FHWA-NJ-2015-005

Evaluation of Surface Resistivity Indication of Ability of Concrete to Resist Chloride Ion Penetration

FINAL REPORT
March 2015

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In cooperation with

New Jersey
Department of Transportation
Bureau of Research
And
U. S. Department of Transportation
Federal Highway Administration

DISCLAIMER STATEMENT

FHWA-NJ-2015-005

TECHNICAL REPORT
STANDARD TITLE PAGE

1. Report No. FHWA NJ-2015-005	2.Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Evaluation of Surface Resistivity Indication of Ability of Concrete to Resist Chloride Ion Penetration		5. Report Date March 2015
		6. Performing Organization Code
7. Author(s) Hani Nassif, Ph.D., PE, Samer Rabie, Graduate Assistant, Chaekuk Na, Ph.D., Research Associate, Michael Salvador, Ph.D. Candidate		8. Performing Organization Report No.
9. Performing Organization Name and Address Rutgers Infrastructure Monitoring and Evaluation (RIME) Group Rutgers, The State University of New Jersey 96 Frelinghuysen Road, Piscataway, NJ 08854		10. Work Unit No.
		11. Contract or Grant No.
12. Sponsoring Agency Name and Address New Jersey Department of Transportation PO 600 Trenton, NJ 08625	Federal Highway Administration U.S. Department of Transportation Washington, D.C.	13. Type of Report and Period Covered Final Report 9/6/2013 – 9/6/2014
		14. Sponsoring Agency Code
15. Supplementary Notes		

16. Abstract

Concrete's ability to resist chloride penetration is a determining factor when evaluating durability performance. The Rapid Chloride Permeability Test (RCPT) has been established for assessing the chloride resistance of concrete, but it is ineffective and has many drawbacks; it is a laborious destructive test that provides an indication of chloride ion movement but with high variances. The main objective of this project is to evaluate the Surface Resistivity Test (SRT) in accordance with AASHTO TP 95-11, and to provide a SR threshold to update the NJDOT HPC Specifications. The SRT is non-destructive, requires less training, and provides higher accuracy with less single-operator and multi-laboratory variation in results, thus reducing construction disputes and litigation efforts. Testing time is reduced from 24 hours to 30 minutes and other agencies have reported savings upwards of $1.5 million annually. Due to its non-destructive nature, the SRT significantly reduces consumption of resources and raw materials as well as increases the reliability of results since the same cylinder may be used for other tests; such as the compression test. This study also investigated the effect of curing conditions as well as the effect of Supplementary Cementitious Materials (SCM) and admixtures in HPC on RCPT and SRT results. Laboratory mixes were utilized for parametric studies and for correlating SRT and RCPT results. Field concrete samples from various bridge projects in New Jersey were also collected and tested to validate the correlation and provide the SR threshold that will be used in the NJDOT HPC Specifications. The outcome of this study is a complete statistical analysis of test data on specimens collected from laboratory as well as field mixes as to validate the SRT in comparison with the RCPT. Results show that adopting SRT in lieu of RCPT would be more economical and effective in determining the quality of construction.

17. Key Words Rapid Chloride Permeability, Surface Resistivity, High Performance Concrete		18. Distribution Statement	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No of Pages 98	22. Price

Form DOT F 1700.7 (8-69)

ACKNOWLEDGEMENTS

The authors would like to thank the New Jersey Department of Transportation (NJDOT) for their support on this project. Their financial support and the technical assistance of NJDOT Engineers in Bureau of Research, Dr. Giri Venkiteela and Paul Thomas, and Bureau of Materials, Eileen Sheehy, Fred Lovett, Jayant Patel, David Simicevic, and Zina Zadoroshnaya are gratefully acknowledged. The efforts of NJDOT field staff to prepare and deliver the concrete samples are also acknowledged.

The authors would also like to thank the undergraduate student research assistants at the RIME Group, Giuseppe Liberti, Dalexander Gonzalez, Mohammad Mansour, Zaina Hamdan, Christopher Sholy, Justin Grant, Dominic Wirkijowski and Anthony Castellano.

The authors would like to acknowledge the support of the cement suppliers (Lafarge N.A., Essroc, Riverside and Lehigh), pozzolan suppliers (Titan America, Holcim, Norchem, Euclid and SIKA), chemical admixture suppliers (W.R. Grace N.A., BASF, Euclid, Great Eastern Technology, SIKA and AXIM), and various aggregate quarries and concrete producers (Ralph Clayton & Son and Eastern Concrete Material) in New Jersey.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

Over the last decades, many bridge structures in the State of New Jersey have been constructed using High Performance Concrete (HPC) due to its advantage in strength and durability. HPC has been introduced by FHWA to help reduce both initial construction costs and long-term maintenance costs. However, when a bridge deck is exposed to aggressive and harsh environments, the chloride ions from de-icing salts could penetrate into the concrete deck through its pores, initiating corrosion of its reinforcement and diminishing its durability. This phenomenon is one of the major factors causing delamination and structural deficiencies of concrete decks. Therefore, there is a need for a reliable test method for measuring and evaluating the durability characteristics of various HPC mixes.

In order to achieve this goal, the New Jersey Department of Transportation (NJDOT), as well as other DOTs and state agencies, adopted the "Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration (AASHTO T 277)" or the Rapid Chloride Permeability Test (RCPT) at 56 days. The RCPT has proven to be a good tool that could provide comparative predictions of durability characteristics among different HPC mixes. However, the RCPT method is time consuming, labor-intensive, and exhibited high variability between various laboratories. An alternative test method that is being considered for evaluation by NJDOT and other agencies is the "Standard Test Method for Surface Resistivity Indication of Concrete's Ability to Resist Chloride Ion Penetration (AASHTO TP 95-11)" or the Surface Resistivity Test (SRT). The SRT method should be considered for durability evaluation because of the following reasons: 1) SRT is simpler and easier (takes 30 minutes compared with 6 personnel hours within 2 days for RCPT), 2) SRT is non-destructive (uses the same concrete cylinder specimen for compressive strength), 3) SRT is more cost-effective (requires less number of labor hours and less expensive equipment ($2,500 for SRT vs. $18,000 for RCPT)), and 4) SRT is repeatable (requires lower level of operating experience). However, prior to adopting SRT in the NJDOT HPC Specifications, there is a need to verify and establish its suitability, range of applicability, and the threshold limit for local materials and conditions in the State of New Jersey.

In this study, the SRT is evaluated as an alternative to the RCPT to determine the chloride ion permeability of concrete in accordance with AASHTO TP 95-11. The RIME Team (RT) has conducted the SRT and RCPT on the various HPC samples prepared in the RIME laboratory and collected from numbers of field mixes. In addition, the RT has performed a parametric study by evaluating the effect of the supplementary cementitious materials (SCMs), chemical admixtures, curing regimes, specimen sizes, etc. The RT has conducted the statistical analysis of the SRT and RCPT data for each parameter, developed a correlation between SR and RCP measurements for HPC mixes, and determined the SR threshold corresponding to coulombs numbers for verification and production phases. The results show that the typical lime curing has very minimal effect by 3.8% on SR and RCP measurement compared with the no-lime moist curing. The inclusion of SCMs results in higher SR reading and lower RCP reading. A minimal change is recorded between 56 days and 91 days of SR and RCP measurement compared with the change between 28 days and 56 days. This states that the SCMs have not fully reached their reaction time at 28 days, and therefore a 56-day SR and RCP measurement should be considered to evaluate the durability performance of the HPC. The set-accelerating admixture has no effect on the SR and RCP measurement, while the retarding admixture results in lower SR reading and higher RCP reading. Based on the testing results, the SR thresholds at 56 days corresponding to 1000 coulombs (verification phase) and 2000 coulombs (field production phase) are concluded. The SR threshold equivalent to 1000 coulombs is 48 kOhm-cm, and this is conservative compared with other agencies and studies (LADOTD and AASHTO = 37 kOhm-cm). However, the threshold equivalent to 2000 coulombs is 21 kOhm-cm, and this is equal to AASHTO value (21 kOhm-cm), but more conservative than LADOTD value (18 kOhm-cm).

The results show that the SRT can be used as an alternative to the RCPT to determine the indication of ability of concrete to resist chloride ion penetration. The SR threshold values of 48 kOhm-cm and 21 kOhm-cm are recommended for verification and production phases, respectively. However, since the numbers of HPC samples are limited due to limited research period, it is recommended to use the proposed SR threshold values simultaneously with RCPT limits of 1000 and 2000 coulombs for a transitional period of one year. This will help provide an updated further confirmation of SR threshold by increasing the data points for the SR vs. RCP correlation.

INTRODUCTION

High Performance Concrete (HPC) has become increasingly popular in the United State, especially for bridge decks. However, when the bridge deck is exposed to harsh conditions, its durability is diminished by the chloride ions penetration through the concrete deck. Due to deicing salts, the reinforcement will corrode as shown in Figure 1. Reinforcement corrosion is a predominant factor causing deterioration of reinforced concrete bridge decks. Reinforcing steel in concrete ideally does not corrode since protection is provided by the formation of a passive oxide coating on the surface of the steel from the initial corrosion reaction. The process of cement hydration in freshly poured concrete develops a high alkalinity, which in the presence of oxygen stabilizes the coating on the surface of the reinforcing steel, ensuring continued protection while alkalinity is retained. However, crack formation in concrete remains unavoidable due to many factors such as shrinkage reactions of setting concrete and tensile stresses occurring in the structure. Crack formation reduces the durability of the concrete as it increases the concrete permeability which allows for carbonation and aggressive elements such as chloride to corrode the reinforcing steel. On top of that, the ingress of the chloride ions into the concrete results in further cracking due to corrosion induced cracking. Figure 1 explains this phenomenon. The deterioration can be reduced by increasing the ingress/travel time for the chloride ions to reach the steel reinforcement which can be achieved by increasing the concrete cover and by utilizing low permeable concrete. HPC is used to enhance the durability of concrete by the addition of supplementary cementitious materials (SCMs), i.e. silica fume, fly ash, and slag. The SCMs react with calcium hydroxide [$Ca(OH)_2$] or the weak link between the aggregate particles and the hydrate cement paste to form calcium silicate hydrates (CSH) gel which is a strong cementing material. It is critical to evaluate the permeability of HPC to minimize delamination in concrete decks. As a result, the majority of the Departments of Transportation (DOTs) utilize the rapid chloride permeability test (RCPT) as a measure of the concrete durability property and it has been successfully used for several decades.

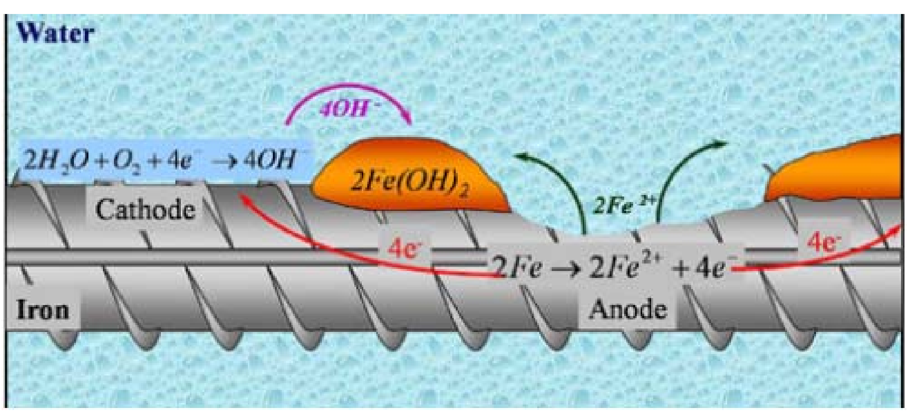


Figure 1. Corrosion Process [1]

To ensure a denser and impermeable concrete, especially for bridge decks constructed with HPC, many DOTs, including New Jersey Department of Transportation (NJDOT), employ the RCPT. Other DOTs also employ the 90-day salt ponding test (AASHTO T 259/T 260) and the Rapid Migration Test (NT Build 492) for quality assurance. The RCPT method has been successfully used to assess the permeability of concrete. However, research shows that the RCPT is not effective in assessing the chloride resistance of concrete and has the following drawbacks:

- The RCP measurement is not solely related to the chloride ion penetration, because it evaluates all ion movement including supplementary cementitious materials and admixtures.
- It is a laborious test which requires 24 hours for conditioning and testing.
- Test duration and destructiveness are directly related to the cost which is approximately $500 per sample.
- The high voltage 60V applied on the concrete specimen during the RCPT results in a temperature increase that could affect the RCP readings and thus compromise the accuracy of the test.

Recently, AASHTO published a provisional test method entitled “Standard Test Method for Surface Resistivity Indication of Concrete’s Ability to Resist Chloride Ion Penetration (AASHTO TP 95-11)”, and ASTM is developing a new test method entitled “New Test Method for Measuring the Surface Resistivity of Hardened Concrete Using the Wenner Four-Electrode Method (ASTM WK37880)”. These test methods are known as the Surface Resistivity Test (SRT) and determine the electrical resistivity of concrete. The SR test provides an indication of the concrete’s resistance to chloride penetration and is potentially an alternative to the Rapid Chloride Permeability Test (RCPT) entitled “Standard Test Method for Electrical Indication of Concrete’s Ability to Resist Chloride Ion Penetration (AASHTO T 277)”.

After Morris et al. (1996) initiated the study on concrete resistivity applications many research efforts have then been directed towards understanding the parameters that could affect the SR and RCP correlation, and how to correlate results between SR and current RCP tests. [2] The major parameters that should be considered for the variability of SR are (1) concrete wetness, (2) concrete mix constituents, and (3) specimen geometry. Sengul et al. (2008) evaluated the effect of curing conditions on the concrete resistivity, and the results indicated that the resistivity was greatly influenced by moist conditions as well as the curing temperatures.[3] The effect of size and type of aggregate was also studied by Morris et al. (1996) and Rupnow et al. (2012). [2; 4] A greater variability was observed with larger aggregate sizes, but less variability was observed between various aggregate types. A comparative study of the aggregate showed that aggregate size was more prone to high variability in comparison with aggregate type.

Previous research and practice show that the surface resistivity effectively provides an indication of concrete durability in a laboratory setting. Other research efforts also developed the correlation between SR and RCP utilizing concrete samples collected from the field. Preliminary results from the AASHTO TP 95-11 have indicated that the electrical resistivity exhibited a good correlation with the chloride ion permeability in most cases. Other State agencies' Specifications show that the SRT could predict the concrete permeability and could substitute the RCPT. However, the SR threshold is not consistent because of the state-specific conditions and different local resources and materials. Therefore, there is a need to establish an appropriate and state-specific SR threshold for HPC with local materials and HPC mix proportions in NJ. This research study tested local HPC mixes to determine the correlation between SR and RCP measurements, and to deduce a SR threshold corresponding to the RCP coulombs at 56 days (e.g., 1000 coulombs for verification requirement and 2000 coulombs for acceptance requirement) that can provide input to update the HPC Specifications.

OBJECTIVES

The main objective of this project is to evaluate the Surface Resistivity Test (SRT) method (AASHTO TP 95-11) and to provide recommendations for NJDOT HPC Specifications. The objectives of the study can be achieved by determining the SR threshold based on validation tests that can be used to develop the HPC Specifications for quality control and assurance. Given that the current standard is the RCPT, it should be evaluated for each HPC mix to compare with the SR. The outcome of this study will be a complete statistical analysis of test data to validate the SRT method in comparison with the RCPT method currently used by NJDOT.

LITERATURE REVIEW

According to a survey conducted by Florida DOT (not published yet but made available by NJDOT's Director of the Bureau of Materials), 14 State DOTs have evaluated or will be evaluating the SRT, while 3 other DOTs already have implemented the requirements based on their in-house evaluation. The details of the survey (condensed by the RIME Team (RT)) are summarized in the Appendix I: SR Survey Summary Conducted by NJDOT. Florida DOT, Louisiana DOTD (DOT and Development) and Virginia DOT have considered the SRT method as a tool to measure the durability characteristics of various concrete classes. Accordingly, FDOT and LADOTD recently published a new version of their Standard Specifications for Roads and Bridges that implemented the SRT for quality control and pay adjustments. Florida DOT made the transition from the RCPT to the SRT for Class V special concrete (fc' = 6000 psi). The threshold value of 29 kOhm-cm has been used as a criterion for acceptance, while quality assurance pay adjustment is determined and implemented based on the Specifications for HPC classes (Class IV, Class V, Class V-Special and Class VI concrete). Similar to FDOT, LADOTD also established its own SR threshold. As a result, concrete resistivity of 27 kOhm-cm has been one of the requirements criteria for structural concrete class including HPC for the acceptance and payment and assessments. VDOT tried to validate whether the SRT could be used to predict the permeability of light weight concrete (LWC), and concluded that it could be applied in screening or accepting the permeability levels of LWC. However, VDOT did not consider using the SRT for HPC class.

Chini et al. (2003) collected 508 samples from Florida DOT projects to perform the SRT and RCPT at different ages, and they found that the two tests (SRT and RCPT) have shown a strong relationship at 28 days (R^2=0.9481) and 91 days (R^2=0.9321).(5) Similarly, Rupnow et al. (2011) performed the SRT and RCPT on 21 laboratory mixtures and 140 field mixtures, and found that the SR and RCP measurements also can be strongly correlated.(4) Salvador et al. (2013) from the RIME Laboratory evaluated the effect of curing temperature using accelerated curing on SR and RCP, and concluded that the curing condition did not affect the correlation between SR and RCP measurements with an R^2 of 0.923.(6)

Salt Ponding Test

The 90-day Salt Ponding test (Ponding test), standardized in AASHTO T 259 and ASTM C1543, has been widely used and adopted by state agencies for determining concrete resistance to chloride ion penetration by the simulation of such penetration into concrete bridge decks. The test consists of three concrete slabs with a 3-inch thickness. A 12-inch square plastic dike is assembled around the top perimeter of the slab to hold the 3% sodium chloride (NaCl) ponding solution while the bottom perimeter remains exposed. During the conditioning phase, the specimens are moist cured for a certain period of time and then stored in a dry 50 percent relative humidity environment. AASHTO T 259 specifies moist curing for 14 days and then drying for 28 days, while ASTM C1543 specifies moist curing until 14 days or a specified compressive strength is reached. The ponded slabs are stored in a 50 percent relative humidity environment. To prevent water evaporation and to maintain a constant concentration of NaCl in the solution, a cover is placed over the plastic dike. AASHTO T 259 specifies a 90 day ponding period after which chloride ion content is determined from 0.5-inch thick specimens according to AASHTO T 260. ASTM C1543 specifies initial sampling of 0.5-inch thick specimens at 90 days, according to ASTM C1152, and later sampling at different durations (6 and 12 months) for more accurate evaluation of low-permeability concretes.

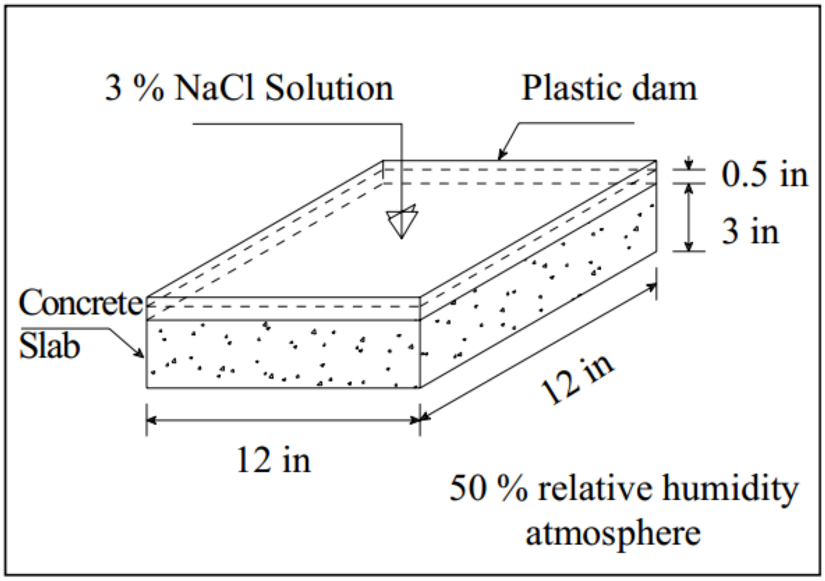


Figure 2. Salt Ponding Test [7]

The ponding test is criticized for its lack of emphasis on the importance of the mechanisms of chloride transportation into the concrete. The test setup and conditioning phase, result in chloride ion penetration through mechanisms besides diffusion such as sorption and wicking. The sorption effect takes place after the 28 day drying period after which the salt solution is poured in the dike on the specimens. As for wicking, it is due to the difference in relative humidity between the diked and exposed areas resulting in moisture transmission and further chloride ion penetration. [7] The amount and speed of chloride ion penetration depends on their mechanisms of transportation which in turn in influenced by many factors such as chemical concentration and environmental conditions.

