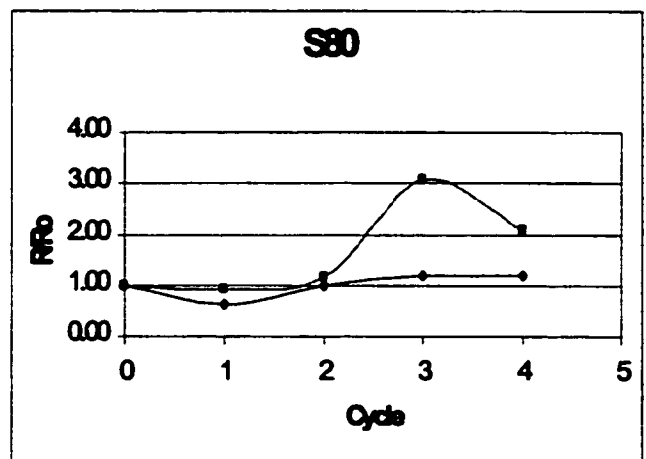
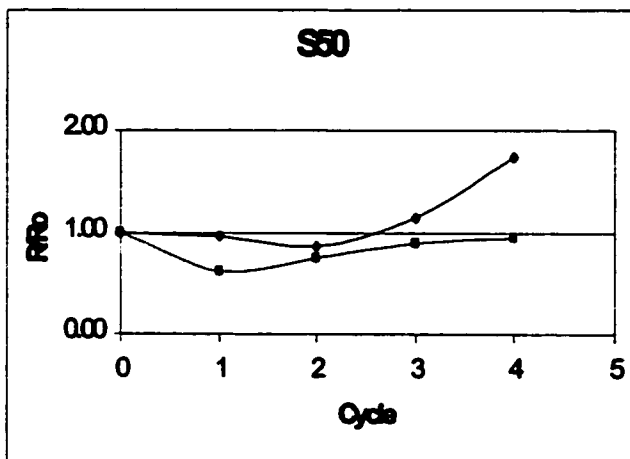
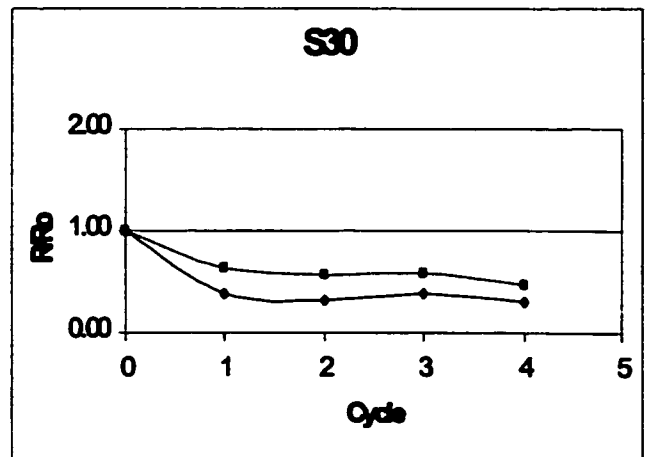
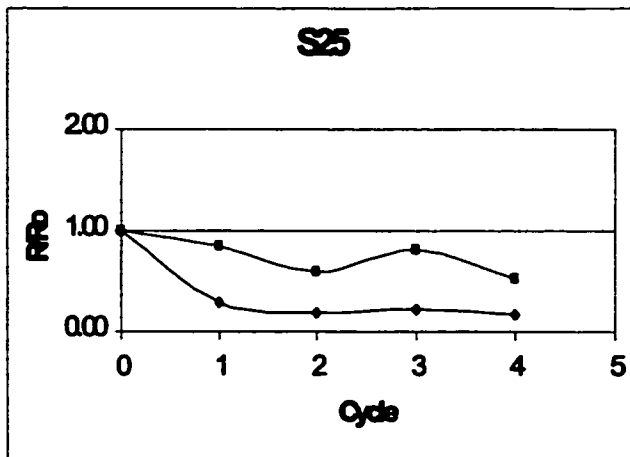
4.3.4.1 Resaturation With Synthetic Pore Solutions

The normalized resistance ($R_2/R_2(0)$) plots in Graph 4.5 show that the resistance of hcp as measured by ACIS decreases with cycles of drying and rewetting. This result suggests that the drying process alters the pore structure of hcp. The pore structure is coarsened and better connected after drying cycles. The conductivity of the pore solution remains constant by design as the synthetic pore solutions match the conductivity of the natural pore solution.

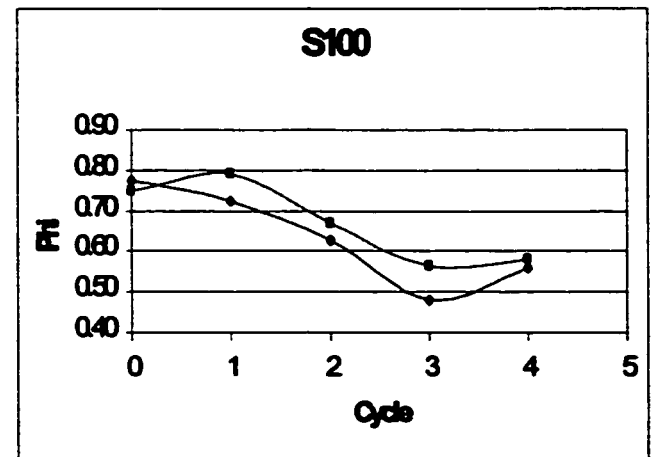
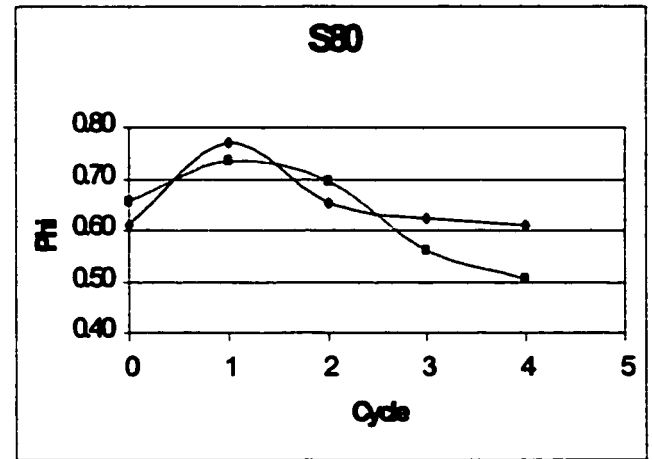
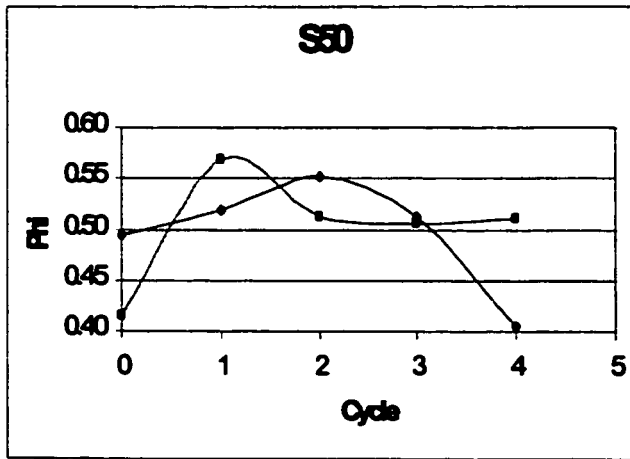
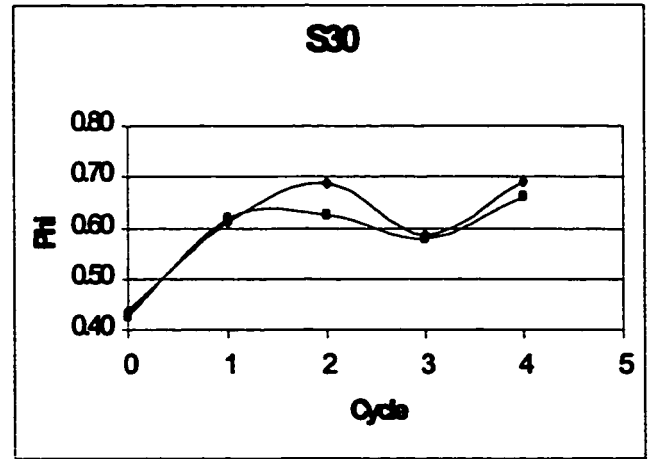
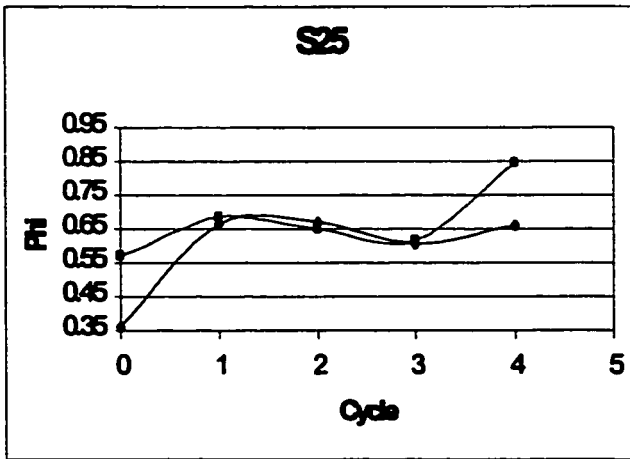
Analysis of the changes to the parameter phi, a function of the depression angle of the high frequency arc, with drying-rewetting cycles also suggests pore coarsening. In Graph 4.6, phi decreases (α_d increases) with drying-rewetting cycles. The depression angle will increase if the pore size distribution of the paste broadens. With the coarsening of the large capillary pores from the gentle drying, the largest pore size is being increased while the micropores remain intact. Therefore, the pore size distribution of the specimens is becoming broader with each drying-rewetting cycle causing the depression angle to increase.

4.3.4.2 Resaturation With Saturated Lime Solution

The data for the specimens resaturated with saturated calcium hydroxide solution is presented in Graphs 4.7 and 4.8. The normalized resistance curves for the w/c ratios 0.25 and 0.30 show that the resistance of those pastes decreases with drying and rewetting, despite the higher resistance of saturated calcium hydroxide solution compared to natural pore solution. At the low w/c ratios, a higher concentration of alkali will dissolve into the solution. The combination of pore coarsening and decrease in conductivity of the lime solution due to alkali dissolution results in this decrease. The pore coarsening effect may be minimized as lime may actually be precipitated from solution. For the same samples, phi increases with each cycle indicating changes to the pore structure resulting in a more uniform pore size distribution.



Graph 4.7: 30 Years Hydration, Rewetting with Saturated Calcium Hydroxide Solution



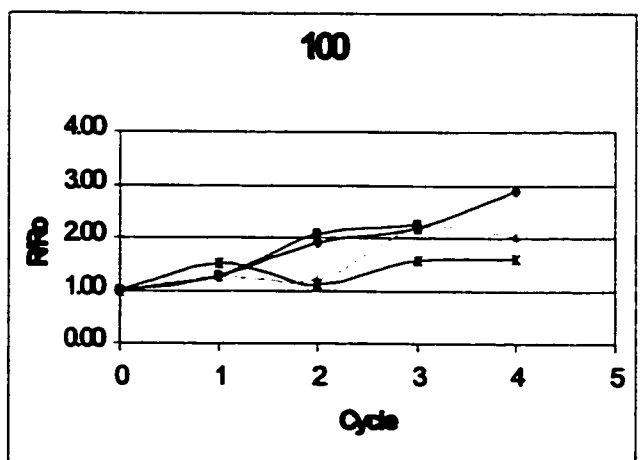
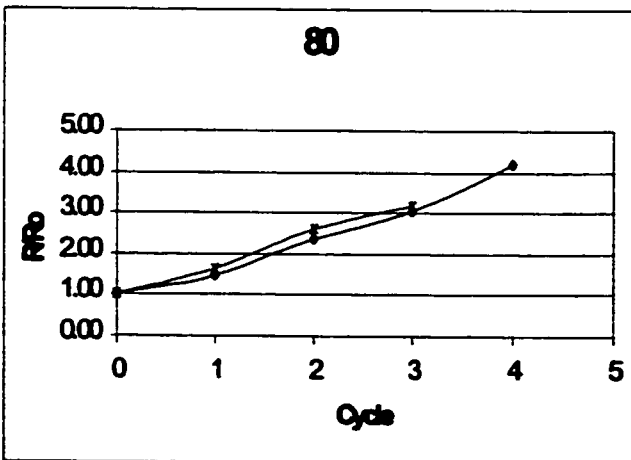
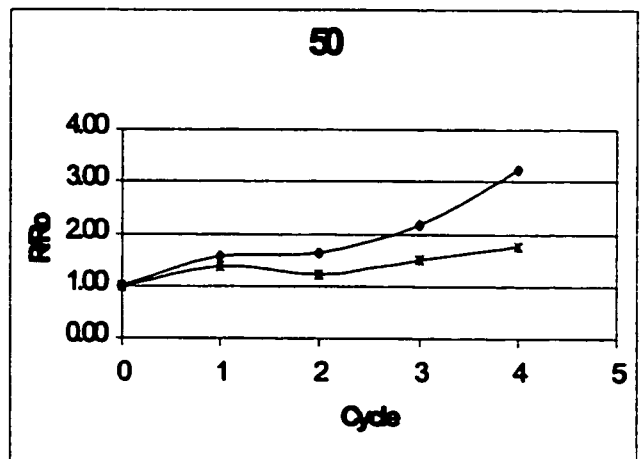
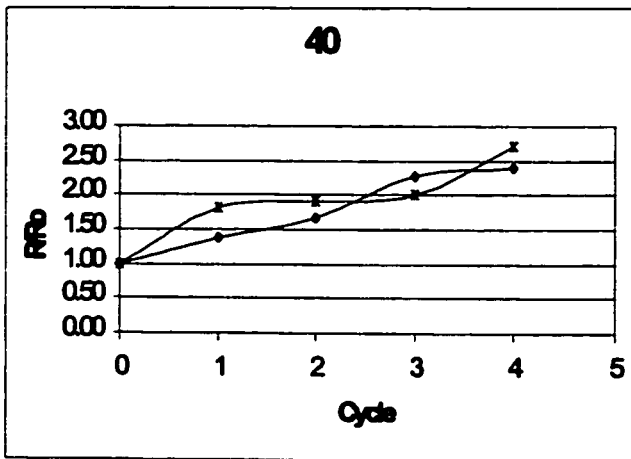
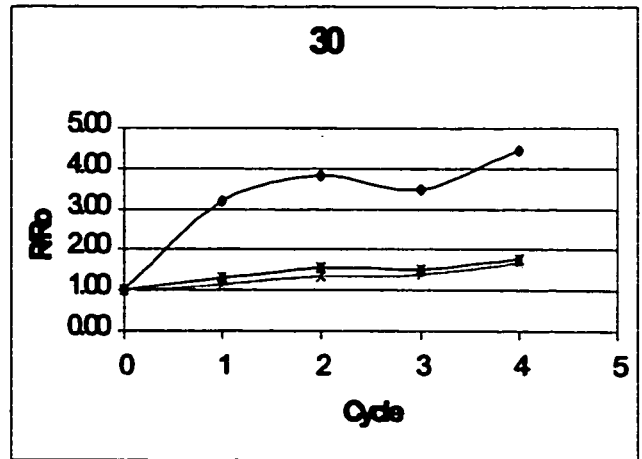
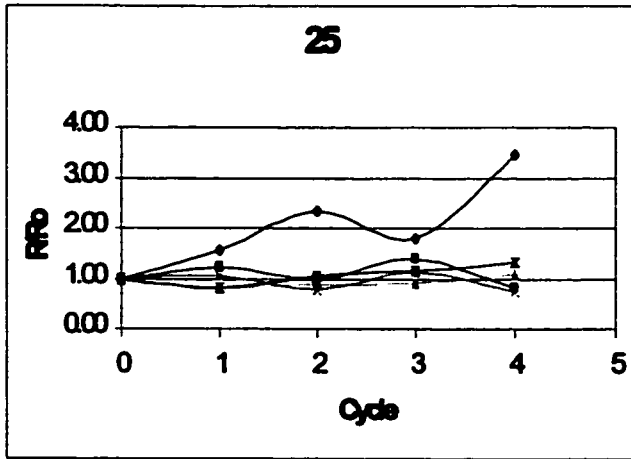
Graph 4.8: Variation in Phi, Saturated Calcium Hydroxide Solution

Trends for the w/c ratios 0.50 and higher, are opposite to the lower w/c ratios. This is because the alkali concentration in the pore solution will be reduced and the effect on the solubility of Ca(OH)_2 is diminished. The overall effect is dominated by the resistivity of the Ca(OH)_2 solution. The increase after one cycle can be attributed to the increased resistivity of the pore solution relative to the original pore solution. However, with subsequent drying-rewetting cycles, resistance continues to increase. This is because with continued cycles and a steady increase in the dissolution of alkali, the solubility of the Ca(OH)_2 in solution continues to change. The solubility becomes sufficiently low that the resistivity of the pore solution increases and this is reflected in the resistivity of the sample. The phi curves decrease for the higher w/c ratios, indicative of changes to the pore structure resulting in the pore size distribution becoming broader. Pore blocking effects due to the precipitation of Ca(OH)_2 are less pronounced than at low w/c ratios.

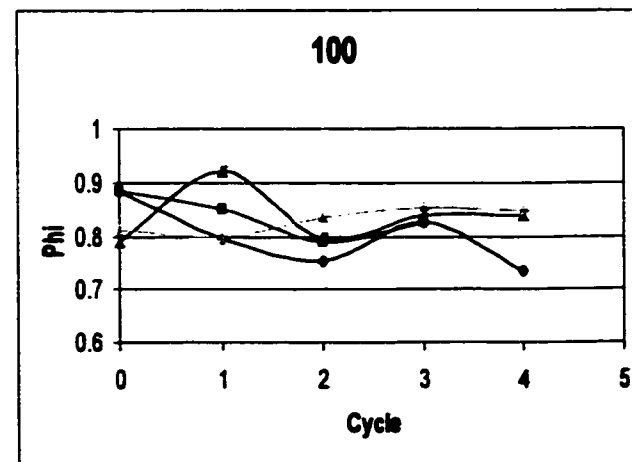
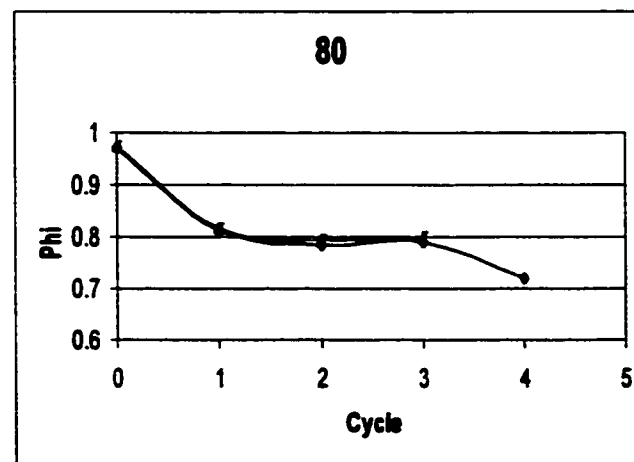
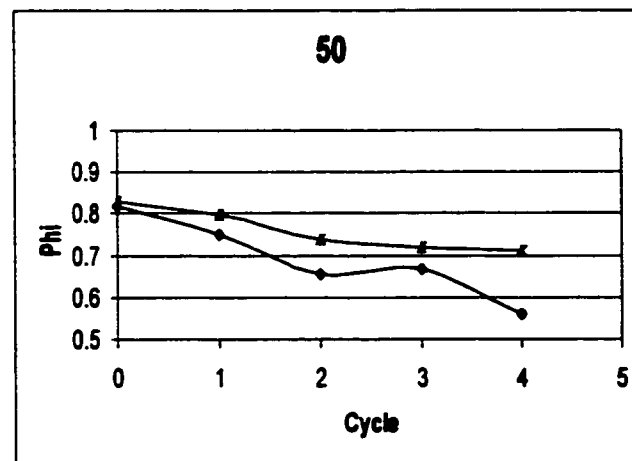
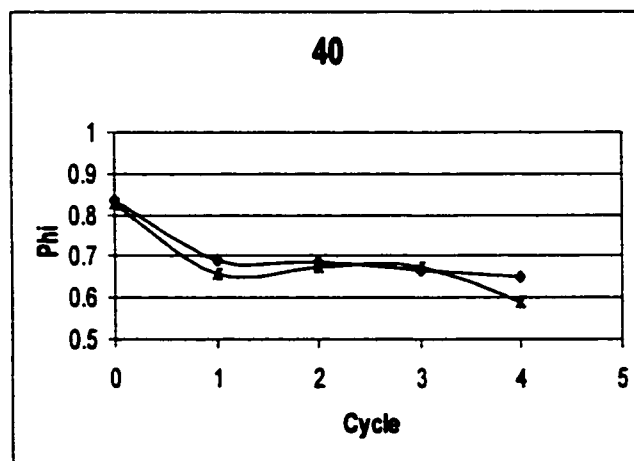
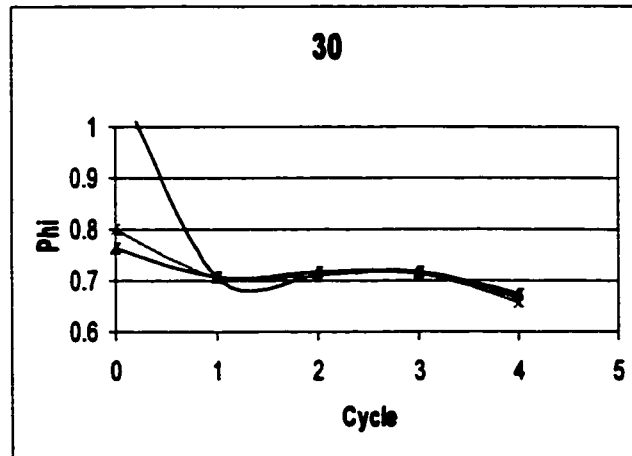
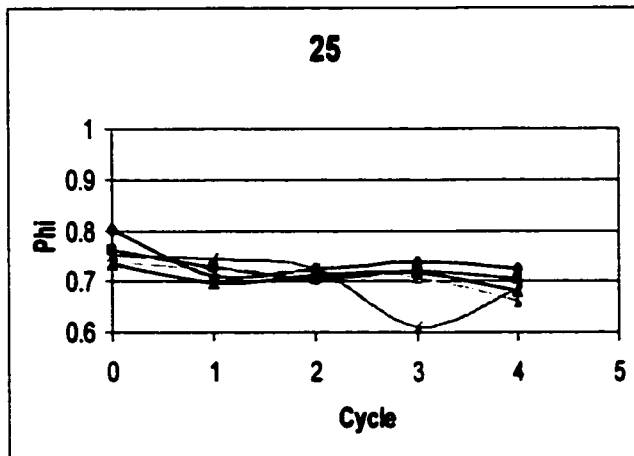
4.3.4.3 Distilled Water

The results for the specimens resaturated with distilled water are presented in Graphs 4.9 and 4.10. The resistance of each sample increases with drying-rewetting cycles. After one cycle it is expected that the resistance would increase because the resistivity of the pore solution within the test specimen has increased by a factor of at least 40. Therefore, the resistance of the entire paste would increase despite the pore coarsening on drying. Subsequent cycles of drying-rewetting, however, continue to increase the resistance of the sample. It is believed that leaching of free lime is occurring on resaturation of the specimens with distilled water. This made the calculation of the formation factor (ρ_p/ρ_s) inappropriate for these tests. The formation factor is associated with the porosity and permeability of a porous material.

Leaching of the free lime will decrease the resistivity of the distilled water. However, the cumulative effect of incremental pore coarsening and calcium hydroxide dissolution remains positive. That is the relative resistivity of the pore solution will increase with each cycle due to the reduced amount of free lime that dissolves and the increased pore solution volume with each cycle. Therefore, the resistance of hcp would be expected to increase as it does (even if the pore structure is coarsening) because the amount of electrolytes per unit volume of solution decreases with each drying-rewetting cycle and the pore size distribution is broadening.



Graph 4.9: 30 Years Hydration, Distilled Water



Graph 4.10: Variation in Phi, Distilled Water

Graph 4.10 shows the decrease in ϕ with each drying-rewetting cycle. This agrees with the analysis of the resistance values. As ϕ decreases, the depression angle increases implying that the pores are coarsening.

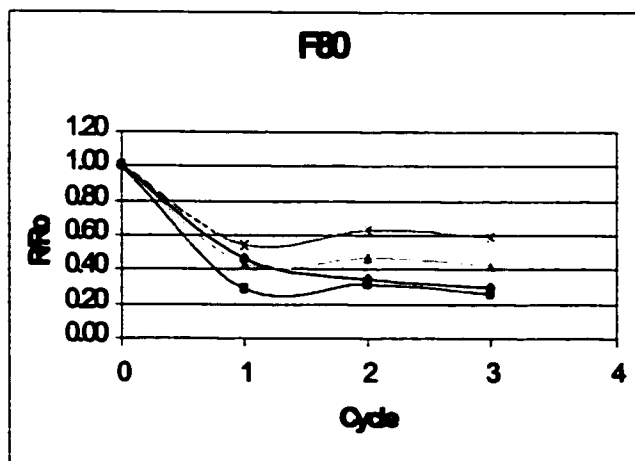
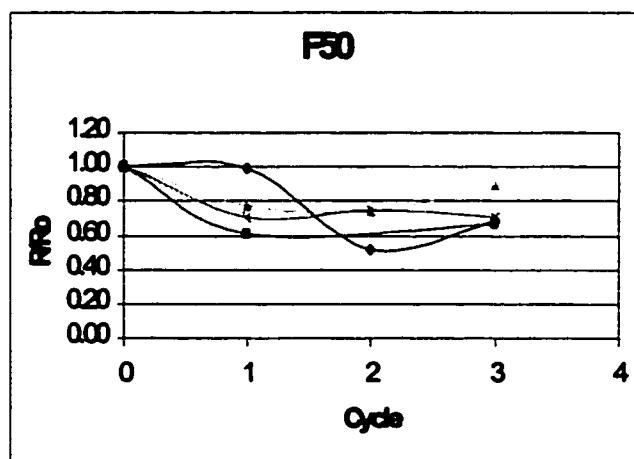
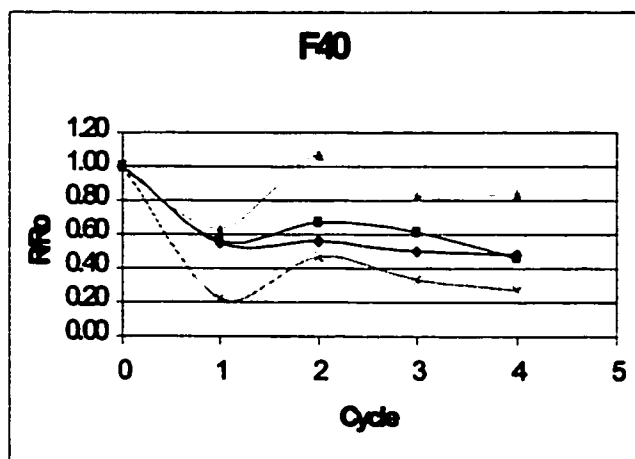
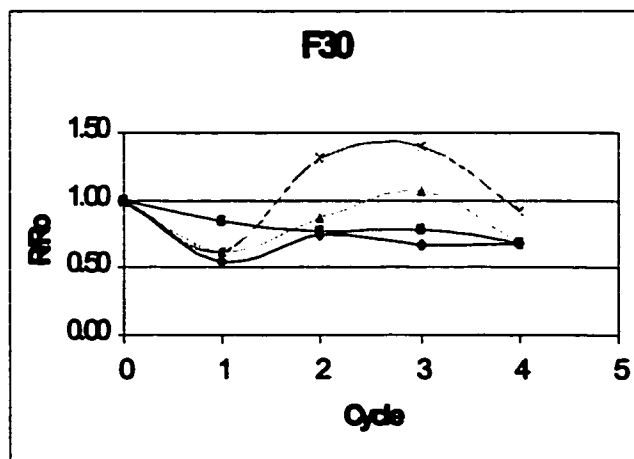
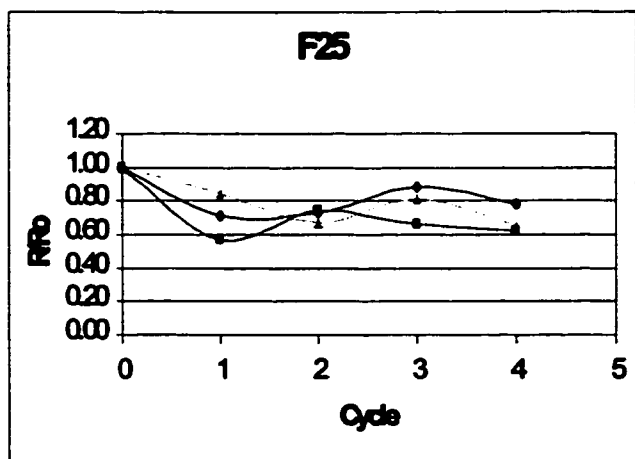
4.3.4.4 Early Age Results - 14 Days Hydration

The results for the samples hydrated for 14 days are less consistent, Graphs 4.11 and 4.12. There is greater variability between samples. The trend however of the sample resistance is in general agreement with the other results. Sample resistance decreases with drying-rewetting cycles as expected. Curing time appears to play a role in the behaviour of cement paste on drying. Changes to the resistance values after the second cycle of drying-rewetting are less significant for the samples with 14 days hydration than those with 30 years hydration.

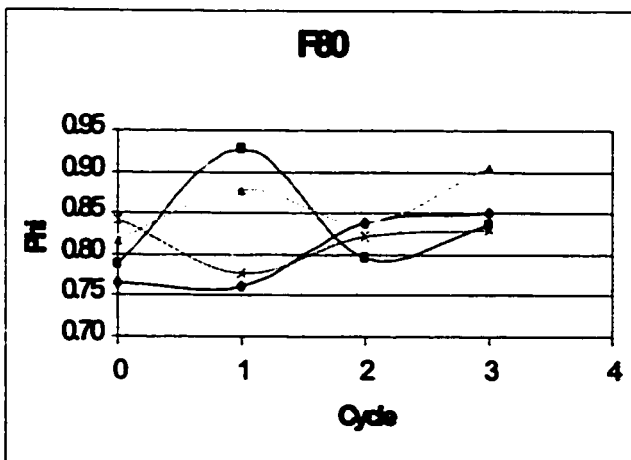
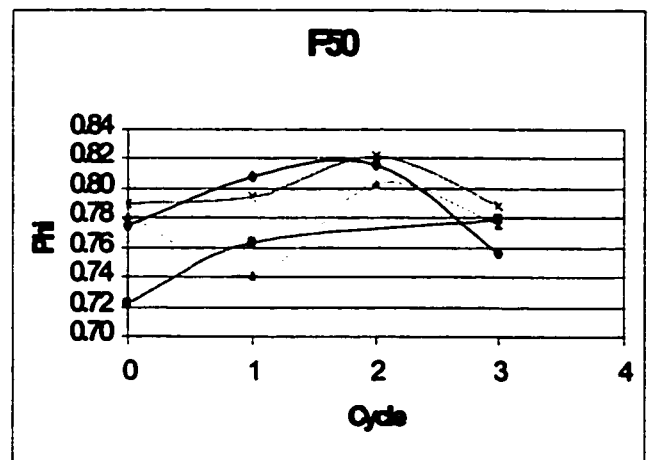
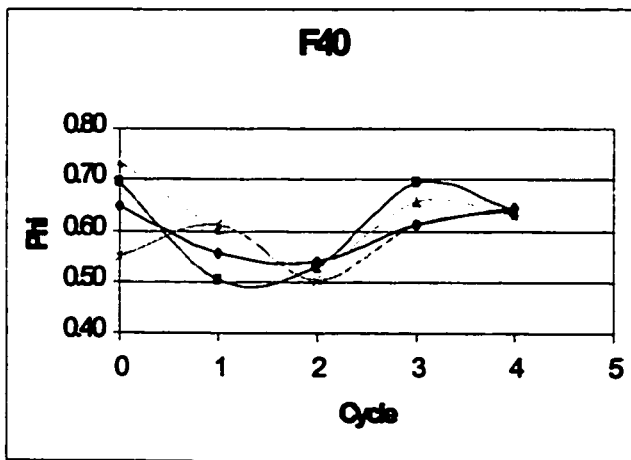
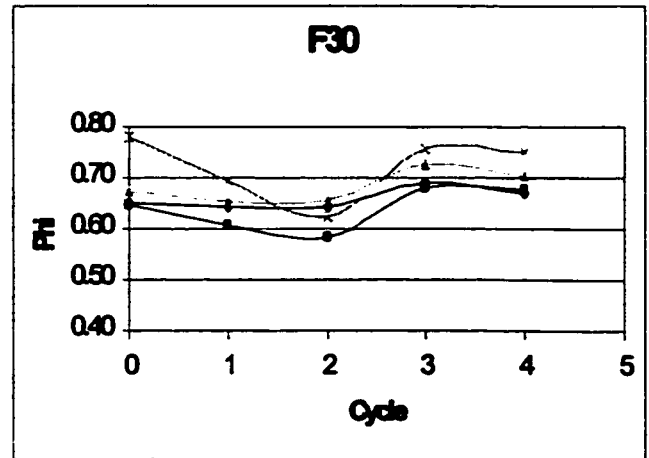
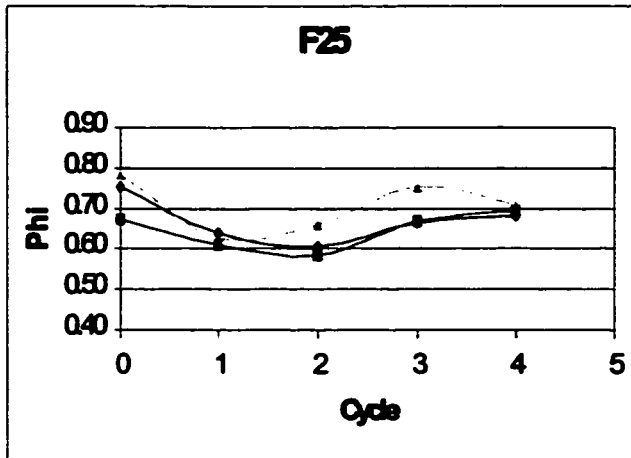
All the pastes had a lower resistance after one cycle of drying and rewetting than the original R_2 , see Graph 4.14. The paste samples with w/c ratio of 0.25 and 0.30 had similar results with their average R_2 after one cycle being 55% and 59% of the initial R_2 values respectively. This result is expected due to pore coarsening as previously discussed. For the remaining w/c ratios, the average changes in R_2 after one cycle of drying and rewetting are 0.37, 0.83 and 0.47 for w/c = 0.40, 0.50, and 0.80 respectively. There is no apparent correlation of the magnitude of the resistances after one cycle of drying and rewetting with respect to the w/c ratios. It was expected that the % R_2 after one cycle would increase with w/c ratio. The results do not exhibit a pattern between % R_2 after one cycle and w/c ratio. This could be due to the relatively low strengths that cement pastes have at 14 days hydration, and the inhomogeneous nature of the young pastes.

With subsequent cycles of drying and rewetting, the R_2 values are even more sporadic. For some samples the % R_2 values decrease and for others they increase. Small changes occur between % R_2 in the third and fourth cycles. The drying effects on the pore structure of cement paste are minimal after the third and fourth cycles resulting in small changes to R_2 .

The majority of the samples experience an increase in R_2 after the second or third cycle, over the R_2 recorded after the first drying and rewetting. All values for R_2 however remain below the initial R_2 value, indicating a net pore coarsening effect. The increase in R_2 values that was observed could be the result of an increase in hydration on wetting. This effect would be more



Graph 4.11: 14 Days Hydration, Synthetic Pore Solution



Graph 4.12: Variation in Phi, 14 Days Hydration

pronounced after the initial pore coarsening associated with the first cycle. Alternately, the limited hydration of the pastes has led to other pore structure effects. The drying process may have more impact (due to weaker solid-solid bonds) on the pore structure. For the cycles that result in an increasing R_2 , it may be due to the collapse of some capillary pores that caused the pore system to become discontinuous. The discontinuous pore system would result in a larger value for R_2 despite the expected increase in the average pore size.

R_2 does not have a relationship with the change in mass. The mass of each sample continually increases with each cycle. Therefore cracking is not causing the decrease in R_2 and signifies that pore collapse and coarsening occurs on drying altering the pore space that can be occupied by pore solution.

Overall, the behaviour of the 14 day samples is similar to the 30 year samples. The greatest change occurs on first drying and R_2 continues to have a net decrease with subsequent cycles. The changes in R_2 are due to changes in the pore structure on drying. The pores become enlarged and interconnected on drying.

Phi values are shown in Graph 4.12. The variation of phi with drying-rewetting cycles indicates that the pore structure is being changed. There is no clear and decisive trend among the results.

4.3.4.5 Three Months Hydration - Drying @ 100°C for 24 hours

These test samples were vacuum dried for 24 hours at 100°C instead of 38°C. They were hydrated for three months in saturated lime solution. There is more consistency between samples with the same w/c ratio when compared to samples cured for 14 days.

Drying at an increased temperature yielded similar R_2 results to those results obtained at 38°C. Most samples had an overall reduction in R_2 of approximately 50% independent of w/c ratio.

The increased drying affected the % change in mass and to a lesser extent the strain on the sample. A larger volume of the sample was affected but it did not change the path taken by the electrical current.

4.4 Conclusions

1. Dynamic drying-rewetting experiments using cement paste specimens enabled separation and estimation of the effects of capillary pores on volume change, electrical properties and pore structure.
2. Partial drying-rewetting cycles of hcp can produce a net swelling effect. Drying-rewetting effects lead to increased intercalation of C-S-H.
3. Evidence was provided for pore coarsening effects on drying of hcp based on length change and electrical characteristics.
4. A.C. Impedance spectroscopy was shown to be a useful tool for following microstructural change due to drying-rewetting effects.
5. The effects of pore solution chemistry on ACIS phenomena were explained and found to be consistent with mechanical strains observed on drying.
6. The dispersion angle changes in a manner consistent with changes to the pore structure of cement paste subjected to non-equilibrium wetting and drying cycles.
7. Curves of resistance versus cycles of wetting and drying for hcp containing various pore solutions can be explained in terms of the solubility characteristics of Ca(OH)_2 in the pore solution.
8. There is a linear relationship between the change in mass and the change in resistance of hcp subjected to drying and resaturation with synthetic pore solution.
9. Drying increases the pore continuity of hcp as indicated by the reduced resistance values of the hcp specimens consistent with the pore coarsening theory.

CHAPTER 5

FREEZING-THAWING PHENOMENA IN HYDRATED PORTLAND CEMENT PASTE

5.1 Introduction

The sensitivity of ACIS to changes in temperature was expected to provide detailed information about the changes in the hcp microstructure. In addition, the test specimens (believed to be the first of their kind) were designed to allow for length-change and ACIS measurements simultaneously. Tests measuring ACIS and length change simultaneously on hcp while undergoing cycles of freezing and thawing have not previously been reported and should provide useful and important data. Changes in ACIS spectra are extremely sensitive to freezing phenomena and may prove to be superior to volume change measurements, see Graph 5.1. Neat cement paste and others containing air entraining agents have been examined. Air entraining agents are commonly used to give concrete increased resistance to frost action. It was anticipated that ACIS parameters would correlate with the amount of water freezing and the average pore size in which it freezes. The degree of hysteresis of the ACIS parameters should be indicative of pore structure damage.

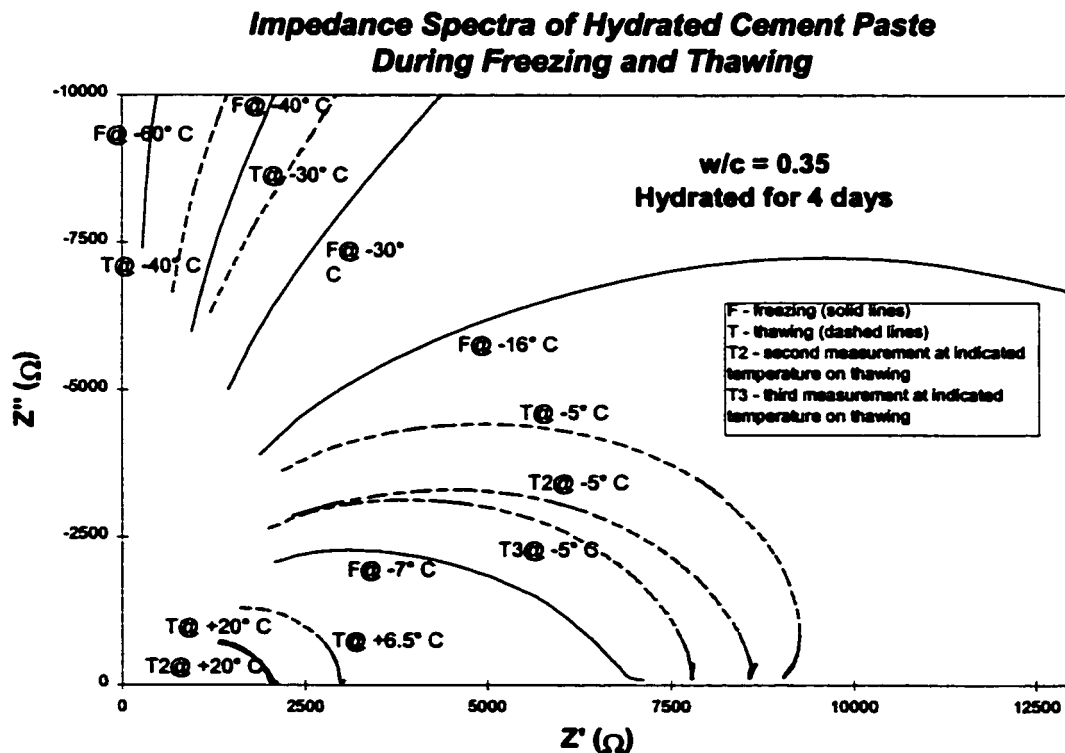
5.2 Results

The sensitivity of the electrical response of cement paste to temperature change is quite dramatic and informative. The information obtained from these experiments was complemented by traditional testing procedures, TMA and DSC, for studying the behaviour of cement paste that is subjected to freezing and thawing cycles. ACIS data was collected for cement paste specimens prepared at varying w/c ratios and hydration times under a variety of test conditions. Among the test specimens were non-air entrained neat cement paste samples, air entrained cement paste and some samples resaturated with a saline solution. The results clearly show that the ACIS technique can be used to evaluate the amount of pore water freezing within the system and the resultant damage to the pore structure on freezing.

5.2.1 Thermal Mechanical Analysis (TMA)

TMA measures the dimension change of a sample due to a variation of temperature. On freezing, the cement paste matrix contracts as most materials do. However, the pore water begins to move throughout the pore structure in search of a place to freeze. This movement causes the paste to expand when exposed to freezing temperatures. Graph 5.2 shows the curves of a paste with varying hydration times. It clearly shows the younger pastes have suffered frost damage. The expansion, hysteresis and residual length change are all large. The paste has not been able to accommodate the movement of the pore water. Refer to Table 5.1 for TMA results and to Appendix A for a complete set of curves.

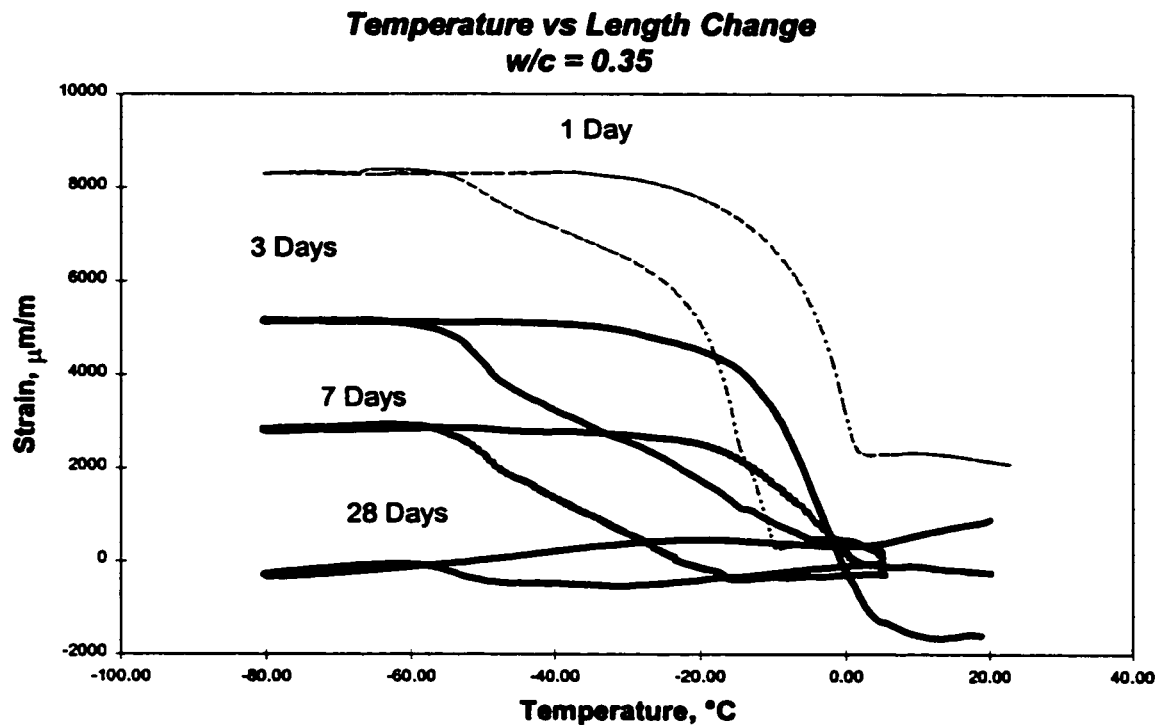
The rate of expansion varies with the movement of the pore water. Since ϕ from the equivalent circuit is also a function of the movement of pore water on freezing, the TMA graphs and the ϕ -T curves have similarities.



Graph 5.1: ACIS Nyquist Plots at Different Temperatures

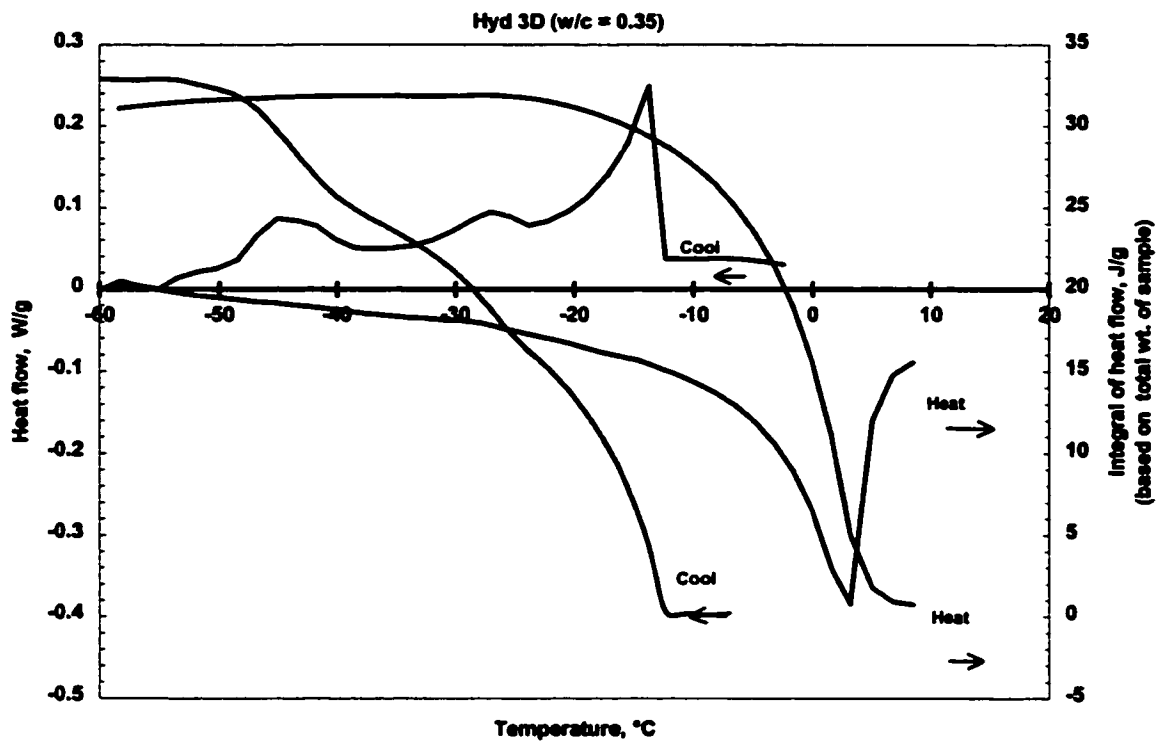
w/c ratio	Sample Hydration Time	Pore Solution	Pore Blockage Temperature (°C)	$\Delta\phi$ gear	$\Delta\phi$	Dilatation ($\mu\text{m/m}^\circ\text{C}$)	Residual Expansion ($\mu\text{m/m}$)	Incipient Freezing (°C) ACIS	Measure of Freezing ACIS (°C) DSC (J/g)
0.35	1 day	natural	-16	0.06	-0.038	157	2230	-8.0	75
0.35	3 days	natural	-25	0.05	-0.004	135	300	-11.5	21
0.35	7 days	natural	-28	0.06	-0.008	80	250	-13.0	15
					-0.022	50	-1000	-22.0	
0.35	7 days	5% salt	-25	0.14	0.06	188	7250	-8.0	64
0.35	28 days	5% salt	-11	0.04	0.15			-14.0	30
0.35	7 days	10% salt	-28	0.24	0.118	125	550	-17.0	27
0.35	28 days	10% salt	-23	0.03	0.028	225	-3000	-15.0	22
0.35	7 days	15% salt	-25	0.09	-0.054	100	-2500	-7.0	27
0.35	28 days	15% salt	-35	0.09	0.001	93	0	-21.0	8
0.35	105 days	15% salt				85	400	-26.2	8.77
0.35	7 days	$\rho = 50 \Omega$	-21	0.08	0.30	200	-2700		
0.35	7 days	$\rho = 50 \Omega$	-26	0.22	0.03	74	500	-16.1	34
0.35	28 days	$\rho = 50 \Omega$	-35	0.09	0.02	70	300	-16.0	
0.35	28 days	$\rho = 50 \Omega$	-37	0.07	0.04	100	300	-20.3	19
0.60	1 day	natural	-13	0.10		309	2207	-8.0	1080
0.60	7 days	natural	-26	0.06	-0.03	234	1200	-6.5	28
0.60	28 days	natural	-28	0.10	-0.04	310	2100	-16.0	19
0.60	7 days	5% salt	-8	0.11	-0.08	400	0	-15.5	38.05
0.60	28 days	5% salt				313	-7500	-15.3	27.00
0.60	7 days	10% salt	-26	0.37	0.70	223	1000	-13.0	400
0.60	28 days	10% salt	-25	0.29	0.35	208	500	-15.0	227
0.60	7 days	15% salt	-30	0.20	0.07	83	375	-19.0	126
0.60	28 days	15% salt	-24	0.04	0.08	93	450	-18.0	87
0.60	7 days	$\rho = 50 \Omega$	-15	0.18	-0.05	273	1400	-6.0	162
0.60	28 days	$\rho = 50 \Omega$	-18	0.19	-0.054	230	450	-8.0	76
9% Air Entrainment									
0.35	7 days	natural	-37	0.27	0.057	-13	160	-25.5	9
0.35	28 days	natural	-39	0.16	0.11	20	250	-8.5	7
0.35	28 days	5% salt	-8	0.08	0.033	53	535	-5.0	21
0.35	28 days	10% salt	-15	0.04	0.047	2	500	-16.2	5
0.60	28 days	natural	-16	0.18	0.023	240	1076	-16.0	10
								-12.2	16.20
								-18.4	4.60
								-16.7	11.80
								-15.1	6.60

Table 5.1: Results



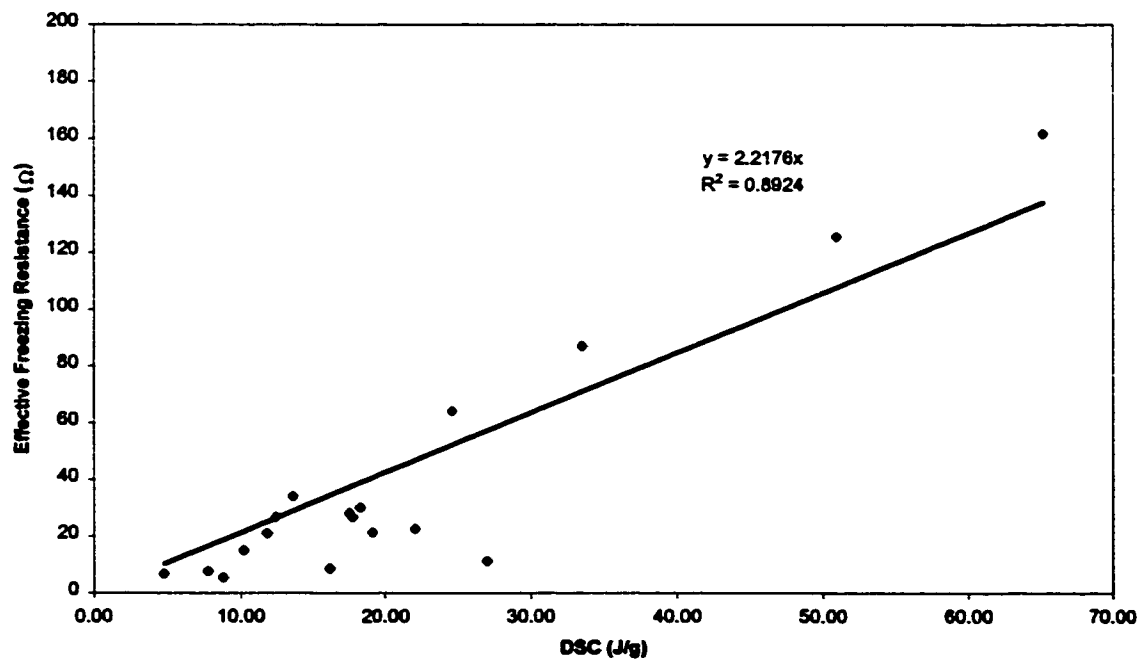
5.2.2 Differential Scanning Calorimetry (DSC)

DSC is effective at measuring the quantity of pore water freezing within a cement sample; a typical curve is illustrated by Graph 5.3 (refer to Appendix A for a complete set of curves). Incipient freezing can be clearly seen from the curve. The results of the DSC tests are tabulated in Table 5.1 along with information from the ACIS tests. Pore water freezing as indicated by DSC analysis correlates with the effective freezing resistance (that will be discussed later) calculated from the equivalent circuits, see Graph 5.4.



Graph 5.3: Typical DSC Curve

Pore Water Freezing



Graph 5.4: Correlation Between DSC and ACIS Results

5.2.3 Theoretical Discussion of the ACIS Response of Freezing Cement Paste

5.2.3.1 Overall Sample Resistance

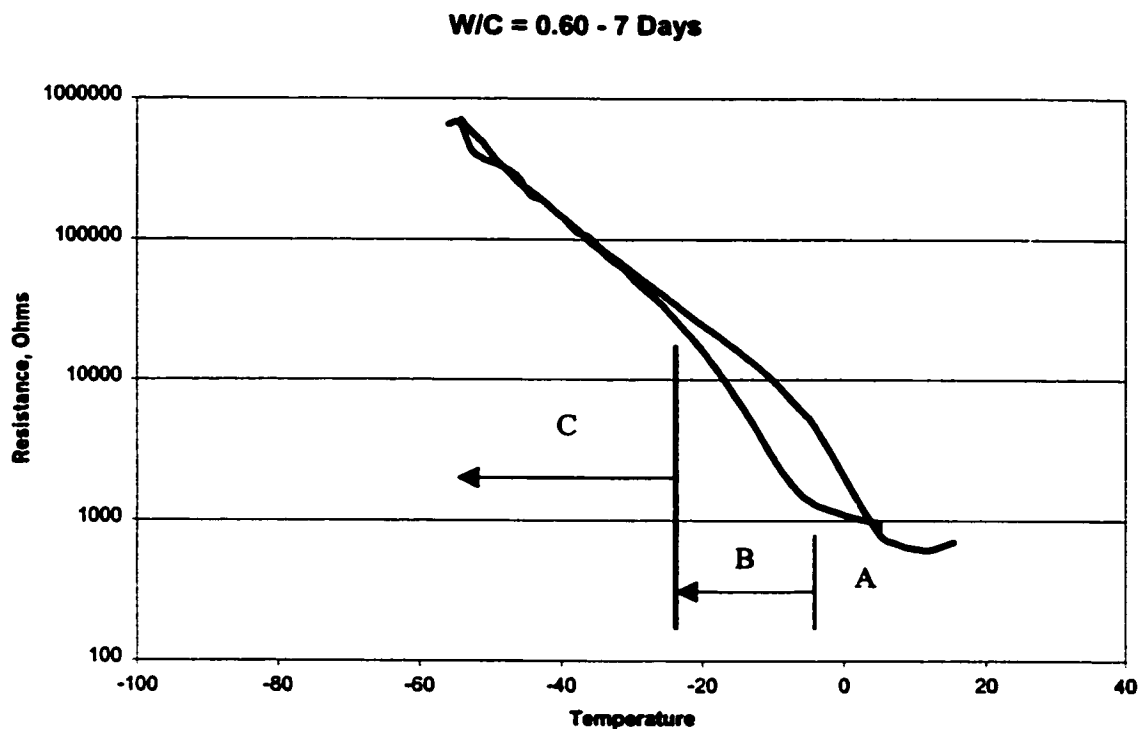
The increase in the resistance of cement paste on freezing is due to a combination of factors. The resistance of most materials will increase with a decrease in temperature. This is mainly caused by the decrease in activity of the ions carrying the electrical signal. The lower the temperature, the slower the response time of the ions therefore increasing the overall resistance of the material. Since the electrical signal is primarily transmitted through the cement paste by the electrolytes dissolved in the pore solution, the overall resistance depends on the conductivity of the pore solution and the tortuosity and connectivity of the pore system of the cement paste.

As the temperature of the paste is lowered and approaches incipient freezing, the increased resistance of the paste results from the decrease in conductivity of the pore solution. Once the temperature is lowered below the triple point of water, 0° C, the pore water becomes supercooled and searches for a location with a lower vapour pressure. These locations are the larger pores within the cement paste where freezing occurs first at about -8° C, the incipient freezing temperature of the pore water of cement paste. This movement of the pore water also affects the electrical response of the cement paste. As the supercooled water tries to find a lower vapour pressure, it will exhaust all possibilities of locating relief. In doing so, it may pass through more restrictive passages that are less connected to the pore system and have a higher degree of tortuosity, thus increasing the resistance of the paste. Once the pore water has reached a location where freezing can occur it further increases the overall resistance of the paste by freezing.

Ice has an extremely high resistance if it conducts electricity at all. In its purest form, ice is an insulator. The overall effect of the freezing pore water is to make the pore system discontinuous. The discontinuous pore system makes it extremely difficult for the electrical signal to be transmitted through the sample. The signal is forced to travel through the smaller pores that have less connectivity but are still connected to the pore network through unfrozen pores.

The change of resistance with temperature is best described with a semi-log graph. Each time the slope of the resistance-temperature curve changes, a different freezing mechanism is occurring. In the first section of the curve (A), see Graph 5.5, the increased resistance is occurring due to the reduced conductivity of the pore solution and the movement of the pore water. The first change

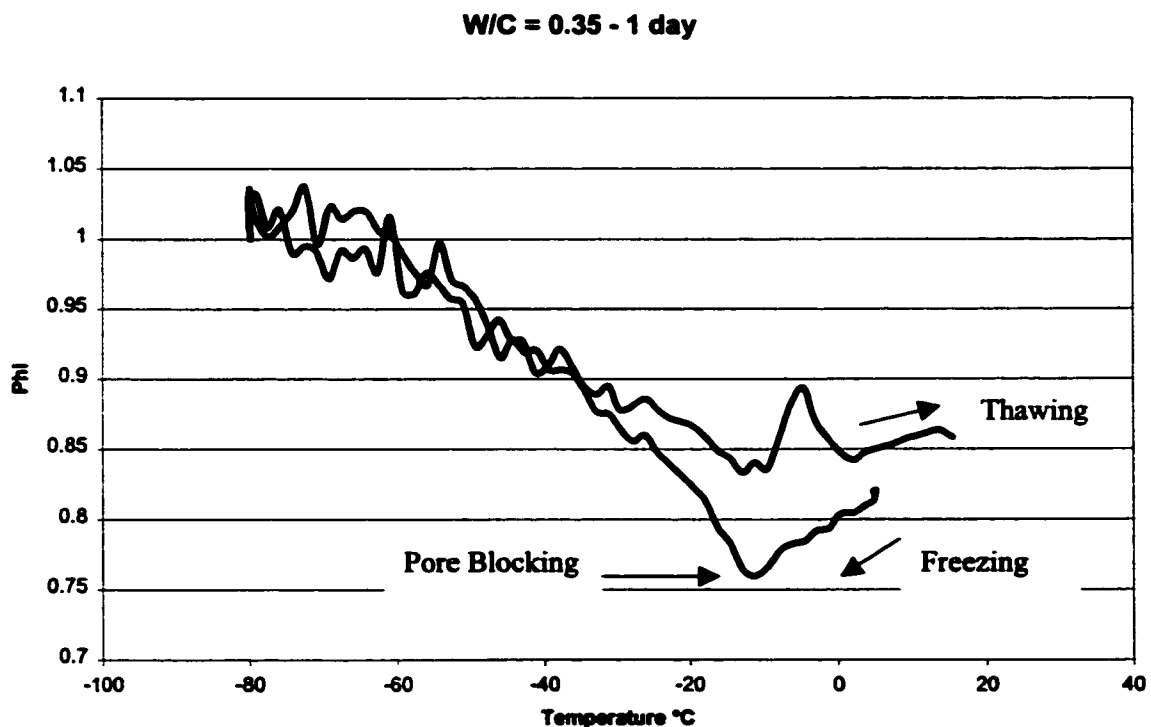
in slope of the resistance-temperature curve indicates that freezing has begun (B). Any subsequent change of slopes indicates that either primary freezing is no longer occurring or that secondary freezing is occurring (C).



5.2.3.2 Depression Angle and Phi of the Constant Phase Element (CPE)

The phenomenon of the depressed arc on the Nyquist plot can be approximated using a constant phase element in the equivalent circuit. The CPE is necessary to compensate for the surface inhomogeneity and fractal geometry of the cement paste pore system. The dispersion angle (α_d) of the hfa is represented by the parameter phi (ϕ) in the equivalent circuit. It has an inverse relationship with ϕ ($\phi = 1 - 2\alpha_d / \pi$). The greater the degree of inhomogeneity of the sample, the larger the dispersion angle and therefore the smaller is ϕ . A uniform pore structure is indicated by a phi value equal to one. The lower the value of phi, the broader the pore size distribution. The results clearly show a relationship between ϕ and temperature. The effects of the surface inhomogeneity of cement paste change with temperature and produce dynamic results for ϕ .

A typical ϕ -Temperature curve is shown in graph 5.6. It is apparent that ϕ is affected by the changes occurring within the pore system on freezing. The initial decrease in the value of ϕ with a decrease in temperature coincides with the occurrence of two phenomena - some nucleation and formation of ice and the movement of water. The movement of water increases as the temperature decreases and has a dominant influence on the value of ϕ . Greater movement of water is analogous to movement through a more open pore structure (with a broader distribution of pores) in a paste system subjected to an externally applied pressure gradient. This is true even though the pore volume is actually reduced slightly as ice begins to nucleate. The movement of the pore water on freezing increases the effects of surface inhomogeneity and pore blocking resulting subsequently in a larger value of ϕ . This can be explained by the need of the pore water to search out a lower vapour pressure on freezing. The pore water will exhaust all possibilities of finding relief and in the process pass through more restricted areas of increased roughness.



Graph 5.6: Phi - Temperature Curve

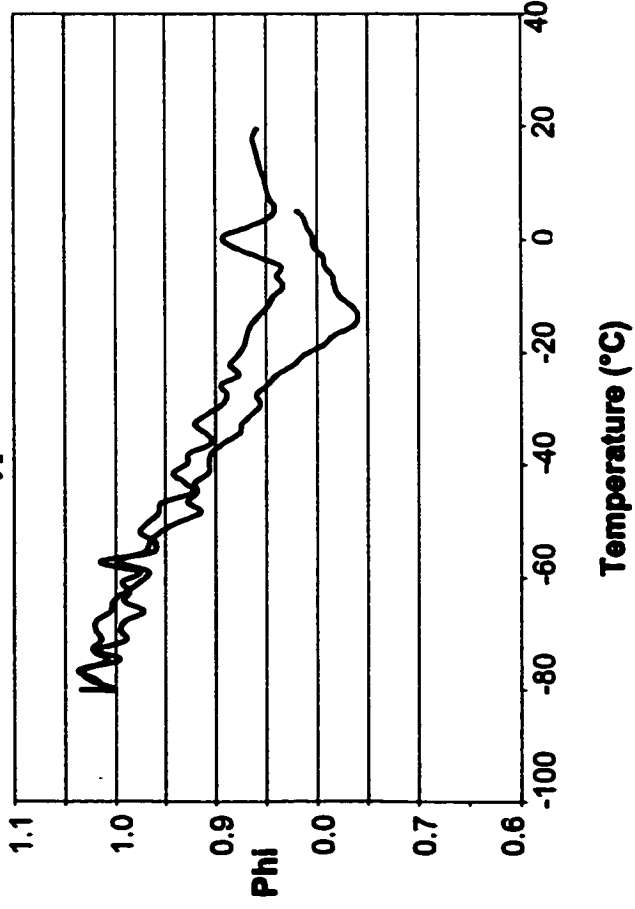
The minimum value of ϕ is related to a significant amount of ice formation that fills entire pores and blocks electrical pathways. The ice is causing the pore system to be disconnected. Since ice

forms first in the larger pores, the effect of the ice formation is to reduce the effective pore size distribution. The ice filled pores will no longer conduct electricity and the smaller pores will only be represented in ϕ . As a result of the blocked passage ways, the pore water has less mobility and ϕ will begin to increase. The temperature at which ϕ is minimum has been termed the blocking temperature. The parameter ϕ will continue to increase as the temperature is lowered below the pore blocking temperature. Beyond -40°C , virtually all the pore water capable of freezing has frozen yet ϕ continues to increase. This could be due to the pore water in the micropores that continue to be more 'ordered' with the decrease in temperature. A phase transition at approximately -90°C is known to occur. This may cause the electrical current to travel along a smoother path and be shielded from the roughness of the pore surfaces.

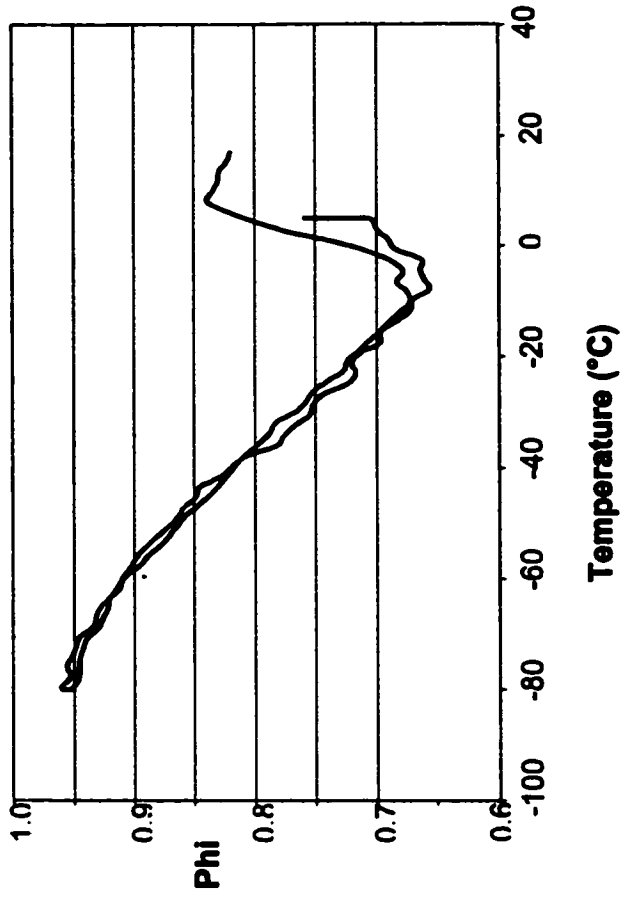
5.2.3.3 Types of Phi Curves

The variation of pore size distributions in the test specimens is evident in the range of ϕ -T curves obtained. In the results, there are four different types of ϕ -T curves that reflect different pore structures. The curves are defined by the change in ϕ before blocking occurs, the temperature range of the blocking temperature, and the shape of the curve at minimum ϕ . Graph 5.7 illustrates the four different curves on freezing. The first curve has a large change of ϕ before blockage and no significant change of slope (prior to blockage) due to freezing. This implies a large pore size distribution that is well connected. Incipient freezing and blockage of the pores occur at similar temperatures. Type two, is defined by a small change of ϕ before blocking and an early blocking temperature. This curve suggests a discontinuous system of large pores and has implications when freezing occurs in the presence of salt solutions due to the early blockage. The shape of the third curve indicates a large, broad pore size distribution. It has a large change in ϕ before pore blockage and changes slope on freezing. The pore blocking temperature is low. Pastes with air entrainment usually follow this shape. Contrasting the deep valleys mentioned in the curves above, the fourth curve is shallow with a small change in ϕ before blocking and has a flat section before climbing upwards. This curve implies a uniform pore structure that results in older pastes due to the additional hydration. The pore blocking temperature is usually low.

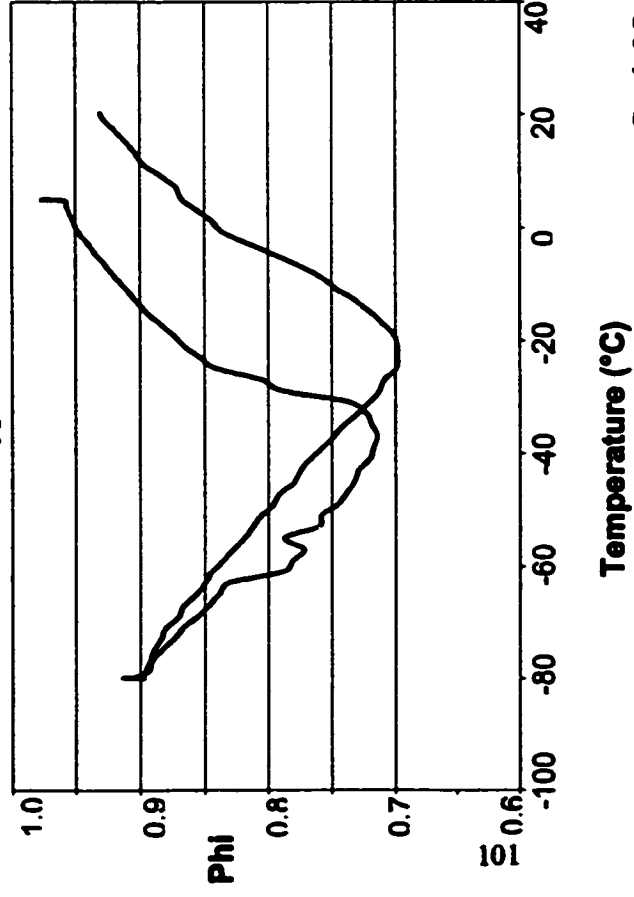
Type 1



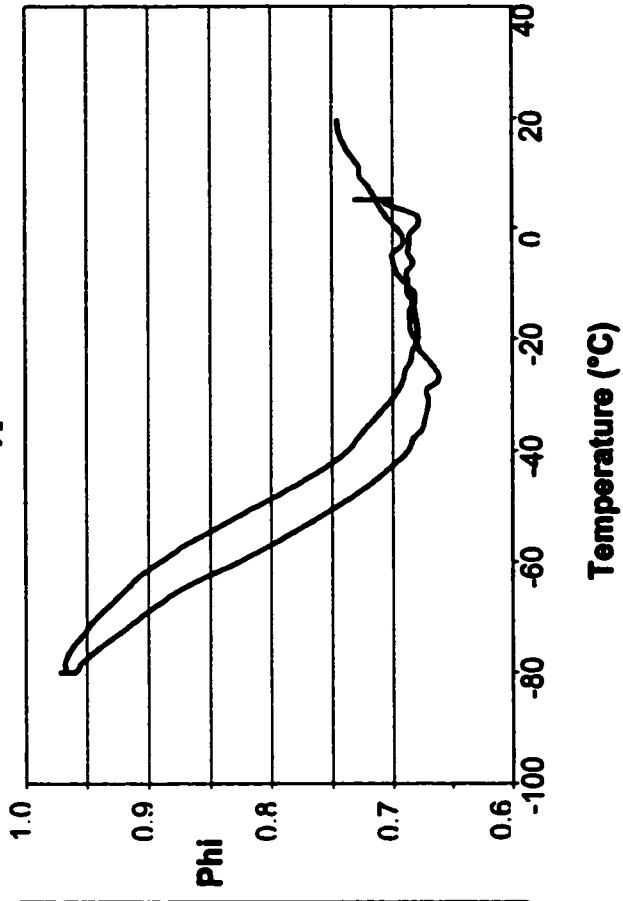
Type 2



Type 3



Type 4



Graph 5.7: Types of Phi Curves

5.2.3.4 Resistance and Phi Combined

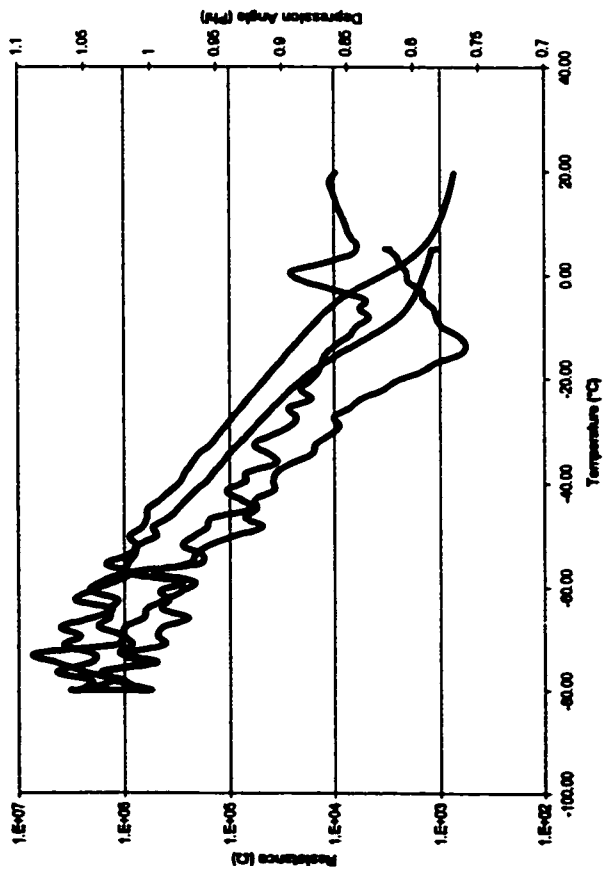
The two graphs (resistance and ϕ versus temperature) are very closely related. One event occurring within the sample will be indicated by a change in both curves. Resistance reflects the amount of pore water freezing within the sample whereas phi represents the effect that freezing has on the effective pore size distribution. The evaluation of the information provided in both curves will give a good indication of the damage resulting from the freezing-thawing cycle. Interpreting the freezing-thawing behaviour of the sample from either curve independently may lead to misleading results.

5.3 W/C = 0.35 – Natural Porewater Condition

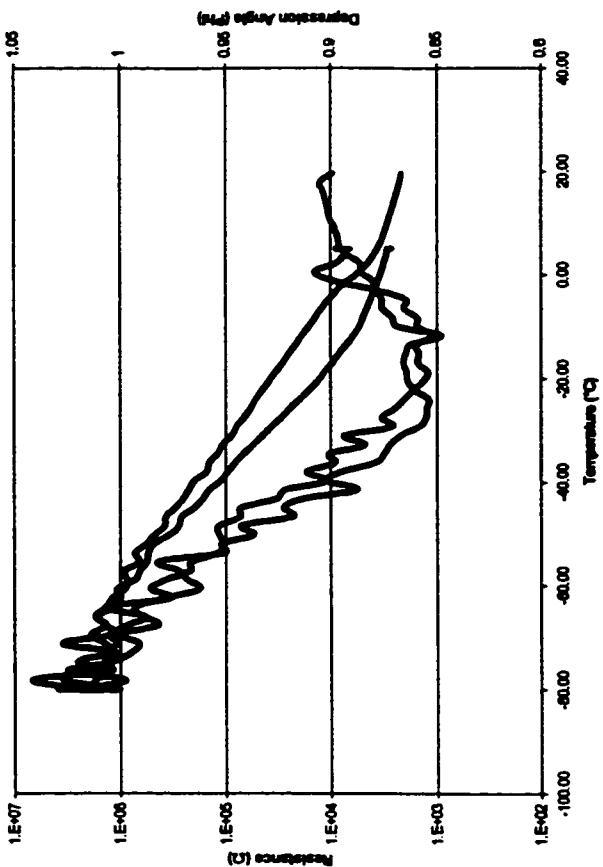
Samples of saturated cement paste with a w/c ratio of 0.35 were tested at 1 day, 7 days, and 28 days hydration and the results are illustrated in Graphs 5.8. The initial resistance of the sample increases with hydration time because the pore system becomes increasingly disconnected with time. In addition, the conductivity of the pore solution decreases as hydration continues increasing the overall resistance of the sample. With each sample, the resistance increases with the decrease in temperature. There is a sharp increase in the resistance when freezing of the pore solution commences. The incipient freezing temperatures of the samples as indicated by the AC impedance data decrease with increased hydration. This can be explained by the finer pore distribution that is created as hydration continues. The increased vapour pressure associated with the smaller pores reduces the incipient freezing temperature.

It is apparent from the graphs that the less hydrated samples go through a larger range of resistances on freezing. For the sample hydrated one day, the slope of the resistance-temperature curve after freezing has begun is the steepest and the most distinctive of all the samples. The slope changes of the 28 day sample are more subtle. This can be explained by the amount of pore water in each sample freezing. The younger the paste, the larger the pore structure and the more pore water there is available to freeze. Resistance will be affected by the amount of freezing pore water and the size of the pore in which it has frozen. The one day sample has the greatest increase in resistance because it is the most porous and therefore contains more pore water available to freeze. Its pore structure is initially very open and will be able to conduct the

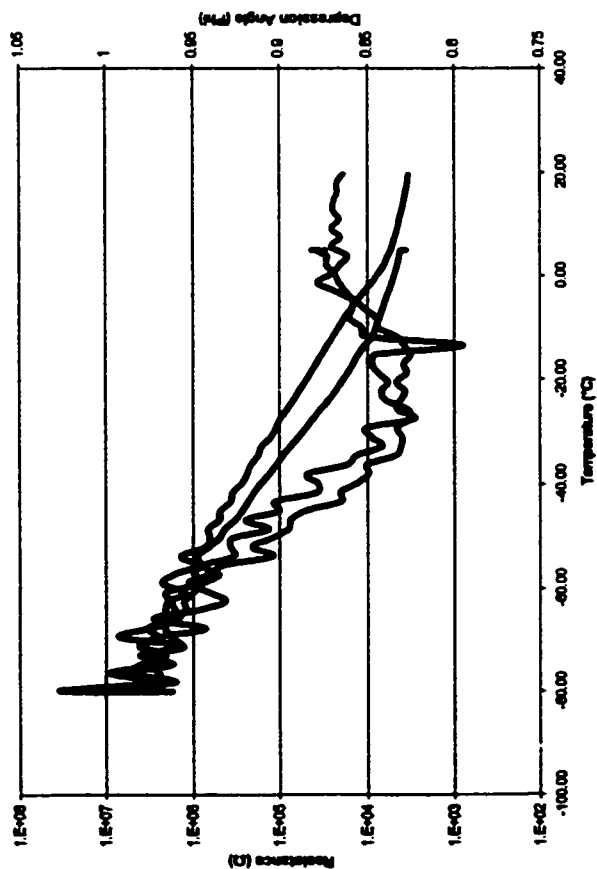
W/C = 0.35 - 1 Day



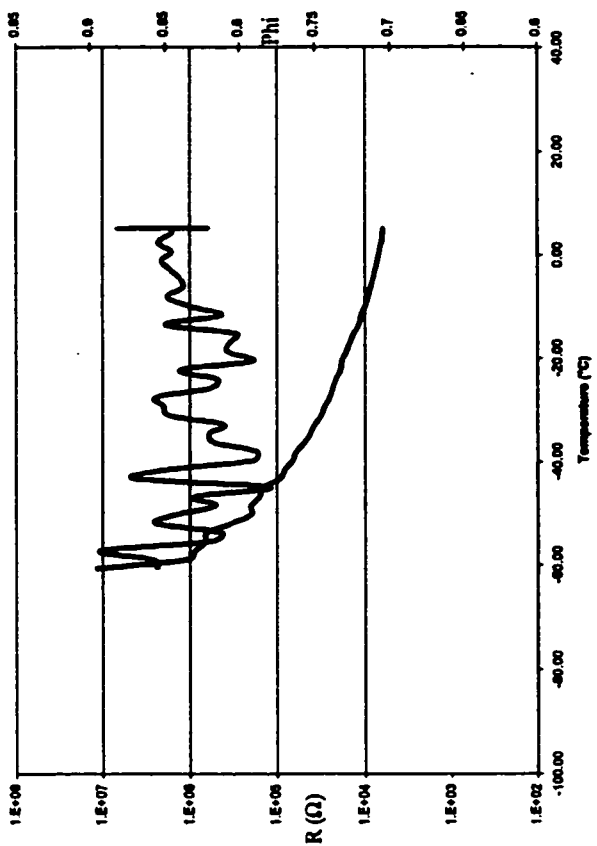
W/C = 0.35 - 3 Day



W/C = 0.35 - 7 Day

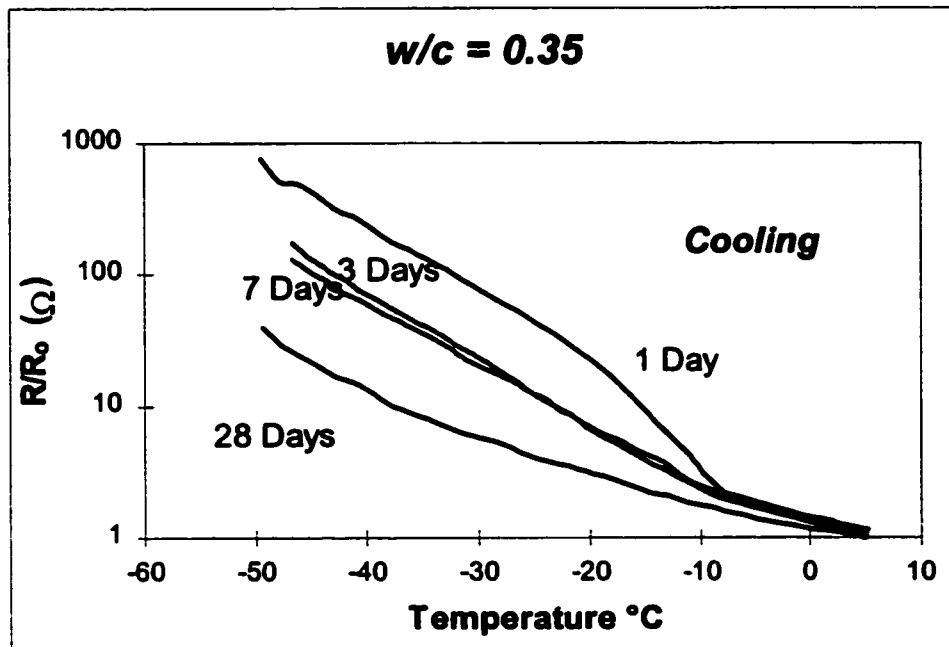


W/C = 0.35 - 28 Days



Graph 5.8: ACIS Results, w/c=0.35, Varying Hydration Times

electrical current with relative ease. The water in the larger pores freezes first and starts to hinder the flow of the electrical current thereby increasing the resistance of the sample. The resistance will continue to increase rapidly while there is still pore water freezing. Eventually, all the pore water that is available to freeze will have frozen and the resistance will continue to increase at a decreased rate due solely to a decrease in temperature.



Graph 5.9: Normalized Resistance, w/c = 0.35

The effective freezing resistance, $(R_{-40} - R_{if})/R_{if}$, was calculated for all the samples using a base resistance at -40°C and the resistance at incipient freezing as the initial reading. As was expected, the relative change in resistance decreased with increased hydration which in turn decreases the amount of water available to freeze. The relative change in resistance is greatest for the samples with a large, well-connected pore structure. The freezing pore water has a greater effect on the overall resistance of the sample. Before freezing the current travels through the open pore structure with ease. Once freezing begins, the non-conducting ice restricts the flow of the electrical current and increases the resistance of the sample. The resistance of all the samples regardless of the hydration time approach similar values of resistance. This is because all the pore water capable of freezing has and now all the samples have similar effective pore size distributions. The samples with initial open pore structures and a larger pore water content will have more freezing and will therefore experience a larger range of resistances. This can clearly

be seen from Graph 5.9 plotting R/R_o versus temperature. Samples tested at lower hydration times experience much higher normalized resistances than the samples with 28 days of hydration.

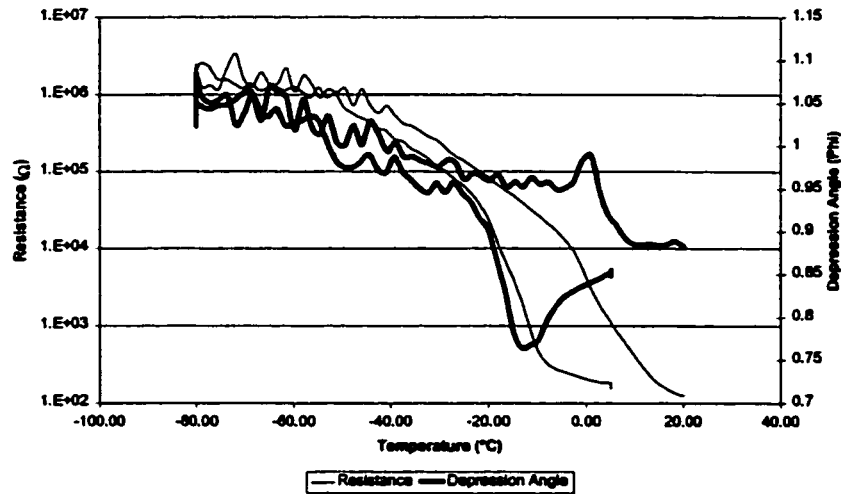
To supplement the information obtained from analyzing the resistance of the cement paste samples on freezing, ϕ (which is a function of the depression angle) versus temperature is plotted for the same samples. The effect that freezing has on the depression angle of the Nyquist Plot is not similar to the behaviour of the resistance of the sample.

The samples with $w/c = 0.35$ behaved predictably. The dispersion angle parameter, ϕ , of the initial readings increased with hydration to reflect the greater number of finer pores that results from hydration and hence increased surface roughness. As the temperature decreases, ϕ decreases. With each sample, there is a change in slope when freezing begins. The blocking temperature (at minimum ϕ) decreases with increased hydration. This can be explained by the inability of the electrical current to bypass the freezing pore water. It may be assumed that the samples with an open pore structure (and hence a greater amount of ice) have fewer pathways through which the electrical current may pass. These pathways become blocked very easily because they contain many large pores that freeze easily. The flow of the electrical current becomes restricted quite rapidly and has fewer alternate paths to pursue. Therefore, the younger pastes will experience pore blockage at higher temperatures than more mature pastes. ϕ will continue to change while the pore water within the paste is unstable and searching for a lower vapour pressure.

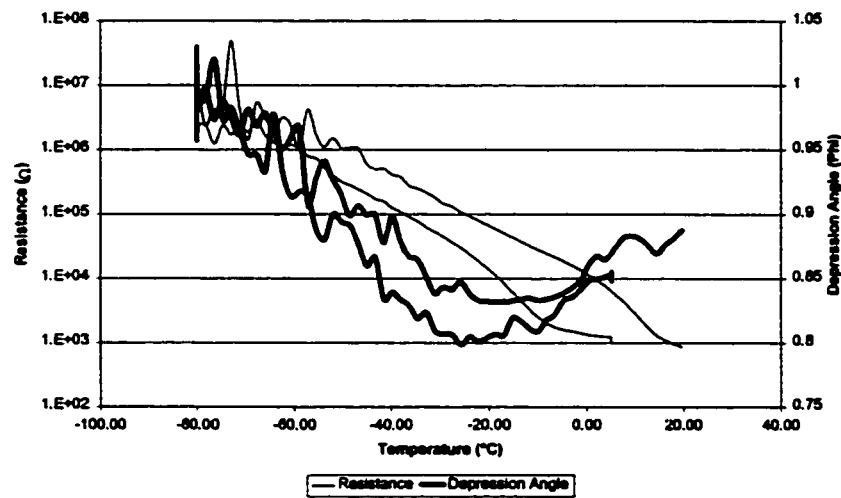
ϕ continues to increase even after the majority of the freezing has been completed. This means that the pore water never reaches an equilibrium state. The water in the micropores never 'freezes' but becomes more 'ordered' which could have the effect of reducing the roughness of the pores.

In several of the curves for the younger pastes, there are some obvious peaks in the ϕ -temperature relationship that correlate with significant slope changes in the resistance-temperature curves of the same sample. Both are related to ice nucleation (at least indirectly) and hence this is expected. This indicates either an air pocket that became water filled and freezes or more likely damage to the pore structure as the pressure from an ice front exceeds the strength of the paste.

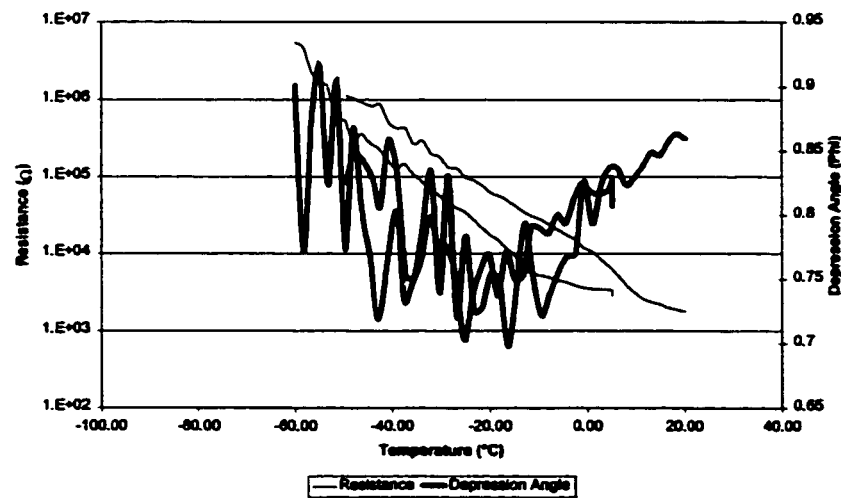
W/C = 0.60 - 1 Day Hydration



W/C = 0.60 - 7 Days Hydration



W/C = 0.60 - 28 Days Hydration



Graph 5.10: ACIS Curves – w/c = 0.60

5.4 W/C = 0.60 – Natural Porewater Condition

Samples with a w/c ratio of 0.60, Graph 5.10, behaved much differently than the 0.35 w/c ratio samples. The difference in pore structure significantly affected their behaviour on freezing.

The sample tested at one day of hydration, had a pore system that contained very large and connected pores. On freezing, the solution in the pores froze easily and the resistance increased rapidly at relatively high temperatures. The majority of freezing occurs above -25°C and this is reflected in the resistance curve by the majority of the increase of the effective R value by -25°C . The slope of the resistance-temperature curve after freezing is the greatest for one day of hydration because it has the pore structure with the most large pores. Hysteresis (both resistance and phi versus temperature) is apparent on thawing. The incipient freezing temperature decreases with increased hydration and therefore decreased porosity.

The curve of phi versus temperature after one day of hydration goes through a large range of ϕ values before reaching a minimum. It exhibits a deep valley once freezing begins. The pore blocking temperature is relatively high at -12.9°C . The curve stabilizes at approximately -25°C at which point the majority of the freezing has occurred. On thawing, the phi-temperature curve undergoes a complete change in shape. There is a peak in the curve where there is a significant amount of thawing. The change in the shape of the phi curve indicates that the freezing has damaged the pore structure.

After seven days of hydration, the porosity of the sample is reduced and this leads to less ice formation. This is indicated on the resistance-temperature curve by a reduced effective freezing resistance after 7 days as opposed to one day. The slope of the curve after freezing is more gentle and the effective R value continues to increase until -50.2°C . The phi-temperature curve does not exhibit as distinct a valley as after one day but has a gentle bowl shaped minimum. The blocking temperature is at -25.8°C . Hysteresis of approximately 10°C occurs on thawing and there is a small peak at approximately 15°C . The more shallow ϕ -T curve on freezing reflects the more uniform and closed pore structure.

With continued hydration, the behaviour of the sample on freezing becomes more restrained. The resistance-temperature curve has a smaller increase in effective resistance and the slope continues

to decrease. The phi curve goes through a smaller range on freezing and the blocking temperature decreases. Hysteresis decreases and the shape of both the freezing and thawing curve are similar indicating that significant damage is unlikely.

5.5 Resaturation with Salt Solutions and Synthetic Pore Solution

In order to facilitate the resaturation of the samples, the specimens were placed under a vacuum for three hours and then covered in the resaturating solution for eighteen hours while still under vacuum. This process alters the pore structure of the cement paste. Therefore, in addition to resaturating the samples with salt solutions, similar samples were resaturated with a synthetic pore solution. To prepare the latter solution, saturated calcium hydroxide solution was used as a base and potassium chloride was added until the mixture produced the same resistivity as natural pore water, $\rho=50 \Omega$. The effects of the salt solution on the behaviour of specimens during a freezing and thawing cycle were then compared to the specimens resaturated with the synthetic pore solution.

Putting the samples under a vacuum dries them. The process of drawing out the pore water alters the pore structure of the cement paste. This leaves the pore structure coarsened which reduces the resistance of the sample. The most significant effect is on the samples with low porosity and small pores, i.e. greater hydration times and lower w/c ratios. This manifests as an increased effective resistance on freezing with the effect decreasing with increased porosity of the original sample.

Resaturating the samples with salt solutions (5%, 10%, and 15% NaCl) reduces its overall resistance. This is due to the increase in conductivity of the salt solution over the synthetic pore solution, Table 5.2. The conductivity of the salt solutions increases with the percentage of salt added which further reduces the resistance of the samples when compared to those resaturated with the synthetic pore solution, see Figure 5.1.

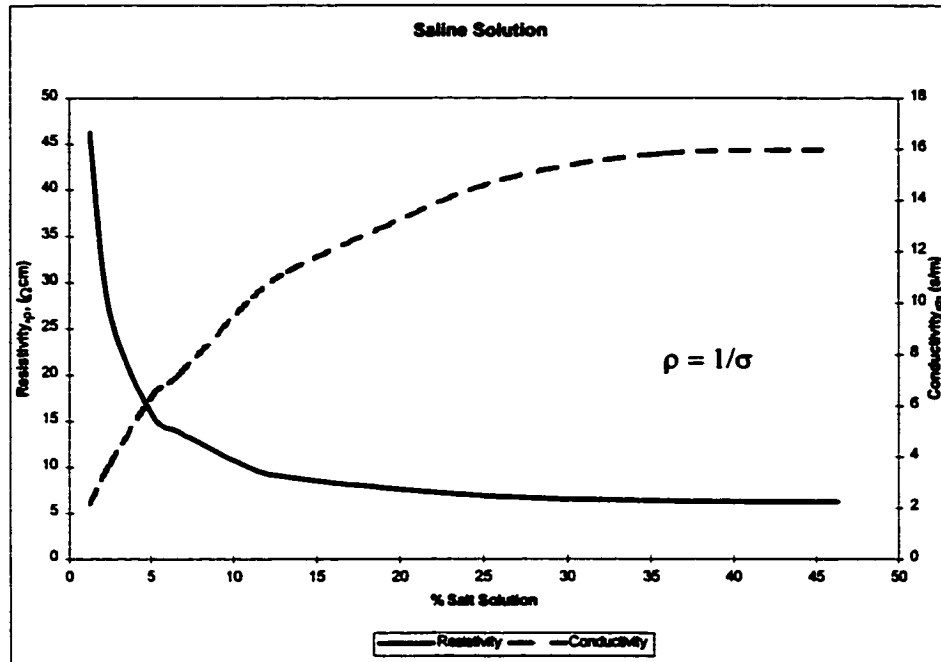
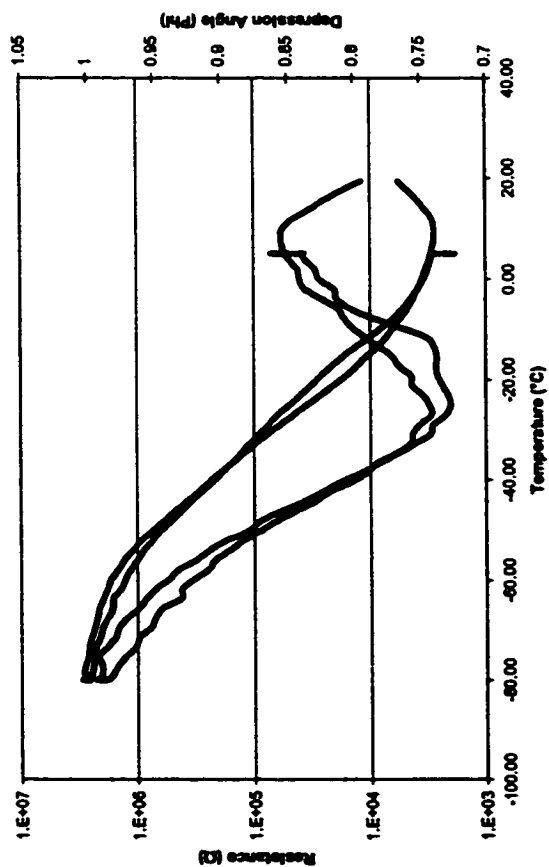


Figure 5.1: Resistivity of Salt Solutions

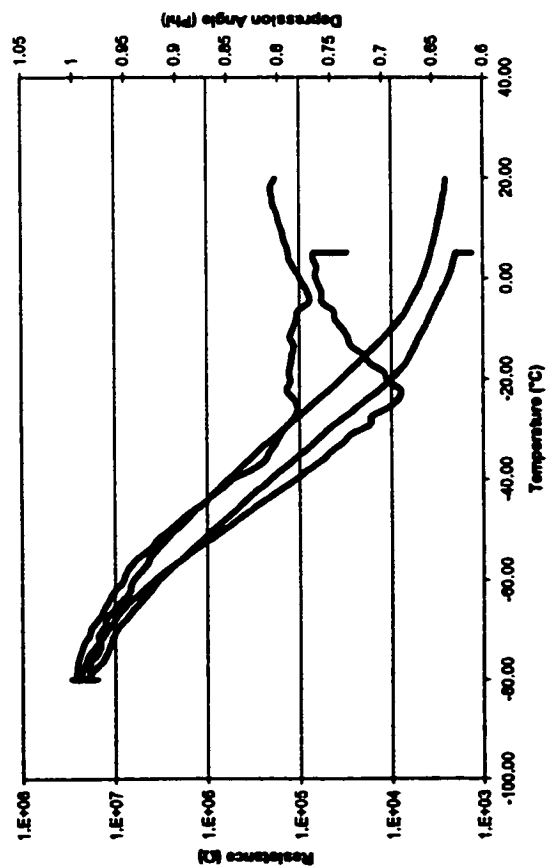
W/C Ratio	Hydration	m_o (g) (initial)	m_d (g) (dry)	m_w (g) resaturated	R_o (Ω) (initial)	R_w (Ω) (resaturated)	Percent Salt Solution	Conductivity (σ) of Pore Solution (S/m)
0.35	7 days	3.3515	3.1400	3.3526	3562	2360	synthetic	2.000
		3.5063	3.2655	3.4072	3611	1831	5%	6.443
		3.3485	3.1119	3.3098	3339	992.1	10%	10.194
		3.7512	3.5097	3.7553	4729	1334	15%	10.799
0.35	28 days	3.6299	3.3715	3.5906	6598	4507	synthetic	2.000
		3.5616	3.3601	3.5612	6161	3678	5%	6.443
		3.4474	3.1926	3.3994	6249	3140	10%	10.194
		3.6539	3.4084	3.6130	5985	2282	15%	10.799
0.6	7 days	2.8953	2.4652	2.8695	1175	1117	synthetic	2.000
		2.9300	2.5180	2.9185	1046		5%	6.443
		2.8927	2.4770	2.9000	1219	134.1	10%	10.194
		2.7704	2.3562	2.7747	957	163.1	15%	10.799
0.6	28 days	2.8560	2.4900	2.8601	3941	1868	synthetic	2.000
		3.1208	2.7078	3.1405	4036	858.8	5%	6.443
		3.2583	2.8166	3.2857	2823	246.6	10%	10.194
		3.2091	2.7971	3.2227	3701	432.1	15%	10.799

Table 5.2: Pore Solution Conductivity

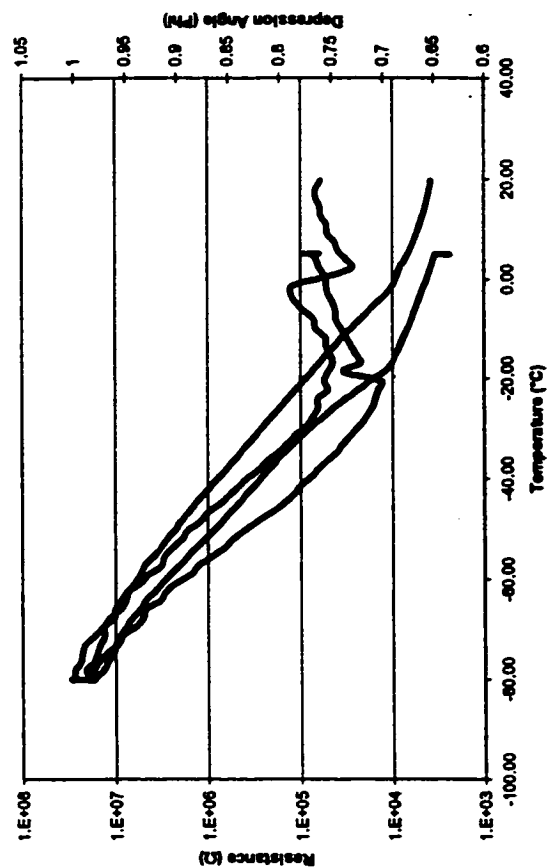
35-7-S35%



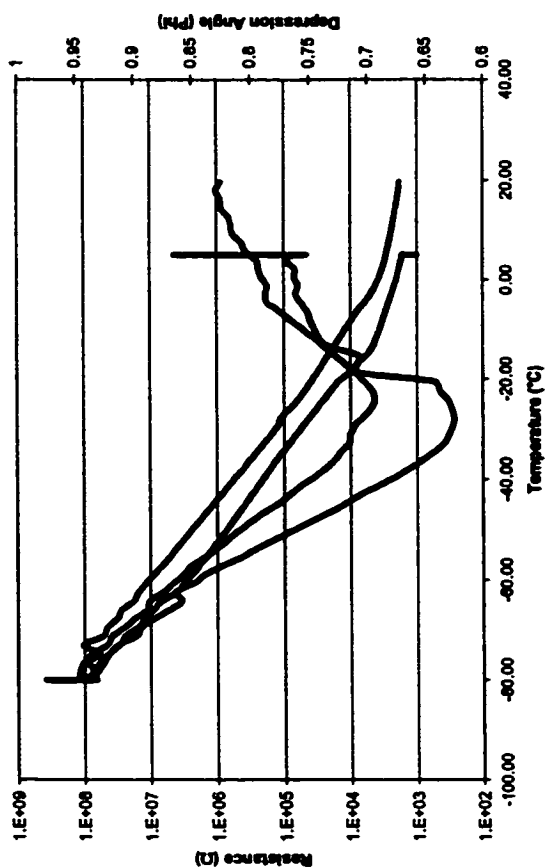
35-7-15%



35-7-NP3



35-7-S10%



Graph 5.11: w/c = 0.35, 7 Days Hydration, Salt Solutions

5.5.1 *W/C = 0.35 – 7 Days Hydration: Resaturated with Salt Solution and Synthetic Pore Solution*

Resaturation of the samples has a significant effect on the behaviour of specimens during freezing and thawing, Graph 5.11. The samples with 5% and 10% salt solutions behaved similarly. They both have a large change in ϕ before pore blocking and undergo several changes of slope before rounding off at the minimum ϕ . Significant damage is indicated in the sample with 5% salt from the decrease in ϕ and increase in resistance after thawing. This damage is confirmed by the large values for dilation and residual length change obtained from the TMA results. This dramatic change in the curve may be caused by the emptying of enlarged pores near the edges of the sample or as the pore water thaws it fills the enlarged pores created during freezing

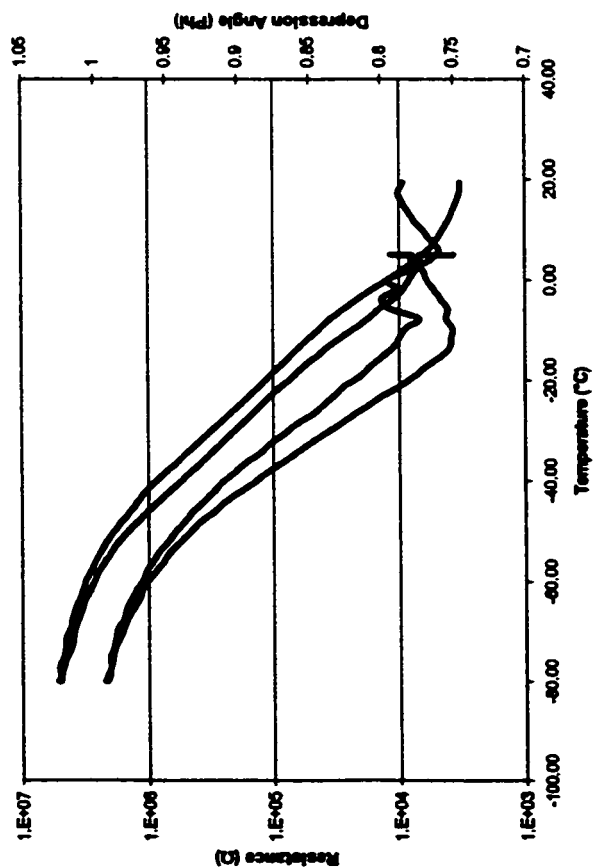
The samples with 15% salt solution exhibit a distinctive ϕ -T curve. The change in ϕ before pore blocking is less than the other salt solutions and has a sharp change of slope at minimum ϕ . This would indicate that the pore solution has less mobility due to the large amount of salt in the solution and behaves in a more viscous manner.

5.5.2 *W/C = 0.35 – 28 Days: Resaturated with Salt Solution and Synthetic Pore Solution*

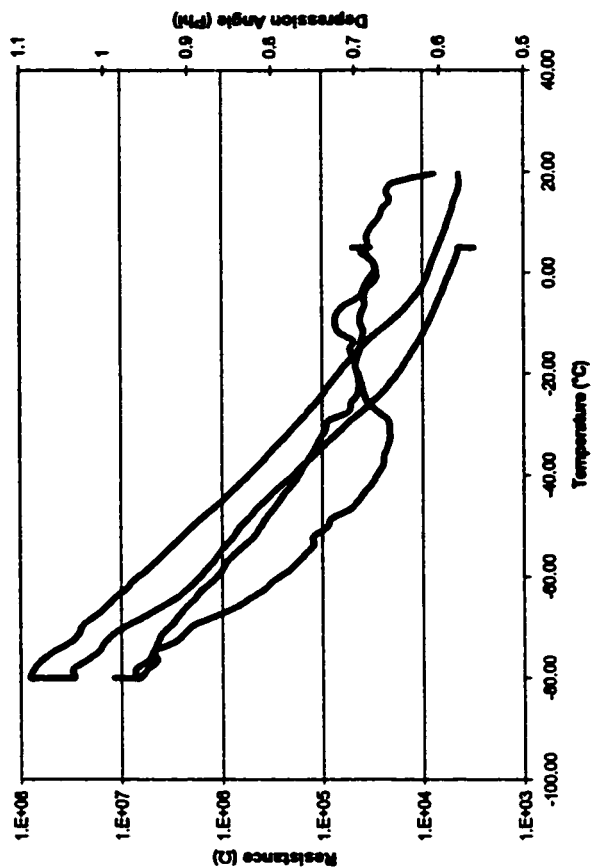
These samples are inherently durable due to the low w/c ratio and 28 day hydration time. However, resaturating them with salt solution makes them more vulnerable to frost damage than in their natural condition. The effects of the salt solution and the drying during vacuum saturation increases the chance of frost damage on the pore structure. The drying coarsened the pore structure and opened it up allowing the paste to retain more pore water that is likely to freeze.

The 5% salt solution ϕ -T curves and R-T curves indicate that the sample was damaged on freezing, Graph 5.12. The effective resistance is much higher than its counterpart with synthetic pore solution and the other samples with varying salt solutions. The pore blocking temperature is high and the change of ϕ before pore blockage is low. These conditions all point to the likelihood of frost damage. The pores were blocked at an early temperature of -11°C

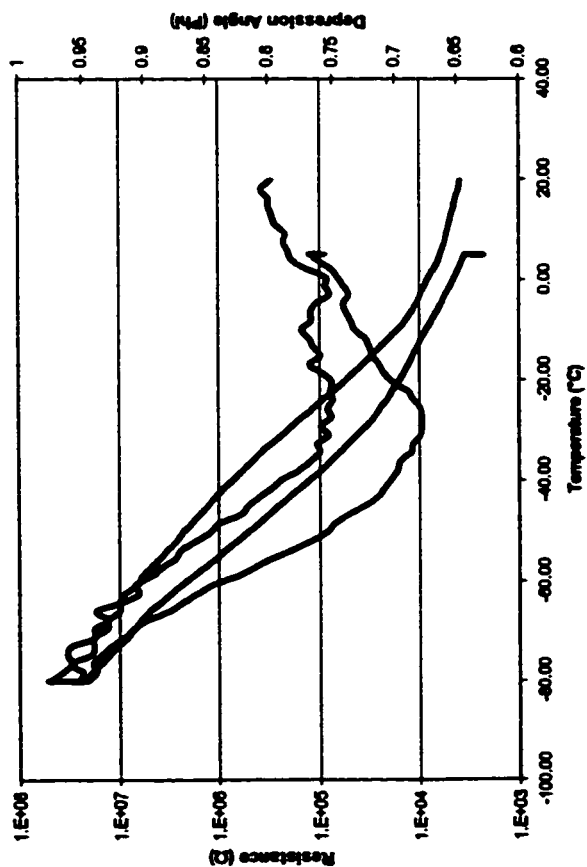
35-28-S5%



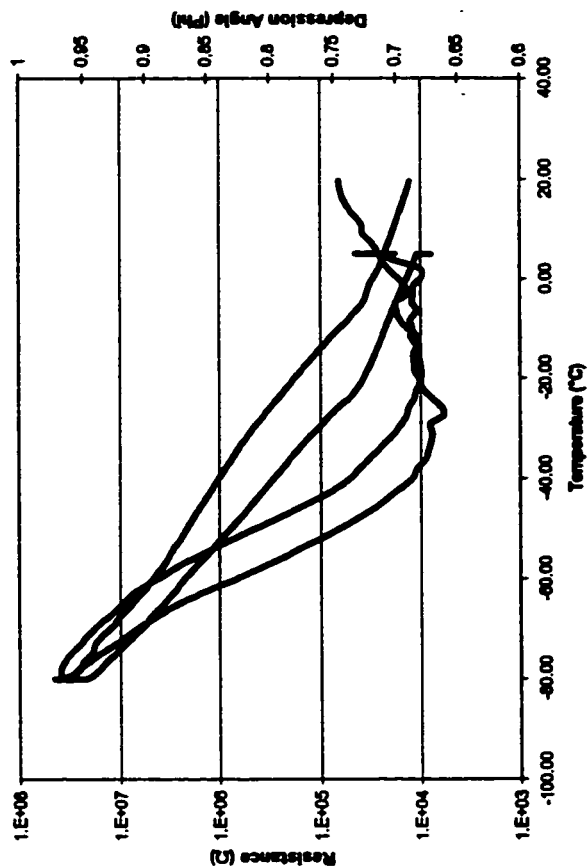
35-28-S10%



35-28-15%



35-28-NPS



Graph 5.12: w/c = 0.35, 28 Days Hydration, Salt Solutions

which forced the pore water to freeze without much movement leading to a small $\Delta\phi$ and a large effective freezing resistance value.

Significant damage is illustrated by the ϕ -T curve and confirmed by the TMA dilation and residual expansion data for the sample with 10% salt. The ϕ -T curve is quite different from the other samples in that it does not curve upward on thawing. It continues its downward trend all through freezing. This implies severe damage to the pore structure in spite of the low effective freezing resistance value. The flat ϕ -T curves on freezing and thawing illustrate the movement of the porewater through similarly sized pores or the inability to find relief from the high vapour pressures.

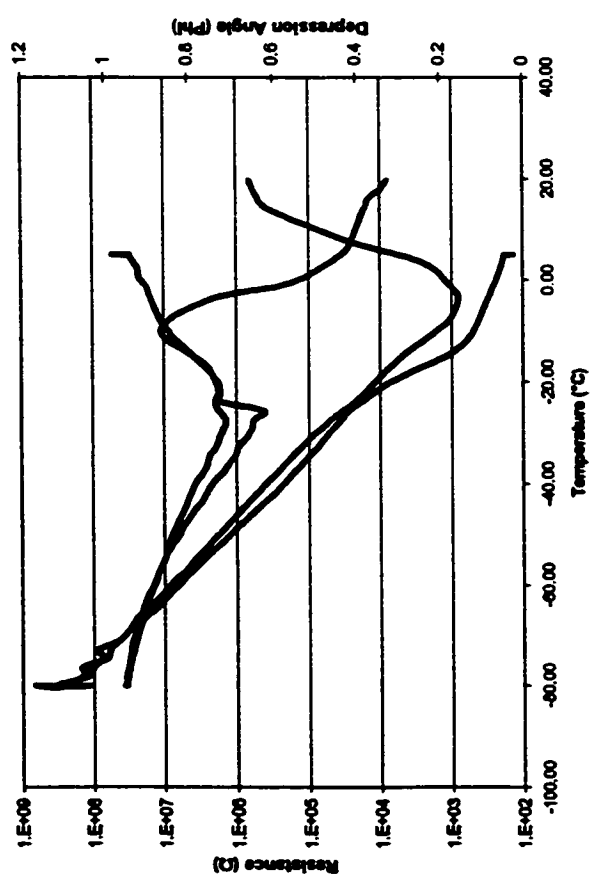
Samples with 15% salt solution have similarly shaped curves and the w/c = 0.35 sample at 28 days hydration is no exception. The ϕ -T curve with 15% salt solution is easily identifiable by its well defined peak on freezing and the smooth thawing curve. The increased viscosity of the 15% salt solution does not allow much movement of the porewater and therefore pore structure damage is minimal. The amount of change in ϕ before pore blocking and the low pore blocking temperature correlate well with the TMA data for this sample. However, some dilation occurred which is represented on thawing by the peak in the ϕ -T curve. The dilation of the paste does not appear to cause significant permanent damage to the pore system.

5.5.3 W/C = 0.60 – 7 Days: Salt Solutions and Synthetic Pore Solutions

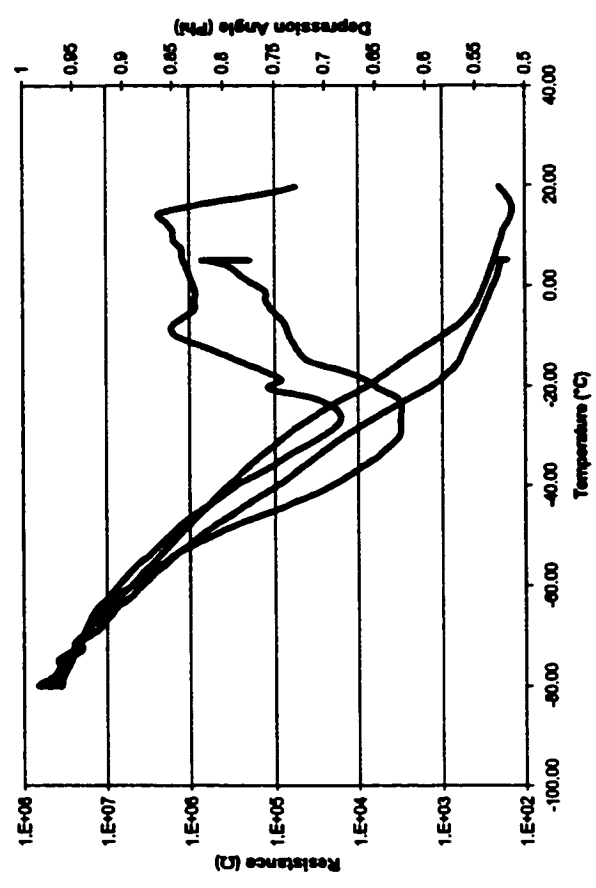
The specimens resaturated with salt solutions behaved much differently from the specimen with the synthetic pore solution. In Graph 5.13, synthetic pore solution, it clearly shows a broad pore size distribution from the significant change in ϕ before pore blockage of the pores. Hysteresis of ϕ and R is apparent and damage is likely. The effective freezing resistance value is 162 Ω which is greater than without drying indicating pore coarsening.

A large amount of damage is apparent from Graph 5.13 with a 10% salt solution. The pore blocking temperature of -25.9°C is lower than that of the specimen with a synthetic pore solution and the change in ϕ up to pore blockage is significant. Hysteresis of both the R-T and ϕ -T curves is enormous indicating that the specimen was severely damaged by the exposure to freezing temperatures.

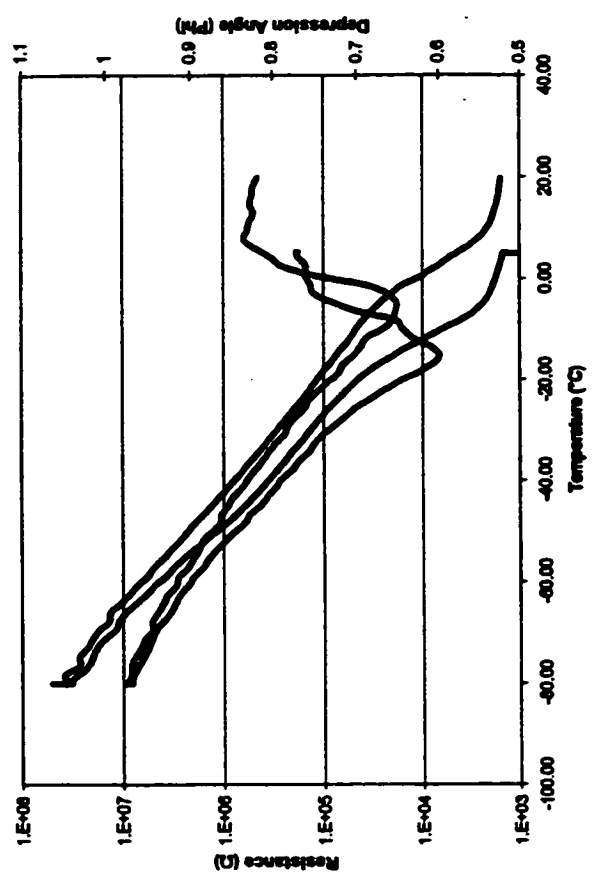
60-7-S10%



60-7-15%

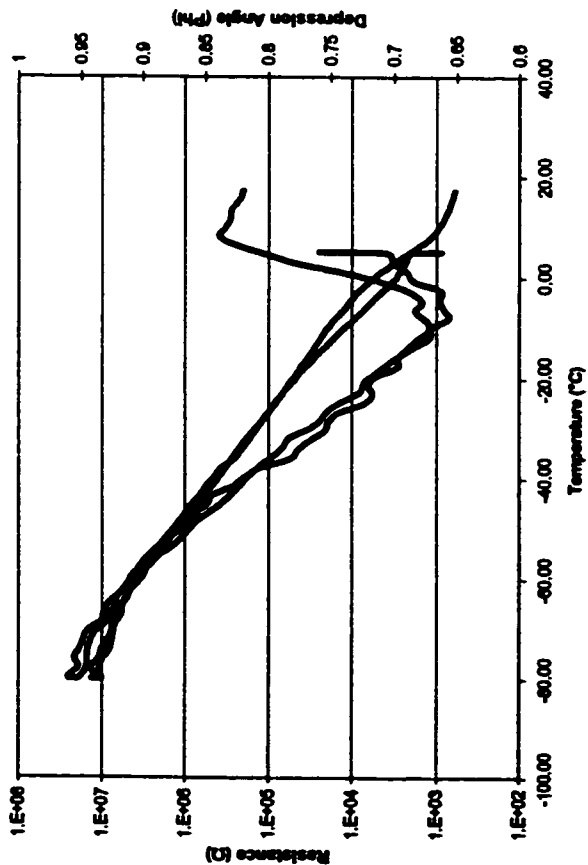


60-7-NPS

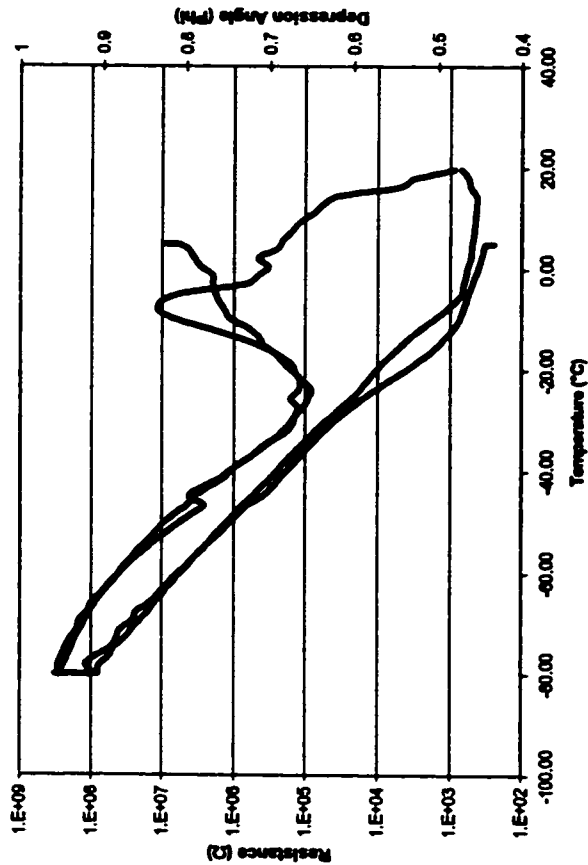


Graph 5.13: w/c = 0.60, 7 Days Hydration, Salt Solutions

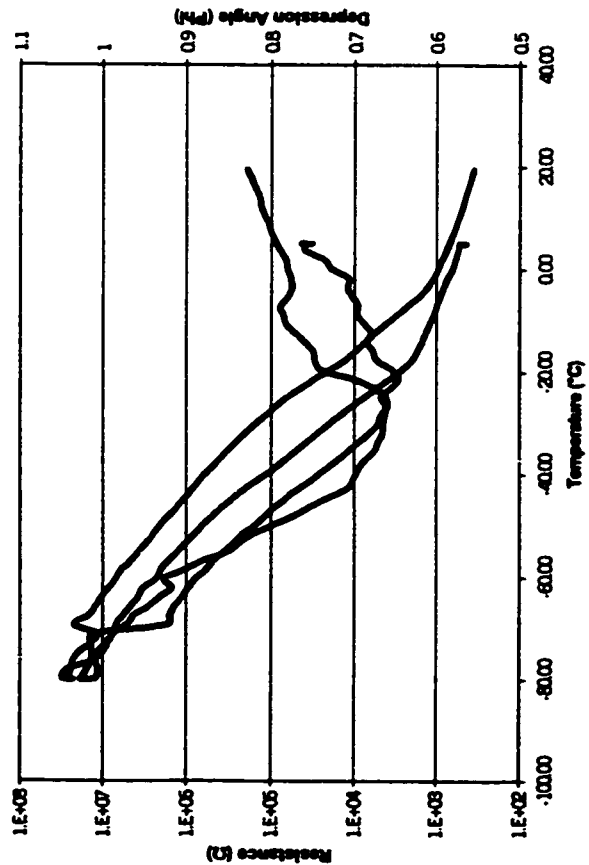
60-28-S5%



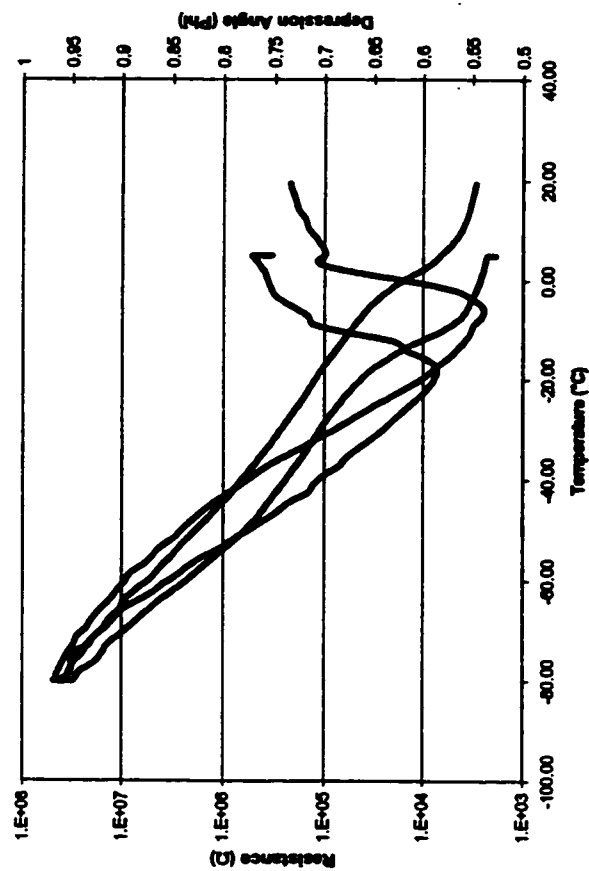
60-28-S10%



60-34-15%



60-34-NPS



Graph 5.14: w/c = 0.60, 28 Days Hydration, Salt Solutions

The specimen resaturated with 15% salt solution behaved typically. Both of the thawing curves of R-T and ϕ -T have some hysteresis. Pore blockage occurs at -30°C and ϕ changes appreciably before this point. Moderate damage occurred.

5.5.4 $W/C = 0.60 - 28$ Days: Salt Solutions and Synthetic Pore Solutions

The results displayed in Graph 5.14 show that the specimen resaturated with a 10% salt solution experienced a tremendous amount of damage. The R-T and ϕ -T curves on thawing are obviously much different from the same curves on freezing. The large change of ϕ before pore blockage at -24.5°C indicates a broad pore size distribution. A significant amount of freezing has occurred due to the large effective resistance of $52\ \Omega$.

Resaturation of the specimen with 5% salt solution results in a small effective freezing resistance. Pore blockage occurs at -8°C before which ϕ changes moderately. On thawing, $\Delta\phi$ is moderate and hence damage is not severe.

The specimen containing a 15% salt solution does not indicate as much mobility of the pore water as the other specimens in this group (i.e. $w/c = 0.60$ at 28 days). The pore blocking temperature is -24°C with a small change in ϕ . The amount of hysteresis for this specimen does not indicate much damage.

Analysis of the results for the specimen with a synthetic pore solution indicate that a small amount of damage is likely to have occurred. A broad pore size distribution is apparent from the shape of the ϕ -T curve. The change of ϕ before pore blocking occurs at -18°C is significant. The effective freezing resistance is significant at $76\ \Omega$.

5.6 Air Entrainment

Cement paste with air entrainment typically performs better during freezing and thawing than paste without air entraining. The additional air bubbles in the paste provide locations of low pressure where the supercooled pore water can find relief. The spacing of the entrained air is important. If it is too great, the paste will be damaged before the pore water reaches the void.

The air entrainment had a significant effect on the response of the ACIS of the paste on freezing and thawing. The pore blocking temperatures are quite low and the change in ϕ before pore blockage is quite large. This indicates that there is much movement of the pore water on freezing and that the additional porosity of the air entrainment is being utilized.

The ϕ -T curves with air entrainment differ from the curves of the non-air entrained samples by having a range of ϕ leading to the pore blocking temperature equal to or greater than $\Delta\phi$ between pore blocking and -80°C , Graphs 5.15. This may be the result of the air entrainment. The initial values for R and ϕ indicate that the entrained air is connected to the pore system. This leads to the lower R and the high ϕ . The extra porosity decreases R and the uniform pore size of the entrained air leads to a ϕ close to unity.

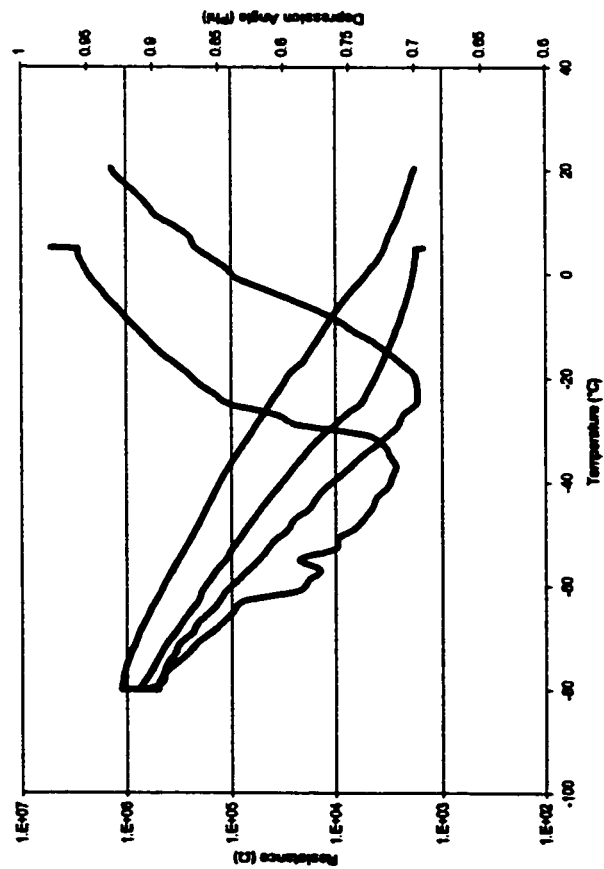
At -80°C , ϕ does not approach one. This could mean that there is pore water left unfrozen at a range of pore sizes. Large hysteresis (about 15°C) exists between freezing and thawing for the ϕ -T curve.

The resistance versus temperature curve of the air entrained samples has a relatively gentle slope. The effective freezing resistance values of the $w/c = 0.35$ samples are low, 15 at 7 days hydration and 11.6 at 28 days hydration. This indicates that the amount of pore water freezing is low.

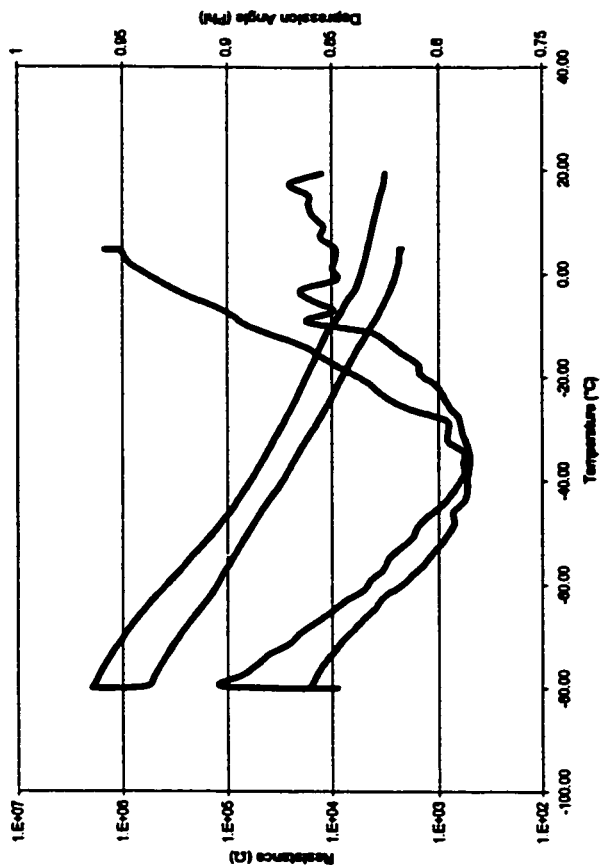
For hydration of 28 days, the ϕ -T curve on thawing does not follow the curve on freezing. This would ordinarily indicate damage. However, considering the low effective freezing resistance values and $\Delta\phi = 0.100$, damage is not expected to be significant.

The air entrained samples that were resaturated with salt solutions, Graph 5.16, did not fare as well as expected. It appears that the drying of the samples resulted in a coarsening of the pore structure that created more links to the air entrainment. On resaturation, a portion of the air entrainment became saturated. Their effective freezing resistance values are relatively high as well as their blocking temperatures. These values would indicate that these samples are susceptible to frost damage.

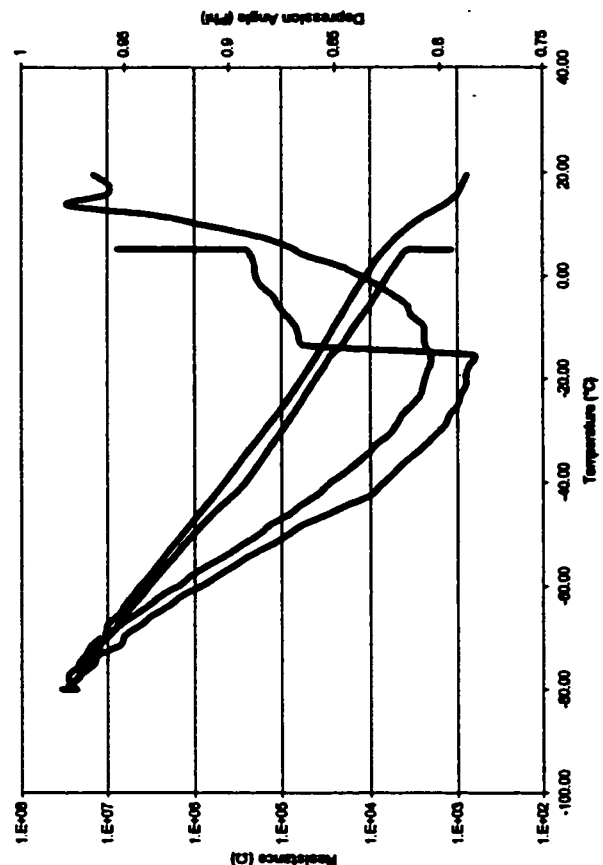
6% Entrained Air - 35 - 7d



6% Entrained Air - 35 - 25d

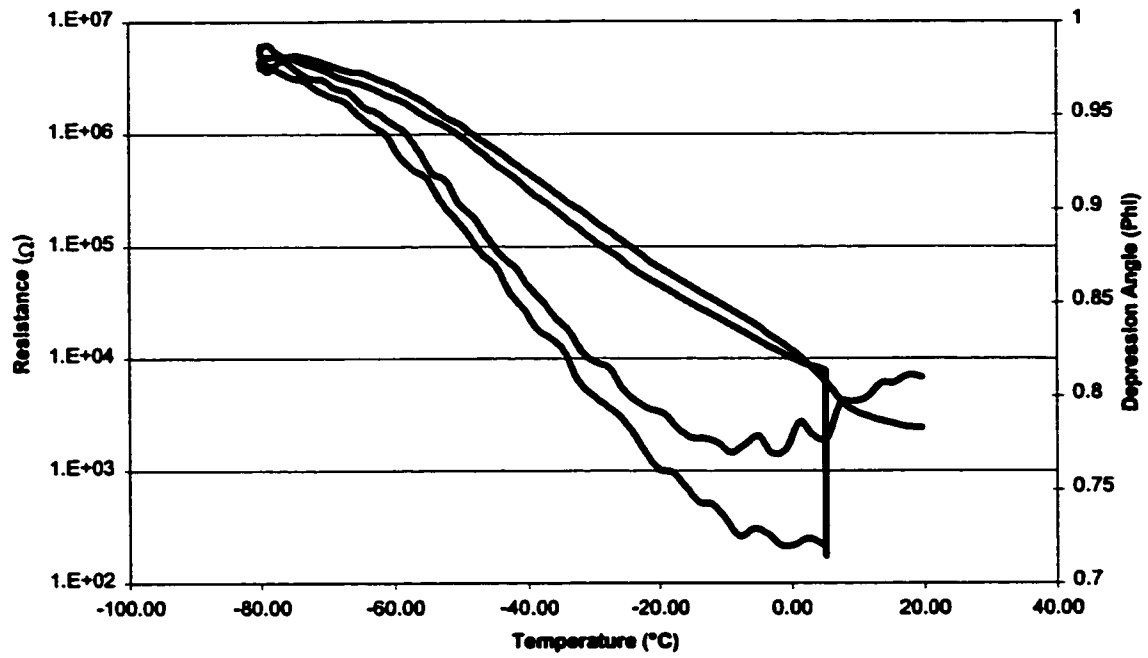


6% Entrained Air - 60 - 25d

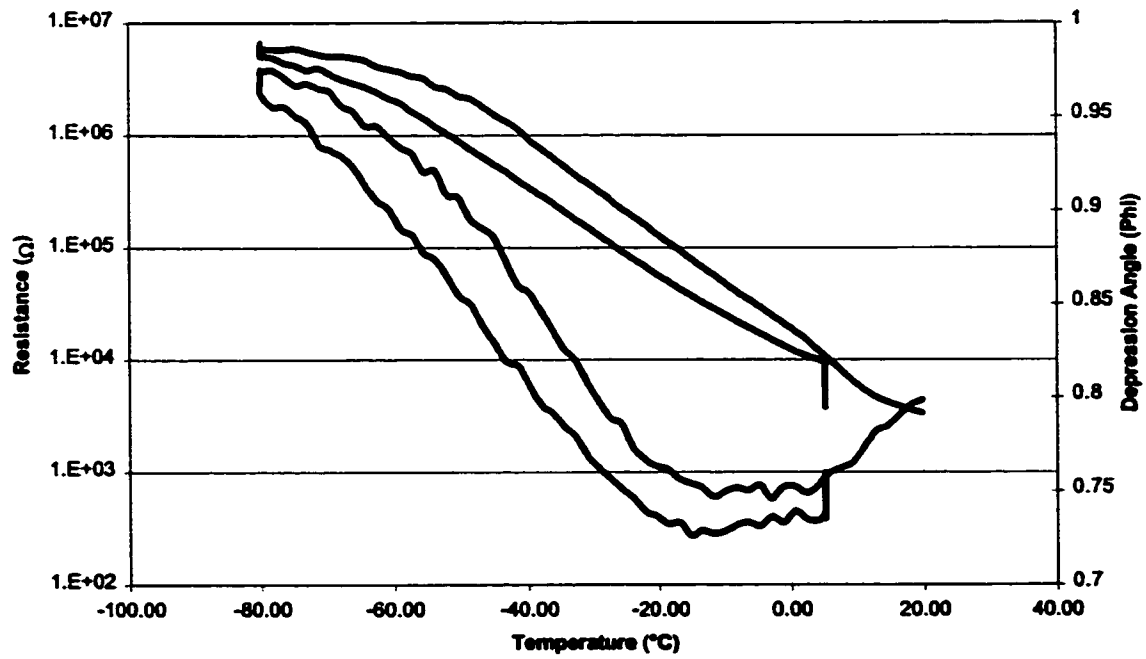


Graph 5.15: Air Entrainment Curves

35-28-6-S5



35-28-6-S10



Graph 5.16: w/c = 0.35, 28 Days Hydration, 6% Air Entrainment, Salt Solutions

5.7 Conclusions

ACIS is an effective technique for analyzing the behaviour of cement systems subjected to freezing and thawing. The resistance and ϕ variables from the equivalent circuit of the sample provide information on porosity, pore-size distribution and pore solution content. This information can then be used to study the frost durability of the paste.

The measure of cement paste's durability or resistance to freezing is its ability to accommodate the movement of pore water. This movement is caused by high vapour pressures of supercooled water. The ACIS data reflect the amount of pore water freezing and the mobility of the pore water. Incipient freezing can be identified by the first change in slope of the Resistance-Temperature curve. The movement of the pore water can be traced through the ϕ -T curve and the range of pores wherein the water has not yet frozen. The effective freezing resistance correlates with the amount of pore water freezing.

Analysis of the shape of the ϕ -T curve on freezing and thawing gives information on the pore size distribution of the sample. A large and open pore structure results in a shallow curve and high pore blocking temperature. A deep curve suggests a fine system of pores that will become blocked at a lower temperature. If no damage was occurring, the shape of the ϕ -T curve on freezing and thawing would be identical. Changes in slope both of ϕ -T and R-T curves usually coincide at the same temperature indicating a change in the path of the electrical current.

The general trends of all of the samples resaturated with salt solutions regardless of w/c ratio and hydration time include:

- Incipient freezing temperature is decreased
- Effective electrical resistance on freezing decreases with increased percentage of salt in solution
- Reduction of hysteresis between freezing and thawing
- Increased mobility of the pore water indicated by an increase in $\Delta\phi$ during freezing
- Pore blockage temperatures are increased
- 15% salt solution has a distinctive curve.

Damage Assessment

- a high initial resistance and low $\Delta\phi$ on freezing indicates low porosity and a fine uniform pore structure that is durable.
- Effective freezing resistance correlates with the amount of water freezing and hence the lower the effective freezing resistance, the more durable the concrete.
- A change in the shape of the ϕ – temperature curve on thawing indicates damage to the pore structure.

CHAPTER 6

FREEZING OF PASTES AND MORTAR WITH FLY ASH

6.1 Introduction

The addition of fly ash to the cement mix brings about many changes to the pore structure of the hcp paste and mortar. The fly ash reacts with the calcium hydroxide and forms a cementitious product. The overall effect that the addition of fly ash has on hcp is to refine its pore structure. The pore size distribution is altered, the average pore size and the threshold diameter decreases.

Fly ash is generally believed to provide increased durability to the concrete against freezing-thawing cycles. The decreased pore size and reduced connectivity of the pore structure result in a less permeable material. Less water penetrates into the network of pores which minimizes the theoretical damage to the concrete on freezing. Furthermore, the freezing temperature is reduced in a concrete with fly ash, because of the smaller pore size diameter, which decreases the number of freezing-thawing cycles and hence concrete damage is reduced.

ACIS is a testing technique that is sensitive enough to measure and evaluate the effects of fly ash on hydrated cement pastes and mortars. The increased density of the matrix will result in an increase in sample resistance. The reduction in overall pore size will be demonstrated by a smaller depression angle.

6.2 Results

6.2.1 TMA

The results of the TMA tests are displayed in Table 6.1 for the samples hydrated for 7 days and in Table 6.2 for the samples hydrated for 9 months. The data that is presented includes dilation of the sample, residual length change at 5°C, and the temperature at which dilation begins. There is a significant difference between the TMA results of the paste samples and the results of the mortar samples, see Graphs 6.1 and 6.2. The pastes experience more dilation on average than the

mortars. Dilation begins at a higher temperature and residual length change (at 5°C) is greater in the pastes than the mortars. This result is expected due to the greater amount of hydration products per gram of sample. The sand particles contained within the mortar samples reduce the amount of the cement matrix per sample. Therefore, the mortar sample contains less pore water and C-S-H per unit volume than its cement paste counter-part. This results in less dilation on freezing which was measured during the TMA tests on freezing.

	Dilation $\mu\text{m/m}$	Residual Length Change $\mu\text{m/m}$	Temp. Expansion Begins °C
Paste			
Plain	2312	168	-27.6
Melligan	-	-	-
Portage	-	-	-
Sundance	-	-	-
Mortar			
Plain	2954	49	-29.2
Melligan	2763	450	-8.3
Portage	1063	321	-17.8
Sundance	1196	-606	-42.4

Table 6.1: TMA Results, 7 Days Hydration

	Dilation $\mu\text{m/m}$	Residual Length Change $\mu\text{m/m}$	Temp. Expansion Begins °C
Paste			
Plain	2514	-161	-38
Melligan	3168	-520	-50
Portage	3281	-373	-38
Sundance	5353	-101	-44
Mortar			
Plain	925	19	-42
Melligan	1492	384	-41
Portage	1438	12	-42
Sundance	1752	376	-45

Table 6.2: TMA Results, 9 Months Hydration

Dilation of the hcp samples begins at higher temperatures because the average pore size of the specimens is greater than for the mortar specimens. There will be a higher CH content in the mortars initially due to the intermediate zone around the sand particles. This allows for more reactions between the CH and fly ash and results in a denser and finer pore structure after nine months of hydration than the cement paste samples. The smaller pore sizes lower the temperature at which dilation occurs.

The amount of dilation of the hcp samples ranged from an average value of 2500 $\mu\text{m}/\text{m}$ to 6000 $\mu\text{m}/\text{m}$. Hcp specimens without fly ash (at 9 months hydration) experienced the least amount of dilation. The plain hcp specimens contain larger pores and less C-S-H interlayer space than the fly ash pastes. The fly ash reacts with CH to form a cementitious matrix that results in an increased amount of dilation on freezing. The plain hcp samples have a greater content of CH and larger pores. In spite of the larger pores, the net result is less dilation. The difference between the plain paste and various brands of fly ash is due to the efficiency of the reaction between the CH and fly ash resulting in formation of C-S-H with a lower C/S ratio. The increased dilation can't be attributed to the pore structure. The nature of C-S-H itself may influence the result. The nature of the C-S-H is dependent on the source of fly ash and its chemical composition e.g. alkali content, CaO content, aluminate content, etc. Dilation results in increasing order for mixes containing fly ash are those where the fly ash was obtained from Portage, Melligan and Sundance.

Mortar specimens behaved similarly to the paste samples. As with the paste samples, including fly ash in the mortar specimens increased the amount of dilation experienced by the specimens. The nature of the C-S-H in the fly ash specimens over the plain mortar specimens may be associated with the greater amount of dilation. Water movement may be impeded by the dense microstructure formed in fly ash pastes. Fewer large interconnected pores can facilitate mass transfer. The plain mortar specimen had a dilation of 750 $\mu\text{m}/\text{m}$ while the fly ash specimens Melligan, Portage, and Sundance, experienced much greater dilations, in increasing order.

In both the mortar and hcp specimens, the Melligan and Portage fly ash samples behaved similarly. The Sundance fly ash specimens always performed the worst of all the test specimens.

6.2.2 DSC

Results for the DSC tests are presented in Tables 6.3 and 6.4. The DSC results agree with the TMA results. The hcp samples contained more pore water that was capable of freezing than the mortar samples. The mortar specimens contain less hydration products per gram of specimen due to the presence of sand particles mixed into each specimen. Therefore, it is expected that the hcp samples will have more pore water to freeze.

Paste	Quantity of Pore Water Freezing mg/g
Plain	0.071
Melligan	0.073
Portage	0.140
Sundance	0.283
Mortar	
Plain	0.052
Melligan	0.059
Portage	0.129
Sundance	0.081

Table 6.3: DSC Results, 7 Days Hydration

Paste	Mass mg	Quantity of Pore Water Freezing mg/g
Plain	18.40	0.037
Melligan	18.37	0.063
Portage	17.93	0.043
Sundance	20.35	0.058
Mortar		
Plain	18.51	0.012
Melligan	21.89	0.020
Portage	21.76	0.021
Sundance	32.02	0.023

Table 6.4: DSC Results, 9 Months Hydration

Fly ash increases the amount of pore water freezing. This is due to the nature of the C-S-H (low C/S ratio) and the discontinuous pore system which acts as a barrier for mass transfer and facilitates freezing insitu. The C-S-H is produced from the reaction between fly ash and CH. The total amount of pore water freezing increases; however, it requires more energy to freeze. Less bulk freezing occurs and secondary freezing increases. As with the TMA results, the plain hcp and mortar samples had less freezing (i.e. amount of dilation and quantity of pore water freezing) occur than the samples with fly ash. In increasing order of the amount of pore water freezing in pastes made with fly ash are: from Portage, Sundance, and Melligan.

The presence of sand reduces the amount of pore water freezing in the mortar samples as compared to the hcp specimens. The fly ash mortar specimens experienced similar amounts of pore water freezing. The plain mortar sample had the least amount of pore water freezing.

6.2.3 ACIS

6.2.3.1 HCP with Fly Ash, 9 Months Hydration

The ACIS results for the hydrated cement pastes with and without fly ash reveal much about the test specimens. The refined pore structure that results from a hydration time of 9 months is apparent on both the resistance and phi versus temperature curves. The ACIS curves are relatively smooth and free of sharp edged turns. The resistance values of the specimens with fly ash are greater than those for the plain paste because the fly ash increases the amount of cementitious products in the matrix and reduces the average pore size.

Changes to the frost mechanism acting within the sample are manifest in the curves by changes in the slopes. The temperatures at which the changes in slope (indicating a change in freezing mechanism) occur as measured by the various testing procedures are in agreement with one another, see Table 6.5.

Sample resistance-temperature (R-T) curves are shown in graphs 6.3a-d. The resistance of the pastes at -80°C range from 5 to 50 $\text{M}\Omega$. Plain cement paste had the smallest sample resistance on freezing ($R = 5 \text{ M}\Omega$). It increased from 6000 Ω at $+5^{\circ}\text{C}$ to 5 $\text{M}\Omega$ during freezing. This represents an increase of 833% whereas the samples with fly ash increased 5000% on freezing. This agrees with the TMA and DSC measurements. Results from both indicated less freezing for the plain hcp specimens compared to paste with fly ash. Again, this is due to the additional amount of cementitious products contained in the fly ash samples as compared to the plain paste. On freezing, the increased resistance is due to pore water freezing and is possibly affected by the surface adsorbed water becoming more ordered. The less dense matrix of the plain paste sample as compared to the samples with fly ash allow for more movement of pore water on freezing to the larger capillary pores still present in the paste. It is hypothesized that the plain pastes have more interconnected pore systems that are more conductive when frozen (at -80°C) than the dense, highly disconnected pore system of the fly ash samples at -80°C which will not be frozen but highly ordered and less conductive.

Pastes	°C @ Incipient Freezing		Blocking Temp. °C	°C @ Secondary Freezing	
	ACIS	DSC*		ACIS	DSC*
7 Days					
Plain	-12	-12	-30	-45	-45
Melligan	-8	-10	-25	-15	-20
Portage	-8	-12	-30		-40
Sundance	0	-12	-35	-20	-40
9 Months					
Plain	-8	-18	-45	-45	-45
Melligan	-10	-18	-	-60	-45
Portage	-8	-18	-35	-60	-50
Sundance	-8	-18	-	-60	-50

Mortars	°C @ Incipient Freezing		Blocking Temp. °C	°C @ Secondary Freezing	
	ACIS	DSC*		ACIS	DSC*
7 Days					
Plain	-10	-12	-15	-55	-40
Melligan	-10	-12	-10	-45	-40
Portage	-10	-12	-10	-40	-45
Sundance	-10	-12	-38	-30	-45
9 Months					
Plain	-8	-15	-22	-37	-45
Melligan	-15	-20	-	-52	-45
Portage	-20	-15	-	-52	-45
Sundance	-10	-18	-	-52	-45

* These temperatures were taken at peaks in the Energy-Temperature Curves

Table 6.5: Temperatures at Changes in Freezing Mechanism

The increase in resistance correlates with the amount of pore water freezing, whereas the value of sample resistance at -80°C will relate to the pore connectivity and magnitude of the pore diameter. The values of sample resistance at -80°C are not all equal due to differences in the pore structure.

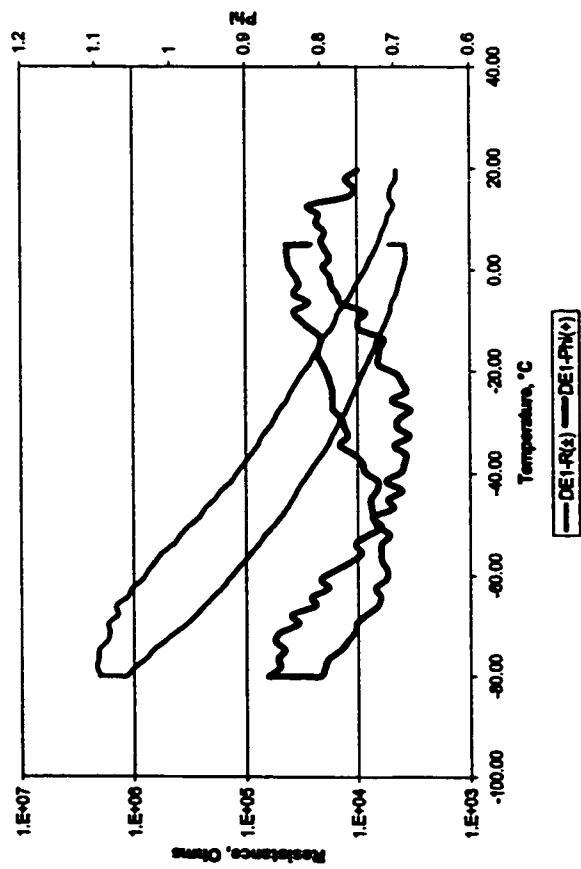
Specimens with Portage fly ash experienced the most freezing as indicated by the steep slope of the resistance-temperature curve. All the samples yielded similarly shaped resistance-temperature curves. The relatively small differences in slope of the R-T curve with change of the freezing mechanism indicates a fine, relatively uniform pore structure. When water in the pores of one size finishes freezing and water in another size of pore begins freezing the rate of the change of resistance of the sample changes. The greater the rate of change of resistance, the greater the difference in pore size where water is freezing. Therefore, since the slopes have small changes, the pore size distribution can be assumed to be fairly uniform.

The phi-temperature curves between samples are also similar, see Graph 6.1. Phi remains relatively constant until the temperature of -45°C is reached. At this point the phi values increase sharply indicating that the pores are becoming blocked with ice, see Table 6.6 with reference to blocking temperatures. Pore water movement is very apparent at temperatures lower than -45°C . Phi begins to climb after the temperature dips below -45°C . However, phi peaks at approximately 0.9. It never reaches 1.0. The specimens never completely freeze but the surface adsorbed and possibly interlayer water becomes more 'ordered'. The complete range of phi on freezing and thawing is 0.7 to 0.9.

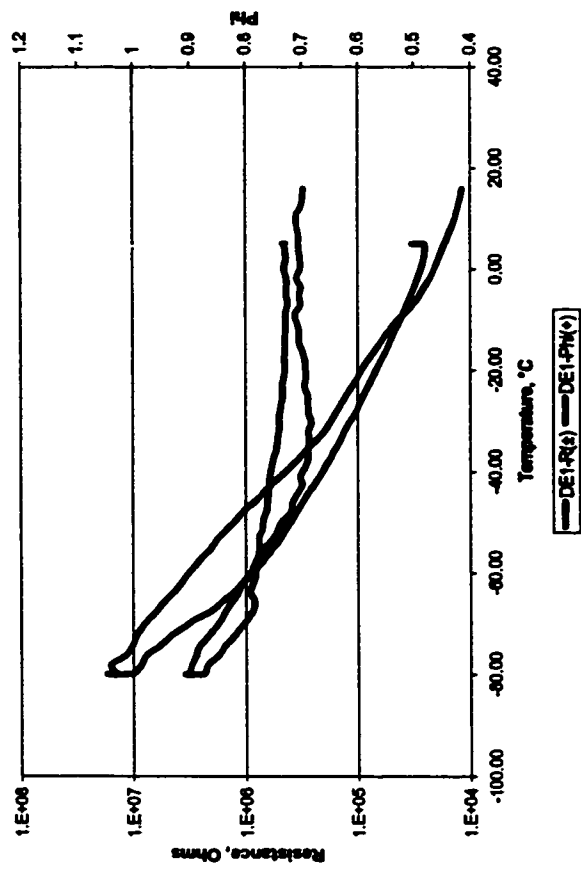
The flat portion of the curve indicates a uniform pore structure. The low blocking temperature implies a fine pore structure which is consistent with hydration times of nine months and the known effects of the reaction of fly ash with CH to form dense cementitious products. Blocking temperature is lower for samples with fly ash.

This group of test specimens may have some inconsistencies in the test data due to microcracking of the cylinders. The pastes were cast into 4 x 8 inch cylinders. This size allows extremely high temperatures to develop in the core on hydration. The sides and ends do not heat up as much due to exposure to ambient temperatures. The temperature differentials cause strains and stresses in the paste which result in cracking. Cracking of the hcp specimens was visible during the preparation of the specimens for testing. This explains the inconsistency in the test data for these specimens. In Table 6.6, incipient freezing temperatures for the nine month hydrated hcp samples vary (as measured by ACIS and DSC). This can be explained by the presence of microcracks in the larger ACIS specimens ($\sim 3.0\text{g}$). The DSC test samples are approximately 30 mg in which microcracks may not have been present. Freezing in the cracks occurs at higher temperatures than in pores.

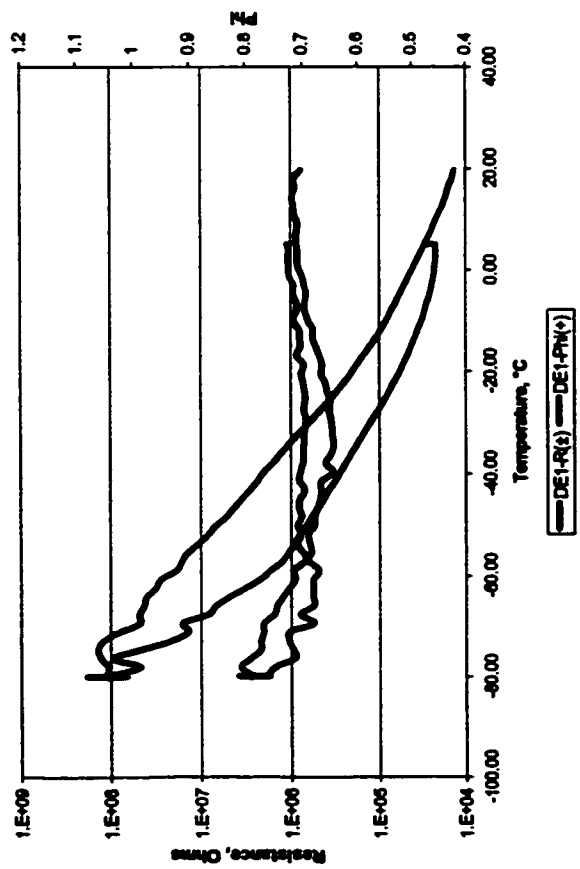
Reference Paste
9 Months Hydration



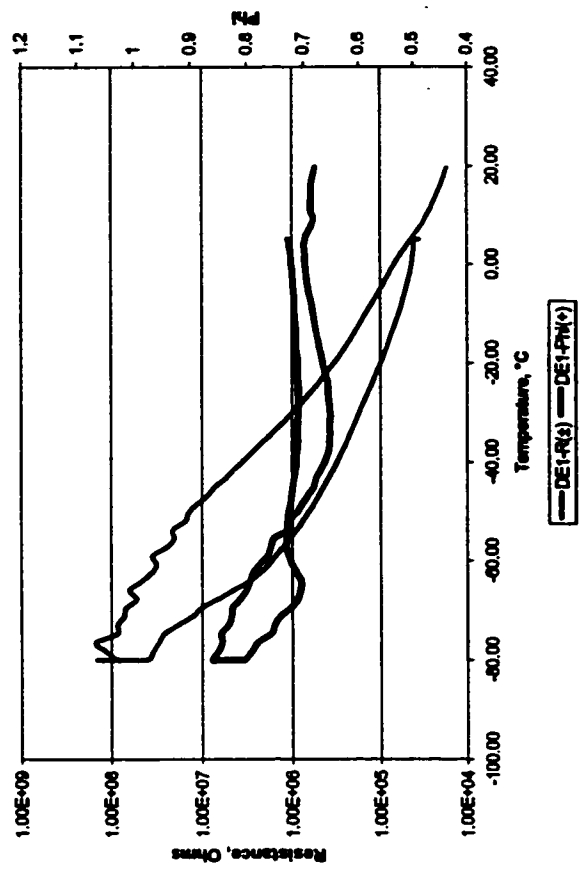
Medigan Paste
9 Months Hydration



Portage Paste
9 Months Hydration



Sundance Paste
9 Months Hydration



Graph 6.1: Hydrated Cement Paste, 9 Months Hydration

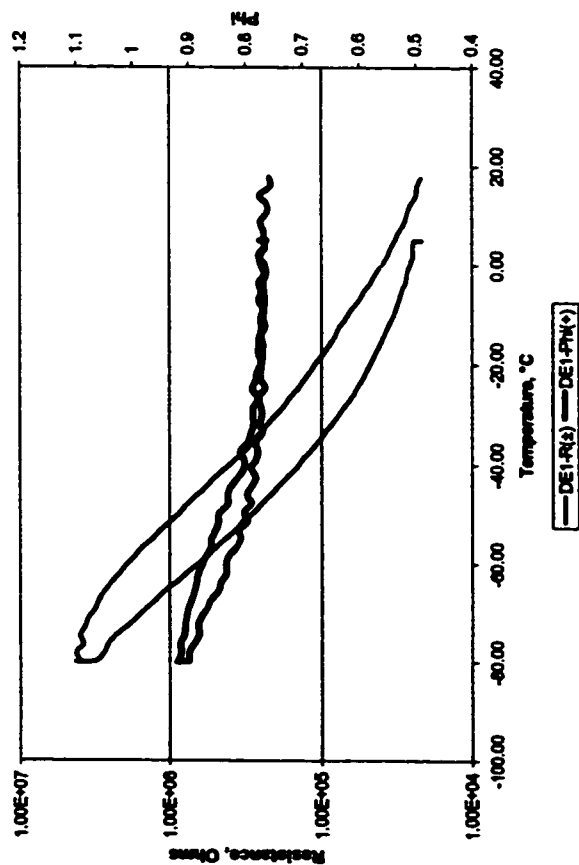
	Sample	R_0 (Ω)	R_{IF} (Ω)	R_F (Ω)	$\Delta\phi_{5^\circ}$	$\Delta\phi_{-80^\circ}$
Reference Paste	110-5_5	7.48E+03	9.30E+03	4.33	-0.077	0.201
	110-5_8	3.72E+03	5.00E+03	4.34	0.040	0.031
	110-5_9	2.96E+03	4.42E+03	3.62	0.044	0.053
Melligan	120-2_5	2.52E+04	3.86E+04	4.57	0.021	0.166
Portage	130-5_1	2.01E+04	3.16E+04	6.93	0.016	0.196
	130-5_2	2.17E+04	2.94E+04	8.58	0.016	0.060
Sundance	140-4_4	3.88E+04	8.00E+04	3.37	0.030	0.275
	140-4_8	4.12E+04	5.69E+04	4.51	0.030	0.136
Reference Mortar	210-6_7	2.44E+04	3.19E+04	3.60	-0.005	0.144
Melligan	220-1_2	1.20E+05	2.09E+05	8.70	0.052	0.196
	220-1_3	1.62E+05	2.44E+05	7.78	0.025	0.134
Portage	230-2_6	5.07E+04	7.74E+04	5.77	0.031	0.176
	230-2_8	7.04E+04	1.06E+05	6.44	0.179	0.374
Sundance	240-2_4	1.22E+05	1.77E+05	4.22	0.213	0.152
	240-2_6	1.70E+05	2.92E+05	9.28	0.076	0.264

Table 6.6: ACIS Results, 9 Months Hydration

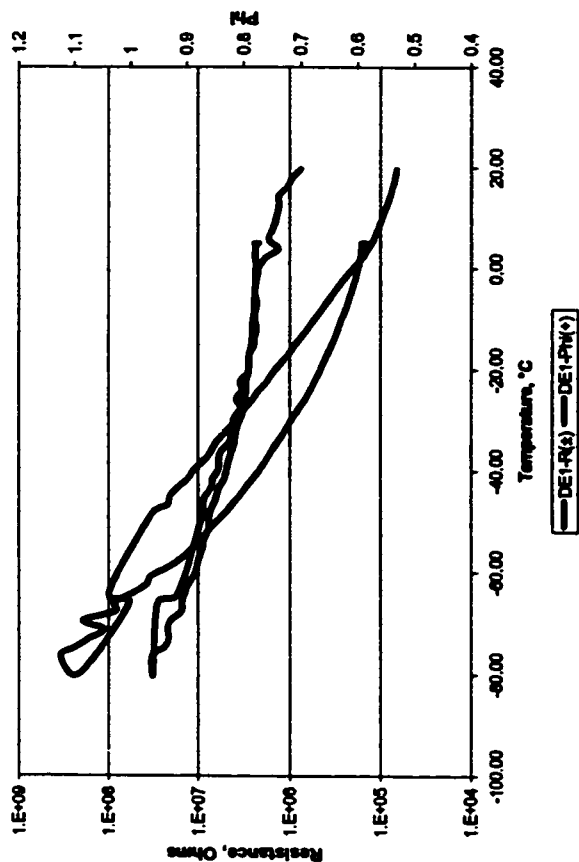
6.2.3.2 Mortar with Fly Ash, 9 Months Hydration

The results of the test group consisting of mortar samples with fly ash have similar results to the group of cement paste samples. The freezing resistance of the test specimen that did not contain any fly ash is 2760 Ω . For the test specimens that included fly ash in their mixes, the freezing resistance was much greater, in the range of 250 to 350 k Ω . The plain mortar specimen has a much lower resistance at -80°C than any of the other pastes and mortar specimens. This is due to the difference in pore structure of the plain mortar specimens. The transition zones of the matrix at the locations of the sand particles are more connected and have larger pore sizes than the rest of

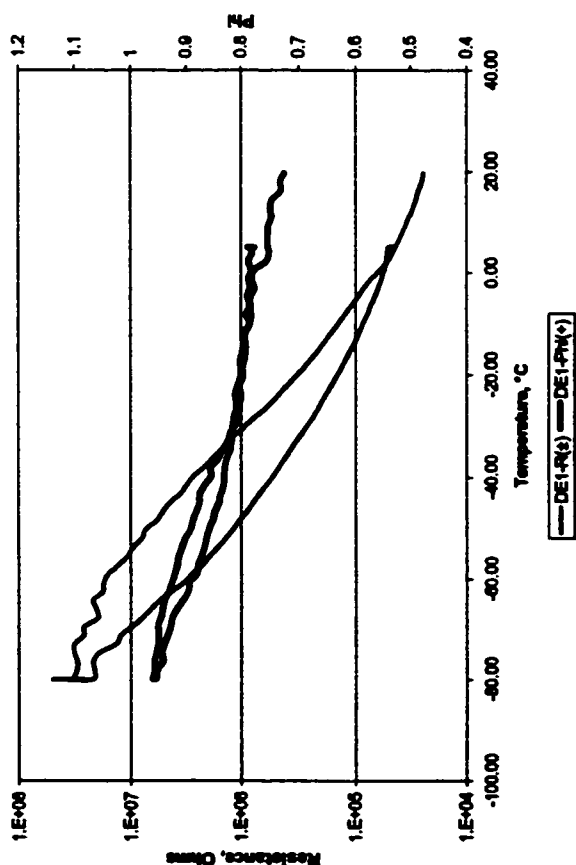
Reference Mortar
9 Months Hydration



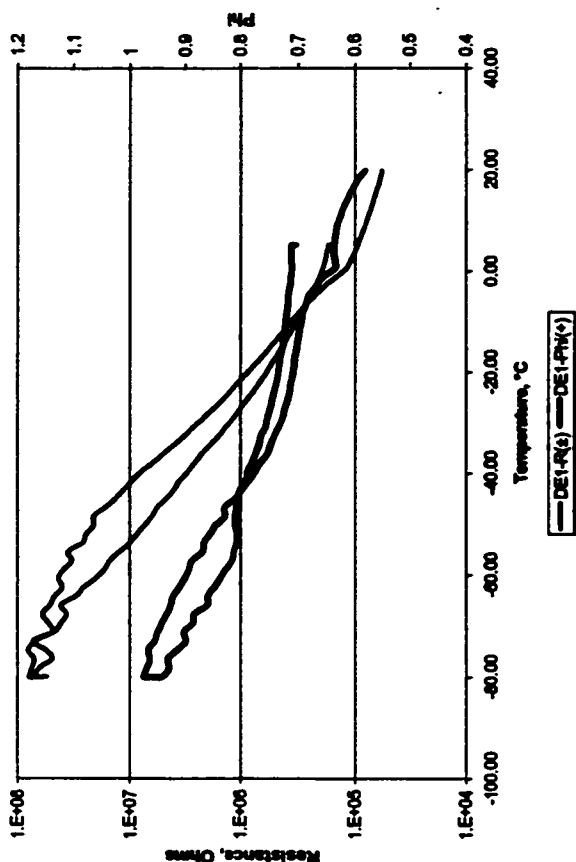
Malligan Mortar
9 Months Hydration



Portage Mortar
9 Months Hydration



Sundance Mortar
9 Months Hydration



Graph 6.2: Mortar, 9 Months Hydration

the matrix. The broader pore size distribution in the transition zones of the mortar without fly ash specimens changes the freezing dynamics of the specimen. The larger pores capable of bulk freezing even if there are very few of these pores will affect the resistance of the sample on freezing. The 'bulk' ice attracts 'free' water creating a more continuous path to conduct the current.

The samples containing fly ash are denser and despite the increased amount of interlayer water, it is the disconnected pore system that creates the high resistances. Inclusion of fly ash in the mortar samples caused increased freezing as measured by ACIS.

Resistance-temperature curves are shown in graph 6.2. The curves are all similar in shape with subtle changes in slope occurring as freezing progresses. As with the cement paste samples, the range of pore sizes within each mortar specimen is expected to be narrow and small in size. The smooth resistance curves are consistent with the expected fine pore structure of the test specimens.

Analysis of the phi-temperature curves also indicates a fine pore structure of the mortar test specimens. Typically, phi starts at 0.7 at 5°C and increases to 0.9 on freezing to -80°C. The curve is a smooth linear curve with one change of slope at approximately -50°C when blockage of the pores occurs due to freezing.

6.2.3.3 Cement Paste, 7 Days Hydration

6.2.3.3.1 Plain Reference Sample

The results from the freezing-thawing experiments on cement paste specimens hydrated for 7 days are presented in Graph 6.3. The average resistance of the pastes at 5°C prior to any freezing is 1200 Ω . Freezing of the pore solution begins at approximately -5°C where the first change of slope occurs. Another change in slope occurs at -15°C which signifies a change in the size of pore that is freezing. This freezing continues until -50°C at which point the slope of the R-T curve changes again. The sample resistance increases to a value of 8 M Ω at a temperature of -80°C. This increase in resistance at -80°C is more than 6500 times greater than its unfrozen

resistance at +5°C. The R-T curve on thawing is similar to the freezing curve with a hysteresis of approximately +8°C.

The phi-T curves coordinate with the R-T curves. Inflection points of the phi-T curve correspond with the change of slope in the R-T curve. Blocking of the pores occurs at -35°C. At +5°C, $\phi=0.95$ and decreases to a low of 0.70 at the blocking temperature. The value of ϕ at -80°C is 0.90. This variation of ϕ indicates a broad pore size distribution as is expected for a paste with 7 days of hydration.

6.2.3.4 Cement Paste with Fly Ash, 7 Days Hydration

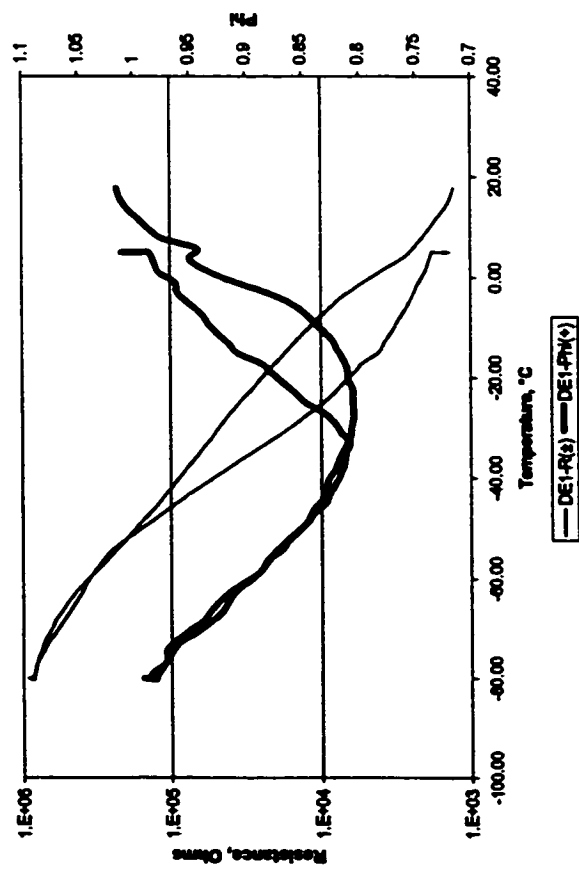
The results of the experiments on pastes with fly ash are summarized in graph 6.3. The incipient freezing temperature is not affected by the presence of fly ash. The R-T curves have a change of slope at -8°C on freezing. Subsequent changes of slope on freezing are very small and indicate uniformity of the pore sizes. The steep slope of the R-T curve results due to the nature of young pastes to have a large and well-connected pore system. The fly ash has only started to combine with the CH of the paste. The pore refinement due to the fly ash has not yet been realized.

The incipient freezing temperature of -8°C from the R-T curve is confirmed by the phi-T curve. The pore blocking temperature occurs on average at -30°C. ϕ ranges from 0.90 at +5°C to a low of 0.65 at -30°C and back up to 0.90 at -80°C.

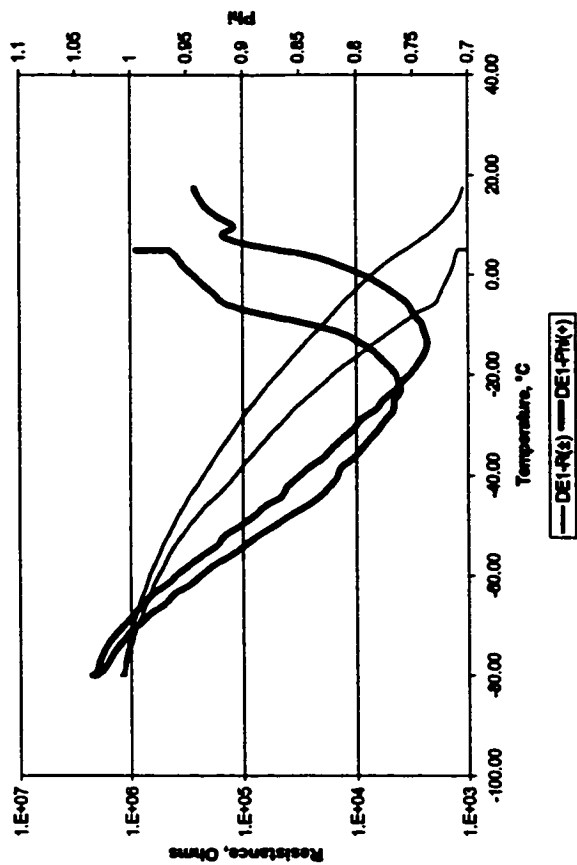
At 7 days of hydration, the effects of the fly ash are very subtle. Longer hydration times are necessary for the fly ash to affect the pore structure of the paste.

The phi-temperature curves on the samples with only 7 days of hydration show that the pore structure of the specimens is very different from those hydrated for 9 months. The range of the ϕ values is much greater after only 7 days of hydration because of the presence of the large capillary pores that freeze first at higher temperatures. Unlike the pastes/mortars with 9 months of hydration, ϕ decreases with temperature until the pores become blocked at which point ϕ increases as the temperature continues to decrease. This result is due to the large pore size distribution and the presence of large capillary pores of pastes/mortars after only 7 days of

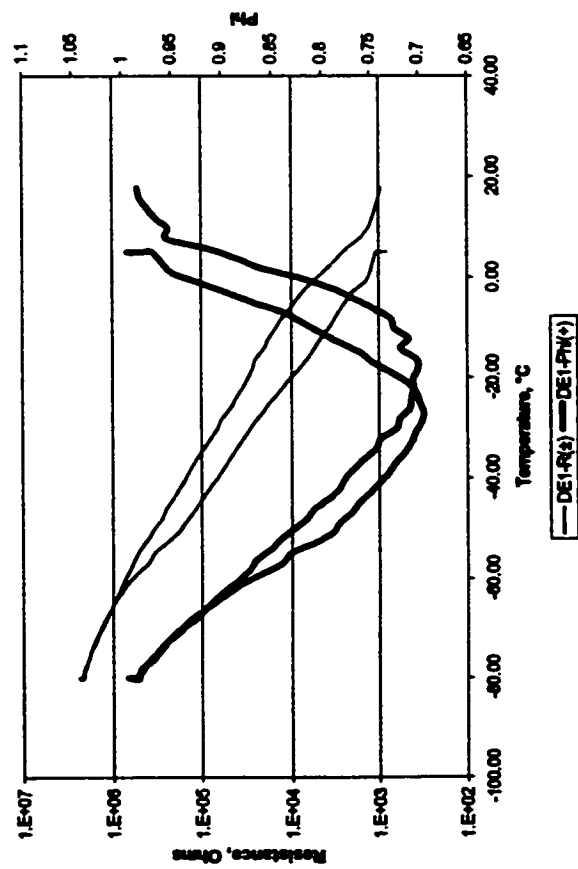
Reference Paste
7 Days Hydration



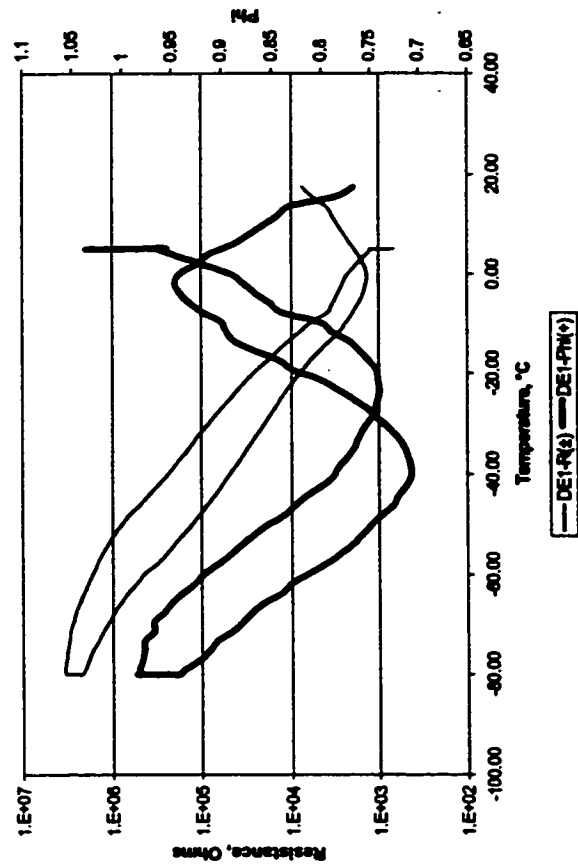
Melligan Paste
7 Days Hydration



Portage Paste
7 Days Hydration

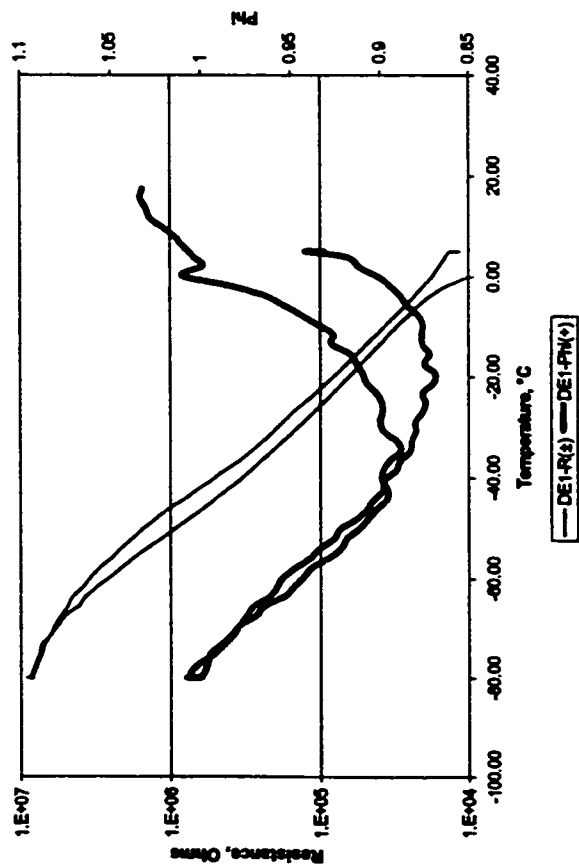


Sundance Paste
7 Days Hydration

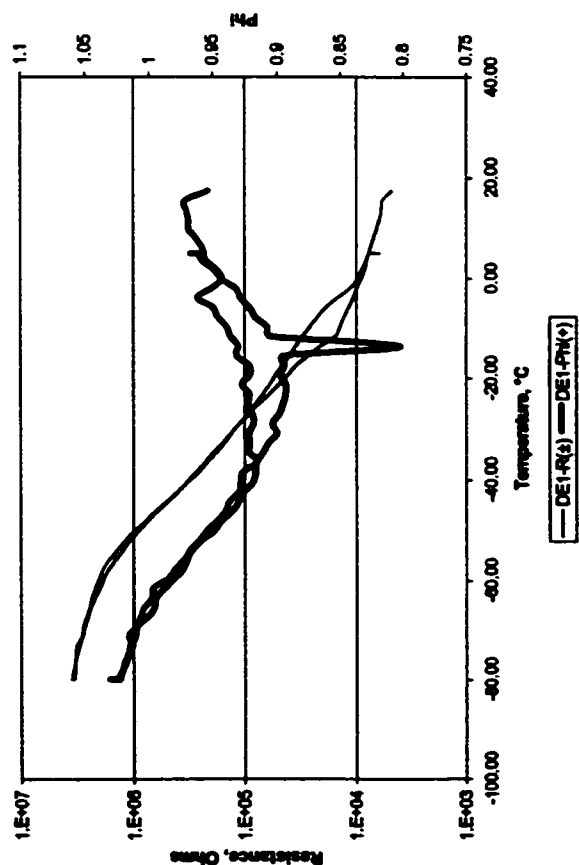


Graph 6.3: Paste with Fly Ash, 7 Days Hydration

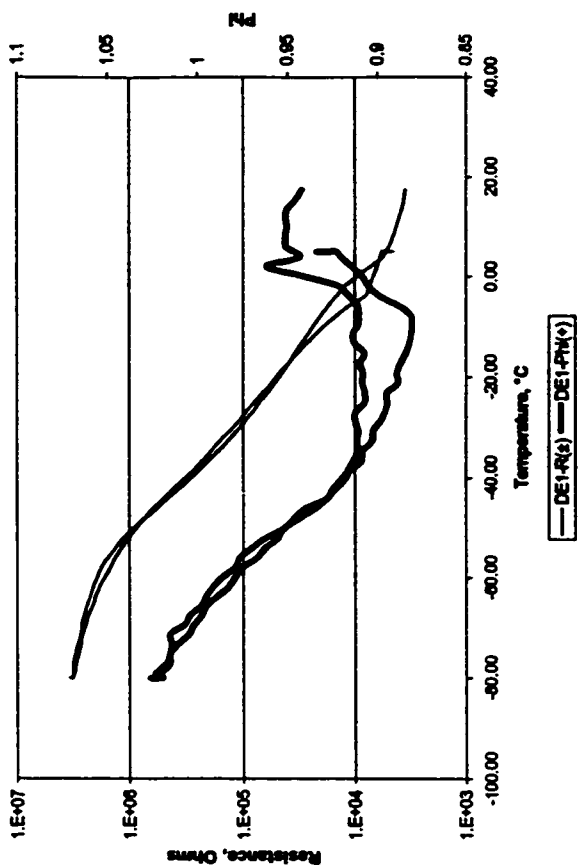
Reference Mortar
7 Days Hydration



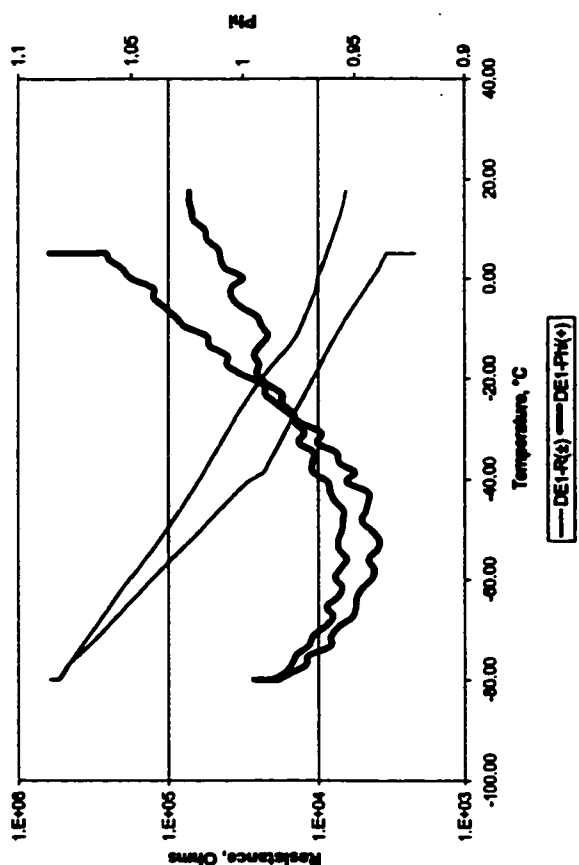
Portage Mortar
7 Days Hydration



Malligan Mortar
7 Days Hydration



Sundance Mortar
7 Days Hydration



Graph 6.4: Mortar with Fly Ash, 7 Days Hydration

hydration. Nine months of hydration results in a more complex pore structure of small pores and a small pore size distribution that results in the flat phi-temperature curve before pore blockage.

6.2.3.5 Mortar, 7 Days Hydration

6.2.3.5.1 Plain Reference Specimens

Experimental results for the ACIS tests on plain mortar specimens are in graph 6.4. The first change of slope of the R-T curve occurs at -8°C on incipient freezing. Further freezing results in a fairly constant slope which represents the 'young' open pore structure. The resistance of the plain mortar increases from $10\,000\,\Omega$ at $+5^{\circ}\text{C}$ to $100\,\text{M}\Omega$ at -80°C .

The phi-T curve decreases to a minimum value at a blocking temperature of -15°C . This high blocking temperature as compared to the other tests can be explained by the transition zone of the mortar. The interface between the sand aggregate and the cement paste will be more porous than the rest of the cement paste matrix. It is probable that the electric current travels through this zone initially. Freezing in the transition zone will occur first and at a relatively high temperature. The quantity of the sand granules within the specimen makes it possible for the transition zone to be responsible for the high pore blocking temperature. Phi ranges from 0.93 at $+5^{\circ}\text{C}$ to 0.82 at -15°C and back up to 0.95 at -80°C .

6.2.3.5.2 Mortar with Fly Ash, 7 Days Hydration

The results of the mortar specimens with fly ash are illustrated in graph 6.4. The resistance values of the Melligan and Portage fly ash specimens increase from approximately $10\,000\,\Omega$ at $+5^{\circ}\text{C}$ to $100\,\text{M}\Omega$ at -80°C . The R-T curves of these samples are similar and do not exhibit many changes of slope. The most significant change of slope is at -8°C when freezing of the porewater begins.

The phi-T curves indicate a blocking temperature of -10°C which is expected for a young mortar. The only difference between the reference and fly ash mortar samples is the valley in the phi-T

curve at the blocking temperature which is due to the increased range of pore size distribution due to the fly ash reacting with CH. This a small effect due to the short hydration times.

6.3 Conclusions

1. Refined pore structure of the specimens with fly ash is apparent from the ACIS curves.
2. Fly ash increases the density of the cement matrix as indicated by the increased sample resistance.
3. The pore blocking temperature is decreased by the fly ash and therefore should have superior durability to freezing-thawing cycles.
4. The mortar ϕ -temperature curves do not exhibit a minimum ϕ during freezing. This is related to a larger more connected pore structure.
5. The TMA, DSC, and ACIS results corroborate field observations that otherwise good quality fly ash concrete can be susceptible to frost action (salt-scaling).
6. The susceptibility referred to above appears to be dependent on fly ash type. The reasons are not clear, but are probably related to chemical composition of the fly ash and the nature of the C-S-H formed on hydration.
7. The ϕ -T and R-T curves for the fly ash pastes are consistent with the postulates advanced in Chapter 5 concerning the role of water movement and pore-structure in the freezing process.
8. The study has provided evidence that well hydrated, low water-cement ratio pastes/mortars containing fly ash are not immune to surface damage. The evidence is related to secondary freezing effects (-30 to -45°C). While these temperatures are not normally experienced in practice, the temperature dependence of the phenomena are initiated at higher temperatures and the effects of secondary freezing may occur over a wide range of temperatures.

CHAPTER 7

FREEZING OF MODEL POROUS SYSTEMS – BRICK AND VYCOR GLASS

7.1. Introduction

Some fundamental characteristics of the materials (hydrated cement paste, brick and vycor glass) are similar. They are all porous materials with interconnected pore systems and a rigid matrix. However, the pore systems of brick and vycor glass are less complex than those of hcp. A study of brick and vycor glass should allow the theories relating ACIS parameters to the freezing of porous materials to be tested and developed in relation to materials that have pore systems complementary to those of hcp.

7.2. Brick

Brick samples were studied in order to relate the AC Impedance parameters (derived from freezing-thawing cycles) of materials that have large, open pore systems. The well-connected pore network of brick allows pore water to travel with ease throughout the pore system as ambient conditions change. ACIS parameters measured from saturated brick samples subjected to a freezing-thawing cycle should complement the information already discussed on cement paste samples. The differences in pore structure between cement paste and brick should be readily apparent in the features of the Resistance-Temperature and Phi-Temperature curves. The testing of the brick samples and subsequent analysis of the curves will be used to verify the analysis methods previously discussed.

7.2.1. Sample Preparation

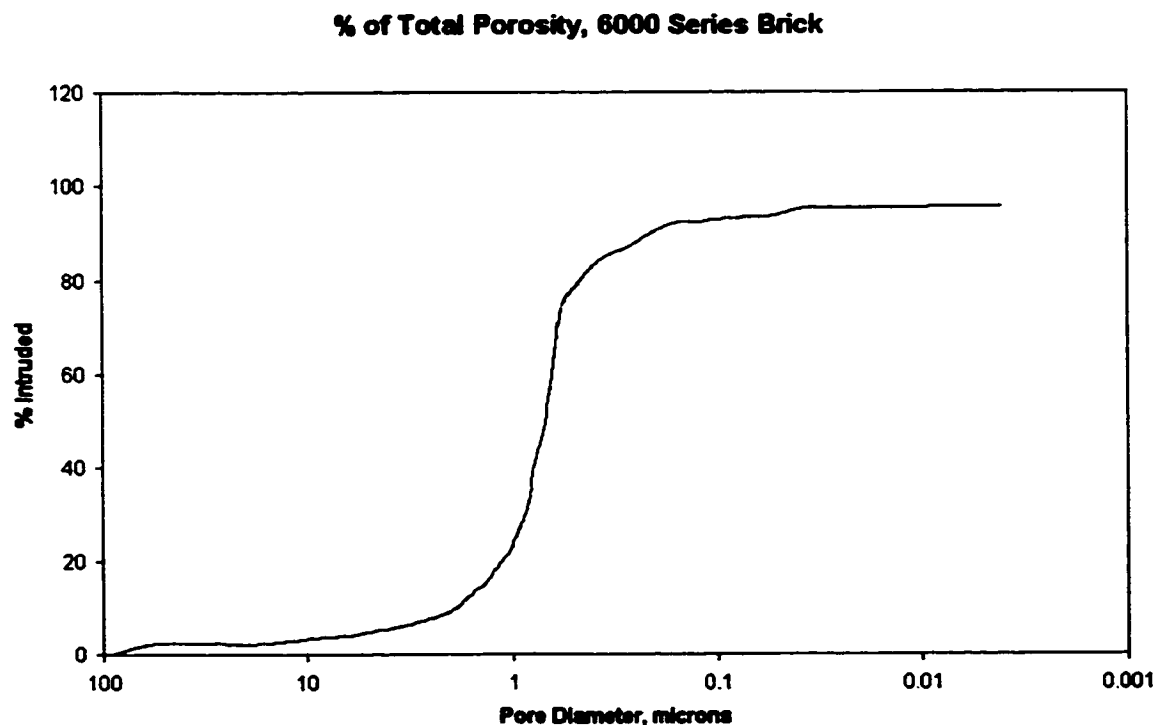
The brick samples were prepared in a similar manner to the fly ash samples taken from 3 by 6 inch cylinders. Cylinders (10 mm in diameter) were cored and cut to lengths of 13 mm. Samples

were then vacuum saturated with distilled water. Electrodes were secured to either end of the sample with conductive epoxy which was cured for a minimum of 24 hours at 100% relative humidity.

7.2.2. Characterization of the Brick

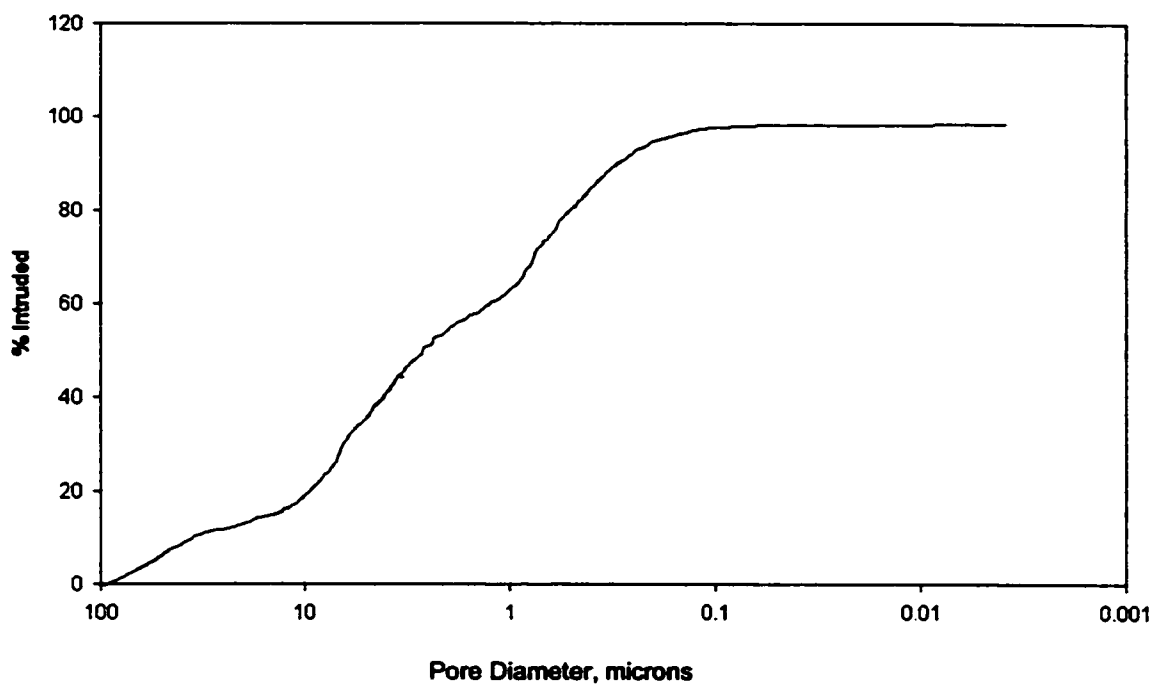
The 5000 series brick used in this thesis was rated the most durable in a report to evaluate the durability of many brick samples from all across Canada (Arnott, 1990). The 4000 and 6000 series bricks performed similarly and were ranked the lowest for Durability Based on Visual Distress and slightly better in the Durability Based on Strength Indices. The visual distress method evaluates visible signs of distress such as cracking due to freezing-thawing cycles. The strength index measures the loss of strength from freezing-thawing cycles. The two indices don't necessarily correlate with one another. A loss in strength is not necessarily accompanied by visual distress. Microcracking will reduce the strength of the brick without visual distress. Field performance of the brick is probably better predicted by the visual distress index.

The pore size distributions are shown in graphs 7.1 to 7.3. High durability of brick has been linked to bricks with pores larger than 1-3 microns (Arnott, 1990).



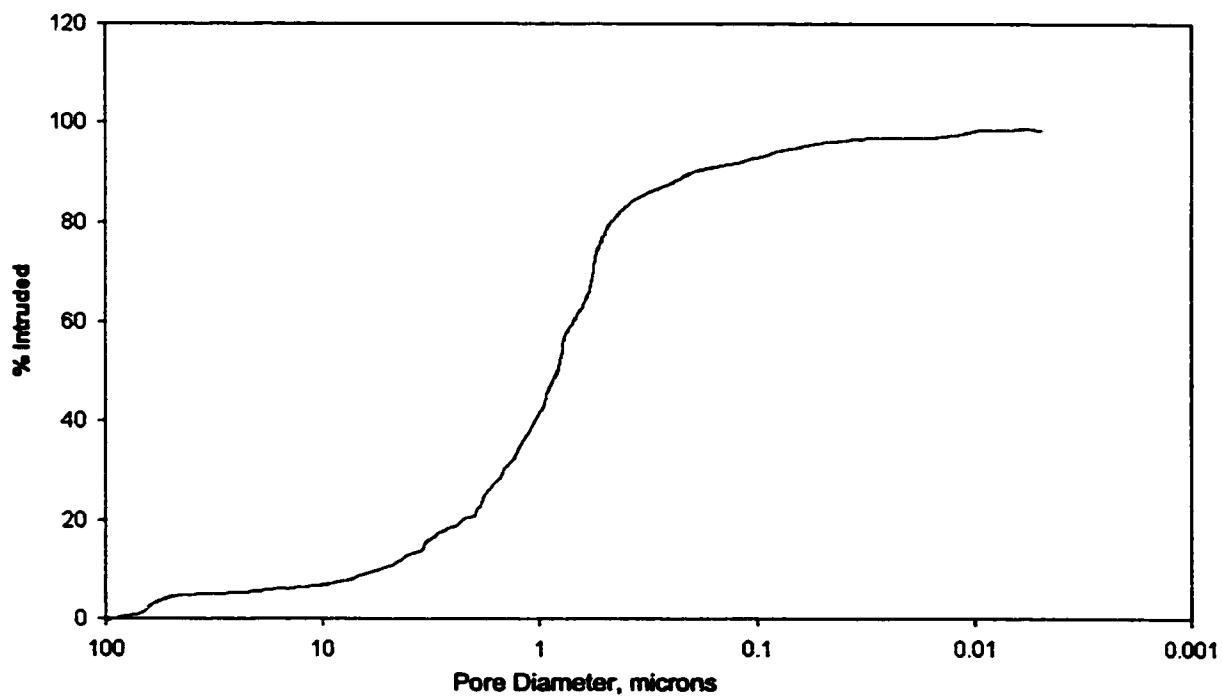
Graph 7.1: 6000 Series Brick, Porosity

% of Total Porosity, 5000 Series Brick



Graph 7.2: 5000 Series Brick, Porosity

% of Total Porosity, 4000 Series Brick



Graph 7.3: 4000 Series Brick, Porosity

7.2.3. Results

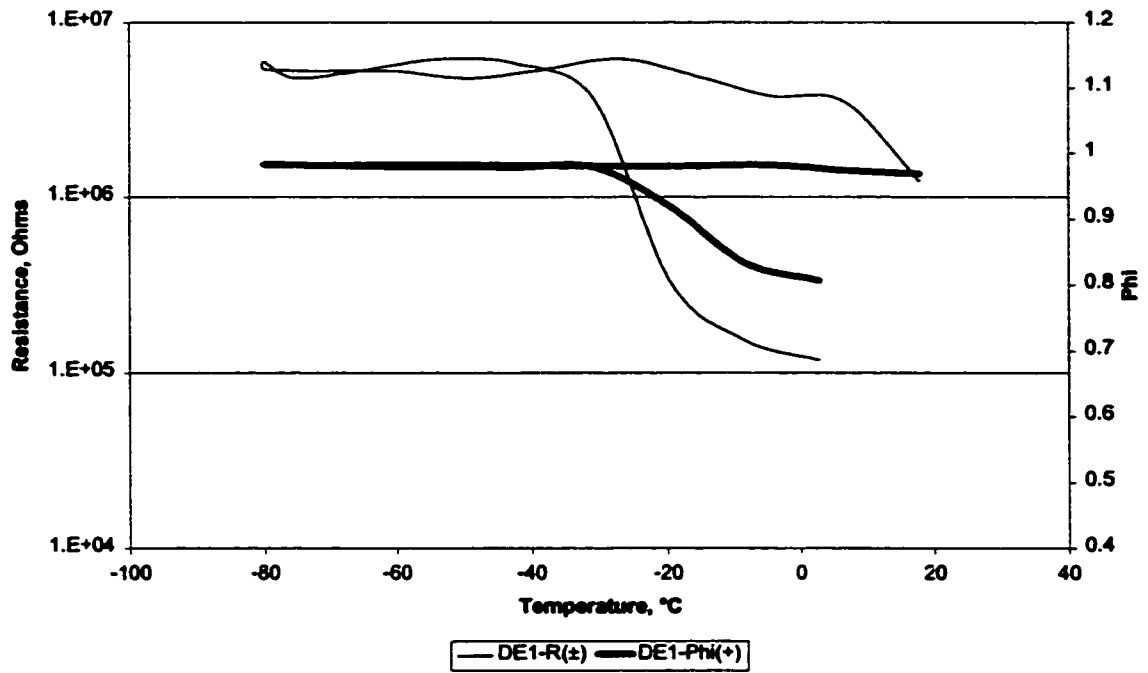
Table 7.1 displays the data from the ACIS tests. Similarly defined in the previous chapters: $\Delta\phi_5$ is change in ϕ after one freezing-thawing cycle calculated at 5°C, $\Delta\phi_{-40}$ is the change in ϕ due to freezing to -40°C, and R_{ef} is the effective freezing resistance. The small variations in $\Delta\phi$ in combination with the large effective freezing resistance are descriptors of the durability of the 5000 series of brick. The freezing of the pore water is easily accommodated in the large connected pore system without a significant amount of damage to the pore structure. This is a contradiction to the behaviour of cement paste as pore drainage is possible. The 4000 and 6000 series brick experience more damage as indicated by the large $\Delta\phi$ values with less effective freezing.

Sample	$\Delta\phi_5$	$\Delta\phi_{-40}$	$R_{ef} (\Omega)$
4000 Series			
A	0.10	0.10	24
B	0.28	0.11	49
5000 Series			
A	0.10	0.10	999
B	0.05	0.05	142
6000 Series			
A	0.15	0.15	99
B	0.20	0.20	699

Table 7.1: ACIS Brick Data

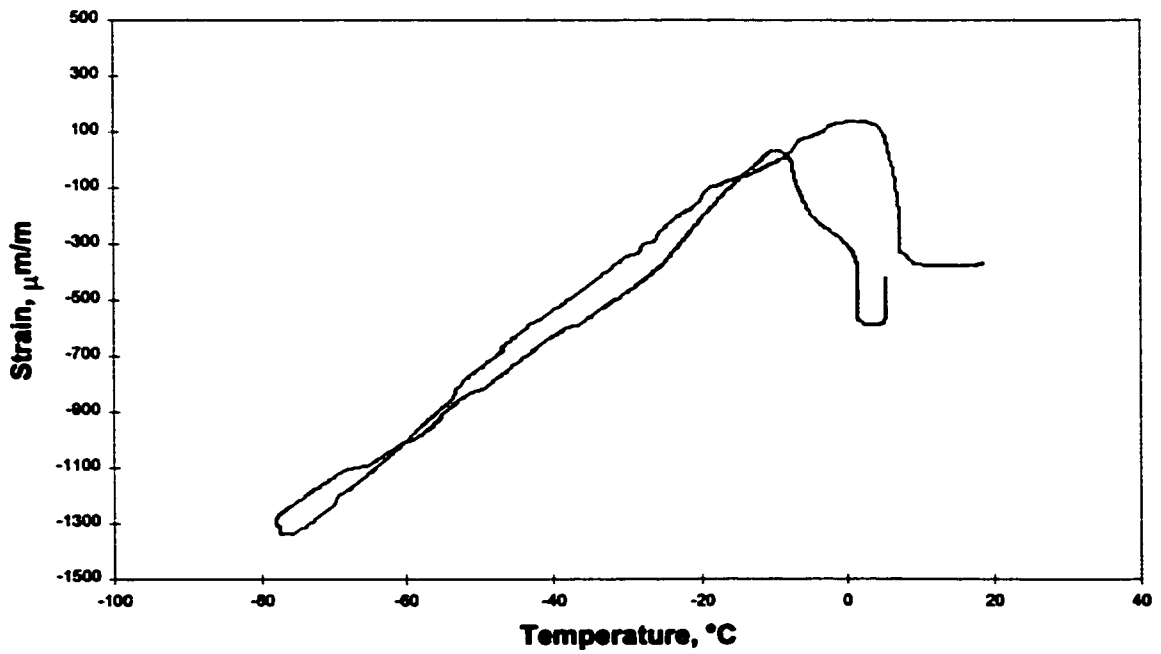
The smaller values of effective freezing resistance are a result of the smaller sized pore system. This corresponds to what is observed for cement paste. More water movement on freezing results in the large $\Delta\phi$ values. Since the brick is relatively weak this damages the pore structure which will compound with subsequent freezing-thawing cycles. In cement paste, finer pore structures are usually associated with increased durability.

6000 Series Brick



Graph 7.4: 6000 Brick Series, ACIS

6000 Series Brick



Graph 7.5: 6000 Brick Series, TMA

7.2.3.1. 6000 Series Brick

The 6000 Series brick had a total porosity of 32% with an average pore diameter of 0.75 μm . Eighty percent of the pores had a pore diameter in excess of 0.40 μm . TMA and ACIS data are illustrated in the graphs 7.4 and 7.5 for 6000 Series brick specimens subjected to freezing and thawing. Both testing procedures indicate that freezing of the pore water is complete at -22°C . The resistance-temperature and phi-temperature curves both climb steeply until -22°C is reached at which point the curves plateau. This result indicates that the brick sample had a large open pore system with a fairly uniform pore size. Freezing of the pore water was quick and alternate paths for the electric current were few. It is likely that all the water has frozen at this point. This implies that the incipient freezing and 'pore blocking' temperature occur very close to 0°C in systems with very large pores.

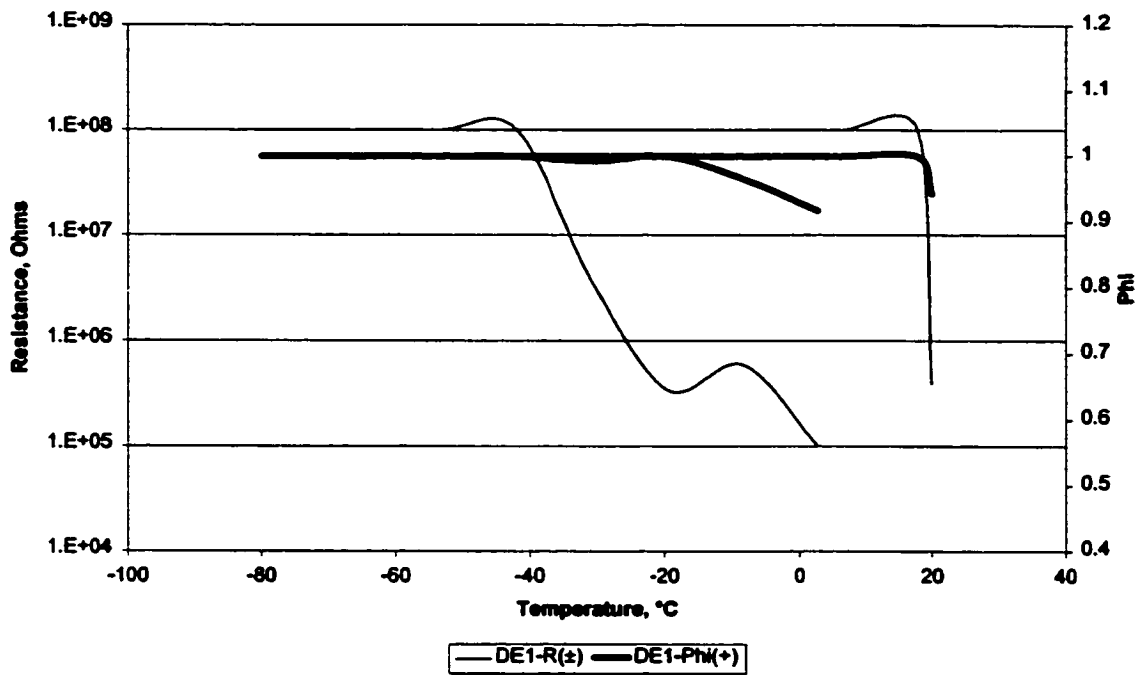
7.2.3.2. 5000 Series Brick

The total porosity of the 5000 Series brick was 22% with an average pore diameter of 3.0 μm ; 80% of the pores had a pore diameter greater than 0.5 μm . Even though these brick samples had a lower overall porosity than the 6000 Series brick, the pore structure of the 5000 Series brick is coarser and more open. This is shown in the ACIS results in graph 7.6 and the TMA results shown in graph 7.7. Freezing occurs at a higher temperature, -17°C . The phi value is higher, at 5°C , than the 6000 Series brick indicating a more uniform pore structure. The curves of the resistance and phi versus temperature are similar to the 6000 Series brick that show freezing of the sample occurred in one step.

7.2.3.3. 4000 Series Brick

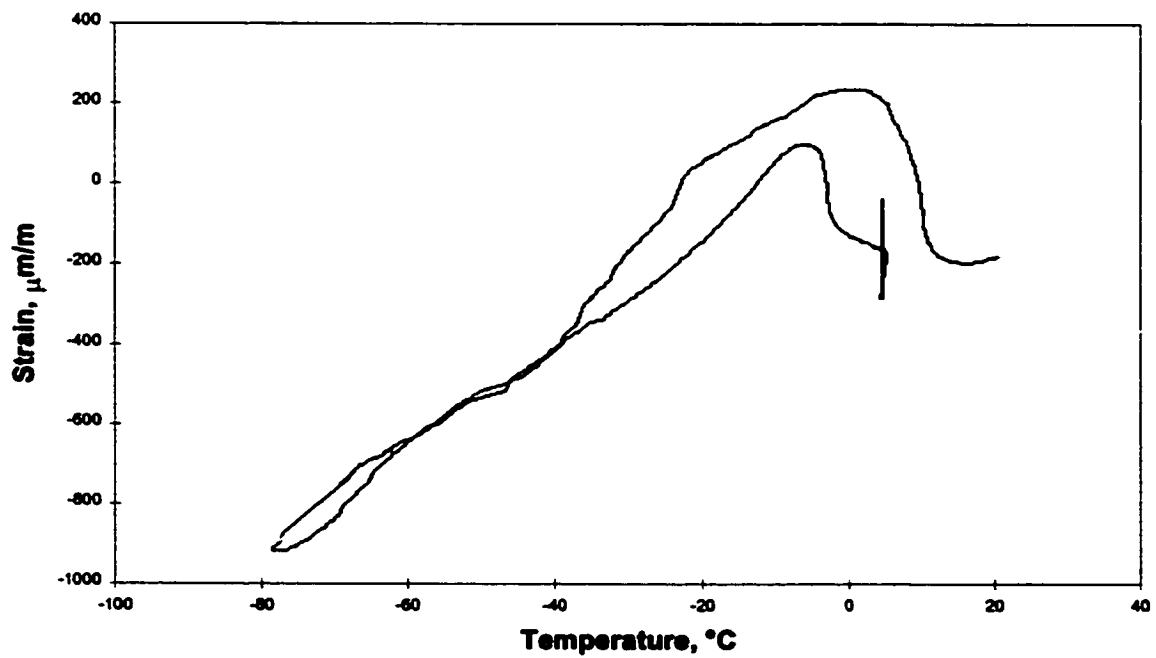
The mercury intrusion porosimetry of the 4000 series brick indicates the porosity is 26% with the average pore diameter being 1.0 micron. The threshold diameter is 2 microns with 80% of the pores having a pore diameter of 0.3 microns or greater.

5000 Series Brick



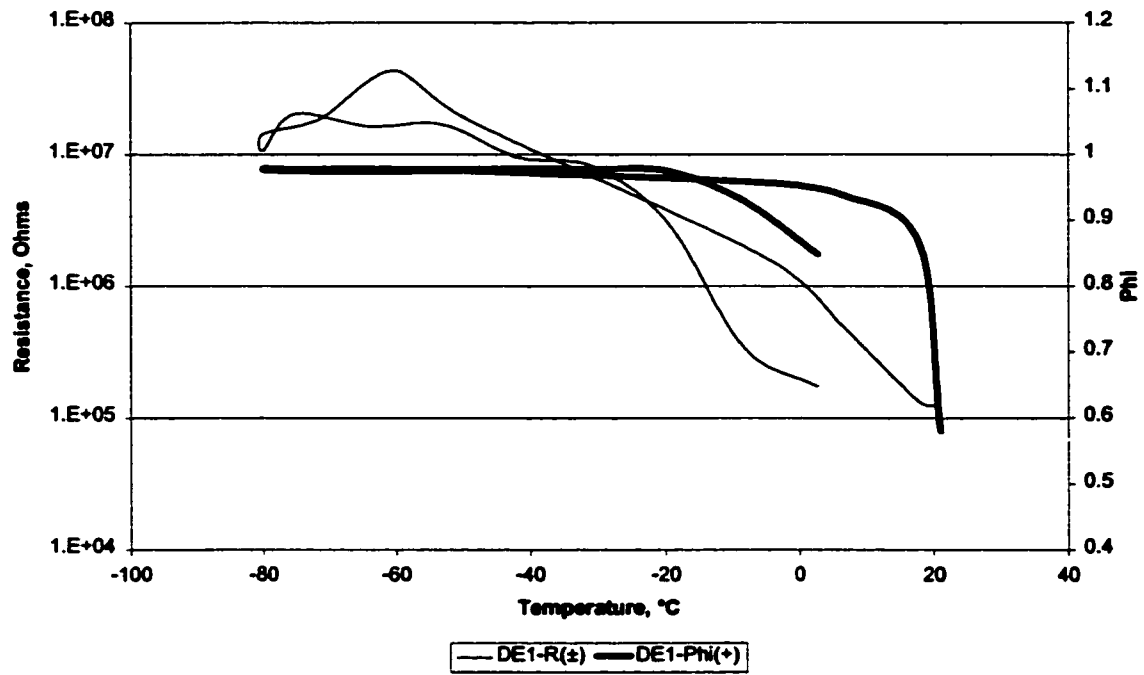
Graph 7.6: 5000 Series Brick, ACIS

5000 Series Brick



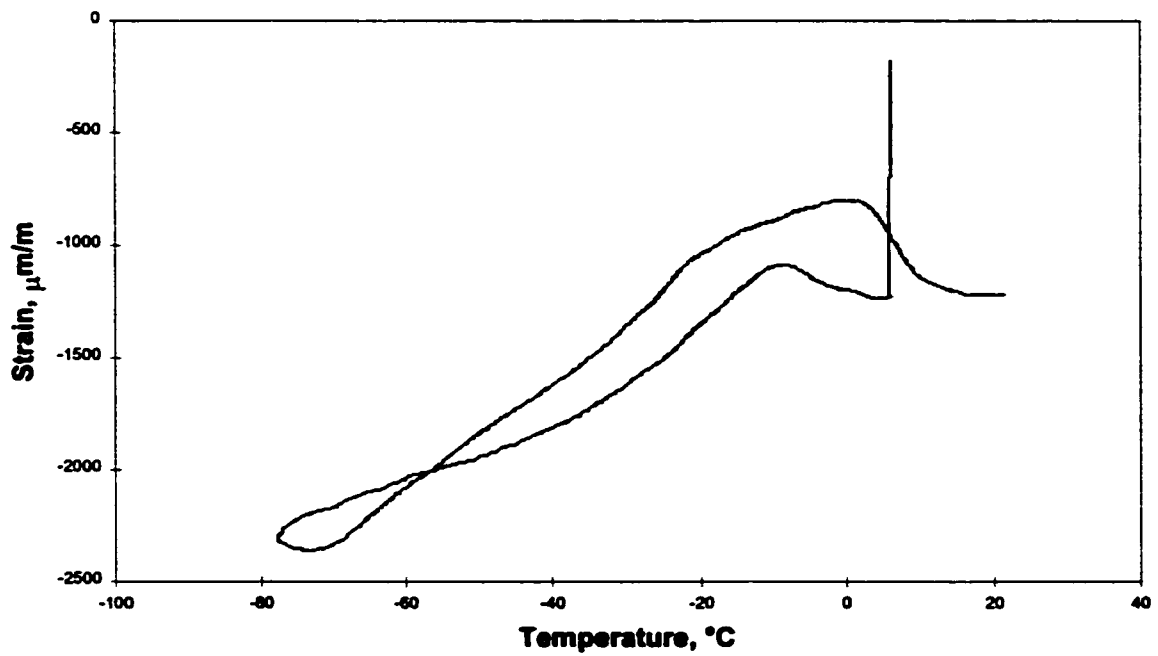
Graph 7.7: 5000 Series Brick, TMA

4000 Series Brick



Graph 7.8: 4000 Series Brick, ACIS

4000 Series Brick



Graph 7.9: 4000 Series Brick, TMA

In graph 7.9, expansion of the brick due to bulk freezing occurs between 0°C and -10°C. Between -10°C and -40°C the contraction of the sample is due to both water movement and contraction of the brick matrix. The residual length change at +5°C is -1200 µm/m whereas dilation of the brick is +1000 µm/m.

Resistance of the sample increases until -40°C has been reached on freezing, see graph 7.8. The majority of freezing occurs between 0°C and -20°C as indicated by the steep Resistance-Temperature curve. The curve of Phi-Temperature reflects the simple open pore system of the brick. Freezing of the sample continues until -20°C. At this point, phi is 1 and remains constant throughout the continued decrease in temperature. The initial phi of 0.89 at +5°C is indicative of the relatively uniform pore structure with predominately large pores.

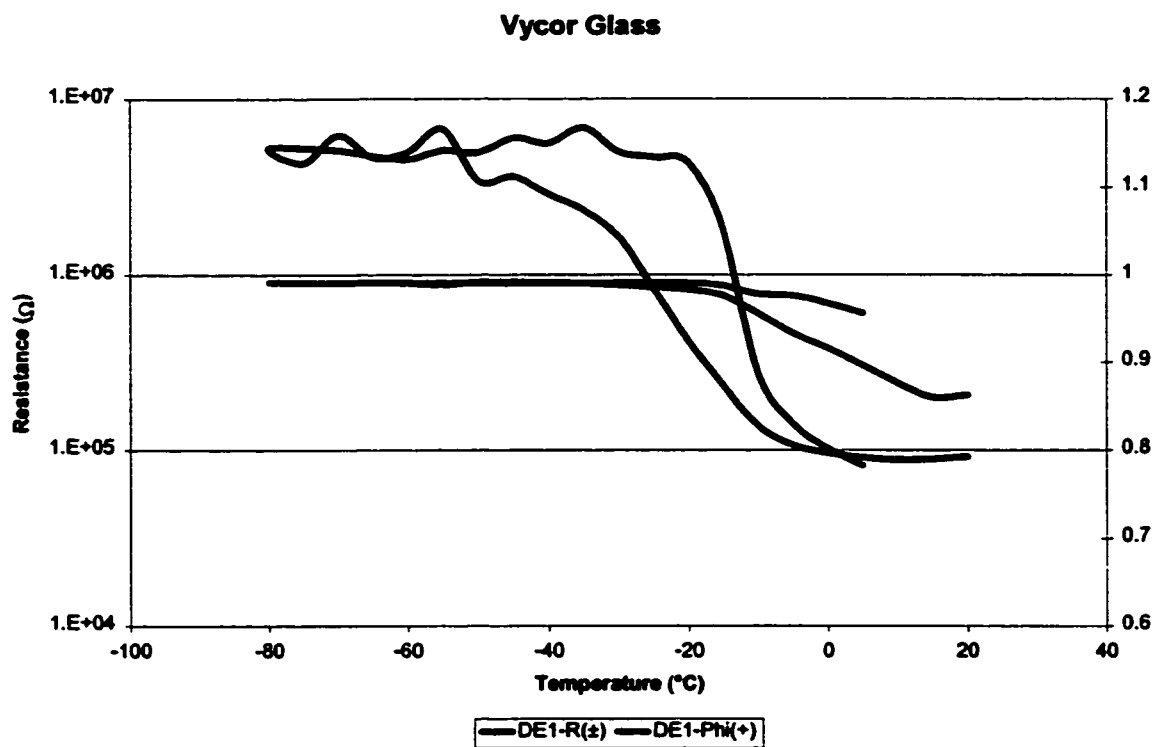
7.3. Vycor Glass

Vycor glass is a porous material that is often used as a model for studies on hydrated cement pastes. Unlike hydrated cement paste, the pore system is relatively uniform in pore size and distribution throughout the material. The controlled pore system of vycor glass makes it an ideal candidate to test the theories related to the analysis of the phi-temperature curves of the hydrated cement paste.

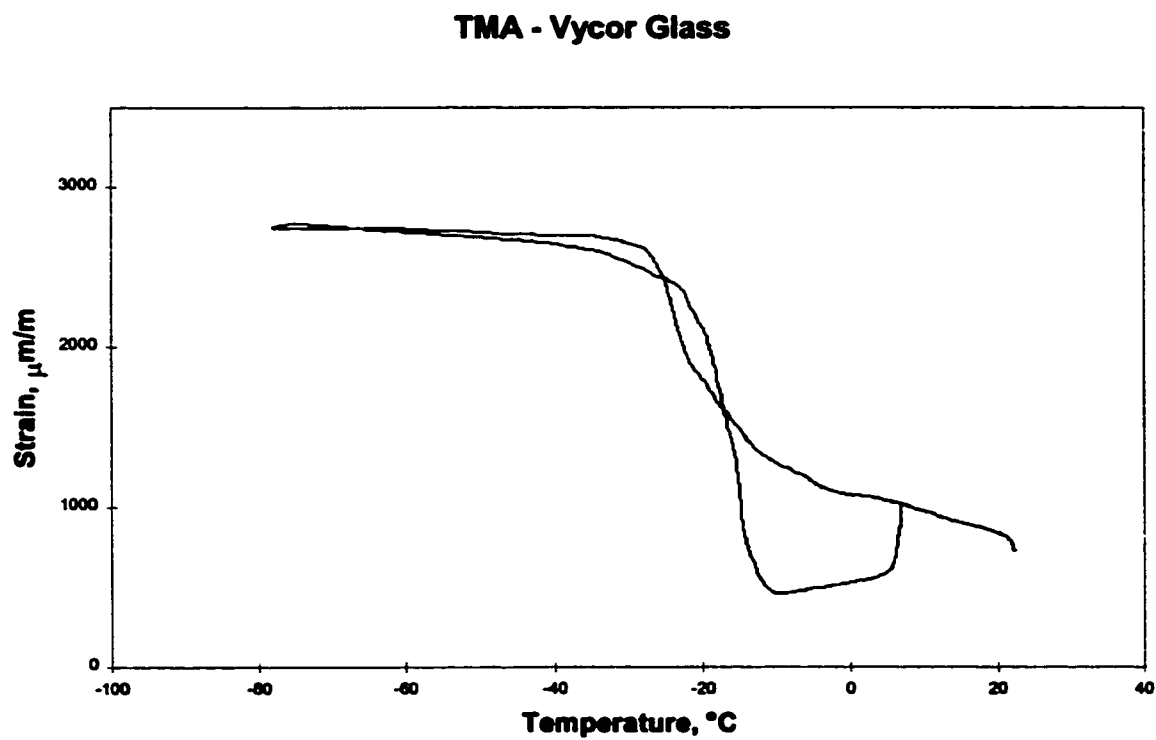
7.3.1. Results

The results of the vycor glass tests are displayed in graphs 7.10 and 7.11. The TMA results indicate that expansion of the material begins at approximately -10°C and continues to expand to -30°C. The ACIS curves of R-T and Phi-T concur with the TMA curves. The sharp change in slope of the R-T curves occur in the same temperature interval, -10 to -30°C as the TMA curve. Freezing of the pore solution is occurring in this range.

The sample resistance increases sharply as the pore water freezes and eventually plateaus when the freezing is complete. The steep slope of R-T on freezing indicates that the significant freezing occurred in pores that were uniform in size and well distributed throughout the sample.



Graph 7.10: Vycor Glass, ACIS



Graph 7.11: Vycor Glass, TMA

As well, freezing occurs over a relatively small temperature range. The sample curves indicate that freezing and thawing occurs in one step. This is due to the uniformity of the pore size. Once freezing begins, it continues at the same rate until the water in all pores has frozen.

Unlike hydrated cement paste once freezing is complete, both R and phi become constant. Phi has reached one and R changes nominally with decreasing temperature. There is no interlayer water in the vycor glass samples that continue to be affected by the decreasing temperatures as was seen in the hydrated cement paste samples where the R and phi values continued to increase even after the bulk pore water had finished freezing.

Another indication of the uniform pore structure of the vycor glass is the narrow range of phi on freezing. The majority of specimens had an initial phi of approximately 0.9 with a total increase of no more than 0.1 on freezing. However, on thawing, damage to the vycor glass specimens is likely because of the large $\Delta\phi_s$ after one freezing-thawing cycle. This value is as much as 0.3 which is a significant change in the properties of the specimen due to the formation of cracks during freezing see Figure 7.1.

7.4. Conclusions

It is evident from both A.C. impedance data and the traditional TMA and MIP data that pore systems in clay brick are open and well connected. Freezing of pore water in brick samples occurred between 0°C and -20°C. The constant values of Resistance and Phi as the temperature continues to decrease below -20°C indicates the absence of fine micropores in the pore systems of brick. As was previously discussed, cement paste samples contain pore water within the C-S-H layers and adsorbed water on their surfaces. This water is held tightly and never 'freezes' but continues to become more 'ordered' with the decreasing temperatures which the impedance measurements can detect. This difference in the pore structure of the materials, brick and cement paste, can be easily recognized in the ACIS data. The durability analysis concurs with a previous durability study on similar specimens with the 5000 Series being the most durable.

The results presented for the vycor glass specimens are consistent with the previous analyses. The impedance data show the uniformity of the pore structure of the vycor glass and the behaviour of the material on freezing.

The arguments based on ACIS describing the low temperature behaviour of saturated brick are consistent with those for all systems studied. The characteristics of the ϕ -T and R-T relationships confirm that the movement of water during freezing-thawing is an important factor in durability assessment.

CHAPTER 8

8 DIELECTRIC PROPERTIES OF CEMENT PASTE AND VYCOR GLASS

8.1 Introduction

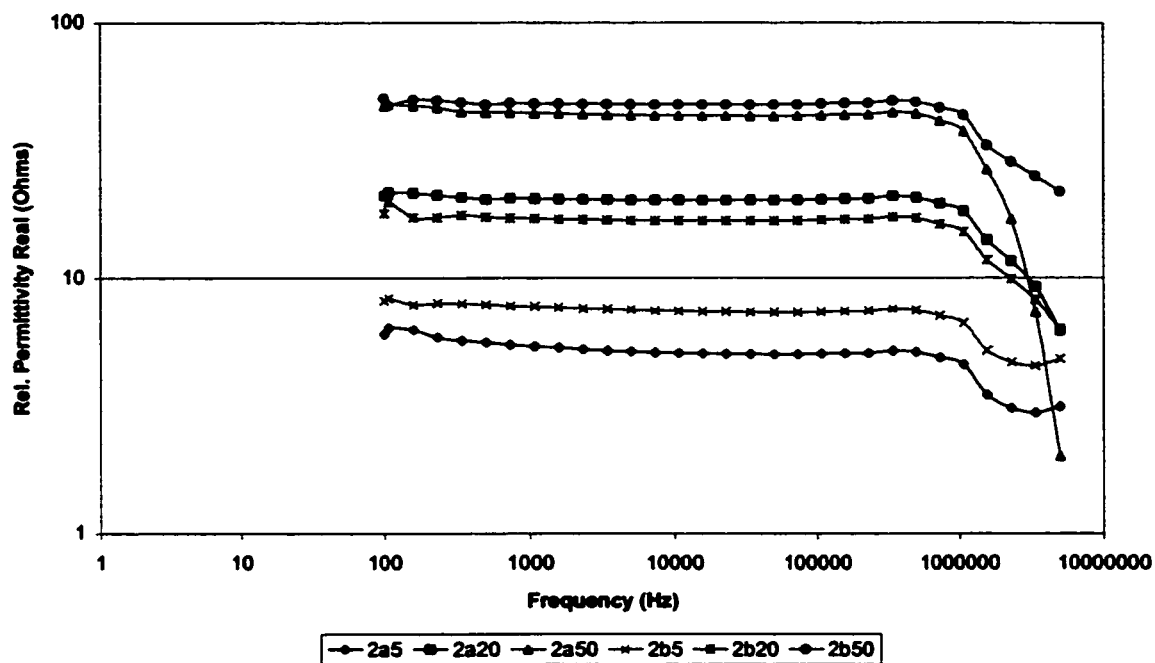
There have been several studies on the dielectric properties of porous, liquid-filled solids that have tried to explain the extremely high permittivity values that occur at low frequencies. It is believed that these high permittivity values can arise from (i) Electrode Polarization Effects and/or (ii) Bulk Polarization Effects. This investigation focused on the behaviour of hydrated cement paste and vycor glass, which also exhibit extremely high permittivity values at low frequencies, in order to determine which of the above effects dominate.

As described in Section 3.5 of Chapter 3, using Teflon sheets in between the electrodes and the samples will minimize the effects arising from electrode polarization. The Teflon behaves as a 'pure' capacitor which stores the electrical charge. The electrodes become isolated from the sample which prevents the buildup of charge at the electrode-sample interface, known as the double layer that is associated with electrode polarization. Using Teflon sheets during the dielectric measurements will make it possible to distinguish between the Electrode Polarization Effects and the Bulk Polarization Effects.

8.2 Results

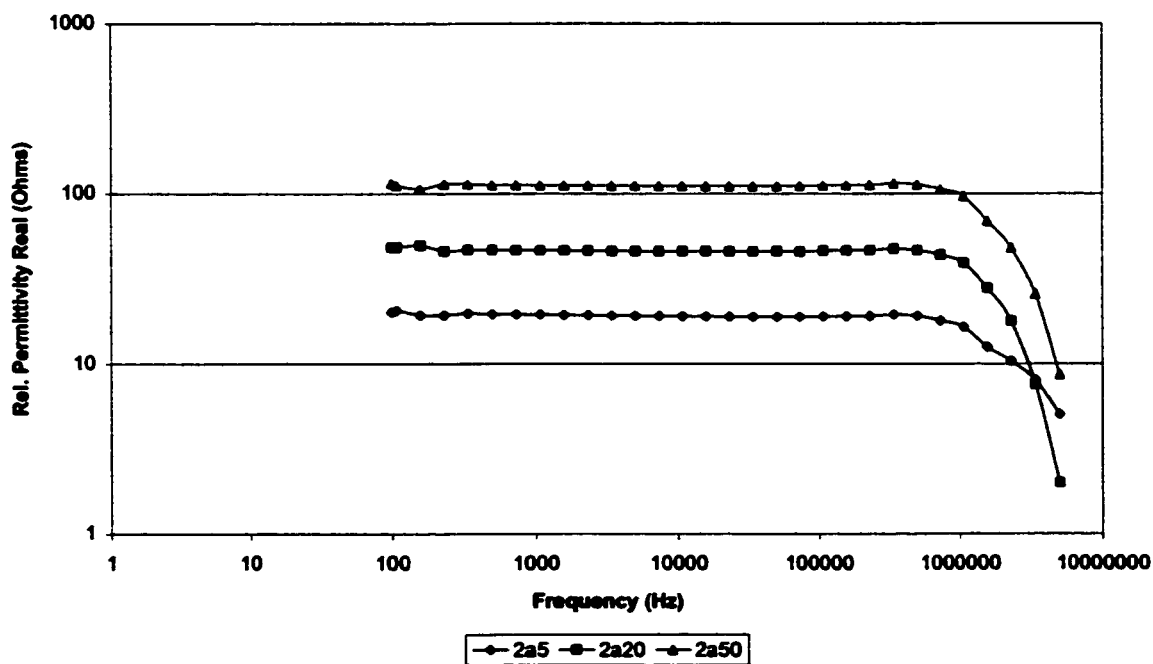
It can be seen by the results tabulated in the Tables 8.1 – 8.7 that the measured permittivities of the cement paste are impacted by both Electrode Polarization Effects and Bulk Polarization Effects. The measured permittivities dropped dramatically when using the teflon sheets between the electrodes. As well, the thickness of the test specimen plays a role in the measured permittivity. Another effect that is apparent relates to the thickness of teflon being used, Tables 8.6 and 8.7. The thicker the teflon sheet, the greater the reduction of permittivity.

Triethanolamine - 1.60 Teflon



Graph 8.1: HCP with Triethanolamine, 1.60 mm Thick Teflon

Triethanolamine - 0.51 Teflon



Graph 8.2: HCP with Triethanolamine, 0.51 mm Total Teflon Thickness

Typical curves of permittivity versus frequency are plotted graphs 8.1 – 8.4. These graphs clearly show effect of the teflon on the permittivity measurements. Graph 8.3 shows the change in the permittivity of hydrated cement paste with frequency. The permittivity is inversely related to frequency. Graphs 8.3 and 8.4 show the same sample measured with 0.8 mm (1.60mm total thickness) and 0.255 mm (0.51 mm total thickness) teflon sheets inside the electrodes. It can be clearly seen that the permittivity of the paste + teflon is independent of frequency in the range of 100 Hz to 1 MHz. This result would not be expected if bulk polarization effects were dominating. Bulk polarization effects would increase the permittivities as the frequency decreased.

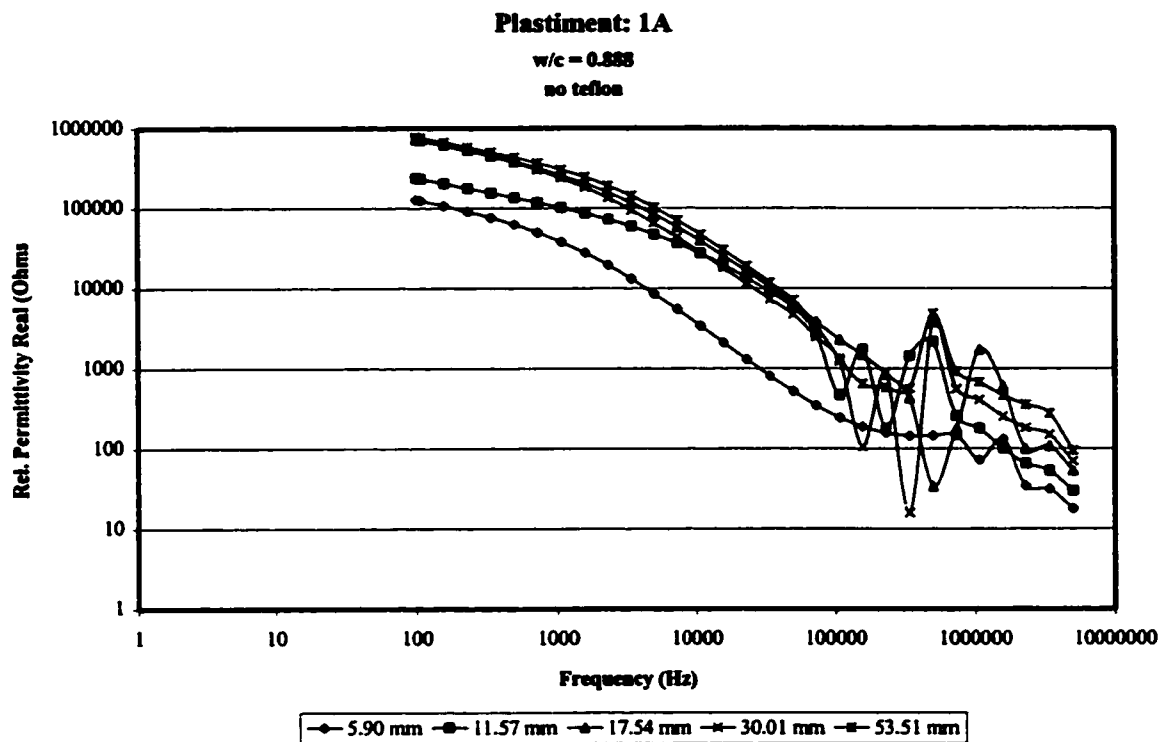
It can be seen from the results in Tables 8.1-8.3 that there is a large difference between the dielectric constant of cement paste measured with teflon (and then subtracted) and that obtained from measurement of the paste without teflon. The values vary slightly with sample thickness and this variation increases with w/c ratio. When teflon is not used in between the electrode and the sample, the dielectric constant of the paste increases greatly with sample thickness and was measured as high as 531. This would suggest that electrode effects are dominating the results and that the teflon sheets effectively minimize the effect. If bulk effects were dominating, it is expected that the dielectric constant would be independent of sample thickness.

The permittivities of the higher w/c ratios have larger increases in permittivity relative to those for the lower w/c ratios. This is consistent with electrode polarization effects. The high w/c ratios have a larger more connected pore system than the low w/c ratios which allows for greater movement of the charged particles of the sample facilitating the formation of a double layer.

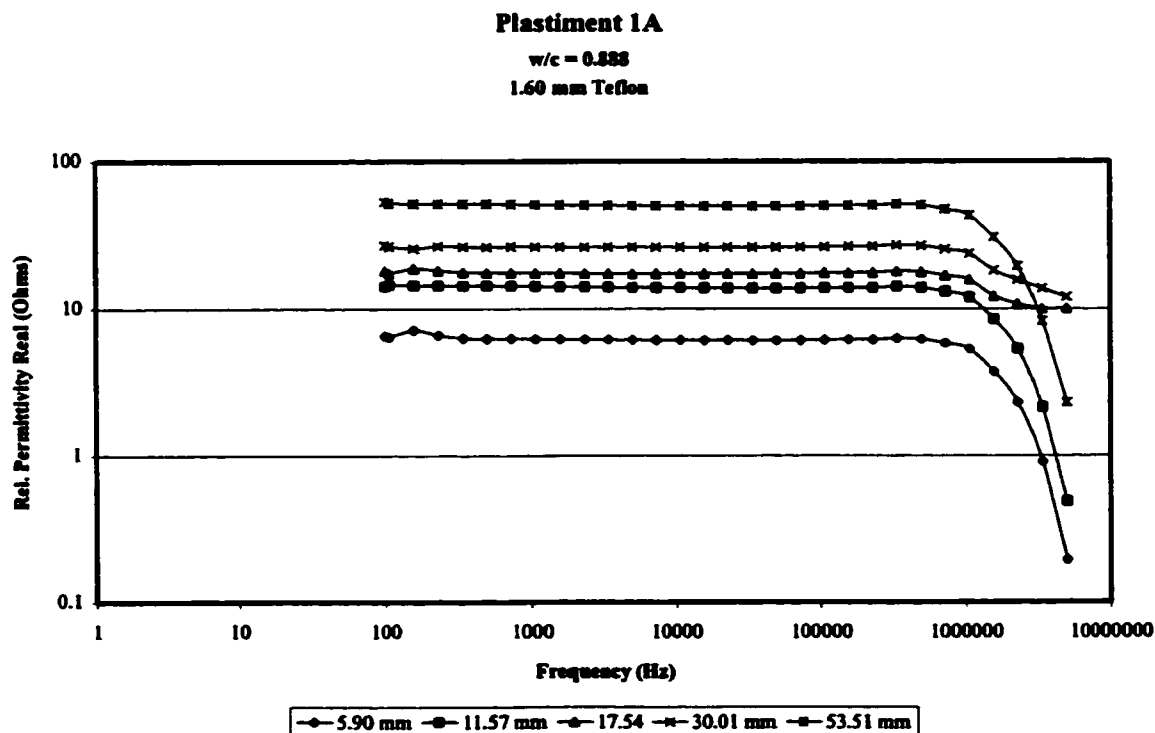
The results of the vycor glass tests are shown in Table 8.4. The values obtained with the Chelsea Dielectric are in agreement with those from the Solartron alone when using teflon sheets. These results also indicate that electrode effects dominate the low frequency high permittivity values. The dielectric constant, ϵ , varies with sample thickness and pore solution conductivity when measured without teflon. The permittivity values calculated from the measurements taken with teflon are reasonable though still slightly variable with sample thickness.

The dielectric constant of cement paste would normally be expected to be much less than that of pure water (about 80). Any amplification effects would also be expected to be considerably less

than otherwise observed when Teflon sheets are used during the measurements. These values might approach 80.



Graph 8.3: HCP with Plastiment, no Teflon Sheets



Graph 8.4: HCP with Plastiment, 1.6 mm Teflon Thickness

Table 8.1: 30 year hydrated cement paste in their natural condition

Measured with Teflon	Sample	Thickness (mm)	C paste + teflon (F)	C paste (F)	ϵ
w/c = 0.25 $\rho=19.1\Omega\text{cm}$, $\sigma=5.24\text{s/m}$	Q25-5-t	5.09	1.458E-11	1.060E-10	78.15
	Q25-10-t	10.01	1.310E-11	5.828E-11	84.52
	Q25-15-t	14.99	1.245E-11	4.723E-11	102.56
w/c = 0.50 $\rho=31.8\Omega\text{cm}$, $\sigma=3.14\text{s/m}$	Q50-5-t	5.89	1.399E-11	8.108E-11	69.72
	Q50-10-t	10.19	1.303E-11	5.681E-11	84.51
w/c = 0.80 $\rho=46.3\Omega\text{cm}$, $\sigma=2.16\text{s/m}$	Q80-5-t	5.10	1.440E-11	9.734E-11	71.82
	Q80-10-t	11.88	1.279E-11	5.256E-11	90.34
	Q80-15-t	15.44	1.280E-11	5.270E-11	117.72

Capacitance of Teflon (F)

1.6903E-11

$\epsilon = 4.8$

Measured without Teflon	Sample	Thickness (mm)	C paste (F)	ϵ
w/c = 0.25	Q25-5	5.09	7.820E-11	57.66
	Q25-10	10.01	9.810E-11	142.25
	Q25-15	14.99	1.030E-10	223.67
w/c = 0.50	Q50-5	5.89	2.340E-10	201.21
	Q50-10	10.19	1.590E-10	236.53
w/c = 0.80	Q80-5	5.10	1.530E-10	112.89
	Q80-10	11.88	2.020E-10	347.20
	Q80-15	15.44	2.380E-10	531.66

Table 8.2:

30 Year Old Cement Pastes: Dried for 24 Hours at 38° C

Vacuum Saturated with pore solution, $\rho = 31.8 \Omega\text{cm}$.

Measured without Teflon

w/c	Thickness, mm	Surface Area, mm ²	Capacitance, F	Dielectric Constant
0.25	5.73	784.3	8.98E-11	74.13
0.25	10.60	784.3	5.87E-11	89.64
0.25	15.58	784.3	3.77E-11	84.62
0.50	5.18	784.3	1.02E-10	76.12
0.50	10.22	784.3	5.84E-11	85.99
0.50	15.01	784.3	6.83E-11	147.70
0.80	5.81	500	2.24E-10	294.11
0.80	10.10	500	1.04E-10	236.92
0.80	17.06	784.3	1.94E-10	476.82

Table 8.3:

30 Year Old Cement Pastes: Dried for 24 Hours at 38° C

Vacuum Saturated with pore solution, $\rho = 44.3 \Omega\text{cm}$.

Measured with Teflon	Sample	Thickness (mm)	C paste + teflon (F)	C paste (F)	ϵ
w/c = 0.25	Q25-5-t2	5.09	1.311E-11	5.834E-11	43.02
	Q25-10-t2	10.01	1.247E-11	4.755E-11	68.95
	Q25-15-t2	14.99	1.266E-11	5.043E-11	109.52
w/c = 0.50	Q50-5-t2	5.89	1.250E-11	4.802E-11	41.29
	Q50-10-t2	10.19	1.310E-11	5.822E-11	86.62
w/c = 0.80	Q80-5-t2	5.10	1.315E-11	5.923E-11	43.70
	Q80-10-t2	11.88	1.249E-11	4.784E-11	82.23
	Q80-15-t2	15.44	1.315E-11	5.929E-11	132.44

Capacitance of Teflon (F) 1.6903E-11 $\epsilon = 4.8$

Measured without Teflon	Sample	Thickness (mm)	Impedance, Ohms	C paste (F)	ϵ
w/c = 0.25	Q25-5-2	5.09	2420	1.663E-10	122.62
	Q25-10-2	10.01	6800	1.253E-10	181.70
	Q25-15-2	14.99	13174	1.791E-10	388.92
w/c = 0.50	Q50-5-2	5.89	1180	3.386E-10	291.15
	Q50-10-2	10.19	1917	2.574E-10	382.91
w/c = 0.80	Q80-5-2	5.1	350	2.508E-10	185.06
	Q80-10-2	11.88	235	1.661E-10	285.49
	Q80-15-2	15.44	236	1.640E-10	366.35

Table 8.4: Vycor Glass vacuum saturated with Brine solution.

			Chelsea Dielectric ($\omega=125$ Hz)		
	Sample	Thickness, mm	No Teflon	With Teflon	ϵ_z
$\sigma = 16.76$ s/m	DS3	1.26	5884000	3.222	4.439
	AS1	3.39	n/a	6.571	21.783
	BS3	4.97	n/a	7.334	17.017
$\sigma = 6.28$ s/m	DM2	1.26	75670	3.486	5.816
	AM2	3.39	132100	6.047	15.310
	BM2	4.97	145200	7.894	21.750
$\sigma = 0.621$ s/m	DW4	1.25	2094	3.474	5.771
	AW3	3.39	3117	6.089	15.714
	BW1	4.97	10560	7.520	18.414

Solartron

	Sample	Thickness (mm)	C glass + teflon (F)	C vycor glass (F)	$\epsilon_r = dC/\epsilon_0 A$
$\sigma = 16.76$ s/m	DS3	1.26	1.402E-11	3.110E-10	50.25
	AS1	3.39	1.319E-11	1.318E-10	21.31
	BS3	4.97	1.225E-11	7.437E-11	12.02
$\sigma = 6.28$ s/m	DM2	1.26	1.285E-11	1.043E-10	16.86
	AM2	3.39	1.294E-11	1.101E-10	17.79
	BM2	4.97	1.227E-11	7.526E-11	12.16
$\sigma = 0.621$ s/m	DW4	1.26	1.521E-11	-4.054E-10	-65.52
	AW3	3.39	1.225E-11	7.437E-11	12.02
	BW1	4.97	1.190E-11	6.332E-11	10.23

results imply that the Solartron gives erroneous results for 1.26 mm thick specimens.

Capacitance of
Teflon (F)
Permittivity of
Teflon

1.466E-11

2.65

$$\epsilon_r = \frac{d_g \epsilon_T \epsilon_t}{d_T \epsilon_t - d_t \epsilon_T}$$

Note: Subscript g represents vycor glass, T: glass + teflon, and t is teflon alone.

Table 8.5: 30 year hydrated cement paste

W/C = 1.00

Permittivity Results

Thickness, mm	Chelsea Dielectric			Solartron
	No Teflon	With Teflon	ϵ_{paste}	$\epsilon = dC/\epsilon_0 A$
2.46	12 300	5.4	16.61	1919
3.61	2 340	6.7	20.77	1437
5.28	40 000	9.1	34.68	780
8.54	20 000	11.6	31.59	429

Table 8.6: Triethanolamine Summary

			Rel. Permittivity Real (Ohms)			
		Sample	Thickness (mm)	no Teflon	1.60 mm Teflon	0.51 mm Teflon
2A	w/c 1.000 Max Dosage 21-Dec-66					
		2a5	5.86	28499	21	598
		2a20	20.49	94869	234	220
		2a50	50.69	1117787	354	546
2B	w/c = 1.000 Regular Dosage 14-Dec-66					
		2b5	5.55	57135	-67	267
		2b20	18.30	231425	124	172
		2b50	53.04	629738	460	943
2C	w/c = 0.900 Regular Dosage 08-Dec-66					
		2c5	5.71	67665	-72	194
		2c20	19.92	42054	208	197
		2c50	52.38	409587	406	766
2D	w/c = 0.700 Regular Dosage 05-Dec-66					
		2d5	5.35	29099	-76	152
		2d20	20.09	59879	145	308
		2d50	49.42	151882	346	1025

* measurements were taken using teflon between the electrode and the sample and then the teflon was subtracted to give the values reported.

Table 8.7: Plastiment Summary

			Rel. Permittivity Real (Ohms)				
			Sample	Thickness (mm)	no Teflon	1.60 mm Teflon	0.51 mm Teflon
1A:	w/c 0.888 Regular Dosage 22-Jul-66	1A5	5.90	127515	32	-158	
		1A10	11.57	239467	-346	-253	
		1A15	17.54	730166	189	-426	
		1A30	30.01	722212	142	286	
		1A50	53.51	783098	723	-12541	
1B:	w/c = 0.524 Double Dosage 02-Aug-66	1B5	5.28	23176	-288	-2546	
		1B10	11.13	68376	-248	-294	
		1B15	16.18	15606	327	38018	
		1B35	36.15	91100	380	1042	
		1B50	53.23	19626	528	4042	
1C:	w/c = 0.500 Regular Dosage 07-Sep-66	1C50	5.80	198935	712	-175	
		1C10	9.90	307721	-170	-213	
		1C15	15.71	86902	1184	18151	
		1C30	28.70	63795	217	33168	
		1C50	44.75	21949	298	886	
1D:	w/c = 0.757 Regular Dosage 21-Jul-66	1D10	10.80	172884	-366	-623	
		1D15	14.41	238659	-227	-877	
		1D20	20.14	85460	295	178	
		1D35	35.07	78155	149	319	
1E:	w/c = 1.00 Regular Dosage 25-Jul-66	1E5	5.91	4	15	-3197	
		1E15	13.41	540084	-188	-1232	
		1E20	19.25	98596	205	293	
		1E30	28.89	353070	242	549	
		1E50	42.85	284779	324	562	
1F:	w/c = 0.683 Double Dosage 03-Aug-66	1F5	5.47	5308	15	-402	
		1F15	12.41	355853	-339	-346	
		1F20	19.60	40049	91	188	
		1F30	32.58	145791	385	-6428	
		1F50	45.55	83770	700	1886	

* measurements were taken using teflon between the electrode and the sample and the teflon was subtracted to give the values reported.

8.3 Conclusions

- 1. Electrode Polarization Effects dominate the permittivity values of cement paste and vycor glass obtained with conventional measurement techniques at low frequencies.**
- 2. Electrode Polarization Effects increase with porosity.**
- 3. Use of teflon sheets (which act as 'pure' capacitors) between the sample and the electrodes minimizes Electrode Polarization Effects. It is suggested that numerous repeated values of the dielectric constant (particularly those at lower frequencies) of water saturated porous media are over estimated. The so-called dielectric amplification effect is considerably less pronounced than has been previously indicated.**

CHAPTER 9

SUMMARY

9.1 Introduction

The data presented and discussed in this thesis are meant to provide the basis to be used in the development of a new testing procedure to assess the durability of concrete using ACIS.

Throughout this work it was shown that ACIS has enough sensitivity to detect pore structure and pore water characteristics resulting from environmental influences. Pore structure and pore water parameters are fundamental in the assessment of the durability of concrete structures.

9.2 Dynamic Drying-Rewetting Experiments

The drying-rewetting experiments using ACIS to detect changes in the pore structure of hcp provide vital information on the deleterious effects that environmental conditions have on the durability of the covering layer of concrete. Cycles of partial drying and rewetting are common occurrences for exposed concrete. Typically this occurs in the outer most layer (50 mm) of concrete the most frequently. Damage to this covering layer of concrete reduces its effectiveness at protecting the interior reinforcing steel. It has been shown through the dynamic drying-rewetting experiments that even partial drying of hcp increases pore continuity. This was indicated by the reduction in sample resistance with each cycle of dynamic drying and rewetting. This corroborated by the change in the measured value of ϕ which supports the pore coarsening theory. ACIS is an effective tool in evaluating durability of concrete to environmental cycles of drying-rewetting.

9.3 Freezing-Thawing Experiments

The work presented on the behaviour of hcp during freezing-thawing cycles shows the effectiveness of ACIS on not only assessing the durability of hcp but also characterising the

material and its pore size distribution. The freezing-thawing results demonstrate the capabilities of ACIS.

Continuous measurement of hcp being subjected to freezing-thawing cycles allows for the determination of incipient freezing temperature, pore blocking temperature, assessment of the pore size distribution and durability assessment. Relationships were found between the effective sample resistance and the amount of pore water freezing. Analysis of the Resistance-Temperature and Phi-Temperature curves separately and in combination provides important information relating to the durability of the hcp. The Resistance-Temperature curve indicate incipient freezing and changes in the freezing mechanism when the slope of the curve changes. A relationship between the amount of pore water freezing and the effective freezing resistance was established. The Phi-Temperature curves reflect the flow of pore water within the pore system. They indicate pore blocking and their shape correlates with the pore size distribution of the specimen. Damage can be related to the combination of parameters obtained from the two curves. A material likely to be damaged from freezing-thawing cycles has a low initial resistance, a high pore blocking temperature and a large $\Delta\phi$.

Identical tests on other materials (pastes and mortars with fly ash, vycor glass, and brick) with a diverse range of pore size distributions complemented the results from the hcp. The results from the narrow pore size distribution and large average pore diameter of the brick contrasted those of the fly ash pastes and mortars which have a broader pore size distribution and smaller average pore size distribution. The fine pore diameters and broad pore size distributions associated with the hcp exhibit several changes of slope in the Resistance-Temperature curves and a decrease in phi with temperature until pore blockage. Pore systems that have large pore diameters with a uniform pore size distributions such as vycor glass and brick have only one change of slope during freezing in the Resistance-Temperature curve and phi increases with decreased temperature.

9.4 Ring-Disc Electrode Experiments

The experiments conducted using ring-disc electrodes were limited but encouraging. Although the results were not presented formally in this thesis, the information obtained from the experiments using the ring-disc electrodes indicates the potential for in situ concrete evaluation

using ACIS. The data collected was reasonable but will require a more extensive analysis for a complete interpretation. The method of analysis developed from the plate electrodes will have to be adjusted to properly interpret the data collected using the ring-disc electrodes.

9.5 Dielectric Amplification

The results from the experiments measuring the dielectric properties of hcp at low frequencies indicate the significance of electrode effects on the dielectric amplification being reported in the literature. Using teflon sheets (insulators) between the electrodes and the sample prevents the development of a double layer within the sample at the electrodes. The measured dielectric properties of the specimens were greatly reduced when using the teflon sheets from the values measured without the teflon sheets. Therefore dielectric amplification of hcp at low frequencies is primarily caused by electrode effects.

9.6 Recommendations for Future Experiments

Further work is required to develop an ACIS testing procedure that can be used in the field to evaluate the durability properties of concrete. Suggested tests using ACIS include:

1. Continuously measure the ACIS parameters during rewetting of a dried sample to monitor movement of water into the pore system.
2. Repeat the Freezing-Thawing experiments using a slower rate of freezing and thawing to better approximate environmental conditions.
3. Monitor the ingress of salt solution into the hcp pore system. Conduct freezing-thawing tests on samples previously submersed in salt solution for a range of different times. An evaluation of the Resistance-Temperature and Phi-Temperature curves will identify the changes in the pore solution and lead to a testing procedure to estimate salt content of the pore water.
4. Develop further a procedure for estimating the amount of freezable pore water in the pore system. Vary the level of saturation in a group of identical hcp samples. Test the samples during one freezing-thawing cycle and evaluate the Resistance-Temperature curve to estimate the amount of freezable pore water.

5. Develop an analysis procedure for ACIS data collected using ring-disc electrodes. Start with specimens of hcp and mortar at early times of hydration so that the electrical current will easily pass through the sample. Run a series of tests using both the plate and the ring-disc electrodes.

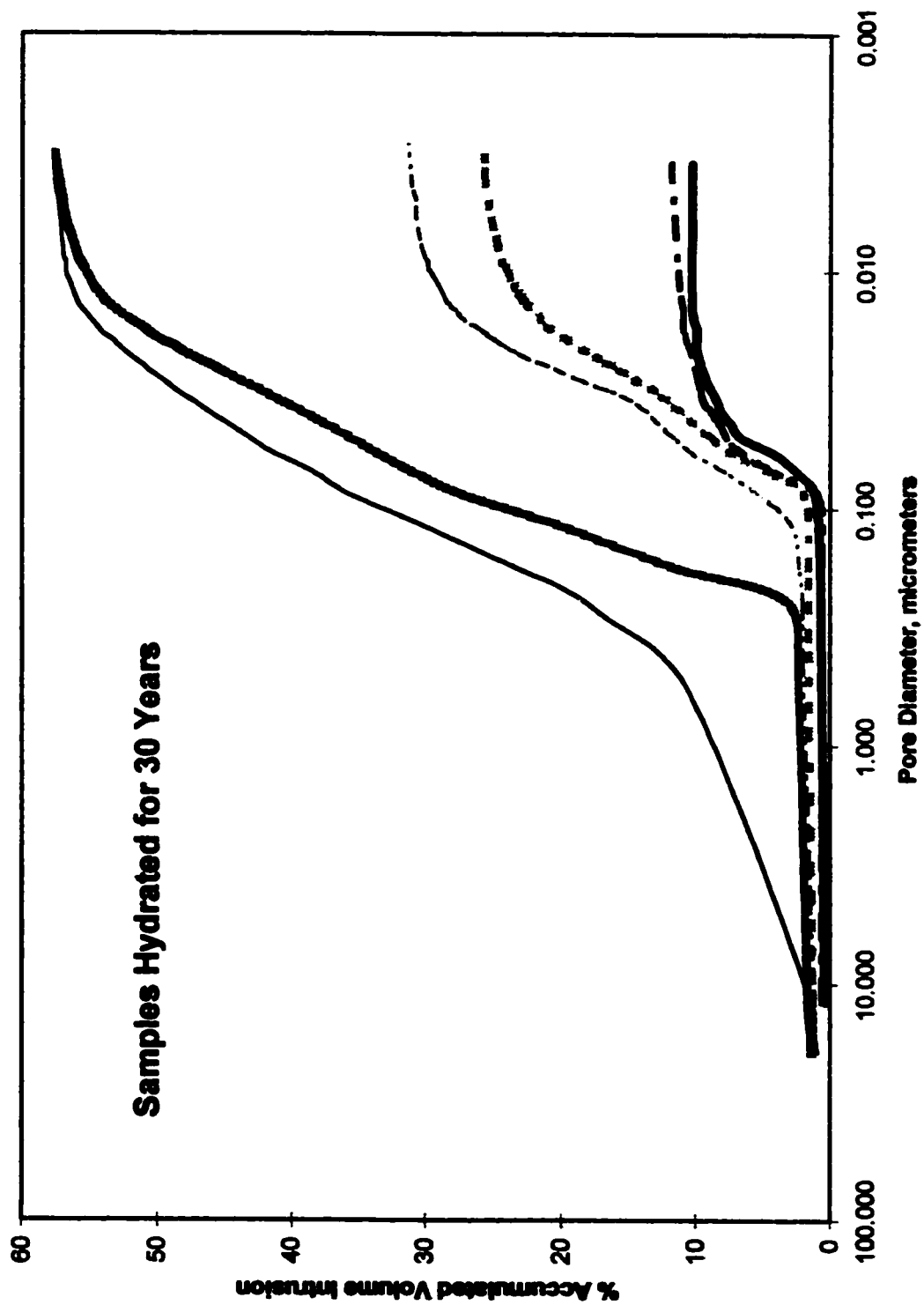
9.7 Conclusions

1. ACIS can be developed to assess durability properties of concrete in situ.
2. Dynamic Drying-Rewetting increases the permeability of concrete surfaces by increasing the pore system continuity and pore coarsening.
3. Durability properties of porous materials against freezing-thawing cycles can be assessed by ACIS parameters.
4. Electrode effects are predominate in creating the dielectric amplification of hcp at low frequencies.

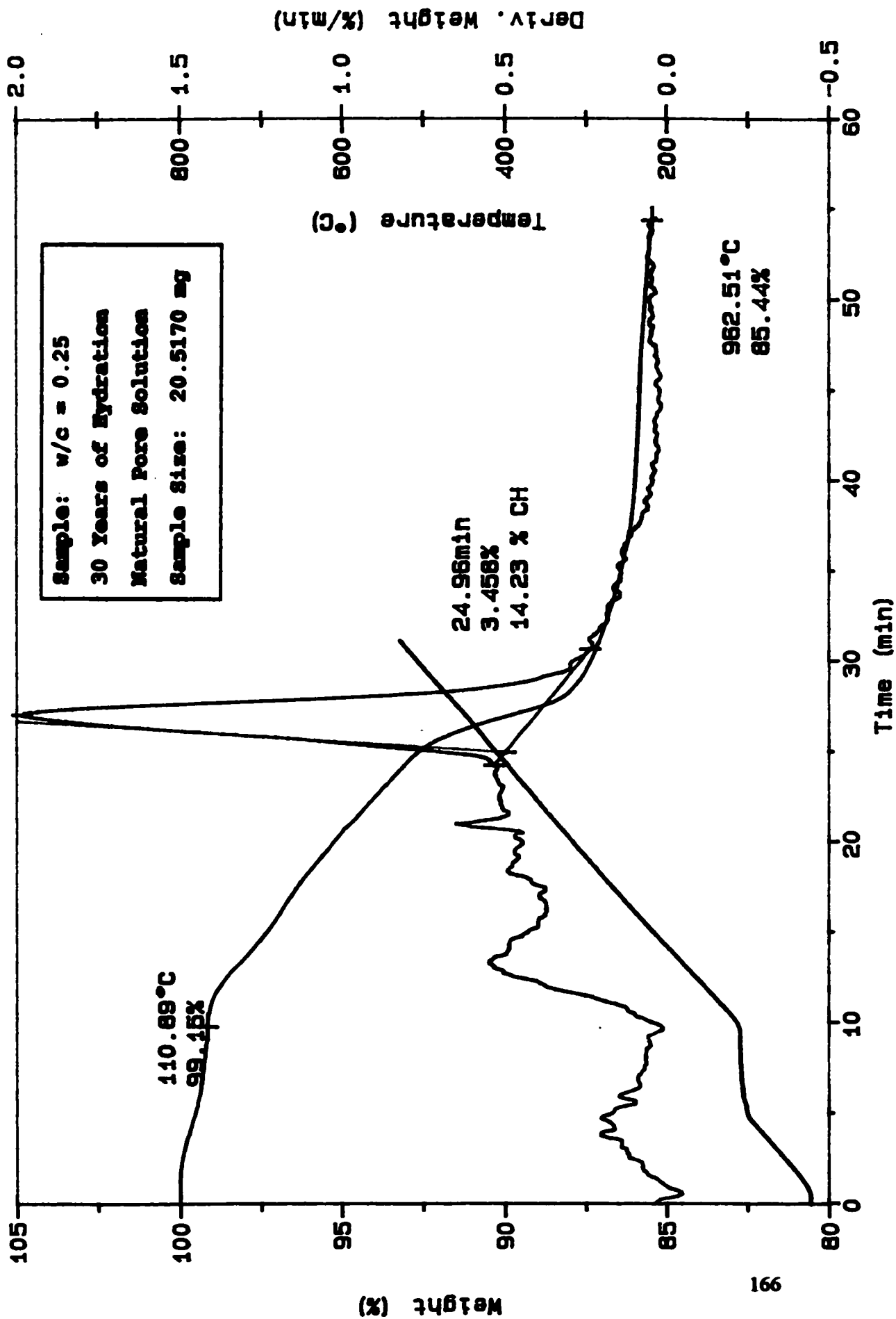
APPENDIX

	PAGE
POROSIMETRY RESULTS	165
TGA RESULTS	166
TMA RESULTS	198
DSC RESULTS	248
ACIS RESULTS	292

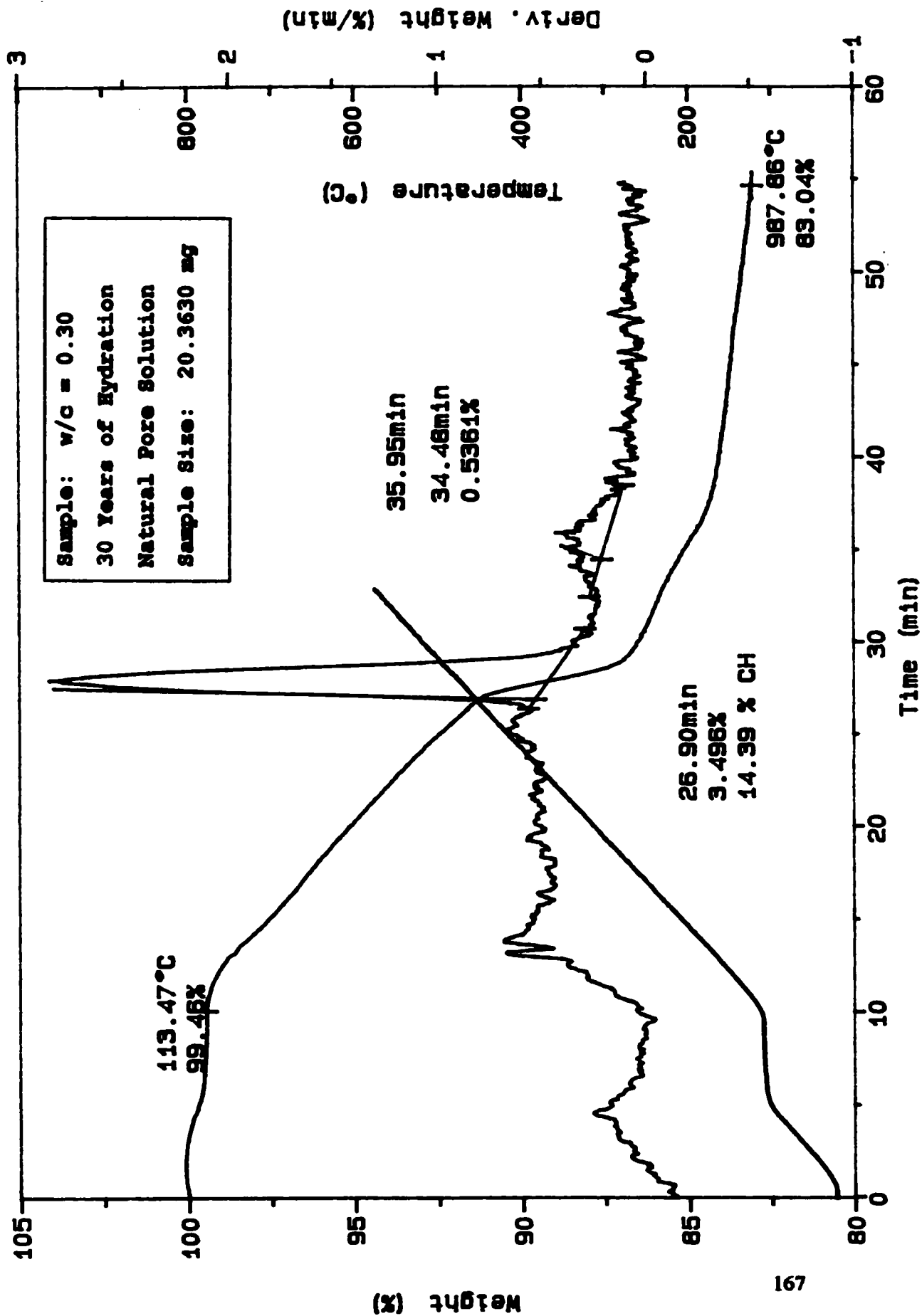
Porosimetry Tests



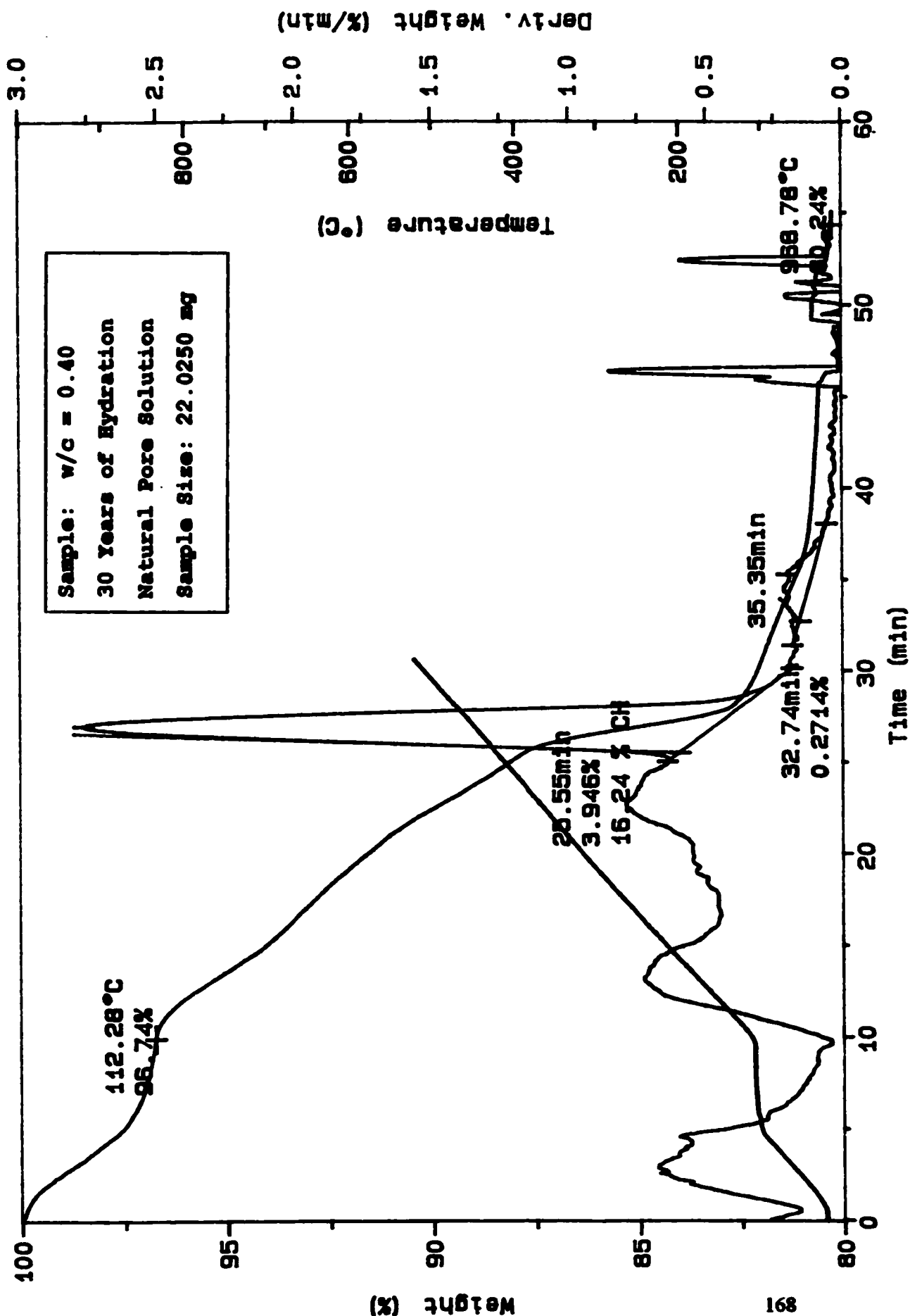
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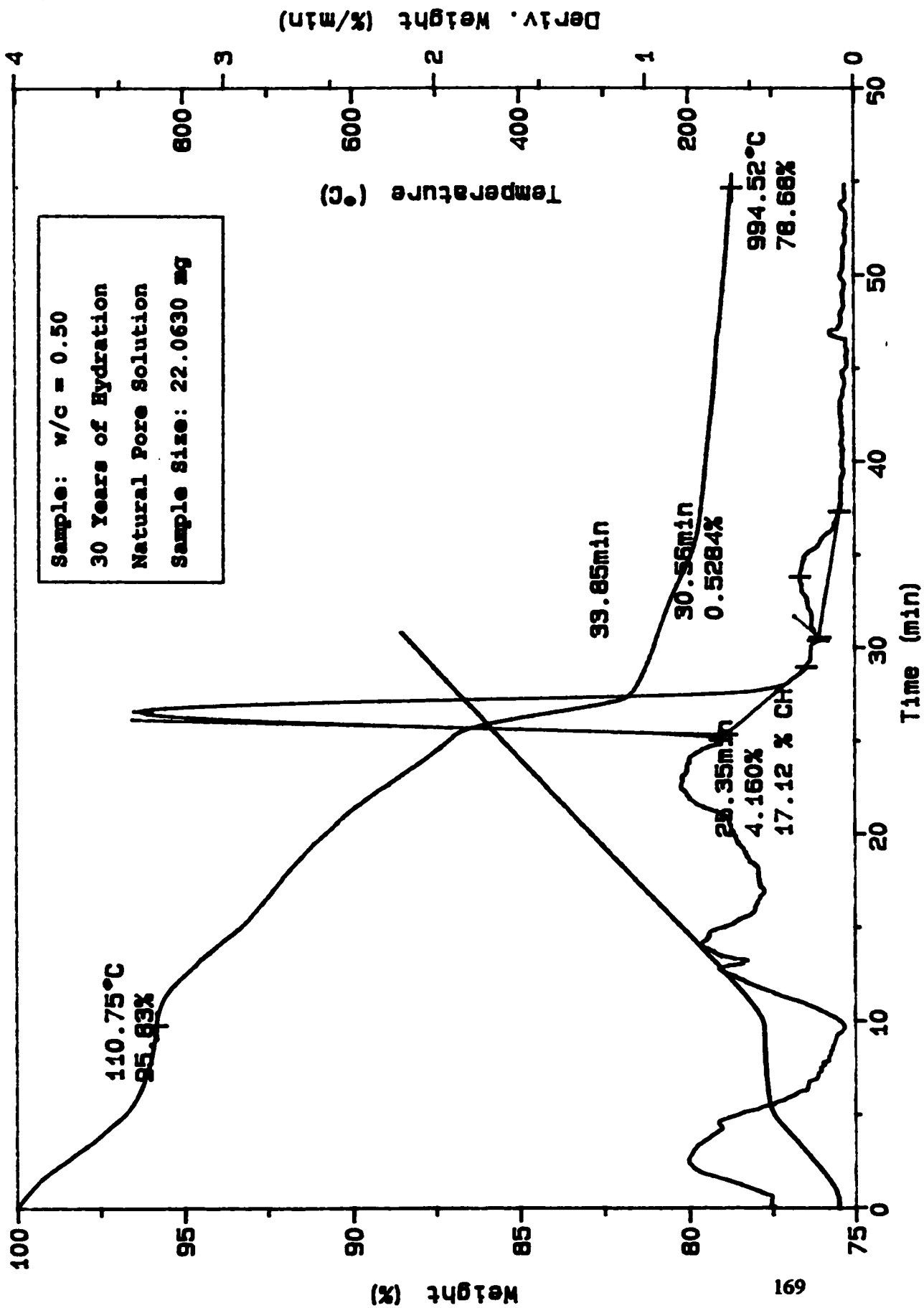
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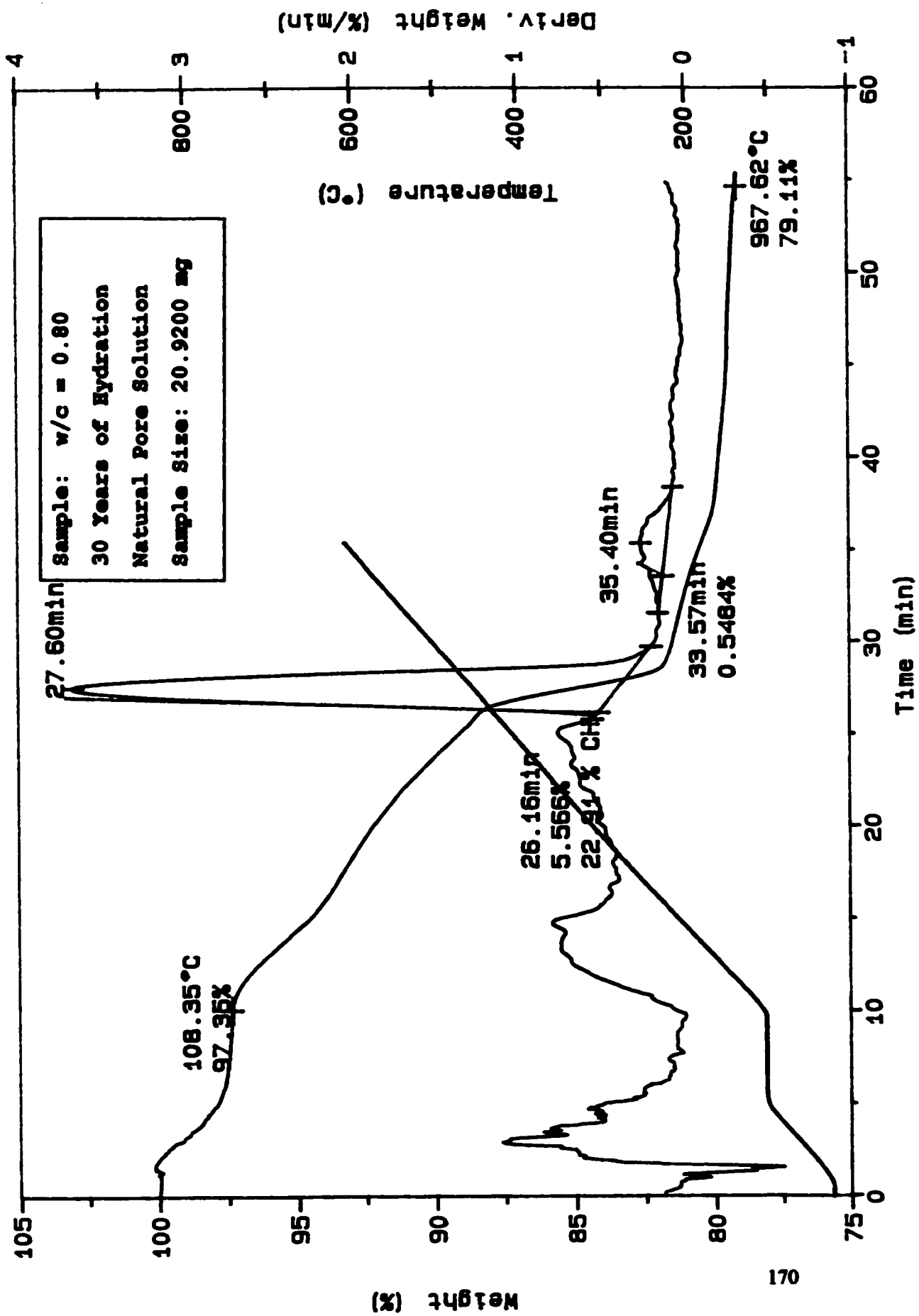
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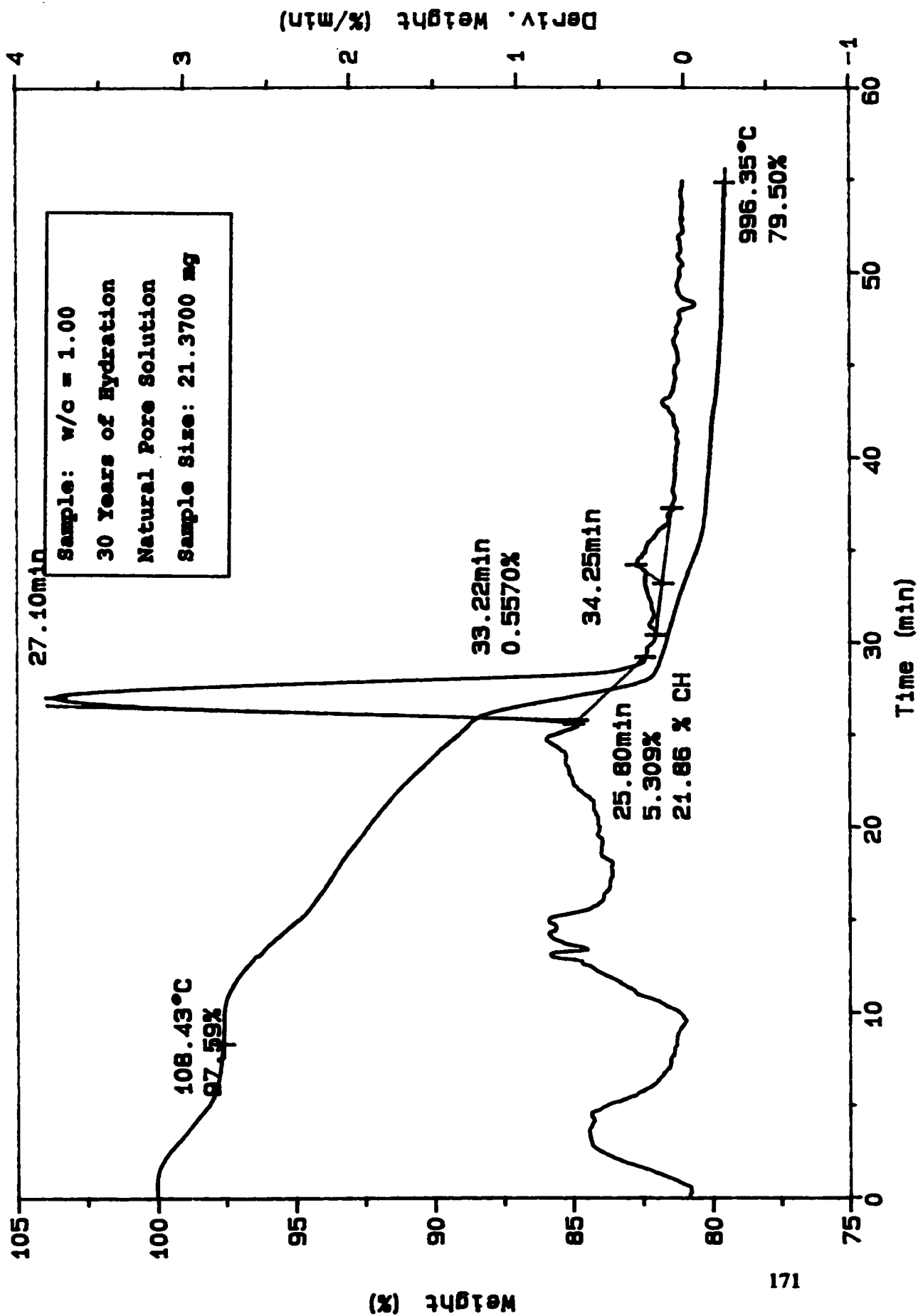
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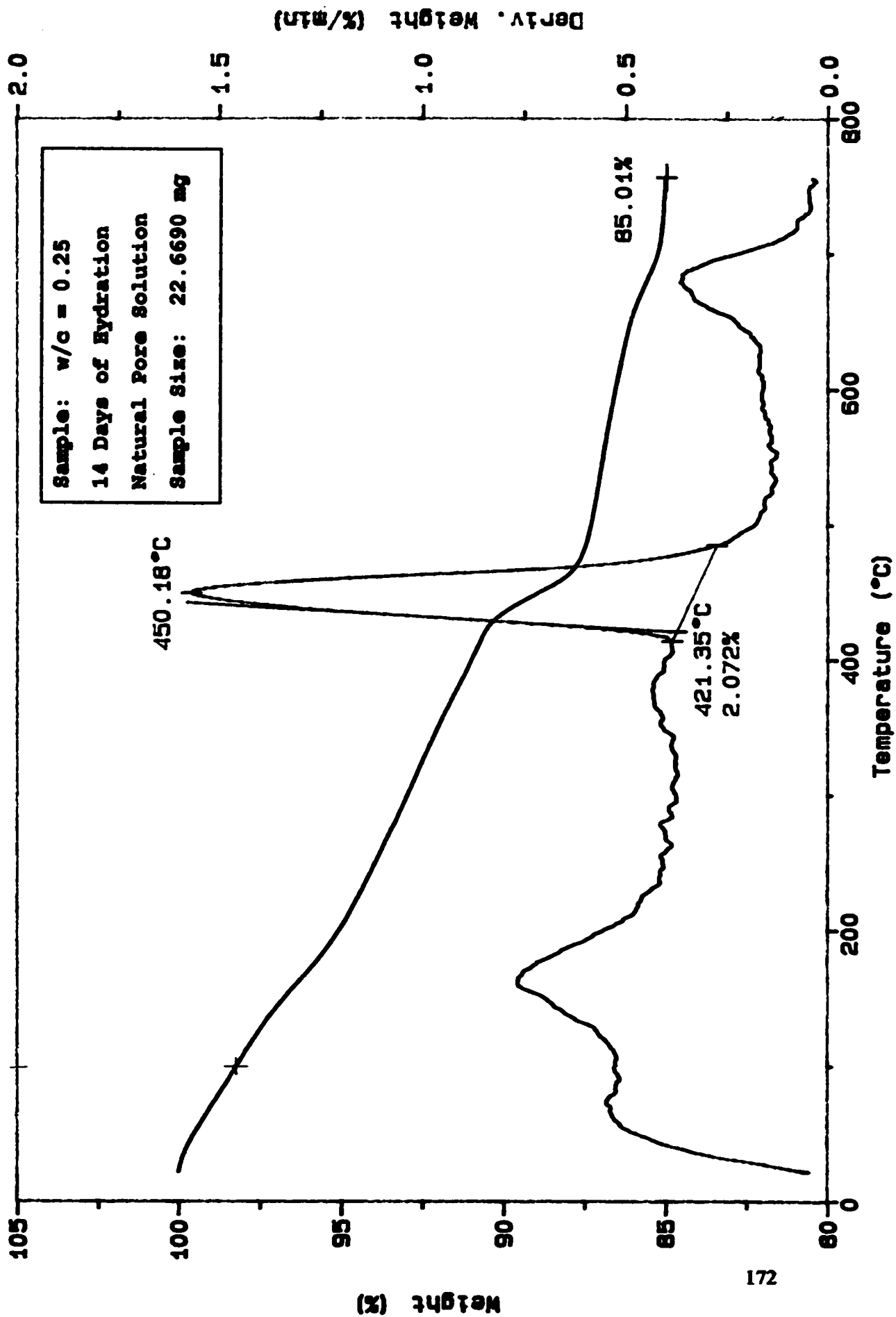
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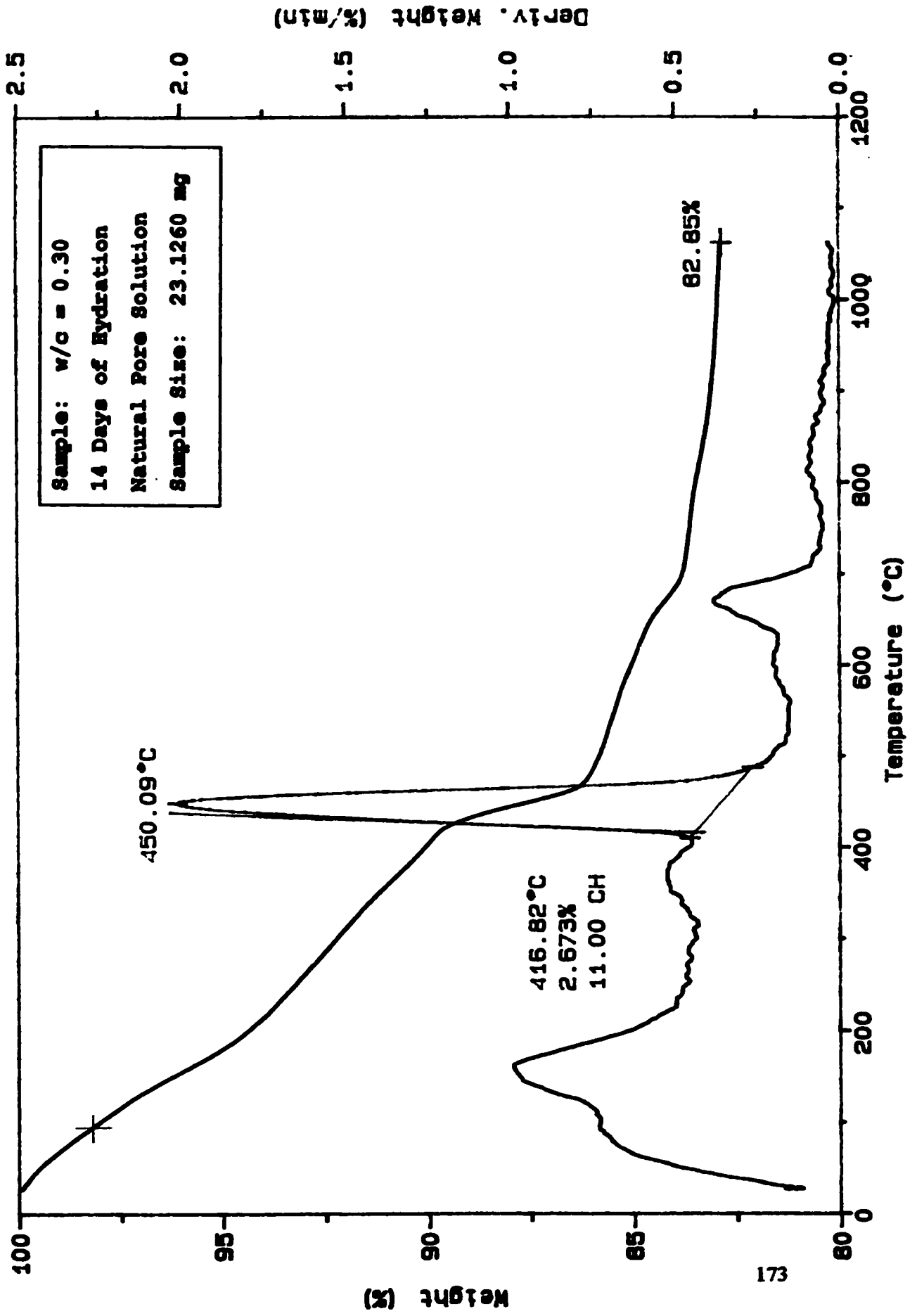
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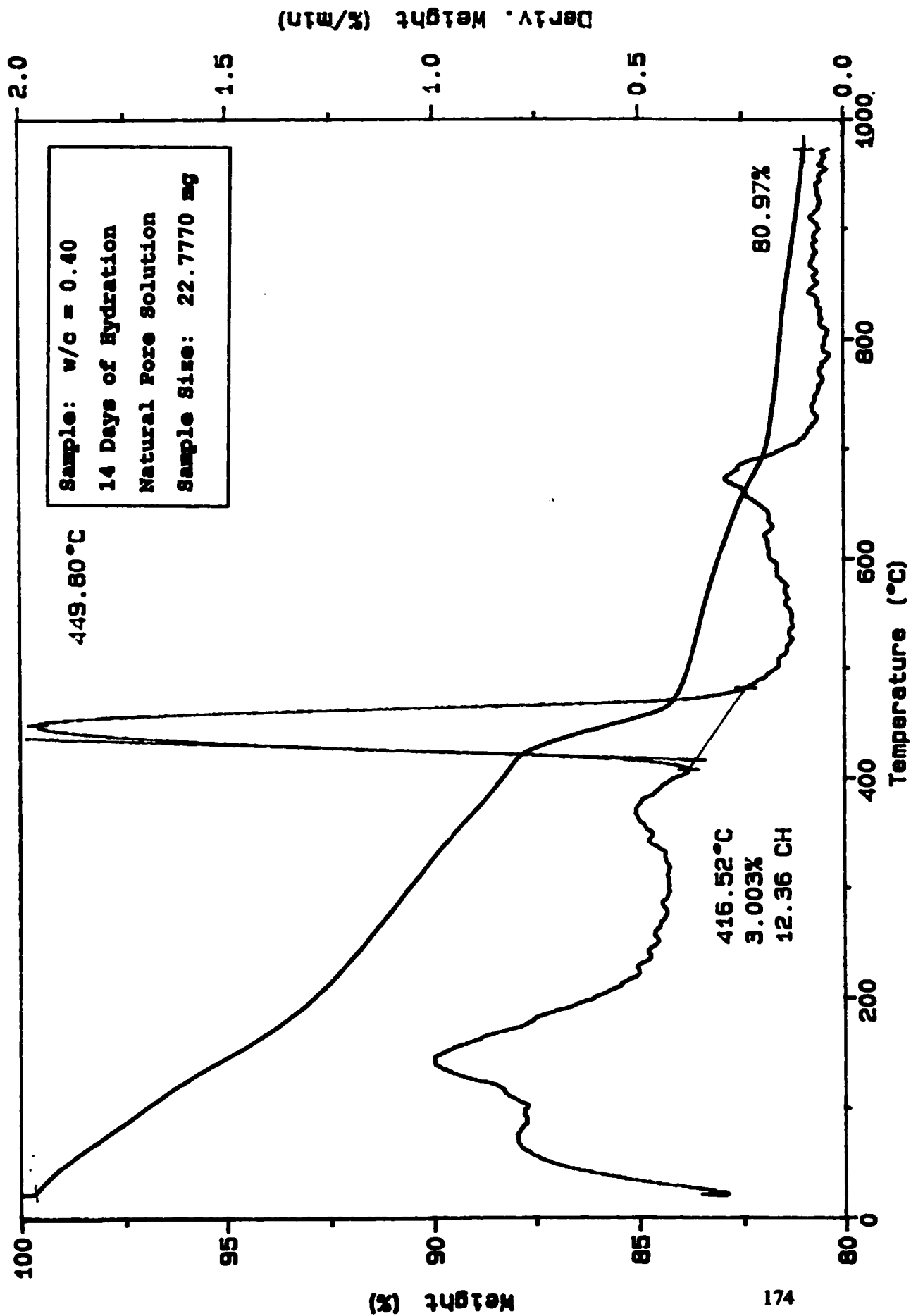
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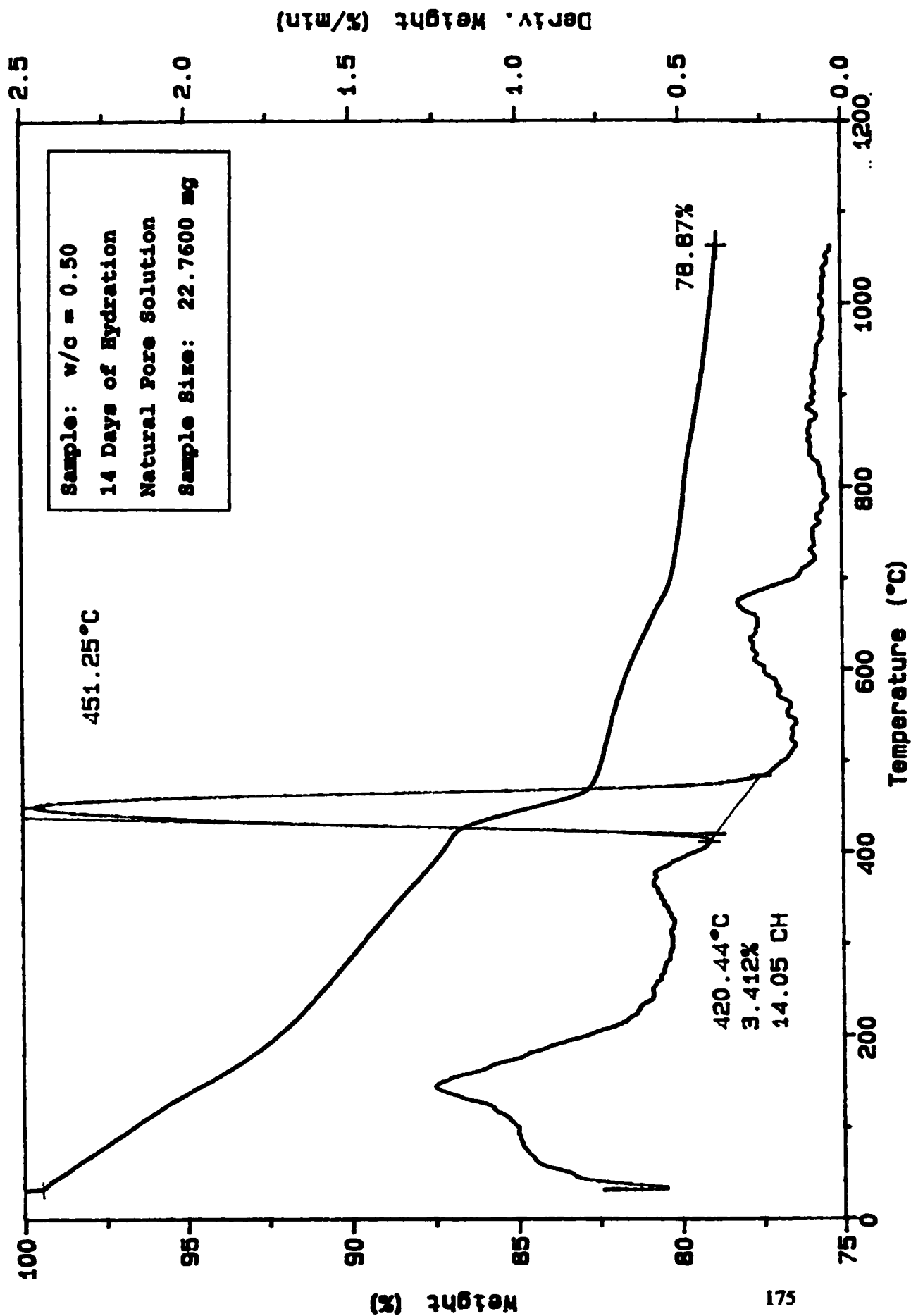
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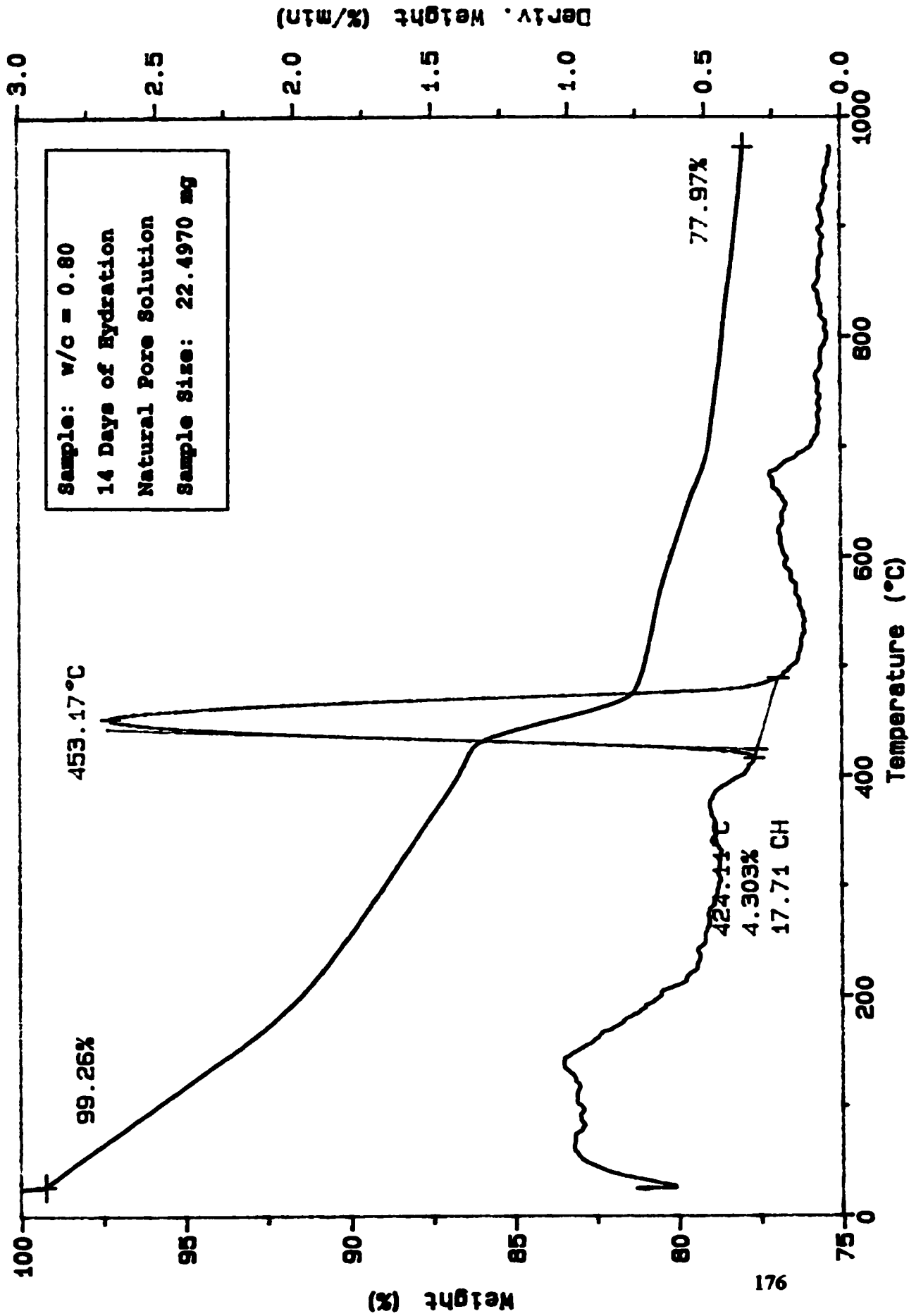
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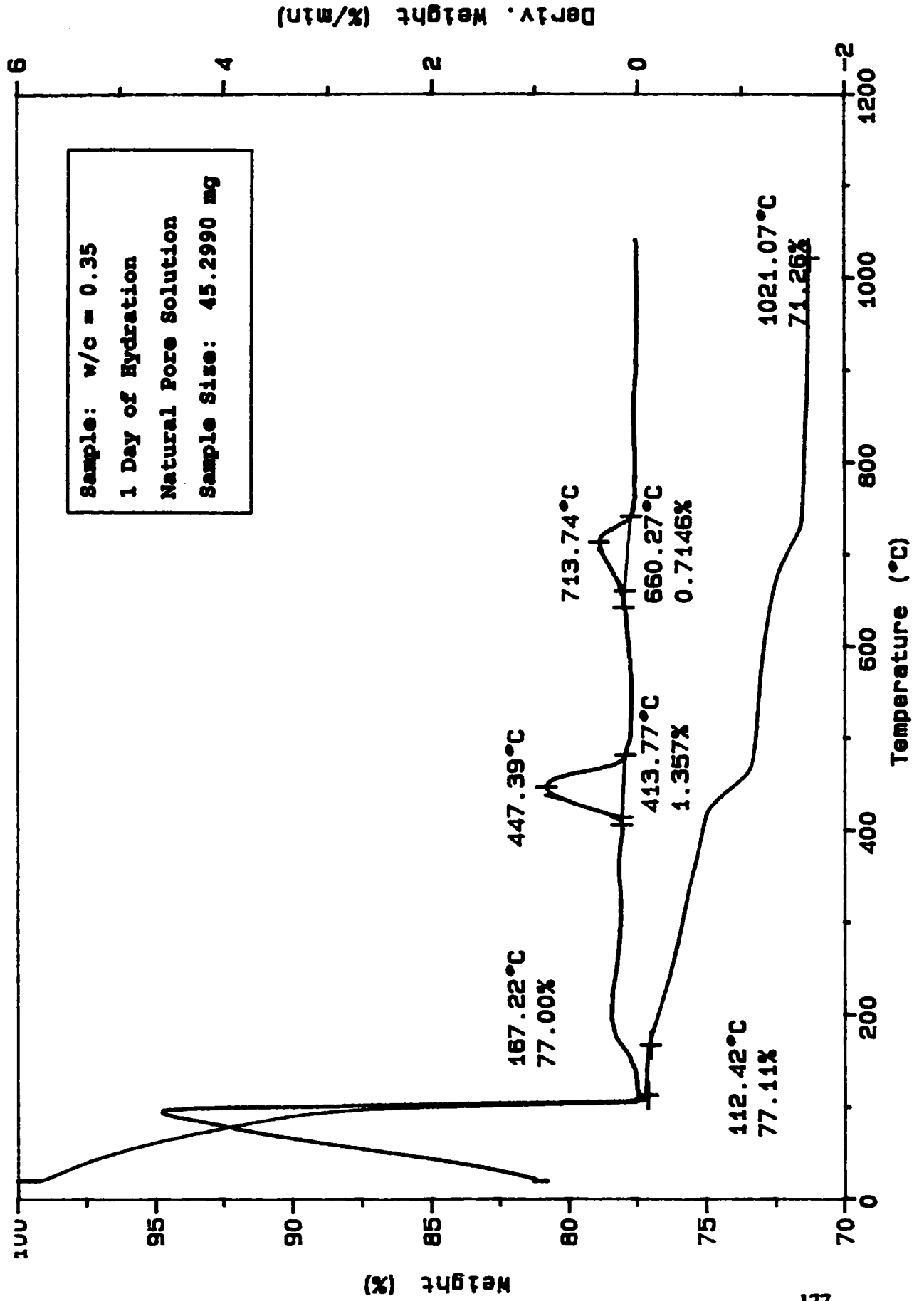
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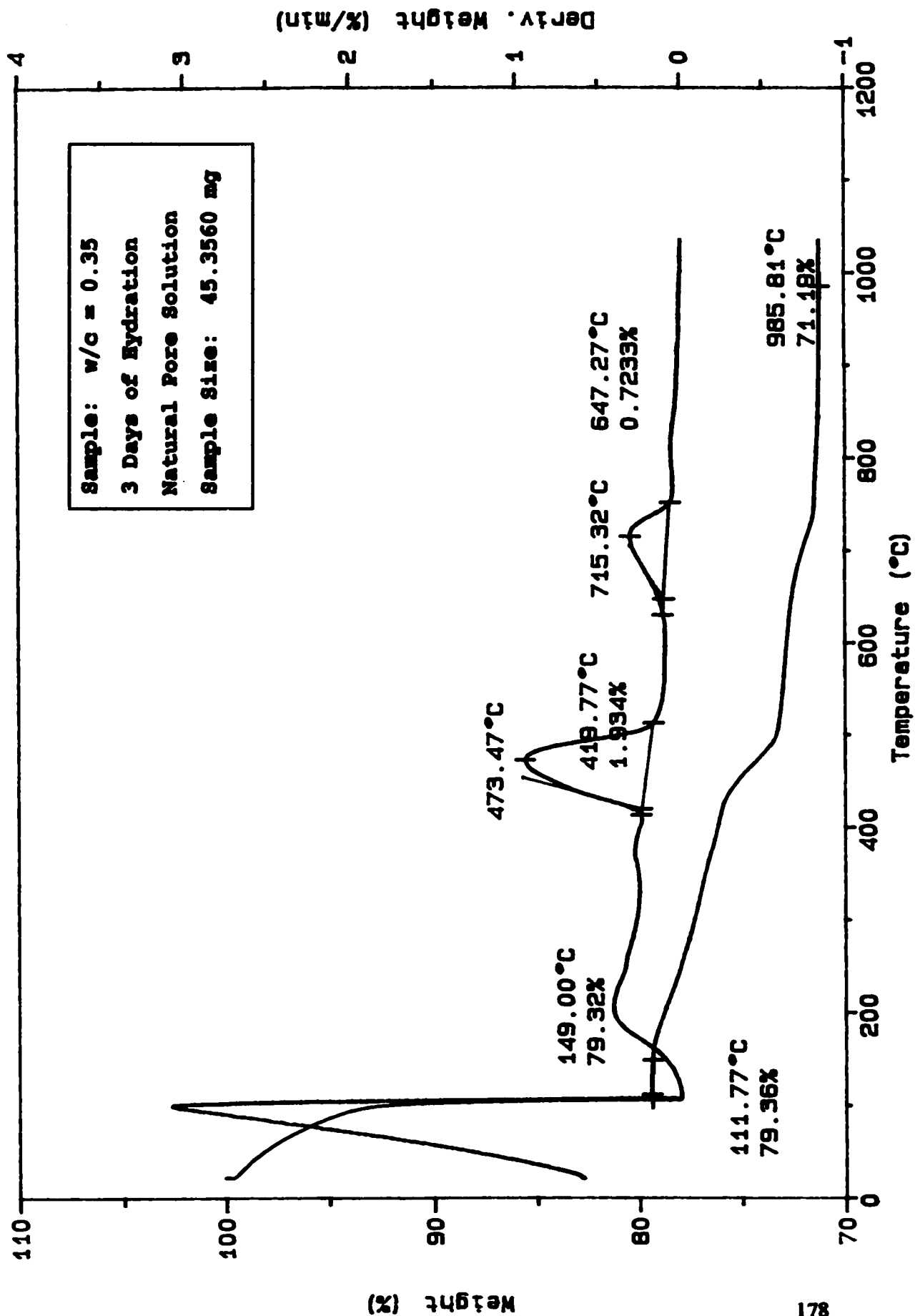
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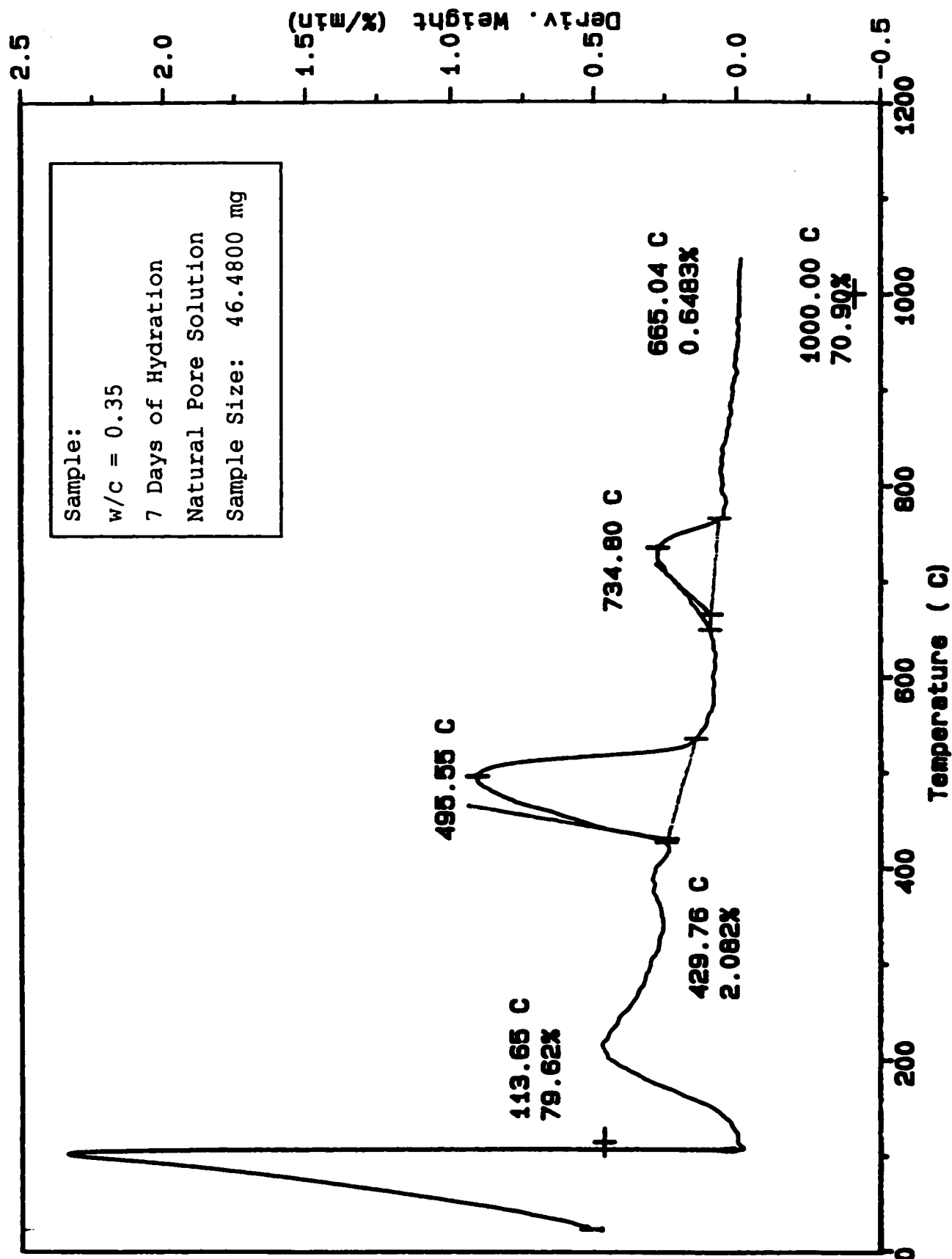
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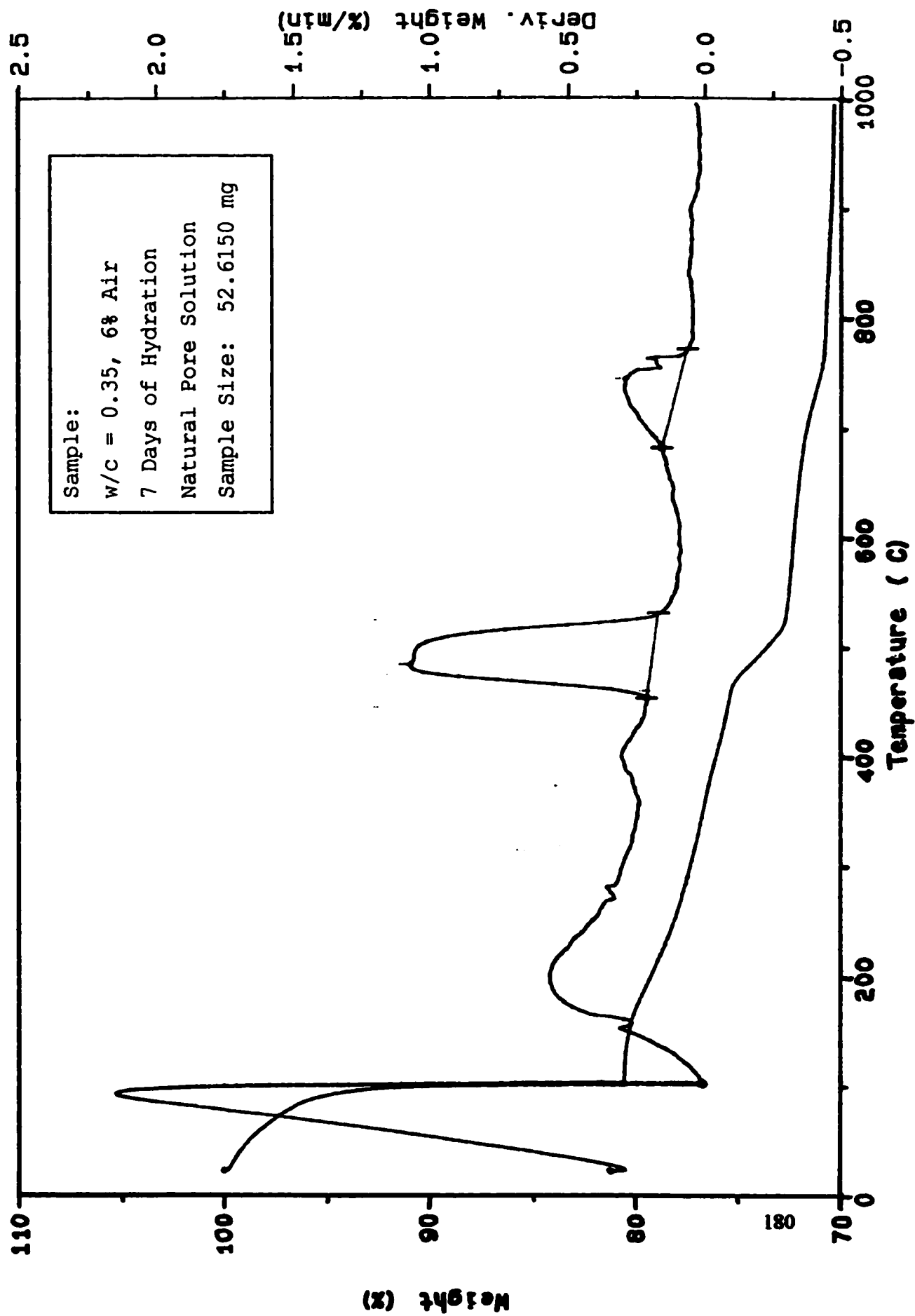
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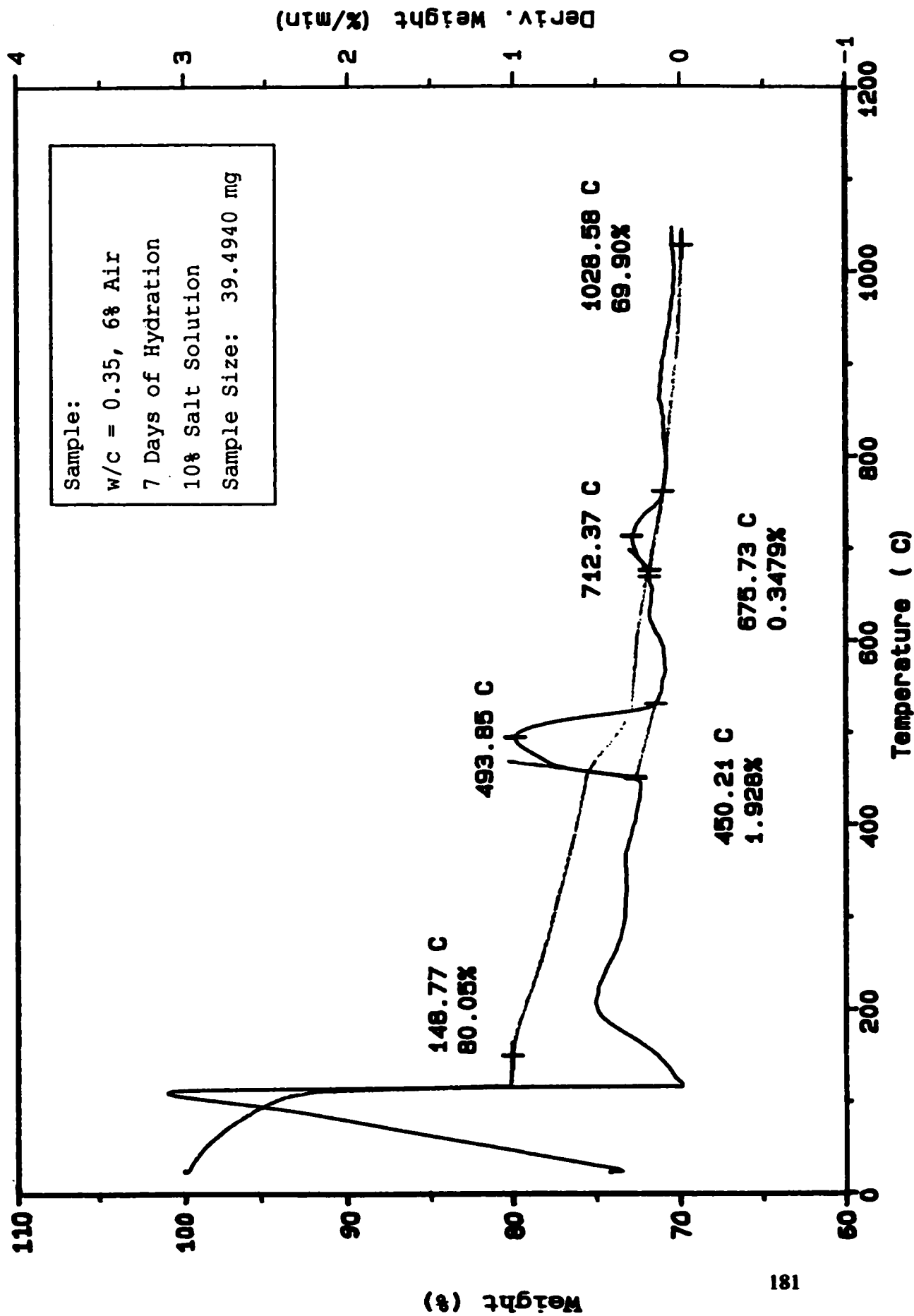
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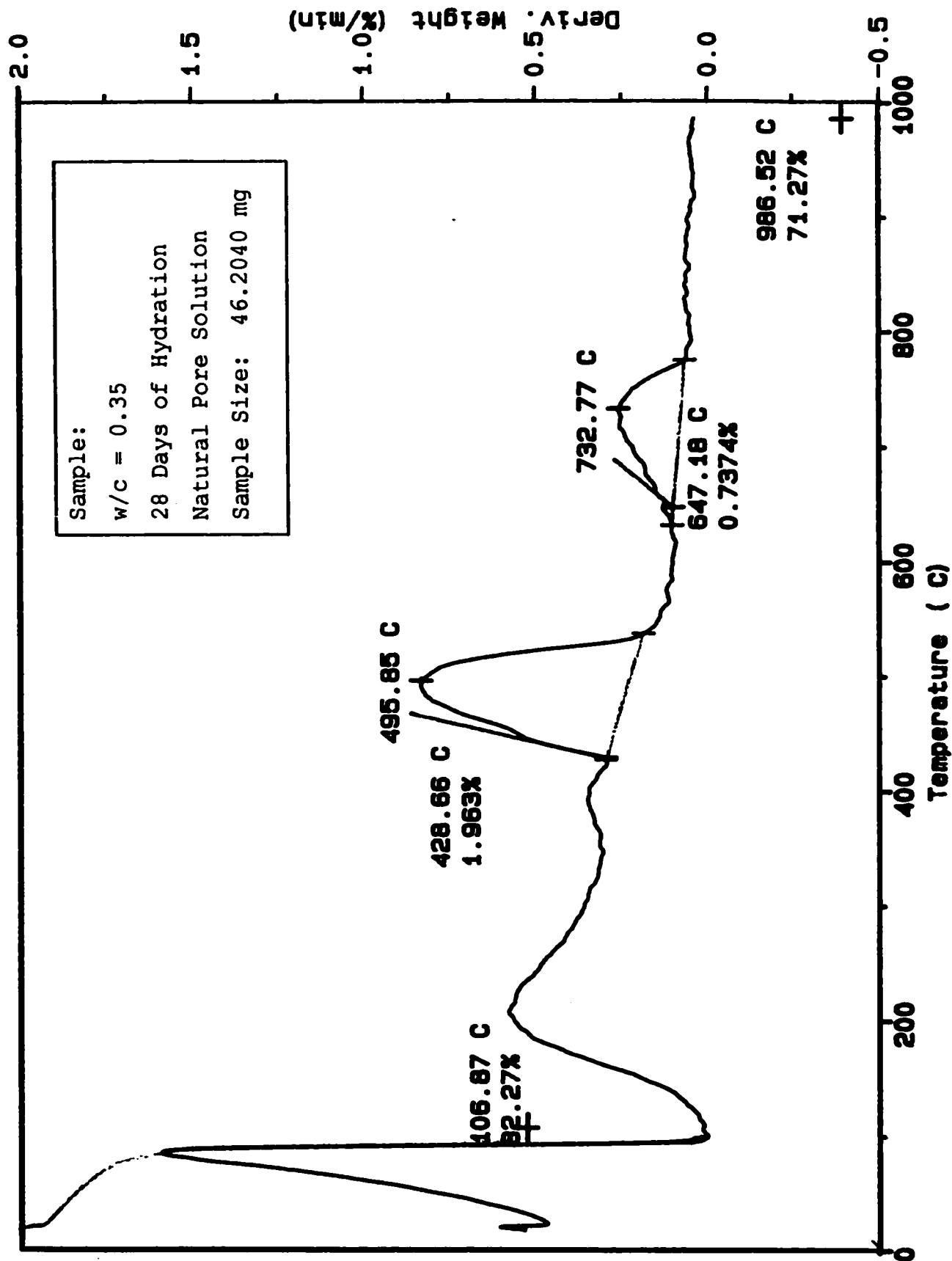
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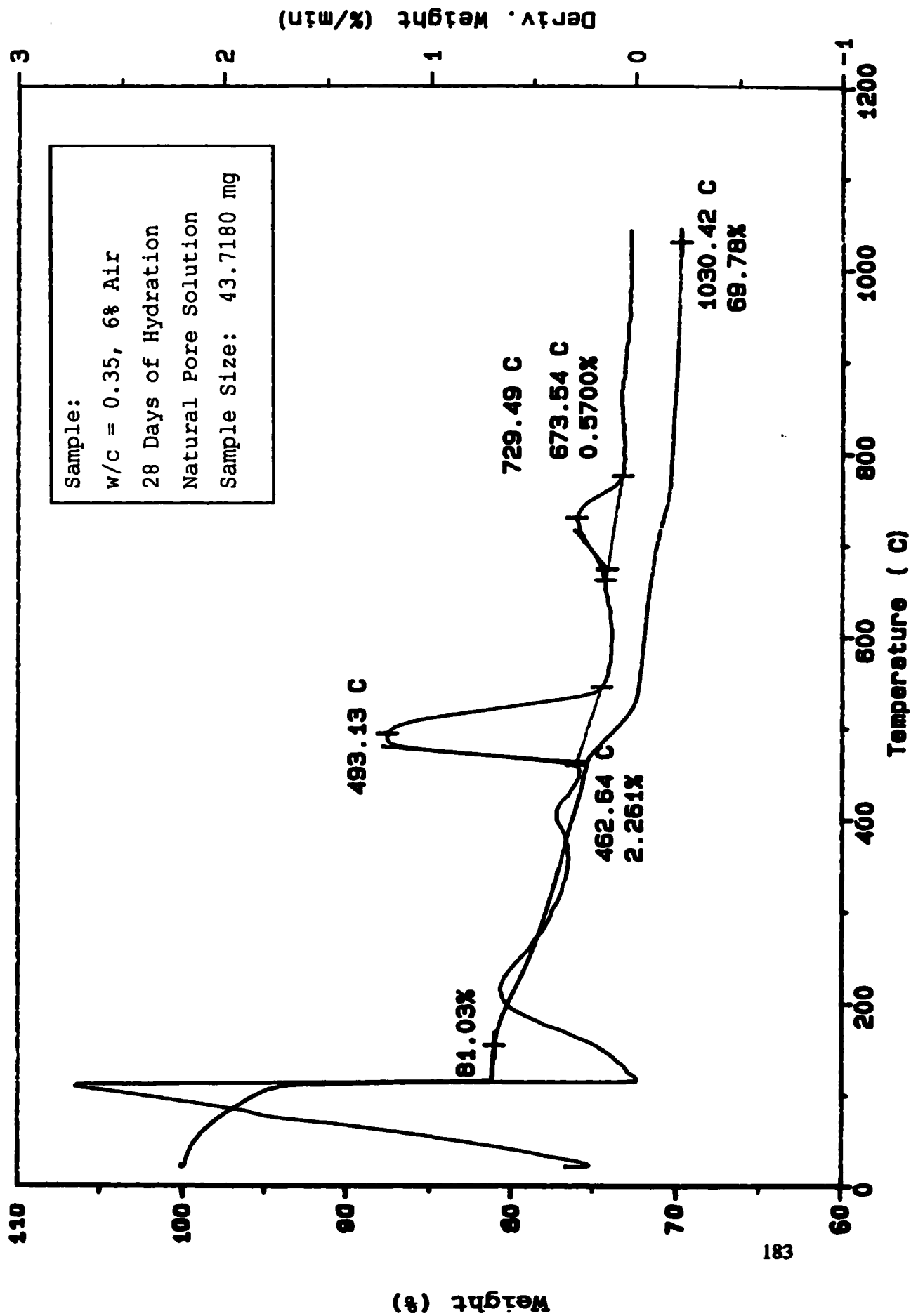
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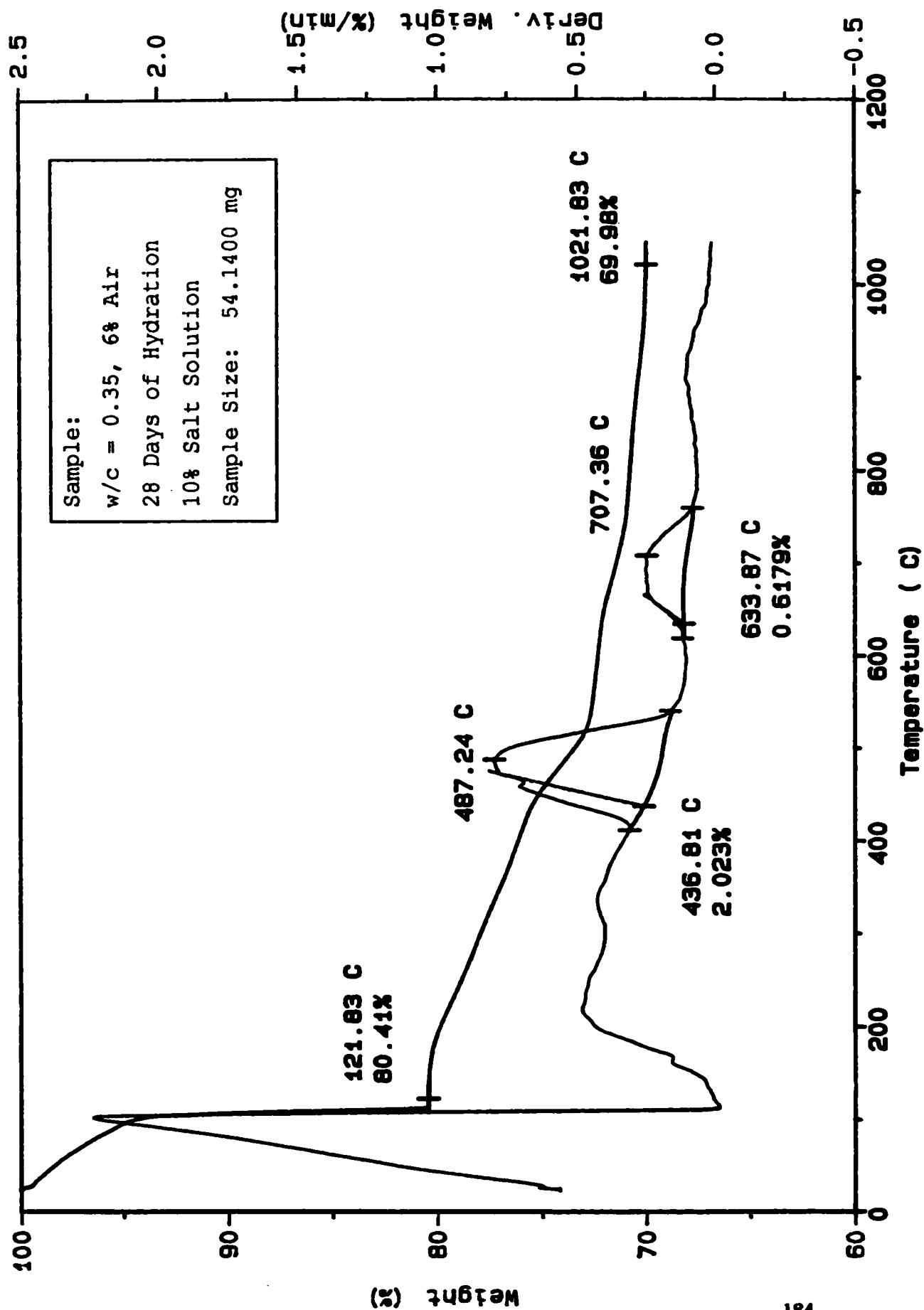
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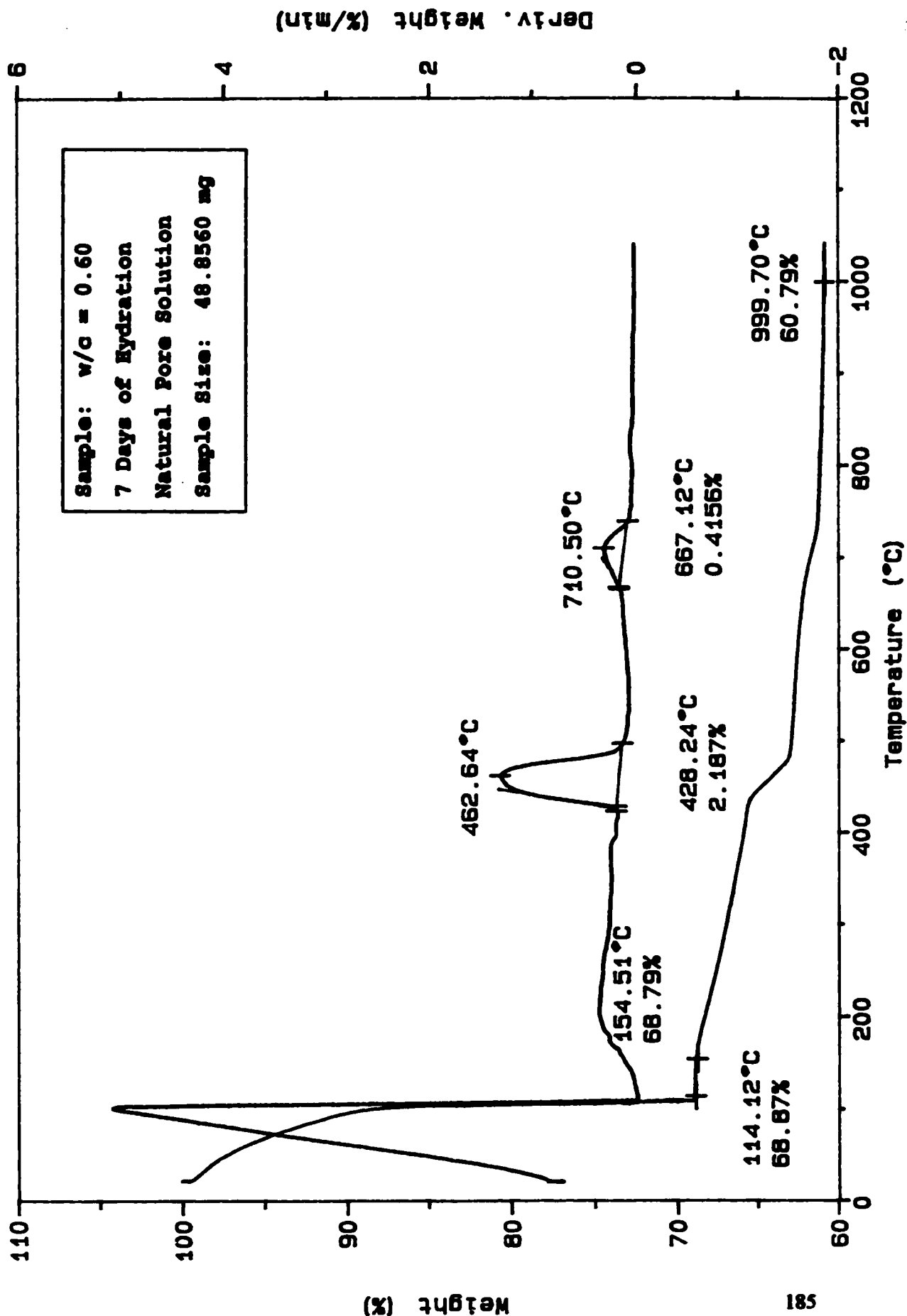
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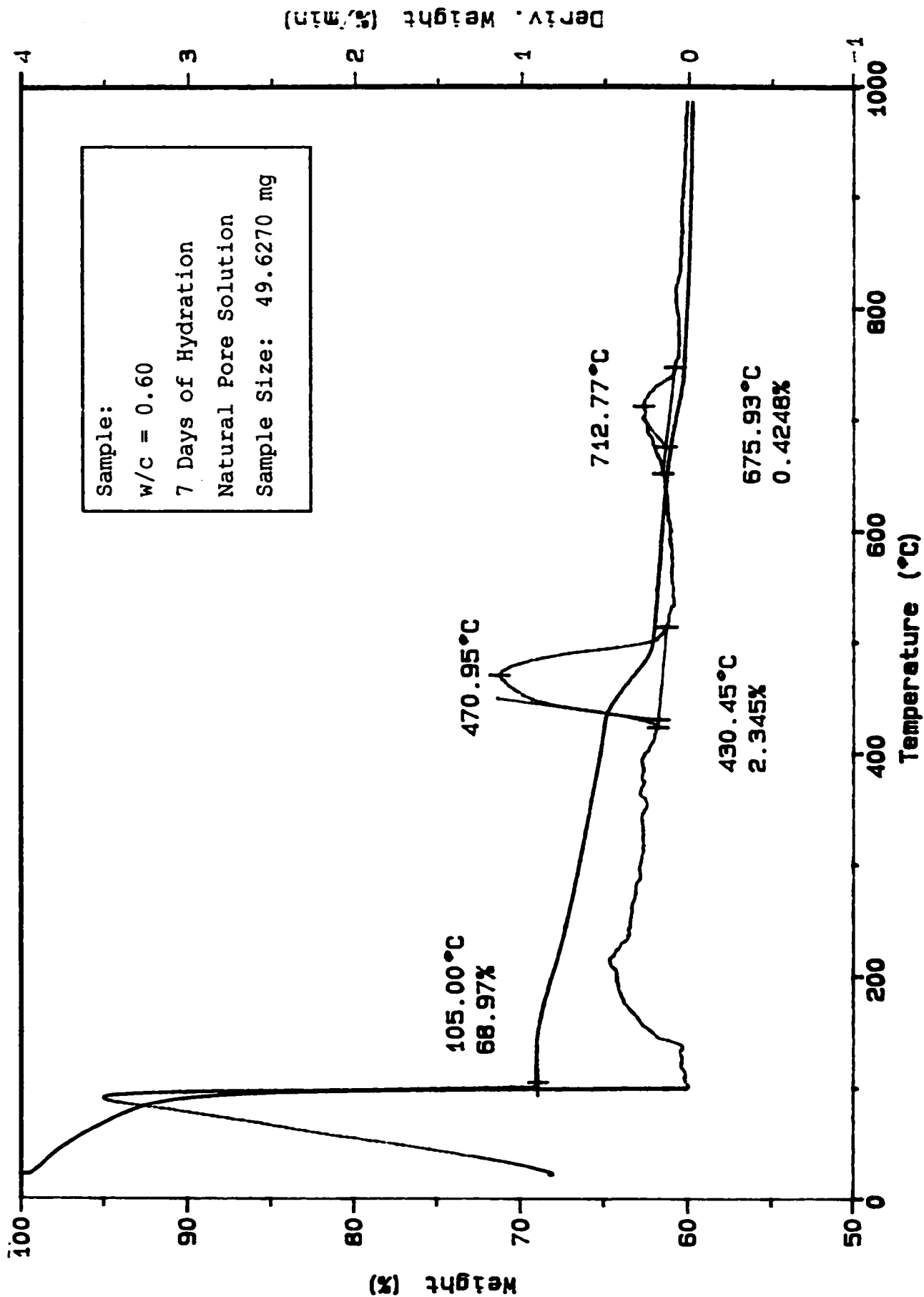
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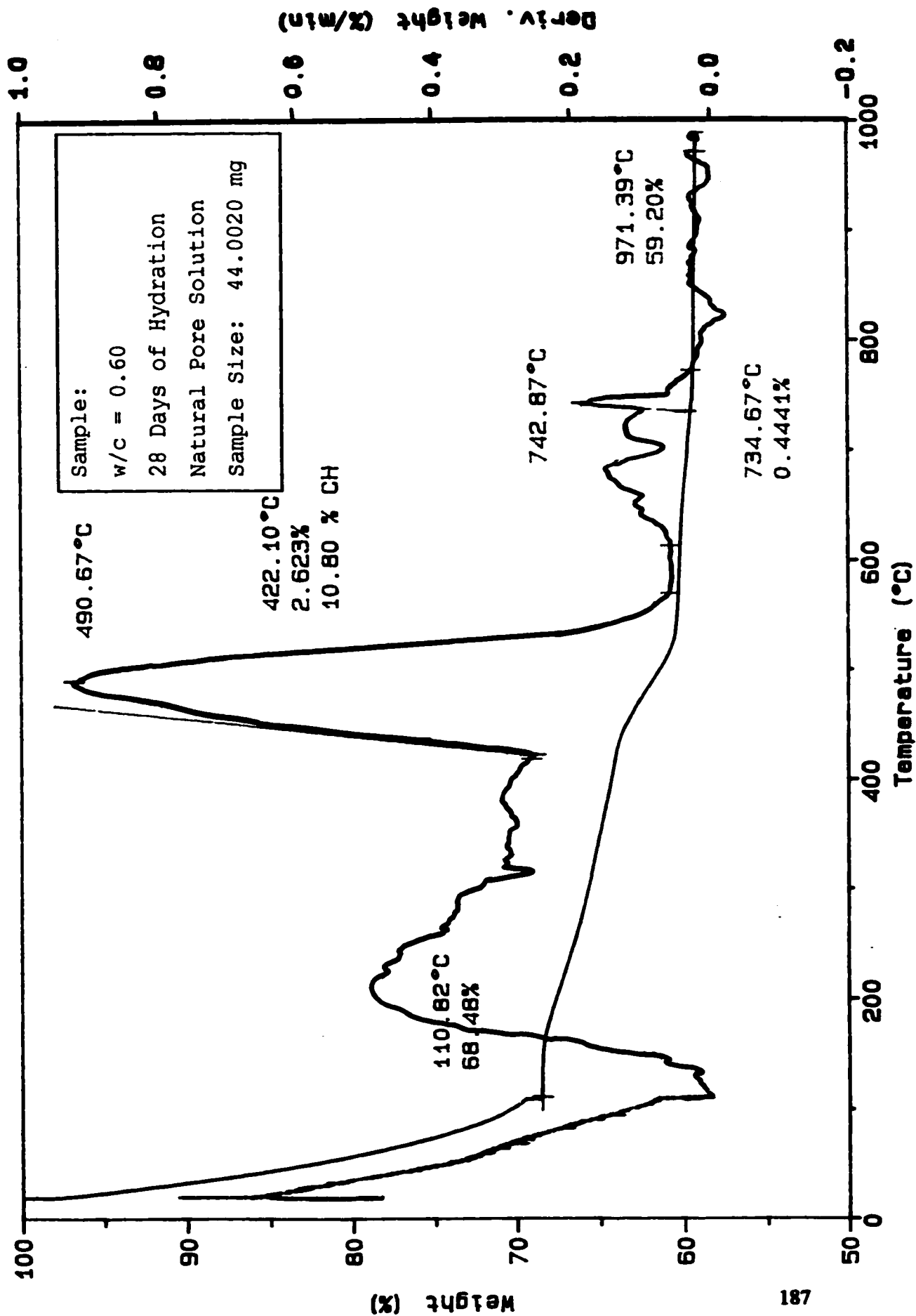
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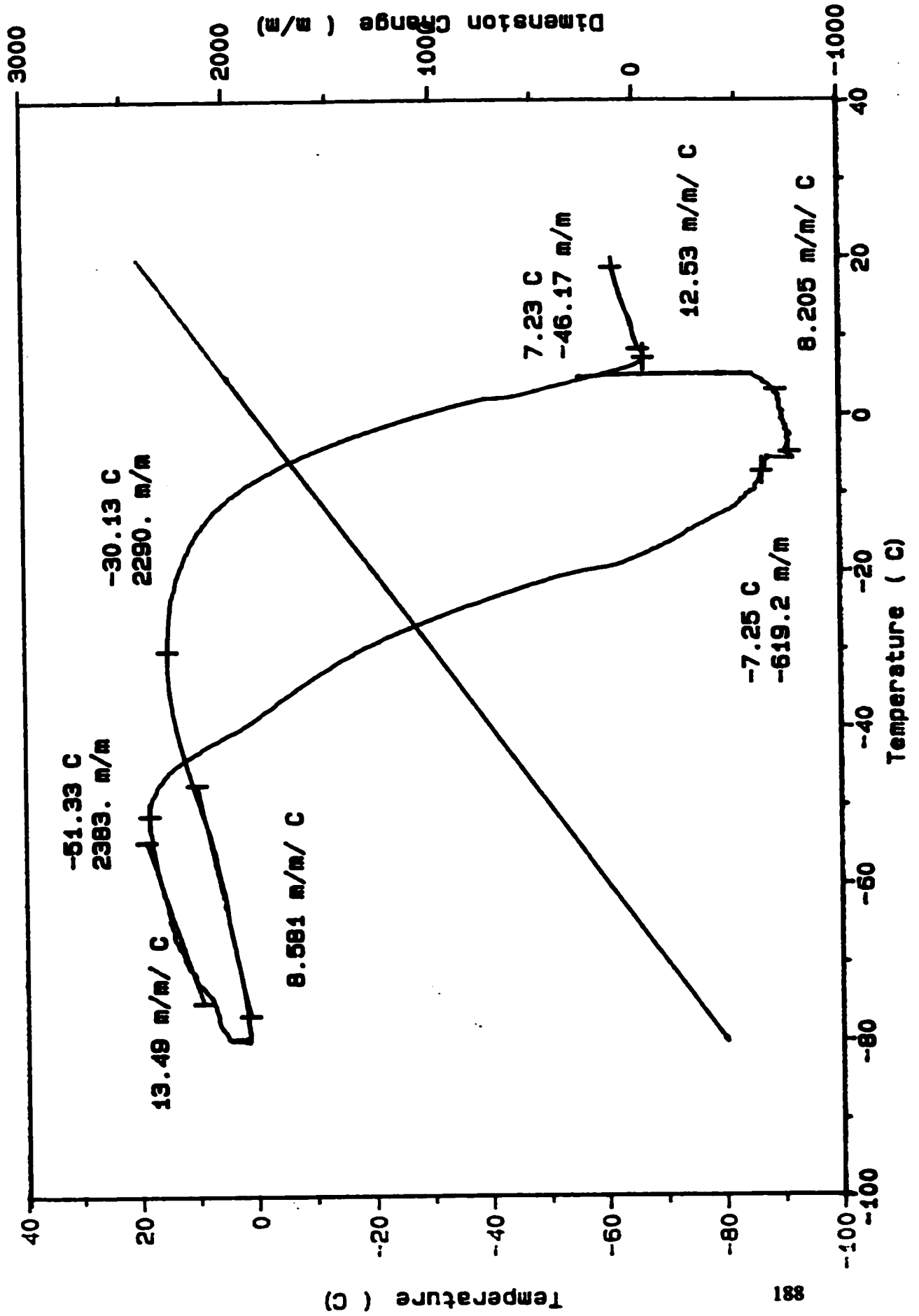


TGA



TMA

Sample: w/c = 0.35, 7 Days Hydration
 Natural Pore Solution
 Sample Size: 12.8655 mm

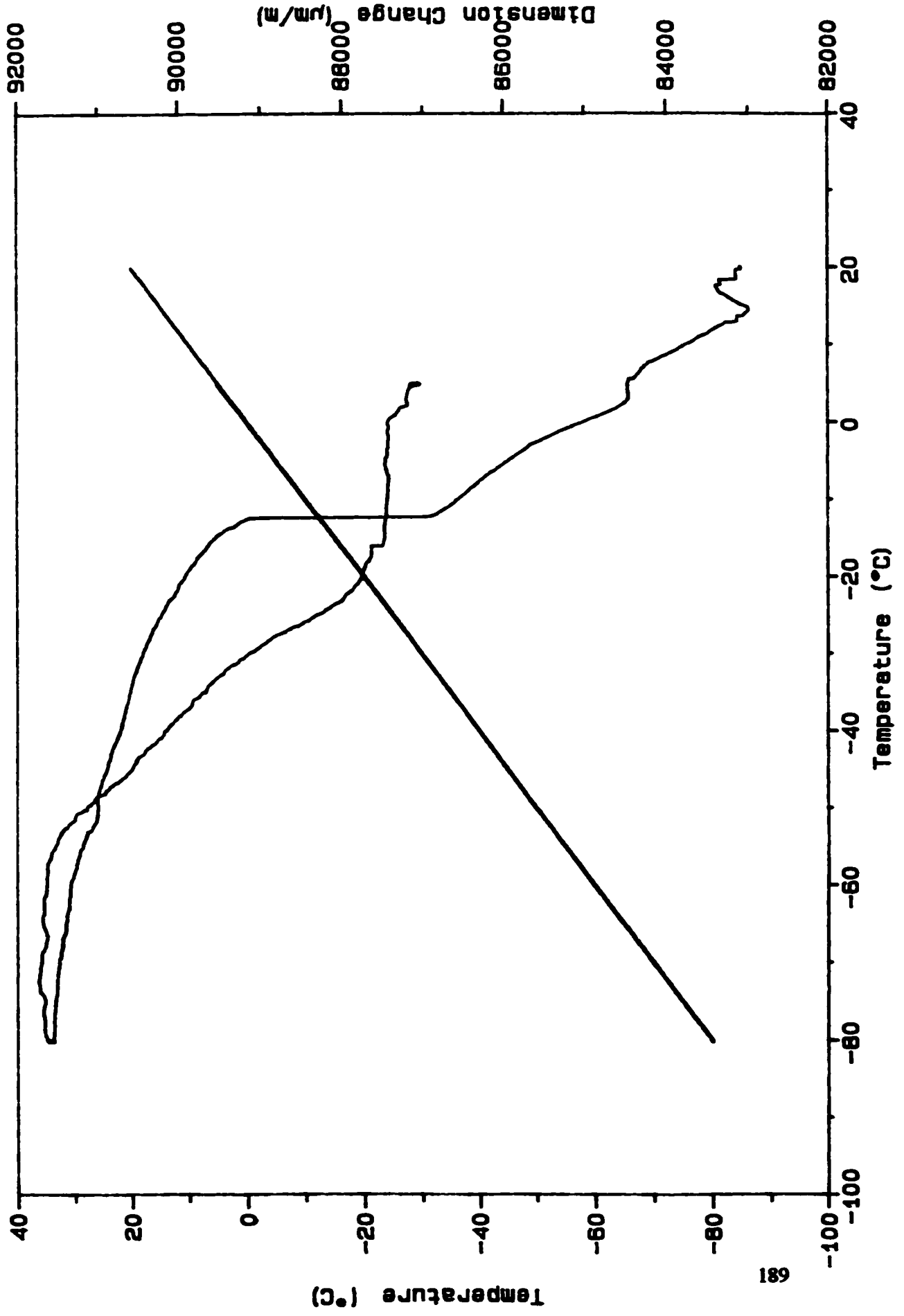


TMA

Sample: w/c = 0.35, 7 Days Hydration

Synthetic Pore Solution

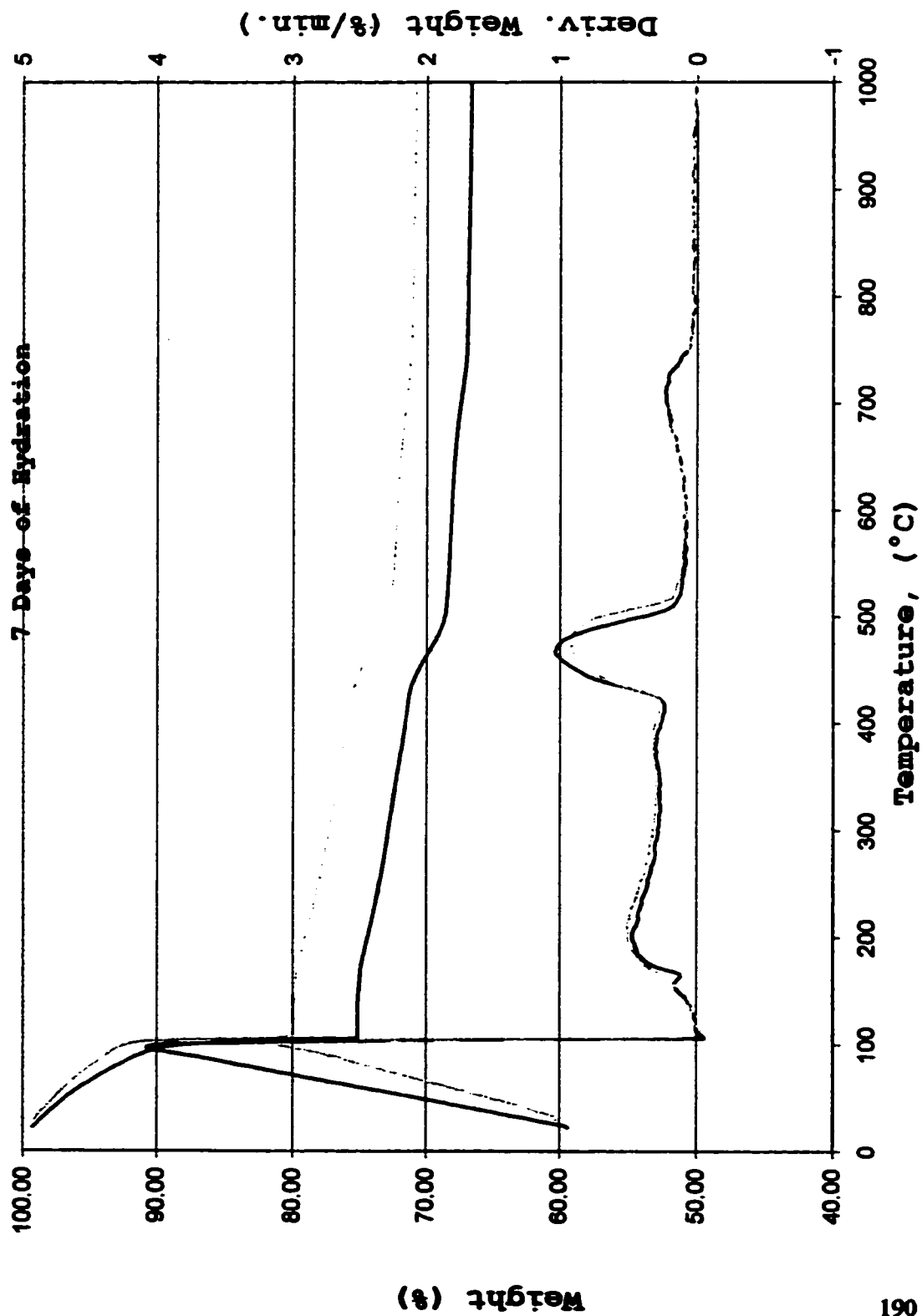
Sample Size: 13.1841 mm



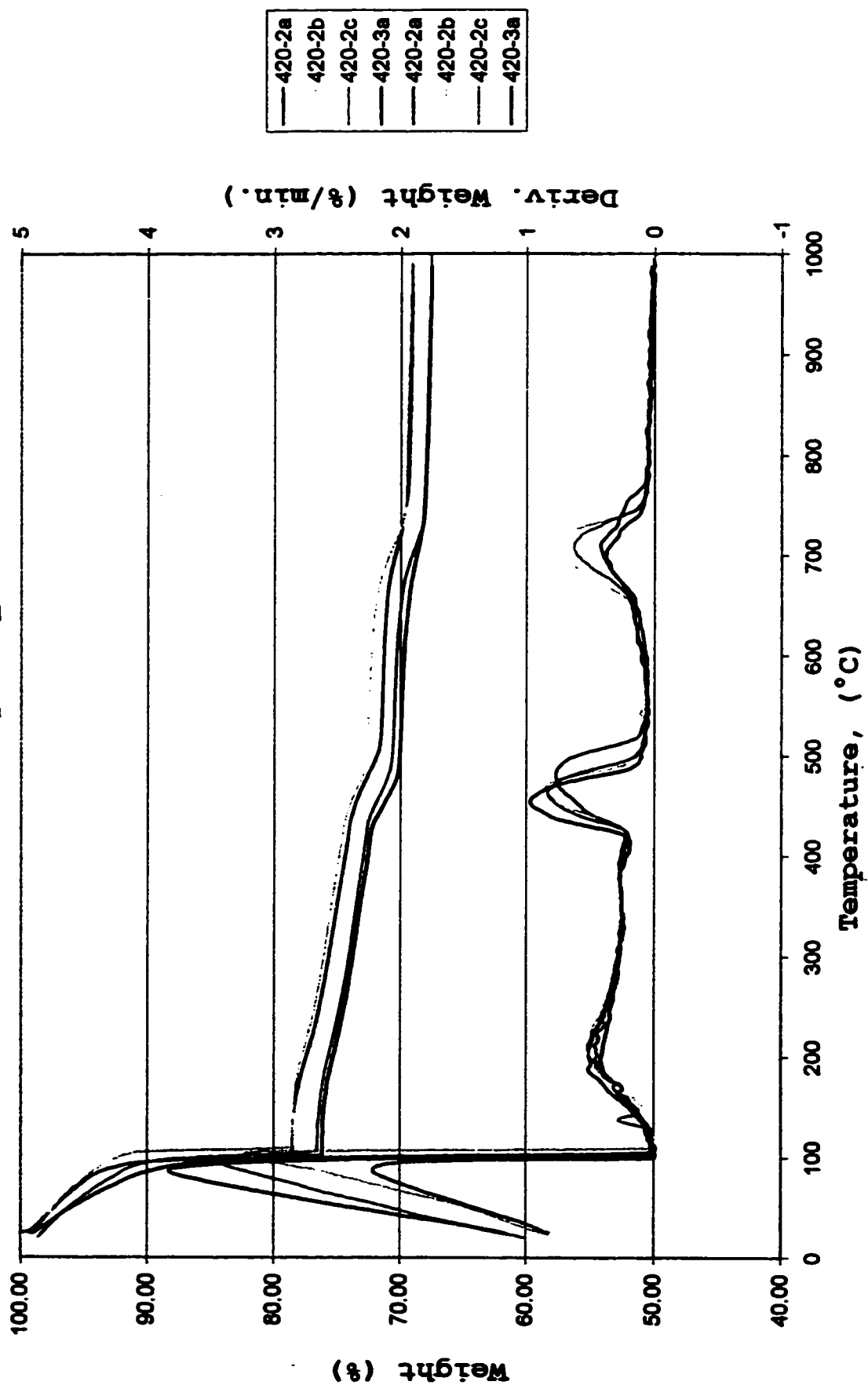
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Cement Paste:
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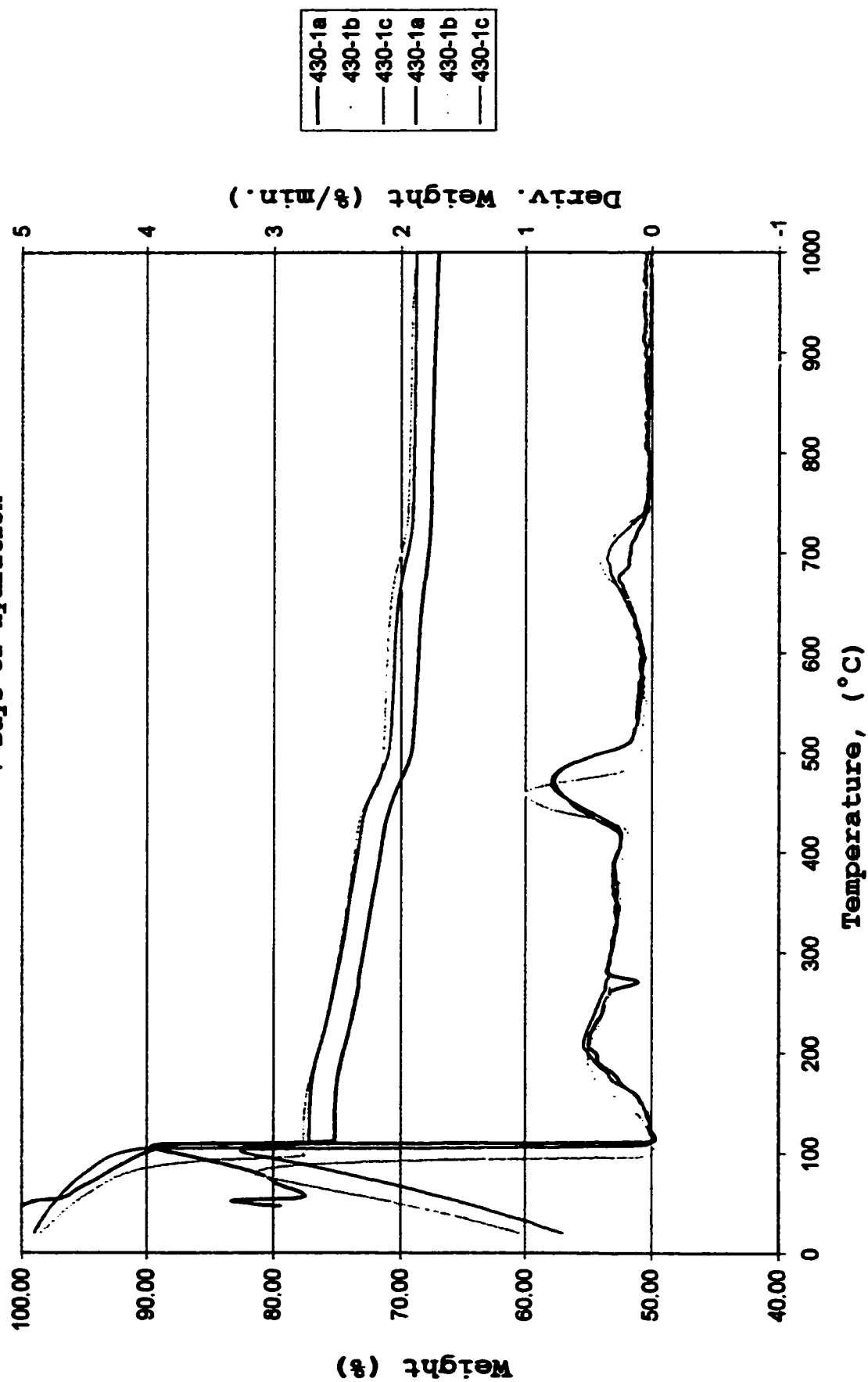
7 Days of Hydration



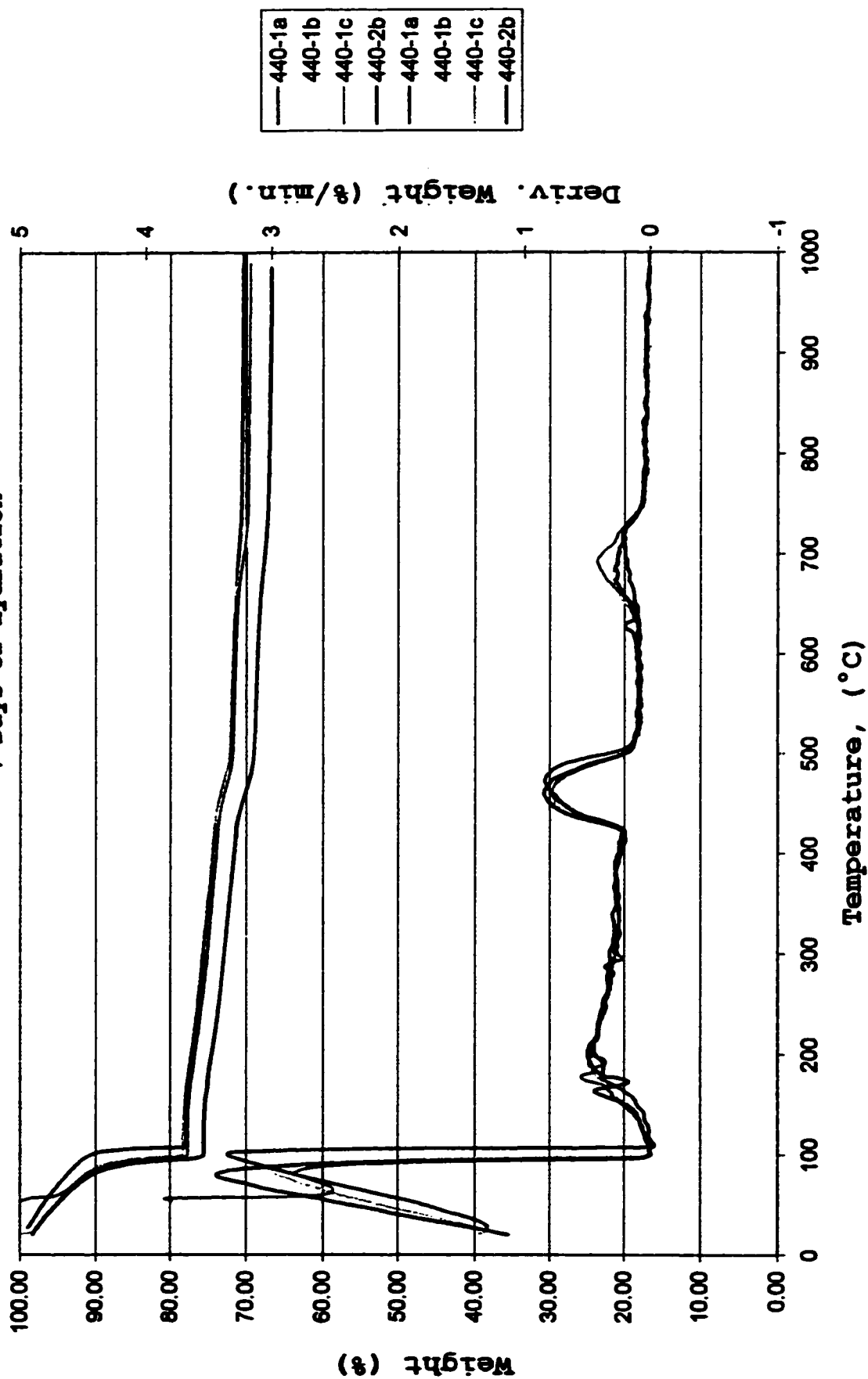
TGA Cement Paste: - Melligan Fly Ash
7 Days of Hydration



TGA Cement Paste: Portage Fly Ash 7 Days of Hydration

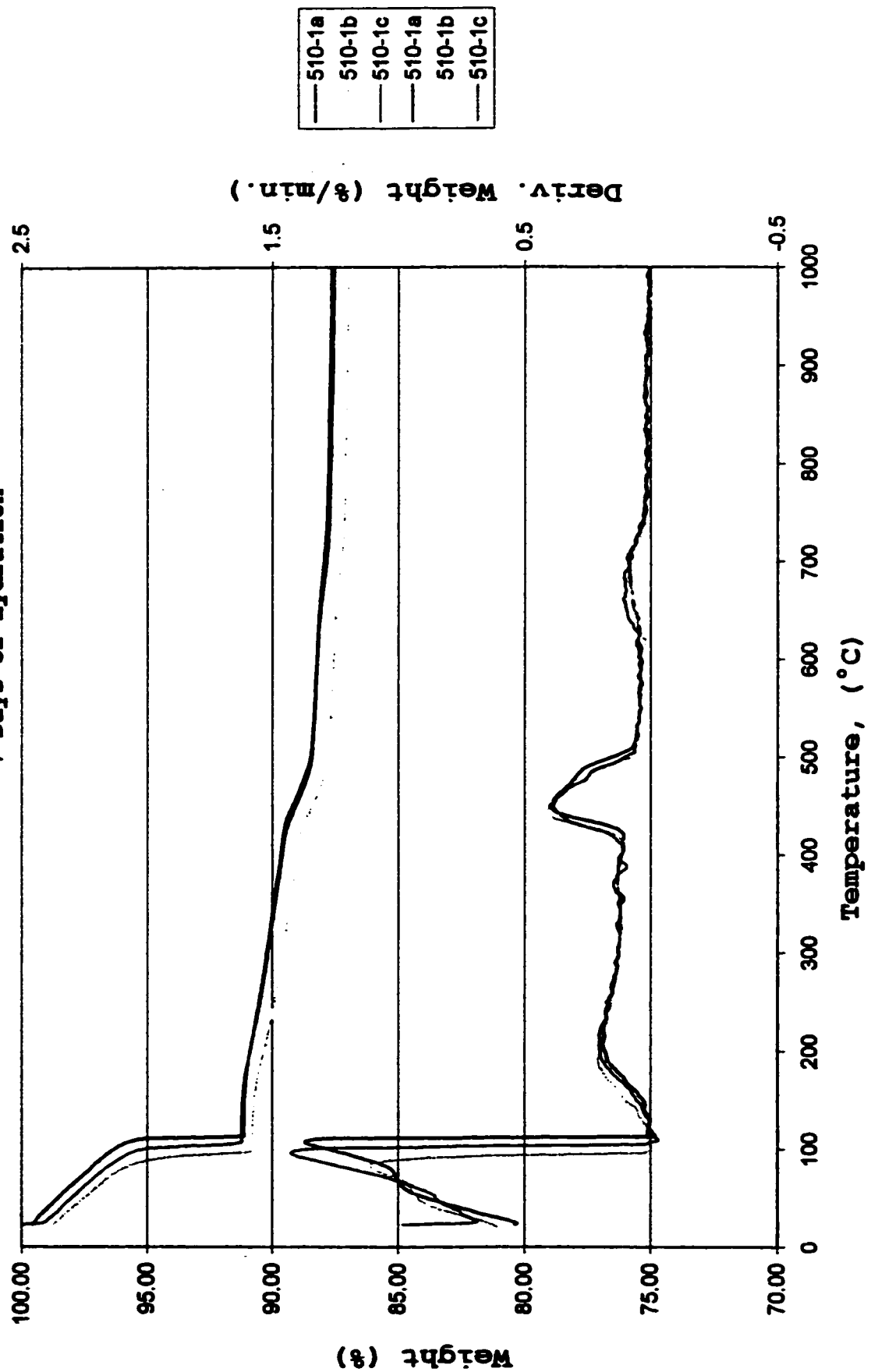


TGA Cement Paste: Sundance Fly Ash 7 Days of Hydration

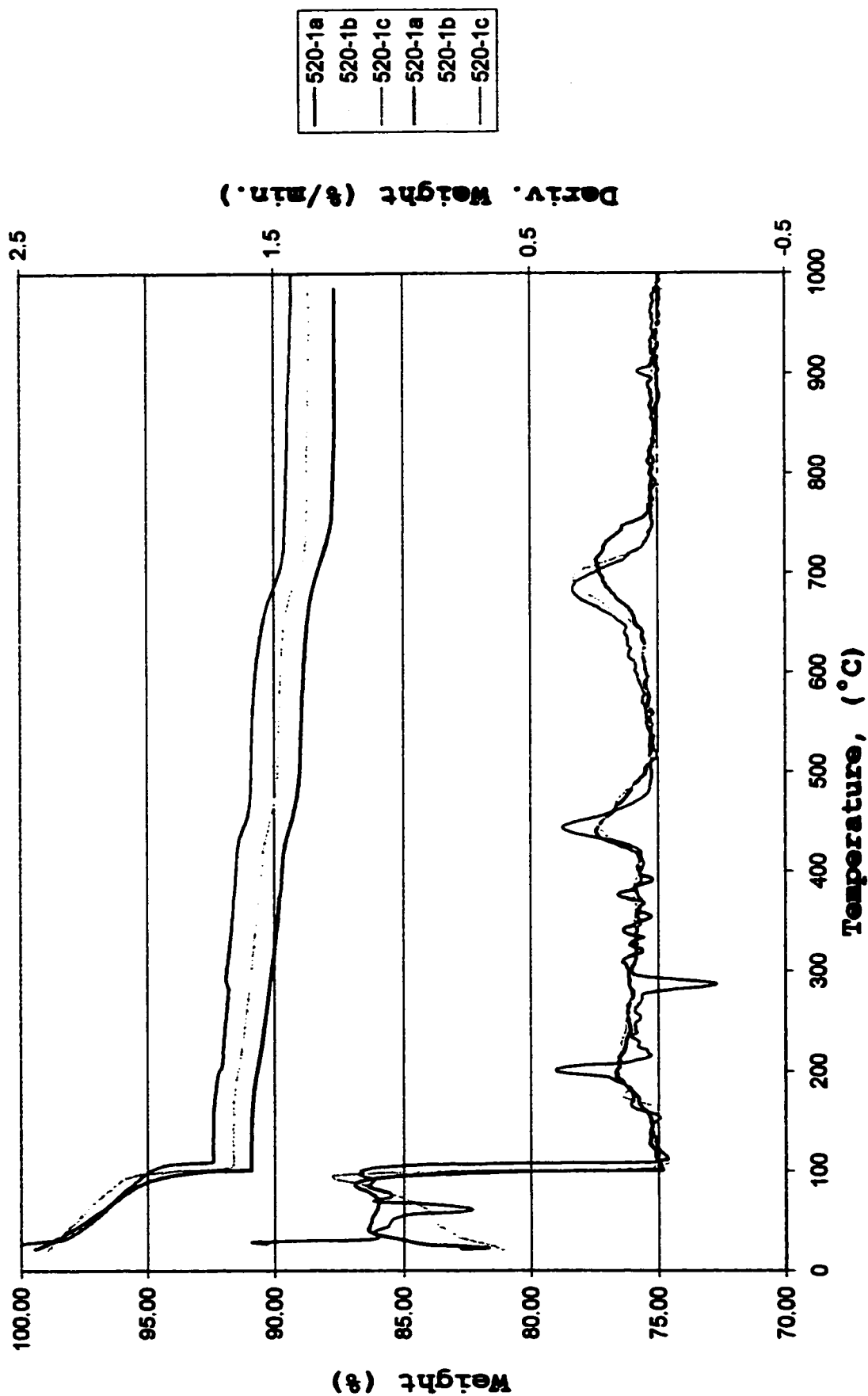


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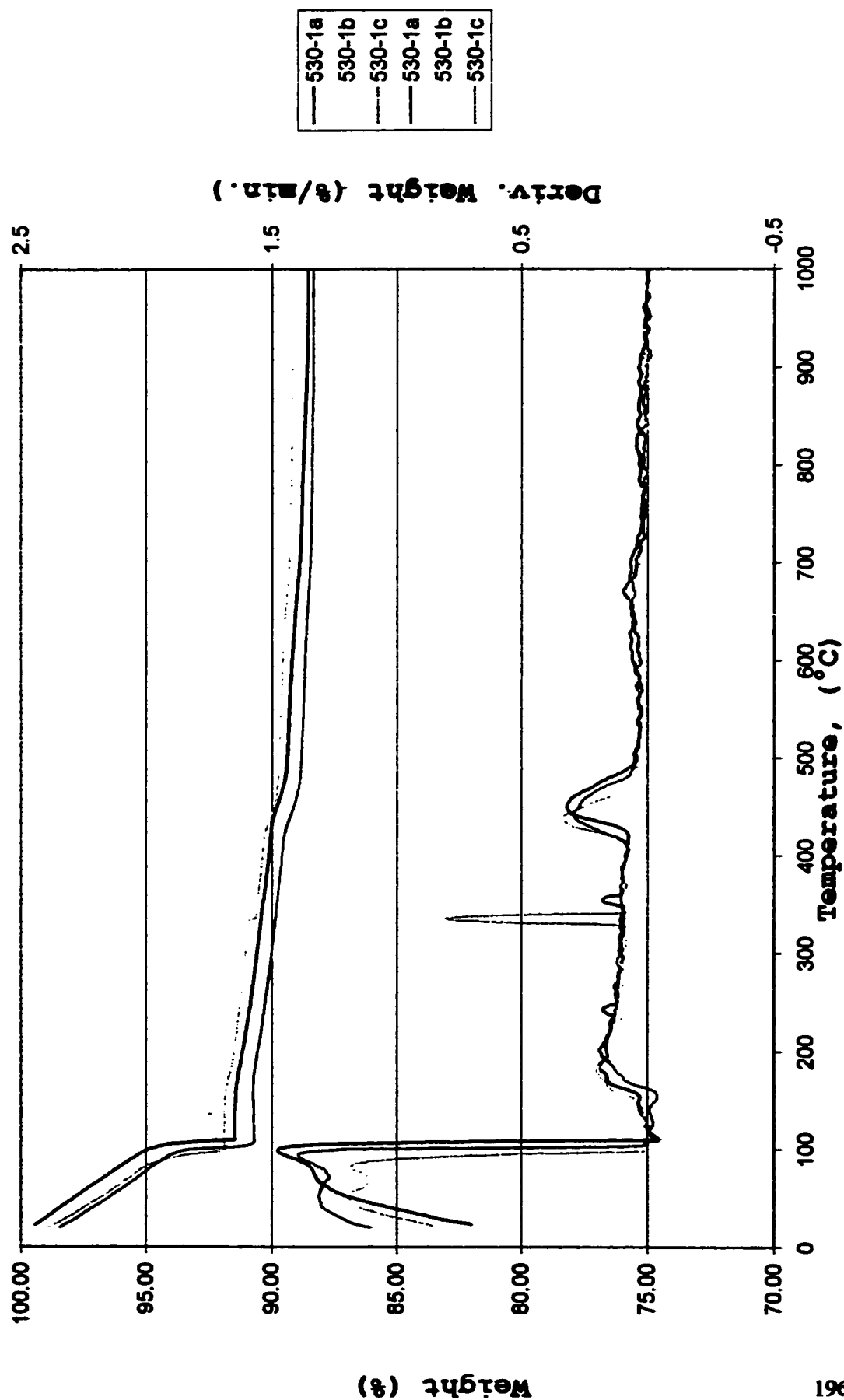
Mortar: Reference
7 Days of Hydration



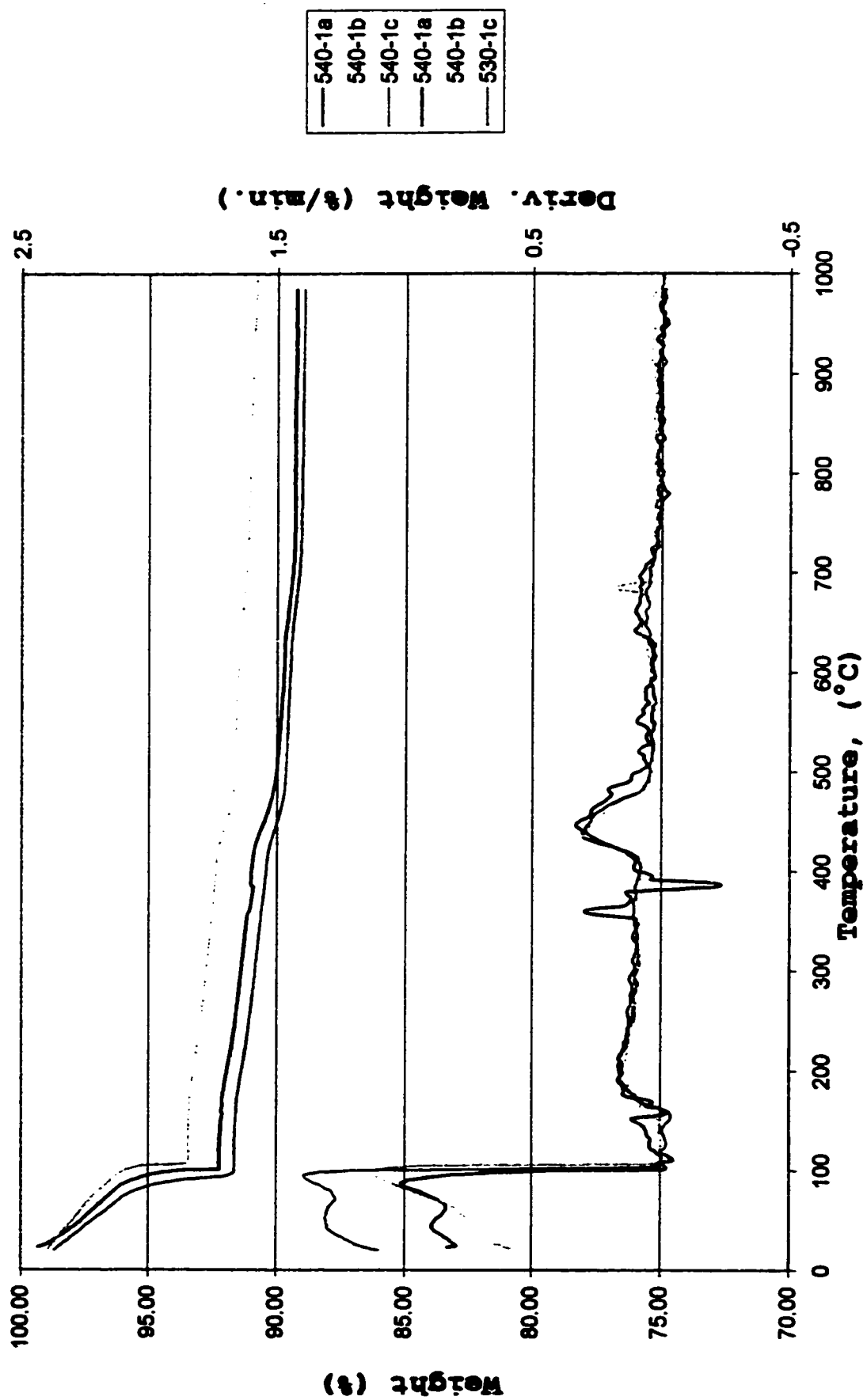
TGA Mortar: Melligan Fly Ash
7 Days of Hydration