Rapid Chloride Permeability Test

Concrete's ability to resist chloride penetration is a determining factor when evaluating performance and durability. This characteristic of concrete is measured and determined by a standard test method for electrical indication of concrete's ability to resist chloride ion penetration known as the rapid chloride permeability test (RCPT). This test was initially developed by the Portland Cement Association, for a research program sponsored by the Federal Highway Administration (FHWA). The test methodology has been revised and adopted by the construction industry, traffic agencies and organizations (AASHTO T277 and ASTM C1202). The RCPT measures concrete electrical conductivity which provides an indication of chloride ion penetration in terms of charged passed (coulombs); through monitoring an electrical current passed through a concrete specimen over a period of 6 hours. [(7)] Before conducting this test, there are certain conditioning procedures up to 20 hours. A direct current induced by a 60 V potential difference causes the transportation of ions between two reservoirs in the cell block containing 3.0 % sodium chloride (NaCl) and 0.3 N sodium hydroxide (NaOH) solutions.

The electric charges effective path length exceeds the thickness of the concrete specimens due to nonconductive and obstructing particles in the concrete referred to as concrete tortuosity. Electrical conductance is determined quantitatively by the measurement of passing charges in coulombs over the test duration. The total charges passed give an indication of the specimen's resistance to chloride ion penetration. [(7)] The ranges set for RCPT readings to rate chloride ion penetrability are listed in Table 1 below. Due to the effect of testing age and curing conditions on chloride ion penetrability, the standards, such as ASTM C1202, provides testing procedures and testing ages.

Table 1 - Chloride ion penetrability based on charge passed (ASTM C1202)

Charge Passed (coulombs)	Chloride Ion Penetrability
> 4,000	High
2,000 - 4,000	Moderate
1,000 - 2,000	Low
100 - 1,000	Very Low
< 100	Negligible

The RCPT is developed to correlate with the actual chloride ion penetrability of concrete during typical environment, and it has been used by many state agencies for quality assurance of HPC. However, the RCPT has been criticized by other researchers during the past decades for inconsistency. The RCPT provides means, through electric indication, to estimate concrete's resistance to chloride ion penetration. In some cases, and for simplicity, the RCPT readings are accepted as indicators of permeability. However, in this context permeability refers to the penetration of water carrying ions into the concrete and not solely chloride ion penetration. Many studies indicate that while the RCPT has correlated well with the Ponding Test explain above (Table 2), ASTM C1543, in conventional concrete, this coloration does not hold when with concretes containing supplement cementitious materials (SCMs) and chemical admixtures. [(9)] A high potential 60V applied to each extremity of the concrete sample increases the rate at which chlorine ions penetrate the concrete, but this is not realistic to demonstrate the actual concrete durability behavior. Prabakar et al. (2010) pointed out that RCPT results at higher potentials (over 40V) resulted in temperature increase during the 6-hour testing period, and the temperature is one of major factor to affect the repeatability of RCPT. (10) The coefficients of variation (COV) of the RCPT are 12.3% and 18.0%, if tested by the same operator or by multiple laboratories, respectively. Due to the high variation, the RCPT may not be suitable as a standalone test to determine the quality of concrete; therefore, a number of state agencies still require the 90-day salt ponding test in case the RCPT fails. Such high discrepancies and non-repeatability suggest that a new test method such as the SRT is needed. Some research has been conducted to evaluate the consistency and repeatability of SRT method. Icenogle et al. (2012) found that the coefficient of variation of a single test result was 2.2% in the same laboratory, which yields 6.2% variability for a single specimen in the same lab. Similarly, the coefficient of variation is 3.9% in a multi-laboratory setting, which yields only an 11% variation among different labs. Compared with the RCPT, the SRT is more precise, and therefore could also be considered more reliable to measure the durability characteristics of concrete. (11)

Researchers agree that the introduction of SCMs and chemical admixtures into the concrete, such as in HPC, the chemistry of the pore solution is altered. (12) This alteration in the pore structure chemistry will impact RCPT results, typically with lower reading, and thus the effectiveness of this test as an indicator of chloride ion penetration. (13) Researchers also argue that since the desirable effects of added SCMs to enhance the concrete may not have been achieved yet during the first 56 days due to their reaction time and behavior, although it has been proven and accepted that SCM containing concretes have lower permeability, the low RCP test reading at that time do not reflect actual chloride ion penetration. (14)

Table 2 - RCP and 90-day Ponding Test correlation

Chloride Ion Penetrability	RCP (coulombs) (ASTM C 1202)	Ponding Test (%) (AASHTO T 259/260)
High	> 4000	> 1.3
Moderate	2000 – 4000	0.8 – 1.3
Low	1000 – 2000	0.55 – 0.8
Very Low	100 – 1000	0.35 – 0.55
Negligible	< 100	< 0.35

Surface Resistivity Test

Concrete resistivity is considered an effective measure in identifying the risk of reinforcement corrosion. Over the past few decades as the methods used to determine concrete resistivity developed, the popularity of SRT has increased because of it nature of nondestructive and cost saving test.(14)

Before discussing the SRT, it is important to make the distinction between resistance and resistivity. Resistance (*R*) the obstruction of electric current (*I*) passage by the conductor, in this context concrete, and is defined with the equation:

$$R \text{ (ohms)} = V/I \tag{1}$$

where V is voltage and I is current.

As for resistivity (ρ) it is a property of the material and defined with the equation:

$$\rho(\mathrm{ohms} - \mathrm{length}) = \mathrm{R/AL} \tag{2}$$

where A is cross-sectional area and L is element length or height of the concrete specimen.

In practice, the current testing method for surface resistivity involves the use of a light weight hand held device, referred to as a resistivity meter, which measures surface resistivity through four probes, known as Wenner probe, that are pushed against the concrete surface. One of the most recent and simplistic devices in the industry is the Resipod Resistivity Meter manufactured by Proceq which was utilized by the RT.

The four probes of the resistivity meter are equally spaced at 50 mm, almost 2 inch, of which a steady current is impressed through the two outer pins, and the current difference is measured by the two inner pins; as illustrated in Figure 3.

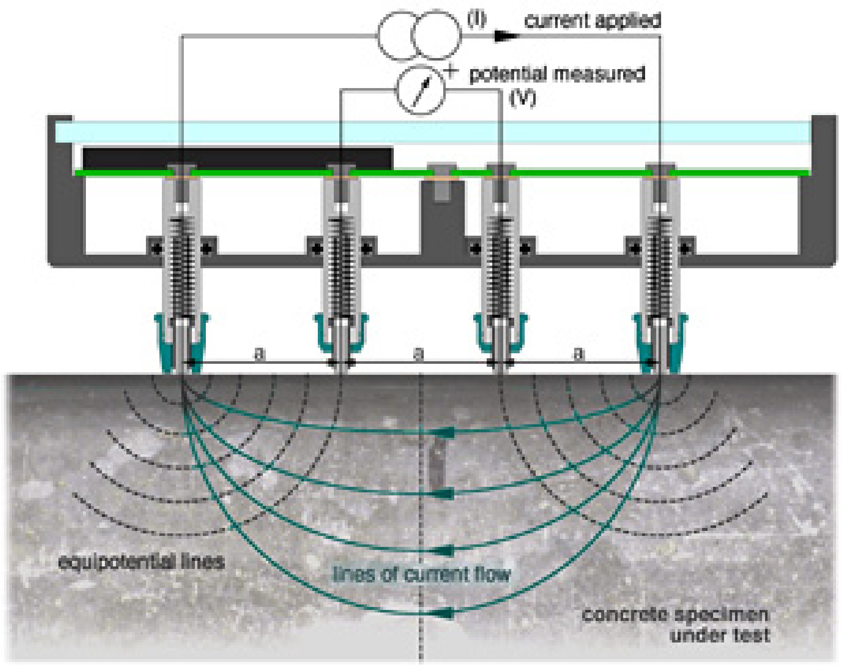


Figure 3. Four-probe resistivity meter [16]

The surface resistivity limits for chloride ion penetrability indication as specified in AASHTO Designation: TP 95-11 are listed in Table 3.

Table 3 - Surface resistivity limits [17]

Chloride Ion Penetrability	100-mm X 200-mm (4 in. X 8 in.) Cylinder (KOhm-cm) a = 1.5	150-mm X 300-mm (6 in. X 12 in.) Cylinder (KOhm-cm) a = 1.5
High	< 12	< 9.5
Moderate	12 – 21	9.5 – 16.5
Low	21 – 37	16.5 – 29
Very Low	37 – 254	29 – 199
Negligible	> 254	> 199

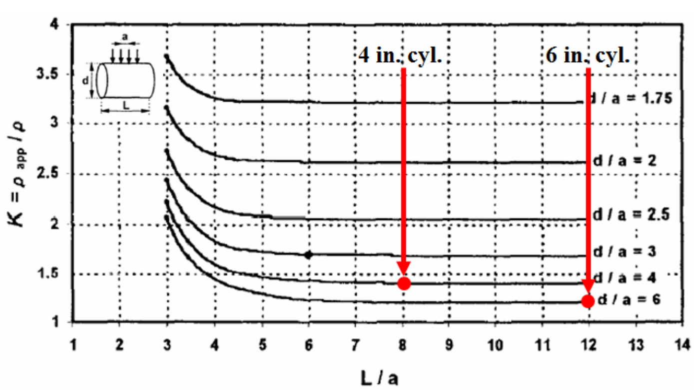
Effect of Various Factors on SR Measurement

Criticism of the SRT has been with regards to the proper implementation of the testing procedure and field applications. Authors have observed that the presence of steel reinforcements and cracks alter the surface resistivity readings and investigated the appropriate adjustments for certain cover thicknesses. (18, 19, 20) However, with laboratory applications and testing of concrete cylinders which do not have reinforcement embedded, such concerns do not apply. Another influencing factor is the non-homogeneity of concrete. The various constituents in the concrete affect the resistivity. (20) This is why it is necessary to take the measurement at different locations of the cylinder for more uniform and useable readings. Proper implementation of the testing procedure as specified in the standards and by the manufacturer, such as frequent dampening of probes and ensuring contact of all four probes with concrete surface, is absolutely necessary to minimize the user sensitivity drawbacks. With SR testing, there is more control, adjustments are very easy to make and drawbacks can be avoided.

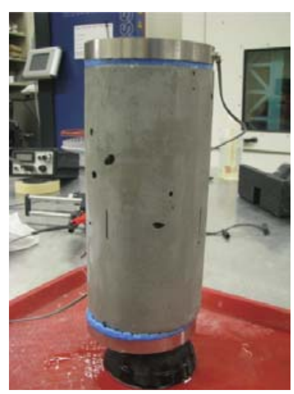
The contributions of various factors on the SR measurement, such as the specimen size and geometry, wetness and temperature, SCMs, admixtures, aggregates, pore structure, etc. will be discussed below.

Effect of Specimen Size and Geometry

Several different specimen geometries and sizes have been used to measure the resistivity of concrete. Morris et al. (1996) applied the resistivity measurement on concrete specimens using the Wenner probe, and it was found that typical cylinder sizes of 4 in. and 6 in. may be used for SR measurement. (2) Alternatively, a correction factor should be applied for an accurate measurement as summarized in Figure 4(a). Spragg et al. (2011) utilized a uniaxial test with a set of plate electrodes to measure the resistance through the cylinder as shown in Figure 4. Spragg et al. (2011) found that a linear agreement was noticed between the Wenner probe measurement and the uniaxial resistivity measurement. (21)



(a)

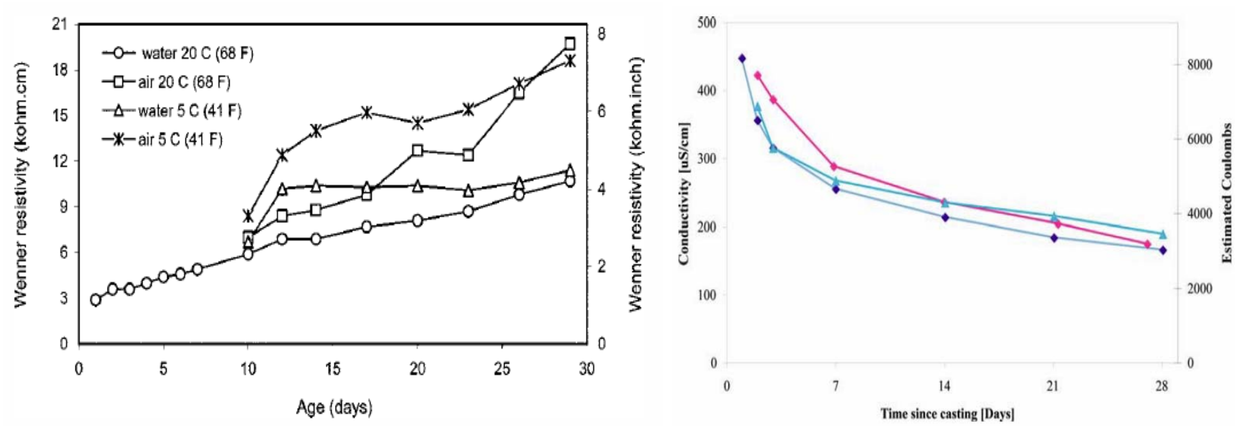


(b)

Figure 4. Specimen geometry; (a) correction factor K (2), and (b) uniaxial test (21)

Effect of Specimen Temperature and Wetness

In AASHTO TP 95-11, it is suggested to measure the SR of a saturated specimen at room temperature (23^{o}C). Specimen wetness and temperature can influence the resistivity measurement. When specimens are dried, ion mobility decreases, conductivity increases and thus resistivity decreases. Salvador et al. (2013) evaluated the effect of wetness on SR readings, and it was found that specimens with higher saturation resulted in higher resistivity than dry specimens, but the increasing rate varied depending on the additives. An increase in both wetness and temperature of the sample gives an increase in the mobility of the ions in the pore solution and a decrease in the resistivity. [(6)] A comparative study of wetness and temperature for the concrete resistivity showed that the wetness and concrete curing temperature affect the concrete resistivity. Similarly, Vivas et al. (2007) performed the SRT on concrete specimens that were both lime ($Ca(OH)_2$) cured and typical moist cured, and showed that curing conditions had no effect on the resistivity measurement. [(22)] The resistivity is also governed by the microstructure and pore solution. Snyder et al. (2003) evaluated the effect of temperature on the conductivity of concrete, and it was found that a 1^{o}C of temperature increase gives a 2% of conductivity increase (or resistivity decrease). [(23)] On the other hand, Nokken et al. (2008) found that the concrete temperature (23^{o}C vs. 6^{o}C) affected the concrete conductivity at early age (within 14 days) because of the degree of hydration. [(24)]



(a) (b)

Figure 5. Effect of Temperature and Wetness; (a) Sengul et al. [(3)], and (b) Nokken et al. [(24)]

Effect of Chemical Admixture, and Aggregate Size

Nokken et al. (2008) evaluated the effects of the chemical admixtures on the conductivity, Types A, C, D, E and F conforming to ASTM C 494. [(24)] The results show that all admixtures except Type E (water reducing and accelerating admixture) increase the conductivity at earlier age only, but the conductivity with Type C admixture (accelerating admixture including corrosion inhibitors) is increased by maximum of 50% compared with control mix. The aggregate size is known as to be more prone to affect the SR than aggregate type. When a smaller size of aggregate (#67) was used, the SR increased by up to 50% compared with a larger aggregate size (#57). These results are summarized in Figure 6. [4]

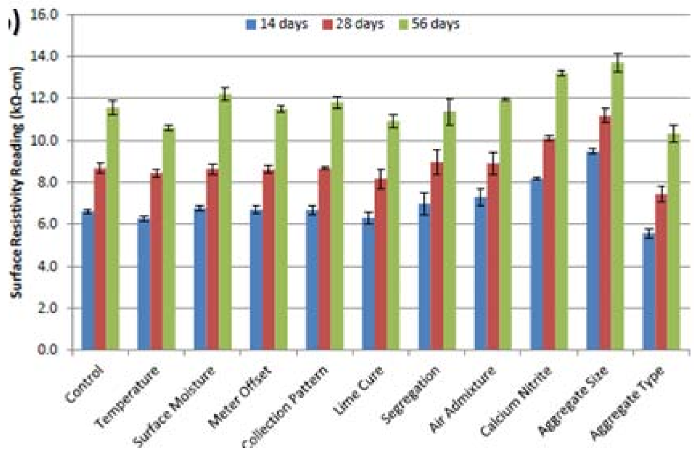


Figure 6. Effect of Various Types of Parameters including Aggregates [4]

Air entraining admixtures (AEA) cause microscopic stable bubbles of air to form evenly throughout the concrete mix to absorb concrete expansion. AEA are conventionally added to improve workability in concretes susceptible to freeze-thaw or poured in environmental conditions where temperature instability may cause undesirable factors in the concrete. AEA is introduced during mixing and thus it is necessary to test on the field for site pours and not at the plant since mixing takes place in the concrete trucks as well. AEA are also used to reduce bleeding and segregation which leads to increasing service life and enhancing durability. [25]

Water Reducer (WR) is used to reduce the amount of water used by around ten percent. High Range Water Reducer (HRWR) or Superplasticizer is used to further reduce amount of water reduced by up to thirty percent. Since it affects fresh concrete properties, its effects are tested for by one the fresh concrete properties tests, known as the slump test. Utilizing certain chemicals, such as hydrocarboxylic acid, WR may be designed and applied to accelerate or retard the concrete setting time as desirable. For accelerators, the industry has moved towards non-calcium chloride chemicals to avoid negatively impacting fresh concrete properties. Desirable effects of WR include less bleeding and segregation, early strength enhancement, increase of slump, reduced permeability, increased workability and durability. The use of WR is very beneficial in HPC where a lower water-to-cementitious ratio is required. [26]

Effect of Supplementary Cementitious Material

Fly ash

The use of fly ash as a SCM in the concrete industry has been consistently increasing over the past few decades. Fly ash is a by-product of the coal burning process generally at electric power generation plants and thus it presents an economical advantage over Portland cement. It is used as a supplementary cementitious material to replace a portion of the Portland cement used in concrete mixtures. As it is exposed to moisture, it forms cementitious compounds adding density and strength to the concrete. Having finer particles than cement, fly ash increases workability, pump ability and alkali and sulfate aggregate resistance. By reducing the amount of water needed, fly ash is also credited for reducing permeability, bleeding and segregation. (27)

Ground Granulated Blast-Furnace Slag

Another SCM used in HPC is ground granulated blast furnace slag (GGBFS) or slag. Slag is obtained from blast furnaces as a by-product of iron manufacturing. It is also used as a supplementary cementitious material to replace a portion of the Portland cement used in concrete mixtures. Like fly ash, slag also presents and economical advantage over Portland cement. Depending on percentage of substituted cement with slag and slag grade desirable benefits of slag include reduction in water demand, extension of setting time, increased workability and reduced permeability. Slag concrete mixes demonstrate higher resistance to chemical attack than traditional concrete. (28)

Silica fume

Micro-silica or silica fume is another pozzolanic cementitious material used in HPC. Silica fume is an ultrafine powder obtained from electric furnaces as a byproduct silicon and ferrosilicon alloy production. (29) Although with the introduction of silica fume into the mix , water demand is slightly increased , concretes with portions of cement substituted for with silica fume tend to demonstrate higher compressive and bond strength as well as higher resistance to chemical attack and deterioration. Conventionally, admixtures, such as AEA and HRWR, are added as needed when silica fume is introduced to maintain required air content and compensate for increased water demand. (30)

RESEARCH APPROACH

A preliminary study performed by the RIME Team (RT) shows that the SRT provides an efficient, reliable, accurate and cost-effective method to evaluate the durability characteristics of HPC as an alternative to the rapid chloride permeability test (RCPT). However, various parameters, (e.g., curing conditions, temperature, specimen geometry, moisture content, aggregate size and type, SCMs, etc.), need to be investigated to validate the SRT method using laboratory as well as field HPC mixes.

Laboratory Mixing and Sampling

Mixing and casting of samples is based on ASTM C192 using a 6 cubic foot capacity portable electric mixer shown below in Figure 7.

Figure 7. Electric Portable Mixer

Mixing

All material to be used are batched in five gallon buckets and placed within a short distance from the mixer to facilitate the mixing process. Carefully measure proportions of certain admixtures, such as high-range water reducer, is poured into the mixing water bucket and stirred. However other admixtures, retarder and superplasticizer, are introduced into the mix at a later stage to avoid intermixing. Mixing water is split into two buckets, one-third and two-thirds. For practicality and safety the mixer is stopped whenever water, cementitious materials, sand or aggregate are added. The mixer is first rinsed with water and buttered with a mixture of cement, sand and water. Coarse aggregate and the two-third mixing water are then added. After starting the mixer for a few revolutions, fine aggregate is then added. After around one minute, the mixer is stopped again and the remaining mixing water along with all the cementitious materials such as, Fly Ash, Silica Fume or Slag, are added to the mixer. At this point all materials are added to the mixer, and allowed to mix uninterruptedly for three minutes followed by three minutes of rest during which the inside of the mixer can be visually inspected to insure uniformity of mixing. The mixer is then turned on again for two minutes of final mixing. Starting with the slump test, fresh concrete properties tests are performed at this point. If required slump is not met, super plasticizer proportions may be adjusted.

Slump Test

Slump test was performed in accordance to ASTM C134. The test is conducted out using a slump cone mold. First the non-absorbent base plate and the interior of the cone are dampened. The base of the cone, or the end with the larger opening, is then placed on the base plate and fresh concrete is scooped into the mold at three stages each time filling one-third of the mold and immediately followed by uniform rodding with twenty five even strokes. The top of the cone is then leveled and excess concrete is disposed from around the mold base. The mold is then vertically removed carefully and immediately placed beside the slumped concrete. Finally the rod is placed horizontally across the mold and the slump is measured. Slump test set up is demonstrated in Figure 8 below.

Figure 8. ASTM C134 Slump Test Setup

Figure 9. ASTM C231 Type B Pressure Air Meter

The next fresh concrete properties test, after meeting required slump, is the ASTM C231 Type B Pressure Air Meter test, shown in Figure 9 to determine the air content of the concrete mixtures. This test must be conducted carefully with and the meter must be calibrated correctly for accurate readings.

After the container is washed, it is placed on a flat surface fresh concrete is scooped in at three stages each time filling one-third of the container and immediately followed by uniform rodding with twenty five even strokes and tapped on the sides with a rubber mallet fifteen times to release entrapped air bubbles. Once the container is filled, the top is then leveled and excess concrete is disposed. Before assembling the apparatus the upper flanges are cleaned with a sponge to achieve an airtight connected. Using a squirt bottle, water is released into one petcock valve until it flows out through the other. This process is repeated to the other petcock valve and then they are both shut simultanously.in the meantime the container is tapped with the rubber mallet as required.

The air pump is then applied until the pressure gauge needle rests at zero percent. Obtaining zero percent reading with require tapping the gauge however improper calibration or fitting might cause the needle to fluctuate away. Air is then released by opening the main air valve and the needle will move towards the air content reading.

Laboratory Sampling

Sampling of fresh concrete is conducted in accordance with ASTM C172. Fresh concrete is scooped into four by eight inch plastic cylindrical molds, greased with sampling oil ,at two stages ,each time consolidating through rodding for twenty five times for each half of the cylinder and then tapping fifteen times. Figure 10 demonstrates the molds used for sampling.

Figure 10. Molds Prepared for Sampling

Field Sampling

Field samples were collected from concrete bridge deck pours across the state of New Jersey by the Rutgers Infrastructure Monitoring and Evaluation (RIME) Group for NJDOT and NJTA sponsored projects. Depending on the study, a sufficient amount of HPC samples were collected from various locations and taken back to the Rutgers Civil Engineering Laboratory for curing and testing. For field samples ASTM C31 was followed as much as permissible, however for safety reasons and due to construction site regulations some samples had to be transported earlier that the specified time. To compensate, the samples were transported in large cooling boxes and placed in a manner to minimize the effect of vibrations. Figure 11 illustrates the field sampling set

up in two different locations.
During the first phase, the research team received 60 samples from 6 different field mixes (10 cylinders per construction site), and performed the SRT at the ages of 28 and 56 days and RCPT at the ages of 56 and 91 days. For the second phase, no samples were delivered to the research team, but the research team visited several NJTA and NJDOT field locations to collect the samples.

Figure 11. Field Sampling Setup

During field sampling, slump and air pressure tests are performed by the quality control professionals and the reading are recorded as illustrated in Figure 12. Sampling by the RIME group is only conducted after the batch is approved by the quality control professionals. In the batch did not meet requirements, the concrete truck is rejected and leaves the site without pouring.

Figure 12. Quality Control Professionals Transporting Fresh Concrete for Slump and Air Pressure Testing

On the site, concrete is poured into a wheel barrel that is then transported to the set up location within a very close radius as shown in Figure 12. Fresh concrete is scooped into four by eight inch plastic cylindrical molds, greased with sampling oil ,at two stages ,each time rodding for twenty five times for each half of the cylinder and then tapping fifteen times as illustrated in Figure 13.

Figure 13. Rodding Fresh Concrete in Molds

The top of the molds then leveled and excess concrete is disposed. At this point the molds are covered with lids to restrict evaporation, as illustrated in Figure 14, and covered with wet burlap. Depending on environmental and weather conditions, samples are either stored in large cooling boxes or left under the wet burlap.

Figure 14. Covering Molds with lids to prevent evaporation

Curing Regimes

After Sampling, all of the cylinders were cured in the environmental temperature and humidity controlled chamber as illustrated in Figure 15 for the first 24 hours for initial curing. Conditions in the environmental chamber are maintained 74 degrees Fahrenheit and 50% relative humidity. As an alternative to using wet burlap and to avoid the risk of contact between the burlap and the fresh concrete, the molds were covered with lids to restrict evaporation.

Figure 15 Environmental Chamber

Moist Curing

The moist curing practice is based on ASTM C511. Samples are stored in the curing room maintained at around 73°F and relative humidity greater than 95% until testing day. Samples are placed away from any sources of water. Figure 16 shows the curing room where the samples were cured.

Figure 16 Moist Curing Room

Lime Bath Curing

Excessive hydrated lime (calcium hydroxide) was dissolved in the water to make a saturated solution. Lime content in the tanks is maintained at 3 g/L in accordance with ASTM C511. Temperature is maintained at 73.5 ± 3.5 °F and galvanized steel tanks were used to avoid corrosion as shown in Figure 17. Concrete samples were cured in the lime bath after demolding at 24 hours. Samples were tested at each age after removing the excess water.

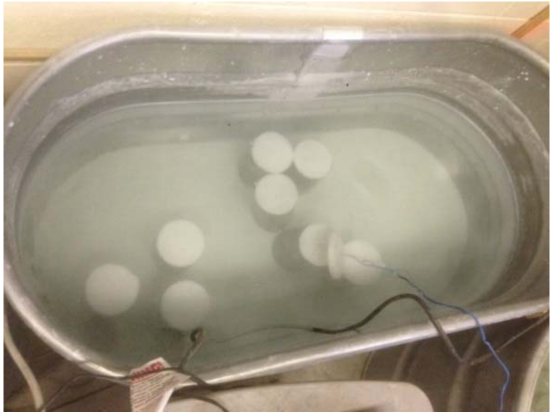


Figure 17 Lime Bath Curing

Water Bath Curing (no lime)

ASTM C511 specifies the addition of hydrated lime into water storage tanks illustrated in Figure 18. Hydrated Lime was not added into water bath to observe the effect of lime on surface resistivity, rapid chloride permeability and compressive strength. Concrete samples were placed in the water tank when they were demolded after 24 hours. Cylinders were tested at the ages described below when the samples were taken from the bath and the excess water was removed.

Figure 18 Water Curing Tanks

Accelerated (Hot) Lime Bath Curing

In this method the samples are taken out of the lime bath after seven days in accordance ASTM C1202 and stored in hot lime bath where temperature is maintained at 100 ± 3°F using electric tank heaters. The tanks are fitted with temperature sensors connected to a data logger for continuous temperature monitoring and control.

Figure 19 Accelerated (Hot) Lime Bath Curing

Testing Procedure

Rapid Chloride Permeability Test

The RCP test is typically conducted at three ages, at 28 days, 56 days and 91 days. Two 4 in x 8 in concrete cylindrical samples are used to conduct this test. One 2 ± 1/8 inch specimen segment is taken from each sample using concrete saw blade in Figure 20, after removing the top exposed surface, top segment is cut for the 28 days test, the following segment for the 56 days test and the bottom segment for the 91 days test. After placing the specimens into the vacuum desiccator, vacuum is maintained for 120 minutes under dry conditions to aspirate entrapped air. Figure 21 illustrates a vacuum pump apparatus setup.

As a purer alternative to preparing deionized water by boiling tap water, distilled water is then added to the vacuum, through water stopcock, until specimens are completely submerged and left with pump on for an additional 60 minutes after which specimens are left to sock between 16 to 20 hours. This procedure insures the removal of ions that would interfere with concrete conductivity.

After this 18 hour period of submergence without vacuuming, the conditioning phase is completed and the specimens are assembled in voltage cells. The cells used for this test are manufactured by Germann Instruments (GI) and designed to include a plastic ring between two voltage test blocks fitted with rubber washers. This design ensures the specimens are not exposed as an alternative to conventional practice of epoxy coating.

This design also includes air vents or cooling fins in each voltage cell block as an answer to skepticism regarding the increase of specimen temperatures in traditional RCPT cell blocks and its effect on the results. The three mentioned parts, two voltage cell blocks and plastic ring with washers, are then tightly screwed together with the specimen enclosed. Both cell blocks include reservoirs where a 3% sodium chloride (NaCl) solution is poured in on one side and a 0.3 N sodium hydroxide (NaOH) solution into the other. The voltage cell blocks are then plugged into the GI Proove-It device which maintains a 60 V voltage through the cells. A predicted reading is given on the monitor and after six hours the actual reading is displayed after which the test is concluded. The test setup is conducted under room temperature conditions. Figure 22 illustrates the final setup for the RCPT.

Figure 20. Concrete Saw Blade

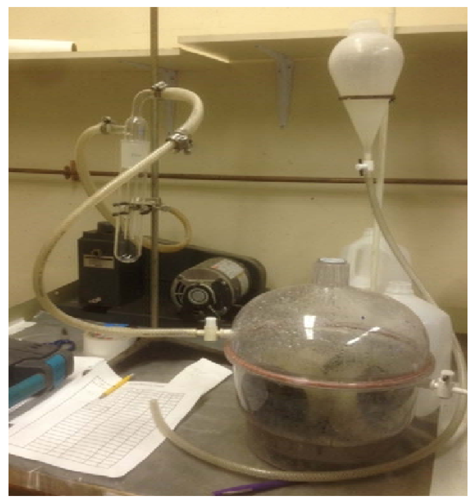


Figure 21. Vacuum Pump Apparatus Setup

Figure 22. Voltage Cell Blacks Assembled and Plugged

Surface Resistivity Test

The Surface Resistivity (SR) Test is conducted in accordance to AASHTO Designation: TP 95-11. Two 4 in x 8 in samples are used to perform the SR test to ensure consistency. Hot cured samples are placed in room temperature tanks for a period of half an hour to allow the samples to cool down and thus eliminate the effect of temperature on the reading. Also samples cured in the curing room are placed in room temperature tanks to insure they are well saturated before testing. Resipod Resistivity Meter, manufactured by Proceq, measure resistivity through a four-point Wenner probe. Firstly, the cylinders are labeled at four points around the circumference of the top face 0, 90, 180, and 270 degrees. Next, all four probes of the SR meter are pushed against the longitudinal surface of the cylinder at the 0 degrees mark and once the reading stabilizes the resistivity measurement is recorded. It is important to ensure that all four probes are in contact with a smooth surface of the cylinder while performing the test as illustrated in Figure 23(a) and (b). The same procedure is then repeated for all the marked degrees going around the cylinder twice and recording a total of eight readings.

(a) (b)

Figure 23. (a) Surface Resistivity Test (b) pushing all four probes at marked degrees

Mix Designs

HPC mixes were prepared in the Civil Laboratory as well as collected from NJTA and NJDOT field pours at several locations. All concrete ingredients used in this study are qualified by NJDOT and listed in the database and the mix designs are summarized in Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9.

For laboratory mixes, fresh concrete properties such as the slump and air content were also tested. After the initial 24 hour curing in an environmental chamber, concrete samples were cured as described in the curing section until the age of testing. The parameters considered in this laboratory study are supplementary cementitious materials (Fly Ash, Slag, and Silica Fume), aggregate size and type and chemical admixtures (retarder and accelerator) as summarized in from Table 4 to Table 9. Chemical admixtures, such as high range water reducer (HRWR), air entraining agent

(AEA), etc., were also used. Another parametric study was conducted to study the effect of SCMs and admixtures in several curing regimes. The RCPT was conducted on 28, 56 and 91 days while the SRT was conducted on 7, 14, 28, 56 and 91 days. The curing regimes applied were 100% humidity (moist curing in curing room), lime saturated solution (lime bath curing), and hot (accelerated) saturated lime solution (hot lime bath curing) at 100 ± 3°F. Temperature in curing room and lime bath was maintained at 74 ± 2 °F.

Through collaborations with Engineers from NJDOT Materials Laboratory, field samples were also collected. The same geometry and environmental parameters (Wenner Probe spacing and concrete specimen size) were applied in both cases. During last phase, the research team received 60 samples from 6 different field mixes (10 cylinders per construction site), and performed the SRT at the ages of 7,14, 28 , 56 and 91 days and RCPT at the ages of 28, 56 and 91 days. For this phase, no samples were delivered to the research team, but the research team visited several NJTA and NJDOT field locations to collect the samples. The followings are examples of mixes collected from the field.

Table 4 - Parametric Study Mix Design and Fresh Concrete Properties

ID		C	SL	FA	RET	ACC
PC	lb/cy Type I	650	430	530	530	530
SF	lb/cy	-	25	25	25	25
FA	lb/cy Class F	-	-	95	95	95
SL	lb/cy Grade 100	-	195	-	-	-
Gravel	lb/cy #57	1815	1805	1802	1802	1802
Sand	lb/cy	1198	1186	1175	1175	1175
W/C	-	0.4	0.4	0.4	0.4	0.4
AEA	fl. oz/cwt.	1.5	1.5	1.5	1.5	1.5
HRWR	fl. oz/cwt.	8	8	8	8	8
RET	fl. oz/cwt.	-	-	-	8	-
ACC	fl. oz/cwt.	-	-	-	-	30
Air	%	8.5	7	6.5	7.5	5.5
Slump	in	6.5	5.5	7.5	7	7

Mix Design Table Abbreviations: PC=Portland Cement, SF=Silica Fume, FA=Fly Ash, SL=Slag, AEA=Air Entraining Agent, HRWR=High Range Water Reducer or Super-plasticizer, WR=Workability Retaining admixture (retarder), ACC = Accelerator.

Table 5 - Laboratory Mixes Based on Field Mixture Design

	Note	**LE1**	**LE2**	**LE3**	**LE4**	**LE5**	**LE6**	**LE7**	**LE8**	**LE9***	**LE10****	**LE11**	**LE12**
Date		9/10/13	9/17/13	9/19/13	9/24/13	9/26/13	10/1/13	10/4/13	10/7/13	10/10/13	10/16/13	10/22/13	10/24/13
PC	lb/cy Type I	700	245	525	385	280	228	263	245	245	245	245	228
SF	lb/cy	0	35	35	35	0	33	38	35	35	35	35	33
FA	lb/cy Class F	0	140	140	0	140	140	150	140	140	140	140	140
SL	lb/cy Grade 100	0	280	0	280	280	260	300	280	280	280	280	260
Gravel	lb/cy #57	1850	1750	1750	1750	1800	1800	1800	1850	1750	1800	1800	1800
Sand	lb/cy	1118	1122	1144	1144	1087	1176	975	1212	1122	1075	1075	1176
W/C	-	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.4	0.4	0.4	0.4
AEA	fl. oz/cwt. Setcon 6A	1	1	1	1	1	1	1	1	1	1	1	1
HRWR	fl. oz/cwt. Chemstrong SP	5	3	3	2.5	2.5	3.5	5	9.5	1.5	2.5	4	2.5
ACC	fl. oz/cwt. Chemstrong CF	-	-	-	-	-	-	-	-	5	-	-	-
RET	fl. oz/cwt. Chemstrong R	-	-	-	-	-	-	-	-	-	5	-	-
Slump	In.	7.5	5.5	6	7.5	4.5	5.5	3	8.5	6.5	6.5	7.5	6

Table 6 - Supplier Samples Mixture Designs

Mix #		LF 1: 335344	LF 2: 335391	LF3: 335482	LF 4: 335491	LF 5: 410624	LF 6: 410937	LF 7: 412407	LF 8: 412673
Concrete Supplier		Supplier A	Supplier B - 1	Supplier B - 2	Supplier C	Supplier B - 3	Supplier D	Supplier E	Supplier F
PC	lb/cy Type I/II	435	395	395	595	395	353	450	345
SL	lb/cy Grade 100/120	200	263	263	0	263	247	300	242
		30.3%	40.0%	40.0%	0	40.0%	35.0%	40.0%	35.0%
FA	lb/cy Class F	0	0	0	105	0	106	0	104
		0	0	0	14.5%	0	15.0%	0	15.1%
SF		25	0	0	25	0	0	0	0
Total Cementitious	lb/cy	660	658	658	725	658	706	750	691
Gravel	lb/cy #57	1910	1800	1850	1840	1850	1625	1500 with 300 of #8	1800
Sand	lb/cy	1150	1201	1170	1205	1247	1208	1165	1237
Water	lb/cy	264	263	263	290	263	282	300	276

Table 7 - Supplier Samples Mixture Materials

Mix #	LF 1: 335344	LF 2: 335391	LF3: 335482	LF 4: 335491	LF 5: 410624	LF 6: 410937	LF 7: 412407	LF 8: 412673
PC	Essroc Type I	Essroc Type I	Essroc Type I	Riverside Type I	Essroc Type I	Lehigh Type I	Essroc Type I	LaFarge Type I
SL	Holcim Gr 100	Holcim Gr 100	Holcim Gr 100	N/A	Holcim Gr 100	Holcim Gr 100	Holcim Gr 100	LaFarge Gr 120
FA	N/A	N/A	N/A	Seperation Tech	N/A	ProAsh (STI) Class F	N/A	ProAsh Class F
SF	Euclid Microsilica	N/A	N/A	Silikacrete 950 DP	N/A	N/A	N/A	N/A
Gravel	Stavola Constr. #57	Tilcon #57	Fanwood #57	Gibralter Rock #57	Trap Rock #57	Hansen #57	Trap Rock #8 & #57	Birdsboro #57
Sand	Phoenix Pinelands	Clayton-Woodmansie	Clayton Sand	Sahara Sand Co.	Hansen Aggregates	REI Pierson	Clayton Sand	Tuckahoe
AEA	Euclid Air Mix	Setcon 6A	Setcon 6A	SIKA Air	Setcon 6A	Axim Catexol AE-260	Visocrete 2100	BASF AE-90
WR	Euclid WR 91	Chemstrong R	Chemstrong R	Plastiment	Chemstrong R, A, CF	Axim Catexol 3000GP or AXIM 1000R	Visocrete 2100	Pozz 200H or 100XR
HRWR	Eucon 37	Chemstrong SP	Chemstrong SP	Sikament 686	Chemstrong SP	Allegro 122	Plastiment	Glenium 5700