TGA Mortar: Portage Fly Ash 7 Days of Hydration

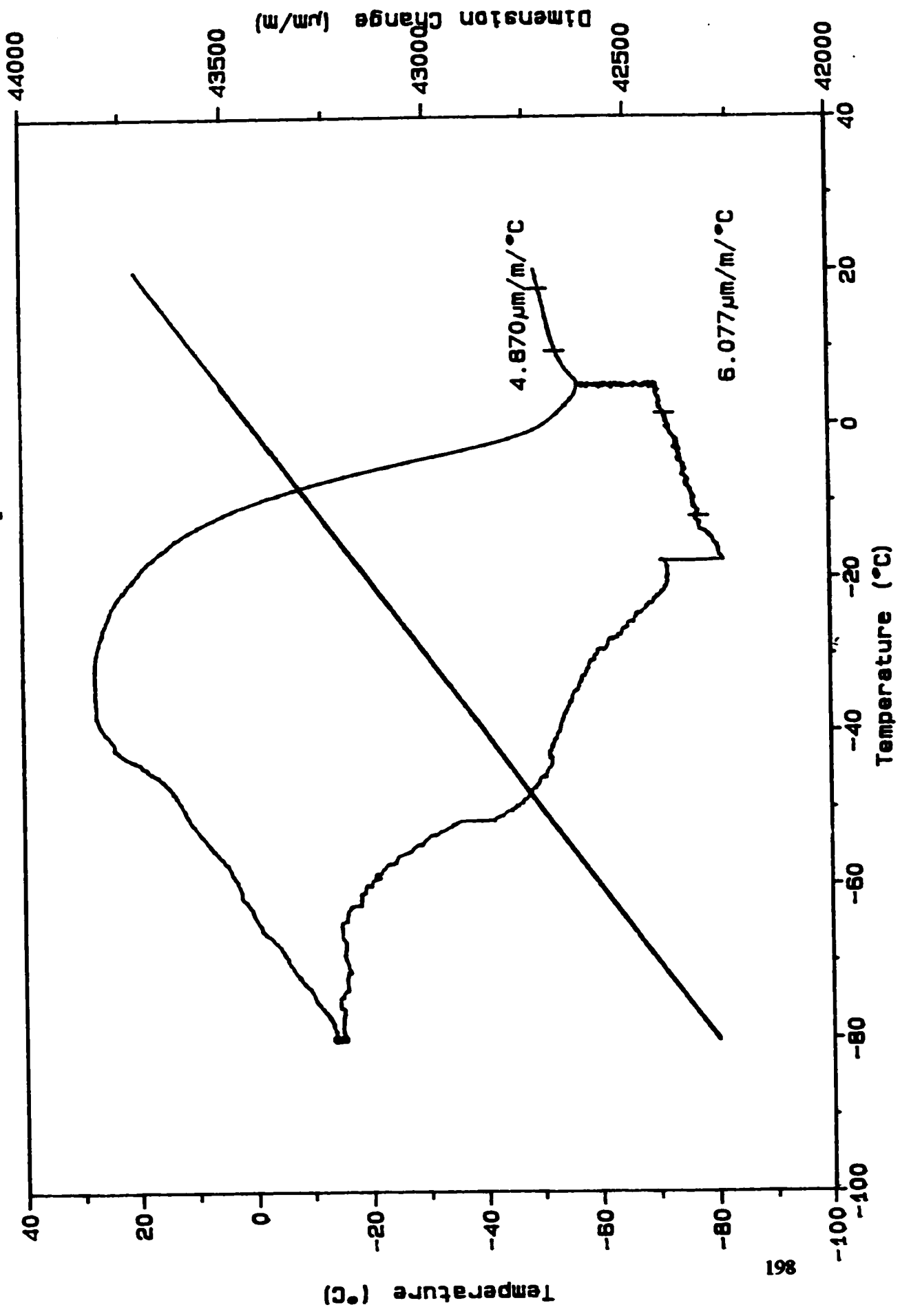


TGA Mortar: Sundance Fly Ash
7 Days of Hydration



TMA

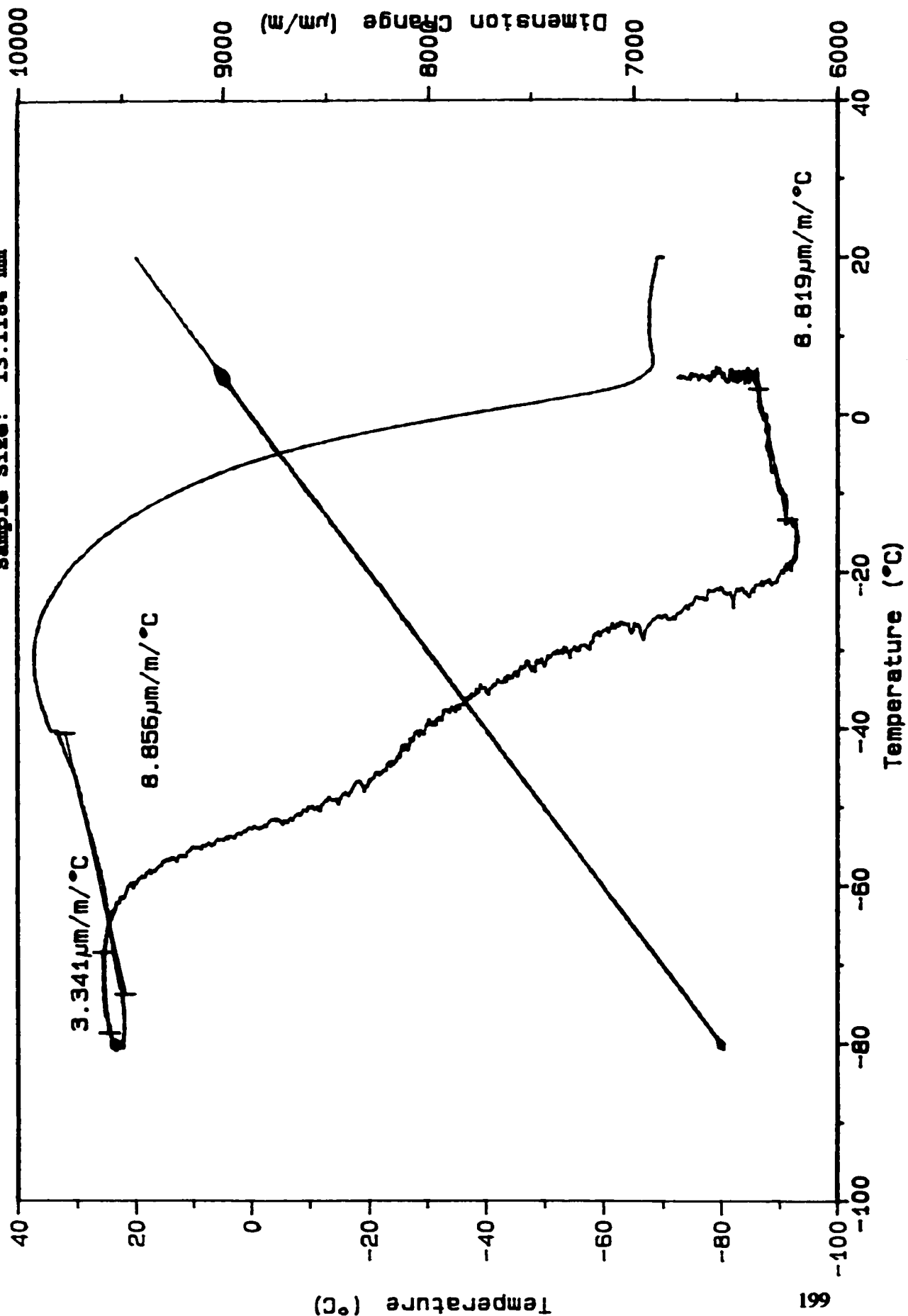
Sample: w/c = 0.35, 7 Days Hydration
Synthetic Pore Solution
Sample Size: 13.1534 mm



TMA

Sample: w/c = 0.35, 7 Days Hydration
5% Salt Solution

Sample Size: 13.1184 mm

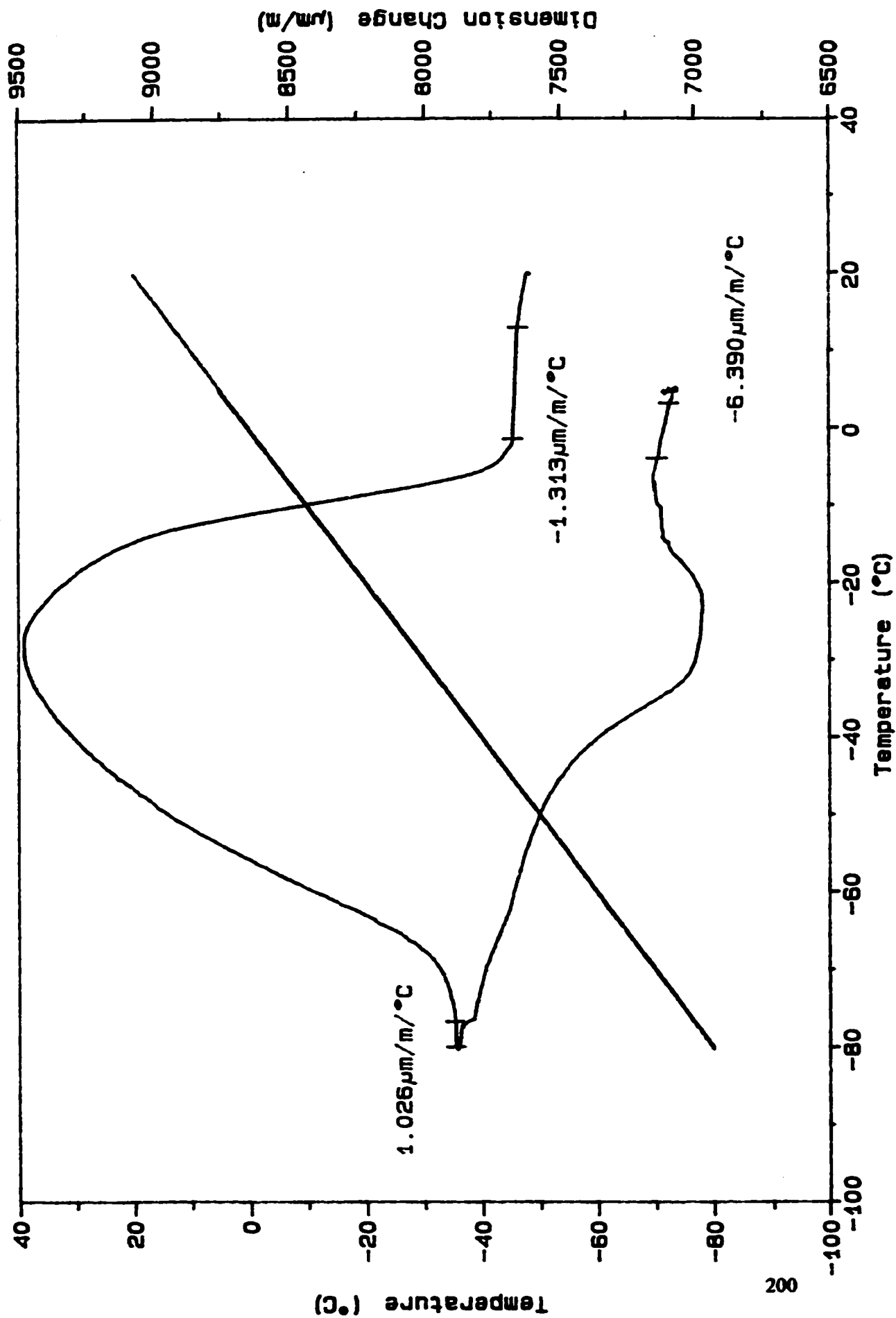


TMA

Sample: w/c = 0.35, 7 Days Hydration

10% Salt Solution

Sample Size: 13.0944 mm

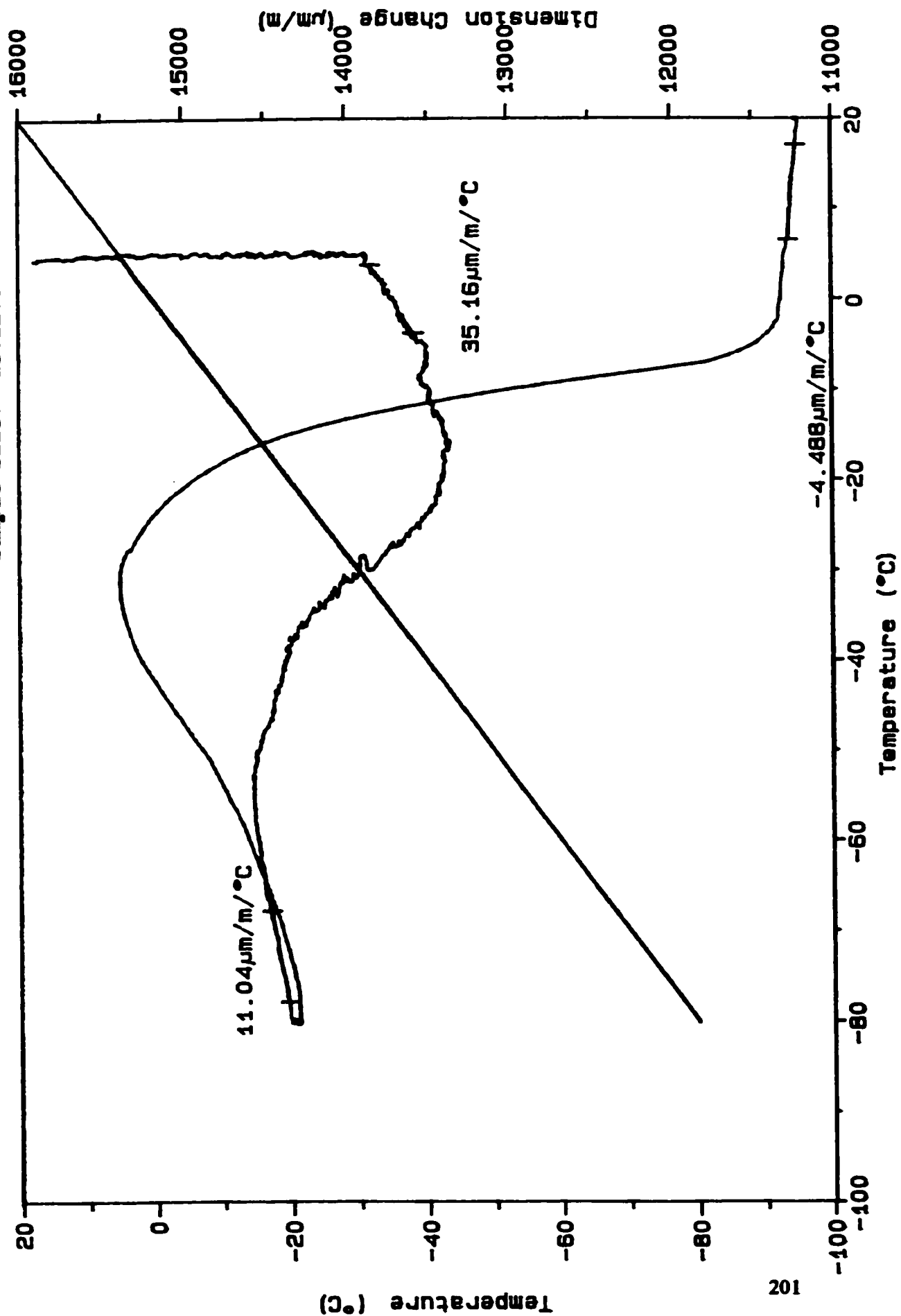


TMA

Sample: w/c = 0.35, 7 Days Hydration

15% Salt Solution

Sample Size: 13.1270 mm

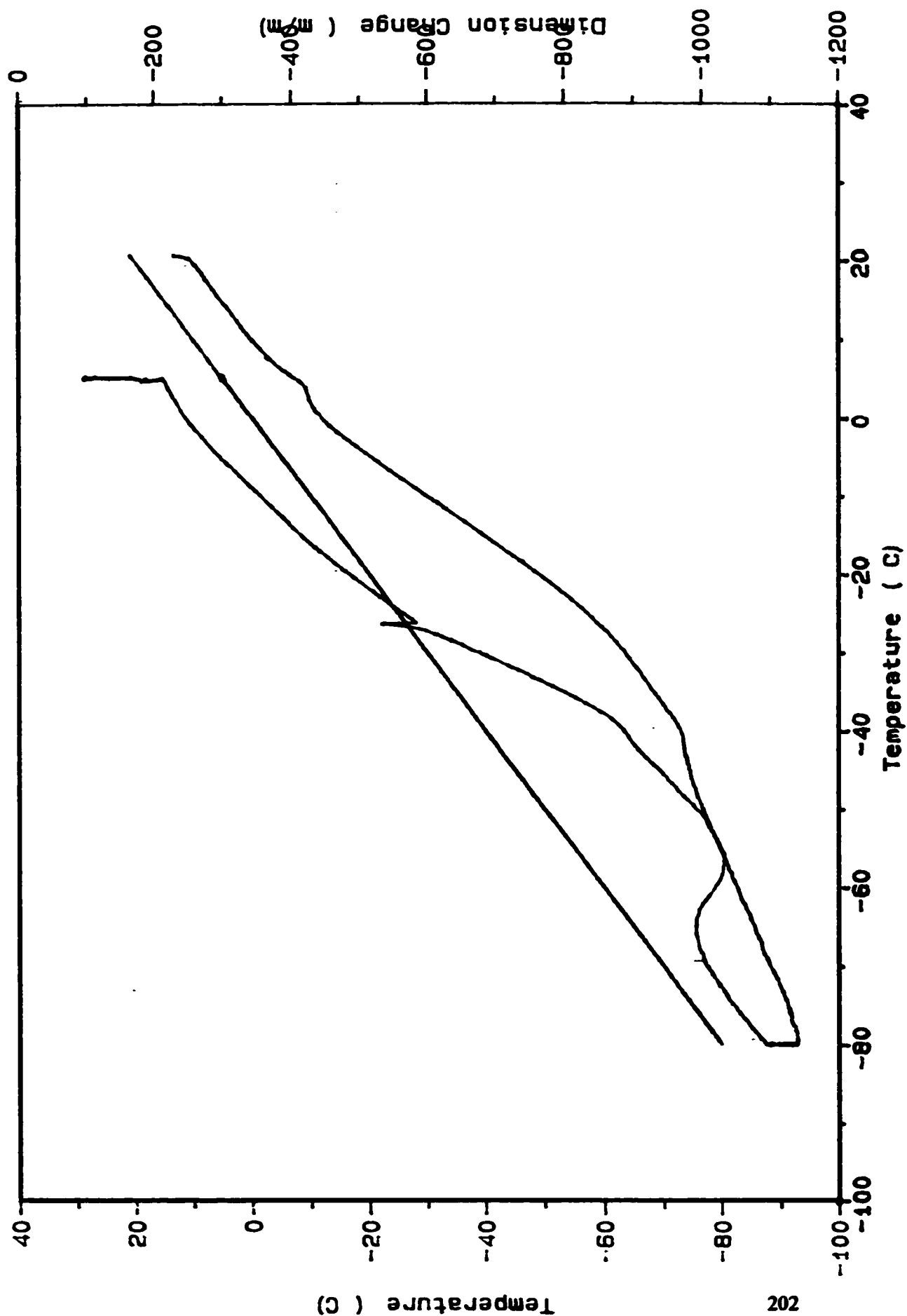


TMA

Sample: w/c = 0.35, 7 Days Hydration

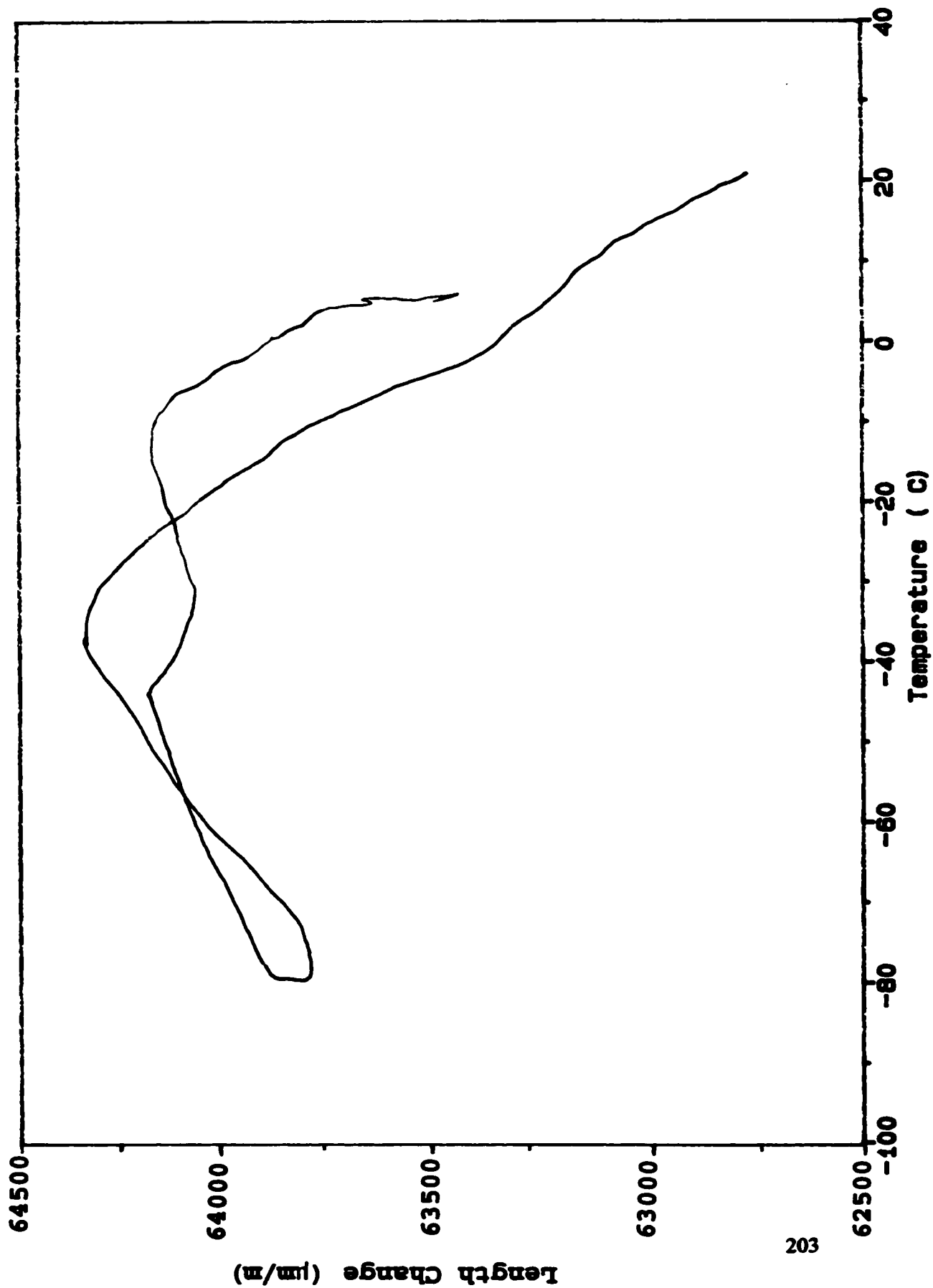
6% Entrained Air

Sample Size: 12.2487 mm



TMA

Sample: $w/c = 0.35$, 7 Days Hydration
6% Entrained Air, 10% Salt Solution
Sample Size: 12.6319 mm

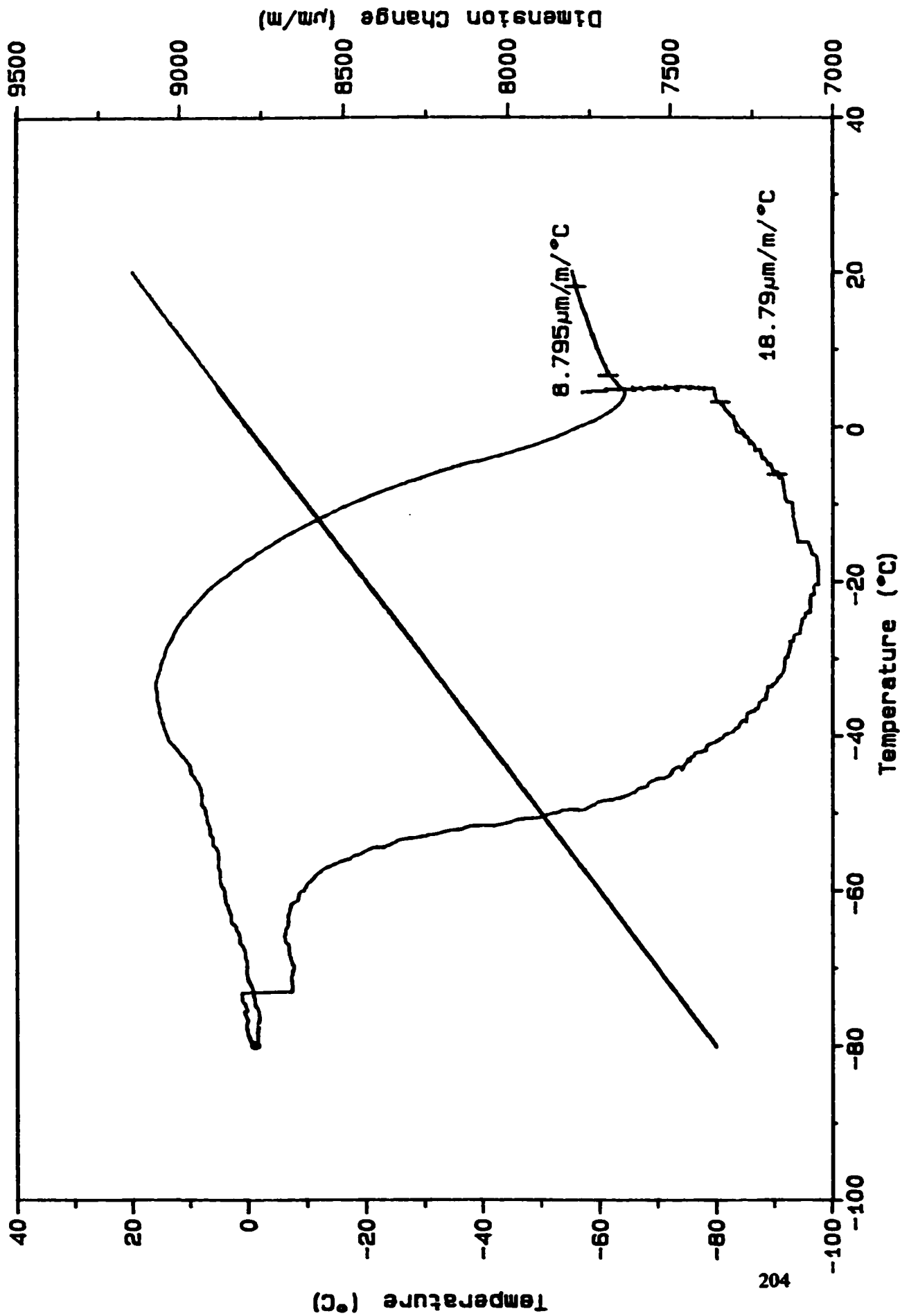


TMA

Sample: w/c = 0.35, 28 Days Hydration

Synthetic Pore Solution

Sample Size: 13.3197 mm

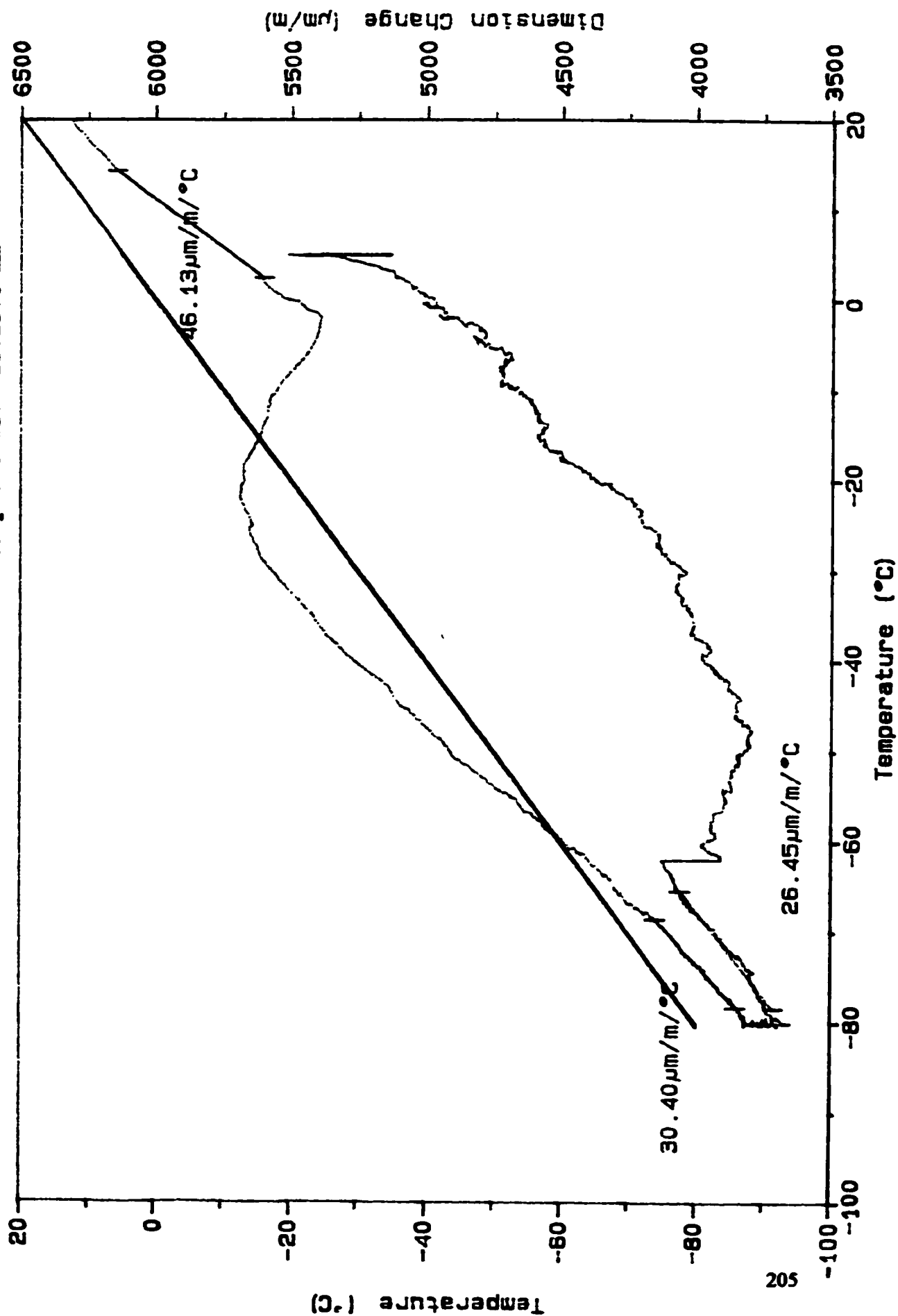


TMA

Sample: w/c = 0.35, 28 Days Hydration

Synthetic Pore Solution

Sample Size: 13.1376 mm

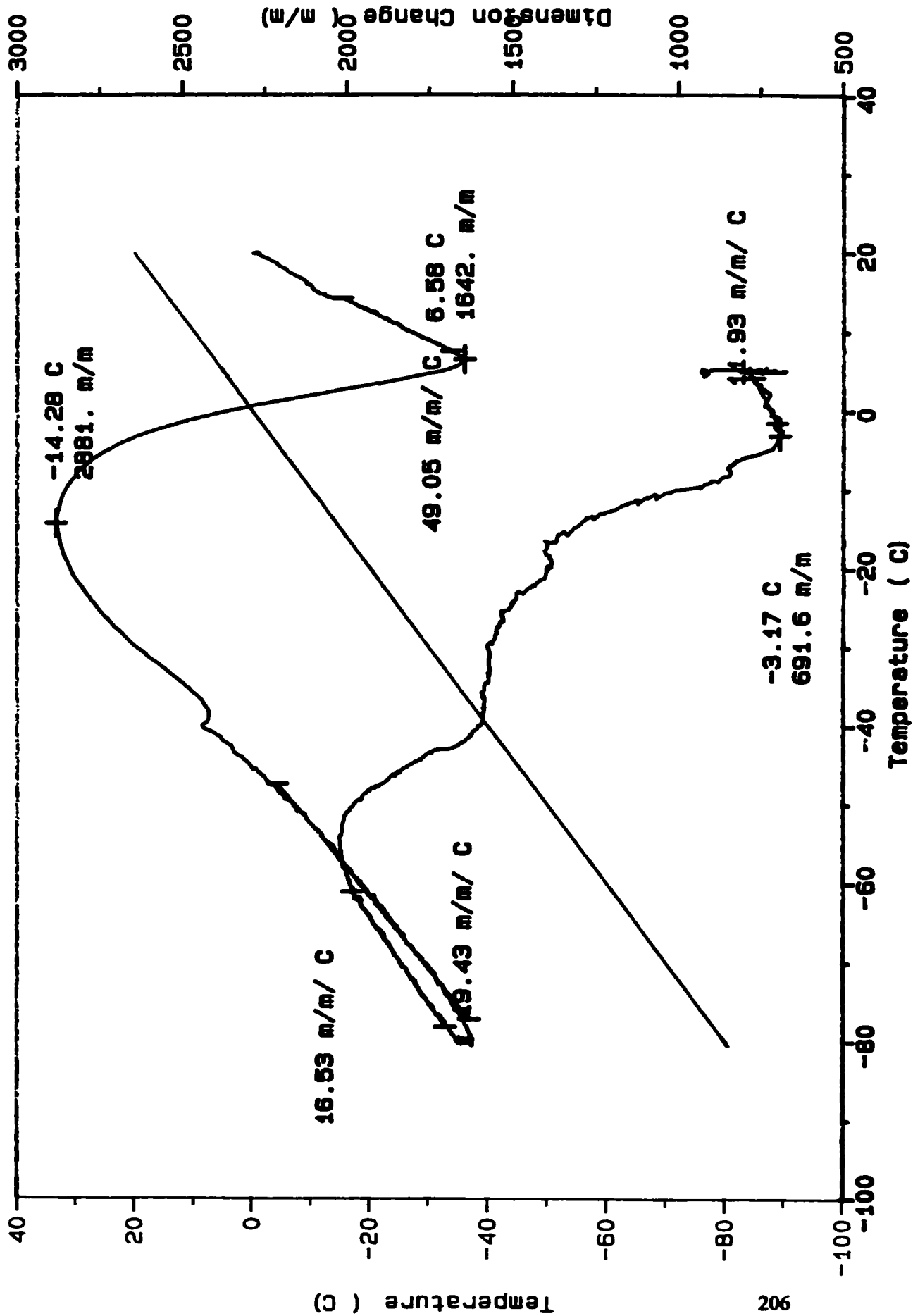


TMA

Sample: w/c = 0.35, 28 Days Hydration

5% Salt Solution

Sample Size: 13.0035 mm

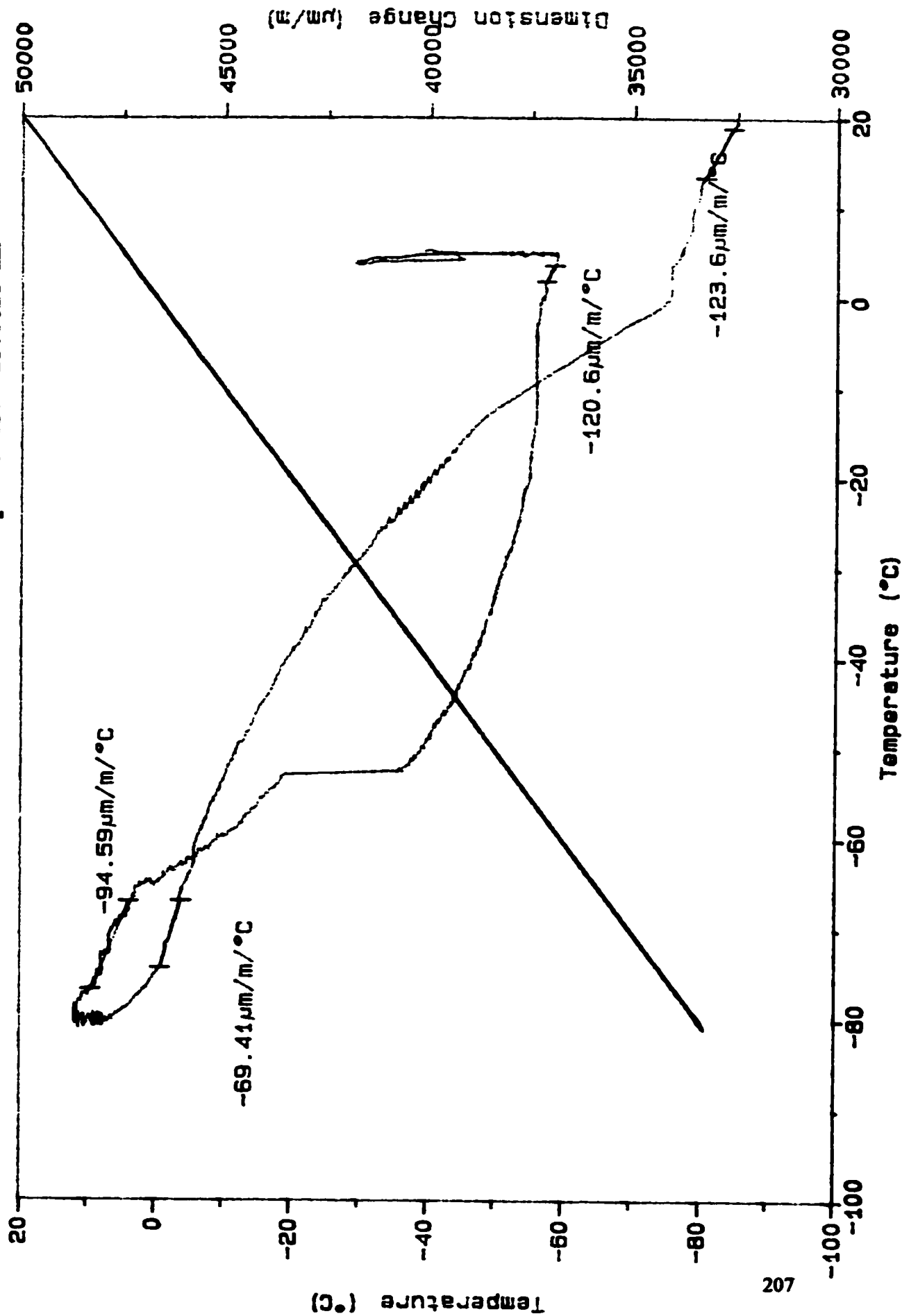


TMA

Sample: w/c = 0.35, 28 Days Hydration

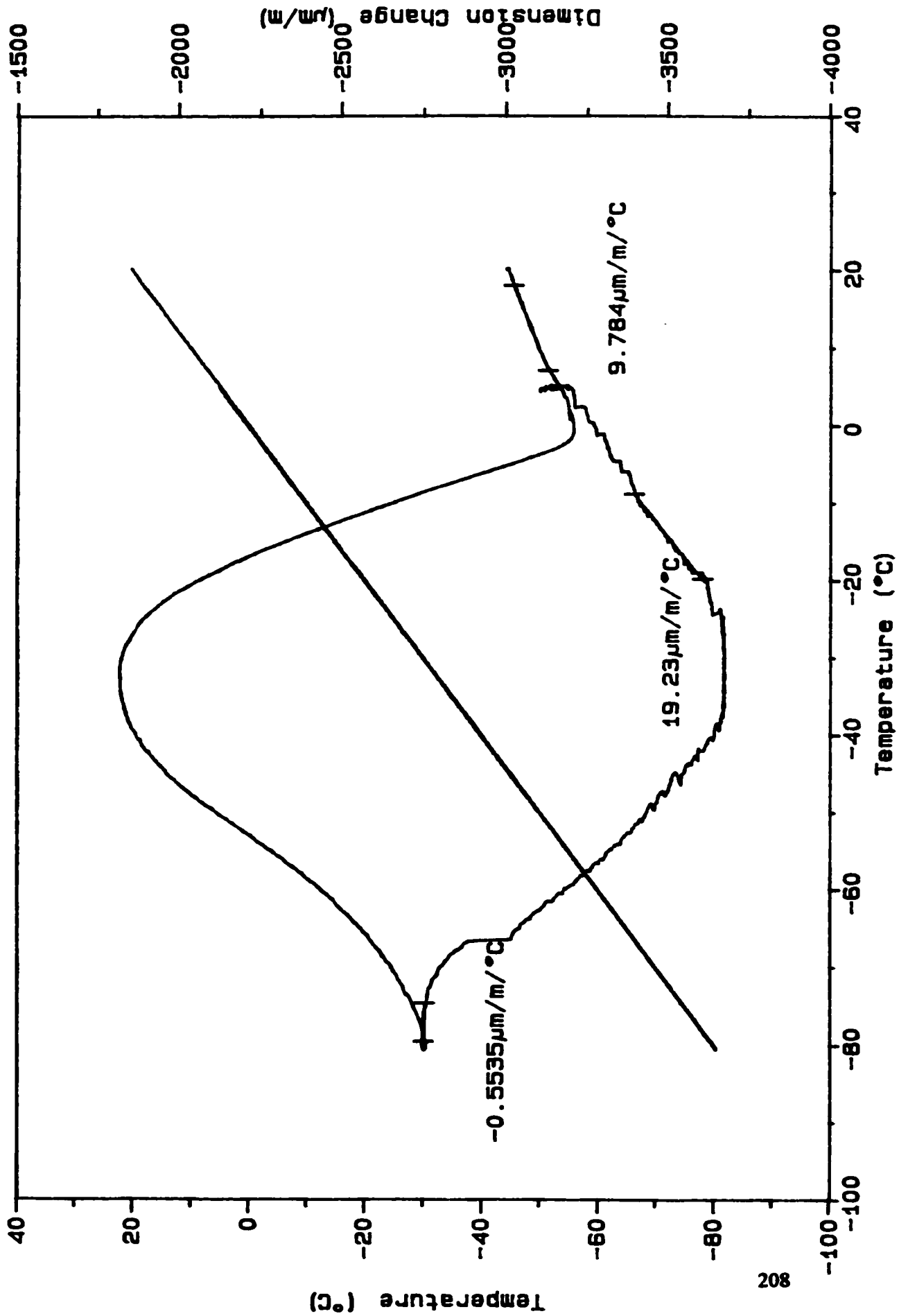
10% Salt Solution

Sample Size: 13.0628 mm



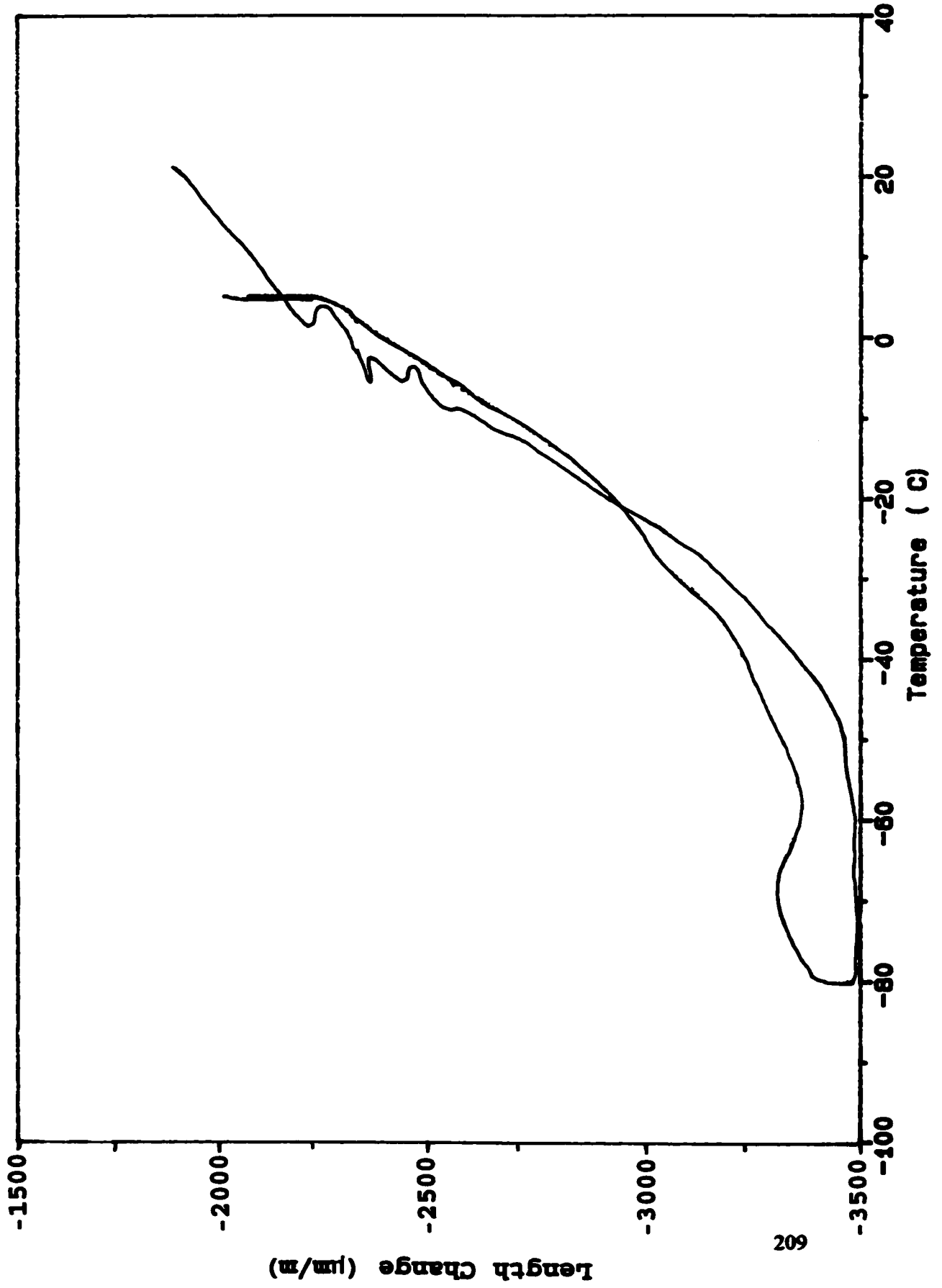
TMA

Sample: w/c = 0.35, 28 Days Hydration
15% Salt Solution
Sample Size: 13.2045 mm



TMA

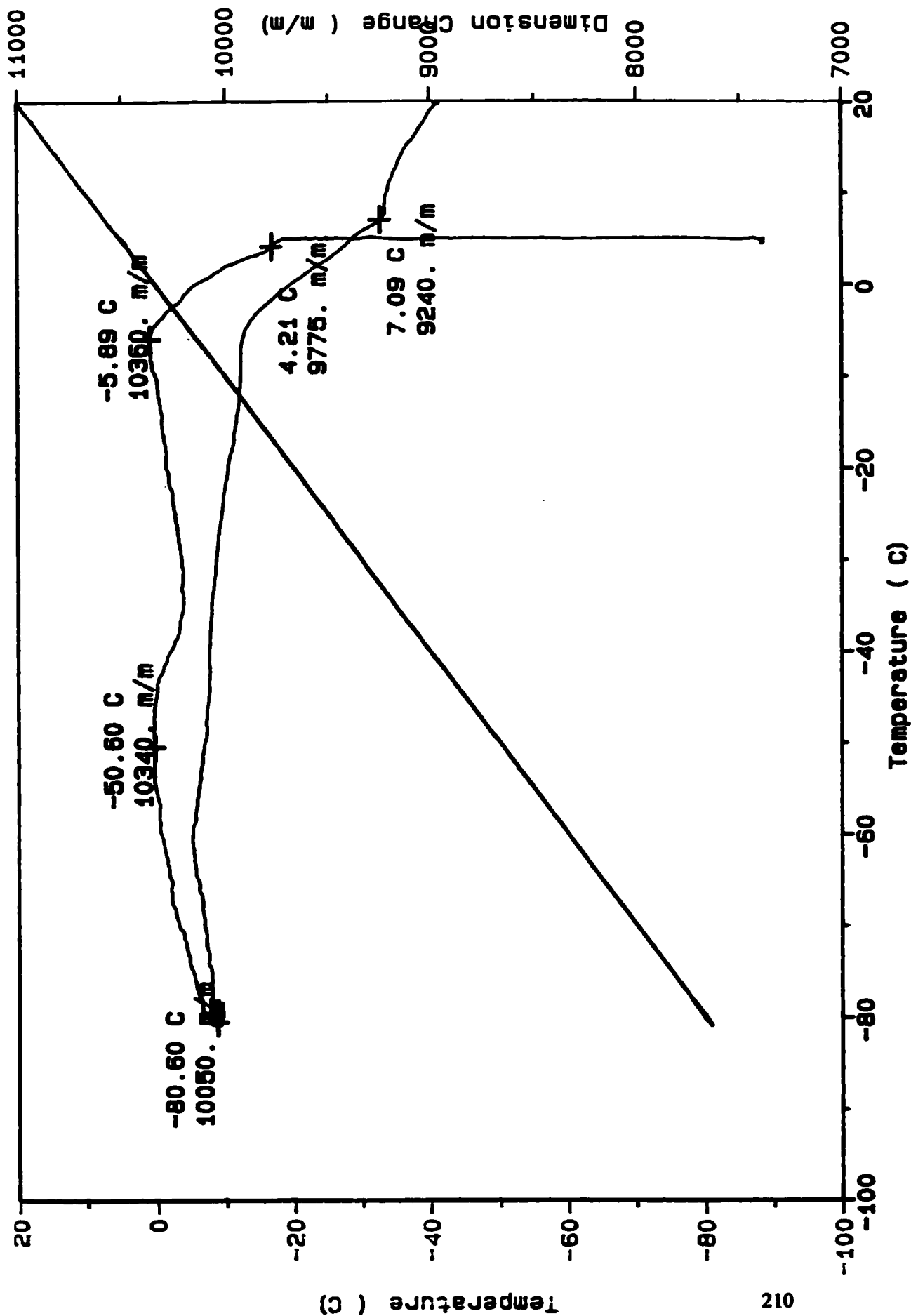
Sample: w/c = 0.35, 28 Days Hydration
6% Entrained Air
Sample Size: 12.8927 mm



TMA

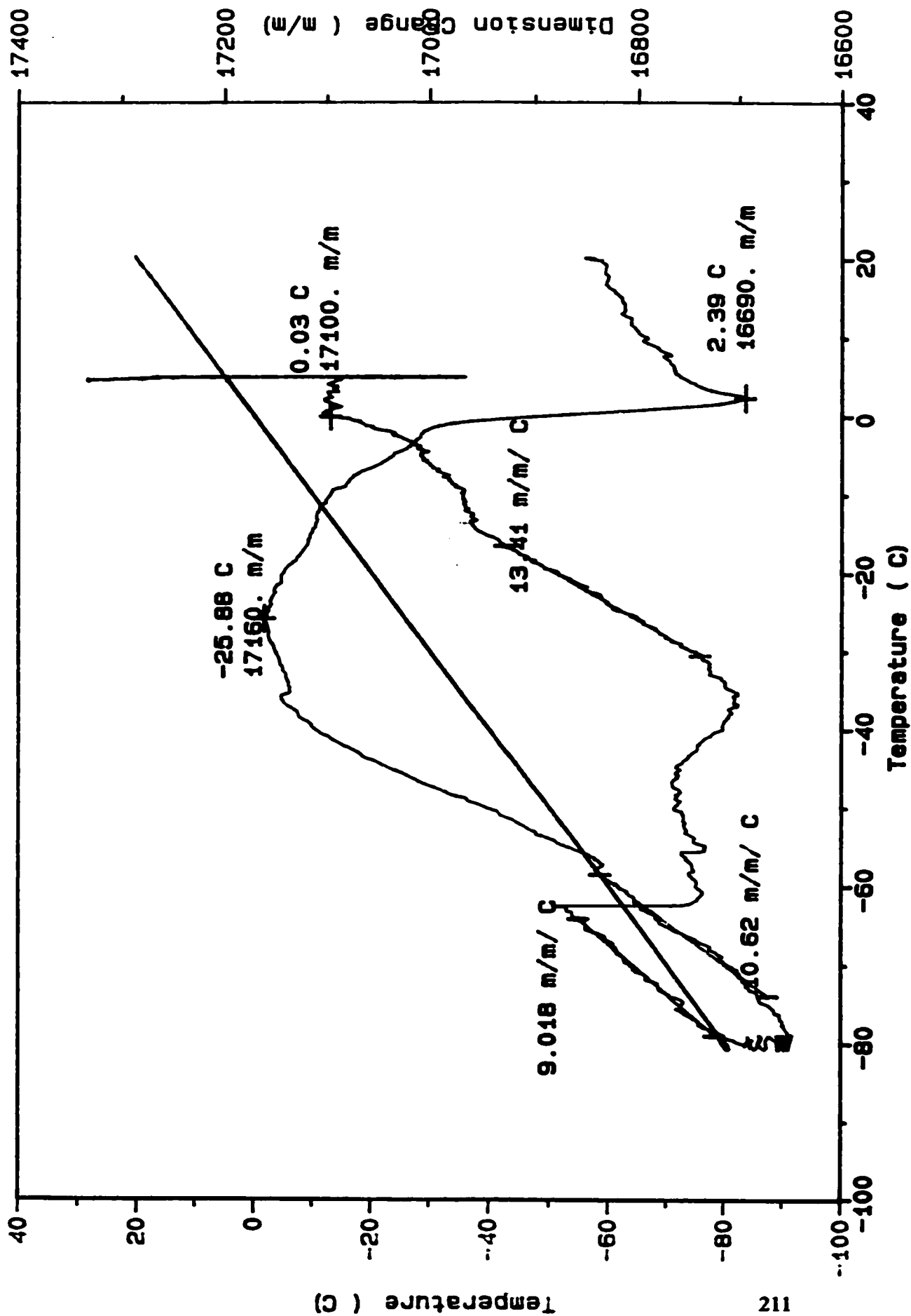
Sample: w/c = 0.35, 28 Days Hydration
6% Entrained Air, 5% Salt Solution

Sample Size: 12.8668 mm



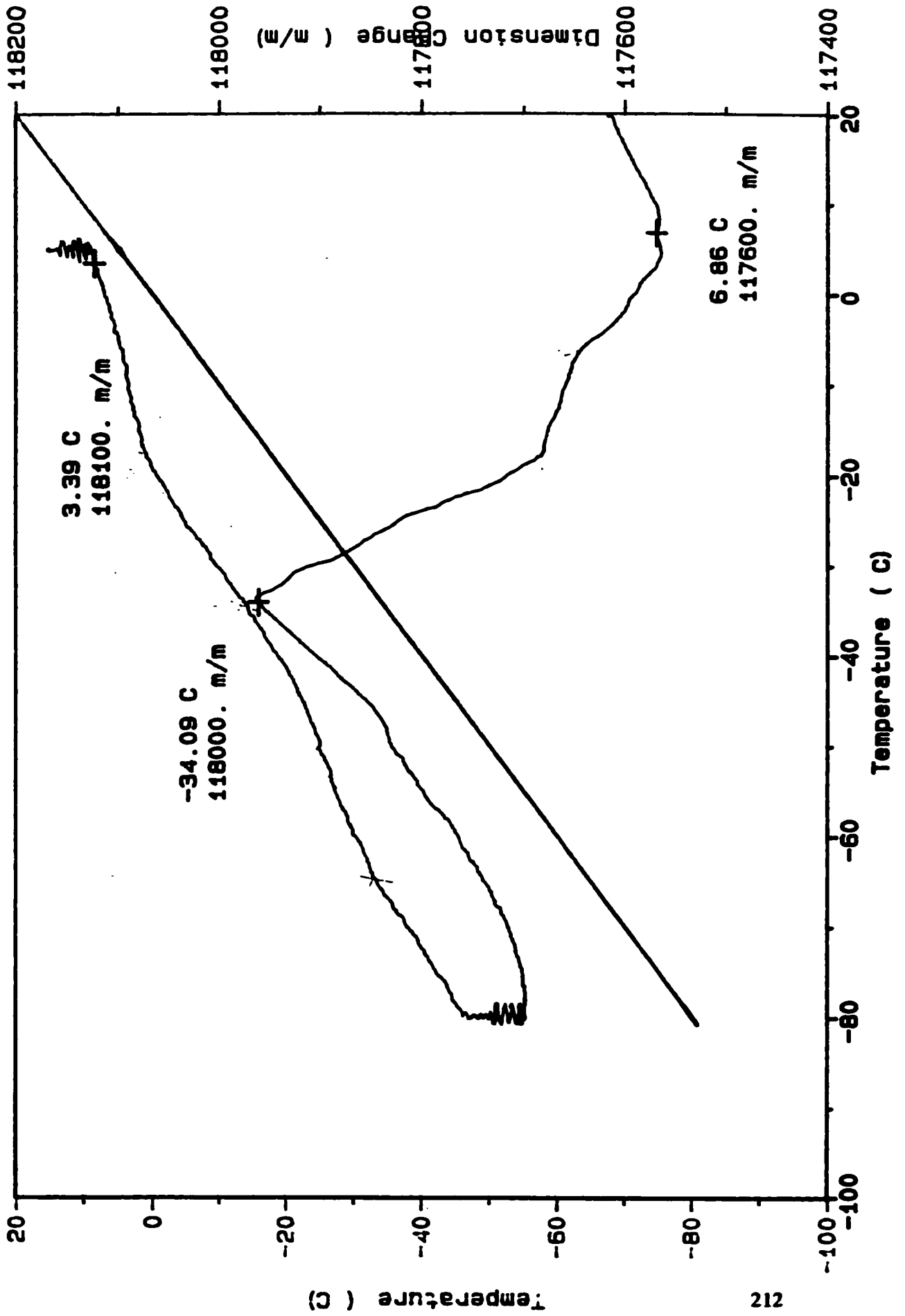
TMA

Sample: w/c = 0.35, 28 Days Hydration
 6% Entrained Air, 10% Salt Solution
 Sample Size: 12.7153 mm



TMA

Sample: $w/c = 0.35$, 28 Days Hydration
 6% Entrained Air, 10% Salt Solution
 Sample Size: 12.7153 mm

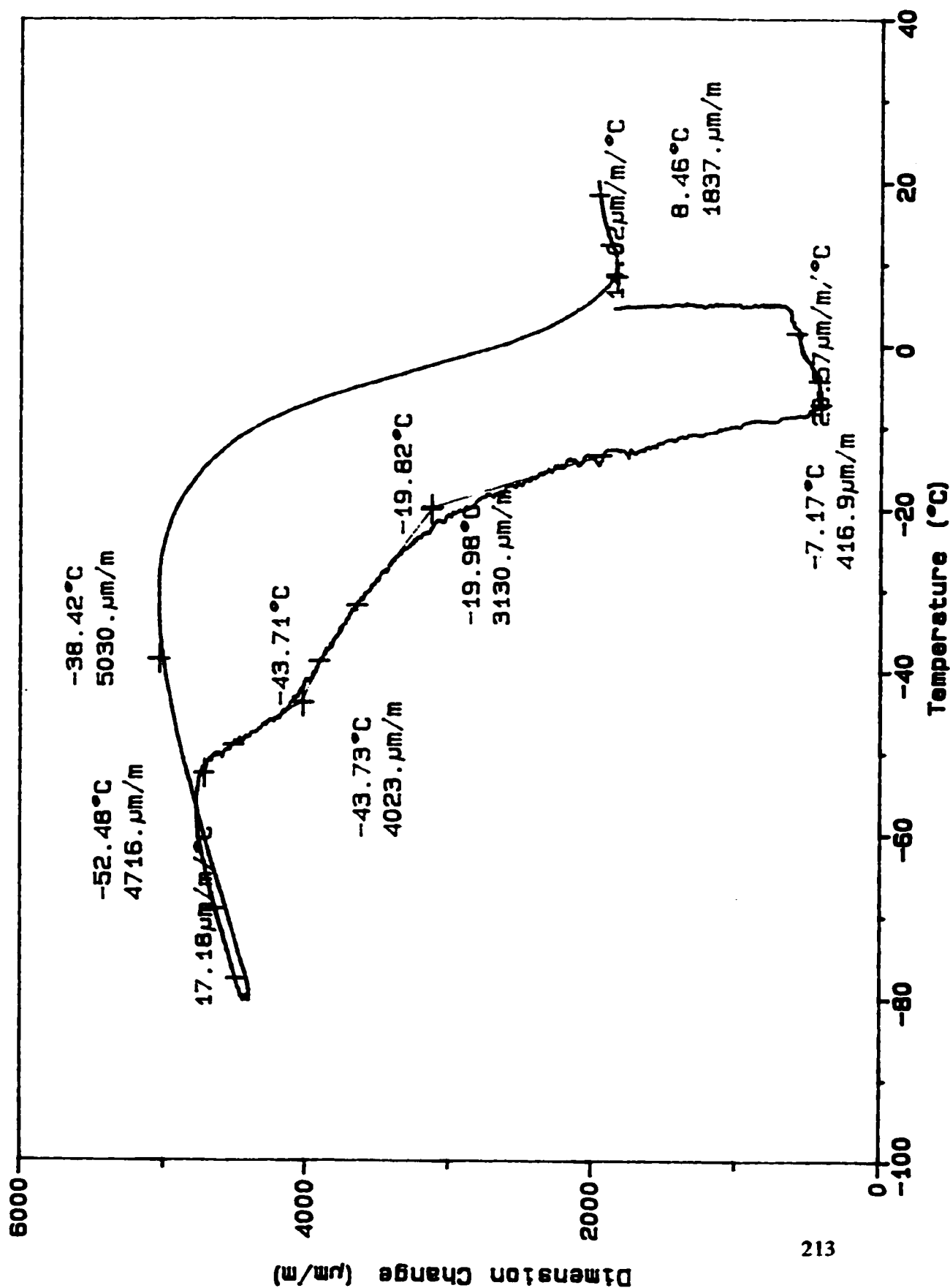


TMA

Sample: w/c = 0.60, 7 Days Hydration

Natural Pore Solution

Sample Size: 14.7481 mm

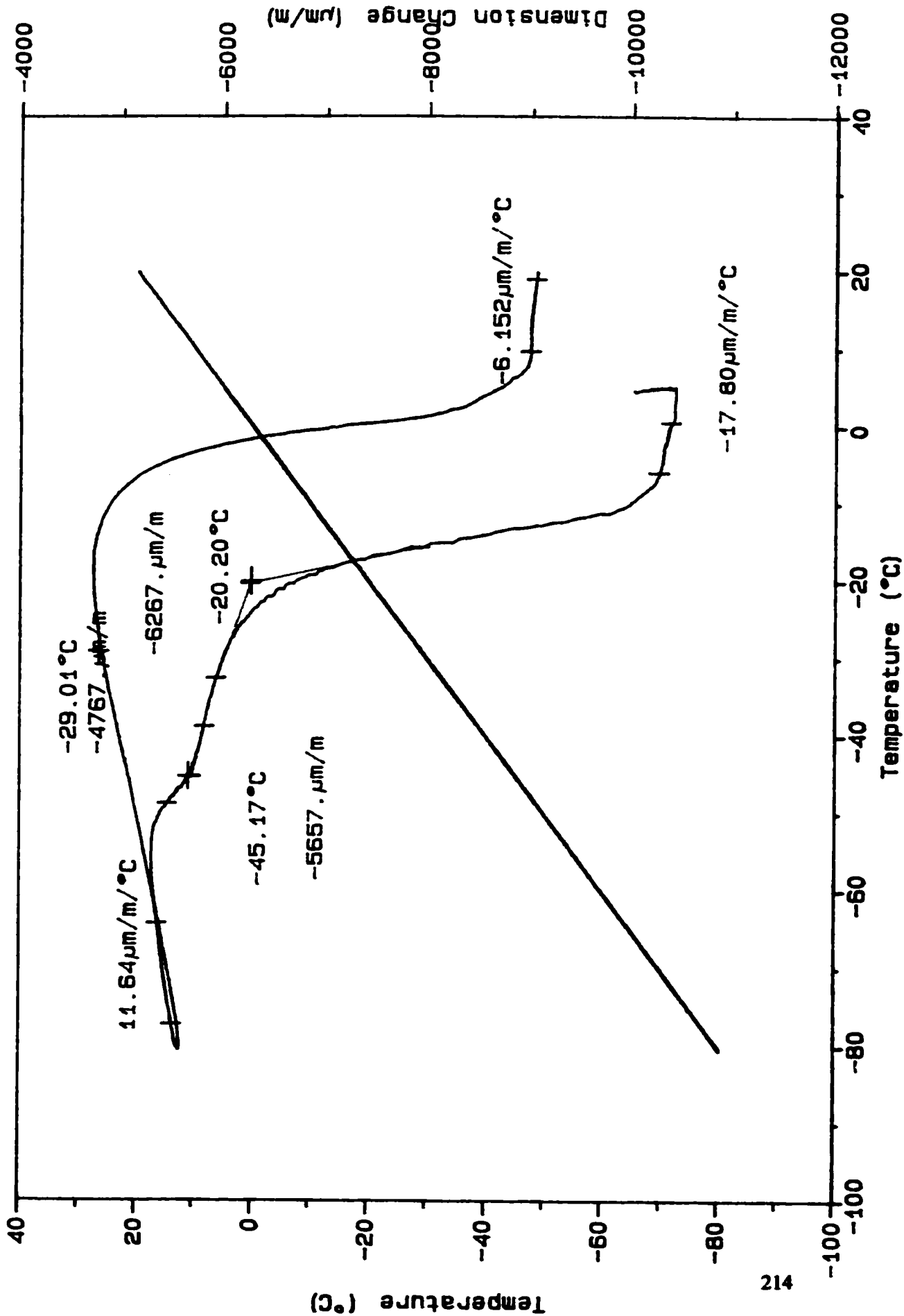


TMA

Sample: w/c = 0.60, 7 Days Hydration

Synthetic Pore Solution

Sample Size: 13.1300 mm

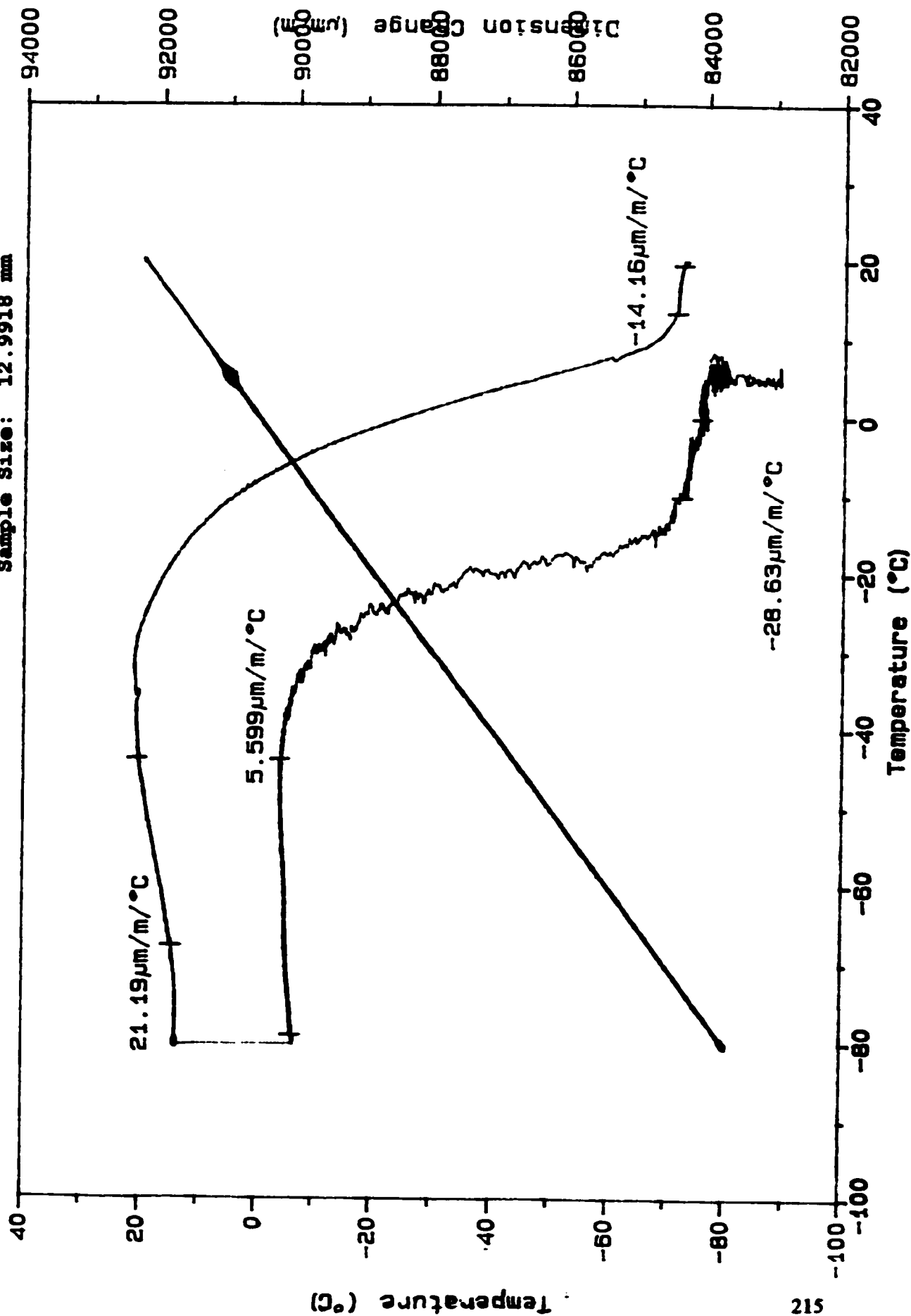


TMA

Sample: w/c = 0.60, 7 Days Hydration

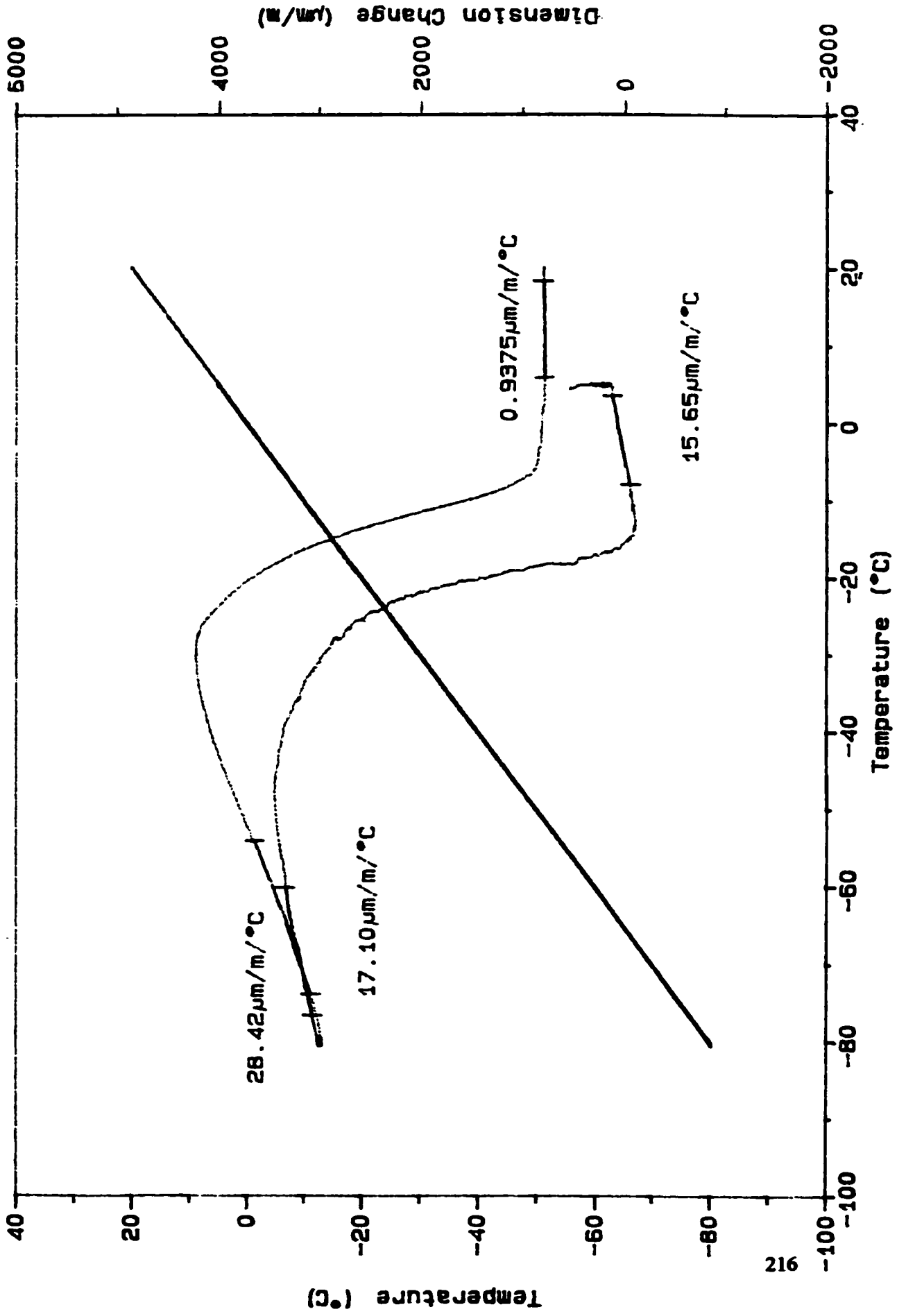
5% Salt Solution

Sample Size: 12.9918 mm



TMA

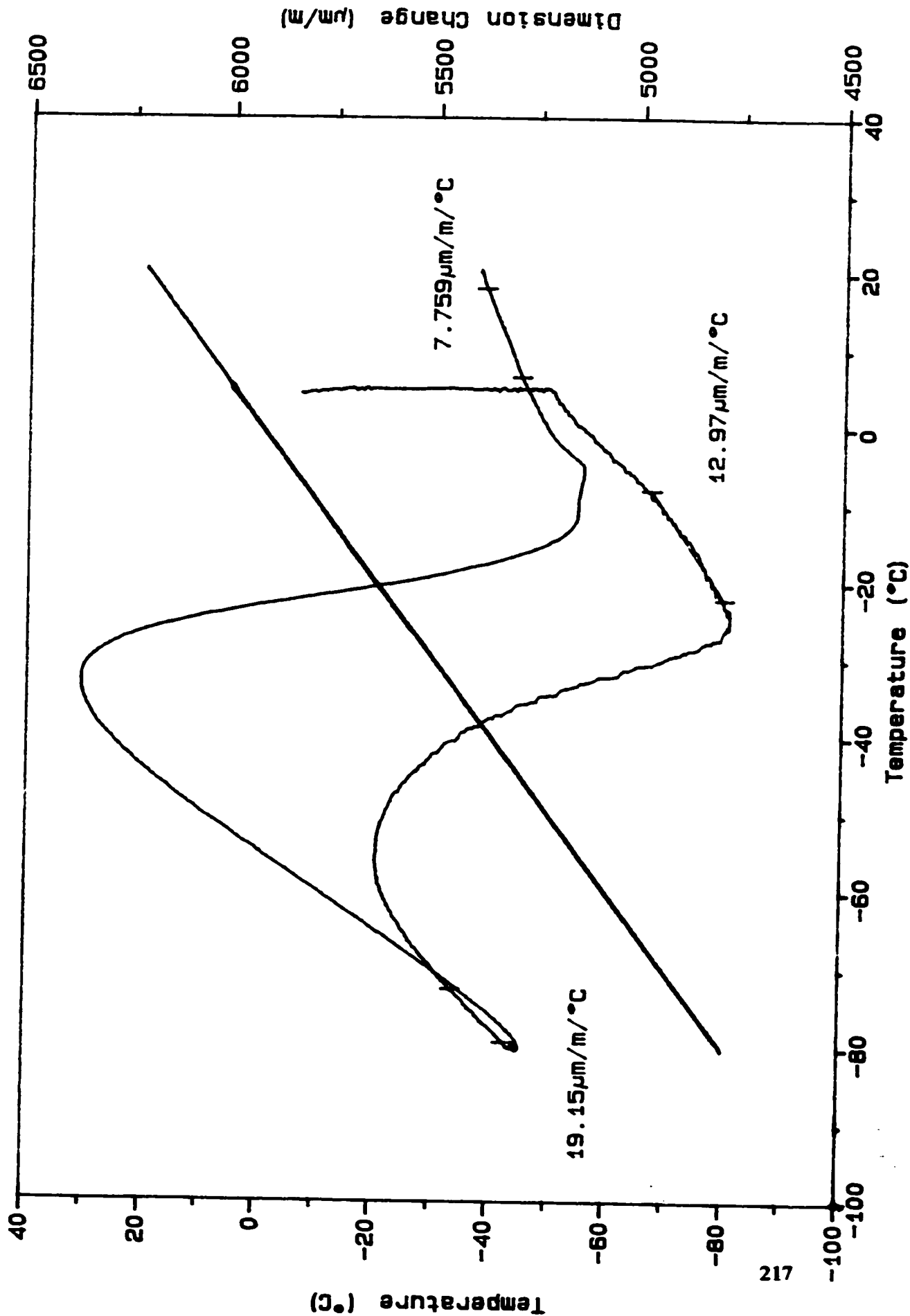
Sample: w/c = 0.60, 7 Days Hydration
10% Salt Solution
Sample Size: 12.9708 mm



TMA

Sample: w/c = 0.60, 7 Days Hydration
15% Salt Solution

Sample Size: 13.0900 mm

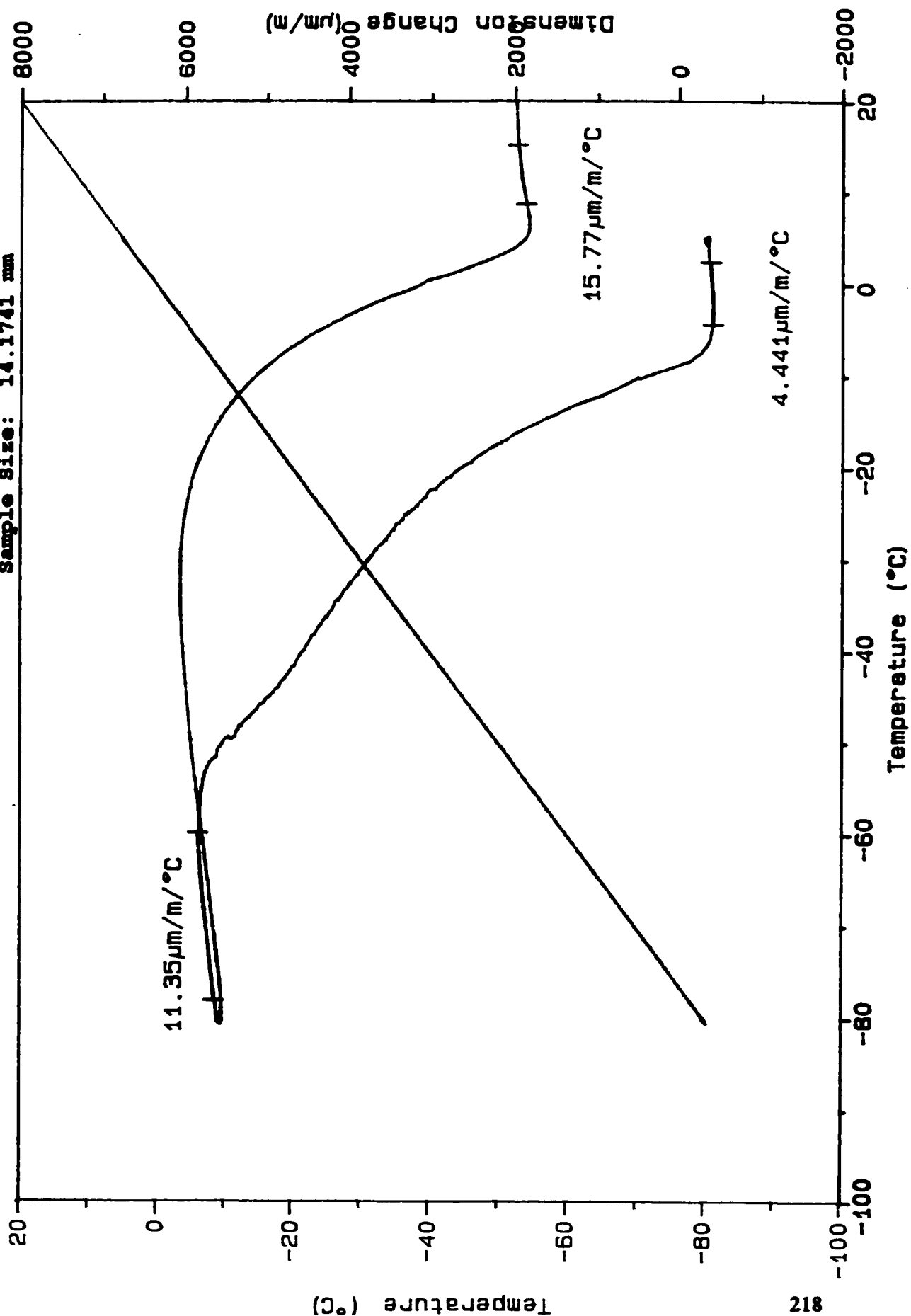


TMA

Sample: w/c = 0.60, 28 Days Hydration

Natural Pore Solution

Sample Size: 14.1741 mm

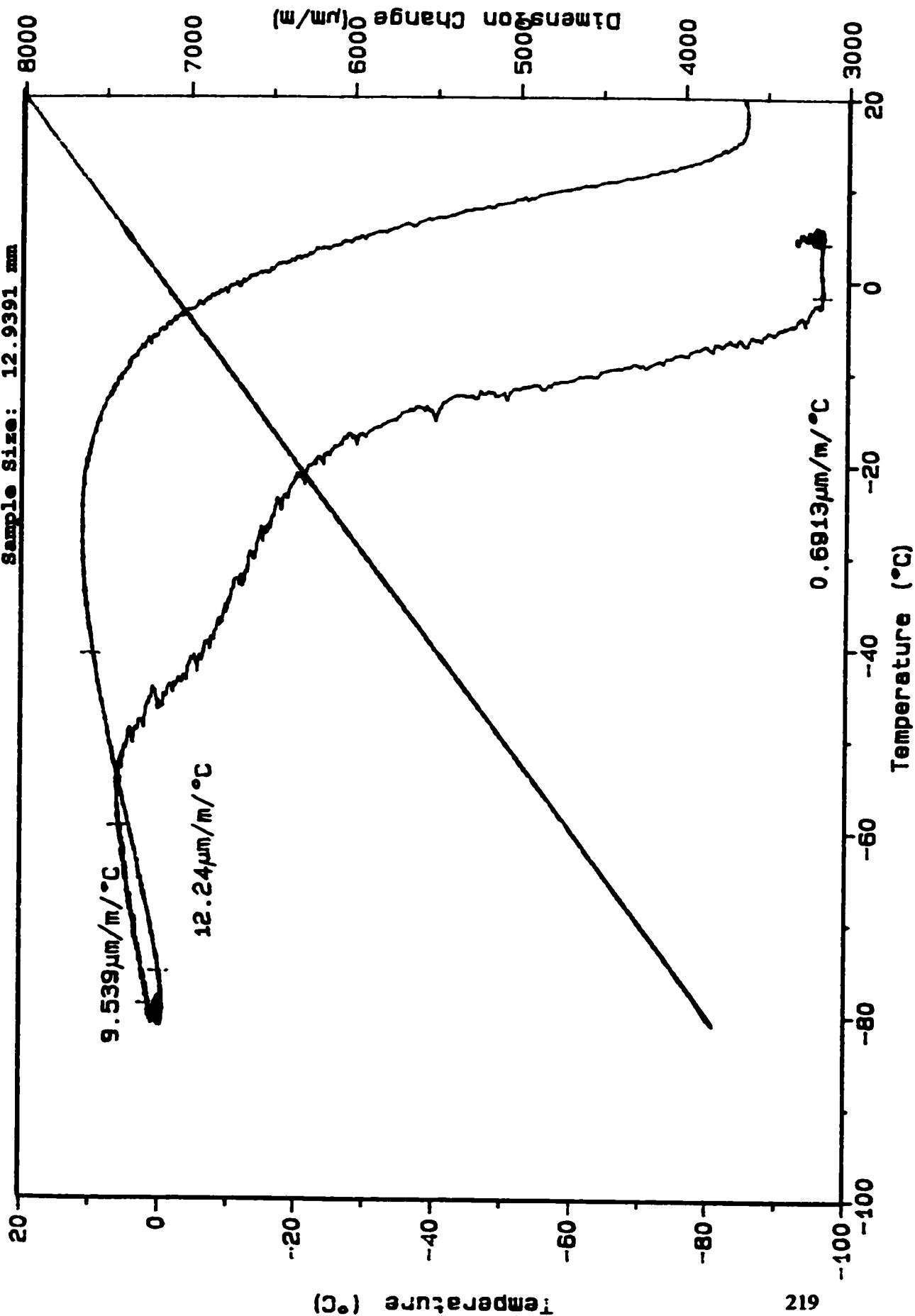


TMA

Sample: w/c = 0.60; 28 Days Hydration

Synthetic Pore Solution

Sample Size: 12.9391 mm

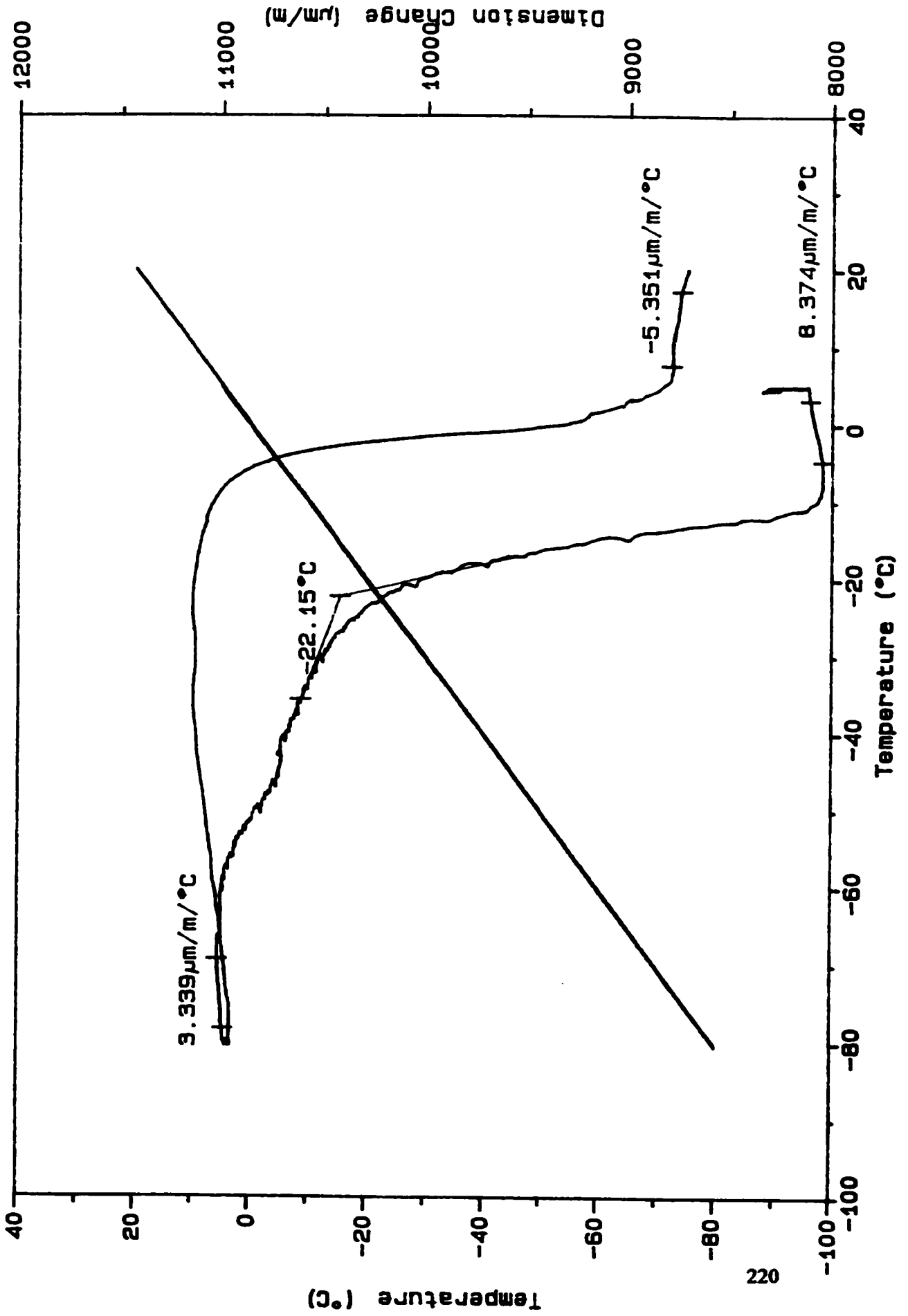


TMA

Sample: w/c = 0.60, 34 Days Hydration

Synthetic Pore Solution

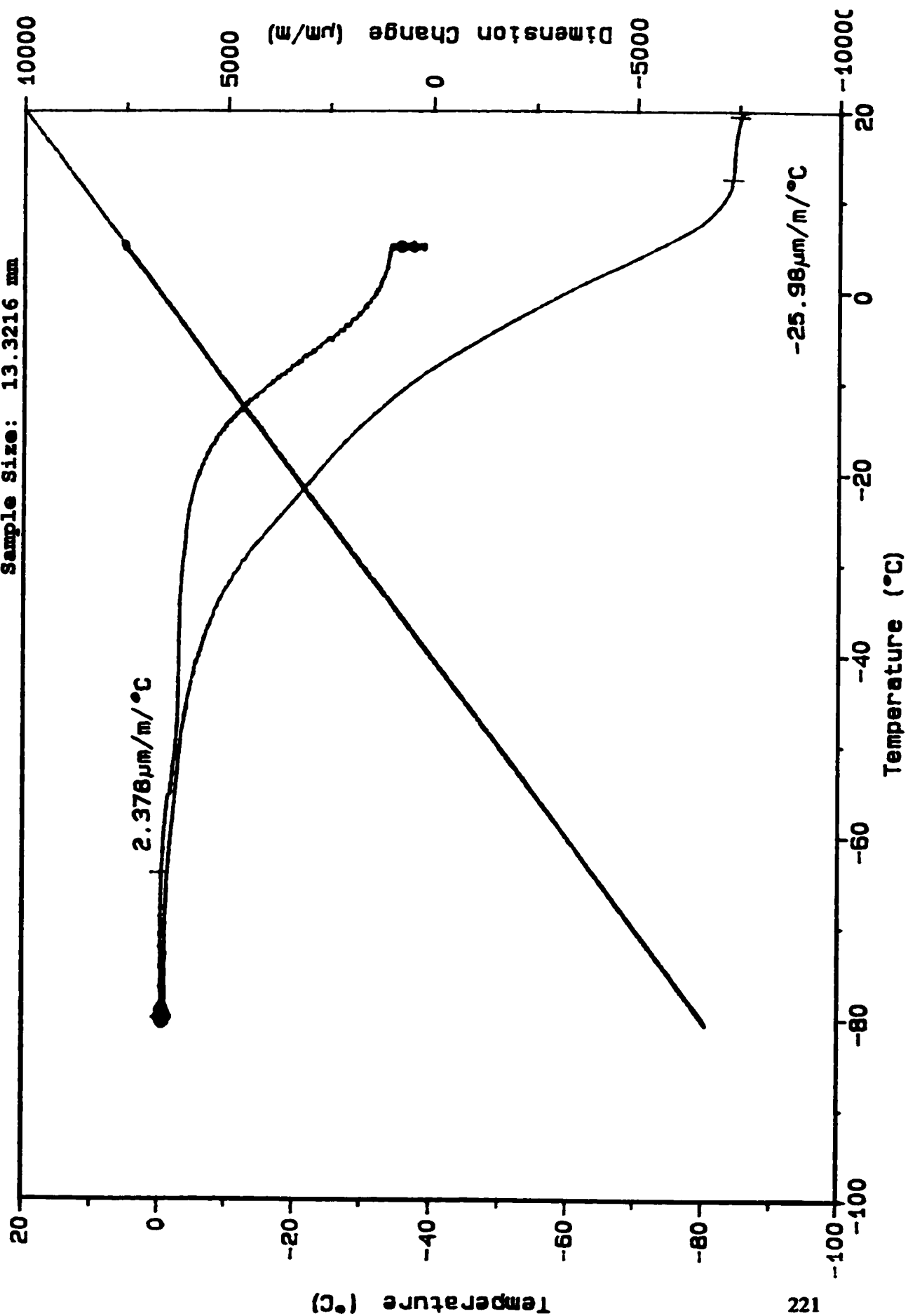
Sample Size: 13.1489 mm



TMA

Sample: w/c = 0.60, 28 Days Hydration
5% Salt Solution

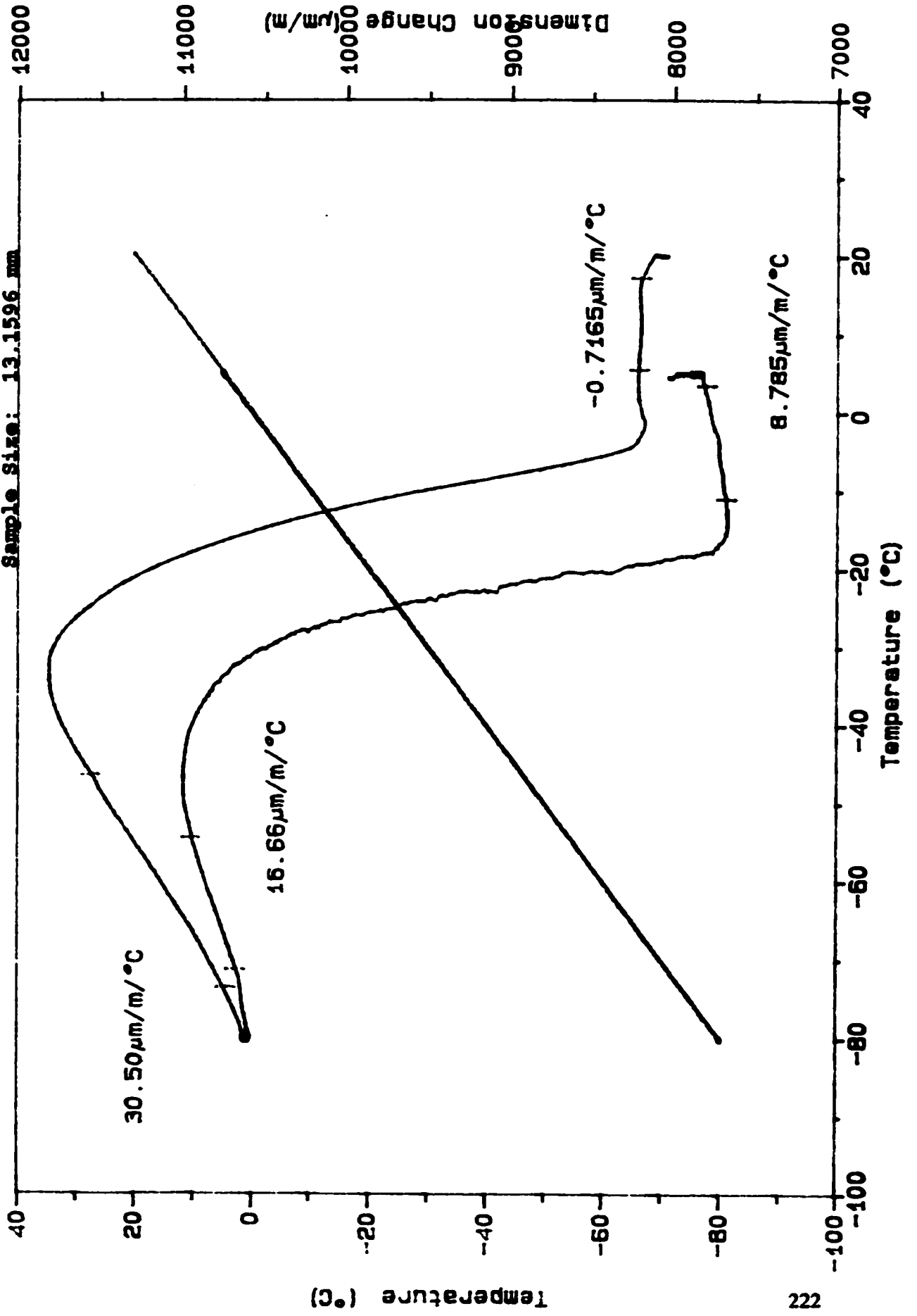
Sample Size: 13.3216 mm



TMA

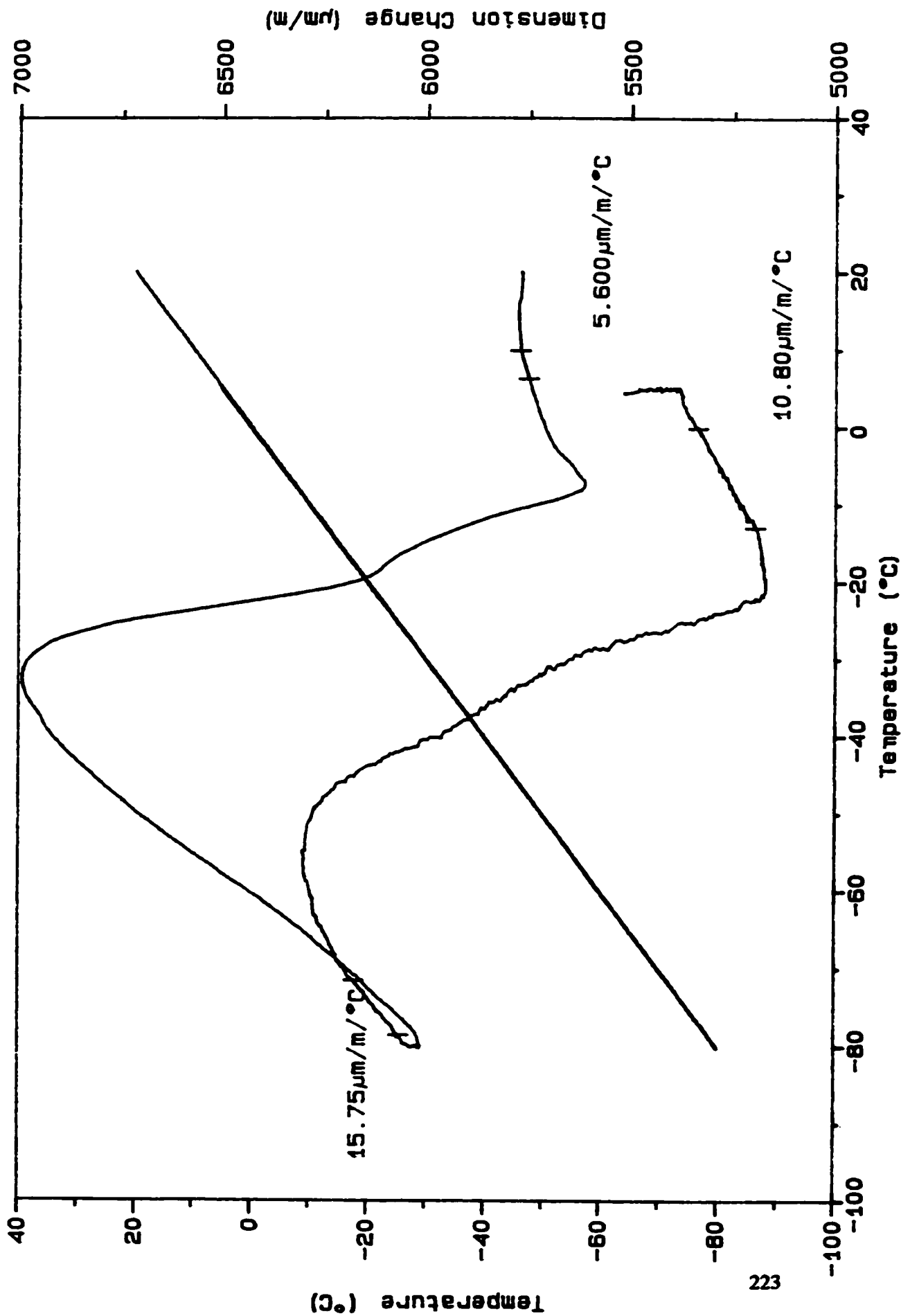
Sample: w/c = 0.60, 28 Days Hydration
10% Salt Solution

Sample Size: 13.1596 mm

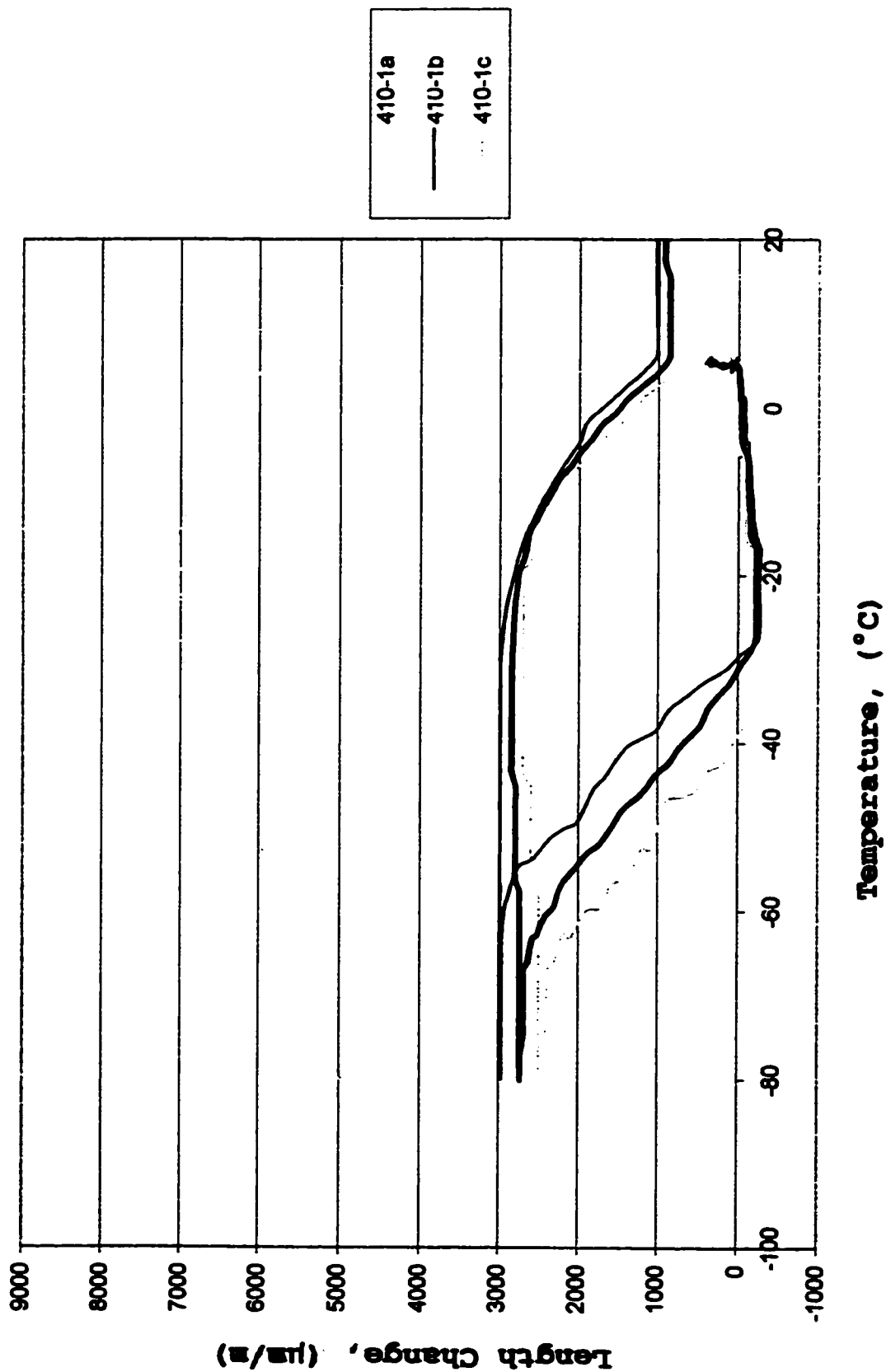


TMA

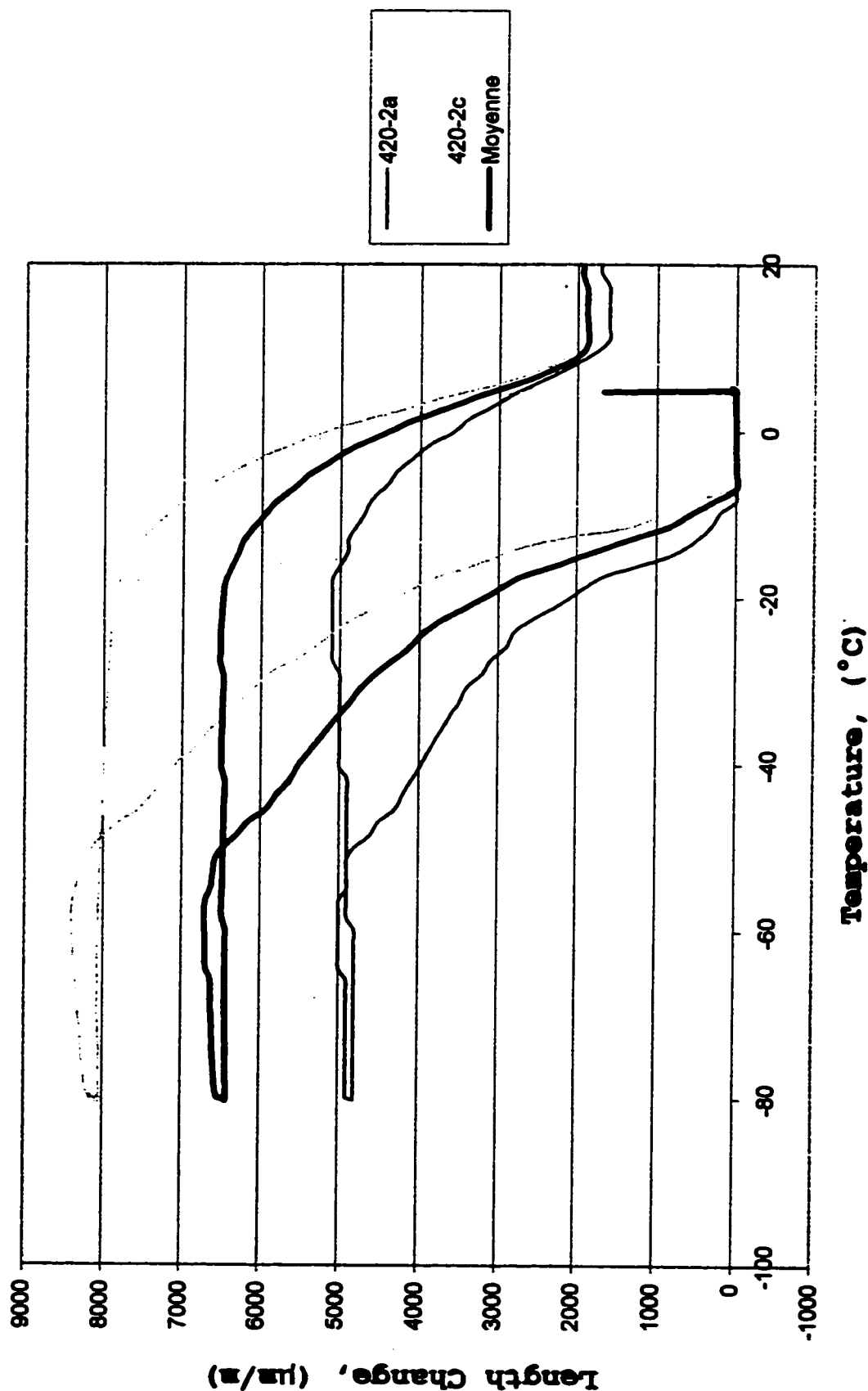
Sample: w/c = 0.60, 34 Days Hydration
15% Salt Solution
Sample Size: 13.0700 mm



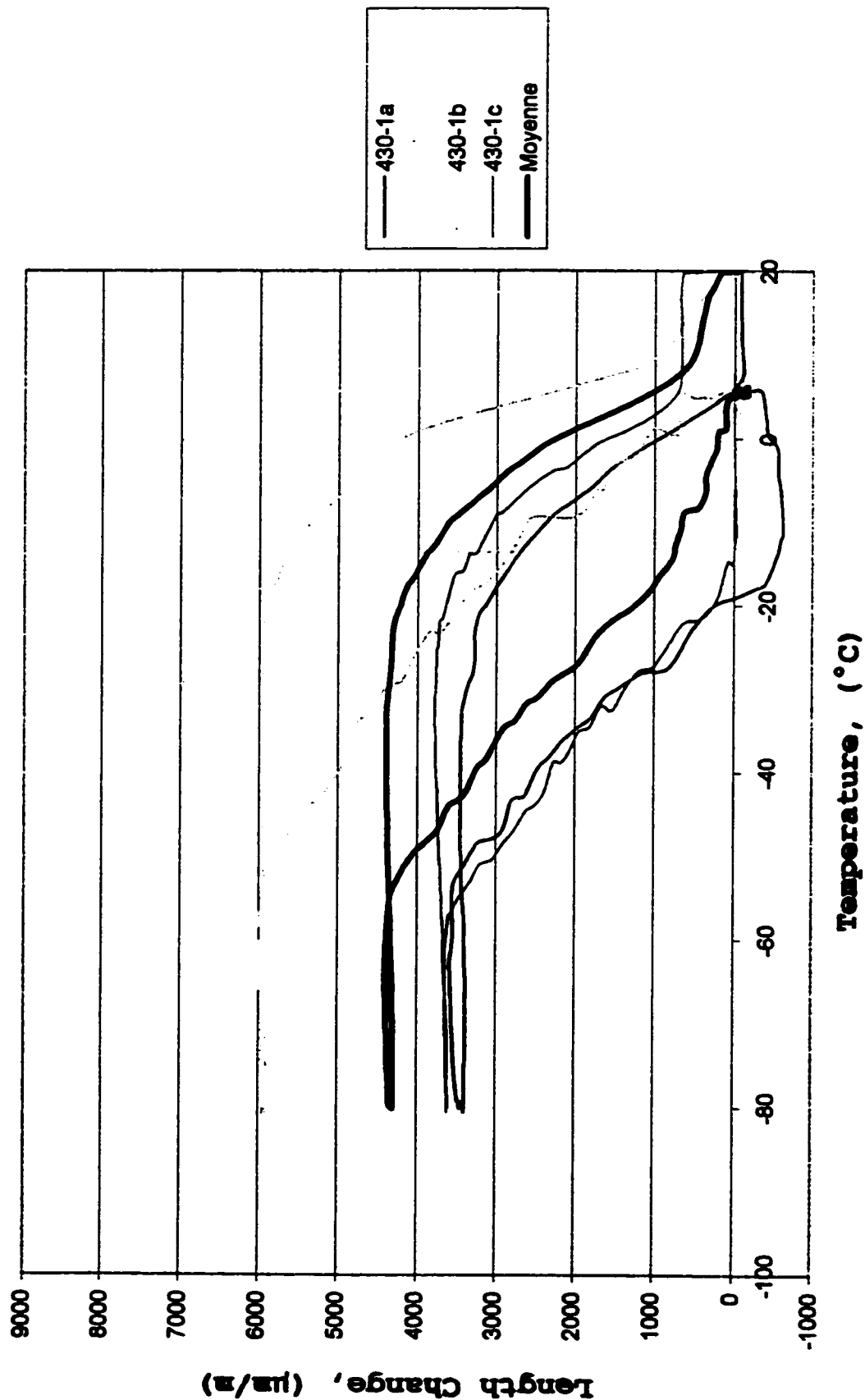
TMA **Cement Paste: Reference** **7 Days of Hydration**



TMA Cement Paste: Melligan 7 Days of Hydration

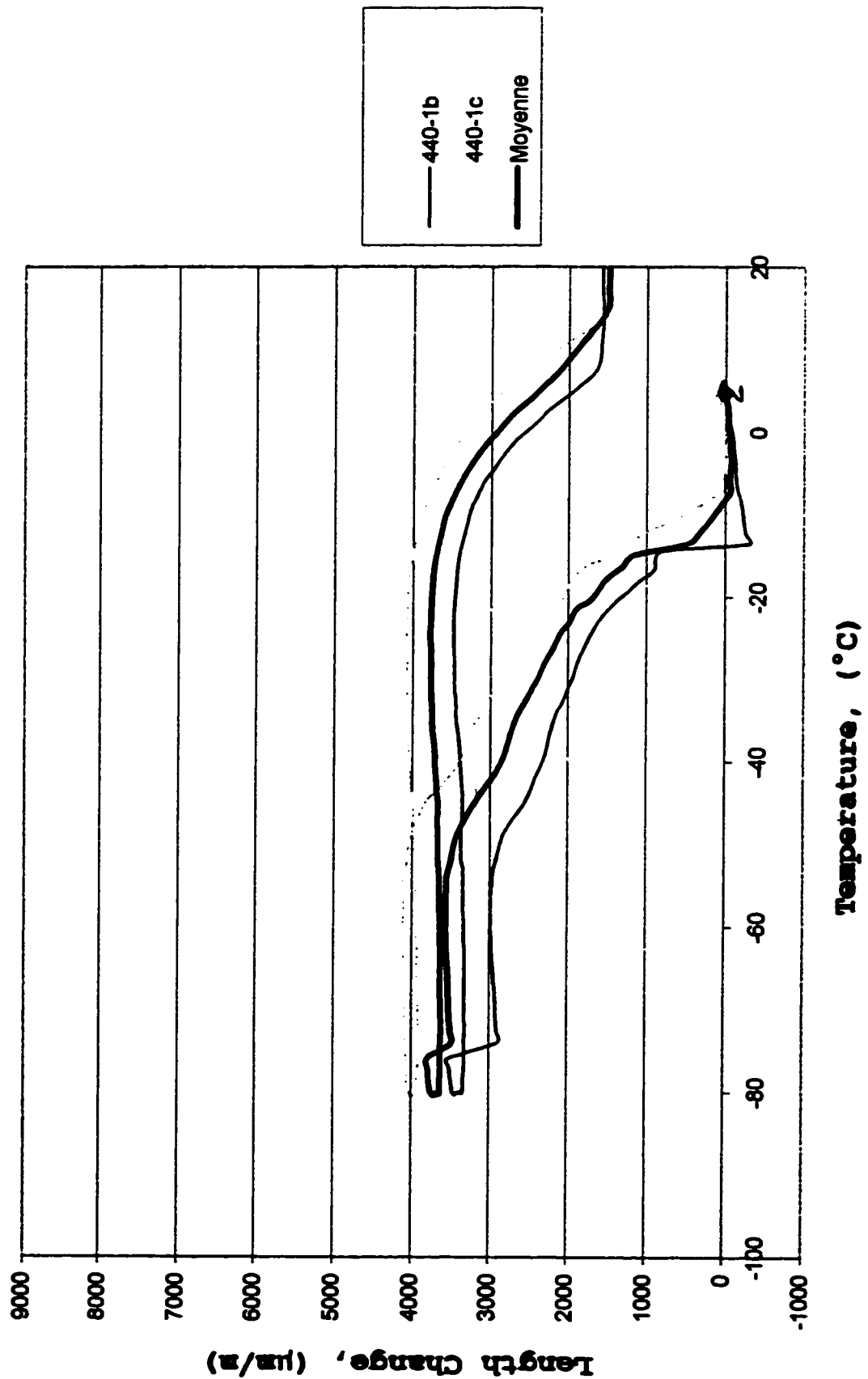


TMA **Cement Paste: Portage Fly Ash** **7 Days of Hydration**



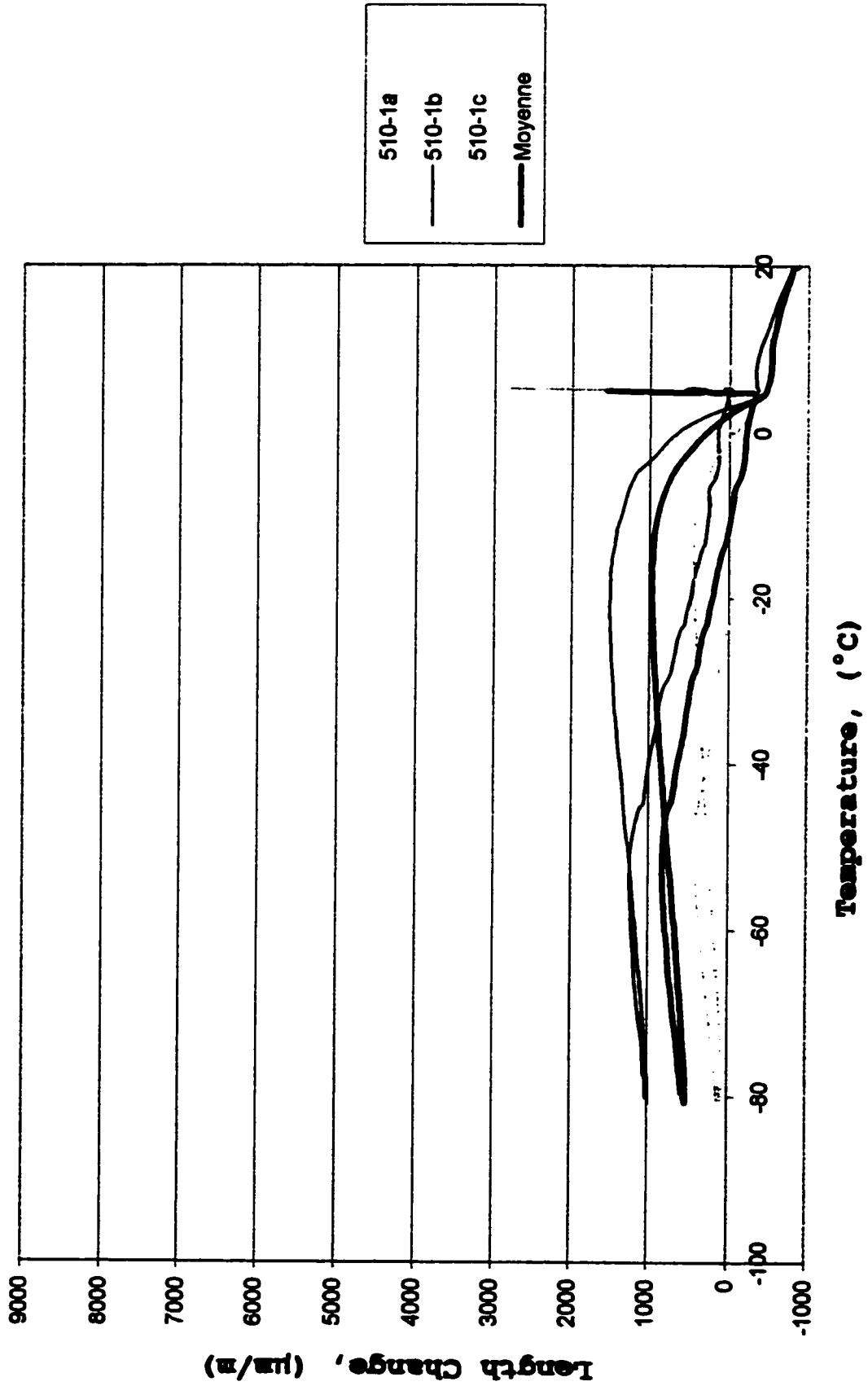
TMA

Cement Paste: Sundance Fly Ash
7 Days of Hydration



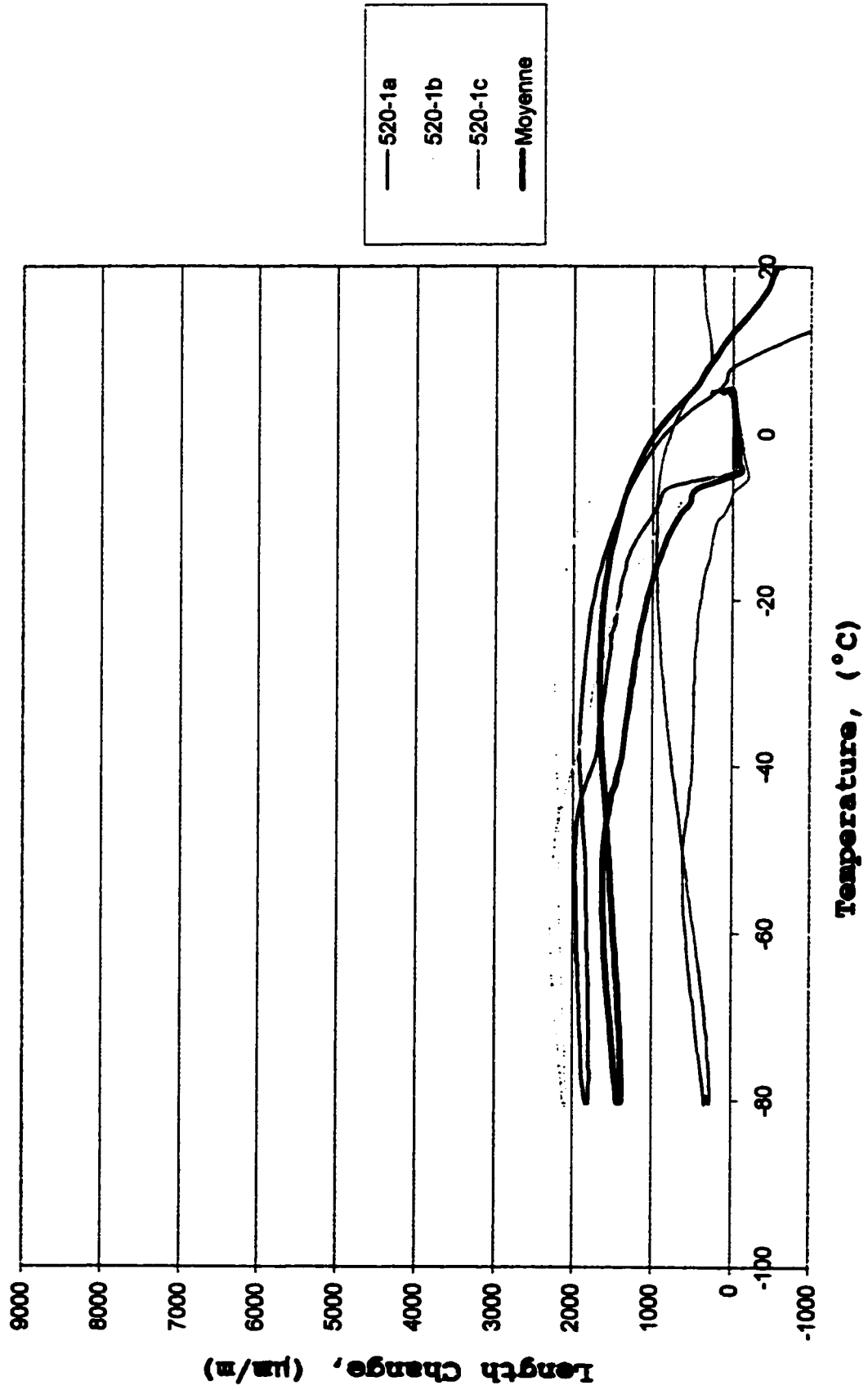
TMA

Mortar: Reference
7 Days of Hydration

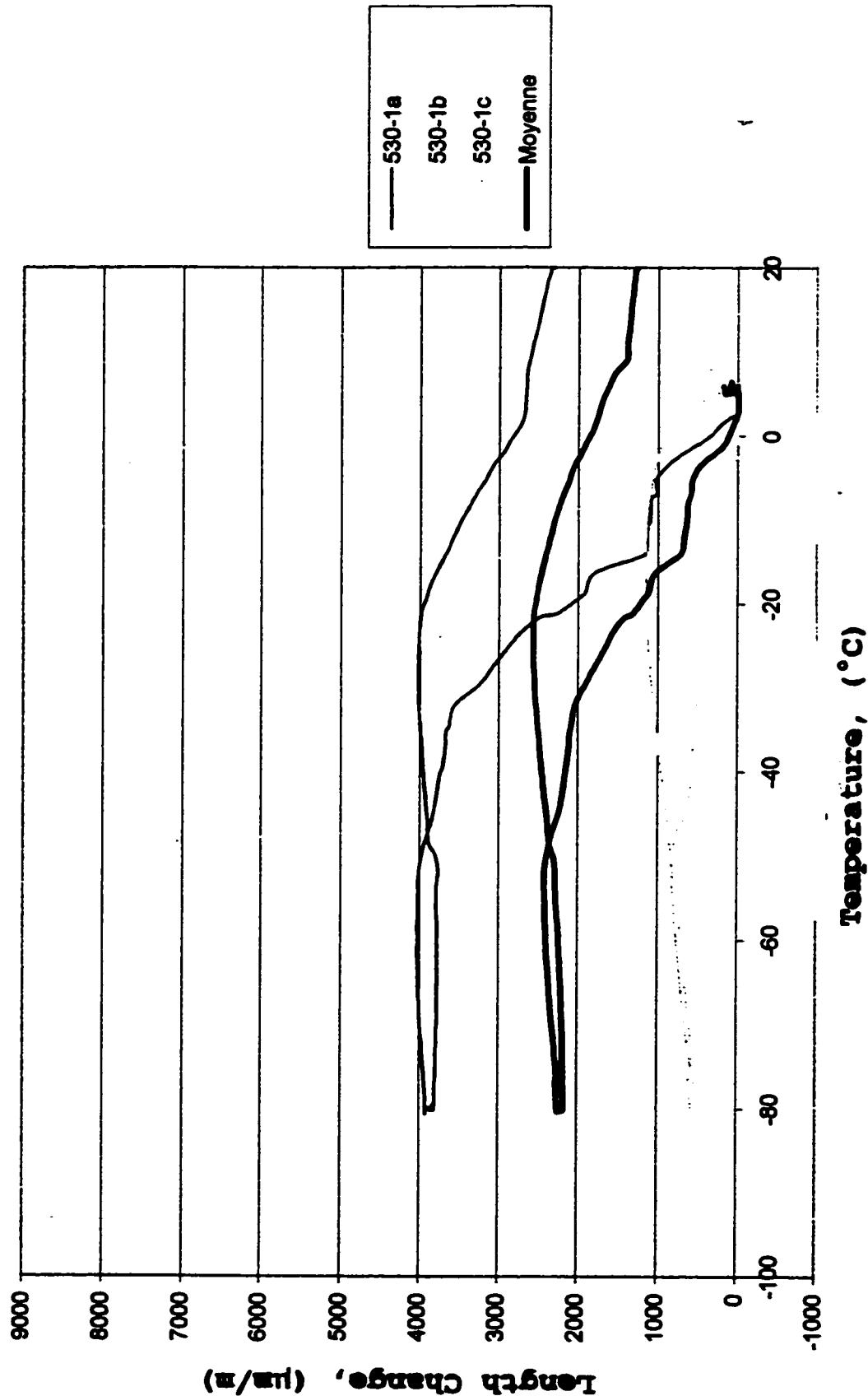


TMA

Mortar: Melligan Fly Ash
7 Days of Hydration

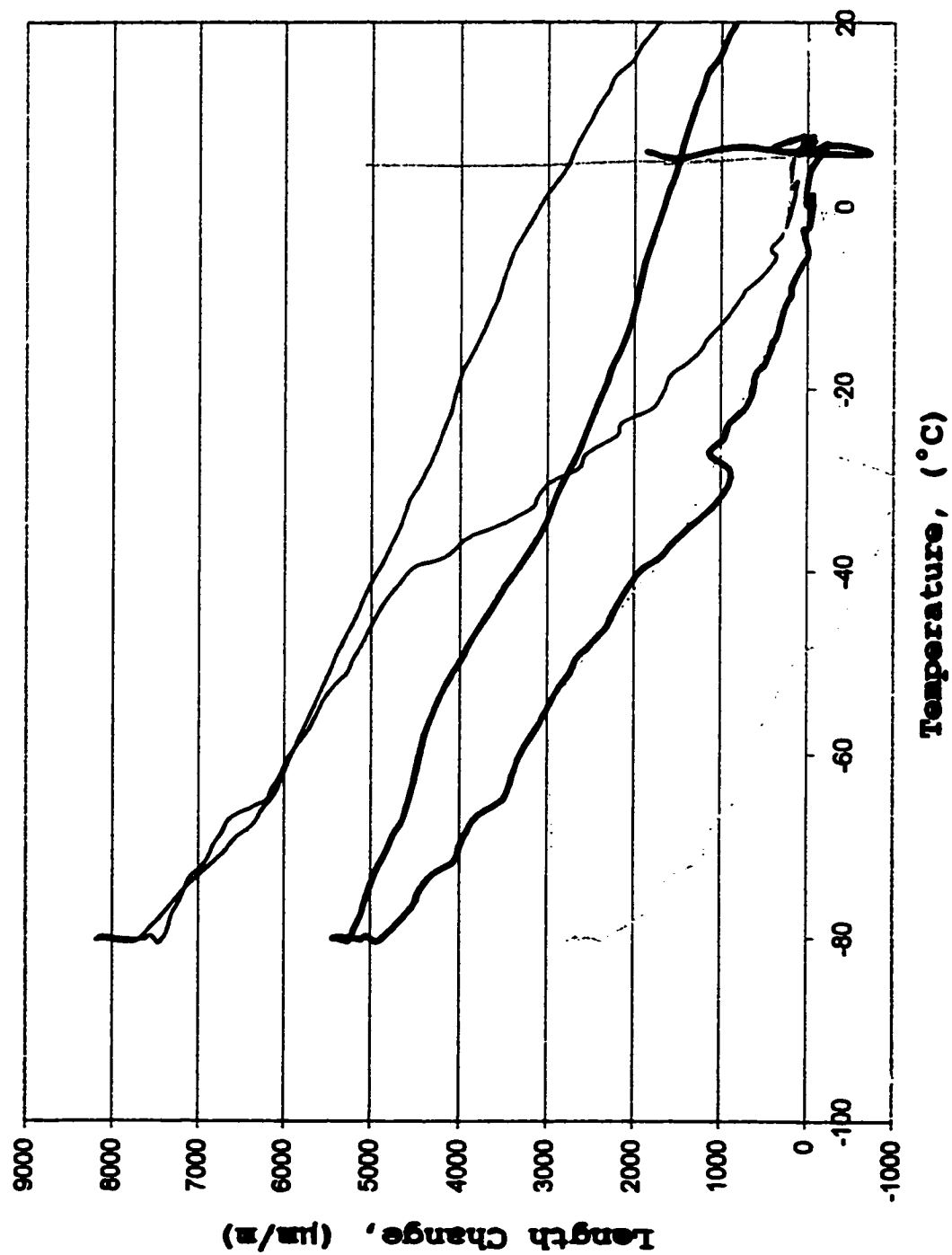


TMA Mortar: Portage Fly Ash 7 Days of Hydration



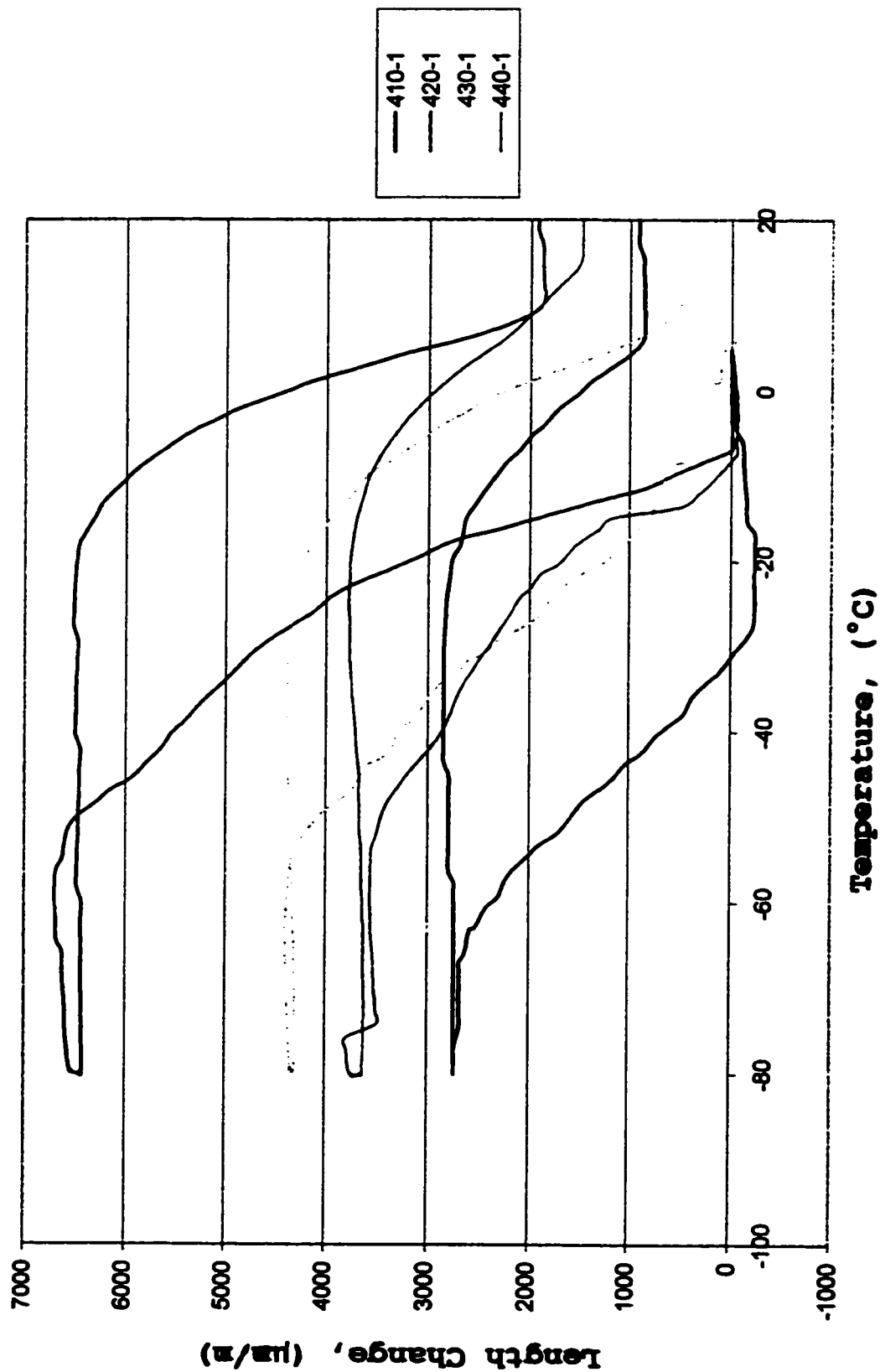
TMA

Mortar: Sundance Fly Ash
7 Days of Hydration

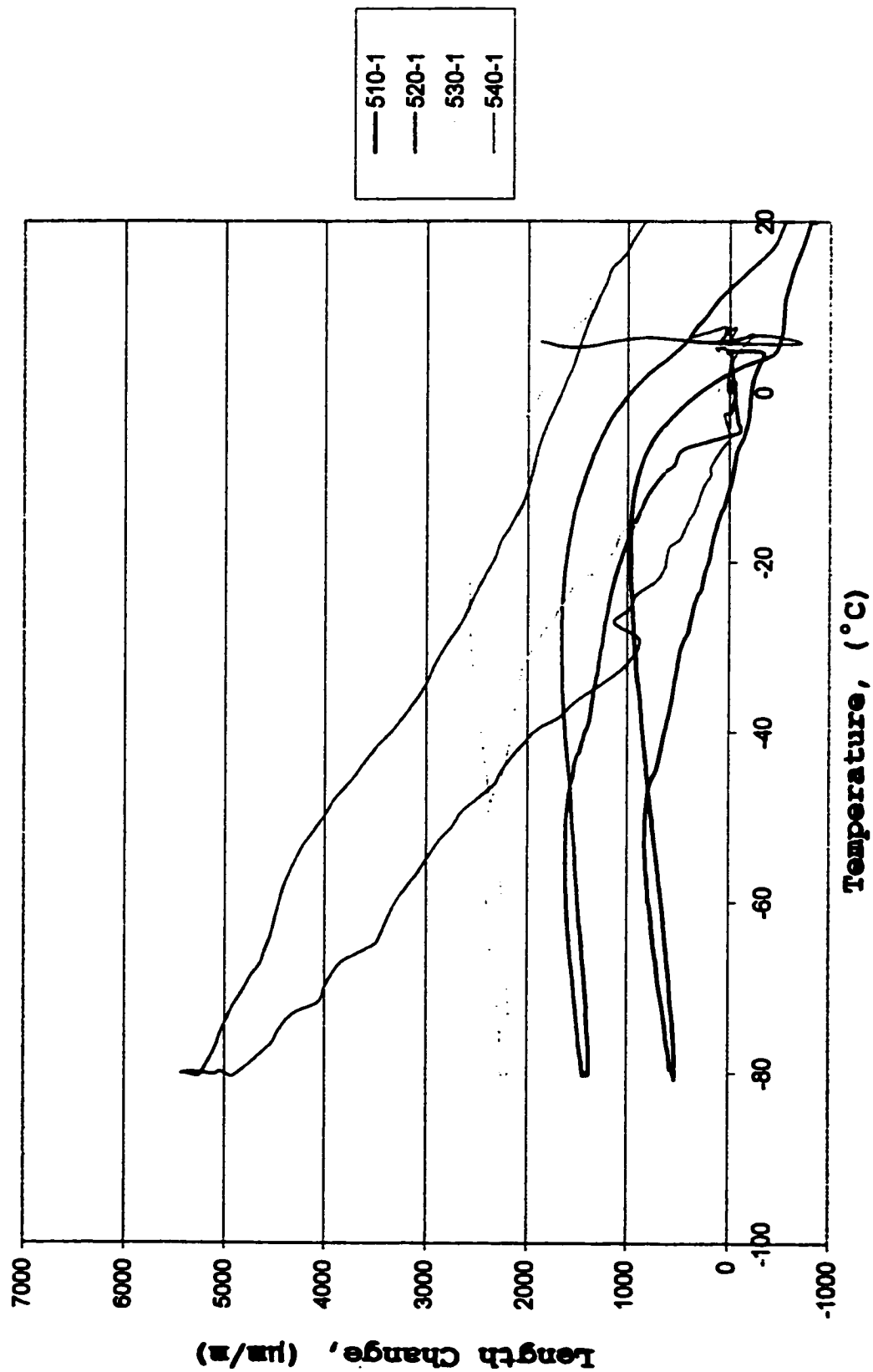


TMA

Cement Paste with Fly Ash
7 Days of Hydration

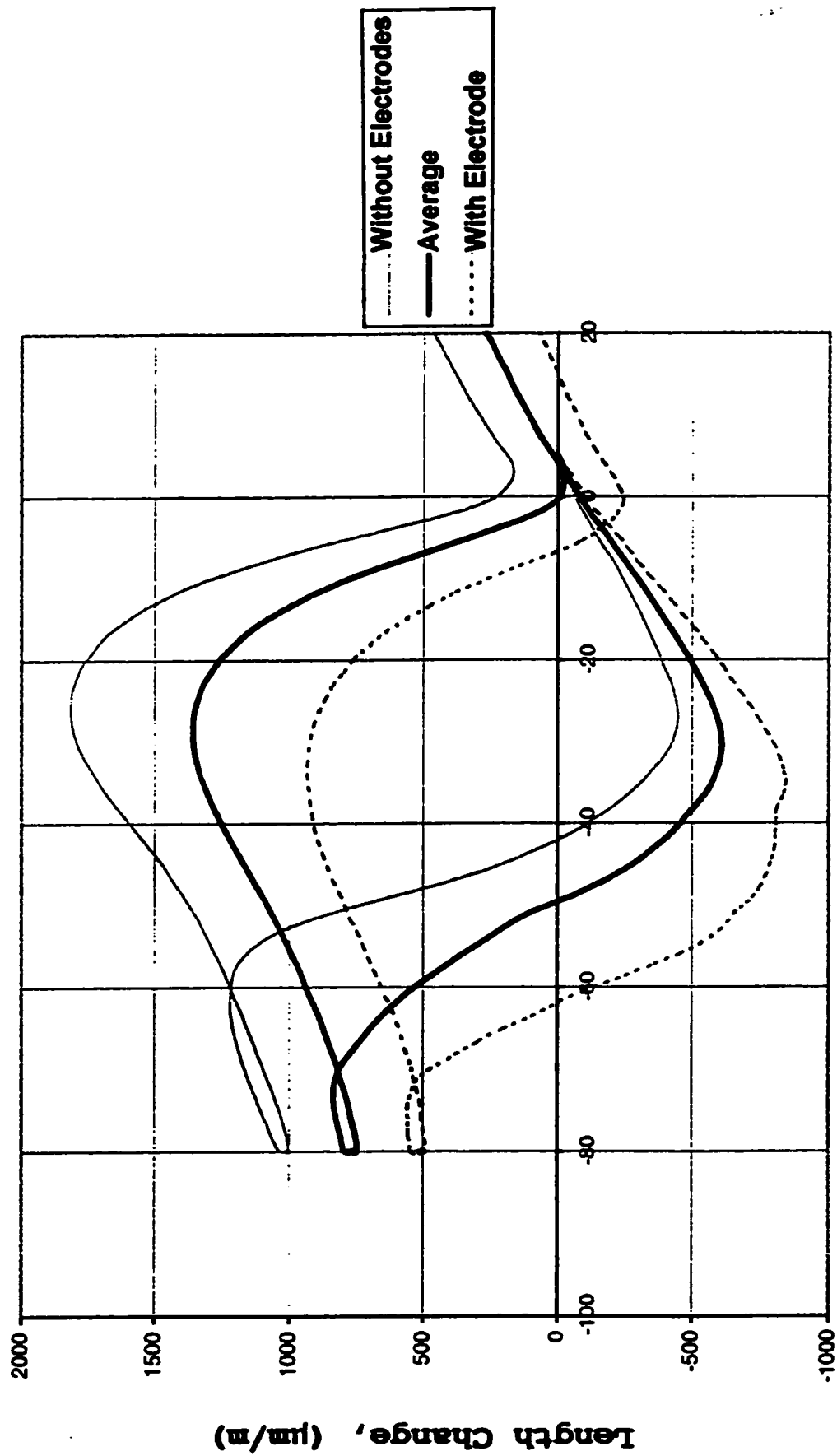


TMA Mortar with Fly Ash 7 Days of Hydration



Cement Paste:Reference
9 Months of Hydration

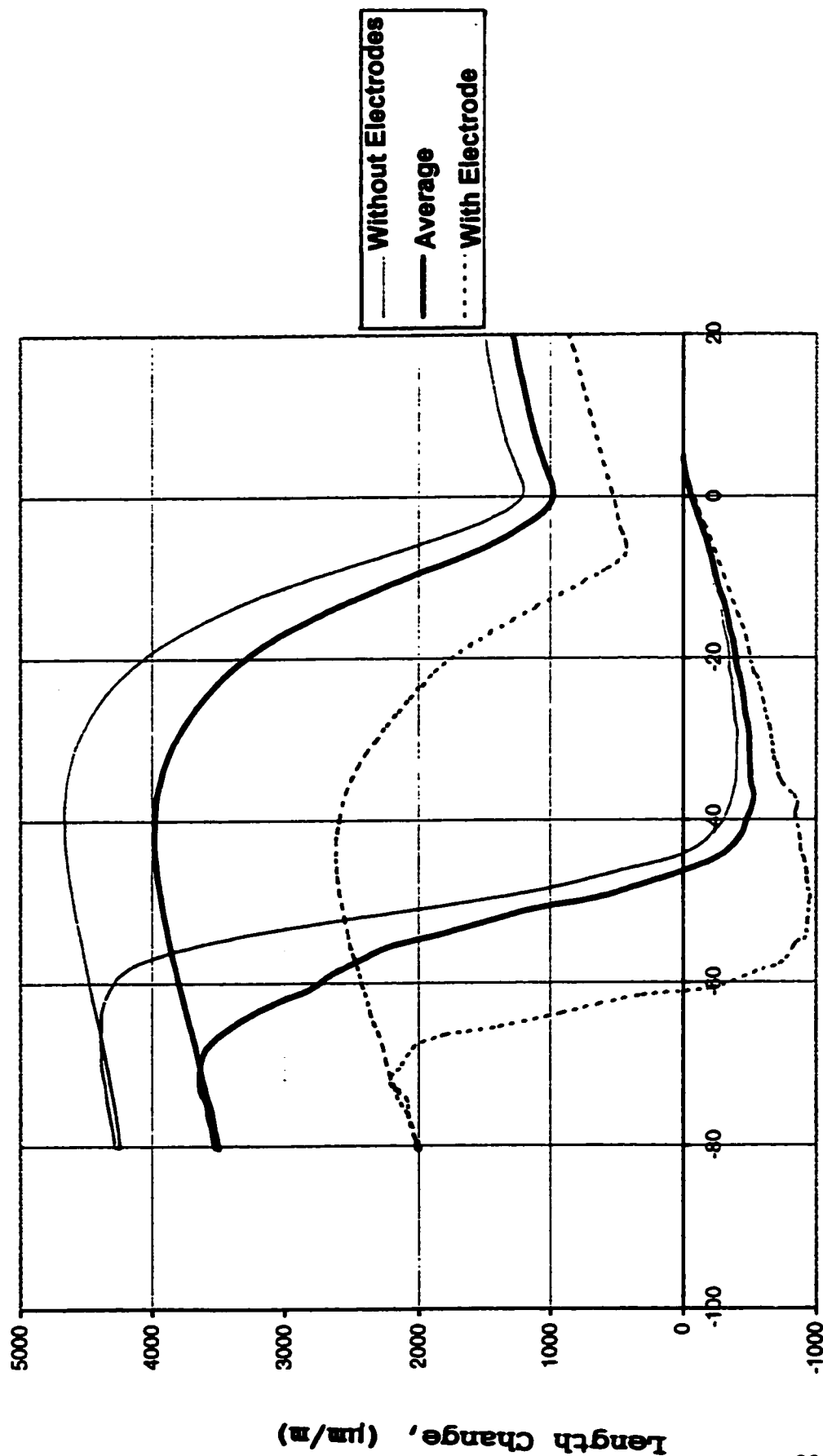
TMA



Temperature, (°C)

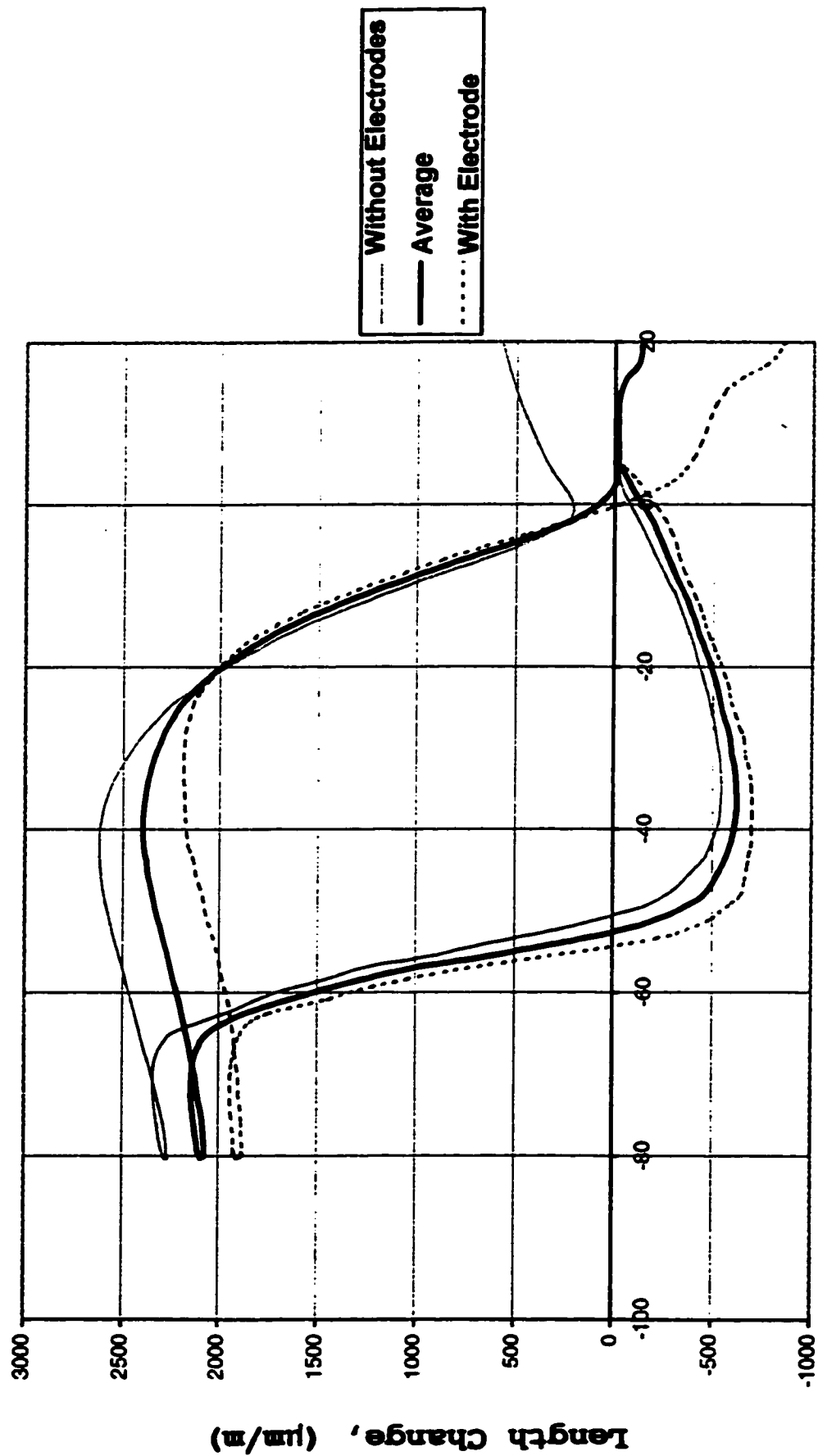
Cement Paste:
Melligan Fly Ash
9 Months Hydration

TMA



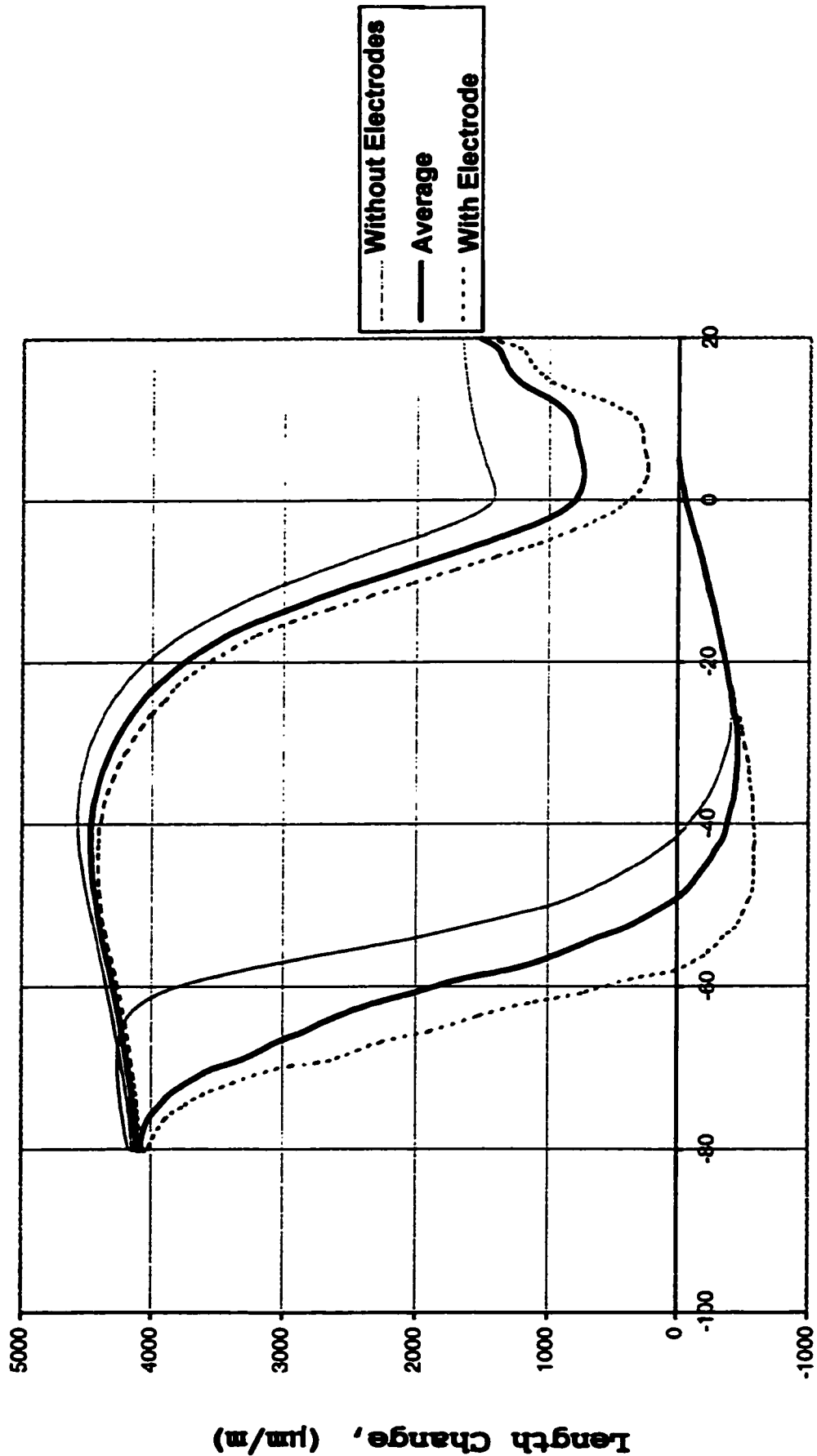
Cement Paste:
Portage Fly Ash
9 Months Hydration

TMA



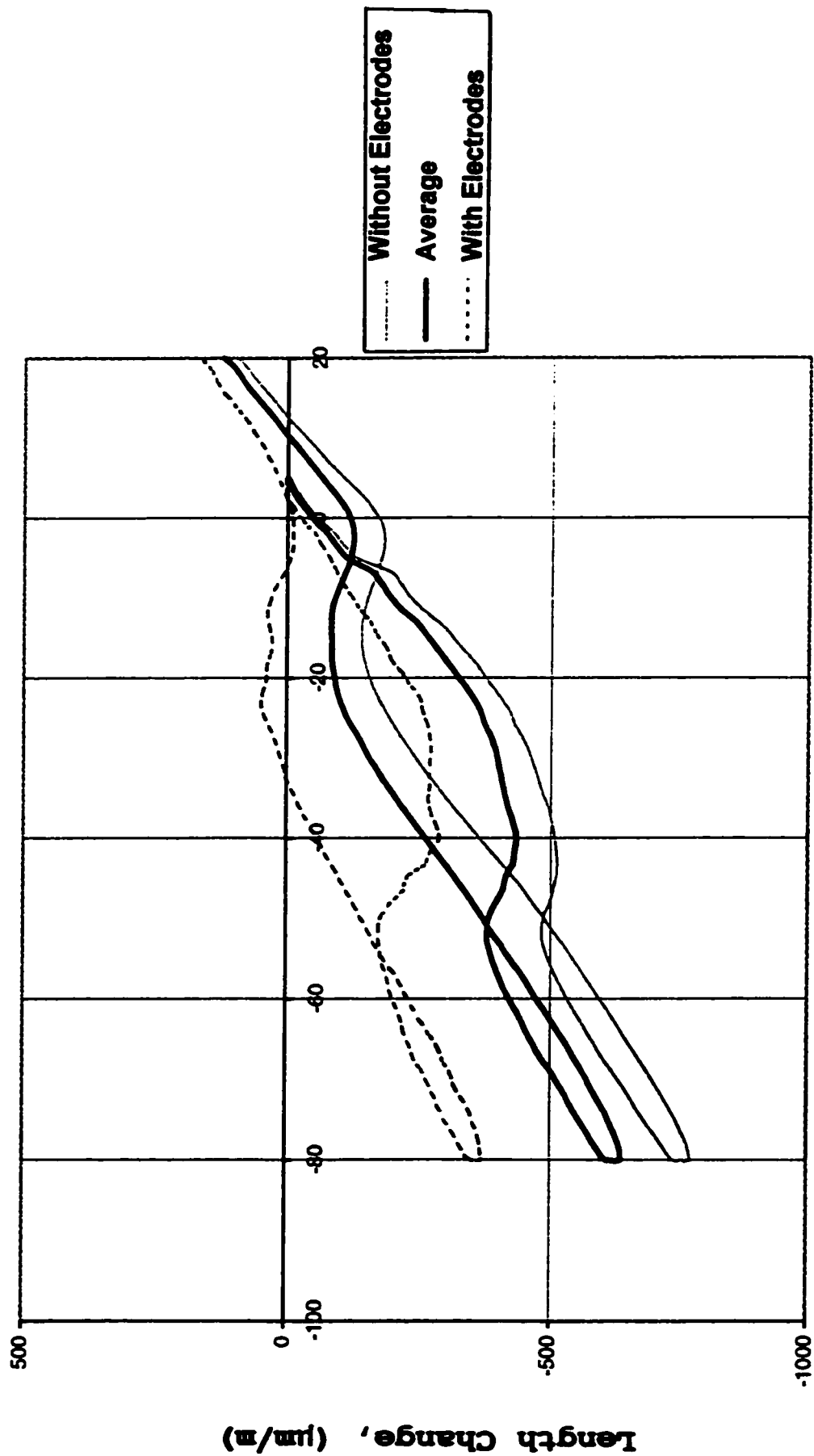
Cement Paste:
Sundance Fly Ash
9 Months Hydration

TMA



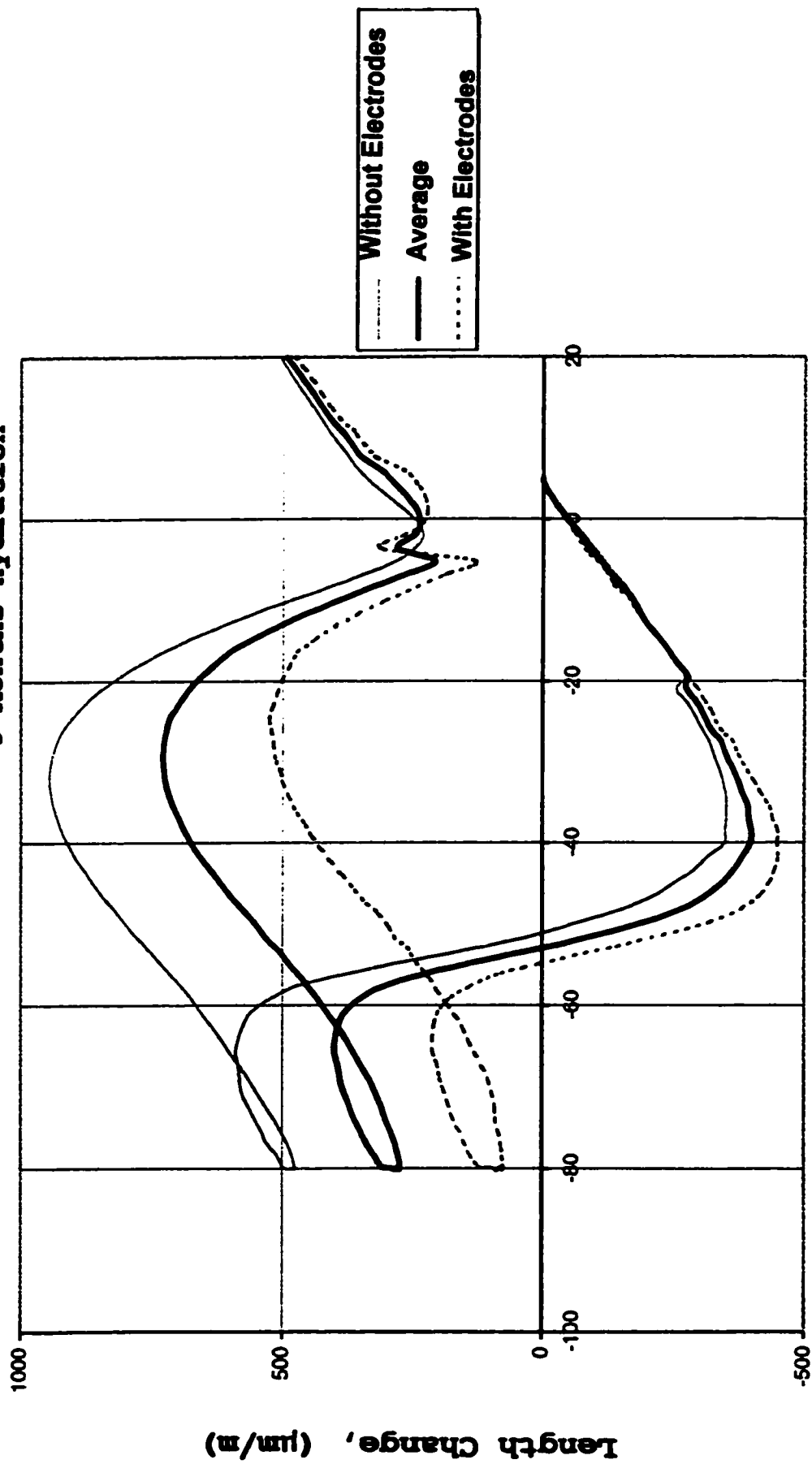
Temperature, ($^{\circ}\text{C}$)

TMA **Mortar: Reference** **9 Months Hydration**

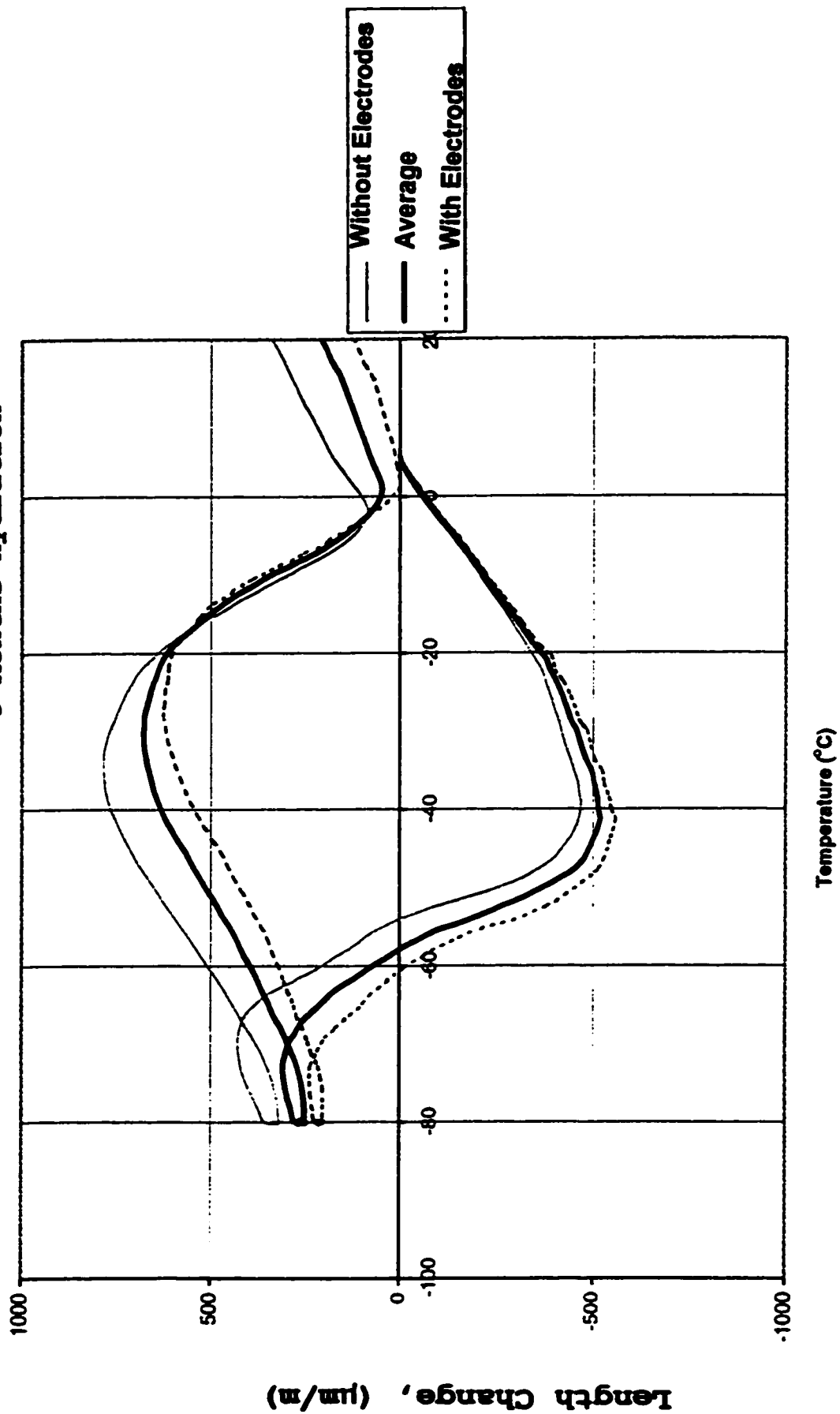


Mortar:
Melligan Fly Ash
9 Months Hydration

TMA

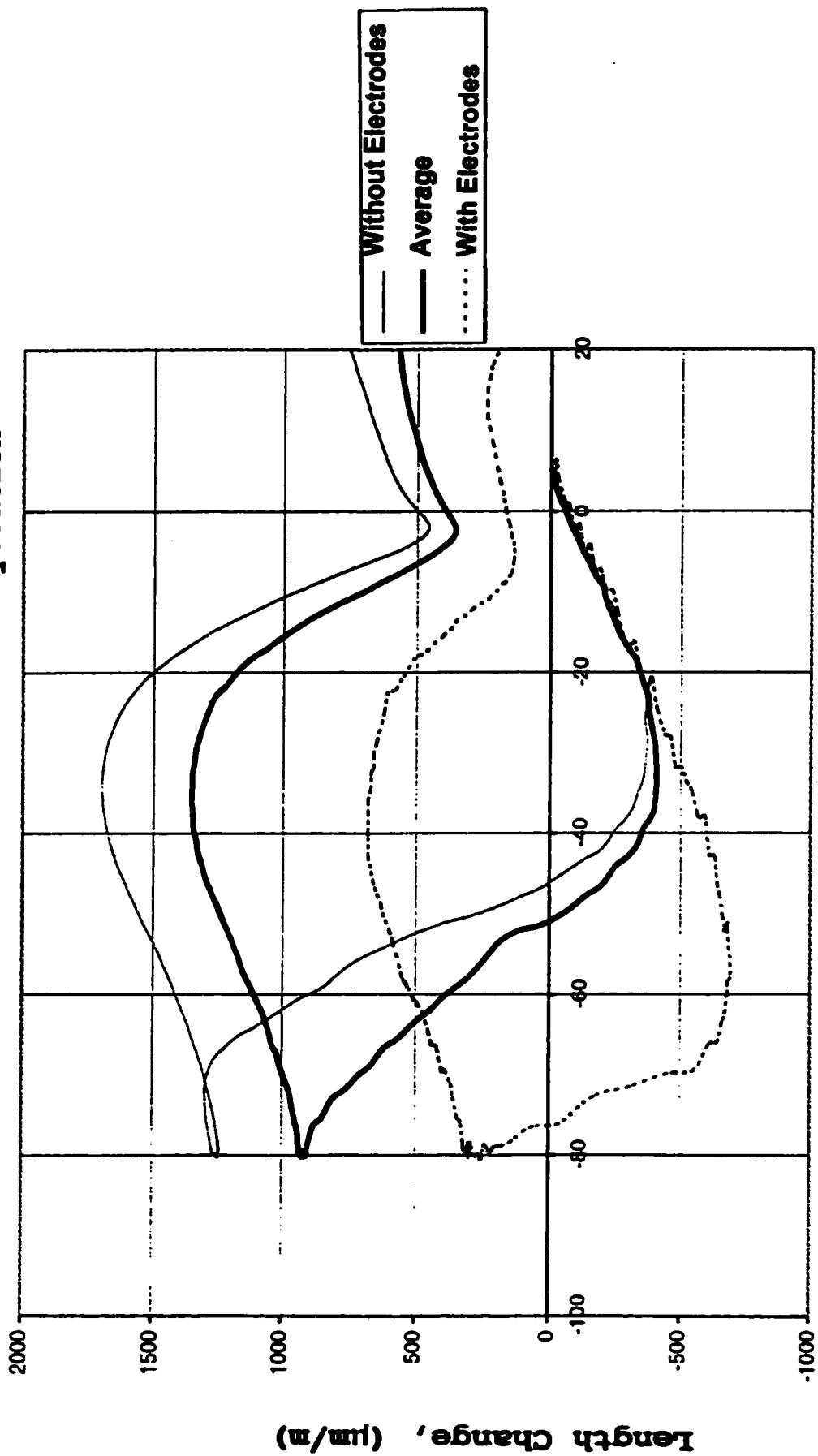


TMA **Mortar:** **Portage Fly Ash**
9 Months Hydration

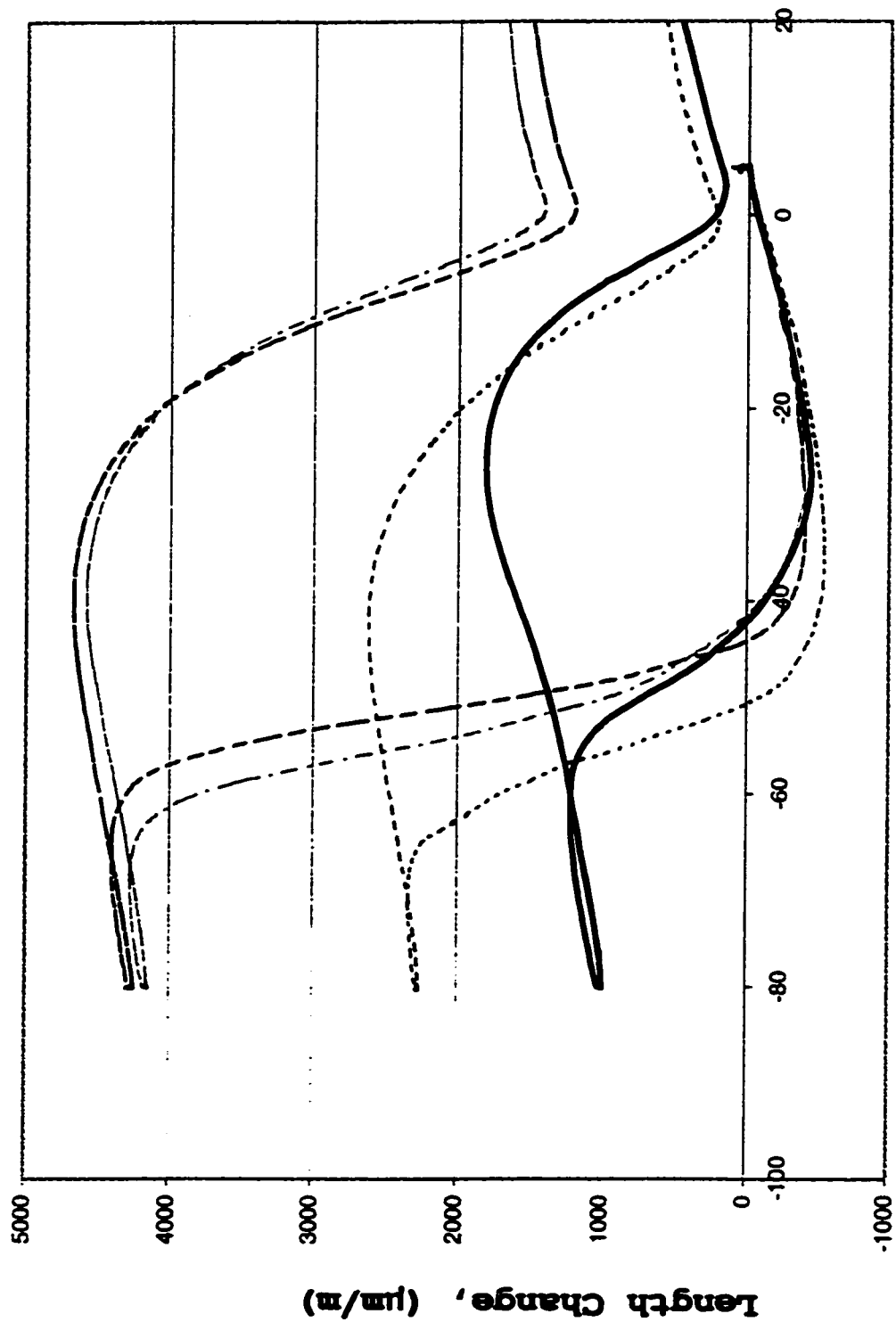


Mortar:
Sundance Fly Ash
9 Month Hydration

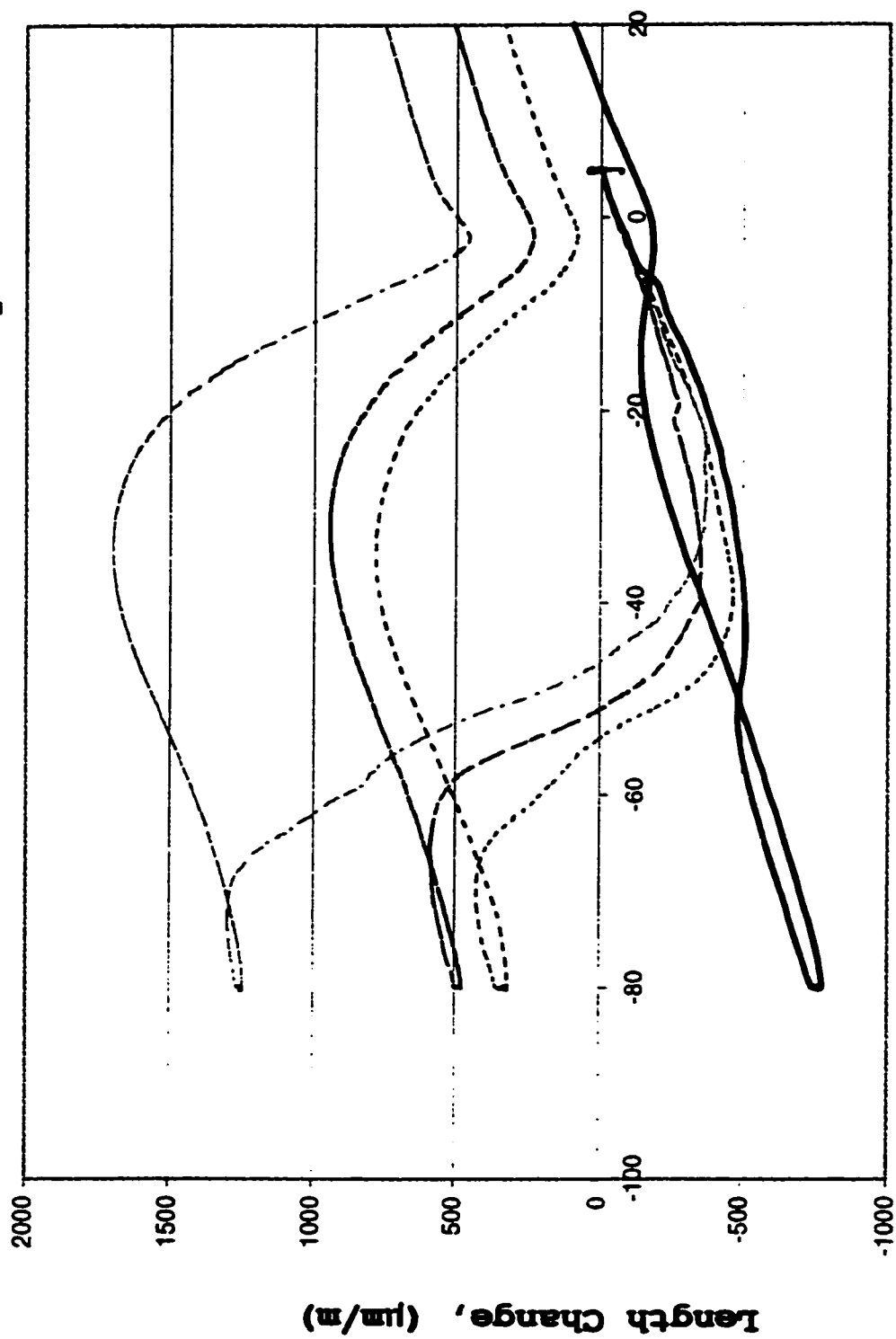
TMA



TMA **Cement Pastes** **9 Months Hydration**

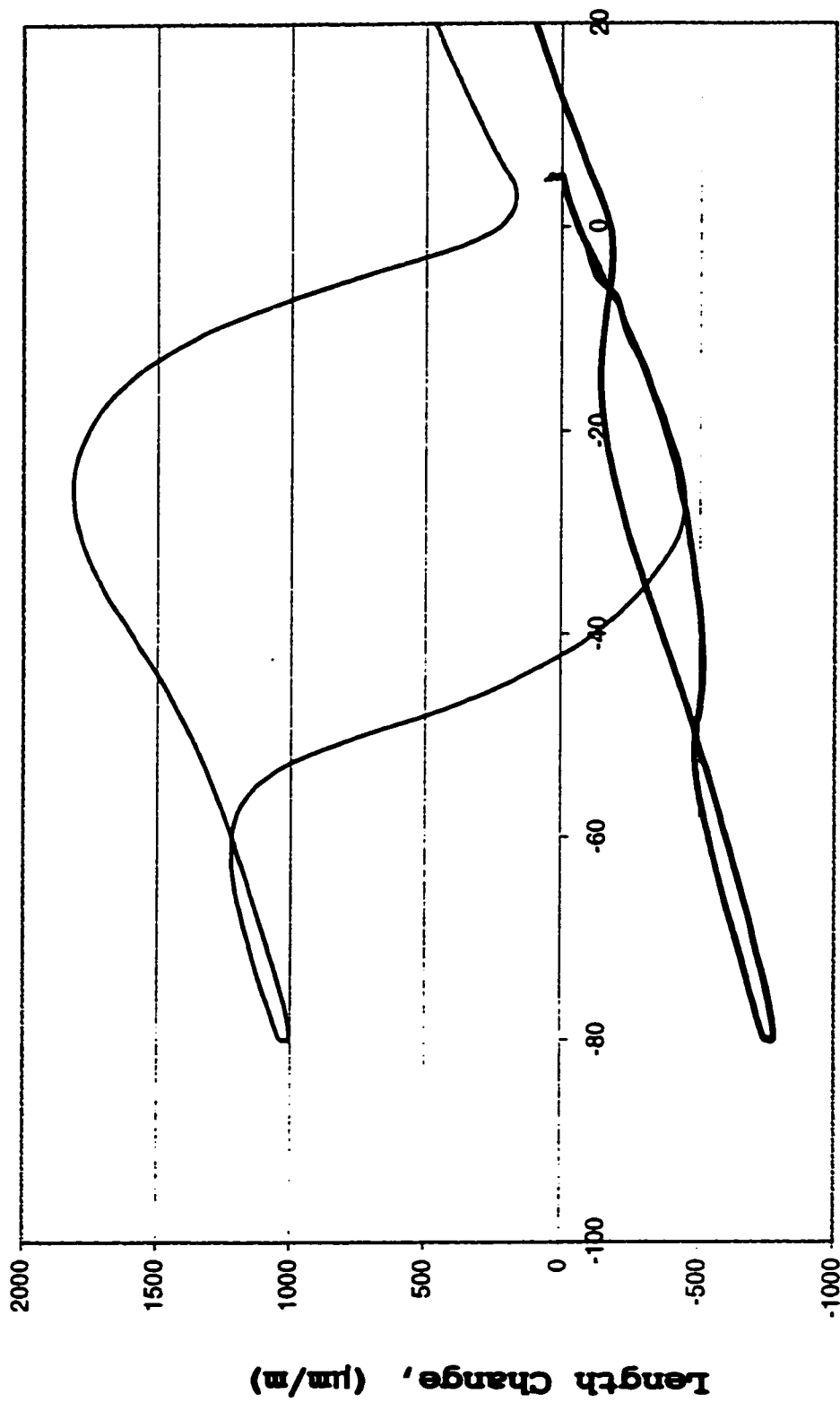


TMA **Mortars**
9 Months Hydration



Temperature, (°C)

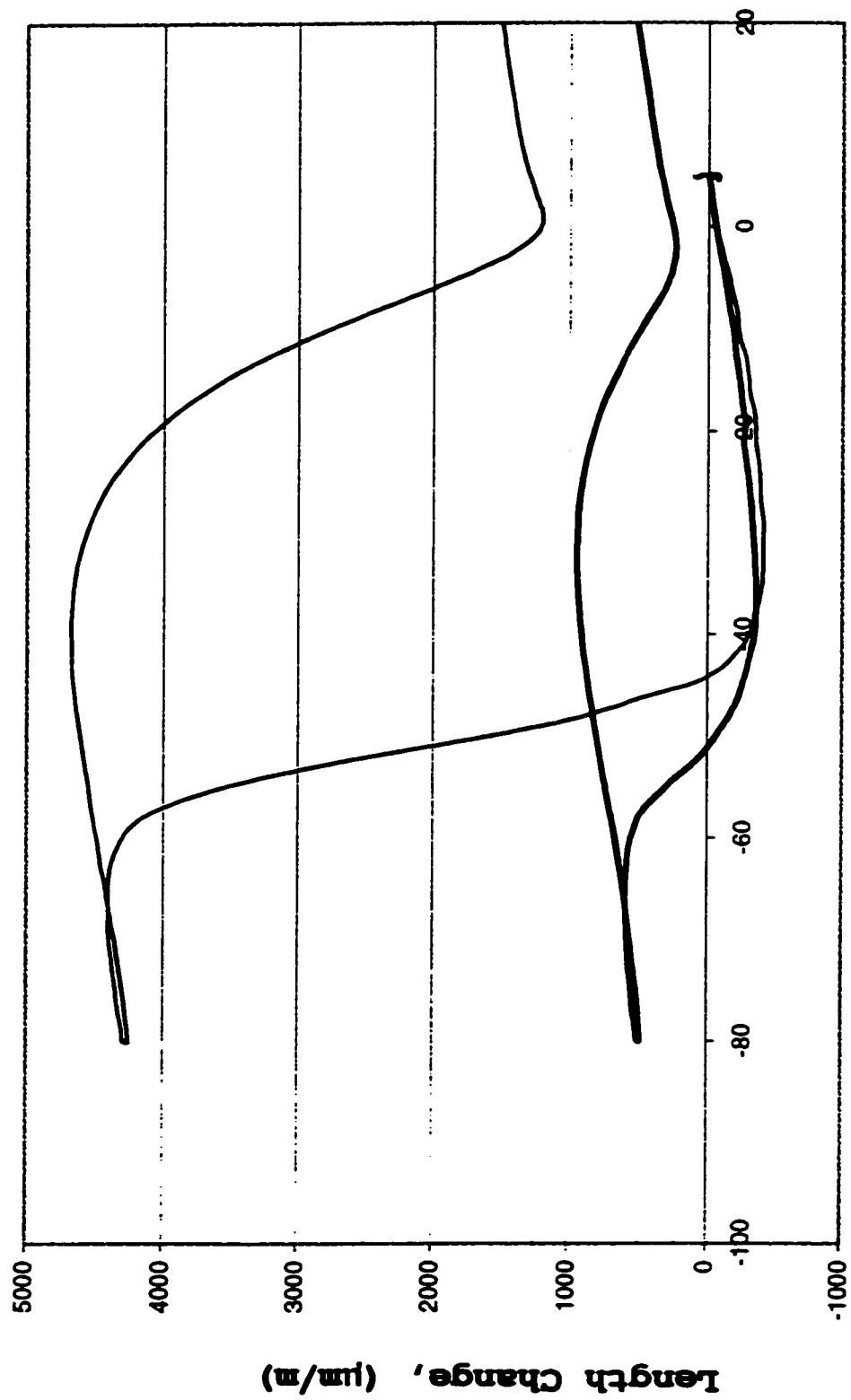
TMA
Reference Samples
9 Months Hydration



— Cement Paste
— Mortar

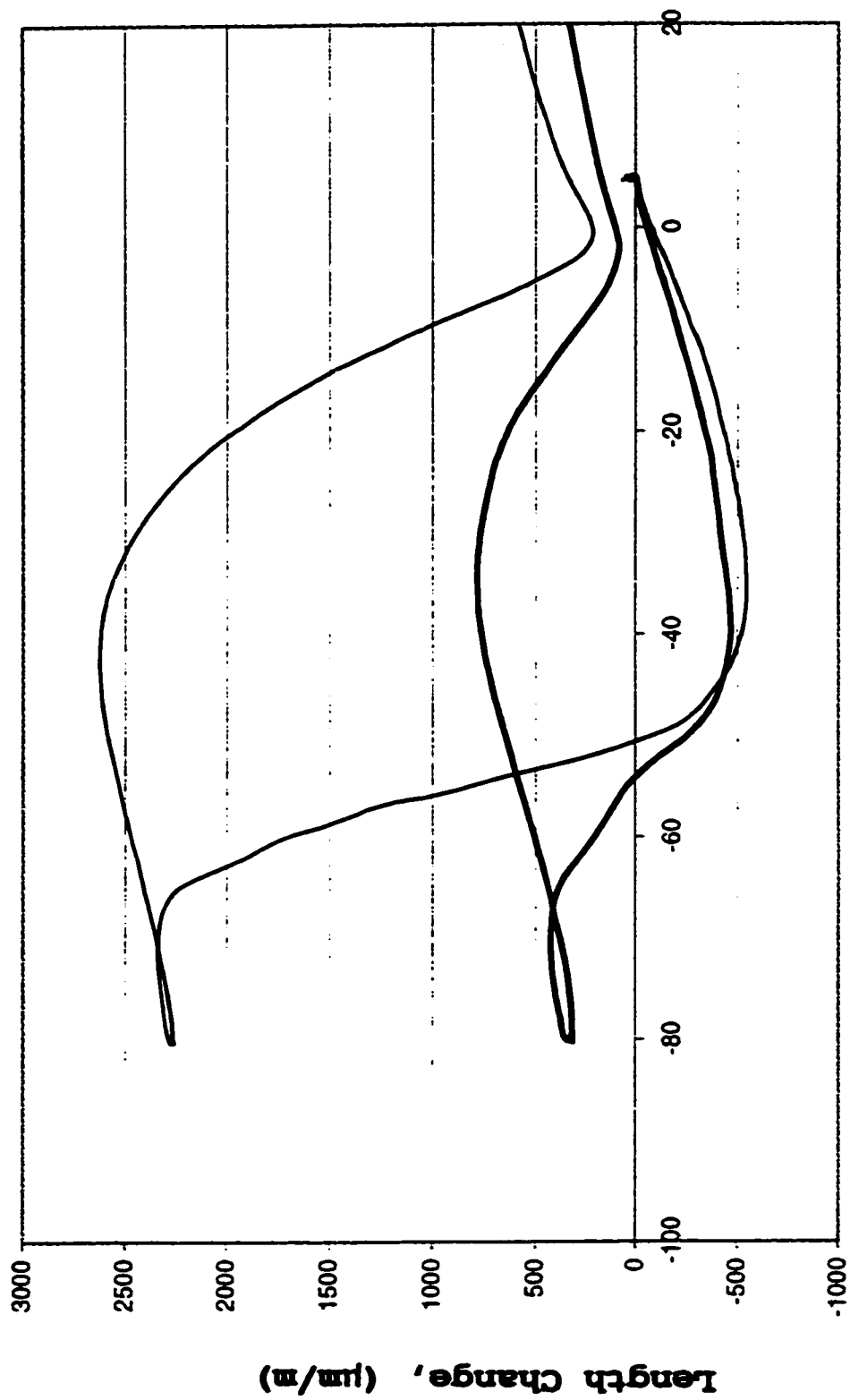
Temperature, (°C)

TMA
Melligan Fly Ash
9 Months Hydration

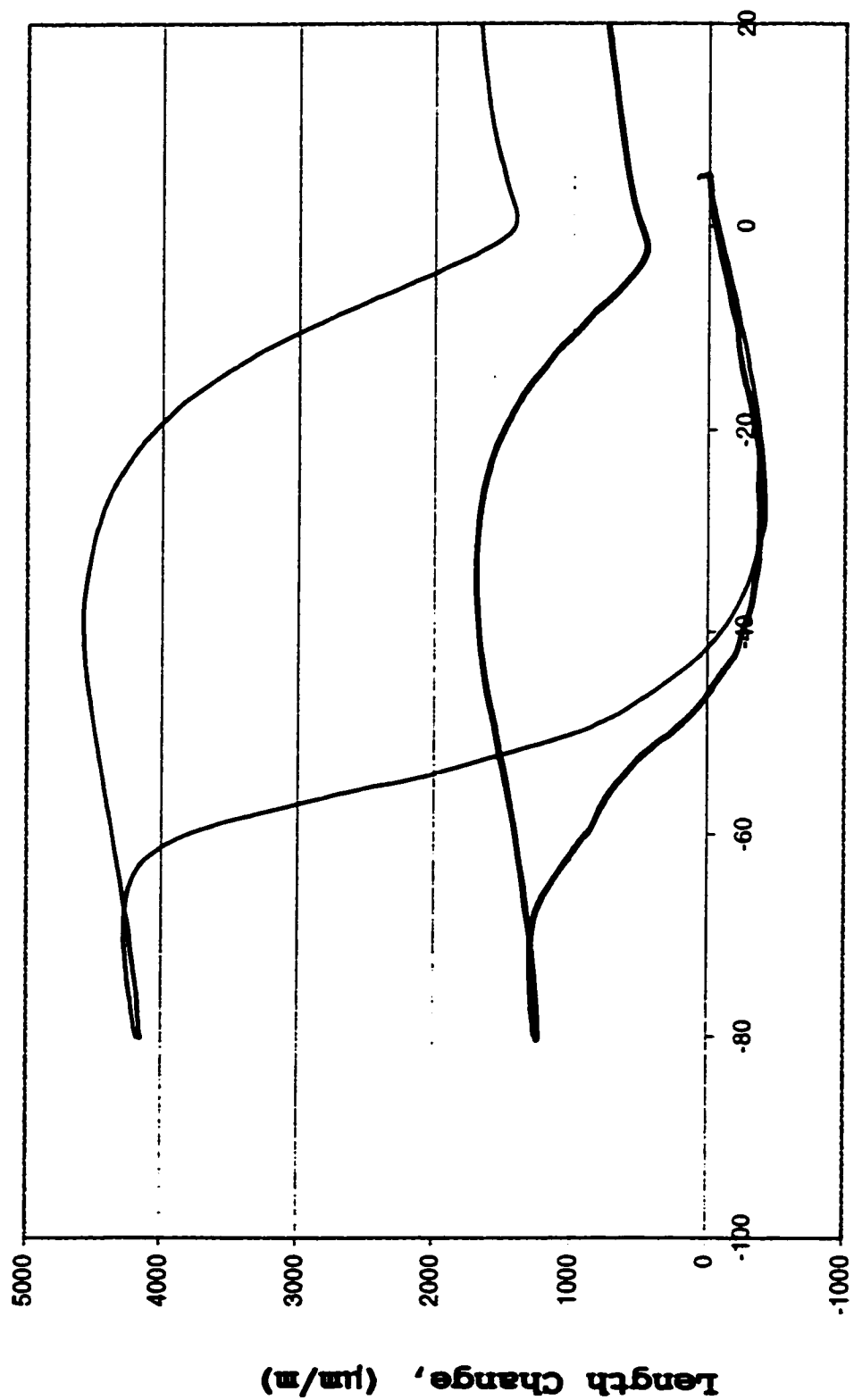


Temperature, (°C)