Table 8 - Field Mix Design and Fresh Concrete Properties for NJDOT Field Mixes

	Unit	HPC1	HPC2	HPC3	HPC4	HPC5
Date		**9/13/13**	**9/27/13**	**10/16/13**	**11/2/13**	**10/25/13**
Project #		**12106**	**12156**	**1000N**	**12106**	**1000N**
Sample ID		TPJWEB213 9G104417	TPJWEB2139U 102432	TPJSALI13A H101525	TPJSHA913B 4124209	TPJBAN213 AP124732
Location of Pour		Broad Ave. east side stage 2	Island Rd. bridge SB side	Rt. 3 W/B Bridge #3 Fast Lane	Rt 1&9 Broad Ave. over Rt. 46 stage 3	-
PC	lb/cy Type I	575	555	570	575	570
FA	lb/cy Class F	110	100	130	110	130
		15.5%	14.7%	17.9%	15.5%	17.9%
SF	lb/cy	25	25	25	25	25
		3.5%	3.7%	3.4%	3.5%	3.4%
Total Cementitious	lb/cy	710	680	725	710	725
W/C		0.4	0.4	0.4	0.4	0.4
Gravel	lb/cy	1780	1800	1773	1780	1773
Sand	lb/cy	1126	1110	1083	1126	1083
AEA	fl. oz/cwt.	2.11	1.25	1.43	2.90	1.46
HWRW	fl. oz/cwt.	11.69	9.53	N/A	11.69	N/A
Retarder	fl. oz/cwt.	2.82	2.88	N/A	-	N/A
Air Content	%	6.0~6.4%	5.5~6.6	6.2~7.0	6.5~7.0	
Slump	inch	5.75~6.25	6~6.75	5~6.5	5.5~6.5	

Table 9 - Field Mix Design and Fresh Concrete Properties 2 for NJTA Field Mixes

		S	CLS	ES	7A1 / 7A2 /TP53/RU	HES 16,19,23
Date/ Location		9/26/2014 Jersey City	9/30/2014 at “C” concrete supplier’s yard	10/2/2014 at “E” concrete supplier’s yard	10/21/2014 Robbinsville	6/16,19, 23/2014 Jersey City
PC	lb/cy Type I	565	426	438	501	535
SF	lb/cy	25	25	25	25	25
FA	lb/cy Class F	0	0	0	132	140
SL	lb/cy Grade 100	106	191	195 Grade 120	0	0
Gravel	lb/cy	1800	1780	1800	1850	1800
Sand	lb/cy	1271	1162	1159	1184	1173
Water		0.33	0.4	0.4	0.4	0.33
AEA	fl. oz/cwt	0.5	0.8	1.2	1.0	1.7
HRWR	fl. oz/cwt	7.7	11.7	13.7	12.2	7.1
WR	fl. oz/cwt MasterSure® Z 60	8	-	-	-	8
RET	fl. oz/cwt	-	2.5	2.0	3.0	-
ACC	fl. oz/cwt	40				40
Air	%	4.0	6.4		5.7	8.0
Slump	in.	3.5	6.25	6.0	6.5	7.87

Parametric Study

Effect of Curing Conditions on SRT and RCPT Results

To study the effect of curing conditions on SRT and RCPT results, RIME Team reproduced one mix in the civil laboratory and performed the SRT and RCPT accordingly. The reproduced mix design named “T” is summarized in Table 3. A total of 25 concrete cylinders (4 in. x 8 in.) were cast and cured in the laboratory. All concrete samples were demolded and cured in two (2) different curing baths.

(1) **Water bath with lime (lime bath):** Excessive hydrated lime (calcium hydroxide) was dissolved in the water to make a saturated solution. Concrete samples were cured in the lime bath after demolding at 24 hours. Samples were tested at each age after removing the excess water.

(2) **Water bath without lime (water bath):** No lime was added in the water bath. Concrete samples were placed in the water tank when they were demolded after 24 hours. Cylinders were tested at the ages described below when the samples were taken from the bath and the excess water was removed.

Effect of SCMs and Admixtures on SR and RCP

Five mixes were made to develop a parametric study of the RCP, SR and compressive strength in three different curing regimes: Curing Room, Lime Bath and Accelerated (Hot) Lime bath. SCMs investigated are Fly Ash and Slag that are typically used in the high performance concrete (HPC) in New Jersey, and the retarder and accelerator are also considered as parameters. The following list includes mixtures used for this study:

- C: Cement Only Mix.
- SL: Slag Mix.
- FA: Fly Ash Mix.
- RET: Fly Ash Mix with Retarder
- ACC: Fly Ash Mix with Accelerator

RESULTS AND COMPARISONS

Effect of Lime Curing on SR and RCP

Concrete samples were tested at 7, 14, 28, 56 and 91 days for SRT, and at 56 and 91 days RCPT. Table 10 and Table 11 show the testing results for SRT and RCPT, respectively. Table 10 shows the difference in SR readings between the concrete samples cured in the water with and without lime. The maximum difference is 8.19% at 91 days with an average difference of 4.66%. Figure 24 shows the SR readings for the two curing regimes are very well correlated (R^2=0.988), but the water curing slightly overestimated the SR compared to lime curing. Also, Figure 25 shows that the error of lime water curing is smaller than that of water curing without lime by 2.85% (0.27% vs. 3.11%), and the SR is more fluctuated if the samples were cured in water bath comparison with lime water curing. Therefore, it can be inferred that the lime has little or minimal effect on the SR measurements (between lime bath and water bath), however, it is recommended to cure all samples in a lime water bath for consistency.

The RCPT results summarized in Table 11 show that the concrete samples in water bath attained slightly higher rapid chloride permeability at 56 days (about 3.6%) and 91 days (about 4.3%) compared to those cured in lime bath. Similar permeability between curing regimes was expected that there would be a higher difference in the RCPT readings between the two curing regimes that would be attributed to the fact that the Ca+ ions in the concrete might react with water in the water bath while the ions were conserved in the lime bath. This expectation does not seem to be supported by the results at 56 days and 91 days results of the RCPT readings.

Table 10 - Surface Resistivity Results (unit: kΩ-cm)

	Curing method		
Age at testing	**Water Bath w/ Lime**	**Water Bath (no lime)**	
			% Difference
7 days	6.8	6.8	0.00%
14 days	12.0	12.9	-7.50%
28 days	15.9	15.2	4.40%
56 days	21.6	22.3	-3.24%
91 days	24.6	26.7	-8.19%
		Average	4.66%

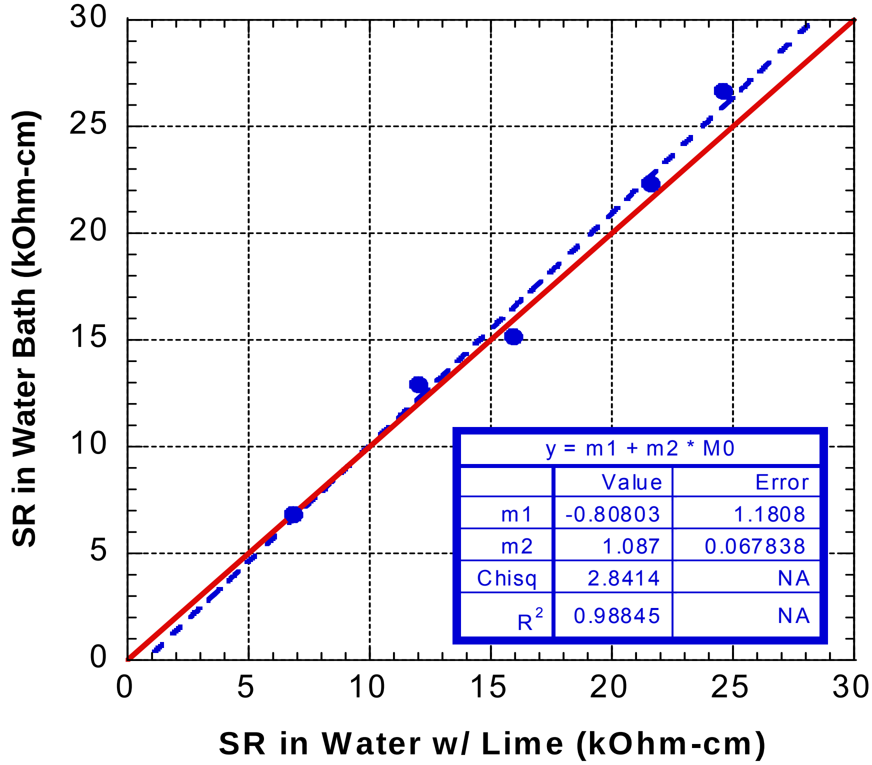


Figure 24. Correlation between curing regimes

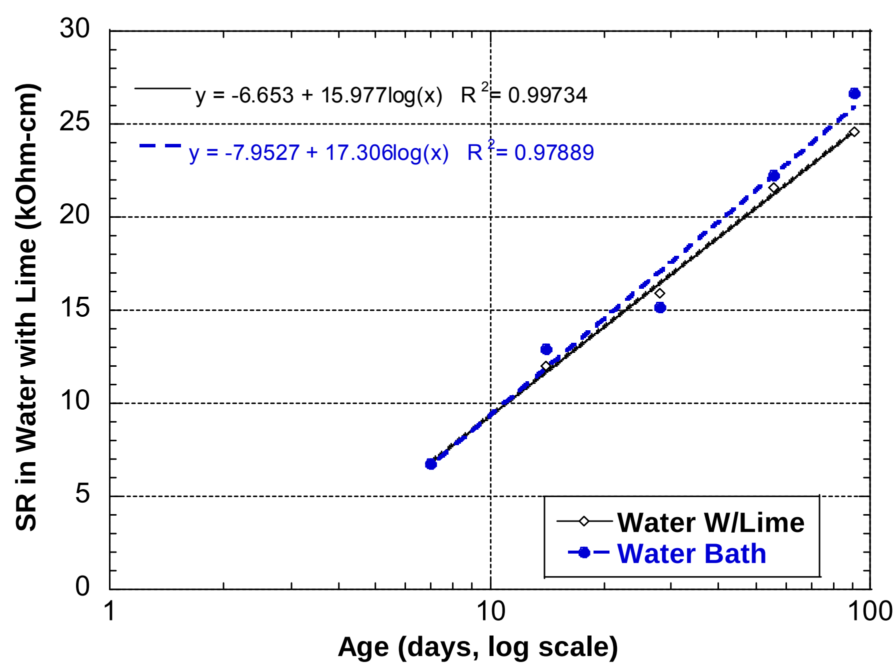


Figure 25. Correlation between SR and Age

Table 11 - Rapid Chloride Permeability Results (unit: coulombs)

	Curing method		
Age at testing	**Water Bath w/ Lime**	**Water Bath (no lime)**	
			% Difference
56 days	1748	1811	3.60%
91 days	1459	1523	4.29%

Based on the testing results for SRT and RCPT, the following conclusions can be summarized:

1- It was observed that the lime does not have a major effect on the surface resistivity and rapid chloride permeability compared to normal water curing. However, the water curing without lime would slightly overestimate the surface resistivity readings with slightly larger fluctuation in comparison with lime water curing. However, the fluctuation is not affecting the regression model used in correlating the RCPT and SRT. Nonetheless, all concrete samples prepared in the laboratory and collected from the field would be cured in lime water bath for consistent results.

2- Further analysis of results and effect of prior correlations made between the surface resistivity at 28 days and the permeability at 56 days in the presence of water curing only will be validated. However, for consistency, all samples will be cured in Water with lime for consistency.

Effect of SCMs on Surface Resistivity

This section is to observe the effect of curing regimes on surface resistivity. The first graph is a compilation of laboratory mixes which illustrates SR results in different curing regimes. “C” denotes the control mix, “SL” denotes the mix with Slag, and “FA” denotes the mix with Fly Ash.

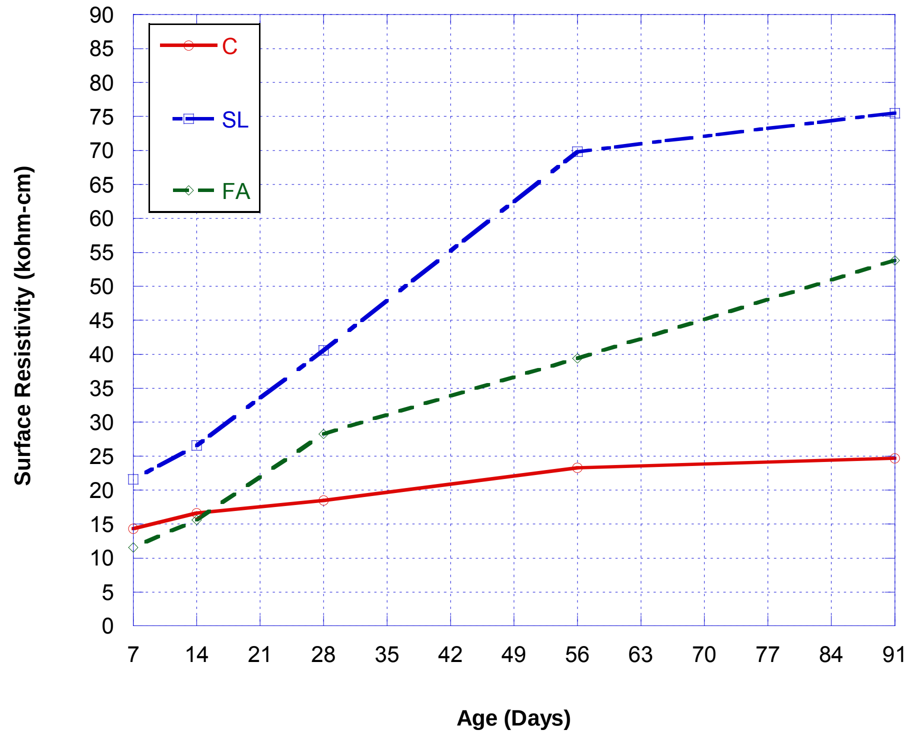


Figure 26. Effect of Slag and FA on SRT Results – Moist Curing

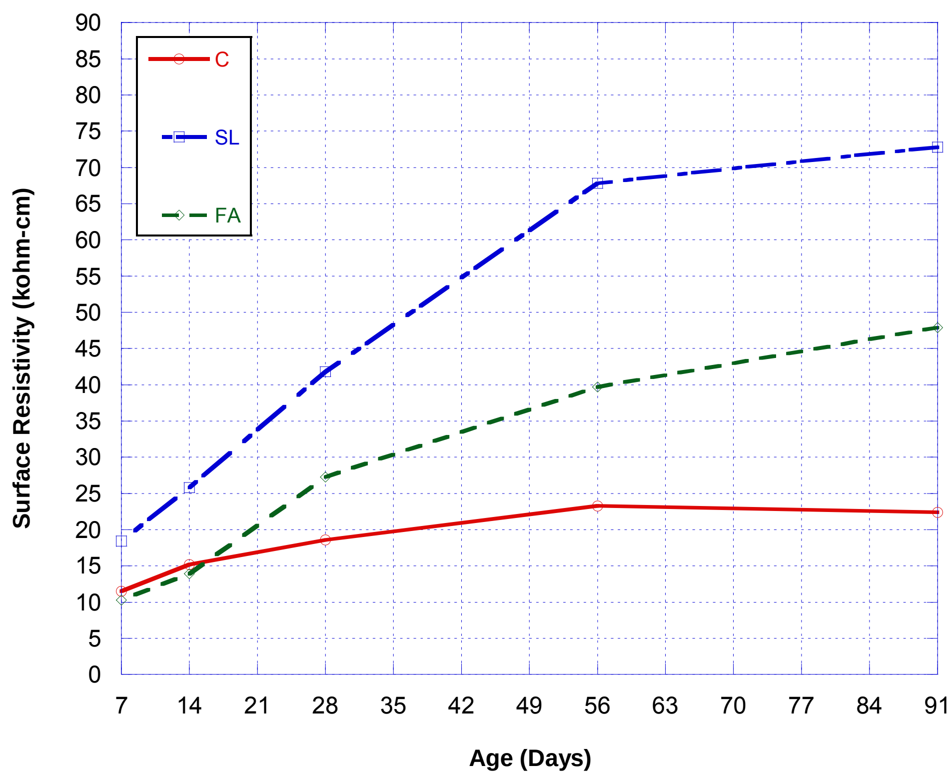


Figure 27. Effect of Slag and FA on SRT Results – Lime Bath

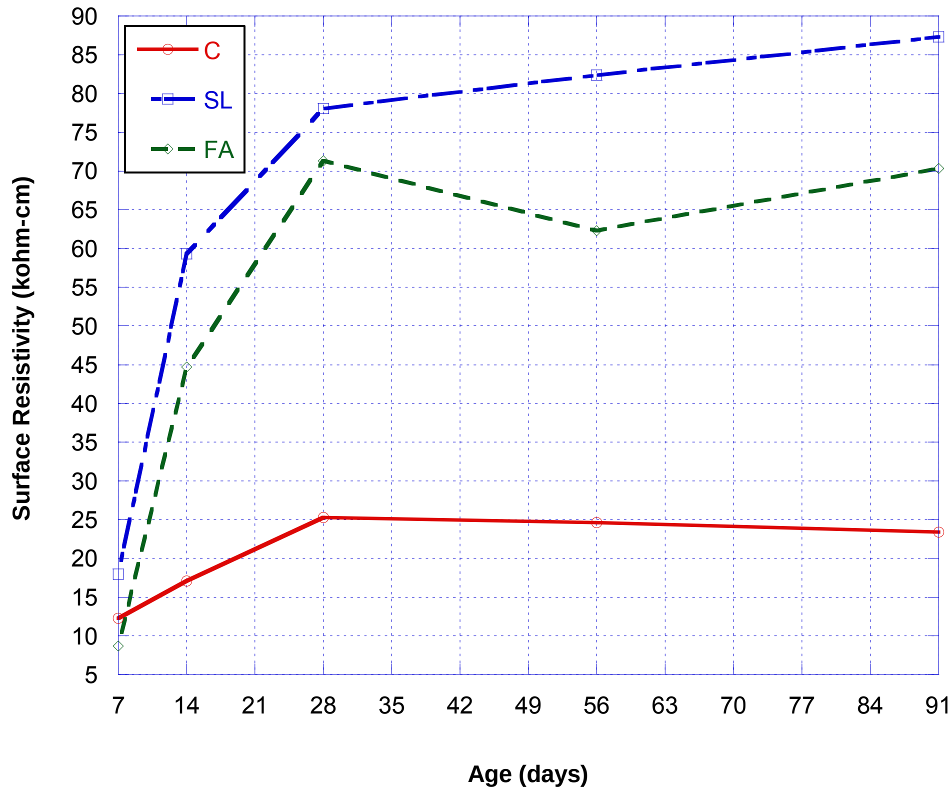


Figure 28 Effect of Slag and FA on SRT Results – Hot Lime

Results presented in this section indicate that at the presence of Slag favorably impacts the surface resistivity of concrete. While the effect of Fly Ash did not significantly impact concrete durability in moist and lime bath curing 14 days, its effect is evident in hot lime curing. At 28 and 56 days the FA mix exceeded the control mix surface resistivity. A possible explanation is the slower reaction time of fly ash which appears to be accelerated in hot lime curing which decreases at 56 days after removal from the hot lime bath. As opposed to the significant increase in SRT reading and durability from 28 days to 56 days, a minimal increase at an average of around 8.0 kOhm-cm is recorded between 56 days and 91 days. This minor increase in durability suggests that the pozzolans have reached, or are very close to reaching, their reaction time.

Effect of Chemical Admixtures on Surface Resistivity

“FA” denotes the Fly Ash mix with (control), “ACC” denotes the Fly Ash mix with accelerator, and “RET” denotes the Fly Ash mix with retarder.

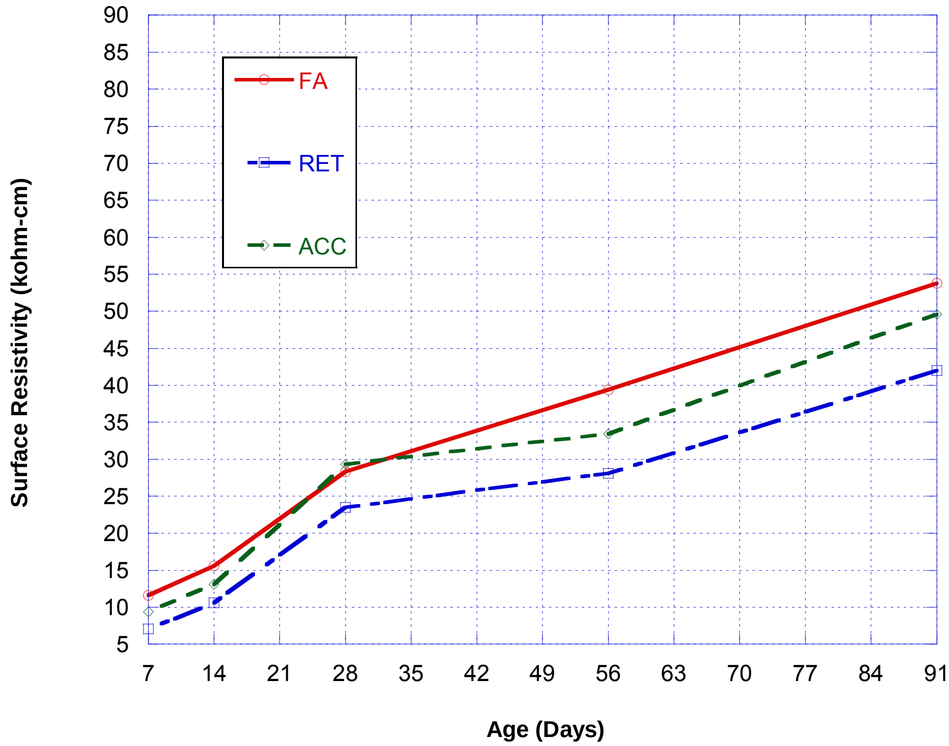


Figure 29. Effect of Retarder and Accelerator on SRT Results – Moist Curing

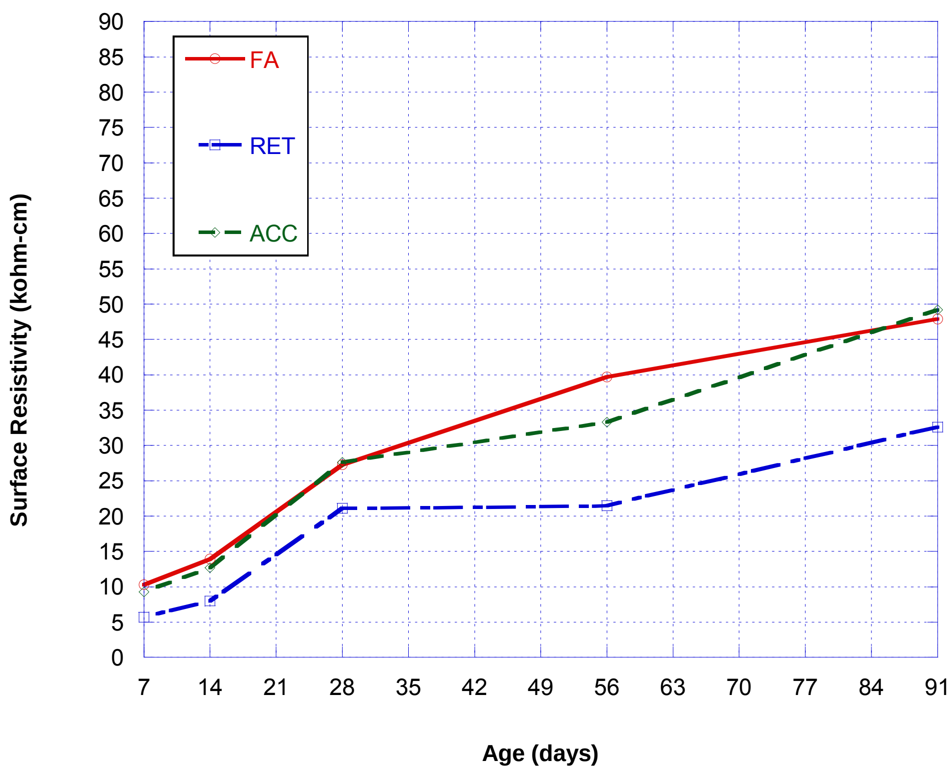


Figure 30. Effect of Retarder and Accelerator on SRT Results – Lime Bath

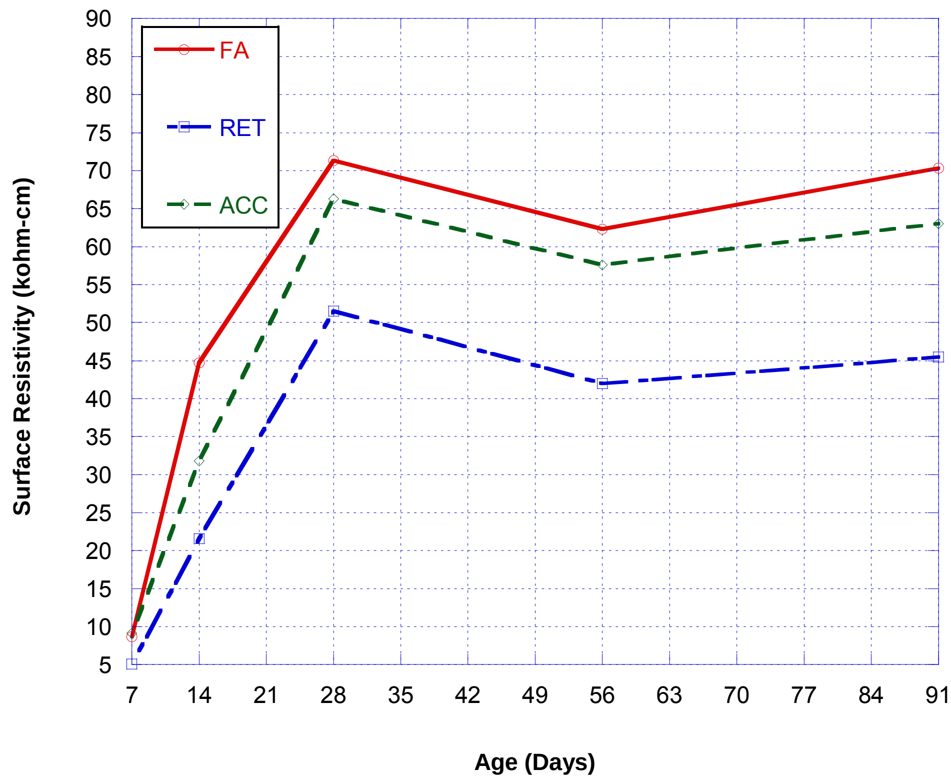


Figure 31. Effect of Retarder and Accelerator on SRT Results – Hot Lime

Results presented in this section indicate, as expected, the accelerating admixture applied favorably impacted the surface resistivity of concrete while the mix with the retarding admixture has lower durability than the control mix. However at 56 days the control mix demonstrated higher durability than both retarder and accelerator mixes. While such chemical admixtures may achieve the desired fresh concrete properties, it may be concluded that such chemical admixtures are not effective for achieving higher durability. Similar results and trends are observed for moist curing and lime bath curing; however the trend changes in hot curing where the surface resistivity results decreased at 56 days compared to 28 days. SRT readings continue to increase at 91 days in moist and lime bath curing conditions, while at 91 days the highest readings obtained at earlier ages were almost achieved at 91 days. The trend observed in hot curing may be attributed to the temperature of the cylindrical specimen at the time of testing.

Effect of SCMs on Rapid Chloride Permeability

This section is to observe the effect of curing regimes on rapid chloride permeability. The first graph is a compilation of laboratory mixes which illustrates RCP results in different curing regimes.

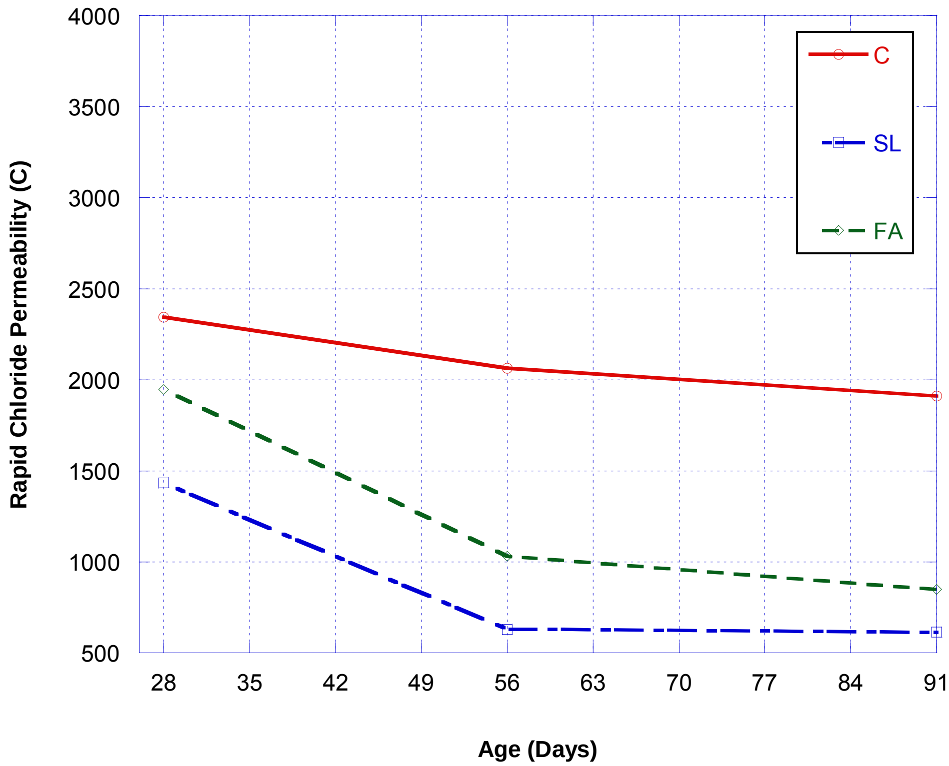


Figure 32. Effect of Slag and FA on RCPT Results – Moist Curing

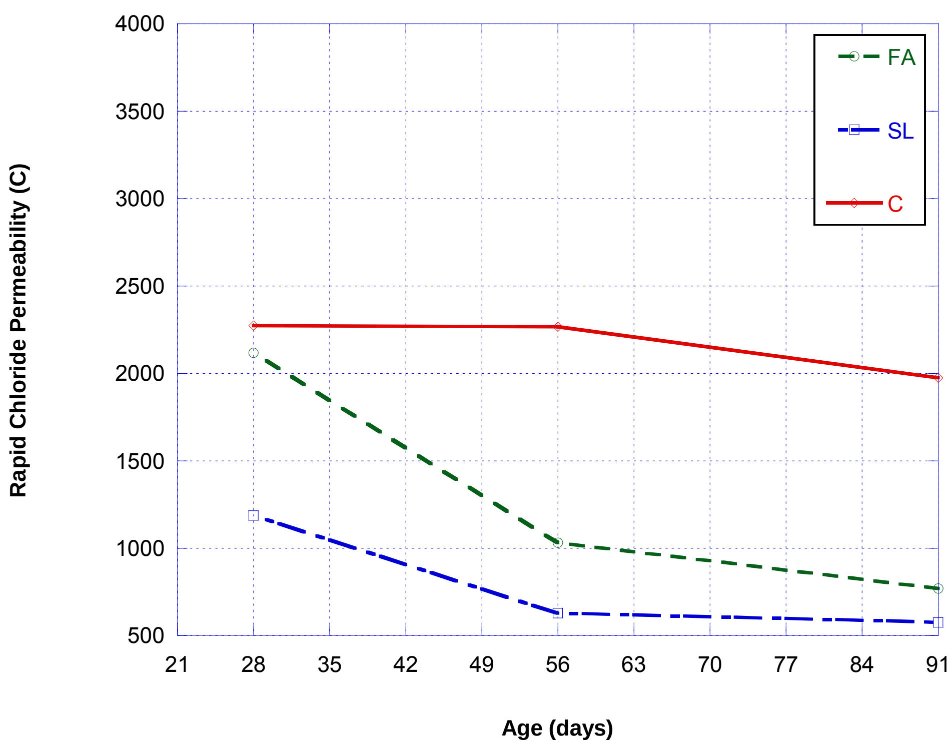


Figure 33. Effect of Slag and FA on RCPT Results – Lime Bath

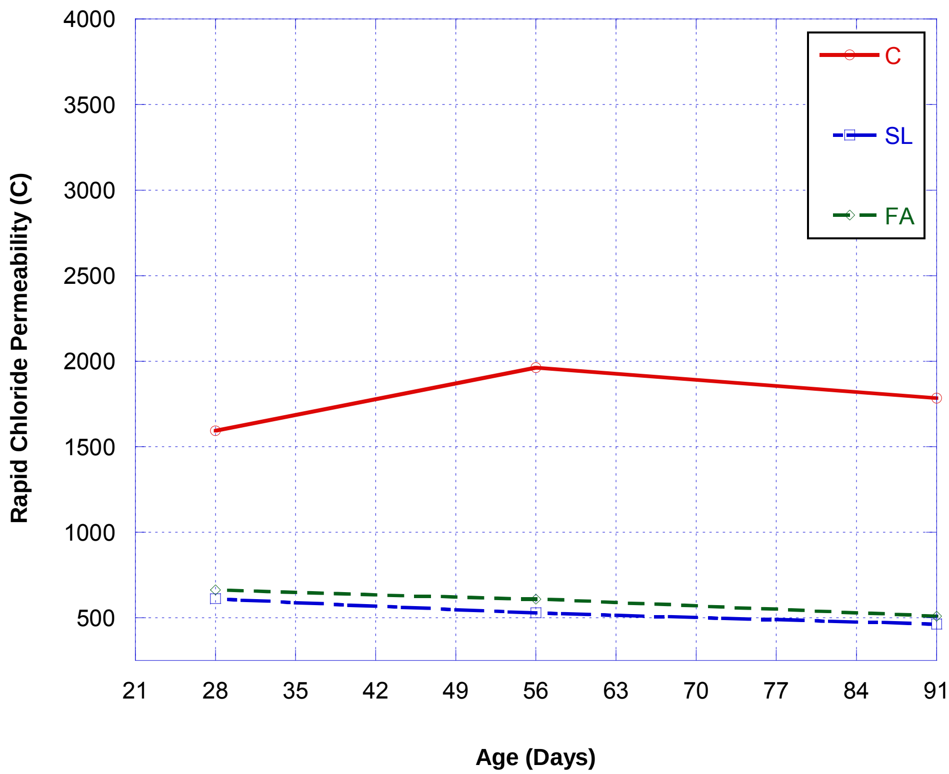


Figure 34. Effect of Slag and FA on RCPT Results – Hot Lime

Results presented in this section indicate that at the presence of Slag and Fly Ash favorably impact the rapid chloride permeability of concrete. While the effect of Fly Ash did not significantly impact concrete durability in moist and lime bath curing 28 days, its effect is evident in hot lime curing. A similar trend can be observed in all three curing methods however the rapid chloride permeability of the control mix increased after removal from the hot lime bath and finally decreased at 91 days.

Effect of Chemical Admixtures on Rapid Chloride Permeability

"FA" denotes the Fly Ash mix with (control), "ACC" denotes the Fly Ash mix with accelerator, and "RET" denotes the Fly Ash mix with retarder.