TMA **Portage Fly Ash**
9 Months Hydration



TMA
Sundance Fly Ash
9 Months Hydration



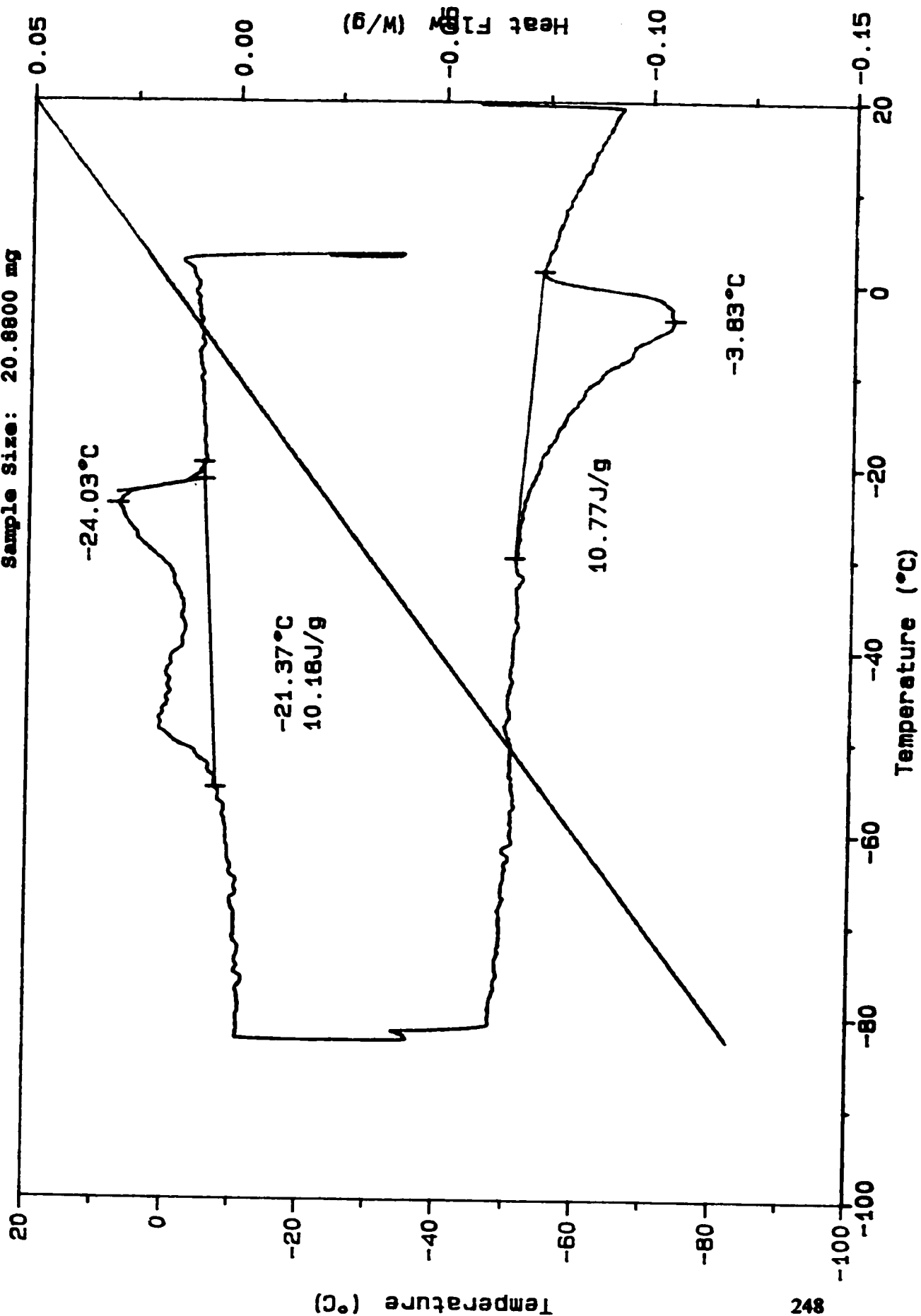
Temperature, (°C)

DSC

Sample: w/c = 0.35, 7 Days Hydration

Natural Pore Solution

Sample Size: 20.8800 mg

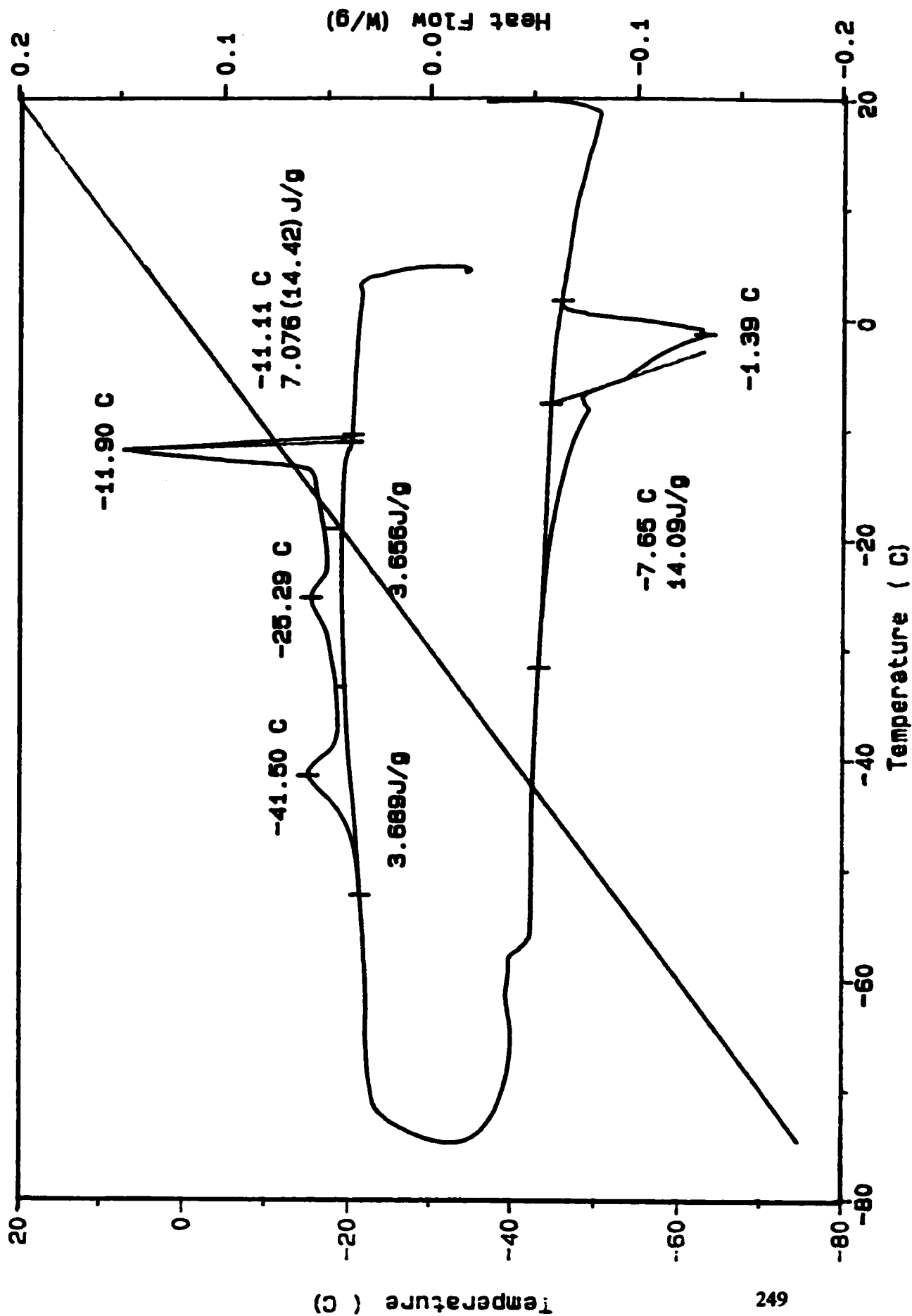


DSC

Sample: w/c = 0.35, 7 Days Hydration

Natural Pore Solution

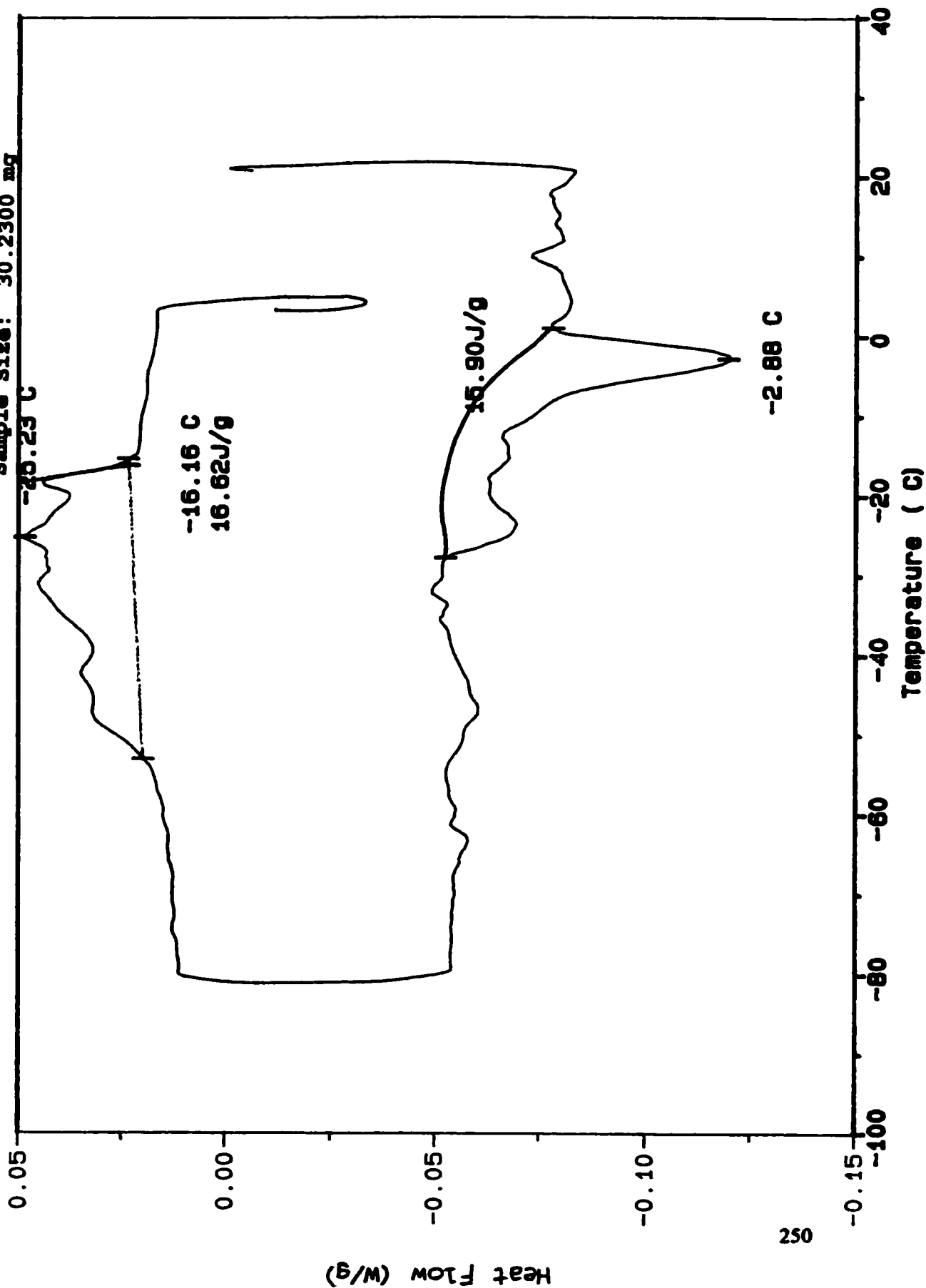
Sample Size: 27.1600 mg



DSC

Sample: w/c = 0.35, 7 Days Hydration
Natural Pore Solution

Sample Size: 30.2300 mg

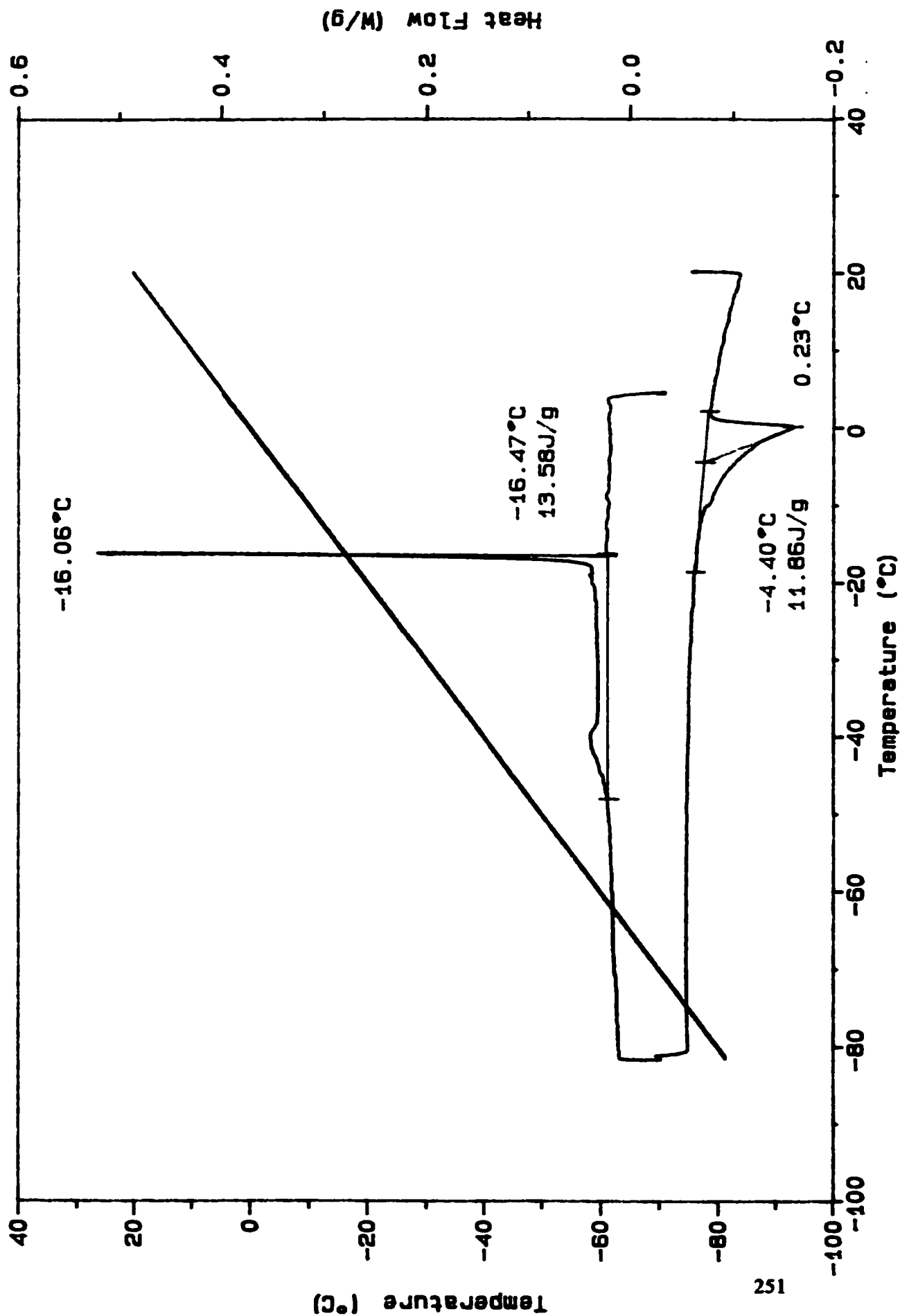


DSC

Sample: w/c = 0.35, 7 Days Hydration

Synthetic Pore Solution

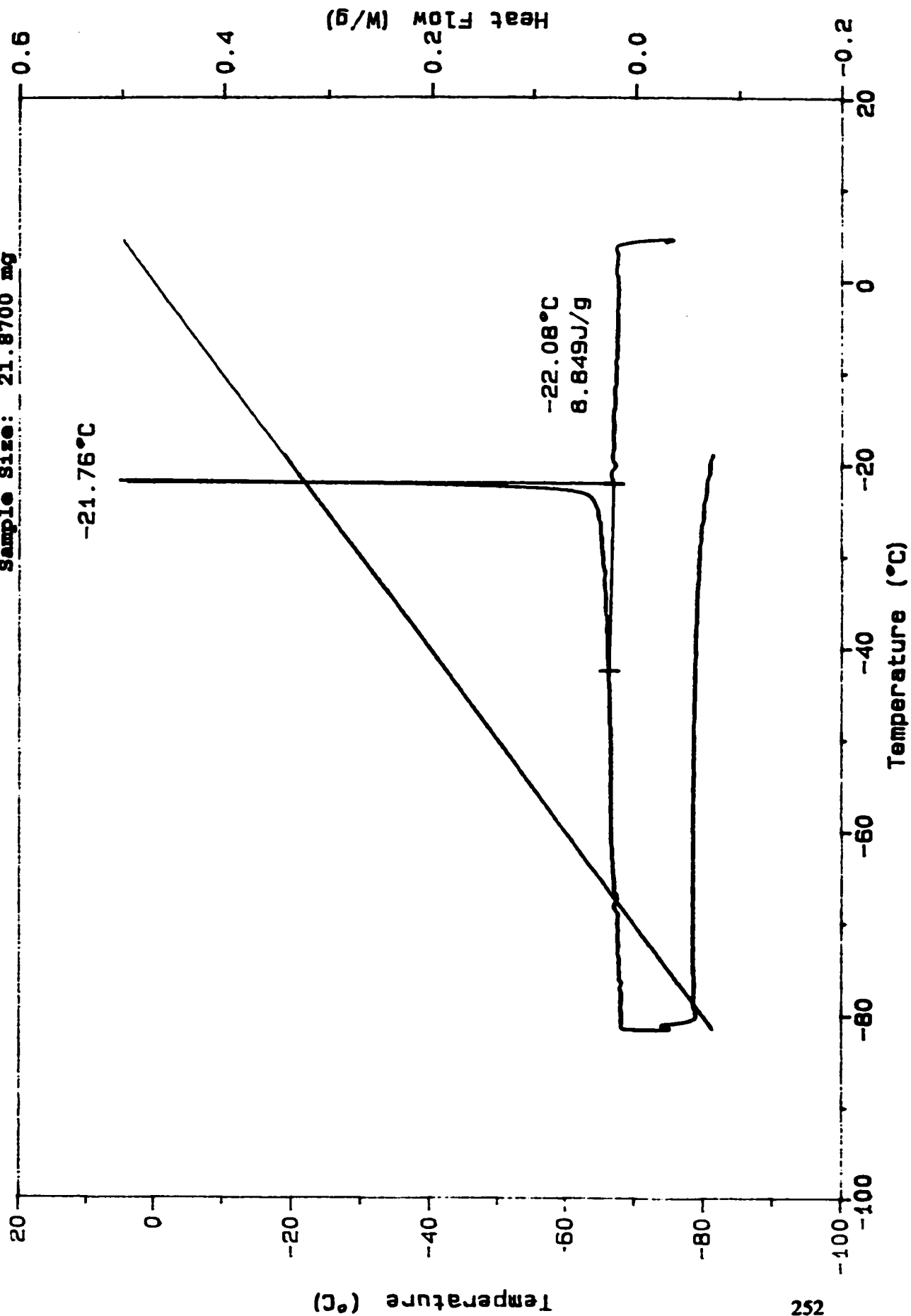
Sample Size: 23.5200 mg



DSC

Sample: w/c = 0.35, 7 Days Hydration
10% Salt Solution

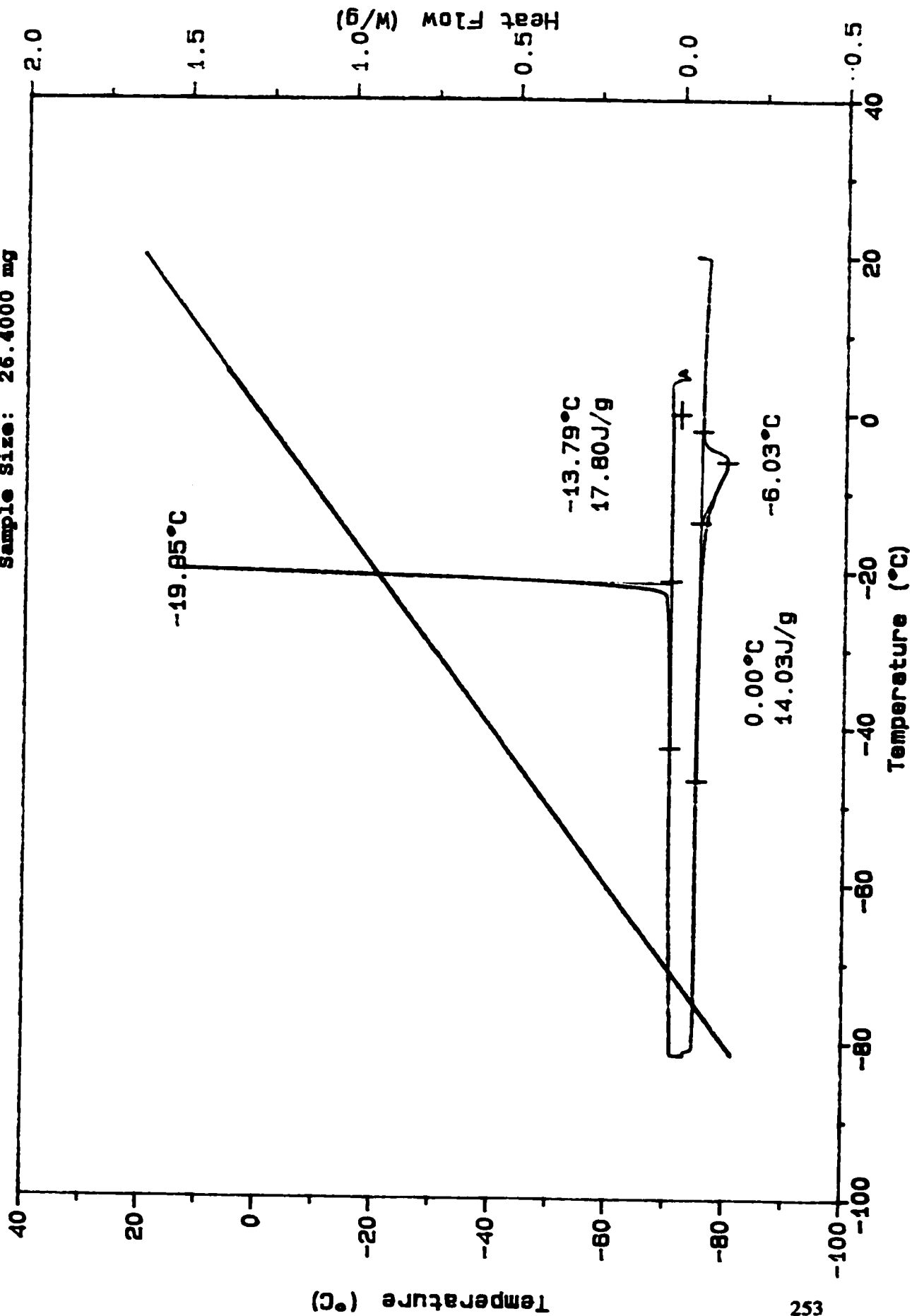
Sample Size: 21.8700 mg



DSC

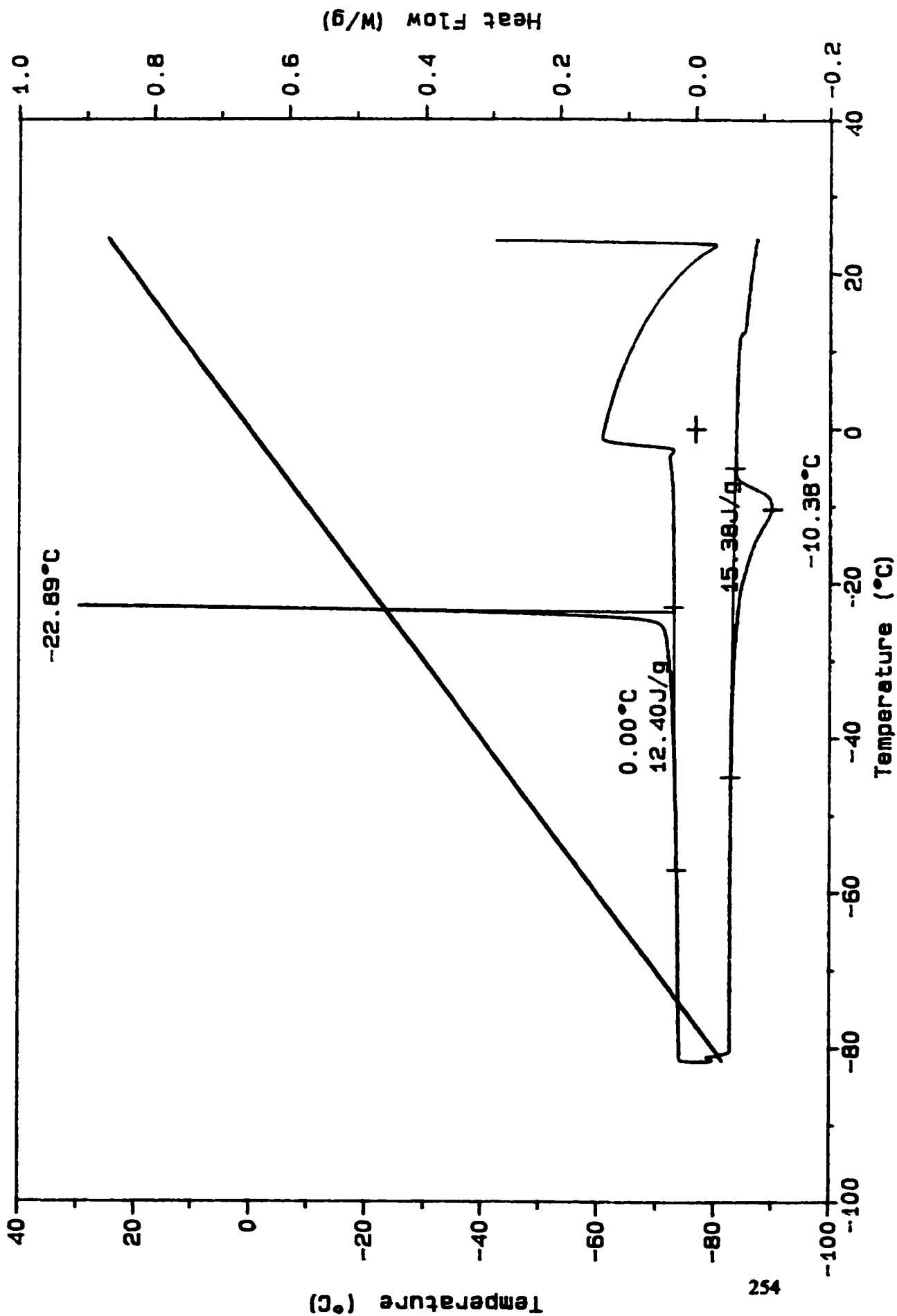
Sample: w/c = 0.35, 7 Days Hydration
10% Salt Solution

Sample Size: 26.4000 mg



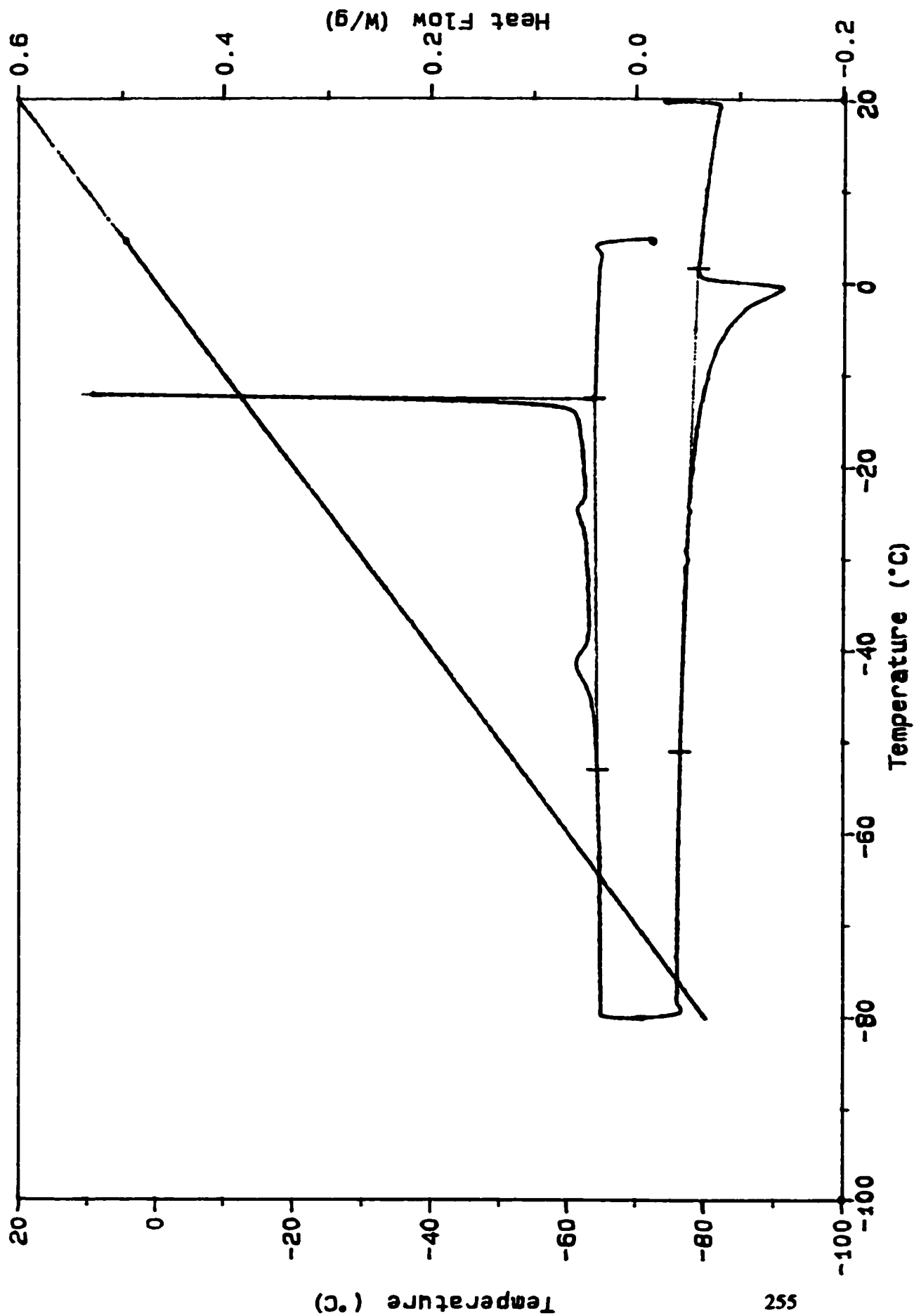
DSC

Sample: w/c = 0.35, 7 Days Hydration
15% Salt Solution
Sample Size: 26.2900 mg



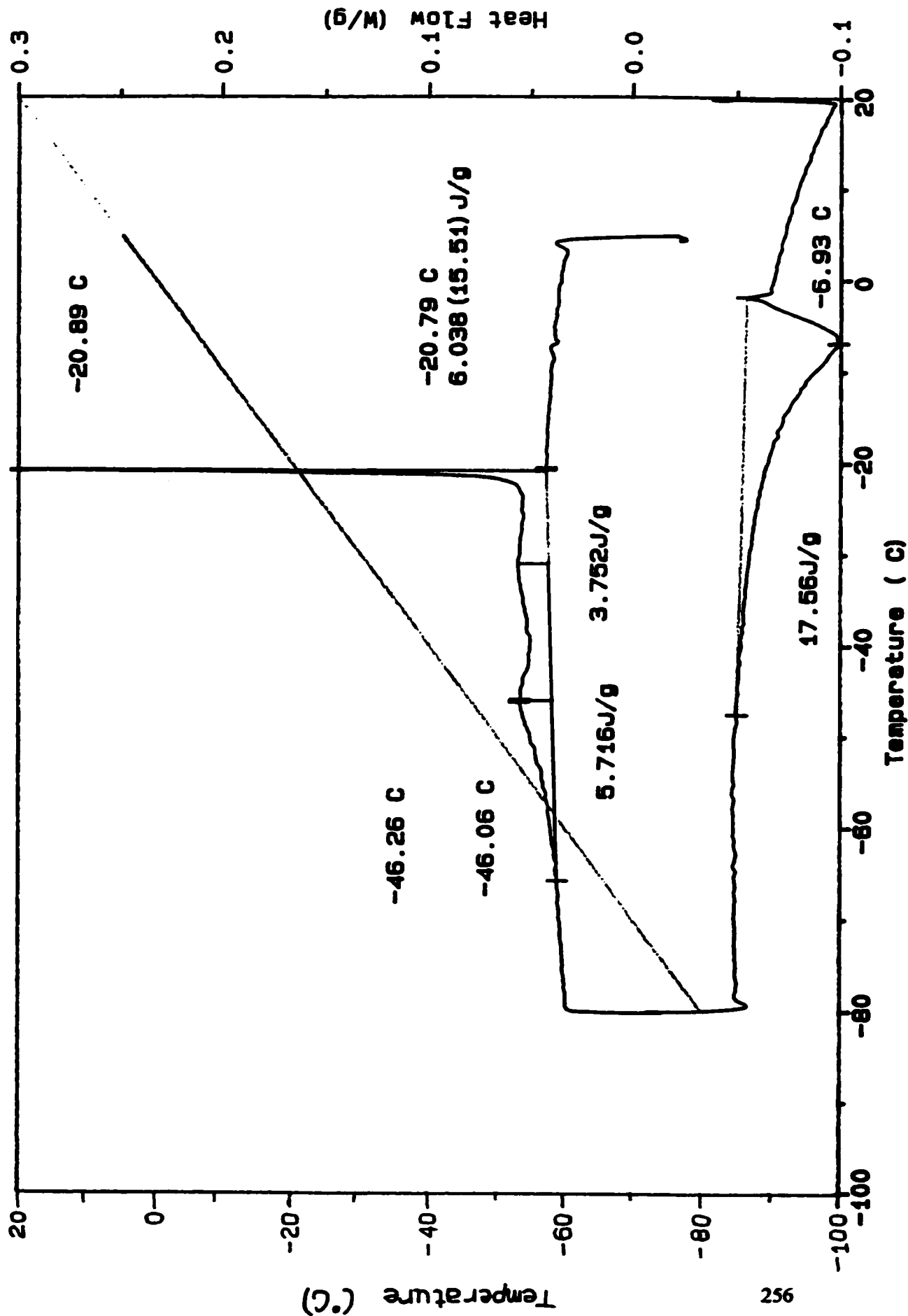
DSC

Sample: w/c = 0.35, 7 Days Hydration
Natural Pore Solution, 6% Entrained Air
Sample Size: 28.0000 mg



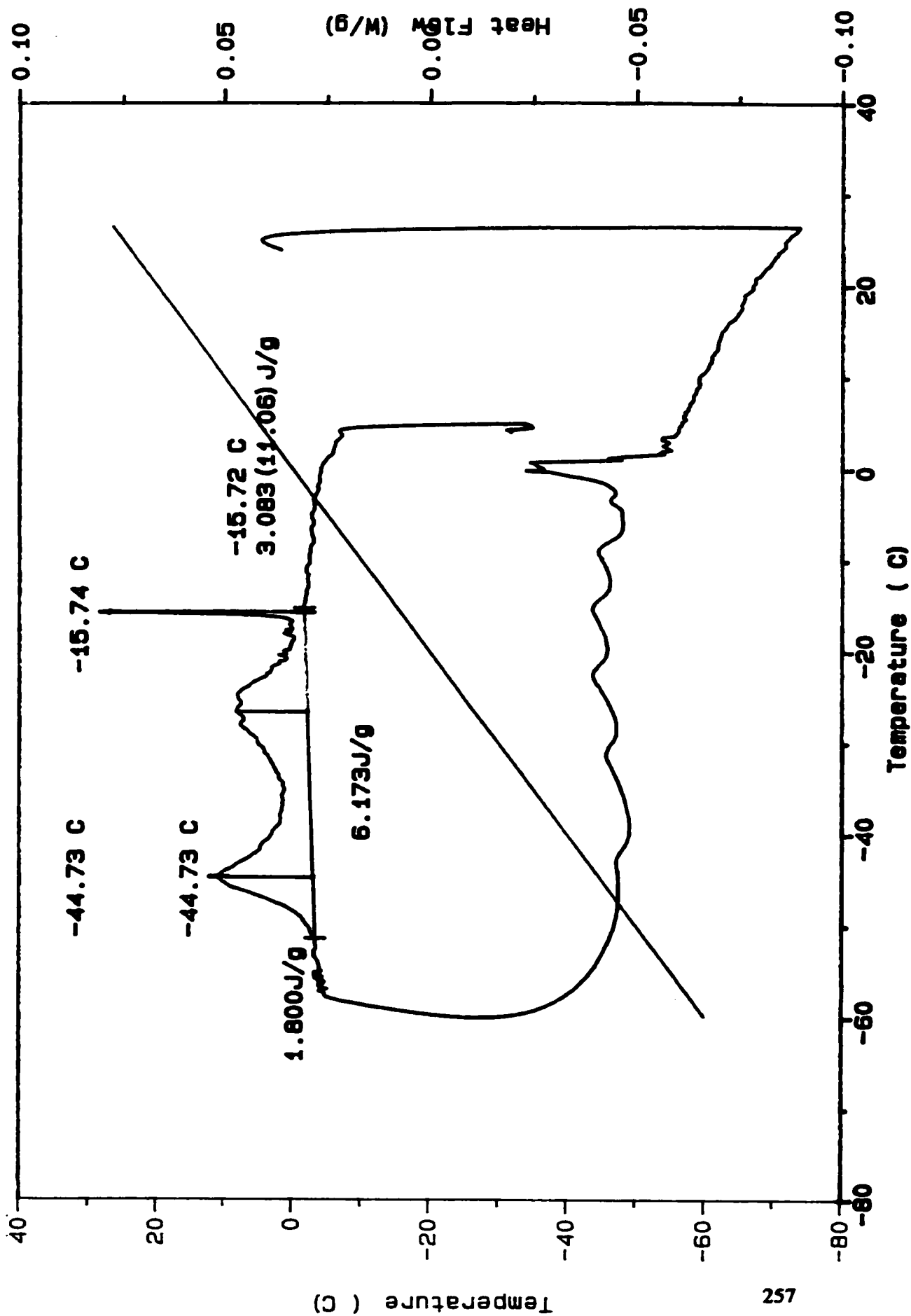
DSC

Sample: w/c = 0.35, 7 Days Hydration
10% Salt Solution, 6% Entrained Air
Sample Size: 16.5600 mg



Sample: w/c = 0.35, 28 Days Hydration
Natural Pore Solution
Sample Size: 25.2200 mg

DSC

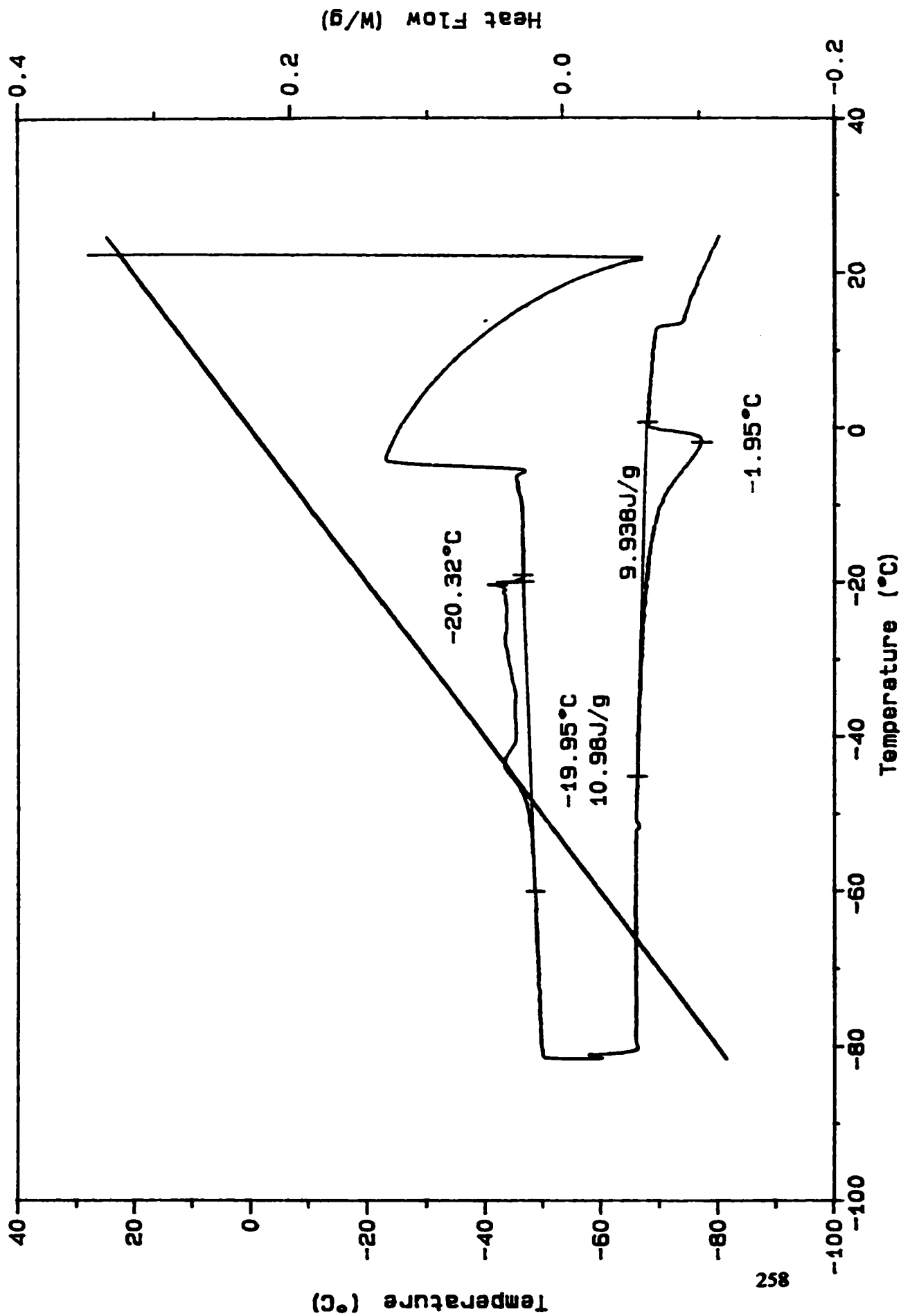


DSC

Sample: w/c = 0.35, 28 Days Hydration

Synthetic Pore Solution

Sample Size: 20.2900 mg

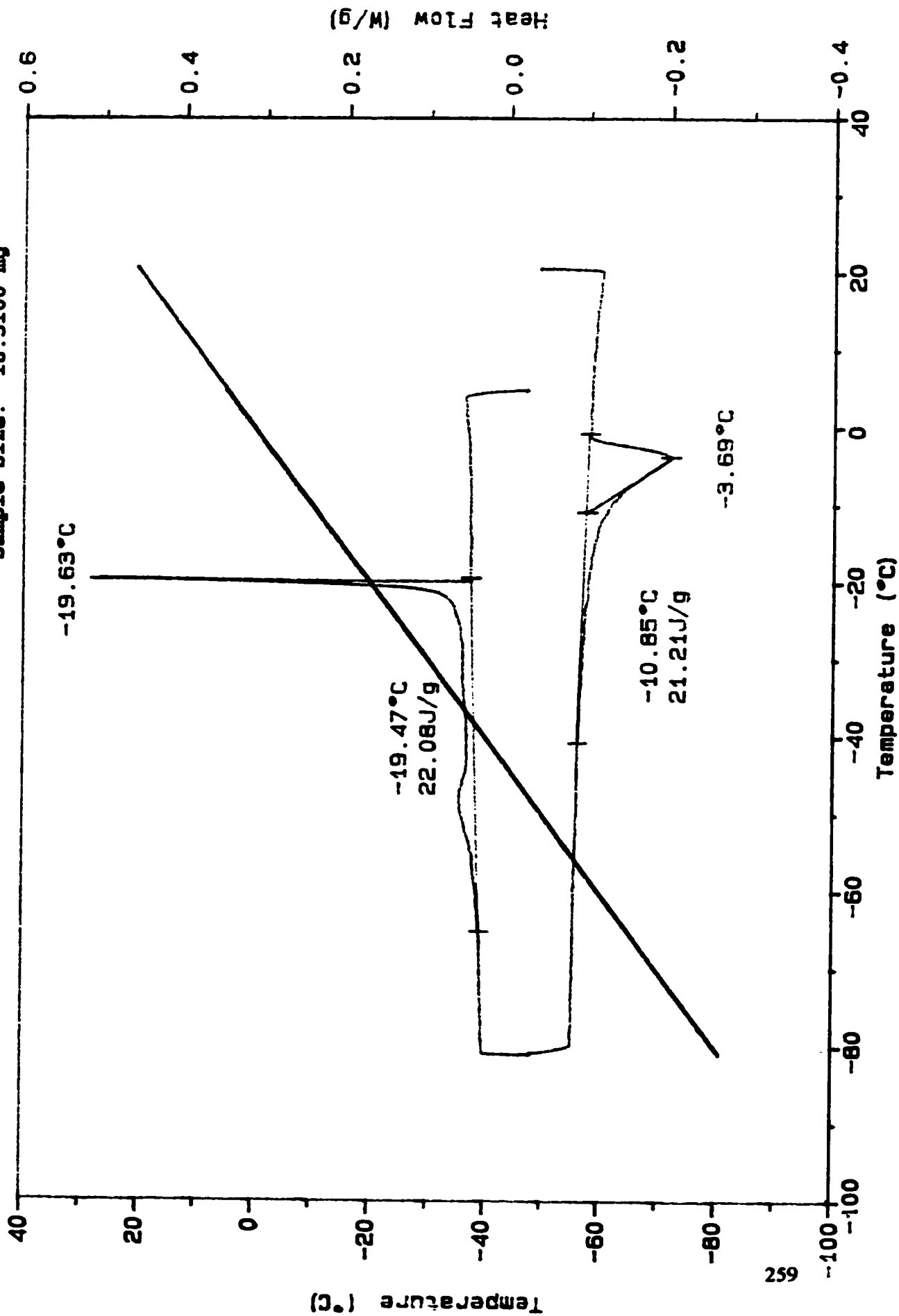


DSC

Sample: w/c = 0.35, 28 Days Hydration

10% Salt Solution

Sample Size: 18.5100 mg

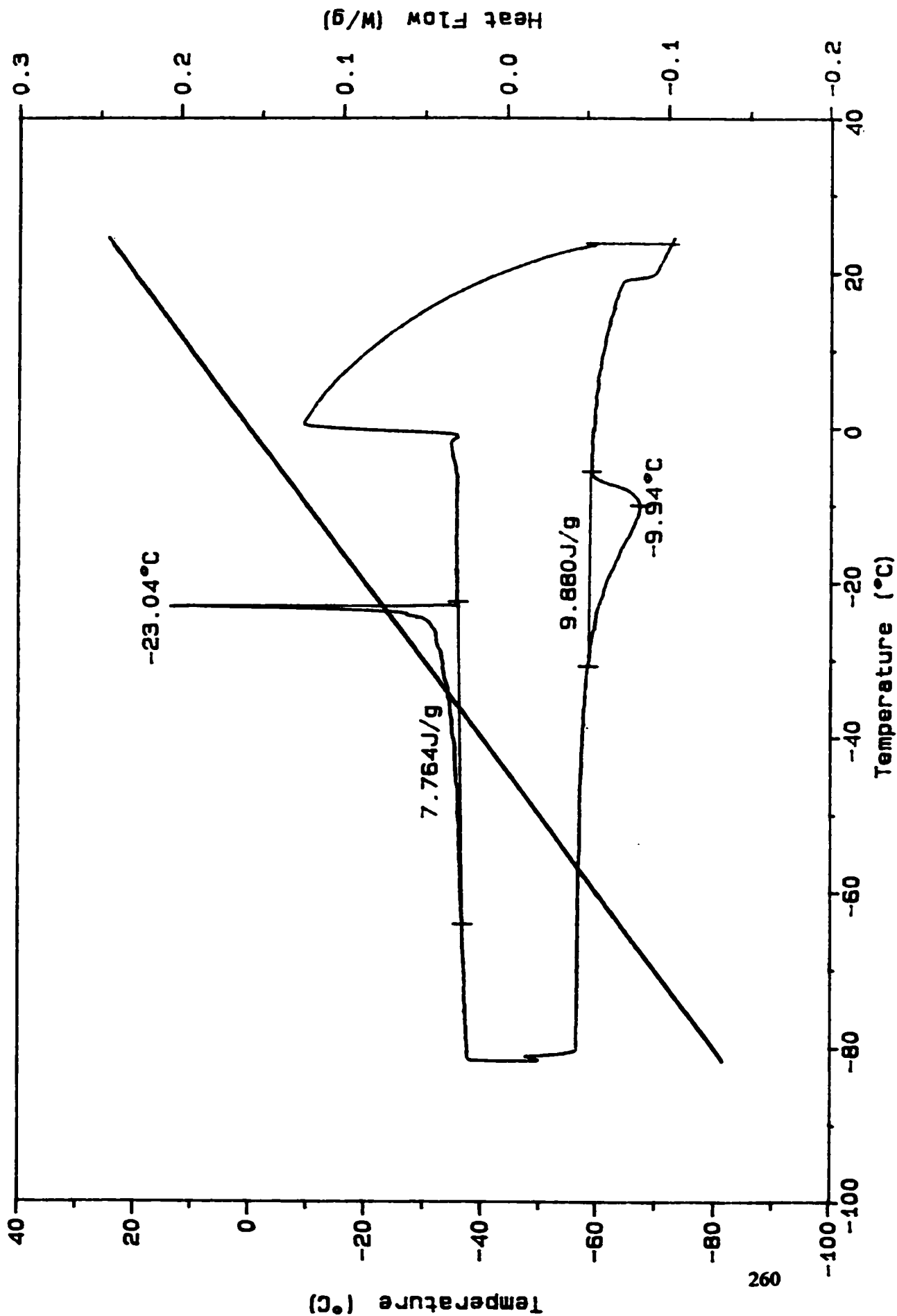


DSC

Sample: w/c = 0.35, 28 Days Hydration

15% Salt Solution

Sample Size: 32.7300 mg

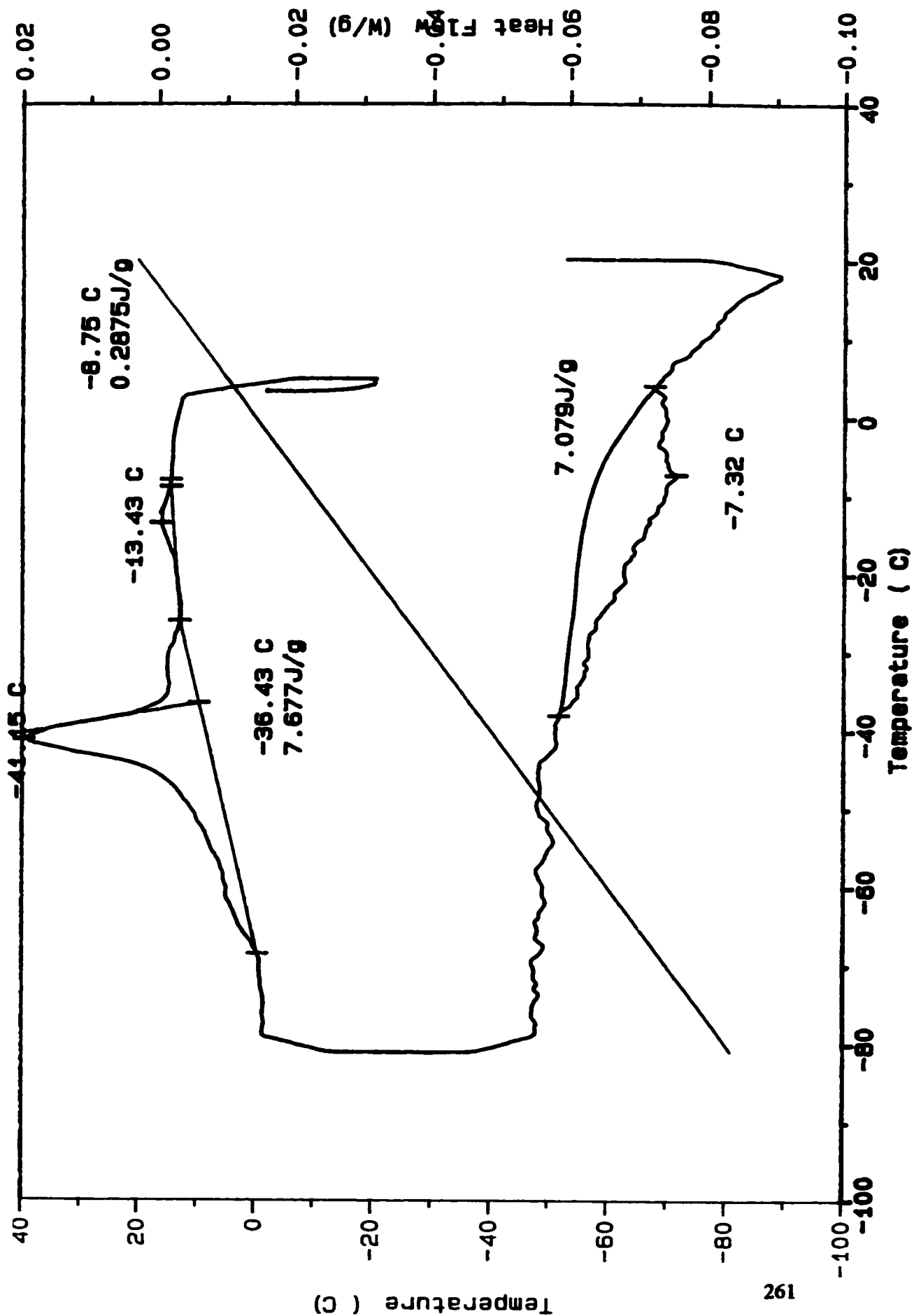


DSC

Sample: w/c = 0.60, 7 Days Hydration

Natural Pore Solution

Sample Size: 18.2900 mg

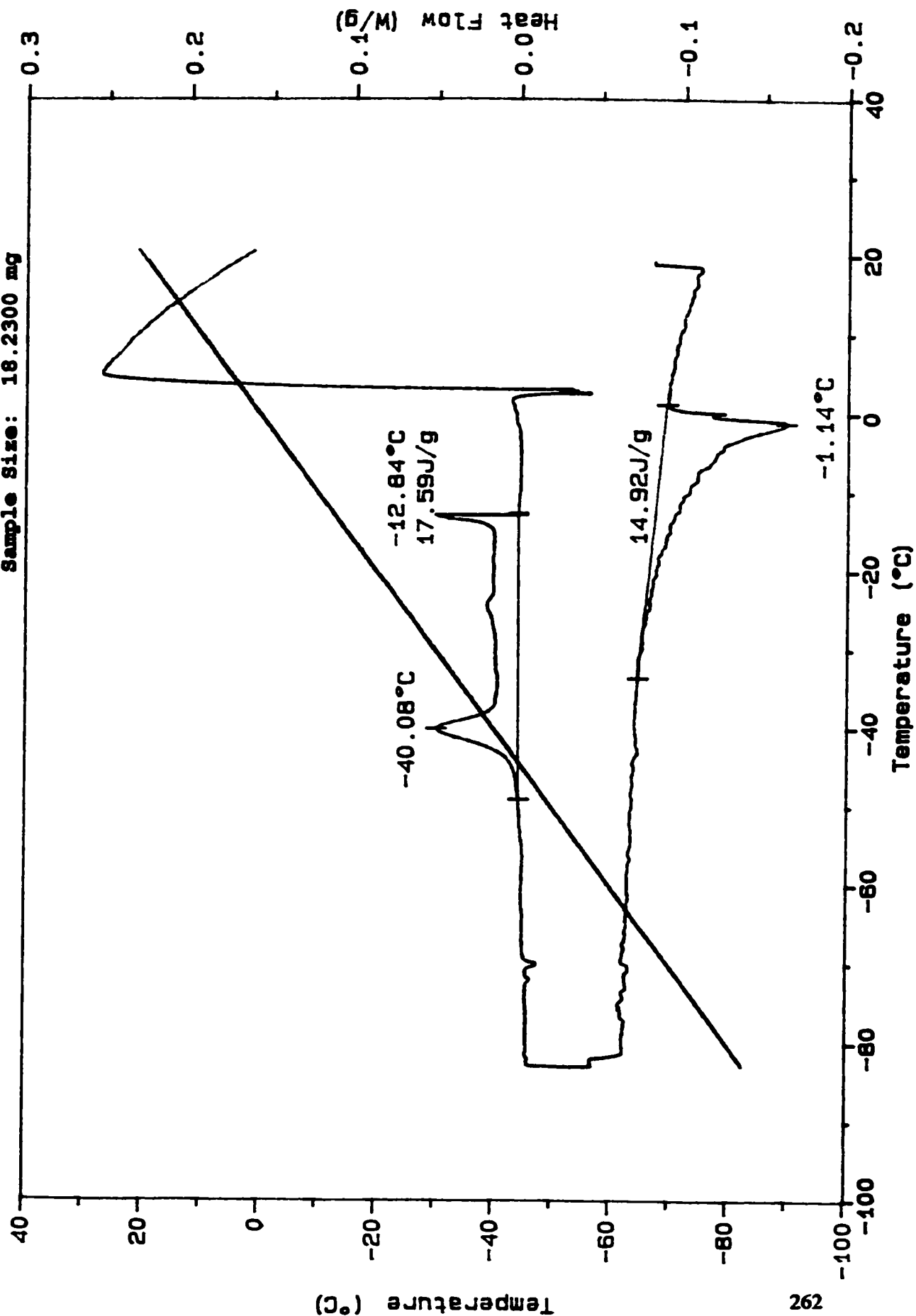


DSC

Sample: w/c = 0.60, 7 Days Hydration

Natural Pore Solution

Sample Size: 18.2300 mg

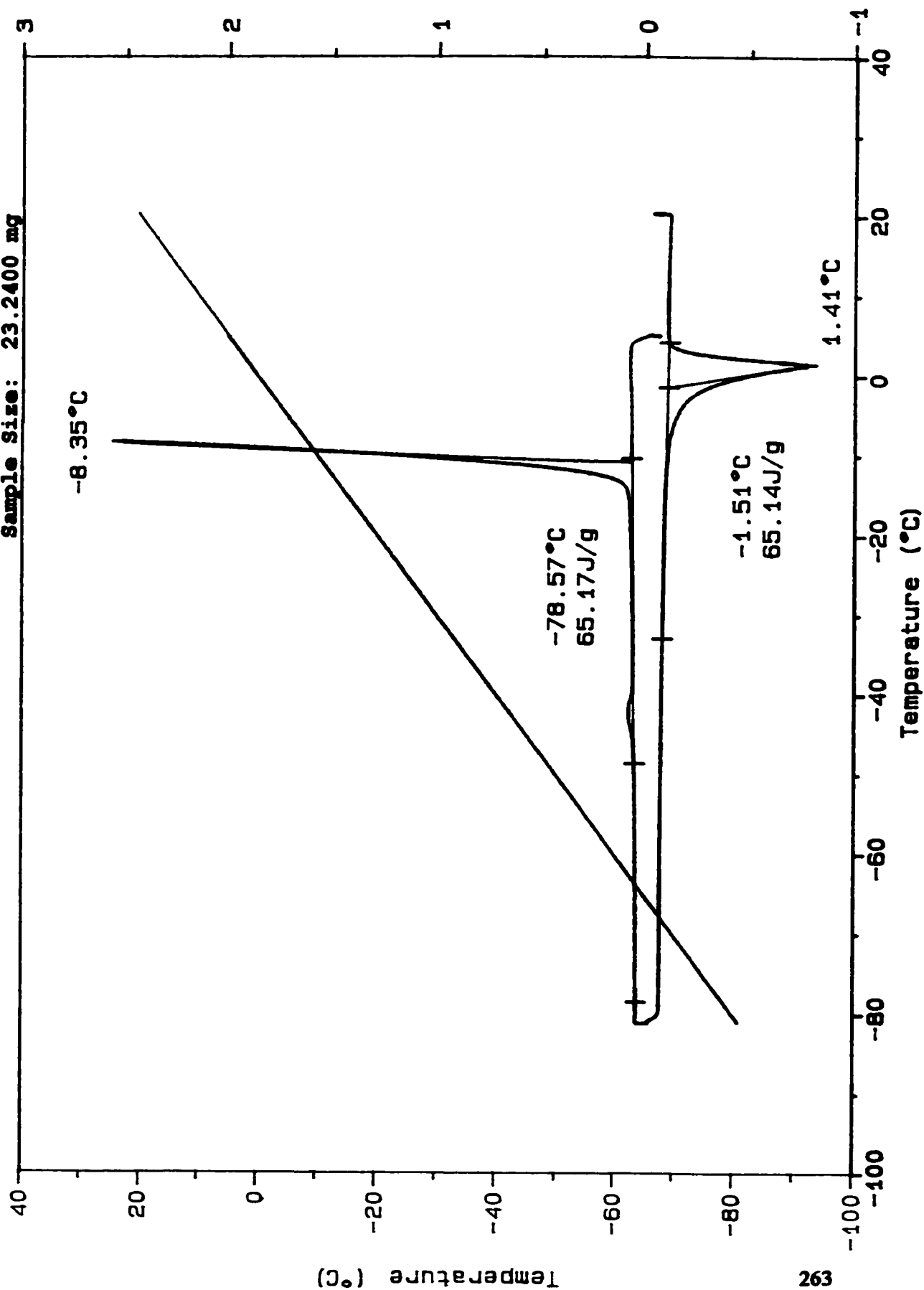


DSC

Sample: w/c = 0.60, 7 Days Hydration

Synthetic Pore Solution

Sample Size: 23.2400 mg

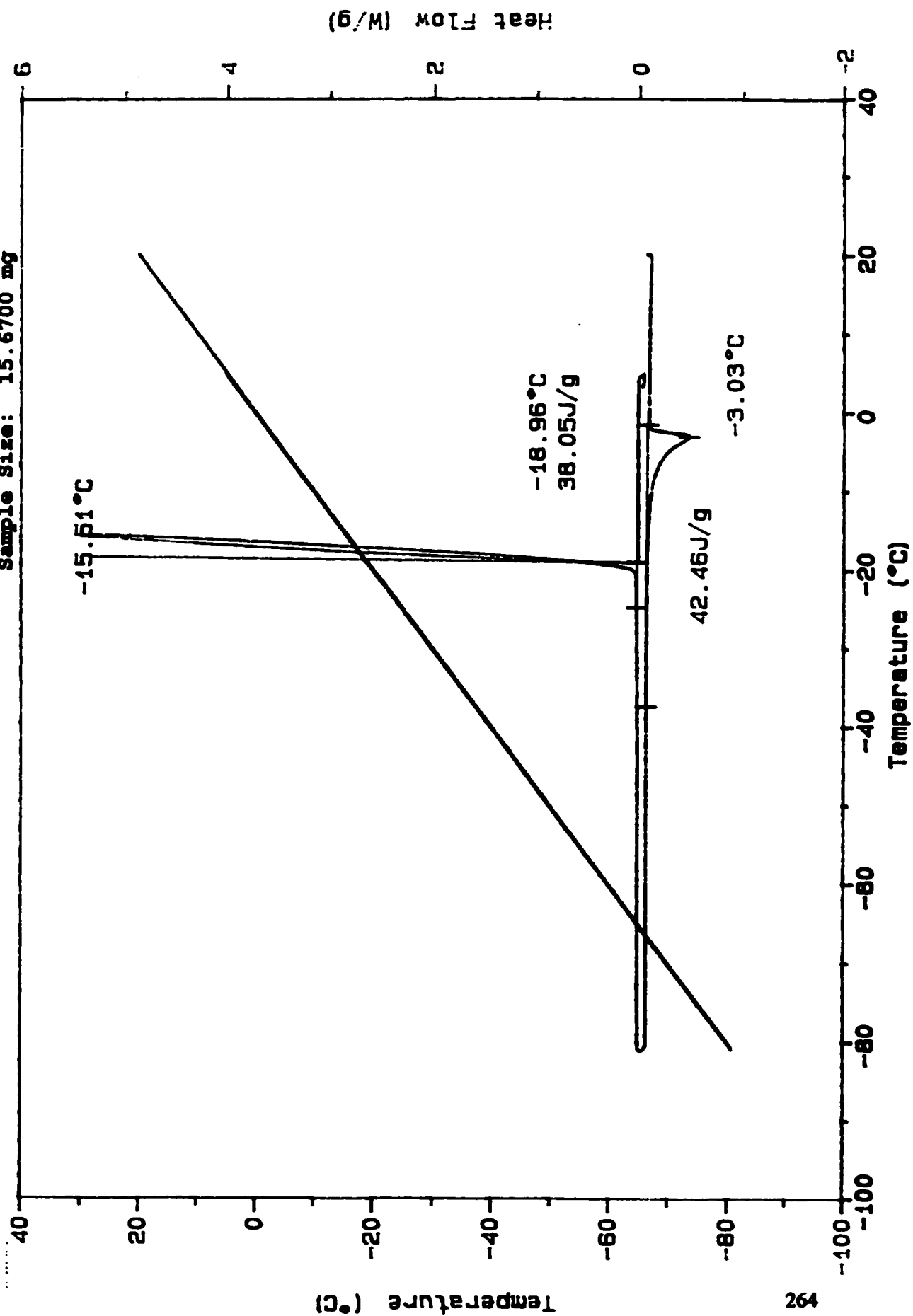


DSC

Sample: w/c = 0.60, 7 Days Hydration

5% Salt Solution

Sample Size: 15.6700 mg

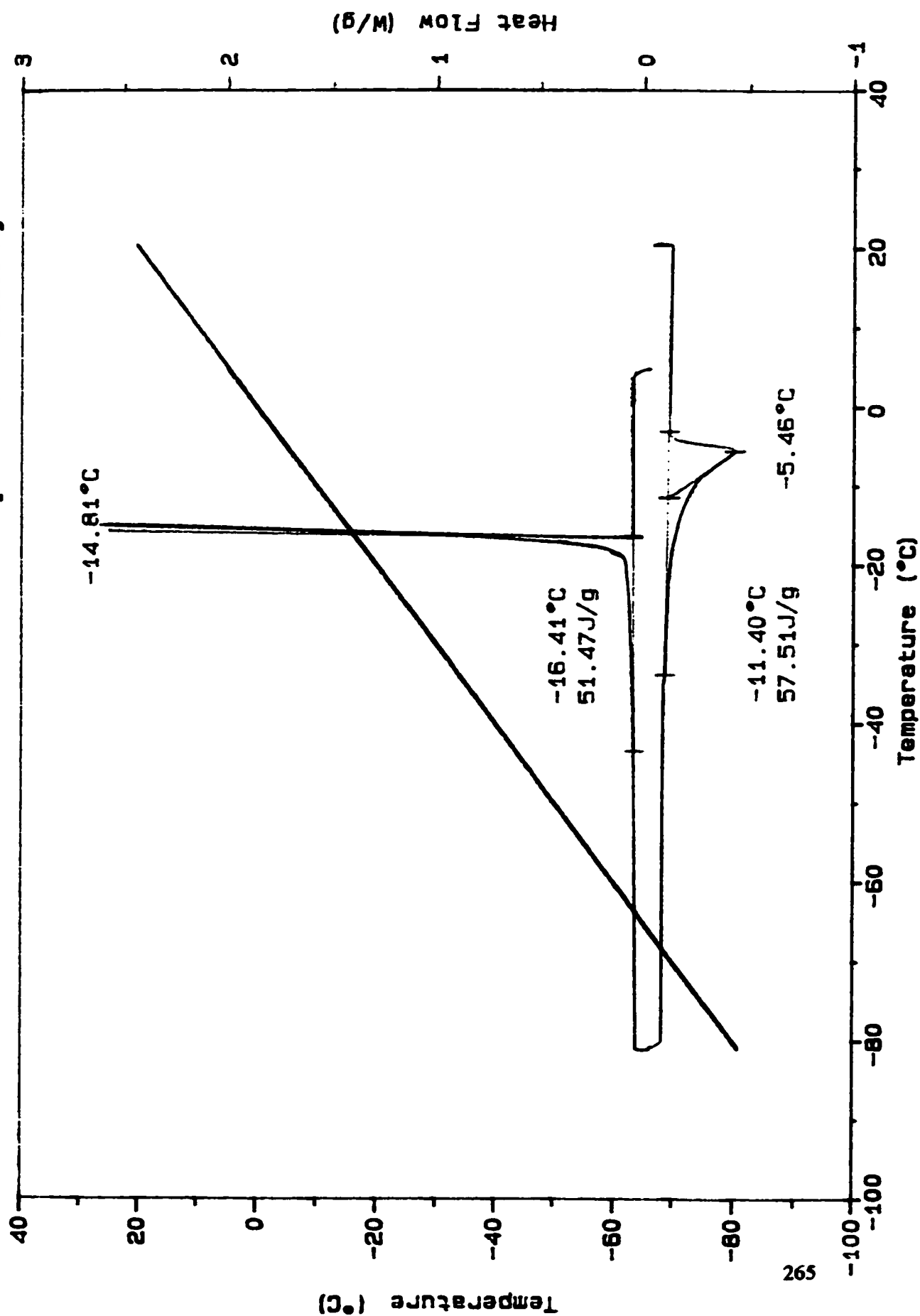


DSC

Sample: w/c = 0.60, 7 Days Hydration

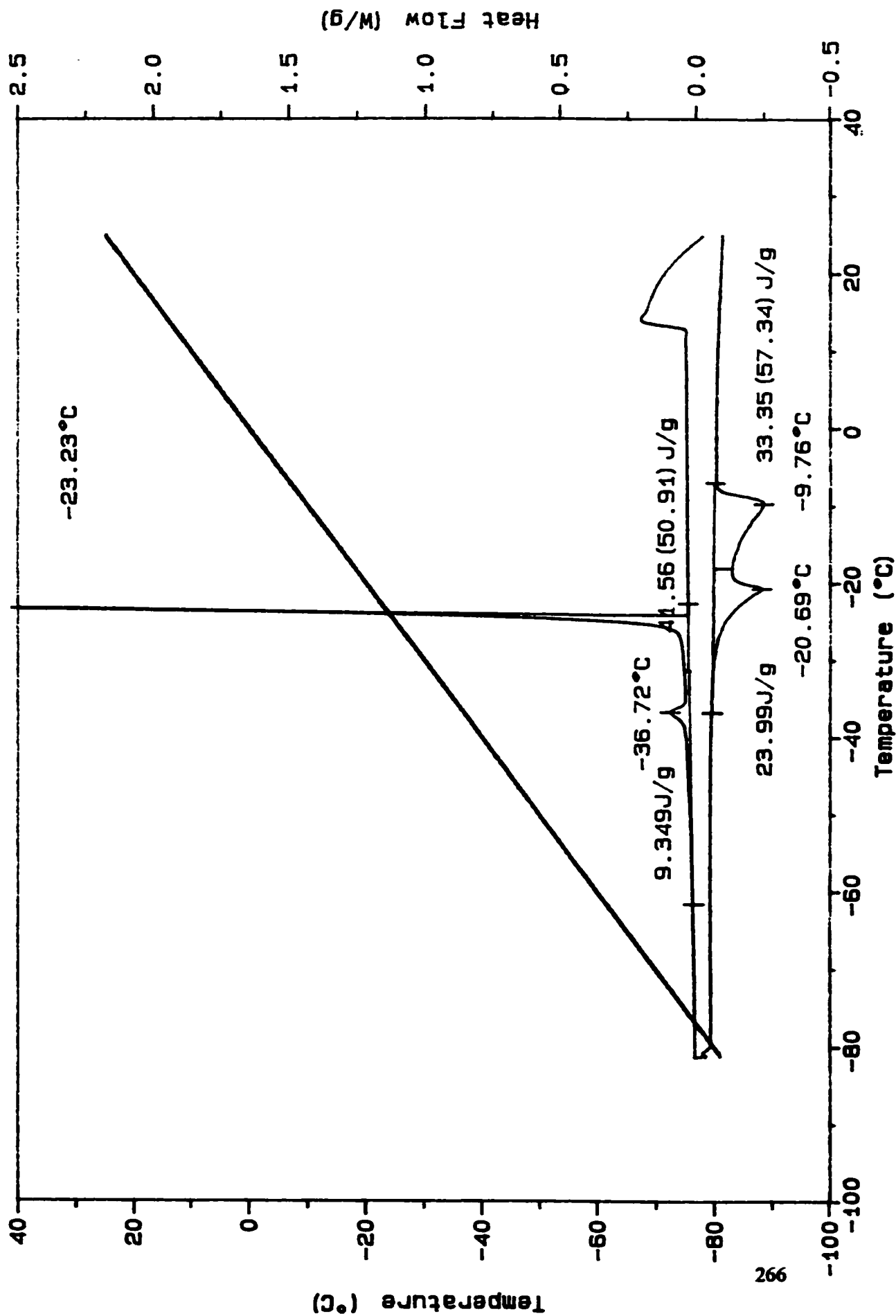
10% Salt Solution

Sample Size: 15.3300 mg



DSC

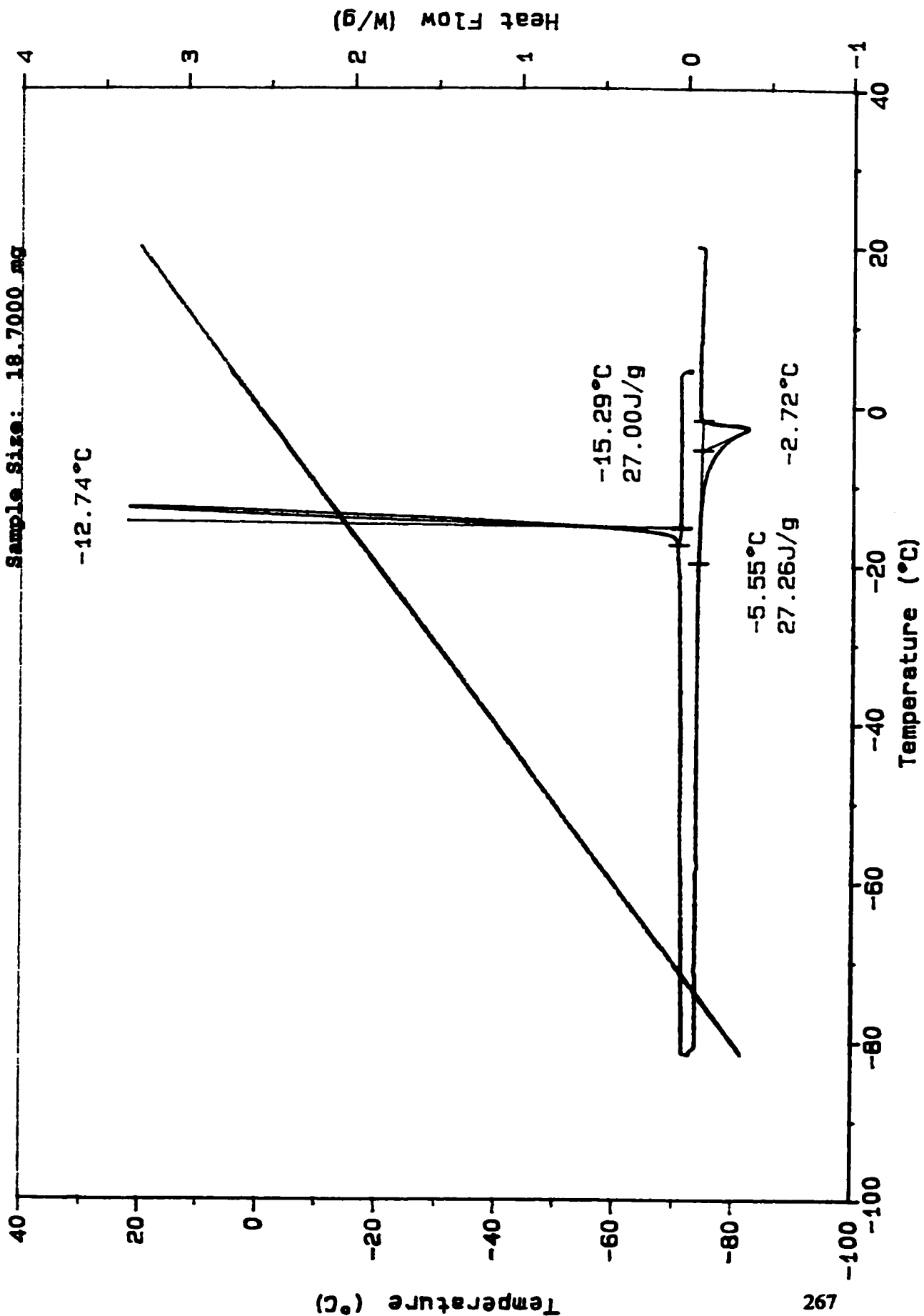
Sample: w/c = 0.60, 7 Days Hydration
15% Salt Solution
Sample Size: 9.2000 mg



DSC

Sample: $w/c = 0.60$, 28 Days Hydration
5% Salt Solution

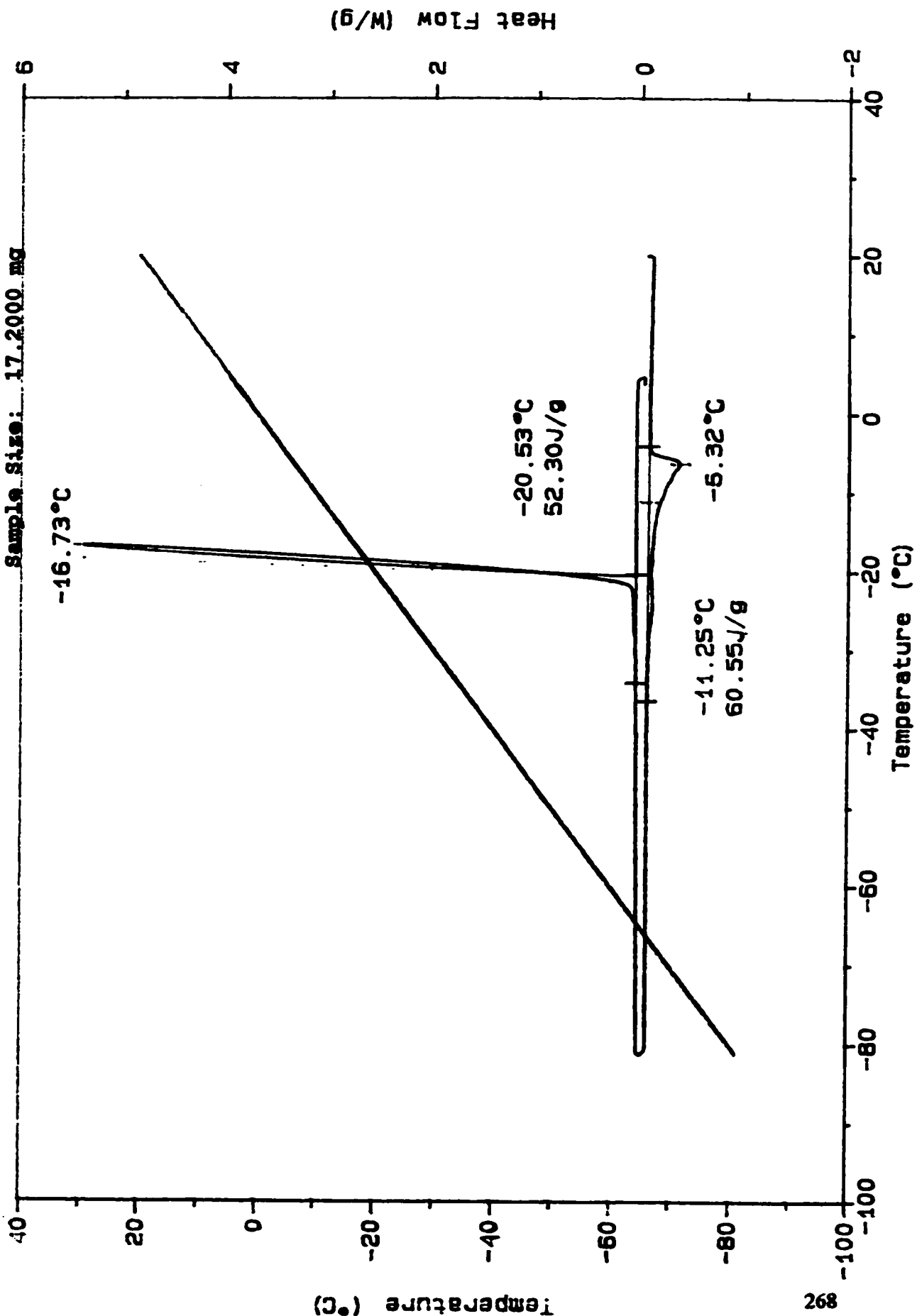
Sample Size: 18.7000 mg



DSC

Sample: w/c = 0.60, 28 Days Hydration
10% Salt Solution

Sample Size: 17.2000 mg

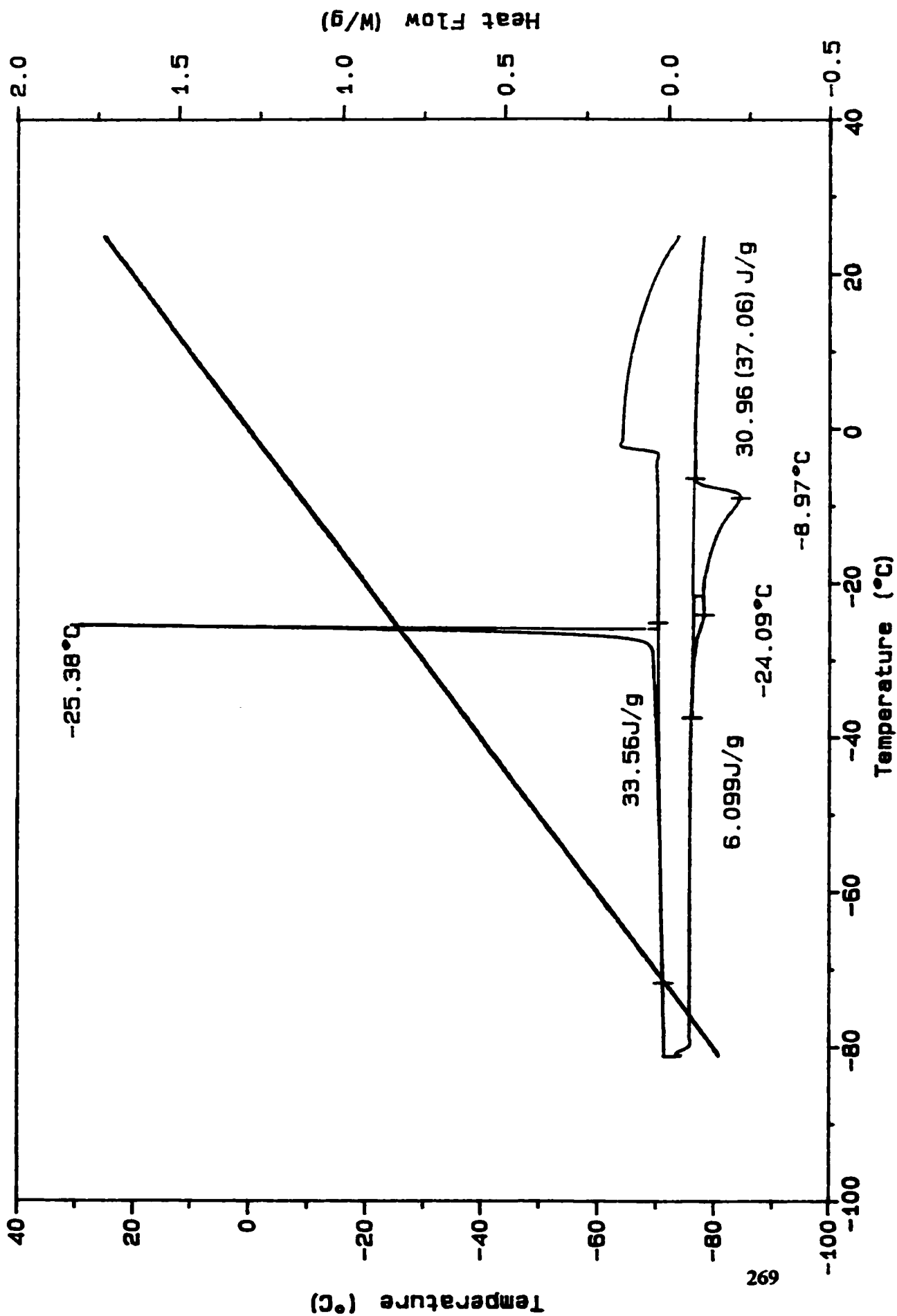


DSC

Sample: w/c = 0.60, 34 Days Hydration

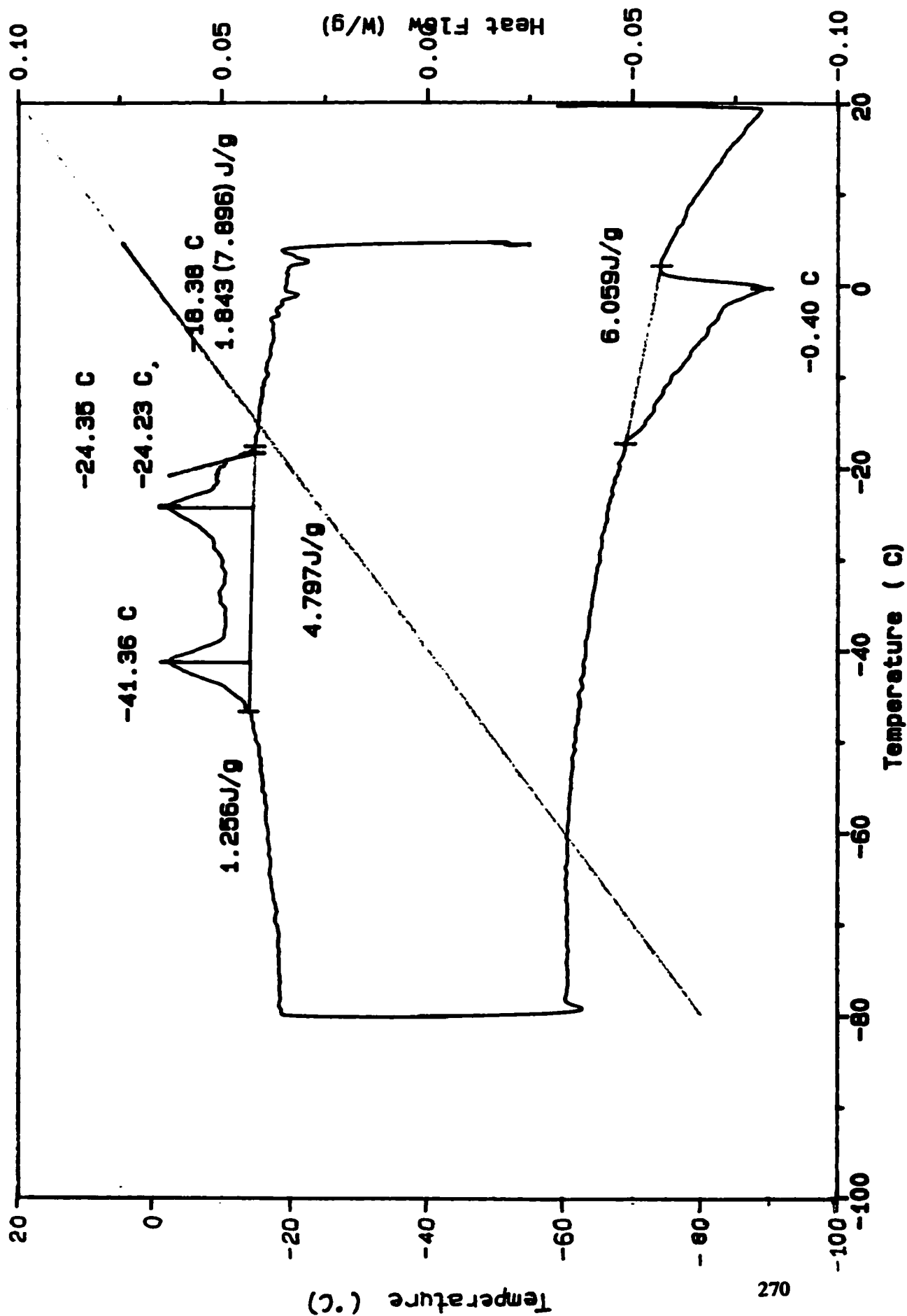
15% Salt Solution

Sample Size: 8.9000 mg



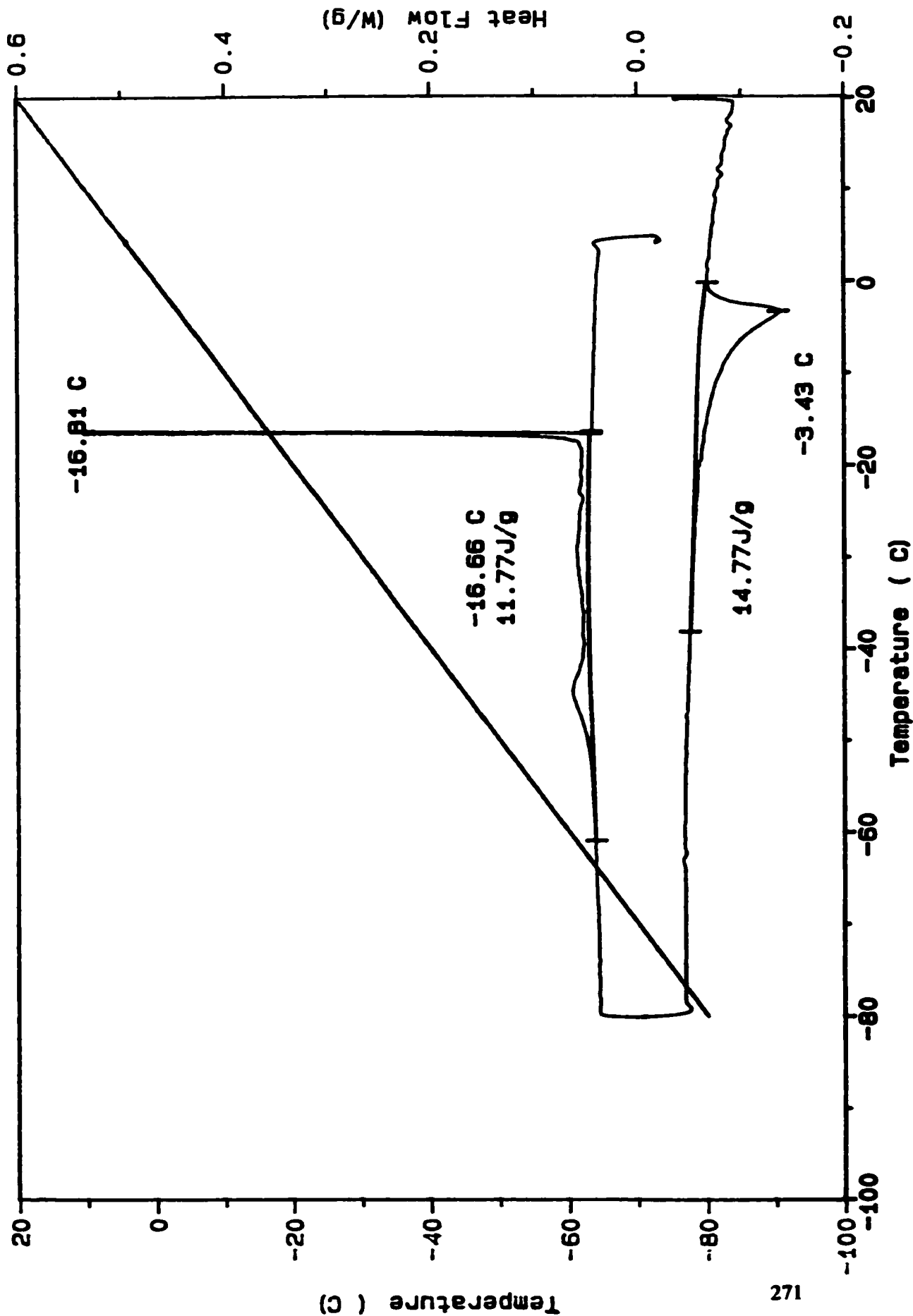
DSC

Sample: w/c = 0.35, 28 Days Hydration
Natural Pore Solution, 6% Entrained Air
Sample Size: 29.6000 mg



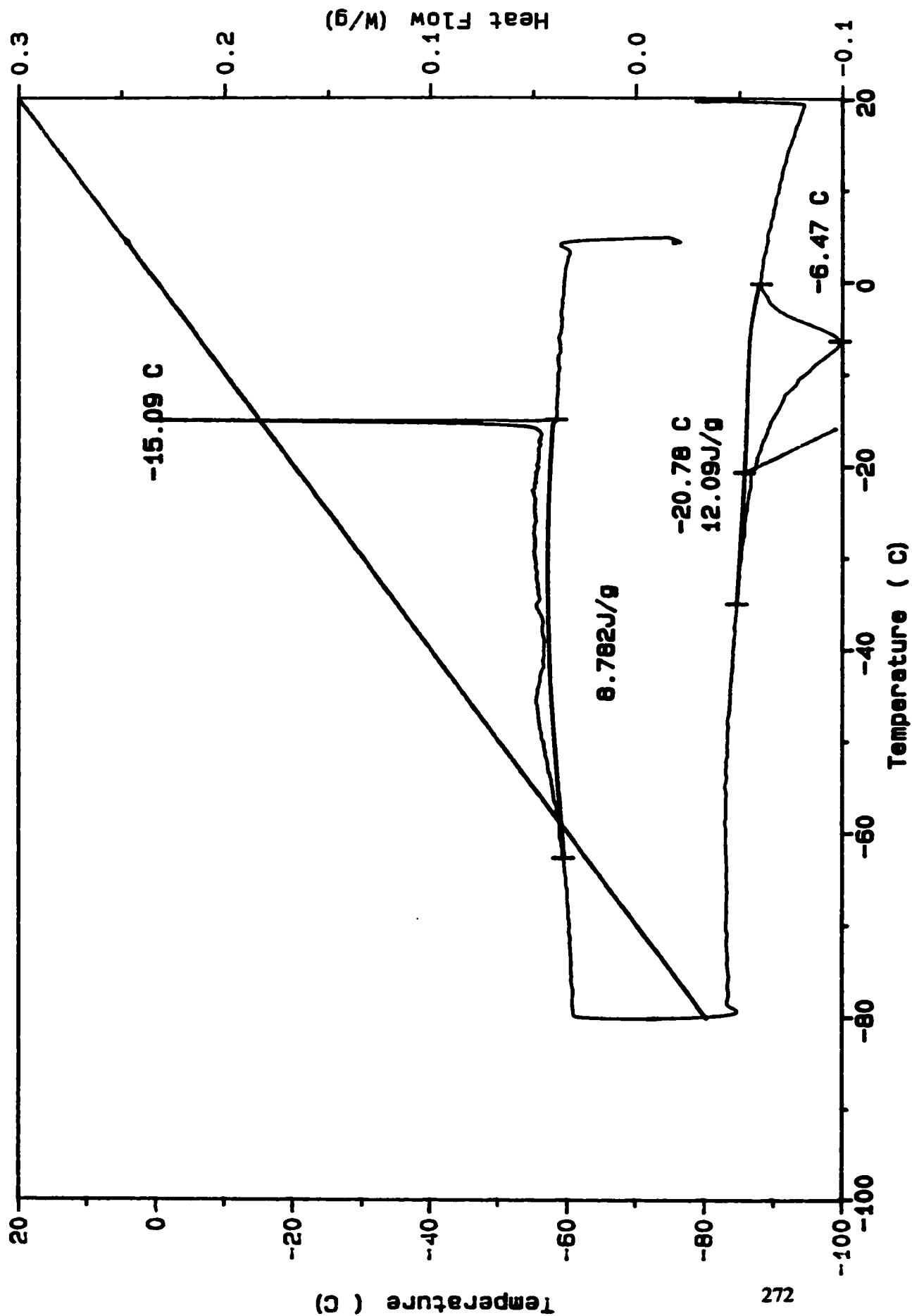
DSC

Sample: w/c = 0.35, 28 Days Hydration
5% Salt Solution, 6% Entrained Air
Sample Size: 19.8300 mg



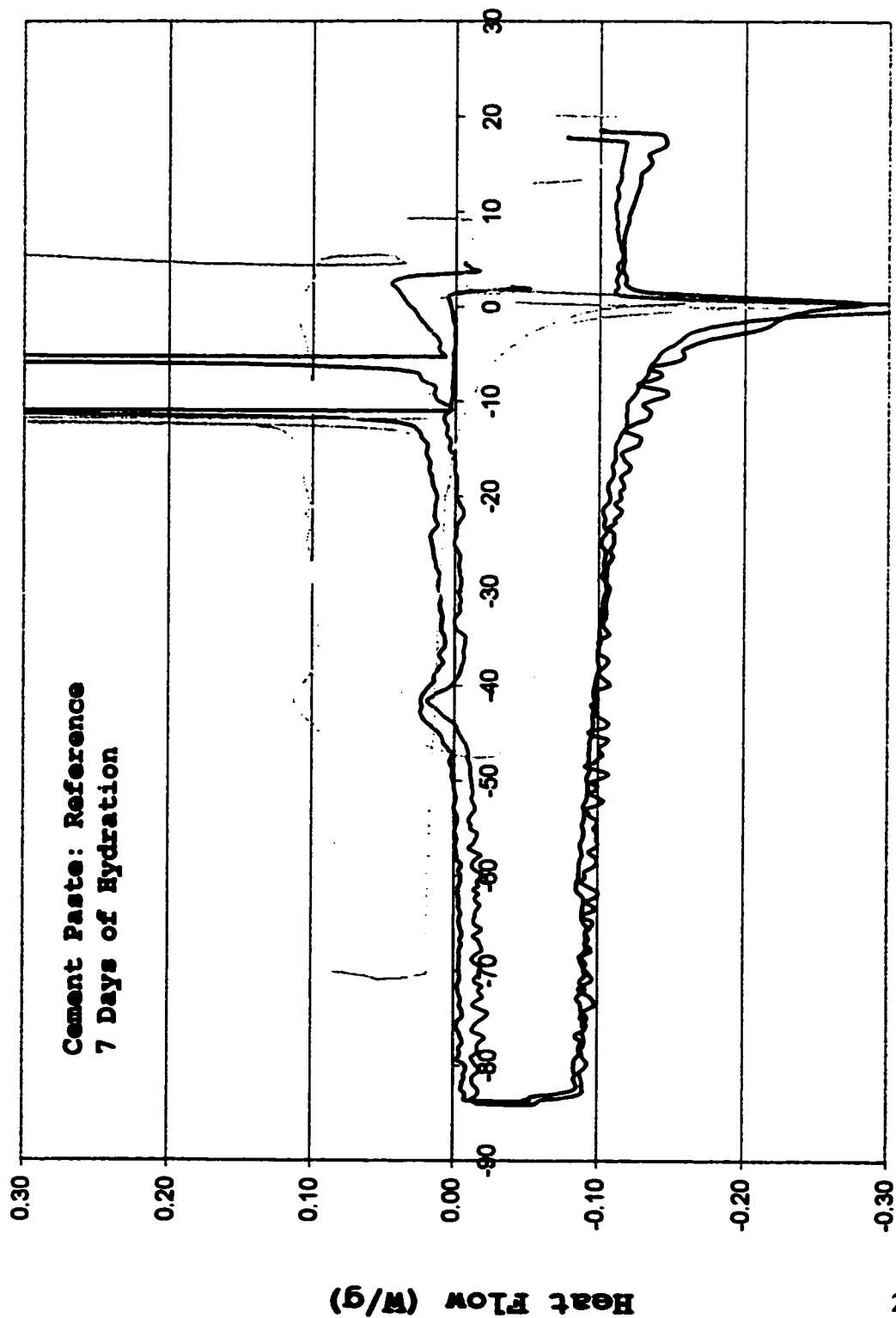
DSC

Sample: w/c = 0.35 28 Days Hydration
10% Salt Solution, 6% Entrained Air
Sample Size: 19.4000 mg



DSC

Cement Paste: Reference
7 Days of Hydration

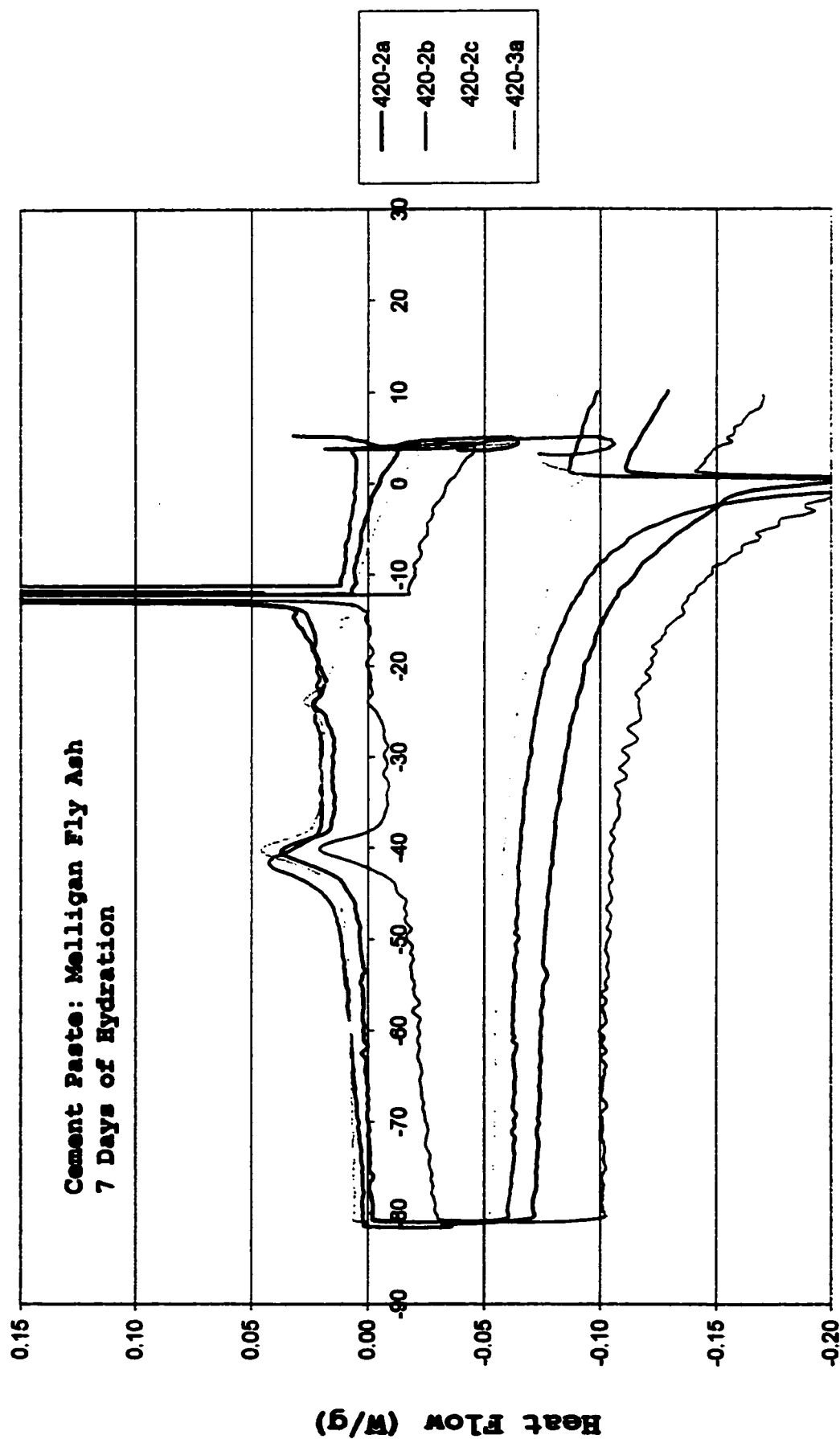


Heat Flow (W/g)

Temperature, (°C)

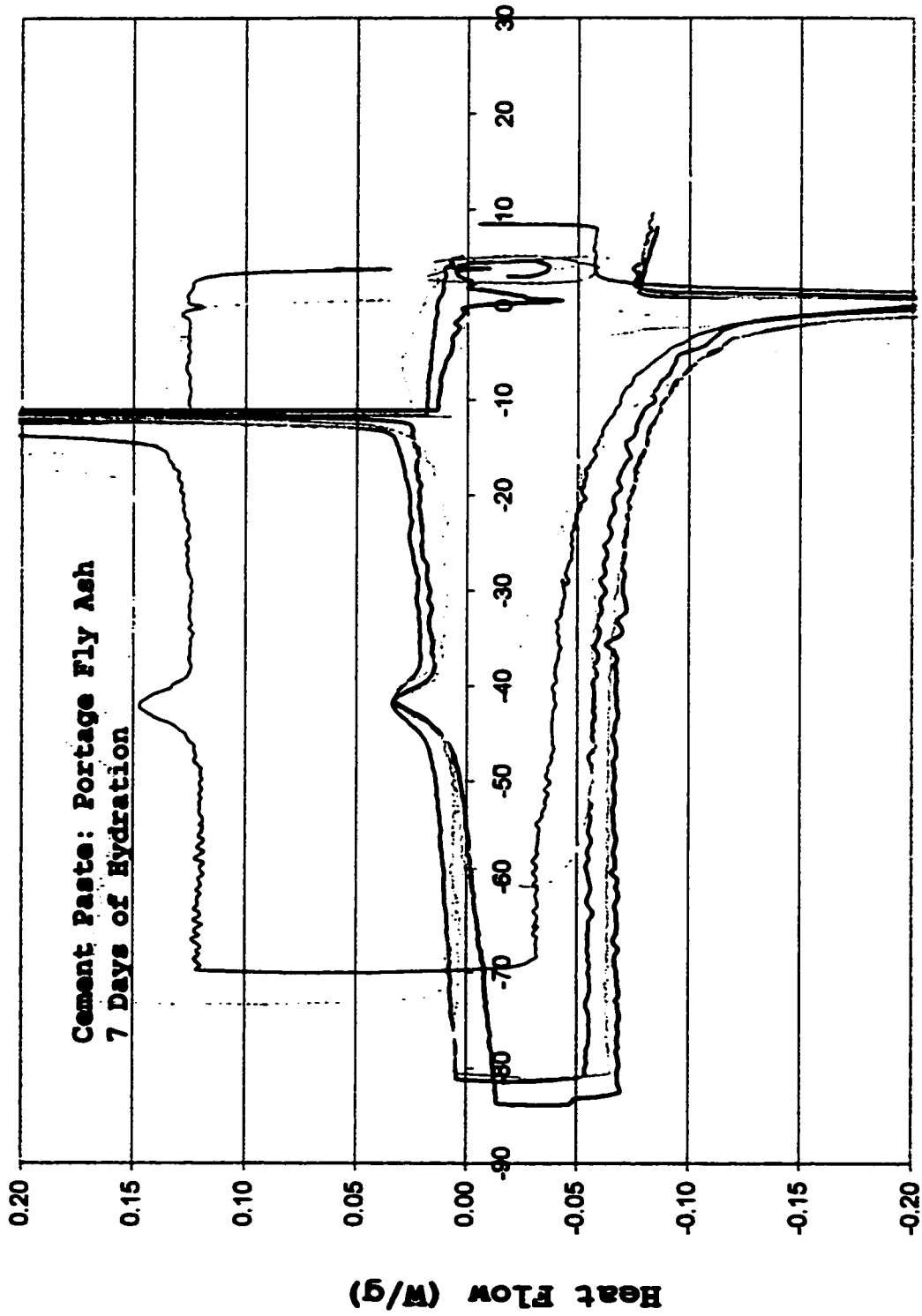
DSC

Cement Paste: Melligan Fly Ash
7 Days of Hydration



DSC

Cement Paste: Portage Fly Ash
7 Days of Hydration

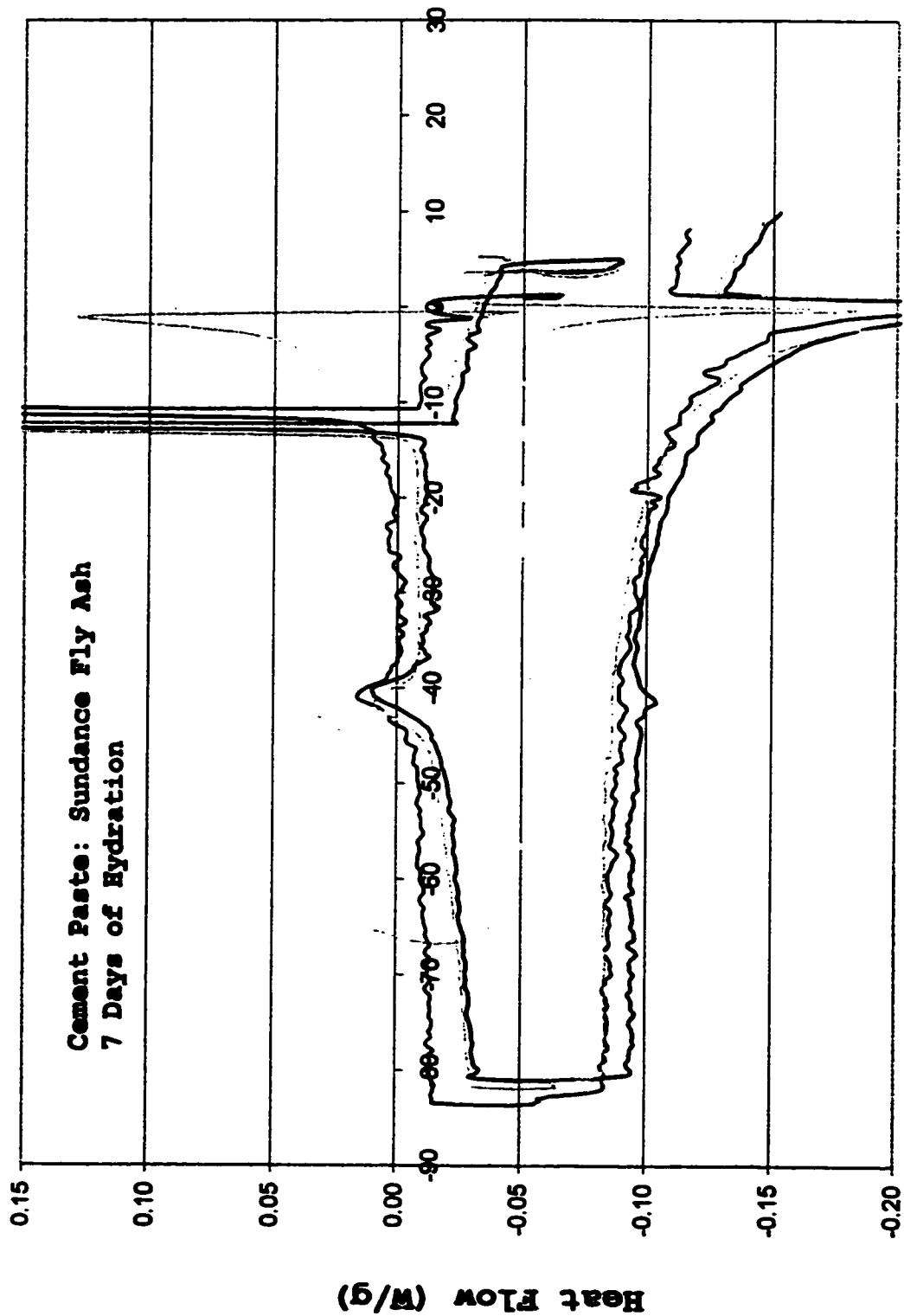


Heat Flow (W/g)

Temperature, (°C)

DSC

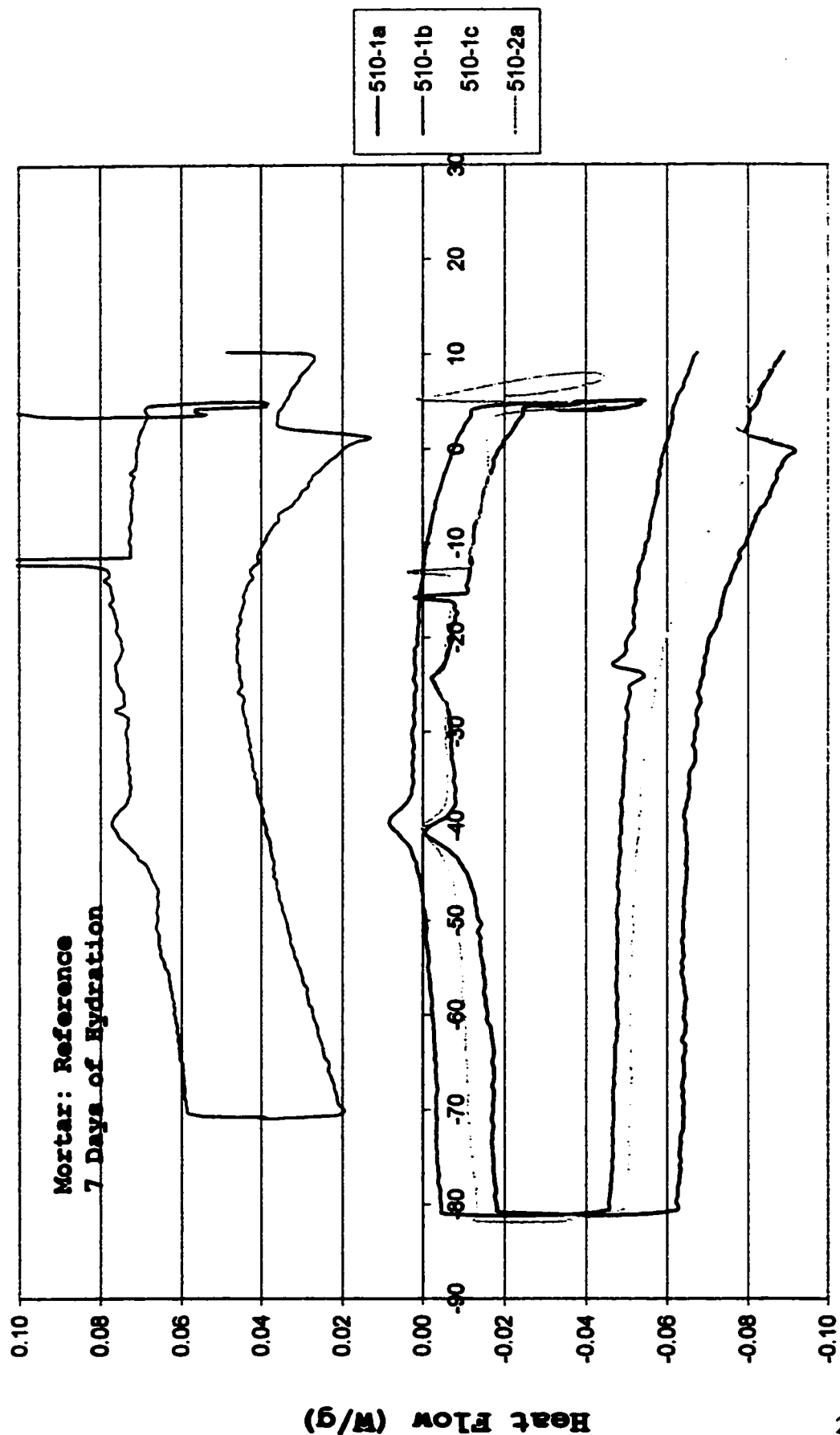
Cement Paste: Sundance Fly Ash
7 Days of Hydration



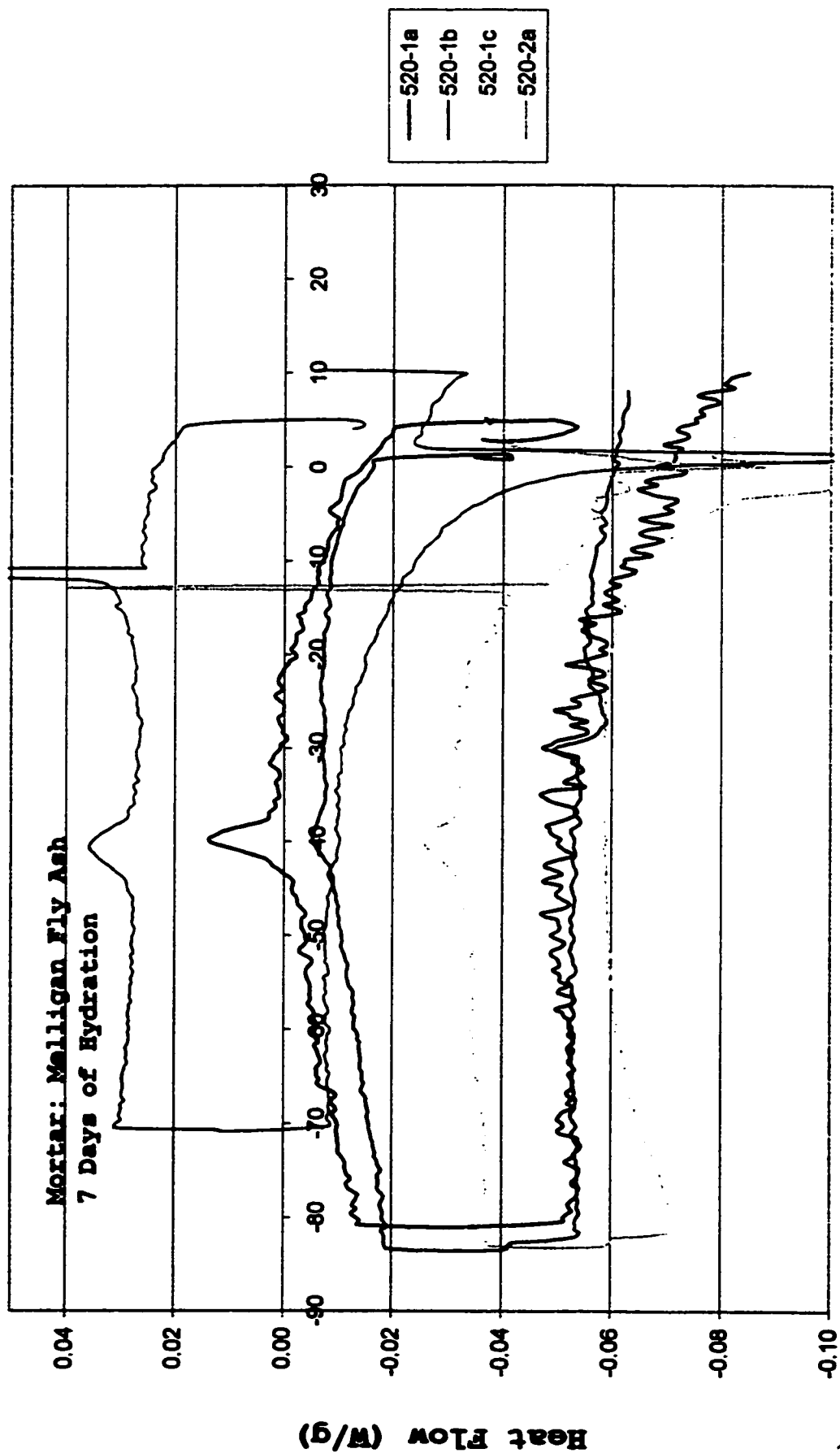
— 440-1a
- - 440-1b
— 440-2a
· · 440-2b

Temperature, (°C)

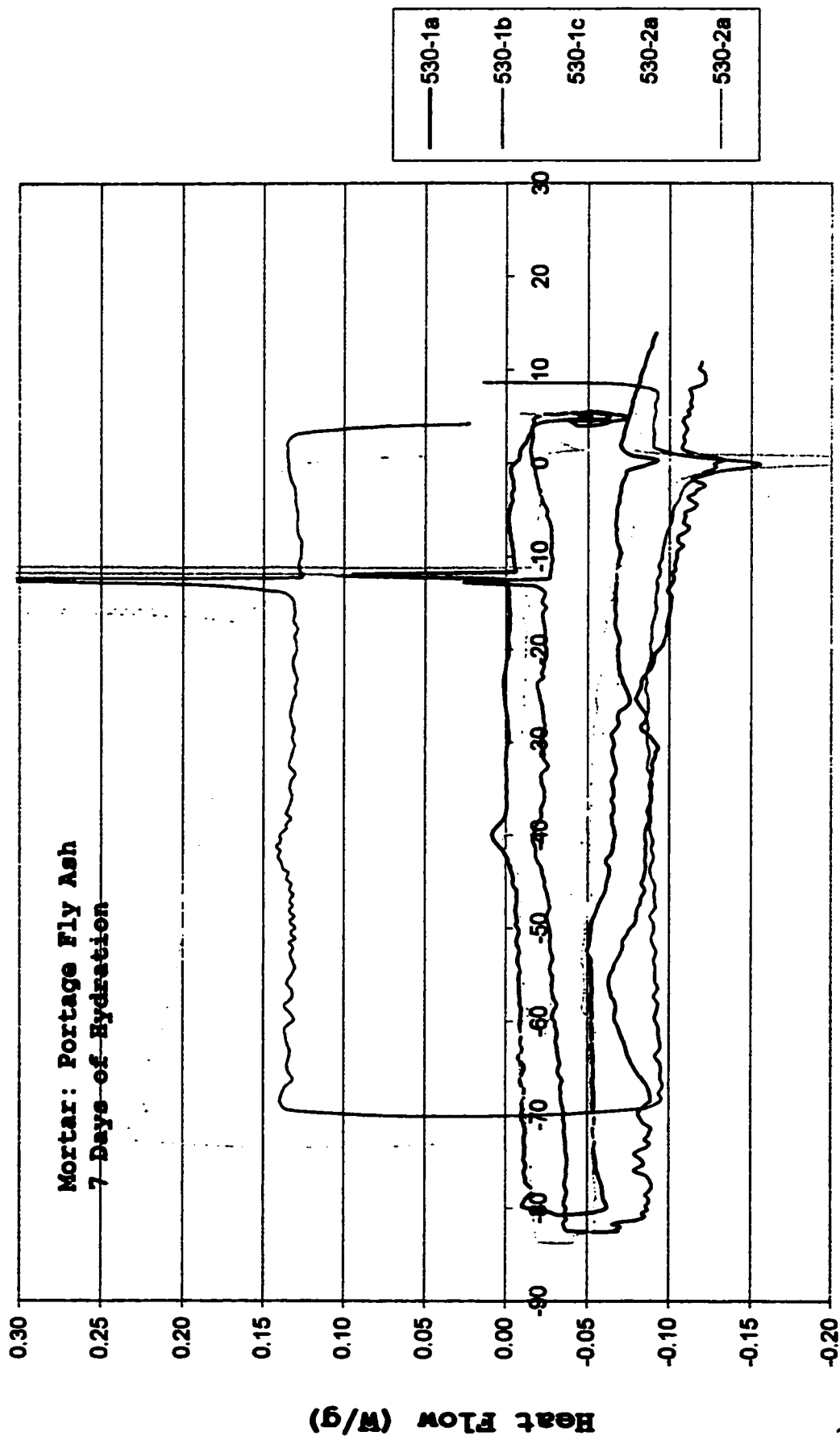
DSC



DSC



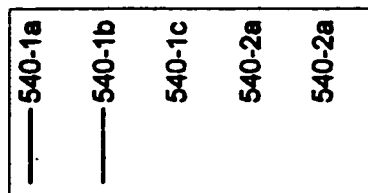
DSC



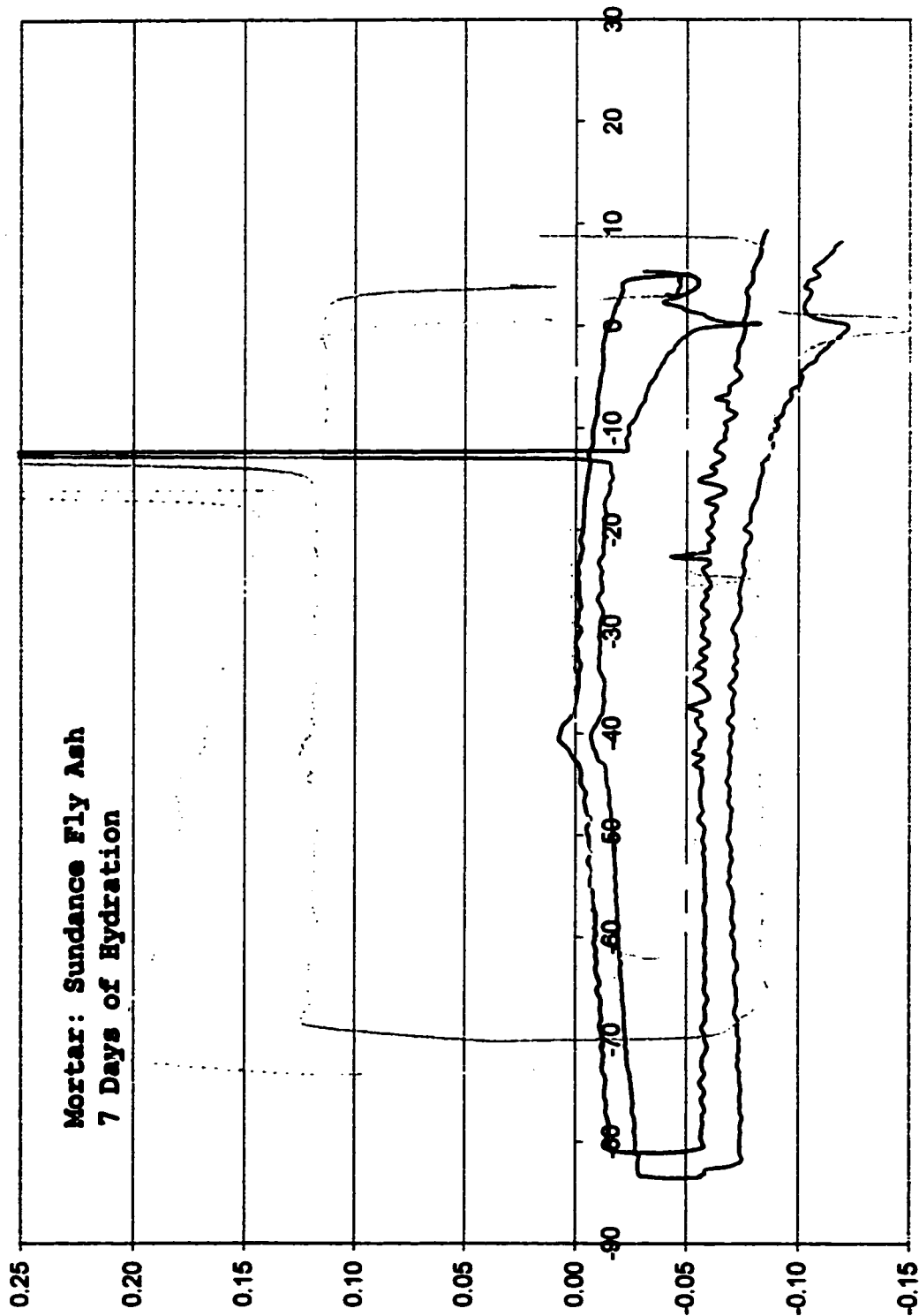
DSC

Mortar: Sundance Fly Ash
7 Days of Hydration

Heat Flow (W/g)



Temperature, (°C)



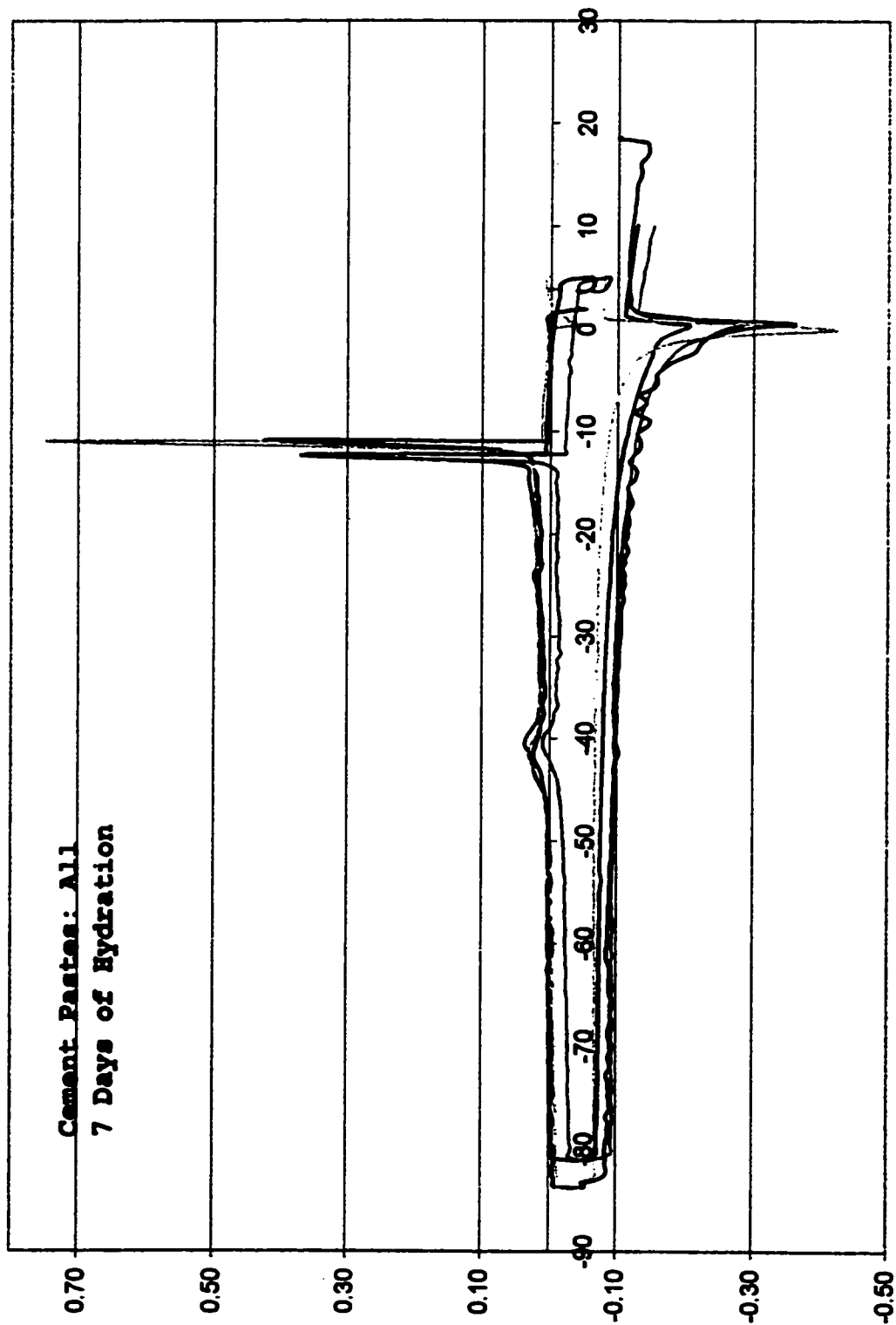
DSC

Cement Pastes: All
7 Days of Hydration

Heat Flow (W/g)

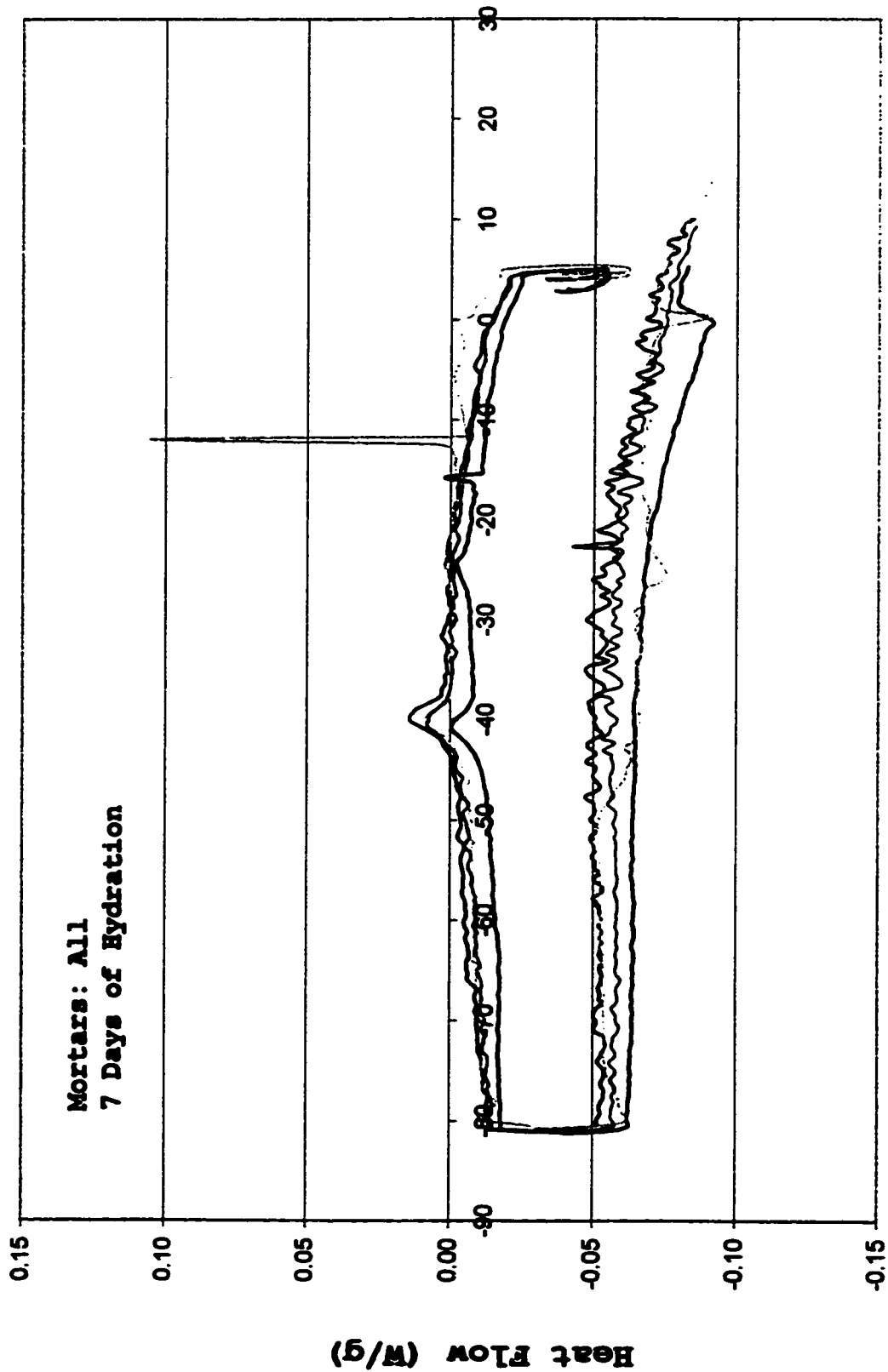
— 410-1a
— 420-2a
— 430-1b
— 440-2a

Temperature, (°C)

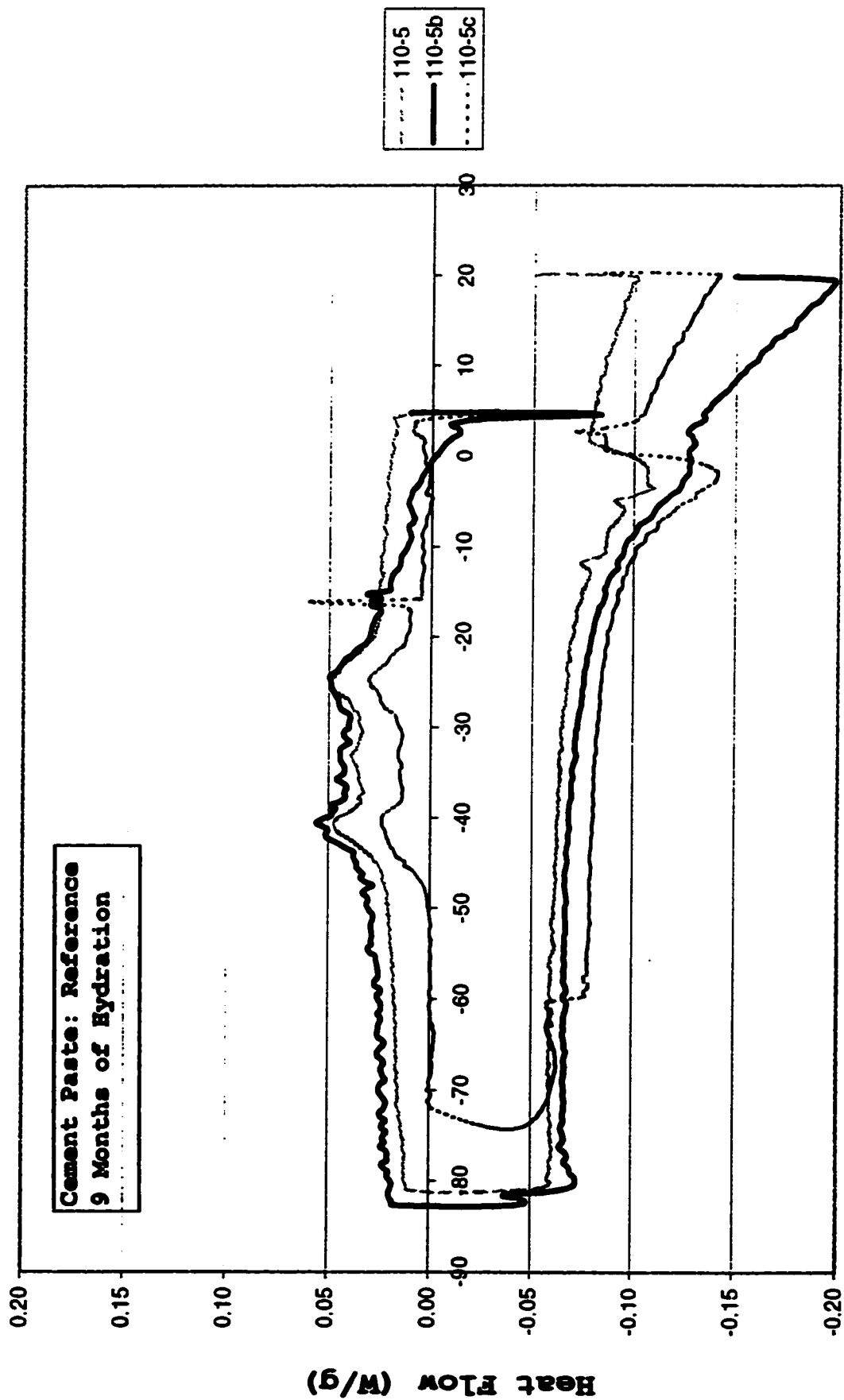


DSC

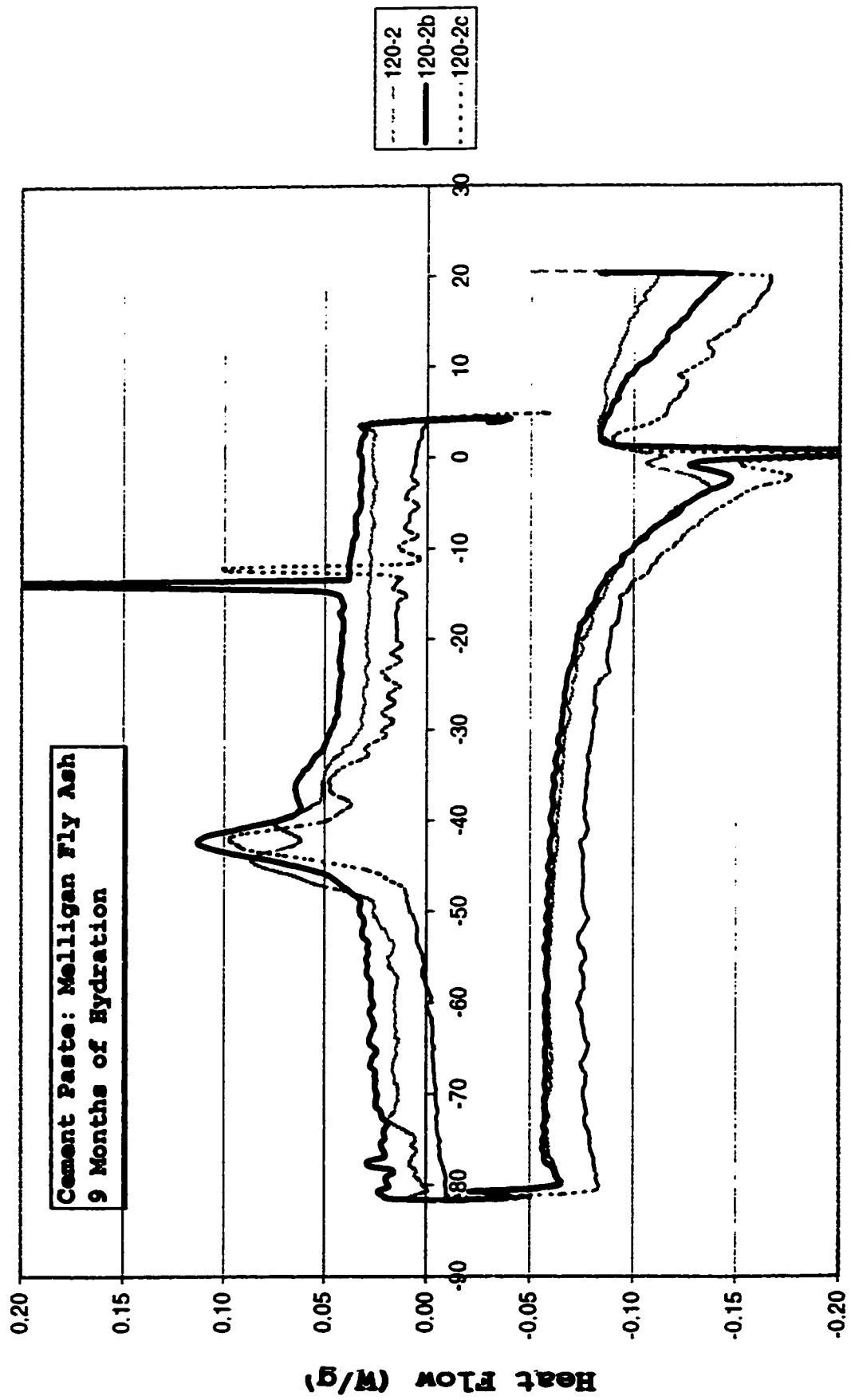
Mortars: All
7 Days of Hydration



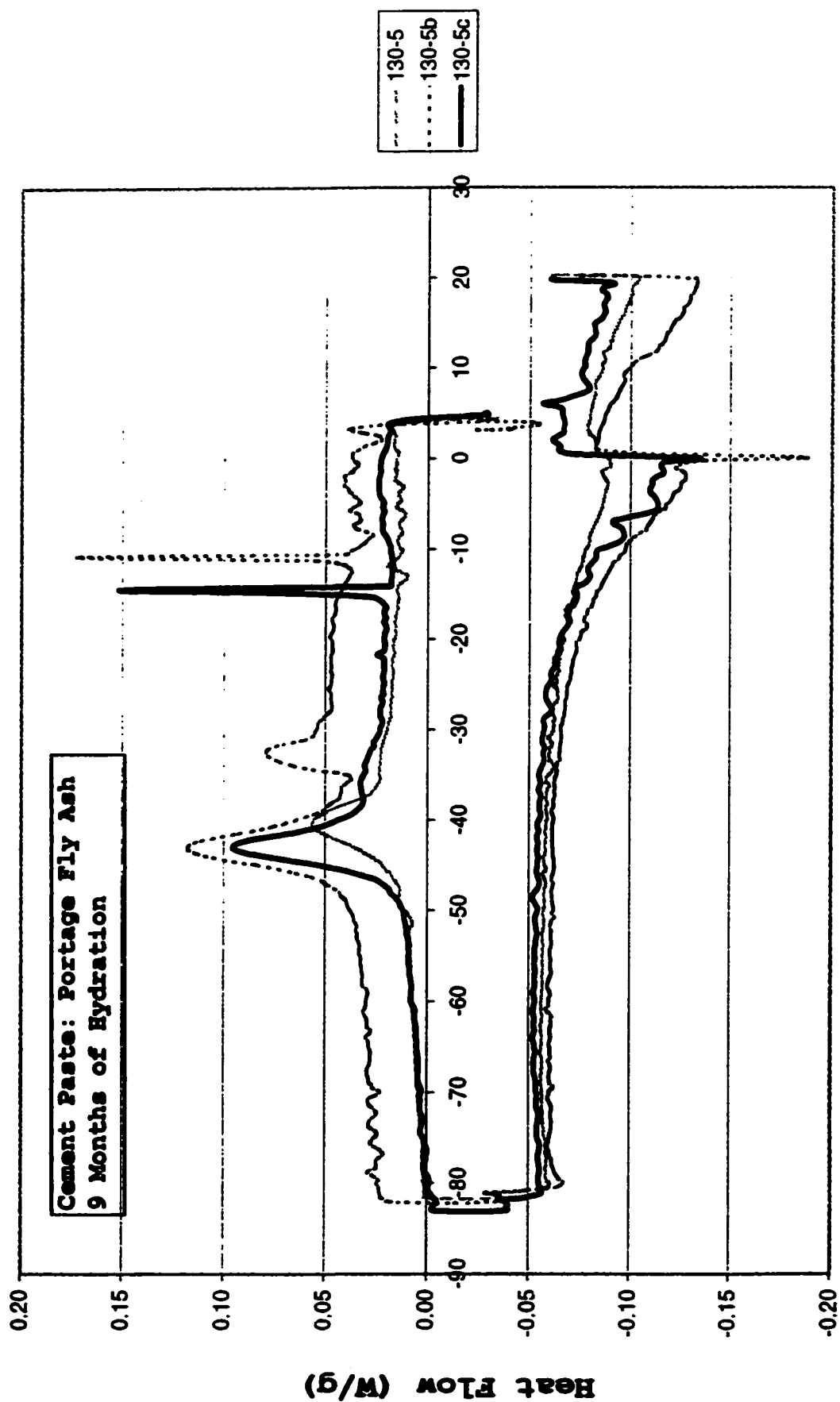
DSC



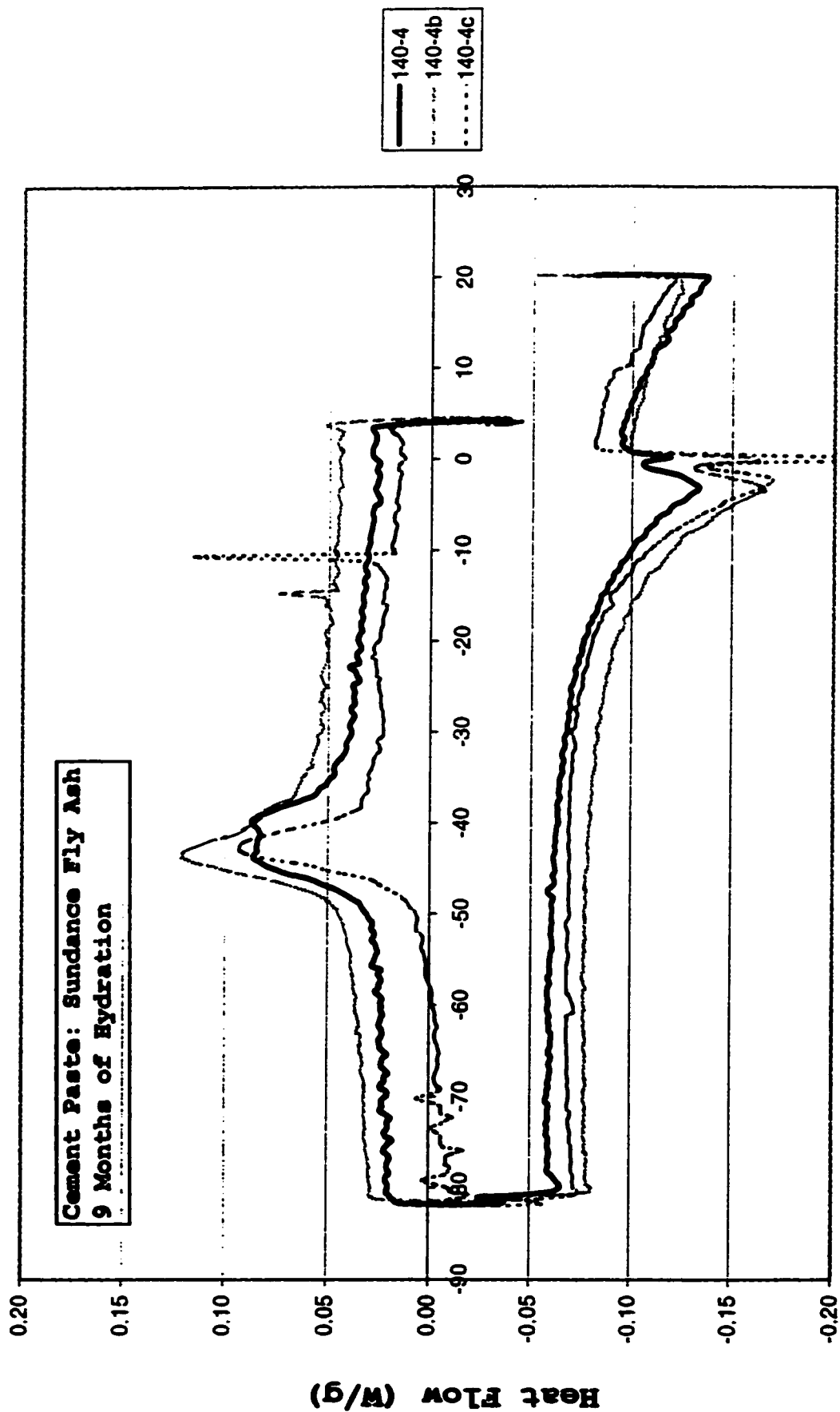
DSC



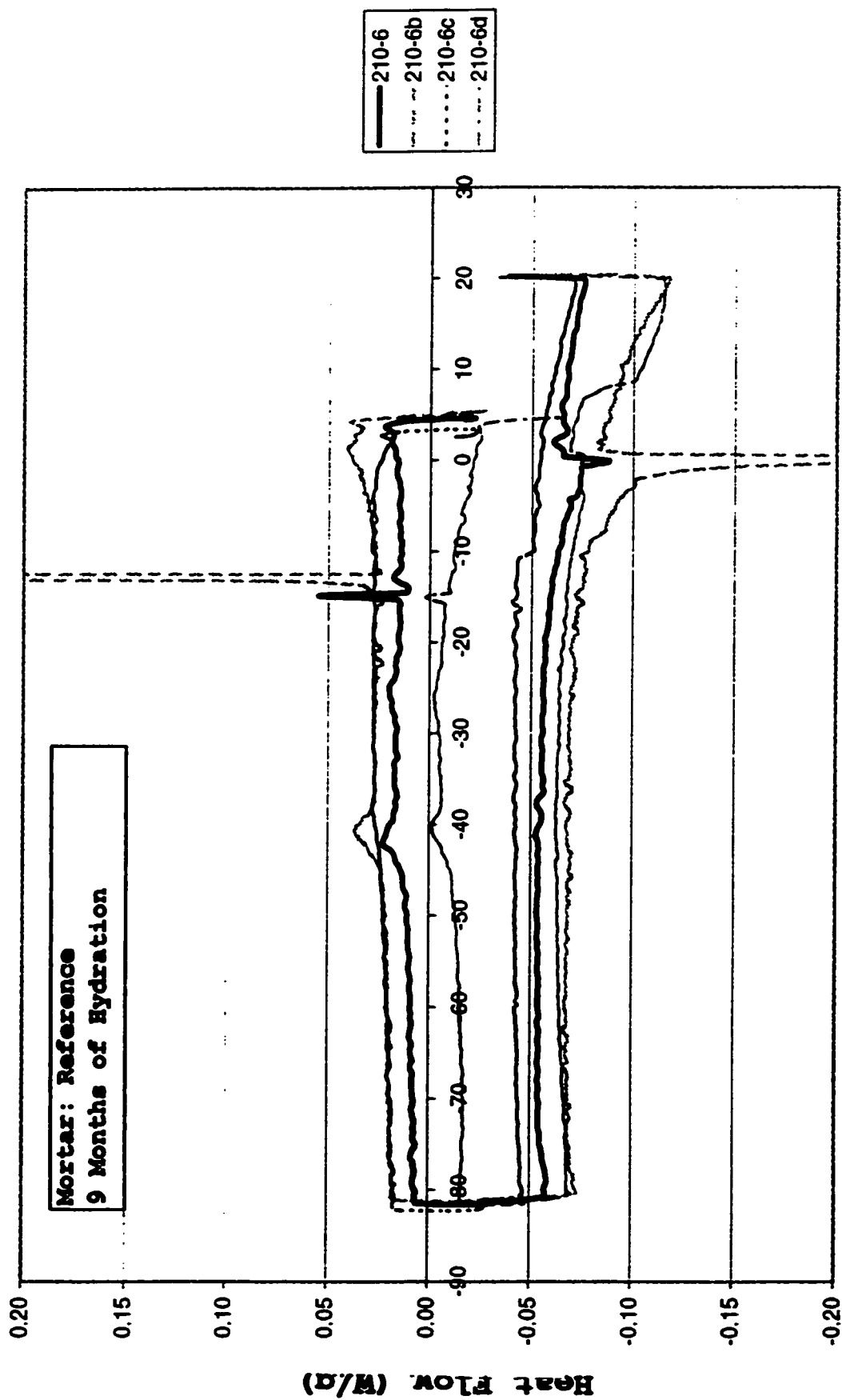
DSC



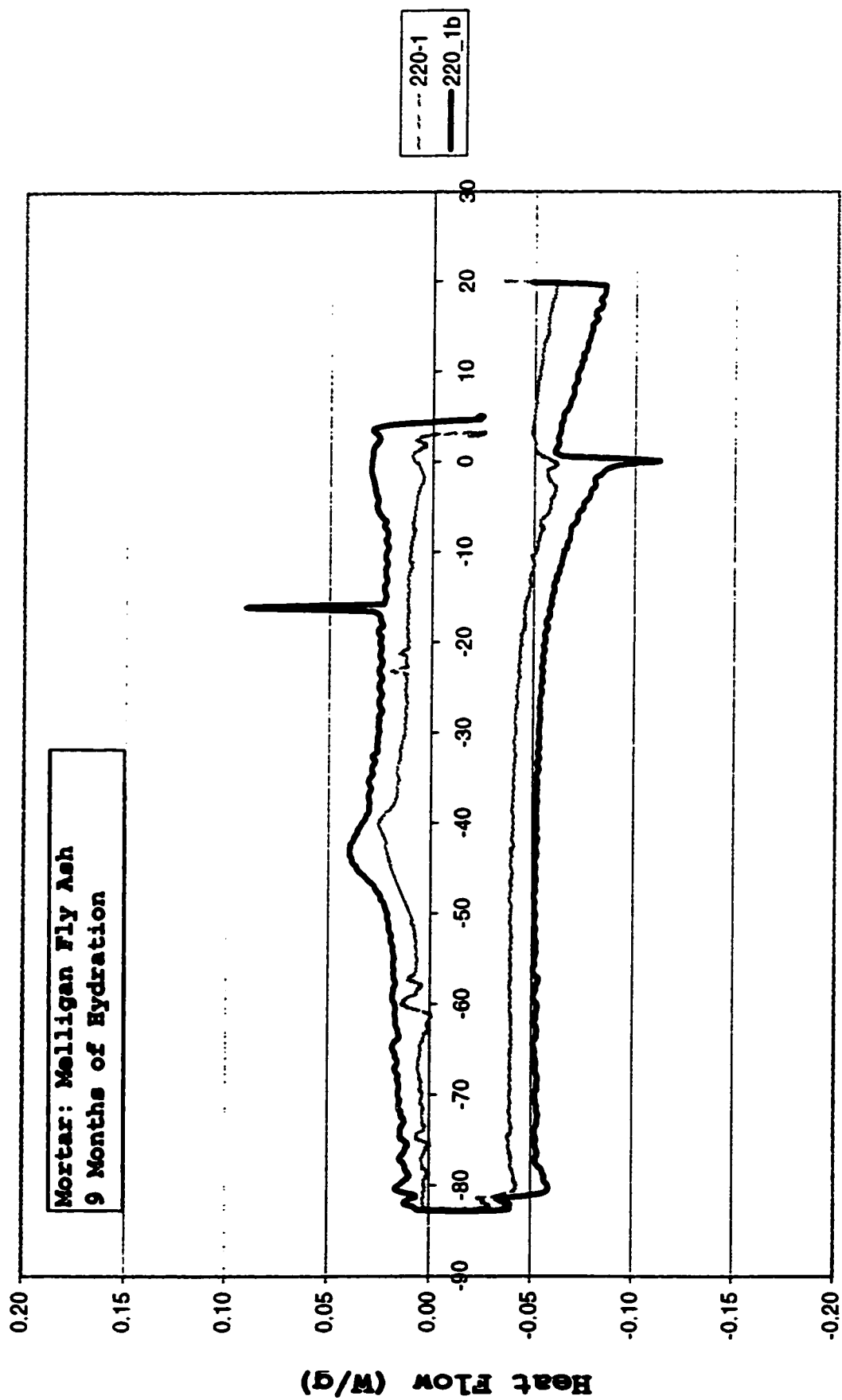
DSC



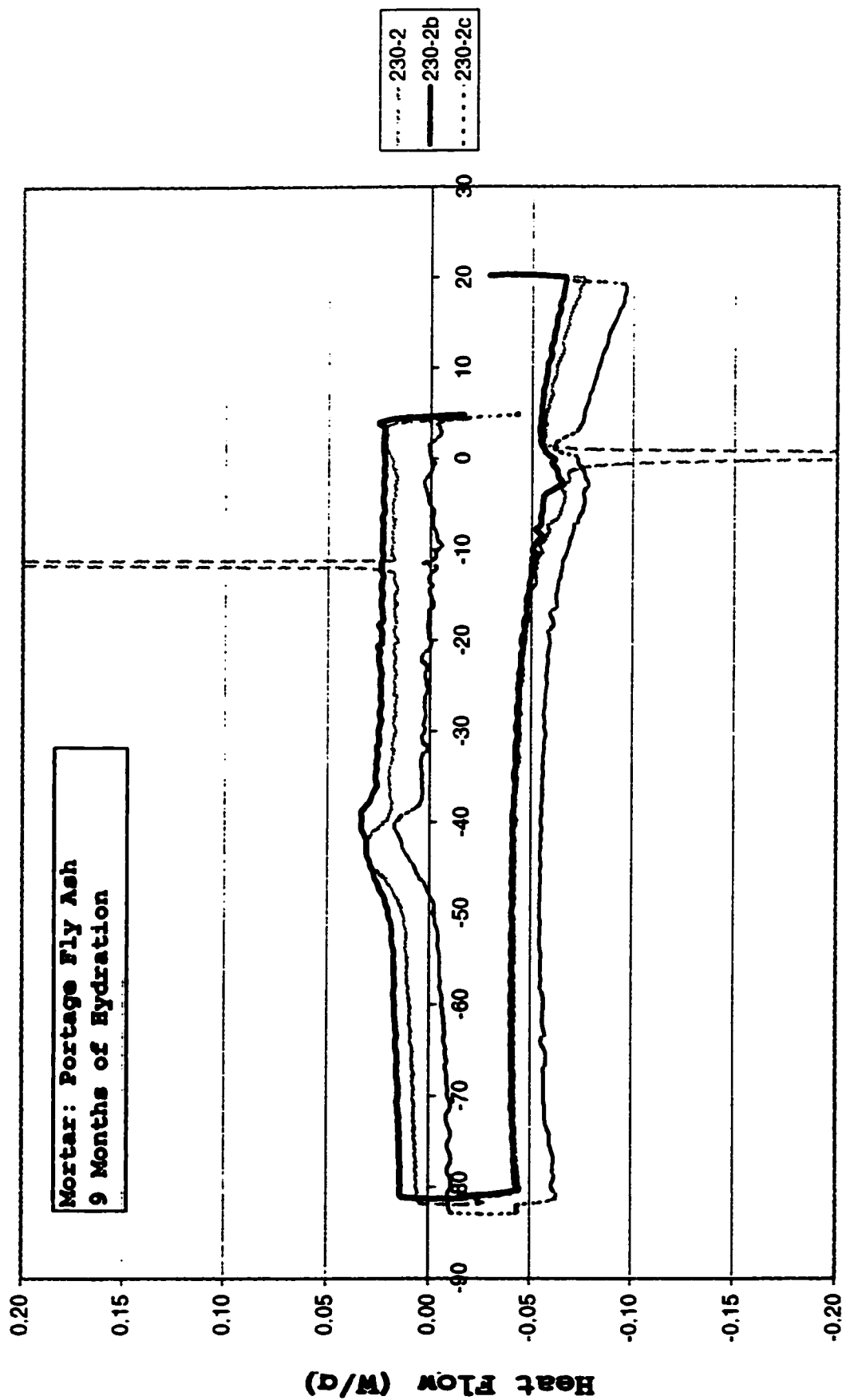
DSC



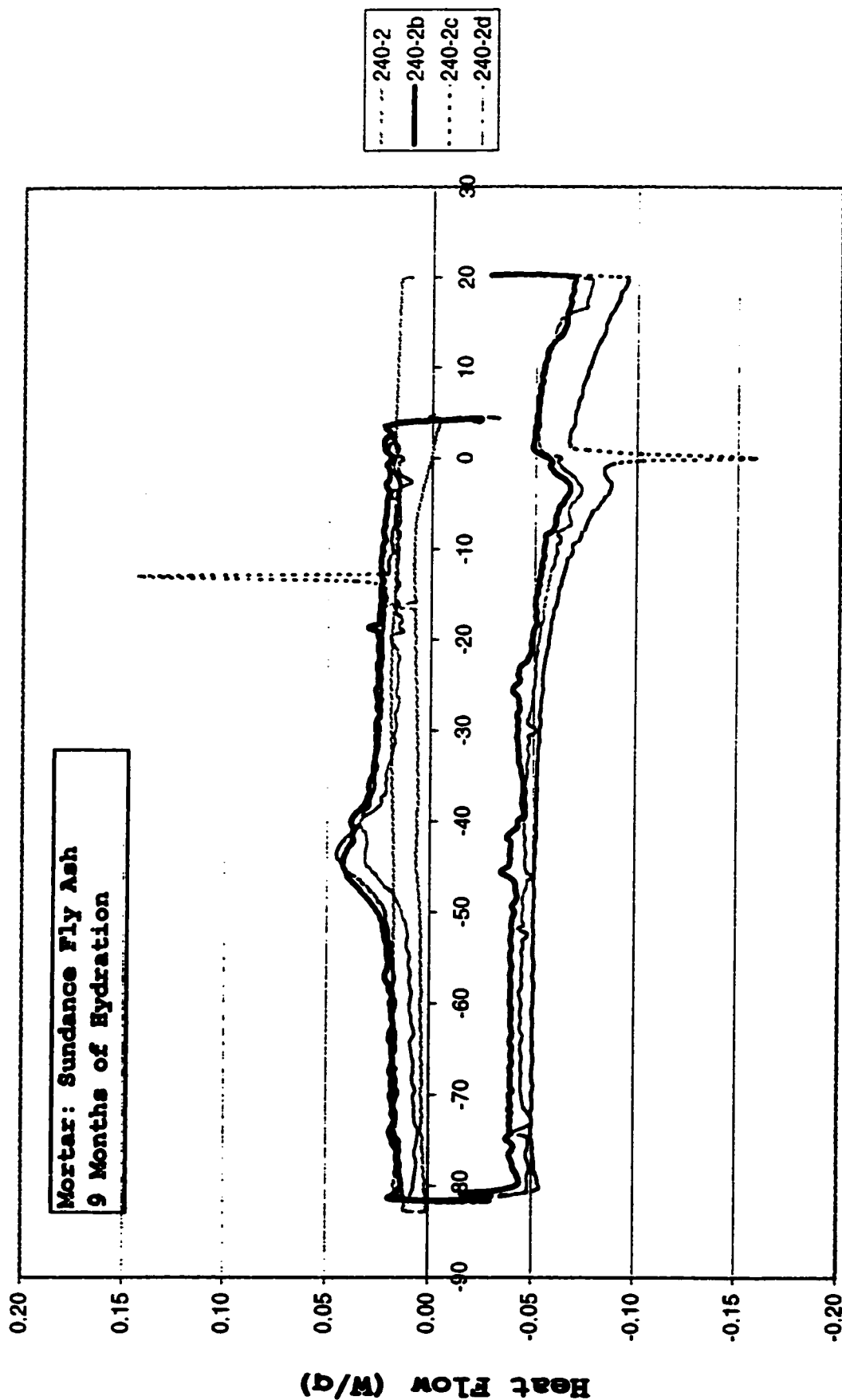
DSC



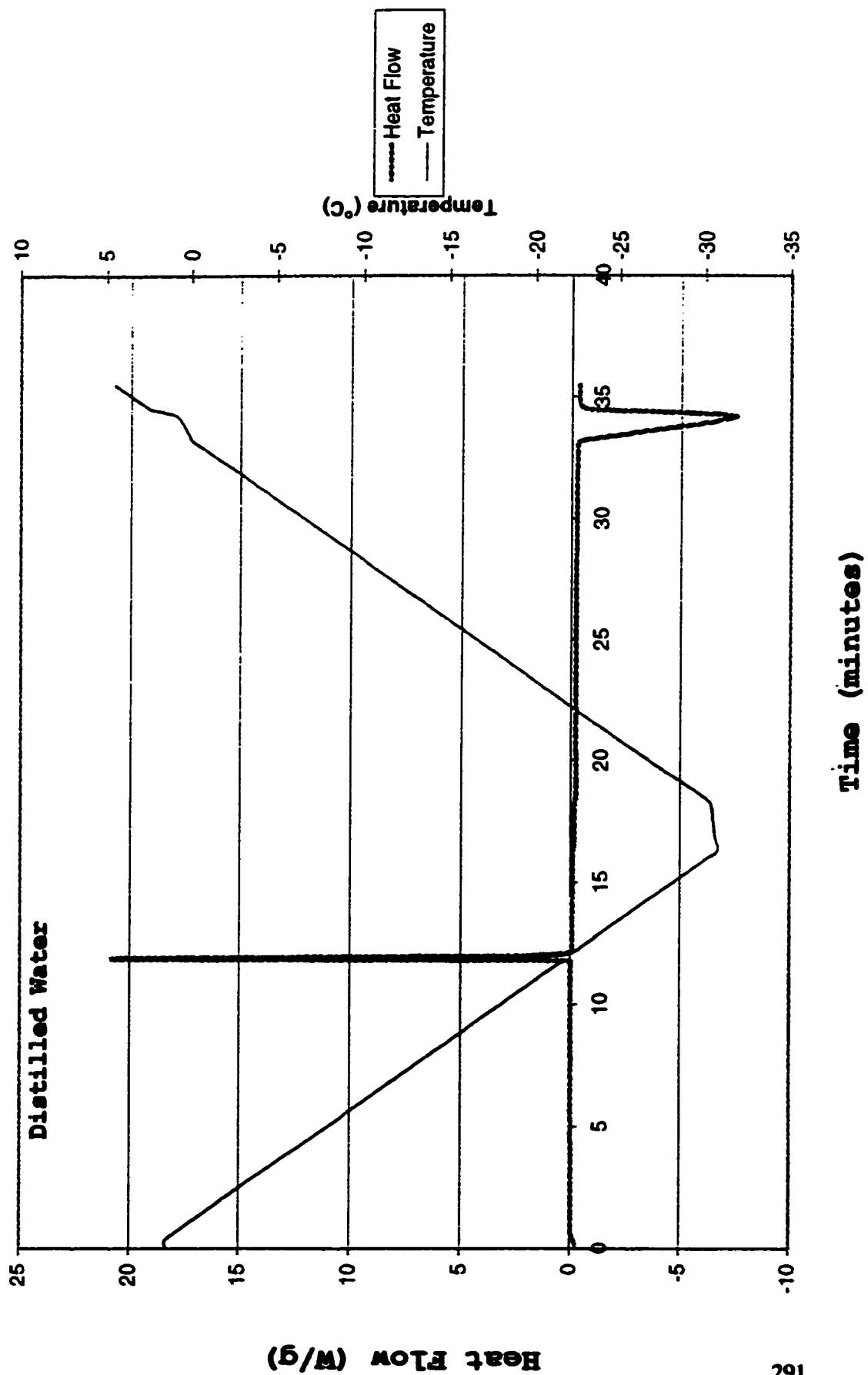
DSC



DSC



DSC



W/C = 0.38
1 Day of Hydration
Natural Pore Solution

File No.	R_1 (Q)	R_2 (Q)	G (F)	PHI	Type	R_1 (Q) (Error)	R_2 (Q) (Error)	R_3 (Q) (Error)	R_4 (Q) (Error)	G (F) (Error)	C (F) (Error)	PHI (Error)	PHI (% Error)
1	1613	501.1	1.03E-11	1.208	4	93.477	122.2	5.80	24.39	2.93E-11	294.59	0.192	15.93
2	1636	524.7	1.08E-11	1.202	4	95.482	125.29	5.84	23.88	3.03E-11	279.45	0.186	15.71
3	1654	541.5	1.13E-11	1.198	4	96.986	127.81	5.86	23.60	3.12E-11	279.62	0.187	15.61
4	1683	561.3	1.10E-11	1.197	4	98.379	128.44	5.85	23.06	2.97E-11	270.33	0.183	15.26
5	1713	586.6	1.17E-11	1.189	4	101.04	133.58	5.90	22.39	3.08E-11	262.97	0.178	14.95
6	1733	614.6	1.18E-11	1.187	4	102.74	136.2	5.93	22.16	3.08E-11	260.95	0.176	14.63
7	1755	636	1.20E-11	1.184	4	104.37	138.51	5.95	21.81	3.07E-11	258.58	0.173	14.65
8	1776	654.9	1.20E-11	1.181	4	105.96	140.17	5.95	21.40	3.02E-11	251.89	0.170	14.41
9	1786	659.5	1.19E-11	1.183	4	105.6	139.83	5.91	21.20	2.89E-11	246.42	0.169	14.24
10	1801	678	1.20E-11	1.179	4	107.32	142.51	5.98	21.02	2.98E-11	247.43	0.167	14.18
11	1816	695.7	1.24E-11	1.175	4	108.89	145.01	6.00	20.84	3.04E-11	245.61	0.166	14.13
12	1831	710.9	1.24E-11	1.174	4	109.96	146.99	6.01	20.62	3.01E-11	243.08	0.164	13.99
13	1850	733.6	1.27E-11	1.170	4	112	148.74	6.03	20.41	3.08E-11	240.84	0.163	13.91
14	1869	758.8	1.37E-11	1.161	4	118.29	156.73	6.16	19.87	3.21E-11	234.94	0.160	13.66
15	1836	869.5	1.48E-11	1.162	4	121	164.39	6.24	19.13	3.26E-11	228.61	0.153	13.30
16	1869	960.9	1.60E-11	1.140	4	127.47	175.22	6.36	18.23	3.47E-11	216.59	0.146	12.85
17	2086	1097	1.73E-11	1.127	4	136.1	189.45	6.52	17.27	3.56E-11	205.45	0.136	12.33
18	2185	1288	1.91E-11	1.112	4	147.26	207.86	6.74	16.39	3.74E-11	183.94	0.124	11.32
19	2289	1476	2.03E-11	1.089	4	159.91	227.38	6.91	15.42	3.96E-11	173.71	0.116	10.81
20	2454	1753	2.07E-11	1.087	4	175.52	254.86	7.15	14.54	3.96E-11	160.98	0.109	10.15
21	2683	2189	2.08E-11	1.073	4	189.58	294.71	7.44	13.46	3.95E-11	147.07	0.099	9.41
22	2641	2615	2.14E-11	1.068	4	228.85	348.19	7.78	12.30	3.19E-11	134.72	0.091	8.77
23	3214	3699	2.28E-11	1.038	4	263.73	412.67	8.21	11.26	3.02E-11	124.07	0.084	8.28
24	3538	5114	2.67E-11	1.011	4	318.52	534.6	9.00	10.45	3.31E-11	112.08	0.078	7.64
25	3659	7091	2.84E-11	0.989	4	378.27	675.51	9.83	9.53	3.18E-11	101.63	0.068	7.01
26	4183	8613	2.88E-11	0.977	4	439.82	839.85	10.52	8.72	2.71E-11	94.82	0.064	6.80
27	4468	12774	2.89E-11	0.964	4	516.41	1051.7	11.56	8.23	2.46E-11	87.46	0.059	6.11
28	4890	16760	2.35E-11	0.957	4	592.57	1385.4	12.42	7.73	2.08E-11	77.57	0.057	5.48
29	4791	22081	2.53E-11	0.942	4	691.94	1717.2	14.23	7.78	2.15E-11	73.97	0.049	5.24
30	4916	27943	2.11E-11	0.944	4	720.82	2047.4	14.85	7.33	1.64E-11	68.49	0.046	4.86
31	4915	35316	2.10E-11	0.937	4	786.34	2597	16.00	7.35	1.55E-11	63.46	0.044	4.46
32	5020	43660	1.79E-11	0.942	4	828.1	3170.5	16.46	7.26	1.22E-11	59.68	0.041	4.37
33	4953	53987	1.69E-11	0.939	4	872.31	4001.8	17.47	7.43	9.47E-12	54.86	0.038	3.85
34	5034	65404	1.48E-11	0.943	4	912.51	4878.2	18.13	7.81	8.10E-12	51.86	0.034	3.54
35	4933	79190	1.48E-11	0.939	4	971.94	6407	19.70	8.09	4.31E-12	48.70	0.032	3.30
36	4913	94654	1.30E-11	0.940	4	997.35	7972.6	20.30	8.42	3.34E-12	44.44	0.032	3.21
37	5040	111910	1.12E-11	0.949	4	1016.8	9722.6	20.17	8.89	2.27E-12	41.86	0.034	2.93
38	5054	135750	1.03E-11	0.952	4	1039	12578	20.86	9.27	1.84E-12	39.53	0.029	2.83
39	5125	155200	8.62E-12	0.960	4	1035	14533	20.20	9.36	1.30E-12	37.8	0.036	3.78
40	5127	185380	8.39E-12	0.959	4	1094.2	18986	21.15	10.51	4.47E-12	35.2	0.034	3.52
41	5036	228040	6.20E-12	0.958	4	1150.5	27365	22.83	12.01	4.30E-12	32.2	0.032	3.30
42	5198	273200	6.87E-12	0.967	4	1122.9	35472	21.61	12.79	3.34E-12	29.5	0.032	3.26
43	5927	297590	4.89E-12	0.969	4	1188.8	38476	20.74	12.93	2.27E-12	27.4	0.032	3.13
44	6824	333980	2.84E-12	1.025	4	1168.6	48094	20.26	14.41	1.32E-12	24.4	0.034	2.93
45	5676	393350	4.14E-12	0.993	4	1144.5	57535	20.53	18.53	1.30E-12	21.86	0.034	2.83
46	6371	493380	2.81E-12	1.021	4	1410	68780	22.13	23.55	1.08E-12	19.5	0.032	2.83
47	5457	632260	4.16E-12	0.990	4	1351.5	148910	24.77	21.40	2.08E-12	17.4	0.031	2.92
48	6201	565780	2.40E-12	1.022	4	1262.1	96721	20.36	42.82	2.08E-12	15.83	0.030	2.82
49	5456	1E+08	4.31E-12	0.984	4	1370.1	556200	23.11	21.95	7.77E-13	14.05	0.030	2.92
50	6865	704600	1.67E-12	1.043	4	1411.2	154730	21.08					

W/C = 0.35
1 Day of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
51	5704	862260	2.8E-12	1.01	4	1349	23.65	2.36E+05	28.49	1.25E-12	44.95	0.026	2.91
52	5590	921400	2.6E-12	1.012	4	1365.1	24.82	2.51E+05	27.26	1.20E-12	45.99	0.030	2.94
53	5472	15+08	2.6E-12	1.008	4	1424	26.02	3.46E+05	32.21	1.32E-12	46.36	0.030	3.01
54	5326	15+08	2E-12	1.026	4	1265.1	19.52	6.22E+05	35.19	7.54E-13	36.81	0.025	2.45
55	5666	25+08	2.7E-12	1.008	4	1514.3	26.63	1.39E+06	63.17	1.30E-12	47.58	0.031	3.09
56	5771	15+08	1.4E-12	1.047	4	1180.9	17.59	3.09E+05	25.70	5.11E-13	36.17	0.024	2.26
57	6082	25+08	2.1E-12	1.023	4	1475.3	24.36	6.16E+05	49.79	9.34E-13	45.27	0.030	2.89
58	7170	15+08	1.1E-12	1.062	4	1219	17.00	2.97E+05	24.73	3.95E-13	36.00	0.024	2.22
59	6220	15+08	1.6E-12	1.04	4	1318.7	21.22	3.19E+05	27.26	6.28E-13	40.07	0.026	2.52
60	6072	75+08	2.1E-12	1.02	4	1565.6	26.11	1.24E+07	184.74	1.00E-12	47.86	0.031	3.06
61	6774	15+08	1.1E-12	1.059	4	1214.6	17.93	2.75E+05	23.76	4.11E-13	36.02	0.024	2.22
62	6553	25+08	1.3E-12	1.046	4	1227.8	18.74	4.75E+05	31.16	4.80E-13	36.19	0.024	2.25
63	6573	25+08	1.4E-12	1.043	4	1266	19.70	6.69E+05	45.34	5.49E-13	37.84	0.026	2.37
64	6779	25+08	1.2E-12	1.055	4	1268.6	18.80	5.49E+05	30.35	4.19E-13	35.10	0.023	2.17
65	6902	25+08	1.3E-12	1.05	4	1240.9	18.80	5.49E+05	33.34	4.69E-13	36.24	0.024	2.25
66	7227	25+08	1E-12	1.053	4	1226.4	17.00	1.13E+06	46.50	5.64E-13	35.02	0.023	2.15
67	6466	35+08	1.5E-12	1.04	4	1367.1	21.05	2.21E+06	69.97	5.99E-13	36.80	0.026	2.50
68	6513	35+08	1.5E-12	1.041	4	1340	20.57	2.07E+06	66.93	5.79E-13	36.90	0.026	2.44
69	6297	25+08	1.6E-12	1.042	4	1368.6	21.73	6.17E+05	45.36	5.87E-13	40.16	0.026	2.52
70	6297	35+08	1.5E-12	1.039	4	1368.2	21.70	1.41E+06	66.21	6.20E-13	40.10	0.026	2.52
71	6703	25+08	1.3E-12	1.046	4	1294.2	19.31	9.04E+05	43.18	4.62E-13	37.44	0.024	2.33
72	6051	35+08	1.7E-12	1.031	4	1466	20.32	1.79E+06	65.23	7.50E-13	42.96	0.026	2.72
73	6469	25+08	1.3E-12	1.049	4	1320.6	20.32	6.85E+05	36.29	5.11E-13	36.58	0.025	2.40
74	7712	25+08	8.3E-13	1.077	4	1335.9	17.32	8.69E+05	41.84	3.11E-13	37.56	0.025	2.26
75	6673	45+08	1.6E-12	1.036	4	1483.2	22.97	4.00E+06	97.53	6.79E-13	42.80	0.026	2.70
76	5992	35+08	1.6E-12	1.026	4	1525.9	25.47	2.35E+06	77.11	8.43E-13	44.91	0.029	2.66
77	6308	25+08	1.4E-12	1.045	4	1363.1	21.44	8.29E+05	42.80	5.59E-13	39.90	0.026	2.49
78	6442	15+08	1.3E-12	1.052	4	1367.9	21.06	3.70E+05	29.98	5.04E-13	40.04	0.026	2.46
79	6951	25+08	1.3E-12	1.049	4	1362.7	20.49	7.93E+05	41.71	5.19E-13	39.57	0.026	2.46
80	6299	55+08	1.6E-12	1.027	4	1507.9	24.09	7.39E+05	136.31	6.19E-13	44.17	0.026	2.61
81	6002	25+08	1.6E-12	1.029	4	1556.2	25.93	1.24E+06	57.34	8.37E-13	46.20	0.030	2.93
82	6776	25+08	1.6E-12	1.026	4	1544.8	26.79	7.86E+05	45.66	8.87E-13	46.36	0.030	2.95
83	6776	25+08	1.3E-12	1.05	4	1236.1	18.24	4.69E+05	31.93	4.79E-13	36.37	0.024	2.26
84	6236	15+08	1.5E-12	1.042	4	1291.9	20.72	4.29E+05	31.17	5.89E-13	36.86	0.025	2.43
85	6336	45+08	1.6E-12	1.026	4	1368.4	21.86	3.12E+06	87.27	7.79E-13	41.43	0.027	2.63
86	5906	25+08	2.4E-12	1.016	4	1480.3	25.60	1.43E+06	62.03	1.09E-12	45.17	0.029	2.90
87	5951	25+08	2.4E-12	1.014	4	1466	26.41	9.13E+05	50.39	1.11E-12	46.33	0.030	2.96
88	6332	15+08	1.6E-12	1.032	4	1269.3	20.05	5.09E+05	34.90	7.03E-13	36.99	0.025	2.47
89	6331	15+08	1.7E-12	1.037	4	1269.2	20.03	2.69E+05	24.74	6.69E-13	36.31	0.026	2.46
90	5733	25+08	2.6E-12	1.005	4	1477.6	25.77	1.07E+06	55.67	1.32E-12	46.52	0.030	3.02
91	6290	15+08	2E-12	1.027	4	1234.1	19.75	3.01E+05	27.13	7.86E-13	36.91	0.025	2.48
92	5790	15+08	2.6E-12	1.011	4	1346.1	23.23	4.57E+05	35.39	1.13E-12	43.14	0.026	2.79
93	5992	15+08	2.6E-12	1.008	4	1268.4	22.00	4.41E+05	34.66	1.17E-12	41.87	0.027	2.71
94	5910	990460	2.6E-12	1.013	4	1213.1	20.53	2.66E+05	26.11	1.09E-12	40.18	0.026	2.59
95	5994	840230	3.5E-12	0.9953	4	1321.4	23.62	2.19E+05	25.92	1.59E-12	44.78	0.029	2.94
96	5214	717690	4.5E-12	0.9916	4	1465.5	26.11	1.69E+05	25.87	2.25E-12	80.36	0.033	3.36
97	5501	650720	4E-12	0.9904	4	1261.6	22.93	1.37E+05	21.06	1.77E-12	44.42	0.029	2.93
98	5342	473100	4E-12	0.9922	4	1270.3	23.78	7.96E+04	16.83	1.65E-12	46.46	0.030	3.06
99	4628	460810	6.3E-12	0.9933	4	1459	30.22	1.02E+05	20.80	3.42E-12	53.98	0.035	3.67

W/C = 0.36
1 Day of Hydration
Normal Pore Solution

File No.	R ₁ (G)	R ₂ (G)	G (F)	Phi	Type	R ₁ (G) (Error)	R ₂ (G) (% Error)	R ₂ (G) (Error)	R ₂ (G) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
101	5277	414870	5.8E-12	0.9733	4	1267	24.01	67462	10.28	2.6784E-12	48.16	0.032	3.24
102	4763	376460	7.4E-12	0.9653	4	1460.4	30.53	67129	17.83	4.1049E-12	56.40	0.037	3.87
103	4771	329120	8.8E-12	0.9487	4	1446.6	30.36	55508	16.66	5.1018E-12	57.99	0.038	4.01
104	4864	273360	8.5E-12	0.9608	4	1377.4	28.14	36637	14.46	7.1579E-12	57.12	0.037	3.94
105	4869	232930	1.1E-11	0.9378	4	1593.9	32.40	36003	15.46	7.1579E-12	67.36	0.044	4.71
106	5278	201080	1.5E-11	0.9196	4	1957.9	37.10	36834	18.22	1.2448E-11	65.32	0.066	6.09
107	4464	168930	1.5E-11	0.9188	4	1911.7	42.82	27046	15.62	1.3069E-11	66.28	0.057	6.17
108	4874	136360	1.3E-11	0.9268	4	1539.6	33.66	16823	12.23	9.8603E-12	75.02	0.046	5.30
109	4899	117980	1.5E-11	0.9237	4	1397.5	28.53	13118	11.12	1.12E-11	72.55	0.046	5.16
110	-87915	320860	7.6E-08	0.2884	4	366940	-536.67	1617600	597.66	1.3862E-08	1802.62	1.313	465.39
111	4698	66346	1.4E-10	0.7858	4	9021.7	100.47	36064	40.64	3.6696E-10	256.90	0.170	21.64
112	5994	66763	1E-11	0.8677	4	1542.1	27.13	8430.1	12.82	1.0874E-11	106.06	0.070	7.22
113	4947	63700	8.7E-12	1.007	4	1457.7	26.47	6571.9	12.24	6.4754E-12	113.08	0.074	7.36
114	8058	47429	8E-12	0.8971	4	845.06	16.71	3207.1	6.95	5.3741E-12	67.48	0.044	4.80
115	4873	41781	1E-11	0.9721	4	794.32	16.30	2743.4	6.57	6.9348E-12	66.53	0.044	4.52
116	4823	36381	1.6E-11	0.9537	4	803.65	16.66	2380.4	6.73	1.0342E-11	71.14	0.047	4.94
117	4897	22008	1.2E-11	0.9832	4	756.48	15.45	1626.3	6.63	9.1578E-12	73.73	0.049	5.08
118	4832	24296	1.6E-11	0.96	4	721.14	14.82	1681.2	6.84	1.204E-11	77.41	0.062	6.37
119	4832	20005	1.3E-11	0.9775	4	566.76	11.94	1243.6	6.22	9.8019E-12	72.11	0.048	4.92
120	4894	16264	1.4E-11	0.9803	4	560.7	11.46	1078.7	6.63	1.162E-11	77.97	0.062	5.32
121	4806	12689	1.3E-11	0.9845	4	502.49	10.46	883.76	6.86	1.0731E-11	81.57	0.065	5.60
122	4891	8966	1.2E-11	1.01	4	436.71	9.31	713.11	7.13	1.0419E-11	85.29	0.057	5.68
123	4523	7402	9.6E-12	1.006	4	362.79	8.02	549.4	7.42	8.6804E-12	86.90	0.060	5.77
124	4275	5240	8.1E-12	1.068	4	312.07	7.30	441.63	8.43	8.1014E-12	100.31	0.066	6.36
125	3631	3401	5.4E-12	1.114	4	242.08	6.16	321.6	9.46	6.0108E-12	111.46	0.076	6.75
126	3464	2030	4.6E-12	1.149	4	194.81	5.64	248.44	12.12	6.9146E-12	140.79	0.085	8.27
127	2922	1267	5.4E-12	1.175	4	166.75	5.36	186.24	15.40	9.6867E-12	178.90	0.120	10.25
128	2463	875.5	6.1E-12	1.186	4	132.6	5.34	166.34	17.26	1.2139E-11	200.43	0.135	11.36
129	2134	761.6	7E-12	1.198	4	114.92	5.39	146.4	19.22	1.5932E-11	223.43	0.151	12.56
130	1829	667.8	7.4E-12	1.204	4	106.77	5.48	135	20.52	1.7759E-11	236.76	0.161	13.36

W/O = 6.36
1 Day of Hydration
Neutral Pore Solution

File No.	R ₁ (μ)	R ₂ (μ)	G (°)	Phi	Type	R ₁ (μ) (Error)	R ₂ (μ) (Error)	R ₁ (μ) (% Error)	R ₂ (μ) (Error)	R ₂ (μ) (% Error)	G (°) (Error)	G (°) (% Error)	Phi (Error)	Phi (% Error)
1	374.3	1049	6.27E-10	0.820	4	36.765	39.525	9.82	37.7	3.77	1.37E-10	21.92	0.017	2.08
2	368.8	1074	6.36E-10	0.817	4	36.722	39.459	10.01	37.6	3.67	1.36E-10	21.17	0.016	2.00
3	375.5	1082	6.21E-10	0.819	4	36.186	39.665	9.64	37.5	3.57	1.30E-10	20.99	0.016	1.96
4	378.3	1108	5.90E-10	0.821	4	35.513	39.243	9.39	37.4	3.46	1.20E-10	20.41	0.016	1.91
5	378.7	1121	5.92E-10	0.820	4	35.14	37.84	9.35	37.4	3.36	1.17E-10	19.86	0.015	1.86
6	375.9	1132	5.97E-10	0.819	4	37.049	39.806	9.83	37.4	3.53	1.24E-10	20.74	0.016	1.95
7	372.6	1142	5.82E-10	0.820	4	37.26	40.111	9.99	37.4	3.51	1.20E-10	20.80	0.016	1.93
8	379	1148	5.71E-10	0.821	4	36.525	39.36	9.64	37.4	3.43	1.16E-10	20.32	0.016	1.90
9	376.6	1161	5.77E-10	0.820	4	37.663	40.577	10.00	37.4	3.50	1.19E-10	20.63	0.016	1.93
10	375.7	1172	5.69E-10	0.820	4	37.864	40.786	10.08	37.4	3.48	1.16E-10	20.53	0.016	1.92
11	375.7	1183	5.68E-10	0.820	4	38.032	40.962	10.12	37.4	3.46	1.16E-10	20.47	0.016	1.92
12	376.1	1192	5.63E-10	0.820	4	38.262	42.31	10.44	37.4	3.55	1.16E-10	20.98	0.016	1.96
13	377	1221	6.19E-10	0.813	4	41.988	45.396	11.14	37.4	3.72	1.37E-10	22.11	0.017	2.08
14	364.3	1285	6.43E-10	0.810	4	45.356	49.277	11.80	37.4	3.63	1.51E-10	23.51	0.018	2.21
15	365	1380	6.78E-10	0.805	4	47.633	52.259	12.42	37.4	3.79	1.61E-10	23.75	0.018	2.24
16	362.4	1482	6.69E-10	0.804	4	51.094	59.186	13.01	37.4	3.79	1.66E-10	24.86	0.019	2.31
17	379.2	1621	7.44E-10	0.794	4	53.403	66.155	14.08	37.4	3.65	1.79E-10	24.10	0.018	2.49
18	394.6	1767	7.35E-10	0.792	4	60.716	67.955	15.39	37.4	3.65	1.66E-10	26.53	0.020	2.49
19	397.6	2030	7.69E-10	0.785	4	77.052	87.43	19.38	37.4	4.31	2.36E-10	30.93	0.023	2.91
20	417.8	2440	7.12E-10	0.783	4	95.723	110.66	22.91	37.4	4.54	2.46E-10	34.51	0.025	3.22
21	416.3	3163	6.53E-10	0.778	4	124.34	148.46	28.87	37.4	4.60	2.46E-10	38.12	0.027	3.52
22	378.7	4390	6.69E-10	0.768	4	158.35	198.84	41.81	37.4	4.56	2.67E-10	40.10	0.028	3.71
23	263.2	6186	6.89E-10	0.760	4	212.28	264.5	74.66	37.4	4.60	2.60E-10	43.41	0.030	3.69
24	162.1	8770	4.59E-10	0.764	4	246.3	359.04	161.94	37.4	4.09	1.90E-10	41.31	0.028	3.72
25	84.83	12001	2.86E-10	0.763	4	264.08	458.25	334.86	37.4	3.82	1.17E-10	41.07	0.028	3.56
26	57.77	16043	2.05E-10	0.764	4	325.55	602.21	563.53	37.4	3.69	6.52E-11	40.85	0.027	3.46
27	104.4	20990	1.39E-10	0.813	4	337.6	703.72	323.37	37.4	3.43	5.37E-11	38.56	0.026	3.15
28	186.6	25983	1.10E-10	0.823	4	361.34	861.54	179.82	37.4	3.33	4.04E-11	36.78	0.024	2.94
29	183.1	31680	7.84E-11	0.840	4	360.76	1034.2	188.53	37.4	3.27	2.79E-11	35.22	0.023	2.74
30	241.1	39977	6.46E-11	0.848	4	368.19	1346.8	161.42	37.4	3.46	2.29E-11	35.39	0.023	2.72
31	229.6	49949	5.13E-11	0.890	4	401.39	1648.9	174.82	37.4	3.53	1.77E-11	34.36	0.022	2.60
32	456.7	66276	5.27E-11	0.896	4	413.27	2094.5	2094.5	37.4	3.67	1.74E-11	33.00	0.021	2.50
33	431.3	66407	4.44E-11	0.864	4	453.69	2810.3	105.19	37.4	4.11	1.51E-11	34.09	0.022	2.58
34	417.1	82344	3.63E-11	0.875	4	439.76	3410	105.43	37.4	4.14	1.14E-11	31.51	0.020	2.33
35	466.3	100650	3.37E-11	0.877	4	464.67	4573.7	454	37.4	4.54	1.05E-11	31.23	0.020	2.30
36	407.2	116360	2.97E-11	0.862	4	487.76	5964.7	119.78	37.4	4.65	8.09E-12	31.51	0.020	2.28
37	378.3	141430	2.03E-11	0.804	4	443.71	8649.6	117.29	37.4	4.70	5.60E-12	27.27	0.018	1.95
38	504.6	163160	1.91E-11	0.807	4	502.65	9179.9	99.67	37.4	5.56	5.60E-12	28.49	0.019	2.10
39	618.7	211430	1.87E-11	0.807	4	521.84	13536	84.21	37.4	6.40	5.43E-12	28.01	0.019	2.07
40	397.9	259080	1.47E-11	0.821	4	479.41	18844	120.49	37.4	6.53	3.90E-12	25.85	0.017	1.82
41	583.3	312360	1.46E-11	0.819	4	627.33	26041	107.55	37.4	6.98	3.69E-12	31.91	0.021	2.25
42	602.5	361850	1.22E-11	0.828	4	594.8	35674	99.39	37.4	9.32	3.69E-12	29.24	0.019	2.05
43	897.5	533980	1.46E-11	0.915	4	622.15	68678	89.32	37.4	12.86	4.37E-12	29.32	0.019	2.08
44	776.5	600660	1.01E-11	0.937	4	690.91	96828	11.90	37.4	14.65	3.11E-12	30.65	0.020	2.12
45	346.3	730920	7.24E-12	0.958	4	663.3	106530	94.79	37.4	14.65	2.12E-12	29.24	0.018	1.96
46	301.4	789620	6.00E-12	0.968	4	658.66	102410	165.36	37.4	12.97	1.47E-12	24.22	0.016	1.63
47	352.9	911860	5.46E-12	0.971	4	642.26	124620	13.70	37.4	13.70	1.26E-12	22.85	0.015	1.53
48	197.1	1E+08	3.53E-12	0.997	4	587.06	159920	297.55	37.4	15.47	8.62E-13	24.42	0.016	1.59
49	487	2E+08	5.69E-12	0.967	4	735.71	494160	151.07	37.4	30.45	1.70E-12	30.08	0.020	2.02
50	346.1	2E+08	4.50E-12	0.978	4	756.57	702130	218.60	37.4	36.32	1.50E-12	30.55	0.020	2.04