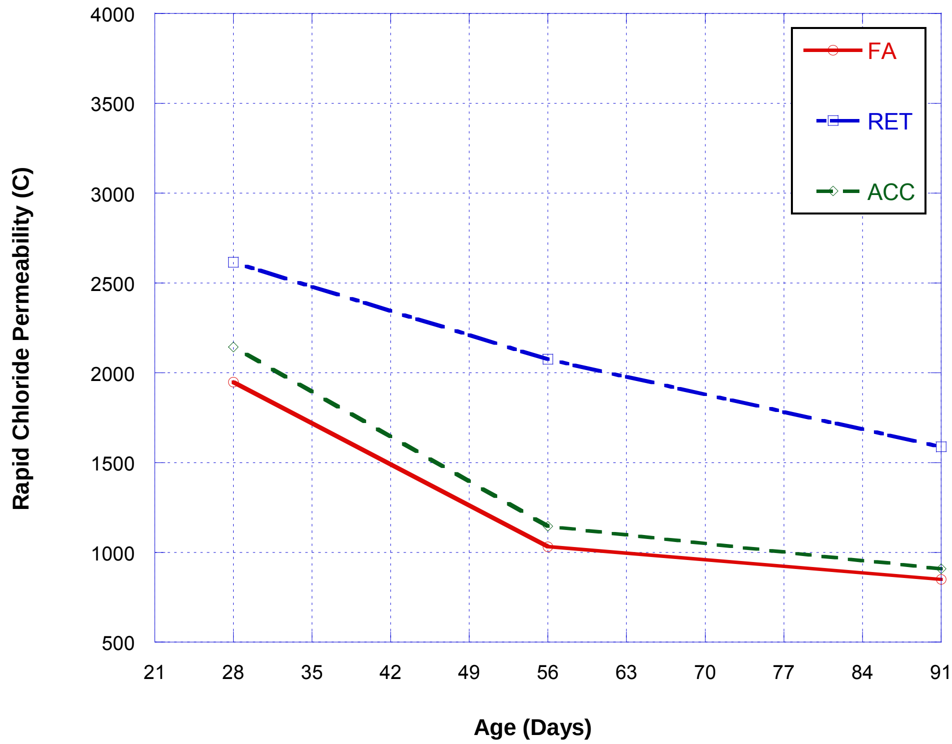


Figure 35. Effect of Retarder and Accelerator on RCPT Results – Moist Curing

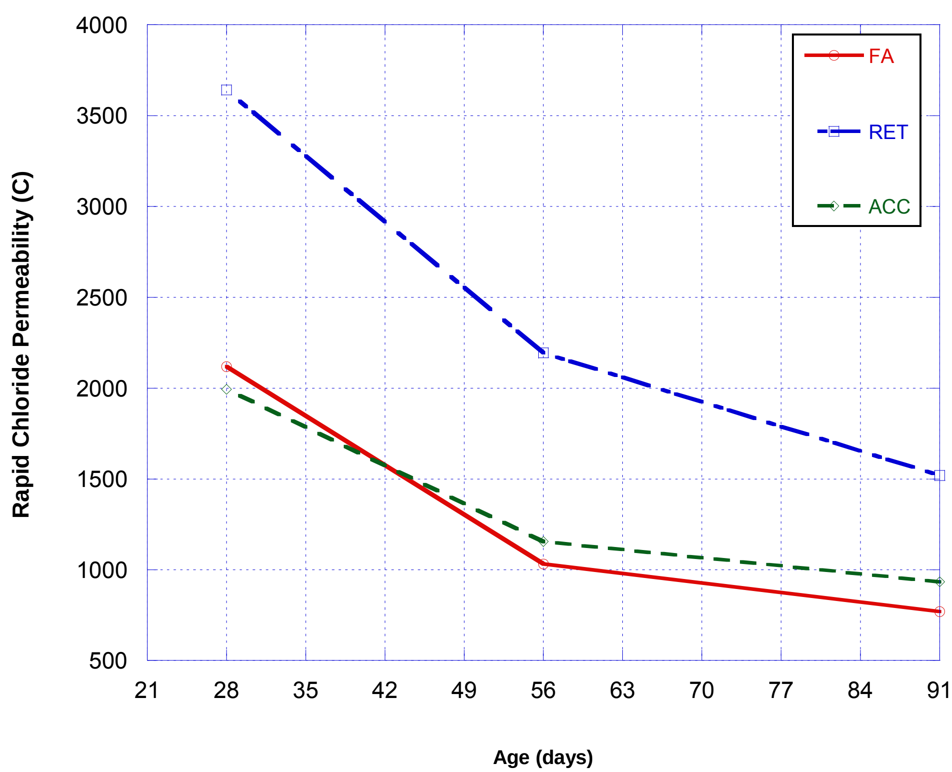


Figure 36. Effect of Retarder and Accelerator on RCPT Results – Lime Bath

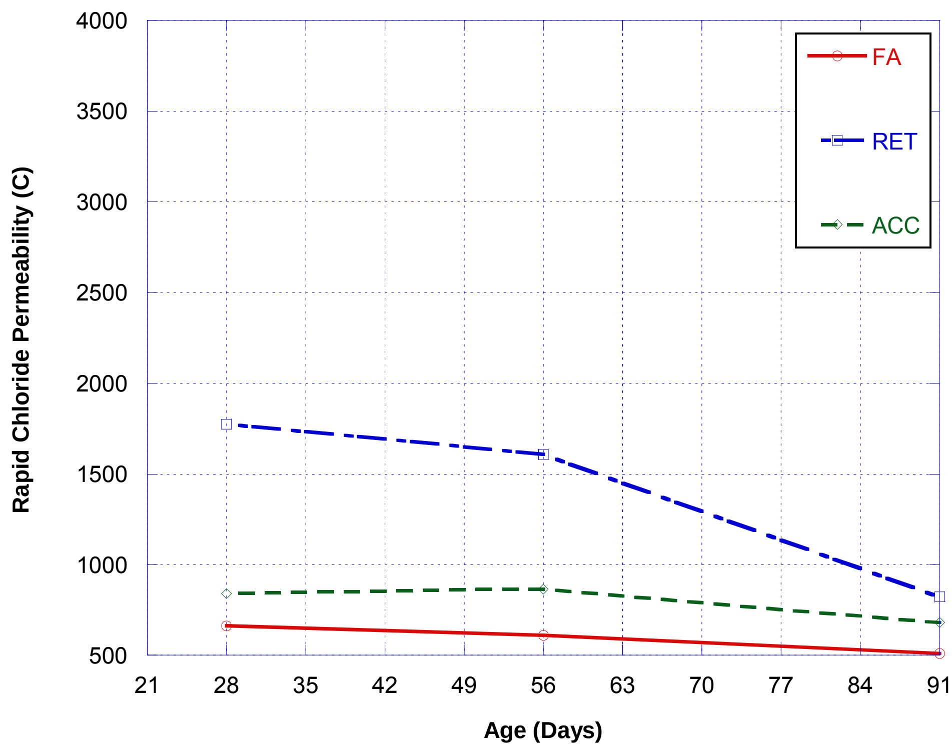


Figure 37. Effect of Retarder and Accelerator on RCPT Results – Hot Lime

Results presented in this section indicate, as expected, the accelerating admixture applied do not favorably impacted the rapid chloride permeability of concrete while the mix with the retarding admixture has lower durability than the control mix. The FA and ACC mixtures yielded close results in all curing methods. The control mix demonstrated higher durability than both retarder and accelerator mixes. While such chemical admixtures may achieve the desired fresh concrete properties, it may be concluded that such chemical admixtures are not effective for achieving higher durability. Similar results and trends are observed for moist curing and lime bath curing; however the trend changes in hot curing where the results slightly increased at 56 days after removal from the hot lime bath and finally decreased at 91 days. Studies have shown that admixtures that contain ionic salts which are composed of materials such as Calcium Nitrite, Calcium Nitrate, Calcium Chloride and Sodium Thiocyanate result is inaccurate SRT and RCPT results [(8)]. Bingol and Tohumcu agreed that hot curing significantly decrease RCP results and increase SR and Compression test results. [(31)] Authors also agreed that Ground Granulated Blast-furnace Slag significantly increases concrete durability while Fly Ash was not effective in increasing concrete durability. [(32,35)]

Comparison Between NJDOT and RIME Results

To develop a further understanding of the precision of the SRT and RCPT, a comparison was developed between mixes tested by both NJDOT and RIME laboratories. Table 12, Table 13, and Table 14 below show the results and comparison factors considered. A total of six mixes were obtained for this comparison. AASHTO

Designation: TP 95-11 specifies that the difference in the results of two SR tests performed by same operator on specimens of the same dimensions from the same batch should not exceed 21%. The standard also specifies that for multi-laboratory testing the difference in results should not exceed 35.2%.

Table 12 - SRT Results Comparison at 28 Days

Mix ID	NJDOT	RIME	Mean	Difference	Percentage Difference	% Difference From Mean
DOTF3	18.6	23.4	21.0	-4.8	**26%**	11%
DOTF5	18.3	15.4	16.8	2.9	**-16%**	-9%
DOTF4	17.3	15.6	16.5	1.7	**-10%**	-5%

Table 13 - SRT Results Comparison at 56 Days

Mix ID	NJDOT	RIME	Mean	Difference	Percentage Difference	% Difference From Mean
DOTF1	26.4	28.0	27.2	-1.5	**6%**	3%
DOTF6	38.9	40.2	39.5	-1.3	**3%**	2%

Taking into consideration the SRT standard precision statement, it can be concluded that the RIME and NJDOT results are well within the multi-laboratory as well as the single operator precision percentage difference.

For the RCPT, ASTM Designation C1202-12 specifies that the difference in the results of two RCP tests performed by same operator on specimens of the same dimensions from the same batch should not exceed 42 %. The standard also specifies that for multi-laboratory testing the difference in results should not exceed 51%.

Table 14 - RCPT Results Comparison at 56 Days

Mix ID	NJDOT	RIME	Mean	Difference	Percentage Difference	% Difference From Mean
DOTF1	1798	1718	1758	80	**-4%**	-2%
DOTF3	1740	1289	1515	451	**-26%**	-15%
DOTF2	1031	1352	1192	-321	**31%**	13%
DOTF5	1198	2020	1609	-822	**69%**	26%
DOTF4	2085	2112	2099	-27	**1%**	1%
DOTF6	862	1042	952	-180	**21%**	9%

Taking into consideration the SRT standard precision statement, it can be concluded that the RIME and NJDOT results are well within the multi-laboratory as well as the single operator precision percentage difference with the exception of one mix. Having such a large precision percentage difference in results is one of the RCPT drawbacks and it impacts the correlation with the SRT results.

Comparison Between KeyTech and RIME Results

A comparison was developed between mixes tested by both KeyTech and RIME laboratories. Table 14 and Figure 39 below show the results and comparison factors considered. A total of five field mixes from NJTA projects were obtained for this comparison.

Table 15 - Comparison with KeyTech Table for RCPT Results – NJTA Mixes

Pour Date	RIME Mix Code	Pour Location	Project	KeyTech	RIME	RIME	% Difference of RCPT
				RCPT 56d	RCPT 56d	SRT 56d	
6/4/14	7A1	195 East Bound Span 1	NJTA Interchange 6 to 9 widening - 402	1422	1108	39.5	28%
6/4/14	7A2	195 East Bound Span 1	NJTA Interchange 6 to 9 widening - 402	1293	1173	37.9	10%
6/19/14	HES19	Newark Bay Extension	Stage 8 of the HES-HPC - T100.125	313	295	121	6%
6/23/14	HES23	Newark Bay Extension	Stage 8 of the HES-HPC - T100.125	278	286	104.2	-3%
9/27/14	TP53	NJTA interchange 7A	NJTA Interchange 6 to 9 widening -Structure 53.01 SNI deck - 904	1036 @ 59d	1282	38.6	-19%

Taking into consideration the RCPT standard precision statement, it can be concluded that the RIME and NJDOT results are well within the multi-laboratory as well as the single operator precision percentage difference.

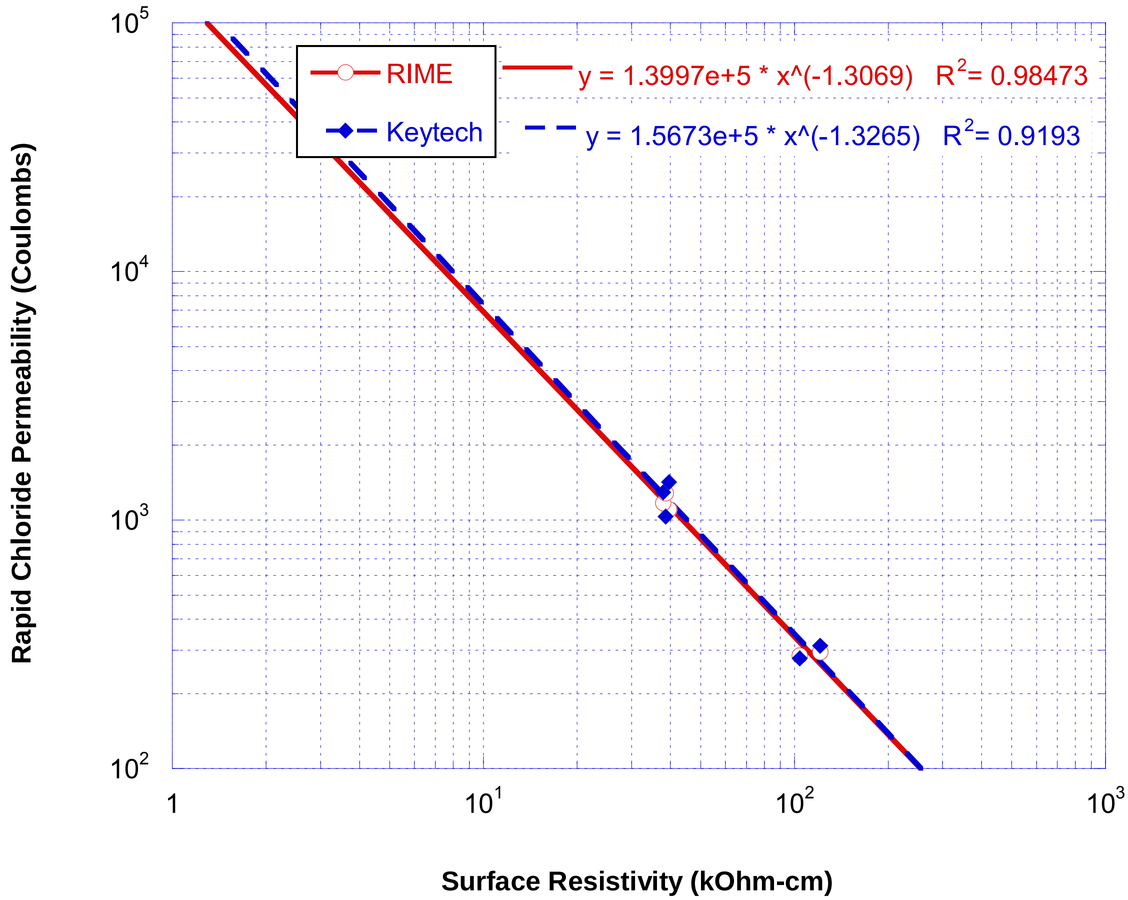


Figure 38. Relationship between the Average 56-Day Surface Resistivity and the Average 56-Day Rapid Chloride Permeability Results

In Figure 38 above, the RIME average 56 day SRT results are correlated with the RIME and KeyTech average 56 day RCPT results. At an R^2 value of 0.98 and 0.91 respectively, both results yielded a strong correlation.

Rapid Chloride Permability and Surface Resistivity Correlation

The RCP and SR correlation was compared with Louisiana Department of Transportation and Development (LADOTD) , Florida Department of Transportation (FDOT) and AASHTO TP 95-11 corelation and surface resistivity evaluation limits. The correlation value in LADOTD report at RCP (28 Day) vs. SR (28 Day) is $R^2 = 0.90$ and $R^2 = 0.92$ from FDOT, while the correlation from RIME is $R^2 = 0.80$. (4) Although all three correlations are considered good, however as observed from SR and RCP versus Age graphs, at 28 days some cementitious material did not reach their reaction time which suggests that the correlation is not as accurate at 28 days as at 56 days. The correlation value from LADOTD report data at RCP (56 Day) vs. SR (56 Day) is $R^2 = 0.84$ while the correlation from this study is $R^2 = 0.89$. (4)

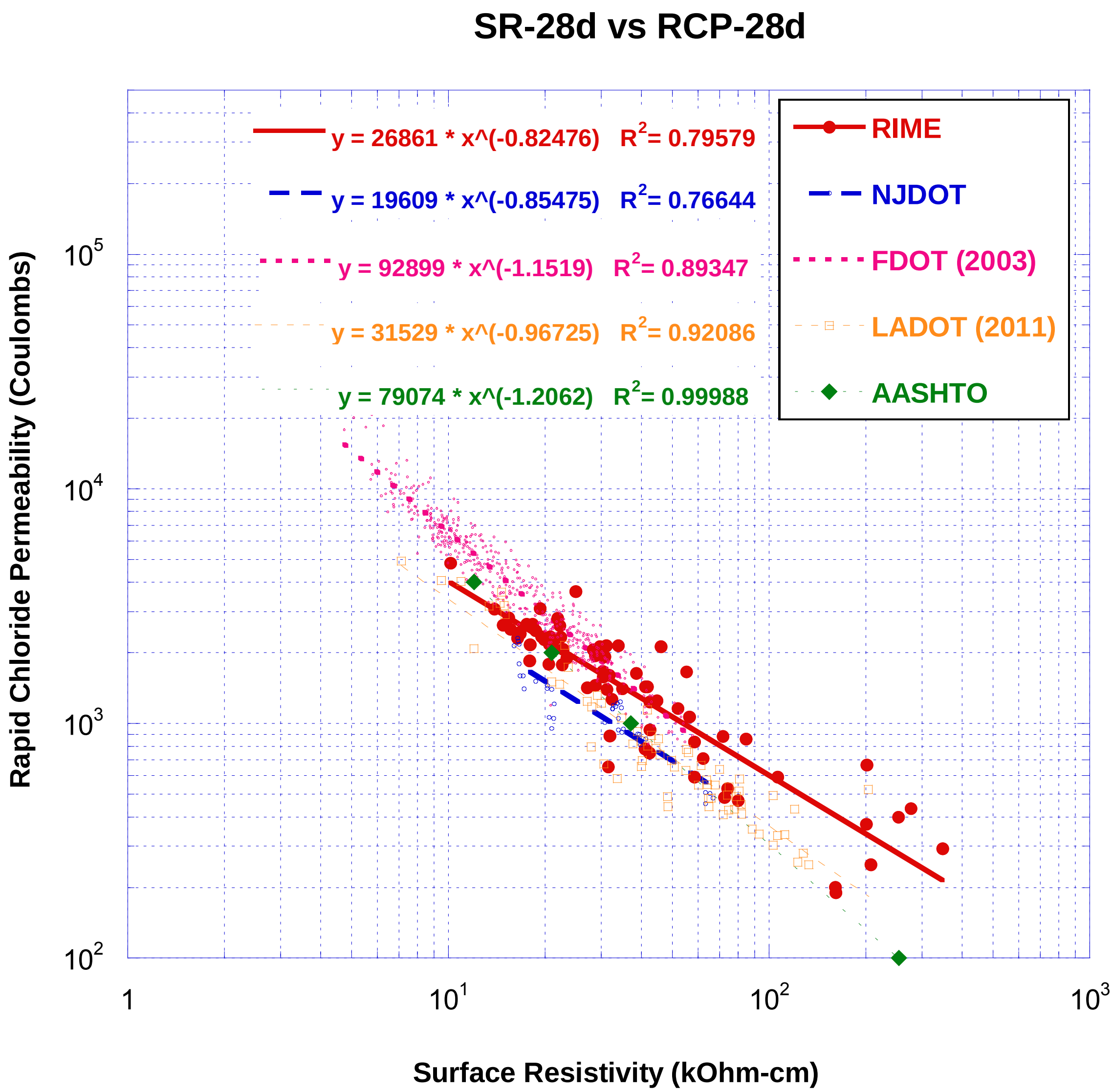


Figure 39. Relationship between the average 28-day surface resistivity and the average 28-day rapid chloride permeability results

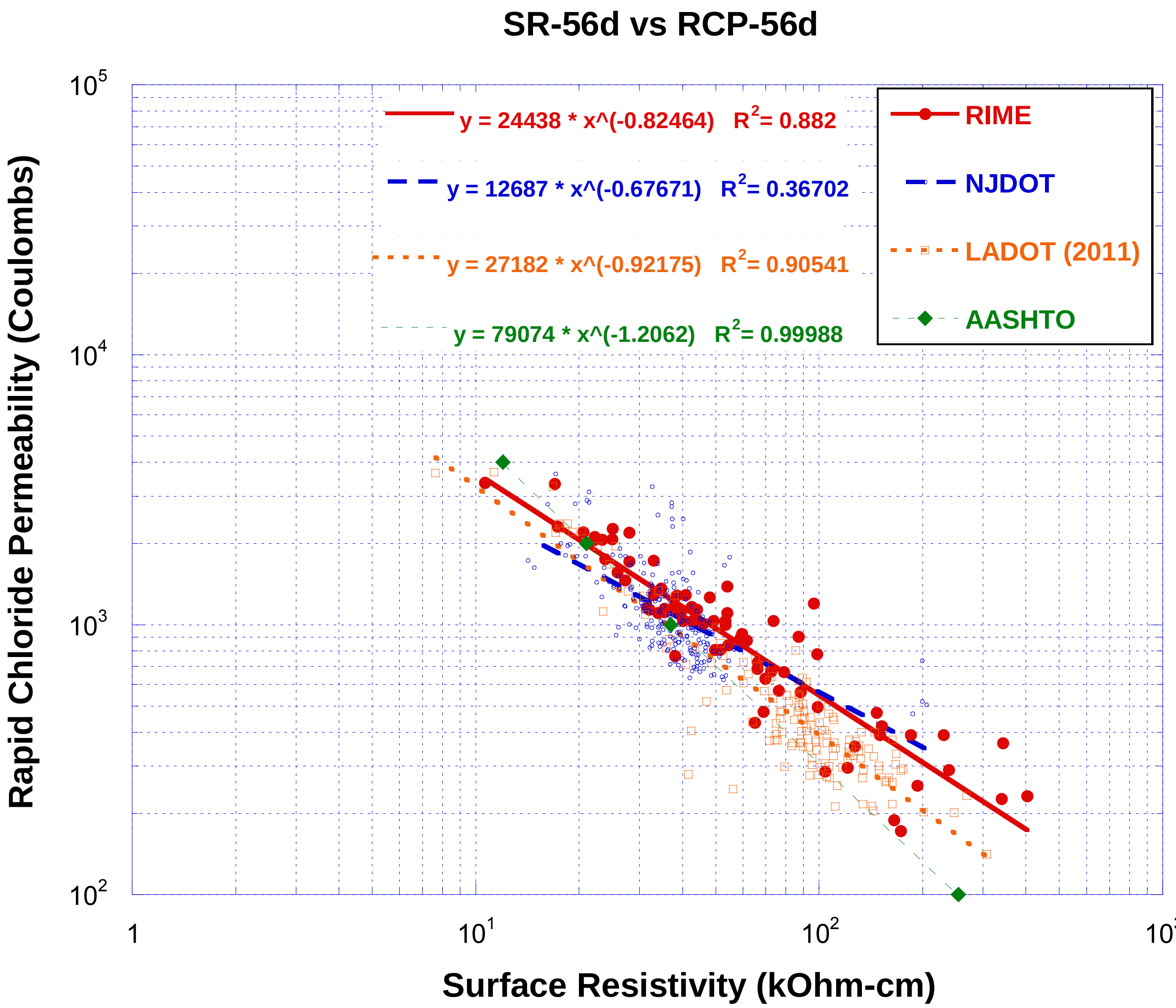


Figure 40. Relationship between the average 56-day surface resistivity and the average 56-day rapid chloride permeability results

Another graph to illustrate and distinguish the similarities and differences in results from FDOT is the graph of test results at 91 days. In Figure 41 below, it can be concluded that the data points scatter observed at 28 days and 56 days is also observed at 91 days. The RIME data scatter overlaps the scatter from FDOT indicating that some mix designs from all three projects are yielding results within the same range.