W/C = 0.36
1 Day of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
51	365.9	1E+08	4E-12	0.9898	4	758.82	191.19	2.51E+05	21.69	1.22E-12	30.73	0.020	2.02
52	8.345	1E+08	3.1E-12	1.003	4	782.74	9490.56	3.50E+05	26.41	9.89E-13	31.87	0.021	2.05
53	0.44341	1E+08	3E-12	1.005	4	969.12	135116.46	2.95E+05	16.71	7.09E-13	23.76	0.015	1.54
54	278.7	2E+08	2.4E-12	1.019	4	635.82	228.14	4.19E+05	24.00	5.80E-13	24.82	0.016	1.66
55	61.37	1E+08	2.3E-12	1.02	4	644.83	1060.73	1.57E+05	14.75	6.80E-13	25.19	0.016	1.60
56	13.44	1E+08	2.6E-12	1.014	4	691.85	5148.44	2.12E+05	16.07	6.89E-13	27.19	0.018	1.74
57	480.4	7E+08	2.1E-12	1.023	4	695.3	178.04	8.43E+05	119.49	8.91E-13	32.55	0.021	2.07
58	314.7	4E+08	3.3E-12	0.9898	4	785.19	249.50	2.86E+05	69.03	6.91E-13	29.91	0.019	1.93
59	590.5	2E+08	1.7E-12	1.037	4	524.81	95.35	6.13E+05	24.85	3.34E-13	19.66	0.013	1.23
60	98.65	1E+08	2.2E-12	1.02	4	726.44	736.36	2.52E+05	19.36	8.25E-13	27.86	0.016	1.77
61	135.7	2E+08	2.7E-12	1.009	4	649.86	478.92	7.44E+05	31.26	6.60E-13	31.47	0.016	1.59
62	393.1	3E+08	3.1E-12	1.001	4	625.11	200.90	1.16E+05	44.01	9.69E-13	31.47	0.020	2.04
63	27.19	3E+08	2.5E-12	1.012	4	613.16	2255.09	1.09E+05	36.24	5.84E-13	23.19	0.015	1.49
64	211.7	2E+08	1.9E-12	1.03	4	762.08	359.86	4.32E+05	26.13	6.64E-13	28.99	0.019	1.82
65	322	1E+08	2.6E-12	1.012	4	871.3	270.59	3.76E+05	26.16	6.69E-13	33.65	0.022	2.16
66	369.8	2E+08	1.7E-12	1.036	4	506.36	136.63	2.35E+05	15.39	3.32E-13	19.21	0.012	1.20
67	284.1	1E+08	2.6E-12	1.011	4	765.52	269.45	3.06E+05	21.93	7.59E-13	29.27	0.019	1.66
68	142.6	1E+08	2.4E-12	1.016	4	707.49	466.48	2.75E+05	20.01	6.54E-13	27.10	0.018	1.73
69	180.8	2E+08	2.1E-12	1.022	4	651.84	390.53	7.46E+05	30.72	5.18E-13	24.36	0.016	1.65
70	127	2E+08	2.6E-12	1.011	4	633.86	499.09	4.95E+05	24.99	6.10E-13	23.91	0.016	1.54
71	42.14	3E+08	2.5E-12	1.015	4	682.36	443.09	4.06E+05	23.87	6.39E-13	25.95	0.017	1.68
72	349.1	3E+08	2.3E-12	1.017	4	592.78	1382.98	1.15E+05	36.09	5.09E-13	21.91	0.014	1.40
73	259.4	2E+08	3.1E-12	1	4	771.18	220.91	1.07E+05	40.60	8.99E-13	29.24	0.019	1.90
74	521.8	2E+08	2E-12	1.027	4	605	234.13	4.83E+05	24.01	4.53E-13	22.80	0.015	1.44
75	130.4	4E+08	1.8E-12	1.032	4	682.41	132.70	2.48E+05	57.11	4.66E-13	25.66	0.017	1.62
76	130.4	2E+08	2.7E-12	1.008	4	671.93	564.30	6.54E+05	31.87	7.87E-13	28.97	0.019	1.87
77	139.3	2E+08	2.2E-12	1.021	4	604.19	433.73	4.45E+05	23.12	5.03E-13	22.87	0.015	1.46
78	496.3	4E+08	3.7E-12	0.9999	4	717.37	157.21	2.07E+05	56.20	1.01E-12	27.41	0.018	1.80
79	351.2	3E+08	3.4E-12	0.995	4	763.61	225.97	1.13E+05	43.60	1.06E-12	30.86	0.020	2.02
80	387.2	4E+08	3.7E-12	0.9909	4	749.33	193.53	2.84E+05	65.82	1.07E-12	29.03	0.019	1.90
81	679.1	2E+08	5.1E-12	0.9717	4	691.72	98.02	8.20E+05	40.42	1.73E-12	34.07	0.021	2.26
82	463.1	1E+08	3.7E-12	0.9917	4	808.1	174.50	3.13E+05	24.16	1.19E-12	32.01	0.021	2.10
83	410.1	3E+08	4E-12	0.9953	4	682.01	166.30	1.29E+05	44.69	1.09E-12	28.85	0.017	1.77
84	130.4	2E+08	3.6E-12	0.9932	4	618.94	474.65	5.89E+05	29.86	8.79E-13	24.34	0.016	1.59
85	602.1	1E+08	4.9E-12	0.976	4	776.11	128.73	3.01E+05	24.07	1.52E-12	31.34	0.020	2.09
86	266.9	6E1400	2.6E-12	1.016	4	598.77	213.48	1.09E+05	12.35	5.96E-13	23.27	0.015	1.49
87	774.5	1E+08	6.1E-12	0.9928	4	744.89	104.66	4.11E+05	26.17	1.69E-12	30.62	0.020	2.07
88	360.5	7E9540	6.4E-12	0.9909	4	705.26	91.06	1.59E+05	17.52	1.60E-12	29.85	0.019	2.01
89	352.8	8E9250	5.9E-12	0.9977	4	544.7	205.09	1.21E+05	15.70	1.57E-12	30.78	0.020	2.05
90	491.8	8E1010	7E-12	0.9571	4	651.01	150.14	1.24E+05	13.94	1.37E-12	23.31	0.015	1.57
91	504.3	603260	7.4E-12	0.954	4	676.05	132.37	9.20E+04	13.62	2.01E-12	28.46	0.016	1.93
92	1093	600430	1.3E-11	0.9225	4	682.64	62.22	6.79E+04	11.13	1.90E-12	25.58	0.017	1.74
93	797.5	460320	1.1E-11	0.9308	4	705.49	86.46	8.31E+04	13.63	3.79E-12	30.01	0.020	2.11
94	485.1	367120	0.9E-11	0.9424	4	549.17	113.21	6.56E+04	12.05	2.51E-12	32.91	0.021	2.30
95	661.7	263980	1.2E-11	0.9281	4	558.23	84.36	2.14E+04	7.27	3.39E-12	26.47	0.017	1.82
96	537.3	265210	1.3E-11	0.9268	4	506.11	94.57	1.71E+04	6.47	3.39E-12	27.90	0.018	1.95
97	848.2	229840	1.9E-11	0.9044	4	617	72.74	1.70E+04	7.40	6.09E-12	32.87	0.021	1.83
98	604.7	199300	1.8E-11	0.9096	4	533.36	98.21	1.22E+04	6.12	5.16E-12	29.42	0.019	2.34
99	413.3	151810	1.5E-11	0.9214	4	468.32	120.57	7.51E+03	4.94	4.24E-12	29.03	0.019	2.03

W/C = 0.36
1 Day of Hydration
Natural Pore Solution

File No.	R_4 (Q)	R_5 (Q)	G (F)	PH	Type	R_4 (Q) (Error)	R_5 (Q) (% Error)	R_4 (Q) (Error)	R_5 (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PH (Error)	PH (% Error)
101	557.1	126800	1.9E-11	0.9099	4	491.03	68.14	6107.1	4.71	5.5461E-12	29.94	0.019	2.13
102	651.7	109810	2.4E-11	0.8939	4	478.85	73.46	4866.3	4.42	7.307E-12	30.39	0.020	2.20
103	675.7	93037	2.6E-11	0.889	4	520.31	77.00	4245.5	4.62	6.994E-12	34.06	0.022	2.48
104	446.5	77676	2.6E-11	0.8947	4	493.54	104.05	3023.5	3.86	8.0038E-12	32.31	0.021	2.33
105	642.1	67291	3.4E-11	0.8778	4	482.36	75.13	2668.7	3.97	1.1707E-11	34.92	0.023	2.58
106	346	55717	3E-11	0.8958	4	438.47	126.00	1957.6	3.51	1.023E-11	33.80	0.022	2.47
107	366.6	44457	3.5E-11	0.8765	4	398.17	102.48	1499.4	3.14	1.1311E-11	32.24	0.021	2.36
108	393.5	39880	4E-11	0.8721	4	413.21	116.23	1285.3	3.25	1.3657E-11	35.04	0.023	2.62
109	285.8	53344	4.3E-11	0.8698	4	374.83	131.15	969.48	3.00	1.4953E-11	33.76	0.022	2.54
110	245	28216	4.7E-11	0.869	4	389.05	150.63	862.21	3.02	1.6628E-11	35.09	0.023	2.66
111	282.5	23635	5.6E-11	0.8579	4	365.86	129.51	728.23	3.08	2.0174E-11	36.32	0.024	2.79
112	256.6	18659	6.6E-11	0.8484	4	332.64	129.63	592.82	2.97	2.3497E-11	34.77	0.023	2.72
113	182.8	16575	7.7E-11	0.8453	4	314.38	183.08	504.3	3.04	2.708E-11	34.99	0.023	2.78
114	194.9	13603	9.5E-11	0.8333	4	291.49	149.56	426.34	3.09	3.2393E-11	34.06	0.023	2.77
115	70.47	11069	9E-11	0.8403	4	265.39	378.60	325.93	3.22	3.0548E-11	33.82	0.023	2.75
116	52.62	6771	1E-10	0.8358	4	246.09	485.90	305.58	3.48	3.442E-11	33.33	0.023	2.78
117	130.8	6439	9E-11	0.8985	4	188.28	142.40	216.62	3.36	2.3284E-11	28.15	0.021	2.40
118	277.8	4451	6.2E-11	0.8532	4	154.02	65.44	169.97	3.82	1.77E-11	28.82	0.021	2.35
119	319.5	3053	6.2E-11	0.8532	4	143.29	44.85	153.08	5.01	1.881E-11	31.50	0.024	2.65
120	325.7	2191	1.2E-10	0.8884	4	110.45	33.91	116.84	5.33	3.8092E-11	23.45	0.023	2.63
121	344	1691	2.2E-10	0.8465	4	69.528	20.21	73.611	4.39	5.2208E-11	23.45	0.018	2.17
122	356.2	1397	2.6E-10	0.8421	4	51.565	14.48	54.997	3.82	6.2188E-11	21.20	0.017	1.97
123	369.6	1185	3E-10	0.8477	4	44.991	12.17	47.53	3.98	6.337E-11	20.93	0.016	1.94
124	378	1083	3.2E-10	0.8503	4	40.883	10.84	43.148	4.08	6.5498E-11	20.71	0.016	1.93
125	379.1	976.1	3.2E-10	0.8529	4	38.894	10.21	40.808	4.16	6.5787E-11	20.57	0.016	1.92
126	382.6	905.2	3.2E-10	0.8562	4	36.894	10.37	41.956	4.89	7.1096E-11	22.25	0.018	2.08
127	380.5	851.1	3.2E-10	0.8589	4	36.087	10.01	36.793	4.68	7.0139E-11	22.12	0.018	2.08
128	382.6	799.8	3.2E-10	0.8615	4	36.095	10.11	40.327	5.04	7.4398E-11	23.42	0.019	2.30
129	376.3	781.3	3.1E-10	0.8634	4	36.12	10.40	40.707	5.35	7.8607E-11	24.11	0.020	2.28
130	375	728.3	3.6E-10	0.8592	4	40.118	10.70	41.72	5.72	8.9258E-11	25.28	0.021	2.42

W/C = 0.36
3 Days of Hydration
Neutral Pore Solution

File No.	R_1 (g)	R_2 (g)	G (°)	PH	Type	R_1 (g) (Error)	R_2 (g) (% Error)	R_2 (g) (% Error)	G (°) (Error)	G (°) (% Error)	PH (Error)	PH (% Error)
1	411	2600	7.90E-11	0.895	4	84.071	20.46	82.572	3.49	2.03E-11	0.016	2.07
2	400	2707	7.90E-11	0.897	4	77.728	19.43	85.616	3.16	1.75E-11	0.017	1.87
3	367.1	2752	8.21E-11	0.891	4	81.2	20.98	89.486	3.25	1.84E-11	0.017	1.93
4	382.2	2776	7.90E-11	0.893	4	84.005	21.98	92.591	3.34	1.93E-11	0.018	1.98
5	372.7	2813	8.02E-11	0.892	4	82.962	22.27	91.569	3.26	1.91E-11	0.017	1.94
6	360.6	2823	7.80E-11	0.893	4	84.398	22.17	93.116	3.30	1.88E-11	0.018	1.97
7	380.5	2848	7.97E-11	0.892	4	87.62	23.03	96.812	3.40	1.96E-11	0.018	2.04
8	362.5	2867	7.90E-11	0.895	4	83.397	23.03	92.57	3.23	1.89E-11	0.017	1.94
9	401.5	2870	7.48E-11	0.898	4	82.397	20.51	91.214	3.16	1.78E-11	0.017	1.92
10	378.8	2898	7.95E-11	0.894	4	88.728	23.61	98.153	3.36	1.86E-11	0.018	2.03
11	373.7	2915	7.80E-11	0.893	4	86.786	23.22	96.001	3.29	1.87E-11	0.018	1.99
12	361.2	2907	7.80E-11	0.893	4	86.652	22.73	95.669	3.30	1.87E-11	0.018	1.99
13	382.3	2908	7.81E-11	0.892	4	85.589	21.81	94.981	3.23	1.86E-11	0.018	1.97
14	378.4	3118	8.47E-11	0.898	4	94.792	24.98	108.03	3.40	2.21E-11	0.019	2.13
15	379.3	3323	8.41E-11	0.895	4	98.767	26.04	111.59	3.40	2.25E-11	0.019	2.16
16	388.6	3590	8.94E-11	0.890	4	103.62	28.32	118.63	3.33	2.43E-11	0.018	2.21
17	363.6	3637	8.80E-11	0.878	4	101.97	32.18	117.62	3.07	2.39E-11	0.018	2.10
18	341	4167	9.04E-11	0.876	4	108.72	33.98	128.76	3.09	2.48E-11	0.019	2.18
19	339	4822	8.87E-11	0.878	4	114.86	33.86	137.13	3.05	2.46E-11	0.019	2.21
20	318.5	4808	8.34E-11	0.871	4	114.6	35.98	136.71	2.85	2.50E-11	0.019	2.14
21	318.6	5322	9.50E-11	0.898	4	120.5	38.16	150.24	2.82	2.80E-11	0.019	2.16
22	313.4	6091	1.31E-10	0.848	4	163.66	66.57	241.36	2.62	2.80E-11	0.020	2.33
23	273.5	7094	9.67E-11	0.862	4	140.52	61.36	192.71	2.72	2.79E-11	0.020	2.27
24	273.4	8240	8.90E-11	0.864	4	148.79	64.42	216.72	2.63	2.98E-11	0.020	2.26
25	264.8	9843	8.27E-11	0.868	4	153.64	60.30	240.01	2.49	2.33E-11	0.019	2.18
26	208.2	11342	8.04E-11	0.864	4	174.27	63.70	266.26	2.80	2.40E-11	0.020	2.30
27	167.9	13376	7.73E-11	0.863	4	178.75	108.46	334.36	2.60	2.22E-11	0.019	2.20
28	112.8	18070	7.81E-11	0.880	4	200.08	177.69	426.3	2.65	2.30E-11	0.020	2.30
29	167.2	19739	8.24E-11	0.864	4	217.65	1301.73	649.02	2.78	2.90E-11	0.020	2.33
30	21.16	24308	7.73E-11	0.855	4	217.65	1301.73	649.02	3.02	2.42E-11	0.020	2.31
31	117.8	29441	7.34E-11	0.855	4	251.4	1139.14	733.4	3.12	2.23E-11	0.020	2.31
32	167.8	36214	6.72E-11	0.858	4	270.57	171.46	1240.7	3.43	2.07E-11	0.020	2.33
33	166.6	43968	6.57E-11	0.857	4	281.82	143.35	1587.5	3.62	1.89E-11	0.019	2.25
34	227.7	54181	4.88E-11	0.872	4	273.23	120.00	1890.6	3.67	1.37E-11	0.018	2.04
35	278.5	68827	4.99E-11	0.875	4	288.26	107.45	2632.8	4.24	1.30E-11	0.018	2.09
36	361.9	80122	4.13E-11	0.879	4	311.4	81.54	3707	4.63	1.10E-11	0.018	2.06
37	288.3	95188	3.14E-11	0.894	4	346.1	119.69	5107.4	6.94	6.33E-12	0.019	2.14
38	326.1	110620	2.70E-11	0.892	4	342.08	104.90	6177.4	6.57	7.85E-12	0.018	2.02
39	533.4	142360	3.34E-11	0.897	4	363.24	71.85	10228	7.16	1.01E-11	0.019	2.19
40	288.2	165130	2.14E-11	0.913	4	366.2	120.26	11468	6.94	5.81E-12	0.017	1.91
41	222.3	197130	1.80E-11	0.923	4	331.26	149.02	13860	7.03	4.38E-12	0.016	1.70
42	351.4	262660	1.89E-11	0.918	4	372.86	109.08	24627	9.46	4.62E-12	0.017	1.84
43	185.3	277130	1.24E-11	0.942	4	308.94	164.72	21373	7.71	2.64E-12	0.014	1.45
44	382.3	343320	1.34E-11	0.898	4	350.92	98.86	34946	10.15	3.12E-12	0.015	1.61
45	154.1	433960	1.02E-11	0.932	4	379.34	248.18	66491	13.75	2.43E-12	0.016	1.64
46	289.3	544330	1.02E-11	0.850	4	371.33	143.78	76664	14.62	2.37E-12	0.015	1.56
47	81.32	686470	5.97E-12	0.972	4	304.35	374.24	63974	11.38	1.12E-12	0.012	1.22
48	127.3	888470	6.85E-12	0.972	4	367.18	288.42	103740	15.80	1.65E-12	0.014	1.46
49	261.9	721610	7.39E-12	0.898	4	411.66	167.30	140620	19.51	1.84E-12	0.016	1.66
50	343.5	1E+06	7.89E-12	0.992	4	468.66	135.65	329490	30.78	2.21E-12	0.018	1.85

W/C = 0.35
3 Days of Hydration
Natural Pore Evolution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
51	130.8	960000	6.1E-12	0.9762	4	391.43	279.09	2.31E+05	23.42	1.42E-12	23.07	0.015	1.52
52	3.23	1E+08	4.7E-12	0.9829	4	405.94	12587.80	3.04E+05	26.44	1.11E-12	23.46	0.015	1.52
53	9.501	2E+08	4.9E-12	0.9801	4	405.94	4267.76	5.97E+05	36.83	1.14E-12	23.23	0.015	1.51
54	257.3	1E+08	5.0E-12	0.9822	4	426.72	167.01	4.68E+05	33.80	1.39E-12	24.73	0.016	1.62
55	32.87	1E+08	4.1E-12	0.9897	4	424.24	1298.56	2.82E+05	25.75	9.94E-13	24.00	0.015	1.54
56	115.1	4E+08	4.7E-12	0.9872	4	468.64	433.22	5.32E+05	63.83	1.33E-12	26.08	0.018	1.62
57	202.4	1E+08	4.5E-12	0.9949	4	403	189.11	2.68E+05	24.21	1.03E-12	22.71	0.015	1.47
58	9.694	1E+08	3.9E-12	1.003	4	382.27	3655.61	3.88E+05	27.63	8.21E-13	21.26	0.014	1.36
59	154	1E+08	3.1E-12	1.016	4	386.29	239.15	2.67E+05	21.81	6.28E-13	20.34	0.013	1.28
60	365.2	2E+08	2.8E-12	1.027	4	434.44	102.26	5.08E+05	29.91	5.15E-13	19.86	0.013	1.24
61	186	2E+08	4E-12	1.001	4	434.44	233.57	6.54E+05	37.94	9.98E-13	24.00	0.015	1.54
62	12.82	1E+08	3.4E-12	1.01	4	402.14	5112.84	3.91E+05	28.07	7.69E-13	22.03	0.014	1.40
63	108.5	1E+08	2.8E-12	1.02	4	389.66	347.10	4.05E+05	27.09	5.86E-13	20.27	0.013	1.28
64	274.2	2E+08	2.7E-12	1.024	4	378.42	137.28	5.64E+05	31.82	5.62E-13	20.43	0.013	1.28
65	17.45	1E+08	3.1E-12	1.016	4	446.61	2570.83	5.03E+05	33.59	7.69E-13	24.74	0.018	1.56
66	2.34	2E+08	3.3E-12	1.011	4	397.9	15722.22	7.32E+05	32.27	6.67E-13	20.09	0.013	1.26
67	123.5	2E+08	3.1E-12	1.015	4	408.16	328.87	7.42E+05	36.52	6.96E-13	22.30	0.014	1.41
68	346.2	3E+08	2.7E-12	1.025	4	353.46	102.36	1.28E+06	46.22	4.71E-13	19.14	0.012	1.19
69	186.7	1E+08	2.7E-12	1.025	4	384.36	203.69	2.66E+05	23.57	5.57E-13	20.63	0.013	1.31
70	179.2	2E+08	3E-12	1.017	4	344.07	182.00	5.04E+05	26.18	5.69E-13	18.78	0.012	1.19
71	13.07	4E+08	3.6E-12	1.009	4	380.78	2913.39	2.62E+05	69.80	7.24E-13	20.83	0.013	1.33
72	86.11	2E+08	3.7E-12	1.005	4	407.73	462.75	9.33E+05	49.43	8.25E-13	22.27	0.014	1.42
73	177.6	2E+08	2.9E-12	1.019	4	428.31	240.04	8.32E+05	41.22	6.70E-13	23.11	0.015	1.46
74	116.3	7E+08	4.2E-12	0.9873	4	423.65	364.27	1.00E+07	147.03	6.83E-13	23.40	0.015	1.51
75	248.3	1E+08	2.7E-12	1.025	4	371.06	148.85	3.55E+05	25.43	5.44E-13	20.38	0.013	1.26
76	34.87	3E+08	3.8E-12	1.004	4	468.4	1431.78	1.84E+06	64.32	1.00E-12	27.80	0.018	1.36
77	1.074	1E+08	3.6E-12	1.008	4	388.45	36188.53	2.89E+05	24.40	7.70E-13	21.80	0.014	1.36
78	74.32	1E+08	4E-12	1.001	4	423.03	598.20	4.18E+05	30.28	9.37E-13	23.80	0.015	1.52
79	80.54	2E+08	3.8E-12	1.005	4	385.43	453.72	6.07E+05	35.74	7.73E-13	20.45	0.013	1.31
80	52.78	1E+08	4.4E-12	0.9999	4	353.44	689.65	3.62E+05	25.85	6.71E-13	19.86	0.013	1.29
81	119.1	1E+08	5E-12	0.9995	4	488.51	410.17	7.77E+05	45.27	1.37E-12	27.67	0.018	1.80
82	248.4	1E+08	3.7E-12	1.007	4	382.74	143.16	3.48E+05	25.57	7.38E-13	19.86	0.013	1.27
83	306.6	1E+08	6.2E-12	0.9764	4	464.48	199.61	4.07E+05	34.39	1.80E-12	28.80	0.019	1.90
84	84.97	801570	5.4E-12	0.9956	4	350.57	412.59	1.88E+05	18.65	1.10E-12	20.43	0.013	1.33
85	232.5	889530	6.1E-12	0.979	4	441.37	217.98	2.01E+05	23.41	1.59E-12	26.13	0.017	1.72
86	288.9	915860	7.4E-12	0.987	4	437.94	161.59	2.30E+05	25.17	1.94E-12	26.15	0.017	1.74
87	316.5	656360	7.5E-12	0.9866	4	480.74	151.89	1.35E+05	20.46	2.19E-12	28.08	0.019	1.93
88	394	729340	9.4E-12	0.9539	4	412.57	113.34	1.48E+05	20.27	2.37E-12	26.24	0.016	1.78
89	333.9	697800	1E-11	0.9505	4	421.21	126.15	9.89E+04	17.00	2.65E-12	26.28	0.017	1.76
90	285.4	476310	9.8E-12	0.9531	4	365.76	130.59	6.53E+04	13.63	2.40E-12	24.46	0.016	1.65
91	279.1	391420	9.8E-12	0.9535	4	342.86	122.85	3.88E+04	10.13	2.19E-12	22.17	0.014	1.49
92	289.8	373320	1.2E-11	0.9428	4	343.86	119.94	3.88E+04	10.41	2.88E-12	22.58	0.015	1.54
93	242.1	309940	1.2E-11	0.9429	4	374.58	154.72	2.99E+04	9.79	3.05E-12	25.22	0.016	1.72
94	443.4	259000	1.6E-11	0.928	4	447.89	101.01	2.67E+04	10.48	4.88E-12	30.78	0.020	2.14
95	424.1	225490	1.7E-11	0.9219	4	363.02	90.31	1.91E+04	8.45	4.72E-12	26.85	0.017	1.86
96	619.8	189790	2.5E-11	0.9019	4	408.68	65.62	1.72E+04	8.61	7.24E-12	28.38	0.019	2.10
97	474.4	152800	2.2E-11	0.9115	4	398.55	83.56	1.08E+04	7.06	6.44E-12	26.87	0.019	2.11
98	506.6	144970	2.7E-11	0.8978	4	336.77	66.22	8.83E+03	6.10	7.15E-12	25.96	0.017	1.86
99	400.7	119690	2.7E-11	0.9007	4	332.07	82.87	6.47E+03	5.41	7.06E-12	26.58	0.017	1.80
100	537.5	107100	3.6E-11	0.8538	4	351.97	65.48	6.03E+03	5.61	1.04E-11	26.95	0.019	2.11

W/C = 0.36
3 Days of Hydration
Neutral Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₃ (Q) (Error)	R ₄ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
101	376.2	87632	3.1E-11	0.8934	4	333.98	66.76	4210.4	4.80	8.6397E-12	28.67	0.018	2.08
102	540	78232	4.0E-11	0.8709	4	348.24	64.49	3855.3	4.93	1.4138E-11	30.76	0.020	2.27
103	427.6	68398	4.3E-11	0.8758	4	313.34	73.28	2773.8	4.16	1.2509E-11	28.86	0.019	2.12
104	401.4	58105	4.0E-11	0.8698	4	309.82	77.21	2309.6	3.97	1.4412E-11	29.52	0.019	2.19
105	397.1	51555	5.4E-11	0.8653	4	311.4	78.42	2017.4	3.91	1.6463E-11	30.77	0.020	2.29
106	395.6	44519	6.9E-11	0.8609	4	303.44	78.66	1642	3.89	1.8287E-11	31.14	0.020	2.34
107	404	39780	6.4E-11	0.8563	4	280.27	69.37	1282.8	3.31	1.917E-11	29.72	0.019	2.25
108	372.9	33527	6.8E-11	0.8542	4	271.73	72.87	1055.2	3.15	2.0462E-11	30.02	0.019	2.28
109	243.4	28629	6.5E-11	0.8698	4	269.32	110.85	862.84	3.10	2.0462E-11	31.32	0.020	2.37
110	215.4	24648	6.8E-11	0.8682	4	247.04	114.69	709.97	2.85	2.0354E-11	30.07	0.020	2.29
111	128.3	21652	6.9E-11	0.8693	4	230.55	179.70	585.26	2.70	2.0337E-11	29.56	0.018	2.25
112	188.2	18820	7.9E-11	0.8519	4	236.1	149.24	529.01	2.80	2.4731E-11	31.19	0.020	2.40
113	70.4	16309	7.3E-11	0.8597	4	204	269.77	407.74	2.50	2.09E-11	28.46	0.019	2.19
114	31.15	14213	7.6E-11	0.869	4	187.7	802.98	342.05	2.41	2.0873E-11	27.55	0.018	2.12
115	64.84	12302	7.2E-11	0.8653	4	185.62	285.43	278.3	2.26	1.8641E-11	25.91	0.017	1.99
116	72.84	10501	7.5E-11	0.8642	4	158.23	217.23	242.78	2.31	1.8695E-11	25.95	0.017	2.01
117	152.2	8705	6.4E-11	0.8776	4	134.08	88.08	188.25	2.18	1.5091E-11	23.67	0.016	1.82
118	251.7	6979	4.9E-11	0.8974	4	117.5	46.69	182.04	2.16	1.1227E-11	22.83	0.016	1.73
119	285.9	5425	4.4E-11	0.8979	4	106.73	38.03	130.61	2.41	1.02E-11	23.01	0.016	1.75
120	305.4	4437	5.8E-11	0.8974	4	91.249	29.88	108.41	2.40	1.2415E-11	21.25	0.015	1.66
121	342.5	3673	6.9E-11	0.8933	4	83.625	24.42	86.85	2.49	1.4708E-11	21.42	0.015	1.69
122	389.5	3478	7E-11	0.8959	4	69.334	18.78	78.922	2.27	1.3151E-11	18.79	0.013	1.49
123	397.2	3198	7.2E-11	0.8985	4	72.878	18.82	82.077	2.57	1.4781E-11	20.52	0.015	1.64
124	384.9	2884	7.2E-11	0.8981	4	68.506	17.80	76.395	2.86	1.418E-11	19.75	0.014	1.56
125	380.2	2802	7.1E-11	0.8905	4	67.459	17.29	74.98	2.87	1.4218E-11	20.01	0.014	1.61
126	386.3	2638	7.2E-11	0.8914	4	67.263	16.88	73.983	2.81	1.4898E-11	20.46	0.015	1.65
127	404.6	2484	7.3E-11	0.8924	4	64.278	15.89	70.289	2.83	1.481E-11	20.09	0.015	1.63
128	404.3	2353	7.3E-11	0.8937	4	62.698	15.50	68.156	2.80	1.4882E-11	20.01	0.015	1.63
129	409.1	2227	7.3E-11	0.8933	4	64.34	15.73	66.673	3.13	1.539E-11	21.12	0.016	1.72
130	389.8	2143	8.2E-11	0.898	4	65.314	16.34	70.469	3.29	1.7656E-11	21.54	0.016	1.78
131	400.2	2120	8.0E-11	0.8947	4	71.491	17.86	77.173	3.64	2.1079E-11	23.68	0.018	1.97
132	405.4	2122	9.2E-11	0.8953	4	67.258	18.59	72.721	3.43	2.0695E-11	22.49	0.017	1.87

W/C = 0.38
7 Days of Hydration
Neutral Pore Solution

File No.	$R_1(Q)$	$R_2(Q)$	G (P)	Phi	Type	$R_1(Q)$ (Error)	$R_2(Q)$ (Error)	$R_1(Q)$ (% Error)	$R_2(Q)$ (% Error)	C (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
1	361	3611	8.40E-11	0.874	4	36.681	10.88	42.733	1.16	7.23E-12	8.64	0.006	0.71
2	369.2	3697	7.70E-11	0.860	4	36.116	9.79	42.361	1.16	6.70E-12	8.80	0.006	0.71
3	377.5	3743	7.88E-11	0.876	4	41.24	10.82	46.917	1.23	7.10E-12	9.12	0.007	0.75
4	382.3	3816	8.00E-11	0.876	4	42.684	11.14	47.957	1.25	7.53E-12	9.36	0.007	0.77
5	384.5	3867	7.78E-11	0.877	4	38.51	10.87	43.004	1.11	6.48E-12	8.81	0.006	0.69
6	373.8	3626	7.88E-11	0.878	4	40.849	10.87	46.5	1.16	6.70E-12	8.80	0.006	0.72
7	365.5	3660	7.46E-11	0.876	4	41.349	11.63	46.239	1.16	6.50E-12	8.80	0.006	0.72
8	362.9	4008	7.46E-11	0.860	4	40.768	11.23	46.634	1.14	6.20E-12	8.69	0.006	0.71
9	360.6	4022	7.10E-11	0.862	4	36.953	10.36	44.3	1.10	6.02E-12	8.48	0.006	0.69
10	369.1	4072	7.27E-11	0.879	4	39.029	10.87	43.796	1.07	5.69E-12	8.24	0.006	0.68
11	343.8	4125	7.46E-11	0.877	4	40.426	11.76	46.316	1.10	6.20E-12	8.36	0.006	0.69
12	357.3	4136	6.94E-11	0.862	4	38.674	10.80	43.276	1.05	5.60E-12	8.06	0.006	0.68
13	342.3	4266	7.88E-11	0.873	4	41.17	12.03	46.486	1.08	6.68E-12	8.46	0.006	0.70
14	364.3	4510	7.78E-11	0.874	4	46.684	12.61	53.266	1.16	7.42E-12	9.54	0.007	0.78
15	326.5	4669	8.17E-11	0.869	4	47.814	14.86	56.166	1.14	7.70E-12	9.43	0.007	0.77
16	312.8	5246	6.35E-11	0.868	4	46.848	14.98	54.917	1.05	7.51E-12	9.01	0.006	0.73
17	274.7	5705	6.82E-11	0.862	4	44.819	16.32	53.447	0.94	7.19E-12	8.34	0.006	0.68
18	239.9	6215	6.90E-11	0.858	4	59.619	24.81	72.312	1.16	9.51E-12	10.66	0.007	0.87
19	240.7	6744	6.72E-11	0.859	4	59.948	23.66	70.892	1.05	8.75E-12	10.03	0.007	0.81
20	258.9	7321	6.40E-11	0.860	4	51.655	19.91	66.137	0.90	7.56E-12	8.96	0.006	0.72
21	186.4	8046	9.14E-11	0.853	4	60.023	31.66	76.254	0.98	9.14E-12	10.01	0.007	0.80
22	147.6	8605	9.15E-11	0.852	4	64.393	43.63	87.973	1.00	9.54E-12	10.43	0.007	0.83
23	24.49	10762	2.30E-10	0.794	4	361.86	1477.56	656.1	5.17	1.24E-10	54.09	0.037	4.62
24	51.66	12673	9.40E-11	0.846	4	67.418	130.76	111.61	0.86	9.26E-12	9.85	0.007	0.78
25	59.35	14460	6.83E-11	0.847	4	67.136	113.12	121.55	0.84	8.47E-12	9.48	0.006	0.74
26	0.43948	16862	8.00E-11	0.844	4	62.263	16977.70	164.6	0.99	1.00E-11	11.05	0.007	0.86
27	100.7	18618	6.82E-11	0.836	4	82.083	92.63	212.22	1.08	1.14E-11	11.54	0.006	0.93
28	130.7	23035	6.82E-11	0.842	4	62.222	70.56	242.7	1.08	9.88E-12	11.19	0.007	0.87
29	202.1	27655	6.82E-11	0.840	4	110	84.43	345.63	1.25	1.12E-11	12.80	0.006	0.96
30	404.6	34316	1.05E-10	0.827	4	126.97	31.97	512.44	1.90	1.46E-11	13.81	0.009	1.09
31	512.8	41562	1.04E-10	0.825	4	121.45	23.66	600.66	1.45	1.27E-11	12.20	0.006	0.96
32	533	49793	8.88E-11	0.833	4	136.24	26.26	844.66	1.70	1.17E-11	13.22	0.009	1.03
33	697.1	60734	8.88E-11	0.830	4	176.19	26.26	1398.5	2.25	1.42E-11	15.77	0.010	1.23
34	768.7	74464	8.88E-11	0.831	4	164.6	21.36	1686.1	2.26	1.22E-11	14.06	0.009	1.09
35	862	80717	8.02E-11	0.834	4	176.72	20.65	2414.8	2.66	1.17E-11	14.61	0.009	1.13
36	743.2	107440	5.88E-11	0.850	4	180.92	25.69	3215.7	2.69	8.95E-12	14.66	0.010	1.13
37	920.7	126660	5.90E-11	0.849	4	185.65	21.24	4324.6	3.33	8.64E-12	14.66	0.006	1.11
38	913.2	169750	5.23E-11	0.865	4	186.9	20.60	5764.7	3.61	7.17E-12	13.71	0.009	1.03
39	861.6	191060	4.34E-11	0.865	4	251.62	26.20	9652.1	5.16	7.58E-12	17.46	0.011	1.30
40	1026	226170	4.20E-11	0.865	4	236.51	23.25	12343	5.41	6.88E-12	16.02	0.010	1.19
41	839.4	262620	3.03E-11	0.865	4	173.92	20.72	16978	4.18	6.06E-12	11.37	0.007	0.83
42	843.6	319130	2.50E-11	0.864	4	231.6	27.46	16907	6.11	3.73E-12	14.62	0.009	1.05
43	908.7	422180	2.44E-11	0.865	4	321.79	35.41	43366	10.26	4.77E-12	16.95	0.013	1.40
44	924.7	480970	2.06E-11	0.864	4	233.21	25.42	40163	8.18	2.86E-12	13.62	0.009	0.96
45	776.7	636220	1.67E-11	0.915	4	197.69	25.45	63300	8.34	1.90E-12	11.36	0.007	0.80
46	1116	867760	2.00E-11	0.904	4	322.82	26.87	163070	16.37	3.66E-12	16.27	0.012	1.30
47	793.9	766300	1.22E-11	0.932	4	242.69	30.69	106270	11.36	1.64E-12	13.41	0.009	0.92
48	740.4	970760	1.07E-11	0.940	4	204.81	27.66	106620	11.21	1.19E-12	11.09	0.007	0.76
49	618.5	776940	6.60E-12	0.953	4	424.37	66.61	140540	16.03	1.96E-12	22.75	0.015	1.53
50	830	25406	1.04E-11	0.940	4	256.45	30.90	553360	27.37	1.40E-12	13.54	0.009	0.92

W/C = 0.36
7 Days of Hydration
Neutral Pore Solution

File No.	R_1 (D)	R_2 (D)	G (F)	PH	Type	R_1 (D) (Error)	R_1 (D) (% Error)	R_2 (D) (Error)	R_2 (D) (% Error)	G (F) (Error)	G (F) (% Error)	PH (Error)	PH (% Error)
51	1102	2E+08	1.2E-11	0.951	4	266.98	24.13	4.59E+05	25.42	1.67E-12	13.91	0.009	0.98
52	863.7	2E+08	9E-12	0.9478	4	412.47	47.78	5.16E+05	32.81	1.05E-12	21.46	0.014	1.45
53	471	1E+08	6E-12	0.9725	4	345.65	73.39	3.54E+05	24.31	1.09E-12	17.84	0.011	1.16
54	1013	3E+08	9.7E-12	0.9423	4	271.33	28.78	1.20E+06	39.74	1.34E-12	13.83	0.009	0.94
55	527.6	7E+08	6.2E-12	0.9893	4	271.16	51.39	6.21E+05	60.30	8.41E-13	13.99	0.009	0.90
56	536.7	1E+08	5.1E-12	0.9807	4	395.05	65.91	2.67E+05	20.84	9.17E-13	17.81	0.011	1.17
57	751.5	3E+08	6.2E-12	0.9894	4	265.94	35.39	1.10E+06	37.67	8.20E-13	13.22	0.008	0.86
58	726.3	2E+08	5.5E-12	0.9749	4	204.37	28.14	4.31E+05	19.66	5.97E-13	10.07	0.008	0.86
59	717.3	9E+08	9E-12	0.9894	4	346.46	48.30	1.22E+07	136.37	1.05E-12	17.06	0.011	1.13
60	846.6	3E+08	6.1E-12	0.9895	4	262.15	34.31	6.19E+05	32.47	6.81E-13	14.37	0.009	0.95
61	654.9	4E+07	5.6E-12	0.9711	4	359.21	54.85	1.92E+09	545.75	1.03E-12	17.83	0.011	1.17
62	462.7	2E+08	4.1E-12	0.9824	4	301.96	65.26	4.39E+05	23.66	6.08E-13	14.96	0.009	0.95
63	534.4	4E+08	4.6E-12	0.9844	4	319.75	60.97	2.69E+05	59.20	7.19E-13	15.42	0.010	1.01
64	594.9	1E+07	4.6E-12	0.9821	4	363.46	61.10	1.69E+07	159.39	8.99E-13	17.66	0.011	1.15
65	321.7	1E+07	4.1E-12	0.9811	4	362.43	118.86	1.48E+07	161.46	7.58E-13	18.36	0.012	1.19
66	894.6	1E+07	6.1E-12	0.9896	4	270.56	30.25	2.59E+07	173.46	6.01E-13	13.19	0.008	0.87
67	760.9	6E+08	5.5E-12	0.9741	4	260.2	38.14	5.03E+09	78.69	7.80E-13	14.10	0.009	0.93
68	682.1	3E+08	5E-12	0.9803	4	212.75	30.74	6.75E+05	28.17	5.19E-13	10.34	0.007	0.86
69	1040	3E+08	6.6E-12	0.9834	4	359.78	34.31	1.49E+06	47.82	1.15E-12	17.44	0.011	1.16
70	621.3	2E+08	4.7E-12	0.985	4	339.36	54.62	4.32E+05	25.12	7.71E-13	16.50	0.011	1.07
71	307.5	3E+08	3.5E-12	1.001	4	177.88	67.78	4.82E+05	18.65	3.02E-13	8.95	0.005	0.55
72	460.5	9E+08	4.3E-12	0.9897	4	275.83	61.23	2.50E+06	53.64	5.70E-13	13.28	0.009	0.86
73	590.1	2E+07	5E-12	0.9809	4	169.65	28.24	1.75E+07	111.19	4.02E-13	8.10	0.005	0.53
74	822.3	2E+08	5.3E-12	0.9765	4	316.89	38.51	3.47E+05	21.74	6.29E-13	16.44	0.010	1.02
75	327.2	9E+08	4.2E-12	0.9807	4	277.04	64.67	2.94E+05	59.09	5.62E-13	13.37	0.009	0.87
76	948.1	4E+08	6.9E-12	0.9814	4	270.12	28.49	1.81E+06	48.68	9.19E-13	13.34	0.009	0.89
77	607.6	2E+08	5.1E-12	0.9802	4	267.33	47.29	5.14E+05	25.53	7.25E-13	14.20	0.009	0.93
78	1015	4E+08	7.9E-12	0.9807	4	471.08	48.41	3.13E+06	61.77	1.79E-12	23.57	0.015	1.58
79	907.5	3E+08	6.9E-12	0.982	4	439.89	48.47	1.34E+06	51.88	1.53E-12	22.04	0.014	1.47
80	675.5	3E+08	6.5E-12	0.9851	4	177.26	26.24	6.34E+05	26.05	5.79E-13	8.87	0.006	0.69
81	703	2E+08	6.7E-12	0.9846	4	264.43	41.88	5.88E+05	26.36	9.90E-13	14.83	0.010	0.99
82	919.3	2E+08	8.1E-12	0.9841	4	371.97	40.46	7.79E+05	37.47	1.84E-12	19.12	0.012	1.29
83	723	2E+08	8E-12	0.9847	4	207.6	26.71	3.72E+05	19.84	8.99E-13	10.87	0.007	0.72
84	862.6	1E+08	6.9E-12	0.9498	4	384.13	42.21	2.80E+05	22.80	1.67E-12	18.97	0.012	1.26
85	814.8	2E+08	9.0E-12	0.9442	4	354.36	43.49	9.24E+05	40.82	1.79E-12	18.56	0.012	1.26
86	914.9	2E+08	1.1E-11	0.9349	4	286.55	31.54	4.31E+05	25.96	1.79E-12	18.35	0.010	1.05
87	762.8	681610	1E-11	0.9437	4	291.13	36.17	1.29E+05	14.26	1.57E-12	15.71	0.010	1.07
88	901	1E+08	1.3E-11	0.928	4	344.78	38.26	3.69E+05	28.94	2.53E-12	18.80	0.012	1.30
89	861.9	717600	1.3E-11	0.9278	4	224.56	26.36	7.02E+04	9.78	1.69E-12	12.46	0.006	0.66
90	802.7	623480	1.4E-11	0.9271	4	185.24	24.32	4.72E+04	7.97	1.49E-12	11.00	0.007	0.78
91	1087	681040	1.9E-11	0.9059	4	344.86	31.74	9.69E+04	14.95	3.84E-12	19.77	0.013	1.40
92	768.7	487820	1.6E-11	0.9191	4	200.06	25.99	3.22E+04	6.61	1.89E-12	11.85	0.007	0.81
93	997.6	483650	2.2E-11	0.9	4	236.71	24.93	4.02E+04	8.32	3.13E-12	14.18	0.009	1.01
94	881.1	390880	2.1E-11	0.9029	4	242.14	28.12	2.37E+04	6.68	3.13E-12	14.66	0.009	1.04
95	1181	343220	3.2E-11	0.8788	4	243.5	20.62	2.33E+04	6.79	4.81E-12	15.05	0.010	1.10
96	1198	269480	3.3E-11	0.8782	4	264.01	24.57	1.77E+04	6.66	5.66E-12	17.99	0.012	1.32
97	932.4	234530	3E-11	0.8946	4	244.09	26.18	1.22E+04	5.20	4.79E-12	16.88	0.010	1.15
98	1124	212380	4.5E-11	0.8814	4	236.66	21.66	1.09E+04	4.96	7.02E-12	15.77	0.010	1.16
99	1126	174130	4.9E-11	0.8698	4	227.46	21.98	8.06E+03	4.63	8.35E-12	17.00	0.011	1.26
100	1222	158750	6.4E-11	0.8415	4	245.77	20.11	7.14E+03	4.50	1.10E-11	17.28	0.011	1.32

W/C = 0.36
7 Days of Hydration
Neutral Pore Solution

File No.	R_p (g)	R_p (g)	C (P)	Phi	Type	R_p (g) (Error)	R_p (g) (% Error)	R_p (g) (Error)	R_p (g) (% Error)	C (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
101	1110	125610	5.0E-11	0.8475	4	224.34	20.21	4462.2	3.86	9.683E-12	16.41	0.011	1.25
102	927.2	106230	6.7E-11	0.8508	4	190.06	20.80	3101.2	2.04	8.224E-12	14.40	0.009	1.09
103	1186	96476	9.1E-11	0.8228	4	223.78	18.84	3197.9	3.25	1.863E-11	17.16	0.011	1.35
104	863.3	81318	7.9E-11	0.8331	4	228.72	23.89	2473.2	3.04	1.453E-11	18.41	0.012	1.43
105	868.7	69848	8.4E-11	0.831	4	183.06	20.37	1623.2	2.32	1.262E-11	15.36	0.010	1.19
106	830.1	60448	8.9E-11	0.8294	4	183.22	22.07	1338.6	2.21	1.411E-11	15.90	0.010	1.24
107	718.9	51302	8.4E-11	0.8335	4	158.26	22.06	937.33	1.83	1.205E-11	14.40	0.009	1.12
108	719.6	44727	9.4E-11	0.8273	4	148.63	20.82	748.06	1.67	1.327E-11	14.09	0.009	1.10
109	633.4	39764	9.3E-11	0.8294	4	132.93	20.89	583.89	1.45	1.2184E-11	13.05	0.008	1.02
110	603.7	33323	1E-10	0.8251	4	120.71	20.00	426.45	1.26	1.240E-11	12.23	0.008	0.96
111	476.3	28684	9.6E-11	0.8286	4	110.86	23.32	337.06	1.17	1.151E-11	11.73	0.008	0.92
112	400.5	24888	9.4E-11	0.8331	4	125.78	31.41	332.6	1.34	1.328E-11	14.05	0.008	1.10
113	280.9	21281	8.1E-11	0.8438	4	80.543	31.13	206.16	0.97	8.918E-12	10.63	0.007	0.83
114	247.6	18283	8.2E-11	0.8448	4	101.34	40.63	201.05	1.10	1.004E-11	12.32	0.008	0.96
115	204.2	15875	7.5E-11	0.851	4	112.08	54.86	186.31	1.26	1.068E-11	14.23	0.009	1.11
116	143.4	13186	7E-11	0.8567	4	104.23	72.66	163	1.24	9.600E-12	13.60	0.009	1.08
117	25.89	11010	6.1E-11	0.8676	4	105.29	408.06	149.97	1.36	8.963E-12	14.83	0.010	1.15
118	63.86	8993	5.3E-11	0.8764	4	101.6	189.02	132.95	1.48	8.132E-12	15.30	0.010	1.19
119	47.05	7570	6.3E-11	0.87	4	93.661	189.07	115.81	1.53	9.2881E-12	14.84	0.010	1.16
120	64.15	6463	7.3E-11	0.8653	4	79.94	64.91	95.7	1.47	9.6807E-12	13.26	0.009	1.07
121	129	5907	8.2E-11	0.8814	4	74.231	57.54	87.282	1.50	1.0598E-11	12.84	0.009	1.06
122	218.4	5234	7.4E-11	0.8707	4	66.518	30.86	76.932	1.47	9.0873E-12	12.29	0.009	1.00
123	211.9	4862	8.2E-11	0.8653	4	64.845	30.60	74.035	1.51	9.5248E-12	12.09	0.009	1.00
124	267.2	4637	7.8E-11	0.8705	4	57.219	21.41	64.676	1.43	8.6771E-12	11.10	0.008	0.92
125	268.7	4284	8.5E-11	0.8661	4	54.817	21.11	61.199	1.43	9.0918E-12	10.86	0.008	0.89
126	268.2	4032	8.3E-11	0.8606	4	49.977	17.80	57.041	1.41	8.5213E-12	10.32	0.008	0.86
127	294.9	3626	8.5E-11	0.8662	4	49.977	18.95	55.195	1.44	8.6466E-12	10.21	0.007	0.86
128	265.5	3652	8.8E-11	0.8671	4	50.954	17.85	55.904	1.53	9.246E-12	10.46	0.008	0.89
129	300	3470	9E-11	0.8674	4	57.032	18.01	62.286	1.79	1.0813E-11	11.97	0.009	1.02
130	310	3352	9.6E-11	0.8638	4	51.084	18.48	55.863	1.66	1.0872E-11	10.80	0.008	0.94
131	305.6	3353	1E-10	0.8601	4	55.802	18.18	60.623	1.62	1.243E-11	11.90	0.009	1.03
132	335.5	3340	1.1E-10	0.8582	4	51.985	15.41	58.57	1.69	1.2427E-11	11.27	0.008	0.96
133	323.8	3584	1.3E-10	0.8483	4	59.728	18.44	66.026	1.85	1.834E-11	12.76	0.009	1.11
134	306.1	3666	1.4E-10	0.8409	4	67.868	21.96	76.308	1.92	1.9747E-11	14.08	0.010	1.22
135	274.4	4549	1.5E-10	0.8349	4	73.122	26.65	94.079	1.85	2.1444E-11	14.46	0.010	1.25
136	254.5	5255	1.5E-10	0.8304	4	73.647	28.94	87.211	1.68	2.1396E-11	13.63	0.010	1.19

W/C = 0.35
7 Days of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	R ₁ (Q) (%) Error	R ₂ (Q) (Error)	G (P) (Error)	G (P) (%) Error	Phi (Error)	Phi (%) Error
1	361	3611	6.48E-11	0.874	4	38.591	42.733	10.69	42.733	7.23E-12	8.56	0.008	0.71
2	368.2	3687	7.70E-11	0.860	4	38.116	42.391	9.79	42.391	6.70E-12	8.60	0.008	0.71
3	377.5	3743	7.88E-11	0.878	4	41.24	45.917	10.92	45.917	7.19E-12	9.12	0.007	0.75
4	382.3	3816	8.05E-11	0.878	4	42.584	47.057	11.14	47.057	7.53E-12	9.36	0.007	0.77
5	384.3	3887	7.79E-11	0.877	4	38.51	43.004	10.57	43.004	6.48E-12	8.32	0.008	0.69
6	373.6	3826	7.88E-11	0.878	4	40.646	45.5	10.87	45.5	6.79E-12	8.81	0.008	0.72
7	380.5	3860	7.46E-11	0.878	4	41.349	46.239	11.63	46.239	6.59E-12	8.80	0.008	0.72
8	382.9	4008	7.24E-11	0.880	4	40.788	45.634	11.23	45.634	6.29E-12	8.69	0.008	0.71
9	380.6	4022	7.10E-11	0.882	4	39.803	44.3	10.36	44.3	6.02E-12	8.48	0.008	0.69
10	386.1	4072	7.27E-11	0.879	4	39.029	43.756	10.87	43.756	6.09E-12	8.24	0.008	0.68
11	343.8	4125	7.48E-11	0.877	4	40.428	45.316	11.78	45.316	6.25E-12	8.36	0.008	0.69
12	357.3	4136	6.94E-11	0.882	4	38.574	43.276	10.80	43.276	6.60E-12	8.68	0.008	0.68
13	342.3	4266	7.88E-11	0.873	4	41.17	48.486	12.03	48.486	6.89E-12	8.45	0.008	0.70
14	364.3	4510	7.78E-11	0.874	4	48.684	53.256	12.81	53.256	7.42E-12	9.54	0.007	0.78
15	328.5	4859	6.17E-11	0.869	4	47.814	55.186	14.56	55.186	7.70E-12	9.43	0.007	0.77
16	312.8	5246	6.33E-11	0.869	4	46.848	54.917	14.98	54.917	7.51E-12	9.01	0.008	0.73
17	274.7	5705	6.82E-11	0.862	4	44.819	53.447	16.32	53.447	7.19E-12	8.34	0.008	0.68
18	239.9	6215	6.90E-11	0.858	4	50.519	72.312	24.61	72.312	9.51E-12	10.68	0.007	0.87
19	240.7	6744	6.72E-11	0.859	4	58.948	70.862	23.66	70.862	8.79E-12	10.03	0.007	0.81
20	288.9	7321	6.40E-11	0.860	4	51.955	66.137	19.91	66.137	7.89E-12	8.98	0.008	0.72
21	188.4	8048	6.14E-11	0.853	4	60.023	78.254	31.86	78.254	9.14E-12	10.01	0.007	0.80
22	147.6	8805	6.15E-11	0.852	4	64.383	87.973	43.63	87.973	9.54E-12	10.43	0.007	0.83
23	24.46	10782	2.30E-10	0.784	4	361.86	958.1	1477.88	958.1	1.24E-10	64.09	0.037	4.62
24	61.95	12973	6.40E-11	0.846	4	67.418	111.61	130.78	111.61	9.29E-12	9.85	0.007	0.78
25	69.35	14490	6.80E-11	0.847	4	67.138	121.85	131.12	121.85	8.47E-12	9.48	0.008	0.74
26	0.43946	16862	6.08E-11	0.844	4	82.081	164.6	82.081	164.6	1.00E-11	11.05	0.007	0.86
27	100.7	18618	6.88E-11	0.838	4	93.283	212.22	92.63	212.22	1.14E-11	11.84	0.008	0.93
28	130.7	23035	6.82E-11	0.842	4	92.222	242.7	70.56	242.7	9.89E-12	11.19	0.007	0.87
29	202.1	27855	6.80E-11	0.840	4	110	345.83	94.43	345.83	1.12E-11	12.60	0.008	0.96
30	408.6	34316	1.03E-10	0.827	4	129.97	512.44	31.97	512.44	1.45E-11	13.81	0.009	1.09
31	584.6	74889	6.98E-11	0.854	4	178.02	1643.7	31.74	1643.7	8.09E-12	14.41	0.009	1.09
32	679.7	102320	4.69E-11	0.862	4	200.22	2840.3	28.46	2840.3	7.11E-12	15.18	0.010	1.13
33	828.1	142090	4.25E-11	0.868	4	244.86	5546.3	29.82	5546.3	7.30E-12	17.17	0.011	1.28
34	639.9	186310	2.81E-11	0.868	4	197.29	7182.2	30.88	7182.2	3.83E-12	12.84	0.008	0.94
35	781.9	287180	2.52E-11	0.862	4	291.52	18705	37.26	18705	4.47E-12	17.78	0.011	1.28
36	843.3	368230	2.08E-11	0.902	4	229.46	21722	27.21	21722	2.80E-12	13.46	0.009	0.96
37	726.1	467820	1.68E-11	0.928	4	254.84	34341	35.10	34341	2.43E-12	14.44	0.009	1.02
38	673.7	623340	1.31E-11	0.928	4	260.79	42955	38.71	42955	1.92E-12	14.43	0.009	1.00
39	608	557860	1.24E-11	0.930	4	372.07	67184	46.05	67184	2.51E-12	20.17	0.013	1.39
40	676.7	800370	1.10E-11	0.932	4	336.9	117680	36.77	117680	2.12E-12	17.98	0.012	1.24
41	1213	1E+08	1.51E-11	0.916	4	347.72	264860	28.87	264860	2.73E-12	18.08	0.012	1.27
42	630.7	2E+08	1.05E-11	0.937	4	311.76	540020	37.53	540020	1.69E-12	16.83	0.010	1.08
43	778.4	1E+08	9.35E-12	0.945	4	268.89	268480	34.24	268480	1.27E-12	13.69	0.009	0.92
44	653.4	2E+08	8.58E-12	0.948	4	271.15	410300	31.77	410300	1.18E-12	13.54	0.009	0.92
45	648.5	1E+08	8.28E-12	0.968	4	453.86	261240	69.69	261240	1.42E-12	22.64	0.015	1.50
46	889	2E+08	7.88E-12	0.953	4	409.52	363146	43.13	363146	1.49E-12	16.98	0.012	1.28
47	944.5	4E+08	7.31E-12	0.957	4	409.52	2684100	66.31	2684100	1.47E-12	20.04	0.013	1.34
48	789.6	3E+08	6.33E-12	0.965	4	262.71	646280	34.56	646280	8.06E-13	12.74	0.008	0.95
49	757.5	3E+08	6.32E-12	0.965	4	352.85	1268900	40.95	1268900	1.09E-12	17.05	0.011	1.13
50	427.3	2E+08	4.48E-12	0.968	4	325.72	557800	78.23	557800	6.89E-13	15.80	0.010	1.02

File No.	R_0 (D)	R_0 (D)	C (P)	Pin	Type	R_0 (D) (Error)	R_0 (D) (% Error)	R_0 (D) (Error)	R_0 (D) (% Error)	C (P) (Error)	Pin (Error)	Pin (% Error)
51	854.1	1E+07	6.0E-12	0.9026	4	262.49	30.73	1.77E+07	130.35	8.22E-13	12.85	0.84
52	680.2	5E+08	5.3E-12	0.9764	4	316.67	47.97	3.52E+10	6855.82	7.86E-13	14.98	0.98
53	8387	3E+08	3.1E-12	1.008	4	327.7	3425.32	1.48E+08	42.66	4.72E-13	15.27	0.97
54	518.3	3E+08	4.1E-12	0.9808	4	336.18	66.11	1.03E+08	36.76	6.46E-13	15.79	1.02
55	867.6	4E+08	5.0E-12	0.9703	4	270.68	31.56	1.82E+08	48.22	7.43E-13	12.86	0.85
56	511.6	4E+08	4.3E-12	0.9869	4	342.11	68.87	1.72E+08	47.86	7.00E-13	16.14	1.05
57	582.5	2E+07	5.1E-12	0.9777	4	243.97	43.30	2.68E+07	186.79	5.87E-13	11.47	0.75
58	531.6	5E+08	4.8E-12	0.9802	4	269.8	50.55	2.18E+08	47.87	6.08E-13	12.61	0.83
59	584	3E+08	4.8E-12	0.982	4	309.46	68.40	1.62E+08	55.57	9.08E-13	19.00	1.24
60	588	5E+08	5E-12	0.9789	4	272.65	48.75	8.38E+08	95.37	6.38E-13	12.87	0.84
61	539.4	3E+08	4.5E-12	0.9854	4	301.42	55.88	8.02E+05	30.88	6.34E-13	14.21	0.83
62	889.3	3E+08	5.7E-12	0.9702	4	368.62	42.08	1.18E+08	41.80	8.08E-13	17.33	1.15
63	502.5	2E+08	3.7E-12	0.986	4	373.91	123.81	3.94E+05	24.10	6.46E-13	17.68	1.14
64	580.2	3E+08	4.8E-12	0.9809	4	243.53	41.97	1.08E+08	32.32	5.81E-13	11.49	0.75
65	467.7	3E+08	4.3E-12	0.9879	4	434.17	82.83	1.83E+08	58.51	8.97E-13	20.68	1.34
66	391.7	3E+08	4.4E-12	0.9867	4	273.04	66.71	1.34E+08	36.34	5.70E-13	12.63	0.84
67	584.2	3E+08	4.8E-12	0.9812	4	247.54	43.87	8.68E+05	29.48	5.69E-13	11.77	0.77
68	618.7	3E+08	6.7E-12	0.9818	4	379.02	48.41	1.43E+08	48.16	1.23E-12	18.34	1.22
69	579.7	5E+08	5.9E-12	0.9888	4	244	42.09	2.18E+08	47.25	6.99E-13	11.76	0.78
70	579.7	5E+08	5.9E-12	0.9888	4	244	42.09	2.18E+08	47.25	6.99E-13	11.76	0.78
71	680.3	2E+08	6.2E-12	0.9782	4	421.25	87.71	4.53E+05	26.70	1.08E-12	20.61	1.35
72	620.1	5E+08	6.0E-12	0.9809	4	363.1	58.56	5.40E+08	92.70	1.22E-12	17.77	1.19
73	687.2	2E+08	6.7E-12	0.9832	4	376.29	53.97	4.24E+05	26.62	1.24E-12	18.85	1.24
74	646	1E+08	6.0E-12	0.9826	4	286.19	46.16	2.10E+05	16.95	1.02E-12	14.92	1.00
75	686.8	1E+08	6.7E-12	0.9482	4	303.83	34.18	1.63E+05	15.45	1.34E-12	15.40	1.04
76	503.9	872400	6.0E-12	0.9828	4	260.28	51.66	9.53E+04	10.95	9.11E-13	13.21	0.86
77	823.7	1E+08	1E-11	0.9407	4	286.25	30.99	1.51E+05	13.98	1.32E-12	13.18	0.80
78	626.1	867260	6.3E-12	0.9459	4	248.3	39.18	9.41E+04	10.87	1.20E-12	12.86	0.87
79	782.9	784820	1.2E-11	0.9315	4	283.19	35.72	8.88E+04	11.74	1.78E-12	18.02	1.04
80	802.8	674380	1.4E-11	0.9246	4	382.98	41.06	7.43E+04	12.83	2.88E-12	20.62	1.45
81	1053	622350	1.6E-11	0.9095	4	300.12	28.50	7.08E+04	11.38	3.05E-12	16.52	1.17
82	738.8	438810	1.4E-11	0.9246	4	275.52	37.29	3.34E+04	7.84	2.18E-12	16.53	1.08
83	1084	387430	2.5E-11	0.9809	4	241.65	22.71	2.88E+04	6.80	3.48E-12	14.08	1.01
84	828.4	283900	2.1E-11	0.9015	4	241.9	29.27	1.47E+04	5.18	3.08E-12	14.54	1.04
85	1057	252720	2.8E-11	0.8826	4	332.02	31.41	1.70E+04	6.73	5.68E-12	20.34	1.48
86	863.5	203190	2.8E-11	0.8826	4	235.09	26.61	8.48E+03	4.17	4.22E-12	14.82	1.08
87	867.2	148200	3.3E-11	0.8778	4	252.02	29.06	5.68E+03	3.82	5.68E-12	16.97	1.24
88	882.3	128880	4E-11	0.8676	4	252.81	27.12	4.72E+03	3.64	7.04E-12	17.56	1.30
89	861.8	113360	4.3E-11	0.8842	4	203.02	23.84	3.12E+03	2.75	6.28E-12	14.53	1.06
90	875.2	93733	5.6E-11	0.8808	4	247.76	25.41	2.82E+03	3.12	1.00E-11	19.36	1.39
91	888.9	81683	5.4E-11	0.8823	4	201.12	24.03	1.97E+03	2.41	8.41E-12	15.49	1.17
92	868.5	71515	6.0E-11	0.8414	4	245.82	27.73	2.04E+03	2.85	1.30E-11	18.85	1.50
93	731.4	60629	6.3E-11	0.8498	4	204.64	27.86	2.04E+03	2.23	1.08E-11	16.91	1.29
94	742.7	52335	7.3E-11	0.8377	4	186.48	25.11	1.03E+03	1.97	1.17E-11	16.02	1.24
95	708.4	45108	7.9E-11	0.8341	4	185.53	26.15	8.58E+02	1.90	1.31E-11	15.56	1.26
96	833.2	39343	8.3E-11	0.833	4	183.87	24.30	6.14E+02	1.56	1.19E-11	14.37	1.12
97	838.5	33815	9.3E-11	0.8272	4	171.66	27.94	5.77E+02	1.71	1.55E-11	16.63	1.31
98	614.4	29018	8.5E-11	0.8346	4	130.25	28.43	3.79E+02	1.20	1.33E-11	13.23	1.04
99	442.6	29018	8.5E-11	0.8346	4	130.25	28.43	3.79E+02	1.20	1.33E-11	13.23	1.04

W/C = 0.36
7 Days of Hydration
Neutral Pore Solution

File No.	R_1 (Q)	R_2 (Q)	C (P)	Phi	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
101	488.9	25099	9.7E-11	0.8277	4	180.07	32.74	397.35	1.58	1.8395E-11	18.83	0.011	1.33
102	374	21479	9.5E-11	0.8312	4	128.36	33.79	275.87	1.26	1.3309E-11	14.04	0.009	1.11
103	360.1	18629	1.1E-10	0.825	4	123.82	36.37	241.14	1.29	1.5395E-11	14.24	0.009	1.14
104	304.5	18130	1.1E-10	0.8298	4	130.64	43.00	228.71	1.42	1.7005E-11	15.62	0.010	1.28
105	188.8	13788	9.5E-11	0.8398	4	102.7	66.50	164.37	1.19	1.2501E-11	13.19	0.009	1.05
106	99.41	11848	9.6E-11	0.8361	4	103.08	103.67	151.61	1.29	1.3139E-11	13.72	0.009	1.11
107	42.64	10129	9.6E-11	0.8403	4	98.198	232.64	138.34	1.35	1.3394E-11	13.91	0.009	1.13
108	41.37	8624	8.7E-11	0.8468	4	108.66	262.70	139.76	1.84	1.4057E-11	16.09	0.011	1.31
109													
110	197.5	5700	6.4E-11	0.875	4	100.75	51.01	116.82	2.05	1.1142E-11	17.40	0.012	1.41
111	252.3	4684	7.3E-11	0.8725	4	87.895	34.84	98.336	2.13	1.2209E-11	16.62	0.012	1.37
112													
113	343	3373	8.5E-11	0.874	4	75.747	22.68	83.019	2.46	1.4415E-11	16.90	0.012	1.43
114	371.4	3024	8.5E-11	0.8768	4	57.043	19.36	61.849	2.05	1.1527E-11	13.26	0.010	1.13
115	362	2789	8.6E-11	0.8772	4	56.412	14.39	60.771	2.19	1.2126E-11	13.68	0.010	1.17
116	419.9	2099	8.4E-11	0.8826	4	46.307	11.03	48.577	1.94	9.8344E-12	11.87	0.009	1.00
117	415.6	2399	8.7E-11	0.8822	4	50.074	12.05	53.353	2.22	1.1233E-11	12.89	0.010	1.12
118	424.4	2244	8.5E-11	0.8857	4	50.656	11.94	53.723	2.39	1.1331E-11	13.39	0.010	1.16
119	415.2	2128	8.9E-11	0.8834	4	49.277	11.87	52.081	2.45	1.1738E-11	13.14	0.010	1.16
120	417.2	2018	9.4E-11	0.8816	4	48.641	11.69	51.242	2.54	1.2439E-11	13.19	0.010	1.17

W/C = 0.36
28 Days of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
1	174.9	6161	1.03E-10	0.820	4	211.18	120.74	300.10	248.85	4.04	5.02E-11	32.90	0.024	2.87
2	49.52	6003	1.12E-10	0.842	4	173.37	380.10	673.11	208.42	3.44	3.32E-11	29.66	0.021	2.49
3	25.55	6057	9.24E-11	0.853	4	171.98	673.11	171.98	204.12	3.37	2.71E-11	29.30	0.021	2.42
4	52.36	6071	9.88E-11	0.850	4	124.55	237.87	237.87	148.86	2.45	2.13E-11	21.55	0.015	1.78
5	49.98	6147	9.03E-11	0.854	4	117.01	234.11	234.11	139.19	2.26	1.79E-11	19.81	0.014	1.63
6	6.907	6134	1.04E-10	0.848	4	156.22	1778.36	1778.36	186.49	3.07	2.79E-11	26.84	0.019	2.22
7	44.85	6211	1.02E-10	0.847	4	135.11	303.28	303.28	181.37	2.80	2.31E-11	22.70	0.016	1.89
8	120	6335	1.27E-10	0.832	4	185.62	163.02	163.02	233.75	3.69	4.03E-11	31.59	0.022	2.69
9	125	6045	6.10E-11	0.851	4	143.99	114.47	114.47	171.52	2.84	1.59E-11	26.13	0.018	2.07
10	83.64	6162	8.08E-11	0.864	4	143.94	180.50	180.50	173.72	2.82	2.08E-11	25.70	0.018	2.08
11	19.16	6223	8.58E-11	0.858	4	143.14	747.08	747.08	171.39	2.75	2.11E-11	24.54	0.017	2.01
12	21.43	6266	1.00E-10	0.847	4	160.19	191.13	191.13	181.13	3.05	2.69E-11	28.57	0.019	2.21
13	3.325	6262	1.04E-10	0.846	4	124.25	3736.84	3736.84	149.11	2.37	2.18E-11	20.88	0.015	1.74
14	39.52	6418	9.03E-11	0.855	4	165.41	418.55	418.55	200.17	3.12	2.55E-11	28.25	0.020	2.31
15	73.62	6800	1.03E-10	0.846	4	166.72	287.21	287.21	241.32	3.55	3.34E-11	32.55	0.023	2.69
16	39.22	7086	9.38E-11	0.852	4	132.82	398.70	398.70	198.98	2.35	2.11E-11	22.89	0.018	1.83
17	88.75	7571	8.83E-11	0.848	4	143.63	162.17	162.17	182.1	2.41	2.27E-11	23.09	0.018	1.89
18	22.22	8055	1.11E-10	0.859	4	180.6	857.79	857.79	248.89	3.09	3.39E-11	30.50	0.021	2.50
19	35.14	8615	1.16E-10	0.858	4	99.88	294.23	294.23	135.99	1.59	1.87E-11	18.18	0.011	1.32
20	101.9	9205	9.37E-11	0.848	4	168.57	163.46	163.46	229.73	2.50	2.44E-11	28.10	0.018	2.09
21	180.5	9897	1.20E-10	0.833	4	136.41	84.99	84.99	165.73	1.98	2.47E-11	20.85	0.014	1.68
22	287.4	11047	1.60E-10	0.812	4	248.71	93.01	93.01	371.89	3.37	5.68E-11	35.31	0.024	2.95
23	52.28	11595	8.97E-11	0.850	4	128.43	241.52	241.52	198.16	1.71	1.69E-11	19.00	0.013	1.50
24	453.5	13265	1.85E-10	0.802	4	285.16	68.08	68.08	483.54	3.72	7.34E-11	39.77	0.027	3.34
25	595.6	14702	1.65E-10	0.807	4	308.98	52.78	52.78	547.4	3.67	8.83E-11	40.23	0.027	3.34
26	623.9	16184	1.62E-10	0.807	4	308.54	46.61	46.61	593.32	3.67	8.83E-11	39.64	0.028	3.27
27	687.4	18226	2.06E-10	0.791	4	347.37	53.24	53.24	741.08	4.07	8.83E-11	43.00	0.029	3.61
28	384.8	18674	9.38E-11	0.840	4	407.86	87.99	87.99	751.77	4.03	4.18E-11	44.38	0.029	3.48
29	487.3	21265	1.38E-10	0.814	4	407.86	87.24	87.24	994.46	4.67	8.82E-11	49.09	0.032	3.98
30	626.2	23178	1.38E-10	0.819	4	245.23	36.04	36.04	652.73	2.82	3.73E-11	29.20	0.019	2.34
31	219.3	25100	7.07E-11	0.859	4	377.85	172.30	172.30	1117.7	4.45	3.27E-11	48.20	0.030	3.51
32	248.5	28708	7.68E-11	0.851	4	339.34	137.68	137.68	1184.3	4.13	3.09E-11	40.32	0.028	3.07
33	280.5	31521	7.76E-11	0.848	4	347.38	133.35	133.35	1313.8	4.17	3.09E-11	39.32	0.028	3.01
34	680.2	38939	1.38E-10	0.810	4	468.11	51.46	51.46	2028.5	5.49	8.48E-11	47.54	0.031	3.81
35	526	41303	1.15E-10	0.820	4	587.08	81.24	81.24	2636.1	6.67	8.83E-11	57.18	0.037	4.52
36	678.4	48655	1.21E-10	0.817	4	517.55	98.85	98.85	3347.6	6.88	6.20E-11	51.40	0.033	4.07
37	1370	59497	1.84E-10	0.788	4	397.59	28.83	28.83	3023.3	5.08	6.18E-11	33.42	0.022	2.75
38	1684	68017	1.74E-10	0.798	4	618.74	37.00	37.00	5636.6	6.54	6.39E-11	53.77	0.035	4.41
39	713.4	80229	6.91E-11	0.846	4	635.55	75.07	75.07	6411.2	7.99	3.18E-11	48.08	0.030	3.51
40	504.5	91899	4.89E-11	0.870	4	714.2	141.57	141.57	10100	11.01	2.72E-11	69.89	0.038	4.41
41	2008	140370	1.89E-10	0.779	4	487.76	23.32	23.32	14083	10.04	7.08E-11	36.16	0.023	2.89
42	1357	164340	8.97E-11	0.830	4	913.85	67.34	67.34	30618	19.89	5.97E-11	68.60	0.045	5.40
43	1760	193960	1.04E-10	0.816	4	520.86	29.80	29.80	24978	12.87	3.92E-11	37.82	0.024	2.96
44	1534	194200	8.59E-11	0.843	4	1208.1	78.75	78.75	53741	27.87	5.68E-11	88.21	0.055	6.58
45	1471	328570	6.20E-11	0.858	4	728.61	44.04	44.04	72861	22.11	2.33E-11	44.77	0.029	3.36
46	2320	635470	1.03E-10	0.811	4	813.24	35.05	35.05	319780	50.32	5.39E-11	62.50	0.034	4.16
47	2454	654130	9.38E-11	0.819	4	852.23	34.73	34.73	363440	55.58	5.22E-11	65.91	0.039	4.39
48	1088	862710	2.81E-11	0.893	4	1453	136.05	136.05	862730	113.91	2.89E-11	95.43	0.081	6.84
49	2180	1E+08	4.54E-11	0.858	4	703.13	32.11	32.11	601780	57.61	1.93E-11	42.55	0.027	3.16

W/O = 0.36
28 Days of Hydration
Natural Pore Solution

File No.	R ₁ (g)	R ₂ (g)	C (P)	Phi	Type	R ₁ (g) (Error)	R ₂ (g) (Error)	R ₂ (g) (% Error)	C (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
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94	1636	410970	4.6E-11	0.8604	4	910.21	1.42E+05	34.63	2.73E-11	90.20	0.036	4.42
95	1846	433660	6.3E-11	0.8424	4	637.83	1.16E+05	27.20	2.67E-11	42.33	0.027	3.23
96	1266	326270	4.2E-11	0.8666	4	967.46	1.01E+05	31.08	2.73E-11	66.34	0.042	4.84
97	2685	315710	1.6E-10	0.7809	4	1000.3	1.24E+05	36.37	1.26E-10	71.66	0.046	5.92
98	1200	236310	5.6E-11	0.8625	4	1110.6	7.36E+04	30.66	4.46E-11	76.07	0.051	5.96
99	1449	163960	6.6E-11	0.8428	4	962.19	3.40E+04	20.80	4.63E-11	71.32	0.046	5.44
100												

W/O = 0.35
28 Days of Hydration
Natural Pore Solution

Pile No.	R_1 (D)	R_2 (D)	C (F)	Phi	Type	R_1 (D) (Error)	R_2 (D) (Error)	R_3 (D) (Error)	R_4 (D) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
101	1314	145710	0.0E-11	0.8439	4	889.53	25653	68.48	17.74	4.4613E-11	67.22	0.043	5.12
102	2236	137570	2.2E-10	0.7707	4	826.55	23604	36.93	17.16	1.3607E-10	62.57	0.040	5.23
103	1809	119290	1.7E-10	0.7698	4	751.6	15708	41.55	13.54	9.9785E-11	58.15	0.038	4.77
104	1801	93088	1.5E-10	0.7653	4	419.77	6381.1	29.22	6.83	5.2497E-11	34.20	0.022	2.78
105	2273	77608	2.7E-10	0.7518	4	747.3	7939.6	32.86	10.89	1.666E-10	62.57	0.041	5.32
106	1536	59329	1.3E-10	0.8088	4	741.14	5729.2	55.47	9.82	8.6533E-11	65.78	0.043	5.27
107	835	50782	9E-11	0.8409	4	328.55	2137.5	36.47	4.21	2.9534E-11	32.00	0.021	2.46
108	1655	45451	2.3E-10	0.7734	4	549.88	2868.7	6.57	6.57	1.1881E-10	50.90	0.033	4.28
109	1852	40369	2.7E-10	0.7693	4	448.18	2165.1	29.91	5.40	1.1829E-10	43.65	0.028	3.71
110	755.6	32811	1.2E-10	0.8188	4	389.52	1507.5	52.87	4.82	5.1428E-11	42.87	0.028	3.40
111	605.9	26338	1.2E-10	0.8186	4	431.22	1379.3	47.44	4.87	5.9476E-11	47.82	0.031	3.80
112	790.8	24988	1.3E-10	0.8148	4	272.34	759.85	34.44	3.04	4.1018E-11	30.80	0.020	2.49
113	643.3	21847	1.1E-10	0.8248	4	290.58	707.65	45.17	3.22	3.9046E-11	34.20	0.022	2.72
114	517.7	19157	9.2E-11	0.8402	4	254.43	657.68	46.15	2.91	2.9452E-11	32.02	0.021	2.51
115	1008	17509	1.0E-10	0.7656	4	422.04	805.2	41.87	4.80	8.8208E-11	49.00	0.033	4.11
116	448.8	15021	8.9E-11	0.8429	4	280.57	456.65	56.08	3.04	3.019E-11	34.07	0.023	2.69
117	674.6	13824	1.4E-10	0.8142	4	237.09	398.39	35.15	2.81	4.2526E-11	30.28	0.020	2.50
118	378.9	11971	1E-10	0.837	4	194.38	295.24	51.17	2.47	2.7081E-11	28.88	0.018	2.15
119	41.34	10280	5.5E-11	0.8768	4	157.45	228.91	360.87	2.21	1.3503E-11	24.51	0.016	1.87
120	241.9	9038	1E-10	0.8413	4	276.27	374.83	114.21	4.02	4.1222E-11	41.05	0.028	3.33
121	317.4	8448	1.2E-10	0.8264	4	260.87	338.81	82.19	3.89	4.7317E-11	38.28	0.028	3.20
122	182.2	7852	1E-10	0.841	4	200.96	250.84	110.30	3.32	3.2098E-11	30.69	0.022	2.56
123	136.6	6914	9E-11	0.8514	4	116.25	210.04	85.10	2.05	1.6988E-11	18.79	0.013	1.54
124	78.65	6341	9.7E-11	0.848	4	178.13	140.82	223.94	3.31	2.8074E-11	28.85	0.020	2.40
125	76.66	5890	9.3E-11	0.8509	4	159.81	168.57	208.47	3.17	2.4576E-11	26.38	0.019	2.20
126	73.46	5481	9.0E-11	0.8478	4	226.91	263.82	312.97	4.81	3.7443E-11	37.91	0.027	3.21
127	58.71	5033	9.1E-11	0.8588	4	170.7	194.65	280.75	3.87	2.7723E-11	30.37	0.022	2.55
128	43.97	4824	8.0E-11	0.8697	4	180.23	202.05	409.89	4.19	2.7297E-11	30.59	0.023	2.63
129	18.83	4553	1E-10	0.8472	4	137.06	152.51	735.70	3.35	2.4822E-11	23.87	0.017	2.05
130	5.731	4323	1.2E-10	0.8413	4	181.82	178.78	2823.99	4.14	3.2771E-11	27.99	0.021	2.47

W/C = 0.60
1 Day of Hydration
Natural Pore Solution

File No.	R ₁ (G)	R ₂ (G)	G (F)	PN	Type	R ₁ (G) (Error)	R ₂ (G) (% Error)	R ₂ (G) (Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
1	208.9	183.4	2.41E-09	0.860	4	12.614	4.37	13.446	1.17E-09	48.43	0.038	4.42
2	262.1	161.7	2.19E-09	0.852	4	12.266	4.20	13.041	9.36E-10	43.62	0.034	3.99
3	263.7	165.8	2.03E-09	0.854	4	12.122	4.13	12.874	8.45E-10	41.71	0.033	3.81
4	264.6	168.8	1.90E-09	0.865	4	11.760	4.01	12.51	7.46E-10	39.32	0.031	3.60
5	265.5	170.8	2.08E-09	0.861	4	12.377	4.17	13.146	8.49E-10	41.13	0.032	3.78
6	266.3	174.5	1.99E-09	0.851	4	12.441	4.17	13.207	8.02E-10	40.31	0.032	3.70
7	266.8	176.8	2.01E-09	0.850	4	12.617	4.22	13.39	8.08E-10	40.18	0.031	3.70
8	300.1	176.3	2.03E-09	0.848	4	12.98	4.32	13.756	8.29E-10	40.85	0.032	3.77
9	302.1	179.7	1.91E-09	0.851	4	12.594	4.17	13.363	7.84E-10	39.44	0.031	3.63
10	302.2	181.8	1.80E-09	0.851	4	12.837	4.25	13.614	7.83E-10	39.54	0.031	3.64
11	302.4	183.2	1.90E-09	0.850	4	12.874	4.26	13.645	7.42E-10	39.00	0.031	3.60
12	304.6	183.1	1.80E-09	0.850	4	13.164	4.33	13.969	7.79E-10	40.44	0.032	3.73
13	308.8	187.8	2.11E-09	0.844	4	14.441	4.66	15.37	9.31E-10	44.04	0.034	4.07
14	315.4	189.6	2.19E-09	0.840	4	15.578	4.94	16.604	9.72E-10	44.99	0.035	4.16
15	321.1	214.2	2.18E-09	0.835	4	16.637	5.18	17.748	9.74E-10	44.74	0.036	4.16
16	328.2	231.4	2.22E-09	0.830	4	17.669	5.39	18.874	9.79E-10	44.09	0.034	4.15
17	336.1	251.8	2.27E-09	0.824	4	19.074	5.69	20.366	9.86E-10	43.53	0.034	4.14
18	346.1	278.4	2.89E-09	0.813	4	23.04	6.68	24.734	1.26E-09	48.98	0.036	4.71
19	374.1	327.2	2.89E-09	0.797	4	33.272	8.69	36.086	1.87E-09	62.81	0.049	6.10
20	448.4	467.3	3.68E-09	0.774	4	62.669	14.03	70.666	3.66E-09	99.16	0.078	9.64
21	584.9	915.8	1.21E-09	0.768	4	114.73	20.31	133.41	2.52E-09	108.31	0.078	10.18
22	630.7	2045	2.37E-09	0.764	4	194.52	30.84	232.76	1.08E-09	86.78	0.084	8.42
23	645.5	3966	6.02E-10	0.763	4	303.86	47.07	376.05	4.01E-10	80.20	0.057	7.29
24	665.9	7056	1.44E-10	0.831	4	422.46	60.71	548.83	1.10E-10	75.63	0.052	6.31
25	713	13265	5.39E-11	0.868	4	610.98	85.69	907.86	4.15E-11	77.01	0.062	5.96
26	579.8	2474.1	2.33E-11	0.803	4	703.72	123.26	1363.7	1.96E-11	67.72	0.044	4.92
27	421.3	3954.1	1.63E-11	0.916	4	798.67	189.10	2133.3	1.03E-11	63.30	0.041	4.48
28	344.1	52236	1.14E-11	0.904	4	792.16	230.21	2605.2	6.46E-12	59.84	0.037	3.92
29	466.7	67704	9.02E-12	0.945	4	803.81	172.23	3731.5	4.78E-12	53.08	0.034	3.61
30	428	80982	7.03E-12	0.958	4	840.66	198.42	4720.1	3.71E-12	52.57	0.034	3.52
31	189.8	101370	8.26E-12	0.946	4	856.26	481.23	6576.7	4.26E-12	51.96	0.033	3.50
32	181.1	117130	6.76E-12	0.957	4	856.26	444.87	7342	3.16E-12	46.56	0.030	3.12
33	27.84	146320	7.88E-12	0.945	4	848.32	3436.17	11258	3.66E-12	46.77	0.032	3.36
34	113.4	174240	7.10E-12	0.951	4	966.2	871.43	14747	3.51E-12	49.41	0.032	3.34
35	27.13	198320	5.97E-12	0.960	4	936.23	3480.90	16711	2.71E-12	45.44	0.029	3.04
36	256.8	246370	4.80E-12	0.970	4	1016.2	366.72	24056	2.32E-12	47.08	0.030	3.12
37	368.8	263180	3.67E-12	0.987	4	934.65	253.43	23916	1.55E-12	42.27	0.027	2.75
38	66.98	341680	4.92E-12	0.968	4	1080.9	1114.44	42797	2.30E-12	46.94	0.030	3.11
39	180.4	364120	4.50E-12	0.973	4	1083.3	989.41	46792	2.06E-12	45.46	0.029	3.00
40	286.1	447960	3.33E-12	0.960	4	972.28	362.66	59576	1.34E-12	40.04	0.028	2.80
41	135.8	501050	3.82E-12	0.981	4	1077.9	793.74	76816	1.67E-12	43.76	0.028	2.87
42	382.2	577940	4.13E-12	0.975	4	1173.7	324.05	100590	1.80E-12	46.04	0.030	3.04
43	466.8	687690	4.01E-12	0.975	4	1361.2	302.36	159980	2.12E-12	52.86	0.034	3.46
44	228.5	1017400	3.46E-12	0.983	4	1268.3	590.96	301740	1.80E-12	47.27	0.030	3.10
45	112.3	914610	2.38E-12	1.008	4	1267.3	1146.30	233290	1.63E-12	47.40	0.031	3.04
46	786	1234800	1.94E-12	1.030	4	1269.2	158.85	361130	7.08E-13	45.36	0.029	2.84
47	634.4	907250	1.44E-12	1.005	4	1269.2	176.17	183600	5.71E-13	39.57	0.026	2.47
48	624.1	1081000	1.52E-12	1.030	4	1220.2	165.91	271300	8.46E-13	42.86	0.027	2.67
49	416.6	1298300	1.61E-12	1.028	4	1277.7	305.23	360480	7.19E-13	44.51	0.029	2.80
50	141	1117850	1.67E-12	1.024	4	1255.9	919.97	301900	7.53E-13	44.96	0.029	2.83

W/C = 0.60
1 Day of Hydration
Natural Pore Solution

File No.	R ₁ (D)	R ₂ (D)	G (P)	PH	Type	R ₁ (D) (Error)	R ₂ (D) (% Error)	R ₁ (D) (Error)	R ₂ (D) (Error)	R ₂ (D) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
51	703.6	1230200	1.21E-12	1.043	4	1087	151.85	1254.2	2.92E+05	23.85	4.42E-13	38.47	0.023	2.25
52	331.2	1185100	1.42E-12	1.004	4	1284.2	272.86	1280.2	3.28E+05	27.57	6.12E-13	43.09	0.028	2.86
53	484.6	1122300	1.18E-12	1.043	4	1280.2	272.86	1280.2	2.82E+05	25.13	6.12E-13	43.32	0.028	2.87
54	1185	1381300	8.48E-13	1.084	4	1200.1	103.01	1200.1	3.84E+05	27.81	3.41E-13	40.26	0.028	2.44
55	971.3	1191800	8.79E-13	1.081	4	1182.6	119.70	1182.6	3.43E+05	23.50	3.43E-13	38.99	0.025	2.37
56	734.9	1361600	1.01E-12	1.053	4	1206	163.49	1206	3.79E+05	27.80	4.07E-13	40.37	0.028	2.47
57	831	1888800	1.07E-12	1.048	4	1291.2	155.38	1291.2	5.18E+05	32.86	4.88E-13	42.72	0.028	2.63
58	406.9	1570700	1.15E-12	1.047	4	1206.3	285.02	1206.3	4.81E+05	32.33	4.81E-13	40.86	0.028	2.51
59	688.8	2311900	1.18E-12	1.043	4	1480.4	211.71	1480.4	1.24E+06	53.77	5.89E-13	48.21	0.031	2.98
60	688	2541800	1.08E-12	1.047	4	1283.7	188.74	1283.7	1.30E+06	51.25	4.91E-13	41.41	0.027	2.85
61	777.1	1831800	1.02E-12	1.051	4	1689.8	218.74	1689.8	1.01E+06	52.45	5.81E-13	56.72	0.036	3.47
62	728.7	1388800	1.02E-12	1.052	4	1330.7	182.36	1330.7	4.28E+05	30.78	4.83E-13	44.36	0.029	2.71
63	1031	1288800	7.78E-13	1.088	4	1146.9	111.34	1146.9	3.04E+05	23.42	2.84E-13	37.89	0.024	2.27
64	207	1621700	1.64E-12	1.023	4	1369.6	681.64	1369.6	6.18E+05	38.14	7.48E-13	46.63	0.029	2.87
65	514.2	2470800	1.22E-12	1.039	4	1429.6	278.02	1429.6	1.38E+06	56.11	5.71E-13	46.85	0.030	2.90
66	1886	1423800	9.88E-13	1.086	4	1125.5	70.86	1125.5	3.44E+05	24.14	2.07E-13	36.35	0.023	2.15
67	279.6	1311800	1.15E-12	1.044	4	1394.6	465.21	1394.6	3.88E+05	25.88	3.88E-13	45.86	0.030	2.83
68	787	1277100	8.82E-13	1.059	4	1280	182.97	1280	3.27E+05	25.88	3.88E-13	41.21	0.027	2.50
69	534	1347400	1.04E-12	1.05	4	1413.2	264.64	1413.2	4.18E+05	31.00	4.88E-13	46.92	0.030	2.87
70	1275	1740800	1.04E-12	1.05	4	1280.3	215.54	1280.3	6.22E+05	35.71	4.38E-13	42.21	0.027	2.56
71	1827	1464700	7.08E-13	1.073	4	1383.1	108.91	1383.1	4.50E+05	30.82	3.18E-13	44.84	0.029	2.87
72	845.1	1240700	9.05E-13	1.058	4	1104.1	72.31	1104.1	2.83E+05	22.80	3.43E-13	37.91	0.024	2.31
73	504.5	1330700	1.08E-12	1.05	4	1154.9	138.86	1154.9	3.88E+05	27.87	4.42E-13	41.80	0.027	2.57
74	683.5	1164700	8.91E-13	1.054	4	1258.7	182.08	1258.7	2.84E+05	24.34	4.14E-13	41.79	0.027	2.55
75	1182	2288400	8.87E-13	1.089	4	1224.8	108.40	1224.8	9.87E+05	43.83	3.88E-13	38.82	0.025	2.40
76	178.3	3380300	1.88E-12	1.024	4	1489	818.80	1489	2.78E+06	82.86	7.71E-13	48.53	0.031	3.05
77	428.6	1882700	1.28E-12	1.038	4	1389.8	317.27	1389.8	5.42E+05	34.83	5.88E-13	45.14	0.029	2.80
78	885	1270700	9.08E-13	1.059	4	1123	114.01	1123	3.03E+05	23.83	3.43E-13	37.71	0.024	2.28
79	139	1948700	1.44E-12	1.03	4	1451.8	1044.48	1451.8	9.24E+05	47.42	7.01E-13	48.67	0.031	3.04
80	1239	1348800	7.65E-13	1.089	4	1343.2	108.41	1343.2	3.88E+05	28.80	3.43E-13	44.84	0.029	2.70
81	1371	1404700	8.68E-13	1.082	4	1285.8	105.80	1285.8	4.14E+05	28.47	3.88E-13	42.74	0.028	2.59
82	1178	2202200	9.48E-13	1.057	4	1200	102.04	1200	9.88E+05	43.86	3.78E-13	38.78	0.028	2.43
83	57.31	1084700	1.78E-12	1.019	4	1301.8	2271.16	1301.8	2.83E+05	26.77	6.08E-13	45.14	0.029	2.85
84	213.5	1388400	1.74E-12	1.022	4	1206.4	86.14	1206.4	6.88E+05	37.10	4.01E-13	40.75	0.026	2.49
85	133	911380	1.88E-12	1.014	4	1335.8	625.87	1335.8	4.77E+05	34.84	8.08E-13	48.55	0.030	2.83
86	682.3	1170800	1.42E-12	1.035	4	1270.2	885.04	1270.2	2.08E+05	22.88	8.84E-13	48.08	0.029	2.86
87	185.5	1083100	2.38E-12	1.004	4	1082.3	180.09	1082.3	2.87E+05	24.51	5.45E-13	38.37	0.025	2.39
88	145.1	1218000	2.82E-12	1.001	4	1273.1	877.39	1273.1	2.88E+05	27.37	1.07E-12	45.32	0.029	2.81
89	178.2	1185400	2.52E-12	1.001	4	1239.2	283.09	1239.2	3.91E+05	32.07	1.15E-12	45.74	0.029	2.84
90	422.8	718180	1.78E-12	1.024	4	1540.2	884.31	1540.2	4.85E+05	38.41	1.42E-12	45.28	0.029	2.84
91	780.7	738800	1.84E-12	1.029	4	826.12	118.63	826.12	1.10E+05	15.04	6.61E-13	34.17	0.022	2.14
92	326	717070	2.88E-12	0.9835	4	1040.9	317.35	1040.9	8.40E+04	14.53	8.88E-13	40.08	0.028	2.54
93	227.7	524760	2.50E-12	1.004	4	1235.2	542.47	1235.2	1.81E+05	21.02	1.38E-13	48.77	0.030	3.03
94	436.9	312940	3.48E-12	0.9889	4	982.09	227.07	982.09	7.22E+04	13.78	1.00E-12	39.28	0.026	2.51
95	55.48	368150	3.44E-12	0.9878	4	1088.9	1881.43	1088.9	5.37E+04	13.01	1.54E-12	44.73	0.029	2.81
96	65.7	328370	3.83E-12	0.9821	4	1085.1	1242.82	1085.1	3.98E+04	12.23	1.51E-12	44.08	0.028	2.87
97	73	278550	4.03E-12	0.9788	4	1152	1578.08	1152	2.81E+04	12.02	1.87E-12	48.86	0.031	3.20
100	181.5				4	1050.2	683.20	1050.2	2.81E+04	10.08	1.88E-12	49.87	0.030	3.01

W/C = 0.60
1 Day of Hydration
Natural Pore Solution

File No.	R_p (Q)	R_p (Q)	G (F)	PH	Type	R_p (Q) (Error)	R_p (Q) (% Error)	R_p (Q) (Error)	R_p (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PH (Error)	PH (% Error)
101	103.9	248310	4.42E-12	0.9761	4	983.19	983.91	22518	9.07	1.9891E-12	44.85	0.029	2.93
102	431.5	197620	3.82E-12	0.9838	4	985.58	226.41	19916	8.06	1.8233E-12	48.54	0.020	3.04
103	308.1	158910	4.28E-12	0.9808	4	980.95	297.27	11232	7.08	1.9449E-12	45.63	0.029	2.98
104	91.02	137160	5.93E-12	0.9812	4	989.46	1069.07	10102	7.36	3.0513E-12	51.49	0.033	3.44
105	185.1	114760	5.44E-12	0.988	4	894.72	483.37	7215.6	6.29	2.6555E-12	48.84	0.031	3.23
106	253.9	97631	5.89E-12	0.9853	4	896.75	319.92	5397.4	5.53	2.7186E-12	48.44	0.030	3.08
107	171.7	82191	6.59E-12	0.9893	4	848.27	494.04	4595.4	5.56	3.3995E-12	50.91	0.033	3.40
108	329.8	99335	5.96E-12	0.9875	4	795	241.08	3377.8	5.07	3.0373E-12	51.05	0.039	3.39
109	194.6	58359	7.91E-12	0.9518	4	600.32	407.08	2848.8	5.05	4.2916E-12	53.85	0.035	3.64
110	398	49899	7.42E-12	0.988	4	728.75	199.11	2188	4.82	3.8988E-12	62.54	0.034	3.53
111	343.9	39539	6.42E-12	0.9822	4	735.94	214.00	1821	4.71	4.7229E-12	56.09	0.038	3.81
112	589.6	31595	7.39E-12	0.9838	4	635.82	107.81	1390.4	4.26	3.9071E-12	62.80	0.034	3.59
113	519	29898	8.87E-12	0.9852	4	627.71	120.95	1164.6	4.47	4.9409E-12	55.72	0.039	3.81
114	694.7	20908	9.02E-12	0.9577	4	582.58	96.22	911.97	4.36	4.8928E-12	54.25	0.038	3.72
115	491	19934	1.1E-11	0.9488	4	519.79	105.86	748.7	4.50	5.9309E-12	53.78	0.038	3.76
116	638.1	12720	1.10E-11	0.951	4	443.56	82.28	580.15	4.56	5.9895E-12	51.24	0.034	3.62
117	603.2	9038	1.13E-11	0.9598	4	365.6	60.61	435.28	4.82	5.444E-12	48.19	0.033	3.44
118	590.2	5930	8.89E-12	0.9837	4	297.09	48.64	314.08	5.88	4.02E-12	45.29	0.032	3.27
119	557.6	2913	1.1E-11	0.9898	4	233.09	41.80	243.8	6.37	5.3084E-12	48.29	0.037	3.69
120	511.8	1825	3.01E-11	0.9487	4	163.46	31.95	188.24	9.27	1.2938E-11	43.03	0.034	3.94
121	448.5	1258	6.08E-11	0.9184	4	140.29	31.42	144.34	11.47	2.7182E-11	44.73	0.038	4.09
122	430.7	898.6	1.04E-10	0.9076	4	104.27	24.21	107.09	12.50	4.7689E-11	45.89	0.039	4.32
123	395.2	612.2	1.81E-10	0.9028	4	83.126	21.58	85.298	13.93	8.8408E-11	47.81	0.042	4.89
124	363	429.4	3.04E-10	0.8953	4	53.691	14.79	55.183	12.85	1.392E-10	45.83	0.040	4.49
125	341.2	309	4.51E-10	0.8949	4	35.83	10.80	36.937	11.95	2.0479E-10	45.38	0.039	4.37
126	320.2	228.8	6.44E-10	0.8951	4	22.182	8.93	22.858	10.03	2.6308E-10	40.86	0.034	3.85
127	311.3	178.2	9.13E-10	0.894	4	14.015	4.50	14.578	8.18	3.3203E-10	38.36	0.030	3.35
128	303.4	152	1.1E-09	0.8949	4	11.846	3.91	12.358	8.13	4.1821E-10	37.74	0.030	3.44
129	297.8	134.5	1.21E-09	0.8994	4	10.891	3.96	11.165	8.30	4.8483E-10	39.88	0.032	3.59
130	293.2	124.1	1.49E-09	0.8927	4	10.559	3.90	11.097	8.92	6.5984E-10	44.14	0.035	3.97

W/C = 0.60
3 Days of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	C (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
1	421.8	444.8	3.15E-09	0.821	4	28.934	7.10	36.549	7.98	2.03E-09	64.38	0.047	5.78
2	482.5	410.3	1.22E-09	0.884	4	18.183	4.15	23.489	5.72	8.54E-10	53.80	0.038	4.27
3	472.5	377	8.97E-12	1.207	4	11.462	2.43	14.157	3.76	4.47E-12	44.97	0.030	2.49
4	473.9	389.4	1.82E-11	1.179	4	10.228	2.18	12.86	3.28	5.87E-12	38.84	0.028	2.20
5	531.9	341.8	8.72E-12	1.224	4	19.387	3.84	24.885	7.21	8.48E-12	87.28	0.058	4.77
6	508.9	377.2	2.10E-11	1.168	4	17.478	3.43	22.088	5.88	1.48E-11	69.80	0.047	4.02
7	480.8	405.6	1.47E-11	1.179	4	10.791	2.24	13.418	3.31	5.81E-12	39.38	0.028	2.24
8	483.8	408.1	7.49E-12	1.222	4	13.778	2.84	17.14	4.22	3.81E-12	51.08	0.034	2.79
9	483.8	428.9	1.28E-11	1.185	4	12.197	2.47	15.312	3.57	5.55E-12	43.02	0.029	2.43
10	508.8	489.3	2.40E-11	1.142	4	10.831	2.15	13.887	2.88	8.51E-12	38.44	0.024	2.09
11	534.8	337.6	1.88E-11	1.150	4	13.128	2.45	17.088	3.18	7.83E-12	39.85	0.026	2.27
12	580.5	854	2.08E-11	1.139	4	14.135	2.43	19.032	2.91	7.38E-12	38.07	0.024	2.12
13	650.2	848.5	3.34E-11	1.089	4	18.988	2.88	26.821	3.14	1.30E-11	38.94	0.028	2.38
14	764	1119	1.87E-11	1.127	4	29.898	3.97	48.49	4.15	9.83E-12	82.88	0.035	3.12
15	839.2	1038	2.38E-11	1.089	4	32.745	3.80	55.775	3.83	1.08E-11	48.73	0.031	2.78
16	888.8	2351	8.07E-10	0.851	4	62.885	7.32	113.89	4.84	4.21E-10	52.14	0.036	4.21
17	943.3	3349	1.22E-09	0.811	4	82.885	9.82	162.08	5.74	7.18E-10	68.83	0.040	4.88
18	1080	4713	1.13E-08	0.805	4	138.14	12.81	309.91	7.15	7.80E-10	70.30	0.048	5.86
19	1343	6220	3.58E-10	0.877	4	135.2	10.07	434.32	6.98	2.40E-10	67.01	0.045	5.18
20	1478	7841	8.88E-11	0.885	4	76.021	8.14	302.15	3.85	2.47E-11	37.85	0.028	2.88
21	1587	10281	1.18E-10	0.940	4	108.88	8.73	542.21	5.28	5.23E-11	44.34	0.030	3.18
22	1881	13334	1.22E-10	0.834	4	112.88	8.78	785.5	5.74	5.18E-11	42.53	0.028	3.05
23	1875	18284	1.00E-10	0.841	4	81.283	4.85	683.89	4.80	2.82E-11	28.22	0.020	2.10
24	1786	20332	1.13E-10	0.830	4	83.181	5.21	985.15	4.80	3.28E-11	28.83	0.020	2.13
25	1883	25408	1.12E-10	0.828	4	101.15	5.43	1389.3	5.51	3.31E-11	29.86	0.020	2.11
26	1784	28634	8.34E-11	0.839	4	102.39	5.74	1785.2	6.08	2.78E-11	32.97	0.022	2.29
27	1883	33288	6.10E-11	0.884	4	120.83	8.18	2380.4	7.07	2.01E-11	28.39	0.018	2.07
28	1882	43831	1.14E-10	0.821	4	111.29	5.87	3307.8	7.80	3.28E-11	28.83	0.018	2.14
29	1883	48821	8.80E-11	0.898	4	119.71	6.13	4172.7	8.88	2.87E-11	28.83	0.020	1.77
30	1847	53809	5.74E-11	0.885	4	100.47	5.18	4181.8	7.78	1.48E-11	28.80	0.017	1.41
31	1818	54805	3.11E-11	1.008	4	116.75	6.08	4974.9	9.13	9.88E-12	30.78	0.021	2.05
32	1771	54879	2.18E-11	1.030	4	82.618	5.23	4188.7	7.88	8.88E-12	28.70	0.017	1.87
33	1825	72887	2.28E-11	1.038	4	88.344	5.45	7271.4	9.97	8.08E-12	28.85	0.018	1.74
34	1825	78870	1.85E-11	1.040	4	82.083	4.80	6840	8.53	4.07E-12	21.97	0.015	1.41
35	1803	87312	1.87E-11	1.038	4	87.57	4.80	9727.5	11.14	4.82E-12	25.71	0.017	1.85
36	1803	94570	1.82E-11	1.037	4	110.88	6.15	13008	13.75	5.88E-12	29.48	0.020	1.90
37	1788	117020	2.11E-11	1.030	4	114.28	6.38	18848	18.88	8.38E-12	28.88	0.020	1.94
38	1884	121330	1.78E-11	1.039	4	102.7	5.97	14878	13.72	5.03E-12	28.83	0.018	1.73
39	1884	128510	1.88E-11	1.045	4	97.678	5.24	17288	14.25	4.48E-12	24.88	0.017	1.81
40	1807	148030	2.07E-11	1.028	4	117.26	6.11	22088	17.03	4.88E-12	28.08	0.019	1.88
41	1885	153400	1.94E-11	1.032	4	97.972	4.84	28829	18.71	5.84E-12	28.18	0.018	1.83
42	1885	181880	2.00E-11	1.030	4	119.54	6.12	33115	18.71	4.81E-12	23.81	0.016	1.54
43	2037	178870	2.48E-11	1.015	4	104.34	5.08	33115	20.15	5.78E-12	28.94	0.019	1.88
44	2188	194030	2.88E-11	1.004	4	111.38	5.08	42039	21.87	7.14E-12	24.59	0.019	1.82
45	2529	4248200	1.48E-10	0.889	4	234.02	9.25	33329000	784.38	6.28E-11	42.78	0.029	3.23

W/C = 0.60
7 Days of Hydration
Neutral Pore Solution

File No.	R ₁ (d)	R ₂ (d)	G (P)	PH	Type	R ₁ (d) (Error)	R ₁ (d) (% Error)	R ₂ (d) (Error)	R ₂ (d) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
1	498.7	1046	3.51E-10	0.854	4	24.85	5.02	26.707	2.55	5.37E-11	15.30	0.012	1.36
2	502.6	1082	3.50E-10	0.853	4	23.433	4.66	26.127	2.32	4.69E-11	14.08	0.011	1.26
3	502.2	1111	3.40E-10	0.854	4	22.968	4.66	24.639	2.22	4.59E-11	13.60	0.010	1.20
4	503.2	1134	3.39E-10	0.854	4	23.279	4.63	24.983	2.20	4.51E-11	13.46	0.010	1.20
5	503.7	1152	3.27E-10	0.854	4	22.959	4.46	24.228	2.10	4.23E-11	12.91	0.010	1.15
6	506.4	1167	3.26E-10	0.854	4	22.943	4.53	24.656	2.11	4.25E-11	13.02	0.010	1.16
7	500.1	1167	3.37E-10	0.851	4	24.151	4.63	25.909	2.19	4.46E-11	13.33	0.010	1.19
8	494.7	1205	3.44E-10	0.848	4	24.665	4.65	25.745	2.14	4.45E-11	12.94	0.010	1.16
9	502.4	1208	3.22E-10	0.852	4	23.695	4.91	26.487	2.19	4.31E-11	13.41	0.010	1.19
10	516.1	1208	3.10E-10	0.855	4	23.005	4.46	24.745	2.05	3.95E-11	12.74	0.010	1.13
11	511.4	1231	3.17E-10	0.853	4	23.557	4.61	25.339	2.08	4.04E-11	12.74	0.010	1.13
12	515.2	1247	3.20E-10	0.852	4	24.589	4.77	26.471	2.12	4.22E-11	13.19	0.010	1.17
13	513.5	1278	3.26E-10	0.850	4	26.38	5.53	30.594	2.39	4.86E-11	14.93	0.011	1.33
14	527.6	1322	3.26E-10	0.849	4	28.104	5.33	30.398	2.30	4.81E-11	14.66	0.011	1.30
15	521.4	1408	3.51E-10	0.842	4	30.781	5.90	33.392	2.37	5.35E-11	15.23	0.011	1.36
16	519.2	1504	3.70E-10	0.836	4	32.583	6.28	35.497	2.36	5.69E-11	15.36	0.012	1.36
17	530.2	1603	3.76E-10	0.833	4	35.351	6.67	38.723	2.42	6.07E-11	16.15	0.012	1.45
18	526.2	1751	4.24E-10	0.823	4	42.346	8.05	46.73	2.67	7.72E-11	18.21	0.014	1.65
19	578.1	2020	4.36E-10	0.818	4	60.774	10.51	68.336	3.36	1.09E-10	24.84	0.016	2.23
20	576.4	2531	4.34E-10	0.809	4	83.521	14.44	95.592	3.78	1.26E-10	26.10	0.021	2.61
21	582.3	3343	3.41E-10	0.811	4	101.95	17.21	119.12	3.56	9.66E-11	29.25	0.021	2.59
22	582.7	4468	2.52E-10	0.817	4	120.18	20.27	144.07	3.20	7.08E-11	28.13	0.020	2.44
23	583.9	6075	1.97E-10	0.819	4	150.08	25.27	166.56	3.07	5.69E-11	26.65	0.020	2.46
24	411.6	8436	1.97E-10	0.808	4	171.15	43.04	230.52	2.73	5.25E-11	26.70	0.019	2.30
25	304.8	11171	1.94E-10	0.807	4	183.61	60.22	253.92	2.27	3.86E-11	23.48	0.016	2.00
26	14646	14646	1.91E-10	0.804	4	237.84	174.37	356.16	2.43	3.94E-11	26.15	0.016	2.21
27	82.83	18674	1.41E-10	0.801	4	246.46	297.55	409.42	2.17	3.39E-11	23.92	0.016	2.01
28	243.9	23705	1.21E-10	0.805	4	264.61	108.46	462.33	2.08	2.89E-11	23.19	0.015	1.92
29	508.4	28787	1.24E-10	0.798	4	303.77	56.75	653.74	2.19	2.69E-11	24.07	0.016	2.00
30	628.6	36254	1.02E-10	0.807	4	342.83	54.54	848.04	2.34	2.89E-11	26.24	0.017	2.06
31	805.2	44345	9.67E-11	0.807	4	343.26	54.54	848.04	2.29	2.26E-11	23.56	0.015	1.92
32	1046	52646	8.96E-11	0.809	4	391.19	36.34	1315.6	2.50	2.21E-11	24.57	0.016	1.96
33	973.3	61622	8.82E-11	0.824	4	362.52	40.33	1590.1	2.57	1.65E-11	24.21	0.016	1.92
34	1157	77134	7.17E-11	0.819	4	413.03	35.70	2162.3	2.60	1.71E-11	23.85	0.016	1.90
35	1236	86905	5.89E-11	0.829	4	362.62	30.86	2364.7	2.63	1.42E-11	21.04	0.014	1.85
36	1262	107620	5.23E-11	0.834	4	523.95	41.52	3655.6	3.68	1.42E-11	27.06	0.016	2.11
37	1419	124630	4.61E-11	0.840	4	430.13	30.31	3698.4	3.13	9.89E-12	21.39	0.014	1.85
38	1686	155350	4.69E-11	0.834	4	555.14	32.93	6696.8	4.31	1.26E-11	25.81	0.017	2.01
39	1276	172060	2.63E-11	0.868	4	567.4	44.36	7491.3	4.35	7.29E-12	25.77	0.017	1.93
40	1643	207570	3.10E-11	0.890	4	471.86	28.73	8313.2	4.01	6.38E-12	20.60	0.013	1.55
41	1376	243170	2.29E-11	0.877	4	506.39	35.67	10743	4.44	4.86E-12	21.23	0.014	1.57
42	1216	260400	1.74E-11	0.891	4	530.1	43.59	13182	4.70	3.69E-12	21.07	0.014	1.53
43	1461	315520	1.63E-11	0.894	4	627.02	42.92	17935	5.68	3.82E-12	24.09	0.016	1.74
44	1534	364400	1.41E-11	0.900	4	667.21	42.84	25902	6.54	3.37E-12	23.84	0.015	1.72
45	2275	635510	1.89E-11	0.880	4	756.21	33.33	48253	9.01	4.84E-12	25.80	0.017	1.90
46	2238	724210	1.62E-11	0.887	4	742.33	33.17	76687	10.59	3.90E-12	24.06	0.016	1.76
47	1869	796760	1.01E-11	0.918	4	681.53	35.39	73987	9.29	2.11E-12	20.89	0.014	1.48
48	1854	1026600	9.51E-12	0.918	4	730.97	39.43	136010	12.80	2.13E-12	22.41	0.015	1.69
49	2404	1184700	9.99E-12	0.914	4	779.96	32.45	173670	14.66	2.33E-12	23.36	0.015	1.66
50	2169	1101300	7.19E-12	0.933	4	699.66	45.64	153290	16.64	2.10E-12	29.29	0.019	2.04

WFO = 0.06
7 Days of Hydration
Natural Pore Solution

File No.	R _a (Q)	R _a (Q)	G (F)	Phi	Type	R _a (Q) (Error)	R _a (Q) (% Error)	R _a (Q) (Error)	R _a (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
51	744.9	1312000	3.30E-12	0.9778	4	640.77	86.02	1.44E+05	10.96	6.25E-13	18.45	0.012	1.23
52	2616	1648000	8.97E-12	0.9334	4	1073.6	42.66	4.00E+05	24.27	2.15E-12	30.83	0.020	2.15
53	1862	2757000	5.98E-12	0.9483	4	1044.4	52.43	1.02E+06	37.04	1.64E-12	29.36	0.019	2.02
54	2214	1875200	5.57E-12	0.9404	4	1151.8	52.02	5.27E+05	28.12	1.81E-12	32.53	0.021	2.23
55	1811	2305800	4.01E-12	0.9848	4	982.46	63.04	5.97E+05	25.89	1.05E-12	26.15	0.017	1.76
56	1361	1702200	2.99E-12	0.9827	4	1026.6	75.43	3.44E+05	20.16	8.37E-13	26.05	0.016	1.85
57	1712	2410600	5.52E-12	0.973	4	982.69	67.41	6.69E+05	27.72	9.42E-13	26.76	0.017	1.79
58	437	1233400	1.63E-12	1.02	4	1251.9	266.48	2.18E+05	17.78	5.64E-13	34.53	0.022	2.19
59	1434	2468000	2.8E-12	0.9909	4	1042.8	72.71	7.01E+05	28.40	7.25E-13	27.83	0.018	1.82
60	1832	2328600	2.82E-12	0.9934	4	983.13	38.20	3.98E+05	18.99	5.19E-13	17.74	0.012	1.17
61	1804	2793000	3.04E-12	0.9789	4	1117.8	56.71	8.89E+05	32.70	9.00E-13	29.63	0.019	1.96
62	1427	3172800	2.57E-12	0.9902	4	874.25	81.26	9.24E+05	29.13	5.90E-13	22.82	0.015	1.50
63	324	2143200	1.38E-12	1.029	4	872.31	269.23	4.03E+05	18.78	3.15E-13	22.87	0.015	1.44
64	2046	6551100	3.28E-12	0.9751	4	1286.7	63.07	4.14E+06	74.55	1.11E-12	34.05	0.022	2.27
65	1429	3632600	2.37E-12	0.9938	4	845.77	56.19	1.23E+06	31.99	5.16E-13	21.90	0.014	1.43
66	2629	3.7E+07	4.4E-12	0.987	4	1416.7	56.02	2.08E+06	562.89	1.68E-12	37.89	0.024	2.56
67	2574	2552400	3.78E-12	0.9874	4	1344.1	52.22	9.82E+05	37.69	1.35E-12	35.86	0.023	2.40
68	431	1869000	1.34E-12	1.03	4	1185	291.47	4.19E+05	22.40	4.17E-13	31.09	0.020	1.95
69	2095	2308800	3.18E-12	0.9777	4	1486	71.50	8.74E+05	37.88	1.27E-12	30.86	0.026	2.65
70	2424	2024600	3.34E-12	0.9751	4	1071.5	44.20	4.82E+05	24.29	9.59E-13	28.67	0.019	1.91
71	2605	6298800	3.87E-12	0.9844	4	1183.9	45.63	8.57E+06	103.63	1.21E-12	31.25	0.020	2.10
72	1814	1.2E+07	3.11E-12	0.9786	4	918.27	50.62	1.53E+07	122.13	7.46E-13	24.05	0.016	1.60
73	1462	2427100	2.28E-12	0.9972	4	936.01	62.26	5.71E+05	23.51	5.61E-13	24.54	0.016	1.80
74	2254	4184800	3.38E-12	0.9759	4	1141.3	50.63	2.16E+06	51.52	1.02E-12	30.30	0.020	2.02
75	1639	3921800	2.68E-12	0.9877	4	866.51	56.65	1.18E+06	32.53	6.01E-13	22.46	0.015	1.48
76	1746	4.9E+07	3.22E-12	0.9757	4	1301.7	74.47	3.23E+06	694.22	1.10E-12	34.26	0.022	2.28
77	2432	8020800	4.12E-12	0.9814	4	1229.6	50.56	3.36E+06	67.29	1.35E-12	32.81	0.021	2.22
78	1953	1406200	3.04E-12	0.9813	4	1039.8	54.37	2.42E+06	17.17	8.63E-13	28.36	0.018	1.87
79	1683	9323700	3.68E-12	0.9865	4	810.45	41.50	2.50E+06	48.63	7.84E-13	21.39	0.014	1.44
80	1679	3251600	3.18E-12	0.9785	4	1042.5	62.09	1.22E+06	37.42	8.91E-13	26.20	0.018	1.87
81	1997	1888800	4.09E-12	0.9851	4	1127.8	56.47	5.42E+05	27.52	1.26E-12	31.44	0.020	2.11
82	2127	3153400	5.09E-12	0.9808	4	813.33	38.24	9.82E+05	31.47	1.14E-12	22.45	0.015	1.53
83	1829	2460700	4.49E-12	0.9853	4	794.21	41.78	5.78E+05	23.13	9.47E-13	21.09	0.014	1.43
84	1881	1121800	3.8E-12	0.9881	4	863.22	58.50	1.47E+05	13.08	9.93E-13	25.48	0.017	1.71
85	3111	4266300	1.04E-11	0.988	4	1043.3	33.54	2.63E+06	61.61	3.08E-12	28.52	0.019	2.11
86	2824	1712800	7.61E-12	0.9278	4	1153.3	45.69	4.97E+05	27.29	2.51E-12	33.04	0.021	2.31
87	2078	1088800	6.28E-12	0.9411	4	877.54	32.61	1.18E+05	10.82	1.26E-12	20.04	0.013	1.38
88	2178	1488800	7.89E-12	0.9269	4	1068.7	48.98	3.43E+05	22.89	2.46E-12	31.22	0.020	2.19
89	2398	1047100	9.75E-12	0.9147	4	1001.8	41.81	1.74E+05	16.84	2.94E-12	30.18	0.020	2.14
90	2710	1088800	1.29E-11	0.8981	4	883.28	25.58	1.35E+05	12.62	2.73E-12	21.22	0.014	1.53
91	2208	1085400	1.19E-11	0.9089	4	816.28	37.09	1.80E+05	14.99	3.25E-12	25.35	0.016	1.82
92	2422	603800	1.34E-11	0.8994	4	739.49	30.53	5.47E+04	9.08	2.90E-12	24.32	0.016	1.75
93	2259	498800	1.34E-11	0.8998	4	730.16	32.32	3.87E+04	7.75	3.30E-12	24.86	0.016	1.77
94	2872	503800	1.80E-11	0.8778	4	650.96	33.09	4.97E+04	5.91	5.69E-12	28.89	0.019	2.12
95	1998	409800	1.42E-11	0.8985	4	598.18	38.02	2.42E+04	5.91	3.01E-12	21.26	0.014	1.53
96	1832	377440	1.89E-11	0.8788	4	733.22	37.95	2.72E+04	7.20	5.26E-12	28.53	0.017	1.86
97	2366	276820	2.44E-11	0.8672	4	781.78	31.74	1.63E+04	5.23	7.23E-12	29.58	0.019	2.21
98	2081	246900	2.98E-11	0.8647	4	687.58	31.80	1.31E+04	5.23	6.62E-12	25.88	0.017	1.82
99	2201	216110	3.28E-11	0.8515	4	653.37	28.69	1.10E+04	5.07	8.69E-12	26.45	0.017	2.01
100	2284	182820	4.13E-11	0.8383	4	731.34	32.02	9.80E+03	5.25	1.26E-11	30.59	0.020	2.37

W/C = 0.60
7 Days of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
101	2071	144910	3.93E-11	0.8431	4	580.42	28.51	588.5	3.93	1.0332E-11	28.26	0.017	2.02
102	1664	132180	4.18E-11	0.8415	4	527.7	31.15	4885.6	3.54	1.0278E-11	24.67	0.016	1.89
103	1631	109080	3.89E-11	0.8473	4	520.11	31.89	3417.2	3.18	9.7332E-12	25.30	0.016	1.94
104	1860	92887	4.8E-11	0.838	4	536.73	33.95	3046.1	3.28	1.2841E-11	27.49	0.018	2.13
105	1432	80458	5.11E-11	0.8332	4	482.37	33.89	2322	2.89	1.3108E-11	25.85	0.017	2.00
106	1337	68741	5.39E-11	0.8319	4	385.29	28.82	1585.1	2.28	1.1586E-11	21.82	0.014	1.88
107													
108	1029	50811	5.68E-11	0.832	4	398.35	35.80	1085.2	2.14	1.2778E-11	22.80	0.015	1.78
109													
110	790.2	37652	5.87E-11	0.8338	4	283.34	35.86	648.91	1.72	1.1357E-11	19.33	0.013	1.53
111	629.4	32422	5.88E-11	0.8351	4	337.38	53.80	688.88	2.12	1.4428E-11	24.23	0.016	1.82
112	489.6	28386	6.39E-11	0.8332	4	277.35	59.19	517.17	1.82	1.3348E-11	20.83	0.014	1.87
113	388.6	24651	6.48E-11	0.834	4	251.3	63.06	427.16	1.73	1.2878E-11	19.84	0.013	1.89
114													
115	195.1	18888	6.58E-11	0.8385	4	245.59	125.88	382.08	1.86	1.4188E-11	21.64	0.015	1.74
116													
117	28.88	13552	6.13E-11	0.848	4	201.48	703.00	282.59	1.94	1.2288E-11	19.88	0.014	1.82
118	207.8	11202	5.4E-11	0.8614	4	156.41	75.34	185.04	1.74	9.3473E-12	17.31	0.012	1.39
119	258.2	9183	5.2E-11	0.8678	4	182.74	63.03	193.85	2.11	1.0128E-11	19.47	0.014	1.57
120	323.8	7484	6E-11	0.885	4	128.08	39.50	147.83	1.97	1.0108E-11	18.84	0.012	1.38
121													
122	424.7	4485	6.01E-11	0.8814	4	148.01	35.09	182.73	3.85	1.5578E-11	25.82	0.019	2.16
123	480	3252	7.14E-11	0.883	4	133.11	29.58	142.84	4.39	2.003E-11	28.04	0.021	2.38
124	455.8	2359	8.2E-11	0.8809	4	118.54	28.02	125.8	5.32	2.8081E-11	30.84	0.023	2.88
125	488.7	1728	1.29E-10	0.8785	4	93.23	19.88	98.121	5.88	3.8004E-11	30.22	0.024	2.70
126	481.3	1314	1.87E-10	0.8885	4	53.564	10.90	58.354	4.29	4.1983E-11	22.48	0.018	2.03
127	513.4	1094	1.88E-10	0.8781	4	34.882	8.80	38.844	3.35	3.4702E-11	17.46	0.014	1.98
128	514.4	987.2	2.01E-10	0.8812	4	30.883	8.02	32.447	3.35	3.438E-11	17.07	0.013	1.53
129	520.4	871.8	1.98E-10	0.8877	4	28.807	5.15	28.031	3.22	3.223E-11	18.28	0.013	1.45

W/C = 0.60
28 Days of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (%) Error	R ₂ (Q) (Error)	R ₂ (Q) (%) Error	G (P) (Error)	G (P) (%) Error	PH (Error)	PH (%) Error
1	262.6	4036	1.80E-10	0.838	4	91.426	32.35	108.93	2.70	4.18E-11	23.17	0.016	1.98
2	247.3	3980	1.80E-10	0.834	4	82.746	33.46	97.815	2.46	3.92E-11	20.63	0.015	1.76
3	301.4	3654	1.80E-10	0.839	4	103.05	34.19	121.66	3.16	4.79E-11	26.59	0.019	2.25
4	327	3762	1.33E-10	0.859	4	79.204	24.22	93.367	2.47	2.84E-11	21.32	0.015	1.75
5	212.4	3947	1.71E-10	0.840	4	108.74	51.20	128.72	3.29	4.60E-11	26.91	0.019	2.29
6	353.8	3607	1.46E-10	0.852	4	86.302	24.11	100.04	2.71	3.43E-11	22.92	0.018	1.91
7	332.3	3909	1.65E-10	0.843	4	107.86	48.44	125.95	3.31	4.80E-11	27.27	0.019	2.31
8	335.4	3997	1.54E-10	0.860	4	82.69	24.65	98.748	2.82	3.37E-11	21.91	0.016	1.83
9	352.5	3678	1.30E-10	0.890	4	66.22	27.01	111.37	3.03	3.34E-11	26.73	0.018	2.12
10	298.2	3773	1.77E-10	0.839	4	88.397	32.21	100.62	2.87	3.89E-11	21.97	0.016	1.87
11	312.6	3715	1.59E-10	0.846	4	78.603	26.21	91.87	2.47	3.25E-11	20.42	0.015	1.72
12	304.1	3726	1.64E-10	0.845	4	87.905	28.91	102.72	2.78	3.75E-11	22.85	0.016	1.93
13	237.4	3656	1.81E-10	0.833	4	109.19	48.99	127.75	3.31	5.17E-11	27.10	0.019	2.32
14	268.9	3968	1.84E-10	0.833	4	86.602	32.85	104.89	2.82	4.28E-11	22.07	0.016	1.86
15	245.8	4235	1.74E-10	0.839	4	113.72	48.27	136.56	3.22	4.89E-11	26.19	0.020	2.37
16	234.5	4540	2.21E-10	0.823	4	74.201	31.64	90.729	2.00	3.91E-11	17.67	0.012	1.51
17	179.6	4640	2.38E-10	0.816	4	117.41	66.74	146.11	2.98	6.34E-11	28.67	0.019	2.29
18	42.19	5497	2.85E-10	0.801	4	144.02	341.36	182.82	3.34	8.67E-11	30.41	0.021	2.66
19	98.5	6069	2.95E-10	0.808	4	104.39	103.98	137.69	2.26	5.89E-11	21.60	0.015	1.86
20	17.89	7180	3.47E-10	0.783	4	191.64	1053.32	265.81	3.70	1.24E-10	35.89	0.025	3.16
21	168.7	8982	4.24E-10	0.787	4	174.22	89.02	267.76	3.01	1.26E-10	29.71	0.020	2.66
22	514.8	9894	3.75E-10	0.772	4	159.89	105.39	255.81	2.59	1.03E-10	26.42	0.018	2.33
23	298.4	13930	3.11E-10	0.777	4	269.82	82.41	465.5	3.89	2.25E-10	38.77	0.026	3.56
24	415.1	18068	3.22E-10	0.772	4	226.9	79.22	428.17	3.17	1.03E-10	33.20	0.022	2.86
25	467.7	18390	3.22E-10	0.772	4	261.21	67.75	430.29	3.73	1.24E-10	38.59	0.026	3.33
26	675.5	22987	3.22E-10	0.770	4	311.04	67.88	500.29	4.05	1.31E-10	40.65	0.027	3.49
27	927	27901	2.89E-10	0.774	4	346.43	51.14	597.82	6.37	1.21E-10	42.34	0.026	3.60
28	1098	32625	3.65E-10	0.783	4	513.79	55.43	1788.9	6.37	2.18E-10	57.73	0.038	5.03
29	604.6	38269	2.82E-10	0.788	4	462.66	42.14	1890.3	5.76	1.79E-10	48.99	0.032	4.28
30	1430	46999	3.63E-10	0.780	4	433.2	46.35	2201.8	6.60	1.26E-10	44.68	0.029	3.78
31	1077	54774	2.04E-10	0.784	4	433.93	30.34	2924.3	6.02	1.82E-10	41.93	0.027	3.64
32	1215	61491	1.71E-10	0.783	4	597.94	54.89	4491.2	6.20	1.13E-10	46.57	0.027	3.60
33	634.6	72316	1.03E-10	0.824	4	845.03	67.05	6823.1	8.20	1.25E-10	73.19	0.047	5.98
34	1892	110470	1.65E-10	0.791	4	665.11	90.42	9080.2	12.51	1.25E-10	75.43	0.049	5.92
35	1426	139160	1.23E-10	0.808	4	736.76	61.59	9956.6	10.63	8.89E-11	54.40	0.035	4.44
36	1957	163210	1.23E-10	0.808	4	919.78	69.07	14148	12.81	7.77E-11	58.27	0.047	5.98
37	1409	163470	7.97E-11	0.833	4	919.68	65.06	26337	17.75	8.63E-11	69.03	0.038	4.87
38	1098	182260	5.63E-11	0.854	4	852.16	65.06	26337	16.14	5.99E-11	69.03	0.045	5.42
39	1070	242030	3.93E-11	0.875	4	1179.6	79.84	35917	19.52	3.52E-11	62.58	0.040	4.71
40	2037	256590	9.67E-11	0.817	4	953.52	110.24	45241	24.82	3.37E-11	63.92	0.055	6.32
41	1270	326990	4.35E-11	0.868	4	1362.3	48.81	60966	25.16	6.30E-11	65.20	0.042	5.14
42	1219	489990	3.35E-11	0.890	4	1362.3	107.27	120620	40.77	4.01E-11	62.02	0.059	6.82
43	1277	521210	2.80E-11	0.890	4	1311.6	107.91	269180	57.03	2.89E-11	66.21	0.065	6.29
44	1188	586630	2.27E-11	0.903	4	1225.2	95.94	269200	51.07	2.18E-11	78.64	0.049	5.53
45						1590	133.00	442620	75.63	2.25E-11	96.37	0.064	7.05

W/C = 0.80
28 Days of Hydration
Natural Pure Solution

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
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85	1843	2E+07	2.03E-11	0.8025	4	1204.3	61.88	2.77E+08	1418.45	1.37E-11	67.36	0.043	4.78
86	1404	1417300	1.44E-11	0.8248	4	1061.4	75.60	1.35E+08	96.36	8.76E-12	60.67	0.039	4.20
87	2188	1.3E+07	3.23E-11	0.8747	4	778.24	35.35	9.04E+07	678.59	1.42E-11	44.06	0.028	3.23
88	1610	1083000	1.75E-11	0.913	4	1139.2	70.76	8.53E+05	76.88	1.15E-11	65.85	0.042	4.63
89	2287	2438700	3.52E-11	0.8704	4	1375.6	59.69	5.80E+08	228.62	2.76E-11	78.19	0.051	5.63
90													
91	3020	1736000	7.51E-11	0.8263	4	1077.2	35.67	2.51E+08	144.86	4.76E-11	63.35	0.041	4.93
92	1628	1180200	3.11E-11	0.8801	4	1336.4	82.24	1.39E+08	116.85	2.48E-11	79.92	0.051	5.82
93	1883	1798800	3.48E-11	0.8765	4	1161.4	68.84	2.83E+08	161.07	2.48E-11	71.71	0.046	5.26
94	1795	551000	3.77E-11	0.8711	4	1597.1	91.00	4.01E+08	72.63	3.62E-11	101.32	0.065	7.46
95	2888	742180	1.11E-10	0.8033	4	1022.2	35.67	4.91E+05	68.17	7.02E-11	63.14	0.041	5.05
96	2285	269870	6.68E-11	0.8356	4	785.63	34.84	8.07E+04	20.94	3.33E-11	50.04	0.032	3.85
97	3423	428570	2.22E-10	0.7823	4	1064.1	31.67	1.97E+05	46.51	1.81E-10	67.88	0.044	5.74
98	423.7	303980	1.88E-11	0.9158	4	981.82	227.00	7.83E+04	25.78	1.17E-11	62.85	0.040	4.41
99	2163	260130	1.12E-10	0.808	4	1147.1	53.03	8.23E+04	31.85	8.57E-11	78.30	0.048	5.08
100	1014	168780	4.18E-11	0.8708	4	1081.4	108.95	3.63E+04	21.89	3.32E-11	73.49	0.051	5.87

W/C = 0.60
28 Days of Hydration
Neutral Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
101	1680	142630	8.12E-11	0.828	4	569.02	34.22	14382	10.08	3.3243E-11	40.83	0.028	3.18
102	2182	148070	1.08E-10	0.7844	4	782.81	35.45	21882	14.98	9.3676E-11	55.27	0.036	4.55
103	1808	127620	1.86E-10	0.7768	4	677.43	34.83	18034	12.58	9.3003E-11	50.45	0.033	4.17
104	2004	101480	1.95E-10	0.7782	4	753.21	37.59	12397	12.22	1.1348E-10	58.29	0.038	4.84
105	1671	81048	1.48E-10	0.7848	4	590.24	35.86	6781.1	8.34	7.1426E-11	47.84	0.031	3.80
106	1280	68880	1.24E-10	0.8053	4	885.43	67.09	8111.4	11.78	9.2375E-11	74.42	0.048	5.95
107	1173	58485	1.18E-10	0.8142	4	911.53	77.71	8407.5	11.35	8.4885E-11	81.34	0.053	6.47
108	1072	54070	1.09E-10	0.7854	4	685.19	64.85	4882.4	8.88	8.9542E-11	62.65	0.041	5.10
109	1168	44807	1.87E-10	0.7837	4	788.04	87.58	4100.1	9.19	1.2308E-10	73.58	0.048	6.03
110	1274	40782	2.34E-10	0.7743	4	458.71	35.85	2170.8	5.33	1.0248E-10	43.75	0.028	3.69
111	1082	35833	2.13E-10	0.7813	4	408.31	38.45	1887.7	4.85	8.6878E-11	40.75	0.027	3.41
112	1808	32677	4.41E-10	0.736	4	497.41	33.03	1887.7	5.53	2.1223E-10	48.11	0.032	4.30
113	1128	28889	3.18E-10	0.7888	4	439.28	38.84	1419.9	4.89	1.4888E-10	48.20	0.030	4.00
114	815.3	23881	2.42E-10	0.7778	4	420.88	51.83	1110.8	4.89	1.1315E-10	48.83	0.031	3.97
115	889.4	21403	3.18E-10	0.7822	4	521.02	58.58	1254.8	8.88	1.8588E-10	58.80	0.038	5.13
116	744.5	18487	2.8E-10	0.7718	4	260.79	39.08	820.35	3.35	9.709E-11	34.84	0.023	2.99
117	810.8	18149	2.73E-10	0.7757	4	328.1	53.72	634.63	3.83	1.1212E-10	41.03	0.027	3.54
118	188.1	13373	1.48E-10	0.8182	4	225.83	135.88	388.18	2.88	4.8001E-11	32.35	0.022	2.64
119	153.1	11508	1.84E-10	0.8138	4	181.49	104.10	255.93	2.22	3.9002E-11	23.82	0.016	1.97
120	280.3	9733	1.78E-10	0.8082	4	213.95	82.19	303.89	3.12	5.8488E-11	31.71	0.022	2.88
121	68.55	7807	1.2E-10	0.8378	4	238.28	385.01	313.8	3.97	4.759E-11	39.67	0.027	3.25
122	78.04	8054	8.85E-11	0.875	4	172.18	217.81	207.78	3.43	2.1716E-11	31.72	0.022	2.52
123	174	4808	9.8E-11	0.8818	4	152.05	87.39	178.57	3.64	2.9844E-11	31.19	0.022	2.58
124	211.1	3873	1.08E-10	0.8618	4	127.52	80.41	144.77	3.74	3.1328E-11	28.12	0.021	2.43
125	312.2	3210	1.01E-10	0.8738	4	80.849	25.83	80.38	2.82	2.181E-11	21.34	0.018	1.77
126	284.8	2812	1.25E-10	0.8821	4	118.03	42.10	132.44	4.95	3.8888E-11	31.81	0.023	2.71
127	272.7	2888	1.22E-10	0.8848	4	86.1	32.67	97.353	3.62	2.8832E-11	24.11	0.018	2.07
128	437.5	2338	9.78E-11	0.8888	4	88.885	18.30	78.008	3.25	2.1888E-11	22.19	0.016	1.85
129	381.8	2228	9.85E-11	0.8873	4	83.688	19.27	89.107	3.10	2.0232E-11	20.88	0.015	1.72

W/C = 0.60
28 Days of Hydration
Natural Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
1	358	2823	2.60E-10	0.824	4	63.482	23.32	93.735	3.49	6.10E-11	23.51	0.017	2.10
2	327	3003	2.70E-10	0.818	4	92.97	26.43	104.73	3.49	6.09E-11	24.76	0.016	2.23
3	289.9	3143	2.60E-10	0.818	4	73.171	24.40	82.904	2.64	5.00E-11	19.13	0.014	1.71
4	361.4	3159	2.60E-10	0.820	4	76.918	21.26	87.466	2.77	5.26E-11	20.42	0.015	1.82
5	373	3197	2.20E-10	0.829	4	60.368	13.51	57.582	1.80	3.09E-11	13.69	0.010	1.20
6	297	3319	2.67E-10	0.816	4	65.303	21.99	74.501	2.24	4.44E-11	18.62	0.012	1.49
7	267.4	3347	2.70E-10	0.812	4	71.363	24.64	81.316	2.43	4.97E-11	17.79	0.013	1.60
8	337.1	3305	2.21E-10	0.829	4	66.2	19.64	75.63	2.29	3.69E-11	17.36	0.013	1.52
9	316.4	3348	2.82E-10	0.813	4	64.263	26.47	66.336	2.68	6.01E-11	21.34	0.016	1.91
10	302.1	3361	3.04E-10	0.807	4	113.07	37.43	129.08	3.82	6.93E-11	27.91	0.020	2.53
11	361.7	3321	2.33E-10	0.826	4	96.123	27.33	110.05	3.31	5.87E-11	25.20	0.018	2.21
12	268.8	3411	2.44E-10	0.819	4	71.377	26.55	81.29	2.38	4.31E-11	17.64	0.013	1.57
13	263.1	3419	2.59E-10	0.817	4	65.984	26.34	68.244	2.87	5.54E-11	21.40	0.016	1.91
14	348.2	3479	2.60E-10	0.818	4	65.629	24.59	68.848	2.84	5.69E-11	21.89	0.016	1.94
15	406.7	3566	2.35E-10	0.825	4	72.115	17.64	84.411	2.35	4.47E-11	18.98	0.014	1.65
16	388	3648	2.71E-10	0.813	4	64.369	25.64	111.2	2.89	6.32E-11	23.36	0.017	2.06
17	230.3	4227	3.44E-10	0.794	4	100.81	46.36	126.59	2.99	7.16E-11	23.63	0.017	2.16
18	265.7	4469	3.10E-10	0.800	4	101.08	39.52	121.83	2.73	7.08E-11	22.78	0.016	2.03
19	147.2	4914	3.71E-10	0.788	4	61.798	65.57	100.18	2.04	6.39E-11	17.14	0.012	1.55
20	158	5222	3.44E-10	0.790	4	117	74.05	145.89	2.79	6.32E-11	24.20	0.017	2.17
21	175.9	5394	3.33E-10	0.791	4	73.753	41.53	94.009	1.98	5.03E-11	15.13	0.011	1.34
22	184	6575	6.20E-10	0.793	4	261.94	142.36	364.61	5.55	3.22E-10	51.92	0.039	4.79
23	263.4	6399	4.67E-10	0.749	4	165.59	73.24	260.24	2.77	1.21E-10	25.84	0.018	2.40
24	182.3	11523	3.12E-10	0.771	4	315.19	208.95	468.51	4.22	1.33E-10	42.81	0.029	3.77
25	697.4	18010	4.74E-10	0.737	4	277.33	41.55	474.94	3.16	1.46E-10	31.36	0.021	2.89
26	463.6	17912	2.77E-10	0.768	4	464.04	92.39	669.6	4.94	1.42E-10	51.11	0.034	4.48
27	889.7	22418	3.07E-10	0.768	4	525.26	99.04	1187.3	5.30	1.84E-10	53.56	0.036	4.71
28	1236	26078	3.69E-10	0.737	4	362.46	28.32	976.07	3.46	1.32E-10	33.08	0.022	2.97
29	2140	35182	6.44E-10	0.703	4	668.14	30.66	2148.9	6.10	3.41E-10	52.83	0.035	4.99
30	1399	40062	2.79E-10	0.764	4	509.43	36.41	1953.5	4.87	1.16E-10	42.23	0.026	3.67
31	1227	47695	1.93E-10	0.775	4	364.66	32.16	1854.6	3.86	6.14E-11	31.76	0.021	2.67
32	1342	58665	1.78E-10	0.777	4	548.31	40.71	3182	5.45	7.34E-11	40.97	0.027	3.43
33	1148	68613	1.22E-10	0.769	4	631.01	46.26	3617.5	5.55	4.76E-11	36.94	0.025	3.15
34	2021	69725	2.11E-10	0.764	4	1270.4	62.86	13764	15.34	1.84E-10	67.06	0.056	7.37
35	2649	109760	2.63E-10	0.747	4	637.13	24.05	8637.4	8.05	1.06E-10	40.22	0.026	3.46
36	3126	147300	3.23E-10	0.733	4	1136.3	36.39	25909	17.52	2.22E-10	69.71	0.044	6.05
37	2312	127530	1.04E-10	0.803	4	1624.2	70.25	29839	21.05	1.06E-10	101.40	0.065	8.15
38	4647	232180	3.69E-10	0.720	4	1346.4	26.61	57763	24.66	2.56E-10	70.76	0.046	6.35
39	3622	269310	1.72E-10	0.767	4	1141.1	31.50	62368	23.16	1.08E-10	61.36	0.040	5.16
40	2651	350170	6.29E-11	0.804	4	1699.8	53.67	140460	39.01	7.84E-11	64.65	0.054	6.76
41	1833	269220	3.22E-11	0.869	4	2252.8	122.80	116740	40.36	3.76E-11	117.66	0.075	8.70
42	4442	642060	1.44E-10	0.773	4	1760	39.62	306620	66.44	1.22E-10	85.16	0.055	7.06
43	1252	941970	1.76E-11	0.904	4	2437.8	194.71	363940	67.15	2.14E-11	122.22	0.078	8.69
44	3532	1431000	6.29E-11	0.823	4	1769.3	90.07	1967920	130.51	5.30E-11	84.37	0.054	6.57
45	1489	1891000	1.37E-11	0.916	4	2541.8	173.03	3116200	185.60	1.63E-11	118.34	0.074	8.25
46	2639	2226400	2.46E-11	0.979	4	2512.7	98.96	6359000	239.62	2.83E-11	115.35	0.076	8.40
47	6108	4596500	1.35E-10	0.771	4	1834.8	30.04	17707000	398.07	1.06E-10	78.99	0.050	6.54
48	2608	5535300	1.62E-11	0.901	4	1861.8	75.05	21543000	399.90	1.34E-11	82.61	0.053	6.96

W/C = 0.60
28 Days of Hydration
Natural Pore Solution

File No.	R_p (g)	R_p (g)	C (F)	Phi	Type	R_p (g) (Error)	R_p (g) (% Error)	R_p (g) (Error)	R_p (g) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
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90	4582	1112800	5.74E-11	0.8251	4	1886	43.56	1.11E+05	99.59	5.08E-11	88.21	0.057	6.86
91	3727	1013000	3.98E-11	0.8482	4	1975.4	53.00	9.03E+05	89.10	3.57E-11	89.62	0.057	6.78
92													
93	3445	823120	5.88E-11	0.8305	4	1243.1	39.06	4.39E+05	53.39	3.30E-11	59.09	0.039	4.57
94	3744	880960	8.11E-11	0.8082	4	1453.3	38.82	5.81E+05	65.83	5.47E-11	67.41	0.043	5.37
95	2399	508370	3.63E-11	0.8691	4	2080.7	88.99	2.86E+05	55.98	3.53E-11	59.85	0.054	7.45
96	2789	426330	5.18E-11	0.8339	4	1370.9	49.15	1.31E+05	30.71	3.39E-11	65.15	0.042	5.02
97	4488	422270	2.05E-10	0.7827	4	2137.3	47.61	2.48E+05	56.79	2.19E-10	100.93	0.069	9.14
98	4538	281280	2.07E-10	0.7915	4	1560.6	34.39	7.29E+04	27.73	1.83E-10	78.48	0.051	6.73
99	2743	204930	1.15E-10	0.7889	4	1149.8	41.82	6.77E+04	22.94	8.82E-11	59.31	0.038	4.84
100	1803	198510	5.91E-11	0.8339	4	1402.2	77.89	3.92E+04	19.77	4.23E-11	75.43	0.049	5.92

W/C = 0.60
28 Days of Hydration
Natural Pore Solution

File No.	R_1 (g)	R_2 (g)	G (F)	Phi	Type	R_1 (g) (Error)	R_2 (g) (Error)	R_1 (g) (% Error)	R_2 (g) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
101	4028	161680	2.60E-10	0.7392	4	900.16	24060	23.09	13.68	1.3108E-11	49.76	0.032	4.35
102	1570	131670	6.34E-11	0.6307	4	1209.1	19245	77.01	14.59	4.5944E-11	72.42	0.047	5.62
103	3944	127780	3.69E-10	0.7203	4	1362.1	21365	35.04	16.72	2.8262E-10	77.17	0.050	6.04
104	2354	97977	1.37E-10	0.7637	4	1190.8	12166	90.58	12.44	1.0061E-10	73.97	0.048	6.08
105	3307	98775	3.58E-10	0.7251	4	1078.1	10038	32.60	11.30	2.3672E-10	68.04	0.043	5.61
106	3136	79772	3.48E-10	0.7282	4	811.99	5631.3	25.69	7.83	1.7622E-10	51.28	0.033	4.59
107	2468	61526	2.3E-10	0.7339	4	697.99	4766	38.41	7.75	1.3932E-10	59.21	0.039	5.12
108	2097	55108	2.6E-10	0.7469	4	1011.1	4875	48.22	8.85	1.8168E-10	66.82	0.046	6.10
109	3029	49511	6.91E-10	0.6978	4	1102.3	4481.4	36.39	9.20	4.3443E-10	73.49	0.046	6.04
110	2235	40270	2.89E-10	0.7434	4	691.13	2898.7	39.87	7.12	1.8759E-10	64.89	0.043	5.75
111	1054	33983	1.39E-10	0.7938	4	443.05	1271.1	42.04	3.76	5.1716E-11	67.01	0.024	3.08
112	1949	30180	2.7E-10	0.7609	4	721.05	1741.3	39.00	5.78	1.537E-10	67.01	0.036	5.05
113	1698	27420	4.37E-10	0.7216	4	637.21	1408.5	34.11	5.14	2.1689E-10	49.62	0.033	4.61
114	1729	23503	3.44E-10	0.739	4	442.07	871.42	25.57	3.71	1.2729E-10	37.01	0.025	3.37
115	1228	20059	2.79E-10	0.7598	4	408.05	731.72	33.26	3.65	1.0315E-10	37.12	0.025	3.31
116	1202	17189	2.29E-10	0.7978	4	437.46	693.66	36.39	4.04	9.3968E-11	40.86	0.028	3.62
117	873.1	14949	2.29E-10	0.7701	4	391.74	534.14	37.17	3.60	8.1522E-11	35.54	0.024	3.17
118	81.48	11815	1.07E-10	0.8264	4	295.39	414.73	392.53	3.51	3.8897E-11	36.12	0.025	2.86
119	630.3	10475	1.71E-10	0.7933	4	325.01	415.36	51.56	3.97	6.1119E-11	35.83	0.025	3.16
120	258.3	8294	1.15E-10	0.8237	4	315.57	392.03	122.17	4.61	4.5985E-11	39.80	0.026	3.42
121	102.9	6948	1.03E-10	0.8389	4	227.85	265.89	221.43	4.00	3.3932E-11	32.57	0.023	2.78
122	115.1	5227	1.11E-10	0.8385	4	251.68	281.41	218.66	5.36	4.2182E-11	38.10	0.028	3.35
123	94.46	3903	1.69E-10	0.8234	4	193.43	212.24	355.18	5.44	5.7398E-11	34.51	0.026	3.15
124	189.5	3089	1.77E-10	0.8301	4	188.61	171.9	93.58	5.60	5.9344E-11	33.50	0.026	3.06
125	314.8	2599	1.77E-10	0.8385	4	100.13	107.94	31.81	4.17	4.3186E-11	24.42	0.019	2.23
126	323.5	2354	1.59E-10	0.8462	4	63.539	89.881	25.85	3.82	3.3848E-11	21.99	0.017	1.97
127	337.2	2182	1.7E-10	0.8498	4	74.59	79.514	22.12	3.64	3.3735E-11	19.86	0.015	1.83
128	412.8	1976	1.67E-10	0.857	4	60.608	98.43	21.95	4.06	4.2035E-11	26.76	0.021	2.42
129	417	1997	1.44E-10	0.8538	4	71.939	75.992	17.19	4.07	3.1102E-11	21.65	0.017	1.98

W/C = 0.36
7 Days of Hydration
Pore Solution: 5% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	715.5	1831	2.04E-10	0.862	4	121.24	16.84	139.77	7.58	1.26E-10	61.87	0.044	5.07
2	707.1	2020	1.90E-10	0.861	4	123.08	17.41	141.29	6.99	1.06E-10	57.52	0.041	4.71
3	673.4	2189	2.07E-10	0.861	4	130.48	19.38	149.06	6.93	1.16E-10	58.05	0.040	4.66
4	644.8	2301	2.00E-10	0.847	4	135.71	21.05	155.74	6.77	1.14E-10	54.45	0.039	4.56
5	644.8	2404	2.04E-10	0.848	4	136.23	21.14	159.88	6.82	1.08E-10	52.86	0.037	4.43
6	631.5	2504	2.12E-10	0.847	4	142.92	22.63	164.97	6.99	1.14E-10	53.53	0.038	4.50
7	624.6	2605	2.23E-10	0.832	4	148.91	23.64	172.85	6.83	1.21E-10	54.15	0.038	4.57
8	625.8	2672	2.08E-10	0.840	4	146.77	23.34	170.51	6.38	1.10E-10	52.85	0.037	4.42
9	621.5	2765	2.06E-10	0.840	4	149.82	23.46	169.8	6.16	1.06E-10	51.12	0.036	4.29
10	597.9	2879	2.02E-10	0.839	4	148.72	24.87	173.71	6.04	1.02E-10	50.44	0.036	4.23
11	587.5	2976	2.08E-10	0.836	4	153.65	26.15	180.14	6.05	1.04E-10	50.84	0.036	4.27
12	588.6	3161	2.27E-10	0.828	4	164.47	27.90	185.22	6.18	1.20E-10	52.85	0.037	4.47
13	588.8	3442	2.27E-10	0.828	4	167.01	29.31	200.35	5.82	1.15E-10	50.73	0.035	4.29
14	547.6	3646	2.61E-10	0.814	4	185.74	33.92	227.87	5.92	1.36E-10	52.92	0.037	4.52
15	520.1	4222	2.64E-10	0.813	4	180.98	34.80	225.32	5.34	1.24E-10	48.71	0.034	4.15
16	482.3	4741	2.88E-10	0.802	4	182.78	36.18	248.76	5.20	1.36E-10	48.70	0.034	4.18
17	417.7	5432	3.62E-10	0.785	4	212.18	50.80	282.52	5.20	1.80E-10	49.59	0.034	4.34
18	328.5	6319	4.87E-10	0.763	4	229.73	69.93	322.48	5.10	2.40E-10	49.35	0.034	4.42
19	284.3	7305	6.28E-10	0.745	4	256.72	101.74	366.51	5.22	3.24E-10	51.52	0.035	4.71
20	144.6	8694	6.23E-10	0.738	4	288.88	169.76	452.55	5.22	3.22E-10	51.65	0.035	4.73
21	49.17	10985	5.54E-10	0.737	4	325.3	681.58	547.26	4.98	2.77E-10	50.07	0.034	4.57
22	187.4	13140	4.86E-10	0.736	4	353.88	184.17	659.08	4.99	2.53E-10	50.67	0.034	4.59
23	321.9	16397	4.69E-10	0.738	4	402.57	125.05	823.09	5.03	2.39E-10	50.94	0.034	4.59
24	586.5	21286	4.48E-10	0.732	4	433.66	76.55	1047.4	4.92	2.18E-10	48.54	0.032	4.36
25	818	27243	4.45E-10	0.728	4	461.75	60.26	1448.1	5.32	2.21E-10	49.78	0.033	4.47
26	1163	36779	4.11E-10	0.727	4	534.31	45.84	1871	5.51	1.97E-10	48.03	0.031	4.30
27	1452	46708	3.69E-10	0.730	4	597.31	41.14	2671.8	6.15	1.75E-10	48.89	0.032	4.33
28	1841	60300	2.87E-10	0.740	4	627.09	38.21	3970.9	6.60	1.39E-10	47.42	0.031	4.12
29	2015	78913	2.86E-10	0.742	4	679.24	33.71	5571.7	7.27	1.20E-10	46.91	0.030	4.06
30	2166	97951	1.89E-10	0.754	4	703.07	32.46	7745.7	7.91	9.02E-11	45.25	0.029	3.84
31	2437	123600	1.53E-10	0.767	4	753.74	30.93	10898	8.80	8.91E-11	45.32	0.029	3.78
32	2685	158010	1.14E-10	0.781	4	780.98	28.78	14653	9.57	4.92E-11	42.89	0.027	3.51
33	2678	197070	8.78E-11	0.794	4	816.18	30.50	21723	11.02	3.80E-11	43.36	0.028	3.48
34	2807	243530	6.30E-11	0.811	4	804.9	28.67	26085	11.54	2.97E-11	40.42	0.026	3.17
35	2863	302260	4.82E-11	0.824	4	836.21	28.21	39477	13.08	1.96E-11	39.93	0.025	3.08
36	2838	378800	3.68E-11	0.839	4	861.46	29.32	55568	14.84	1.43E-11	38.93	0.025	2.95
37	3085	480880	2.86E-11	0.856	4	919.36	30.09	82228	17.10	1.05E-11	38.28	0.025	2.92
38	3108	585980	1.98E-11	0.870	4	943.49	30.36	109980	18.70	7.84E-12	38.28	0.024	2.80
39	3383	740040	1.63E-11	0.879	4	1013.8	30.15	162840	21.88	6.31E-12	36.83	0.025	2.80
40	3482	913000	1.18E-11	0.888	4	1048.9	30.12	228540	24.70	4.46E-12	36.05	0.024	2.70
41	3646	1094000	9.24E-12	0.909	4	1101.3	30.21	302820	27.88	3.52E-12	36.15	0.024	2.67
42	3634	1294400	7.69E-12	0.918	4	1157.4	31.71	408770	31.59	2.96E-12	36.84	0.025	2.68
43	3724	1469400	5.93E-12	0.932	4	1162.8	31.36	490180	32.97	2.26E-12	37.88	0.024	2.59
44	3771	1678600	5.18E-12	0.939	4	1185.2	31.43	607440	36.19	1.84E-12	37.36	0.024	2.54
45	3485	1801100	4.30E-12	0.949	4	1141.2	33.03	639440	35.34	1.52E-12	36.35	0.023	2.37
46	3620	1966800	3.77E-12	0.966	4	1221.7	34.71	770880	39.22	1.40E-12	37.09	0.024	2.47
47	3635	2135300	3.37E-12	0.981	4	1251.2	32.63	883380	41.37	1.25E-12	37.15	0.024	2.46
48	3773	2218900	2.89E-12	0.970	4	1276.9	33.84	939840	42.34	1.08E-12	37.48	0.024	2.48
49	3645	2327400	2.57E-12	0.978	4	1256	34.46	982950	42.23	9.41E-13	38.54	0.023	2.36
50	3811	2491900	2.44E-12	0.978	4	1278.2	33.57	1109500	44.95	8.90E-13	38.95	0.023	2.38

W/C = 0.36
7 Days of Hydration
Pore Solution: 6% Salt Solution

File No.	R ₁ (d)	R ₂ (d)	G (°)	PH	Type	R ₁ (d) (Error)	R ₂ (d) (% Error)	R ₂ (d) (Error)	G (°) (Error)	G (°) (% Error)	PH (Error)	PH (% Error)
51	3645	2610800	2.2E-12	0.985	4	1253.4	34.39	1.10E+08	7.84E-13	35.69	0.023	2.31
52	3513	2668700	1.98E-12	0.9818	4	1259.6	35.96	1.21E+08	7.04E-13	35.82	0.023	2.30
53	3764	2622100	2.03E-12	0.989	4	1266.7	34.24	1.36E+08	7.30E-13	36.13	0.023	2.33
54	3783	2663700	2.01E-12	0.9884	4	1328.8	35.13	1.43E+08	7.43E-13	37.06	0.024	2.39
55	3726	2773600	1.91E-12	0.9824	4	1270.6	34.06	1.29E+08	6.81E-13	36.97	0.023	2.28
56	3690	2636700	1.86E-12	0.9829	4	1267.2	34.72	1.32E+08	6.71E-13	35.45	0.023	2.27
57	3697	2663600	2E-12	0.9888	4	1330.5	33.54	1.46E+08	7.33E-13	36.68	0.023	2.36
58	3672	2638700	1.93E-12	0.9819	4	1284.7	34.69	1.36E+08	6.92E-13	35.90	0.023	2.31
59	3768	2668800	1.83E-12	0.9815	4	1309.5	34.75	1.43E+08	7.05E-13	36.45	0.023	2.34
60	3756	2617800	1.91E-12	0.9822	4	1304.9	34.74	1.44E+08	6.98E-13	36.32	0.023	2.33
61	3711	2677200	2E-12	0.9893	4	1309.8	35.30	1.51E+08	7.26E-13	36.36	0.023	2.34
62	3620	2601800	1.98E-12	0.9814	4	1307.7	36.12	1.36E+08	7.14E-13	36.70	0.023	2.36
63	3753	2606600	2E-12	0.9868	4	1300.5	34.85	1.36E+08	7.30E-13	36.49	0.023	2.35
64	3708	2663100	2.06E-12	0.9874	4	1301.2	35.11	1.27E+08	7.68E-13	36.73	0.023	2.37
65	3698	2655400	2.2E-12	0.986	4	1278.2	34.66	1.15E+08	8.01E-13	36.41	0.023	2.35
66	3769	2472700	2.35E-12	0.9812	4	1261	33.26	1.07E+08	8.49E-13	36.05	0.023	2.34
67	3700	2401600	2.65E-12	0.9769	4	1274	34.43	1.05E+08	9.39E-13	36.82	0.023	2.40
68	3765	2313000	2.84E-12	0.9707	4	1267.5	33.87	9.97E+05	1.05E-12	36.97	0.024	2.43
69	3766	2261500	3.23E-12	0.9635	4	1253.6	33.02	9.72E+05	1.19E-12	36.89	0.023	2.44
70	3775	2081500	3.44E-12	0.9608	4	1256.1	33.35	8.61E+05	1.30E-12	37.73	0.024	2.50
71	3691	1975400	4E-12	0.9618	4	1262.3	32.11	8.00E+05	1.53E-12	36.12	0.024	2.55
72	3779	1787500	4.3E-12	0.9488	4	1203.3	31.84	6.57E+05	1.60E-12	37.21	0.024	2.60
73	3768	1827100	4.82E-12	0.9429	4	1232.3	32.70	5.86E+05	1.87E-12	36.87	0.026	2.62
74	4016	1611400	6.08E-12	0.9262	4	1276.6	31.76	6.18E+05	2.47E-12	40.53	0.026	2.78
75	3735	1375800	6.32E-12	0.9269	4	1163.3	31.86	4.49E+05	2.48E-12	38.91	0.026	2.67
76	3842	1257500	7.48E-12	0.9184	4	1167.1	31.16	3.86E+05	3.00E-12	40.03	0.026	2.77
77	3670	1130400	9.12E-12	0.9098	4	1190.4	29.21	3.30E+05	3.61E-12	39.56	0.026	2.77
78	3744	977780	1.02E-11	0.9038	4	1128.9	28.40	2.58E+05	4.04E-12	38.75	0.026	2.80
79	3626	871030	1.34E-11	0.9029	4	1103.9	28.85	2.13E+05	4.90E-12	36.64	0.026	2.83
80	3604	734670	1.5E-11	0.8928	4	1066.5	28.56	1.62E+05	6.08E-12	40.35	0.026	2.91
81	3679	621520	1.63E-11	0.8897	4	1072.6	28.79	1.27E+05	7.88E-12	41.47	0.026	3.04
82	3725	507690	2.41E-11	0.8952	4	1036.1	28.22	9.13E+04	1.01E-11	41.81	0.027	3.10
83	3636	413960	3.11E-11	0.8447	4	1026.8	28.29	6.70E+04	1.34E-11	43.19	0.027	3.25
84	3671	344980	4.18E-11	0.8294	4	890.13	27.73	5.05E+04	1.80E-11	43.40	0.028	3.33
85	3427	275730	6.23E-11	0.8182	4	959.63	28.00	3.61E+04	2.33E-11	44.54	0.028	3.47
86	3623	224610	7.05E-11	0.8019	4	930.05	26.40	2.62E+04	3.17E-11	44.85	0.029	3.57
87	3308	187740	8.65E-11	0.79	4	910.22	27.53	2.04E+04	4.14E-11	46.29	0.030	3.74
88	3126	153580	1.06E-10	0.7823	4	880.3	26.16	1.51E+04	5.00E-11	47.22	0.030	3.85
89	3065	129970	1.39E-10	0.7679	4	865.87	26.25	1.26E+04	6.88E-11	48.30	0.031	4.02
90	2972	109010	1.72E-10	0.7569	4	837.39	26.18	9.21E+03	8.48E-11	48.02	0.031	4.15
91	2669	69409	1.85E-10	0.7553	4	781.98	26.08	6.63E+03	9.03E-11	48.60	0.031	4.13
92	2641	74182	2.11E-10	0.7463	4	785.55	31.31	5.48E+03	1.10E-10	51.84	0.033	4.45
93	2380	61953	2.5E-10	0.7411	4	757.98	31.85	4.21E+03	1.29E-10	51.68	0.033	4.49
94	2039	50725	2.66E-10	0.7429	4	693.08	32.52	2.85E+03	1.26E-10	48.87	0.032	4.25
95	1883	40360	2.53E-10	0.7477	4	688.42	36.36	2.14E+03	1.21E-10	47.75	0.031	4.14
96	1362	32735	2.34E-10	0.758	4	539.45	36.82	1.68E+03	1.09E-10	46.60	0.030	4.01
97	1175	26626	2.4E-10	0.7597	4	514.56	43.79	1.24E+03	1.13E-10	47.17	0.031	4.09
98	924.3	21422	2.19E-10	0.7665	4	466.47	50.36	9.44E+02	1.01E-10	46.22	0.030	3.98
99	679.5	17068	2.16E-10	0.7707	4	415.86	61.17	7.29E+02	9.72E-11	45.05	0.030	3.89
100	409.8	13226	2.03E-10	0.7802	4	341.87	83.35	5.31E+02	8.49E-11	41.70	0.028	3.59

W/O = 0.36
7 Days of Hydration
Pore Solution: 0% Salt Solution

File No.	R_1 (g)	R_2 (g)	G (F)	Phi	Type	R_1 (g) (Error)	R_2 (g) (% Error)	R_2 (g) (Error)	R_2 (g) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
101	162.2	10060	1.0E-10	0.7914	4	291.6	179.76	408.63	4.08	7.7212E-11	40.69	0.028	3.49
102	31.86	7776	1.04E-10	0.8008	4	245.85	771.97	320.9	4.13	7.2217E-11	39.35	0.027	3.37
103	203.8	6143	1.03E-10	0.8073	4	213.79	104.90	268.82	4.36	7.7481E-11	40.20	0.028	3.44
104	327.2	5142	2.09E-10	0.8119	4	188.37	67.57	234.39	4.99	8.6535E-11	41.90	0.029	3.54
105	439.2	4407	1.88E-10	0.8251	4	170.06	39.99	207.82	4.72	7.6999E-11	42.46	0.029	3.57
106	487.5	3993	1.65E-10	0.8373	4	156.11	32.02	187.24	4.61	7.0239E-11	42.51	0.030	3.53
107	518.3	3557	1.68E-10	0.8408	4	154.58	29.82	183.6	5.16	7.4604E-11	44.94	0.031	3.73
108	526.5	3304	1.69E-10	0.8424	4	152.37	28.94	179.02	5.42	7.7532E-11	46.11	0.032	3.84
109	561	3077	1.6E-10	0.8492	4	146.59	26.12	171.39	5.67	7.5614E-11	47.34	0.033	3.91
110	574.6	2913	1.59E-10	0.8528	4	141.36	24.90	164.51	5.65	7.4325E-11	47.65	0.033	3.92
111	594.3	2803	1.59E-10	0.8543	4	139.56	23.95	162.84	5.91	7.7882E-11	48.11	0.034	4.03
112	600.8	2768	1.5E-10	0.8539	4	139.84	23.27	163.42	5.85	8.1461E-11	49.96	0.035	4.10
113	609.4	2606	1.04E-10	0.8469	4	147.01	24.12	174.11	5.99	9.6025E-11	52.31	0.037	4.31
114	597.5	3292	2.16E-10	0.8342	4	161.21	29.98	165.97	5.97	1.1671E-10	53.69	0.037	4.46
115	572.8	3688	2.44E-10	0.8225	4	173.58	30.30	218.61	5.68	1.3007E-10	53.30	0.037	4.46
116	532.1	4682	2.8E-10	0.8091	4	184.13	34.60	243.62	5.23	1.4346E-10	51.17	0.036	4.32
117	471.3	5652	3.31E-10	0.7939	4	197.93	42.00	277.85	4.92	1.6412E-10	49.52	0.034	4.23
118	412.5	6624	4.13E-10	0.776	4	228.49	55.39	348.66	5.04	2.1404E-10	51.77	0.035	4.49
119	276.8	9499	4.87E-10	0.7601	4	232.43	63.97	383.73	4.54	2.2762E-10	46.73	0.031	4.12
120	167.8	10932	5.7E-10	0.7463	4	254.18	151.48	457.71	4.95	2.6561E-10	46.53	0.031	4.17

W/C = 0.36
28 Days of Hydration
Pore Solution: 6% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (°)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	R ₁ (Q) (%) Error	R ₂ (Q) (%) Error	G (°) (Error)	G (°) (%) Error	Phi (Error)	Phi (%) Error
1	369	3678	4.33E-10	0.764	4	152.33	165.47	38.18	5.04	2.01E-10	46.34	0.032	4.08
2	318.1	4358	4.42E-10	0.768	4	151.12	188.6	47.51	4.33	1.81E-10	40.80	0.028	3.82
3	277.1	4824	4.42E-10	0.782	4	154.36	197.66	55.71	4.01	1.72E-10	39.03	0.027	3.45
4	242.7	5405	4.16E-10	0.782	4	153.43	200.19	63.22	3.70	1.54E-10	36.80	0.026	3.24
5	192.9	5798	4.13E-10	0.780	4	155.17	205.23	80.44	3.54	1.47E-10	35.57	0.024	3.13
6	172.6	6099	3.89E-10	0.781	4	153.06	205.15	86.66	3.26	1.37E-10	34.25	0.023	3.00
7	154.8	6402	3.88E-10	0.780	4	153.26	208.65	98.94	3.21	1.34E-10	33.58	0.023	2.94
8	132.3	6703	4.02E-10	0.778	4	155.84	216.39	117.79	3.12	1.34E-10	32.56	0.023	2.85
9	127.5	6907	3.85E-10	0.779	4	152.75	212.2	119.80	3.07	1.29E-10	32.16	0.022	2.81
10	114.3	6900	3.94E-10	0.779	4	151.96	212.04	132.85	3.12	1.27E-10	32.16	0.022	2.85
11	116.3	6991	3.89E-10	0.778	4	153.46	213.79	131.95	3.13	1.30E-10	32.57	0.022	2.85
12	115.5	7394	4.48E-10	0.771	4	169.7	248.38	148.93	3.33	1.59E-10	35.36	0.024	3.11
13	99.83	8316	4.46E-10	0.768	4	171.35	260.96	169.39	3.13	1.52E-10	33.81	0.023	2.97
14	15.44	8378	4.72E-10	0.763	4	182.82	284.26	1182.12	3.14	1.61E-10	34.23	0.023	3.01
15	48.46	11081	4.84E-10	0.768	4	200.8	383.86	441.42	3.20	1.70E-10	35.18	0.024	3.10
16	136.1	14242	4.88E-10	0.764	4	222.9	462.33	161.40	3.25	1.72E-10	35.36	0.023	3.11
17	293.8	17624	4.35E-10	0.758	4	221.87	523.09	75.82	2.97	1.39E-10	31.79	0.021	2.78
18	420.2	22460	4.40E-10	0.780	4	258.42	748.82	61.80	3.32	1.46E-10	32.76	0.022	2.95
19	606.4	28300	3.97E-10	0.791	4	272	965.55	44.63	3.36	1.27E-10	31.91	0.021	2.77
20	786	37463	3.63E-10	0.793	4	268.74	1359.3	37.63	3.63	1.15E-10	31.65	0.021	2.74
21	918.4	47124	3.05E-10	0.780	4	305.82	1777.9	33.30	3.77	9.22E-11	30.24	0.020	2.58
22	1031	58275	2.46E-10	0.789	4	315.37	2303.8	30.59	3.95	7.25E-11	28.10	0.019	2.48
23	1114	70318	2.08E-10	0.777	4	321.78	2811	28.89	4.14	5.89E-11	28.02	0.018	2.33
24	1175	86997	1.70E-10	0.787	4	329.22	3639.2	27.12	4.42	4.80E-11	27.00	0.017	2.22
25	1221	106590	1.35E-10	0.789	4	331.14	4944.4	26.02	4.64	3.46E-11	25.66	0.017	2.07
26	1237	126990	1.12E-10	0.808	4	328.9	6117	26.87	4.83	2.73E-11	24.42	0.016	1.95
27	1257	151850	9.13E-11	0.820	4	329.88	7784.5	26.24	5.11	2.13E-11	23.37	0.015	1.84
28	1280	183980	7.47E-11	0.830	4	334.04	10054	26.10	5.47	1.69E-11	22.54	0.015	1.78
29	1278	222850	6.10E-11	0.841	4	332.49	12894	26.06	5.83	1.31E-11	21.47	0.014	1.65
30	1262	268990	5.01E-11	0.851	4	336.87	17118	26.28	6.37	1.05E-11	20.90	0.014	1.59
31	1274	325170	4.16E-11	0.861	4	335.89	22419	26.38	6.89	8.34E-12	20.04	0.013	1.51
32	1253	391110	3.44E-11	0.871	4	338.87	28803	26.41	7.35	6.93E-12	19.02	0.012	1.41
33	1242	476910	2.85E-11	0.881	4	333.99	38944	26.89	8.17	5.27E-12	18.52	0.012	1.36
34	1226	574990	2.40E-11	0.890	4	335.89	51911	27.38	9.03	4.32E-12	17.99	0.012	1.31
35	1203	700940	1.97E-11	0.900	4	339.55	70355	27.98	10.04	3.44E-12	17.46	0.011	1.26
36	1205	847400	1.63E-11	0.910	4	338.67	93991	27.84	11.08	2.76E-12	16.88	0.011	1.20
37	1214	1096000	1.41E-11	0.917	4	343.51	131140	28.30	12.63	2.34E-12	16.62	0.011	1.18
38	1197	1239900	1.16E-11	0.927	4	349.75	175630	28.47	14.25	1.96E-12	16.53	0.011	1.16
39	1193	1480900	1.05E-11	0.933	4	344.97	227510	28.82	15.58	1.68E-12	15.89	0.010	1.11
40	1185	1713900	9.15E-12	0.940	4	348.55	298180	28.17	17.40	1.44E-12	15.72	0.010	1.09
41	1180	1933900	8.04E-12	0.947	4	347.42	391180	28.44	18.88	1.24E-12	15.45	0.010	1.08
42	1223	2211000	7.34E-12	0.952	4	354.93	457260	29.02	20.88	1.13E-12	15.46	0.010	1.08
43	1181	2476300	6.64E-12	0.957	4	355.64	557210	30.11	23.58	1.02E-12	15.35	0.010	1.04
44	1148	2994900	6.02E-12	0.963	4	355.45	632440	30.96	25.33	9.13E-13	15.18	0.010	1.03
45	1135	3606900	5.57E-12	0.967	4	362.46	739020	31.94	27.50	8.86E-13	15.36	0.010	1.03
46	1139	3185400	5.29E-12	0.969	4	367.9	876900	32.30	27.58	8.15E-13	15.42	0.010	1.03
47	1090	3366900	4.69E-12	0.974	4	367.18	927500	32.77	27.58	7.30E-13	14.86	0.010	0.99
48	1080	3813400	4.08E-12	0.977	4	361.91	1053100	32.64	28.14	6.85E-13	14.92	0.010	0.99
49	1078	3980900	4.39E-12	0.980	4	359.56	1169400	33.35	30.34	6.46E-13	14.76	0.010	0.98
50	1048	3989900	4.17E-12	0.982	4	362.52	1234900	34.59	31.12	6.18E-13	14.81	0.010	0.98

W/C = 0.36
28 Days of Hydration
Pure Solution: 6% Salt Solution

File No.	R ₁ (d)	R ₂ (d)	G (F)	Phi	Type	R ₁ (d) (Error)	R ₁ (d) (% Error)	R ₂ (d) (Error)	R ₂ (d) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
51	1036	406300	3.94E-12	0.9956	4	359	34.36	1.29E+08	30.94	5.71E-13	14.49	0.009	0.98
52	1026	4446000	3.62E-12	0.9971	4	364.61	35.56	1.51E+08	33.92	5.64E-13	14.75	0.010	0.97
53	1037	4703700	3.71E-12	0.9960	4	354.99	34.23	1.62E+08	34.45	5.29E-13	14.26	0.009	0.94
54	1029	4915100	3.65E-12	0.9994	4	360.28	35.01	1.78E+08	36.17	5.26E-13	14.43	0.009	0.95
55	1023	4626000	3.53E-12	0.9912	4	369.62	35.65	1.77E+08	35.99	5.06E-13	14.39	0.009	0.94
56	1034	4699800	3.47E-12	0.9925	4	355.72	34.40	1.79E+08	35.94	4.99E-13	14.26	0.009	0.94
57	1011	5036100	3.51E-12	0.9916	4	357.2	35.33	1.83E+08	36.36	5.00E-13	14.26	0.009	0.94
58	970.6	4949400	3.44E-12	0.9926	4	357.01	36.78	1.77E+08	35.83	4.91E-13	14.26	0.009	0.94
59	1001	4690000	3.48E-12	0.9925	4	355.51	35.52	1.78E+08	35.83	4.92E-13	14.23	0.009	0.93
60	1008	5114700	3.46E-12	0.9921	4	364.07	36.12	1.82E+08	37.61	5.05E-13	14.55	0.009	0.95
61	1010	5226400	3.5E-12	0.9918	4	362.45	36.89	2.01E+08	38.36	5.07E-13	14.49	0.009	0.95
62	1010	5126600	3.52E-12	0.9913	4	363.71	36.01	1.93E+08	37.70	5.12E-13	14.53	0.009	0.95
63	1019	5157800	3.53E-12	0.9912	4	359.94	36.22	1.93E+08	37.40	5.05E-13	14.32	0.009	0.94
64	1014	5009800	3.51E-12	0.9917	4	359.59	36.46	1.93E+08	36.47	5.04E-13	14.37	0.009	0.94
65	1031	5032900	3.62E-12	0.9913	4	357.87	34.71	1.87E+08	36.73	5.02E-13	14.27	0.009	0.94
66	997.9	4957100	3.59E-12	0.9911	4	361.03	36.18	1.91E+08	36.67	5.15E-13	14.49	0.009	0.95
67	1003	5076900	3.7E-12	0.9904	4	356.14	33.69	1.86E+08	37.02	5.29E-13	14.31	0.009	0.94
68	1026	4703200	3.69E-12	0.990	4	361.73	36.26	1.86E+08	35.19	5.36E-13	14.58	0.009	0.96
69	1008	4629800	3.65E-12	0.9905	4	361.58	33.86	1.95E+08	34.17	5.63E-13	14.80	0.009	0.96
70	1067	4494800	3.69E-12	0.9948	4	351.7	32.66	1.95E+08	33.41	5.69E-13	14.27	0.009	0.94
71	1042	4126000	4.09E-12	0.9935	4	354.69	34.04	1.95E+08	31.51	5.92E-13	14.47	0.009	0.98
72	1005	4013900	4.4E-12	0.9791	4	356.74	32.76	1.96E+08	31.29	6.45E-13	14.66	0.010	0.97
73	1107	3626900	4.54E-12	0.9777	4	361.69	32.67	1.17E+08	30.65	7.76E-13	14.90	0.010	0.99
74	1125	3519100	4.84E-12	0.9742	4	363.34	32.30	1.02E+08	29.01	7.30E-13	15.09	0.010	1.01
75	1105	3322900	5.14E-12	0.9709	4	364.45	32.08	9.10E+08	27.37	7.63E-13	14.83	0.010	0.99
76	1177	3142900	5.57E-12	0.9664	4	366.36	30.26	8.39E+08	26.99	8.39E-13	14.99	0.010	1.01
77	1207	2827400	5.9E-12	0.9636	4	369.35	29.77	7.03E+08	24.87	9.03E-13	15.31	0.010	1.03
78	1209	2619700	6.49E-12	0.9595	4	364.67	30.16	6.26E+08	23.69	1.01E-12	15.65	0.010	1.06
79	1203	2349900	6.99E-12	0.9548	4	367.1	29.66	5.13E+08	21.85	1.08E-12	15.82	0.010	1.08
80	1263	2136200	7.79E-12	0.9485	4	364.4	27.41	4.39E+08	20.36	1.21E-12	15.92	0.010	1.08
81	1261	194100	8.59E-12	0.9435	4	366.32	27.62	3.48E+08	18.69	1.39E-12	15.98	0.010	1.09
82	1303	1636000	9.99E-12	0.9374	4	367.9	27.47	2.81E+08	17.15	1.54E-12	16.15	0.011	1.12
83	1317	1405400	1.07E-11	0.9316	4	362.79	26.79	2.15E+08	15.28	1.73E-12	16.22	0.011	1.13
84	1349	1229900	1.22E-11	0.9243	4	364.76	26.30	1.79E+08	14.09	2.02E-12	16.57	0.011	1.16
85	1354	1070700	1.39E-11	0.9176	4	361.87	25.99	1.37E+08	12.84	2.30E-12	16.69	0.011	1.18
86	1395	896900	1.59E-11	0.9116	4	361.35	25.19	1.02E+08	11.41	2.64E-12	17.05	0.011	1.21
87	1409	735780	1.83E-11	0.9027	4	349.34	24.76	7.42E+08	10.08	3.19E-12	17.44	0.011	1.25
88	1339	603510	2.12E-11	0.895	4	346.22	25.66	5.34E+08	8.89	3.79E-12	17.66	0.012	1.29
89	1445	469940	2.54E-11	0.8951	4	345.51	23.91	4.01E+08	8.03	4.65E-12	18.31	0.012	1.34
90	1348	409920	2.94E-11	0.8777	4	346.62	25.64	2.89E+08	7.26	5.99E-12	19.00	0.012	1.40
91	1409	337430	3.52E-11	0.866	4	348.99	24.77	2.29E+08	6.66	6.99E-12	19.66	0.013	1.48
92	1398	276210	4.13E-11	0.8599	4	349.25	24.66	1.86E+08	6.10	8.59E-12	20.73	0.013	1.56
93	1403	229520	5.09E-11	0.8497	4	347.2	24.11	1.26E+08	5.60	1.08E-11	21.37	0.014	1.63
94	1373	183290	5.99E-11	0.8405	4	339.41	24.72	9.81E+08	5.10	1.30E-11	21.66	0.014	1.66
95	1362	155600	7.01E-11	0.8323	4	341.59	25.08	7.54E+08	4.94	1.62E-11	23.13	0.015	1.79
96	1302	129280	8.14E-11	0.8252	4	328.66	25.27	5.71E+08	4.42	1.91E-11	23.43	0.015	1.83
97	1390	109410	1E-10	0.8143	4	330.02	24.45	4.80E+08	4.24	2.46E-11	24.99	0.016	1.95
98	99791	89791	1.19E-10	0.8072	4	320.22	24.76	3.82E+08	3.92	2.91E-11	25.10	0.016	2.01
99	1260	74670	1.37E-10	0.799	4	315.21	25.02	2.77E+08	3.70	3.59E-11	26.00	0.017	2.10
100	1193	62437	1.6E-10	0.7914	4	301.64	25.28	2.15E+08	3.44	4.19E-11	26.19	0.017	2.14

W/C = 0.36
28 Days of Hydration
Pore Solution: 6% Salt Solution

Pile No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₃ (Q) (Error)	R ₃ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
101	1008	51590	1.78E-10	0.7872	4	286.74	28.07	1641.7	3.18	4.7037E-11	26.37	0.017	2.17
102	1009	42277	2E-10	0.7826	4	279.45	27.70	1287.4	3.05	5.4807E-11	27.41	0.018	2.27
103	944.6	34589	2.47E-10	0.7732	4	227.82	24.12	873.34	2.53	5.0227E-11	24.03	0.016	2.02
104	937.5	27004	2.07E-10	0.7637	4	185.54	34.52	629.59	2.33	4.8887E-11	23.86	0.015	1.84
105	420.1	20362	2E-10	0.7693	4	185.6	39.42	448.15	2.13	4.8331E-11	23.21	0.015	1.89
106	414.8	19187	2.20E-10	0.7691	4	178	42.91	351.8	2.17	5.8075E-11	24.91	0.016	2.07
107	12118	12118	2.24E-10	0.7651	4	151.86	62.49	252.81	2.08	5.325E-11	23.81	0.016	1.99
108	174.5	9404	3.21E-10	0.7764	4	140.24	80.37	210.42	2.24	7.8184E-11	24.34	0.016	2.10
109	62.99	7286	4.59E-10	0.7682	4	131.16	209.65	182.24	2.51	1.1698E-10	23.97	0.018	2.29
110	61.78	5912	5.8E-10	0.7688	4	126.14	204.24	188.02	2.86	1.6203E-10	28.11	0.019	2.55
111	152.9	5104	5.83E-10	0.7646	4	121.62	79.54	158.03	3.10	1.7345E-10	29.77	0.021	2.69
112	209.6	4647	5.84E-10	0.7703	4	118.19	56.39	149.89	3.30	1.791E-10	31.04	0.022	2.80
113	259.8	4123	5.4E-10	0.7763	4	113.01	43.67	140.77	3.41	1.7086E-10	31.63	0.022	2.84
114	285.9	3801	5.29E-10	0.7808	4	111.4	38.98	136.77	3.60	1.7218E-10	32.79	0.023	2.94
115	316.5	3333	5.11E-10	0.7851	4	108.04	34.14	131.13	3.71	1.7039E-10	33.36	0.023	2.96
116	348.8	3319	5.12E-10	0.7879	4	108.76	31.36	131.27	3.98	1.8098E-10	35.38	0.025	3.15
117	368.7	3288	5.09E-10	0.7946	4	111.09	30.97	134.73	4.10	2.0437E-10	38.79	0.026	3.29
118	354.3	3387	5.33E-10	0.775	4	119.34	33.86	146.35	4.35	2.9507E-10	39.21	0.027	3.55
119	331.1	3786	5.38E-10	0.758	4	135.65	40.97	172.24	4.55	3.5298E-10	42.12	0.029	3.89
120	282.9	4510	5.89E-10	0.7422	4	151.56	57.88	200.83	4.45	4.2225E-10	42.27	0.029	3.93
121	183.9	5452	1.13E-09	0.7293	4	168.62	90.60	233.11	4.28	4.7091E-10	41.67	0.029	3.94
122	90.11	8915	1.24E-09	0.7184	4	179.89	189.62	268.72	4.08	5.0011E-10	40.45	0.028	3.86
123	45.14	8009	1.35E-09	0.7074	4	197.85	438.30	317.37	3.86	5.3914E-10	39.84	0.027	3.84
124	138.2	6812	1.38E-09	0.703	4	209.48	191.59	364.69	3.63	5.2637E-10	39.91	0.028	3.75
125	217	11388	1.28E-09	0.7038	4	221.43	102.04	427.15	3.78	4.8442E-10	39.40	0.028	3.67
126	208.1	14125	8.84E-10	0.723	4	229.13	110.11	510.72	3.62	3.244E-10	37.54	0.028	3.45
127	319.9	18397	8.84E-10	0.7313	4	239.62	74.90	640.78	3.49	2.4138E-10	35.27	0.023	3.18
128	460.3	24079	6.13E-10	0.7328	4	252.82	51.52	843.14	3.50	2.0439E-10	33.36	0.022	2.98
129	682.8	30438	5.53E-10	0.7345	4	268.01	40.15	1080.7	3.58	1.7586E-10	31.89	0.021	2.84
130	785.2	37032	4.85E-10	0.7412	4	273.34	34.37	1344.9	3.63	1.4185E-10	30.45	0.020	2.68
131	693.2	43984	4.02E-10	0.7473	4	283.19	31.71	1942.8	3.78	1.1943E-10	28.73	0.019	2.59
132	979.9	50113	3.44E-10	0.7545	4	282.01	29.89	1661.5	3.89	1.0073E-10	29.27	0.019	2.52
133	997.1	56072	2.98E-10	0.7617	4	298.71	29.78	2234.3	3.86	8.5466E-11	28.71	0.019	2.44
134	1032	61975	2.89E-10	0.7671	4	292.48	28.34	2440.6	3.99	7.3154E-11	27.47	0.018	2.32

W/C = 0.66
28 Days of Hydration
Pore Solution: 6% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
1	435.1	659.8	2.89E-09	0.769	4	70.341	16.95	78.95	8.91	1.41E-09	54.43	0.042	5.53
2	431.9	625.1	2.39E-09	0.760	4	68.324	15.82	74.428	8.05	1.19E-09	49.80	0.038	5.01
3	421.2	1004	2.69E-09	0.750	4	75.691	17.97	82.599	8.22	1.29E-09	50.00	0.039	5.15
4	422.5	1085	2.22E-09	0.758	4	73.702	17.46	80.799	7.45	1.04E-09	48.90	0.036	4.75
5	419.9	1174	2.29E-09	0.752	4	76.953	18.33	84.915	7.23	1.07E-09	49.92	0.036	4.75
6	430	1318	2.26E-09	0.752	4	74.313	17.26	83.635	6.35	1.02E-09	44.95	0.034	4.47
7	417.7	1462	2.26E-09	0.748	4	70.637	16.91	80.435	5.80	9.21E-10	40.35	0.030	4.01
8	401.7	1970	2.60E-09	0.739	4	76.349	19.01	87.293	5.99	1.05E-09	40.44	0.030	4.09
9	398.5	1891	2.89E-09	0.725	4	87.436	23.73	99.651	5.99	1.19E-09	41.43	0.031	4.29
10	395.8	1793	2.87E-09	0.720	4	87.462	27.40	110.87	6.18	1.23E-09	42.80	0.032	4.47
11	398.9	1891	2.79E-09	0.720	4	104.98	29.41	119.51	6.35	1.20E-09	44.08	0.033	4.60
12	393.1	2097	3.23E-09	0.704	4	125.3	38.54	142.95	6.92	1.51E-09	48.84	0.035	5.04
13	398.8	2323	3.17E-09	0.700	4	140.36	46.73	161.23	6.94	1.51E-09	47.97	0.036	5.14
14	291.3	2712	3.32E-09	0.690	4	163.39	59.08	190.03	7.01	1.63E-09	49.04	0.037	5.35
15	290.3	3283	3.29E-09	0.684	4	187.41	72.00	222.37	6.81	1.61E-09	49.72	0.037	5.42
16	162.3	4182	3.82E-09	0.653	4	243.65	180.12	298.31	7.13	2.09E-09	53.32	0.040	5.97
17	26.7	5448	3.10E-09	0.694	4	298.53	1039.64	333.13	6.11	1.47E-09	47.39	0.035	5.25
18	124.3	6998	2.79E-09	0.691	4	304.51	244.98	393.82	5.63	1.29E-09	45.64	0.033	5.03
19	298.2	8076	2.69E-09	0.698	4	391.05	126.36	494.09	5.45	1.19E-09	46.60	0.034	5.11
20	502.3	12022	1.72E-09	0.670	4	354.03	70.48	514.43	4.26	6.79E-10	39.21	0.028	4.14
21	602.8	15947	1.49E-09	0.671	4	370.6	46.16	592.74	3.72	5.19E-10	35.47	0.025	3.69
22	980.4	20106	1.10E-09	0.692	4	396.15	37.09	624.5	3.11	3.39E-10	30.84	0.021	3.12
23	1203	26230	7.99E-10	0.695	4	342.8	28.60	694	2.65	2.19E-10	26.91	0.016	2.63
24	1411	33237	6.31E-10	0.705	4	337.99	23.93	800.2	2.41	1.54E-10	24.34	0.016	2.33
25	1729	41826	5.05E-10	0.714	4	335.56	19.41	948.82	2.26	1.12E-10	22.28	0.015	2.09
26	1839	52047	4.11E-10	0.724	4	316.26	17.20	1094.5	2.06	8.09E-11	19.60	0.013	1.80
27	2232	64799	3.69E-10	0.727	4	339.81	15.04	1424.8	2.20	7.09E-11	19.35	0.013	1.78
28	2220	78950	2.94E-10	0.741	4	318.14	14.24	1648.8	2.09	4.99E-11	17.18	0.011	1.53
29	2274	98002	2.29E-10	0.752	4	304.86	13.41	1978.9	2.08	3.69E-11	15.77	0.010	1.39
30	2491	119950	2.03E-10	0.759	4	320.24	12.89	2601.1	2.23	3.11E-11	15.59	0.010	1.35
31	2718	143380	1.67E-10	0.767	4	348.66	12.83	3699.1	2.53	2.67E-11	16.04	0.011	1.36
32	2995	181110	1.29E-10	0.783	4	336.87	12.97	4697.7	2.59	1.84E-11	14.72	0.010	1.24
33	2938	219460	1.11E-10	0.799	4	315.99	11.25	5933.5	2.53	1.49E-11	12.80	0.009	1.09
34	2926	269490	9.49E-11	0.799	4	327.26	11.19	7371	2.78	1.21E-11	12.60	0.009	1.06
35	2993	316900	7.89E-11	0.809	4	349.58	11.76	9949.4	3.14	1.03E-11	13.13	0.009	1.07
36	2993	378190	6.79E-11	0.815	4	343.87	11.83	12499	3.31	8.39E-12	12.47	0.008	1.01
37	3136	453220	5.94E-11	0.822	4	346.37	10.74	16200	3.63	5.67E-12	10.93	0.007	0.87
38	3267	549050	5.09E-11	0.829	4	329.39	10.85	19800	4.06	4.71E-12	10.79	0.007	0.85
39	3111	690900	4.37E-11	0.837	4	337.66	11.12	26943	4.71	4.12E-12	11.22	0.007	0.86
40	3266	787140	3.04E-11	0.849	4	362.07	11.61	37075	5.42	3.47E-12	11.41	0.008	0.86
41	3297	949910	3.04E-11	0.857	4	379.17	11.24	51695	5.92	2.79E-12	10.96	0.007	0.81
42	3262	1200300	2.84E-11	0.863	4	399.99	10.93	71079	6.91	2.41E-12	10.45	0.007	0.80
43	3462	1504600	2.31E-11	0.870	4	378.1	10.85	103960	7.99	2.01E-12	10.17	0.007	0.77
44	3670	1793400	1.99E-11	0.878	4	390.14	12.16	139110	9.97	1.77E-12	10.74	0.007	0.80
45	3363	2231000	1.69E-11	0.898	4	411.82	11.24	177500	10.57	1.39E-12	9.96	0.006	0.72
46	3415	2762700	1.43E-11	0.899	4	393.94	11.78	279500	13.32	1.11E-12	9.46	0.006	0.70
47	3238	3132700	1.17E-11	0.907	4	390.56	12.80	331180	17.77	1.05E-12	11.32	0.008	0.82
48	3299	3631400	1.04E-11	0.913	4	415.73	13.08	510360	19.79	8.99E-13	11.29	0.009	0.81
49	3948	4777400	9.24E-12	0.919	4	477.1	13.12	948720					
50	3930	5849300	7.89E-12	0.928	4	490.2		1099500					

WRC = 0.06
28 Days of Hydration
Pore Solution: 0% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (°)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₁ (Q) (% Error)	G (°) (Error)	G (°) (% Error)	PH (Error)	PH (% Error)
51	3367	6674100	7.30E-12	0.932	4	430.56	12.96	1370600	20.54	7.30E-13	10.08	0.007	0.72
52	3725	7319000	6.90E-12	0.934	4	464.84	12.47	1667600	22.78	7.22E-13	10.42	0.007	0.74
53	3451	7512100	6.70E-12	0.945	4	485.46	14.07	1762400	23.73	6.33E-13	10.94	0.007	0.77
54	3559	8490000	5.41E-12	0.948	4	481.87	13.54	2180400	25.71	5.80E-13	10.72	0.007	0.75
55	3446	1E+07	5.08E-12	0.952	4	482.26	13.96	2679200	26.52	5.37E-13	10.66	0.007	0.74
56	3604	1.1E+07	4.71E-12	0.958	4	512.71	14.23	3026800	32.75	5.27E-13	11.19	0.007	0.78
57	3673	1.3E+07	4.88E-12	0.952	4	528.29	13.84	5518600	40.97	5.50E-13	11.25	0.007	0.79
58	3619	1.2E+07	4.29E-12	0.951	4	500.32	14.22	4014600	33.84	4.62E-13	10.78	0.007	0.75
59	3634	1.2E+07	4.42E-12	0.959	4	500.82	14.17	4297700	35.07	4.74E-13	10.73	0.007	0.75
60	3465	1.3E+07	4.37E-12	0.959	4	472.24	13.67	4239900	33.69	4.42E-13	10.12	0.007	0.75
61	3649	1.3E+07	4.80E-12	0.958	4	544.01	13.78	5460000	41.16	5.33E-13	11.59	0.006	0.81
62	3611	1.1E+07	4.33E-12	0.961	4	479.9	13.67	3981800	31.43	4.48E-13	10.37	0.007	0.72
63	3687	1.3E+07	4.69E-12	0.956	4	560.84	14.94	5632500	44.77	5.83E-13	12.94	0.006	0.87
64	3614	1.2E+07	4.69E-12	0.957	4	473.21	13.47	3694300	31.86	4.68E-13	10.23	0.007	0.71
65	3625	1.2E+07	4.69E-12	0.958	4	484.37	13.17	3669700	31.41	4.67E-13	10.00	0.007	0.70
66	4051	1.3E+07	4.90E-12	0.953	4	542.71	13.36	5233300	40.91	5.73E-13	11.70	0.006	0.82
67	4001	1.1E+07	4.91E-12	0.953	4	515.25	12.86	3712600	33.54	5.46E-13	11.12	0.007	0.78
68	3657	1E+07	4.82E-12	0.955	4	467.27	13.32	2985100	29.47	5.14E-13	10.66	0.007	0.74
69	3466	1.1E+07	5.00E-12	0.953	4	465.71	14.05	3557200	32.36	5.33E-13	10.66	0.007	0.75
70	3618	1.1E+07	4.69E-12	0.946	4	473.55	12.40	3403300	31.30	5.08E-13	10.30	0.007	0.73
71	3670	8636200	5.93E-12	0.946	4	534.36	13.46	3266000	33.23	6.69E-13	11.81	0.006	0.83
72	3582	6277700	6.73E-12	0.945	4	482.37	13.13	2114400	25.54	6.17E-13	10.76	0.007	0.76
73	3652	7696700	6.01E-12	0.943	4	478.34	13.35	1820200	23.96	6.46E-13	10.80	0.007	0.78
74	3653	7230600	6.39E-12	0.940	4	464.46	12.76	1966500	22.11	6.61E-13	10.34	0.007	0.73
75	3638	6665400	7.36E-12	0.931	4	447.66	11.37	1463800	21.11	7.44E-13	10.11	0.007	0.72
76	4108	6757000	7.94E-12	0.927	4	463.34	12.02	1169000	20.25	8.98E-13	11.31	0.006	0.81
77	3660	6962100	8.08E-12	0.922	4	413.25	10.71	692480	16.78	8.19E-13	9.52	0.006	0.69
78	3674	4713900	8.94E-12	0.921	4	409.24	11.45	662560	14.96	8.62E-13	9.64	0.006	0.70
79	4212	4270300	1.03E-11	0.912	4	467.67	11.10	675090	15.76	1.14E-12	11.06	0.007	0.81
80	3666	3651300	1.08E-11	0.910	4	469.66	11.71	516670	14.13	1.23E-12	11.32	0.006	0.83
81	4130	3154800	1.22E-11	0.904	4	440.13	10.86	377080	11.95	1.31E-12	10.77	0.007	0.79
82	3752	2710000	1.34E-11	0.899	4	370.96	9.69	246150	9.08	1.23E-12	9.23	0.006	0.68
83	4112	2208400	1.54E-11	0.891	4	410.49	9.66	193770	8.77	1.61E-12	10.45	0.007	0.78
84	3763	1626600	1.80E-11	0.882	4	364.07	9.67	126520	6.89	1.70E-12	9.46	0.006	0.71
85	4037	1449100	2.15E-11	0.872	4	360.05	9.66	63414	6.45	2.25E-12	10.47	0.007	0.80
86	3674	1192500	2.51E-11	0.864	4	349.53	9.02	61263	5.14	2.41E-12	9.59	0.006	0.74
87	4086	861300	2.79E-11	0.856	4	365.5	9.43	50708	5.12	3.08E-12	10.65	0.007	0.84
88	4180	636230	3.31E-11	0.849	4	365.5	9.43	39747	4.75	3.77E-12	11.37	0.006	0.89
89	3684	666620	3.81E-11	0.845	4	338.77	9.12	23684	3.62	3.72E-12	10.30	0.007	0.80
90	4013	557460	4.79E-11	0.828	4	350.18	8.73	16707	3.54	5.25E-12	10.94	0.007	0.87
91	3607	449300	5.74E-11	0.819	4	329.17	8.36	13542	3.03	6.18E-12	10.78	0.007	0.87
92	3766	372690	7.26E-11	0.807	4	291.19	7.67	9691.2	2.57	7.27E-12	10.02	0.007	0.82
93	3668	256590	1.12E-10	0.782	4	325.86	6.16	6540.4	2.65	1.36E-11	12.16	0.006	1.02
94	3620	211410	1.26E-10	0.776	4	331.4	6.45	5135.4	2.43	1.68E-11	12.97	0.006	1.10
95	3624	176610	1.51E-10	0.767	4	323.41	6.46	3940.5	2.24	1.98E-11	13.21	0.006	1.13
96	3635	144760	1.66E-10	0.765	4	316.08	6.24	2693.9	2.07	2.51E-11	13.43	0.006	1.17
97	3466	119710	2.03E-10	0.752	4	266.51	6.29	2168.7	1.81	2.83E-11	12.93	0.006	1.13
98	3263	100090	2.37E-10	0.744	4	257.51	7.69	1569.6	1.57	2.66E-11	12.13	0.006	1.06
99	3444	84639	3.34E-10	0.724	4	268.15	6.69	1507.3	1.77	4.81E-11	14.43	0.010	1.32
100	3269	66593	3.63E-10	0.717	4	310	9.40	1223.7	1.78	6.05E-11	15.78	0.010	1.49

WRC = 0.00
28 Days of Hydration
Pure Solution: 0% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
101	2762	69918	3.02E-10	0.720	4	276.03	9.99	916.15	1.81	5.60E-11	15.20	0.010	1.41
102	2912	49993	4.39E-10	0.714	4	294.85	10.91	773.71	1.86	7.21E-11	18.40	0.011	1.54
103	2762	39979	5.79E-10	0.697	4	314.07	11.25	729.52	1.83	1.09E-10	18.24	0.012	1.77
104	2333	33028	6.13E-10	0.697	4	308.08	13.21	624.86	1.89	1.19E-10	19.20	0.013	1.87
105	2208	27981	7.10E-10	0.690	4	332.4	15.07	599.89	2.14	1.53E-10	21.54	0.015	2.14
106	2255	23939	8.39E-10	0.691	4	380.39	16.68	593.04	2.45	1.99E-10	23.79	0.017	2.42
107	2078	20151	9.87E-10	0.672	4	410.85	19.77	608.14	3.02	2.79E-10	27.92	0.020	2.92
108	1723	16448	1.04E-09	0.674	4	416.21	24.16	571.99	3.48	3.20E-10	30.72	0.022	3.24
109	1208	12794	1.02E-09	0.653	4	398.79	33.07	513.27	4.01	3.42E-10	33.68	0.024	3.55
110	1145	10855	1.19E-09	0.678	4	422.84	36.93	518.27	4.85	4.29E-10	36.93	0.027	4.01
111	899.8	8991	1.12E-09	0.695	4	402.08	45.20	472.08	5.50	4.39E-10	39.95	0.029	4.25
112	495.9	6323	9.63E-10	0.708	4	341.8	68.55	398.38	5.97	3.87E-10	40.11	0.030	4.30
113	180	4828	7.18E-10	0.735	4	268.71	179.19	318.38	6.59	3.04E-10	42.38	0.032	4.39
114	107.9	3058	4.89E-10	0.773	4	214.97	199.23	233.57	6.98	2.13E-10	42.91	0.033	4.25
115	191.2	2333	3.94E-10	0.800	4	159.85	83.09	188.67	7.23	1.99E-10	39.54	0.031	3.88
116	412.5	1894	4.20E-10	0.824	4	83.249	20.18	88.988	5.58	1.43E-10	33.97	0.026	3.15
117	437	1169	4.49E-10	0.839	4	88.782	12.76	89.515	5.09	1.40E-10	31.97	0.024	2.86
118	428	932.6	5.99E-10	0.834	4	80.038	11.86	83.325	5.72	2.09E-10	34.80	0.027	3.19
119	417.8	794.9	7.34E-10	0.830	4	80.356	12.05	83.497	6.73	2.91E-10	39.62	0.031	3.68
120	409.6	709.9	8.23E-10	0.829	4	80.896	12.42	83.832	7.63	3.62E-10	43.92	0.034	4.10
121	399.4	641.9	9.99E-10	0.823	4	82.948	13.26	86.058	8.73	4.91E-10	49.17	0.036	4.88
122	400.6	603.8	1.13E-09	0.820	4	83.004	13.23	86.188	9.31	5.69E-10	62.75	0.041	5.01
123	15.99	13053	5.30E-10	0.792	4	189.71	1049.51	259.41	1.98	1.18E-10	22.38	0.015	2.04

W/G = 0.56
7 Days of Hydration
Pore Solution: 10% Salt

File No.	R _g (d)	R _g (d)	G (P)	PHI	Type	R _g (d) (Error)	R _g (d) (% Error)	R _g (d) (Error)	R _g (d) (% Error)	G (P) (Error)	G (P) (% Error)	PHI (Error)	PHI (% Error)
1	410.3	902.1	4.53E-10	0.803	4	53.008	12.92	59.598	6.01	2.29E-10	49.72	0.036	4.11
2	334.2	1115	1.32E-09	0.780	4	55.482	18.80	62.189	5.58	5.29E-10	40.14	0.030	3.78
3	305	1080	1.07E-09	0.800	4	73.643	18.64	81.169	7.52	9.46E-10	51.27	0.038	4.79
4	418.6	1110	1.28E-09	0.777	4	91.424	21.83	98.071	8.84	6.12E-10	48.62	0.038	4.92
5	411	1184	1.28E-09	0.774	4	97.532	23.73	104.71	9.00	6.24E-10	49.51	0.039	5.03
6	325.6	1515	1.46E-09	0.782	4	123.71	37.69	131.85	10.03	7.43E-10	50.01	0.040	5.37
7	406.2	1298	1.24E-09	0.788	4	104.87	25.89	112.92	8.70	6.03E-10	48.47	0.038	4.94
8	393.4	1382	1.23E-09	0.785	4	110.51	27.86	118.1	8.62	6.92E-10	48.02	0.038	4.82
9	385.4	1480	1.10E-09	0.770	4	113.51	29.45	122.36	8.35	5.15E-10	48.92	0.037	4.77
10	385.9	1537	1.08E-09	0.768	4	115.51	30.01	125.1	8.14	5.00E-10	48.33	0.036	4.70
11	347.7	1646	1.07E-09	0.764	4	124.82	32.83	134.78	8.18	4.91E-10	46.71	0.036	4.69
12	370.5	1885	9.77E-10	0.770	4	121.63	35.93	131.76	7.77	4.42E-10	45.21	0.035	4.56
13	349.5	1831	1.04E-09	0.763	4	131.82	37.71	143.31	7.63	4.77E-10	45.98	0.036	4.67
14	349.5	1886	9.94E-10	0.763	4	138.75	39.13	149.68	7.54	4.58E-10	46.08	0.035	4.64
15	330.5	2188	9.82E-10	0.760	4	141.25	42.74	155.64	7.09	4.38E-10	44.82	0.034	4.48
16	334.2	2405	9.14E-10	0.762	4	142.19	42.95	158.21	6.98	3.98E-10	43.59	0.033	4.32
17	284.3	2698	9.18E-10	0.757	4	151.47	51.12	169.91	6.33	3.89E-10	43.01	0.032	4.26
18	285.5	2885	8.39E-10	0.751	4	157.68	60.78	178.51	5.98	3.62E-10	41.70	0.031	4.14
19	280.6	3285	8.36E-10	0.749	4	157.97	63.00	181.1	5.91	3.78E-10	40.08	0.030	3.96
20	236.8	3828	8.53E-10	0.745	4	165.9	70.08	193.25	5.33	3.83E-10	40.26	0.030	3.97
21	185.9	4078	8.57E-10	0.741	4	178.08	88.88	208.55	5.11	3.84E-10	40.08	0.029	3.94
22	145.5	4628	1.03E-09	0.733	4	187	128.52	226	4.88	4.06E-10	39.39	0.029	3.90
23	125.2	5722	1.53E-09	0.707	4	277.22	221.42	381.84	8.32	8.43E-10	55.04	0.039	5.56
24													
25													
26	748.2	15128	3.08E-09	0.842	4	281.56	38.07	445	2.84	9.14E-10	30.00	0.021	3.31
27	843.5	18280	3.08E-09	0.838	4	303.96	32.22	538.24	2.73	8.72E-10	28.48	0.020	3.14
28	1187	24816	3.17E-09	0.831	4	333.92	28.13	698.34	2.72	8.62E-10	28.14	0.020	3.11
29	1880	31294	3.08E-09	0.827	4	368.55	25.38	818.85	2.93	9.08E-10	29.72	0.021	3.29
30	1843	38873	2.90E-09	0.825	4	459.59	23.80	1259.9	3.15	8.59E-10	30.79	0.021	3.40
31	2310	50352	2.84E-09	0.828	4	535.02	23.18	1788.3	3.47	8.54E-10	32.33	0.022	3.56
32	2781	64897	2.33E-09	0.829	4	610.03	21.84	2465.2	3.79	7.78E-10	33.41	0.023	3.65
33	3201	81815	2.02E-09	0.833	4	672.89	21.02	3332.2	4.07	6.78E-10	33.57	0.023	3.63
34	3653	102880	1.65E-09	0.842	4	780.78	21.41	4670.9	4.54	5.78E-10	35.07	0.024	3.73
35	3829	129110	1.31E-09	0.852	4	844.3	21.49	6428.9	4.98	4.72E-10	35.94	0.025	3.78
36	4239	161340	1.02E-09	0.864	4	901.02	21.28	8808	5.27	3.84E-10	35.57	0.024	3.65
37	4439	201150	7.84E-10	0.877	4	975.49	21.96	11503	5.72	2.89E-10	35.81	0.024	3.81
38	4878	248730	5.86E-10	0.882	4	1018.1	21.78	15023	6.04	2.10E-10	35.34	0.024	3.48
39	4853	307800	4.59E-10	0.708	4	1087.2	22.40	20071	6.53	1.62E-10	35.49	0.024	3.43
40	5038	362040	3.83E-10	0.720	4	1148.5	22.78	26733	7.00	1.24E-10	35.13	0.024	3.34
41	5284	474840	2.71E-10	0.734	4	1208.9	22.80	39708	7.82	9.42E-11	34.80	0.024	3.25
42	5353	591680	2.05E-10	0.749	4	1231.7	23.27	48777	7.91	6.88E-11	33.60	0.023	3.08
43	5380	733010	1.64E-10	0.785	4	1220.2	22.68	58283	8.08	4.88E-11	31.82	0.022	2.84
44	5491	917310	1.18E-10	0.779	4	1291.1	23.46	80801	8.79	3.70E-11	31.38	0.022	2.77
45	5674	1157100	9.02E-11	0.795	4	1328.5	23.78	102880	9.53	2.78E-11	30.82	0.021	2.69
46	5802	1468800	7.04E-11	0.808	4	1331	24.19	148350	10.12	2.08E-11	29.30	0.020	2.51
47	5288	1853800	5.28E-11	0.825	4	1317.3	24.82	188250	10.89	1.47E-11	27.87	0.019	2.35
48	5344	2340100	4.08E-11	0.839	4	1289.8	24.62	262080	11.30	1.07E-11	26.09	0.018	2.17
49	5401	3088300	3.39E-11	0.849	4	1363.1	25.61	411080	13.32	8.89E-12	26.42	0.018	2.18
50	5417	4027000	2.61E-11	0.864	4	1393.4	25.72	597480	14.81	9.70E-12	25.70	0.016	2.09

W/C = 0.38
7 Days of Hydration
Pore Solution: 15% Salt

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	G (P) (% Error)	G (P) (Error)	PH (Error)	PH (% Error)
51	0120	0570900	2.7E-11	0.8999	4	1414.1	23.11	6.72E+05	10.22	5.55E-12	0.015	1.72
52	0156	0637200	2.26E-11	0.8999	4	1394.6	22.06	1.00E+06	12.92	4.30E-12	0.014	1.61
53	0600	1.2E+07	1.8E-11	0.8918	4	1434.6	24.09	1.53E+06	11.00	3.44E-12	0.014	1.59
54	5902	1.5E+07	1.47E-11	0.8931	4	1401.6	23.75	2.20E+06	14.36	2.88E-12	0.013	1.47
55	0162	2.4E+07	1.35E-11	0.8972	4	1511.6	24.53	4.75E+06	20.16	2.81E-12	0.014	1.52
56	5983	2.9E+07	1.05E-11	0.9126	4	1422.1	25.02	6.17E+06	21.11	1.81E-12	0.013	1.39
57	5908	4.2E+07	0.88E-12	0.9205	4	1418.6	25.06	1.12E+07	20.89	1.52E-12	0.012	1.33
58	5905	5.6E+07	8.22E-12	0.9206	4	1498.5	26.79	1.96E+07	35.17	1.41E-12	0.013	1.36
59	5957	7.3E+07	7.48E-12	0.9311	4	1480.6	26.78	3.16E+07	43.06	1.26E-12	0.012	1.34
60	5314	8.1E+07	6.88E-12	0.9382	4	1474.6	27.75	3.64E+07	45.11	1.19E-12	0.012	1.32
61	5999	1.2E+08	6.15E-12	0.9479	4	1520.5	27.21	7.89E+07	65.67	1.05E-12	0.013	1.33
62	5514	7E+07	5.82E-12	0.9461	4	1488.9	26.80	2.58E+07	39.70	9.61E-13	0.012	1.29
63	5939	6.6E+07	5.7E-12	0.9474	4	1531.6	27.17	2.29E+07	36.30	8.65E-13	0.013	1.34
64	5315	8E+07	5.3E-12	0.9521	4	1488.7	27.63	3.29E+07	40.84	8.77E-13	0.012	1.28
65	5715	1.4E+08	5.75E-12	0.9459	4	1517.3	28.55	9.89E+07	70.49	9.80E-13	0.012	1.30
66	5421	9E+07	5.99E-12	0.9463	4	1509	27.84	4.25E+07	47.25	9.45E-13	0.012	1.31
67	5922	1.5E+08	5.68E-12	0.9472	4	1505.6	28.78	1.18E+08	77.30	9.53E-13	0.012	1.31
68	5947	8.8E+07	5.65E-12	0.9467	4	1488	27.32	4.02E+07	46.43	9.24E-13	0.012	1.29
69	5347	1.5E+08	5.45E-12	0.9466	4	1480.3	27.68	1.11E+08	74.16	8.98E-13	0.012	1.28
70	5119	1.1E+08	5.48E-12	0.9484	4	1415.2	27.65	6.10E+07	54.39	8.08E-13	0.012	1.23
71	5131	3.8E+08	5.91E-12	0.9488	4	1434.3	27.85	7.01E+08	183.78	8.76E-13	0.012	1.24
72	5290	1.2E+08	5.82E-12	0.9478	4	1471.5	27.98	7.48E+07	61.25	9.18E-13	0.012	1.27
73	5237	6.8E+07	5.77E-12	0.9462	4	1463	27.84	2.41E+07	35.31	9.48E-13	0.012	1.28
74	5673	8.8E+07	6.1E-12	0.9432	4	1463.5	28.26	4.08E+07	46.31	1.00E-12	0.012	1.26
75	5762	5.8E+07	6.83E-12	0.9381	4	1515.4	28.35	1.84E+07	33.47	1.17E-12	0.013	1.34
76	6187	1E+08	6.39E-12	0.9229	4	1486.8	24.06	3.11E+07	30.31	1.20E-12	0.011	1.17
77	5977	5.3E+07	6.08E-12	0.9189	4	1455.7	24.38	9.42E+06	17.80	1.33E-12	0.011	1.20
78	6389	4.4E+07	1.08E-11	0.9078	4	1584.6	24.80	7.98E+06	17.08	1.70E-12	0.012	1.30
79	6615	3.2E+07	1.24E-11	0.8998	4	1546.5	23.74	4.33E+06	13.65	1.89E-12	0.012	1.33
80	6940	2.7E+07	1.5E-11	0.8981	4	1594.5	22.88	3.69E+06	13.44	2.82E-12	0.012	1.40
81	6915	1.8E+07	1.57E-11	0.8981	4	1517.2	22.94	1.89E+06	10.34	2.88E-12	0.013	1.41
82	6938	1.5E+07	1.91E-11	0.8744	4	1546.5	22.62	1.52E+06	10.00	3.30E-12	0.013	1.46
83	6744	1.2E+07	2.18E-11	0.8989	4	1573.5	23.33	1.10E+06	9.30	4.08E-12	0.014	1.58
84	7129	6999000	2.57E-11	0.8574	4	1591.6	21.90	7.51E+05	6.35	4.82E-12	0.014	1.63
85	7187	6922800	2.8E-11	0.8511	4	1556	21.68	5.05E+05	7.62	5.65E-12	0.015	1.72
86	7391	5120100	3.54E-11	0.839	4	1592.5	21.58	3.71E+05	7.24	7.88E-12	0.015	1.84
87	7300	4077500	4.23E-11	0.8269	4	1596.1	21.32	2.79E+05	6.78	9.25E-12	0.016	1.90
88	7289	3194300	4.97E-11	0.82	4	1521.9	20.89	1.98E+05	6.28	1.12E-11	0.016	1.97
89	7000	2445300	5.89E-11	0.8107	4	1506	21.24	1.48E+05	5.96	1.40E-11	0.017	2.06
90	7014	1892500	7.05E-11	0.8004	4	1488.2	20.80	1.05E+05	5.57	1.74E-11	0.017	2.16
91	6992	1481000	8.59E-11	0.7901	4	1433.4	20.50	7.79E+04	5.26	2.17E-11	0.018	2.25
92	7083	1154100	1.06E-10	0.7773	4	1418.7	20.03	5.81E+04	5.03	2.85E-11	0.019	2.39
93	6735	894630	1.28E-10	0.7682	4	1336	19.87	4.18E+04	4.67	3.48E-11	0.019	2.45
94	6418	694130	1.55E-10	0.7597	4	1289	20.09	3.07E+04	4.42	4.35E-11	0.019	2.56
95	6431	537430	1.83E-10	0.747	4	1234.5	19.20	2.23E+04	4.15	5.55E-11	0.020	2.65
96	6273	417890	2.34E-10	0.737	4	1197.7	18.93	1.63E+04	3.91	6.94E-11	0.020	2.77
97	5912	324990	2.79E-10	0.7284	4	1112	18.61	1.18E+04	3.62	8.36E-11	0.021	2.82
98	5313	253200	3.24E-10	0.722	4	1019.3	18.19	8.42E+03	3.32	9.89E-11	0.020	2.84
99	4915	198360	3.78E-10	0.7153	4	983.87	19.61	6.24E+03	3.14	1.15E-10	0.021	2.93
100	4554	153770	3.95E-10	0.7149	4	972.06	22.33	5.89E+03	3.91	1.41E-10	0.024	3.35

W/C = 0.56
7 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
101	3008	121800	4.52E-10	0.7101	4	878.04	22.08	4224.4	3.48	1.9721E-10	34.79	0.024	3.32
102													
103													
104													
105	2633	48359	6.06E-10	0.6958	4	558.26	21.20	1229.9	2.54	2.1908E-10	30.81	0.021	3.03
106													
107													
108													
109													
110													
111													
112													
113													
114	180.1	8040	3.88E-10	0.7742	4	181.26	95.35	238.81	2.95	1.0495E-10	28.49	0.020	2.57
115	26.37	6296	3.44E-10	0.7851	4	151.37	574.02	186.79	2.97	9.3031E-11	27.04	0.019	2.43
116	77.4	8052	3.71E-10	0.7873	4	130.05	168.02	154.81	3.08	9.6802E-11	28.08	0.019	2.37
117	180.1	4272	4.35E-10	0.7895	4	121.69	78.01	142.86	3.34	1.2007E-10	27.81	0.020	2.53
118	230.8	3710	4.35E-10	0.7808	4	112.79	48.85	130.18	3.51	1.2128E-10	27.60	0.020	2.56
119	269.5	3511	4.42E-10	0.7831	4	111.24	41.28	126.66	3.82	1.2805E-10	28.19	0.021	2.69
120	282	3046	4.48E-10	0.7949	4	110.41	37.81	124.25	4.08	1.3377E-10	30.05	0.022	2.78
121	329.4	2814	4.08E-10	0.8038	4	107.89	32.89	120.41	4.28	1.2882E-10	31.22	0.023	2.86
122	300	2627	3.98E-10	0.8073	4	102.83	29.32	114.08	4.34	1.2395E-10	31.07	0.023	2.84
123	375.7	2448	3.71E-10	0.8147	4	100.21	26.87	110.83	4.53	1.1905E-10	32.10	0.024	2.92
124	374.1	2318	3.7E-10	0.8163	4	101.84	27.17	111.79	4.82	1.2352E-10	33.39	0.025	3.04
125	363.9	2192	3.71E-10	0.8162	4	99.215	25.84	108.88	4.98	1.2488E-10	33.88	0.025	3.07
126	401.8	2083	3.47E-10	0.8248	4	98.091	23.82	104.84	5.08	1.188E-10	34.25	0.026	3.10
127	397.4	1987	3.0E-10	0.8253	4	97.898	24.88	108.42	5.41	1.2433E-10	35.51	0.027	3.23
128	408.1	1863	3.42E-10	0.829	4	95.824	23.48	103.77	5.57	1.2378E-10	36.16	0.027	3.28
129	390	1800	3.63E-10	0.8253	4	99.016	25.36	108.71	5.83	1.3465E-10	37.05	0.028	3.41
130	396.1	1738	3.78E-10	0.8253	4	102.34	25.84	110.24	6.34	1.4829E-10	39.52	0.030	3.64
131	398.8	1708	4.32E-10	0.8178	4	112.47	28.13	121.88	6.83	1.8854E-10	43.84	0.033	4.05
132	403.6	1628	5.2E-10	0.8051	4	124.91	30.85	136.88	7.09	2.4422E-10	48.94	0.036	4.38
133	432.4	2205	4.97E-10	0.8061	4	127.5	29.49	142.22	6.45	2.3341E-10	46.82	0.036	4.29
134	427.9	2638	4.97E-10	0.8014	4	132.24	31.14	152.03	5.78	2.2454E-10	45.20	0.033	4.10

W/C = 0.36
28 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
1	364.5	3140	1.90E-09	0.703	4	185.94	51.01	200.79	6.90E-10	36.65	0.029	4.13
2	28.97	3725	2.01E-09	0.682	4	200.4	686.67	213.91	5.71E-10	28.46	0.023	3.43
3	13.24	3653	1.79E-09	0.696	4	193.16	1495.91	205.93	4.73E-10	28.46	0.022	3.17
4	26.97	3679	1.72E-09	0.690	4	187.65	722.56	200.51	4.53E-10	26.36	0.021	3.11
5	4.839	3663	1.71E-09	0.689	4	191.75	3662.60	206.01	4.52E-10	26.46	0.022	3.13
6	10.2	4017	1.70E-09	0.689	4	193.37	1896.78	206.93	4.52E-10	26.54	0.022	3.13
7	14.74	4103	1.71E-09	0.686	4	197.96	1343.01	211.95	4.59E-10	26.64	0.022	3.15
8	4.331	4167	1.62E-09	0.691	4	194.02	4479.80	208.26	4.29E-10	26.65	0.021	3.10
9	25.91	4227	1.62E-09	0.691	4	198.65	798.97	211.44	4.39E-10	26.62	0.022	3.13
10	2.462	4329	1.60E-09	0.693	4	197.57	8034.78	212.5	4.12E-10	26.66	0.021	3.08
11	74.29	4495	1.59E-09	0.698	4	208.87	278.46	222.33	4.19E-10	26.32	0.021	3.08
12	13.25	4615	1.52E-09	0.692	4	203.25	1533.96	219.16	4.09E-10	26.77	0.021	3.09
13	118.9	4844	1.40E-09	0.679	4	233.27	198.19	252.46	5.13E-10	24.52	0.023	3.37
14	143.3	5240	1.68E-09	0.675	4	240.18	187.81	262.16	5.39E-10	26.65	0.023	3.37
15	161.9	5725	1.83E-09	0.676	4	237.32	146.96	261.69	6.09E-10	27.66	0.022	3.23
16	104.7	6178	1.59E-09	0.695	4	215.56	205.86	241.33	4.09E-10	26.07	0.020	2.91
17	137.9	6748	1.42E-09	0.699	4	208.68	180.02	234.36	3.49E-10	24.46	0.019	2.69
18	137.7	7353	1.40E-09	0.699	4	205.05	148.91	235.96	3.34E-10	23.65	0.018	2.59
19	102.5	7982	1.29E-09	0.693	4	193.81	189.08	227.48	2.92E-10	22.99	0.017	2.41
20	141	8620	1.24E-09	0.694	4	182.74	129.60	219.07	2.89E-10	20.74	0.015	2.19
21	247.5	9759	1.26E-09	0.690	4	183.41	74.11	224.11	2.49E-10	19.74	0.014	2.08
22	130.8	10631	1.24E-09	0.692	4	182.86	147.54	245.87	2.60E-10	20.99	0.015	2.18
23	277.2	12465	1.12E-09	0.694	4	182.43	65.81	240.9	2.09E-10	18.65	0.013	1.91
24	280.2	14039	1.05E-09	0.697	4	171.98	69.74	239.07	1.82E-10	17.29	0.012	1.75
25	263.8	15678	9.91E-10	0.695	4	163.09	57.47	239.21	1.57E-10	15.85	0.011	1.59
26	366.3	18307	1.03E-09	0.695	4	171.26	49.86	270.46	1.64E-10	15.87	0.011	1.59
27	478.7	21410	1.04E-09	0.692	4	180.34	37.83	309.29	1.63E-10	15.70	0.011	1.57
28	506.3	25432	1.04E-09	0.690	4	183.89	36.36	352.87	1.57E-10	15.11	0.010	1.50
29	594.8	31733	1.08E-09	0.695	4	186.15	33.86	447.59	1.61E-10	15.00	0.010	1.50
30	911.2	40173	1.20E-09	0.673	4	211.41	23.20	672.31	1.72E-10	14.35	0.010	1.45
31	1384	50996	1.35E-09	0.691	4	214.21	18.48	676.98	1.82E-10	12.02	0.008	1.25
32	1644	63494	1.31E-09	0.699	4	227.36	13.83	731.14	1.82E-10	11.62	0.008	1.21
33	1970	79623	1.24E-09	0.698	4	236.34	12.00	828.08	1.37E-10	11.01	0.008	1.14
34	2237	96031	1.11E-09	0.692	4	261.1	11.67	1250.5	1.25E-10	11.20	0.008	1.15
35	2982	123060	9.89E-10	0.696	4	282.3	11.41	1724.5	1.14E-10	11.58	0.008	1.18
36	3073	164220	9.08E-10	0.695	4	323.66	10.53	2368.1	1.09E-10	11.62	0.008	1.19
37	3322	197300	7.71E-10	0.673	4	369.26	11.03	3199.2	9.43E-11	12.22	0.008	1.24
38	3754	234870	6.79E-10	0.679	4	411.17	10.85	4894.3	8.61E-11	12.78	0.009	1.28
39	3907	269960	6.51E-10	0.696	4	459.87	12.06	6539.1	7.29E-11	13.24	0.009	1.31
40	4228	365940	4.98E-10	0.696	4	516.31	12.21	9041	6.29E-11	13.73	0.009	1.35
41	4547	449980	3.74E-10	0.708	4	561.53	12.35	12101	5.19E-11	13.86	0.010	1.35
42	5146	636570	2.89E-10	0.726	4	703.21	13.67	18312	4.39E-11	17.00	0.012	1.60
43	4776	657220	2.23E-10	0.734	4	663.12	13.86	21536	3.30E-11	14.79	0.010	1.38
44	5967	790940	1.89E-10	0.750	4	834.75	14.18	30771	3.05E-11	18.29	0.013	1.69
45	6426	803370	1.89E-10	0.750	4	851.85	13.26	36311	2.73E-11	17.23	0.012	1.59
46	6988	1091800	1.32E-10	0.760	4	864.82	13.17	48077	2.19E-11	16.67	0.012	1.51
47	6633	1241300	1.09E-10	0.770	4	978.95	13.22	59400	1.79E-11	16.19	0.011	1.45
48	6701	1477300	8.80E-11	0.781	4	914.9	13.85	70348	1.42E-11	16.19	0.011	1.44
49	8417	1779800	6.70E-11	0.797	4	938.45	14.62	86608	1.07E-11	16.03	0.011	1.40
50	9919	2224900	6.34E-11	0.809	4	919.79	13.90	112710	7.86E-12	14.78	0.010	1.27

W/C = 0.36
28 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (Q)	R ₂ (Q)	C (P)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (P) (Error)	C (P) (% Error)	PH (Error)	PH (% Error)
51	6442	2040700	3.91E-11	0.8203	4	981.87	14.93	1.50E+05	5.55	5.76E-12	14.74	0.010	1.25
52	6580	4004300	2.91E-11	0.8421	4	993.59	15.10	2.50E+05	8.25	4.11E-12	14.15	0.010	1.18
53	6282	5739000	1.9E-11	0.8652	4	1017	19.19	4.00E+05	7.07	2.80E-12	13.69	0.010	1.11
54	5933	6498800	1.21E-11	0.8225	4	1082.3	18.21	7.10E+05	8.36	1.64E-12	13.58	0.010	1.06
55	6435	1.2E+07	9.4E-12	0.9046	4	994.83	15.46	1.00E+06	8.66	1.10E-12	11.74	0.008	0.92
56	6326	1.5E+07	7.53E-12	0.9169	4	1042.1	15.97	1.43E+06	9.78	8.97E-13	11.92	0.008	0.93
57	5901	1.7E+07	5.3E-12	0.941	4	1075	18.53	1.82E+06	10.87	6.79E-13	12.82	0.009	0.97
58	6130	2.2E+07	3.36E-12	0.9369	4	1036.7	16.94	2.69E+06	12.15	6.18E-13	11.49	0.008	0.88
59	5940	3E+07	4.39E-12	0.9495	4	1000.8	17.14	4.26E+06	14.28	4.77E-13	10.89	0.008	0.82
60	6334	2.8E+07	3.7E-12	0.9892	4	1006.8	18.19	3.83E+06	13.16	4.02E-13	10.87	0.008	0.81
61	4877	3.3E+07	2.95E-12	0.9725	4	993.72	20.36	4.69E+06	13.89	3.18E-13	10.83	0.008	0.80
62	5320	3.7E+07	2.47E-12	0.9841	4	999.15	18.78	5.39E+06	14.57	2.71E-13	10.97	0.008	0.80
63	5302	4.8E+07	2.44E-12	0.9844	4	1053.6	19.87	8.72E+06	18.80	2.81E-13	11.48	0.008	0.84
64	5336	3.7E+07	2.31E-12	0.9866	4	1014.5	19.01	5.44E+06	14.82	2.57E-13	11.16	0.008	0.81
65	4849	4.3E+07	2.41E-12	0.9857	4	1048.1	21.81	7.51E+06	17.48	2.78E-13	11.53	0.008	0.84
66	4891	4.2E+07	2.46E-12	0.9837	4	1024.4	20.52	6.96E+06	18.67	2.74E-13	11.14	0.008	0.81
67	4759	3.8E+07	2.96E-12	0.9807	4	996.93	20.74	5.72E+06	14.89	2.73E-13	10.66	0.008	0.78
68	5251	4.8E+07	2.71E-12	0.976	4	972.92	18.53	8.86E+06	18.07	2.77E-13	10.20	0.007	0.75
69	5307	5.2E+07	2.79E-12	0.9752	4	993.05	19.66	9.73E+06	19.10	2.80E-13	10.46	0.007	0.77
70	5307	6.8E+07	3.48E-12	0.9711	4	1081.5	20.00	1.07E+07	20.72	3.09E-13	11.14	0.008	0.82
71	6082	7.8E+07	3.35E-12	0.9815	4	1116.1	18.03	7.01E+06	10.66	3.40E-13	9.73	0.007	0.75
72	5787	7.3E+07	3.35E-12	0.983	4	1298.2	22.46	9.53E+06	12.04	3.11E-13	9.29	0.007	0.72
73	6087	6.2E+07	4.21E-12	0.9479	4	1273.7	19.31	9.74E+06	13.30	3.74E-13	11.16	0.008	0.86
74	6730	4.8E+07	4.76E-12	0.9412	4	1208.4	17.97	4.69E+06	9.87	4.96E-13	10.77	0.008	0.84
75	7337	3.2E+07	5.30E-12	0.9383	4	1519.7	20.71	3.25E+06	10.00	7.36E-13	13.86	0.010	1.09
76	7310	2.7E+07	6.86E-12	0.9314	4	1475.4	20.16	2.35E+06	8.66	8.14E-13	13.89	0.010	1.10
77	7634	2.4E+07	7.04E-12	0.9201	4	1454.8	18.57	2.09E+06	8.55	9.89E-13	13.72	0.010	1.09
78	7899	1.8E+07	6.2E-12	0.9117	4	1465.1	19.11	1.43E+06	7.78	1.18E-12	14.35	0.010	1.15
79	7949	1.4E+07	6.69E-12	0.9032	4	1394.2	17.54	9.91E+05	6.67	1.35E-12	14.17	0.010	1.14
80	8089	1.2E+07	1.7E-11	0.8916	4	1454.1	17.98	7.87E+05	6.79	1.77E-12	15.20	0.011	1.24
81	8048	9047800	1.39E-11	0.8933	4	1433.7	18.04	5.62E+05	6.21	2.13E-12	15.71	0.011	1.28
82	8443	7624000	1.7E-11	0.87	4	1597.1	18.44	4.93E+05	6.46	2.97E-12	17.42	0.013	1.44
83	8678	5967600	2E-11	0.8609	4	1478.4	17.02	3.38E+05	5.76	3.47E-12	17.30	0.012	1.44
84	8280	4498800	2.36E-11	0.8547	4	1423.8	17.24	2.80E+05	5.37	4.04E-12	17.72	0.013	1.48
85	8419	3740900	2.74E-11	0.8443	4	1390.9	18.05	1.83E+05	4.80	4.80E-12	17.83	0.012	1.47
86	8337	3034100	3.39E-11	0.833	4	1333.5	15.99	1.43E+05	4.72	6.11E-12	18.17	0.013	1.54
87	8398	2480900	4.15E-11	0.821	4	1302.5	15.93	1.11E+05	4.48	7.69E-12	18.48	0.013	1.58
88	8023	1983900	4.8E-11	0.8136	4	1218.1	15.18	8.10E+04	4.08	8.78E-12	18.31	0.013	1.58
89	7998	1806900	5.46E-11	0.8071	4	1131.5	14.15	5.94E+04	3.72	9.92E-12	18.09	0.013	1.69
90	7852	1257400	6.46E-11	0.7985	4	1021.9	13.46	4.14E+04	3.29	1.13E-11	17.43	0.012	1.51
91	7807	999910	7.69E-11	0.7901	4	986.83	13.31	3.17E+04	3.17	1.40E-11	18.25	0.013	1.59
92	7071	762650	8.69E-11	0.7834	4	912.02	12.80	2.27E+04	2.87	1.59E-11	17.92	0.012	1.57
93	6948	645750	1.07E-10	0.7733	4	804.19	11.74	1.81E+04	2.49	1.78E-11	18.87	0.011	1.48
94	6930	522410	1.23E-10	0.7695	4	780.19	11.46	1.21E+04	2.31	2.05E-11	18.63	0.011	1.48
95	6163	425630	1.39E-10	0.7612	4	696.2	11.26	9.09E+03	2.13	2.30E-11	18.54	0.011	1.48
96	5989	352180	1.62E-10	0.7535	4	633.4	10.74	6.80E+03	1.93	2.88E-11	18.93	0.011	1.44
97	5986	261670	1.84E-10	0.7478	4	670.29	10.07	5.07E+03	1.74	2.91E-11	19.25	0.010	1.38
98	5439	241180	2.07E-10	0.7422	4	522.75	9.81	3.83E+03	1.59	3.06E-11	14.86	0.010	1.35
100	5310	189530	2.39E-10	0.7381	4	502.54	9.46	3.20E+03	1.61	3.97E-11	15.32	0.010	1.41

W/C = 0.36
28 Days of Hydration
Pore Solution: 10% Salt

Pile No.	R ₁ (g)	R ₂ (g)	G (F)	Phi	Type	R ₁ (g) (Error)	R ₂ (g) (% Error)	R ₂ (g) (Error)	R ₂ (g) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
101	4851	164330	2.62E-10	0.7319	4	486.51	9.66	2494.5	1.52	4.0248E-11	15.34	0.010	1.41
102	4265	130040	4.1E-10	0.7079	4	429.34	10.07	2016.1	1.46	6.0795E-11	14.82	0.010	1.42
103	3680	115370	4.47E-10	0.7046	4	431.33	10.82	1710.3	1.46	7.0686E-11	15.86	0.011	1.52
104	3669	90060	5.22E-10	0.6957	4	368.46	10.50	1313.9	1.34	7.7875E-11	14.86	0.010	1.45
105	3647	84369	5.5E-10	0.6959	4	367.63	10.63	1153.3	1.37	8.6403E-11	15.72	0.011	1.53
106	2722	72027	5.7E-10	0.6953	4	186.46	7.22	515.23	0.72	4.8239E-11	8.47	0.008	0.83
107	2261	60959	5.69E-10	0.6953	4	185.63	6.22	426.1	0.70	4.8578E-11	8.56	0.008	0.84
108	2058	51040	5.94E-10	0.6958	4	187.43	6.11	360.08	0.74	5.404E-11	9.25	0.008	0.90
109	2014	42445	5.44E-10	0.7081	4	206.79	10.37	373.49	0.88	6.0233E-11	11.07	0.008	1.07
110	1862	30265	6.03E-10	0.702	4	206.8	11.15	335.69	0.95	7.0533E-11	11.72	0.008	1.15
111	1838	27865	4.82E-10	0.7184	4	220.13	14.33	315.53	1.13	6.8306E-11	13.78	0.010	1.33
112	1155	21662	4.8E-10	0.724	4	207.66	17.66	271.11	1.25	6.894E-11	14.32	0.010	1.36
113	837.4	17408	6.33E-10	0.7223	4	182.82	20.57	237.73	1.37	7.7341E-11	14.52	0.010	1.42
114	817.8	14378	6.69E-10	0.7133	4	180.37	22.06	214.42	1.46	9.7697E-11	14.60	0.010	1.47
115	770.9	12121	9.77E-10	0.6947	4	182.05	23.62	210.97	1.74	1.9076E-10	15.43	0.011	1.63
116	638.2	10362	1.19E-09	0.6993	4	167.65	36.77	186.62	2.04	1.8379E-10	15.44	0.011	1.85
117	453.9	6260	1.39E-09	0.6936	4	165.56	39.90	207.3	2.41	2.8239E-10	18.25	0.014	2.04
118	464.8	6097	1.6E-09	0.6761	4	165.45	39.90	207.3	2.41	2.8239E-10	18.25	0.014	2.12
119	398.1	6042	1.56E-09	0.6767	4	166.66	46.66	207.38	2.56	3.0026E-10	16.99	0.014	2.20
120	308.7	7368	1.48E-09	0.6965	4	164.41	59.74	202.74	2.75	2.8662E-10	19.79	0.015	2.40
121	333	6630	1.46E-09	0.695	4	166.74	59.66	218.07	3.16	3.1787E-10	21.31	0.016	2.57
122	321.4	6311	1.5E-09	0.6958	4	207.62	64.60	223.67	3.54	3.3734E-10	22.55	0.016	2.83
123	286.1	5916	1.69E-09	0.69	4	222.44	74.37	237.63	4.09	4.0666E-10	24.23	0.019	3.12
124	365	5498	1.62E-09	0.6711	4	246.78	67.81	261.82	4.77	4.9513E-10	25.84	0.021	3.34
125	333.1	5123	2.08E-09	0.6973	4	237.2	77.21	271.59	5.30	5.653E-10	27.10	0.022	3.67
126	363.4	4676	2.39E-09	0.6667	4	264.45	72.31	268.66	6.13	6.7644E-10	26.64	0.024	3.84
127	305.3	4601	2.36E-09	0.6621	4	263.33	62.60	266.56	6.59	7.0166E-10	26.92	0.025	4.18
128	366.6	4315	2.63E-09	0.6532	4	315.93	61.72	328.92	7.62	8.166E-10	31.19	0.027	5.26
129	646.5	4469	5.14E-09	0.606	4	437.66	67.73	454.49	10.17	1.7442E-09	33.61	0.032	6.68
130	1083	5124	1.18E-08	0.5462	4	639.46	60.73	695.31	12.66	4.2916E-09	36.06	0.037	6.60
131	1031	5779	1.69E-08	0.5345	4	669.69	57.69	631.81	10.63	5.7705E-09	37.28	0.038	6.60

W/C = 0.60
7 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (g)	R ₂ (g)	G (P)	PH	Type	R ₁ (g) (Error)	R ₂ (g) (Error)	R ₁ (g) (%) Error	R ₂ (g) (%) Error	G (P) (Error)	G (P) (%) Error	PH (Error)	PH (%) Error
1	300.9	134.1	4.77E-10	0.903	4	14.943	16.783	4.15	12.52	5.30E-10	110.99	0.078	7.89
2	308.5	141.1	5.46E-10	0.908	4	15.219	16.903	4.27	12.04	5.61E-10	102.85	0.072	7.46
3	303.4	145	5.82E-10	0.902	4	15.145	16.903	4.29	11.96	5.84E-10	98.61	0.070	7.23
4	303	150.5	5.83E-10	0.906	4	15.54	17.287	4.40	11.49	5.58E-10	95.74	0.068	7.06
5	303.9	155.3	6.28E-10	0.902	4	16.506	18.369	4.66	11.36	6.11E-10	97.18	0.069	7.24
6	306	157.5	5.80E-10	0.905	4	16.187	17.916	4.55	11.38	5.39E-10	92.42	0.068	6.86
7	306.3	161.1	6.28E-10	0.948	4	16.865	18.717	4.74	11.62	5.92E-10	94.21	0.067	7.06
8	305.5	167	6.36E-10	0.945	4	17.862	19.876	5.01	11.90	6.08E-10	95.96	0.068	7.20
9	301.3	171.6	6.60E-10	0.941	4	18.185	20.122	5.03	11.75	6.18E-10	93.41	0.067	7.09
10	302.5	179	6.38E-10	0.941	4	18.623	20.578	5.14	11.69	5.91E-10	92.82	0.066	7.03
11	303.7	181.4	6.38E-10	0.938	4	19.037	20.991	5.23	11.57	5.74E-10	90.51	0.065	6.91
12	308	187.4	6.70E-10	0.934	4	19.987	22.082	5.43	11.79	6.20E-10	92.56	0.068	7.10
13	379.7	204.5	7.72E-10	0.920	4	22.2	24.611	6.69	12.03	7.28E-10	93.95	0.067	7.32
14	369	225.7	7.34E-10	0.918	4	23.261	26.809	5.98	11.44	6.55E-10	89.21	0.064	6.96
15	368.9	268.8	8.47E-10	0.900	4	27.097	30.084	6.63	11.70	7.53E-10	88.90	0.064	7.14
16	410.5	289.1	8.62E-10	0.902	4	29.261	32.5	7.13	11.24	7.32E-10	84.87	0.061	6.89
17	431.8	326.2	8.63E-10	0.893	4	31.707	35.2	7.52	10.75	6.89E-10	79.81	0.058	6.56
18	431.6	370.7	8.80E-10	0.874	4	34.45	38.243	7.96	10.32	6.70E-10	75.65	0.055	6.31
19	440.5	419.8	9.34E-10	0.863	4	36.663	43.37	8.65	10.33	7.03E-10	75.25	0.055	6.37
20	463.5	485.7	1.11E-09	0.845	4	46.871	52.462	10.34	10.80	8.67E-10	78.48	0.057	6.79
21	462.6	589.1	1.21E-09	0.850	4	54.553	61.608	11.30	10.46	9.27E-10	76.77	0.058	6.76
22	525.8	614.6	1.40E-09	0.808	4	77.669	88.363	14.77	10.97	1.15E-09	82.44	0.060	7.46
23	621.8	1274	1.53E-09	0.791	4	110.87	133.27	17.85	10.46	1.29E-09	84.36	0.061	7.77
24	676.4	2418	1.42E-09	0.754	4	191.53	241.92	28.32	10.00	1.20E-09	84.53	0.060	7.99
25	602.1	4481	1.03E-09	0.741	4	241.7	321.27	40.14	7.17	8.52E-10	60.31	0.045	6.02
26	228.7	7925	8.98E-10	0.726	4	296.18	428.73	129.51	5.41	4.25E-10	46.98	0.035	4.79
27													
28													
29	2096	27638	2.58E-09	0.620	4	489.83	767.91	23.81	2.78	7.24E-10	28.03	0.020	3.22
30	2128	34886	1.69E-09	0.646	4	433.56	769.42	20.37	2.21	3.94E-10	23.97	0.017	2.80
31	2309	4747	1.48E-09	0.849	4	462.78	951.85	18.61	2.13	3.40E-10	23.24	0.016	2.46
32	2514	58678	1.11E-09	0.693	4	463.78	1204.3	18.46	2.05	2.46E-10	22.15	0.015	2.30
33	2802	73722	7.50E-10	0.691	4	443.22	1383.7	15.82	1.86	1.86E-10	19.89	0.014	2.00
34	2890	97723	6.89E-10	0.698	4	464.55	1607.7	15.75	1.85	1.27E-10	19.29	0.013	1.90
35	3186	126970	4.75E-10	0.705	4	468.83	2578.1	15.22	2.04	8.97E-11	18.86	0.013	1.81
36	3397	197530	3.54E-10	0.720	4	476.68	3388.2	14.20	2.01	6.04E-11	17.05	0.012	1.80
37	3501	217370	2.91E-10	0.740	4	485.04	4693.5	15.00	2.14	4.18E-11	16.71	0.011	1.52
38	3541	265010	1.85E-10	0.753	4	515.48	6531.9	14.98	2.29	3.15E-11	16.14	0.011	1.45
39	3685	322360	1.59E-10	0.764	4	501.81	8984.1	13.98	2.32	2.26E-11	14.43	0.010	1.28
40	3832	523120	1.12E-10	0.783	4	543.68	13974	14.97	2.66	1.84E-11	14.63	0.010	1.27
41	3707	709940	8.67E-11	0.797	4	528.68	19147	14.21	2.71	1.14E-11	13.10	0.009	1.12
42	3686	667010	6.60E-11	0.812	4	535.86	26089	14.90	2.93	8.22E-12	12.45	0.009	1.05
43	3614	1272600	5.35E-11	0.823	4	519.66	36348	14.36	3.01	6.01E-12	11.23	0.008	0.94
44	3439	1688400	4.15E-11	0.837	4	543.17	57284	15.79	3.40	4.63E-12	11.16	0.008	0.92
45	3433	2280000	3.36E-11	0.849	4	536.35	84081	15.68	3.69	3.46E-12	10.43	0.007	0.85
46	3368	3045100	2.79E-11	0.860	4	540.42	125050	15.95	4.11	2.77E-12	9.94	0.007	0.81
47	3294	4086700	2.32E-11	0.870	4	478.1	164420	14.45	4.04	1.62E-12	8.30	0.006	0.87
48	3414	5425000	2.00E-11	0.878	4	505.46	264600	14.81	4.66	1.69E-12	8.43	0.006	0.86
49	3234	7180900	1.69E-11	0.887	4	489.42	379840	14.48	5.27	1.28E-12	7.56	0.005	0.80
50	2629	8297900	1.38E-11	0.899	4	449.89	537890	15.90	5.79	9.81E-13	7.10	0.005	0.89

W/C = 0.60
7 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PHI	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PHI (Error)	PHI (% Error)
51	2774	1.2E+07	1.21E-11	0.9072	4	432.06	15.56	7.87E+06	6.56	8.05E-13	6.67	0.006	0.52		
52	2836	1.7E+07	1.08E-11	0.9134	4	410.17	14.46	1.30E+06	7.96	6.58E-13	6.12	0.004	0.46		
53	2712	2.0E+07	9.48E-12	0.9209	4	399.8	14.74	2.51E+06	10.23	5.52E-13	5.84	0.004	0.45		
54	2607	3.3E+07	8.61E-12	0.9261	4	422.31	16.20	4.59E+06	13.80	5.25E-13	6.10	0.004	0.47		
55	2606	4.5E+07	7.84E-12	0.9337	4	384.27	14.75	7.03E+06	15.76	4.11E-13	5.46	0.004	0.42		
56	2263	5.6E+07	7.04E-12	0.9371	4	369	16.31	1.12E+07	19.07	3.64E-13	5.17	0.004	0.39		
57	2326	6.6E+07	6.61E-12	0.941	4	362.55	16.45	1.43E+07	21.72	3.55E-13	5.37	0.004	0.41		
58	2280	1.5E+08	6.1E-12	0.9451	4	375.46	16.47	6.89E+07	44.62	3.14E-13	5.15	0.004	0.39		
59	2136	1.2E+08	5.82E-12	0.9489	4	360.74	16.89	3.63E+07	33.03	2.77E-13	4.93	0.004	0.37		
60	2679	3.2E+08	5.69E-12	0.9493	4	408.76	15.26	3.29E+08	101.26	3.14E-13	5.52	0.004	0.42		
61	2466	1.1E+08	5.4E-12	0.9523	4	399.76	16.06	3.84E+07	34.56	2.69E-13	5.47	0.004	0.41		
62	2306	2.7E+08	5.26E-12	0.9539	4	366.76	16.76	2.24E+08	81.61	2.79E-13	5.29	0.004	0.40		
63	2183	3.4E+08	5.48E-12	0.9513	4	382.33	17.89	3.56E+08	104.19	2.93E-13	5.35	0.004	0.40		
64	2365	2.6E+08	5.43E-12	0.9519	4	362.46	16.67	1.95E+08	76.97	2.62E-13	5.36	0.004	0.40		
65	2109	2.1E+08	5.24E-12	0.9544	4	397.4	16.85	1.42E+08	66.06	2.69E-13	5.45	0.004	0.41		
66	2775	4.8E+08	5.62E-12	0.9473	4	363.93	13.64	7.03E+08	145.37	3.03E-13	5.21	0.004	0.39		
67	2494	6.6E+08	5.61E-12	0.95	4	411.83	16.56	1.36E+09	211.35	3.17E-13	5.64	0.004	0.43		
68	2646	2.3E+09	5.64E-12	0.9494	4	398.16	14.46	1.56E+09	66.90	2.63E-13	5.01	0.004	0.38		
70															
71															
72															
73															
74															
75	2771	7.4E+07	7.01E-12	0.9372	4	350.53	12.85	8.40E+06	11.31	2.66E-13	4.21	0.003	0.33		
76	2853	8.9E+07	7.8E-12	0.9309	4	429.3	15.05	1.53E+07	17.14	4.04E-13	5.16	0.004	0.41		
77	2945	4.9E+07	6.43E-12	0.9267	4	401.36	14.11	4.22E+06	9.10	4.17E-13	4.94	0.004	0.39		
78	2715	3.4E+07	6.46E-12	0.92	4	410.11	15.11	2.46E+06	7.26	4.66E-13	5.14	0.004	0.41		
79	3029	2.8E+07	1.03E-11	0.9137	4	420	13.67	1.79E+06	6.46	5.89E-13	5.33	0.004	0.42		
80	3502	2.3E+07	1.25E-11	0.903	4	442.46	12.84	1.40E+06	6.12	7.03E-13	5.64	0.004	0.46		
81	3422	1.6E+07	1.39E-11	0.8973	4	498.57	14.26	8.44E+05	5.33	9.00E-13	6.46	0.005	0.52		
82	3511	1.2E+07	1.5E-11	0.8933	4	514.26	14.65	5.77E+05	4.91	1.09E-12	7.09	0.005	0.57		
83	3376	9126400	1.69E-11	0.8965	4	512.3	15.17	3.84E+05	4.20	1.24E-12	7.34	0.005	0.60		
84	3603	7189100	2E-11	0.8765	4	577.65	15.19	3.07E+05	4.27	1.71E-12	8.51	0.006	0.70		
85	3602	6189600	2.24E-11	0.8701	4	539.13	13.54	1.60E+05	3.49	1.87E-12	8.33	0.006	0.66		
86	4440	3697400	2.7E-11	0.8598	4	527.39	11.98	1.26E+05	3.13	2.26E-12	8.42	0.006	0.69		
87	4413	3120300	3.14E-11	0.8505	4	535.66	12.14	9.28E+04	2.97	2.62E-12	8.69	0.006	0.74		
88	4439	2360300	3.46E-11	0.846	4	556.11	12.54	6.79E+04	2.89	3.44E-12	9.97	0.007	0.82		
89	4115	1831800	4.04E-11	0.8378	4	594.36	14.20	5.21E+04	2.84	4.49E-12	11.12	0.008	0.82		
90	4302	1416900	4.7E-11	0.829	4	602.06	13.14	3.69E+04	2.53	5.20E-12	11.06	0.008	0.92		
91	4374	1098900	5.89E-11	0.8168	4	642.86	12.41	2.61E+04	2.37	6.52E-12	11.51	0.008	0.97		
92	4332	854640	6.73E-11	0.8091	4	612.91	11.64	1.53E+04	2.14	7.73E-12	11.49	0.008	0.97		
93	4163	653400	7.85E-11	0.8002	4	485.64	11.91	1.27E+04	1.94	9.24E-12	11.63	0.008	0.99		
94	4007	603220	9.39E-11	0.7915	4	460.04	12.23	9.46E+03	1.86	1.19E-11	12.57	0.009	1.06		
95	3965	384630	1.14E-10	0.7812	4	471.02	11.82	6.74E+03	1.75	1.49E-11	12.99	0.009	1.13		
96	4144	264520	1.48E-10	0.7691	4	439.03	10.59	4.60E+03	1.59	1.89E-11	12.79	0.009	1.13		
97	3965	223620	1.66E-10	0.7544	4	420.82	10.80	3.28E+03	1.46	2.46E-11	13.22	0.009	1.16		
98	3679	166900	2.13E-10	0.7487	4	424.06	11.85	2.46E+03	1.46	3.11E-11	14.60	0.010	1.31		
99	3713	127460	2.83E-10	0.7325	4	371.65	10.01	1.58E+03	1.25	3.84E-11	13.96	0.009	1.25		
100	3271	84468	3.35E-10	0.7252	4	359.42	10.06	1.15E+03	1.22	4.63E-11	14.40	0.010	1.34		

W/C = 0.60
7 Days of Hydration
Pore Solution: 10% Salt

Phi No.	R_1 (g)	R_2 (g)	C (P)	PN	Type	R_1 (g) (Error)	R_2 (g) (% Error)	R_2 (g) (Error)	R_2 (g) (% Error)	C (P) (Error)	C (P) (% Error)	PH (Error)	PH (% Error)
101	3148	68338	4E-10	0.7188	4	334.07	10.82	809.54	1.17	5.8898E-11	14.68	0.010	1.39
102	2786	49151	4.83E-10	0.7107	4	287.81	10.26	536.38	1.09	6.4138E-11	13.86	0.009	1.33
103	1917	33104	3.88E-10	0.726	4	263.15	13.73	383.19	1.19	5.8944E-11	15.02	0.010	1.42
104	1480	22804	3.81E-10	0.7351	4	228.88	15.86	288.8	1.32	5.8488E-11	15.37	0.011	1.46
105	1030	16437	4.81E-10	0.7271	4	207.57	20.15	248.49	1.91	7.4118E-11	16.42	0.011	1.51
106	788.7	12884	4.87E-10	0.731	4	192.02	25.31	219.3	1.75	7.9548E-11	16.00	0.012	1.59
107	420	8824	4.88E-10	0.742	4	188.55	48.13	206.15	2.20	8.4121E-11	18.07	0.013	1.80
108	185.3	7128	3.84E-10	0.7885	4	183.88	69.23	197.63	2.77	8.0385E-11	20.40	0.015	2.02
109	77.14	5116	3.18E-10	0.7839	4	175.18	227.09	184.95	3.61	7.8873E-11	24.20	0.018	2.35
110	237	3687	2.34E-10	0.8141	4	176.84	74.62	183.98	5.13	7.2184E-11	30.81	0.024	2.93
111	364	2400	1.73E-10	0.8485	4	152.01	39.59	158.78	6.53	6.3538E-11	36.88	0.029	3.38
112	440.4	1812	1.88E-10	0.8839	4	118.07	26.81	121.2	7.52	7.5308E-11	39.83	0.032	3.65
113	447.4	1137	3.43E-10	0.8484	4	86.359	19.30	88.638	7.80	1.3788E-10	40.14	0.032	3.77
114	385.7	823.3	6.91E-10	0.8184	4	90.518	23.47	92.839	10.08	3.303E-10	47.81	0.039	4.78
115	283.2	822.3	1.51E-09	0.7723	4	115.25	30.31	117.81	14.33	8.4027E-10	55.65	0.046	6.27
116	181	801.8	3.88E-09	0.7108	4	165.32	91.34	168.27	20.88	2.1825E-09	58.13	0.058	8.09
117	114.5	1024	1.59E-09	0.5872	4	413.25	380.82	417.58	40.78	7.2828E-09	47.17	0.087	11.34
118	837.3	1787	2.22E-09	0.4875	4	914.04	203.63	918.49	70.14	1.5743E-08	57.61	0.074	14.18
119	2341	3138	1.15E-08	0.4517	4	2087.5	220.58	2073.7	117.36	2.8588E-08	128.88	0.080	18.38
120	8087	8632	2.05E-08	0.4253	4	8149	348.10	8158	258.81	4.587E-08	388.80	0.086	18.97
121	23873	24807	3.08E-10	0.4116	4	77791	864.31	77799	880.88	3.3943E-08	1888.85	0.091	21.44
122	53312	54018	6.78E-11	0.404	4	683700	2805.79	683710	2818.16	1.7428E-08	5852.84	0.098	23.28
124	113870	114840	1.85E-11	0.3852	4	3788800	7125.80	3788800	7032.73	9.574E-09	14102.85	0.089	24.58
126	223830	224480	4.55E-12	0.3884	4	18554000	17157.15	18554000	17058.87	5.7268E-09	34805.52	0.108	28.72
128	402830	403480	1.81E-12	0.3778	4	88257000	39430.37	88257000	38018.20	3.8478E-09	80189.05	0.115	29.67
127	80810	807420	1.11E-12	0.3688	4	445880000	110889.37	445880000	110818.53	3.631E-09	228822.50	0.164	43.38
128	584040	584850	1.38E-12	0.3408	4	288030000	58831.85	288030000	58763.63	1.2587E-09	113427.05	0.072	19.45
128	863830	864640	1.38E-12	0.3288	4	418800000	71384.88	418800000	71280.52	1.9887E-09	142473.00	0.081	23.88
130	788570	787180	1.72E-12	0.3015	4	227840000	34386.75	227840000	34255.27	8.4748E-10	88472.80	0.042	12.92
131	845340	845010	1.82E-12	0.2823	4	77832000	10188.83	77832000	10180.72	3.4871E-10	20310.72	0.032	10.57
						115880000	12247.71	115880000	12239.02	4.4858E-10	24485.19	0.030	10.60

W/C = 0.60
28 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
1	334.5	248.6	3.77E-09	0.817	4	28.984	8.07	28.391	11.92	3.08E-09	82.08	0.081	7.52
2	339.8	266.3	3.13E-09	0.824	4	28.269	7.73	28.503	11.12	2.39E-09	75.84	0.057	6.90
3	339.4	268.8	3.41E-09	0.815	4	28.188	8.30	30.513	11.44	2.80E-09	76.17	0.057	7.04
4	342.8	274.7	3.44E-09	0.813	4	29.016	8.46	31.449	11.45	2.82E-09	76.01	0.057	7.05
5	345.1	282	3.39E-09	0.812	4	29.554	8.56	31.99	11.34	2.80E-09	74.58	0.056	6.94
6	346.5	286.2	3.13E-09	0.816	4	29.477	8.43	31.869	11.16	2.30E-09	73.63	0.056	6.81
7	351.9	286.4	3.17E-09	0.813	4	30.575	8.69	33.07	11.19	2.32E-09	73.28	0.056	6.82
8	355.4	303.9	3.18E-09	0.811	4	31.32	8.81	33.882	11.15	2.31E-09	72.78	0.056	6.79
9	357.8	311.1	3.12E-09	0.810	4	32.081	8.66	34.658	11.14	2.28E-09	72.29	0.056	6.78
10	358.6	318.6	3.04E-09	0.809	4	32.362	8.02	34.823	10.95	2.13E-09	70.15	0.053	6.59
11	360.9	325.6	3.00E-09	0.808	4	32.977	9.14	36.572	10.93	2.08E-09	69.64	0.053	6.55
12	362.2	337.4	3.48E-09	0.798	4	35.659	10.93	38.668	11.52	2.85E-09	72.94	0.056	6.97
13	367.2	365.9	3.62E-09	0.791	4	39.089	10.65	42.305	11.98	2.84E-09	72.82	0.056	7.04
14	373.8	397.8	3.61E-09	0.783	4	42.408	11.35	45.971	11.96	2.78E-09	72.41	0.055	7.08
15	378.4	444.7	4.30E-09	0.789	4	48.121	12.68	52.299	11.78	3.16E-09	72.63	0.056	7.26
16	385.1	482.9	3.88E-09	0.788	4	50.058	13.01	54.375	11.03	2.83E-09	67.63	0.052	6.78
17	393.6	551.2	3.62E-09	0.788	4	52.518	13.34	57.077	10.36	2.31E-09	63.69	0.049	6.40
18	400.9	606.3	3.59E-09	0.781	4	55.468	13.85	60.434	9.97	2.20E-09	61.46	0.047	6.21
19	404.7	688.5	3.70E-09	0.754	4	60.218	14.88	65.745	9.63	2.25E-09	60.67	0.047	6.20
20	408.4	743.8	3.75E-09	0.747	4	64.261	15.81	70.274	9.45	2.16E-09	58.00	0.046	5.99
21	413.6	860	4.75E-09	0.727	4	82.002	19.83	90.991	10.22	3.07E-09	64.87	0.050	6.85
22	412.1	1160	4.81E-09	0.714	4	98.775	23.97	111.42	9.61	3.08E-09	63.88	0.046	6.79
23	410.8	1538	4.33E-09	0.707	4	111.67	27.20	128.07	8.33	2.50E-09	57.75	0.044	6.16
24	435.1	2098	4.80E-09	0.693	4	135.85	31.22	162.21	7.73	2.88E-09	59.25	0.043	6.24
25	431.3	3047	4.17E-09	0.683	4	165.17	36.30	208.82	6.78	2.28E-09	54.80	0.040	5.86
26	382.2	4891	3.84E-09	0.671	4	205.27	53.71	271.49	5.91	1.93E-09	50.26	0.038	5.41
27	285.3	7020	3.48E-09	0.660	4	248.32	82.85	362.47	8.02	1.55E-09	44.72	0.032	4.83
28	7.689	10597	3.06E-09	0.651	4	287.08	3873.78	489.59	4.43	1.28E-09	40.78	0.029	4.41
29	298.3	15999	2.33E-09	0.654	4	324.48	126.13	597.25	3.73	8.30E-10	35.54	0.025	3.77
30	685.8	23280	1.78E-09	0.680	4	326.16	50.19	721.91	3.10	8.16E-10	29.64	0.020	3.07
31	634.3	32664	1.28E-09	0.670	4	334.3	36.78	918.42	2.79	3.34E-10	25.91	0.018	2.62
32	1495	46199	1.01E-09	0.677	4	343.88	23.47	1185.6	2.62	2.38E-10	23.11	0.016	2.29
33	1628	60797	7.91E-10	0.686	4	354.04	19.39	1594.8	2.61	1.82E-10	21.30	0.014	2.08
34													
35	2337	102980	4.28E-10	0.714	4	344.58	14.74	2815.5	2.54	7.48E-11	17.35	0.011	1.81
36	2520	135200	3.14E-10	0.730	4	365.28	14.10	3590.9	2.69	5.20E-11	16.57	0.011	1.50
37	2710	173270	2.28E-10	0.748	4	385.15	13.47	4993.8	2.88	3.80E-11	15.79	0.010	1.39
38	2898	226280	1.78E-10	0.768	4	400.11	13.99	7641.2	3.35	2.82E-11	18.01	0.011	1.39
39	2898	286830	1.18E-10	0.780	4	380.47	13.62	10298	3.47	1.74E-11	14.62	0.010	1.23
40	2978	389270	8.77E-11	0.798	4	383.32	12.88	14828	3.67	1.17E-11	13.31	0.009	1.10
41	3966	603940	1.08E-10	0.779	4	526.39	13.25	16323	2.80	1.40E-11	12.83	0.009	1.12
42	4145	875410	8.32E-11	0.763	4	526.18	12.77	25969	2.86	9.80E-12	11.90	0.008	1.02
43	4198	1164700	6.30E-11	0.808	4	548.82	13.21	37885	3.26	7.28E-12	11.55	0.008	0.98
44	4083	1547800	4.87E-11	0.823	4	536.82	13.20	53485	3.45	5.20E-12	10.67	0.007	0.89
45	4048	2082700	3.73E-11	0.837	4	533.59	13.18	78367	3.74	3.71E-12	9.85	0.007	0.82
46	3832	2788400	3.01E-11	0.848	4	537.51	13.67	114890	4.16	2.88E-12	9.52	0.007	0.78
47	3682	3756800	2.37E-11	0.863	4	551.12	14.27	181130	4.88	2.20E-12	9.28	0.006	0.75
48	3715	4899300	1.94E-11	0.873	4	497.75	13.40	238980	4.88	1.59E-12	8.02	0.006	0.64
49	3740	6884300	1.81E-11	0.884	4	516.74	13.67	400380	5.99	1.29E-12	6.04	0.006	0.64
50	3849	8992400	1.34E-11	0.894	4	501.05	13.73	599140	6.62	1.01E-12	7.52	0.005	0.59

W/O = 0.60
28 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
51	3053	1.1E+07	1.13E-11	0.9036	4	476.16	13.36	8.32E+05	7.40	7.66E-13	0.96	0.005	0.54
52	3222	1.5E+07	9.43E-12	0.9142	4	476.21	14.34	1.35E+06	8.92	6.43E-13	0.82	0.005	0.53
53	3276	2.3E+07	8.46E-12	0.9163	4	483.9	13.86	2.69E+06	11.78	5.34E-13	0.28	0.004	0.48
54	3298	2.5E+07	7.18E-12	0.9283	4	433.53	13.31	3.02E+06	11.79	4.25E-13	5.93	0.004	0.45
55	3430	3.8E+07	6.73E-12	0.9321	4	484.16	14.12	7.28E+06	18.76	4.36E-13	6.49	0.005	0.48
56	3268	4.4E+07	5.87E-12	0.9401	4	479.67	14.86	8.81E+06	20.08	3.74E-13	6.37	0.005	0.48
57	2953	5.2E+07	5.27E-12	0.9481	4	484.16	15.72	1.13E+07	21.79	3.21E-13	8.09	0.004	0.46
58	3214	8.0E+07	4.86E-12	0.9547	4	480.43	14.86	2.67E+07	36.09	3.02E-13	8.21	0.004	0.46
59	3238	1.2E+08	4.48E-12	0.9647	4	489.36	15.11	5.77E+07	48.22	2.78E-13	8.23	0.004	0.46
60	3348	8.3E+07	4.48E-12	0.9648	4	488.31	14.53	3.42E+07	38.86	2.78E-13	8.20	0.004	0.46
61	3226	1.4E+08	4.34E-12	0.966	4	477.63	14.81	7.22E+07	52.82	2.82E-13	6.03	0.004	0.46
62	3291	1.8E+08	4.28E-12	0.9673	4	489.42	14.87	1.29E+08	70.44	2.88E-13	6.22	0.004	0.46
63	3118	8.8E+07	4.23E-12	0.9683	4	478.89	15.36	3.02E+07	34.12	2.88E-13	6.13	0.004	0.45
64	3040	1.1E+08	4.3E-12	0.967	4	463.31	15.24	4.59E+07	41.28	2.83E-13	5.89	0.004	0.44
65	3362	3E+08	4.44E-12	0.9648	4	511.14	15.07	3.77E+08	124.78	2.88E-13	6.50	0.005	0.48
66	3184	1.2E+08	4.2E-12	0.9684	4	521.33	16.32	6.53E+07	52.33	2.78E-13	6.82	0.005	0.48
67	3087	1.4E+08	4.3E-12	0.9572	4	477.97	15.58	7.94E+07	55.53	2.63E-13	6.11	0.004	0.45
68	3120	2E+08	4.34E-12	0.9581	4	453.73	14.54	1.49E+08	71.38	2.48E-13	5.74	0.004	0.42
69	3329	9.1E+07	4.41E-12	0.965	4	443.32	13.32	2.98E+07	32.85	2.47E-13	5.80	0.004	0.41
70	3108	1.1E+08	4.32E-12	0.9685	4	469.33	14.36	4.30E+07	39.80	2.50E-13	5.80	0.004	0.43
71	3308	8.8E+07	4.34E-12	0.9684	4	474.81	14.36	3.05E+07	34.22	2.62E-13	6.02	0.004	0.45
72	3208	8.1E+07	4.88E-12	0.9623	4	434.87	13.85	2.40E+07	29.50	2.88E-13	5.85	0.004	0.41
73	3297	7.7E+07	5.01E-12	0.9483	4	454.15	13.77	2.32E+07	30.15	2.82E-13	5.83	0.004	0.44
74	3470	5.5E+07	5.48E-12	0.9437	4	471.33	13.68	1.31E+07	23.67	3.36E-13	6.16	0.004	0.46
75	3488	4.7E+07	5.88E-12	0.9384	4	470.28	13.48	8.79E+06	20.84	3.71E-13	6.20	0.004	0.47
76	3980	3.4E+07	6.43E-12	0.9344	4	465.63	12.80	5.18E+06	15.19	3.88E-13	6.07	0.004	0.48
77	3676	2.8E+07	7.18E-12	0.9281	4	430.23	11.70	3.11E+06	9.86	4.15E-13	5.77	0.004	0.44
78	3888	2.1E+07	7.94E-12	0.9228	4	436.93	11.82	2.08E+06	8.86	4.75E-13	5.98	0.004	0.46
79	3838	1.8E+07	8.88E-12	0.9185	4	431.39	12.19	1.27E+06	8.07	5.38E-13	6.03	0.004	0.48
80	3985	1.3E+07	9.88E-12	0.91	4	448.51	12.82	9.70E+05	7.41	6.30E-13	6.36	0.004	0.49
81	3741	9239300	1.15E-11	0.9211	4	445.03	11.80	8.11E+05	6.15	7.44E-13	6.47	0.005	0.50
82	3920	8018800	1.39E-11	0.9235	4	468.86	11.73	4.51E+05	5.63	9.27E-13	6.84	0.005	0.54
83	4139	6284600	1.58E-11	0.8834	4	468.71	12.05	3.38E+05	5.34	1.22E-12	7.84	0.005	0.61
84	4134	4773300	1.81E-11	0.8787	4	520.51	12.59	2.28E+05	4.81	1.80E-12	8.31	0.005	0.66
85	4119	3730300	2.18E-11	0.8652	4	508.22	12.34	1.57E+05	4.20	1.82E-12	8.37	0.005	0.67
86	4187	2682700	2.58E-11	0.8689	4	528.99	12.59	1.12E+05	3.92	2.38E-12	9.12	0.005	0.74
87	4258	2207800	3.1E-11	0.8487	4	518.36	12.20	7.75E+04	3.60	2.82E-12	9.40	0.005	0.77
88	4348	1713800	3.73E-11	0.8353	4	533.8	12.28	5.63E+04	3.29	3.78E-12	10.12	0.007	0.83
89	4329	1301800	4.5E-11	0.8253	4	534.02	12.34	3.98E+04	3.04	4.88E-12	10.77	0.007	0.89
90	4419	991800	5.8E-11	0.8143	4	529.82	11.99	2.79E+04	2.81	6.38E-12	11.36	0.008	0.95
91	4700	746310	7.27E-11	0.7888	4	502.07	10.66	1.87E+04	2.49	8.30E-12	11.40	0.008	0.97
92	4359	590230	8.94E-11	0.7882	4	481.55	11.41	1.30E+04	2.32	1.08E-11	12.09	0.008	1.04
93	4345	421830	1.17E-10	0.7665	4	468.8	10.81	8.89E+03	2.10	1.48E-11	12.37	0.008	1.08
94	4487	320370	1.61E-10	0.7665	4	453.15	9.65	5.92E+03	1.85	1.88E-11	12.14	0.008	1.06
95	4235	242340	1.98E-10	0.748	4	441.25	10.42	4.43E+03	1.83	2.88E-11	13.47	0.009	1.21
96	4107	184180	2.87E-10	0.7304	4	415.19	10.11	3.08E+03	1.68	3.84E-11	13.62	0.009	1.25
97	3985	140380	3.61E-10	0.7182	4	417.18	10.47	2.32E+03	1.66	5.18E-11	14.77	0.010	1.39
98	3714	108820	4.54E-10	0.7038	4	411.86	11.09	1.74E+03	1.63	7.16E-11	15.78	0.011	1.51
99	3700	80065	6.97E-10	0.6833	4	400.41	10.82	1.28E+03	1.59	1.08E-10	16.37	0.011	1.63
100	3248	60381	8.3E-10	0.6731	4	400.58	12.33	1.01E+03	1.67	1.48E-10	17.84	0.012	1.82

W/C = 0.60
28 Days of Hydration
Pore Solution: 10% Salt

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
101	2708	44217	0.05E-10	0.0004	4	379.07	14.00	763.06	1.73	1.814E-10	18.99	0.013	1.98
102	2315	32302	1.09E-09	0.0009	4	347.37	15.01	578.36	1.79	2.1181E-10	19.37	0.014	2.03
103	1824	23380	1.09E-09	0.0744	4	299.08	18.42	434.83	1.86	2.1164E-10	19.58	0.014	2.05
104	1346	17851	1.36E-09	0.005	4	284.46	21.13	378.54	2.11	2.7934E-10	20.30	0.016	2.19
105	1141	14072	1.51E-09	0.0044	4	260.64	24.80	348.27	2.47	3.3035E-10	21.91	0.016	2.40
106	829.6	11047	1.85E-09	0.0094	4	264.82	31.93	313.86	2.84	3.8897E-10	23.22	0.017	2.57
107	655.6	8736	1.95E-09	0.0743	4	250.81	34.26	285.82	3.27	3.7865E-10	24.20	0.018	2.71
108	314	6677	1.41E-09	0.0024	4	216.39	68.91	240.21	3.65	3.5762E-10	25.26	0.019	2.80
109	85.87	4683	1.16E-09	0.7121	4	187.07	127.85	202.89	4.09	3.0806E-10	26.35	0.020	2.86
110	116.2	3643	6.77E-10	0.7413	4	154.99	133.36	165.5	4.54	2.4499E-10	27.89	0.022	2.93
111	256.4	2896	6.34E-10	0.7748	4	128.88	49.80	135.5	5.22	1.9228E-10	30.32	0.024	3.07
112	386.6	1787	4.71E-10	0.8117	4	100.36	25.98	104.85	5.93	1.6035E-10	34.03	0.027	3.28
113	416.4	1213	4.5E-10	0.8333	4	79.223	18.93	82.267	6.78	1.6883E-10	37.48	0.029	3.53
114	408.2	889.8	6.36E-10	0.8298	4	63.219	15.86	65.431	7.52	2.5144E-10	39.36	0.031	3.78
115	379	665.2	1.23E-09	0.805	4	56.046	14.79	58.029	8.47	5.2103E-10	42.39	0.034	4.25
116	308.6	646.4	4.21E-09	0.73	4	78.857	24.82	79.407	12.26	2.0798E-09	42.37	0.043	5.86
117	302.2	590.3	5.52E-09	0.7137	4	80.836	26.75	83.537	13.94	3.1806E-09	53.86	0.047	6.63
118	287	571.4	7.29E-09	0.7019	4	86.003	29.97	88.724	15.53	4.0898E-09	56.07	0.050	7.17
119	288.2	517.4	6.72E-09	0.7137	4	78.677	26.30	81.187	15.89	3.9818E-09	58.95	0.052	7.31
120	275.6	505.3	9.46E-09	0.6915	4	88.675	32.22	91.543	18.12	5.6223E-09	61.33	0.056	8.14
121	269.3	479.4	1.12E-09	0.6839	4	91.202	33.87	93.87	19.58	7.1054E-09	63.69	0.059	8.68
122	258.1	461.3	1.34E-09	0.6735	4	95.844	37.17	98.627	21.36	8.721E-09	65.30	0.062	9.22
123	248.2	444.3	1.59E-09	0.664	4	100.73	40.58	103.46	23.28	1.0873E-08	67.40	0.065	9.65
124	231	437.3	2E-09	0.648	4	110.97	48.04	113.77	26.02	1.3994E-08	67.96	0.069	10.57
125	218.7	427.3	2.39E-09	0.6397	4	119.15	54.48	122.02	28.86	1.6964E-08	69.33	0.072	11.30
126	200	426.1	3.06E-09	0.6186	4	134.2	67.10	137.21	32.20	2.1188E-08	69.09	0.075	12.19
127	101.6	517.7	6.69E-09	0.5474	4	243.54	239.70	247.89	47.84	4.0297E-08	60.48	0.084	15.30
128	66.12	550.5	8.2E-09	0.5278	4	290.78	438.86	295.45	53.19	4.7821E-08	59.32	0.088	16.34
129	54.48	684.2	1.21E-07	0.4788	4	463.27	935.79	469.47	71.95	6.8411E-08	56.51	0.092	18.10
130	322.3	1009	1.72E-07	0.4218	4	1082.7	335.93	1082.4	108.27	1.5843E-07	90.56	0.099	23.96
131	101.7	846.7	1.43E-07	0.4642	4	544.37	535.27	553.02	65.39	7.6442E-08	53.36	0.090	18.28
132	13.38	813.2	1.19E-07	0.4835	4	358.38	2678.33	367.11	45.14	6.9895E-08	59.84	0.092	16.64
133	24.19	884.6	7.28E-08	0.5211	4	319.81	1522.08	328.17	38.68	4.2278E-08	59.23	0.074	14.16
134	77.44	948.4	4.65E-08	0.5523	4	256.3	330.97	264.37	27.93	2.7522E-08	59.45	0.069	11.98
135	118.2	1023	3.09E-08	0.579	4	217.39	183.82	225.35	22.03	1.7887E-08	58.45	0.059	10.27
136	180.4	1118	2.09E-08	0.6019	4	190.62	128.88	198.73	17.81	1.189E-08	55.97	0.053	8.89

W/C = 0.35
7 Days of Hydration
Pore Solution: 15% Salt Solution

File No.	R ₁ (D)	R ₂ (D)	C (F)	Phi	Type	R ₁ (D) (Error)	R ₁ (D) (% Error)	R ₂ (D) (Error)	R ₂ (D) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	438.6	1334	2.30E-09	0.734	4	122.16	27.65	130.15	9.78	1.25E-09	52.33	0.042	5.71
2	483.3	1436	1.70E-09	0.746	4	113.18	24.97	120.76	8.41	8.29E-10	47.13	0.037	4.96
3	483.6	1516	1.40E-09	0.755	4	109.97	24.30	117.33	7.74	9.57E-10	44.06	0.035	4.59
4	482.3	1573	1.42E-09	0.757	4	108.85	23.55	116.33	7.40	9.07E-10	42.85	0.034	4.44
5	475.2	1614	1.24E-09	0.764	4	103.93	21.87	111.24	6.89	5.10E-10	41.01	0.032	4.18
6	468.2	1680	1.20E-09	0.761	4	107.53	23.47	115.15	6.81	5.05E-10	40.40	0.031	4.13
7	460.1	1736	1.22E-09	0.762	4	109.86	23.86	117.63	6.79	4.97E-10	40.84	0.032	4.16
8	447.3	1800	1.19E-09	0.761	4	112.82	25.22	121.05	6.73	4.82E-10	40.54	0.031	4.13
9	461.8	1855	1.14E-09	0.763	4	110.81	24.53	119.1	6.42	4.47E-10	39.30	0.030	3.98
10	463.4	1913	1.10E-09	0.765	4	110.03	23.74	118.65	6.20	4.29E-10	38.04	0.030	3.92
11	462.5	1978	1.06E-09	0.766	4	110.25	23.84	119.15	6.03	4.06E-10	36.80	0.030	3.86
12	472.8	2048	1.03E-09	0.767	4	108.69	23.25	119.23	5.82	3.89E-10	36.29	0.029	3.80
13	483.2	2175	1.00E-09	0.763	4	114.24	23.64	125.04	5.75	4.31E-10	36.51	0.030	3.91
14	512.5	2338	1.06E-09	0.765	4	108.69	21.21	120.23	5.14	3.66E-10	37.36	0.028	3.65
15	509.7	2365	1.00E-09	0.762	4	111.26	21.83	124.2	4.84	3.87E-10	36.36	0.027	3.64
16	502.8	2399	1.00E-09	0.759	4	111.24	22.12	125.54	4.59	3.64E-10	36.36	0.025	3.53
17	526.7	3191	1.03E-09	0.759	4	106.27	20.06	121.85	3.82	3.24E-10	31.44	0.023	3.03
18	482.1	3067	1.14E-09	0.747	4	111.06	22.57	128.81	3.61	3.42E-10	30.00	0.022	2.93
19	482.1	3036	1.11E-09	0.745	4	108.69	22.27	128.87	3.27	3.13E-10	28.12	0.020	2.73
20	473.4	4071	1.10E-09	0.738	4	114.13	24.11	136.72	3.11	3.25E-10	27.43	0.020	2.86
21	431.8	4973	1.10E-09	0.733	4	110.71	25.64	134.81	2.71	2.91E-10	24.47	0.018	2.40
22	409.7	5533	1.10E-09	0.730	4	111.94	27.32	139	2.51	2.77E-10	23.30	0.017	2.28
23	396	6242	1.30E-09	0.718	4	126.01	34.24	161.18	2.56	3.37E-10	24.43	0.017	2.42
24	289.5	7024	1.42E-09	0.711	4	125.44	46.55	163.35	2.33	3.16E-10	22.16	0.016	2.22
25	212	8576	1.59E-09	0.698	4	177.93	63.93	242.59	2.83	4.35E-10	27.61	0.020	2.80
26	116.4	10830	1.53E-09	0.693	4	187.93	171.52	285.7	2.71	4.18E-10	27.27	0.019	2.77
27	192.2	13769	1.60E-09	0.691	4	254.07	180.60	368.33	2.87	4.70E-10	29.37	0.021	3.01
28	362.3	18121	1.30E-09	0.693	4	313.58	66.55	542.11	2.99	4.20E-10	31.43	0.022	3.18
29	549.9	24136	1.02E-09	0.693	4	352.1	64.03	697.51	2.89	3.10E-10	31.02	0.021	3.07
30	795.2	31690	6.97E-10	0.710	4	399.23	51.54	908.48	2.83	2.14E-10	30.70	0.021	2.83
31	1028	43184	6.21E-10	0.711	4	478.95	48.88	1401	3.24	2.08E-10	33.82	0.023	3.17
32	1326	53233	4.10E-10	0.730	4	512.48	38.65	1787	3.40	1.34E-10	32.30	0.022	2.86
33	1510	70390	3.41E-10	0.736	4	556.73	38.87	2379.8	3.40	1.10E-10	32.25	0.022	2.82
34	1763	86509	2.62E-10	0.750	4	619.52	34.75	3284.6	3.67	8.57E-11	32.89	0.022	2.80
35	2072	116720	2.13E-10	0.758	4	697.72	33.67	4915.7	4.13	7.19E-11	33.83	0.022	2.84
36	2343	152020	1.63E-10	0.771	4	751.94	32.09	6787.6	4.45	5.37E-11	32.94	0.022	2.84
37	2517	194960	1.30E-10	0.782	4	816.66	32.33	9632.8	4.96	4.32E-11	33.19	0.022	2.82
38	2768	246250	1.02E-10	0.794	4	869.66	32.23	13924	5.89	3.46E-11	33.74	0.022	2.83
39	2935	326930	8.03E-11	0.808	4	936.46	32.31	20115	6.11	2.61E-11	32.49	0.022	2.89
40	3007	411010	6.24E-11	0.819	4	987.24	32.83	27393	6.86	2.01E-11	32.15	0.021	2.82
41	3167	523780	5.00E-11	0.830	4	1046.1	33.03	36070	7.46	1.60E-11	31.99	0.021	2.89
42	3187	698340	3.98E-11	0.842	4	1058.3	33.14	53753	8.04	1.21E-11	30.42	0.020	2.42
43	3260	869050	3.19E-11	0.854	4	1091.6	33.48	76942	8.65	9.49E-12	29.69	0.020	2.34
44	3277	1066000	2.54E-11	0.866	4	1155.5	35.26	111220	10.21	7.59E-12	29.83	0.020	2.32
45	3253	1362200	2.02E-11	0.879	4	1139.8	35.03	162290	11.02	5.89E-12	28.08	0.019	2.16
46	3151	1784400	1.62E-11	0.891	4	1169.3	36.69	217980	12.35	4.41E-12	27.24	0.018	2.07
47	3029	2251800	1.30E-11	0.903	4	1169.3	36.69	316190	14.04	3.46E-12	26.81	0.018	2.00
48	3081	2824400	1.08E-11	0.914	4	1163.8	37.77	441970	15.65	2.72E-12	25.99	0.017	1.80
49	2936	3469700	8.81E-12	0.925	4	1165	39.66	616970	17.63	2.20E-12	24.99	0.017	1.84
50	2630	4246700	7.50E-12	0.933	4	1177.9	41.62	839390	19.77	1.84E-12	24.56	0.017	1.79

W/C = 0.36
7 Days of Hydration
Pore Solution; 10% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₃ (Q) (Error)	R ₃ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
51	2697	5086000	6.27E-12	0.9436	4	1173.2	43.50	1.12E+08	21.86	1.50E-12	23.58	0.016	1.73
52	2739	6170800	5.39E-12	0.9822	4	1204.4	43.97	1.56E+08	25.28	1.30E-12	24.14	0.016	1.73
53	2549	7332200	4.77E-12	0.9597	4	1178.7	46.24	2.03E+08	27.62	1.11E-12	23.22	0.016	1.85
54	2594	8988100	4.29E-12	0.9842	4	1282.4	48.85	3.09E+08	34.05	1.05E-12	24.36	0.017	1.73
55	2651	1E+07	3.62E-12	0.9707	4	1208.8	47.31	3.62E+08	36.30	8.77E-13	22.88	0.016	1.62
56	2631	1.1E+07	3.46E-12	0.9782	4	1245.6	49.21	4.23E+08	37.93	8.09E-13	23.45	0.016	1.64
57	2420	1.2E+07	3.04E-12	0.9837	4	1283.4	52.21	4.88E+08	40.11	7.18E-13	23.65	0.016	1.64
58	2458	1.4E+07	2.82E-12	0.9873	4	1288.5	51.81	5.85E+08	40.11	6.62E-13	23.39	0.016	1.62
59	2448	1.7E+07	2.69E-12	0.9909	4	1240.8	50.89	8.71E+08	51.41	6.03E-13	22.74	0.016	1.57
60	2581	1.9E+07	2.53E-12	0.9928	4	1259.2	48.79	1.09E+07	56.73	5.74E-13	22.88	0.015	1.56
61	2368	1.8E+07	2.39E-12	0.9886	4	1280.1	54.06	9.82E+08	53.85	5.46E-13	23.00	0.016	1.58
62	2377	2E+07	2.28E-12	0.9888	4	1307.4	55.00	1.23E+07	60.27	5.33E-13	23.38	0.016	1.60
63	2314	2.1E+07	2.20E-12	0.989	4	1288.8	55.70	1.24E+07	56.80	5.18E-13	22.85	0.016	1.57
64	2369	2.1E+07	2.31E-12	0.9873	4	1342.1	58.25	1.30E+07	62.47	5.91E-13	23.81	0.016	1.63
65	2385	2.2E+07	2.21E-12	1	4	1320.2	55.82	1.37E+07	63.53	5.20E-13	23.55	0.016	1.61
66	2336	1.8E+07	2.17E-12	1.002	4	1312	58.16	9.52E+08	52.99	5.12E-13	23.55	0.016	1.60
67	2243	1.6E+07	2.24E-12	0.9888	4	1280.5	55.20	7.18E+08	45.82	5.18E-13	23.12	0.016	1.58
68	2431	1.9E+07	2.19E-12	0.9894	4	1303.5	52.95	7.99E+08	48.28	5.01E-13	23.35	0.016	1.59
69	2427	1.8E+07	2.24E-12	0.9888	4	1287.3	52.86	1.00E+07	53.72	5.19E-13	22.93	0.016	1.57
70	2427	1.8E+07	2.24E-12	0.9888	4	1274.5	52.51	9.28E+08	51.88	5.08E-13	22.77	0.016	1.58
71	2380	1.9E+07	2.29E-12	0.9894	4	1288.1	53.80	1.07E+07	55.65	5.17E-13	22.88	0.016	1.57
72	2573	1.8E+07	2.29E-12	0.9881	4	1288.8	50.52	9.73E+08	53.28	5.29E-13	23.09	0.016	1.58
73	2433	1.8E+07	2.39E-12	0.9897	4	1289.8	53.42	1.03E+07	55.29	5.47E-13	23.28	0.016	1.59
74	2605	1.8E+07	2.41E-12	0.9888	4	1282.5	51.20	9.85E+08	54.27	5.60E-13	23.19	0.016	1.59
75	2340	1.5E+07	2.53E-12	0.9829	4	1278.5	54.55	8.84E+08	45.56	5.87E-13	23.18	0.016	1.59
76	2418	1.4E+07	2.67E-12	0.9803	4	1252	51.78	9.01E+08	42.85	6.13E-13	22.95	0.016	1.58
77	2582	1.5E+07	2.82E-12	0.9851	4	1280.6	48.44	7.08E+08	47.12	6.72E-13	22.88	0.016	1.59
78	2418	1.3E+07	3.12E-12	0.982	4	1233.9	51.03	5.41E+08	41.88	7.20E-13	23.11	0.016	1.61
79	2718	1.2E+07	3.46E-12	0.975	4	1264	46.50	5.10E+08	41.60	8.22E-13	23.97	0.016	1.65
80	2628	1E+07	3.78E-12	0.9708	4	1258.1	44.42	3.71E+08	38.14	9.00E-13	23.73	0.016	1.67
81	2672	8184000	4.18E-12	0.9898	4	1238.2	44.77	2.45E+08	28.92	8.85E-13	23.78	0.018	1.68
82	2672	8887400	4.54E-12	0.9811	4	1207	45.17	1.77E+08	25.78	1.07E-12	23.80	0.018	1.87
83	2804	8888800	5.22E-12	0.9829	4	1231.6	42.41	1.72E+08	26.25	1.27E-12	24.28	0.017	1.74
84	2874	5882800	6.63E-12	0.9484	4	1180.5	41.08	1.30E+08	23.00	1.33E-12	23.71	0.016	1.70
85	2742	4804000	6.21E-12	0.9444	4	1151.4	41.88	9.01E+08	19.88	1.47E-12	23.89	0.016	1.71
86	2853	4118900	7.21E-12	0.9381	4	1187.7	40.22	7.92E+08	19.24	1.79E-12	24.88	0.017	1.81
87	3087	3378700	8.63E-12	0.9254	4	1120.5	38.30	5.43E+08	16.08	2.08E-12	23.77	0.016	1.74
88	3057	2753300	9.9E-12	0.9184	4	1131.7	37.02	4.02E+08	14.61	2.48E-12	24.84	0.017	1.84
89	3211	2240000	1.21E-11	0.9057	4	1159.6	36.11	3.01E+08	13.42	2.48E-12	26.04	0.018	1.95
90	3285	1752500	1.43E-11	0.8877	4	1187.9	36.18	2.12E+08	12.11	3.97E-12	27.72	0.019	2.09
91	3416	1418300	1.74E-11	0.8867	4	1188	34.19	1.54E+08	10.86	4.91E-12	28.20	0.019	2.15
92	3414	1125100	2.18E-11	0.8744	4	1142.6	33.47	1.10E+08	9.73	6.28E-12	28.78	0.019	2.22
93	3452	884100	2.6E-11	0.865	4	1125.5	32.83	7.88E+08	8.82	7.72E-12	28.75	0.020	2.31
94	3468	712200	3.21E-11	0.8533	4	1133.6	32.50	5.97E+08	8.28	1.00E-11	31.28	0.021	2.46
95	3408	588220	3.8E-11	0.8431	4	1071.5	31.44	4.17E+08	7.32	1.22E-11	31.27	0.021	2.48
96	3484	448870	6.38E-11	0.8255	4	1042.5	29.82	3.08E+08	6.85	1.74E-11	32.33	0.022	2.61
97	3535	358170	8.88E-11	0.8132	4	974.92	28.25	2.23E+08	6.23	2.22E-11	32.39	0.022	2.65
98	2887	281380	7.8E-11	0.8088	4	835.78	28.85	1.48E+08	5.25	2.37E-11	30.34	0.020	2.49
99	2787	218880	9.02E-11	0.8021	4	786.14	28.21	1.03E+08	4.70	2.79E-11	30.63	0.020	2.53
100	2815	170440	1.02E-10	0.7978	4	739.88	28.08	7.23E+08	4.24	3.18E-11	31.08	0.021	2.58

W/C = 0.58
7 Days of Hydration
Pore Solution: 18% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
101	2297	130040	1.18E-10	0.7918	4	840.15	27.87	4848.2	3.84	3.4741E-11	28.56	0.020	2.47
102	2024	103360	1.37E-10	0.7947	4	592.87	29.26	3397.5	3.29	4.0803E-11	29.53	0.020	2.49
103	1780	90518	1.52E-10	0.782	4	508.92	29.06	2280.6	2.83	4.219E-11	27.79	0.018	2.35
104	1336	62407	1.53E-10	0.7858	4	423.73	31.87	1513.1	2.42	3.8878E-11	26.86	0.017	2.18
105	980.2	48534	1.48E-10	0.7824	4	394.74	40.27	1144.9	2.36	4.0118E-11	27.00	0.018	2.26
106	755	35124	1.88E-10	0.7885	4	328.98	43.57	793.98	2.07	4.1578E-11	24.65	0.016	2.08
107	599.8	30259	1.78E-10	0.7801	4	298.28	52.35	609.63	2.01	4.3371E-11	24.66	0.016	2.09
108	440.3	24028	1.93E-10	0.7864	4	251.86	57.16	449.5	1.86	4.3695E-11	22.77	0.015	1.94
109	280.5	18048	2.12E-10	0.7873	4	221.17	78.85	348.71	1.83	4.6945E-11	22.03	0.015	1.90
110	189.2	18231	2.38E-10	0.7851	4	183.8	115.33	264.54	1.74	4.7917E-11	20.15	0.014	1.75
111	16.7	12157	2.47E-10	0.7858	4	156.26	935.89	210.14	1.73	4.7503E-11	19.27	0.013	1.68
112	109.4	9887	2.84E-10	0.7883	4	130.01	118.84	188.23	1.86	5.0508E-11	17.80	0.012	1.57
113	221.5	8162	3.33E-10	0.7832	4	112.26	50.70	139	1.70	5.7101E-11	17.16	0.012	1.54
114	330.1	6865	3.8E-10	0.7818	4	94.822	28.73	116.14	1.87	6.4182E-11	16.48	0.012	1.48
115	353.8	8189	5.25E-10	0.7707	4	80.777	22.83	98.844	1.80	8.1515E-11	15.52	0.011	1.42
116	407.5	8508	5.88E-10	0.7715	4	86.644	18.85	84.112	1.53	8.6905E-11	14.85	0.010	1.36
117	445.6	4620	5.92E-10	0.7781	4	64.015	14.37	77.841	1.58	9.0398E-11	15.20	0.011	1.39
118	488.1	4471	5.83E-10	0.7809	4	64.07	13.86	78.777	1.72	9.5086E-11	16.30	0.012	1.48
119	464.7	4116	5.88E-10	0.7856	4	63.595	13.12	75.424	1.83	9.75E-11	17.16	0.012	1.55
120	505.6	3831	5.54E-10	0.7803	4	63.184	12.50	74.401	1.84	9.8655E-11	18.05	0.013	1.62
121	488.6	3619	5.82E-10	0.7913	4	64.333	12.80	75.171	2.08	1.0872E-10	18.99	0.014	1.71
122	508.8	3419	5.97E-10	0.7944	4	63.922	12.56	74.337	2.17	1.1032E-10	19.75	0.014	1.78
123	512	3246	5.81E-10	0.798	4	63.829	12.47	73.874	2.27	1.1478E-10	20.46	0.015	1.84
124	518.5	3091	5.83E-10	0.7982	4	63.583	12.26	73.333	2.37	1.1784E-10	21.25	0.015	1.90
125	515.8	2956	5.81E-10	0.8012	4	63.481	12.31	72.822	2.47	1.2088E-10	21.82	0.016	1.96
126	524	2821	5.4E-10	0.8046	4	62.693	11.86	71.819	2.85	1.2189E-10	22.61	0.016	2.01
127	520.1	2708	5.49E-10	0.8089	4	62.953	12.10	71.858	2.65	1.2733E-10	23.35	0.017	2.08
128	521.7	2598	5.48E-10	0.8075	4	62.389	11.86	71.041	2.73	1.3137E-10	23.94	0.017	2.13
129	515.9	2548	6.05E-10	0.803	4	65.861	12.73	74.84	2.94	1.5489E-10	25.82	0.018	2.29
130	505.1	2826	7.83E-10	0.7878	4	75.242	14.87	88.582	3.30	2.2803E-10	28.86	0.021	2.64
131	488.8	2889	9.8E-10	0.7738	4	82.973	19.80	97.276	3.37	2.8016E-10	30.22	0.022	2.80
132	489	3288	1.08E-09	0.7844	4	87.095	17.45	104.89	3.18	3.1387E-10	29.60	0.021	2.78

W/C = 0.36
28 Days of Hydration
Pure Solution; 10% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PH (Error)	PH (% Error)
1	649.2	2282	9.79E-10	0.756	4	163.07	25.16	174.01	7.63	4.29E-10	43.93	0.034	4.53
2	698.1	2340	7.70E-10	0.769	4	149.35	22.76	159.07	6.90	3.01E-10	39.16	0.031	3.99
3	695.8	2436	8.24E-10	0.763	4	160.39	24.46	171.13	7.05	3.39E-10	40.61	0.032	4.19
4	649.9	2513	7.87E-10	0.763	4	163.6	25.20	174.75	6.95	3.19E-10	40.16	0.031	4.12
5	645.9	2607	7.69E-10	0.763	4	166.21	25.73	177.46	6.81	3.04E-10	39.61	0.031	4.08
6	622.4	2727	7.69E-10	0.760	4	178.09	28.29	188.07	6.90	3.09E-10	39.99	0.031	4.12
7	627.1	2835	7.89E-10	0.757	4	181.3	28.91	194.07	6.85	3.19E-10	40.12	0.031	4.14
8	630.6	2974	7.39E-10	0.760	4	182.93	29.01	196.39	6.80	2.94E-10	39.61	0.031	4.07
9	623.7	3130	7.09E-10	0.760	4	182.46	29.16	196.37	6.27	2.72E-10	39.99	0.030	3.92
10	625.4	3293	6.79E-10	0.761	4	182.29	29.15	198.8	5.98	2.54E-10	37.61	0.029	3.80
11	641.9	3445	6.20E-10	0.766	4	181.94	28.34	197.2	5.72	2.31E-10	37.29	0.028	3.70
12	629.1	3641	6.24E-10	0.763	4	189.57	31.12	205.9	5.66	2.31E-10	37.07	0.028	3.70
13	630.5	3662	7.23E-10	0.762	4	207.31	35.53	227.2	5.73	2.89E-10	38.73	0.029	3.91
14	599.1	4362	7.59E-10	0.746	4	215.1	38.47	237.61	5.45	2.87E-10	38.04	0.029	3.84
15	538.9	4893	7.79E-10	0.741	4	217.35	40.48	243.07	5.01	2.84E-10	36.40	0.027	3.67
16	495.8	5436	7.87E-10	0.737	4	226.17	46.62	258.1	4.72	2.61E-10	35.70	0.027	3.60
17	503.8	6014	7.07E-10	0.741	4	235.15	46.95	270.01	4.49	2.53E-10	35.64	0.026	3.55
18	462.8	6724	6.89E-10	0.739	4	238.62	62.72	278.25	4.14	2.37E-10	34.40	0.025	3.39
19	460.9	7493	7.10E-10	0.738	4	252.68	54.62	301.15	4.02	2.49E-10	34.97	0.025	3.44
20	381.6	8414	7.09E-10	0.732	4	257.31	67.43	312.39	3.71	2.36E-10	33.30	0.024	3.27
21	269.9	9405	7.81E-10	0.724	4	273.16	101.22	338.63	3.60	2.51E-10	32.66	0.024	3.26
22	218.1	10328	7.69E-10	0.721	4	280.22	133.07	369.65	3.51	2.59E-10	33.24	0.024	3.29
23	120.6	11799	7.60E-10	0.718	4	301.43	249.94	393.46	3.34	2.47E-10	32.44	0.023	3.20
24	65.89	12994	6.00E-10	0.713	4	319.96	485.60	430.66	3.31	2.63E-10	32.84	0.023	3.25
25	35.15	14493	8.17E-10	0.708	4	342.13	973.34	475.18	3.29	2.71E-10	33.15	0.023	3.29
26	104.8	16399	8.79E-10	0.702	4	357.81	341.42	523.63	3.19	2.89E-10	32.69	0.023	3.28
27	321.5	18995	1.01E-09	0.690	4	410.59	127.71	632.81	3.39	3.62E-10	34.99	0.024	3.54
28	461.2	21182	1.04E-09	0.695	4	448.07	98.86	728.42	3.44	3.79E-10	36.89	0.025	3.64
29	708.6	24607	1.09E-09	0.679	4	514.87	72.66	906.24	3.63	4.09E-10	39.00	0.026	3.67
30	838.7	28724	1.03E-09	0.677	4	598.13	67.66	1078	3.75	4.12E-10	39.22	0.027	3.69
31	1113	34677	9.73E-10	0.678	4	667.24	59.05	1362.4	4.02	4.09E-10	41.90	0.029	4.24
32	1416	42773	8.89E-10	0.679	4	764.41	63.20	1624.3	4.27	3.89E-10	43.78	0.030	4.40
33	1624	52193	7.49E-10	0.695	4	830.43	51.13	2313.9	4.43	3.32E-10	44.59	0.030	4.41
34	2019	63575	6.73E-10	0.697	4	943.63	46.78	3030.9	4.77	3.11E-10	46.24	0.031	4.55
35	2326	78094	6.49E-10	0.698	4	1062.6	45.25	3683.8	5.10	2.89E-10	47.67	0.032	4.62
36	2785	96020	4.92E-10	0.698	4	1216.5	43.60	5498.9	5.71	2.49E-10	50.41	0.034	4.86
37	3271	120660	4.24E-10	0.702	4	1296.2	39.63	7207.1	5.97	2.07E-10	48.93	0.033	4.67
38	3721	153960	3.63E-10	0.708	4	1502.1	40.37	10570	6.68	1.89E-10	51.78	0.035	4.90
39	4442	197070	3.09E-10	0.713	4	1865.9	38.16	15207	7.72	1.63E-10	52.87	0.036	4.99
40	4994	230300	2.43E-10	0.724	4	1877.3	37.82	21594	8.62	1.31E-10	53.99	0.038	4.99
41	5371	300300	1.89E-10	0.737	4	1991.7	37.08	26205	9.16	9.99E-11	53.23	0.036	4.83
42	5478	366300	1.80E-10	0.746	4	2149.2	39.23	36335	10.16	8.07E-11	53.67	0.038	4.81
43	6211	500820	1.29E-10	0.754	4	2380.1	38.00	57373	11.46	6.79E-11	53.60	0.038	4.77
44	6746	643460	9.80E-11	0.765	4	2654.3	39.36	64941	13.16	5.43E-11	55.42	0.037	4.86
45	7034	818790	7.43E-11	0.760	4	2775.5	39.46	117160	14.31	4.01E-11	53.99	0.038	4.66
46	7112	1040600	6.40E-11	0.767	4	2964.4	41.86	167170	16.08	2.89E-11	54.63	0.037	4.62
47	7500	1359600	4.10E-11	0.811	4	3143.9	41.92	242710	17.81	2.17E-11	53.05	0.036	4.42
48	7759	1766600	3.09E-11	0.825	4	3410.2	43.95	398300	20.50	1.64E-11	53.26	0.036	4.37
49	7879	2318600	2.17E-11	0.843	4	3516.6	44.66	519480	22.40	1.12E-11	51.63	0.035	4.15
50	8132	3043900	1.69E-11	0.857	4	3751.5	46.13	787940	25.99	8.53E-12	51.50	0.035	4.06

W/C = 0.34
28 Days of Hydration
Pore Solution: 10% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	% ₀ (Q) (% Error)	G (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
51	8772	3948000	1.31E-11	0.8894	4	4125.9	1.16E+08	30.25	6.97E-12	53.18	0.036	4.17
52	8698	4899500	1.05E-11	0.8798	4	4362.8	1.89E+08	34.55	5.97E-12	53.21	0.036	4.13
53	8653	5922500	7.71E-12	0.8698	4	4234.5	2.14E+08	36.07	3.86E-12	50.04	0.034	3.81
54	8600	6903000	6.18E-12	0.808	4	4467.4	2.76E+08	39.44	3.12E-12	50.55	0.035	3.81
55	8477	8199400	5.29E-12	0.9151	4	4899.7	3.72E+08	45.35	2.83E-12	53.82	0.037	4.01
56	8184	1E+07	4.29E-12	0.8281	4	4993.3	5.47E+08	50.59	2.23E-12	51.83	0.036	3.84
57	8390	1.3E+07	3.62E-12	0.9341	4	5422.1	7.89E+08	60.53	1.95E-12	53.53	0.037	3.95
58	8722	1.5E+07	3.11E-12	0.9414	4	5708.7	1.02E+07	68.02	1.86E-12	54.45	0.037	3.97
59	10868	1.9E+07	3.09E-12	0.9383	4	6887.9	1.75E+07	91.23	1.51E-12	61.12	0.042	4.48
60	10375	2.2E+07	2.61E-12	0.9477	4	6932.8	2.10E+07	93.43	1.51E-12	67.87	0.040	4.19
61	9976	2.1E+07	2.03E-12	0.963	4	6448	1.80E+07	95.03	1.18E-12	66.96	0.039	4.07
62	8691	2.4E+07	1.84E-12	0.969	4	6368.7	2.15E+07	91.07	1.03E-12	55.92	0.036	3.97
63	8715	2.4E+07	1.72E-12	0.9727	4	6280.8	2.18E+07	89.41	9.43E-13	54.84	0.038	3.88
64	10032	2.6E+07	1.69E-12	0.9728	4	6488.1	2.23E+07	90.74	9.44E-13	55.73	0.038	3.94
65	10559	3.1E+07	2.07E-12	0.9563	4	7230.3	3.95E+07	124.81	1.24E-12	59.85	0.041	4.30
66	8902	2.5E+07	1.71E-12	0.9715	4	6861.4	2.35E+07	95.11	9.91E-13	58.09	0.040	4.12
67	8643	2.5E+07	1.64E-12	0.9745	4	6268.7	2.20E+07	86.69	8.86E-13	54.11	0.037	3.82
68	10398	2.3E+07	1.7E-12	0.9711	4	7020	2.12E+07	90.89	8.89E-13	58.73	0.040	4.18
69	9490	2.9E+07	1.69E-12	0.9783	4	6473.8	3.13E+07	103.51	8.19E-13	59.84	0.039	3.93
70	8723	2.8E+07	1.64E-12	0.9748	4	6954.3	2.88E+07	102.42	8.19E-13	58.14	0.039	3.97
71	10071	2.3E+07	1.62E-12	0.9748	4	6859.2	2.01E+07	85.93	9.12E-13	58.33	0.039	3.98
72	8771	2.5E+07	1.6E-12	0.9758	4	6453.1	2.26E+07	90.63	8.84E-13	55.23	0.038	3.89
73	10021	2.4E+07	1.87E-12	0.9685	4	6884.9	2.18E+07	92.40	1.08E-12	58.18	0.040	4.15
74	10898	3.1E+07	2.11E-12	0.968	4	6930.2	3.77E+07	122.78	1.23E-12	59.09	0.040	4.17
75	10231	1.9E+07	2.08E-12	0.982	4	6379.1	1.51E+07	77.71	1.18E-12	56.30	0.039	4.02
76	10078	1.8E+07	2.23E-12	0.9885	4	6301.1	1.35E+07	74.98	1.27E-12	58.81	0.039	4.07
77	10891	1.8E+07	3.01E-12	0.9385	4	6930.8	1.75E+07	83.37	1.79E-12	58.17	0.040	4.28
78	10298	1.3E+07	3.07E-12	0.9403	4	6075.1	7.82E+08	80.05	1.72E-12	58.23	0.039	4.10
79	11008	1.3E+07	3.79E-12	0.9395	4	6221.6	8.37E+08	94.41	1.72E-12	59.09	0.040	4.29
80	9840	9625000	3.39E-12	0.9391	4	5299.1	4.65E+08	48.87	1.81E-12	53.36	0.037	3.89
81	8684	8874800	4.73E-12	0.9182	4	5817.7	5.18E+08	52.30	2.84E-12	55.89	0.038	4.16
82	10263	8898800	6.02E-12	0.904	4	5938.9	4.83E+08	51.04	3.41E-12	58.55	0.039	4.29
83	9838	8817800	6.04E-12	0.9075	4	4888.7	2.83E+08	38.18	3.22E-12	53.38	0.038	4.02
84	9737	5870400	7.49E-12	0.8948	4	4914.1	2.15E+08	36.69	4.09E-12	54.83	0.037	4.17
85	9833	4774200	8.83E-12	0.8985	4	4718.4	1.54E+08	32.16	4.82E-12	54.51	0.037	4.19
86	10086	3985000	1.08E-11	0.8752	4	4746.3	1.18E+08	30.04	6.14E-12	56.55	0.039	4.40
87	9467	3287500	1.22E-11	0.8701	4	4833.8	8.86E+08	28.94	7.00E-12	56.96	0.039	4.46
88	8904	2689400	1.82E-11	0.8682	4	4460.1	6.47E+08	24.36	8.88E-12	58.43	0.040	4.82
89	9414	2287200	1.9E-11	0.8493	4	4259.9	5.20E+08	22.74	1.10E-11	59.09	0.039	4.65
90	9415	1899400	2.21E-11	0.8391	4	4055.9	3.75E+08	20.07	1.27E-11	57.44	0.039	4.63
91	9438	1658800	2.94E-11	0.8223	4	4304.8	3.12E+08	20.05	1.88E-11	62.83	0.043	5.17
92	8218	1283900	3.4E-11	0.8163	4	3869.5	2.25E+08	17.52	2.05E-11	60.22	0.041	4.98
93	8883	1053500	4.09E-11	0.8072	4	3893.5	1.70E+08	15.98	2.48E-11	60.15	0.041	5.02
94	8904	878270	5.01E-11	0.7988	4	3586.6	1.31E+08	14.98	3.11E-11	62.05	0.042	5.24
95	8395	709800	5.91E-11	0.7885	4	3342.8	9.55E+04	13.51	3.87E-11	62.04	0.042	5.28
96	7975	578880	7.51E-11	0.7785	4	3151.5	7.11E+04	12.28	4.61E-11	61.46	0.041	5.30
97												
98	7417	377080	1.08E-10	0.7802	4	2800.6	3.89E+04	10.51	6.80E-11	64.32	0.043	5.66
99	6307	297360	1.1E-10	0.782	4	2835.3	2.78E+04	9.39	7.08E-11	64.42	0.043	5.64
100	5998	236390	1.33E-10	0.7529	4	2323.2	1.85E+04	8.19	8.09E-11	61.03	0.041	5.40

W/C = 0.35
28 Days of Hydration
Pore Solution: 10% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
101	4991	106160	1.20E-10	0.7698	4	2142.6	43.19	13060	7.46	8.0270E-11	62.48	0.042	5.48
102	4493	148800	1.82E-10	0.751	4	1853.1	43.47	10006	6.74	9.2944E-11	61.12	0.041	5.42
103	3637	116630	1.66E-10	0.7636	4	1665.4	46.62	9005.6	5.93	9.0917E-11	59.60	0.039	5.17
104	3266	92466	1.74E-10	0.7498	4	1474.2	44.74	4870.3	5.27	9.6917E-11	59.34	0.037	4.93
105	2672	73438	1.81E-10	0.7515	4	1291.6	48.34	3536.2	4.81	9.6902E-11	53.33	0.036	4.75
106	2173	59783	1.86E-10	0.7503	4	1127.9	51.91	2628	4.47	1.0113E-10	51.15	0.034	4.59
107	1446	47026	1.94E-10	0.7507	4	933.21	64.54	1899.6	4.04	9.1949E-11	47.49	0.032	4.23
108	923.2	37669	1.77E-10	0.7677	4	615.39	66.32	1472.1	3.60	8.2649E-11	46.73	0.032	4.11
109	920.9	33661	2.15E-10	0.759	4	679.45	73.78	1101.9	3.57	8.9645E-11	41.62	0.028	3.74
110	997.8	24938	2.15E-10	0.7648	4	660.08	66.71	878.71	3.52	8.6944E-11	40.33	0.028	3.61
111	286.1	20143	2.24E-10	0.7692	4	477.05	184.12	664.61	3.30	8.1927E-11	36.63	0.025	3.29
112	1471	16931	2.20E-10	0.7738	4	366.08	26178.11	511.1	3.09	7.541E-11	33.31	0.023	2.99
113	103.7	14110	2.77E-10	0.7695	4	340.67	326.51	437.39	3.10	8.6909E-11	31.92	0.022	2.91
114	226.6	12291	3.06E-10	0.7697	4	266.49	124.77	361.65	2.94	9.0909E-11	29.76	0.021	2.72
115	345.6	10765	3.61E-10	0.7627	4	247.78	71.69	308.82	2.87	1.0202E-10	28.26	0.020	2.61
116	270.8	9740	4.48E-10	0.7623	4	224.78	83.00	275.07	2.82	1.1862E-10	26.54	0.019	2.51
117	344.2	8762	4.54E-10	0.7657	4	202.33	58.78	244.53	2.78	1.1865E-10	25.75	0.018	2.43
118	386.4	7699	4.84E-10	0.7546	4	186.72	47.50	226.18	2.63	1.2304E-10	25.40	0.018	2.41
119	486.8	7026	3.94E-10	0.7709	4	179.55	39.89	209.19	2.66	1.0281E-10	26.08	0.019	2.44
120	682.1	6396	3.51E-10	0.7818	4	168.5	28.95	184.42	3.04	9.2893E-11	26.46	0.019	2.44
121	686.5	5970	3.46E-10	0.7949	4	167.9	28.53	191.9	3.21	9.4469E-11	27.36	0.020	2.52
122	646	5548	3.41E-10	0.7863	4	164.72	25.50	186.82	3.37	9.6295E-11	28.20	0.020	2.69
123	620	5304	3.59E-10	0.7887	4	164.29	26.50	185.29	3.49	1.0160E-10	28.65	0.021	2.84
124	671.5	4690	3.27E-10	0.7949	4	161.87	24.11	181.77	3.64	9.7398E-11	29.73	0.022	2.72
125	677.2	4728	3.23E-10	0.797	4	162.07	23.63	180.9	3.63	9.8927E-11	30.64	0.022	2.81
126	682.6	4600	3.14E-10	0.7994	4	162.12	24.84	179.87	3.69	9.7909E-11	31.16	0.023	2.86
127	630.7	4291	3.14E-10	0.7998	4	165.79	26.29	182.33	4.26	1.0091E-10	32.09	0.024	2.98
128	691.2	4012	2.99E-10	0.8066	4	166.21	25.52	181.85	4.53	9.9752E-11	33.65	0.025	3.09
129	697.8	3695	3.47E-10	0.7979	4	174.02	26.46	180.14	4.69	1.2463E-10	35.87	0.027	3.34
130	600.9	4004	3.39E-10	0.7709	4	204.62	34.05	224.91	5.62	2.1495E-10	40.05	0.030	3.69
131	523.6	4619	7.79E-10	0.7453	4	233.91	44.67	262.39	5.68	3.2675E-10	42.20	0.031	4.22
132	539.2	5532	9.19E-10	0.7339	4	234.53	43.50	273.25	4.94	3.7398E-10	40.61	0.030	4.05
133	448.6	6939	1.14E-09	0.7182	4	238.7	53.09	291.05	4.19	4.2062E-10	38.76	0.027	3.72
134	365	6695	1.24E-09	0.708	4	248.32	64.50	321.19	3.71	4.3046E-10	34.85	0.025	3.62
135	307.1	10779	1.39E-09	0.6953	4	254.31	82.81	352.22	3.27	4.3698E-10	32.16	0.023	3.27
136	132	13365	1.51E-09	0.6929	4	267.66	217.94	428.1	3.21	4.6009E-10	32.20	0.023	3.31
137	69.8	16301	1.87E-09	0.6748	4	327.35	499.99	526.48	3.23	5.1794E-10	32.91	0.023	3.41

W/C = 0.60
7 Days of Hydration
Pore Solution: 18% Salt Solution

File No.	R ₁ (d)	R ₂ (d)	G (P)	Phi	Type	R ₁ (d) (Error)	R ₂ (d) (% Error)	R ₁ (d) (Error)	R ₂ (d) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
1	270.4	163.1	1.18E-09	0.776	4	20.185	7.46	21.778	13.35	1.03E-09	66.79	0.068	8.55
2	283.2	162	8.18E-09	0.815	4	19.354	6.83	20.786	12.84	5.42E-09	87.74	0.068	8.11
3	287.3	168.6	5.76E-09	0.817	4	19.503	6.79	20.928	12.96	5.02E-09	85.30	0.068	7.87
4	280.6	169.7	5.51E-09	0.816	4	19.624	6.75	21.044	12.40	4.83E-09	84.01	0.063	7.74
5	283.1	172.3	5.43E-09	0.816	4	19.912	6.79	21.342	12.36	4.54E-09	83.61	0.063	7.72
6	285.6	174.3	5.06E-09	0.821	4	19.812	6.70	21.217	12.17	4.15E-09	82.15	0.062	7.55
7	287.3	177.5	5.15E-09	0.818	4	20.331	6.84	21.768	12.26	4.23E-09	82.20	0.062	7.59
8	289.1	180	5.12E-09	0.816	4	20.662	6.91	22.113	12.26	4.20E-09	82.04	0.062	7.59
9	300.5	183	5.13E-09	0.816	4	21.114	7.03	22.592	12.34	4.16E-09	81.70	0.062	7.58
10	282.5	189.3	9.30E-09	0.774	4	19.866	6.82	21.218	10.65	8.15E-09	86.17	0.051	6.81
11	302.9	189.8	5.30E-09	0.811	4	22.239	7.34	23.765	12.82	4.33E-09	81.59	0.062	7.65
12	303.2	189.2	8.80E-09	0.768	4	24.331	8.02	26.025	13.13	5.44E-09	83.62	0.064	8.04
13	300.5	211.6	7.44E-09	0.784	4	26.188	8.55	28.072	13.27	6.22E-09	83.59	0.064	8.19
14	310.5	231.9	8.39E-09	0.771	4	28.102	9.37	31.215	13.46	8.89E-09	83.21	0.064	8.33
15	316.2	269.1	9.24E-09	0.769	4	32.672	10.33	36.077	13.54	7.59E-09	81.97	0.064	8.40
16	325	268.2	8.25E-09	0.766	4	34.979	10.78	37.479	13.10	6.43E-09	78.01	0.061	8.02
17	333.5	319.4	8.06E-09	0.763	4	37.974	11.39	40.707	12.74	6.09E-09	75.24	0.059	7.82
18	339.3	368.7	8.18E-09	0.744	4	41.946	12.36	44.957	12.53	5.94E-09	72.48	0.057	7.66
19	346.1	402.2	7.94E-09	0.739	4	45.464	13.14	48.778	12.19	5.52E-09	69.48	0.055	7.41
20	353	448.7	7.49E-09	0.738	4	48.14	13.64	51.632	11.51	4.99E-09	65.80	0.052	7.04
21	369.5	500.7	7.26E-09	0.731	4	51.429	14.35	55.209	11.03	4.59E-09	62.54	0.049	6.77
22	362.3	562.3	7.12E-09	0.725	4	55.547	15.33	59.696	10.82	4.27E-09	59.91	0.047	6.55
23	364.8	638.2	7.67E-09	0.714	4	62.375	17.10	67.24	10.57	4.58E-09	59.45	0.047	6.61
24	364.5	783.2	1.10E-08	0.682	4	65.864	23.56	83.423	11.83	7.26E-09	66.15	0.053	7.75
25	365.2	1020	1.30E-08	0.681	4	112.47	29.20	124.24	12.18	9.09E-09	70.05	0.056	8.42
26	403.5	1483	1.22E-08	0.647	4	154	37.86	173.45	11.70	8.70E-09	71.13	0.058	8.63
27	368.7	2282	1.12E-08	0.626	4	217.71	60.69	249.34	10.53	7.89E-09	67.78	0.053	8.42
28	248.2	3491	8.54E-09	0.624	4	274.2	111.37	320.41	9.18	5.11E-09	59.80	0.049	7.41
29	75.12	5352	6.18E-09	0.624	4	322.06	428.77	360.65	7.30	3.22E-09	52.20	0.039	6.33
30	224	8006	4.65E-09	0.624	4	355.44	158.66	454.25	5.63	2.05E-09	44.11	0.033	5.23
31	597	11882	3.75E-09	0.624	4	393.65	65.94	548.65	4.61	1.48E-09	39.50	0.029	4.58
32	1012	17150	2.83E-09	0.629	4	414.12	65.94	548.65	4.61	1.48E-09	39.50	0.029	4.58
33	1400	24056	2.16E-09	0.639	4	401.82	40.82	649.36	3.79	1.03E-09	35.09	0.025	3.96
34	1888	33509	1.66E-09	0.649	4	400.05	26.70	737.08	3.08	6.45E-10	29.87	0.021	3.26
35	2498	46204	1.22E-09	0.662	4	400.05	21.53	898.74	2.68	4.35E-10	26.26	0.018	2.76
36	2628	63016	9.10E-10	0.676	4	395.83	18.47	1149.4	2.49	2.80E-10	23.70	0.016	2.43
37	2628	67973	6.73E-10	0.690	4	392.11	15.64	1462.1	2.37	1.92E-10	21.13	0.014	2.11
38	3053	126570	4.80E-10	0.707	4	428.05	13.87	2109	2.40	1.30E-10	19.28	0.013	1.87
39	3050	184270	3.20E-10	0.728	4	441.33	13.17	3449.8	2.73	9.13E-11	19.00	0.013	1.79
40	3598	267460	2.13E-10	0.749	4	446.01	12.44	5805	2.69	5.89E-11	17.77	0.012	1.63
41	3988	378480	1.40E-10	0.772	4	448.03	12.09	8601.5	3.22	3.45E-11	16.21	0.011	1.44
42	3739	537070	9.40E-11	0.784	4	441.1	11.80	20052	3.73	2.08E-11	14.84	0.010	1.28
43	3819	753480	6.75E-11	0.811	4	449.84	11.70	31583	4.19	1.27E-11	13.50	0.009	1.14
44	3829	1020900	4.89E-11	0.830	4	449.84	11.80	48955	4.71	8.53E-12	12.64	0.008	1.05
45	3733	1380800	3.61E-11	0.846	4	455.95	12.21	74785	5.42	4.17E-12	11.53	0.008	0.97
46	3753	1848000	2.84E-11	0.869	4	425.06	11.24	105470	5.72	2.66E-12	10.15	0.007	0.90
47	3682	2467400	2.22E-11	0.873	4	445.04	12.15	171710	6.89	2.27E-12	10.24	0.007	0.80
48	3588	3187500	1.75E-11	0.885	4	444.04	12.14	259310	8.94	1.75E-12	9.85	0.007	0.76
49	3588	4102900	1.47E-11	0.898	4	448.96	12.51	398040	9.46	1.42E-12	9.67	0.007	0.73
50	3335	5234500	1.12E-11	0.913	4	519.28	15.62	671830	12.53	1.24E-12	11.10	0.008	0.83

W/C = 0.60
7 Days of Hydration
Pore Solution: 10% Salt Solution

File No.	R ₁ (D)	R ₂ (D)	G (P)	Phi	Type	R ₁ (D) (Error)	R ₁ (D) (% Error)	R ₂ (D) (Error)	R ₂ (D) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
51	3574	7158000	1.04E-11	0.9144	4	454.35	12.71	1.00E+08	13.98	9.86E-13	9.27	0.006	0.69
52	3531	6947400	8.89E-12	0.9235	4	498.31	14.08	1.60E+08	17.92	8.89E-13	9.96	0.007	0.74
53	3401	1.1E+07	7.73E-12	0.9313	4	481.18	14.15	2.14E+08	19.80	7.39E-13	9.51	0.009	0.70
54	3504	1.4E+07	7.00E-12	0.9358	4	478.65	13.30	3.34E+08	23.88	6.40E-13	9.20	0.008	0.67
55	3523	2E+07	6.30E-12	0.9412	4	482.21	13.97	6.72E+08	33.49	5.93E-13	9.33	0.008	0.68
56	3493	2E+07	5.82E-12	0.9485	4	515.63	14.76	8.81E+08	33.93	5.47E-13	9.74	0.007	0.70
57	3511	3.1E+07	5.3E-12	0.9512	4	535.26	14.82	1.59E+07	51.27	5.29E-13	9.93	0.007	0.71
58	3505	3.6E+07	4.91E-12	0.9553	4	539.03	15.39	2.16E+07	59.32	4.86E-13	9.92	0.007	0.71
59	3500	4.4E+07	4.54E-12	0.9598	4	539.35	15.41	3.02E+07	68.94	4.45E-13	9.81	0.007	0.70
60	3438	6.7E+07	4.34E-12	0.9619	4	552.11	16.12	7.13E+07	108.16	4.33E-13	9.97	0.007	0.71
61	3520	4.6E+07	4.08E-12	0.966	4	555.78	15.79	3.82E+07	77.47	4.08E-13	10.05	0.007	0.71
62	3593	5.5E+07	4.11E-12	0.9651	4	555.96	15.80	4.71E+07	85.83	4.11E-13	10.02	0.007	0.71
63	3444	4.3E+07	4.02E-12	0.9665	4	539.37	15.57	2.81E+07	65.10	3.89E-13	9.67	0.007	0.68
64	3548	4.1E+07	3.97E-12	0.9674	4	544.1	15.34	2.52E+07	62.08	3.90E-13	9.64	0.007	0.69
65	3465	3.9E+07	4E-12	0.9686	4	523.32	14.96	2.24E+07	57.27	3.77E-13	9.41	0.006	0.66
66	3579	5.9E+07	4.14E-12	0.9644	4	535.49	14.96	5.29E+07	89.07	3.96E-13	9.62	0.007	0.68
67	3468	4.9E+07	3.98E-12	0.9672	4	549.32	15.76	3.71E+07	75.80	3.94E-13	9.91	0.007	0.70
68	3492	5.5E+07	4.1E-12	0.9649	4	532.87	14.47	4.46E+07	61.57	3.90E-13	9.52	0.007	0.67
69	3542	6.1E+07	4.12E-12	0.9647	4	550.22	15.53	5.74E+07	94.05	4.07E-13	9.87	0.007	0.70
70	3532	3.4E+07	4.04E-12	0.9662	4	530.65	15.02	1.76E+07	51.25	3.89E-13	9.58	0.007	0.68
71	3600	6.3E+07	4.02E-12	0.9686	4	533.29	14.81	4.12E+07	78.39	3.89E-13	9.60	0.007	0.68
72	3600	4.4E+07	4.18E-12	0.9644	4	540.43	15.01	2.98E+07	68.01	4.11E-13	9.82	0.007	0.70
73	3751	3.6E+07	4.49E-12	0.9659	4	521.89	13.91	2.32E+07	59.15	4.20E-13	9.49	0.006	0.67
74	3698	3.6E+07	4.82E-12	0.9659	4	498.9	13.52	1.89E+07	52.75	4.39E-13	9.09	0.008	0.65
75	3667	3.8E+07	5.08E-12	0.9635	4	528.16	14.81	2.35E+07	61.79	4.99E-13	9.75	0.007	0.70
76	3690	2.5E+07	5.51E-12	0.9487	4	502.33	13.85	1.03E+07	40.44	5.14E-13	9.32	0.008	0.67
77	3762	2.4E+07	6.11E-12	0.943	4	502.4	13.28	9.36E+08	39.31	5.79E-13	9.43	0.008	0.68
78	3770	1.8E+07	6.57E-12	0.9382	4	495.95	12.39	5.81E+08	28.44	5.81E-13	8.85	0.008	0.64
79	3605	1.4E+07	7.1E-12	0.9382	4	492.09	13.85	3.80E+08	25.16	6.74E-13	9.49	0.008	0.69
80	3571	9770700	7.74E-12	0.9308	4	436.33	12.22	1.57E+08	18.09	6.84E-13	8.58	0.008	0.63
81	3595	8621100	6.79E-12	0.9238	4	461.83	12.84	1.46E+08	16.35	6.09E-13	9.21	0.008	0.68
82	3788	7177800	1.02E-11	0.9148	4	448.85	11.78	9.65E+05	13.45	9.22E-13	9.01	0.008	0.67
83	3759	6596600	1.16E-11	0.9093	4	411.86	10.95	5.73E+05	10.31	9.89E-13	8.51	0.008	0.64
84	3849	4390700	1.33E-11	0.9008	4	421.81	10.95	3.89E+05	8.99	1.19E-12	8.90	0.008	0.67
85	3935	3954600	1.54E-11	0.9024	4	420.51	10.88	2.78E+05	7.82	1.40E-12	9.09	0.008	0.69
86	3998	2733600	1.8E-11	0.8941	4	410.9	10.36	1.77E+05	6.48	1.69E-12	9.16	0.008	0.70
87	4038	2197200	2.17E-11	0.8732	4	409.05	10.11	1.24E+05	5.68	2.03E-12	9.34	0.008	0.72
88	4130	1730400	2.57E-11	0.8639	4	404.57	9.80	8.56E+04	4.95	2.49E-12	9.56	0.008	0.75
89													
90	4228	1089800	3.68E-11	0.8448	4	419.03	9.91	4.49E+04	4.13	3.93E-12	10.74	0.007	0.86
91	4238	8963500	4.39E-11	0.8349	4	430.02	10.15	3.31E+04	3.85	5.09E-12	11.54	0.008	0.93
92	4298	6970200	5.53E-11	0.8217	4	402.49	9.37	2.29E+04	3.32	6.21E-12	11.24	0.008	0.92
93	4239	5427300	6.91E-11	0.8091	4	397.51	9.36	1.64E+04	3.01	8.04E-12	11.63	0.008	0.96
94	4295	4269000	8.61E-11	0.7971	4	399.92	9.14	1.17E+04	2.75	1.04E-11	12.05	0.008	1.01
95	4182	3344200	1.09E-10	0.7857	4	378.43	9.05	8.29E+03	2.48	1.31E-11	12.36	0.008	1.05
96	4235	2809800	1.41E-10	0.7694	4	344.98	8.15	5.52E+03	2.12	1.69E-11	11.88	0.008	1.03
97	4245	2025100	1.87E-10	0.754	4	355.32	8.37	4.18E+03	2.08	2.43E-11	13.00	0.009	1.15
98	4119	1853400	2.39E-10	0.7411	4	343.3	8.33	2.94E+03	1.89	3.20E-11	13.44	0.009	1.21
99	3995	1179100	3.15E-10	0.7258	4	303.87	7.61	1.89E+03	1.60	4.00E-11	12.70	0.009	1.16
100	3754	891490	4.2E-10	0.7107	4	284.39	7.58	1.27E+03	1.44	5.39E-11	12.77	0.009	1.20

W/C = 0.60
7 Days of Hydration
Pore Solution: 10% Salt Solution

File No.	R _h (D)	R _h (D)	G (F)	Phi	Type	R ₁ (D) (Error)	R ₁ (D) (% Error)	R ₂ (D) (Error)	R ₂ (D) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
101	365.7	64636	5.55E-10	0.8661	4	279.56	7.86	505.78	1.40	7.510E-11	13.93	0.009	1.31
102	3228	46174	6.93E-10	0.8657	4	271.45	8.41	643.62	1.39	9.931E-11	14.33	0.010	1.42
103	2680	32028	7.62E-10	0.8646	4	271.98	10.15	491.38	1.53	1.223E-10	18.05	0.011	1.61
104	1896	21336	7.33E-10	0.863	4	286.51	14.63	415.98	1.95	1.427E-10	19.47	0.014	1.97
105	1249	13600	6.82E-10	0.7183	4	296.53	23.66	369.04	2.67	1.402E-10	24.11	0.017	2.41
106	646.5	8636	3.48E-10	0.758	4	268.97	44.46	324.86	3.76	1.012E-10	28.10	0.021	2.83
107	366.2	5991	4.89E-10	0.7439	4	265.99	53.06	223.66	3.73	1.136E-10	23.23	0.021	2.40
108	78.97	4303	4.69E-10	0.761	4	182.85	231.54	194.99	4.53	1.169E-10	25.67	0.020	2.65
109	189.1	3050	4.18E-10	0.7817	4	148.83	93.54	186.98	5.15	1.147E-10	27.46	0.022	2.79
110	315.6	2139	4.03E-10	0.8016	4	123.63	39.17	129.44	6.05	1.254E-10	31.09	0.025	3.10
111	400.3	1472	3.88E-10	0.8244	4	93.328	23.36	97.465	6.82	1.309E-10	33.75	0.027	3.27
112	434.9	1003	3.98E-10	0.8466	4	68.368	15.72	71.068	7.09	1.449E-10	36.57	0.029	3.43
113	428.8	700.9	5.29E-10	0.8512	4	46.711	10.89	48.613	6.94	1.941E-10	36.70	0.029	3.40
114	404.7	628.1	8.92E-10	0.8408	4	34.15	8.44	35.885	6.78	3.317E-10	37.20	0.029	3.47
115	366.2	427.9	1.41E-09	0.8283	4	31.071	8.07	32.699	7.62	6.042E-10	42.76	0.033	4.03
116	378.1	368.1	1.7E-09	0.8283	4	29.633	7.84	31.156	8.46	8.317E-10	48.90	0.036	4.59
117	370	329.3	1.97E-09	0.8272	4	28.883	7.81	30.412	9.24	1.063E-09	53.96	0.042	5.06
118	363.1	297.4	2.1E-09	0.8301	4	27.308	7.58	28.968	8.74	1.209E-09	57.57	0.044	6.36
119	365	271.9	2.2E-09	0.8332	4	26.496	7.46	27.963	10.26	1.339E-09	61.02	0.047	5.95
120	348.5	248.9	2.29E-09	0.8394	4	25.334	7.27	26.894	10.72	1.473E-09	64.37	0.050	5.92
121	343.1	228.6	2.38E-09	0.8401	4	24.123	7.03	25.427	11.12	1.614E-09	67.86	0.052	6.19
122	334.7	213.1	2.51E-09	0.8408	4	23.973	7.07	24.839	11.70	1.788E-09	71.11	0.055	6.49
123	331.4	194.1	2.49E-09	0.8485	4	21.961	6.63	23.167	11.94	1.899E-09	74.86	0.057	6.71
124	322.5	182.7	2.59E-09	0.8494	4	21.711	6.73	22.89	12.53	2.029E-09	78.10	0.060	7.01
125	311.2	167.7	2.74E-09	0.8681	4	20.053	6.44	21.189	13.42	2.338E-09	85.40	0.065	7.57
126	308.6	143.8	2.79E-09	0.8629	4	19.547	6.01	19.617	13.64	2.509E-09	90.07	0.068	7.86
127	299	145.3	5.43E-09	0.8219	4	22.306	7.46	23.644	16.27	5.499E-09	101.24	0.078	9.44
128	295	167.1	1.18E-08	0.7879	4	28.869	9.76	30.803	18.43	1.279E-08	108.08	0.085	11.01
129	300.1	203	1.89E-08	0.7287	4	37.937	12.64	40.572	19.99	2.043E-08	109.99	0.099	12.04

W/C = 0.60
34 Days of Hydration
Pore Solution: 10% Salt Solution

File No.	R ₁ (G)	R ₂ (G)	C (F)	Phi	Type	R ₁ (G) (Error)	R ₁ (G) (% Error)	R ₂ (G) (Error)	R ₂ (G) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	366.5	432.1	5.30E-09	0.751	4	58.873	15.23	62.348	14.43	4.12E-08	76.36	0.081	8.15
2	377.5	461.8	4.66E-09	0.752	4	62.868	16.60	65.891	14.27	3.16E-09	70.05	0.057	7.59
3	381.2	468.2	3.75E-09	0.763	4	61.331	16.09	64.303	13.84	2.57E-09	68.49	0.056	7.29
4	383.1	474	4.10E-09	0.757	4	63.754	16.64	66.974	14.13	2.84E-09	69.36	0.057	7.47
5	386.7	476.2	3.69E-09	0.763	4	62.28	16.02	65.408	13.74	2.46E-09	68.24	0.055	7.28
6	388.8	489.5	3.71E-09	0.760	4	64.86	16.72	67.875	13.67	2.52E-09	68.03	0.055	7.29
7	390.1	497.7	3.76E-09	0.758	4	65.871	16.83	68.987	13.66	2.59E-09	68.09	0.055	7.31
8	392.5	505	3.63E-09	0.760	4	66.263	16.69	69.608	13.78	2.47E-09	67.90	0.055	7.27
9	392.6	513.5	3.48E-09	0.761	4	68.408	16.91	69.678	13.57	2.29E-09	68.33	0.054	7.10
10	400.9	516.1	3.31E-09	0.764	4	65.15	16.25	68.439	13.26	2.16E-09	68.20	0.054	7.02
11	399.5	528.2	3.48E-09	0.760	4	67.916	17.00	71.352	13.51	2.33E-09	68.89	0.054	7.15
12	398.7	542	3.38E-09	0.760	4	69.51	17.43	72.98	13.46	2.23E-09	68.10	0.054	7.09
13	396.1	556.2	4.66E-09	0.736	4	60.974	20.81	65.186	14.53	3.22E-09	69.04	0.057	7.73
14	391	634.1	5.01E-09	0.728	4	65.349	21.83	69.943	14.16	3.37E-09	67.34	0.056	7.64
15	378.9	716.7	6.29E-09	0.707	4	100.26	26.46	105.64	14.71	4.22E-09	67.96	0.058	7.96
16	378.2	708.2	5.45E-09	0.708	4	101.08	26.75	106.7	13.37	3.36E-09	61.81	0.051	7.25
17	378.1	879.4	5.52E-09	0.703	4	107.08	28.32	113.26	12.86	3.30E-09	59.71	0.050	7.08
18	369.9	971.7	5.69E-09	0.698	4	114.38	30.92	127.69	12.47	2.86E-09	57.51	0.048	6.90
19	369.4	1057	5.12E-09	0.697	4	120.69	32.67	139.78	11.70	2.89E-09	55.14	0.046	6.66
20	361.4	1185	5.40E-09	0.688	4	131.4	36.36	151.63	11.30	3.00E-09	53.32	0.044	6.53
21	344.1	1342	5.62E-09	0.679	4	142.2	41.33	161.63	10.21	2.46E-09	50.86	0.042	6.09
22	351.1	1469	4.89E-09	0.695	4	140.02	39.86	150	10.21	2.46E-09	50.86	0.042	6.09
23	344.9	1667	5.11E-09	0.677	4	153.05	44.36	163.15	9.91	2.62E-09	51.24	0.042	6.15
24	343.8	1936	4.97E-09	0.673	4	174.16	50.66	189.22	9.77	2.60E-09	52.40	0.042	6.28
25	323.7	2500	5.70E-09	0.654	4	241.29	74.54	268.64	10.67	3.44E-09	60.42	0.048	7.36
26	228.5	3591	5.09E-09	0.645	4	325.46	143.69	368.81	10.21	3.14E-09	61.95	0.049	7.54
27	165.7	5196	3.48E-09	0.654	4	347.62	209.79	405.3	7.82	1.89E-09	54.41	0.041	6.32
28	35.56	7402	2.29E-09	0.667	4	354.04	694.77	429.5	5.80	1.03E-09	45.73	0.034	5.07
29	271.2	10519	2.01E-09	0.661	4	402.6	148.45	416.79	4.80	6.36E-10	41.71	0.030	4.59
30	539.1	14723	1.69E-09	0.663	4	417.5	77.44	592.45	3.96	6.10E-10	38.81	0.026	3.98
31	923.6	20306	1.37E-09	0.665	4	418.07	45.27	646.62	3.16	4.31E-10	31.46	0.022	3.32
32	1349	27653	1.21E-09	0.665	4	452.53	33.57	814.65	2.92	3.62E-10	29.85	0.021	3.11
33	1758	38121	8.92E-10	0.671	4	477.82	27.23	1039.5	2.73	2.77E-10	27.85	0.019	2.85
34	2271	51633	6.34E-10	0.678	4	512.54	22.57	1394.6	2.68	2.22E-10	26.81	0.018	2.87
35	2597	69402	6.39E-10	0.687	4	574.29	22.20	1991.3	2.87	1.73E-10	27.07	0.018	2.85
36	3034	94742	5.13E-10	0.685	4	623.5	20.55	2684.6	3.02	1.34E-10	26.19	0.016	2.52
37	4025	136630	4.17E-10	0.701	4	694.66	17.26	4647.4	3.32	1.04E-10	25.02	0.017	2.39
38	4805	198860	3.46E-10	0.707	4	829.32	17.26	7695.1	4.01	9.08E-11	26.26	0.016	2.48
39	5523	306910	1.45E-10	0.762	4	977.93	17.71	17729	4.65	3.70E-11	25.52	0.017	2.27
40	5965	479430	9.90E-11	0.772	4	1029.9	17.21	24878	5.19	2.44E-11	24.89	0.017	2.14
41	6945	616960	6.52E-11	0.795	4	1126.4	19.27	35981	5.83	1.66E-11	23.36	0.017	2.13
42	5108	791090	4.10E-11	0.831	4	1227.7	24.03	51189	6.55	1.10E-11	26.32	0.016	2.15
43	5478	997000	3.08E-11	0.836	4	1269.3	23.17	68655	6.95	7.76E-12	25.33	0.017	2.03
44	5965	1259400	2.30E-11	0.851	4	1320.6	22.44	95549	7.59	5.69E-12	24.74	0.017	1.99
45	4293	1611800	1.59E-11	0.879	4	2413.8	56.23	268990	17.91	7.53E-12	47.62	0.032	3.65
46	4931	1999000	9.99E-12	0.902	4	1802.6	30.47	454960	20.58	2.66E-12	28.57	0.018	1.99
47	3396	2209200	7.19E-12	0.925	4	2765.5	81.43	454960	20.58	3.74E-12	51.95	0.035	3.81
48	5964	3275500	7.07E-12	0.917	4	1732.4	30.43	447890	13.67	1.90E-12	26.93	0.018	1.99
49	5708	3749200	5.35E-12	0.931	4	1505.1	26.39	421990	11.28	1.16E-12	22.15	0.015	1.62

W/C = 0.60
34 Days of Hydration
Pore Solution: 10% Salt Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
51	6578	4504400	4.21E-12	0.9439	4	1483.6	22.55	5.42E+05	11.88	8.80E-13	20.88	0.014	1.51
52	5374	5474400	3.08E-12	0.9919	4	1496	27.65	6.39E+05	12.69	6.39E-13	20.63	0.014	1.46
53	5914	6603000	2.67E-12	0.9992	4	1496.3	27.90	9.72E+05	14.61	5.99E-13	20.64	0.014	1.47
54	5102	7326000	2.01E-12	0.9952	4	1496.3	26.19	1.01E+06	13.77	3.92E-13	19.46	0.013	1.35
55	5022	8605100	1.7E-12	0.9945	4	1637.9	30.62	1.30E+06	15.25	3.39E-13	19.75	0.013	1.36
56	5094	9809600	1.42E-12	1.005	4	1548.4	30.46	2.70E+06	16.36	2.70E-13	19.50	0.013	1.32
57	5166	1.2E+07	1.27E-12	1.01	4	1605.3	28.03	2.46E+06	18.81	2.46E-13	19.40	0.013	1.31
58	5763	1.1E+07	7.77E-13	1.043	4	1532.6	26.59	1.90E+06	16.63	1.51E-13	19.36	0.013	1.27
59	6131	1.2E+07	7.1E-13	1.049	4	2308.5	37.65	3.14E+06	26.08	2.08E-13	26.36	0.020	1.91
60	5791	1.5E+07	8.13E-13	1.035	4	1835.6	28.52	2.90E+06	19.18	1.46E-13	17.79	0.012	1.17
61	5976	1.7E+07	7.89E-13	1.036	4	1603.7	27.29	3.78E+06	21.66	1.46E-13	18.47	0.013	1.22
62	5931	1.6E+07	7.39E-13	1.04	4	1598.1	27.24	4.19E+06	22.67	1.33E-13	18.11	0.012	1.19
63	5925	1.7E+07	7.09E-13	1.042	4	1658.7	28.46	3.55E+06	21.16	1.34E-13	18.66	0.013	1.24
64	5795	1.7E+07	7.05E-13	1.042	4	1620.3	28.16	3.70E+06	21.36	1.30E-13	18.44	0.013	1.21
65	5441	1.6E+07	6.8E-13	1.045	4	1682	30.91	3.18E+06	20.35	1.32E-13	19.45	0.013	1.27
66	5624	1.5E+07	6.89E-13	1.044	4	1592.9	28.32	2.91E+06	18.69	1.29E-13	18.28	0.012	1.20
67	5742	1.7E+07	7.27E-13	1.04	4	1649.6	28.73	3.73E+06	21.72	1.37E-13	18.63	0.013	1.24
68	5702	1.6E+07	6.91E-13	1.044	4	1660.9	28.13	3.44E+06	20.91	1.32E-13	19.05	0.013	1.26
69	5892	1.6E+07	6.89E-13	1.044	4	1641.8	28.36	3.35E+06	20.68	1.31E-13	18.95	0.013	1.24
70	6065	1.7E+07	7.33E-13	1.04	4	1644.4	28.33	3.36E+06	20.69	1.29E-13	17.66	0.012	1.16
71	6004	1.6E+07	7.29E-13	1.041	4	1527	27.74	3.26E+06	21.69	1.29E-13	17.97	0.012	1.16
72	6011	1.6E+07	7.69E-13	1.038	4	1558.6	25.93	3.14E+06	19.78	1.39E-13	17.99	0.012	1.18
73	6350	1.4E+07	6.07E-13	1.036	4	1608.6	28.21	2.44E+06	17.55	1.43E-13	17.75	0.012	1.17
74	6296	1.3E+07	6.19E-13	1.028	4	1536.1	26.20	2.46E+06	18.21	1.69E-13	18.27	0.012	1.21
75	6302	1.4E+07	1.14E-12	1.015	4	1624.3	25.77	2.79E+06	20.39	2.20E-13	19.30	0.013	1.30
76	6228	1.2E+07	1.23E-12	1.012	4	1565.2	25.45	2.90E+06	17.78	2.39E-13	19.14	0.013	1.29
77	6700	2.2E+07	8.29E-12	0.9226	4	1397.7	16.07	9.20E+06	41.78	6.04E-13	16.36	0.011	1.21
78	6677	1.5E+07	6.78E-12	0.919	4	1343.9	15.67	4.32E+06	29.16	9.34E-13	16.25	0.011	1.21
79	6246	1.2E+07	6.29E-12	0.9146	4	1335.8	16.20	3.16E+06	23.00	1.04E-12	16.97	0.011	1.24
80	6207	1E+07	7.41E-12	0.9053	4	1319.2	16.07	2.41E+06	23.00	1.23E-12	16.90	0.011	1.25
81	6267	8653600	6.53E-12	0.9978	4	1307.3	15.76	1.72E+06	20.05	1.44E-12	16.86	0.012	1.28
82	6226	6947900	9.94E-12	0.9966	4	1263	15.35	1.19E+06	17.08	1.69E-12	16.72	0.011	1.28
83	6704	6007700	1.24E-11	0.8767	4	1200	13.79	9.09E+05	15.13	1.99E-12	16.12	0.011	1.25
84	6638	4639600	1.44E-11	0.8996	4	1170.4	13.65	5.97E+05	12.65	2.39E-12	16.26	0.011	1.27
85	6726	3798300	1.79E-11	0.897	4	1130.2	12.66	4.19E+05	11.01	2.89E-12	16.18	0.011	1.28
86	6605	3045700	2.23E-11	0.8437	4	1130.9	12.76	3.00E+05	9.84	3.71E-12	16.61	0.011	1.33
87	6605	2467700	2.7E-11	0.8336	4	1065.3	12.44	2.14E+05	8.69	4.52E-12	16.72	0.011	1.36
88	6609	2008100	3.52E-11	0.8185	4	1069	12.14	1.59E+05	7.87	5.95E-12	16.80	0.011	1.40
89	6766	1620700	4.33E-11	0.8073	4	1052.4	11.98	1.15E+05	7.12	7.52E-12	17.36	0.012	1.45
90	6624	1299600	6.42E-11	0.7951	4	1016.7	11.52	8.26E+04	6.36	9.51E-12	17.54	0.012	1.49
91	6761	1036000	6.97E-11	0.7811	4	986.16	11.25	5.90E+04	5.73	1.24E-11	17.63	0.012	1.53
92	6636	833590	8.69E-11	0.7681	4	970.96	11.24	4.41E+04	5.29	1.63E-11	16.43	0.012	1.61
93	6612	678100	1.18E-10	0.7515	4	940.84	10.56	3.26E+04	4.80	2.19E-11	16.53	0.012	1.65
94													
95	6470	432100	2.01E-10	0.7228	4	865.82	10.46	1.75E+04	4.06	3.90E-11	19.42	0.013	1.80
96	6367	342370	2.89E-10	0.71	4	814.94	9.74	1.21E+04	3.54	4.80E-11	18.93	0.013	1.78
97	7060	267380	3.31E-10	0.6964	4	752.35	9.42	8.39E+03	3.14	6.17E-11	18.67	0.012	1.79
98	7672	207410	4.22E-10	0.6835	4	716.99	8.35	5.88E+03	2.83	7.99E-11	18.83	0.013	1.85
99	7205	160380	5.34E-10	0.6715	4	691.96	9.80	4.23E+03	2.84	1.05E-10	19.56	0.013	1.96
100	6605	120040	5.91E-10	0.698	4	615.22	9.31	2.72E+03	2.26	1.12E-10	18.99	0.013	1.90

W/O = 0.60
34 Days of Hydration
Pore Solution: 16% Salt Solution

File No.	R ₁ (g)	R ₂ (g)	G (P)	Phi	Type	R ₁ (g) (Error)	R ₂ (g) (% Error)	R ₁ (g) (Error)	R ₂ (g) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
101	5908	89238	7.19E-10	0.8992	4	59732	9.34	1821.4	2.04	1.339E-10	18.60	0.013	1.91
102	5184	65114	7.39E-10	0.8911	4	48226	9.53	1197	1.84	1.3348E-10	18.09	0.012	1.86
103	4078	46542	6.51E-10	0.8741	4	45275	11.10	843.13	1.85	1.2416E-10	18.06	0.013	1.85
104	2808	30789	4.73E-10	0.7001	4	423.5	14.57	833.13	2.08	1.0012E-10	21.16	0.015	2.10
105	1972	20108	2.81E-10	0.7368	4	384.15	19.48	485.82	2.42	6.5162E-11	23.16	0.016	2.22
106	1364	13693	2.77E-10	0.7476	4	316.01	22.87	385.86	2.69	6.1085E-11	22.07	0.016	2.15
107	897.2	8983	3.07E-10	0.7465	4	278.02	28.54	307.08	3.08	6.7623E-11	22.01	0.016	2.19
108	675.7	7576	2.83E-10	0.7599	4	259.63	36.42	280.65	3.70	6.7895E-11	23.14	0.018	2.34
109	435.7	5705	2.76E-10	0.77	4	250.2	67.42	264.9	4.64	6.9302E-11	25.13	0.020	2.89
110	201.5	4220	2.71E-10	0.7815	4	228.35	113.33	236.63	5.65	7.323E-11	27.03	0.022	2.82
111	10.08	3091	3.23E-10	0.7848	4	194.06	1826.20	201.41	6.54	9.1714E-11	28.43	0.024	3.03
112	208.4	2210	4.15E-10	0.7888	4	147.65	70.85	152.98	8.92	1.2288E-10	29.59	0.025	3.15
113	311.8	1646	6.61E-10	0.7801	4	112.02	35.93	118.26	7.06	2.0156E-10	30.51	0.026	3.28
114	394.9	1298	9.73E-10	0.7765	4	89.354	23.21	93.17	7.18	3.2184E-10	33.09	0.027	3.52
115	412	1080	1.18E-09	0.7784	4	84.233	20.44	87.886	8.08	4.3883E-10	37.86	0.031	3.99
116	424.6	953.1	1.24E-09	0.7802	4	81.564	19.21	85.053	8.92	5.1827E-10	41.77	0.034	4.40
117	434.1	844.6	1.38E-09	0.7821	4	78.833	18.16	82.163	9.73	6.1728E-10	45.44	0.037	4.77
118	440	785.4	1.36E-09	0.7878	4	75.157	17.08	78.289	10.36	6.7163E-10	48.69	0.040	5.07
119	443	694.7	1.37E-09	0.7942	4	71.34	16.10	74.271	10.85	7.0203E-10	51.32	0.042	5.26
120	448.2	620.4	1.38E-09	0.7988	4	67.321	15.09	70.088	11.29	7.4807E-10	53.90	0.044	5.49
121	441.1	599.9	1.42E-09	0.8029	4	65.803	14.97	68.222	11.97	8.0807E-10	56.85	0.046	5.78
122	441.3	519.8	1.44E-09	0.8079	4	62.216	14.10	64.689	12.45	8.5885E-10	59.82	0.049	6.02
123	436.4	479.2	1.46E-09	0.812	4	59.784	13.64	62.156	13.00	9.1864E-10	62.86	0.051	6.28
124	434.1	444.4	1.53E-09	0.8136	4	56.629	13.51	60.935	13.71	1.0143E-09	66.26	0.054	6.61
125	432.8	410.7	1.53E-09	0.8186	4	55.947	12.83	58.15	14.16	1.0814E-09	69.25	0.058	6.84
126	426.4	379.6	1.55E-09	0.8228	4	53.868	12.55	56.005	14.79	1.1266E-09	72.73	0.059	7.13
127	426.3	351.4	1.55E-09	0.8277	4	51.832	12.16	53.851	15.32	1.1784E-09	76.06	0.061	7.39
128	417	339.9	2.17E-09	0.8097	4	58.228	13.48	58.489	17.20	1.8029E-09	83.26	0.068	8.34
129	400.9	381.2	4.22E-09	0.7852	4	71.21	17.78	74.136	20.52	3.8578E-09	91.33	0.076	9.89

W/C = 0.36
7 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (g)	R ₂ (g)	C (P)	Phi	Type	R ₁ (g) (Error)	R ₂ (g) (% Error)	R ₁ (g) (% Error)	R ₂ (g) (% Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)	
1	481.2	2390	8.76E-10	0.762	4	182.22	31.63	182.98	6.91	3.59E-10	40.99	0.032	4.19
2	488.7	2433	8.54E-10	0.763	4	183.23	30.86	184.53	6.76	3.51E-10	41.14	0.032	4.17
3	511.8	2524	7.80E-10	0.768	4	150.1	28.34	161.77	6.41	3.18E-10	40.46	0.031	4.04
4	539.5	2997	7.20E-10	0.773	4	144.29	28.75	156.13	6.01	2.83E-10	39.39	0.030	3.88
5	538.1	2716	7.21E-10	0.772	4	144.05	26.77	156.45	5.78	2.78E-10	38.91	0.029	3.78
6	548.9	2626	6.96E-10	0.773	4	141.7	25.82	154.96	5.47	2.62E-10	37.61	0.028	3.67
7	565.4	2993	6.93E-10	0.777	4	133.79	23.86	146.81	5.00	2.32E-10	35.48	0.027	3.42
8	568.7	3046	7.03E-10	0.772	4	137.49	24.26	151.33	4.97	2.51E-10	36.70	0.027	3.48
9	581.5	3178	7.10E-10	0.769	4	137.36	24.46	151.68	4.77	2.46E-10	34.69	0.026	3.36
10	546.5	3308	7.23E-10	0.768	4	139.58	25.40	154.41	4.67	2.46E-10	34.02	0.025	3.31
11	564.7	3416	6.89E-10	0.769	4	136.17	24.47	153.37	4.49	2.30E-10	33.35	0.025	3.22
12	548	3680	7.01E-10	0.765	4	143.33	26.16	159.6	4.45	2.33E-10	33.27	0.025	3.23
13	551.3	3804	7.24E-10	0.762	4	147.6	26.77	165.45	4.35	2.41E-10	33.23	0.025	3.22
14	521.2	4119	7.06E-10	0.768	4	154.92	29.72	174.83	4.24	2.46E-10	32.90	0.024	3.21
15	511.9	4498	7.38E-10	0.765	4	159.24	31.11	181.63	4.04	2.38E-10	32.41	0.024	3.15
16	511.6	4875	7.28E-10	0.764	4	159.92	31.26	184.4	3.78	2.28E-10	31.30	0.023	3.03
17	470	5312	7.46E-10	0.749	4	165.04	35.11	182.16	3.62	2.26E-10	30.47	0.022	2.98
18	450	5771	7.46E-10	0.746	4	166.37	37.42	186.42	3.44	2.23E-10	29.71	0.021	2.88
19	432.9	6279	7.25E-10	0.746	4	173.37	40.05	207.21	3.30	2.13E-10	29.42	0.021	2.84
20	407	6891	7.62E-10	0.740	4	177.18	43.53	215.52	3.13	2.18E-10	28.66	0.020	2.78
21	384.4	7605	7.89E-10	0.735	4	183.65	51.00	230.31	3.03	2.22E-10	28.29	0.020	2.75
22	315.2	8390	8.04E-10	0.731	4	184.89	61.83	248.47	2.95	2.26E-10	26.17	0.020	2.74
23	272.8	9228	8.39E-10	0.726	4	203.06	74.44	263.02	2.85	2.32E-10	27.82	0.020	2.71
24	221.6	10227	8.54E-10	0.722	4	213.89	98.52	285	2.79	2.36E-10	27.82	0.020	2.72
25	628.5	12419	8.89E-10	0.732	4	338.78	54.07	508.69	4.08	3.11E-10	48.31	0.031	4.24
26	130.2	17895	9.01E-10	0.702	4	591.04	124.33	818.72	3.46	3.31E-10	38.70	0.028	3.63
27	378.5	23953	7.89E-10	0.704	4	468.12	72.12	1136	3.66	2.86E-10	37.78	0.026	3.69
28	780.8	31825	8.32E-10	0.707	4	883.15	63.77	1678.5	3.71	2.19E-10	40.07	0.027	3.82
29	1230	42519	8.37E-10	0.710	4	981.4	63.77	1678.5	3.71	2.19E-10	40.07	0.027	3.82
30	1811	55982	4.42E-10	0.716	4	773.73	48.03	2224.1	3.99	1.85E-10	41.77	0.028	3.93
31	2045	71837	3.67E-10	0.722	4	924.4	45.20	3232.4	4.50	1.65E-10	44.90	0.030	4.17
32	2415	91397	3.02E-10	0.730	4	1029.8	42.64	4420.7	4.84	1.37E-10	45.53	0.030	4.17
33	2777	114120	2.50E-10	0.738	4	1109.4	39.95	5872.9	5.15	1.13E-10	46.29	0.030	4.10
34	3250	141730	2.13E-10	0.744	4	1246.9	38.34	8078.9	5.70	9.93E-11	46.72	0.031	4.19
35	3515	174140	1.74E-10	0.753	4	1345.5	38.26	10770	6.18	8.19E-11	47.18	0.031	4.17
36	3775	212490	1.43E-10	0.762	4	1455.5	38.56	14362	6.76	6.84E-11	47.77	0.032	4.17
37	4144	258610	1.20E-10	0.770	4	1578.1	38.03	19069	7.38	5.81E-11	48.35	0.032	4.18
38	4238	314290	9.89E-11	0.787	4	1915.3	36.83	24471	7.79	4.63E-11	48.87	0.031	4.00
39	4683	382380	8.51E-11	0.797	4	1713.5	37.47	32165	8.42	3.89E-11	48.42	0.031	3.94
40	4841	468370	7.02E-11	0.797	4	1814	38.13	42721	9.16	3.24E-11	48.29	0.031	3.86
41	4918	588980	6.57E-11	0.808	4	1888.4	38.36	59901	9.81	2.63E-11	48.41	0.030	3.78
42	5018	697580	4.35E-11	0.822	4	1987.6	39.61	74954	10.69	1.99E-11	48.35	0.030	3.70
43	5159	854180	3.42E-11	0.834	4	2030	39.35	85996	11.24	1.46E-11	43.67	0.028	3.52
44	5216	1046900	2.72E-11	0.845	4	2162.9	41.47	128680	12.34	1.19E-11	43.83	0.029	3.49
45	5842	1313600	2.28E-11	0.854	4	2362.5	40.44	183180	13.94	9.99E-12	44.42	0.030	3.51
46	5912	1682900	1.79E-11	0.868	4	2465.4	42.21	266210	15.82	7.91E-12	44.38	0.030	3.46
47	6007	2028100	1.40E-11	0.879	4	2561	43.36	344070	18.87	6.08E-12	43.49	0.029	3.35
48	6377	2517400	1.20E-11	0.896	4	2623.4	44.27	468860	19.92	5.40E-12	43.06	0.031	3.45
49	6037	3086200	9.34E-12	0.900	4	2721.6	45.08	660230	20.98	3.96E-12	42.25	0.029	3.19
50	6122	3791000	7.62E-12	0.911	4	2803.5	45.79	895530	23.35	3.19E-12	41.91	0.029	3.13

W/C = 0.36
7 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (G)	R ₂ (G)	G (P)	PHI	Type	R ₁ (G) (Error)	R ₁ (G) (% Error)	R ₂ (G) (Error)	R ₂ (G) (% Error)	G (P) (Error)	G (P) (% Error)	PHI (Error)	PHI (% Error)
51	6436	4684300	6.70E-12	0.9163	4	2894.1	46.62	1.29E+06	27.66	2.89E-12	42.62	0.026	3.19
52	6652	5229800	5.31E-12	0.9303	4	2674.4	50.83	1.48E+06	26.22	2.23E-12	42.00	0.029	3.08
53	6119	6932000	4.94E-12	0.933	4	3041.1	49.70	2.14E+06	32.90	2.04E-12	41.30	0.026	3.02
54	6311	7539700	4.34E-12	0.9397	4	3269.8	51.81	2.83E+06	37.57	1.87E-12	43.16	0.026	3.14
55	5903	6667400	3.51E-12	0.9328	4	3068.3	52.49	3.35E+06	36.67	1.43E-12	40.85	0.026	2.93
56	6085	6984100	3.18E-12	0.9571	4	3306.3	54.34	4.28E+06	43.34	1.34E-12	42.16	0.029	3.02
57	5760	1E+07	2.67E-12	0.968	4	3368.6	53.62	4.28E+06	41.34	1.08E-12	39.63	0.027	2.80
58	5698	1.2E+07	2.31E-12	0.9756	4	3278.3	55.60	5.81E+06	46.85	9.48E-13	40.98	0.026	2.87
59	5791	1.3E+07	2.13E-12	0.9803	4	3263.4	56.35	6.72E+06	50.17	8.65E-13	40.55	0.026	2.83
60	5468	1.7E+07	1.98E-12	0.9835	4	3317.6	60.70	1.06E+07	62.57	6.04E-13	40.47	0.026	2.82
61	5495	1.8E+07	1.81E-12	0.9893	4	3335	61.02	1.20E+07	65.22	7.35E-13	40.70	0.026	2.82
62	5345	1.8E+07	1.57E-12	0.9903	4	3231.1	60.45	1.11E+07	61.05	6.10E-13	39.44	0.027	2.71
63	5151	2.1E+07	1.59E-12	0.9965	4	3396.6	65.16	1.47E+07	70.92	6.47E-13	40.61	0.026	2.79
64	5750	1.9E+07	1.57E-12	0.9998	4	3462.2	60.56	1.23E+07	65.21	6.52E-13	41.43	0.026	2.85
65	5097	1.7E+07	1.44E-12	1.003	4	3198.7	63.80	9.18E+06	55.04	5.89E-13	39.62	0.027	2.69
66	4821	2E+07	1.43E-12	1.003	4	3198.7	62.12	1.80E+07	72.90	6.25E-13	39.78	0.027	2.73
67	5367	2.2E+07	1.57E-12	0.9998	4	3333.8	65.82	1.35E+07	67.34	6.03E-13	41.40	0.026	2.83
68	5064	1.9E+07	1.46E-12	1.002	4	3333.1	60.96	1.35E+07	67.34	5.94E-13	40.84	0.026	2.79
69	5065	2E+07	1.46E-12	1.002	4	3465.6	65.48	1.18E+07	63.16	5.94E-13	40.84	0.026	2.79
70	5160	1.9E+07	1.46E-12	1.002	4	3416.8	62.77	1.18E+07	60.94	5.44E-13	37.97	0.026	2.59
71	4770	1.9E+07	1.43E-12	1.003	4	3123.4	61.71	9.38E+06	56.42	6.13E-13	40.87	0.026	2.80
72	5435	1.7E+07	1.5E-12	0.9997	4	3411.3	62.77	1.42E+07	66.22	5.93E-13	40.87	0.027	2.67
73	5310	2.1E+07	1.52E-12	0.9998	4	3216.3	61.71	1.42E+07	66.22	5.93E-13	39.01	0.027	2.67
74	5428	1.7E+07	1.67E-12	0.9937	4	3277.4	60.36	9.57E+06	56.96	6.59E-13	39.95	0.027	2.73
75	5965	1.6E+07	1.75E-12	0.9921	4	3233.2	58.10	8.26E+06	53.24	6.79E-13	39.34	0.027	2.72
76	5460	1.5E+07	1.83E-12	0.9953	4	3235.1	59.25	7.54E+06	51.87	7.54E-13	40.04	0.027	2.77
77	5977	1.3E+07	2.13E-12	0.9789	4	3412.9	57.10	6.59E+06	50.56	8.98E-13	42.08	0.026	2.94
78	6186	1.3E+07	2.44E-12	0.9717	4	3362.8	54.33	6.89E+06	51.47	1.02E-12	41.58	0.026	2.93
79	6186	1E+07	2.73E-12	0.9654	4	3450.2	55.77	4.96E+06	44.24	1.10E-12	43.21	0.030	3.06
80	6416	1E+07	3.27E-12	0.9549	4	3432.8	53.50	4.86E+06	45.28	1.42E-12	43.41	0.030	3.11
81	6498	6823800	3.64E-12	0.9462	4	3311.4	51.20	3.36E+06	39.42	1.85E-12	42.60	0.029	3.07
82	5941	7445400	3.87E-12	0.9472	4	3102.2	52.22	2.80E+06	34.92	1.81E-12	41.49	0.028	2.99
83	6116	6188300	4.71E-12	0.9357	4	3174.5	51.90	1.97E+06	31.85	2.02E-12	42.97	0.029	3.14
84	6960	5336100	5.41E-12	0.9278	4	3209.7	46.79	1.59E+06	29.64	2.39E-12	44.00	0.030	3.23
85	6929	4811300	6.71E-12	0.9153	4	3185	45.81	1.39E+06	23.62	2.96E-12	44.14	0.030	3.29
86	6465	3864400	7.23E-12	0.9127	4	2862	44.53	9.44E+05	23.81	3.04E-12	42.08	0.029	3.14
87	6347	3260700	8.37E-12	0.9046	4	2665.5	46.72	7.26E+05	22.14	3.71E-12	44.36	0.030	3.33
88	6786	2777200	9.86E-12	0.895	4	2628.1	43.14	5.67E+05	20.41	4.89E-12	45.11	0.031	3.42
89	6908	2262100	1.12E-11	0.8995	4	2609.9	42.62	4.04E+05	17.88	5.09E-12	46.08	0.031	3.43
90	6831	1973200	1.4E-11	0.877	4	2716.1	40.66	3.32E+05	16.83	6.27E-12	44.85	0.030	3.46
91	6287	1622700	1.62E-11	0.8701	4	2655.9	40.65	2.42E+05	14.92	7.10E-12	44.32	0.030	3.44
92	6831	1399800	1.89E-11	0.8696	4	2593.5	39.11	1.94E+05	14.27	9.24E-12	46.95	0.031	3.68
93	6408	1127300	2.37E-11	0.8491	4	2574	40.16	1.51E+05	13.36	1.14E-11	48.14	0.032	3.61
94	6259	826240	2.84E-11	0.8397	4	2523.5	39.69	1.15E+05	12.41	1.67E-11	48.50	0.033	3.96
95	6259	759850	3.43E-11	0.8302	4	2345.7	37.48	8.44E+04	11.13	1.87E-11	49.64	0.033	3.93
96	6024	625770	4.22E-11	0.8182	4	2348.4	39.00	6.71E+04	10.73	2.17E-11	51.36	0.034	4.20
97	518500	437180	6.99E-11	0.6109	4	2244.8	36.13	5.10E+04	9.87	2.89E-11	51.84	0.035	4.27
98	5786	437180	6.18E-11	0.7069	4	2227.5	38.50	3.44E+04	9.47	3.34E-11	54.00	0.036	4.51
99	5437	363650	7.39E-11	0.791	4	2026.7	37.26	3.05E+04	8.48	3.86E-11	62.19	0.035	4.40
100	5123	280330	8.61E-11	0.7837	4	1992.4	36.70	2.34E+04	8.07	4.67E-11	64.28	0.036	4.61

W/C = 0.36
7 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (d)	R ₂ (d)	C (F)	Phi	Type	R ₁ (d) (Error)	R ₁ (d) (% Error)	R ₂ (d) (Error)	R ₂ (d) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
101	5089	240320	1.05E-10	0.7733	4	1832.4	36.17	17519	7.26	5.5333E-11	52.78	0.035	4.54
102	4626	186950	1.2E-10	0.7677	4	1760.1	36.05	13710	6.90	6.491E-11	54.15	0.036	4.60
103	4169	164250	1.35E-10	0.7631	4	1647.9	39.72	10584	6.44	7.3326E-11	54.34	0.036	4.74
104	3664	136710	1.42E-10	0.7634	4	1421.9	36.81	7630.5	5.62	7.206E-11	50.86	0.034	4.43
105	3668	113180	1.71E-10	0.7534	4	1348.8	37.80	5882	5.29	8.6808E-11	50.50	0.034	4.47
106	2620	93032	1.71E-10	0.7573	4	1185.4	40.94	4483.7	4.82	8.402E-11	49.13	0.033	4.32
107	2624	77171	1.91E-10	0.7534	4	1105.7	43.12	3512.4	4.55	9.2808E-11	48.98	0.032	4.31
108	2251	64034	2.14E-10	0.7469	4	988.27	43.90	2682.1	4.19	9.8211E-11	46.35	0.031	4.14
109	1878	52627	2.21E-10	0.7508	4	861.7	45.86	2028.7	3.84	9.703E-11	43.66	0.029	3.92
110	1511	43398	2.18E-10	0.7554	4	782.62	46.81	1593.9	3.61	9.1539E-11	41.83	0.028	3.74
111	1185	35987	2.3E-10	0.7559	4	629.83	52.71	1189.3	3.25	8.7778E-11	39.19	0.026	3.42
112	727.7	29707	2.14E-10	0.7656	4	548.15	75.33	907.91	3.16	7.9975E-11	37.37	0.025	3.31
113	619.4	23433	2.25E-10	0.7698	4	466.7	69.65	704.4	3.01	7.8147E-11	34.68	0.024	3.09
114	171.2	18840	2.14E-10	0.7759	4	384.24	224.44	539.15	2.86	6.9108E-11	32.27	0.022	2.86
115	36.95	15139	2.08E-10	0.7846	4	327.1	694.94	431.06	2.85	6.3423E-11	30.99	0.021	2.73
116	221.6	12147	2.12E-10	0.7892	4	265.84	119.88	333.77	2.75	6.0277E-11	28.50	0.020	2.52
117	317.1	9681	2.42E-10	0.7973	4	231.99	73.16	261.99	2.82	6.7102E-11	27.70	0.020	2.48
118	264	8992	4.59E-10	0.7549	4	201.14	76.19	244.53	2.72	1.1638E-10	25.37	0.018	2.40
119	240.6	8378	7.65E-10	0.7304	4	188.42	69.17	208.12	2.46	1.7351E-10	22.68	0.016	2.22
120	322.4	7480	7.80E-10	0.7353	4	134.75	41.80	165.95	2.24	1.6494E-10	20.72	0.015	2.01
121	376.6	6883	7.51E-10	0.7439	4	121.39	32.23	147.78	2.24	1.545E-10	20.59	0.015	1.98
122	417.2	5937	7.58E-10	0.7489	4	116.23	27.86	139.22	2.34	1.5842E-10	20.97	0.015	2.02
123	489.2	5418	7.11E-10	0.7544	4	111.57	23.78	132.24	2.44	1.5396E-10	21.84	0.016	2.06
124	476	5041	7.31E-10	0.7549	4	110.81	23.26	129.93	2.59	1.6293E-10	22.30	0.016	2.13
125	518.2	4885	7.02E-10	0.7608	4	109	21.12	126.94	2.71	1.6367E-10	23.29	0.017	2.21
126	525.7	4408	7.19E-10	0.7612	4	107.87	20.52	124.99	2.83	1.7182E-10	23.87	0.017	2.27
127	546.3	4144	7.02E-10	0.7653	4	107.24	19.67	123.21	2.97	1.7415E-10	24.62	0.016	2.36
128	534.5	3939	7.13E-10	0.7656	4	106.41	19.91	121.45	3.06	1.7963E-10	25.24	0.018	2.40
129	521.2	3603	7.69E-10	0.7607	4	111.52	21.40	126.81	3.33	2.1014E-10	26.73	0.020	2.57
130	524.2	3797	9.8E-10	0.7499	4	123.71	23.60	141.36	3.72	2.8958E-10	28.74	0.022	2.91
131	489.9	4108	1.29E-09	0.732	4	139.64	26.62	161.95	3.94	3.9402E-10	31.64	0.023	3.18
132	460	4601	1.39E-09	0.7249	4	150.65	30.79	178.31	3.68	4.3816E-10	32.42	0.024	3.26
133	442.8	5385	1.51E-09	0.7125	4	163.81	36.99	198.27	3.70	4.8085E-10	31.75	0.023	3.24
134	394.7	6326	1.89E-09	0.7047	4	174.39	44.18	217.74	3.44	4.8714E-10	30.74	0.022	3.15
135	332.1	7300	1.64E-09	0.6975	4	183.53	55.35	236.17	3.16	4.8194E-10	29.41	0.021	3.02
136	227.5	8888	1.78E-09	0.6891	4	197.34	86.74	268.4	2.99	4.8894E-10	28.43	0.020	2.94
137	195.4	10375	1.7E-09	0.696	4	207.55	105.22	294.17	2.84	4.7332E-10	27.95	0.020	2.87

WFO = 0.36
7 Days of Hydration
Synthetic Pure Solution

File No.	R ₁ (g)	R ₂ (g)	C (P)	Phi	Type	R ₁ (g) (Error)	R ₂ (g) (% Error)	R ₂ (g) (Error)	R ₂ (g) (% Error)	C (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
1	330.5	4236	1.30E-10	0.843	4	183.15	55.42	202.93	4.70	4.91E-11	35.95	0.026	3.11
2	351.8	4236	1.44E-10	0.840	4	186.11	52.90	208.21	4.87	5.22E-11	36.34	0.027	3.16
3	270.8	4361	1.59E-10	0.831	4	204.64	75.57	226.28	5.17	5.99E-11	37.62	0.026	3.33
4	270.3	4498	1.67E-10	0.831	4	207.87	76.90	230.36	5.16	5.99E-11	37.66	0.026	3.33
5	262.8	4634	1.41E-10	0.837	4	207.16	70.80	230.22	5.08	5.40E-11	36.27	0.026	3.33
6	263.7	4645	1.43E-10	0.836	4	208.19	73.38	231.82	5.08	5.40E-11	37.85	0.026	3.30
7	263	4751	1.42E-10	0.836	4	208.95	73.83	233.41	4.91	5.37E-11	37.72	0.027	3.28
8	310.5	4835	1.39E-10	0.837	4	203.96	63.69	228.89	4.73	5.10E-11	37.12	0.027	3.21
9	268.2	4687	1.34E-10	0.839	4	208.91	71.79	232.65	4.69	4.97E-11	37.15	0.027	3.20
10	407	4680	1.29E-10	0.843	4	193.15	47.46	219.09	4.42	4.70E-11	36.33	0.026	3.09
11	362.5	5100	1.30E-10	0.840	4	182.66	50.37	219.16	4.30	4.70E-11	35.47	0.026	3.03
12	294.5	5390	1.48E-10	0.831	4	216.91	82.01	247.25	4.80	5.89E-11	37.66	0.027	3.26
13	215.7	5711	1.63E-10	0.824	4	235.1	108.99	270.62	4.74	6.48E-11	39.56	0.026	3.44
14	240.3	6059	1.69E-10	0.822	4	225.49	93.64	263.08	4.34	6.22E-11	37.52	0.027	3.25
15	93.5	6980	2.00E-10	0.807	4	253.09	270.68	288.62	4.47	7.74E-11	38.73	0.026	3.42
16	372.1	6971	1.71E-10	0.821	4	216.47	56.16	264.56	3.80	6.19E-11	36.04	0.026	3.07
17	232.4	7685	1.94E-10	0.810	4	242.29	104.26	303.07	3.85	7.22E-11	37.31	0.026	3.22
18	103.5	8615	2.10E-10	0.803	4	250.92	115.31	322.46	3.73	7.79E-11	37.03	0.026	3.21
19	48.67	10665	2.36E-10	0.793	4	269.72	260.60	356.66	3.71	8.64E-11	37.46	0.026	3.27
20	0.68876	11918	2.29E-10	0.793	4	263.94	608.40	360.15	3.65	8.70E-11	36.08	0.026	3.30
21	278.2	13434	3.04E-10	0.789	4	332.29	45182.87	431.93	3.62	8.77E-11	36.37	0.026	3.35
22	1029	21140	3.08E-09	0.625	4	1086.8	119.44	463.87	3.68	1.19E-10	36.81	0.027	3.46
23	1415	25959	1.46E-09	0.665	4	960.07	108.59	1326.8	11.46	3.18E-09	102.01	0.070	11.21
24	1604	30519	1.80E-09	0.689	4	645.18	39.48	1749.2	5.73	6.99E-10	48.21	0.033	4.92
25	267	37275	1.80E-09	0.695	4	789.25	39.90	1749.2	5.73	7.79E-10	51.71	0.036	5.31
26	2606	47503	1.63E-09	0.637	4	910.97	34.94	2435.3	6.53	8.43E-10	56.13	0.036	5.77
27	3468	58982	1.64E-09	0.640	4	1070.3	35.84	5322.9	8.92	1.09E-09	66.20	0.040	6.24
28	4030	73664	1.39E-09	0.646	4	1228.2	35.44	7463.3	10.13	1.09E-09	64.58	0.043	6.74
29	4271	86068	1.10E-09	0.658	4	1377.7	34.02	9893.5	11.11	9.47E-10	66.45	0.046	7.05
30	4442	100030	7.71E-10	0.676	4	1416.3	34.71	11787	11.44	7.86E-10	71.07	0.047	7.20
31	4271	120800	6.03E-10	0.688	4	1565.6	36.66	15310	12.66	5.46E-10	70.74	0.047	6.93
32	4442	140400	4.23E-10	0.707	4	1625.1	36.58	18323	13.05	4.46E-10	74.26	0.049	7.14
33	4817	160000	3.27E-10	0.720	4	1734.5	36.01	22595	13.65	3.11E-10	73.65	0.049	6.97
34	4845	187770	2.39E-10	0.737	4	1827.2	36.95	27394	14.57	2.43E-10	74.46	0.049	6.82
35	4896	261940	1.82E-10	0.763	4	1807.6	36.49	32967	14.74	1.79E-10	75.11	0.049	6.71
36	5081	309700	1.11E-10	0.779	4	1891.3	39.15	42065	16.07	1.09E-10	71.99	0.047	6.17
37	5221	312660	8.02E-11	0.787	4	2025.1	36.76	52433	16.77	8.22E-11	74.05	0.049	6.24
38	5614	369700	6.74E-11	0.816	4	2233.1	40.82	66973	18.75	5.79E-11	71.90	0.047	5.93
39	5614	421800	4.40E-11	0.829	4	2260.7	41.36	82713	18.75	4.42E-11	77.00	0.051	6.20
40	15123	1260000	3.60E-10	0.696	4	2405.7	18.33	76256	6.29	1.13E-10	31.43	0.022	5.92
41	14126	1626100	2.89E-10	0.696	4	2667.6	18.81	111750	6.87	3.29E-11	31.73	0.023	5.26
42	14861	2090000	2.26E-10	0.709	4	2968.8	19.34	156240	7.44	1.13E-10	31.74	0.023	5.22
43	15241	2687500	1.74E-10	0.724	4	2968.8	19.61	206300	7.75	7.18E-11	30.70	0.022	5.06
44	15363	3395100	1.29E-10	0.741	4	3120.6	20.29	279770	8.20	5.39E-11	30.52	0.022	5.06
45	15636	4306000	7.46E-11	0.755	4	3218.7	20.72	373900	8.66	3.96E-11	29.86	0.022	2.89
46	15963	5354600	1.07E-10	0.772	4	3277.6	20.90	477430	8.82	3.02E-11	27.71	0.022	2.73
47	16228	6609600	5.83E-11	0.786	4	3265.8	21.58	646760	9.36	1.62E-11	27.71	0.020	2.59
48	14639	8341500	4.44E-11	0.803	4	3344.4	22.84	816120	9.77	1.22E-11	27.44	0.020	2.52
49	14751	1E+07	3.81E-11	0.814	4	3371.3	22.85	1072600	10.26	9.58E-12	26.97	0.020	2.42