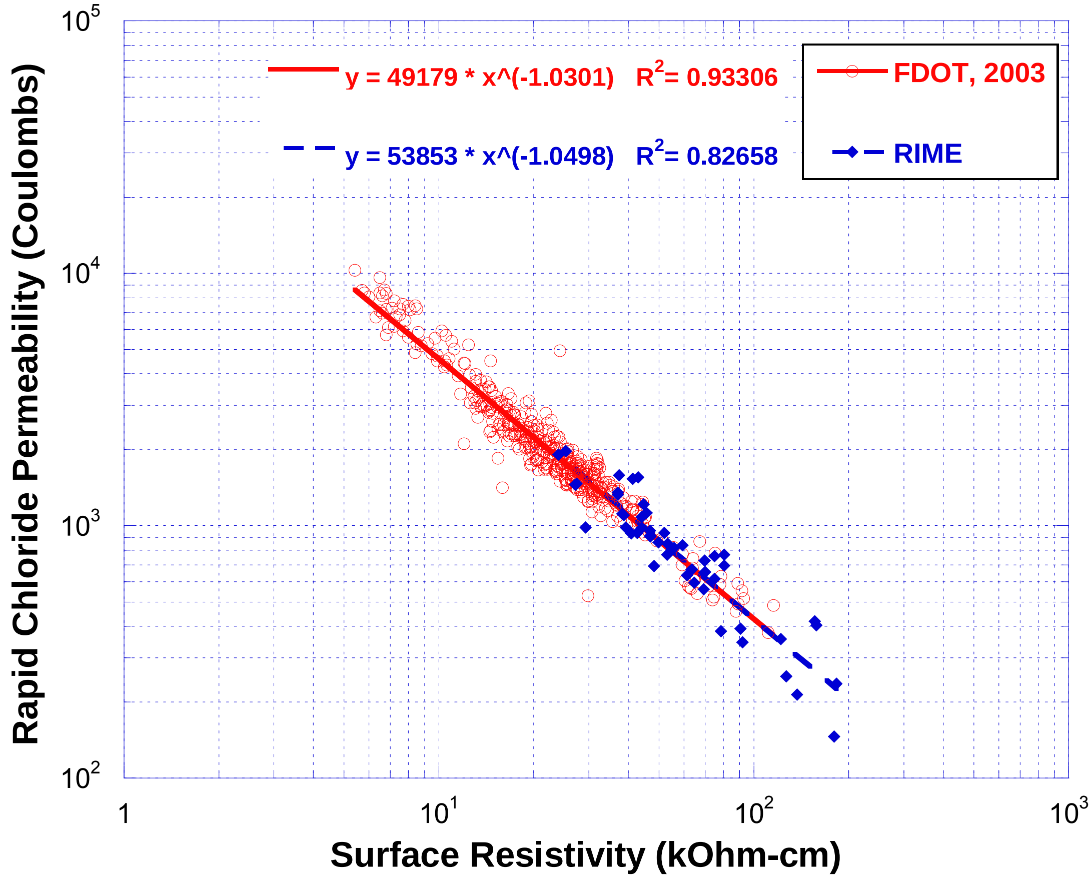


Figure 41. Relationship between the average at all ages surface resistivity and the average at all ages rapid chloride permeability results

Surface Resistivity Thresholds

AASHTO TP-95 specifies surface resistivity limits based on correlation of SR and RCP data. Florida Department of Transportation (FDOT) and LADOTD also adopted the AASHTO surface resistivity limits after conducting their studies. Due to many differences such as geographic, temperature, resources and materials, it is necessary that each area develop the surface resistivity limits that accurately evaluate their concrete mixtures. For the majority of the tested samples, the results difference between 56 days and 91 days is within the precision limits for the same sample at the same testing age (33) .Therefore, 56 days is a reliable age for correlating test results and establishing surface resistivity limits based on the correlation.

Surface resistivity limits drawn from the SR vs RCP correlation equations are illustrated in Table 16 below. In ASTM C1202, the RCP limits for low permeability are within 1000 C to 2000 C. Using that low permeability range the low surface resistivity limits can then be calculated using the correlation equations. For the low category, the surface resistivity limits adopted by AASHTO, FDOT and LADOTD are 21 to 37 kOhm-cm. The low surface resistivity limits obtained from RIME data is 23.8 to 55.3 kOhm-cm at 28 days and 21.2 to 49.3 kOhm-cm at 56 days.

Table 16 - RIME Data for Surface Resistivity Limits

Correlation graphs	Equation	Surface Resistivity Threshold at RCP (kOhm-cm)	
		1000 coulombs	2000 coulombs
RCP 28 days vs SR 28days	$y = 26861x^{-0.825}$ $R^2 = 0.80$	54	23
RCP 56 days vs SR 56 days	$y = 24438x^{-0.825}$ $R^2 = 0.88$	48	21

Using Data from LADOTD and FDOT reports, the correlation was obtained at 28 days and 56 days depending on available data. The comparison between the limits and R^2 values are illustrated in Table 17 for 28 days and Table 18 for 56 days. FDOT report provides data for 28 days and 91 days of testing.

Table 17 - Surface Resistivity Limit 28 days (kOhm-cm)

	SR- 28d vs RCP- 28d				
RCPT	RIME	NJDOT	FLDOT	LADOTD	AASHTO
2000 coulombs	23	14	28	18	21
1000 coulombs	54	33	52	36	37
R^2	0.80	0.77	0.82	0.90	N/A

Table 18 - Surface Resistivity Limit 56 days (kOhm-cm)

	SR- 56d vs RCP- 56d				
RCPT	RIME	NJDOT	FLDOT	LADOTD	AASHTO
2000 coulombs	21	15	N/A	18	21
1000 coulombs	48	43	N/A	37	37
R^2	0.88	0.37	N/A	0.84	N/A

CONCLUSIONS

In this report, the Surface Resistivity Test is evaluated as an indicator of the chloride permeability of concrete in accordance with AASHTO TP 95-11. The SRT and the RCPT were conducted on the same HPC specimens, from laboratory and field mixes, to develop a correlation through which a SR threshold is deduced. A parametric study was developed to study the effect of supplementary cementitious materials, Fly Ash and Slag, and admixtures, Accelerator and Retarder, on concrete specimens cured in several conditions. RCP tests were conducted on 28, 56 and 91 days while the SR tests were conducted on 7, 14, 28, 56, 91 days. The curing regimes applied were 100% humidity (moist curing), saturated $Ca(OH)_2$ solution (lime bath) at 3g of lime per liter of water , and hot (accelerated) saturated $Ca(OH)_2$ solution (hot lime bath) at 100 ± 3°F. Temperature in curing room and lime bath was maintained at 73.5 ± 3.5 °F.

Based on the analysis results of this study, the following conclusions can be drawn from the results:

1. The effect of different curing regimes, such as moist curing, lime bath curing, and water bath curing was minimal. Difference of SR and RCP measurements between curing conditions was at an average of 3.8 %.

2. Hot curing has a significant impact on the SR and RCP measurements. SR testing results increased by up to 218% while RCP test results decreased by up to 75%. Moreover, SRT results of hot cured samples at 28 days were most comparable to regularly cured samples at 56 days, while RCPT results of hot cured samples at 28 days were most comparable to results of standard temperature cured samples at 90 days.

3. The addition of slag favorably impacts the surface resistivity of concrete. While the effect of fly ash did not significantly impact SRT and RCPT results in moist and lime bath curing at 14 days, its effect on SRT and RCPT results is evident in hot lime curing. At 28, 56 and 91 days, the surface resistivity of FA mix exceeds that of the control mix. A possible explanation is the slower reaction time of fly ash. As opposed to the significant increase in resistivity reading from 28 days to 56 days, a minimal increase at an average of 8.0 kOhm-cm is recorded between 56 days and 91 days. This minor increase in durability suggests that the SCMs have reached, or are very close to reach their reaction time.

4. The addition of SCMs (slag and fly ash) to the mixture proportions favorably reduces the rapid chloride penetrability of concrete. While the effect of fly ash did not significantly impact SRT and RCPT results in moist and lime bath curing at 28 days, its effect is evident in hot lime curing. A similar trend can be observed in all three curing conditions; however the rapid chloride permeability of the control mix increased after removal from the hot lime bath and finally decreased at 91 days.

5. The addition of the set-accelerating admixture has almost no impact on the surface resistivity of concrete while the mix with the retarding admixture has lower surface resistivity compared to the control mix.

6. Similar results and trends are observed for moist curing and lime bath curing; however the trend changes in hot curing where the surface resistivity results decreased at 56 days compared to 28 days and the highest readings obtained at earlier ages were almost achieved at 91 days. The trend observed in hot curing may be attributed to the difference in the concrete hydration process between hot and standard cured specimens.

7. Due to materials such as Calcium Nitrite, Calcium Nitrate and Sodium Thiocyanate, the set-accelerating admixture has no effect on the rapid chloride permeability of concrete while the mix with the retarding admixture has higher permeability compared to the control mix.

8. For HPC it is proposed to develop the SRT and RCPT correlation for a SR threshold at 56 days due to pozzolanic reaction times.

9. The SRT threshold equivalent to an RCPT value of 2000 coulombs for the acceptance criteria for field mixes is very close to limits from other agencies. However, the SRT threshold equivalent to an RCPT value of 1000 coulombs for the acceptance criteria is more conservative. There is a need to perform additional testing of mixes around 1000 coulombs.

10. Recommended SRT threshold limits for the NJDOT Specifications based on 56 day RCPT versus SRT correlation are shown in Table 19 below:

Table 19 - Recommended SRT Threshold Limits Based on 56 Days RCPT-SRT Correlation

Chloride Ion Penetrability	**100-mm X 200-mm (4 in. X 8 in.) Cylinder (kOhm-cm) a = 1.5**	**150-mm X 300-mm (6 in. X 12 in.) Cylinder (kOhm-cm) a = 1.5**
High	< 9	< 7
Moderate	9 – 20	7 – 16
Low	20 – 48	16 – 38
Very Low	48 – 817	38 – 637
Negligible	> 817	> 637

FUTURE RESEARCH

To assess the surface resistivity test evaluation limits relative to the rapid chloride permeability test as accurately as possible, it is necessary to achieve the correlation from data obtained from testing field samples, such that the limits are based on mixtures composed of local resources and cementitious contents. There is a need for an additional number of field mixes that are used on NJDOT contracts especially those that would be failing the RCPT test threshold.

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APPENDIX I: SR SURVEY SUMMARY CONDUCTED BY NJDOT

State	Has your DOT evaluated this technology?	Has your DOT implemented any requirements based on this technology?	If you have impelmented requirements please attach them to your response.	If you haven't implemented requiremtns, do you plan to?
Alabama	No	No	N/A	
Alaska				
Arizona	No	No	N/A	At this time, the answer to all four is no. However, we have performed AASHTO T-277 "Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration" for concrete in the higher elevations in Arizona/ In the future we plan on researching high performance concrete for the high country where they use deicing products and this test method may be useful.
Arkansas				
California	No	No	N/A	California DOT does not plan to implement any requirements based on this technology.
Colorado	CDOT participated in the round robin testing program for the develop of the procedure with a loaner gauge from FHWA	No	N/A	We have no plans to use this method at this time. We only require ASTM C1202 testing on trial mixes for bare concrete bridge decks.We do not monitor the concrete's permeability in the field. But we are moving away from requiring ASTM C1202.
Connecticut	No	No	N/A	Not being discussed at this time.
Delaware				
Florida				
Georgia				
Hawaii				
Idaho	Idaho plans to start evaluating TP95-11 this summer. Plans are for in house testing with a potential outside research project also. Once the research is complete we anticipate adding a requirement to various concrete specifications.			N/A
Illinois	ILDOT has not fully evaluated this technology.	ILDOT has not implemented any requirements based on this technology	N/A	At this point we are evaluating and may consider implementation.
Indiana				
Iowa				
Kansas	Yes	No	N/A	Yes
Kentucky	No	No	N/A	No
Louisiana	Yes	Yes	Documents were attached to email.	N/A
Maine	Yes.We have been conducting side by side testing of the SR and RCP test for over a year.	Not Yet	N/A	We plan on beginning pilot specifications in 2013.
Maryland				
Massachusetts				
Michigan				
Minnesota	Limited evaluation- plan to do more extensive evaluation this summer 2013. MnDOT has purchased 4 surface resistivity probes.	Not at this time	N/A	We hope to determine how best to implement and potentially look at the 2014 construction season.
Mississippi	No	No	N/A	We're considering how to apply the technology.
Missouri	MoDOT has not evaluated this technology	No	N/A	N/A
Montana	Not Yet	No	N/A	We plan to start evaluating this technology sometime this summer
Nebraska	Yes	Nebraska uses this technology for research purposes (new mix designs)	Nebraska uses (SRI) for mix design permeability information.	No not at this time.

State	Has your DOT evaluated this technlogy?	Has your DOT implemented any requirements based on this technology?	If you have impelmented requirements please attach them to your response.	If you haven't implemented requiremtns, do you plan to?
Nevada	Yes	No	N/A	The FHWA Testing trailer was here last summer on one of our projects in Reno and performed both C1202 and the surface resistivity tests. The test results compare very nicely.We plan to borrow the equipment from the FHWA and evaluate further. Currently we use the "Prove-it" permeability system for running C1202. Should the surface resistivity meter show signs of producing consistent results, there is a possibility we may recommend using it. The time saving, 5 minutes vs. 2-3 days, alone is worth looking into it.
New Hampshire	Yes, NH performed SRT and Rapid Chloride Penetration testing on ultiple batches of variety of mixes to develop a correlation curve. The results matched with the Louisiana work, which became public shortly before our work was completed.	Yes	We revised our concrete specifications in January of this year to adopt the SRT test method. See Attachments in Attachments column.	N/A
New Jersey	No	No	N/A	NJ is planning on looking into this test method and possibly adopting it.
New Mexico				
New York	Yes, NYSDOT is familiar with the technology. NY is a participating member along with your state on the AASHTO Technology Implementation Group for implementation of the Surface Resistivity meter.	We have not presently.		We have long term intentions to do so as we attempt to migrate towards more performance based specification requirements in the future, in addition to trying to better streamline our laboratory testing/evaluation process.
North Carolina		No	N/A	Still evaluating, no real time frame.
North Dakota				
Ohio				
Oklahoma	No	No	N/A	Yes.We are in the process of purchasing the equipment. Our initial evaluation will focus on bridge deck concrete.
Oregon	No	No	N/A	Perhaps in the future. Currently we use AASHTO T277 to correlate chloride penetration.
Pennsylvania				
Rhode Island	In the process of evaluating	No	N/A	Yes, if the evaluation comes out favorably.
South Carolina	No	No	N/A	N/A
South Dakota	We are in process of purchasing equipment and starting an evaluation	No	N/A	Yes
Tennessee				
Texas	No	No	N/A	The use of a performance spec will not be included in our 2014 Specifications, but we are always looking for opportunities to improve concrete quality in cost-effective ways. So we are interested and will continue to consider this technology as a possible avenue for improvement.
Utah	No, not formally	No	N/A	It is possible that the test my be referenced as we continue to seek to develop Concrete Performance specifications.
Vermont				
Virginia	Yes	Yes	See link in email	We use AASHTO TP95 routinely as an acceptance method.We found that we could improve the reproducibility of the test method if we kept the sample saturated surface wet during testing. Also, if the accelerated curing method is used (which we do), placing the cylinder into a room temperature water bath until cylinder reaches a room temperature before testing reduces potential variability.
Washington				
West Virginia				
Wisconsin				
Wyoming				

APPENDIX II: RAW TEST RESULTS

Raw test results of SRT and RCPT.

Field HPC NJTA										
Lab ID	7A1									
Report ID	TPF1									
Mixing Date	6/4/2014									
	7A(1)N-4-S					7A(1)H-4-S				
Curing Regime	Curing Room					Hot Lime Bath				
Testing Date	6/11/2014	6/18/2014	7/2/2014	7/30/2014	9/3/2014	6/11/2014	6/18/2014	7/2/2014	7/30/2014	9/3/2014
Testing Age	7	14	28	56	91	7	14	28	56	91
SR	7.9	11.4	16.8	40.2	47.5	6.7	27.5	38.9	59.6	84.4
	7.5	11.3	16.5	39.9	47.8	6.8	27.4	39.7	59.3	80.4
	7.4	11.3	16.7	40.8	47.2	6.9	26.9	37.5	59.6	83.6
	7	11.4	16.9	37.6	46.3	6.5	28.9	38.4	58.8	83.4
	7.4	11.5	16.7	38.8	46	6.7	27.4	37.3	56.7	80.3
	7.6	11.6	16.6	40.8	46.2	6.9	28.5	38.8	59.8	82.8
	7.4	11.5	16.6	39.3	47.8	6.9	28.3	37.1	59.4	81.4
	7.1	11.4	16.8	38.6	46	6.9	29.5	39.8	59.7	83.9
AVG	7.4	11.4	16.7	39.5	46.9	6.8	28.1	38.4	59.1	82.5
STD (%)	3.5%	0.8%	0.7%	2.7%	1.6%	2.0%	3.0%	2.6%	1.6%	1.8%
	7A(1)N-4-R					7A(1)N-4-R				
RCP	N/A	3804	2435	951	923	N/A	1018	766	411	397
	N/A	3420	2396	1265	909	N/A	1078	733	457	384
AVG	N/A	3612	2416	1108	916	N/A	1048	750	434	391
STD (%)	N/A	5.3%	0.8%	14.2%	0.8%	N/A	2.9%	2.2%	5.3%	1.7%

Lab ID	7A2									
Report ID	TPF2									
Mixing Date	6/4/2014									
	7A(2)N-4-S					7A(2)H-4-S				
Curing Regime	Curing Room					Hot Lime Bath				
Testing Date	6/11/2014	6/18/2014	7/2/2014	7/30/2014	9/3/2014	6/11/2014	6/18/2014	7/2/2014	7/30/2014	9/3/2014
Testing Age	7	14	28	56	91	7	14	28	56	91
SR	7.4	11.2	16.6	36.6	49.5	6.6	21.6	39.1	64.7	84.3
	7.5	10.4	16.2	37.6	47.6	6.4	22.2	39.6	60.5	82.5
	7.5	10.7	16.1	38.3	47.8	6.3	20.3	39.4	63.6	80.6
	7.1	10.5	16.9	38.1	49.9	6.2	21	35.3	61.7	86.9
	7.3	11.4	16.8	38	47.3	6.4	20.1	35.8	64.2	86.2
	7.6	10.6	16.6	37.8	47.1	6.7	20.7	35	61.6	83.3
	7.3	10.9	16.8	38.4	47.3	6.3	21.8	36.9	62.6	83.5
	7.3	10.6	17	38.1	48.9	6.4	20.5	36	60.8	83.3
AVG	7.4	10.8	16.6	37.9	48.2	6.4	21.0	37.1	62.5	83.8
STD (%)	2.0%	3.1%	1.8%	1.4%	2.1%	2.4%	3.4%	4.9%	2.4%	2.2%
	7A(2)N-4-R					7A(2)N-4-R				
RCP	N/A	3352	2432	1130	689	N/A	1039	770	494	333
	N/A	3713	2434	1215	695	N/A	898	786	458	357
AVG	N/A	3533	2433	1173	692	N/A	969	778	476	345
STD (%)	N/A	5.1%	0.0%	3.6%	0.4%	N/A	7.3%	1.0%	3.8%	3.5%