W/O = 0.36
7 Days of Hydration
Synthetic Pore Solution

File No.	R ₁ (g)	R ₂ (g)	C (°)	Phi	Type	R ₁ (g) (Error)	R ₂ (g) (Error)	R ₃ (g) (Error)	C (°) (Error)	C (°) (Error)	G (°) (Error)	Phi (Error)	Phi (% Error)
51	14041	1.3E+07	2.65E-11	0.8339	4	3161.7	22.52	1.33E+08	10.22	6.54E-12	24.68	0.018	2.20
52	14476	1.7E+07	2.25E-11	0.842	4	3235.3	22.35	1.82E+08	10.90	5.37E-12	23.84	0.018	2.11
53	13919	2E+07	1.8E-11	0.8539	4	3268.8	23.48	2.31E+08	11.53	4.27E-12	23.70	0.018	2.07
54	13932	2.7E+07	1.52E-11	0.8646	4	3282.2	23.59	3.48E+08	12.79	3.43E-12	22.54	0.017	1.96
55	13980	3.2E+07	1.21E-11	0.8764	4	3181.6	23.54	4.10E+08	12.85	2.80E-12	21.53	0.016	1.84
56	13011	4E+07	1.03E-11	0.8878	4	3197.7	24.56	5.74E+08	14.18	2.23E-12	21.29	0.016	1.81
57	13273	5.8E+07	8.85E-12	0.8911	4	3287.8	24.77	1.08E+09	18.52	2.08E-12	21.07	0.016	1.80
58	11507	8.0E+07	6.74E-12	0.9186	4	3036.7	24.85	8.94E+08	18.13	1.26E-12	19.98	0.014	1.57
59	11814	1E+08	6.43E-12	0.918	4	3031.6	25.69	2.43E+09	23.69	1.22E-12	19.02	0.015	1.59
60	12202	1.3E+08	6.84E-12	0.9149	4	3077	25.22	3.80E+09	28.25	1.25E-12	18.85	0.014	1.58
61	12599	1.3E+08	6.78E-12	0.9134	4	3068.8	25.53	3.70E+09	28.54	1.33E-12	19.61	0.015	1.65
62	11985	9.7E+07	5.9E-12	0.9228	4	2989.9	25.28	2.08E+09	21.63	1.12E-12	18.92	0.014	1.56
63	12514	8.0E+07	6.08E-12	0.9203	4	3051.9	24.39	1.72E+09	19.43	1.15E-12	18.95	0.014	1.57
64	11794	2.5E+08	5.91E-12	0.9274	4	3107.3	26.37	1.18E+09	47.72	1.04E-12	18.84	0.014	1.59
65	12008	1.8E+08	5.85E-12	0.9248	4	2925.3	24.37	5.85E+08	32.88	9.97E-13	17.64	0.014	1.47
66	11359	1.3E+08	5.34E-12	0.9308	4	2894.5	26.40	3.28E+09	24.85	9.45E-13	18.04	0.014	1.48
67	11297	8.5E+07	5.12E-12	0.9325	4	2804	25.71	1.59E+09	18.39	9.82E-13	18.79	0.014	1.53
68	12986	1.7E+08	6.82E-12	0.9109	4	3047.1	26.38	6.89E+09	38.17	1.38E-12	18.98	0.015	1.69
69	11909	1.2E+08	5.74E-12	0.9242	4	3212.8	26.98	2.85E+09	24.91	1.15E-12	19.73	0.015	1.64
70	12079	7.7E+07	6.39E-12	0.9181	4	3005	24.89	1.40E+09	18.01	1.21E-12	19.05	0.015	1.58
71	10262	8.1E+07	5.08E-12	0.9352	4	2897.2	27.43	1.48E+09	28.10	1.68E-12	22.84	0.017	1.80
72	10916	4.2E+07	6.08E-12	0.9233	4	2867.2	27.18	1.12E+09	28.77	1.46E-12	23.89	0.018	1.91
73	11633	3.8E+07	7.18E-12	0.9128	4	3018.8	25.95	9.87E+08	28.00	1.74E-12	24.17	0.018	1.95
74	11379	2.8E+07	7.48E-12	0.9119	4	2893.7	26.31	5.78E+08	20.93	1.86E-12	24.95	0.018	2.01
75	11740	2.8E+07	6.08E-12	0.9098	4	3025.5	26.77	5.48E+08	21.09	2.26E-12	25.12	0.018	2.05
76	12038	2E+07	1.05E-11	0.8908	4	3083.7	25.37	3.63E+08	18.30	2.73E-12	25.85	0.019	2.13
77	11691	1.5E+07	1.2E-11	0.8835	4	2893.7	25.35	2.47E+08	15.99	3.16E-12	26.26	0.019	2.17
78	12270	1.3E+07	1.48E-11	0.8708	4	3139.4	25.69	2.12E+08	15.93	4.15E-12	27.97	0.020	2.34
79	12217	1E+07	1.7E-11	0.8632	4	2938.8	24.05	1.44E+08	13.78	4.88E-12	27.39	0.020	2.30
80	12701	893000	2.13E-11	0.8497	4	3070.4	24.17	1.16E+08	13.45	6.20E-12	28.12	0.021	2.48
81	12807	708900	2.87E-11	0.8382	4	3018.2	23.57	8.99E+05	12.10	7.85E-12	29.41	0.021	2.54
82	12855	5761800	3.3E-11	0.824	4	3088.2	24.17	6.89E+05	11.29	1.02E-11	31.00	0.022	2.70
83	12945	4713900	4.08E-11	0.8121	4	2988.6	23.10	5.32E+05	11.17	1.27E-11	31.16	0.022	2.75
84	13980	3103900	7.47E-11	0.7755	4	3188.4	22.78	3.57E+05	11.51	2.81E-11	34.98	0.025	3.22
85	14279	2812700	1.07E-10	0.7638	4	3192.7	22.39	3.18E+05	11.29	3.82E-11	35.63	0.025	3.37
86	14675	2418900	1.54E-10	0.7322	4	3257.5	22.20	2.78E+05	11.51	5.72E-11	37.09	0.029	3.62
87	14719	2038900	2.17E-10	0.7121	4	3197.7	21.72	2.31E+05	11.31	6.17E-11	37.56	0.027	3.76
88	15097	1439900	4.28E-10	0.6732	4	3118.2	20.65	1.58E+05	11.02	8.17E-11	39.42	0.028	4.16
89	14513	1182400	5.99E-10	0.6581	4	2941.2	20.27	1.24E+05	10.38	1.68E-10	39.98	0.028	4.20
90	14168	995990	7.44E-10	0.6419	4	2843.2	20.07	1.00E+05	10.04	2.17E-10	39.49	0.028	4.36
91	13518	828930	9.12E-10	0.6316	4	2646.8	19.58	7.50E+04	9.27	3.58E-10	39.27	0.028	4.39
92	12386	644790	1.05E-09	0.6253	4	2423.8	19.57	5.40E+04	8.37	4.11E-10	38.94	0.027	4.38
93	11765	528990	1.31E-09	0.6145	4	2218.8	18.61	4.08E+04	7.72	5.01E-10	38.17	0.027	4.36
94	11140	443790	1.57E-09	0.6028	4	1977.2	18.18	3.29E+04	7.42	6.10E-10	38.95	0.027	4.51
95	10587	370990	1.78E-09	0.6019	4	1877.2	18.71	2.54E+04	6.86	6.75E-10	38.61	0.027	4.49
96	9488	310340	1.91E-09	0.5998	4	1734.5	18.27	1.86E+04	6.09	7.00E-10	38.61	0.028	4.27
97	8935	288900	2.18E-09	0.5943	4	1618.1	18.09	1.47E+04	5.85	7.82E-10	38.24	0.028	4.26
98	3147	222170	2.85E-09	0.594	4	1164.1	16.99	3.30E+03	1.48	3.07E-10	10.78	0.009	1.48
99	1305	178930	2.8E-09	0.5964	4	1110.3	95.08	2.70E+03	1.50	3.01E-10	11.55	0.009	1.56
100	162	145970	2.32E-09	0.6108	4	1045.9	574.87	2.21E+03	1.52	2.84E-10	12.25	0.010	1.52

W/C = 0.36
7 Days of Hydration
Synthetic Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (%) Error	R ₂ (Q) (Error)	R ₂ (Q) (%) Error	G (F) (Error)	G (F) (%) Error	Phi (Error)	Phi (%) Error
101	1275	119170	2.00E-09	0.8244	4	965.32	75.71	1808.7	1.52	2.5049E-10	12.60	0.010	1.84
102	2488	98219	1.62E-09	0.8494	4	1047.8	42.11	1748.3	1.82	2.5292E-10	15.54	0.013	1.86
103	2801	76280	1.32E-09	0.8897	4	771.32	28.85	1180.5	1.56	1.8097E-10	13.66	0.011	1.86
104	2972	62330	1.00E-09	0.8970	4	722.01	24.29	1024.9	1.64	1.9019E-10	14.29	0.012	1.89
105	3270	49172	8.79E-10	0.7087	4	688.13	21.07	901.83	1.83	1.3674E-10	15.47	0.013	1.79
106	3440	39771	7.08E-10	0.7287	4	679.78	19.78	838.45	2.11	1.2039E-10	17.05	0.014	1.94
107	3988	30394	3.89E-10	0.7768	4	917.54	22.85	1098.8	3.52	1.0693E-10	27.55	0.023	2.94
108	3281	23449	4.1E-10	0.7777	4	863.54	21.27	773.44	3.30	9.2062E-11	22.44	0.019	2.46
109	3054	18143	3.17E-10	0.7982	4	746.42	24.12	804.89	4.43	8.3049E-11	26.26	0.023	2.87
110	2944	14026	2.99E-10	0.8183	4	847.86	32.07	888.73	8.34	7.8188E-11	30.56	0.028	3.43
111	1798	11634	2.80E-10	0.8011	4	978.2	55.70	1009.2	8.67	8.902E-11	30.36	0.030	3.80
112	250.6	11251	8.03E-10	0.7198	4	1126.9	449.88	1152.2	10.24	1.848E-10	22.96	0.027	3.78
113	880.2	8887	7.17E-10	0.7418	4	975.48	108.58	988.34	10.44	1.867E-10	25.89	0.029	3.97
114	322.1	6219	9.52E-10	0.7183	4	1193.1	370.41	1216	13.19	2.4714E-10	4.52	0.032	4.52
115	223.3	6081	1.25E-09	0.6917	4	1428.6	940.21	1452.8	16.03	3.1539E-10	26.26	0.035	5.01
116	883.1	9116	1.59E-09	0.687	4	1788.2	204.86	1782.8	19.87	3.8807E-10	24.32	0.037	5.54
117	1088	8827	1.73E-09	0.6894	4	1847.9	182.73	1970.9	22.33	4.2419E-10	24.46	0.038	5.82
118	2332	9731	2.18E-09	0.8237	4	2840.1	121.79	2885.3	29.45	5.5012E-10	25.09	0.042	6.87
119	3189	10283	2.39E-09	0.8057	4	3610.3	113.83	3636.2	35.43	6.9698E-10	26.06	0.044	7.19
120	4723	11593	2.8E-09	0.5753	4	5188.2	110.08	5226.4	45.08	1.132E-09	40.47	0.045	7.86
121	6388	13225	3.68E-09	0.5403	4	7137.8	111.72	7170.5	54.22	1.983E-09	54.57	0.048	8.55
122													
123	2188	9489	8.91E-09	0.5401	4	2980.5	138.18	3030	31.93	2.308E-09	25.89	0.046	8.50
124	1387	9804	8.07E-09	0.5821	4	2134.9	153.82	2176.8	22.90	2.0841E-09	25.44	0.042	7.46
125	1834	9139	9.23E-09	0.603	4	1305	7889.98	1347.1	14.74	1.8173E-09	28.18	0.037	6.18
126	633.6	9825	4.3E-09	0.641	4	902.52	98.67	944.59	9.82	1.2807E-09	29.34	0.032	4.98
127	1882	10443	3.02E-09	0.6708	4	685.18	43.94	738.37	7.07	6.3172E-10	27.80	0.027	4.08
128	2104	11752	2.22E-09	0.6941	4	564.25	28.34	588.28	5.09	5.383E-10	24.21	0.023	3.27
129	2440	13886	2.08E-09	0.6974	4	518.88	21.19	570.32	4.12	4.683E-10	22.80	0.020	2.83
130	2889	18674	1.43E-09	0.7219	4	375.67	12.70	421.88	2.68	2.4289E-10	16.97	0.016	2.05
131	3089	18180	1.43E-09	0.7181	4	387.83	12.51	444.74	2.44	2.3848E-10	16.47	0.014	1.88
132	3405	21105	1.32E-09	0.7208	4	322.82	9.48	380.2	1.80	1.733E-10	13.14	0.011	1.55
133	3785	22688	1.12E-09	0.7289	4	235.62	6.27	284.2	1.19	1.0431E-10	9.30	0.008	1.07
134	5888	31818	1.28E-09	0.7312	4	590.08	10.03	853.01	2.88	3.2589E-10	25.47	0.020	2.80
135	4838	38588	1.48E-09	0.7017	4	282.03	6.23	385.28	1.02	1.3272E-10	9.07	0.007	1.05
136	4387	45785	1.74E-09	0.8533	4	339.23	7.73	489.94	1.09	1.8819E-10	9.84	0.008	1.15
137	4878	53480	1.81E-09	0.8781	4	438.03	9.57	688.28	1.28	2.0784E-10	11.44	0.009	1.37

W/C = 0.36
28 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
1	302.2	4507	4.27E-10	0.765	4	172.7	44.03	194.39	4.31	1.40E-10	34.97	0.029	3.25
2	393.5	4791	4.10E-10	0.765	4	156.03	39.85	177.01	3.70	1.20E-10	30.83	0.022	2.85
3	343.8	5044	5.07E-10	0.771	4	187.73	46.88	180.37	3.58	1.51E-10	29.81	0.022	2.81
4	321.4	5282	6.10E-10	0.759	4	180.84	49.98	185.21	3.51	1.79E-10	29.29	0.021	2.81
5	249.9	5588	7.11E-10	0.747	4	187.84	67.16	194.41	3.48	2.05E-10	28.77	0.021	2.81
6	228.1	5888	7.86E-10	0.739	4	175	76.39	204.23	3.46	2.20E-10	28.80	0.021	2.84
7	182.7	6282	8.47E-10	0.732	4	188	88.52	218.87	3.46	2.40E-10	29.27	0.021	2.81
8	130.4	6828	8.34E-10	0.731	4	188.83	144.91	223.24	3.47	2.30E-10	28.47	0.021	2.83
9	78.78	6960	8.23E-10	0.729	4	188.17	255.59	233	3.33	2.34E-10	28.40	0.021	2.83
10	10.31	7382	8.52E-10	0.725	4	197.25	1209.38	235.88	3.21	2.75E-10	27.82	0.020	2.75
11	21.98	7703	8.51E-10	0.724	4	208.6	939.85	249.19	3.23	2.40E-10	28.19	0.020	2.81
12	48.63	8037	8.59E-10	0.722	4	212.87	437.32	258.6	3.22	2.43E-10	28.40	0.020	2.84
13	89.6	8810	8.30E-10	0.716	4	228.88	252.99	280.89	3.28	2.74E-10	29.48	0.021	2.88
14	180.8	9324	8.71E-10	0.712	4	243.85	136.02	307.89	3.30	2.84E-10	30.32	0.022	3.05
15	244.9	10128	8.97E-10	0.708	4	257.21	105.03	332.81	3.28	3.08E-10	31.00	0.022	3.12
16	345.3	11125	1.05E-09	0.703	4	274.78	79.58	365.43	3.28	3.35E-10	31.64	0.022	3.20
17	379.3	12144	1.03E-09	0.703	4	284.29	74.85	380.88	3.22	3.20E-10	31.97	0.023	3.21
18	485.3	13353	1.09E-09	0.700	4	309.21	63.72	439.52	3.30	3.50E-10	33.33	0.023	3.35
19	632.8	14534	1.01E-09	0.701	4	320.08	60.07	471.72	3.25	3.30E-10	33.86	0.023	3.35
20	803.1	15802	1.05E-09	0.700	4	330.35	54.78	508.39	3.20	3.37E-10	33.63	0.023	3.34
21	617.1	17381	9.50E-10	0.702	4	344.37	55.80	555.38	3.20	3.27E-10	34.28	0.024	3.38
22	718.1	18224	9.18E-10	0.703	4	359.77	50.31	608.15	3.20	3.17E-10	34.83	0.024	3.40
23	809.1	20843	8.98E-10	0.702	4	374.95	46.34	686.75	3.20	3.19E-10	34.83	0.024	3.41
24	874.7	28117	8.49E-10	0.704	4	317.44	68.87	698.78	2.88	1.88E-10	30.36	0.021	2.79
25	484.4	30388	4.94E-10	0.740	4	284.91	63.50	750.46	2.47	1.35E-10	27.43	0.018	2.49
26	617.8	35524	4.89E-10	0.738	4	302.78	52.39	879.2	2.47	1.29E-10	26.83	0.018	2.41
27	682.8	42534	5.01E-10	0.734	4	324.18	47.48	1112.8	2.82	1.35E-10	26.83	0.018	2.42
28	887.1	51808	5.28E-10	0.728	4	389.32	40.05	1479.8	2.87	1.43E-10	27.12	0.018	2.49
29	1097	62723	5.41E-10	0.723	4	383.53	38.20	1878.4	3.15	1.49E-10	27.82	0.018	2.54
30	1325	77238	5.89E-10	0.719	4	443.11	33.44	2772.1	3.68	1.57E-10	28.99	0.019	2.85
31	1637	94807	5.44E-10	0.717	4	503.04	30.73	3889.1	4.12	1.63E-10	29.94	0.020	2.79
32	1898	118820	5.26E-10	0.715	4	582.91	28.68	5487.3	4.89	1.63E-10	30.81	0.021	2.89
33	2212	142210	5.02E-10	0.716	4	630.85	28.82	7609.5	5.35	1.67E-10	32.10	0.021	3.00
34	2482	172880	4.89E-10	0.718	4	707.39	26.80	10537	6.15	1.57E-10	33.51	0.022	3.13
35	2788	212880	4.18E-10	0.721	4	781.24	27.82	14824	6.83	1.41E-10	33.67	0.023	3.13
36	3004	261840	3.67E-10	0.728	4	848.13	28.23	20513	7.83	1.28E-10	35.05	0.024	3.23
37	3451	397870	2.38E-10	0.747	4	934.89	28.47	28418	8.87	1.07E-10	36.28	0.024	3.31
38	3685	462840	1.79E-10	0.763	4	1009	29.24	39187	9.85	1.07E-10	36.60	0.025	3.28
39	3826	583700	1.29E-10	0.781	4	1083.6	29.82	51304	10.63	8.48E-11	36.88	0.025	3.23
40	3454	703000	8.69E-11	0.800	4	1073.7	30.45	63877	10.84	4.43E-11	36.08	0.024	3.03
41	3318	842860	6.25E-11	0.820	4	1125.9	32.80	82021	11.87	3.14E-11	36.05	0.024	2.98
42	3440	1035300	4.35E-11	0.841	4	1170.8	34.03	104080	12.35	2.18E-11	34.87	0.024	2.87
43	3173	1288000	2.89E-11	0.861	4	1186.5	34.95	131350	12.69	1.43E-11	32.89	0.022	2.85
44	3101	1688800	2.13E-11	0.879	4	1186.9	36.56	171150	13.29	9.42E-12	31.51	0.021	2.48
45	2885	2130800	1.50E-11	0.897	4	1180.2	38.08	238480	14.43	8.48E-12	30.23	0.020	2.33
46	2837	2814100	1.20E-11	0.911	4	1165.9	40.45	334850	15.70	4.47E-12	28.88	0.019	2.17
47	2840	3167800	9.71E-12	0.923	4	1234.4	42.03	463830	17.75	3.48E-12	28.09	0.020	2.17
48	2800	3739400	7.81E-12	0.939	4	1241.8	43.73	618010	19.84	2.77E-12	26.90	0.019	2.10
49	2897	4642800	6.85E-12	0.941	4	1186.8	45.78	758480	20.29	2.08E-12	26.79	0.018	1.95
50					4	1240.5	48.03	1118200	24.11	1.88E-12	27.10	0.018	1.98

W/C = 0.36
28 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (g)	R ₂ (g)	C (P)	PH	Type	R ₁ (g) (Error)	R ₂ (g) (% Error)	R ₂ (g) (Error)	R ₂ (g) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
51	2424	6417600	5.05E-12	0.9517	4	1195	49.30	1.36E+08	25.71	1.52E-12	25.95	0.018	1.95
52	2598	6474800	5.35E-12	0.956	4	1216.1	49.89	1.86E+08	25.26	1.36E-12	25.74	0.018	1.84
53	2364	7398900	4.75E-12	0.9527	4	1248.6	52.37	2.41E+08	32.83	1.24E-12	26.12	0.018	1.95
54	2374	6335300	4.20E-12	0.9897	4	1293.8	54.50	3.04E+08	36.36	1.14E-12	26.75	0.018	1.98
55	2320	6873600	3.75E-12	0.9769	4	1205.3	51.95	3.10E+08	34.92	9.27E-13	24.87	0.017	1.74
56	2240	1E+07	3.43E-12	0.9812	4	1256.8	56.11	3.98E+08	39.55	8.75E-13	25.55	0.017	1.78
57	2068	1.1E+07	3.03E-12	0.988	4	1237.5	59.90	4.50E+08	41.08	7.70E-13	25.14	0.017	1.74
58	2159	1.3E+07	2.95E-12	0.9897	4	1264.8	58.58	6.62E+08	46.53	7.46E-13	25.33	0.017	1.75
59	2180	1.5E+07	2.8E-12	0.9925	4	1243	58.00	7.87E+08	50.70	7.03E-13	25.12	0.017	1.73
60	2048	1.5E+07	2.95E-12	0.9977	4	1243	67.59	7.44E+08	50.70	6.30E-13	24.98	0.017	1.86
61	1891	1.7E+07	2.39E-12	1.002	4	1257.9	67.59	9.50E+08	57.02	5.94E-13	24.82	0.017	1.89
62	2034	1.8E+07	2.4E-12	1.001	4	1269	62.78	1.11E+07	62.20	6.07E-13	25.33	0.017	1.73
63	2027	2E+07	2.31E-12	1.004	4	1251.9	61.78	1.29E+07	65.79	5.86E-13	24.80	0.017	1.87
64	1891	1.8E+07	2.26E-12	1.005	4	1244.9	62.53	1.21E+07	63.27	5.51E-13	24.37	0.017	1.88
65	1808	2.1E+07	2.24E-12	1.005	4	1219.1	67.43	1.41E+07	67.62	5.36E-13	23.96	0.016	1.83
66	1778	1.9E+07	2.22E-12	1.008	4	1241.4	68.82	1.15E+07	61.86	5.41E-13	24.35	0.017	1.95
67	1946	1.8E+07	2.23E-12	1.008	4	1202.3	61.78	1.14E+07	60.52	5.28E-13	23.85	0.016	1.81
68	1789	1.9E+07	2.23E-12	1.008	4	1289.9	70.98	1.15E+07	62.15	5.54E-13	24.89	0.017	1.89
69	1805	1.9E+07	2.18E-12	1.007	4	1226	64.38	1.14E+07	60.98	5.28E-13	24.13	0.016	1.84
70	2008	1.9E+07	2.2E-12	1.007	4	1206.4	60.08	1.20E+07	61.94	5.22E-13	23.72	0.016	1.81
71	1783	1.9E+07	2.16E-12	1.007	4	1210.8	68.66	1.12E+07	62.26	5.24E-13	23.90	0.016	1.82
72	1880	1.9E+07	2.25E-12	1.005	4	1246.5	67.02	1.19E+07	62.80	5.53E-13	24.46	0.017	1.86
73	1946	1.7E+07	2.25E-12	1.004	4	1212.2	62.29	9.74E+08	58.40	5.47E-13	23.90	0.016	1.83
74	2109	1.9E+07	2.43E-12	1.001	4	1289.3	60.04	1.27E+07	62.89	6.05E-13	24.89	0.017	1.70
75	1800	1.7E+07	2.5E-12	0.9993	4	1239.9	68.28	1.03E+07	59.98	6.18E-13	24.70	0.017	1.89
76	2031	1.4E+07	2.63E-12	0.9998	4	1223.3	60.23	6.71E+08	49.43	6.46E-13	24.54	0.017	1.86
77	2084	1.3E+07	2.78E-12	0.9942	4	1207.8	57.68	6.02E+08	46.04	6.72E-13	24.36	0.017	1.87
78	2151	1.3E+07	3.13E-12	0.9952	4	1287.3	59.85	8.31E+08	48.28	8.11E-13	25.83	0.018	1.80
79	2252	1.1E+07	3.31E-12	0.9834	4	1241.8	55.14	5.07E+08	44.11	8.37E-13	25.26	0.017	1.75
80	2277	9999900	3.57E-12	0.9792	4	1238.3	54.30	3.71E+08	38.24	9.09E-13	25.37	0.017	1.77
81	2331	9189500	3.86E-12	0.9748	4	1228.5	54.00	3.43E+08	37.43	9.91E-13	25.54	0.017	1.79
82	2531	8335300	4.45E-12	0.9695	4	1234.1	48.78	2.95E+08	35.37	1.14E-12	25.65	0.017	1.81
83	2526	6789300	4.74E-12	0.9632	4	1246.9	49.36	2.05E+08	30.28	1.25E-12	26.29	0.018	1.86
84	2642	6398300	5.62E-12	0.9532	4	1221.2	46.22	1.89E+08	28.42	1.46E-12	25.91	0.018	1.85
85	2787	5394200	6.31E-12	0.9498	4	1228.7	44.41	1.42E+08	26.39	1.67E-12	26.43	0.018	1.90
86	2808	4091300	8.09E-12	0.9331	4	1203.9	41.43	8.98E+08	22.08	2.17E-12	26.83	0.018	1.96
87	2919	3372300	9.25E-12	0.9256	4	1248.9	42.79	8.88E+08	20.40	2.63E-12	28.42	0.019	2.09
88	3013	2899900	1.05E-11	0.9163	4	1213.5	40.28	8.89E+08	18.70	3.05E-12	28.04	0.019	2.08
89	3179	2518900	1.27E-11	0.9075	4	1244	39.13	4.44E+08	17.82	3.75E-12	28.39	0.020	2.20
90	3148	2187100	1.52E-11	0.8975	4	1245.2	39.58	3.84E+08	16.86	4.89E-12	30.11	0.020	2.28
91	3308	1881000	1.82E-11	0.8875	4	1219.7	39.87	2.89E+08	15.36	5.53E-12	30.29	0.021	2.31
92	3403	1804800	2.2E-11	0.8771	4	1234.2	36.27	2.35E+08	14.82	6.93E-12	31.49	0.021	2.43
93	3579	1391800	2.62E-11	0.8628	4	1291	38.07	2.02E+08	14.54	8.45E-12	33.54	0.023	2.63
94	3719	1182300	3.54E-11	0.8497	4	1285.7	34.84	1.69E+08	13.94	1.23E-11	34.89	0.023	2.76
95	3882	1032700	4.8E-11	0.8348	4	1289.4	33.13	1.38E+08	13.44	1.63E-11	35.44	0.023	2.87
96	4013	8999300	6.11E-11	0.8164	4	1294.8	32.27	1.18E+08	13.13	2.23E-11	36.57	0.025	3.02
97	4197	778770	7.82E-11	0.8036	4	1297.1	30.91	9.63E+08	12.78	2.96E-11	37.84	0.025	3.16
98	4386	672040	1.01E-10	0.7904	4	1291.3	30.79	8.15E+08	12.12	3.83E-11	37.97	0.026	3.24
100	4204	578190	1.28E-10	0.7789	4	1251.4	29.53	6.71E+08	11.60	4.89E-11	39.95	0.028	3.35

W/C = 0.36
28 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R _h (Q)	R _h (Q)	G (F)	Phi	Type	R _h (Q) (Error)	R _h (Q) (% Error)	R _h (Q) (Error)	R _h (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
101	4123	481830	1.95E-10	0.7668	4	1185.8	29.00	53089	10.80	6.0333E-11	38.83	0.026	3.41
102	3947	411240	1.82E-10	0.759	4	1120.2	28.36	39069	9.72	6.9534E-11	39.22	0.026	3.36
103	3979	340320	2.04E-10	0.754	4	1055.2	28.86	29793	8.74	7.7348E-11	37.99	0.025	3.38
104	3545	263060	2.29E-10	0.749	4	986.64	27.32	21670	7.86	8.3676E-11	39.81	0.025	3.29
105	3189	232930	2.4E-10	0.7481	4	874.2	27.41	15329	6.87	8.4776E-11	35.37	0.024	3.16
106	2842	162710	2.47E-10	0.7486	4	824.97	26.01	11705	6.07	8.8038E-11	35.66	0.024	3.18
107	2627	160160	2.59E-10	0.7478	4	722.97	27.52	8281.4	6.16	8.6122E-11	33.21	0.022	2.86
108	2246	132400	2.51E-10	0.7542	4	635.5	28.29	6072.9	4.96	8.0813E-11	32.17	0.021	2.84
109	1983	110180	2.53E-10	0.7559	4	679.02	26.50	4803.1	4.59	7.3246E-11	31.33	0.021	2.75
110	1804	91598	2.48E-10	0.7597	4	510.14	31.80	3263.5	3.56	7.3988E-11	29.71	0.020	2.80
111	1331	78940	2.39E-10	0.7682	4	461.17	33.90	2406	3.17	6.7588E-11	28.61	0.019	2.48
112	1113	63093	2.28E-10	0.7711	4	398.73	35.91	1765.1	2.80	6.2081E-11	27.27	0.018	2.34
113	987	52413	2.35E-10	0.7703	4	374.99	38.78	1332.7	2.54	6.2088E-11	26.68	0.018	2.30
114	686.3	43481	2.23E-10	0.7782	4	339.33	48.73	1024.3	2.36	5.8286E-11	26.17	0.017	2.24
115	511.2	39587	2.17E-10	0.7811	4	298.02	58.34	744.32	2.08	5.2228E-11	24.11	0.016	2.05
116	309.8	28215	1.97E-10	0.7916	4	238.36	76.95	537.88	1.84	4.3788E-11	22.28	0.015	1.87
117	210.2	24098	2.09E-10	0.7918	4	211.78	100.74	421.89	1.76	4.4889E-11	21.48	0.014	1.91
118	291	20983	3.28E-10	0.7853	4	224.85	77.16	410.88	1.86	7.897E-11	23.37	0.016	2.09
119	367	18532	5.18E-10	0.7423	4	226.18	61.63	393.82	2.13	1.263E-10	24.48	0.017	2.25
120	267	16842	6.88E-10	0.7405	4	207.12	77.57	352.42	2.09	1.382E-10	23.97	0.016	2.21
121	189.8	12381	8.9E-10	0.7407	4	185.34	103.03	316.15	2.08	1.3983E-10	23.71	0.016	2.19
122	89.86	14018	6.62E-10	0.7483	4	180.19	200.52	264.19	2.03	1.297E-10	23.06	0.016	2.12
123	15.88	13083	6.3E-10	0.782	4	186.71	1049.81	256.41	1.86	1.1647E-10	22.36	0.015	2.04
124	42.18	12284	5.07E-10	0.7584	4	158.82	376.77	239.01	1.85	1.1233E-10	22.14	0.015	2.01
125	86.84	11637	4.89E-10	0.7657	4	146.21	170.73	219.85	1.89	1.0244E-10	21.06	0.014	1.90
126	143.8	11030	4.61E-10	0.7657	4	138.09	98.03	200.88	1.82	9.5132E-11	20.88	0.014	1.86
127	228.4	10484	4.17E-10	0.7741	4	130.78	57.77	186.3	1.79	8.9635E-11	20.64	0.014	1.82
128	289.5	10041	3.88E-10	0.779	4	124.25	47.86	177	1.76	7.8888E-11	20.21	0.014	1.78
129	262.8	9894	3.88E-10	0.7804	4	120.27	42.51	170.22	1.76	7.8888E-11	20.09	0.014	1.77
130	262.3	9844	4.34E-10	0.7774	4	123.86	42.36	178.44	1.83	8.8833E-11	20.93	0.014	1.85
131	285.8	10288	5.88E-10	0.7708	4	140.01	52.68	207.49	2.02	1.2822E-10	22.87	0.016	2.07
132	170.4	11893	7.24E-10	0.7437	4	151.55	88.84	239.88	2.05	1.887E-10	23.28	0.018	2.15
133	130.4	13814	7.88E-10	0.7349	4	153.92	128.48	282.94	2.09	1.8833E-10	23.67	0.018	2.20
134	88.88	18337	8.91E-10	0.773	4	184.92	325.05	359.39	2.20	2.102E-10	24.80	0.017	2.33
135	89.04	18395	8.8E-10	0.7218	4	183.24	315.71	398.97	2.03	1.8971E-10	22.68	0.015	2.12
136	198.8	23803	8.03E-10	0.7188	4	182.85	115.62	478.31	2.04	1.8797E-10	21.91	0.015	2.09
137	283.5	28018	8.93E-10	0.7141	4	205.04	72.68	588.84	2.09	1.9388E-10	21.74	0.015	2.05

W/C = 0.60
7 Days of Hydration
Pore Solution: Synthetic Pore Solution

Pile No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
1	489.9	1117	1.38E-09	0.771	4	104.1	20.87	109.69	9.82	7.19E-10	51.44	0.041	5.34
2	463.3	1170	1.26E-09	0.772	4	100.90	20.47	106.23	9.06	5.99E-10	46.75	0.036	4.86
3	482.1	1215	1.23E-09	0.772	4	104.35	21.64	108.71	9.03	5.69E-10	46.19	0.037	4.61
4	474.1	1251	1.21E-09	0.771	4	106.96	22.56	112.41	8.89	5.82E-10	45.61	0.037	4.77
5	460.7	1273	1.19E-09	0.771	4	105.21	21.89	110.61	8.69	5.29E-10	44.29	0.036	4.63
6	475.6	1309	1.17E-09	0.771	4	108.01	22.71	113.59	8.69	5.19E-10	44.33	0.036	4.63
7	479.9	1333	1.14E-09	0.771	4	107.41	22.36	113.01	8.48	4.97E-10	43.63	0.036	4.54
8	472.2	1372	1.13E-09	0.770	4	110.61	23.42	116.39	8.48	4.94E-10	43.56	0.036	4.55
9	476.6	1401	1.08E-09	0.772	4	109.73	23.02	115.52	8.25	4.62E-10	42.77	0.034	4.44
10	467	1446	1.08E-09	0.771	4	112.45	24.08	118.86	8.19	4.49E-10	42.44	0.034	4.41
11	463.2	1484	1.03E-09	0.772	4	113.82	24.57	119.86	8.08	4.32E-10	42.07	0.034	4.37
12	457.7	1526	1.04E-09	0.770	4	116.64	25.53	123.15	8.07	4.39E-10	42.12	0.034	4.38
13	447.6	1614	1.16E-09	0.761	4	126.32	28.22	133.49	8.27	5.07E-10	43.55	0.036	4.59
14	452.3	1720	1.11E-09	0.762	4	126.81	28.04	134.51	7.82	4.79E-10	42.83	0.034	4.46
15	433.4	1870	1.17E-09	0.755	4	133.76	30.87	142.39	7.61	4.94E-10	42.39	0.033	4.43
16	429.6	2047	1.18E-09	0.752	4	136.36	31.73	146	7.13	4.91E-10	41.41	0.032	4.31
17	397.1	2328	1.96E-09	0.730	4	165.34	42.71	176.51	7.67	7.09E-10	45.16	0.035	4.84
18	363.7	2655	2.57E-09	0.701	4	215.26	60.87	262.01	6.91	1.22E-09	47.37	0.036	5.12
19	353.9	4109	5.29E-09	0.662	4	251.42	91.79	329.21	5.26	2.59E-09	48.94	0.036	5.59
20	273.9	6237	4.77E-09	0.644	4	267.46	94.732	414.61	4.53	2.12E-09	44.46	0.032	5.04
21	31.4	9162	4.45E-09	0.631	4	267.46	94.732	414.61	4.53	1.79E-09	38.39	0.028	4.51
22	481.8	13967	4.79E-09	0.606	4	404.56	83.97	605	4.43	1.84E-09	38.39	0.028	4.55
23	1321	20046	4.16E-09	0.609	4	515.46	99.02	626.66	4.12	1.90E-09	36.04	0.026	4.31
24	2274	28101	2.81E-09	0.606	4	595.66	26.20	1025.6	3.65	9.30E-10	33.14	0.023	3.65
25	3017	37652	1.74E-09	0.627	4	631.8	20.84	1209.2	3.21	5.34E-10	30.58	0.021	3.40
26	3696	46759	1.07E-09	0.650	4	632.43	17.11	1375	2.82	2.86E-10	27.83	0.019	2.84
27	4033	63512	7.39E-10	0.696	4	607.94	14.96	1527.6	2.62	1.65E-10	25.10	0.017	2.55
28	4430	73966	5.32E-10	0.695	4	621.06	14.02	1623.9	2.47	1.29E-10	24.25	0.016	2.39
29	4692	86166	3.84E-10	0.703	4	629.16	13.79	2162.7	2.46	9.07E-11	23.61	0.016	2.25
30	4818	109160	2.99E-10	0.716	4	629.35	13.06	2597.4	2.44	6.73E-11	22.52	0.015	2.10
31	4672	126360	2.40E-10	0.726	4	650.11	13.06	3165.6	2.53	5.36E-11	22.30	0.015	2.04
32	5106	147670	1.87E-10	0.741	4	640.26	12.53	3698.8	2.60	3.94E-11	21.06	0.014	1.89
33	5216	173960	1.98E-10	0.751	4	664.23	12.73	4562.7	2.64	3.26E-11	20.94	0.014	1.85
34	5412	208900	1.39E-10	0.759	4	703.12	12.99	5929.4	2.66	2.87E-11	21.07	0.014	1.84
35	5526	241430	1.10E-10	0.769	4	671.59	12.15	6727.1	2.79	2.13E-11	19.35	0.013	1.67
36	5966	286020	9.42E-11	0.777	4	730.16	12.84	8694.5	3.11	1.89E-11	20.06	0.013	1.71
37	5991	341010	7.86E-11	0.780	4	729.97	13.06	11027	3.23	1.46E-11	19.29	0.013	1.62
38	5915	409060	6.60E-11	0.797	4	757.37	12.80	14203	3.47	1.25E-11	18.97	0.013	1.58
39	5960	460110	5.50E-11	0.806	4	764.15	12.82	17624	3.64	1.00E-11	18.25	0.012	1.50
40	6112	533500	4.65E-11	0.815	4	793.14	12.98	23302	3.93	8.39E-12	17.96	0.012	1.47
41	6104	732960	3.66E-11	0.827	4	844.06	13.53	32107	4.36	6.69E-12	16.15	0.012	1.46
42	6566	912340	3.21E-11	0.833	4	869.06	13.69	44463	4.66	5.79E-12	16.03	0.012	1.45
43	6620	1161400	2.51E-11	0.846	4	963.81	14.56	66370	5.62	4.67E-12	16.18	0.012	1.44
44	6962	1552700	2.03E-11	0.857	4	1036.4	14.82	98462	6.41	3.60E-12	17.75	0.012	1.39
45	7049	1874600	1.67E-11	0.866	4	1036.8	14.74	142720	7.23	2.91E-12	17.47	0.012	1.36
46	7072	2653000	1.41E-11	0.877	4	1062.3	15.45	220650	8.65	2.49E-12	17.61	0.012	1.36
47	7211	3179600	1.21E-11	0.885	4	1084.7	16.04	302010	9.60	2.03E-12	16.76	0.011	1.28
48	6941	3621400	1.00E-11	0.896	4	1090.6	15.95	401470	10.51	1.65E-12	16.48	0.011	1.25
49	7167	4665100	8.62E-12	0.902	4	1137	15.80	613240	12.60	1.46E-12	16.59	0.011	1.25
50	6953	5953400	7.42E-12	0.912	4	1105.6	16.07	816020	13.67	1.19E-12	15.91	0.011	1.19

W/C = 0.60
7 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
51	7080	7397300	6.65E-12	0.918	4	1146.1	1.23E+06	16.19	19.63	1.07E-12	16.03	0.011	1.19
52	7324	9228400	5.97E-12	0.9236	4	1176.3	1.88E+06	16.06	20.10	9.84E-13	16.13	0.011	1.19
53	6976	1.1E+07	5.16E-12	0.9322	4	1191.7	2.45E+06	17.33	22.62	6.31E-13	16.11	0.011	1.16
54	7167	1.2E+07	4.46E-12	0.9407	4	1186.1	2.71E+06	16.30	23.04	7.04E-13	15.70	0.011	1.14
55	6772	1.5E+07	4.11E-12	0.9454	4	1262.8	4.65E+06	18.50	30.54	6.83E-13	16.63	0.011	1.20
56	6856	1.8E+07	3.8E-12	0.9494	4	1221.9	6.04E+06	18.64	33.75	6.06E-13	16.01	0.011	1.15
57	7123	2.2E+07	3.11E-12	0.9609	4	1200.7	7.96E+06	16.66	36.90	4.77E-13	15.35	0.011	1.08
58	6827	2.7E+07	2.89E-12	0.9663	4	1226.4	1.24E+07	18.54	46.19	4.52E-13	15.64	0.011	1.12
59	6962	3.5E+07	2.69E-12	0.9695	4	1246.4	2.13E+07	19.04	60.44	4.30E-13	15.96	0.011	1.13
60	6911	3.8E+07	2.71E-12	0.9691	4	1233.3	2.43E+07	18.66	63.07	4.20E-13	15.49	0.011	1.09
62	6940	4.4E+07	2.55E-12	0.9723	4	1235.1	3.18E+07	18.08	72.08	3.97E-13	15.99	0.011	1.10
63	6919	3.2E+07	2.53E-12	0.9726	4	1191.8	1.96E+07	18.01	49.53	3.60E-13	15.01	0.010	1.06
64	6964	3.7E+07	2.61E-12	0.9706	4	1311.1	2.33E+07	18.97	63.61	4.30E-13	16.49	0.011	1.16
65	6963	3.9E+07	2.46E-12	0.9736	4	1241.6	2.34E+07	18.56	62.03	3.93E-13	15.73	0.011	1.11
66	6935	4.6E+07	2.5E-12	0.9739	4	1262.3	3.56E+07	18.87	77.04	3.96E-13	15.92	0.011	1.12
67	6991	4.1E+07	2.57E-12	0.9716	4	1331.1	2.92E+07	19.69	71.71	4.31E-13	16.76	0.011	1.16
68	6951	3.9E+07	2.46E-12	0.974	4	1290.1	2.55E+07	18.83	66.09	4.06E-13	16.38	0.011	1.15
69	6974	3.4E+07	2.51E-12	0.9731	4	1234.4	1.92E+07	18.50	55.75	3.90E-13	15.53	0.011	1.09
70	6957	4.9E+07	2.4E-12	0.9762	4	1255.1	4.03E+07	18.74	81.43	3.83E-13	15.92	0.011	1.12
71	6959	3.9E+07	2.4E-12	0.9765	4	1275.9	2.55E+07	21.78	65.00	3.91E-13	16.30	0.011	1.14
72	6956	3.5E+07	2.44E-12	0.9764	4	1264.3	2.08E+07	19.30	59.46	3.97E-13	16.30	0.011	1.14
73	6948	3.7E+07	2.64E-12	0.9897	4	1223.3	2.21E+07	18.69	59.83	4.04E-13	15.31	0.010	1.08
74	6410	2.6E+07	2.67E-12	0.9702	4	1204.7	1.16E+07	18.79	43.83	4.13E-13	15.47	0.011	1.09
75	6955	2.7E+07	2.89E-12	0.9652	4	1305.2	1.31E+07	20.84	48.95	4.86E-13	16.60	0.012	1.16
76	6753	2.2E+07	3.25E-12	0.9582	4	1211.5	8.62E+06	17.42	39.69	5.08E-13	15.57	0.011	1.11
77	7282	2E+07	3.51E-12	0.9541	4	1260.7	7.65E+06	18.10	36.46	5.89E-13	16.81	0.011	1.21
78	7282	1.7E+07	4.05E-12	0.945	4	1260.4	5.74E+06	17.28	33.28	6.61E-13	16.33	0.011	1.18
79	6710	1.4E+07	4.06E-12	0.9465	4	1165.8	3.47E+06	17.37	25.47	6.34E-13	15.46	0.011	1.12
80	7267	1.3E+07	4.64E-12	0.9395	4	1164.7	3.51E+06	16.30	26.37	7.37E-13	15.69	0.011	1.16
81	7262	1.1E+07	5.14E-12	0.9323	4	1137.8	2.23E+06	15.62	21.00	7.89E-13	15.34	0.010	1.12
82	6963	9677900	6.96E-12	0.9273	4	1136.4	1.96E+06	16.30	18.19	8.90E-13	16.72	0.011	1.16
83	7323	7293300	6.97E-12	0.9173	4	1215.1	1.24E+06	16.59	17.14	1.13E-12	16.06	0.012	1.26
84	6957	5904600	7.15E-12	0.9141	4	1114.4	7.83E+05	16.02	13.50	1.14E-12	15.92	0.011	1.19
85	7363	5032900	6.96E-12	0.9031	4	1096.9	6.03E+05	14.73	12.08	1.35E-12	15.69	0.011	1.18
86	7232	4031900	6.69E-12	0.8998	4	1098.6	4.29E+05	15.02	10.60	1.55E-12	16.10	0.011	1.22
87	7612	3419800	1.11E-11	0.8991	4	1046.3	3.19E+05	13.93	9.31	1.76E-12	15.85	0.011	1.21
88	7172	2799900	1.21E-11	0.895	4	1033.6	2.27E+05	14.41	8.21	1.97E-12	16.26	0.011	1.25
89	7660	2329900	1.45E-11	0.8741	4	1099.9	1.81E+05	14.11	7.76	2.46E-12	17.16	0.012	1.33
90	7767	1962400	1.73E-11	0.8639	4	966.46	1.31E+05	12.65	6.69	2.83E-12	16.35	0.011	1.28
91	7351	1597000	1.84E-11	0.8631	4	1005.7	9.79E+04	13.68	6.17	3.16E-12	17.40	0.012	1.36
92	7673	1319900	2.13E-11	0.8537	4	977.94	7.32E+04	12.75	5.55	3.71E-12	17.44	0.012	1.37
93	7463	1095100	2.39E-11	0.8478	4	948.25	5.43E+04	12.66	5.00	4.22E-12	17.66	0.012	1.40
94	7368	911420	2.87E-11	0.8375	4	899.4	4.11E+04	12.17	4.51	4.96E-12	17.36	0.012	1.39
95	7343	795260	3.29E-11	0.8302	4	965.07	3.33E+04	12.73	4.41	6.22E-12	18.66	0.013	1.52
96	6956	634110	3.82E-11	0.8222	4	815.4	2.33E+04	11.72	3.68	6.57E-12	17.19	0.011	1.39
97	7023	534640	4.47E-11	0.8135	4	811.71	1.87E+04	11.56	3.50	7.97E-12	17.81	0.012	1.45
98	7134	448710	5.16E-11	0.8056	4	826.33	1.53E+04	11.56	3.41	9.82E-12	16.84	0.013	1.66
99	6954	376750	6.03E-11	0.7977	4	746.2	1.12E+04	10.87	2.96	1.06E-11	17.69	0.012	1.49
100	6970	319390	7.3E-11	0.7968	4	758.24	9.20E+03	11.01	2.89	1.37E-11	18.82	0.012	1.58

W/C = 0.68
7 Days of Hydration
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File No.	R ₁ (Q)	R ₂ (Q)	G (P)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	Phi (Error)	Phi (% Error)
101	6766	268030	8.05E-11	0.7823	4	808.79	11.90	8038.8	3.00	1.7086E-11	21.24	0.014	1.80
102	6851	227670	9.37E-11	0.7746	4	762.79	11.64	8311.2	2.77	1.9675E-11	21.01	0.014	1.79
103	6854	180730	1.15E-10	0.7629	4	757.02	11.55	5201.2	2.66	2.4912E-11	21.63	0.014	1.68
104	5980	164320	1.26E-10	0.7579	4	702.96	11.76	4032.9	2.45	2.7171E-11	21.13	0.014	1.85
105	6208	140880	1.57E-10	0.7464	4	687.79	11.24	3558.8	2.36	3.4053E-11	21.65	0.014	1.93
106	6055	121140	1.82E-10	0.7353	4	716.55	11.83	2539.1	2.43	4.4281E-11	23.04	0.015	2.09
107	6032	104420	2.4E-10	0.7228	4	700.48	11.57	2463.2	2.36	5.9981E-11	23.17	0.015	2.14
108	5546	88917	2.7E-10	0.7178	4	644.21	11.82	1865.9	2.20	6.0748E-11	22.46	0.015	2.10
109	5501	76301	3.38E-10	0.7047	4	599.09	10.99	1562.2	2.05	7.2024E-11	21.32	0.014	2.04
110	5198	68012	4.09E-10	0.6949	4	598.56	11.32	1344.2	2.07	8.8812E-11	21.76	0.015	2.12
111	4698	53317	4.86E-10	0.6868	4	567.45	11.45	1146.5	2.07	1.021E-10	21.60	0.016	2.17
112	5195	47480	6.37E-10	0.6695	4	661.46	12.83	1179.8	2.48	1.6166E-10	25.37	0.018	2.62
113	4839	40078	8.01E-10	0.6573	4	675.4	13.95	1087.4	2.71	2.1315E-10	28.61	0.019	2.83
114	4332	33335	9.08E-10	0.6339	4	666.74	16.36	962.63	2.95	2.5096E-10	27.66	0.020	3.00
115	3746	27230	9.82E-10	0.613	4	654.23	17.46	863.05	3.28	2.8944E-10	28.07	0.021	3.20
116	2843	21284	9.21E-10	0.6038	4	575.06	20.23	735.06	3.45	2.8801E-10	29.10	0.021	3.19
117	1823	15573	6.73E-10	0.6014	4	487.22	28.73	594.88	3.78	2.0257E-10	30.12	0.022	3.19
118	729.7	10343	3.23E-10	0.7502	4	382.13	49.63	411.35	3.98	9.9897E-11	30.83	0.023	3.02
119	198.5	7302	2.18E-10	0.7874	4	262.34	131.50	288.62	3.95	6.2346E-11	28.85	0.021	2.71
120	21.2	5397	1.87E-10	0.8017	4	209.07	986.18	224.19	4.16	5.2856E-11	26.80	0.020	2.54
121	284	3876	2E-10	0.8195	4	144.01	50.71	153.67	3.96	5.0918E-11	25.60	0.019	2.38
122	419.3	2875	2.07E-10	0.8344	4	108.91	25.97	115.78	4.03	5.3594E-11	25.91	0.020	2.35
123	499.3	2289	2.82E-10	0.8304	4	83.126	18.10	86.47	3.87	7.0523E-11	24.98	0.019	2.28
124	488.2	1898	3.34E-10	0.826	4	84.841	17.41	88.959	4.50	9.5839E-11	28.70	0.022	2.63
125	463.6	1862	3.77E-10	0.8225	4	91.838	19.81	97.207	5.22	1.1862E-10	31.74	0.024	2.96
126	480.8	1732	3.78E-10	0.8288	4	91.155	18.98	96.39	5.57	1.272E-10	33.84	0.026	3.14
127	469.8	1608	3.65E-10	0.8246	4	94.242	20.08	96.418	5.99	1.4027E-10	36.46	0.027	3.32
128	462.8	1597	4.15E-10	0.8233	4	96.65	20.83	102	6.39	1.5375E-10	37.07	0.028	3.49
129	460.7	1593	4.61E-10	0.8195	4	102.87	22.33	108.39	6.94	1.5479E-10	40.11	0.031	3.81

WRC = 0.66
28 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R_p (d)	R_p (d)	G (P)	PH	Type	R_p (d) (Error)	R_p (d) (% Error)	R_p (d) (Error)	R_p (d) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
1	66.7	1900	7.04E-10	0.774	4	119.9	179.78	129.84	6.79	2.80E-10	37.70	0.030	3.82
2	260.5	1794	5.41E-10	0.807	4	83.336	33.27	91.275	5.09	1.83E-10	33.86	0.025	3.15
3	247.8	1831	6.21E-10	0.797	4	86.365	36.56	96.365	5.26	2.13E-10	34.26	0.026	3.25
4	271.9	1888	6.80E-10	0.793	4	88.787	32.85	97.78	5.18	2.29E-10	34.81	0.028	3.27
5	278.9	1912	7.01E-10	0.790	4	86.266	30.63	95.194	4.98	2.34E-10	33.39	0.025	3.17
6	289.8	1959	6.67E-10	0.793	4	84.066	29.04	93.175	4.76	2.18E-10	32.71	0.024	3.08
7	239.9	2138	1.12E-09	0.799	4	107.78	44.82	120.82	5.98	4.32E-10	38.67	0.029	3.62
8	268.7	2170	7.24E-10	0.798	4	79.846	27.56	89.750	4.14	2.16E-10	29.85	0.022	2.81
9	299.1	2191	8.89E-10	0.799	4	79.307	28.62	89.389	4.06	2.08E-10	29.81	0.022	2.79
10	302.8	2264	7.11E-10	0.787	4	82.107	27.13	93.313	4.12	2.21E-10	31.05	0.023	2.89
11	271.3	2325	6.81E-10	0.789	4	77.769	28.68	88.059	3.79	1.88E-10	28.19	0.021	2.82
12	284.8	2387	7.01E-10	0.795	4	78.789	29.75	88.035	3.79	2.00E-10	28.90	0.021	2.86
13	288.8	2657	6.78E-10	0.774	4	91.895	30.79	108.05	4.23	3.02E-10	34.33	0.025	3.20
14	341.7	3051	1.07E-09	0.795	4	88.395	28.15	112.8	3.70	3.61E-10	33.82	0.024	3.13
15	325	3080	1.33E-09	0.749	4	78.74	23.81	103.63	2.83	3.61E-10	27.19	0.019	2.84
16	240.7	4348	2.04E-09	0.717	4	84.212	39.14	133.68	3.07	6.80E-10	28.16	0.020	2.85
17	202.4	6708	3.08E-09	0.685	4	108.44	54.07	175.78	3.08	9.08E-10	29.39	0.020	2.88
18	48.81	7520	3.72E-09	0.684	4	146.02	289.18	259.97	3.42	1.19E-09	32.05	0.022	3.34
19	91.54	9793	3.18E-09	0.683	4	168.65	181.84	319.15	3.26	9.71E-10	30.71	0.021	3.18
20	224.5	12637	2.80E-09	0.698	4	175.85	78.33	379.88	2.83	6.80E-10	27.70	0.019	2.82
21	477.5	17122	2.12E-09	0.688	4	213.32	44.67	524.27	3.08	6.02E-10	28.37	0.019	2.87
22	765.4	22327	1.67E-09	0.673	4	228.51	29.69	630.84	2.83	4.29E-10	25.84	0.017	2.59
23	1183	28912	1.38E-09	0.678	4	254.4	21.80	804.41	2.79	3.38E-10	24.86	0.016	2.43
24	1700	37873	1.03E-09	0.685	4	289.3	17.81	1136.1	2.89	2.80E-10	25.17	0.017	2.44
25	1851	49960	7.18E-10	0.702	4	281.74	14.59	1284.4	2.89	1.98E-10	21.80	0.014	2.05
26	1844	68942	4.78E-10	0.725	4	286.74	13.21	1833.8	2.44	9.12E-11	19.04	0.013	1.73
27	2262	86278	3.77E-10	0.736	4	289.19	11.90	1642.5	2.52	7.10E-11	18.63	0.012	1.68
28	2439	79987	3.20E-10	0.744	4	282.81	11.82	2054.8	2.87	5.88E-11	18.73	0.012	1.85
29	2287	87181	2.33E-10	0.762	4	285.1	11.54	2224	2.55	4.00E-11	17.18	0.011	1.48
30	2687	102630	2.24E-10	0.781	4	284.81	10.87	2809	2.73	3.81E-11	17.04	0.011	1.47
31	2980	117430	1.80E-10	0.789	4	278.09	10.74	3219.4	2.74	3.08E-11	16.07	0.011	1.37
32	2465	136330	1.43E-10	0.788	4	283.08	10.68	3623.3	2.88	2.11E-11	14.79	0.010	1.23
33	2982	158900	1.14E-10	0.789	4	284.82	10.24	4333.8	2.79	1.84E-11	14.42	0.009	1.18
34	2982	178900	8.12E-11	0.818	4	287.33	11.09	6338.5	3.03	1.25E-11	15.14	0.010	1.21
35	2882	208010	8.09E-11	0.815	4	282.9	9.58	6386.7	3.08	1.12E-11	13.91	0.009	1.11
36	2990	240180	6.77E-11	0.824	4	289.01	8.80	7838.9	3.26	9.28E-12	13.89	0.009	1.08
37	3262	282180	5.82E-11	0.831	4	302.37	9.21	10065	3.59	8.08E-12	13.63	0.009	1.07
38	3208	327910	4.88E-11	0.841	4	324.63	10.13	13188	4.02	6.80E-12	13.12	0.009	1.10
39	3411	385880	4.38E-11	0.847	4	311.8	9.14	15801	4.12	5.70E-12	14.21	0.009	1.01
40	3437	444780	3.48E-11	0.859	4	338.37	9.84	20533	4.71	4.80E-12	13.84	0.009	1.05
41	3546	518280	2.32E-11	0.882	4	338.07	8.63	23344	4.80	3.88E-12	11.88	0.008	0.91
42	3883	618880	2.79E-11	0.871	4	333.62	9.11	32808	5.33	3.48E-12	12.83	0.008	0.86
43	3814	748440	2.27E-11	0.881	4	360.09	9.44	47018	6.31	2.88E-12	13.18	0.009	0.98
44	3480	883320	1.82E-11	0.884	4	328.5	8.41	58375	6.27	2.14E-12	11.75	0.007	0.86
45	3623	1111200	1.86E-11	0.889	4	328.99	9.34	80801	7.24	2.11E-12	11.17	0.007	0.82
46	3489	1321600	1.62E-11	0.898	4	314.29	9.08	101880	7.70	1.88E-12	10.43	0.007	0.78
47	3215	1817800	1.40E-11	0.908	4	317.42	8.87	128000	8.80	1.48E-12	10.41	0.007	0.75
48	3246	1753000	1.22E-11	0.914	4	319.32	9.84	164700	9.40	1.28E-12	10.34	0.007	0.74
49	3838	2082000	1.15E-11	0.917	4	383.4	10.82	271880	13.08	1.43E-12	12.43	0.008	0.89
50	3888	2388900	1.08E-11	0.921	4	389.08	9.74	312550	13.07	1.17E-12	11.12	0.007	0.79

WVC = 0.60
28 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (d)	R ₂ (d)	G (P)	PH	Type	R ₁ (d) (Error)	R ₁ (d) (% Error)	R ₂ (d) (Error)	R ₂ (d) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
51	3314	2404900	8.27E-12	0.9090	4	331.93	10.02	2.90E+05	12.07	8.09E-13	10.90	0.007	0.74
52	3536	2707800	7.09E-12	0.9409	4	360.02	11.03	4.10E+05	15.45	9.07E-13	12.21	0.006	0.65
53	3816	3168700	7.42E-12	0.942	4	369.95	10.47	5.69E+05	17.86	9.37E-13	12.22	0.006	0.65
54	3878	3399400	8.87E-12	0.946	4	357.56	9.72	6.28E+05	17.46	7.42E-13	10.79	0.007	0.75
55	3269	3679800	6.09E-12	0.9541	4	337.96	10.34	6.12E+05	18.65	6.21E-13	10.26	0.007	0.71
56	3779	4198300	6.09E-12	0.9527	4	401.5	10.62	9.03E+05	21.73	7.29E-13	11.98	0.006	0.63
57	3727	4247100	5.53E-12	0.9583	4	411.8	11.05	9.43E+05	22.20	6.79E-13	12.20	0.006	0.64
58	3463	5228000	5.69E-12	0.9559	4	399.1	11.52	1.34E+06	25.72	6.99E-13	11.60	0.006	0.60
59	3163	5179700	6.09E-12	0.9534	4	413.8	13.08	1.37E+06	26.45	6.19E-13	12.17	0.006	0.63
60	3008	5802200	4.89E-12	0.9577	4	361.72	12.03	1.37E+06	24.42	4.99E-13	10.97	0.007	0.72
61	3016	6805100	4.04E-12	0.9679	4	340.76	11.30	1.41E+06	23.89	4.57E-13	10.66	0.006	0.67
62	3047	6889700	4.42E-12	0.9709	4	395.21	11.66	1.44E+06	24.96	4.89E-13	10.30	0.007	0.70
63	3207	6897200	4.23E-12	0.9738	4	344.26	10.74	1.41E+06	23.69	4.29E-13	10.03	0.007	0.68
64	3714	6922300	4.47E-12	0.9702	4	439.42	11.75	2.19E+06	33.49	5.63E-13	12.61	0.006	0.66
65	3660	6188900	4.39E-12	0.9713	4	418.26	11.40	1.87E+06	30.12	5.24E-13	11.98	0.006	0.61
66	3321	6703100	4.41E-12	0.9705	4	322.53	9.71	1.69E+06	26.02	4.09E-13	9.25	0.006	0.63
67	3854	6821300	4.54E-12	0.9687	4	391.5	10.44	2.12E+06	30.56	4.94E-13	10.90	0.007	0.74
68	3396	6839500	4.34E-12	0.9716	4	316.66	9.41	1.61E+06	24.24	3.99E-13	9.09	0.006	0.62
69	3390	6111200	4.31E-12	0.9731	4	366.1	11.53	1.72E+06	26.16	4.87E-13	11.31	0.007	0.77
70	3229	6268900	4.43E-12	0.9709	4	315.51	9.77	1.39E+06	22.76	4.09E-13	9.17	0.006	0.62
71	3736	7403700	4.77E-12	0.9681	4	412.26	11.04	2.69E+06	38.22	5.89E-13	11.69	0.006	0.61
72	3394	6899900	4.89E-12	0.9693	4	369.9	10.87	2.09E+06	30.21	4.89E-13	10.72	0.007	0.73
73	3842	6807400	4.79E-12	0.9684	4	373.56	10.26	1.99E+06	29.25	5.12E-13	10.77	0.007	0.73
74	3395	6391400	4.7E-12	0.9676	4	368.39	10.66	1.79E+06	27.63	4.69E-13	10.48	0.007	0.71
75	3628	6191800	5.05E-12	0.9629	4	363.69	10.58	1.79E+06	28.95	5.63E-13	11.14	0.007	0.76
76	3680	6097300	5.33E-12	0.9589	4	425.36	10.84	1.92E+06	31.67	6.60E-13	12.39	0.006	0.65
77	3628	6266300	6.24E-12	0.9915	4	369.43	10.71	1.39E+06	25.68	6.02E-13	11.48	0.006	0.79
78	3689	5099000	5.5E-12	0.9599	4	399.87	10.64	1.32E+06	25.84	6.82E-13	11.86	0.006	0.81
79	3699	4309100	6.79E-12	0.9997	4	361.43	10.69	9.23E+05	21.44	6.99E-13	11.46	0.006	0.76
80	3629	4999000	6.6E-12	0.9457	4	369.96	9.37	8.90E+05	21.59	7.23E-13	10.63	0.007	0.74
81	3768	3918900	7.15E-12	0.9441	4	408.19	10.87	8.89E+05	22.14	8.89E-13	12.45	0.006	0.87
82	3980	3691000	8.3E-12	0.9349	4	401.25	10.06	7.74E+05	20.98	1.01E-12	12.21	0.006	0.86
83	4170	3372400	9.32E-12	0.9281	4	411.8	9.87	6.83E+05	20.24	1.19E-12	12.63	0.006	0.90
84	3725	2854600	9.52E-12	0.926	4	359.37	9.65	4.46E+05	15.60	1.07E-12	11.29	0.007	0.80
85	4111	2539100	1.06E-11	0.9208	4	369.49	9.69	4.01E+05	15.80	1.36E-12	12.56	0.006	0.90
86	3953	2207300	1.14E-11	0.918	4	365.87	10.01	3.08E+05	13.95	1.42E-12	12.41	0.006	0.89
87	4044	2032000	1.39E-11	0.9058	4	341.74	8.45	2.37E+05	11.65	1.51E-12	10.93	0.007	0.79
88	4278	1732000	1.53E-11	0.9002	4	376.19	8.79	1.97E+05	11.40	1.87E-12	12.21	0.006	0.89
89	4182	1499000	1.63E-11	0.8976	4	365.83	9.53	1.59E+05	10.66	2.15E-12	13.16	0.006	0.97
90	3946	1239000	1.75E-11	0.8942	4	374.66	9.49	1.12E+05	9.04	2.23E-12	12.76	0.006	0.94
91	3968	1079800	2.04E-11	0.885	4	304.83	7.90	7.29E+04	6.75	2.14E-12	10.49	0.007	0.78
92	4292	941780	2.91E-11	0.8723	4	342.63	7.98	6.53E+04	6.93	2.98E-12	11.86	0.006	0.89
93	3824	795150	2.69E-11	0.8997	4	312.56	7.97	4.49E+04	5.68	3.01E-12	11.19	0.007	0.84
94	4077	678780	3.12E-11	0.8912	4	330.56	8.11	3.79E+04	5.53	3.79E-12	12.06	0.006	0.82
95	3962	572520	3.34E-11	0.8982	4	307.19	7.89	2.67E+04	4.67	3.87E-12	11.59	0.006	0.86
96	3920	463220	3.66E-11	0.8479	4	280.04	7.14	1.93E+04	3.91	4.27E-12	10.75	0.007	0.83
97	3982	417780	4.4E-11	0.8428	4	351.99	8.84	1.93E+04	4.55	6.17E-12	14.01	0.009	1.09
98	3772	399080	5.02E-11	0.8339	4	350.86	8.77	1.43E+04	3.99	6.83E-12	13.60	0.009	1.06
99	4003	311540	6.39E-11	0.8216	4	341.68	8.54	1.21E+04	3.90	9.13E-12	14.31	0.009	1.14
100	4040	295290	7.09E-11	0.8163	4	390.82	9.42	1.09E+04	4.07	1.17E-11	16.90	0.011	1.32

W/C = 0.60
28 Days of Hydration
Pore Solution: Synthetic Pore Solution

Pile No.	R ₁ (Q)	R ₂ (Q)	G (P)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (% Error)	R ₁ (Q) (% Error)	G (P) (Error)	G (P) (% Error)	PH (Error)	PH (% Error)
101	3765	229470	8.58E-11	0.8054	4	289.12	7280.1	7.66	3.07	3.07	1.3877E-11	13.26	0.009	1.08
102	3774	208440	9.97E-11	0.7871	4	302.11	6182.9	8.01	2.97	2.97	1.3728E-11	13.77	0.009	1.13
103	3692	183050	1.21E-10	0.7858	4	285.71	5081.2	7.80	2.76	2.76	1.8888E-11	13.78	0.009	1.15
104	3718	187180	1.28E-10	0.7858	4	322.73	4599.5	8.86	2.80	2.80	1.8874E-11	15.85	0.010	1.32
105	3646	136890	1.8E-10	0.7769	4	288.09	3411.8	8.13	2.80	2.80	2.1828E-11	14.83	0.010	1.23
106	3795	120180	1.8E-10	0.7818	4	324.86	3254.2	8.85	2.71	2.71	3.2042E-11	16.84	0.011	1.45
107	3602	108170	2.43E-10	0.7472	4	308.91	2818.9	7.87	2.46	2.46	3.8277E-11	16.17	0.011	1.42
108	3697	82863	2.62E-10	0.7447	4	318.32	2329.2	8.58	2.50	2.50	4.885E-11	17.50	0.011	1.54
109	3697	82864	3.12E-10	0.735	4	288.98	1859.5	8.03	2.24	2.24	5.123E-11	16.41	0.011	1.47
110	3693	71828	3.38E-10	0.7323	4	404.62	2122.2	11.29	3.08	3.08	8.0831E-11	24.08	0.016	2.16
111	3607	64687	4.41E-10	0.7162	4	288.66	1481.5	8.52	2.24	2.24	7.8338E-11	17.88	0.012	1.88
112	3616	88344	6.07E-10	0.6889	4	332.72	1437.5	9.46	2.46	2.46	1.2204E-10	20.10	0.013	1.91
113	3378	51484	6.38E-10	0.6806	4	291.51	1103.3	8.63	2.15	2.15	1.1707E-10	18.33	0.012	1.75
114	2881	49138	8.68E-10	0.6883	4	228.63	782.24	7.97	1.73	1.73	1.0202E-10	15.35	0.010	1.47
115	2882	38823	7.82E-10	0.6888	4	247.18	743.85	8.88	1.87	1.87	1.3431E-10	15.85	0.011	1.65
116	2743	35234	9.88E-10	0.6749	4	283.07	682.64	9.23	1.94	1.94	1.7508E-10	17.76	0.012	1.77
117	2328	30188	9.84E-10	0.6829	4	204.1	464.71	8.77	1.64	1.64	1.479E-10	15.51	0.010	1.54
118	2089	28878	1.02E-09	0.68	4	200.73	438.08	9.61	1.86	1.86	1.8467E-10	16.19	0.011	1.61
119	1891	23228	1.12E-09	0.6764	4	222.59	431.72	11.24	1.98	1.98	2.1205E-10	18.88	0.013	1.90
120	1838	18189	1.08E-09	0.6835	4	207.86	382.26	12.86	1.88	1.88	2.0718E-10	19.24	0.013	1.83
121	1268	14747	9.88E-10	0.6808	4	180.68	285.04	14.25	1.93	1.93	1.7823E-10	18.62	0.013	1.85
122	1019	11882	8.33E-10	0.7088	4	184.86	278.31	19.12	2.34	2.34	1.8271E-10	21.94	0.015	2.16
123	783.4	9379	8.88E-10	0.7288	4	157.94	208.89	20.88	2.23	2.23	1.3318E-10	20.22	0.014	1.88
124	388.8	7180	8.28E-10	0.7321	4	148.78	188.88	37.31	2.81	2.81	1.2188E-10	23.03	0.016	2.17
125	187	6801	4.01E-10	0.7783	4	120.88	148.88	72.39	2.85	2.85	9.2088E-11	22.88	0.016	2.10
126	134	4088	2.3E-10	0.8281	4	98.05	112.35	71.88	2.74	2.74	5.4881E-11	23.88	0.017	2.08
127	254.1	3088	1.88E-10	0.8004	4	75.378	83.088	28.88	2.88	2.88	3.8228E-11	22.48	0.016	1.88
128	311.4	2882	1.88E-10	0.8044	4	88.161	73.014	20.83	2.88	2.88	3.8288E-11	23.21	0.017	1.83
129	322.4	2316	1.88E-10	0.8077	4	88.435	77.278	21.84	3.34	3.34	5.0348E-11	28.21	0.019	2.20
130	388.1	2178	1.88E-10	0.8087	4	88.138	73.784	18.07	3.39	3.39	5.1107E-11	27.16	0.020	2.25
131	377	2381	2.78E-10	0.8452	4	82.428	64.338	21.88	4.00	4.00	8.3888E-11	33.80	0.024	2.88
132	404.7	2889	3.88E-10	0.8273	4	90.708	110.26	22.41	3.80	3.80	1.3333E-10	36.11	0.025	3.05
133	428.4	4392	8.18E-10	0.7741	4	130.94	188.27	32.30	4.24	4.24	3.8388E-10	44.07	0.030	3.82
134	388.8	12714	4.48E-09	0.6888	4	207.45	714.01	58.10	5.62	5.62	2.0882E-09	48.74	0.031	4.77
135	834.1	31805	4.3E-09	0.8201	4	428.05	2188.8	87.19	8.81	8.81	2.0142E-09	48.87	0.031	6.08
136	2218	78839	8.82E-10	0.6848	4	520.88	4828.3	23.48	5.84	5.84	3.1307E-10	35.08	0.023	3.38

W/C = 0.60
34 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (g)	R ₂ (g)	C (P)	Phi	Type	R ₁ (g) (Error)	R ₁ (g) (% Error)	R ₂ (g) (Error)	R ₂ (g) (% Error)	C (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
101	7248	210980	6.70E-10	0.6919	4	659.99	11.82	7725.1	3.66	1.5901E-10	23.37	0.016	2.39
102	7098	181080	8.80E-10	0.6474	4	836.72	11.83	6488.1	3.57	2.0071E-10	23.76	0.016	2.49
103	7239	158430	1.19E-09	0.6303	4	827.57	11.43	5484.4	3.47	2.8219E-10	23.86	0.016	2.57
104	7176	136890	1.59E-09	0.6136	4	800.65	11.16	4850.8	3.35	3.7378E-10	23.90	0.016	2.62
105	7125	121610	2.03E-09	0.5991	4	796.48	10.66	3644.4	3.16	4.8686E-10	22.86	0.016	2.61
106	6994	105390	2.61E-09	0.5863	4	720.49	10.45	3180.4	3.00	5.6347E-10	22.45	0.015	2.62
107	6966	90634	3.11E-09	0.5787	4	683.18	10.21	2688.4	2.85	6.8012E-10	21.86	0.015	2.62
108	6397	78328	3.71E-09	0.5678	4	628.01	9.82	2076.2	2.64	7.7234E-10	20.83	0.014	2.54
109	6077	68018	4.38E-09	0.5587	4	603.34	9.83	1751.7	2.58	9.003E-10	20.68	0.014	2.57
110	5726	58740	5.09E-09	0.5537	4	545.31	9.52	1401.8	2.39	9.7878E-10	19.37	0.014	2.46
111	5345	48817	5.99E-09	0.5491	4	468.94	8.77	1056.9	2.12	9.8925E-10	17.41	0.012	2.24
112	4829	42442	6.79E-09	0.5408	4	436.86	8.05	893.43	2.11	1.1827E-09	17.05	0.012	2.25
113	4297	36619	7.3E-09	0.5385	4	399.15	8.29	733.53	2.06	1.2124E-09	16.61	0.012	2.22
114	3491	28688	8.82E-09	0.5468	4	356.32	10.21	592.98	2.07	1.1594E-09	16.70	0.012	2.20
115	2578	22242	9.58E-09	0.57	4	326.3	12.67	491.19	2.21	9.8808E-10	18.00	0.013	2.30
116	1479	16037	9.28E-09	0.6139	4	288.69	19.52	353.56	2.45	8.8925E-10	20.60	0.015	2.45
117	584.5	11112	1.58E-09	0.6709	4	228.79	39.14	268.8	2.58	3.4988E-10	22.13	0.016	2.40
118	182.8	8046	1.04E-09	0.7082	4	186.5	87.87	200.12	2.49	2.135E-10	20.44	0.015	2.12
119	24.38	6640	1.46E-09	0.6889	4	125.42	514.44	147.89	2.26	2.6557E-10	18.28	0.013	1.92
120	231	5322	1.78E-09	0.7028	4	98.419	42.61	117.41	2.21	3.2594E-10	18.47	0.013	1.92
121	399.2	4487	2.01E-09	0.7084	4	74.777	19.21	90.685	2.02	3.5628E-10	17.76	0.013	1.81
122	436	3869	1.98E-09	0.717	4	66.8	15.78	82.802	2.08	3.582E-10	18.25	0.013	1.84
123	440.8	3657	1.97E-09	0.7189	4	68.328	15.05	78.919	2.16	3.6788E-10	18.64	0.014	1.86
124	482.1	3393	1.9E-09	0.7297	4	63.981	13.27	75.899	2.24	3.6938E-10	19.45	0.014	1.94
125	489.3	3214	1.91E-09	0.7289	4	63.758	13.03	75.273	2.34	3.6998E-10	20.24	0.015	2.02
126	501.3	3060	1.88E-09	0.7322	4	62.865	12.54	73.982	2.42	3.6257E-10	20.86	0.015	2.07
127	501.7	2935	1.85E-09	0.735	4	62.558	12.47	73.33	2.50	3.6787E-10	21.49	0.016	2.12

W/C = 0.60
 34 Days of Hydration
 Pore Solution: Synthetic Pore Solution

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
51	5811	5374000	1.05E-11	0.8981	4	861.45	14.82	5.17E+05	9.63	1.35E-12	12.87	0.009	0.96
52	5983	6438000	7.64E-12	0.9151	4	864.82	14.43	1.05E+06	12.43	9.29E-13	12.15	0.008	0.91
53	5829	1.1E+07	6.29E-12	0.9289	4	864.08	15.99	1.80E+06	18.00	7.74E-13	12.32	0.008	0.92
54	5482	1.4E+07	5.40E-12	0.9346	4	867.33	16.34	2.62E+06	18.66	6.72E-13	12.29	0.008	0.91
55	5499	1.0E+07	4.99E-12	0.9401	4	867.23	16.44	3.22E+06	20.29	6.05E-13	12.15	0.008	0.89
56	5385	1.9E+07	4.29E-12	0.9483	4	862.18	16.36	4.29E+06	22.46	5.02E-13	11.99	0.008	0.85
57	5169	2.6E+07	3.64E-12	0.9536	4	864.03	17.30	7.65E+06	30.24	4.69E-13	11.63	0.008	0.86
58	5335	3E+07	3.69E-12	0.9574	4	860.42	16.78	9.88E+06	33.01	4.29E-13	11.63	0.008	0.84
59	4970	3.1E+07	3.29E-12	0.9643	4	862.26	17.39	1.05E+07	33.92	3.77E-13	11.56	0.008	0.83
60	4979	4.3E+07	3.13E-12	0.9698	4	815.54	18.39	1.98E+07	46.23	3.71E-13	11.86	0.008	0.85
61	4695	4.1E+07	3.11E-12	0.9689	4	865.21	17.83	1.74E+07	42.49	3.69E-13	11.45	0.008	0.82
62	5032	4.4E+07	3.14E-12	0.9683	4	867.57	18.04	2.11E+07	47.41	3.69E-13	11.73	0.008	0.84
63	5031	4.4E+07	3.15E-12	0.9681	4	862.68	17.54	1.97E+07	45.17	3.69E-13	11.41	0.008	0.82
64	4887	3.9E+07	3.04E-12	0.9687	4	861.77	17.35	1.84E+07	39.45	3.36E-13	11.17	0.008	0.80
65	4898	3.9E+07	3.11E-12	0.9672	4	878.4	17.54	1.96E+07	40.60	3.03E-13	11.37	0.008	0.81
66	5112	4.4E+07	3.10E-12	0.9681	4	868.07	17.51	2.01E+07	46.09	3.69E-13	11.60	0.008	0.83
67	4974	3.9E+07	3.08E-12	0.9681	4	915.4	18.40	1.86E+07	42.21	3.64E-13	11.86	0.008	0.85
68	4975	4E+07	3.12E-12	0.9699	4	877.43	17.64	1.63E+07	41.00	3.55E-13	11.37	0.008	0.81
69	4852	3.9E+07	2.89E-12	0.9697	4	879.58	17.70	1.34E+07	36.98	3.39E-13	11.37	0.008	0.81
70	5086	4.3E+07	3.08E-12	0.9675	4	908.64	17.63	1.95E+07	46.53	3.63E-13	11.76	0.008	0.84
71	5140	3.3E+07	3.24E-12	0.9648	4	887.41	17.26	1.13E+07	34.65	3.74E-13	11.55	0.008	0.83
72													
73	5486	3.2E+07	3.81E-12	0.9653	4	909.67	16.64	1.16E+07	36.43	4.59E-13	11.96	0.008	0.87
74	5385	2.2E+07	4.23E-12	0.9498	4	860.5	16.04	5.39E+06	24.63	4.80E-13	11.36	0.008	0.83
75	5961	1.9E+07	4.97E-12	0.945	4	861.6	15.90	4.29E+06	22.39	5.27E-13	11.53	0.008	0.84
76	5711	1.5E+07	6.32E-12	0.9357	4	847.36	14.84	2.80E+06	18.42	6.09E-13	11.39	0.008	0.84
77	5841	1.3E+07	5.88E-12	0.9304	4	844.13	14.45	2.23E+06	16.80	6.73E-13	11.80	0.008	0.85
78	6035	1.1E+07	6.72E-12	0.9223	4	848.79	14.03	1.50E+06	14.24	7.65E-13	11.69	0.008	0.87
79	6179	9827000	7.89E-12	0.9129	4	867.24	13.87	1.31E+06	13.72	9.40E-13	11.93	0.008	0.90
80	6236	7746700	6.01E-12	0.9055	4	862.08	13.82	9.37E+05	12.10	1.11E-12	12.28	0.008	0.93
81	6275	5981100	1.03E-11	0.9079	4	839.87	13.36	5.89E+05	9.87	1.26E-12	12.23	0.008	0.94
82	6014	4721300	1.15E-11	0.9026	4	837.77	14.76	4.33E+05	9.16	1.55E-12	13.46	0.008	1.03
83	6370	3921000	1.43E-11	0.8796	4	833.07	13.08	3.05E+05	7.78	1.82E-12	12.77	0.009	1.00
84	6422	3267400	1.69E-11	0.8704	4	821.6	12.80	2.30E+05	7.03	2.17E-12	12.94	0.009	1.02
85	6431	2718400	1.97E-11	0.8617	4	815.7	12.66	1.75E+05	6.46	2.61E-12	13.26	0.009	1.05
86	6685	2209400	2.42E-11	0.8468	4	812.35	12.19	1.30E+05	5.87	3.26E-12	13.60	0.009	1.09
87	6883	1802900	2.87E-11	0.8404	4	777.75	11.67	9.39E+04	5.19	3.89E-12	13.53	0.009	1.08
88	6886	1494000	3.44E-11	0.8305	4	782.31	11.84	7.27E+04	4.90	4.87E-12	14.15	0.010	1.16
89	6734	1238900	4.17E-11	0.8195	4	797.36	11.84	5.76E+04	4.66	6.21E-12	14.91	0.010	1.23
90	6731	1020900	5E-11	0.81	4	759.9	11.27	4.32E+04	4.23	7.42E-12	14.84	0.010	1.24
91	6835	844100	6.39E-11	0.796	4	774.09	11.33	3.48E+04	4.13	1.01E-11	15.76	0.011	1.33
92	6821	716970	8.03E-11	0.7828	4	807.4	11.84	2.89E+04	4.13	1.37E-11	16.99	0.011	1.48
93	6782	607990	1E-10	0.771	4	789.72	11.64	2.39E+04	3.94	1.74E-11	17.33	0.012	1.51
94	6850	518460	1.29E-10	0.7579	4	817.05	11.76	2.02E+04	3.81	2.32E-11	18.53	0.012	1.64
95	6860	444890	1.65E-10	0.7425	4	812.21	11.67	1.70E+04	3.61	3.13E-11	18.99	0.013	1.72
96	7141	376700	2.21E-10	0.7254	4	829.96	11.62	1.42E+04	3.77	4.43E-11	20.03	0.013	1.86
97	7185	323300	2.82E-10	0.7098	4	837.66	11.71	1.21E+04	3.75	6.11E-11	20.94	0.014	1.99
98	7313	278900	3.94E-10	0.6924	4	848.54	11.80	1.04E+04	3.72	8.69E-11	21.79	0.015	2.12
99	7270	242900	5.14E-10	0.6778	4	865.49	11.90	9.10E+03	3.75	1.18E-10	22.96	0.015	2.29
100													

W/C = 0.60
34 Days of Hydration
Pore Solution: Synthetic Pore Solution

File No.	R ₁ (g)	R ₂ (g)	C (P)	Phi	Type	R ₁ (g) (Error)	R ₂ (g) (% Error)	R ₃ (g) (Error)	R ₄ (g) (% Error)	G (P) (Error)	C (P) (% Error)	Phi (Error)	Phi (% Error)
1	397.2	1065	1.10E-09	0.752	4	139.92	35.23	147.5	7.90	4.06E-10	41.34	0.033	4.41
2	398.8	1918	1.02E-09	0.759	4	132.73	33.45	139.82	7.29	3.90E-10	39.43	0.031	4.06
3	401.3	1943	9.62E-10	0.762	4	131.4	32.74	136.45	7.13	3.69E-10	37.94	0.030	3.98
4	403.1	1974	9.43E-10	0.763	4	132.31	32.82	138.53	7.07	3.69E-10	38.04	0.030	3.97
5	397.3	2034	9.71E-10	0.760	4	136.71	35.30	144.28	7.09	3.70E-10	38.13	0.030	4.00
6	404	2084	8.98E-10	0.765	4	131.83	32.83	139.36	6.75	3.33E-10	37.47	0.030	3.87
7	407.8	2114	8.79E-10	0.769	4	130.85	32.08	138.82	6.66	3.25E-10	37.18	0.029	3.82
8	413.6	2186	8.30E-10	0.769	4	128.9	30.66	134.69	6.22	3.00E-10	36.16	0.028	3.66
9	418.3	2204	8.11E-10	0.770	4	124.89	30.00	132.75	6.02	2.86E-10	35.59	0.028	3.60
10	416.7	2246	7.83E-10	0.772	4	123.25	29.58	131.2	5.84	2.79E-10	35.08	0.027	3.53
11	422.8	2288	7.81E-10	0.772	4	122.22	28.91	130.4	5.70	2.73E-10	34.91	0.027	3.49
12	408.4	2363	8.40E-10	0.767	4	127.47	31.44	136.25	5.77	2.97E-10	36.41	0.027	3.57
13	409.9	2484	9.24E-10	0.760	4	131.22	32.01	141.05	5.68	3.32E-10	35.90	0.028	3.63
14	408.3	2659	9.62E-10	0.757	4	132.03	32.50	142.76	5.37	3.34E-10	35.08	0.027	3.54
15	409.6	2871	9.86E-10	0.753	4	134.21	32.77	146.28	5.10	3.42E-10	34.71	0.028	3.49
16	397	3150	1.05E-09	0.747	4	134.49	33.86	147.9	4.70	3.47E-10	33.11	0.028	3.34
17	398.3	3990	1.63E-09	0.718	4	177.77	52.86	200.81	5.05	5.76E-10	37.61	0.028	3.92
18	395.5	5014	1.53E-09	0.712	4	204.3	60.89	239.22	4.77	6.03E-10	39.32	0.029	4.05
19	132.3	6828	2.30E-09	0.676	4	275.6	208.31	337.6	4.87	9.43E-10	41.07	0.030	4.45
20	99.88	11022	4.34E-09	0.628	4	349.73	360.16	503.6	4.57	1.81E-09	41.84	0.030	4.77
21	500.5	16438	4.22E-09	0.616	4	327.45	64.27	534.87	3.25	1.28E-09	30.44	0.022	3.51
22	1260	23153	4.63E-09	0.597	4	395.18	39.57	699.65	3.02	1.28E-09	27.63	0.020	3.26
23	2077	31800	4.98E-09	0.586	4	430.97	20.75	893.29	2.81	1.15E-09	25.17	0.018	3.02
24	2814	40714	3.92E-09	0.587	4	472.78	18.80	1103.4	2.71	9.45E-10	24.07	0.017	2.86
25	3808	60186	2.89E-09	0.601	4	465.35	13.01	1460.3	2.48	5.76E-10	21.41	0.015	2.46
26	4705	97096	1.43E-09	0.631	4	542.52	11.53	2452.9	2.53	2.80E-10	20.24	0.014	2.18
27	4856	111990	1.17E-09	0.641	4	548.86	11.08	2637.2	2.53	2.31E-10	19.63	0.013	2.08
28	4991	127040	9.48E-10	0.653	4	598.35	11.95	3508.9	2.78	1.97E-10	20.77	0.014	2.15
29	5183	169200	6.02E-10	0.678	4	637.09	12.29	5048.7	2.98	1.24E-10	20.86	0.014	2.06
30	5489	199850	5.11E-10	0.695	4	624.14	11.43	5751.1	2.92	9.83E-11	19.23	0.013	1.89
31	5393	228080	3.98E-10	0.700	4	645.23	11.96	6944.1	3.07	7.69E-11	19.32	0.013	1.86
32	5474	261830	3.25E-10	0.710	4	660.5	12.07	8398.6	3.20	6.19E-11	19.02	0.013	1.80
33	5726	309550	2.79E-10	0.718	4	699.38	11.69	10051	3.28	5.10E-11	18.28	0.012	1.71
34	5885	367270	2.08E-10	0.735	4	676.84	11.91	12014	3.36	3.69E-11	17.88	0.012	1.63
35	5721	416960	1.69E-10	0.746	4	698.11	11.88	14147	3.40	2.85E-11	16.94	0.011	1.53
36	5750	483920	1.31E-10	0.760	4	698.04	11.97	17127	3.54	2.30E-11	16.76	0.011	1.49
37	5951	718920	7.82E-11	0.787	4	753.99	12.67	28454	4.10	1.29E-11	16.82	0.011	1.41
38	6209	927250	6.08E-11	0.800	4	757.35	12.20	40032	4.32	9.37E-12	15.46	0.010	1.30
39	6231	1173500	4.49E-11	0.817	4	765.2	12.26	53975	4.59	6.63E-12	14.77	0.010	1.22
40	6284	1489700	3.44E-11	0.831	4	778.84	12.39	74133	4.98	4.91E-12	14.28	0.010	1.16
41	6291	1892100	2.79E-11	0.843	4	820.28	13.04	107170	5.66	3.93E-12	14.26	0.010	1.15
42	6278	2392100	2.19E-11	0.859	4	829.36	13.21	148170	6.26	3.03E-12	13.86	0.009	1.10
43	6331	3180100	1.79E-11	0.887	4	847.89	13.39	228570	7.23	2.40E-12	13.48	0.009	1.08
44	6180	4118100	1.39E-11	0.953	4	957.53	13.66	349820	8.28	1.79E-12	13.15	0.009	1.02

Reference Paste
7 Days of Hydration

File No.	$R_1(Q)$	$R_2(Q)$	C (F)	Phi	Type	$R_1(Q)$ (Error)	$R_1(Q)$ (% Error)	$R_2(Q)$ (Error)	$R_2(Q)$ (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	819.4	1410	1.80E-11	1.011	4	78.233	9.30	91.209	6.47	1.30E-11	71.60	0.047	4.61
2	828.3	1454	2.03E-11	1.005	4	79.948	9.66	98.153	8.61	1.48E-11	73.48	0.048	4.75
3	831.3	1524	2.14E-11	1.000	4	81.757	9.63	98.644	8.49	1.56E-11	72.29	0.047	4.70
4	828.1	1553	2.07E-11	1.001	4	80.999	9.73	97.372	8.27	1.44E-11	69.66	0.045	4.53
5	833.6	1572	2.11E-11	0.999	4	83.021	9.96	100.32	8.38	1.50E-11	71.01	0.046	4.62
6	853.1	1591	2.08E-11	1.000	4	82.483	9.67	99.898	8.28	1.44E-11	70.08	0.046	4.58
7	857.2	1644	2.08E-11	0.998	4	83.352	9.72	101.23	8.16	1.43E-11	68.91	0.045	4.49
8	861.7	1686	2.24E-11	0.994	4	87.027	10.10	108.12	8.37	1.80E-11	71.45	0.048	4.67
9	863.2	1719	2.18E-11	0.994	4	86.899	10.04	105.82	8.16	1.81E-11	69.16	0.045	4.52
10	861.3	1764	2.24E-11	0.991	4	88.257	10.26	107.89	8.12	1.84E-11	68.65	0.045	4.50
11	863.7	1830	2.40E-11	0.985	4	92.023	10.85	113.18	8.18	1.87E-11	68.67	0.045	4.60
12	868.3	1822	2.46E-11	0.981	4	94.763	10.90	117.33	8.10	1.72E-11	69.10	0.045	4.57
13	874.1	2039	2.57E-11	0.977	4	98.089	11.22	122.45	8.01	1.76E-11	68.40	0.044	4.54
14	872.8	2230	3.10E-11	0.952	4	106.18	12.39	137.23	8.15	2.16E-11	70.47	0.048	4.75
15	878.5	2408	3.04E-11	0.960	4	109.4	12.45	140.28	8.62	2.04E-11	67.30	0.044	4.54
16	886.5	2618	3.36E-11	0.951	4	114.18	13.18	148.15	8.66	2.20E-11	65.63	0.043	4.47
17	884.5	2859	3.81E-11	0.940	4	122.4	14.16	161.97	8.67	2.52E-11	68.13	0.043	4.55
18	885.7	3142	3.96E-11	0.934	4	127.13	14.66	171.07	8.44	2.55E-11	63.68	0.041	4.43
19	880.9	3435	4.32E-11	0.928	4	133.95	15.74	184.03	8.36	2.79E-11	63.37	0.041	4.42
20	832.7	3611	4.82E-11	0.916	4	142.09	17.08	200.01	8.25	3.01E-11	62.38	0.040	4.39
21	818.8	4174	5.25E-11	0.908	4	148.63	18.15	214.53	8.14	3.22E-11	61.38	0.040	4.38
22	778.2	5298	6.49E-11	0.897	4	175.09	22.56	289.94	8.13	4.00E-11	61.59	0.040	4.46
23	744.3	6052	7.12E-11	0.877	4	191.62	25.74	309.28	8.11	4.38E-11	61.34	0.039	4.49
24	702.5	6983	7.81E-11	0.867	4	206.31	28.80	355.71	8.09	4.77E-11	61.02	0.039	4.51
25	654.4	8114	8.84E-11	0.859	4	232.94	35.60	420.09	8.18	5.32E-11	61.60	0.039	4.60
26	594.1	9828	9.31E-11	0.846	4	255.72	43.78	497.11	8.16	5.86E-11	60.78	0.039	4.58
27	479.2	11698	1.10E-10	0.831	4	298.73	60.46	625.19	8.34	6.73E-11	61.32	0.039	4.70
28	371	14431	1.17E-10	0.821	4	333.61	69.92	811.02	8.44	7.30E-11	62.69	0.040	4.84
29	232.7	18095	1.17E-10	0.815	4	370.21	159.09	1042.8	8.77	7.22E-11	61.68	0.039	4.78
30	68.04	22880	1.20E-10	0.808	4	430.99	633.44	1444.7	8.32	7.84E-11	63.70	0.040	4.97
31	87.16	28081	1.02E-10	0.811	4	462.01	530.07	1872.7	8.44	8.28E-11	60.82	0.038	4.72
32	278.8	36874	9.21E-11	0.812	4	513.91	184.33	2546.6	8.91	8.88E-11	60.81	0.038	4.68
33	464	46398	8.02E-11	0.815	4	561.69	116.06	3431.8	7.40	4.80E-11	59.85	0.037	4.59
34	679.6	59183	8.87E-11	0.820	4	611.82	80.03	4794.4	8.10	4.08E-11	59.19	0.037	4.51
35	675	74944	6.81E-11	0.825	4	656.97	75.08	6822.1	8.84	3.36E-11	58.05	0.036	4.38
36	1050	92283	5.17E-11	0.829	4	693.52	68.05	8903.2	9.65	2.84E-11	58.95	0.035	4.28
37	1197	113680	4.09E-11	0.839	4	749.57	62.62	12137	10.68	2.33E-11	57.04	0.035	4.23
38	1498	141300	3.39E-11	0.846	4	820.08	55.86	16881	11.81	1.93E-11	57.14	0.038	4.20
39	1864	179300	2.62E-11	0.857	4	893.35	52.15	22935	13.01	1.49E-11	56.84	0.035	4.11
40	1944	219820	2.09E-11	0.869	4	970.62	49.93	32574	14.81	1.20E-11	57.53	0.038	4.13
41	2181	262070	1.69E-11	0.878	4	1027.1	47.09	42444	16.20	9.70E-12	57.36	0.038	4.07
42	2284	298350	1.47E-11	0.882	4	1099.3	46.82	52481	17.53	8.45E-12	57.43	0.038	4.05
43	2394	339270	1.25E-11	0.890	4	1105	46.16	62856	18.69	7.18E-12	57.39	0.038	4.01
44	2414	377850	1.02E-11	0.901	4	1124.7	46.59	74019	19.59	5.74E-12	56.48	0.035	3.90
45	2404	406130	8.32E-12	0.912	4	1138.9	47.29	81148	20.98	4.68E-12	56.00	0.035	3.82
46	2519	447070	7.46E-12	0.917	4	1144.9	45.45	93758	19.97	4.11E-12	55.05	0.034	3.73
47	2493	494760	6.56E-12	0.923	4	1202.9	48.25	112740	22.79	3.70E-12	56.39	0.035	3.80
48	2588	551940	5.29E-12	0.934	4	1242.3	48.00	132780	24.08	2.96E-12	56.38	0.035	3.75
49	2598	611370	4.21E-12	0.947	4	1280.6	48.52	153270	25.07	2.34E-12	55.70	0.035	3.66
50	2598	665390	3.20E-12	0.960	4	1246.6	48.54	175980	25.66	1.75E-12	53.50	0.033	3.47

Reference Paste
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
51	2632	746660	2.67E-12	0.967	4	1280.1	49.02	203360	27.24	1.06E-12	54.05	0.034	3.48
52	2640	801580	2.67E-12	0.972	4	1333.3	50.50	231640	28.90	1.41E-12	54.91	0.034	3.51
53	2607	837150	2.10E-12	0.984	4	1286.1	49.33	235560	28.14	1.10E-12	52.49	0.033	3.32
54	2592	860560	2.08E-12	0.984	4	1321.1	50.97	260100	29.54	1.10E-12	53.18	0.033	3.36
55	2551	884910	1.85E-12	0.980	4	1308.2	51.28	254800	28.78	9.73E-13	52.55	0.033	3.30
56	2602	908460	1.66E-12	0.980	4	1308.1	50.27	265760	29.32	8.73E-13	52.28	0.033	3.29
57	2599	911340	1.60E-12	0.982	4	1305.4	50.42	268660	29.27	9.40E-13	52.12	0.032	3.27
58	2618	904630	1.66E-12	0.980	4	1327.9	50.72	269530	29.67	9.86E-13	53.02	0.033	3.33
59	2651	930140	1.83E-12	0.988	4	1286.1	48.89	278420	29.72	9.92E-13	51.46	0.032	3.24
60	2632	885940	1.93E-12	0.988	4	1287.2	50.44	265260	28.81	1.00E-12	51.89	0.032	3.27
61	2642	873660	2.08E-12	0.983	4	1312.3	49.67	263730	29.03	1.10E-12	52.78	0.033	3.34
62	2620	889870	2.04E-12	0.985	4	1321.1	50.42	254460	29.25	1.09E-12	53.34	0.033	3.37
63	2663	883270	2.21E-12	0.980	4	1359.3	50.48	267960	30.34	1.20E-12	54.50	0.034	3.46
64	2647	847500	2.16E-12	0.982	4	1290.9	49.11	240400	28.37	1.14E-12	52.68	0.033	3.34
65	2713	829540	2.38E-12	0.978	4	1355.3	49.88	242250	29.20	1.31E-12	54.99	0.034	3.51
66	2726	796750	2.63E-12	0.971	4	1306.7	47.93	224630	28.19	1.42E-12	53.79	0.033	3.45
67	2694	746210	2.65E-12	0.971	4	1298.6	48.13	199280	28.71	1.43E-12	53.98	0.034	3.48
68	2713	710820	3.17E-12	0.961	4	1279.4	47.16	186960	28.57	1.72E-12	55.10	0.034	3.51
69	2722	645480	3.88E-12	0.960	4	1273.1	46.77	164360	25.46	2.14E-12	55.10	0.034	3.61
70	2793	604810	4.84E-12	0.938	4	1281.7	45.89	154310	25.83	2.73E-12	56.51	0.035	3.75
71	2762	540560	5.58E-12	0.931	4	1252.2	45.01	129130	23.88	3.17E-12	56.77	0.035	3.79
72	2726	488410	6.53E-12	0.923	4	1217.4	44.61	109760	22.36	3.70E-12	56.65	0.035	3.82
73	2697	438280	7.97E-12	0.913	4	1185.8	44.84	90184	21.01	4.87E-12	57.38	0.036	3.91
74	2678	370660	1.05E-11	0.898	4	1135	44.08	71751	19.35	5.99E-12	56.77	0.036	3.93
75	2602	318080	1.33E-11	0.887	4	1125.5	44.98	57625	18.12	7.75E-12	58.44	0.036	4.10
76	2300	288500	1.51E-11	0.891	4	1057	45.98	43210	16.09	8.73E-12	57.68	0.036	4.07
77	2298	238230	1.83E-11	0.899	4	1023.6	44.58	35953	15.24	1.12E-11	58.08	0.036	4.16
78	2128	201500	2.24E-11	0.892	4	982.16	46.63	28284	14.03	1.31E-11	58.72	0.037	4.24
79	2050	174090	2.70E-11	0.881	4	954.14	48.54	22671	13.02	1.62E-11	58.85	0.037	4.30
80	1932	152200	3.24E-11	0.844	4	928.04	48.04	18751	12.32	1.83E-11	59.77	0.037	4.41
81	1802	130900	3.90E-11	0.840	4	875.25	48.57	14579	11.14	2.11E-11	58.91	0.037	4.37
82	1689	115740	4.21E-11	0.832	4	861.82	51.03	12441	10.75	2.54E-11	60.37	0.038	4.52
83	1547	101450	4.57E-11	0.828	4	820.74	53.05	10139	9.99	2.79E-11	60.14	0.037	4.52
84	1407	86557	4.97E-11	0.828	4	787.03	54.52	8228.5	9.19	2.92E-11	58.75	0.037	4.43
85	1309	79396	5.71E-11	0.820	4	738.39	58.41	6940.2	8.74	3.37E-11	59.97	0.037	4.48
86	1200	69999	6.22E-11	0.817	4	720	60.00	5629.3	8.38	3.74E-11	60.10	0.038	4.59
87	1102	61886	7.00E-11	0.812	4	681.96	61.89	4882.7	7.89	4.16E-11	59.49	0.037	4.56
88	1005	54398	7.76E-11	0.812	4	663.53	68.01	4224.5	7.77	4.82E-11	62.13	0.039	4.81
89	976.5	48898	8.29E-11	0.808	4	647.82	73.99	3997.9	7.39	5.11E-11	61.63	0.039	4.79
90	782.5	43186	8.80E-11	0.805	4	622.62	78.55	3043.6	7.05	5.44E-11	61.81	0.039	4.82
91	648.9	36048	9.15E-11	0.805	4	598.19	90.92	2557	6.72	5.64E-11	61.61	0.039	4.81
92	525.9	33367	9.50E-11	0.805	4	550.75	104.73	2128.7	6.38	5.80E-11	61.07	0.038	4.77
93	389.3	28784	1.00E-10	0.805	4	517.05	132.82	1759.5	6.11	6.13E-11	61.11	0.039	4.79
94	237.4	25112	9.85E-11	0.809	4	474.29	189.79	1448.4	5.78	5.88E-11	59.80	0.038	4.67
95	125	21943	1.02E-10	0.810	4	445.47	356.39	1228	5.59	6.10E-11	59.74	0.038	4.67
96	18	18933	1.02E-10	0.813	4	417.62	2320.11	1030.8	5.44	6.12E-11	59.84	0.038	4.68
97	111.5	19401	9.84E-11	0.819	4	383.92	344.32	863.46	5.26	5.84E-11	59.33	0.038	4.61
98	208.1	14216	9.63E-11	0.824	4	358.4	172.22	739.59	5.20	5.74E-11	59.80	0.038	4.62
99	327.9	12110	8.86E-11	0.833	4	319.51	97.44	608.02	5.00	5.17E-11	58.19	0.037	4.47
100	417.2	10408	8.24E-11	0.841	4	298.11	70.98	521.1	5.01	4.84E-11	58.67	0.038	4.47

Reference Profile
7 Days of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
101	509.6	6063	7.51E-11	0.952	4	266.66	52.31	439.2	4.94	4.39E-11	56.08	0.037	4.39
102	601.1	7450	6.26E-11	0.967	4	235.85	39.24	382.76	4.87	3.59E-11	57.25	0.037	4.28
103	709.3	8039	4.71E-11	0.991	4	201.66	28.43	260.22	4.81	2.69E-11	56.37	0.036	4.06
104	802	4834	3.41E-11	0.918	4	166.36	20.75	228.25	4.66	1.86E-11	54.50	0.036	3.84
105	648.5	3754	2.87E-11	0.938	4	136.66	16.36	180.36	4.80	1.59E-11	54.91	0.036	3.60
106	688.2	2907	2.82E-11	0.950	4	114.66	12.94	144.31	4.66	1.57E-11	55.55	0.036	3.81
107	827.5	2446	3.76E-11	0.943	4	92.774	11.21	116.23	4.75	1.99E-11	52.31	0.034	3.62
108	710.2	2147	2.32E-11	0.973	4	90.503	12.74	109.29	5.09	1.26E-11	55.12	0.036	3.70
109	724.5	1692	2.07E-11	0.966	4	84.071	11.60	100.45	5.31	1.19E-11	57.20	0.037	3.79
110	724.9	1699	1.92E-11	0.966	4	79.443	10.96	93.818	5.55	1.14E-11	59.13	0.039	3.69
111	763.9	1462	1.76E-11	1.006	4	75.927	9.94	86.965	5.96	1.13E-11	63.25	0.041	4.12
112	772.7	1376	1.73E-11	1.012	4	73.035	9.45	85.262	6.20	1.14E-11	65.66	0.043	4.25
113	773.3	1310	1.71E-11	1.015	4	71.942	9.30	83.793	6.40	1.16E-11	67.81	0.044	4.38

Paste with Medium Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PHI	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
1	637.4	673.4	4.26E-11	0.965	4	59.612	9.35	72.269	8.28	3.92E-11	92.21	0.080	6.04
2	645.1	690.4	4.50E-11	0.967	4	62.118	9.63	75.83	7.98	4.01E-11	89.08	0.058	5.88
3	647.7	1002	4.57E-11	0.983	4	63.247	9.78	77.369	7.72	3.93E-11	86.15	0.058	5.71
4	649.9	1039	4.73E-11	0.979	4	64.414	9.91	79.099	7.61	4.02E-11	85.01	0.055	5.65
5	651.4	1075	4.86E-11	0.976	4	65.836	10.11	80.895	7.53	4.08E-11	84.08	0.055	5.61
6	655.6	1113	4.87E-11	0.974	4	66.699	10.17	82.309	7.40	4.03E-11	82.72	0.054	5.53
7	657	1144	5.08E-11	0.971	4	68.164	10.36	84.423	7.36	4.20E-11	82.71	0.054	5.55
8	658.4	1170	4.92E-11	0.971	4	67.616	10.30	83.935	7.17	3.95E-11	80.35	0.052	5.39
9	661.2	1188	5.10E-11	0.968	4	69.488	10.51	86.284	7.26	4.15E-11	81.45	0.053	5.46
10	660.8	1204	5.21E-11	0.967	4	69.894	10.57	86.699	7.22	4.22E-11	81.03	0.053	5.46
11	661.8	1230	5.21E-11	0.965	4	70.432	10.64	87.705	7.13	4.17E-11	80.08	0.052	5.40
12	667.7	1300	5.65E-11	0.959	4	74.291	11.13	93.448	7.19	4.69E-11	81.20	0.053	5.51
13	689.2	1376	5.94E-11	0.953	4	78.982	11.46	97.057	7.05	4.74E-11	79.80	0.052	5.45
14	674.5	1467	6.00E-11	0.944	4	82.035	12.16	105.22	7.08	5.31E-11	80.51	0.052	5.55
15	675.1	1633	7.15E-11	0.935	4	85.888	12.72	111.56	6.83	5.68E-11	78.02	0.051	5.43
16	676.7	1708	7.94E-11	0.925	4	91.834	13.59	121.34	6.78	6.15E-11	77.50	0.050	5.45
17	680.4	2008	8.70E-11	0.915	4	97.038	14.28	130.78	6.51	6.54E-11	75.19	0.049	5.34
18	683.5	2849	1.14E-10	0.895	4	127.97	19.89	188.15	6.36	8.57E-11	75.22	0.049	5.49
19	632.5	3902	1.89E-10	0.849	4	156.34	24.72	251.24	6.44	1.41E-10	74.84	0.046	5.72
20	568	5145	2.72E-10	0.813	4	185.91	34.61	344.16	6.69	2.07E-10	76.10	0.049	6.04
21	489.6	6714	2.99E-10	0.797	4	244.83	49.97	481.8	8.88	2.28E-10	77.08	0.050	6.23
22	573.1	6750	3.11E-10	0.784	4	266.86	77.43	602.66	6.69	2.35E-10	75.70	0.049	6.20
23	0	0	#####	0.000	0	0	#DIV/0!	0	#DIV/0!	0.00E+00	#DIV/0!	0.000	#DIV/0!
24	86.13	14632	3.16E-10	0.787	4	363.78	435.45	1080.7	7.24	2.34E-10	74.11	0.047	6.15
25	87.77	18220	3.02E-10	0.793	4	430.35	490.32	1363	7.48	2.22E-10	73.41	0.047	6.11
26	244.6	22877	2.86E-10	0.781	4	463.83	197.84	1632.8	8.01	2.11E-10	74.05	0.047	6.15
27	399.3	26451	2.39E-10	0.788	4	521.63	130.61	2390.9	8.30	1.73E-10	72.30	0.046	5.95
28	605.7	35735	2.15E-10	0.797	4	579.92	96.74	3208.6	8.88	1.96E-10	72.40	0.046	5.93
29	742.3	42861	1.78E-10	0.774	4	615.6	82.93	4016.7	9.37	1.28E-10	71.12	0.045	5.78
30	946.5	62088	1.49E-10	0.781	4	657.1	88.28	5161.7	9.95	1.04E-10	70.00	0.044	5.61
31	1073	61949	1.24E-10	0.788	4	692.59	64.55	6526.3	10.54	8.68E-11	69.10	0.043	5.48
32	1235	74855	1.03E-10	0.785	4	744.47	80.28	8578.1	11.44	7.12E-11	68.69	0.043	5.41
33	1408	86754	8.59E-11	0.803	4	782.57	55.69	10781	12.15	5.83E-11	67.98	0.042	5.28
34	1527	104070	6.86E-11	0.813	4	788.73	52.31	13056	12.65	4.49E-11	65.45	0.041	5.01
35	1746	121930	6.09E-11	0.817	4	897.61	50.84	17102	14.03	4.14E-11	67.96	0.042	5.18
36	1989	145450	5.00E-11	0.825	4	977.7	49.16	22413	15.41	3.48E-11	69.32	0.043	5.23
37	2283	177050	4.05E-11	0.833	4	1073.8	46.83	30238	17.08	2.84E-11	70.16	0.044	5.24
38	2687	221480	3.08E-11	0.845	4	1186.7	44.68	42805	19.24	2.17E-11	71.09	0.044	5.24
39	2842	258760	2.24E-11	0.860	4	1248.6	43.93	53021	20.49	1.59E-11	70.66	0.044	5.13
40	2993	305480	1.75E-11	0.873	4	1295.1	43.71	68258	22.35	1.23E-11	70.27	0.044	5.01
41	3077	353960	1.33E-11	0.897	4	1334.3	43.36	83633	23.70	9.16E-12	69.26	0.043	4.86
42	3258	403980	1.09E-11	0.908	4	1368.9	42.57	102020	25.27	7.32E-12	68.98	0.043	4.78
43	3335	465760	8.34E-12	0.911	4	1435.8	43.05	122680	26.98	5.75E-12	68.65	0.043	4.71
44	3348	503170	6.29E-12	0.928	4	1450.1	43.31	137780	27.38	4.24E-12	67.43	0.042	4.53
45	3300	560330	5.07E-12	0.937	4	1454.7	44.08	162880	28.24	3.33E-12	66.67	0.041	4.39
46	3434	617610	4.21E-12	0.947	4	1539.5	44.83	186150	30.14	2.82E-12	67.11	0.042	4.41
47	3246	665210	3.27E-12	0.961	4	1473.4	45.36	199440	29.83	2.08E-12	63.62	0.040	4.12
48	3393	725690	2.79E-12	0.969	4	1530.7	45.11	227620	31.41	1.79E-12	64.19	0.040	4.13
49	3279	775080	2.22E-12	0.982	4	1529.6	46.65	245480	33.08	1.40E-12	63.09	0.039	4.00
50	3298	838270	1.89E-12	0.991	4	1559.8	47.32	277320	33.08	1.19E-12	63.11	0.039	3.97

Paste with Medium Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
51	3381	922190	1.56E-12	1.001	4	1567.7	46.37	317680	34.47	9.65E-13	61.95	0.039	3.86
52	3392	908940	1.35E-12	1.008	4	1600	47.59	339900	35.12	8.40E-13	62.22	0.039	3.85
53	3455	1041700	1.21E-12	1.015	4	1591.5	46.06	361160	36.59	7.39E-13	61.12	0.038	3.75
54	3432	1069500	1.09E-12	1.020	4	1593.5	46.14	402780	37.07	6.99E-13	60.34	0.038	3.69
55	3439	1130200	9.79E-13	1.028	4	1611.1	46.85	426980	37.78	5.93E-13	60.60	0.038	3.66
56	3299	1139600	8.69E-13	1.033	4	1604.2	46.63	426980	37.63	5.25E-13	60.47	0.038	3.65
57	3429	1177100	8.91E-13	1.031	4	1647.1	48.03	460780	39.15	5.47E-13	61.43	0.038	3.71
58	3420	1163200	8.19E-13	1.038	4	1618.1	47.31	453590	38.34	5.47E-13	60.33	0.038	3.63
59	3494	1213100	8.82E-13	1.031	4	1680.8	47.53	484970	39.98	5.41E-13	61.33	0.038	3.71
60	3373	1215000	8.43E-13	1.034	4	1648.1	48.66	466320	41.66	5.17E-13	61.31	0.038	3.70
61	3418	1224000	8.18E-13	1.038	4	1680	48.57	482980	40.27	5.04E-13	61.57	0.038	3.70
62	3511	1239700	8.83E-13	1.031	4	1695.1	48.28	516400	41.66	5.52E-13	62.49	0.039	3.76
63	3472	1222800	8.25E-13	1.031	4	1686	48.39	493380	40.35	5.12E-13	62.04	0.039	3.74
64	3429	1230300	8.49E-13	1.034	4	1686	48.17	506900	41.36	5.28E-13	62.53	0.039	3.77
65	3481	1239600	8.69E-13	1.032	4	1685.4	48.42	508020	41.34	5.43E-13	62.41	0.039	3.77
66	3535	1218000	8.62E-13	1.034	4	1688.6	47.20	486580	40.18	5.25E-13	61.67	0.038	3.72
67	3387	1163200	8.99E-13	1.031	4	1610.2	47.54	449400	38.63	5.44E-13	60.51	0.038	3.66
68	3573	1142800	9.42E-13	1.028	4	1652.2	48.24	436740	38.48	5.61E-13	61.67	0.038	3.74
69	3554	1082400	1.02E-12	1.024	4	1674.7	47.12	409980	37.78	6.43E-13	63.14	0.039	3.84
70	3640	1045700	1.12E-12	1.019	4	1651.5	45.37	387100	37.02	7.04E-13	62.67	0.039	3.83
71	3599	999340	1.27E-12	1.012	4	1645.6	45.86	358870	36.27	8.05E-13	63.44	0.040	3.81
72	3545	936730	1.48E-12	1.004	4	1634.5	46.11	333980	35.64	9.45E-13	63.89	0.040	3.97
73	3592	873390	1.70E-12	0.998	4	1603.6	44.64	297840	34.10	1.08E-12	63.68	0.040	3.86
74	3600	830180	1.97E-12	0.988	4	1609.7	43.71	263810	33.53	1.28E-12	64.85	0.040	4.09
75	3601	772140	2.29E-12	0.980	4	1593.4	44.42	247680	32.10	1.47E-12	64.11	0.040	4.08
76	3681	714280	2.97E-12	0.967	4	1560.2	43.52	228360	31.97	1.91E-12	66.44	0.041	4.28
77	3771	668120	3.42E-12	0.958	4	1571.1	41.88	207740	31.09	2.28E-12	68.65	0.042	4.33
78	3695	610350	4.16E-12	0.947	4	1559.9	42.80	193950	30.12	2.85E-12	67.78	0.042	4.49
79	3747	561840	5.15E-12	0.938	4	1553.1	41.45	166810	29.48	3.56E-12	69.07	0.043	4.80
80	3723	514390	6.52E-12	0.923	4	1529.5	41.08	148270	28.44	4.54E-12	69.59	0.043	4.70
81	3998	490390	7.54E-12	0.916	4	1481	40.95	121310	26.42	5.20E-12	68.93	0.043	4.68
82	3611	420310	9.68E-12	0.902	4	1462.3	40.50	106940	25.92	6.82E-12	70.49	0.044	4.86
83	3486	377140	1.22E-11	0.891	4	1415.1	40.57	93545	24.80	8.61E-12	70.78	0.044	4.85
84	3450	337600	1.47E-11	0.881	4	1374.7	39.85	78540	23.27	1.04E-11	70.71	0.044	5.00
85	3390	301800	1.89E-11	0.866	4	1358.4	40.01	67957	22.52	1.39E-11	72.02	0.045	5.17
86	3191	262080	2.17E-11	0.851	4	1308.1	40.99	54305	20.68	1.57E-11	72.37	0.045	5.23
87	2896	231710	2.85E-11	0.832	4	1226.8	40.95	44954	19.28	1.86E-11	71.11	0.044	5.20
88	2870	202780	3.24E-11	0.841	4	1195.2	41.84	39947	18.07	2.30E-11	71.82	0.045	5.31
89	2798	176560	4.11E-11	0.829	4	1173.7	41.83	30867	17.28	3.01E-11	73.13	0.046	5.49
90	2840	166390	4.68E-11	0.821	4	1111.9	42.12	26100	16.08	3.54E-11	72.49	0.045	5.50
91	2482	136170	5.94E-11	0.812	4	1071.4	43.17	20514	15.14	4.34E-11	73.08	0.046	5.61
92	2371	116770	7.23E-11	0.802	4	1036.4	43.84	17035	14.34	5.30E-11	74.03	0.046	5.75
93	2198	102280	8.47E-11	0.795	4	993.99	45.22	13997	13.39	6.31E-11	74.44	0.046	5.84
94	2108	89104	1.08E-10	0.783	4	977.97	46.36	11552	12.98	8.26E-11	76.42	0.046	6.10
95	1892	78419	1.27E-10	0.776	4	912.97	46.26	9159.8	11.99	9.63E-11	75.64	0.047	6.09
96	1782	66272	1.60E-10	0.765	4	800.24	50.52	7994.8	11.84	1.25E-10	78.40	0.049	6.42
97	1596	56059	1.90E-10	0.758	4	834.59	52.56	5628.4	10.77	1.48E-10	77.57	0.049	6.42
98	1386	46273	2.32E-10	0.750	4	784.21	58.58	4725.6	10.21	1.81E-10	78.16	0.049	6.56
99	1213	36813	2.76E-10	0.744	4	728.86	60.09	3729.7	9.61	2.15E-10	77.99	0.049	6.61
100	1018	32328	3.21E-10	0.739	4	680.32	68.83	2948.2	9.12	2.51E-10	78.43	0.050	6.72

Pastes with Mettigan Fly Ash
7 Days of Hydration

File No.	$R_1(Q)$	$R_2(Q)$	C (F)	PHI	Type	$R_1(Q)$ (Error)	$R_1(Q)$ (% Error)	$R_2(Q)$ (Error)	$R_2(Q)$ (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
101	798.9	28922	3.57E-10	0.737	4	615.52	77.24	2303.1	8.55	2.78E-10	77.31	0.049	6.66
102	598.8	22422	3.09E-10	0.739	4	555.34	94.32	1802.3	8.04	2.82E-10	76.26	0.049	6.58
103	410	18724	3.79E-10	0.742	4	488.43	121.57	1419.3	7.59	2.84E-10	74.90	0.048	6.44
104	231	15919	3.89E-10	0.750	4	441.98	191.33	1116	7.15	2.67E-10	73.22	0.047	6.25
105	81.68	13048	3.64E-10	0.755	4	401.98	492.14	908.17	6.96	2.68E-10	73.21	0.047	6.23
106	64.51	10820	3.30E-10	0.766	4	354.15	548.98	721.37	6.67	2.37E-10	71.87	0.046	6.05
107	203.2	8903	2.91E-10	0.779	4	312.51	153.79	577.94	6.49	2.07E-10	71.23	0.046	5.91
108	317.8	7244	2.51E-10	0.794	4	268.09	84.36	453.9	6.27	1.74E-10	69.47	0.045	5.68
109	432.6	5745	2.01E-10	0.815	4	224.47	51.89	349.4	6.08	1.36E-10	67.77	0.044	5.42
110	530.9	4409	1.51E-10	0.840	4	183.74	34.61	264.04	5.99	1.00E-10	66.49	0.043	5.17
111	647.1	3232	8.21E-11	0.868	4	133.15	20.58	178.83	5.53	5.08E-11	61.91	0.040	4.65
112	663	2360	6.17E-11	0.918	4	106.9	15.94	136.29	5.53	3.97E-11	64.29	0.042	4.59
113	644.5	1888	9.22E-11	0.908	4	80.712	14.07	115.73	6.14	6.16E-11	66.77	0.044	4.83
114	637	1851	8.90E-11	0.921	4	79.752	12.52	101.07	6.52	6.40E-11	71.36	0.047	5.09
115	637.5	1322	8.49E-11	0.932	4	74.047	11.82	92.489	7.00	6.45E-11	76.21	0.050	5.36
116	634.9	1177	8.36E-11	0.939	4	70.421	11.09	87.305	7.42	6.74E-11	80.59	0.053	5.63
117	631.4	1098	8.37E-11	0.943	4	68.411	10.83	84.541	7.70	7.00E-11	83.83	0.055	5.82

Peds with Portage Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	644.4	633.2	4.30E-11	0.965	4	52.111	8.09	60.2	7.23	3.50E-11	76.61	0.052	5.25
2	649.2	633.3	4.22E-11	0.965	4	51.735	7.97	59.772	6.92	3.22E-11	76.26	0.050	5.03
3	653.6	637.2	5.00E-11	0.964	4	55.896	8.55	65.058	7.17	3.97E-11	76.41	0.052	5.29
4	653.6	623.6	4.51E-11	0.966	4	53.64	8.18	62.291	6.75	3.36E-11	74.61	0.049	4.95
5	657.7	633.3	4.42E-11	0.966	4	53.534	8.14	62.186	6.64	3.25E-11	73.54	0.049	4.86
6	659.3	654.1	4.91E-11	0.962	4	56.223	8.53	65.571	6.87	3.74E-11	76.26	0.050	5.09
7	661.5	661.3	4.91E-11	0.961	4	56.702	8.57	66.127	6.86	3.74E-11	76.26	0.050	5.10
8	663.3	663.7	4.64E-11	0.961	4	56.83	8.54	66.355	6.73	3.62E-11	74.78	0.049	5.00
9	664.4	668.4	5.02E-11	0.978	4	57.476	8.65	67.097	6.73	3.74E-11	74.56	0.049	5.00
10	670	1029	4.64E-11	0.979	4	57.443	8.57	67.18	6.53	3.61E-11	72.60	0.048	4.86
11	673.5	1075	5.50E-11	0.980	4	61.408	9.12	72.185	6.71	4.11E-11	74.68	0.049	5.08
12	0	0	6.69E-09	0.000	0	0	#DIV/0!	0	#DIV/0!	0.00E+00	#DIV/0!	0.000	#DIV/0!
13	685.5	1257	6.81E-11	0.960	4	66.72	10.02	82.012	6.52	4.98E-11	73.14	0.048	5.05
14	692.3	1443	9.91E-11	0.923	4	64.624	12.22	103.07	7.14	7.96E-11	60.49	0.053	5.73
15	690.5	2023	1.20E-10	0.865	4	93.51	13.74	119.11	5.89	6.55E-11	66.04	0.045	4.99
16	692.2	2437	1.80E-10	0.866	4	100.4	15.39	133.66	5.48	1.15E-10	64.04	0.042	4.84
17	621.2	2998	2.72E-10	0.838	4	112.65	18.17	159.19	5.37	1.71E-10	62.92	0.041	4.92
18	686.4	3463	3.40E-10	0.819	4	121.56	20.73	178.11	5.14	2.04E-10	60.02	0.039	4.80
19	687.8	4131	4.19E-10	0.801	4	137.36	24.20	212.94	5.15	2.82E-10	60.08	0.039	4.91
20	625.2	4975	5.09E-10	0.782	4	150.99	29.69	256.4	5.15	3.02E-10	59.41	0.039	4.97
21	498.5	6988	6.67E-10	0.780	4	164.93	39.39	320.41	5.46	4.12E-10	61.78	0.040	5.31
22	378.4	7038	7.30E-10	0.747	4	203.22	53.56	368.91	5.24	4.27E-10	59.42	0.038	5.11
23	278.3	8655	8.70E-10	0.728	4	243.63	87.54	498.72	5.62	5.22E-10	60.01	0.038	5.37
24	132.3	1160	1.02E-09	0.712	4	286.44	216.78	498.64	5.61	6.25E-10	61.04	0.040	5.56
25	30.91	13991	1.07E-09	0.702	4	330.61	1059.59	631.5	5.99	6.81E-10	60.61	0.039	5.62
26	181.9	17398	1.02E-09	0.698	4	366.74	201.82	1062	6.11	6.09E-10	59.73	0.039	5.53
27	397.2	20648	9.95E-10	0.694	4	408.23	111.45	1326.4	6.36	6.96E-10	59.95	0.039	5.57
28	498.3	25462	8.67E-10	0.697	4	439.28	86.15	1671.4	6.56	5.22E-10	58.66	0.038	5.43
29	614.8	30366	7.44E-10	0.703	4	460.32	76.69	2032	6.69	4.26E-10	57.67	0.037	5.28
30	797.5	36099	6.44E-10	0.707	4	487.29	62.38	2480.7	6.87	3.65E-10	56.63	0.036	5.12
31	631.2	42699	5.40E-10	0.713	4	519.05	65.74	3030	7.05	2.98E-10	55.09	0.035	4.92
32	1031	50944	4.37E-10	0.723	4	536.3	52.02	3654	7.22	2.34E-10	53.48	0.034	4.71
33	1149	59527	3.67E-10	0.730	4	564.54	46.13	4461.3	7.53	1.94E-10	52.77	0.034	4.59
34	1283	72467	2.94E-10	0.739	4	590.39	46.02	5727.6	7.80	1.61E-10	51.34	0.033	4.40
35	1413	87045	2.30E-10	0.750	4	612.53	43.35	7120.9	8.19	1.16E-10	49.63	0.031	4.19
36	1503	104150	1.84E-10	0.761	4	634.05	42.19	8984.8	8.63	8.88E-11	48.48	0.031	4.03
37	1704	124360	1.51E-10	0.769	4	672.3	36.45	11322	9.10	7.21E-11	47.67	0.030	3.92
38	1808	152760	1.15E-10	0.761	4	711.62	36.35	14670	9.73	5.38E-11	46.79	0.030	3.79
39	2066	184170	9.41E-11	0.769	4	767.16	36.74	19211	10.43	4.37E-11	46.47	0.029	3.72
40	2270	245440	6.49E-11	0.808	4	822.41	36.23	26960	11.69	2.95E-11	45.40	0.029	3.55
41	2417	339670	4.04E-11	0.830	4	879.8	36.40	45307	13.30	1.78E-11	44.15	0.028	3.37
42	2659	407760	3.31E-11	0.839	4	913.36	34.36	57036	14.23	1.44E-11	43.41	0.027	3.27
43	2804	526640	2.25E-11	0.869	4	972.76	34.69	64766	16.12	9.62E-12	42.61	0.027	3.16
44	2936	676760	1.54E-11	0.878	4	1018.9	34.66	122750	18.14	6.48E-12	42.08	0.027	3.04
45	3053	806320	1.14E-11	0.863	4	1039.6	34.06	169760	19.27	4.66E-12	40.89	0.026	2.90
46	3151	999470	8.60E-12	0.907	4	1070.6	33.06	201370	20.89	3.56E-12	40.47	0.026	2.83
47	3073	1066500	6.72E-12	0.922	4	1079	35.11	242000	22.09	2.67E-12	39.76	0.025	2.74
48	3031	1263500	5.27E-12	0.935	4	1081.6	35.69	295910	23.42	2.04E-12	38.77	0.025	2.63
49	3049	1366700	4.51E-12	0.943	4	1121.2	36.77	348860	24.84	1.77E-12	39.15	0.025	2.84
50	2922	1566800	3.55E-12	0.956	4	1084.2	37.10	398110	25.41	1.33E-12	37.29	0.024	2.48

Paste with Portage Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
51	2640	1776000	2.97E-12	0.986	4	1116.6	37.98	487070	27.42	1.11E-12	37.42	0.024	2.48
52	2640	1914800	2.03E-12	0.975	4	1103.6	37.54	534000	27.89	9.22E-13	36.46	0.023	2.38
53	2607	2063900	2.22E-12	0.982	4	1129.2	38.64	620650	29.66	8.14E-13	38.73	0.023	2.38
54	2677	2189900	2.09E-12	0.986	4	1117.8	38.85	659990	30.14	7.40E-13	36.18	0.023	2.33
55	2664	2276300	2.04E-12	0.988	4	1120.9	38.73	708620	31.14	7.30E-13	38.07	0.023	2.33
56	2614	2218200	1.98E-12	0.988	4	1126.3	38.85	673490	30.36	7.10E-13	36.33	0.023	2.34
57	2766	2240800	1.84E-12	0.993	4	1086.7	37.86	644300	28.76	6.32E-13	36.34	0.022	2.20
58	2762	2314000	1.79E-12	0.994	4	1086.8	39.26	702100	30.34	6.20E-13	36.28	0.022	2.26
59	2667	2279700	1.90E-12	0.987	4	1143.9	38.30	712670	31.26	7.20E-13	36.61	0.023	2.36
60	2642	2302300	1.90E-12	0.990	4	1112.4	39.14	708430	30.77	6.70E-13	36.72	0.023	2.29
61	2662	2284300	1.91E-12	0.990	4	1120	38.86	704170	30.83	6.80E-13	36.04	0.023	2.32
62	2667	2310200	1.87E-12	0.991	4	1134.6	39.16	715980	30.98	6.70E-13	36.23	0.023	2.33
63	2664	2366200	1.87E-12	0.991	4	1136.3	39.81	757840	31.98	6.70E-13	36.32	0.023	2.33
64	3018	2143300	2.13E-12	0.984	4	1120.6	37.13	632330	28.50	7.70E-13	36.10	0.023	2.33
65	2638	2077400	2.22E-12	0.981	4	1143.3	38.91	613480	29.53	8.22E-13	37.06	0.024	2.40
66	3146	1867400	2.70E-12	0.989	4	1126.2	35.80	517760	27.86	1.03E-12	37.13	0.024	2.44
67	3239	1708200	3.23E-12	0.980	4	1145.2	35.36	480840	26.98	1.22E-12	37.87	0.024	2.51
68	3169	1633900	3.70E-12	0.952	4	1111.7	34.88	386280	26.32	1.49E-12	37.89	0.024	2.53
69	3265	1341200	4.04E-12	0.941	4	1106.6	34.00	316300	23.73	1.70E-12	38.56	0.025	2.80
70	3268	1172600	6.16E-12	0.928	4	1119.8	34.09	270730	23.09	2.40E-12	40.20	0.026	2.76
71	3232	1048000	7.35E-12	0.917	4	1092.9	33.81	227210	21.74	2.97E-12	40.35	0.026	2.79
72	3249	914040	8.83E-12	0.907	4	1078.6	33.20	186820	20.42	3.68E-12	41.02	0.026	2.87
73	3294	811060	1.11E-11	0.895	4	1044.6	32.00	155370	18.16	4.83E-12	40.84	0.026	2.89
74	3272	723530	1.41E-11	0.882	4	1051.4	32.13	134630	18.61	5.94E-12	42.02	0.027	3.02
75	3249	642400	1.71E-11	0.872	4	1037.4	31.83	113560	17.68	7.29E-12	42.59	0.027	3.10
76	3137	563920	1.98E-11	0.865	4	1021.3	32.56	93260	16.54	8.60E-12	43.26	0.027	3.17
77	3103	489500	2.64E-11	0.851	4	991.03	31.86	7987	15.55	1.11E-11	43.50	0.026	3.24
78	2836	404380	3.12E-11	0.841	4	988.84	31.15	57237	14.15	1.30E-11	44.37	0.026	3.34
79	2836	349360	4.02E-11	0.828	4	940.97	32.03	46387	13.40	1.82E-11	45.24	0.029	3.46
80	2814	278890	6.28E-11	0.815	4	888.49	30.86	32884	11.79	2.39E-11	44.40	0.026	3.45
81	2742	260200	8.16E-11	0.807	4	878.12	32.06	29105	11.63	2.89E-11	46.35	0.029	3.63
82	2639	205710	8.11E-11	0.793	4	844.21	31.89	22087	10.74	3.82E-11	47.04	0.030	3.75
83	2637	177140	1.01E-10	0.782	4	837.79	33.02	18294	10.33	4.91E-11	48.65	0.031	3.94
84	2372	151840	1.18E-10	0.776	4	794.84	33.60	14859	9.80	5.67E-11	48.77	0.031	3.98
85	2213	131470	1.43E-10	0.768	4	771.82	34.87	12173	9.26	7.11E-11	48.82	0.032	4.11
86	2106	112200	1.79E-10	0.755	4	749.24	35.58	9878.5	8.81	9.07E-11	50.78	0.032	4.28
87	1967	93327	2.30E-10	0.743	4	725.29	36.50	7829.8	8.39	1.20E-10	52.18	0.033	4.45
88	1822	78221	2.68E-10	0.738	4	700.72	36.48	6107.1	7.81	1.37E-10	53.04	0.034	4.56
89	1686	66019	3.85E-10	0.722	4	688.99	39.56	5081.1	7.70	1.80E-10	54.36	0.035	4.79
90	1589	58585	3.99E-10	0.719	4	641.01	40.85	4312.4	7.38	2.18E-10	54.58	0.035	4.83
91	1403	47909	6.07E-10	0.709	4	607.01	43.27	3340.1	7.02	2.82E-10	55.73	0.036	5.02
92	1285	41180	6.46E-10	0.707	4	573.4	45.33	2735.7	6.64	3.03E-10	55.64	0.036	5.03
93	1161	34943	6.94E-10	0.704	4	542.08	47.10	2199.8	6.30	3.31E-10	55.78	0.036	5.08
94	998.9	33391	6.28E-10	0.705	4	507.86	53.07	1847.5	6.08	3.50E-10	55.94	0.036	5.10
95	753.3	28947	7.29E-10	0.700	4	485.81	64.49	1665.3	6.17	4.20E-10	57.63	0.037	5.30
96	691.7	24634	7.21E-10	0.702	4	460.48	66.57	1453.3	5.90	4.08E-10	58.69	0.036	5.19
97	543.9	20250	6.74E-10	0.718	4	400.16	73.57	1046	5.17	3.09E-10	53.12	0.034	4.78
98	367.6	18002	7.28E-10	0.709	4	383.45	110.06	988.61	5.54	4.13E-10	56.73	0.037	5.18
99	280.8	15189	6.88E-10	0.724	4	343.38	131.88	753.6	4.86	3.12E-10	53.11	0.034	4.76
100	52.07	12898	6.17E-10	0.728	4	317.59	609.93	654.59	5.09	3.40E-10	55.15	0.036	4.93

Pecan with Portage Fly Ash
7 Days of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PHI	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
101	94.04	10317	6.03E-10	0.745	4	276.29	292.74	468.97	4.84	2.71E-10	53.81	0.036	4.72
102	227.4	8611	3.79E-10	0.767	4	233.43	102.65	366.19	4.63	1.94E-10	51.24	0.034	4.37
103	302.8	6623	2.92E-10	0.789	4	186.61	53.92	297.7	4.36	1.45E-10	49.76	0.033	4.14
104	510.2	5221	2.03E-10	0.819	4	180.61	31.46	226.42	4.34	1.01E-10	49.61	0.033	3.96
105	627.4	3636	1.24E-10	0.859	4	125.11	19.94	165.56	4.21	5.88E-11	48.26	0.032	3.89
106	673.3	3078	9.61E-11	0.884	4	104.89	15.58	133.35	4.33	4.73E-11	49.16	0.032	3.86
107	694.1	2360	7.04E-11	0.913	4	83.916	12.09	103.16	4.37	3.46E-11	49.15	0.032	3.54
108	694.1	1898	4.39E-11	0.955	4	63.777	9.19	76.128	4.51	2.16E-11	49.42	0.032	3.40
109	700	1343	6.63E-11	0.963	4	67.998	9.71	79.726	5.94	3.63E-11	64.60	0.043	4.46
110	697.1	1192	4.95E-11	0.988	4	63.421	9.10	73.6	6.17	3.29E-11	68.95	0.044	4.54
111	693.4	1062	4.62E-11	0.975	4	61.327	8.84	70.715	6.54	3.24E-11	70.12	0.046	4.74
112	690.2	1003	4.39E-11	0.962	4	59.132	8.57	67.699	6.77	3.15E-11	72.47	0.046	4.86
113	687.3	956.1	4.37E-11	0.985	4	59.994	8.56	67.602	7.08	3.31E-11	75.66	0.050	5.08

Paste with Sandstone Fly Ash
7 Days of Hydration

File No.	R_1 (Q)	R_2 (Q)	G (F)	Phi	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	1199	696	3.70E-11	1.036	4	50.465	4.21	60.172	8.62	3.90E-11	107.29	0.070	6.71
2	1210	720.9	3.91E-11	1.030	4	51.061	4.22	60.97	8.46	4.11E-11	104.99	0.066	6.61
3													
4													
5	1073	974.1	5.09E-11	0.989	4	60.11	5.80	70.693	7.26	4.31E-11	85.19	0.056	5.63
6	994.7	1101	5.49E-11	0.973	4	65.157	6.62	76.005	6.90	4.29E-11	78.59	0.062	5.30
7	990.7	1136	5.39E-11	0.972	4	66.405	6.70	77.521	6.81	4.18E-11	77.64	0.051	5.24
8	1010	1166	6.32E-11	0.962	4	70.34	6.96	82.666	6.97	5.04E-11	79.66	0.062	5.44
9	992.7	1200	6.49E-11	0.955	4	78.675	7.95	92.674	7.16	5.27E-11	81.52	0.054	5.61
10	1125	1244	5.94E-11	0.965	4	80.16	7.13	95.143	7.65	5.31E-11	89.35	0.059	6.06
11													
12													
13													
14	805.6	2348	1.10E-10	0.980	4	108.3	13.44	131.7	5.61	6.80E-11	62.78	0.042	4.66
15	798.6	2662	1.29E-10	0.978	4	115.16	14.42	142.27	5.34	7.51E-11	60.27	0.040	4.54
16	781.9	3014	1.40E-10	0.969	4	124.86	15.97	156.96	5.21	8.26E-11	59.25	0.039	4.52
17	762.5	3446	1.63E-10	0.952	4	135.39	17.76	174.12	5.05	9.44E-11	57.95	0.036	4.49
18	739.2	3939	1.94E-10	0.940	4	145.95	19.74	192.5	4.89	1.04E-10	56.56	0.037	4.44
19	737.5	3902	2.57E-10	0.901	4	243.65	36.22	339.12	5.75	1.70E-10	66.03	0.044	5.44
20	593.1	7999	2.59E-10	0.769	4	291.85	50.96	419.21	5.25	1.59E-10	61.50	0.040	5.12
21	347.5	10736	2.60E-10	0.771	4	343.63	98.94	559.45	5.19	1.78E-10	60.67	0.040	5.17
22	121.2	14315	3.03E-10	0.791	4	398.36	326.69	720.96	5.04	1.77E-10	59.11	0.038	5.08
23	130	16360	3.12E-10	0.751	4	457.14	361.65	932.2	5.39	1.83E-10	56.70	0.036	5.07
24	395.4	24502	3.23E-10	0.743	4	528.53	144.10	1298.1	5.30	1.90E-10	58.80	0.038	5.12
25	701.5	31302	2.90E-10	0.741	4	590.07	82.69	1676.2	5.35	1.70E-10	57.19	0.037	4.99
26	991.2	39155	2.63E-10	0.739	4	630.87	63.65	2169.4	5.54	1.69E-10	56.05	0.036	4.86
27	1226	46366	2.57E-10	0.741	4	685.54	55.92	2612.9	5.83	1.43E-10	55.66	0.036	4.80
28	1516	60777	2.27E-10	0.744	4	740.65	49.60	3799.1	6.16	1.24E-10	54.61	0.035	4.69
29	1696	75794	1.98E-10	0.749	4	782.67	46.15	4628.6	6.50	1.05E-10	53.13	0.034	4.62
30	1624	91619	1.65E-10	0.756	4	826.96	42.96	6313.9	6.66	8.65E-11	52.36	0.033	4.41
31	2163	114440	1.42E-10	0.762	4	873.21	39.82	8429.7	7.37	7.26E-11	51.03	0.032	4.26
32	2456	137620	1.28E-10	0.766	4	944.13	36.44	11028	8.00	6.40E-11	51.24	0.033	4.13
33	2710	160320	1.03E-10	0.774	4	998.17	36.76	14499	8.58	5.20E-11	50.27	0.032	4.07
34	2959	203640	8.41E-11	0.783	4	1067.9	36.09	16944	9.21	4.20E-11	49.66	0.032	4.05
35	3393	254080	7.14E-11	0.788	4	1178.9	34.79	25978	10.22	3.60E-11	49.30	0.031	3.92
36	3708	324250	6.44E-11	0.801	4	1249.1	33.70	36302	11.20	2.69E-11	48.10	0.030	3.76
37	3933	402340	4.03E-11	0.816	4	1303.7	33.15	46265	12.00	1.94E-11	47.59	0.030	3.67
38	4213	509010	3.16E-11	0.827	4	1361	32.76	67631	13.37	1.51E-11	47.26	0.030	3.60
39	4546	654390	2.48E-11	0.839	4	1486.2	32.67	99729	15.24	1.17E-11	46.19	0.030	3.49
40	4696	769470	1.80E-11	0.855	4	1520.7	32.36	175630	16.47	8.31E-12	45.92	0.029	3.39
41	4946	970910	1.40E-11	0.868	4	1598.9	32.79	213230	18.12	5.09E-12	45.20	0.029	3.29
42	4915	1119500	1.12E-11	0.860	4	1620.5	32.97	268140	19.12	4.08E-12	44.73	0.029	3.22
43	4937	1299300	9.05E-12	0.891	4	1655.5	33.53	314960	20.53	3.09E-12	43.62	0.028	3.10
44	4771	1460900	7.07E-12	0.904	4	1697.5	34.95	363920	21.26	2.41E-12	43.52	0.028	3.05
45	4916	1645600	5.54E-12	0.918	4	1705.1	34.66	432030	22.11	1.96E-12	42.83	0.027	2.96
46	4893	1894300	4.66E-12	0.927	4	1714	35.10	496270	23.16	1.59E-12	41.76	0.027	2.88
47	4813	2054200	3.71E-12	0.939	4	1741.9	35.82	577770	25.10	1.27E-12	41.60	0.027	2.82
48	4781	2303000	3.04E-12	0.950	4	1741.9	36.43	673250	26.45	1.05E-12	41.45	0.027	2.78
49	4644	2549500	2.61E-12	0.958	4	1761	36.77	800240	26.26	8.49E-13	39.00	0.025	2.59
50	4622	2891200	2.17E-12	0.969	4	1893.7	35.12						

Pastes with Standard Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
51	4762	2636100	2.13E-12	0.966	4	1622.1	36.26	631620	26.31	6.76E-13	41.06	0.026	2.73
52	4617	3000800	1.83E-12	0.976	4	1745.9	37.81	620450	27.34	7.22E-13	39.64	0.026	2.60
53	4744	3170500	1.60E-12	0.976	4	1762.5	37.57	612320	26.78	7.20E-13	39.61	0.026	2.63
54	4726	3247200	1.75E-12	0.960	4	1765	37.26	642110	29.01	6.66E-13	39.44	0.026	2.59
55	4647	3417100	1.67E-12	0.963	4	1764.4	37.75	1030600	30.16	6.66E-13	39.32	0.026	2.56
56	4766	3266900	1.66E-12	0.964	4	1776.5	37.26	980570	29.14	6.62E-13	39.61	0.026	2.56
57	4666	3266200	1.64E-12	0.964	4	1766.6	36.55	966620	29.26	6.46E-13	39.67	0.026	2.59
58	4671	3261300	1.64E-12	0.964	4	1770	36.92	963620	29.26	6.46E-13	39.60	0.026	2.61
59	4613	3267100	1.59E-12	0.966	4	1763.4	36.01	941640	28.65	6.22E-13	39.21	0.026	2.56
60	4616	3334200	1.81E-12	0.977	4	1614.6	37.66	1003300	30.09	7.24E-13	40.09	0.026	2.64
61	4612	3101100	1.74E-12	0.961	4	1760.3	37.20	676650	26.24	6.66E-13	40.21	0.026	2.64
62	4604	2976300	1.66E-12	0.972	4	1632.5	37.37	647210	26.45	6.20E-13	41.15	0.026	2.72
63	4646	2614700	2.12E-12	0.966	4	1604.4	37.21	770780	27.36	6.73E-13	41.10	0.026	2.73
64	4691	2391200	2.52E-12	0.960	4	1604.6	36.90	661210	26.66	1.05E-12	41.66	0.027	2.60
65	6029	2377600	3.03E-12	0.960	4	1623.7	36.26	624660	26.27	1.26E-12	42.78	0.026	2.90
66	4660	2206800	3.50E-12	0.942	4	1763.6	36.66	563540	25.64	1.50E-12	42.72	0.027	2.92
67	6069	2000900	3.66E-12	0.937	4	1778.4	34.91	460030	23.96	1.67E-12	43.23	0.026	2.97
68	6121	1636000	5.07E-12	0.922	4	1766.9	34.35	437450	23.80	2.21E-12	43.61	0.026	3.04
69	6111	1642100	6.14E-12	0.911	4	1727.6	33.61	372960	22.71	2.70E-12	43.66	0.026	3.10
70	6161	1416800	7.10E-12	0.904	4	1703.5	33.01	266400	20.66	3.16E-12	44.67	0.026	3.16
71	6166	1246800	9.42E-12	0.866	4	1697.5	32.66	264240	20.34	4.30E-12	45.66	0.026	3.30
72	6137	1066800	1.10E-11	0.878	4	1650.4	32.13	206570	16.92	5.26E-12	45.61	0.026	3.34
73	6099	947590	1.37E-11	0.869	4	1637.6	32.16	166620	16.63	6.41E-12	46.63	0.030	3.45
74	4677	762460	1.73E-11	0.857	4	1663.2	31.61	126700	16.37	8.18E-12	47.24	0.030	3.53
75	4636	666730	2.40E-11	0.839	4	1639.9	31.20	101060	15.32	1.15E-11	48.04	0.031	3.66
76	4662	636270	2.97E-11	0.826	4	1466.6	31.02	72060	13.64	1.43E-11	48.35	0.031	3.72
77	4634	430160	4.14E-11	0.812	4	1416.1	30.60	54660	12.76	2.06E-11	48.66	0.032	3.80
78	4353	316260	5.73E-11	0.796	4	1366.6	31.37	36371	11.36	2.97E-11	51.67	0.033	4.16
79	4046	246410	7.66E-11	0.761	4	1267.6	31.61	26674	10.30	4.05E-11	52.73	0.034	4.30
80	3760	166660	1.02E-10	0.766	4	1161.7	32.66	16346	9.67	6.63E-11	54.06	0.034	4.49
81	3602	160140	1.26E-10	0.767	4	1161.7	33.17	14205	8.67	7.03E-11	55.01	0.035	4.63
82	3247	131020	1.57E-10	0.746	4	1112.3	34.26	10631	8.34	8.63E-11	56.37	0.036	4.80
83	3066	105760	1.96E-10	0.736	4	1076.6	35.26	6362.9	7.91	1.16E-10	56.39	0.037	5.05
84	2637	67022	2.64E-10	0.725	4	1035.5	36.60	6661.3	7.57	1.62E-10	56.76	0.036	5.27
85	2467	71619	2.66E-10	0.720	4	965.99	36.44	5073.7	7.09	1.77E-10	56.63	0.036	5.32
86	2266	60313	3.64E-10	0.712	4	931.46	40.63	4207.9	6.66	2.19E-10	61.94	0.040	5.66
87	2046	60465	4.10E-10	0.707	4	865.01	42.24	3342	6.62	2.63E-10	61.71	0.040	5.62
88	1721	42146	4.34E-10	0.707	4	796.47	46.26	2646.8	6.26	2.67E-10	61.45	0.040	5.61
89	1460	35066	4.35E-10	0.710	4	730.91	50.06	2072.9	5.91	2.64E-10	60.76	0.039	5.64
90	1161	30117	4.36E-10	0.714	4	676.51	56.60	1724.2	5.73	2.64E-10	60.70	0.039	5.61
91	666.8	26626	4.14E-10	0.721	4	607.66	67.79	1366	5.44	2.46E-10	59.42	0.039	5.59
92	666.1	21413	3.71E-10	0.731	4	549.4	76.70	1112	5.16	2.16E-10	56.26	0.036	5.20
93	366	16220	3.34E-10	0.742	4	476.24	120.57	666.46	4.91	1.67E-10	56.12	0.037	4.94
94	200.7	16631	2.66E-10	0.753	4	429.43	213.97	743.71	4.79	1.65E-10	55.33	0.036	4.61
95	14.27	13162	2.46E-10	0.766	4	376.66	266.76	611.76	4.65	1.33E-10	54.22	0.036	4.62
96	207.3	10664	2.04E-10	0.765	4	337.2	162.66	507.6	4.62	1.10E-10	53.97	0.035	4.52
97	371	9066	1.66E-10	0.802	4	260.79	76.36	412.16	4.63	6.74E-11	48.70	0.035	4.32
98	636	7424	1.17E-10	0.829	4	237.67	44.16	316.67	4.30	5.63E-11	46.70	0.033	3.95
99	646.6	6036	1.03E-10	0.843	4	213	32.94	273.66	4.63	5.36E-11	51.24	0.034	4.02
100	756.2	4739	7.97E-11	0.866	4	172.74	22.67	212.67	4.46	3.97E-11	46.79	0.033	3.60

Pecis with Sundance Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PH (Error)	PH (% Error)
101	828.6	3056	6.04E-11	0.868	4	141.95	17.19	170.02	4.86	3.48E-11	50.42	0.033	3.77
102	836.7	2871	7.54E-11	0.865	4	113.44	13.56	134.56	4.89	3.79E-11	50.33	0.033	3.74
103	824.6	2396	6.36E-11	0.801	4	97.306	11.80	115.75	4.83	4.41E-11	52.56	0.035	3.87
104	830.9	1983	7.12E-11	0.820	4	87.163	10.46	102.37	5.16	3.90E-11	56.06	0.037	4.04
105	837.7	1716	6.36E-11	0.833	4	81.346	9.71	94.576	5.91	3.78E-11	59.49	0.039	4.22
106	835.3	1519	6.11E-11	0.842	4	77.986	9.34	89.99	5.82	3.88E-11	63.66	0.042	4.47
107	835	1421	5.97E-11	0.847	4	76.165	9.12	87.662	6.17	3.66E-11	66.20	0.044	4.63
108	834.2	1365	6.63E-11	0.940	4	79.827	9.57	92.087	6.80	4.83E-11	70.79	0.047	4.99
109	840.7	1517	8.79E-11	0.823	4	90.062	10.71	105.07	6.93	6.57E-11	74.72	0.050	5.37
110	868.7	1746	9.63E-11	0.912	4	98.695	11.52	116.66	6.88	7.04E-11	73.17	0.046	5.32
111	843.2	2065	1.25E-10	0.868	4	113.76	13.46	136.51	6.65	8.94E-11	71.53	0.047	5.35
112	836.9	2326	1.42E-10	0.872	4	125.51	14.98	153.75	6.09	9.59E-11	67.37	0.045	5.12
113	823.3	2871	1.61E-10	0.856	4	135.66	16.46	166.62	5.72	1.03E-10	63.99	0.042	4.94
114	800.4	3465	1.85E-10	0.844	4	149.27	18.65	191.12	5.62	1.15E-10	62.31	0.041	4.89
115	771.7	4029	2.08E-10	0.831	4	160.79	20.84	211.22	5.24	1.23E-10	59.60	0.040	4.76
116	670.6	5796	3.42E-10	0.766	4	241.61	34.02	337.41	5.62	2.24E-10	65.56	0.043	5.53
117	628.2	7524	3.83E-10	0.767	4	284.72	56.01	433.46	5.76	2.66E-10	65.07	0.043	5.61

Reference Mortar
7 Days of Hydration

File No.	R_1 (Q)	R_2 (Q)	G (F)	PHI	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PHI (Error)	PHI (% Error)
1	570.1	11561	1.01E-11	0.937	4	486.94	85.41	589.82	5.10	6.25E-12	62.04	0.040	4.32
2	544.8	11889	9.20E-12	0.941	4	480.28	88.99	594.06	5.01	5.71E-12	61.58	0.040	4.28
3	551.6	11977	9.06E-12	0.942	4	475.18	86.15	578.1	4.83	5.42E-12	59.89	0.039	4.12
4	530.5	12036	9.37E-12	0.939	4	468.05	83.88	604.74	5.02	5.79E-12	61.74	0.040	4.28
5	501.8	12440	9.32E-12	0.939	4	468.62	90.41	610.72	4.91	5.69E-12	61.04	0.040	4.23
6	527.7	12382	8.98E-12	0.941	4	482.17	87.58	584.71	4.58	5.09E-12	58.88	0.037	3.91
7	485.4	12837	9.40E-12	0.938	4	488.03	105.82	608.71	4.82	5.65E-12	60.07	0.039	4.16
8	423.9	12881	9.46E-12	0.937	4	517.99	122.20	638.51	4.84	5.83E-12	61.87	0.040	4.28
9	389.8	13255	9.39E-12	0.937	4	523.46	134.29	647.15	4.88	5.75E-12	61.39	0.040	4.28
10	368.6	13487	1.02E-11	0.931	4	543.57	147.47	674.73	5.00	6.44E-12	62.85	0.041	4.39
11	394.9	13501	8.68E-12	0.940	4	528.89	133.93	658.74	4.83	5.32E-12	61.29	0.040	4.23
12	235	14507	1.24E-11	0.918	4	587.38	248.95	741.23	5.11	8.04E-12	64.83	0.042	4.58
13	85.88	16003	1.35E-11	0.911	4	617.41	720.80	789.48	5.00	8.96E-12	64.51	0.042	4.69
14	118.8	17787	1.52E-11	0.901	4	672.29	565.90	894.05	5.02	9.97E-12	65.64	0.043	4.72
15	327.2	20281	1.61E-11	0.894	4	731.58	223.99	1011.2	4.99	1.07E-11	68.57	0.043	4.81
16	589.5	23482	1.69E-11	0.889	4	788.02	140.30	1180.8	4.94	1.12E-11	67.20	0.043	4.81
17	828.7	27185	1.69E-11	0.885	4	842.66	101.99	1302.6	4.79	1.12E-11	68.30	0.043	4.81
18	1189	31538	1.79E-11	0.878	4	929.87	79.54	1532.1	4.88	1.21E-11	67.85	0.043	4.83
19	1450	38816	1.72E-11	0.878	4	972.86	67.09	1741.9	4.78	1.12E-11	68.43	0.042	4.84
20	1899	42382	1.72E-11	0.878	4	988.04	60.22	1972.8	4.68	1.12E-11	68.43	0.041	4.71
21	1983	48281	1.68E-11	0.878	4	1047.8	53.38	2283.8	4.85	1.07E-11	63.95	0.041	4.63
22	2252	58838	1.74E-11	0.872	4	1089.2	48.23	2688.9	4.69	1.08E-11	62.84	0.040	4.57
23	2417	68707	1.61E-11	0.875	4	1116	46.17	3088.8	4.72	9.82E-12	61.82	0.039	4.45
24	2811	77055	1.73E-11	0.869	4	1199.3	42.66	3821.1	4.86	1.07E-11	61.87	0.039	4.50
25	3087	90828	1.68E-11	0.870	4	1238.8	39.61	4575.5	5.05	9.89E-12	59.91	0.038	4.35
26	3352	108970	1.46E-11	0.878	4	1284.9	37.74	5544.5	5.19	8.51E-12	58.51	0.037	4.22
27	3808	128810	1.46E-11	0.874	4	1320	35.61	6885.4	5.49	8.42E-12	57.77	0.038	4.17
28	3938	152800	1.39E-11	0.878	4	1357.7	34.67	8784.5	5.74	7.72E-12	55.89	0.035	4.03
29	4073	177820	1.28E-11	0.880	4	1384.1	33.98	10579	5.98	8.88E-12	54.42	0.034	3.91
30	4301	205490	1.25E-11	0.880	4	1419.5	33.00	12881	6.28	8.63E-12	53.24	0.034	3.83
31	4819	241730	1.17E-11	0.883	4	1488.3	32.45	16040	6.84	8.11E-12	52.38	0.033	3.78
32	4775	280760	1.12E-11	0.883	4	1504.5	31.51	20483	7.08	6.70E-12	50.78	0.032	3.65
33	4872	354390	1.05E-11	0.889	4	1541.2	31.00	28833	7.80	4.85E-12	49.30	0.031	3.53
34	5331	440480	9.37E-12	0.891	4	1614.7	30.29	36713	8.34	4.52E-12	48.23	0.031	3.45
35	5803	537870	8.19E-12	0.898	4	1683	29.88	48442	9.01	3.85E-12	47.03	0.030	3.35
36	6013	677120	7.84E-12	0.898	4	1768.8	28.22	68813	10.16	3.64E-12	46.38	0.030	3.31
37	6189	828820	7.03E-12	0.904	4	1775.3	28.78	91784	11.08	3.14E-12	44.70	0.029	3.18
38	6307	1032100	6.49E-12	0.907	4	1857.2	28.22	134030	12.74	2.86E-12	44.29	0.029	3.15
39	6808	1278000	6.70E-12	0.913	4	1904	28.82	179730	14.10	2.46E-12	43.45	0.028	3.07
40	6863	1537800	4.87E-12	0.922	4	1916.7	28.77	238080	15.48	2.07E-12	42.48	0.027	2.98
41	6834	1812800	4.53E-12	0.928	4	1943.8	28.30	313430	17.29	1.80E-12	42.01	0.027	2.94
42	6898	2148800	3.89E-12	0.934	4	1939.6	28.01	407620	18.99	1.62E-12	41.08	0.027	2.88
43	6774	2483700	3.58E-12	0.948	4	1989.6	28.37	524420	21.03	1.46E-12	41.04	0.027	2.84
44	6860	2888400	3.09E-12	0.948	4	1986.2	28.73	688880	23.49	1.26E-12	40.35	0.026	2.77
45	6459	3489300	2.71E-12	0.955	4	1889.3	30.49	803920	28.05	1.08E-12	39.73	0.026	2.71
46	6859	3888800	2.53E-12	0.958	4	2011.8	30.21	1083200	27.99	9.88E-13	39.49	0.026	2.69
47	6822	4480700	2.31E-12	0.962	4	2073.1	30.39	1408800	31.37	8.15E-13	39.85	0.026	2.69
48	6814	4844300	2.00E-12	0.971	4	2011.8	30.88	1583300	32.27	7.77E-13	38.80	0.025	2.61
49	6810	5388100	1.88E-12	0.975	4	2045.2	31.42	1873200	34.93	7.23E-13	38.94	0.025	2.61
50	6478	5928200	1.72E-12	0.979	4	2058	31.77	2228700	37.58	6.88E-13	38.84	0.025	2.59

Reference Material
7 Days of Hydration

File No.	R ₁ (Ω)	R ₂ (Ω)	C (F)	PM	Type	R ₁ (Ω) (Error)	R ₁ (Ω) (% Error)	R ₂ (Ω) (Error)	R ₂ (Ω) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
51	6034	633400	1.61E-12	0.982	4	2098.6	32.12	250600	39.60	0.26E-13	39.12	0.026	2.60
52	6060	7271500	1.47E-12	0.989	4	2099.7	32.01	3160300	43.76	5.06E-13	38.79	0.026	2.57
53	6183	7467400	1.35E-12	0.993	4	2092	33.30	3279300	43.97	5.18E-13	38.34	0.026	2.52
54	6124	7666200	1.16E-12	1.001	4	2043.6	33.37	3574300	44.87	4.40E-13	37.85	0.026	2.47
55	6135	8417200	1.08E-12	1.006	4	2022.3	32.96	3899200	46.32	4.03E-13	37.31	0.024	2.42
56	6157	8289600	1.11E-12	1.004	4	2056.6	33.44	3811700	45.99	4.21E-13	37.66	0.026	2.47
57	5938	8675700	1.04E-12	1.008	4	2016.4	33.96	4037700	47.08	3.88E-13	37.44	0.024	2.43
58	6447	8073100	1.16E-12	1.000	4	2136.6	33.14	4623500	50.96	4.49E-13	36.44	0.026	2.51
59	6339	8762200	1.12E-12	1.003	4	2084.3	32.89	4269900	48.57	4.23E-13	37.90	0.026	2.47
60	6334	8612500	1.08E-12	1.005	4	2081.2	32.89	3969800	48.48	4.06E-13	37.49	0.026	2.44
61	6315	8980700	1.11E-12	1.003	4	2122	33.60	4476400	49.96	4.26E-13	38.39	0.026	2.50
62	6227	9081700	1.08E-12	1.008	4	2086.5	33.22	4484700	49.16	3.98E-13	37.46	0.026	2.44
63	6067	9043100	1.13E-12	1.002	4	2104.5	34.57	4600400	50.87	4.34E-13	38.35	0.026	2.50
64	6094	8765700	1.08E-12	1.005	4	2084.7	34.21	4233700	48.35	4.11E-13	38.08	0.026	2.48
65	6074	8292600	1.05E-12	1.007	4	2083.4	33.81	3778500	45.98	3.98E-13	37.78	0.026	2.45
66	6315	8772100	1.15E-12	1.001	4	2125.2	33.65	4391000	49.60	4.44E-13	36.47	0.026	2.51
67	6402	9180600	1.20E-12	0.998	4	2116.2	33.09	3772300	46.23	4.81E-13	38.39	0.026	2.51
68	6158	7983900	1.28E-12	0.998	4	2100.5	34.11	3446300	44.82	4.86E-13	36.72	0.026	2.54
69	6264	7219600	1.30E-12	0.995	4	2086.4	32.99	3043200	42.15	4.97E-13	38.29	0.026	2.52
70	6400	8639100	1.45E-12	0.998	4	2088.2	32.32	2891700	41.67	5.08E-13	36.46	0.026	2.54
71	6637	8286100	1.05E-12	0.993	4	2116.1	31.86	2476400	39.32	6.21E-13	39.29	0.026	2.61
72	6635	8821500	1.74E-12	0.978	4	2070	31.20	2013700	35.82	6.78E-13	36.92	0.026	2.60
73	6632	4696000	2.03E-12	0.969	4	2120.1	31.03	1669500	33.80	8.12E-13	40.07	0.026	2.70
74	6700	4123400	2.23E-12	0.965	4	2047.6	30.58	1198200	29.08	8.90E-13	39.69	0.026	2.70
75	6976	3702400	2.70E-12	0.964	4	2083.9	28.44	1019100	27.63	1.09E-12	40.15	0.026	2.74
76	6932	3076300	3.02E-12	0.948	4	2015.3	28.63	739090	24.03	1.21E-12	40.40	0.026	2.77
77	6780	2538000	3.37E-12	0.942	4	1892	28.47	537310	21.25	1.39E-12	41.21	0.027	2.84
78	6898	2116300	3.67E-12	0.938	4	1836.6	28.08	369500	18.69	1.51E-12	41.14	0.027	2.85
79	6836	1753700	4.36E-12	0.928	4	1946.2	28.32	266170	16.83	1.85E-12	42.35	0.027	2.96
80	6932	1432000	4.89E-12	0.921	4	1916.2	28.69	213910	14.82	2.15E-12	42.95	0.028	3.02
81	6434	1142300	5.38E-12	0.916	4	1848.7	28.73	148240	12.98	2.33E-12	43.49	0.028	3.06
82	6485	932910	6.08E-12	0.911	4	1844.3	28.44	109390	11.72	2.75E-12	44.85	0.029	3.17
83	6219	796960	6.72E-12	0.907	4	1805.9	28.00	81259	10.70	3.11E-12	46.21	0.030	3.27
84	6124	618940	7.35E-12	0.902	4	1775.9	28.04	59995	9.68	3.48E-12	47.39	0.030	3.36
85	6098	610980	8.20E-12	0.898	4	1773.6	28.23	49956	9.00	4.04E-12	48.30	0.031	3.51
86	6830	423700	8.43E-12	0.898	4	1699.6	28.15	34638	8.17	4.19E-12	49.74	0.032	3.54
87	6391	346980	8.21E-12	0.899	4	1627.1	30.18	28037	7.47	4.17E-12	50.61	0.032	3.59
88	5122	200970	6.47E-12	0.898	4	1595.4	30.95	20247	6.98	4.42E-12	52.19	0.033	3.66
89	4988	245460	8.20E-12	0.894	4	1551.5	31.23	16198	6.60	4.93E-12	53.60	0.034	3.79
90	4854	209150	1.02E-11	0.889	4	1546.6	31.66	13097	6.29	5.67E-12	55.43	0.035	3.95
91	4632	176280	1.00E-11	0.891	4	1499.9	33.10	10491	5.95	5.70E-12	56.67	0.036	4.09
92	4065	146230	6.12E-12	0.898	4	1406.2	34.34	6245.6	5.53	5.20E-12	56.96	0.036	4.00
93	3948	127180	9.04E-12	0.900	4	1349.6	35.07	6646.1	5.22	5.21E-12	57.61	0.036	4.03
94	3630	109060	9.34E-12	0.899	4	1363.1	37.65	5644.6	5.18	5.69E-12	60.84	0.036	4.26
95	3348	93878	8.49E-12	0.899	4	1291.8	38.58	4624.5	4.93	5.78E-12	60.75	0.036	4.25
96	3016	81118	6.10E-12	0.903	4	1233.3	40.91	3646.5	4.74	5.68E-12	61.26	0.036	4.26
97	2878	69950	8.62E-12	0.908	4	1184.6	44.23	3218.6	4.60	5.38E-12	62.14	0.039	4.31
98	2464	60633	8.47E-12	0.910	4	1171.9	47.75	2800	4.62	5.45E-12	64.39	0.041	4.47
99	2308	52712	8.19E-12	0.913	4	1121.6	50.77	2395	4.54	5.31E-12	64.79	0.041	4.46
100	1914	45791	7.95E-12	0.917	4	1049.9	54.65	2037	4.45	5.10E-12	64.31	0.041	4.44

Reference Mortar
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
101	1552	39553	8.90E-12	0.927	4	979.15	63.09	1732.8	4.37	4.41E-12	63.98	0.041	4.37
102	1572	34575	7.23E-12	0.928	4	993.46	70.44	1572.4	4.55	4.79E-12	66.09	0.042	4.54
103	1046	29984	6.48E-12	0.934	4	900.71	86.11	1390.4	4.58	4.28E-12	65.65	0.042	4.48
104	678.6	25599	6.79E-12	0.944	4	809.26	119.61	1148.7	4.49	3.70E-12	63.80	0.041	4.32
105	381.9	21899	5.16E-12	0.954	4	748.54	208.64	999.79	4.61	3.29E-12	63.78	0.041	4.29
106	55.1	16009	4.94E-12	0.964	4	652.66	1194.32	828.68	4.60	2.89E-12	61.45	0.040	4.10
107	318.5	14157	3.63E-12	0.995	4	532.55	167.21	641.39	4.53	2.09E-12	57.54	0.037	3.78
108	748.1	9670	2.78E-12	1.010	4	410.07	54.61	487.17	4.69	1.52E-12	54.90	0.038	3.52
109	938.8	8152	3.86E-12	0.999	4	391.36	39.77	428.01	5.25	2.24E-12	57.98	0.038	3.81
110	1086	7231	3.86E-12	1.004	4	338.15	30.95	373.85	5.17	2.14E-12	55.71	0.037	3.69
111	1139	6808	3.97E-12	1.009	4	352.88	30.98	398.21	5.89	2.29E-12	61.18	0.041	4.01
112	1186	6082	3.54E-12	1.014	4	333.98	27.92	365.16	6.00	2.17E-12	61.32	0.041	4.01
113	1257	5620	3.27E-12	1.021	4	319.43	25.41	347.21	6.19	2.03E-12	61.99	0.041	4.04
114	1301	5328	3.07E-12	1.028	4	301.47	23.17	328.08	6.24	1.89E-12	61.99	0.041	3.99
115	1339	4874	3.09E-12	1.030	4	293	21.89	315.68	6.48	1.93E-12	62.79	0.042	4.07
116	1366	4567	3.05E-12	1.033	4	283.07	20.89	303.89	6.65	1.94E-12	63.53	0.042	4.11
117	1381	4422	3.16E-12	1.032	4	268.79	20.77	307.38	6.95	2.08E-12	65.68	0.044	4.28
118	1372	4327	3.45E-12	1.028	4	290.89	21.20	311.38	7.20	2.31E-12	67.07	0.045	4.36
119	1350	4528	4.86E-12	1.007	4	328.72	24.20	351.44	7.79	3.59E-12	72.58	0.049	4.85
120	1256	5152	6.23E-12	0.987	4	399.72	29.44	400.74	7.78	4.80E-12	73.92	0.050	5.04
121	1153	5997	7.15E-12	0.974	4	418.68	38.14	456.14	7.81	5.31E-12	74.50	0.050	5.13
122	1018	7044	7.93E-12	0.992	4	450.94	44.30	500.3	7.10	5.74E-12	72.38	0.048	5.03

Mortar with Medium Fly Ash
7 Days of Hydration

File No.	R_1 (Q)	R_2 (Q)	G (F)	PH	Type	R_1 (Q) (Error)	R_2 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PH (Error)	PH (% Error)
1	990.4	4647	2.07E-11	0.931	4	266.94	294.83	27.03	6.34	1.32E-11	63.90	0.043	4.58
2	992.5	4787	1.97E-11	0.934	4	248.62	286.22	26.10	6.00	1.20E-11	61.17	0.041	4.36
3	937.8	4680	2.02E-11	0.931	4	266.19	295.76	27.32	6.06	1.25E-11	61.89	0.041	4.42
4	921.7	4672	2.04E-11	0.930	4	266.46	298.66	28.04	6.01	1.26E-11	61.47	0.041	4.40
5	921.8	5094	2.04E-11	0.929	4	262.78	304.6	28.51	5.99	1.26E-11	61.75	0.041	4.42
6	885.7	5216	2.08E-11	0.927	4	266.52	312.85	30.06	6.00	1.26E-11	61.96	0.041	4.44
7	883.7	5319	2.00E-11	0.928	4	269.96	314.26	30.14	5.91	1.23E-11	61.46	0.041	4.40
8	885.9	5408	2.01E-11	0.927	4	273.86	319.75	30.91	5.86	1.23E-11	61.26	0.041	4.36
9	875.1	5988	2.09E-11	0.925	4	278.15	325.57	31.78	5.85	1.26E-11	61.31	0.041	4.40
10	878.6	5884	1.99E-11	0.927	4	273.2	320.7	31.17	5.86	1.18E-11	59.68	0.040	4.28
11	893.2	5793	2.09E-11	0.923	4	284.62	335.22	33.30	5.79	1.26E-11	61.24	0.041	4.40
12	845.4	6008	2.17E-11	0.920	4	284.44	348.57	34.63	5.80	1.34E-11	61.95	0.041	4.46
13	908.1	6395	2.33E-11	0.914	4	302.6	382.82	37.47	5.67	1.43E-11	61.36	0.041	4.44
14	794.6	6889	2.47E-11	0.908	4	318.5	385.91	41.66	5.62	1.62E-11	61.70	0.041	4.48
15	739.9	7410	2.61E-11	0.905	4	326.36	400.5	43.66	5.40	1.62E-11	60.59	0.040	4.40
16	671.8	8088	2.66E-11	0.899	4	343.77	430.5	51.17	5.34	1.82E-11	60.84	0.040	4.44
17	489.8	11140	2.66E-11	0.898	4	459.78	612.59	93.87	5.50	1.76E-11	66.16	0.043	4.85
18	243	14413	2.63E-11	0.882	4	532.61	764.66	219.16	5.31	1.75E-11	66.49	0.043	4.87
19	6.267	16221	2.41E-11	0.881	4	572.64	869.8	9157.39	4.94	1.64E-11	63.77	0.041	4.64
20	226.5	22425	2.22E-11	0.881	4	624.96	1083.8	277.14	4.83	1.41E-11	63.32	0.040	4.59
21	413.2	27333	2.08E-11	0.883	4	680.39	1290.7	159.62	4.72	1.27E-11	61.83	0.039	4.45
22	577.5	32662	1.90E-11	0.885	4	681.14	1518.2	117.86	4.62	1.13E-11	59.66	0.038	4.25
23	705.7	36276	1.74E-11	0.887	4	707.97	1616	100.32	4.62	1.01E-11	57.96	0.037	4.11
24	905	46762	1.62E-11	0.889	4	729.03	2180.3	80.56	4.66	9.12E-12	56.19	0.036	3.97
25	1088	55397	1.59E-11	0.889	4	756.66	2664.2	70.86	4.61	8.76E-12	55.06	0.036	3.86
26	1163	66727	1.39E-11	0.885	4	787.94	3213.6	64.91	4.69	7.33E-12	52.94	0.033	3.70
27	1321	78887	1.39E-11	0.885	4	763.17	3991.4	57.77	4.86	6.73E-12	49.82	0.031	3.47
28	1481	93904	1.29E-11	0.888	4	819.6	5072.9	55.35	5.40	6.49E-12	50.31	0.031	3.51
29	1694	111570	1.20E-11	0.889	4	813.96	6220.2	51.39	5.56	5.74E-12	47.66	0.030	3.32
30	1745	132370	1.10E-11	0.903	4	861.54	7980.9	49.37	6.03	5.28E-12	47.76	0.030	3.31
31	1912	159900	1.08E-11	0.903	4	891.04	10326	46.08	6.46	4.80E-12	46.14	0.029	3.20
32	1888	191460	9.53E-12	0.908	4	897.65	13264	45.15	6.93	4.26E-12	44.97	0.028	3.11
33	2125	228640	9.22E-12	0.909	4	926.23	17270	43.64	7.52	4.05E-12	43.94	0.028	3.04
34	2212	274180	8.18E-12	0.915	4	946.55	22468	42.79	8.19	3.62E-12	43.16	0.027	2.97
35	2341	339680	7.61E-12	0.916	4	971.1	30246	41.46	8.68	3.14E-12	41.81	0.028	2.87
36	2480	414330	6.94E-12	0.924	4	1003.9	41558	40.56	10.03	2.74E-12	41.16	0.028	2.81
37	2689	512350	5.82E-12	0.929	4	1055.3	56518	39.25	11.42	2.43E-12	41.04	0.028	2.79
38	2751	628820	5.19E-12	0.935	4	1080.3	80214	39.27	12.80	2.08E-12	40.26	0.025	2.73
39	2867	746350	4.47E-12	0.944	4	1073.4	105220	38.79	14.10	1.75E-12	39.12	0.026	2.63
40	2983	874550	3.82E-12	0.952	4	1054.2	132310	38.15	15.13	1.44E-12	37.61	0.024	2.50
41	2871	1021000	3.65E-12	0.955	4	1104	175050	38.45	17.14	1.35E-12	38.15	0.024	2.53
42	2779	1170800	3.13E-12	0.962	4	1099.5	217790	38.66	18.60	1.17E-12	37.42	0.024	2.47
43	2775	1340300	2.69E-12	0.977	4	1119.5	274560	40.34	20.46	1.07E-12	37.30	0.024	2.45
44	2762	1488000	2.47E-12	0.975	4	1098.1	317040	39.40	21.30	8.93E-13	36.07	0.023	2.36
45	2759	1652800	2.27E-12	0.979	4	1111.2	361610	40.29	23.10	8.20E-13	36.10	0.023	2.34
46	2760	1836500	2.12E-12	0.983	4	1143.7	467650	41.89	25.44	7.75E-13	36.64	0.023	2.37
47	2722	1985400	1.90E-12	0.989	4	1151.6	533970	42.31	26.71	6.94E-13	36.45	0.023	2.35
48	2678	2124400	1.70E-12	0.995	4	1107.9	660050	41.37	28.13	5.84E-13	36.03	0.022	2.23
49	2682	2349700	1.61E-12	0.998	4	1127.1	864570	42.02	28.79	5.84E-13	35.07	0.022	2.24
50	2708	2474400	1.49E-12	1.002	4	1125.4	736350	41.56	29.76	5.17E-13	34.72	0.022	2.20

Mortar with Mulliken Fly Ash
7 Days of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
61	2625	2654900	1.41E-12	1.005	4	1128.4	42.89	834030	31.41	4.87E-13	34.57	0.022	2.19
62	2572	2728400	1.26E-12	1.011	4	1133.2	44.08	866110	31.77	4.36E-13	34.71	0.022	2.18
63	2574	2668800	1.16E-12	1.015	4	1118.5	43.38	822080	32.14	3.98E-13	33.93	0.022	2.13
64	2540	3020500	1.16E-12	1.015	4	1128.1	44.33	1017900	33.70	4.01E-13	33.95	0.022	2.13
65	2507	3103900	1.07E-12	1.020	4	1119.9	44.67	1053400	33.91	3.93E-13	33.78	0.021	2.11
66	2525	3280200	1.10E-12	1.019	4	1130.5	45.13	1163900	35.80	3.74E-13	34.09	0.022	2.13
67	2493	3227800	1.08E-12	1.019	4	1147.2	48.02	1149000	35.80	3.71E-13	34.28	0.022	2.14
68	2668	3266800	1.04E-12	1.022	4	1137.9	44.35	1143300	35.11	3.51E-13	33.88	0.022	2.11
69	2495	3275900	1.05E-12	1.021	4	1134.2	45.48	1198200	35.68	3.57E-13	33.92	0.022	2.11
60	2473	3293300	1.03E-12	1.022	4	1134.4	45.67	1151700	35.40	3.51E-13	33.99	0.022	2.12
61	2519	3353300	1.08E-12	1.021	4	1148.9	45.65	1219700	38.80	3.62E-13	34.34	0.022	2.14
62	2565	3226100	1.03E-12	1.022	4	1132.8	43.82	1131800	34.85	3.48E-13	33.78	0.022	2.10
63	2469	3375900	1.08E-12	1.020	4	1144.1	48.34	1242700	38.77	3.81E-13	34.08	0.022	2.13
64	2448	3202300	9.76E-13	1.028	4	1121.8	45.82	1089800	34.31	3.28E-13	33.70	0.021	2.09
65	2542	3276400	1.03E-12	1.022	4	1139.9	44.84	1198800	35.38	3.48E-13	34.00	0.022	2.12
66	2437	3207800	1.02E-12	1.023	4	1113.5	45.69	1104300	34.43	3.41E-13	33.62	0.021	2.09
67	2497	3169900	1.03E-12	1.023	4	1116.9	45.48	1083200	34.23	3.48E-13	33.60	0.021	2.09
68	2625	3175900	1.12E-12	1.017	4	1148.9	43.77	1114400	35.09	3.85E-13	34.28	0.022	2.15
69	2622	3018700	1.17E-12	1.015	4	1138.8	43.43	1019700	33.78	4.00E-13	34.28	0.022	2.16
70	2673	2665900	1.20E-12	1.014	4	1123.1	43.65	935380	32.41	4.08E-13	34.02	0.022	2.14
71	2693	2718400	1.20E-12	1.015	4	1094.9	42.72	882810	30.88	4.05E-13	33.68	0.021	2.11
72	2687	2665000	1.30E-12	1.007	4	1132	43.78	837740	31.43	4.71E-13	34.71	0.022	2.19
73	2756	2653800	1.44E-12	1.004	4	1149	41.69	780540	30.97	5.08E-13	35.31	0.022	2.24
74	2713	2406800	1.60E-12	0.998	4	1147.2	42.39	722390	29.99	5.88E-13	35.47	0.023	2.26
75	2772	2228900	1.69E-12	0.995	4	1125.4	40.60	622920	27.89	5.94E-13	35.10	0.022	2.24
76	2752	2090900	1.82E-12	0.991	4	1130.4	41.08	598070	27.08	6.48E-13	35.80	0.023	2.26
77	2813	1823300	2.01E-12	0.988	4	1132.4	40.28	497380	25.88	7.25E-13	38.08	0.023	2.33
78	2831	1793900	2.28E-12	0.979	4	1153.3	39.35	439950	24.72	8.28E-13	36.63	0.023	2.39
79	2797	1538900	2.40E-12	0.977	4	1113.3	39.80	339300	22.05	8.74E-13	38.48	0.023	2.37
80	2853	1320400	2.79E-12	0.969	4	1100.9	38.59	281390	19.79	1.01E-12	38.69	0.023	2.40
81	2835	1119900	3.18E-12	0.981	4	1085.7	38.30	197560	17.70	1.18E-12	37.05	0.024	2.45
82	2898	914020	3.82E-12	0.951	4	1088.8	37.56	144180	15.77	1.45E-12	38.12	0.024	2.54
83	2822	730980	4.27E-12	0.948	4	1055.5	37.40	89842	13.49	1.89E-12	38.40	0.024	2.57
84	2748	560850	4.84E-12	0.940	4	1030.5	37.53	67765	11.67	1.89E-12	39.10	0.025	2.63
85	2770	464780	5.01E-12	0.928	4	1053.2	38.02	49758	10.71	2.48E-12	41.43	0.028	2.82
86	2824	370530	6.48E-12	0.925	4	1031.7	39.32	34946	9.43	2.75E-12	42.99	0.027	2.90
87	2810	299440	7.18E-12	0.920	4	988.74	39.39	24950	8.33	3.08E-12	42.85	0.027	2.93
88	2433	243030	7.89E-12	0.916	4	987.96	39.78	16347	7.55	3.47E-12	44.02	0.028	3.02
89	2325	198030	8.39E-12	0.913	4	953.69	41.02	13772	6.92	3.82E-12	45.80	0.029	3.13
90	2142	163580	8.92E-12	0.911	4	916.42	42.78	10331	6.32	4.12E-12	48.21	0.029	3.18
91	1900	136910	9.17E-12	0.911	4	899.94	45.79	7804.2	5.82	4.28E-12	48.69	0.029	3.21
92	1816	113630	9.30E-12	0.911	4	855.35	47.10	6183.7	5.44	4.51E-12	47.97	0.030	3.29
93	1830	95778	9.38E-12	0.912	4	820.24	50.32	4878.5	5.09	4.88E-12	48.78	0.030	3.34
94	1468	61189	9.67E-12	0.912	4	788.34	53.77	3907.8	4.81	4.78E-12	49.45	0.031	3.39
95	1374	69551	1.08E-11	0.907	4	787.64	57.32	3297.6	4.74	5.57E-12	51.67	0.032	3.56
96	1250	59484	1.10E-11	0.907	4	755.95	60.48	2897.7	4.54	5.78E-12	52.28	0.033	3.61
97	1078	51130	1.10E-11	0.908	4	748.09	69.21	2282.6	4.48	5.97E-12	54.18	0.034	3.74
98	946.4	44338	1.14E-11	0.908	4	714.78	75.52	1925.9	4.34	6.22E-12	54.80	0.034	3.77
99	800.3	38718	1.14E-11	0.910	4	683.4	88.64	1681.4	4.29	6.31E-12	55.57	0.035	3.84
100	734.8	34057	1.21E-11	0.907	4	680.52	92.61	1488.8	4.31	6.90E-12	58.85	0.036	3.95

Mortar with Metigan Fly Ash
7 Days of Hydration

File No.	R_1 (Q)	R_0 (Q)	C (F)	PM	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
101	538	29742	1.18E-11	0.913	4	639.86	119.36	1269.3	4.23	6.03E-12	56.72	0.036	3.92
102	421.1	29020	1.10E-11	0.913	4	618.5	146.86	1109.4	4.26	6.08E-12	57.40	0.036	3.96
103	344.2	22762	1.27E-11	0.911	4	594.7	172.76	968.86	4.34	7.34E-12	57.99	0.037	4.05
104	215.4	19723	1.32E-11	0.911	4	590.76	269.82	963.76	4.53	7.86E-12	59.79	0.036	4.20
105	95.46	18954	1.38E-11	0.911	4	552.86	579.26	795.86	4.69	8.28E-12	60.52	0.036	4.27
106	51.35	14366	1.32E-11	0.916	4	507.51	968.33	698.65	4.77	7.91E-12	59.66	0.039	4.21
107	237.8	11954	1.29E-11	0.922	4	445.32	187.27	571.89	4.78	7.41E-12	57.47	0.037	4.05
108	462.5	9525	1.04E-11	0.941	4	361.85	74.99	442.07	4.64	5.59E-12	53.50	0.035	3.71
109	710.6	7226	8.46E-12	0.962	4	289.73	40.77	338.59	4.69	4.31E-12	50.99	0.034	3.49
110	627.7	5737	1.39E-11	0.943	4	269.47	32.19	307.09	5.35	7.06E-12	55.23	0.037	3.69
111	938.2	5052	1.34E-11	0.950	4	254.49	27.13	290.04	5.74	7.78E-12	56.05	0.039	4.07
112	995.4	4630	1.39E-11	0.951	4	249.4	25.63	281.6	6.06	6.33E-12	56.87	0.040	4.21
113	994.7	4343	1.48E-11	0.950	4	242.1	24.59	272.09	6.27	8.97E-12	60.72	0.041	4.28
114	1007	4077	1.53E-11	0.951	4	235.95	23.53	265.01	6.50	9.47E-12	61.99	0.042	4.39
115	1013	3845	1.60E-11	0.950	4	238.47	23.34	263.09	6.84	1.02E-11	63.98	0.043	4.54
116	1008	3674	1.79E-11	0.945	4	235.62	23.74	264.6	7.21	1.16E-11	66.06	0.045	4.73
117	1012	3599	1.93E-11	0.942	4	236.69	23.59	264.5	7.37	1.30E-11	67.11	0.045	4.83

Mortar with Portage Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	G (F)	PHI	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PHI (Error)	PHI (% Error)
1	1130	6214	9.40E-12	0.900	4	330.52	29.02	29.02	6.11	6.04E-12	63.81	0.042	4.40
2	1150	6326	9.05E-12	0.902	4	335.99	29.22	29.22	6.11	5.82E-12	64.23	0.042	4.41
3	1180	6415	8.22E-12	0.906	4	335.73	28.24	28.24	6.03	5.29E-12	64.02	0.042	4.36
4	1153	6435	8.63E-12	0.904	4	337.92	29.31	29.31	6.04	5.49E-12	63.65	0.042	4.36
5	1160	6518	8.20E-12	0.907	4	338.74	28.96	28.96	5.98	5.19E-12	63.35	0.042	4.33
6	1163	6563	8.20E-12	0.905	4	348.63	30.00	30.00	6.11	5.39E-12	64.64	0.043	4.42
7	1163	6703	8.79E-12	0.902	4	355.09	30.53	30.53	6.12	5.72E-12	65.14	0.043	4.47
8	1124	6841	9.39E-12	0.905	4	379.53	33.77	33.77	6.34	6.34E-12	67.49	0.046	4.66
9	1119	7155	8.77E-12	0.909	4	373.91	33.41	33.41	6.07	5.73E-12	65.30	0.043	4.46
10	1110	7342	8.75E-12	0.909	4	381	34.32	34.32	6.05	5.75E-12	65.99	0.043	4.50
11	1113	7665	8.34E-12	0.909	4	372.36	33.46	33.46	5.75	5.29E-12	62.90	0.041	4.31
12	1074	7915	8.31E-12	0.909	4	382	35.57	35.57	5.68	5.22E-12	62.79	0.041	4.30
13	1047	8288	8.57E-12	0.909	4	411.21	39.28	39.28	5.60	6.29E-12	65.64	0.043	4.54
14	991.9	8653	1.03E-11	0.943	4	428.64	44.56	44.56	5.76	6.71E-12	65.15	0.043	4.53
15	870.1	8894	1.19E-11	0.932	4	499.77	53.69	53.69	5.62	7.98E-12	67.05	0.044	4.71
16	823.8	10633	1.23E-11	0.928	4	485.46	58.93	58.93	5.69	8.21E-12	68.82	0.043	4.70
17	862.9	11063	1.31E-11	0.921	4	516.36	75.82	75.82	5.61	8.71E-12	68.68	0.043	4.71
18	907	12871	1.35E-11	0.917	4	530.11	87.33	87.33	5.37	8.84E-12	65.30	0.042	4.62
19	920.2	14018	1.54E-11	0.907	4	562.68	106.17	106.17	5.37	1.02E-11	68.27	0.043	4.73
20	430.4	15491	1.54E-11	0.905	4	590.13	137.11	137.11	5.27	1.02E-11	68.17	0.043	4.72
21	14.03	21029	8.63E-11	0.902	4	1204.7	856.60	856.60	9.61	1.00E-10	116.37	0.075	9.40
22	27418	27418	1.35E-11	0.895	4	667.76	254.25	254.25	5.32	9.78E-12	70.87	0.046	5.03
23	680.6	34593	1.30E-11	0.895	4	953.5	140.10	140.10	5.28	9.08E-12	70.01	0.044	4.96
24	821.5	41644	1.16E-11	0.897	4	986.66	168.36	168.36	5.19	8.05E-12	68.18	0.043	4.80
25	1246	50598	1.20E-11	0.893	4	1094.5	2159.4	2159.4	5.27	8.04E-12	67.13	0.042	4.73
26	1809	61214	1.18E-11	0.894	4	1089.9	2094.7	2094.7	5.35	7.80E-12	65.04	0.041	4.57
27	1946	75001	1.06E-11	0.898	4	1163.6	3273.9	3273.9	5.54	8.72E-12	63.42	0.040	4.44
28	2066	81763	9.89E-12	0.899	4	1202.5	4228.2	4228.2	5.79	8.11E-12	61.97	0.039	4.32
29	2262	110300	8.79E-12	0.904	4	1217.7	5315.7	5315.7	5.93	5.19E-12	59.13	0.037	4.10
30	2672	133790	8.97E-12	0.900	4	1317.7	6644.9	6644.9	6.50	5.35E-12	59.57	0.037	4.15
31	2760	155330	7.81E-12	0.907	4	1327.6	8702.2	8702.2	6.73	4.47E-12	57.16	0.036	3.95
32	2899	193390	7.14E-12	0.911	4	1338.6	13666	13666	7.17	3.91E-12	54.74	0.034	3.78
33	3065	226150	6.40E-12	0.916	4	1362.2	17493	17493	7.63	3.44E-12	53.74	0.034	3.66
34	3321	275770	6.22E-12	0.917	4	1418.9	22642	22642	8.32	3.27E-12	52.91	0.033	3.60
35	3605	331710	5.64E-12	0.919	4	1473.2	28932	28932	9.02	3.00E-12	51.48	0.032	3.52
36	3620	398080	5.09E-12	0.926	4	1499	36702	36702	9.72	2.64E-12	49.89	0.031	3.40
37	3984	491310	4.69E-12	0.929	4	1660.8	53654	53654	10.62	2.28E-12	48.32	0.031	3.35
38	4219	610080	4.09E-12	0.935	4	1632.7	74875	74875	12.27	1.99E-12	48.75	0.031	3.30
39	4276	747600	3.49E-12	0.944	4	1880.2	102540	102540	13.72	1.86E-12	47.74	0.030	3.20
40	4549	907320	3.09E-12	0.949	4	1727.3	140970	140970	15.54	1.47E-12	47.68	0.030	3.19
41	4496	1072100	2.99E-12	0.959	4	1727.3	181110	181110	16.89	1.19E-12	46.41	0.028	3.07
42	4430	1242400	2.24E-12	0.968	4	1720.6	227120	227120	18.26	1.02E-12	46.28	0.029	2.98
43	4459	1444400	2.09E-12	0.970	4	1737.9	283460	283460	20.32	9.29E-13	44.72	0.028	2.93
44	4539	1694900	1.82E-12	0.974	4	1797.8	378060	378060	22.71	8.66E-13	46.09	0.029	2.95
45	4493	1847400	1.69E-12	0.981	4	1790.1	446410	446410	24.11	7.53E-13	44.44	0.026	2.86
46	4510	1969800	1.49E-12	0.986	4	1778.3	498070	498070	24.94	6.50E-13	43.72	0.026	2.82
47	4549	2204300	1.32E-12	0.986	4	1778	576640	576640	26.16	5.66E-13	42.98	0.027	2.75
48	4495	2400200	1.29E-12	0.986	4	1832.2	666230	666230	28.59	5.60E-13	43.73	0.026	2.80
49	4406	2549300	1.14E-12	1.002	4	1830.5	751970	751970	29.50	4.97E-13	43.52	0.026	2.77
50	4309	2897400	1.05E-12	1.010	4	1774.7	762040	762040	29.35	4.22E-13	42.01	0.027	2.65

Marble with Poragla Fly Ash
7 Days of Hydration

File No.	R ₁ (G)	R ₂ (G)	G (F)	Phi	Type	R ₁ (G) (Error)	R ₂ (G) (Error)	R ₁ (G) (% Error)	R ₂ (G) (Error)	R ₁ (G) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
51	4450	2844000	9.75E-13	1.011	4	1804.7	40.56	41.22	948720	31.50	3.00E-13	41.98	0.027	2.64
52	4332	3011800	9.06E-13	1.016	4	1765.7	41.22	41.64	948720	31.50	3.75E-13	41.40	0.028	2.80
53	4323	3178800	8.79E-13	1.016	4	1800.1	41.64	43.40	1034600	32.88	3.62E-13	41.25	0.028	2.99
54	4262	3294800	8.31E-13	1.019	4	1888.5	43.40	40.80	1137400	34.62	3.95E-13	42.70	0.027	2.67
55	4444	3302800	7.76E-13	1.023	4	1813.1	42.86	41.78	1096500	33.17	3.21E-13	41.30	0.028	2.57
56	4411	3409800	7.80E-13	1.023	4	1891.3	42.86	41.65	1202000	35.25	3.35E-13	42.91	0.027	2.67
57	4165	3395800	6.95E-13	1.031	4	1740.2	41.65	41.78	1063400	32.29	2.78E-13	40.04	0.028	2.47
58	4458	3658800	7.47E-13	1.025	4	1858.7	41.65	41.65	1288300	35.64	3.13E-13	41.87	0.027	2.60
59	4259	3462700	7.40E-13	1.026	4	1844.7	43.31	41.94	1228600	35.19	3.11E-13	42.04	0.027	2.61
60	4165	3462700	7.40E-13	1.031	4	1747	41.94	42.86	1100000	32.52	2.75E-13	40.08	0.028	2.48
61	4221	3440300	7.15E-13	1.028	4	1814.4	42.86	41.94	1172800	34.09	2.96E-13	41.39	0.027	2.57
62	4410	3534700	7.48E-13	1.025	4	1843.7	42.86	42.86	1247800	36.30	3.11E-13	41.82	0.028	2.59
63	4268	3502700	7.17E-13	1.028	4	1810.2	42.86	42.86	1205200	34.41	2.94E-13	41.07	0.028	2.55
64	4271	3644800	7.16E-13	1.028	4	1819.4	43.18	42.86	1244400	35.10	2.97E-13	41.41	0.028	2.57
65	4168	3462700	7.16E-13	1.028	4	1803.8	43.02	41.94	1157800	33.69	3.03E-13	41.25	0.028	2.54
66	4361	3415400	7.35E-13	1.027	4	1813.6	41.94	41.94	1197600	34.62	3.28E-13	41.80	0.028	2.57
67	4359	3465200	7.98E-13	1.022	4	1824.5	42.86	41.94	1197600	33.42	3.44E-13	41.81	0.027	2.60
68	4258	3294300	8.20E-13	1.020	4	1802.8	42.86	42.86	1080300	33.42	3.62E-13	41.81	0.027	2.61
69	4333	3161900	8.22E-13	1.013	4	1801.5	42.18	40.50	1084000	34.30	4.02E-13	43.65	0.028	2.75
70	4333	2828200	8.97E-13	1.016	4	1755	40.50	40.50	838420	29.57	3.88E-13	41.10	0.028	2.58
71	4465	2763400	8.98E-13	1.010	4	1791.5	40.12	40.12	843860	30.17	4.18E-13	41.89	0.027	2.64
72	4412	2808300	1.05E-12	1.007	4	1775.4	40.24	40.24	747830	28.69	4.42E-13	41.98	0.027	2.65
73	4437	2467000	1.12E-12	1.004	4	1788.7	40.31	40.31	687100	27.96	4.78E-13	42.89	0.027	2.71
74	4414	2342500	1.25E-12	0.998	4	1780.8	40.57	39.59	647090	27.62	5.40E-13	43.09	0.027	2.75
75	4442	2179800	1.29E-12	0.997	4	1758.6	39.59	38.16	596820	25.64	5.48E-13	42.73	0.027	2.73
76	4463	2028200	1.98E-12	0.985	4	1824.3	38.16	38.16	524960	25.90	8.98E-13	44.99	0.028	2.88
77	4823	1859000	1.71E-12	0.980	4	1839.9	38.16	37.91	449760	24.21	7.88E-13	44.80	0.029	2.92
78	4756	1633000	1.95E-12	0.973	4	1802.8	37.91	37.91	380830	22.10	8.72E-13	44.81	0.028	2.93
79	4731	1391000	2.18E-12	0.968	4	1791.7	37.87	36.79	278010	19.99	9.85E-13	46.69	0.029	3.00
80	4698	1172300	2.49E-12	0.960	4	1727.5	36.79	36.47	207790	17.72	1.13E-12	46.49	0.029	3.01
81	4682	973300	2.80E-12	0.955	4	1711.3	36.47	36.47	154830	15.91	1.30E-12	46.51	0.029	3.09
82	4591	795940	3.28E-12	0.948	4	1672.3	36.47	36.47	105360	13.70	1.55E-12	47.33	0.030	3.17
83	4394	625280	3.73E-12	0.940	4	1681.2	37.81	37.81	77273	12.38	1.83E-12	48.99	0.031	3.30
84	4243	488180	4.03E-12	0.938	4	1603	37.81	37.81	53144	10.71	2.00E-12	49.61	0.031	3.34
85	4131	398820	4.67E-12	0.929	4	1567.7	37.81	37.81	38668	9.65	2.37E-12	50.79	0.032	3.44
86	3991	320540	4.96E-12	0.928	4	1528.6	39.31	39.31	27721	8.65	2.54E-12	52.37	0.033	3.55
87	3957	257980	5.19E-12	0.926	4	1477.1	40.39	42.01	20276	7.88	2.77E-12	53.78	0.034	3.64
88	3530	215440	6.23E-12	0.915	4	1482.9	42.01	42.01	16121	7.48	3.50E-12	58.11	0.035	3.84
89	3188	178870	5.81E-12	0.921	4	1428.3	44.65	46.39	12291	6.66	3.34E-12	57.38	0.035	3.90
90	2822	151970	6.00E-12	0.921	4	1324.5	46.39	46.39	9692.8	6.29	3.39E-12	58.34	0.035	3.83
91	2702	128250	8.08E-12	0.921	4	1287.8	47.68	47.68	7875.9	5.84	3.46E-12	57.50	0.036	3.90
92	2617	106120	8.50E-12	0.918	4	1252.6	48.39	48.39	6283.2	5.78	3.62E-12	60.29	0.036	4.11
93	2305	82814	8.61E-12	0.919	4	1223.3	53.07	53.07	5083.7	5.47	4.02E-12	60.75	0.038	4.13
94	2304	78888	8.39E-12	0.922	4	1194.7	58.62	58.62	4200.9	5.27	3.96E-12	62.11	0.039	4.21
95	1672	62238	8.61E-12	0.921	4	1175.9	69.80	69.80	3694.1	5.19	4.23E-12	63.92	0.040	4.35
96	1578	62238	8.23E-12	0.927	4	1101.5	69.80	69.80	2993.6	4.97	3.98E-12	63.53	0.040	4.30
97	1506	52850	7.00E-12	0.921	4	1087	72.64	72.64	2644.7	5.00	4.69E-12	65.59	0.041	4.48
98	1288	46888	7.13E-12	0.922	4	1042.9	82.25	82.25	2261.4	4.93	4.70E-12	65.92	0.042	4.50
99	957.7	40045	8.32E-12	0.931	4	958.88	101.17	101.17	1918.7	4.79	4.13E-12	65.32	0.041	4.42

Mortar with Portage Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
101	833	34999	8.02E-12	0.930	4	947.3	1697.9	4.87	4.42E-12	68.76	0.042	4.54
102	577.3	30350	8.16E-12	0.936	4	971.69	1443.4	4.78	4.03E-12	65.21	0.041	4.42
103	398.2	26238	8.11E-12	0.939	4	819.17	1200.8	4.80	3.99E-12	65.22	0.041	4.42
104	113.7	22288	5.72E-12	0.948	4	787.45	1086.1	4.87	3.71E-12	64.96	0.042	4.39
105	69.97	16553	5.69E-12	0.950	4	653.24	916.45	4.93	3.61E-12	63.46	0.041	4.29
106	277.4	14641	5.05E-12	0.962	4	590.35	725.25	4.99	3.06E-12	60.68	0.039	4.08
107	595.6	11113	7.23E-12	0.950	4	506	606.24	5.48	4.49E-12	62.03	0.041	4.27
108	792.3	9805	9.16E-12	0.943	4	461.22	547.9	5.70	5.79E-12	62.98	0.041	4.39
109	885.6	8713	8.88E-12	0.948	4	438.97	511.36	5.87	5.80E-12	63.23	0.042	4.40
110	986.7	7962	8.10E-12	0.956	4	411.86	478.99	5.97	5.10E-12	63.01	0.042	4.36
111	1016	7411	8.17E-12	0.959	4	403.46	461.63	6.23	5.29E-12	64.30	0.043	4.45
112	1088	6858	7.86E-12	0.962	4	387.66	440.63	6.33	5.07E-12	64.65	0.043	4.46
113	1128	6515	7.27E-12	0.969	4	374.03	421.69	6.47	4.72E-12	64.86	0.043	4.46
114	1176	6159	7.53E-12	0.969	4	363.94	408.43	6.63	4.92E-12	65.50	0.044	4.51
115	1237	5919	7.49E-12	0.971	4	359.66	402.13	6.79	4.98E-12	66.43	0.044	4.57
116	1221	5790	7.48E-12	0.972	4	355.47	398.79	6.85	4.98E-12	66.73	0.045	4.59
117	1198	4809	1.15E-11	0.954	4	342.27	377.69	7.85	8.23E-12	71.47	0.048	5.07

Mortar with Semisec Fly Ash
7 Days of Hydration

File No.	R_1 (Q)	R_2 (Q)	G (F)	Phi	Type	R_1 (Q) (Error)	R_2 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (% Error)	R_1 (Q) (Error)	R_2 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
1	1549	2207	2.19E-12	1.068	4	180.86	205.92	12.32	9.33	180.86	205.92	12.32	9.33	1.82E-12	62.97	0.055	5.10
2	1670	2280	2.15E-12	1.068	4	186.77	212.85	12.53	9.41	186.77	212.85	12.53	9.41	1.82E-12	64.38	0.056	5.18
3	1664	2310	2.21E-12	1.063	4	202.77	219	12.86	9.40	202.77	219	12.86	9.40	1.87E-12	64.46	0.056	5.21
4	1664	2399	2.22E-12	1.060	4	208.36	225.25	13.32	9.40	208.36	225.25	13.32	9.40	1.86E-12	63.91	0.056	5.19
5	1663	2517	2.26E-12	1.077	4	215.32	233.13	13.78	9.28	215.32	233.13	13.78	9.28	1.86E-12	62.95	0.055	5.14
6	1671	2687	2.18E-12	1.077	4	225.09	244.1	14.33	9.15	225.09	244.1	14.33	9.15	1.78E-12	62.57	0.055	5.11
7	1660	2766	2.20E-12	1.074	4	231.63	251.36	14.85	8.99	231.63	251.36	14.85	8.99	1.80E-12	61.94	0.055	5.09
8	1668	2917	2.22E-12	1.071	4	239.62	261.2	15.30	8.95	239.62	261.2	15.30	8.95	1.81E-12	61.71	0.054	5.08
9	1647	3040	2.21E-12	1.069	4	250.49	272.6	16.19	8.97	250.49	272.6	16.19	8.97	1.80E-12	61.43	0.054	5.08
10	1654	3179	2.27E-12	1.065	4	264.12	288.28	17.00	9.07	264.12	288.28	17.00	9.07	1.86E-12	63.15	0.055	5.20
11	1617	3394	2.26E-12	1.061	4	267.2	292.12	17.61	8.61	267.2	292.12	17.61	8.61	1.80E-12	79.09	0.053	4.98
12	1648	3567	2.26E-12	1.060	4	273.53	300.35	17.69	8.42	273.53	300.35	17.69	8.42	1.80E-12	78.70	0.052	4.93
13	1634	3670	2.37E-12	1.054	4	286.29	327.19	19.31	8.45	286.29	327.19	19.31	8.45	1.80E-12	80.29	0.053	5.05
14	1506	4228	2.40E-12	1.050	4	312.1	346.86	20.72	8.20	312.1	346.86	20.72	8.20	1.90E-12	79.12	0.052	4.99
15	1484	4684	2.62E-12	1.040	4	320.14	358.63	21.57	7.88	320.14	358.63	21.57	7.88	1.97E-12	75.28	0.050	4.78
16	1441	5186	2.47E-12	1.040	4	349.77	394.95	24.27	7.65	349.77	394.95	24.27	7.65	1.90E-12	78.98	0.051	4.87
17	1391	5799	2.51E-12	1.035	4	372.56	425.35	28.78	7.39	372.56	425.35	28.78	7.39	1.92E-12	78.27	0.050	4.83
18	1344	6346	2.60E-12	1.030	4	398.2	459.78	29.63	7.25	398.2	459.78	29.63	7.25	1.99E-12	78.49	0.050	4.86
19	1298	6917	2.66E-12	1.028	4	413.45	482.73	31.90	6.98	413.45	482.73	31.90	6.98	1.99E-12	75.20	0.049	4.78
20	1221	7865	2.89E-12	1.016	4	438.4	517.16	35.74	6.81	438.4	517.16	35.74	6.81	2.21E-12	74.84	0.049	4.79
21	1197	8248	2.91E-12	1.015	4	453.27	545.57	37.67	6.61	453.27	545.57	37.67	6.61	2.17E-12	74.55	0.048	4.76
22	1121	8865	3.18E-12	1.007	4	466.73	570.58	41.64	6.37	466.73	570.58	41.64	6.37	2.32E-12	72.88	0.047	4.69
23	1105	9844	3.10E-12	1.007	4	488.19	604.44	44.00	6.27	488.19	604.44	44.00	6.27	2.28E-12	73.38	0.047	4.70
24	1017	10478	3.36E-12	1.000	4	500.92	634.79	49.25	6.08	500.92	634.79	49.25	6.08	2.42E-12	72.05	0.046	4.64
25	932.6	11375	3.70E-12	0.991	4	520.03	673.08	55.78	5.82	520.03	673.08	55.78	5.82	2.68E-12	71.28	0.046	4.62
26	865.3	12291	3.70E-12	0.990	4	558.05	739.85	65.25	6.02	558.05	739.85	65.25	6.02	2.74E-12	73.94	0.047	4.78
27	791.4	13340	3.94E-12	0.985	4	575.51	785.24	72.72	5.89	575.51	785.24	72.72	5.89	2.89E-12	73.45	0.047	4.76
28	678.6	14428	4.10E-12	0.980	4	598.22	837.92	86.42	5.61	598.22	837.92	86.42	5.61	3.05E-12	73.29	0.047	4.77
29	618.8	16578	4.49E-12	0.974	4	632.43	912.47	102.70	5.86	632.43	912.47	102.70	5.86	3.35E-12	74.55	0.047	4.87
30	497.1	18186	4.70E-12	0.965	4	680.52	964.78	135.80	5.84	680.52	964.78	135.80	5.84	3.77E-12	74.69	0.047	4.82
31	471.5	18186	5.08E-12	0.965	4	673.77	1040.5	142.80	5.73	673.77	1040.5	142.80	5.73	3.54E-12	74.11	0.047	4.86
32	349	19720	5.42E-12	0.958	4	697.52	1124.2	160.86	5.70	697.52	1124.2	160.86	5.70	4.00E-12	73.85	0.047	4.88
33	278.9	21397	5.42E-12	0.957	4	708.24	1186.2	255.77	5.69	708.24	1186.2	255.77	5.69	3.94E-12	72.77	0.046	4.80
34	181.2	23247	5.97E-12	0.950	4	733.44	1300	404.77	5.59	733.44	1300	404.77	5.59	4.33E-12	72.49	0.046	4.81
35	45.08	28210	5.15E-12	0.954	4	825.27	1681.3	-1831.49	5.69	825.27	1681.3	-1831.49	5.69	3.78E-12	73.46	0.046	4.83
36	316.7	34282	5.77E-12	0.944	4	882.89	2008.2	-281.94	5.85	882.89	2008.2	-281.94	5.85	4.28E-12	73.80	0.046	4.89
37	482.9	39787	5.89E-12	0.944	4	928.55	2342.7	-187.96	5.89	928.55	2342.7	-187.96	5.89	4.04E-12	72.35	0.045	4.79
38	683.9	48084	5.29E-12	0.945	4	958.13	2736.7	-148.53	5.94	958.13	2736.7	-148.53	5.94	3.73E-12	70.56	0.044	4.65
39	794.1	52824	4.89E-12	0.947	4	1008.4	3287.5	-128.98	6.17	1008.4	3287.5	-128.98	6.17	3.51E-12	70.74	0.044	4.65
40	680.8	61282	5.25E-12	0.942	4	1047.5	3658	-108.80	6.46	1047.5	3658	-108.80	6.46	3.68E-12	70.00	0.043	4.62
41	1408	70858	5.34E-12	0.939	4	1134	4911.1	-88.68	6.83	1134	4911.1	-88.68	6.83	3.61E-12	71.35	0.044	4.72
42	1408	82229	5.15E-12	0.940	4	1142.9	5978.5	-81.29	7.15	1142.9	5978.5	-81.29	7.15	3.54E-12	68.83	0.043	4.64
43	1808	95550	4.69E-12	0.944	4	1168.9	7204.2	-78.71	7.54	1168.9	7204.2	-78.71	7.54	3.16E-12	68.02	0.042	4.47
44	1790	111480	4.79E-12	0.941	4	1231.4	8018.8	-88.18	8.09	1231.4	8018.8	-88.18	8.09	3.22E-12	67.35	0.042	4.44
45	1265.40	128540	4.60E-12	0.942	4	1270.1	9167.8	-86.57	8.60	1270.1	9167.8	-86.57	8.60	3.06E-12	66.57	0.041	4.39
46	2028	147870	4.18E-12	0.946	4	1289.8	13359	-83.57	9.05	1289.8	13359	-83.57	9.05	2.72E-12	65.05	0.040	4.28
47	2163	169740	3.90E-12	0.949	4	1319.2	16392	-81.27	9.66	1319.2	16392	-81.27	9.66	2.52E-12	64.13	0.040	4.19
48	2352	186130	3.81E-12	0.949	4	1367.3	20312	-58.13	10.41	1367.3	20312	-58.13	10.41	2.43E-12	63.80	0.040	4.17
49	2503	224680	3.64E-12	0.951	4	1413.1	25419	-56.46	11.31	1413.1	25419	-56.46	11.31	2.31E-12	63.61	0.039	4.15
50	2559	256390	3.25E-12	0.957	4	1408.3	30864	-54.98	11.98	1408.3	30864	-54.98	11.98	2.05E-12	61.88	0.038	4.00

Mortar with Sundance Fly Ash
7 Days of Hydration

File No.	$R_1(Q)$	$R_2(Q)$	G (F)	Phi	Type	$R_1(Q)$ (Error)	$R_1(Q)$ (% Error)	$R_2(Q)$ (Error)	$R_2(Q)$ (% Error)	G (F) (Error)	G (F) (% Error)	Phi (Error)	Phi (% Error)
51	-2742	205080	2.80E-12	0.961	4	1453.4	-53.01	39401	12.90	1.83E-12	61.36	0.038	3.97
52	-2970	344820	2.80E-12	0.961	4	1558.6	-52.42	50148	14.54	1.79E-12	62.65	0.039	4.05
53	-2962	402860	2.40E-12	0.971	4	1650.1	-51.81	63429	16.75	1.48E-12	60.66	0.038	3.90
54	-3176	472200	2.20E-12	0.972	4	1680.1	-52.27	84614	17.90	1.41E-12	62.42	0.039	3.99
55	-3236	517330	1.93E-12	0.961	4	1656.2	-51.24	90265	18.41	1.18E-12	61.02	0.038	3.87
56	-3276	593090	1.80E-12	0.965	4	1699.5	-51.57	108550	19.35	1.11E-12	61.48	0.038	3.89
57	-3263	575950	1.71E-12	0.966	4	1691.6	-50.61	112720	19.56	1.03E-12	60.13	0.037	3.79
58	-3297	598980	1.62E-12	0.961	4	1678.9	-51.02	120010	20.10	9.77E-13	60.26	0.036	3.76
59	-3336	610860	1.62E-12	0.960	4	1676.7	-50.35	123740	20.28	9.69E-13	59.60	0.037	3.76
60	-3323	606150	1.69E-12	0.961	4	1678.6	-50.51	122620	20.23	9.69E-13	60.05	0.037	3.77
61	-3218	606980	1.60E-12	0.965	4	1643.9	-51.07	117920	19.71	8.86E-13	59.14	0.037	3.70
62	-3332	602680	1.67E-12	0.969	4	1680.2	-50.43	119160	20.10	1.01E-12	60.37	0.038	3.80
63	-3347	603420	1.70E-12	0.968	4	1675.1	-50.05	115180	19.74	1.02E-12	60.16	0.037	3.79
64	-3348	572820	1.76E-12	0.966	4	1664.9	-49.73	111670	19.54	1.05E-12	60.12	0.037	3.80
65	-3328	566510	1.73E-12	0.967	4	1663.8	-50.59	110450	19.50	1.05E-12	60.78	0.038	3.83
66	-3214	536300	1.73E-12	0.967	4	1634.7	-50.86	99032	18.47	1.04E-12	59.66	0.037	3.77
67	-3262	509800	1.86E-12	0.963	4	1636	-49.85	90248	17.84	1.13E-12	60.25	0.037	3.81
68	-3237	461860	2.04E-12	0.979	4	1647.1	-50.86	79414	17.19	1.26E-12	61.87	0.038	3.93
69	-3174	418170	2.12E-12	0.976	4	1632.2	-51.42	68639	15.94	1.32E-12	61.97	0.039	3.95
70	-3148	376510	2.36E-12	0.971	4	1611.4	-51.19	59833	15.04	1.47E-12	62.44	0.039	4.00
71	-3081	340740	2.47E-12	0.969	4	1570	-50.98	47489	13.94	1.54E-12	62.18	0.039	3.99
72	-3095	306740	2.73E-12	0.963	4	1617.1	-52.25	41542	13.54	1.78E-12	65.16	0.040	4.20
73	-3020	277180	2.86E-12	0.960	4	1549.4	-51.30	34940	12.61	1.89E-12	64.10	0.040	4.15
74	-2733	246510	2.86E-12	0.963	4	1482	-51.23	29800	11.51	1.80E-12	63.15	0.039	4.07
75	-2798	229020	3.12E-12	0.958	4	1481.3	-53.55	25082	11.09	2.01E-12	64.36	0.040	4.17
76	-2653	203210	3.26E-12	0.956	4	1465	-56.35	21844	10.85	2.17E-12	66.31	0.041	4.31
77	-2518	178900	3.15E-12	0.959	4	1414	-58.18	17352	8.65	2.04E-12	64.83	0.040	4.19
78	-2365	159960	3.34E-12	0.955	4	1413.3	-58.78	14913	8.32	2.24E-12	66.92	0.041	4.34
79	-2319	143090	3.54E-12	0.954	4	1379.2	-59.47	12580	8.78	2.37E-12	67.02	0.042	4.38
80	-2056	127230	3.40E-12	0.957	4	1316.1	-63.96	10410	6.18	2.26E-12	66.59	0.041	4.31
81	-1873	114020	3.48E-12	0.957	4	1291.7	-67.36	8953.4	7.78	2.31E-12	68.55	0.041	4.31
82	-1844	102910	3.60E-12	0.956	4	1273.5	-69.06	7775.2	7.56	2.47E-12	68.69	0.043	4.45
83	-1713	92867	3.65E-12	0.955	4	1269.4	-74.10	6847.5	6.94	2.57E-12	70.25	0.044	4.56
84	-1599	84126	3.74E-12	0.955	4	1201.3	-77.08	5635.5	6.46	2.66E-12	68.67	0.043	4.47
85	-1391	76276	3.54E-12	0.959	4	1152.2	-82.83	5018.8	6.56	2.42E-12	68.23	0.042	4.41
86	-1235	69054	3.48E-12	0.961	4	1146.9	-82.87	4478	6.46	2.44E-12	70.23	0.044	4.53
87	-1118	63094	3.45E-12	0.962	4	1132.7	-101.31	4016.9	6.37	2.47E-12	71.39	0.044	4.61
88	-914.2	57399	3.17E-12	0.969	4	1041.6	-113.94	3404.9	5.94	2.18E-12	68.62	0.043	4.40
89	-827.8	52843	3.21E-12	0.969	4	1026.1	-123.96	3394.3	5.86	2.24E-12	69.56	0.043	4.46
90	-718.2	48147	3.28E-12	0.969	4	1024.6	-142.86	2823.1	5.86	2.34E-12	71.46	0.044	4.59
91	-582.7	43956	3.05E-12	0.975	4	979.99	-174.16	2498.8	5.86	2.12E-12	70.79	0.044	4.52
92	-504.6	40363	3.19E-12	0.973	4	951.71	-188.53	2286.7	5.61	2.27E-12	71.14	0.044	4.56
93	-399.6	36996	3.08E-12	0.977	4	913.79	-240.85	2027.2	5.50	2.17E-12	70.86	0.044	4.53
94	-276.7	33735	3.07E-12	0.978	4	889.63	-319.28	1849.1	5.48	2.18E-12	71.51	0.045	4.57
95	-146.9	30713	2.87E-12	0.983	4	863.31	-699.25	1667.9	5.40	2.05E-12	71.22	0.045	4.53
96	-65.46	26074	2.94E-12	0.983	4	831.97	-1489.32	1524.6	5.43	2.12E-12	71.96	0.045	4.59
97	107.5	23396	2.72E-12	0.989	4	776.29	723.99	1345.5	5.30	1.92E-12	70.99	0.044	4.46
98	240.9	22699	2.62E-12	0.994	4	741.64	307.88	1205.1	5.32	1.85E-12	70.64	0.044	4.47
99	335.2	20108	2.74E-12	0.993	4	713.43	212.84	1091.6	5.43	1.96E-12	71.39	0.045	4.54
100	468.9	17696	2.79E-12	0.995	4	688.25	149.28	971.47	5.49	1.89E-12	71.19	0.045	4.53

Mortar with Gerdunee Fly Ash
7 Days of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PHI	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
101	528	15416	3.10E-12	0.982	4	611.63	116.26	948.59	5.50	2.16E-12	69.70	0.044	4.47
102	672.9	13679	3.50E-12	0.989	4	574.29	86.36	780.66	6.62	2.46E-12	70.19	0.045	4.53
103	754.9	12944	3.43E-12	0.992	4	592.53	74.52	747.39	5.77	2.44E-12	71.10	0.046	4.59
104	795.1	12179	3.37E-12	0.994	4	596.69	69.93	724.86	5.95	2.43E-12	72.23	0.046	4.66
105	877.5	11444	3.09E-12	1.001	4	514.21	59.60	659.42	5.78	2.14E-12	69.37	0.045	4.45
106	928.6	10603	2.60E-12	1.005	4	504.44	54.31	639.25	5.99	2.05E-12	69.95	0.045	4.48
107	954	10226	3.00E-12	1.005	4	523.23	54.86	649.02	6.35	2.22E-12	73.90	0.046	4.75
108	619.4	10040	3.10E-12	1.000	4	500.44	80.76	608.07	6.04	2.10E-12	67.71	0.044	4.40
109	749	9403	2.82E-12	1.008	4	499.16	68.24	595.37	6.33	1.99E-12	70.54	0.046	4.55
110	803.3	8905	2.79E-12	1.010	4	487.64	60.70	578.42	6.50	1.97E-12	71.04	0.046	4.58
111	618.5	8468	2.79E-12	1.011	4	485.26	56.84	548.49	6.45	1.93E-12	69.35	0.045	4.48
112	878.6	8028	2.63E-12	1.016	4	452.86	51.53	527.36	6.57	1.83E-12	69.67	0.046	4.49
113	917.1	7820	2.64E-12	1.017	4	444.63	49.48	513.63	6.74	1.86E-12	70.29	0.046	4.53
114	967	7229	2.49E-12	1.022	4	433.88	44.87	497.04	6.86	1.78E-12	70.82	0.046	4.54
115	999.7	6976	2.51E-12	1.023	4	431.17	43.17	490.46	7.13	1.80E-12	71.97	0.047	4.63
116	1028	6594	2.55E-12	1.024	4	418.77	40.82	474	7.19	1.83E-12	71.55	0.047	4.61
117	1053	6452	2.55E-12	1.024	4	415.52	39.49	469.5	7.28	1.84E-12	71.97	0.046	4.64

Reference Paste
9 Months Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PM	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
1	533.9	5100	1.65E-10	0.813	4	230.33	43.14	267.28	5.04	6.09E-11	34.43	0.026	3.14
2	716.5	4065	1.22E-10	0.838	4	186.8	27.33	218.83	4.89	4.08E-11	33.40	0.026	2.92
3	551.4	4810	1.46E-10	0.822	4	227.49	41.28	260.9	5.44	5.29E-11	35.55	0.027	3.23
4	578.1	4390	1.51E-10	0.823	4	228.39	39.30	248.82	5.57	5.48E-11	35.45	0.027	3.32
5	689.9	4105	1.27E-10	0.839	4	208.12	29.45	228.78	5.62	4.84E-11	36.64	0.027	3.25
6	708.7	3989	1.44E-10	0.831	4	213.31	30.10	233.76	5.89	5.46E-11	37.81	0.028	3.41
7	758.4	3828	1.25E-10	0.843	4	201.81	28.65	220.88	5.77	4.70E-11	37.71	0.028	3.34
8	811.7	3717	1.24E-10	0.845	4	194.16	23.82	212.63	5.73	4.66E-11	37.79	0.028	3.33
9	801.1	3999	1.30E-10	0.842	4	198.14	24.73	217.08	5.88	5.00E-11	38.41	0.029	3.41
10	782.9	3671	1.37E-10	0.839	4	200.83	25.34	219.79	5.99	5.28E-11	38.60	0.029	3.45
11	718.5	3721	1.33E-10	0.839	4	212.78	29.81	231.82	6.23	5.23E-11	39.32	0.030	3.53
12	787.3	3666	1.26E-10	0.845	4	208.66	27.19	228.02	6.24	5.04E-11	40.31	0.030	3.57
13	843	3843	1.32E-10	0.843	4	198.27	23.82	217.69	5.98	5.21E-11	39.58	0.029	3.49
14	827.3	3778	1.33E-10	0.841	4	205.36	24.82	225.89	5.98	5.31E-11	39.82	0.030	3.52
15	758.9	4022	1.44E-10	0.833	4	221.78	28.34	244.4	6.05	5.79E-11	40.28	0.030	3.60
16	775.4	4221	1.52E-10	0.828	4	224.99	29.02	243.49	5.91	6.09E-11	39.64	0.030	3.57
17	820	4413	1.38E-10	0.835	4	217.9	28.67	243.49	5.52	5.32E-11	39.09	0.029	3.44
18	852.3	4881	1.68E-10	0.815	4	251.07	38.49	280.72	5.75	6.89E-11	39.57	0.029	3.59
19	820	5004	1.28E-10	0.835	4	217.8	28.58	236.15	4.94	4.79E-11	37.12	0.027	3.23
20	728.8	5444	1.41E-10	0.825	4	236.06	32.34	268.15	4.93	5.24E-11	37.07	0.027	3.27
21	647.8	5914	1.67E-10	0.811	4	249.3	38.48	288.48	4.84	6.09E-11	38.53	0.027	3.27
22	436.2	6554	1.86E-10	0.799	4	278.69	63.14	318.7	4.86	8.72E-11	38.20	0.028	3.30
23	535.3	6942	1.81E-10	0.801	4	284.98	49.23	310.87	4.48	8.39E-11	38.21	0.025	3.17
24	448.6	7559	1.86E-10	0.803	4	270.59	60.59	321.59	4.25	5.80E-11	34.61	0.026	3.08
25	416.7	8205	1.80E-10	0.797	4	269.08	64.57	325.03	3.98	5.85E-11	33.04	0.024	2.88
26	297.6	9001	1.86E-10	0.791	4	265.96	69.09	351.29	3.90	6.28E-11	33.31	0.024	2.99
27	281.2	9793	1.94E-10	0.787	4	284.48	101.16	357.11	3.68	8.25E-11	32.15	0.023	2.88
28	297.3	10584	2.01E-10	0.784	4	279.57	94.04	360.49	3.40	8.20E-11	30.85	0.022	2.75
29	185.4	11818	1.85E-10	0.784	4	292.09	178.90	398.19	3.32	8.04E-11	30.87	0.022	2.75
30	188.7	12818	1.82E-10	0.783	4	284.03	149.73	387.81	3.07	6.86E-11	28.46	0.020	2.60
31	101.3	13998	2.23E-10	0.772	4	299.95	268.23	410.62	2.94	8.39E-11	28.53	0.020	2.55
32	38.65	15332	2.30E-10	0.768	4	293.53	800.90	432.31	2.82	6.39E-11	27.82	0.019	2.48
33	240.1	17053	2.36E-10	0.763	4	328.94	138.17	500.86	2.93	6.98E-11	29.25	0.020	2.62
34	41.48	18427	2.02E-10	0.774	4	283.65	684.15	482.67	2.51	5.23E-11	25.87	0.018	2.28
35	291.1	20727	2.66E-10	0.765	4	312.01	107.16	533.14	2.57	6.73E-11	25.87	0.018	2.34
36	620.6	23884	2.87E-10	0.743	4	333.84	53.81	618.8	2.59	7.74E-11	28.10	0.018	2.37
37	691.2	26704	3.04E-10	0.740	4	342.94	49.62	664.99	2.66	7.81E-11	28.10	0.017	2.33
38	1188	30853	3.71E-10	0.723	4	370.82	31.27	798.37	2.60	9.40E-11	25.31	0.017	2.35
39	1255	34321	3.69E-10	0.724	4	368.43	33.28	871.91	2.54	8.77E-11	24.41	0.018	2.25
40	1402	38181	3.08E-10	0.732	4	365.27	30.70	988.54	2.61	7.63E-11	24.93	0.017	2.28
41	1402	43052	2.89E-10	0.731	4	407.24	29.05	1159.5	2.69	7.51E-11	25.10	0.017	2.27
42	1333	48027	2.88E-10	0.729	4	398.8	27.65	1177.7	2.40	6.43E-11	21.88	0.014	1.95
43	1790	59487	3.07E-10	0.723	4	413.38	23.09	1471.7	2.61	6.89E-11	22.46	0.015	2.04
44	2735	68819	3.71E-10	0.708	4	505.53	18.48	2027.3	3.04	8.16E-11	24.67	0.016	2.30
45	2527	78510	3.00E-10	0.718	4	476.82	18.67	2201.3	2.90	6.78E-11	22.62	0.015	2.06
46	3191	88584	2.80E-10	0.718	4	468.28	15.52	2847.8	2.99	6.17E-11	22.04	0.014	2.00
47	3228	103500	2.74E-10	0.717	4	468.28	16.28	3352.8	3.24	6.08E-11	22.15	0.014	2.01
48	4724	121820	2.88E-10	0.710	4	591.02	13.21	4408.8	3.62	6.82E-11	22.97	0.015	2.11
49	4723	141860	2.70E-10	0.712	4	621.71	13.16	5593.1	3.94	6.23E-11	23.10	0.015	2.11
50	4872	162800	2.07E-10	0.728	4	680.28	13.55	7017.2	4.31	4.93E-11	23.85	0.015	2.13

Reference Profile
8 Months Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PM	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
51	5243	186350	2.18E-10	0.719	4	678.69	12.85	9128.8	4.80	4.94E-11	22.62	0.015	2.04
52	5539	237430	1.94E-10	0.724	4	723.77	12.84	12159	5.12	4.42E-11	22.78	0.015	2.03
53	5781	278850	1.47E-10	0.736	4	632.78	10.86	12760	4.97	2.78E-11	16.98	0.012	1.86
54	5987	331010	1.13E-10	0.752	4	844.36	12.90	21074	6.37	2.78E-11	24.22	0.016	2.08
55	7821	420880	1.01E-10	0.754	4	886.36	11.33	28781	7.07	2.36E-11	23.36	0.015	2.00
56	7354	527700	8.13E-11	0.765	4	815.9	11.08	37844	7.13	1.88E-11	20.38	0.013	1.71
57	8105	680400	6.70E-11	0.773	4	777.5	9.59	48378	7.33	1.22E-11	16.20	0.012	1.52
58	8884	788320	4.88E-11	0.789	4	924.13	10.64	40716	9.16	1.05E-11	20.88	0.014	1.71
59	9088	971400	4.42E-11	0.794	4	972.37	10.73	108390	10.85	9.27E-12	20.96	0.013	1.70
60	10888	1157800	3.88E-11	0.800	4	1014.2	9.23	140160	12.11	8.04E-12	20.61	0.013	1.67
61	9801	1333000	2.88E-11	0.817	4	921.41	9.40	155880	11.88	5.27E-12	18.43	0.012	1.45
62	9712	1486700	2.38E-11	0.827	4	989.84	9.99	162250	12.93	4.52E-12	19.00	0.012	1.48
63	10098	1682800	2.20E-11	0.831	4	1080.1	10.50	253330	15.17	4.48E-12	20.28	0.013	1.57
64	11528	1728500	1.87E-11	0.840	4	1289.1	11.27	317950	18.37	4.89E-12	24.59	0.016	1.88
65	10948	1889000	1.91E-11	0.837	4	1133.2	10.36	363740	17.70	4.00E-12	20.87	0.013	1.80
66	10082	1827700	1.98E-11	0.850	4	1031.4	10.23	285630	15.34	3.01E-12	19.12	0.012	1.45
67	9798	1973800	1.44E-11	0.865	4	1048.4	10.72	312020	15.81	2.80E-12	19.43	0.012	1.46
68	11628	2047000	1.47E-11	0.863	4	1419.6	12.21	447980	21.87	3.85E-12	26.10	0.017	1.97
69	10712	1833400	1.25E-11	0.863	4	1279.3	11.84	368230	18.43	2.87E-12	23.69	0.015	1.77
70	11627	2022400	1.27E-11	0.861	4	1197.7	10.04	348000	17.11	2.70E-12	21.21	0.014	1.58
71	10588	2031200	1.18E-11	0.868	4	1084.3	10.38	327950	18.15	2.38E-12	20.02	0.013	1.49
72	9863	1863300	1.12E-11	0.870	4	1091.9	10.97	315930	18.85	2.28E-12	20.11	0.013	1.49
73	11887	2137400	1.41E-11	0.865	4	1215	10.24	387680	18.61	3.08E-12	21.88	0.014	1.65
74	10888	2033800	1.38E-11	0.857	4	985	9.05	284100	14.32	2.38E-12	17.36	0.011	1.30
75	11888	2097200	1.57E-11	0.849	4	1182.3	10.03	386300	17.83	3.38E-12	21.62	0.014	1.84
76	10142	1723800	1.32E-11	0.861	4	1185.8	11.40	288000	15.55	2.88E-12	21.84	0.014	1.63
77	10128	1828200	1.51E-11	0.854	4	1349.2	13.32	291030	17.80	3.81E-12	25.89	0.017	1.85
78	11884	1882100	2.21E-11	0.829	4	1174.7	9.89	274900	18.25	4.88E-12	22.10	0.014	1.71
79	8835	1377400	1.88E-11	0.839	4	938.28	9.54	159440	11.58	3.88E-12	18.62	0.012	1.43
80	11085	1433000	3.27E-11	0.808	4	1114.3	10.07	211800	14.80	7.13E-12	21.77	0.014	1.73
81	9768	1141200	3.17E-11	0.812	4	858.53	8.80	113330	9.93	5.80E-12	17.63	0.011	1.40
82	11307	1040500	4.57E-11	0.780	4	1123.7	9.84	130550	12.85	1.08E-11	23.29	0.015	1.80
83	9280	832710	4.13E-11	0.798	4	908.93	9.77	78385	9.01	8.28E-12	20.02	0.013	1.61
84	9180	737880	5.62E-11	0.782	4	825.09	9.01	57888	7.88	1.04E-11	18.88	0.012	1.53
85	10137	944050	6.07E-11	0.780	4	918.65	9.08	53552	8.31	1.70E-11	21.07	0.014	1.78
86	10378	558140	1.07E-10	0.744	4	888.28	8.85	42718	7.65	2.25E-11	21.08	0.014	1.82
87	8472	440160	9.81E-11	0.783	4	780.63	9.22	28310	5.88	1.83E-11	19.72	0.013	1.69
88	7875	385880	1.33E-10	0.783	4	725.21	9.09	20707	5.37	2.81E-11	18.79	0.012	1.65
89	9034	323380	1.62E-10	0.718	4	616.23	9.02	16107	5.56	3.82E-11	21.80	0.014	1.94
90	7178	281780	1.81E-10	0.730	4	681.4	9.83	11808	4.43	3.20E-11	19.91	0.013	1.78
91	8252	251800	2.82E-10	0.701	4	781.1	9.89	11011	4.75	5.67E-11	22.55	0.015	2.08
92	6877	191780	2.38E-10	0.708	4	582.33	9.01	6512.8	3.40	4.32E-11	18.11	0.012	1.86
93	7372	168230	3.28E-10	0.680	4	688.28	9.08	6016.9	3.62	6.78E-11	20.71	0.013	1.95
94	5230	134830	2.80E-10	0.711	4	518.05	9.81	3712.3	2.75	4.47E-11	17.83	0.012	1.83
95	5885	118850	3.48E-10	0.691	4	555.31	9.28	3328.3	2.81	6.80E-11	19.19	0.013	1.81
96	5839	103080	3.82E-10	0.687	4	578.89	10.41	2848.7	2.88	7.82E-11	20.71	0.014	1.98
97	4782	90880	4.18E-10	0.685	4	636.08	13.25	2883.8	3.16	9.84E-11	23.89	0.016	2.28
98	3889	78381	3.40E-10	0.700	4	472.89	11.84	1834.8	2.35	8.52E-11	19.15	0.013	1.80
99	4270	71179	4.74E-10	0.680	4	613.19	14.36	2124	2.88	1.17E-10	24.60	0.018	2.40
100	3288	61713	3.88E-10	0.688	4	478.65	14.48	1479.6	2.40	8.12E-11	20.88	0.014	1.89

Reference Points
8 Months Hydration

File No.	R_1 (Ω)	R_2 (Ω)	C (F)	PH	Type	R_1 (Ω) (Error)	R_1 (Ω) (% Error)	R_2 (Ω) (Error)	R_2 (Ω) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
101	3118	55163	4.18E-10	0.663	4	500.51	18.08	1382.7	2.62	9.38E-11	22.68	0.016	2.17
102	3460	60317	5.21E-10	0.679	4	568.1	18.85	1463.7	2.91	1.38E-10	28.14	0.018	2.58
103	2513	43282	3.82E-10	0.703	4	418.05	18.58	949.29	2.19	7.91E-11	20.88	0.014	1.97
104	2537	38949	5.18E-10	0.684	4	548.89	18.66	1136.4	2.88	1.37E-10	28.49	0.018	2.62
105	2577	35381	4.89E-10	0.680	4	487.59	19.31	854.12	2.70	1.23E-10	25.28	0.017	2.49
106	2399	31573	4.61E-10	0.688	4	465.69	19.41	829.33	2.63	1.12E-10	24.76	0.017	2.43
107	1303	27177	3.40E-10	0.721	4	381.33	27.73	617.02	2.27	7.48E-11	21.99	0.015	2.08
108	1460	24682	3.39E-10	0.721	4	382.91	24.86	579.34	2.35	7.80E-11	22.41	0.015	2.13
109	1188	22202	3.67E-10	0.719	4	394.8	33.00	597.54	2.65	9.09E-11	24.79	0.017	2.38
110	1320	20384	3.85E-10	0.714	4	435.78	33.01	630.85	3.10	1.11E-10	28.03	0.020	2.73
111	488.6	17913	2.70E-10	0.746	4	315.44	87.19	448.88	2.66	6.50E-11	24.04	0.017	2.23
112	388.8	18814	2.68E-10	0.748	4	310.15	83.87	425.32	2.69	6.82E-11	24.84	0.017	2.30
113	738.9	14788	3.02E-10	0.738	4	351.41	47.56	459.46	3.11	8.09E-11	28.77	0.019	2.68
114	34.15	12857	2.07E-10	0.772	4	270.04	780.75	349.39	2.78	5.11E-11	24.65	0.017	2.24
115	74.03	11530	1.86E-10	0.777	4	288.88	382.91	338.81	2.89	5.18E-11	25.99	0.018	2.36
116	51.41	10273	1.80E-10	0.765	4	249.78	485.86	308.74	2.99	4.54E-11	25.22	0.018	2.28
117	200.5	8223	1.86E-10	0.787	4	254.88	127.11	307.91	3.34	5.10E-11	27.43	0.020	2.49
118	284.9	8277	1.70E-10	0.788	4	238.49	88.28	279.83	3.38	4.57E-11	28.94	0.019	2.43
119	223.7	7851	1.97E-10	0.787	4	289.67	120.35	313.12	4.09	6.03E-11	30.59	0.022	2.83
120	388.7	6823	1.82E-10	0.783	4	288.72	70.44	288.47	4.31	6.04E-11	31.54	0.023	2.91
121	441.2	6347	1.84E-10	0.788	4	249.64	66.56	284.12	4.48	5.80E-11	32.00	0.024	2.95
122	388.3	5975	1.98E-10	0.784	4	281.39	87.32	283.88	4.91	6.88E-11	33.23	0.025	3.11
123	517.1	5480	1.77E-10	0.805	4	238.91	48.20	287.05	4.80	5.87E-11	33.08	0.025	3.08
124	432.3	5180	1.85E-10	0.802	4	252.65	58.49	279.48	5.38	6.34E-11	34.34	0.028	3.22
125	682.7	4843	1.70E-10	0.816	4	224.37	33.88	248.28	5.35	5.85E-11	35.07	0.028	3.22
126	1309	5088	3.02E-10	0.782	4	383.28	28080.87	423.14	8.35	1.27E-10	41.88	0.034	4.40
127	100.6	4914	3.33E-10	0.754	4	440.51	438.32	470.15	8.57	1.47E-10	44.23	0.036	4.80
128	117.2	4449	3.08E-10	0.788	4	384.18	327.80	410.25	9.22	1.34E-10	43.88	0.038	4.84
129	38.94	4428	3.61E-10	0.749	4	444.35	1202.90	471.28	10.85	1.78E-10	45.83	0.038	5.11

Paste with Malign Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PHI	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
1	578.1	32515	6.43E-10	0.733	4	102.47	17.89	339.39	1.04	8.81E-11	10.59	0.007	0.97
2	540.4	30818	6.30E-10	0.734	4	102.7	19.00	323.86	1.05	8.87E-11	10.85	0.007	0.99
3	528.4	29411	6.46E-10	0.733	4	101.1	19.21	304.43	1.04	7.02E-11	10.82	0.007	0.99
4	527	28294	6.76E-10	0.731	4	101.19	19.20	293.44	1.04	7.37E-11	10.82	0.007	1.00
5	487.5	27352	6.96E-10	0.733	4	103.13	21.15	280.03	1.08	7.42E-11	11.31	0.008	1.03
6	488.2	26734	6.70E-10	0.732	4	107.53	21.97	298.03	1.11	7.84E-11	11.86	0.008	1.09
7	480.3	26257	6.71E-10	0.732	4	105.16	21.45	283.99	1.08	7.81E-11	11.84	0.008	1.07
8	478.8	25821	6.84E-10	0.731	4	102.23	21.44	272.8	1.05	7.75E-11	11.33	0.008	1.04
9	441	25559	6.86E-10	0.733	4	104.33	23.66	275.85	1.08	7.80E-11	11.88	0.008	1.07
10	569	25491	7.09E-10	0.728	4	107.75	18.94	280.21	1.10	8.41E-11	11.87	0.008	1.09
11	465	25165	6.91E-10	0.731	4	105.28	21.27	272.14	1.08	8.11E-11	11.72	0.008	1.08
12	508.5	25106	7.09E-10	0.728	4	111.53	22.02	287.49	1.15	8.76E-11	12.40	0.008	1.14
13	480.2	25751	7.20E-10	0.728	4	115.66	24.08	305.69	1.19	9.18E-11	12.78	0.009	1.18
14	420.1	26800	6.80E-10	0.732	4	121.78	28.38	337.42	1.25	9.12E-11	13.40	0.009	1.23
15	531.9	26833	7.13E-10	0.727	4	128.65	23.81	388.23	1.29	9.81E-11	13.48	0.009	1.24
16	585.7	30603	7.11E-10	0.727	4	130.39	23.05	403.44	1.32	9.84E-11	13.67	0.009	1.25
17	532.5	33081	6.86E-10	0.727	4	132.05	24.80	441.82	1.34	9.34E-11	13.44	0.009	1.24
18	530.8	36076	7.05E-10	0.725	4	128.63	20.36	461.28	1.29	8.85E-11	12.99	0.008	1.16
19	578.5	38838	6.55E-10	0.728	4	131.47	22.73	511.82	1.32	8.32E-11	12.70	0.008	1.16
20	652.8	41942	6.41E-10	0.728	4	139.36	21.35	588.19	1.30	8.36E-11	13.07	0.008	1.20
21	652.2	46727	6.33E-10	0.728	4	138.51	20.93	630.04	1.36	7.88E-11	12.41	0.008	1.14
22	694.4	49931	6.15E-10	0.730	4	138.5	20.34	701.12	1.40	7.51E-11	12.22	0.008	1.12
23	709.2	54995	6.02E-10	0.730	4	137.36	19.37	784.82	1.40	7.07E-11	11.74	0.008	1.07
24	801.5	60270	6.82E-10	0.731	4	149.02	18.69	923.93	1.53	7.17E-11	12.32	0.008	1.12
25	858.2	66331	5.78E-10	0.730	4	140.98	18.47	987.32	1.48	6.48E-11	11.22	0.007	1.02
26	848.6	72858	6.93E-10	0.731	4	141.1	17.63	1072.9	1.46	6.03E-11	10.90	0.007	0.99
27	887.8	78946	5.15E-10	0.736	4	151.88	16.50	1282.9	1.61	5.89E-11	11.44	0.008	1.04
28	922.1	87531	5.12E-10	0.734	4	148.73	16.13	1386.3	1.59	5.93E-11	10.79	0.007	0.98
29	980	98946	4.89E-10	0.738	4	158.81	15.84	1633.6	1.71	5.39E-11	11.09	0.007	1.00
30	988	105100	4.65E-10	0.738	4	161.74	16.24	1862	1.76	5.14E-11	11.11	0.007	1.00
31	982.8	117380	4.39E-10	0.740	4	158.45	16.56	2118.1	1.80	4.83E-11	10.57	0.007	0.95
32	1071	130360	4.27E-10	0.743	4	163.11	14.30	2293	1.78	4.17E-11	9.75	0.007	0.88
33	1094	142910	4.05E-10	0.743	4	167.31	14.78	2622.1	1.84	3.95E-11	9.78	0.007	0.88
34	1127	158200	3.88E-10	0.744	4	160.1	14.21	3022.8	1.91	3.72E-11	9.69	0.008	0.86
35	1017	174040	3.51E-10	0.749	4	165.17	16.34	3524.4	2.03	3.41E-11	9.72	0.008	0.87
36	1043	194020	3.26E-10	0.753	4	178.01	17.07	4323.1	2.23	3.29E-11	10.10	0.007	0.90
37	994.7	215320	3.05E-10	0.758	4	177.95	18.07	4909.9	2.28	2.98E-11	9.78	0.007	0.87
38	1027	242180	2.86E-10	0.768	4	173.47	16.89	5520.4	2.28	2.84E-11	9.17	0.008	0.81
39	1097	277330	2.78E-10	0.769	4	174.01	15.86	6578.7	2.37	2.43E-11	8.80	0.008	0.78
40	1258	309000	2.59E-10	0.781	4	178.34	14.02	7893.6	2.48	2.23E-11	8.61	0.008	0.76
41	1232	346540	2.46E-10	0.782	4	189.36	13.75	9421.4	2.43	1.97E-11	7.95	0.008	0.70
42	1144	388620	2.19E-10	0.789	4	183.31	16.02	10421	2.70	1.84E-11	8.38	0.008	0.73
43	1241	438260	2.10E-10	0.789	4	185.8	14.98	12341	2.62	1.70E-11	8.11	0.008	0.71
44	1088	488880	1.82E-10	0.777	4	202.72	18.63	15238	3.12	1.57E-11	8.59	0.008	0.74
45	1321	562700	1.78E-10	0.775	4	197.8	14.97	17322	3.08	1.38E-11	7.84	0.008	0.69
46	1482	649940	1.59E-10	0.778	4	221.18	14.82	22124	3.41	1.30E-11	8.18	0.008	0.71
47	1488	748440	1.34E-10	0.784	4	246.22	16.50	27563	3.69	1.13E-11	8.45	0.008	0.73
48	2114	822180	1.25E-10	0.782	4	288.37	12.89	38985	3.97	1.03E-11	8.24	0.008	0.71
49	2881	1097800	1.07E-10	0.788	4	321.35	12.45	46788	4.88	9.82E-12	9.00	0.008	0.77
50	2814	1272500	8.97E-11	0.791	4	379.61	14.52	64198	5.05	8.63E-12	9.81	0.008	0.82

Pecds with Metagen Fly Ash
9 Months of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PHI	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
51	4368	1611400	8.61E-11	0.764	4	513.84	11.71	103620	6.43	9.66E-12	11.11	0.008	0.008	0.008	0.96
52	5266	2026500	7.20E-11	0.787	4	612.21	11.56	149740	7.39	8.53E-12	11.71	0.008	0.008	0.008	1.01
53	6255	2802800	6.65E-11	0.768	4	686.89	10.98	244280	8.72	8.59E-12	11.66	0.008	0.008	0.008	0.99
54	7278	3681900	4.17E-11	0.811	4	820.14	11.27	407340	11.03	5.34E-12	12.61	0.008	0.008	0.008	1.07
55	7417	4794000	3.24E-11	0.822	4	788.68	10.65	547480	11.44	3.72E-12	11.49	0.008	0.008	0.008	0.95
56	7419	5617000	2.44E-11	0.838	4	667.69	11.56	764940	13.15	2.82E-12	11.66	0.008	0.008	0.008	0.97
57	8110	7813800	1.84E-11	0.849	4	888.43	10.86	1171400	15.38	2.28E-12	11.74	0.008	0.008	0.008	0.94
58	7865	6391800	1.41E-11	0.868	4	984.68	12.77	1378800	18.43	1.78E-12	12.50	0.008	0.008	0.008	0.88
59	8425	8804200	1.24E-11	0.873	4	918.38	10.80	1629100	18.82	1.41E-12	11.39	0.008	0.008	0.008	0.86
60	8635	1.3E+07	1.05E-11	0.882	4	1057.8	11.97	2823800	22.56	1.35E-12	12.66	0.008	0.008	0.008	1.00
61	8149	1.2E+07	8.61E-12	0.883	4	1089.9	13.09	3600800	21.29	1.04E-12	12.85	0.008	0.008	0.008	0.99
62	8508	1.5E+07	8.78E-12	0.882	4	1004.3	11.60	3470100	23.28	1.14E-12	11.84	0.008	0.008	0.008	0.91
63	7640	1.6E+07	7.53E-12	0.901	4	1087	14.23	3659400	26.21	9.78E-13	12.85	0.008	0.008	0.008	0.96
64	8029	1.6E+07	7.80E-12	0.901	4	1088.1	13.32	3862200	24.82	9.44E-13	12.66	0.008	0.008	0.008	0.95
65	8387	1.6E+07	7.44E-12	0.901	4	971.84	11.57	3151700	21.12	8.39E-13	11.26	0.008	0.008	0.008	0.85
66	8385	1.6E+07	7.10E-12	0.903	4	1050.8	12.71	3849400	23.58	8.77E-13	12.19	0.008	0.008	0.008	0.92
67	8144	1.6E+07	6.97E-12	0.905	4	1045.9	12.84	3515800	23.07	8.51E-13	12.22	0.008	0.008	0.008	0.92
68	8667	1.7E+07	7.30E-12	0.902	4	1108.4	12.78	4861100	27.22	9.30E-13	12.74	0.008	0.008	0.008	0.96
69	8463	1.7E+07	6.81E-12	0.907	4	1089.6	12.66	4509800	26.69	8.74E-13	12.84	0.008	0.008	0.008	0.97
70	7124	1.6E+07	6.56E-12	0.909	4	1019.5	14.31	3884400	24.19	7.90E-13	12.03	0.008	0.008	0.008	0.90
71	8148	1.4E+07	7.22E-12	0.903	4	1054.8	12.55	3032100	21.61	8.67E-13	12.29	0.008	0.008	0.008	0.93
72	7817	1.2E+07	8.20E-12	0.889	4	1114.1	13.68	4280800	26.84	1.08E-12	13.14	0.008	0.008	0.008	1.00
73	8074	1E+07	1.09E-11	0.883	4	1037	12.84	2318500	19.49	1.13E-12	12.14	0.008	0.008	0.008	0.93
74	8386	9822800	1.30E-11	0.871	4	985.92	11.52	1808200	18.61	1.59E-12	12.85	0.008	0.008	0.008	0.99
75	8585	8677000	1.63E-11	0.858	4	837.69	9.76	1698800	17.63	1.69E-12	12.16	0.008	0.008	0.008	0.95
76	8055	7383800	2.01E-11	0.845	4	816.78	9.02	1254100	14.82	1.73E-12	10.86	0.007	0.007	0.007	0.85
77	8978	6138800	2.42E-11	0.838	4	758.99	8.46	981080	13.29	2.13E-12	10.57	0.007	0.007	0.007	0.85
78	8628	6336100	2.98E-11	0.825	4	737.12	8.64	688880	11.40	2.46E-12	10.16	0.007	0.007	0.007	0.83
79	8253	4452300	3.63E-11	0.814	4	602.21	8.67	475480	10.64	3.02E-12	10.21	0.007	0.007	0.007	0.84
80	8351	3804100	4.28E-11	0.808	4	783.46	9.14	371010	10.66	4.15E-12	11.43	0.008	0.008	0.008	0.85
81	8084	3384400	5.51E-11	0.791	4	712.88	7.86	287780	8.85	4.65E-12	11.36	0.008	0.008	0.008	0.86
82	8183	2846300	6.33E-11	0.785	4	673.55	8.22	268270	7.85	5.88E-12	10.82	0.007	0.007	0.007	0.83
83	7924	2498700	8.14E-11	0.771	4	577.16	7.28	183880	6.54	6.80E-12	10.74	0.007	0.007	0.007	0.83
84	7773	2041200	9.40E-11	0.765	4	632.69	8.14	138310	6.82	7.67E-12	9.43	0.008	0.008	0.008	0.83
85	7442	1807400	1.19E-10	0.752	4	487.53	6.55	92711	5.13	1.03E-11	10.98	0.007	0.007	0.007	0.97
86	7217	1510700	1.44E-10	0.742	4	485.61	6.52	75042	4.97	1.32E-11	9.18	0.008	0.008	0.008	0.78
87	7238	1298800	1.71E-10	0.735	4	489.68	6.82	60818	4.82	1.67E-11	9.81	0.007	0.007	0.007	0.84
88	6916	1073900	2.28E-10	0.719	4	434.42	6.00	43819	4.08	2.00E-11	8.63	0.008	0.008	0.008	0.80
89	6916	888310	2.48E-10	0.717	4	378.84	6.13	28040	3.36	2.08E-11	8.28	0.008	0.008	0.008	0.78
90	6916	718780	2.88E-10	0.708	4	308.04	6.07	22101	3.07	2.46E-11	8.32	0.008	0.008	0.008	0.79
91	6915	588390	3.04E-10	0.699	4	355.5	6.01	17835	2.88	3.18E-11	8.75	0.008	0.008	0.008	0.84
92	4774	488400	3.74E-10	0.702	4	288.44	6.25	11805	2.42	2.98E-11	8.01	0.005	0.005	0.005	0.77
93	4710	401330	4.47E-10	0.683	4	284.17	6.25	9287	2.31	3.78E-11	8.41	0.008	0.008	0.008	0.81
94	4079	335420	5.22E-10	0.688	4	273.72	6.71	7134.7	2.13	4.38E-11	8.36	0.008	0.008	0.008	0.82
95	3541	282910	5.48E-10	0.688	4	230.03	6.50	5018.7	1.77	4.17E-11	7.60	0.005	0.005	0.005	0.74
96	3204	233610	6.07E-10	0.688	4	223.94	6.89	3659	1.69	4.83E-11	7.96	0.005	0.005	0.005	0.78
97	2818	188830	6.21E-10	0.688	4	192.83	6.84	2882.4	1.46	4.61E-11	7.42	0.005	0.005	0.005	0.72
98	2884	178880	7.00E-10	0.683	4	216.91	7.57	2802.6	1.84	6.12E-11	6.73	0.005	0.005	0.005	0.85
100	2321	158200	8.85E-10	0.687	4	181.89	7.84	2188.8	1.39	5.33E-11	7.78	0.005	0.005	0.005	0.78

Paste With Mettigan Fly Ash
0 Months of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
101	2287	141820	8.94E-10	0.688	4	174.82	7.72	1882.7	1.33	5.46E-11	7.87	0.005	0.77
102	2109	127080	7.19E-10	0.689	4	172.28	8.17	1875.3	1.32	5.69E-11	8.18	0.005	0.79
103	1732	112320	8.91E-10	0.684	4	148.86	8.46	1286	1.13	5.14E-11	7.43	0.005	0.72
104	1665	100580	7.49E-10	0.682	4	148.38	8.91	1157.8	1.15	5.90E-11	7.69	0.005	0.76
105	1537	89802	7.08E-10	0.683	4	134.82	8.75	942.04	1.05	5.78E-11	7.55	0.005	0.73
106	1491	76300	7.84E-10	0.684	4	138.84	9.32	871.95	1.10	6.50E-11	8.29	0.006	0.80
107	1382	69552	7.08E-10	0.689	4	130.8	9.80	728.48	1.05	6.40E-11	8.38	0.006	0.80
108	1049	61172	7.28E-10	0.705	4	122.69	11.70	611.3	1.00	6.12E-11	8.41	0.006	0.80
109	1095	53908	7.84E-10	0.704	4	119.28	10.89	528.22	0.98	6.57E-11	8.60	0.006	0.82
110	904.1	46019	7.80E-10	0.708	4	113.28	12.53	436.28	0.95	6.69E-11	8.60	0.006	0.83
111	841.8	39111	7.41E-10	0.712	4	111.75	13.28	359.13	0.94	6.80E-11	9.35	0.006	0.88
112	928.8	32120	9.10E-10	0.701	4	116.72	12.61	321.73	1.00	9.32E-11	10.23	0.007	0.98
113	690.1	28218	9.28E-10	0.704	4	122.14	17.70	309.65	1.10	1.06E-10	11.49	0.008	1.10
114	722.3	25493	9.82E-10	0.701	4	119.86	18.59	278.89	1.09	1.16E-10	11.59	0.008	1.12
115	531.4	22858	9.11E-10	0.709	4	117.82	22.17	263.61	1.12	1.11E-10	12.15	0.008	1.16
116	633.2	20722	1.02E-09	0.702	4	122.74	19.38	245.71	1.19	1.31E-10	12.83	0.009	1.25
117	603.8	19167	1.04E-09	0.702	4	120.93	20.03	228.22	1.19	1.35E-10	12.95	0.009	1.28
118	471.8	17673	1.04E-09	0.705	4	118.54	24.71	211.55	1.20	1.35E-10	13.01	0.009	1.27
119	482.4	16468	1.02E-09	0.708	4	117.16	24.29	202.62	1.23	1.37E-10	13.38	0.009	1.30
120	448.8	16374	1.08E-09	0.705	4	128.39	28.62	214.24	1.39	1.69E-10	16.03	0.010	1.47
121	354.1	14322	1.02E-09	0.709	4	129.37	38.63	208.82	1.46	1.80E-10	16.73	0.011	1.53
122	315.7	13407	1.04E-09	0.709	4	121.23	38.40	189.01	1.41	1.80E-10	16.05	0.010	1.47
123	401.4	12727	1.18E-09	0.701	4	124.47	31.01	187.03	1.47	1.80E-10	15.28	0.011	1.52
124	431.5	12127	1.28E-09	0.697	4	132.68	30.75	184.5	1.60	2.07E-10	18.34	0.011	1.84
125	334.9	11744	1.33E-09	0.698	4	144.94	43.28	212.13	1.81	2.44E-10	18.37	0.013	1.85

Paste with Portage Fly Ash
8 Months of Hydration

File No.	$R_1(Q)$	$R_2(Q)$	C (F)	Phi	Type	$R_1(Q)$ (Error)	$R_1(Q)$ (% Error)	$R_2(Q)$ (Error)	$R_2(Q)$ (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	689.8	28331	6.20E-10	0.727	4	497.84	83.00	601.99	2.12	7.91E-11	14.66	0.012	1.64
2	607.7	28749	5.34E-10	0.728	4	542	106.76	645.54	2.41	8.53E-11	15.96	0.013	1.82
3	587	28446	5.98E-10	0.724	4	500.33	86.24	588.66	2.32	8.31E-11	14.89	0.012	1.71
4	543.1	24536	5.48E-10	0.728	4	582.99	103.66	658.43	2.68	9.24E-11	16.83	0.014	1.95
5	583.9	23770	5.77E-10	0.724	4	522.16	87.92	607.36	2.56	9.10E-11	15.78	0.013	1.83
6	765	22877	5.60E-10	0.727	4	508.42	87.47	590.85	2.57	8.88E-11	15.66	0.013	1.83
7	686.9	22839	5.70E-10	0.725	4	532.69	77.32	616.3	2.72	9.50E-11	16.48	0.014	1.92
8	657.3	22139	5.64E-10	0.728	4	516.73	60.27	596.35	2.69	9.24E-11	16.36	0.014	1.90
9	680.1	22116	5.82E-10	0.725	4	573.44	86.67	659.31	2.66	1.04E-10	17.80	0.015	2.09
10	578.3	21988	5.88E-10	0.722	4	598.35	98.72	641.07	2.91	1.03E-10	17.13	0.015	2.02
11	723.8	21671	5.78E-10	0.728	4	583.83	80.68	660.87	3.09	1.08E-10	18.36	0.016	2.14
12	683.8	21628	5.93E-10	0.724	4	578.37	82.82	660.58	3.05	1.07E-10	18.02	0.016	2.11
13	914.7	21622	6.05E-10	0.725	4	540.4	89.08	622.73	2.88	1.08E-10	17.32	0.016	2.02
14	941	22150	6.09E-10	0.724	4	573.24	80.82	664.05	3.00	1.11E-10	18.31	0.015	2.13
15	938.1	22889	6.18E-10	0.723	4	577.89	80.33	674.61	2.95	1.13E-10	18.37	0.015	2.13
16	778.8	24188	6.68E-10	0.715	4	599.52	75.70	693.58	2.87	1.20E-10	18.04	0.015	2.11
17	885.6	26371	6.82E-10	0.718	4	582.2	86.12	707.36	2.79	1.21E-10	18.23	0.016	2.11
18	802.8	27472	6.99E-10	0.709	4	678.93	112.33	819.8	2.88	1.39E-10	19.89	0.016	2.31
19	721.8	29389	6.88E-10	0.710	4	637.13	88.27	787.79	2.68	1.28E-10	18.60	0.015	2.14
20	1080	31480	6.40E-10	0.715	4	587.99	55.47	747.5	2.38	1.12E-10	17.44	0.014	1.97
21	988.6	30058	6.94E-10	0.708	4	685.72	117.49	888.24	2.47	1.28E-10	18.41	0.015	2.09
22	968.2	36479	6.82E-10	0.705	4	680.58	112.69	889.88	2.31	1.24E-10	17.87	0.014	2.02
23	451.9	42732	6.86E-10	0.703	4	689.65	152.61	985.87	2.28	1.24E-10	18.03	0.014	2.02
24	988.7	46783	6.28E-10	0.709	4	689.5	58.91	840.39	1.89	9.40E-11	14.98	0.012	1.65
25	137.1	53127	6.94E-10	0.698	4	683.83	488.78	1081.9	1.98	1.15E-10	16.82	0.013	1.84
26	463.1	58881	6.48E-10	0.702	4	680.43	120.44	983.07	1.67	9.24E-11	14.32	0.011	1.57
27	180	68818	6.50E-10	0.699	4	683.67	348.25	1187.7	1.75	9.82E-11	15.12	0.012	1.68
28	139.8	76289	6.54E-10	0.698	4	618.6	442.17	1185.2	1.55	8.80E-11	13.46	0.010	1.47
29	195.1	97582	6.39E-10	0.695	4	681.37	338.99	1399.9	1.59	8.88E-11	13.67	0.010	1.49
30	238.7	100740	6.80E-10	0.698	4	645.16	270.28	1509	1.50	7.94E-11	12.78	0.010	1.38
31	557.5	118940	6.88E-10	0.694	4	683.88	119.05	1749.8	1.50	7.38E-11	12.41	0.009	1.34
32	674.7	134850	6.88E-10	0.695	4	591.99	87.74	1784.1	1.31	6.98E-11	10.82	0.008	1.13
33	828.8	157410	6.28E-10	0.697	4	585.43	71.84	2047.2	1.30	6.27E-11	10.05	0.007	1.07
34	1086	182030	4.74E-10	0.698	4	582.05	64.60	2285.3	1.28	4.84E-11	9.31	0.007	0.98
35	1785	244850	4.44E-10	0.698	4	588.44	48.54	2587.1	1.23	4.07E-11	8.69	0.006	0.91
36	1740	261710	4.02E-10	0.703	4	682.03	38.94	3438.1	1.40	4.13E-11	9.31	0.007	0.98
37	1887	325390	3.74E-10	0.705	4	605.6	32.09	4274.2	1.31	3.21E-11	7.98	0.006	0.83
38	3669	363430	4.01E-10	0.695	4	681.66	25.73	7889.4	1.05	2.91E-11	7.77	0.006	0.81
39	2988	435740	3.38E-10	0.704	4	689.28	28.83	8485.2	1.49	4.46E-11	11.20	0.008	1.19
40	2759	501970	3.12E-10	0.708	4	789.28	27.85	8284.3	1.65	2.63E-11	7.78	0.008	0.80
41	4091	586080	3.13E-10	0.708	4	1023.3	25.01	13185	2.22	3.12E-11	6.11	0.006	0.64
42	3602	683380	2.70E-10	0.708	4	846.1	23.49	12449	1.82	2.08E-11	9.97	0.007	1.03
43	4818	804080	2.70E-10	0.703	4	1273.8	27.58	21879	2.72	2.89E-11	10.71	0.008	1.11
44	3303	904890	2.30E-10	0.710	4	781.28	23.85	14678	1.62	1.42E-11	6.18	0.004	0.63
45	3372	1052900	2.48E-10	0.699	4	1597.4	48.48	33097	3.14	2.78E-11	11.18	0.008	1.18
46	6679	1280200	2.84E-10	0.699	4	1587.5	18.73	32882	2.81	2.19E-11	8.64	0.008	0.91
47	9722	1691200	2.92E-10	0.671	4	3150.3	32.40	102440	6.17	5.02E-11	17.20	0.012	1.88
48	9887	2170100	2.28E-10	0.681	4	2324	23.99	88851	4.65	2.89E-11	11.30	0.008	1.20
49	13328	3168100	2.03E-10	0.680	4	3392.3	25.45	227890	7.20	2.89E-11	14.27	0.010	1.52

Peds With Porag Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	Phi	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
51	16198	4741400	1.76E-10	0.661	4	5886.9	34.49	639860	13.49	3.62E-11	20.52	0.015	2.18
52	25598	6748500	1.57E-10	0.680	4	5919	27.04	1252700	18.57	3.53E-11	22.49	0.016	2.39
53	19258	8238900	1.05E-10	0.704	4	5528.4	28.71	1255100	14.99	1.76E-11	16.87	0.012	1.73
54	44031	1.9E+07	1.31E-10	0.679	4	11163	25.40	7437300	46.87	3.87E-11	29.46	0.021	3.13
55	25449	1.4E+07	8.78E-11	0.722	4	6653.6	28.83	2970300	21.50	1.20E-11	17.78	0.013	1.77
56	31942	2.1E+07	6.16E-11	0.723	4	10078	31.55	6228900	39.84	1.47E-11	23.84	0.017	2.36
57	49844	4.7E+07	6.18E-11	0.717	4	13961	29.97	4934000	105.08	1.86E-11	30.08	0.022	3.02
58	64158	9.3E+07	6.04E-11	0.713	4	17365	27.11	20713000	221.61	2.07E-11	34.29	0.025	3.46
59	51598	4.7E+07	3.55E-11	0.747	4	12837	24.88	3360400	72.63	8.66E-12	24.91	0.018	2.40
60	43745	1.1E+08	2.80E-11	0.761	4	12860	28.99	17212000	154.02	6.85E-12	23.71	0.017	2.25
61	69411	6.9E+07	2.73E-11	0.757	4	16321	23.51	31399000	45.52	5.68E-12	20.44	0.015	2.02
62	68614	8.4E+07	2.26E-11	0.768	4	15819	23.68	41117000	46.90	4.34E-12	19.23	0.014	1.87
63	54947	7.8E+07	1.79E-11	0.763	4	14378	26.17	30347000	38.70	3.12E-12	17.42	0.013	1.66
64	59745	9.3E+07	1.59E-11	0.763	4	11754	21.09	26999000	32.45	2.22E-12	14.30	0.011	1.35
65	43044	8.5E+07	1.39E-11	0.800	4	14434	33.53	32409000	38.33	2.37E-12	17.13	0.013	1.60
66	61860	6.7E+07	1.26E-11	0.805	4	10849	17.02	14760000	21.89	1.89E-12	12.53	0.009	1.16
67	110570	1.9E+08	1.82E-11	0.772	4	18070	17.25	18789000	102.94	4.03E-12	20.82	0.016	2.03
68	70156	1E+08	1.39E-11	0.766	4	15665	22.23	49463000	48.67	2.45E-12	17.64	0.013	1.66
69	62276	1.8E+08	1.2E-11	0.813	4	11949	21.82	24674000	29.23	1.58E-12	13.95	0.010	1.28
70	93931	1.8E+08	1.74E-11	0.778	4	22061	23.49	15166000	67.06	4.12E-12	23.67	0.016	2.27
71	62867	9.9E+07	1.26E-11	0.802	4	16820	26.84	46394000	46.86	2.39E-12	18.67	0.014	1.78
72	68225	1.1E+08	1.55E-11	0.768	4	22158	24.83	76086000	69.13	3.66E-12	23.79	0.018	2.26
73	62219	1E+08	1.17E-11	0.809	4	10557	20.22	32683000	31.78	1.45E-12	12.33	0.009	1.14
74	55287	1.2E+08	1.52E-11	0.791	4	15131	27.38	71002000	56.53	2.66E-12	17.46	0.013	1.65
75	80075	1.4E+08	1.97E-11	0.773	4	17474	21.82	10533000	78.33	3.93E-12	19.97	0.015	1.93
76	68553	1.2E+08	2.04E-11	0.773	4	16382	24.63	81013000	65.86	3.85E-12	19.57	0.014	1.66
77	74075	6.1E+07	2.26E-11	0.768	4	13068	17.67	31618000	39.18	3.62E-12	18.06	0.012	1.56
78	48740	4.7E+07	2.36E-11	0.768	4	15031	30.22	13812000	29.10	4.86E-12	19.28	0.014	1.66
79	62549	4.8E+07	3.16E-11	0.780	4	14863	23.95	15573000	32.43	6.18E-12	19.63	0.015	1.86
80	57498	4.2E+07	3.55E-11	0.745	4	12167	26.18	11111000	28.19	5.89E-12	16.67	0.013	1.69
81	47041	4E+07	4.35E-11	0.735	4	12170	25.67	11487000	28.40	7.73E-12	17.78	0.013	1.61
82	52182	3.2E+07	5.30E-11	0.723	4	12524	24.00	8010800	25.40	1.00E-11	18.90	0.014	1.95
83	57025	2.8E+07	6.50E-11	0.713	4	10428	18.28	5664100	21.50	1.08E-11	16.59	0.012	1.74
84	43860	1.8E+07	8.80E-11	0.714	4	8858.2	19.73	2622800	14.03	1.02E-11	14.94	0.011	1.56
85	43864	1.8E+07	9.04E-11	0.697	4	10207	23.27	2700400	19.52	1.66E-11	16.29	0.014	1.98
86	45957	1.4E+07	1.15E-10	0.685	4	8979.8	19.54	2028000	14.50	1.88E-11	17.06	0.013	1.86
87													
88	26945	8351400	1.24E-10	0.680	4	5588.1	20.97	625500	7.48	1.58E-11	12.60	0.009	1.36
89	25098	6967400	1.53E-10	0.679	4	6146.3	24.54	599550	7.99	2.24E-11	14.67	0.011	1.61
90	26248	5233900	1.68E-10	0.678	4	3919.4	14.55	234390	4.48	1.65E-11	9.94	0.007	1.09
91	22085	4327300	1.90E-10	0.673	4	3574	16.20	177690	4.10	1.02E-11	10.02	0.007	1.11
92	18901	3543100	2.19E-10	0.668	4	4168	22.16	163090	4.60	2.70E-11	12.53	0.009	1.40
93	14842	2862000	2.37E-10	0.667	4	3530.5	23.79	108860	3.78	2.72E-11	11.49	0.009	1.29
94	17951	2351700	2.55E-10	0.667	4	2224.9	17.10	54858	2.33	2.02E-11	7.91	0.008	0.88
95	9632	1953300	3.24E-10	0.659	4	4218.8	23.60	57032	4.33	5.47E-11	16.36	0.011	1.78
96	10815	1321100	3.86E-10	0.650	4	2482.1	24.99	39653	2.50	3.32E-11	10.22	0.009	1.16
97	11258	1086900	4.44E-10	0.645	4	2622.2	27.53	36288	2.90	4.98E-11	12.62	0.010	1.47
98	8721	879800	4.67E-10	0.648	4	2895.1	23.05	27952	2.55	5.44E-11	12.26	0.009	1.42
99	6715	708540	4.85E-10	0.647	4	1858.5	20.13	18658	1.92	4.78E-11	10.18	0.008	1.18
100						2101.1	30.39	14486	2.05	5.95E-11	12.01	0.009	1.39

Pastes with Poragite Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	Phi	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
101	4006	571130	5.23E-10	0.649	4	2012.7	40.29	11366	1.99	6.04E-11	12.70	0.010	1.47
102	4030	462170	5.31E-10	0.653	4	1362	29.42	6334.3	1.37	5.05E-11	9.90	0.007	1.09
103	4181	390120	5.92E-10	0.650	4	1676.9	40.06	6336.7	1.72	7.48E-11	12.63	0.010	1.46
104	2881	311020	5.87E-10	0.656	4	1344.6	46.67	4460.2	1.43	6.66E-11	11.22	0.008	1.29
105	26700	257090	6.03E-10	0.659	4	1232.6	59.47	3529.4	1.37	6.78E-11	11.27	0.009	1.30
106	1073	213100	5.78E-10	0.667	4	968.27	66.32	2804.3	1.18	5.82E-11	10.06	0.008	1.15
107	1328	179830	6.30E-10	0.664	4	1170	66.10	2598.1	1.44	7.93E-11	12.69	0.010	1.45
108	769	162000	6.23E-10	0.670	4	1064.8	136.47	2135.2	1.40	7.77E-11	12.46	0.010	1.43
109	367	129360	6.12E-10	0.675	4	929.77	263.34	1704.6	1.32	7.23E-11	11.82	0.009	1.35
110	169	110440	5.91E-10	0.682	4	808.56	508.53	1371.8	1.24	6.61E-11	11.17	0.009	1.27
111	4797	95941	6.29E-10	0.681	4	677.2	18286.43	1365	1.45	7.69E-11	12.76	0.010	1.46
112	427.1	83017	5.84E-10	0.680	4	665.74	160.66	1028.6	1.24	6.35E-11	10.67	0.009	1.23
113	560.5	72770	5.71E-10	0.685	4	635.46	113.37	905.61	1.24	6.13E-11	10.74	0.008	1.22
114	443.9	64347	5.88E-10	0.685	4	636.44	143.37	868.67	1.35	6.63E-11	11.24	0.009	1.26
115	1.066	57436	6.24E-10	0.693	4	662.34	64647.47	903.59	1.57	7.61E-11	12.51	0.010	1.45
116	76.99	50397	6.19E-10	0.697	4	642.06	833.95	810.34	1.59	7.51E-11	12.19	0.010	1.42
117	58.91	45312	6.04E-10	0.700	4	614.03	1042.32	782.5	1.66	7.39E-11	12.21	0.010	1.42
118	312.2	39699	5.80E-10	0.707	4	555.17	177.63	63.24	1.66	6.78E-11	11.71	0.010	1.37
119	136	35627	5.80E-10	0.708	4	573.66	415.93	567.81	1.87	7.19E-11	12.41	0.010	1.47
120	142.7	31670	5.88E-10	0.708	4	624.85	437.66	709.08	2.24	8.03E-11	13.65	0.012	1.64
121	71.93	27879	6.08E-10	0.710	4	573.62	797.33	640.63	2.30	8.01E-11	13.21	0.011	1.61
122	52.62	24772	6.40E-10	0.709	4	590.69	1066.55	617.68	2.49	8.54E-11	13.34	0.012	1.65
123	210.5	22630	6.66E-10	0.707	4	610.32	269.94	662.06	2.94	9.34E-11	14.27	0.013	1.62
124	68.66	20076	6.39E-10	0.713	4	591.62	671.23	625.43	3.12	9.14E-11	14.38	0.013	1.64
125	288.6	16104	6.47E-10	0.716	4	560.42	204.77	567.21	3.24	9.09E-11	14.06	0.013	1.63
126	363.6	16463	6.46E-10	0.717	4	564.96	155.36	568.66	3.63	9.69E-11	14.64	0.014	1.65
127	7.542	15536	6.76E-10	0.712	4	669.42	8743.30	662.9	4.46	1.10E-10	16.30	0.016	2.23
128	161.1	14204	6.85E-10	0.714	4	664.66	412.71	665.74	4.90	1.17E-10	17.01	0.017	2.36
129	61.57	13602	6.02E-10	0.703	4	668.06	1130.62	724.94	5.37	1.39E-10	19.60	0.017	2.45

Pedals With Sundares Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	Phi	Type	R_1 (Q) (Error)	R_2 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	875.1	48628	1.37E-09	0.674	4	550.44	814.44	62.90	1.64	1.76E-10	12.86	0.010	1.55
2	1019	46801	1.50E-09	0.668	4	619.31	869.77	60.78	1.90	2.16E-10	14.47	0.012	1.78
3	1221	44628	1.73E-09	0.660	4	686.14	935.14	54.56	2.10	2.67E-10	15.44	0.013	1.94
4	1332	42694	1.91E-09	0.653	4	722.97	997.36	54.26	2.34	3.16E-10	16.74	0.014	2.14
5	1481	41419	2.12E-09	0.646	4	763.78	1040.7	51.57	2.51	3.72E-10	17.54	0.015	2.28
6	1618	40511	2.33E-09	0.639	4	809.21	1092.6	50.01	2.70	4.28E-10	18.42	0.016	2.43
7	1750	39684	2.52E-09	0.634	4	863.18	1143.9	48.75	2.87	4.86E-10	19.23	0.017	2.57
8	1868	38936	2.72E-09	0.628	4	901.72	1202.3	48.27	3.05	5.47E-10	20.12	0.017	2.72
9	1972	38071	2.87E-09	0.625	4	945.31	1255.8	47.94	3.21	6.00E-10	20.91	0.018	2.86
10	2078	36952	3.02E-09	0.621	4	989.74	1310.3	47.63	3.37	6.54E-10	21.68	0.019	2.99
11	2252	36791	3.19E-09	0.618	4	1025.2	1362.3	45.52	3.49	7.08E-10	22.09	0.019	3.08
12	2278	36637	3.34E-09	0.613	4	1057.8	1388.2	46.42	3.60	7.59E-10	22.73	0.020	3.19
13	2158	36588	3.40E-09	0.613	4	1057.3	1428.7	48.48	3.61	7.88E-10	23.14	0.020	3.23
14													
15													
16													
17													
18													
19													
20													
21													
22	3179	98272	4.18E-09	0.598	4	641.78	2350.9	20.19	2.39	1.08E-09	25.84	0.018	3.10
23	3187	108960	3.70E-09	0.602	4	641.97	2591.6	20.14	2.39	9.44E-10	25.80	0.018	3.02
24	3119	117360	3.23E-09	0.610	4	633.94	2773.8	20.33	2.36	8.03E-10	24.86	0.018	2.80
25	3089	129170	2.60E-09	0.616	4	637.23	3070.6	20.63	2.36	7.12E-10	24.66	0.017	2.69
26	3088	141310	2.45E-09	0.628	4	623.63	3293	20.34	2.33	6.82E-10	23.75	0.017	2.69
27	3011	155140	2.20E-09	0.632	4	623.67	3618.1	20.72	2.33	5.12E-10	23.27	0.016	2.61
28	2978	170650	1.92E-09	0.639	4	623.14	3997.7	20.94	2.34	4.40E-10	22.86	0.016	2.53
29	1359	151440	5.15E-10	0.725	4	193.89	2388.6	14.27	1.58	5.31E-11	10.30	0.007	0.96
30	1362	168980	4.79E-10	0.729	4	199.26	2798.1	14.31	1.64	4.87E-11	10.23	0.007	0.95
31	1368	186000	4.41E-10	0.732	4	202.3	3171.5	14.57	1.69	4.43E-11	10.05	0.007	0.93
32	1365	212650	4.04E-10	0.737	4	202.36	3654.7	14.62	1.72	3.91E-11	9.67	0.007	0.89
33	1418	240860	3.79E-10	0.739	4	216.4	4485.9	15.28	1.86	3.78E-11	9.93	0.007	0.91
34	1444	272850	3.49E-10	0.743	4	209.21	5001.6	14.49	1.83	3.21E-11	9.22	0.006	0.84
35	1480	307770	3.27E-10	0.745	4	205.26	5812.7	13.87	1.82	2.83E-11	8.67	0.006	0.79
36	1479	348900	2.89E-10	0.749	4	209.24	6820.9	14.15	1.89	2.54E-11	8.49	0.006	0.77
37	1509	394070	2.71E-10	0.754	4	230.09	8371.3	15.25	2.12	2.45E-11	9.04	0.006	0.82
38	1437	457980	2.46E-10	0.758	4	219.49	9808.1	15.27	2.08	2.04E-11	6.20	0.006	0.74
39	1455	516930	2.28E-10	0.762	4	225.18	11178	15.48	2.17	1.86E-11	8.10	0.006	0.73
40	1571	580160	2.10E-10	0.765	4	235.54	13715	14.69	2.32	1.71E-11	8.14	0.006	0.73
41	1597	677230	1.97E-10	0.767	4	236.47	16142	14.80	2.36	1.63E-11	7.78	0.006	0.70
42	1563	770600	1.76E-10	0.773	4	245.41	19489	15.70	2.59	1.37E-11	7.78	0.005	0.69
43	1541	812130	1.65E-10	0.774	4	244.39	23527	15.86	2.58	1.20E-11	7.28	0.005	0.65
44	1589	1039700	1.51E-10	0.777	4	249.47	27800	15.90	2.67	1.07E-11	7.08	0.005	0.63
45	1615	1180900	1.41E-10	0.779	4	254.63	32542	14.04	2.76	9.69E-12	6.88	0.005	0.61
46	1672	1357400	1.26E-10	0.783	4	278.12	40725	16.51	3.00	8.90E-12	7.05	0.005	0.62
47	1946	1599800	1.20E-10	0.783	4	281.35	47470	14.44	3.03	7.98E-12	6.86	0.005	0.59
48	2342	1823700	1.10E-10	0.783	4	308.11	56391	13.20	3.26	7.41E-12	6.73	0.005	0.60
49	2594	2099800	1.05E-10	0.781	4	349.33	73946	12.07	3.53	7.27E-12	6.95	0.005	0.62

Pavement with Surface Fly Ash
6 Months of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₃ (Q) (Error)	R ₃ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
51	N/A	N/A	N/A	N/A	0	0	N/A	0	N/A	0.00E+00	N/A	0.000	N/A
52	4742	2607000	1.03E-10	0.766	4	503.49	10.62	126100	4.40	6.00E-12	7.74	0.006	0.70
53	6477	3675000	9.67E-11	0.763	4	670.61	10.36	196770	5.60	8.55E-12	8.63	0.006	0.82
54	6602	5112400	8.14E-11	0.764	4	807.41	9.39	340900	6.77	7.42E-12	9.12	0.006	0.63
55	10759	7394600	6.15E-11	0.773	4	996.79	9.00	612000	8.31	5.81E-12	9.46	0.007	0.66
56	11978	1.1E+07	4.43E-11	0.767	4	1103	9.29	1111700	10.31	4.27E-12	9.63	0.007	0.66
57	13126	1.5E+07	2.98E-11	0.808	4	1250.4	9.62	1603900	12.80	3.02E-12	10.10	0.007	0.66
58	12500	2E+07	2.10E-11	0.827	4	1371.2	10.97	2625100	14.86	2.21E-12	10.61	0.007	0.90
59	16426	2.6E+07	1.63E-11	0.838	4	1620.5	9.86	4671500	17.69	1.77E-12	10.64	0.006	0.91
60	13661	2.6E+07	1.14E-11	0.860	4	1669.2	11.49	4147400	16.23	1.27E-12	11.15	0.006	0.92
61	13067	3.3E+07	9.84E-12	0.866	4	1665.9	12.21	6336000	18.26	1.06E-12	11.06	0.006	0.90
62	12662	3.6E+07	8.07E-12	0.879	4	1660.1	12.46	6626600	16.13	8.70E-13	10.78	0.006	0.87
63	14466	4.3E+07	7.66E-12	0.861	4	1703.5	11.76	10246000	23.64	6.67E-13	11.31	0.006	0.81
64	14301	4.1E+07	7.30E-12	0.863	4	1669.6	11.19	8269600	20.26	7.66E-13	10.62	0.007	0.84
65	13326	4.4E+07	6.71E-12	0.869	4	1676.3	12.66	6796200	22.26	7.44E-13	11.09	0.006	0.86
66	16101	4.6E+07	6.70E-12	0.866	4	1762.6	11.61	10491000	23.26	7.61E-13	11.36	0.006	0.91
67	14462	4.6E+07	6.40E-12	0.860	4	1767.1	12.13	10720000	23.24	7.22E-13	11.29	0.006	0.90
68	13046	6.3E+07	6.63E-12	0.866	4	1664.4	12.61	16694000	26.70	6.47E-13	10.91	0.006	0.86
69	14667	5E+07	5.66E-12	0.866	4	1727	11.62	12107000	24.19	6.33E-13	11.15	0.006	0.86
70	14166	6.6E+07	6.04E-12	0.864	4	1662.1	11.94	21446000	31.67	6.06E-13	10.76	0.006	0.85
71	13137	4.7E+07	5.80E-12	0.867	4	1640	12.46	10161000	21.72	6.19E-13	10.67	0.006	0.84
72	16671	3.8E+07	6.39E-12	0.861	4	1603.2	11.66	7691000	20.24	7.94E-13	11.81	0.006	0.94
73	16666	5.3E+07	8.09E-12	0.876	4	1759.1	11.17	15153000	26.42	9.10E-13	11.24	0.006	0.91
74	13632	4E+07	8.61E-12	0.876	4	1660.6	12.27	6760200	21.66	8.46E-13	11.11	0.006	0.90
75	14466	3.6E+07	1.02E-11	0.864	4	1664.7	10.11	6364200	16.02	9.96E-13	9.78	0.007	0.80
76	16760	2.6E+07	1.20E-11	0.855	4	1664.6	9.65	4166600	16.76	1.26E-12	10.71	0.006	0.86
77	16644	2.2E+07	1.46E-11	0.844	4	1607.2	9.63	3131600	14.21	1.56E-12	10.64	0.006	0.86
78	N/A	N/A	N/A	N/A	0	0	N/A	0	N/A	0.00E+00	N/A	0.000	N/A
79	16046	1.6E+07	2.14E-11	0.823	4	1407	9.35	2366600	13.14	2.23E-12	10.42	0.007	0.86
80	14666	1.7E+07	2.80E-11	0.807	4	1260.9	8.43	2036600	12.24	2.66E-12	9.61	0.007	0.83
81	16166	1.4E+07	3.33E-11	0.769	4	1316.2	8.66	1636600	11.66	3.43E-12	10.31	0.007	0.81
82	14640	1.2E+07	4.34E-11	0.763	4	1164.1	7.63	1264100	10.66	4.10E-12	9.45	0.007	0.85
83	13734	1E+07	5.03E-11	0.777	4	1067.1	7.77	910420	9.00	4.47E-12	8.63	0.006	0.81
84	12600	6666700	6.77E-11	0.771	4	976.74	7.74	664360	7.79	4.66E-12	8.62	0.006	0.76
85	13420	7066700	7.67E-11	0.766	4	966.6	7.12	523400	7.42	6.63E-12	8.75	0.006	0.81
86	12266	6606400	8.66E-11	0.746	4	867.33	7.23	361260	6.66	7.67E-12	8.66	0.006	0.80
87	12264	4642600	1.11E-10	0.756	4	760.9	6.44	271660	5.61	8.63E-12	7.92	0.006	0.75
88	11916	3646200	1.37E-10	0.727	4	766.62	6.66	206600	6.26	1.13E-11	6.23	0.006	0.79
89	10345	3219100	1.55E-10	0.723	4	717.09	6.63	163620	4.75	1.26E-11	8.26	0.006	0.79
90	9674	2660600	1.86E-10	0.713	4	646.16	5.74	94415	3.62	1.46E-11	6.62	0.006	0.64
91	9416	2206600	2.26E-10	0.705	4	612.66	5.44	70226	3.16	1.46E-11	6.63	0.006	0.64
92	8617	1666300	2.66E-10	0.701	4	604.63	5.66	56430	3.07	1.76E-11	6.66	0.006	0.66
93	7634	1445100	2.93E-10	0.697	4	467.46	5.66	36046	2.70	2.01E-11	6.67	0.006	0.66
94	6266	1223400	3.66E-10	0.666	4	361.36	5.27	27164	2.22	2.16E-11	5.66	0.004	0.60
95	6021	1003600	3.66E-10	0.666	4	339.12	5.40	16603	1.94	2.26E-11	5.61	0.004	0.66
96	6661	633740	4.61E-10	0.676	4	267.69	4.76	13467	1.62	2.37E-11	5.26	0.004	0.63
97	6661	666430	5.01E-10	0.677	4	262.36	5.09	10666	1.66	2.60E-11	5.66	0.004	0.57
98	6066	666630	5.71E-10	0.672	4	267.07	5.06	7667.1	1.41	3.16E-11	5.61	0.004	0.66
99	4167	462460	6.66E-10	0.676	4	220.67	6.33	5626.2	1.22	3.06E-11	5.21	0.004	0.63
100	4057	367030	6.66E-10	0.672	4	214.61	5.26	4667.4	1.16	3.66E-11	5.43	0.004	0.65

Pecds With Surdsnce Phy Ash
8 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	G (F)	PH	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	G (F) (Error)	G (F) (% Error)	PH (Error)	PH (% Error)
101	3556	327260	7.24E-10	0.659	4	218.4	5.97	3971.2	1.21	4.33E-11	5.95	0.004	0.61
102	2946	276970	7.30E-10	0.673	4	190.44	6.46	2954.8	1.07	4.16E-11	5.89	0.004	0.59
103	3943	243900	6.69E-10	0.656	4	276.36	7.01	3750.5	1.54	6.15E-11	6.42	0.006	0.87
104	3472	206630	9.69E-10	0.660	4	236.7	6.86	2805.9	1.34	7.66E-11	7.91	0.005	0.82
105	3029	180160	8.69E-10	0.662	4	207.75	6.86	2130.1	1.16	7.33E-11	7.42	0.005	0.78
106	2949	156660	1.06E-09	0.658	4	231.28	7.84	2056.8	1.32	9.97E-11	6.75	0.006	0.90
107	2515	134490	1.04E-09	0.668	4	197.73	7.66	1559.8	1.16	8.59E-11	6.20	0.006	0.84
108	2498	117910	1.16E-09	0.662	4	212.88	6.52	1463.2	1.28	1.07E-10	9.30	0.006	0.86
109	2327	101260	1.14E-09	0.666	4	197.74	6.50	1185	1.18	1.06E-10	9.33	0.006	0.86
110	2101	67632	1.21E-09	0.665	4	186.67	9.50	1067.3	1.22	1.22E-10	10.07	0.007	1.09
111	2334	79334	1.44E-09	0.666	4	221.57	6.53	1011.8	1.34	1.06E-10	11.62	0.006	1.21
112	2079	63294	1.53E-09	0.665	4	242.72	11.67	948.61	1.50	2.10E-10	13.70	0.009	1.43
113	2151	61255	1.97E-09	0.642	4	272.25	12.66	864.22	1.69	3.17E-10	16.12	0.011	1.72
114	2337	40705	2.64E-09	0.625	4	267.64	12.74	752.84	1.85	4.79E-10	18.15	0.013	2.01
115	2112	35722	3.17E-09	0.617	4	289.64	13.72	672.29	1.86	6.65E-10	18.47	0.013	2.09
116	1918	31759	3.39E-09	0.616	4	310.58	16.19	669.33	2.11	7.06E-10	20.89	0.015	2.37
117	1944	28971	3.69E-09	0.612	4	326.22	17.69	659.79	2.26	8.23E-10	22.64	0.016	2.58
118	1737	26598	3.90E-09	0.609	4	334.18	19.24	639.91	2.41	9.30E-10	23.71	0.017	2.74
119	1895	24671	4.67E-09	0.608	4	347.66	18.35	628.09	2.53	1.13E-09	24.22	0.017	2.86
120	1910	23078	5.09E-09	0.595	4	362.5	20.03	627.83	2.72	1.30E-09	25.78	0.018	3.09
121	1821	21553	5.79E-09	0.597	4	372.27	20.44	617.84	2.86	1.52E-09	26.35	0.019	3.23
122	1708	20168	6.12E-09	0.595	4	398.63	22.79	626.03	3.10	1.73E-09	28.31	0.020	3.49
123	1755	18653	6.93E-09	0.577	4	416.6	23.74	647.25	3.41	2.06E-09	30.19	0.022	3.80
124	1808	15061	8.07E-09	0.598	4	439.83	24.33	683.82	3.67	2.53E-09	31.37	0.023	4.05
125	1835	17464	1.00E-08	0.564	4	490.64	24.85	709.33	4.06	3.32E-09	33.07	0.025	4.42
126	1987	17251	1.26E-08	0.540	4	535.66	26.97	769.79	4.58	4.54E-09	35.96	0.027	4.97

Reference Mortar
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
1	11124	699560	6.30E-14	1.069	4	23494	211.20	45533	6.63	7.31E-14	87.50	0.057	5.35
2	193.2	700070	6.15E-14	1.065	4	21198	10971.01	41087	5.87	4.86E-14	74.13	0.048	4.45
3	2208	699610	8.14E-14	1.071	4	20413	925.34	41863	6.00	6.18E-14	75.97	0.049	4.62
4	6729	703930	6.21E-14	1.087	4	18379	273.13	37293	5.30	4.16E-14	67.10	0.044	4.01
5	20335	691980	3.95E-14	1.126	4	18769	82.41	39355	5.18	2.38E-14	65.80	0.043	3.78
6	8946	707940	5.78E-14	1.091	4	19318	218.94	39749	5.47	3.06E-14	66.14	0.045	4.12
7	12012	749980	1.14E-13	1.045	4	27828	232.48	59321	7.54	1.05E-13	92.80	0.081	5.79
8	11.48	735140	1.57E-13	1.028	4	23489	204908.01	49766	6.38	1.25E-13	79.44	0.032	5.08
9	1161	733080	5.61E-14	1.098	4	14715	1267.44	27808	3.79	2.68E-14	48.67	0.032	2.82
10	7408	714800	6.91E-14	1.081	4	20169	272.33	41989	5.67	5.19E-14	74.57	0.049	4.49
11	33900	690310	4.44E-14	1.113	4	17762	52.69	37781	5.47	3.05E-14	69.50	0.046	4.05
12	8385	781460	6.78E-14	1.054	4	21943	281.89	45728	6.65	7.08E-14	72.07	0.047	4.46
13	13964	741080	6.35E-14	1.053	4	15913	113.79	31827	4.29	2.89E-14	54.80	0.038	3.27
14	16842	767160	3.30E-14	1.129	4	17653	103.61	39704	5.24	2.18E-14	68.50	0.043	3.81
15	22376	823980	6.03E-14	1.059	4	18392	88.68	44998	5.41	5.37E-14	68.86	0.044	4.07
16	10095	862230	7.00E-14	1.075	4	21111	209.12	49693	5.60	4.86E-14	69.47	0.045	4.21
17	64.82	975170	7.37E-14	1.071	4	22880	35313.17	58791	8.03	5.29E-14	71.86	0.047	4.38
18	8998	1020900	4.61E-14	1.101	4	20641	231.62	59078	5.79	3.28E-14	68.14	0.044	4.00
19	19405	1033900	3.80E-14	1.113	4	20331	104.77	61344	5.61	2.47E-14	64.16	0.041	3.72
20	5341	1238800	7.07E-14	1.071	4	23783	445.46	76321	6.18	4.91E-14	69.35	0.045	4.20
21	18971	1289700	5.89E-14	1.087	4	25069	132.14	90382	7.18	4.53E-14	78.90	0.050	4.58
22	3310	1386800	4.90E-14	1.094	4	23907	722.27	90287	6.52	3.47E-14	69.64	0.045	4.12
23	21708	1488800	4.45E-14	1.104	4	28589	122.38	111880	7.81	3.47E-14	77.98	0.050	4.56
24	22848	1618200	2.90E-14	1.128	4	24603	107.86	108210	6.69	1.86E-14	67.10	0.043	3.65
25	612.8	1805800	5.13E-14	1.059	4	27743	4827.25	134080	7.43	3.72E-14	72.60	0.047	4.32
26	8956	1923900	4.61E-14	1.097	4	29435	332.37	157890	8.21	3.56E-14	77.01	0.050	4.55
27	23928	2137800	4.72E-14	1.090	4	22439	93.78	123900	5.80	2.67E-14	64.51	0.035	3.25
28	6994	2354900	4.30E-14	1.097	4	28620	439.59	180530	7.78	2.84E-14	68.40	0.044	4.05
29	16482	2559800	5.97E-14	1.078	4	28165	178.85	216580	8.43	4.11E-14	68.87	0.045	4.16
30	22791	2747000	4.52E-14	1.086	4	30289	132.81	247540	9.01	3.24E-14	71.56	0.047	4.25
31	32367	2959100	2.69E-14	1.132	4	29880	92.28	284280	9.62	1.87E-14	73.48	0.048	4.22
32	26008	3247300	2.91E-14	1.124	4	30534	122.11	311590	9.60	2.06E-14	71.83	0.047	4.16
33	26285	3740000	2.89E-14	1.122	4	32375	179.39	375470	10.04	2.05E-14	71.05	0.048	4.13
34	32643	4123600	3.22E-14	1.114	4	30727	104.92	407130	9.87	2.12E-14	65.89	0.043	3.86
35	26578	4651800	2.64E-14	1.128	4	32822	100.24	494080	10.85	1.82E-14	69.01	0.045	4.01
36	18805	5922800	4.67E-14	1.087	4	33058	124.39	594680	11.14	2.63E-14	68.29	0.044	3.98
37	27517	6677800	2.92E-14	1.117	4	40220	213.83	699420	14.84	3.88E-14	78.56	0.050	4.63
38	16142	7211000	2.62E-14	1.123	4	38994	254.68	1082500	13.39	2.01E-14	69.89	0.045	4.08
39	14235	8657800	3.84E-14	1.099	4	39807	286.27	1269900	14.73	1.91E-14	73.08	0.048	4.28
40	10005	1.1E+07	4.24E-14	1.088	4	40597	298.14	1893300	17.67	2.35E-14	64.83	0.043	3.87
41	23628	1.2E+07	3.05E-14	1.108	4	39308	392.86	2007600	17.32	2.80E-14	68.05	0.044	4.02
42	44116	1.2E+07	2.62E-14	1.113	4	39879	131.67	2346000	18.80	1.96E-14	63.81	0.042	3.81
43	34515	1.3E+07	2.48E-14	1.123	4	44168	100.12	2877000	22.67	1.82E-14	64.39	0.043	3.83
44	33588	1.6E+07	2.03E-14	1.130	4	41157	122.64	3469200	21.93	1.30E-14	64.12	0.042	3.79
45	18818	1.5E+07	1.74E-14	1.143	4	45770	230.85	3639800	24.80	1.31E-14	75.10	0.050	4.35
46	28679	1.6E+07	1.84E-14	1.139	4	44057	162.56	3671800	24.68	1.31E-14	71.31	0.047	4.15
47	21317	1.7E+07	1.71E-14	1.143	4	42853	201.50	4041500	24.48	1.16E-14	68.73	0.046	3.98
48	34515	1.7E+07	1.86E-14	1.138	4	45286	131.98	4516200	26.94	1.36E-14	72.86	0.046	4.25

Reference Mortar
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PM	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
61	18028	1.0E+07	1.30E-14	1.154	4	41952	211.56	4169400	23.18	8.70E-15	63.91	0.042	3.67
62	20528	2E+07	2.14E-14	1.126	4	48182	234.76	5967700	30.37	1.56E-14	72.51	0.045	4.27
63	30158	2E+07	1.72E-14	1.141	4	47653	158.14	5363700	28.92	1.26E-14	73.18	0.049	4.25
64	62621	1.7E+07	1.14E-14	1.170	4	43025	81.92	4347600	25.42	8.12E-15	71.31	0.047	4.04
65	27631	2E+07	1.82E-14	1.144	4	45082	163.16	5516100	27.79	1.10E-14	68.24	0.045	3.95
66	31869	1.0E+07	1.28E-14	1.160	4	44668	140.07	4804200	25.72	8.87E-15	68.88	0.046	3.94
67	18624	2E+07	1.30E-14	1.154	4	45720	288.93	5286600	28.68	9.19E-15	67.71	0.045	3.86
68	45707	1.0E+07	1.07E-14	1.171	4	44137	98.57	5128200	28.82	7.40E-15	69.29	0.046	3.82
69	52713	2.1E+07	1.08E-14	1.167	4	47840	90.76	5786200	28.15	7.79E-15	71.72	0.048	4.08
70	47748	2E+07	1.01E-14	1.172	4	43908	91.76	5304900	28.02	8.73E-15	68.47	0.044	3.78
71	38811	2.1E+07	9.81E-15	1.176	4	47348	122.00	6180300	28.19	7.08E-15	73.41	0.049	4.14
72	59989	2.1E+07	1.04E-14	1.172	4	45189	80.74	5848300	28.10	7.19E-15	68.26	0.048	3.92
73	15404	2.2E+07	1.57E-14	1.143	4	44124	288.45	5872400	27.38	1.00E-14	63.98	0.042	3.71
74	60249	2.1E+07	1.32E-14	1.168	4	47794	65.11	6107500	28.65	9.55E-15	72.18	0.049	4.14
75	23312	2E+07	1.40E-14	1.180	4	43820	187.87	6301800	25.87	8.97E-15	64.02	0.042	3.69
76	28133	2.3E+07	1.57E-14	1.180	4	43840	168.99	6356000	27.16	8.41E-15	61.59	0.041	3.55
77	47601	2.1E+07	1.07E-14	1.168	4	48098	98.84	5744700	27.73	7.36E-15	68.13	0.046	3.92
78	51313	2E+07	8.18E-15	1.168	4	44948	87.80	5506800	27.42	5.88E-15	71.79	0.048	4.01
79	44283	2.3E+07	1.37E-14	1.153	4	49528	111.82	7848100	34.16	1.02E-14	74.43	0.049	4.29
80	38619	1.0E+07	1.00E-14	1.175	4	47182	121.57	5412300	28.28	7.43E-15	74.02	0.049	4.18
81	58355	1.0E+07	7.35E-15	1.198	4	50197	84.57	6224000	31.98	6.20E-15	84.33	0.056	4.67
82	48281	1.0E+07	1.02E-14	1.173	4	43008	87.30	4816800	24.90	6.71E-15	65.97	0.044	3.73
83	57143	2E+07	1.09E-14	1.168	4	48728	85.27	5880000	28.85	8.15E-15	74.88	0.050	4.25
84	48511	1.0E+07	8.88E-15	1.182	4	41673	85.90	4488000	23.85	5.88E-15	65.84	0.044	3.69
85	37775	2.3E+07	1.68E-14	1.139	4	43052	113.97	6252400	27.45	1.03E-14	82.17	0.041	3.62
86	40065	2.2E+07	1.44E-14	1.149	4	43560	108.84	6036600	27.80	9.28E-15	64.52	0.043	3.73
87	30273	2.1E+07	1.28E-14	1.168	4	43760	90.62	5370500	26.44	8.24E-15	65.30	0.043	3.73
88	48938	2.1E+07	1.44E-14	1.151	4	44242	144.42	5576500	27.14	8.83E-15	67.28	0.045	3.85
89	48074	1.7E+07	8.82E-15	1.178	4	41368	98.31	5908500	28.28	9.85E-15	68.38	0.045	3.94
90	41058	2.2E+07	1.67E-14	1.139	4	43825	88.85	4088900	23.86	8.72E-15	67.75	0.045	3.81
91	48102	1.0E+07	1.25E-14	1.183	4	43855	108.25	5743500	28.80	1.07E-14	64.05	0.042	3.73
92							91.38	4840500	25.99	9.83E-15	71.30	0.047	4.07
93													
94	48915	1.0E+07	1.31E-14	1.180	4	42840	91.53	3808400	22.94	9.04E-15	69.14	0.048	3.94
95													
96	27633	1.0E+07	1.82E-14	1.139	4	43151	154.48	3946800	24.33	1.27E-14	69.86	0.046	4.07
97	8004	1.5E+07	1.85E-14	1.136	4	41844	522.79	3346800	22.20	1.31E-14	67.31	0.045	3.93
98	27659	1.4E+07	1.53E-14	1.162	4	40151	144.12	2825600	20.89	1.05E-14	68.82	0.045	3.94
99	1754	1.5E+07	2.25E-14	1.128	4	41977	239.22	3186200	21.21	1.48E-14	68.43	0.044	3.91
100	36417	1.2E+07	1.54E-14	1.182	4	39438	102.85	2291700	18.77	1.05E-14	67.53	0.045	3.89
101	18102	1.2E+07	2.80E-14	1.113	4	41743	230.80	2518800	20.19	1.90E-14	67.80	0.045	4.03
102	20280	1.1E+07	2.08E-14	1.135	4	40772	200.85	2086300	19.99	1.51E-14	72.16	0.046	4.20
103	20778	1.1E+07	2.59E-14	1.120	4	38807	185.82	1888500	17.89	1.71E-14	65.82	0.044	3.89
104	4878	8816400	2.71E-14	1.118	4	39182	602.83	1678000	17.07	1.86E-14	68.08	0.045	4.02
105	32507	8818200	2.05E-14	1.139	4	38825	119.44	1483100	18.93	1.51E-14	73.61	0.049	4.27
106	38655	8394400	3.27E-14	1.107	4	38556	100.13	1367000	16.34	2.33E-14	71.11	0.047	4.24
107	22352	7838000	2.68E-14	1.123	4	38744	189.91	1028300	13.84	1.70E-14	65.83	0.043	3.86
108	16417	7038000	3.13E-14	1.110	4	38836	242.85	1037800	14.85	2.26E-14	72.93	0.048	4.32
109							235.01	867070	13.95	2.48E-14	74.00	0.049	4.39
110	16577	6141700	3.37E-14	1.107	4	38957							

Reference Mortar
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
101	29102	6431800	2.79E-14	1.122	4	36601	125.42	700460	12.90	2.07E-14	74.16	0.049	4.34
102	30698	4649600	2.69E-14	1.126	4	34697	94.24	594460	12.28	2.00E-14	74.34	0.049	4.32
103	8360	4471800	3.45E-14	1.109	4	35439	423.91	517410	11.57	2.53E-14	73.33	0.048	4.33
104	29692	3640900	1.93E-14	1.148	4	32005	108.71	390260	10.16	1.39E-14	71.92	0.047	4.08
105													
106	39260	3129600	2.64E-14	1.130	4	31318	79.77	308530	9.97	1.98E-14	74.12	0.048	4.27
107	24205	2979200	3.21E-14	1.117	4	31200	128.90	299510	9.34	2.37E-14	73.72	0.048	4.29
108	24438	2469000	2.13E-14	1.145	4	27748	113.64	203960	6.18	1.48E-14	69.69	0.045	3.94
109	28236	2333900	3.40E-14	1.113	4	26526	93.94	172950	7.40	2.19E-14	64.59	0.042	3.78
110	13303	2111800	4.69E-14	1.094	4	26931	202.44	167920	7.47	3.16E-14	67.33	0.044	3.99
111	18398	1917600	6.07E-14	1.079	4	26977	167.76	151510	7.90	4.48E-14	73.43	0.048	4.42
112	25216	1634400	2.90E-14	1.130	4	23475	93.10	111910	6.85	1.99E-14	66.39	0.044	3.91
113	16716	1912900	4.71E-14	1.098	4	23580	140.94	99532	6.59	3.16E-14	67.16	0.043	3.86
114	13300	1397300	5.10E-14	1.094	4	26825	201.89	100630	7.39	4.00E-14	76.29	0.051	4.62
115	1739	1292900	4.35E-14	1.102	4	23029	128749.14	72975	5.78	2.79E-14	63.61	0.041	3.73
116	9607	1137000	5.22E-14	1.093	4	22498	238.85	69816	6.12	3.60E-14	69.01	0.046	4.08
117	23198	1002000	2.91E-14	1.135	4	17982	76.64	51797	5.17	1.79E-14	60.42	0.039	3.43
118	22237	914400	2.65E-14	1.131	4	20779	93.44	51581	5.64	2.07E-14	70.13	0.045	4.01
119	13781	943100	5.69E-14	1.095	4	21364	155.25	54171	6.43	4.42E-14	78.04	0.050	4.61
120													
121	11610	772280	6.94E-14	1.057	4	20907	180.06	40653	5.29	5.97E-14	68.79	0.044	4.13
122	20723	671410	4.69E-14	1.108	4	15894	79.70	32596	4.85	2.89E-14	61.82	0.040	3.62
123	19093	637440	5.60E-14	1.094	4	15327	80.32	28374	4.61	3.44E-14	59.30	0.039	3.53
124	6820	627690	8.14E-14	1.093	4	22179	325.21	40739	6.49	7.62E-14	82.30	0.054	5.08
125	14223	659270	6.30E-14	1.093	4	16578	116.56	30213	5.40	4.39E-14	69.56	0.045	4.15
126	25677	597240	1.33E-13	1.094	4	20803	80.39	32713	5.77	9.89E-14	72.85	0.048	4.66
127	6975	514940	1.43E-13	1.098	4	19679	268.24	31079	6.04	1.09E-13	76.17	0.050	4.66
128	8493	497920	8.97E-14	1.099	4	14711	174.03	22918	4.83	5.54E-14	61.72	0.041	3.81
129	4339	499090	1.20E-13	1.046	4	16234	373.91	23051	5.02	7.41E-14	61.95	0.041	3.85
130	499240	509590	1.89E-11	0.452	4	6953700	1402.93	6994500	1349.71	4.43E-10	2342.72	0.128	28.25

Mortar with Medium Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
1	2367	99173	4.01E-10	0.704	4	321.55	13.58	1267.8	1.27	4.81E-11	12.00	0.008	1.14
2	2660	108250	4.01E-10	0.703	4	317.45	12.40	1309	1.24	4.82E-11	11.51	0.008	1.10
3	2940	107140	3.98E-10	0.703	4	325.7	11.08	1382.6	1.28	4.81E-11	11.65	0.008	1.11
4	2747	108660	3.92E-10	0.704	4	315.61	11.46	1539.7	1.22	4.39E-11	11.20	0.008	1.07
5	2739	111030	3.82E-10	0.710	4	307.34	11.22	1319	1.19	3.89E-11	10.98	0.007	1.03
6	2867	112800	3.67E-10	0.709	4	346.93	11.73	1608.2	1.34	4.38E-11	12.27	0.008	1.16
7	3128	114610	3.69E-10	0.707	4	351.37	11.23	1639.4	1.34	4.38E-11	12.23	0.008	1.16
8	2818	116080	3.43E-10	0.710	4	319.57	11.34	1415.6	1.22	3.81E-11	11.11	0.007	1.05
9	2740	116800	3.20E-10	0.715	4	312.69	11.41	1393.1	1.19	3.90E-11	10.94	0.007	1.02
10	3038	118200	3.20E-10	0.714	4	317.07	10.44	1428.5	1.21	3.82E-11	11.00	0.007	1.03
11	3167	120170	3.41E-10	0.709	4	376.61	11.94	1709	1.42	4.37E-11	12.61	0.009	1.21
12	2735	120170	3.09E-10	0.716	4	312.24	11.42	1428.3	1.19	3.34E-11	10.80	0.007	1.01
13	3048	125940	3.05E-10	0.717	4	345.12	11.32	1658.6	1.32	3.89E-11	11.78	0.008	1.10
14	3360	136680	3.18E-10	0.712	4	388.58	11.50	1897	1.47	4.05E-11	12.69	0.008	1.19
15	3462	147070	3.18E-10	0.711	4	397.98	11.11	2181	1.48	3.94E-11	12.34	0.008	1.16
16	2888	159180	2.68E-10	0.722	4	344.03	11.51	2122.2	1.33	2.92E-11	10.88	0.007	1.01
17	3538	174370	2.65E-10	0.722	4	377.61	10.67	2568.8	1.48	3.07E-11	11.60	0.008	1.07
18	3815	182760	2.74E-10	0.718	4	424.68	11.13	3247.2	1.68	3.42E-11	12.47	0.008	1.16
19	3208	206950	2.30E-10	0.728	4	372.33	11.61	3158.4	1.51	2.82E-11	10.94	0.007	1.00
20	4023	232030	2.51E-10	0.721	4	421.7	10.48	3973.6	1.71	2.93E-11	11.68	0.008	1.08
21	3869	259160	2.33E-10	0.725	4	435.02	11.19	4648.9	1.81	2.74E-11	11.78	0.008	1.08
22	4303	282870	2.18E-10	0.742	4	438.34	10.43	5241.3	1.85	2.52E-11	11.48	0.008	1.05
23	3121	353130	1.78E-10	0.748	4	748.9	24.00	12824	3.53	3.40E-11	19.13	0.013	1.73
24	4823	423900	1.54E-10	0.743	4	500.54	10.17	9112.6	2.15	1.74E-11	11.28	0.008	1.02
25	4528	473170	1.26E-10	0.754	4	449.37	10.38	9423.4	1.99	1.28E-11	10.00	0.007	0.89
26	4787	532580	1.21E-10	0.757	4	478.94	9.98	11880	2.17	1.24E-11	10.28	0.007	0.91
27	5408	601280	1.20E-10	0.755	4	530.1	9.81	14859	2.47	1.30E-11	10.68	0.007	0.96
28	4853	670310	1.03E-10	0.765	4	472.05	10.15	15223	2.27	8.78E-12	9.82	0.008	0.84
29	4873	763040	8.44E-11	0.769	4	492.78	10.64	18427	2.45	9.11E-12	9.85	0.008	0.84
30	5409	862980	8.90E-11	0.772	4	578.38	10.69	25430	2.88	8.73E-12	10.94	0.007	0.85
31	5746	988980	8.30E-11	0.774	4	578.61	10.07	28782	3.08	8.82E-12	10.52	0.007	0.82
32	4803	1088000	7.35E-11	0.781	4	547.28	11.18	32764	3.02	7.13E-12	9.71	0.007	0.84
33	5383	1237800	7.13E-11	0.781	4	580.88	9.93	41087	3.32	7.03E-12	9.89	0.007	0.85
34	6214	1405700	6.69E-11	0.784	4	617.3	10.79	51875	3.69	6.78E-12	10.15	0.007	0.86
35	6142	1600400	6.11E-11	0.789	4	683.74	10.81	68453	4.15	6.46E-12	10.59	0.007	0.91
36	6254	1818700	5.70E-11	0.791	4	700.05	11.19	83238	4.58	6.20E-12	10.77	0.007	0.92
37	5352	2023100	4.69E-11	0.803	4	583.14	10.90	79227	3.92	4.18E-12	8.87	0.008	0.75
38	5988	2337200	4.33E-11	0.808	4	645.61	11.55	105670	4.82	4.08E-12	9.38	0.008	0.79
39	6915	2718900	4.21E-11	0.805	4	787.87	11.10	150370	5.53	4.40E-12	10.44	0.007	0.88
40	7388	3131200	3.51E-11	0.815	4	845.48	11.48	197890	6.32	3.94E-12	11.22	0.008	0.94
41	7884	3686100	3.20E-11	0.818	4	917.47	11.67	281720	7.16	3.71E-12	11.58	0.008	0.97
42	6885	4341400	2.69E-11	0.820	4	983.86	11.33	348830	8.04	3.46E-12	11.72	0.008	0.98
43	7447	4894500	2.49E-11	0.828	4	988.21	13.01	408420	8.19	2.78E-12	11.18	0.008	0.92
44	10171	6086700	2.60E-11	0.822	4	1110.4	10.82	614210	10.07	3.08E-12	11.83	0.008	0.99
45	9727	6832300	2.02E-11	0.838	4	1284.8	13.21	788780	11.88	2.71E-12	13.39	0.009	1.10
46	11114	6786100	1.91E-11	0.835	4	1282.5	11.54	1121400	12.75	2.34E-12	12.29	0.009	1.01
47	12370	1.2E+07	1.70E-11	0.837	4	1420.1	11.48	1979700	16.81	2.24E-12	12.74	0.009	1.05
48	11863	1.4E+07	1.30E-11	0.855	4	1801.7	13.48	2880000	20.21	1.84E-12	14.15	0.010	1.14
49	14785	2.1E+07	1.28E-11	0.854	4	1763.6	11.92	6381500	28.83	1.85E-12	14.89	0.010	1.19
50	14089	2.1E+07	9.89E-12	0.869	4	1873	13.31	6347500	29.42	1.54E-12	15.58	0.011	1.24

Mortar with Medium Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PHI	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
51	12438	3.4E+07	8.84E-12	0.874	4	1738.8	13.98	13780000	40.48	1.24E-12	14.05	0.010	1.11
52	12595	3.2E+07	7.50E-12	0.894	4	1836.3	14.58	12808000	38.98	1.11E-12	14.75	0.010	1.15
53	13455	4.1E+07	6.77E-12	0.889	4	1848.6	13.72	16588000	45.88	9.86E-13	14.88	0.010	1.13
54	13581	4.1E+07	5.99E-12	0.897	4	1832.4	14.23	19135000	48.72	9.07E-13	15.15	0.010	1.17
55	13508	7E+07	5.40E-12	0.902	4	1883.4	14.54	54785000	78.25	8.35E-13	15.29	0.011	1.17
56	12289	1.4E+08	4.97E-12	0.907	4	1980.2	16.14	204810000	147.47	7.47E-13	15.02	0.010	1.15
57	13894	1.2E+08	4.89E-12	0.905	4	2099.6	14.80	181140000	131.31	7.63E-13	15.32	0.011	1.17
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79	13168	1.1E+08	5.11E-12	0.905	4	1762.8	13.40	40478000	37.22	5.32E-13	10.41	0.007	0.82
80	13454	1.4E+08	5.47E-12	0.902	4	1826.1	14.34	71185000	52.72	6.32E-13	11.55	0.008	0.82
81	14805	8.5E+07	6.11E-12	0.885	4	1850.3	12.67	16838000	25.92	8.87E-13	11.24	0.008	0.80
82	13868	6.6E+07	7.51E-12	0.882	4	1577.7	11.52	15742000	23.83	7.16E-13	9.54	0.007	0.77
83	12847	4.3E+07	8.08E-12	0.879	4	1588.3	12.38	7310100	18.85	7.89E-13	9.80	0.007	0.80
84	13304	3E+07	8.94E-12	0.873	4	1482.5	10.99	3587300	11.92	6.34E-13	9.33	0.007	0.76
85	14732	3E+07	1.12E-11	0.880	4	1652.7	11.22	4241200	14.17	1.19E-12	10.84	0.008	0.86
86	16015	2.2E+07	1.23E-11	0.854	4	1570.8	9.81	2487100	11.04	1.26E-12	10.24	0.007	0.85
87	14330	1.7E+07	1.33E-11	0.852	4	1588.9	10.65	1878800	9.61	1.44E-12	10.80	0.008	0.80
88	18482	1.6E+07	1.69E-11	0.838	4	1503.8	9.13	1447100	8.94	1.71E-12	10.17	0.007	0.88
89	16028	1.2E+07	1.81E-11	0.832	4	1433.2	8.94	870870	7.20	1.83E-12	10.09	0.007	0.88
90	15885	1E+07	2.28E-11	0.820	4	1323.6	8.50	687540	6.38	2.13E-12	9.48	0.007	0.81
91	13988	8834100	2.38E-11	0.819	4	1232.1	9.07	487480	5.41	2.19E-12	9.31	0.007	0.80
92	14831	7288600	2.91E-11	0.805	4	1200.4	8.08	360380	4.94	2.67E-12	9.15	0.008	0.80
93	14970	5764100	2.98E-11	0.808	4	1322.4	8.83	288080	5.01	3.23E-12	10.81	0.008	0.94
94	15827	4883100	3.68E-11	0.798	4	1228.8	7.91	222270	4.45	3.65E-12	10.26	0.007	0.90
95	15573	4212800	4.21E-11	0.788	4	1158.2	7.44	187140	3.97	4.18E-12	9.93	0.007	0.88
96	12888	3487800	4.32E-11	0.787	4	980.17	7.58	110580	3.19	3.87E-12	8.88	0.008	0.79
97	15727	2913800	5.27E-11	0.775	4	981.05	7.00	88482	2.97	4.74E-12	8.89	0.008	0.80
98	12173	2472000	6.53E-11	0.775	4	924.8	7.80	68732	2.78	5.11E-12	9.23	0.008	0.82
99	13108	2083200	8.32E-11	0.768	4	1027.8	7.84	62835	3.00	6.79E-12	10.74	0.007	0.88
100													

Mortar with Metigan Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PM	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
101	11666	1762400	7.00E-11	0.763	4	643.19	7.23	42476	2.36	8.44E-12	9.20	0.006	0.83
102	12170	1527000	6.16E-11	0.764	4	662.19	7.25	36694	2.42	8.16E-12	10.00	0.007	0.91
103	12624	1309400	9.29E-11	0.748	4	620.74	7.29	32379	2.47	1.01E-11	10.67	0.007	0.96
104	11603	1121600	1.04E-10	0.742	4	762.48	6.71	23372	2.08	1.02E-11	9.62	0.007	0.90
105	11218	960620	1.11E-10	0.740	4	748.32	6.67	18680	1.83	1.08E-11	9.80	0.007	0.90
106	9680	626900	1.21E-10	0.737	4	612.78	6.16	12608	1.56	1.02E-11	8.43	0.006	0.78
107	8665	714160	1.34E-10	0.732	4	651.36	6.62	11662	1.63	1.26E-11	9.36	0.006	0.67
108	6937	614330	1.41E-10	0.731	4	660.71	6.27	8646.4	1.39	1.21E-11	8.67	0.006	0.79
109	6541	536060	1.75E-10	0.718	4	640.27	6.71	8293.8	1.55	1.75E-11	9.65	0.007	0.94
110	9075	460720	1.86E-10	0.716	4	543	5.98	5969.9	1.30	1.66E-11	8.91	0.006	0.84
111	7655	390700	1.79E-10	0.722	4	472.36	6.17	4466.3	1.14	1.62E-11	8.49	0.006	0.79
112	6038	337260	2.16E-10	0.711	4	553.6	6.69	4440.1	1.32	2.22E-11	10.25	0.007	0.97
113	7242	296360	2.32E-10	0.710	4	477.05	6.69	3267.6	1.14	2.18E-11	9.43	0.006	0.69
114	6479	256700	2.16E-10	0.717	4	346.97	5.36	2000.8	0.84	1.65E-11	7.64	0.005	0.71
115	6673	198190	2.61E-10	0.709	4	406.16	5.91	1613	0.97	2.32E-11	9.26	0.006	0.69
116	6665	156630	2.70E-10	0.706	4	421.94	6.30	1564.2	0.99	2.76E-11	10.24	0.007	0.96
117	6709	116600	3.02E-10	0.702	4	419.84	7.35	1177	0.69	3.36E-11	11.06	0.007	1.06
118	6557	89948	3.62E-10	0.690	4	518.66	7.91	1065.6	1.23	5.17E-11	14.26	0.010	1.41
119	6223	69762	6.87E-10	0.653	4	459.03	7.36	608.67	1.16	8.67E-11	12.61	0.009	1.34
120	4861	61180	6.16E-10	0.664	4	341.52	7.03	566.39	0.93	6.36E-11	10.33	0.007	1.06
121	6235	56762	6.80E-10	0.657	4	376.31	7.23	565.23	1.05	7.71E-11	11.33	0.008	1.21
122	4336	51913	6.74E-10	0.661	4	362.37	8.61	563.6	1.12	8.16E-11	12.10	0.009	1.29
123	4600	46362	6.29E-10	0.646	4	430.66	6.79	626.07	1.27	1.07E-10	12.92	0.009	1.42
124	4662	46436	7.66E-10	0.646	4	425.03	8.53	599.76	1.29	1.04E-10	13.01	0.009	1.43
125	4197	43023	7.66E-10	0.654	4	376.67	9.04	524.66	1.22	9.36E-11	12.25	0.009	1.33
126	4216	40679	7.66E-10	0.655	4	402.67	8.55	543.1	1.34	1.01E-10	13.16	0.009	1.44
127	4609	36636	6.16E-10	0.646	4	412.06	9.14	539.79	1.39	1.07E-10	13.11	0.009	1.46
128	4479	37112	6.26E-10	0.641	4	472.27	10.54	603.63	1.63	1.36E-10	14.66	0.011	1.67
129	4674	36665	6.31E-10	0.640	4	454.9	9.73	571.81	1.60	1.31E-10	14.06	0.010	1.61

Mortar with Portage Fly Ash
9 Months of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PN	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
1	5777	65068	7.16E-10	0.646	4	2328.4	40.32	2849.2	4.32	1.84E-10	22.89	0.020	3.11
2	8432	70339	7.87E-10	0.633	4	2553.8	30.29	3105.6	4.42	1.78E-10	22.67	0.020	3.16
3	8530	69455	8.50E-10	0.626	4	2637.6	30.92	3200.7	4.61	1.97E-10	23.21	0.021	3.26
4	8277	68642	8.74E-10	0.627	4	2692.1	32.63	3268.4	4.76	2.05E-10	23.91	0.021	3.39
5	7666	66166	8.18E-10	0.633	4	2513.5	32.79	3064.4	4.48	1.87E-10	22.64	0.020	3.20
6	7646	66571	7.18E-10	0.641	4	2474.4	32.80	3001.3	4.36	1.82E-10	22.65	0.020	3.11
7	7693	66169	7.13E-10	0.641	4	2546.6	33.10	3067.9	4.46	1.84E-10	22.97	0.020	3.17
8	7841	66628	6.62E-10	0.642	4	2662.1	33.78	3240.5	4.66	1.66E-10	23.79	0.021	3.26
9	7854	66669	6.66E-10	0.642	4	2666.9	33.63	3213.5	4.61	1.63E-10	23.66	0.021	3.26
10	7860	66665	6.77E-10	0.643	4	2662.2	33.66	3209.1	4.58	1.60E-10	23.66	0.021	3.24
11	8254	70378	6.66E-10	0.641	4	2760.2	33.32	3318.4	4.72	1.84E-10	24.01	0.021	3.32
12	8144	70265	6.90E-10	0.641	4	2734	33.67	3301.8	4.70	1.65E-10	23.98	0.021	3.31
13	6916	70862	6.43E-10	0.649	4	2424.5	35.06	2971.4	4.20	1.46E-10	22.60	0.020	3.03
14	6968	73690	6.60E-10	0.659	4	2180.5	36.52	2743.9	3.73	1.16E-10	21.26	0.016	2.77
15	5182	77684	4.78E-10	0.671	4	2036.1	36.86	2623.4	3.36	9.82E-11	20.66	0.017	2.66
16	5201	63911	4.36E-10	0.676	4	1846.7	36.51	2445.5	2.91	8.12E-11	16.61	0.015	2.59
17	5117	60254	3.86E-10	0.684	4	1660.2	33.03	2307.6	2.66	6.66E-11	17.10	0.014	2.06
18	4739	67187	3.42E-10	0.682	4	1654.6	32.81	2203.6	2.27	5.43E-11	15.67	0.013	1.66
19	5126	106620	3.15E-10	0.686	4	1433.3	27.66	2106.2	1.99	4.63E-11	14.41	0.012	1.66
20	4637	114330	2.78E-10	0.704	4	1476.5	31.64	2277.6	1.99	4.17E-11	14.94	0.012	1.66
21	4461	123780	2.50E-10	0.710	4	1369.5	30.77	2216.8	1.79	3.46E-11	13.61	0.011	1.53
22	4662	136500	2.36E-10	0.712	4	1347.7	27.55	2303.6	1.70	3.19E-11	13.33	0.010	1.46
23	5132	146510	2.21E-10	0.718	4	1272.5	24.80	2309.7	1.66	2.74E-11	12.36	0.010	1.34
24	5375	162260	2.05E-10	0.719	4	1337.4	24.66	2369.7	1.69	2.63E-11	12.78	0.010	1.36
25	6745	180660	2.19E-10	0.712	4	841.23	12.47	1751.6	0.97	1.68E-11	7.70	0.006	0.63
26	6015	165740	1.78E-10	0.726	4	1346.1	22.36	3202.9	1.64	2.22E-11	12.36	0.009	1.29
27	6137	215040	1.70E-10	0.726	4	1366.1	22.62	3398.9	1.69	2.13E-11	12.64	0.009	1.30
28	5620	239460	1.46E-10	0.735	4	1631.2	27.55	4366.6	1.62	2.12E-11	14.30	0.011	1.46
29	7613	276860	1.42E-10	0.734	4	1639.8	20.69	4990.9	1.77	1.82E-11	13.63	0.010	1.37
30	6003	310970	1.26E-10	0.740	4	1742.4	21.77	6672.7	1.69	1.77E-11	14.00	0.010	1.40
31	6946	354660	1.17E-10	0.743	4	1631.4	20.47	7054.6	1.69	1.66E-11	14.15	0.010	1.40
32	6516	366660	1.07E-10	0.747	4	2004.1	21.36	8667.6	2.23	1.63E-11	16.22	0.011	1.45
33	10543	463400	9.60E-11	0.762	4	2069.6	19.63	10365	2.29	1.43E-11	14.66	0.011	1.45
34	10842	514640	8.60E-11	0.766	4	2074.1	18.86	12105	2.35	1.27E-11	14.45	0.011	1.39
35	11465	560760	7.36E-11	0.766	4	2206.7	18.26	15113	2.56	1.06E-11	14.61	0.011	1.40
36	12264	663360	6.60E-11	0.766	4	2266.9	18.36	17631	2.69	1.01E-11	14.66	0.011	1.36
37	12607	765360	5.64E-11	0.776	4	2544.5	20.16	24666	3.17	9.26E-12	15.62	0.011	1.47
38	13350	860400	5.21E-11	0.782	4	2569.5	19.43	26910	3.26	8.07E-12	15.60	0.011	1.43
39	14466	1036600	4.22E-11	0.782	4	2660	16.60	36244	3.46	6.41E-12	15.20	0.011	1.36
40	16066	1151600	3.67E-11	0.794	4	2605.9	17.47	42200	3.66	6.03E-12	15.19	0.011	1.37
41	16666	1347100	3.16E-11	0.806	4	3262	20.57	59649	4.42	5.32E-12	16.66	0.012	1.50
42	17754	1626400	2.65E-11	0.814	4	3665.3	20.76	83260	5.12	4.70E-12	17.72	0.012	1.56
43	20512	1946600	2.21E-11	0.821	4	3617.4	18.61	103720	5.33	3.74E-12	16.66	0.012	1.47
44	23720	2266400	1.91E-11	0.826	4	4762.6	20.06	146030	6.58	3.74E-12	19.60	0.014	1.69
45	27341	2616600	1.60E-11	0.833	4	5160	16.66	166610	7.07	3.16E-12	19.61	0.014	1.69
46	30422	3116600	1.27E-11	0.843	4	5940.1	19.63	253160	8.13	2.66E-12	21.05	0.015	1.77
47	34005	3772100	1.06E-11	0.851	4	6704.5	16.72	356660	9.52	2.36E-12	22.14	0.016	1.65
48	36776	4417500	8.43E-12	0.863	4	6766.6	16.46	436660	9.63	1.78E-12	21.19	0.015	1.74
49	36441	5016600	6.74E-12	0.878	4	7266.2	16.91	544760	10.65	1.46E-12	21.63	0.015	1.75
50	37467	5616400	4.96E-12	0.894	4	7066.6	16.94	606640	10.60	1.01E-12	20.30	0.014	1.61

Meritar with Portage Fly Ash
9 Months of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₂ (Q) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
51	39711	6357700	4.24E-12	0.902	4	6807.5	22.16	682480	1.03E-12	0.017	1.91
52	39222	6780900	3.30E-12	0.916	4	7802.2	19.86	632430	7.00E-13	0.015	1.61
53	42636	6110300	3.12E-12	0.920	4	6465.3	19.79	1212100	6.87E-13	0.016	1.70
54	41175	5385500	2.30E-12	0.937	4	6960.9	21.52	1250100	5.26E-13	0.016	1.66
55	40641	6726400	1.90E-12	0.948	4	6505.1	20.93	1233000	4.09E-13	0.015	1.56
56	41263	6704500	1.69E-12	0.957	4	6582.6	23.16	1612000	3.84E-13	0.016	1.69
57	41182	1E+07	1.43E-12	0.967	4	6034.6	22.00	1611100	3.02E-13	0.016	1.54
58	43756	1.1E+07	1.30E-12	0.971	4	6828.2	17.82	1947700	2.82E-13	0.016	1.63
59	39480	1.1E+07	1.02E-12	0.987	4	6402.4	23.81	1666500	2.13E-13	0.015	1.50
60	42109	1.2E+07	6.16E-13	0.993	4	10256	24.36	2206600	2.06E-13	0.016	1.60
61	40540	1.3E+07	6.16E-13	1.000	4	9984.4	24.63	2560600	1.75E-13	0.015	1.52
62	42724	1.4E+07	7.69E-13	1.003	4	10363	24.93	2639400	1.70E-13	0.016	1.56
63	43967	1.4E+07	7.69E-13	1.004	4	11617	26.18	3284400	1.85E-13	0.017	1.71
64	41086	1.5E+07	6.89E-13	1.009	4	11183	27.22	3218600	1.64E-13	0.017	1.64
65	37702	1.5E+07	6.29E-13	1.016	4	9240.7	24.51	2666300	1.21E-13	0.014	1.34
66	39935	1.4E+07	6.17E-13	1.017	4	9804.1	24.80	2637900	1.27E-13	0.015	1.43
67	39363	1.5E+07	6.22E-13	1.017	4	9800.6	24.62	2666600	1.26E-13	0.014	1.39
68	43443	1.3E+07	6.44E-13	1.014	4	10630	24.47	2500600	1.42E-13	0.016	1.53
69	40754	1.4E+07	6.20E-13	1.015	4	10475	26.70	2626600	1.34E-13	0.015	1.51
70	41868	1.4E+07	6.42E-13	1.015	4	10075	24.06	2664600	1.34E-13	0.015	1.46
71	40143	1.5E+07	5.93E-13	1.020	4	10865	27.14	3097500	1.33E-13	0.016	1.56
72	42136	1.6E+07	6.30E-13	1.015	4	10144	24.07	3363000	1.33E-13	0.015	1.46
73	41036	1.4E+07	6.16E-13	1.017	4	10112	24.64	2603700	1.26E-13	0.015	1.46
74	41680	1.4E+07	6.74E-13	1.012	4	10808	25.62	2747400	1.52E-13	0.016	1.56
75	41751	1.3E+07	7.12E-13	1.009	4	10081	24.16	2300400	1.52E-13	0.015	1.49
76	42666	1.4E+07	6.69E-13	0.998	4	9833.6	23.17	2721100	1.86E-13	0.015	1.52
77	41501	1.2E+07	9.70E-13	0.990	4	9798.6	19.70	2275400	2.11E-13	0.015	1.55
78	44177	1.1E+07	1.29E-12	0.973	4	10350	23.53	2026500	3.00E-13	0.017	1.71
79	44887	1.1E+07	1.63E-12	0.958	4	11201	24.86	2406600	4.30E-13	0.019	1.94
80	44625	6694600	1.69E-12	0.947	4	9418.7	21.11	1566600	4.45E-13	0.016	1.70
81	42540	6003400	2.20E-12	0.939	4	6724.7	20.51	1362100	4.84E-13	0.015	1.84
82	43275	7846000	2.62E-12	0.928	4	9291.4	21.47	1240800	6.72E-13	0.017	1.82
83	42611	6991400	3.30E-12	0.917	4	6136.9	19.10	686040	7.08E-13	0.015	1.86
84	40666	6147700	3.94E-12	0.907	4	6164.5	20.19	760640	8.65E-13	0.016	1.75
85	41308	6534100	5.09E-12	0.902	4	7833.3	18.66	635670	1.12E-12	0.016	1.76
86	42219	5046600	6.42E-12	0.877	4	8326.6	19.73	604360	1.66E-12	0.017	1.96
87	42560	4596600	8.14E-12	0.863	4	6943	16.31	445640	1.70E-12	0.015	1.72
88	39315	3911800	9.51E-12	0.855	4	6641.5	17.40	353630	2.04E-12	0.015	1.76
89	40633	3910000	1.23E-11	0.840	4	7137.3	17.46	340440	2.85E-12	0.016	1.96
90	40316	3225900	1.54E-11	0.828	4	6976.5	17.06	262660	3.62E-12	0.016	1.97
91	37419	2764100	1.69E-11	0.823	4	5730.7	15.31	191080	3.26E-12	0.014	1.71
92	37521	2432700	2.10E-11	0.808	4	6168.5	16.41	172140	4.77E-12	0.016	1.95
93	35904	2103200	2.73E-11	0.795	4	5596.7	15.64	139870	5.73E-12	0.015	1.89
94	34264	1824600	3.20E-11	0.785	4	5462.9	15.94	109970	6.97E-12	0.015	1.94
95	32668	1666600	3.63E-11	0.775	4	5055.5	15.47	63002	8.02E-12	0.015	1.89
96	30825	1373300	4.72E-11	0.765	4	4797.5	15.51	65214	9.57E-12	0.015	1.90
97	30610	1162800	6.96E-11	0.752	4	4079.6	13.33	46121	1.07E-11	0.013	1.72
98	28828	1029700	8.97E-11	0.744	4	4167.5	14.42	39720	1.35E-11	0.014	1.85
99	26912	862110	8.09E-11	0.737	4	3676.6	14.40	30630	1.46E-11	0.013	1.62
100	25937	762210	9.57E-11	0.728	4	3670.4	13.82	29725	1.70E-11	0.013	1.77

Mortar with Portage Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PM	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
101	24481	603400	1.12E-10	0.720	4	3228.7	13.18	18317	2.78	1.86E-11	18.88	0.012	1.88
102	22218	674820	1.20E-10	0.718	4	2779.7	12.61	13450	2.34	1.80E-11	15.00	0.011	1.53
103	21669	502000	1.44E-10	0.703	4	2719.8	12.39	11354	2.28	2.18E-11	15.16	0.011	1.56
104	20004	430020	1.62E-10	0.708	4	2644.6	12.72	9084.7	2.11	2.41E-11	14.86	0.011	1.57
105	18658	374020	1.74E-10	0.701	4	2627.9	15.24	8789	2.35	2.89E-11	17.17	0.013	1.83
106	17808	328960	1.88E-10	0.694	4	2666.3	15.09	7284.1	2.23	3.31E-11	16.71	0.013	1.81
107	17032	284160	2.22E-10	0.689	4	2267.8	13.31	5473.1	1.93	3.25E-11	14.89	0.011	1.82
108	16437	246780	2.39E-10	0.686	4	2160.3	13.63	4630.7	1.88	3.41E-11	14.50	0.011	1.81
109	14133	218250	2.58E-10	0.685	4	2275.4	16.10	4480.7	2.07	4.11E-11	15.88	0.012	1.80
110	13670	180030	2.89E-10	0.679	4	2428.4	17.49	4342.6	2.29	5.00E-11	17.33	0.014	1.99
111	14080	186310	3.26E-10	0.672	4	2290.5	16.27	3734	2.25	5.36E-11	16.49	0.013	1.94
112	13698	146210	3.70E-10	0.684	4	2468.2	17.69	3704.6	2.55	6.60E-11	17.87	0.014	2.17
113	14823	127070	4.80E-10	0.651	4	2735.8	18.71	3808.1	2.89	8.73E-11	19.40	0.016	2.48
114	16286	111510	6.05E-10	0.630	4	3414.7	20.86	4413.2	3.68	1.37E-10	22.84	0.019	3.08
115	21030	99181	1.10E-09	0.582	4	5049.5	24.01	6058	6.11	3.00E-10	27.20	0.025	4.30
116	21173	87825	1.70E-09	0.553	4	5605.6	28.48	6607.1	7.43	4.70E-10	27.73	0.027	4.90
117	20242	80727	2.08E-09	0.541	4	6054.2	29.91	6824.5	8.58	6.02E-10	29.20	0.029	5.45
118	22865	76889	2.53E-09	0.522	4	7474.3	33.12	8389.4	10.63	7.79E-10	30.75	0.033	6.33
119	24650	77000	3.05E-09	0.505	4	8884.4	38.04	9779.6	12.70	9.44E-10	30.98	0.038	7.08
120	28017	77271	3.71E-09	0.494	4	11097	39.61	12021	15.56	1.14E-09	30.57	0.039	8.04
121	33228	79783	4.32E-09	0.463	4	14887	44.14	15825	19.58	1.24E-09	28.85	0.042	9.16
122	36522	82489	4.91E-09	0.443	4	18549	50.75	20348	24.92	1.27E-09	25.82	0.046	10.48
123	52853	94988	5.43E-09	0.410	4	33821	64.18	35038	37.05	1.14E-09	20.98	0.052	12.77
124	72001	111610	6.36E-09	0.382	4	61824	68.00	63168	56.60	1.89E-09	38.04	0.059	16.47
125	105300	142880	4.80E-09	0.354	4	131100	124.82	132480	92.66	4.23E-09	93.98	0.066	18.57
126	246870	283010	1.77E-08	0.319	4	710230	287.83	711880	251.54	6.89E-09	394.60	0.077	24.01
127	461340	466880	8.43E-10	0.378	4	2611700	588.11	2613500	527.04	6.13E-09	953.36	0.082	28.92
128	812910	846570	2.30E-10	0.298	4	9237000	1138.29	9238800	1092.48	4.78E-09	2074.88	0.090	30.20

Mortar with Sandstone Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	Phi	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	2816	125160	4.00E-10	0.712	4	1181.9	45.18	2697.8	2.35	8.23E-11	20.25	0.015	2.12
2	3333	130780	3.94E-10	0.712	4	1113.1	33.40	2612.7	2.15	7.26E-11	18.47	0.014	1.94
3	2829	126880	3.67E-10	0.717	4	1067.3	34.99	2643.7	1.98	8.30E-11	17.16	0.013	1.79
4	3690	128030	4.13E-10	0.707	4	1087.3	27.44	2622.2	2.02	7.74E-11	17.44	0.013	1.85
5	2832	122130	3.67E-10	0.714	4	1094.2	37.07	2678.8	2.11	7.12E-11	18.43	0.014	1.93
6	2099	119410	3.39E-10	0.724	4	1122	54.23	2620.8	2.19	6.97E-11	19.45	0.015	2.01
7	3212	120780	3.89E-10	0.712	4	1083.2	33.72	2491.8	2.08	7.02E-11	18.04	0.014	1.90
8	4897	123630	4.27E-10	0.703	4	1819.6	31.03	3472.5	2.80	1.04E-10	24.28	0.018	2.99
9	3003	118940	3.75E-10	0.715	4	1132.1	37.70	2688.5	2.18	7.08E-11	18.98	0.014	1.99
10	2829	120040	3.49E-10	0.720	4	1234.8	47.02	2846.6	2.37	7.32E-11	20.97	0.016	2.19
11	2415	122180	3.49E-10	0.721	4	1037.2	42.95	2424.5	1.98	6.05E-11	17.51	0.013	1.81
12	2463	122890	3.32E-10	0.723	4	1132.7	45.99	2697.8	2.16	6.35E-11	19.12	0.014	1.97
13	2753	126380	3.43E-10	0.721	4	1179.1	42.83	2800.9	2.23	8.74E-11	19.86	0.015	2.04
14	2762	130900	3.33E-10	0.722	4	1239.1	44.86	3083.2	2.34	8.82E-11	20.49	0.015	2.11
15	2997	136980	3.13E-10	0.728	4	1182.9	48.51	2998.5	2.20	8.00E-11	19.17	0.014	1.98
16	2844	145880	3.18E-10	0.724	4	1097.5	41.51	2697.8	2.08	6.61E-11	17.89	0.013	1.81
17	916.8	151300	2.80E-10	0.739	4	908.67	99.22	2637.2	1.74	3.89E-11	14.99	0.011	1.50
18	2163	165720	2.80E-10	0.732	4	1027.7	47.73	3208.3	1.94	4.82E-11	18.16	0.012	1.83
19	2872	189470	2.77E-10	0.731	4	1139.1	39.86	3783.8	2.12	4.46E-11	17.39	0.013	1.74
20	2825	189470	2.59E-10	0.735	4	1146.8	45.42	4089.9	2.15	4.46E-11	17.40	0.013	1.75
21	2883	202900	2.44E-10	0.738	4	1128.9	42.08	4302.6	2.12	4.07E-11	16.70	0.012	1.68
22	2882	221880	2.39E-10	0.738	4	1112.2	41.32	4689.5	2.11	3.63E-11	17.09	0.012	1.59
23	2823	239470	2.12E-10	0.745	4	1188	47.40	5413.9	2.29	3.63E-11	17.09	0.012	1.68
24	2720	254250	2.11E-10	0.745	4	1201	44.15	5891.9	2.32	3.64E-11	16.78	0.012	1.84
25	2850	278180	2.08E-10	0.744	4	1078.6	36.49	5780.3	2.09	3.03E-11	14.99	0.011	1.43
26	2894	289580	1.90E-10	0.749	4	1099.9	36.71	6237.1	2.11	2.78E-11	14.29	0.010	1.39
27	2898	328980	1.79E-10	0.754	4	1223.8	47.32	8088.4	2.48	2.82E-11	16.02	0.012	1.54
28	3302	392170	1.69E-10	0.758	4	1083.6	51.11	7854.5	2.23	2.27E-11	13.87	0.010	1.33
29	2884	432050	1.69E-10	0.758	4	1240	37.55	10154	2.59	2.52E-11	15.29	0.011	1.47
30	2894	489580	1.49E-10	0.762	4	1328.3	44.30	12321	2.85	2.38E-11	16.08	0.012	1.53
31	2817	543910	1.39E-10	0.769	4	1282.1	44.30	13931	2.86	2.06E-11	15.12	0.011	1.43
32	2843	610110	1.23E-10	0.771	4	1398.2	50.58	18883	3.08	1.90E-11	15.24	0.011	1.43
33	3281	675780	1.09E-10	0.778	4	1280.4	39.38	18483	3.03	1.73E-11	14.05	0.010	1.32
34	2802	744980	1.01E-10	0.782	4	1280.9	48.07	20845	3.05	1.47E-11	13.42	0.010	1.25
35	2465	830540	9.42E-11	0.785	4	1329.4	53.50	25087	3.38	1.41E-11	13.95	0.010	1.29
36	2844	923780	8.69E-11	0.788	4	1482.7	47.15	31858	3.84	1.40E-11	14.91	0.011	1.37
37	3015	1020300	8.39E-11	0.791	4	1421.7	45.57	35990	3.86	1.25E-11	14.07	0.010	1.29
38	3286	1107400	7.19E-11	0.800	4	1488.8	48.17	43058	4.22	1.20E-11	14.45	0.010	1.32
39	1880	1247300	7.10E-11	0.799	4	1435	78.33	48033	4.16	9.78E-12	13.83	0.010	1.23
40	2733	1343300	6.19E-11	0.808	4	1370.3	60.14	51779	4.15	8.88E-12	12.54	0.009	1.13
41	2182	1511800	5.90E-11	0.809	4	1483.9	60.42	62165	4.63	8.34E-12	13.47	0.010	1.20
42	2148	1678800	5.64E-11	0.812	4	1481.9	68.08	71834	4.78	7.55E-12	12.79	0.009	1.14
43	2808	1838200	5.23E-11	0.815	4	1581.3	63.10	90089	5.36	7.46E-12	13.47	0.010	1.20
44	2180	2086300	4.73E-11	0.820	4	1413.1	84.82	90873	4.95	6.13E-12	11.73	0.008	1.04
45	2802	2238800	4.59E-11	0.821	4	1723.2	62.77	132170	6.39	6.82E-12	13.98	0.010	1.23
46	2847	2398900	4.22E-11	0.825	4	1711.3	70.22	149200	6.48	6.18E-12	13.48	0.010	1.19
47	2468	2787400	3.81E-11	0.830	4	1754	89.72	174500	6.98	5.67E-12	13.43	0.010	1.16
48	1907	2961800	3.39E-11	0.837	4	1711	313.93	193600	8.99	4.85E-12	12.74	0.009	1.11
49	847.7	3432100	3.39E-11	0.834	4	1719.4	78.34	211480	7.09	4.20E-12	12.51	0.009	1.08
50	2845				4	2072		302280	8.01	4.84E-12	14.39	0.010	1.25

Mortar with Sandstone Fly Ash
8 Months of Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
51	439.2	372800	2.87E-11	0.843	4	1867.8	448.04	317360	8.52	3.80E-12	13.22	0.010	1.13
52	787.1	4107200	2.61E-11	0.847	4	2167.4	271.91	368600	9.47	3.65E-12	13.66	0.010	1.19
53	1221	4686000	2.47E-11	0.847	4	2369.7	185.72	498820	10.71	3.62E-12	14.66	0.011	1.25
54	1469	5241700	2.41E-11	0.846	4	2369.6	185.14	562540	10.73	3.31E-12	13.78	0.010	1.18
55	2325	5826600	2.25E-11	0.847	4	2638.3	112.33	747760	12.83	3.52E-12	15.85	0.011	1.34
56	2800	6942200	2.19E-11	0.844	4	2818.8	108.42	930420	13.40	3.18E-12	14.66	0.011	1.25
57	946.3	7993800	1.91E-11	0.854	4	3321.3	351.35	1290100	18.20	2.98E-12	18.43	0.012	1.39
58	2830	9887900	1.79E-11	0.852	4	3572.9	121.94	1665700	19.17	2.91E-12	18.59	0.012	1.41
59	1138	1.2E+07	1.43E-11	0.864	4	4038.7	354.72	2628700	22.80	2.59E-12	18.03	0.013	1.51
60	2039	1.4E+07	1.37E-11	0.864	4	3768.9	184.84	3300200	23.46	2.18E-12	15.97	0.012	1.34
61	3205	1.7E+07	1.19E-11	0.871	4	4353.7	135.84	4839400	28.31	2.12E-12	17.82	0.013	1.48
62	1039	1.8E+07	1.05E-11	0.878	4	4184.4	403.12	5238300	29.08	1.77E-12	16.79	0.012	1.36
63	1807	2E+07	9.95E-12	0.880	4	4630.6	242.82	7132400	34.94	1.81E-12	18.24	0.013	1.50
64	181.2	2.4E+07	9.40E-12	0.882	4	4639.8	2728.16	9797900	41.11	1.80E-12	18.97	0.014	1.56
65	2869	2.5E+07	1.02E-11	0.875	4	5448.7	182.22	11096000	44.89	2.08E-12	20.36	0.015	1.68
66	6168	2.6E+07	1.07E-11	0.870	4	5111	82.46	13101000	48.52	2.00E-12	18.65	0.013	1.55
67	1708	2.5E+07	9.64E-12	0.878	4	5205.1	305.11	10181000	41.51	1.88E-12	19.27	0.014	1.59
68	489.5	2.2E+07	9.10E-12	0.881	4	5203.7	1041.78	8386300	37.49	1.77E-12	19.24	0.014	1.56
69	7055	3E+07	9.50E-12	0.874	4	5427	78.92	15250000	50.62	1.94E-12	19.53	0.014	1.61
70	6863	2.9E+07	9.89E-12	0.875	4	5234.6	75.94	13388000	48.78	1.86E-12	18.86	0.014	1.56
71	7107	2.7E+07	1.02E-11	0.873	4	5289.2	74.42	12056000	44.75	1.94E-12	19.03	0.014	1.58
72	3204	3.3E+07	9.79E-12	0.878	4	5485.2	171.20	18693000	56.97	1.85E-12	19.98	0.014	1.65
73	4637	2.4E+07	9.89E-12	0.875	4	5181.9	111.75	9194000	39.01	1.87E-12	18.92	0.014	1.56
74	5111	2.6E+07	1.08E-11	0.872	4	5289.8	103.89	10876000	43.21	2.05E-12	19.80	0.014	1.62
75	6191	2.4E+07	1.10E-11	0.868	4	5284.1	85.03	10753000	44.06	2.30E-12	19.71	0.014	1.64
76	3513	2.1E+07	1.18E-11	0.868	4	4932.1	140.40	7998000	37.32	2.21E-12	18.75	0.014	1.56
77	4698	2E+07	1.33E-11	0.859	4	4385.9	93.40	6160500	31.52	2.25E-12	18.65	0.012	1.42
78	6168	1.8E+07	1.41E-11	0.865	4	4567.3	74.37	5513300	30.87	2.52E-12	17.86	0.013	1.51
79	6238	1.7E+07	1.61E-11	0.848	4	4415.5	70.78	4621300	29.55	2.84E-12	17.82	0.013	1.50
80	4807	1.3E+07	1.89E-11	0.851	4	4494.2	91.59	3282400	24.86	2.89E-12	18.43	0.013	1.57
81	5349	1.2E+07	1.87E-11	0.847	4	4356.4	81.44	2714000	22.49	3.00E-12	17.93	0.013	1.53
82	6312	1.2E+07	1.82E-11	0.839	4	4271.9	87.86	2638700	22.44	3.43E-12	17.84	0.013	1.54
83	7128	1.1E+07	2.28E-11	0.829	4	3708	52.01	2150400	19.69	3.64E-12	15.90	0.011	1.39
84	7910	9489400	2.57E-11	0.822	4	3743.8	47.33	1887400	17.87	4.17E-12	16.23	0.012	1.43
85	6285	6304200	2.69E-11	0.821	4	3911.9	62.14	1470800	17.71	4.78E-12	17.70	0.013	1.56
86	7975	7422500	3.28E-11	0.809	4	3408.9	42.74	1110400	14.88	5.20E-12	15.80	0.011	1.41
87	6165	6535600	3.49E-11	0.808	4	3204.3	51.98	888110	13.25	5.30E-12	15.30	0.011	1.37
88	6824	5481500	3.81E-11	0.803	4	3381.6	48.84	694850	12.49	6.33E-12	16.83	0.012	1.50
89	8014	4856100	4.32E-11	0.798	4	3308.1	41.28	598850	11.71	7.24E-12	16.77	0.012	1.52
90	6875	4120000	4.80E-11	0.791	4	2878.1	41.86	391210	9.50	7.29E-12	15.18	0.011	1.39
91	5485	3529100	5.28E-11	0.788	4	2803.5	51.30	323670	8.92	6.11E-12	15.42	0.011	1.41
92	6284	3098300	6.07E-11	0.780	4	2538.8	40.50	230830	7.45	8.70E-12	14.34	0.010	1.33
93	5802	2618500	6.72E-11	0.775	4	2430.7	41.89	174710	6.67	9.65E-12	14.36	0.010	1.34
94	5808	2298200	7.55E-11	0.770	4	2043.1	37.11	120550	5.34	9.46E-12	12.58	0.009	1.18
95	5151	1858300	8.30E-11	0.768	4	2053.3	39.88	100280	5.13	1.10E-11	13.19	0.010	1.24
96	4815	1648300	8.23E-11	0.768	4	2181.2	45.30	81033	4.91	1.18E-11	14.48	0.010	1.36
97	4136	1418300	8.65E-11	0.769	4	1883.8	47.86	63897	4.50	1.25E-11	14.24	0.010	1.34
98	5337	1248400	1.03E-10	0.761	4	2035.2	38.13	55889	4.47	1.52E-11	15.15	0.011	1.44
99	5546	1089700	9.99E-11	0.760	4	1867.8	34.04	38854	3.67	1.40E-11	14.04	0.010	1.34
100	5125	880740	1.29E-10	0.747	4	1791.2	34.95	38083	3.66	1.85E-11	14.22	0.010	1.39

Mortar with Sandless Fly Ash
9 Months of Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
101	3081	802800	1.29E-10	0.751	4	1654.4	44.94	28572	3.31	1.77E-11	13.82	0.010	1.33
102	3122	748900	1.33E-10	0.751	4	1415.4	45.34	20536	2.74	1.65E-11	12.41	0.009	1.20
103	3005	865810	1.48E-10	0.748	4	1395.2	38.67	17180	2.62	1.88E-11	12.72	0.009	1.24
104	3780	576100	1.63E-10	0.741	4	1344.2	36.47	14274	2.48	2.06E-11	12.81	0.009	1.25
105	3635	507620	1.78E-10	0.738	4	1367.3	35.65	12517	2.47	2.41E-11	13.56	0.010	1.34
106	4416	441780	1.91E-10	0.735	4	1460.7	33.08	11344	2.57	2.90E-11	15.16	0.011	1.50
107	3672	388340	1.89E-10	0.734	4	1327.8	38.15	8984.3	2.30	2.87E-11	14.42	0.011	1.43
108	4673	343800	2.31E-10	0.728	4	1311.5	28.68	7652.7	2.23	3.39E-11	14.67	0.011	1.48
109	3683	288800	2.41E-10	0.728	4	1243.2	33.78	6300.7	2.10	3.53E-11	14.86	0.011	1.46
110	4840	261780	2.86E-10	0.713	4	1234.1	24.86	5335.7	2.04	4.40E-11	14.89	0.011	1.53
111	5525	228080	3.51E-10	0.703	4	1274.5	23.07	4747.7	2.08	5.58E-11	15.83	0.012	1.68
112	8091	194380	3.86E-10	0.698	4	1328.2	28.05	4232.1	2.18	6.84E-11	17.30	0.013	1.84
113	8464	168080	5.58E-10	0.675	4	1415.4	21.90	3805.4	2.31	1.04E-10	18.57	0.014	2.08
114	7622	136380	8.71E-10	0.647	4	1707.4	22.70	3823.6	2.82	1.86E-10	22.63	0.017	2.85
115	10725	108770	1.93E-09	0.591	4	2898.2	25.16	4898.4	4.50	6.30E-10	32.88	0.028	4.35
116	10748	95597	3.22E-09	0.558	4	2818.9	28.23	4786.1	4.89	1.08E-09	33.48	0.027	4.81
117	11063	89483	3.81E-09	0.551	4	3327	30.07	5328.2	6.02	1.41E-09	38.95	0.032	5.78
118	11351	83191	4.39E-09	0.538	4	3417.4	30.11	5235.5	6.30	1.69E-09	38.74	0.032	5.95
119	12314	78433	5.27E-09	0.523	4	3650.1	31.27	5957.2	7.12	2.17E-09	41.15	0.035	6.82
120	13407	76370	6.40E-09	0.508	4	4481.9	33.43	6339	8.30	2.86E-09	44.69	0.038	7.58
121	14704	74057	7.97E-09	0.490	4	5192.6	35.31	7088.4	9.58	3.78E-09	47.44	0.042	8.53
122	15533	71601	9.28E-09	0.478	4	6054.1	38.98	8043.3	11.23	4.61E-09	51.74	0.047	9.78
123	17488	71155	1.20E-08	0.456	4	7032.5	40.22	9078.6	12.78	6.32E-09	52.47	0.049	10.78
124	18628	69678	1.48E-08	0.439	4	8174.7	43.42	10288	14.72	7.97E-09	54.60	0.053	12.04
125	22962	72039	1.88E-08	0.413	4	11105	48.38	13480	18.71	1.07E-08	57.35	0.060	14.44
126	24804	71704	2.28E-08	0.385	4	13458	54.28	16005	22.32	1.35E-08	59.21	0.065	16.54
127	34181	79680	3.08E-08	0.365	4	22514	66.87	25985	32.12	1.71E-08	68.08	0.075	21.18
128	37275	80878	3.63E-08	0.337	4	28878	77.47	32283	38.83	2.00E-08	84.91	0.084	24.88

Reference Paste
8 Months Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_2 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
1	633.9	6100	1.65E-10	0.813	4	230.33	43.14	267.26	5.04	5.68E-11	34.43	0.028	3.14
2	718.5	4885	1.22E-10	0.838	4	195.8	27.33	218.83	4.89	4.08E-11	33.40	0.028	2.92
3	551.4	4610	1.46E-10	0.822	4	227.49	41.26	250.9	5.44	5.28E-11	35.65	0.027	3.23
4	578.1	4380	1.51E-10	0.823	4	228.39	39.30	248.82	5.67	5.46E-11	36.45	0.027	3.32
5	698.9	4105	1.27E-10	0.839	4	205.12	29.45	228.76	5.62	4.84E-11	38.64	0.027	3.25
6	708.7	3969	1.44E-10	0.831	4	213.31	30.10	233.76	5.69	5.46E-11	37.61	0.028	3.41
7	766.4	3828	1.25E-10	0.843	4	201.61	26.65	220.86	5.77	4.70E-11	37.71	0.028	3.34
8	801.1	3717	1.24E-10	0.845	4	194.16	23.92	212.93	5.73	4.69E-11	37.79	0.028	3.33
9	782.6	3671	1.30E-10	0.842	4	186.14	24.73	217.05	5.68	5.03E-11	38.41	0.029	3.41
10	718.5	3671	1.37E-10	0.839	4	200.63	26.34	219.79	5.99	5.29E-11	38.66	0.029	3.45
11	787.3	3721	1.35E-10	0.839	4	212.78	28.61	231.92	6.23	5.23E-11	39.32	0.030	3.53
12	843	3686	1.25E-10	0.845	4	208.66	27.19	228.02	6.24	5.04E-11	40.31	0.030	3.57
13	827.3	3943	1.32E-10	0.843	4	198.27	23.62	217.89	5.99	5.21E-11	39.56	0.029	3.49
14	765.9	3776	1.33E-10	0.841	4	205.36	24.82	225.69	5.99	5.31E-11	39.82	0.030	3.52
15	775.4	4022	1.44E-10	0.833	4	221.78	29.34	244.4	6.08	5.79E-11	40.28	0.030	3.60
16	820	4413	1.52E-10	0.828	4	224.99	29.02	249.28	5.91	5.08E-11	39.84	0.030	3.57
17	852.3	4681	1.38E-10	0.835	4	217.9	26.57	243.49	5.62	5.32E-11	39.09	0.029	3.44
18	820	5004	1.29E-10	0.835	4	251.07	36.49	260.72	5.75	6.06E-11	39.57	0.029	3.59
19	847.8	5444	1.67E-10	0.828	4	217.8	28.59	247.21	4.94	4.79E-11	37.12	0.027	3.23
20	438.2	6554	1.86E-10	0.811	4	235.08	32.34	268.15	4.93	5.24E-11	37.07	0.027	3.26
21	538.3	6942	1.81E-10	0.801	4	249.3	38.48	288.48	4.84	6.08E-11	38.53	0.027	3.27
22	418.7	7899	1.86E-10	0.803	4	276.69	63.14	318.7	4.86	8.72E-11	38.20	0.028	3.30
23	287.6	8205	1.80E-10	0.797	4	284.98	49.23	310.87	4.48	6.39E-11	35.21	0.026	3.17
24	281.2	9001	1.80E-10	0.791	4	270.69	60.59	323.03	4.25	5.80E-11	34.61	0.025	3.08
25	287.3	9793	1.84E-10	0.784	4	285.99	94.57	351.29	3.99	5.89E-11	33.04	0.024	2.95
26	281.2	10894	2.01E-10	0.764	4	294.49	98.09	367.11	3.69	6.28E-11	33.31	0.024	2.99
27	287.3	12616	1.92E-10	0.783	4	272.57	101.16	360.49	3.40	6.28E-11	32.15	0.023	2.89
28	281.2	13956	2.23E-10	0.772	4	282.03	146.73	387.61	3.32	6.04E-11	30.67	0.022	2.75
29	287.3	15332	2.30E-10	0.763	4	293.63	208.23	410.82	3.07	5.86E-11	29.46	0.020	2.60
30	281.2	16427	2.02E-10	0.774	4	328.94	136.17	432.31	2.94	6.39E-11	28.53	0.020	2.55
31	281.2	20727	2.69E-10	0.755	4	323.65	684.15	500.89	2.63	6.96E-11	27.82	0.019	2.46
32	281.2	23704	3.04E-10	0.740	4	312.01	107.18	462.87	2.61	5.23E-11	29.25	0.020	2.62
33	281.2	26704	3.71E-10	0.723	4	333.94	53.61	533.14	2.57	6.73E-11	28.08	0.018	2.34
34	281.2	30363	3.06E-10	0.732	4	342.94	49.62	618.6	2.59	7.74E-11	26.10	0.018	2.37
35	281.2	34321	3.09E-10	0.724	4	370.82	31.27	694.59	2.56	7.81E-11	25.67	0.017	2.33
36	281.2	38161	3.09E-10	0.731	4	366.43	33.26	706.37	2.60	9.40E-11	25.31	0.017	2.35
37	281.2	40327	2.89E-10	0.728	4	385.27	30.70	808.54	2.64	8.77E-11	24.41	0.016	2.25
38	281.2	43032	2.89E-10	0.723	4	407.24	28.05	898.64	2.61	7.63E-11	24.93	0.017	2.28
39	281.2	46819	3.03E-10	0.718	4	398.6	27.65	1159.5	2.69	7.51E-11	25.10	0.017	2.27
40	281.2	50467	3.71E-10	0.708	4	413.39	23.09	1471.7	2.40	6.43E-11	21.88	0.014	1.95
41	281.2	55910	3.03E-10	0.716	4	505.53	18.48	2027.3	2.61	6.89E-11	22.46	0.015	2.04
42	281.2	60854	2.80E-10	0.718	4	478.83	18.67	2201.6	3.04	9.18E-11	22.67	0.016	2.30
43	281.2	66594	2.74E-10	0.717	4	485.28	15.52	2647.8	2.99	6.17E-11	22.82	0.015	2.08
44	281.2	71920	2.80E-10	0.710	4	525.14	18.26	3352.8	3.24	6.06E-11	22.04	0.014	2.00
45	281.2	78160	2.70E-10	0.712	4	591.02	13.21	4409.8	3.62	6.23E-11	22.97	0.015	2.01
46	281.2	82171	2.07E-10	0.728	4	621.71	13.16	5593.1	3.94	6.23E-11	23.10	0.015	2.11
47	281.2	86200	2.07E-10	0.728	4	680.28	13.55	7017.2	4.31	4.93E-11	23.85	0.015	2.13

Reference Pools
9 Months Hydration

File No.	R_1 (Q)	R_2 (Q)	C (F)	PH	Type	R_1 (Q) (Error)	R_1 (Q) (% Error)	R_2 (Q) (Error)	R_2 (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
51	5243	195300	2.19E-10	0.719	4	678.89	12.95	9125.8	4.80	4.94E-11	22.62	0.016	2.04
52	5639	237430	1.94E-10	0.724	4	723.77	12.84	12159	5.12	4.42E-11	22.78	0.016	2.03
53	5761	276900	1.47E-10	0.736	4	632.78	10.86	12760	4.57	2.79E-11	16.99	0.012	1.98
54	6997	331010	1.13E-10	0.752	4	644.36	12.80	12704	6.37	2.73E-11	24.22	0.016	2.06
55	7821	420980	1.01E-10	0.764	4	666.36	11.33	28781	7.07	2.36E-11	23.36	0.016	2.00
56	7364	527700	6.13E-11	0.765	4	616.6	11.06	37644	7.13	1.66E-11	20.36	0.013	1.71
57	8105	680400	6.70E-11	0.773	4	777.5	9.59	46378	7.33	1.22E-11	16.20	0.012	1.52
58	8694	798320	4.99E-11	0.789	4	824.13	10.64	70416	9.16	1.05E-11	20.98	0.014	1.71
59	9088	971400	4.42E-11	0.794	4	972.37	10.73	106390	10.95	9.27E-12	20.98	0.013	1.70
60	10968	1157600	3.66E-11	0.800	4	1014.2	9.23	140160	12.11	6.04E-12	20.61	0.013	1.67
61	9801	1333000	2.88E-11	0.817	4	921.41	9.40	156980	11.89	5.27E-12	18.43	0.012	1.46
62	9712	1469700	2.36E-11	0.827	4	969.94	9.99	162260	12.93	4.52E-12	19.00	0.012	1.46
63	10096	1682800	2.20E-11	0.831	4	1080.1	10.50	255330	15.17	4.49E-12	20.26	0.013	1.57
64	11528	1726500	1.97E-11	0.840	4	1299.1	11.27	317960	16.37	4.89E-12	24.59	0.016	1.66
65	10949	1899000	1.91E-11	0.837	4	1133.2	10.35	363740	17.70	4.00E-12	20.87	0.013	1.60
66	10082	1927700	1.66E-11	0.850	4	1031.4	10.23	286630	15.34	3.01E-12	19.12	0.012	1.46
67	9798	1973800	1.44E-11	0.855	4	1049.4	10.72	312020	15.81	2.80E-12	19.43	0.012	1.46
68	11629	2047000	1.47E-11	0.863	4	1419.6	12.21	447960	21.87	3.66E-12	26.10	0.017	1.97
69	10712	1933400	1.25E-11	0.863	4	1279.3	11.84	356230	18.43	2.97E-12	23.69	0.016	1.77
70	11627	2022400	1.27E-11	0.861	4	1197.7	10.04	346000	17.11	2.70E-12	21.21	0.014	1.58
71	10996	2031200	1.19E-11	0.868	4	1094.3	10.39	327960	16.15	2.39E-12	20.02	0.013	1.49
72	9963	1993200	1.12E-11	0.870	4	1091.9	10.97	315930	16.65	2.26E-12	20.11	0.013	1.49
73	11897	2137400	1.41E-11	0.865	4	1215	10.24	397990	18.61	3.08E-12	21.66	0.014	1.65
74	10666	2033600	1.36E-11	0.867	4	965	9.05	294100	14.32	2.36E-12	17.36	0.011	1.30
75	11896	2037200	1.67E-11	0.849	4	1192.3	10.03	396300	17.93	3.39E-12	21.62	0.014	1.64
76	10142	1729600	1.32E-11	0.861	4	1185.6	11.40	289000	16.55	2.89E-12	21.84	0.014	1.63
77	10126	1626200	1.51E-11	0.864	4	1349.2	13.32	281030	17.90	3.91E-12	25.69	0.017	1.95
78	11864	1692100	2.21E-11	0.829	4	1174.7	9.63	274900	16.26	4.86E-12	22.10	0.014	1.71
79	9635	1377400	1.96E-11	0.839	4	936.26	9.54	159440	11.56	3.66E-12	18.62	0.012	1.43
80	11065	1430000	3.27E-11	0.808	4	1114.3	10.07	211960	14.80	7.15E-12	21.77	0.014	1.73
81	9759	1141200	3.17E-11	0.812	4	658.53	8.80	113330	9.63	5.80E-12	17.63	0.011	1.40
82	11307	1040500	4.57E-11	0.790	4	1123.7	9.94	130650	12.55	1.06E-11	23.29	0.016	1.90
83	9260	832710	4.13E-11	0.799	4	903.93	9.77	75035	9.01	8.26E-12	20.02	0.013	1.61
84	9180	737960	5.62E-11	0.782	4	825.09	9.01	57966	7.86	1.04E-11	18.99	0.012	1.53
85	10137	944060	6.07E-11	0.790	4	918.65	9.06	63552	8.31	1.70E-11	21.07	0.014	1.78
86	10379	658140	1.07E-10	0.744	4	696.26	8.65	42716	7.65	2.28E-11	21.06	0.014	1.82
87	8472	440160	9.61E-11	0.793	4	780.63	9.22	26310	5.98	1.93E-11	19.72	0.013	1.69
88	7975	365980	1.35E-10	0.736	4	725.21	9.09	20707	5.37	2.61E-11	18.79	0.012	1.65
89	9034	323360	1.62E-10	0.716	4	616.23	9.02	16107	5.56	3.92E-11	21.60	0.014	1.94
90	7178	291790	1.61E-10	0.730	4	691.4	9.63	11608	4.43	3.20E-11	19.91	0.013	1.76
91	8252	231900	2.62E-10	0.701	4	791.1	9.59	11011	4.75	5.87E-11	22.55	0.016	2.08
92	6677	191790	2.36E-10	0.708	4	592.33	9.01	6512.6	3.40	4.32E-11	18.11	0.012	1.66
93	7372	169230	3.26E-10	0.690	4	699.28	9.08	6016.9	3.62	6.76E-11	20.71	0.013	1.86
94	5230	134930	2.60E-10	0.711	4	518.05	9.91	3712.3	2.75	4.47E-11	17.63	0.012	1.63
95	9965	118950	3.46E-10	0.691	4	665.31	9.28	3329.3	2.61	6.00E-11	19.16	0.013	1.61
96	5539	103090	3.62E-10	0.697	4	576.59	10.41	2948.7	2.86	7.82E-11	20.71	0.014	1.98
97	4782	90680	4.16E-10	0.695	4	635.08	13.25	2693.6	3.16	9.94E-11	23.69	0.016	2.29
98	3959	79091	3.40E-10	0.700	4	472.69	11.94	1834.8	2.35	6.92E-11	19.15	0.013	1.80
99	4270	71179	4.74E-10	0.690	4	613.19	14.36	2124	2.68	1.17E-10	24.60	0.016	2.40
100	3298	61713	3.89E-10	0.698	4	476.65	14.46	1479.6	2.40	8.12E-11	20.66	0.014	1.99

Reference Peaks
9 Monitors Hydration

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PM	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PM (Error)	PM (% Error)
101	3116	55163	4.10E-10	0.693	4	500.51	18.06	1392.7	2.62	9.39E-11	22.66	0.015	2.17
102	3460	50317	5.21E-10	0.679	4	596.1	16.85	1463.7	2.91	1.39E-10	28.14	0.016	2.59
103	2613	43262	3.62E-10	0.703	4	418.05	16.56	949.29	2.19	7.91E-11	20.66	0.014	1.97
104	2637	36949	6.16E-10	0.694	4	548.69	16.69	1138.4	2.66	1.37E-10	26.49	0.016	2.62
105	2677	35391	4.69E-10	0.690	4	497.59	19.31	954.12	2.70	1.25E-10	25.28	0.017	2.49
106	2399	31573	4.81E-10	0.696	4	465.69	19.41	826.33	2.63	1.12E-10	24.76	0.017	2.43
107	1303	27177	3.40E-10	0.721	4	361.33	27.73	617.02	2.27	7.49E-11	21.99	0.015	2.08
108	1460	24692	3.39E-10	0.721	4	362.91	24.66	579.34	2.35	7.60E-11	22.41	0.015	2.13
109	1166	22202	3.67E-10	0.719	4	394.5	33.00	587.54	2.65	9.09E-11	24.79	0.017	2.36
110	1320	20364	3.66E-10	0.714	4	436.76	33.01	630.95	3.10	1.11E-10	26.03	0.020	2.73
111	499.5	17513	2.70E-10	0.746	4	315.44	67.19	448.86	2.56	6.50E-11	24.04	0.017	2.23
112	399.8	14768	2.69E-10	0.746	4	310.16	63.87	425.32	2.69	6.62E-11	24.64	0.017	2.30
113	739.9	14768	3.02E-10	0.739	4	351.41	47.56	469.46	3.11	6.09E-11	26.77	0.019	2.56
114	34.15	12667	2.07E-10	0.772	4	270.04	790.75	346.39	2.76	5.11E-11	24.66	0.017	2.24
115	74.03	11330	1.99E-10	0.777	4	269.66	362.91	338.61	2.99	5.19E-11	25.99	0.016	2.36
116	51.41	10273	1.80E-10	0.765	4	249.76	485.66	306.74	2.99	4.54E-11	25.22	0.016	2.26
117	200.5	9223	1.86E-10	0.767	4	254.86	127.11	307.91	3.34	5.10E-11	27.43	0.020	2.49
118	264.9	8277	1.70E-10	0.766	4	238.49	89.26	279.93	3.36	4.57E-11	26.94	0.019	2.43
119	223.7	7651	1.97E-10	0.767	4	269.67	120.55	313.12	4.09	6.03E-11	30.59	0.022	2.63
120	368.7	6823	1.62E-10	0.763	4	259.72	70.44	296.47	4.31	6.04E-11	31.54	0.023	2.91
121	441.2	6347	1.84E-10	0.766	4	249.64	66.56	294.12	4.49	5.99E-11	32.00	0.024	2.99
122	366.3	5975	1.69E-10	0.764	4	261.39	67.32	293.66	4.61	6.09E-11	33.23	0.025	3.11
123	517.1	5450	1.77E-10	0.805	4	238.91	46.20	287.05	4.90	5.87E-11	33.06	0.026	3.06
124	432.3	5180	1.65E-10	0.802	4	262.65	58.49	279.48	5.36	6.34E-11	34.34	0.026	3.22
125	662.7	4643	1.70E-10	0.815	4	224.37	33.86	246.26	5.35	5.69E-11	36.07	0.026	3.22
126	1509	5006	3.02E-10	0.762	4	393.26	26090.97	423.14	8.35	1.27E-10	41.99	0.034	4.40
127	100.5	4614	3.33E-10	0.754	4	440.51	436.32	470.15	9.57	1.47E-10	44.23	0.036	4.60
128	117.2	4449	3.09E-10	0.766	4	394.16	327.80	410.25	9.22	1.34E-10	43.69	0.036	4.64
129	56.94	4428	3.61E-10	0.749	4	444.35	1202.90	471.26	10.65	1.75E-10	46.63	0.036	5.11

6000 Series Brick

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	Phi	Type	R ₁ (Q) (Error)	R ₁ (Q) (% Error)	R ₂ (Q) (Error)	R ₂ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	Phi (Error)	Phi (% Error)
1	5530	101050	6.07E-11	0.917	4	99.498	1.80	1712.4	1.89	4.55E-12	7.50	0.005	0.57
2	4764	595070	2.67E-11	0.966	4	52.052	1.09	21829	3.63	9.23E-13	3.46	0.002	0.25
3	24210	342780	1.83E-16	1.000	4	9154.5	37.81	135560	39.55	1.82E-16	99.60	0.071	7.07
4	185.5	3603200	1.06E-11	0.993	4	55.768	30.06	801650	22.25	6.19E-13	3.72	0.003	0.26
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20	19528	388360	3.71E-11	0.943	4	512.58	2.63	15015	3.87	5.10E-12	13.74	0.010	1.09

6000 Series Brick

File No.	R ₁ (Ω)	R ₂ (Ω)	C (F)	PHI	Type	R ₁ (Ω) (Error)	R ₁ (Ω) (% Error)	R ₂ (Ω) (Error)	R ₂ (Ω) (% Error)	C (F) (Error)	C (F) (% Error)	PHI (Error)	PHI (% Error)
1	2517	117900	1.77E-10	0.907	4	275.32	10.94	3197	2.71	2.41E-11	13.58	0.009	1.18
2	2257	153260	1.16E-10	0.834	4	242.87	10.76	4223.3	2.76	1.34E-11	11.82	0.008	0.98
3	800.8	327450	2.94E-11	0.919	4	135.98	16.98	7743	2.38	1.72E-12	5.86	0.004	0.43
4	1084	3619100	1.04E-11	0.978	4	154.93	14.29	733540	20.27	5.95E-13	5.70	0.004	0.39
5	1167	5753500	1.04E-11	0.978	4	164.64	14.11	1952000	33.93	6.29E-13	6.03	0.004	0.42
6	1147	6172300	1.02E-11	0.980	4	162.34	14.15	2204800	35.72	6.09E-13	5.93	0.004	0.41
7	1150	5384600	1.01E-11	0.980	4	172.44	14.99	1762700	32.86	6.37E-13	6.29	0.004	0.43
8	1121	4798500	9.94E-12	0.982	4	168.89	15.07	1378100	28.72	6.05E-13	6.15	0.004	0.42
9	1076	5930600	9.78E-12	0.982	4	166.11	15.44	2084600	34.81	5.91E-13	6.05	0.004	0.42
10	1060	5395100	9.82E-12	0.984	4	156.32	14.75	1608000	29.77	5.47E-13	5.69	0.004	0.39
11	1136	5285200	9.93E-12	0.981	4	171.18	15.07	1677600	31.86	6.18E-13	6.23	0.004	0.43
12	1097	5280600	9.78E-12	0.982	4	164.48	14.99	1608200	30.57	5.89E-13	5.98	0.004	0.41
13	1127	4786500	9.94E-12	0.982	4	174.71	15.50	1412000	29.50	6.25E-13	6.35	0.004	0.44
14	1119	5388000	9.94E-12	0.981	4	171.59	15.33	1746000	32.56	6.21E-13	6.24	0.004	0.43
15	1132	6181300	1.02E-11	0.980	4	162.07	14.32	2197400	35.55	6.01E-13	5.91	0.004	0.41
16	1131	4909100	1.01E-11	0.981	4	168.57	14.90	1440600	29.35	6.18E-13	6.14	0.004	0.42
17	1115	3772800	9.82E-12	0.982	4	172.31	15.45	860160	22.80	6.13E-13	6.25	0.004	0.43
18	1268	3495100	1.11E-11	0.974	4	171.13	13.29	748010	21.40	6.94E-13	6.24	0.004	0.43
19	1436	1224200	1.21E-11	0.969	4	197.84	13.78	107830	8.81	8.79E-13	7.26	0.005	0.51
20	3948	108430	2.97E-10	0.770	4	452.38	11.48	4164.5	3.91	6.29E-11	21.19	0.015	1.81

Vycor Glass

File No.	R ₁ (Q)	R ₂ (Q)	C (F)	PH	Type	R ₁ (Q) (Error)	R ₂ (Q) (% Error)	R ₃ (Q) (Error)	R ₄ (Q) (% Error)	C (F) (Error)	C (F) (% Error)	PH (Error)	PH (% Error)
1	232.6	110540	3.30E-11	0.989	4	29.579	12.72	4201.6	3.80	2.54E-12	7.51	0.005	0.50
2	218.9	149760	2.95E-11	0.977	4	25.942	11.85	6514.7	4.35	1.93E-12	6.53	0.004	0.43
3	202.2	187280	2.71E-11	0.983	4	23.933	11.84	9247.7	4.94	1.83E-12	6.00	0.004	0.40
4	193.4	270690	2.61E-11	0.985	4	22.924	11.85	16302	6.76	1.50E-12	5.74	0.004	0.38
5	175.3	662020	2.40E-11	0.990	4	21.479	12.25	100440	15.17	1.28E-12	5.34	0.003	0.35
6	164.4	1660600	2.17E-11	0.988	4	20.826	12.67	601470	36.22	1.12E-12	5.15	0.003	0.33
7	164.4	1935200	2.12E-11	0.988	4	20.616	12.54	803530	41.52	1.08E-12	5.09	0.003	0.33
8	164.4	2172800	2.12E-11	0.988	4	20.43	12.43	1003200	46.17	1.07E-12	5.05	0.003	0.33
9	163.1	2210100	2.11E-11	0.988	4	20.366	12.51	1036100	46.86	1.06E-12	5.04	0.003	0.33
10	166.3	2223700	2.13E-11	0.987	4	20.635	12.41	1062500	47.78	1.09E-12	5.10	0.003	0.33
11	164.3	2097500	2.12E-11	0.988	4	20.436	12.44	935920	44.62	1.07E-12	5.05	0.003	0.33
12	166.8	2278300	2.14E-11	0.987	4	20.423	12.24	1103700	48.44	1.08E-12	5.04	0.003	0.33
13	167.8	2355700	2.19E-11	0.987	4	20.616	12.41	1212200	51.46	1.12E-12	5.16	0.003	0.33
14	168.4	2354100	2.19E-11	0.988	4	20.489	12.17	1194700	50.75	1.11E-12	5.08	0.003	0.33
15	169	2413100	2.19E-11	0.988	4	20.731	12.27	1269600	52.61	1.13E-12	5.14	0.003	0.33
16	170.1	2450300	2.19E-11	0.988	4	21.104	12.41	1332500	54.36	1.15E-12	5.23	0.003	0.34
17	170.3	2505200	2.20E-11	0.988	4	20.987	12.32	1398400	55.34	1.15E-12	5.21	0.003	0.34
18	170.1	2503100	2.21E-11	0.988	4	20.861	12.28	1380000	55.13	1.14E-12	5.19	0.003	0.34
19	169.2	2631700	2.22E-11	0.985	4	20.861	12.33	1769700	62.50	1.15E-12	5.19	0.003	0.34
20	167.8	2234700	2.21E-11	0.988	4	20.749	12.37	1088500	49.16	1.14E-12	5.16	0.003	0.34
21	163.5	2313100	2.19E-11	0.988	4	20.952	12.81	1190400	51.46	1.14E-12	5.22	0.003	0.34
22	164.9	2363700	2.21E-11	0.988	4	21.022	12.75	1250700	52.91	1.16E-12	5.25	0.003	0.34
23	163.6	2213200	2.19E-11	0.988	4	20.799	12.70	1085300	49.04	1.14E-12	5.19	0.003	0.34
24	165.6	2140200	2.20E-11	0.988	4	20.983	12.66	1024800	47.88	1.15E-12	5.24	0.003	0.34
25	163.3	1831000	2.18E-11	0.987	4	20.952	12.83	750400	40.98	1.14E-12	5.24	0.003	0.34
26	163	1712400	2.19E-11	0.987	4	20.924	12.84	657470	38.39	1.15E-12	5.24	0.003	0.34
27	164.5	1415800	2.22E-11	0.988	4	21.443	13.04	463300	32.72	1.19E-12	5.30	0.003	0.35
28	164.4	1069300	2.26E-11	0.985	4	21.182	12.88	262210	24.54	1.20E-12	5.33	0.003	0.35
29	166.7	657170	2.34E-11	0.983	4	21.286	12.62	100880	15.35	1.26E-12	5.38	0.003	0.35
30	163.5	387020	2.55E-11	0.988	4	21.183	11.55	35363	9.14	1.37E-12	5.38	0.003	0.35

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