Lab ID	TP53														
Report ID	TPF3														
Mixing Date	9/27/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/4/2014	10/11/2014	10/25/2014	11/22/2014	12/20/2014	10/4/2014	10/11/2014	10/25/2014	11/22/2014	12/20/2014	10/4/2014	10/11/2014	10/25/2014	11/22/2014	12/20/2014
Testing Age	7	14	28	56	80	7	14	28	56	80	7	14	28	56	80
SR	5.9	10	16.3	36.1	40.5	6.6	9.9	17.5	33.2	40.5	7.7	24.8	49.6	55.8	63.5
	5.9	9	16	32.5	39	7.2	9.5	18.5	35.1	42.5	8.3	22.8	53.5	67.9	65.3
	6.5	8.4	16.7	32	40	7	9.8	17.9	35	42.1	7.2	22.2	53.7	65.2	62.5
	6.1	9.2	16.8	35.9	39.1	6.8	9.8	17.9	37.5	39.1	7.1	23.5	49.5	61.3	62
	6.6	9.3	16.2	34.9	39.9	7.1	9.7	17.1	35.3	41.8	7.6	22.5	50.3	59.7	64.2
	6	8.9	16.8	34.7	38.6	7.3	9.7	18.3	35.1	41.3	7.8	22.9	52.5	64.9	65.5
	5.7	9.2	16.1	30.8	39	7	9.9	17.8	35.3	38.8	7.1	22.3	55.1	60.5	61.1
	6.5	9.4	16.5	32.7	40.8	7	9.3	18.1	34.6	40.9	6.9	22.5	49.9	59.3	61.9
AVG	6.2	9.2	16.4	33.7	39.6	7.0	9.7	17.9	35.1	40.9	7.5	22.9	51.8	61.8	63.3
STD (%)	5.1%	4.6%	1.8%	5.4%	1.9%	2.9%	2.0%	2.3%	3.1%	3.1%	5.9%	3.5%	4.0%	5.9%	2.4%
RCP	N/A	N/A	2314	1347	985	N/A	N/A	3073	1293	1083	N/A	N/A	729	679	543
	N/A	N/A	N/A	1382	N/A	N/A	N/A	3103	1271	1076	N/A	N/A	453	693	577
AVG	N/A	N/A	2314	1365	985	N/A	N/A	3088	1282	1080	N/A	N/A	591	686	560
STD (%)	N/A	N/A	0.0%	1.3%	0.0%	N/A	N/A	0.5%	0.9%	0.3%	N/A	N/A	23.4%	1.0%	3.0%

Lab ID	TP53														
Report ID	TPF3														
Mixing Date	9/27/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/4/2014	10/11/2014	10/25/2014	11/22/2014	12/20/2014	10/4/2014	10/11/2014	10/25/2014	11/22/2014	12/20/2014	10/4/2014	10/11/2014	10/25/2014	11/22/2014	12/20/2014
Testing Age	7	14	28	56	80	7	14	28	56	80	7	14	28	56	80
SR	6.5	9.7	16.8	36	39.2	7.1	9.5	18.1	34.8	38.7	6.7	23.1	55.8	61.2	65.5
	6.1	9.2	15.7	36.3	38.8	6.8	9.8	16.3	37.2	38.7	6.6	23	56.9	55.1	60.5
	6	9.1	16.6	35	41	6.9	9.5	16.9	35.8	38.1	7.8	22.8	54.6	56.2	62.3
	7.6	9.1	17.6	34.3	39.2	7.1	9.4	17.2	33.9	41.6	8.9	23.1	53.5	59.3	62.1
	8.8	9.3	16.3	35.2	37.4	6.6	9.3	17.1	34.1	39	9.3	22.7	53.5	60.5	61.8
	6.8	8.9	15.5	35.8	38.9	6.4	10.1	16.8	33.5	38.2	8.5	23.8	55	55.1	63.7
	6.2	9	15.2	36	39.5	6.4	9.9	17.2	34.9	39.6	8.1	23.1	54.3	55.4	63.7
	7.6	8.8	17.8	36.8	38.6	7	9.7	17.7	34.4	40.7	6.6	23.7	54.8	62.3	62.2
AVG	7.0	9.1	16.4	35.7	39.1	6.8	9.7	17.2	34.8	39.3	7.8	23.2	54.8	58.1	62.7
STD (%)	13.1%	2.8%	5.4%	2.1%	2.4%	4.0%	2.6%	3.0%	3.2%	3.0%	12.9%	1.6%	1.9%	4.8%	2.3%

Lab ID	CLS 9/30														
Report ID	TPF4														
Mixing Date	9/30/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/7/2014	10/14/2014	10/28/2014	11/25/2014	12/21/2015	10/7/2014	10/14/2014	10/28/2014	11/25/2014	12/21/2015	10/7/2014	10/14/2014	10/28/2014	11/25/2014	12/21/2015
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	13.2	18.2	21.7	34.5	37.1	12.9	16	20.6	32.6	34	11.7	26.7	39.6	38.2	39.1
	13.4	18.8	23.7	34.5	36.9	13.3	17.7	20	30.3	33.3	11.8	27.4	39.1	35.5	37.5
	13.6	17.2	23.1	32.6	34	12.4	16.8	18	32.9	32.2	11.2	26.6	36.8	40.2	37.6
	13.6	17.5	21.3	34.1	34.9	12.7	16.5	22.2	32	32	11.1	27.7	37	39.7	39.4
	13.1	17.6	22.7	34.8	35.9	13.1	16.3	20.9	34.6	34.5	11.9	26.2	39.2	39	40.2
	13.5	18	23	34.3	37	12.9	16.8	19.7	30.4	32.4	12	27.4	37.6	39	40
	13.6	17.7	22.6	33.1	35.4	13.1	16.1	19.6	29.2	33.1	11.4	26.8	39.8	41.5	39.5
	13.6	17.6	22.3	32.2	37.7	13	17.2	21.7	29.9	32.6	11	26.7	39.2	39.5	38.6
AVG	13.5	17.8	22.6	33.8	36.1	12.9	16.7	20.3	31.5	33.0	11.5	26.9	38.5	39.1	39.0
STD (%)	1.4%	2.6%	3.2%	2.7%	3.3%	2.0%	3.2%	6.1%	5.4%	2.5%	3.1%	1.8%	2.9%	4.2%	2.4%
RCP	N/A	N/A	2073	1346	1428	N/A	N/A	2181	1089	1341	N/A	N/A	1337	1158	1179
	N/A	N/A	2589	865	1276	N/A	N/A	1387	1136	1320	N/A	N/A	1527	1173	1248
AVG	N/A	N/A	2331	1106	1352	N/A	N/A	1784	1113	1331	N/A	N/A	1432	1166	1214
STD (%)	N/A	N/A	11.1%	21.8%	5.6%	N/A	N/A	22.3%	2.1%	0.8%	N/A	N/A	6.6%	0.6%	2.8%

Lab ID	CLS 9/30														
Report ID	TPF4														
Mixing Date	9/30/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/7/2014	10/14/2014	10/28/2014	11/25/2014	12/21/2015	10/7/2014	10/14/2014	10/28/2014	11/25/2014	12/21/2015	10/7/2014	10/14/2014	10/28/2014	11/25/2014	12/21/2015
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	13.1	17.9	21.4	33.6	37.1	12.2	17	20.1	32.1	35.2	12	28	37.2	38.4	43.2
	13.2	17.3	21.5	32.6	39.4	13	16.3	20.5	30.6	36.1	12.7	27.3	37.8	38.9	42
	13.4	17.9	22.4	35.5	38.9	12.9	16.8	21.4	33.5	31.6	12	27.8	36.7	37.1	41.5
	13	17.9	23.5	33.4	36	12.4	16.7	21.6	32.6	33.7	12.4	28.2	38.3	35.3	41
	13	17.3	21.5	32.9	37	11.8	16.6	19.8	33	35.2	12.1	27.4	35.6	39.3	39.6
	13.1	17.3	21.8	35	40.1	12.5	16.6	20.3	35.4	35.1	13.2	27.7	36.9	39.5	43.5
	13.5	17.7	23.1	35.3	38.3	13.1	16.8	21.5	34.9	32.7	12	27.5	37.8	39.3	42.1
	13.1	17.4	22.7	34	36.3	12.9	16.7	21.2	31.4	34.4	12.5	27.8	37.4	38	43.3
AVG	13.2	17.6	22.2	34.0	37.9	12.6	16.7	20.8	32.9	34.3	12.4	27.7	37.2	38.2	42.0
STD (%)	1.3%	1.5%	3.4%	3.0%	3.7%	3.4%	1.1%	3.2%	4.7%	4.1%	3.3%	1.0%	2.1%	3.5%	3.0%

Lab ID	ES 10/3														
Report ID	TPF5														
Mixing Date	3/10/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	8.1	13.9	31.6	47.3	54.3	7.2	12.6	27.6	48.8	54.6	8	12.2	50.9	54.5	63.4
	8.4	13.8	30.7	45.7	57.1	7.3	12.2	27.2	47.3	55.1	8.1	12.3	50.5	59.1	66.4
	7.9	13.4	31.2	49.5	54.1	6.9	12.7	27.7	48.5	52.9	7.8	12.6	53.8	56.2	63.9
	7.7	12.7	30.6	44.5	55.3	7.6	13	28	49.5	53.5	7.6	11.4	50.6	56	64.2
	7.9	13.8	29.9	46.3	54.1	7	12.5	27.2	50.3	53.3	7.6	12	53.8	56.4	65
	7.2	13.8	31.8	50.1	54.4	7.1	12	27.9	48	54	7.9	12.2	51.3	56.1	64.5
	7.9	13.6	30.5	42.9	52.8	6.9	12.2	27.5	47.8	54.1	7.5	12.5	52	57.8	63.7
	7.9	13.8	30.6	46.7	54.5	7.5	12.3	28.1	47.8	54	8	11.9	51.4	56.3	64.8
AVG	7.9	13.6	30.9	46.6	54.6	7.2	12.4	27.7	48.5	53.9	7.8	12.1	51.8	56.6	64.5
STD (%)	4.1%	2.7%	1.9%	4.8%	2.1%	3.4%	2.4%	1.2%	1.9%	1.2%	2.7%	2.9%	2.4%	2.3%	1.4%
RCP	N/A	N/A	1820	1059	858	N/A	N/A	1861	1052	823	N/A	N/A	904	845	683
	N/A	N/A	1523	958	759	N/A	N/A	1990	1014	848	N/A	N/A	1225	907	774
AVG	N/A	N/A	1672	1009	809	N/A	N/A	1926	1033	836	N/A	N/A	1065	876	729
STD (%)	N/A	N/A	8.9%	5.0%	6.1%	N/A	N/A	3.3%	1.8%	1.5%	N/A	N/A	15.1%	3.5%	6.2%

Lab ID	ES 10/3														
Report ID	TPF5														
Mixing Date	3/10/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	8.4	14.8	29.5	42.2	55.8	7	12.5	28.1	48.4	53.9	7.8	12.5	50.1	56.1	64.5
	7.7	12.9	29.4	45.4	55.5	7	12.4	28	50.5	53.4	7.8	12.7	54.6	54.3	63.1
	8.2	14.2	29.9	44.4	53.2	6.9	12.3	27.8	47.9	53.1	7.2	12.8	49.4	55.7	63.8
	8.2	14.8	29.3	46.3	56.4	6.6	12.3	28.7	46.8	54.7	7.6	12.8	51.5	51.7	62.2
	8.1	14	29	43.7	54.4	6.7	12.6	28.4	50.6	53	7.4	12.5	50	55.9	61.5
	7.7	12.8	29.1	47.6	54.4	7.1	12.7	28.2	47.3	54	7.4	12.6	50.3	57.2	63.7
	8.3	13.7	31.2	45.9	54.8	6.8	12.8	27.9	48.4	53.1	7.3	13.3	50.2	57.4	60.6
	8.1	13.6	29.9	45.8	56.3	6.2	12.9	28.1	48.6	55.4	7.4	12.8	50.7	53.6	62
AVG	8.1	13.9	29.7	45.2	55.1	6.8	12.6	28.2	48.6	53.8	7.5	12.8	50.9	55.2	62.7
STD (%)	3.0%	5.1%	2.2%	3.5%	1.9%	4.0%	1.7%	1.0%	2.6%	1.5%	2.8%	1.9%	3.0%	3.3%	2.0%

Lab HPC 9/2014 - 12/2014

Lab ID	T														
Report ID	Lab#3-6														
Mixing Date	5/5/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	5/12/2014	5/19/2014	6/2/2014	6/30/2014	8/5/2014	5/12/2014	5/19/2014	6/2/2014	6/30/2014	8/5/2014	5/12/2014	5/19/2014	6/2/2014	6/30/2014	8/5/2014
Testing Age	7	14	28	56	91	7	14	28	56	91	7	14	28	56	91
SR	10	16.9	19.9	26.8	28.6	6.8	11.9	15.7	21.5	24.5	6.8	11.9	15.7	24.8	33.5
	9.5	18	20.5	27.4	28.3	6.5	12.1	15.3	21.2	25	6.5	12.1	15.3	25.9	30.2
	10.2	17.2	20	26.7	29.3	7.4	12	16.2	21	24.4	7.4	12	16.2	26.5	31.4
	9.8	17.4	20.2	26.9	29.4	6.4	11.7	16	21.7	24.3	6.4	11.7	16	28.4	30.3
	9.9	17.2	20.3	27.4	29.1	6.9	12.2	15.8	21.6	24.2	6.9	12.2	15.8	26	31.1
	10	17.7	21.1	27.6	29.7	6.5	11.7	16.1	22	24.8	6.5	11.7	16.1	25.8	32.3
	9.7	17.5	20.8	27.2	29.3	7	12.5	16	21.8	24.7	7	12.5	16	26.5	31.3
	9.8	17.3	21	27.7	29.7	6.8	12	15.9	21.6	24.6	6.8	12	15.9	26.6	30.3
AVG	9.9	17.4	20.5	27.2	29.2	6.8	12.0	15.9	21.6	24.6	6.8	12.0	15.9	26.3	31.3
STD (%)	2.0%	1.8%	2.1%	1.3%	1.6%	4.5%	2.1%	1.7%	1.4%	1.0%	4.5%	2.1%	1.7%	3.6%	3.4%
RCP	N/A	2093	1876	1465	1012	N/A	N/A	2670	1701	1445	N/A	N/A	1320	1066	901
	N/A	2189	1703	1452	960	N/A	N/A	2621	1795	1473	N/A	N/A	1348	1038	974
AVG	N/A	2141	1790	1459	986	N/A	N/A	2646	1748	1459	N/A	N/A	1334	1052	938
STD (%)	N/A	2.2%	4.8%	0.4%	2.6%	N/A	N/A	0.9%	2.7%	1.0%	N/A	N/A	1.0%	1.3%	3.9%

Lab ID	PSC														
Report ID	Lab#3-1														
Mixing Date	10/1/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/8/2014	10/15/2014	10/29/2014	11/26/2014	12/22/2014	10/8/2014	10/15/2014	10/29/2014	11/26/2014	12/22/2014	10/8/2014	10/15/2014	10/29/2014	11/26/2014	12/22/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	14.2	16.6	19.6	23	24.4	11.9	16	19	23.3	21.9	12.8	16	26.6	27	22.1
	14.4	16.5	20.6	22.3	24.7	11.5	15.5	18	23.3	22.8	12.4	16.7	25.8	23.4	22.9
	13.9	16.7	20.7	21.3	24.9	11.1	14.9	18.8	21.6	20.9	12.1	16.4	25	23.4	23.6
	14.5	16.8	21.8	25.4	24	11.9	15.6	19.5	23.9	22.6	12	17.5	25.5	23.6	24.4
	13.8	16.8	19.8	23.7	23.7	11.4	15.1	18	23.8	22.9	12.3	18.4	25.6	24.2	24
	14.6	15.9	20.5	22.6	24.1	11.5	14.7	18.5	22.2	23.1	12.2	17.2	24.7	25.2	23.3
	14.3	16.4	20.7	22.2	25.6	11.3	14.6	17.5	23.4	22.8	12.8	17.2	25	25.7	23.9
	14.6	17.2	20.3	25.8	25.9	11.3	15.1	19.7	24.9	22.5	12.1	17.6	24.5	24.5	23.3
AVG	14.3	16.6	20.5	23.3	24.7	11.5	15.2	18.6	23.3	22.4	12.3	17.1	25.3	24.6	23.4
STD (%)	2.0%	2.1%	3.0%	6.4%	2.9%	2.3%	3.0%	3.9%	4.1%	3.0%	2.4%	4.1%	2.5%	4.8%	2.9%
RCP	N/A	N/A	2339	2075	1915	N/A	N/A	2403	2268	2100	N/A	N/A	1629	2317	1761
	N/A	N/A	2351	2055	1909	N/A	N/A	2147	N/A	1849	N/A	N/A	1560	1607	1806
AVG	N/A	N/A	2345	2065	1912	N/A	N/A	2275	2268	1975	N/A	N/A	1595	1962	1784
STD (%)	N/A	N/A	0.3%	0.5%	0.2%	N/A	N/A	5.6%	0.0%	6.4%	N/A	N/A	2.2%	18.1%	1.3%

Lab ID	PSC														
Report ID	Lab#3-1														
Mixing Date	10/1/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/8/2014	10/15/2014	10/29/2014	11/26/2014	12/22/2014	10/8/2014	10/15/2014	10/29/2014	11/26/2014	12/22/2014	10/8/2014	10/15/2014	10/29/2014	11/26/2014	12/22/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	13.9	17.9	18.7	25.5	23.9	12.5	15.1	18.2	22.3	22.8	12.5	17.1	25.9	21.6	22
	14.6	17.4	19.4	23.8	23.4	12.4	15	17.1	21.9	22.2	10.9	16.6	24.7	21.8	21.5
	14	17.1	18.8	23.2	23.4	11.9	15.4	17.1	21.8	23.8	12.4	16.6	24.6	24.3	21.4
	13.8	16.9	19	22.6	23	12.7	15.8	17.6	23.5	24.2	13.1	16.5	24.4	23	21.4
	13.6	16.7	18.8	24.5	24.4	12.2	15.1	17.7	22.4	24.4	12.2	16.1	24.7	22.2	20.5
	13.7	16.8	16.9	22.5	22.6	12.1	15.3	17.1	22.1	22.2	12.6	16.6	25.2	20.6	24.8
	14.8	16.9	17.8	23.2	22.5	12.1	14.8	16.9	21.9	24.4	12.8	16.9	24.6	21.4	22
	13.7	18.3	18.8	23.2	23	11.8	15.2	19.1	22.8	24.1	10.8	17.1	24	23.3	19.2
AVG	14.0	17.3	18.5	23.6	23.3	12.2	15.2	17.6	22.3	23.5	12.2	16.7	24.8	22.3	21.6
STD (%)	3.0%	3.1%	4.0%	4.0%	2.6%	2.3%	1.8%	3.9%	2.4%	3.8%	6.6%	1.9%	2.1%	5.0%	6.9%

Lab ID	PSS														
Report ID	Lab#3-2														
Mixing Date	10/2/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	21.4	26.2	42.1	68.7	77.9	18.5	25.8	42	65.9	71	18	56.2	78.4	83.5	83.7
	22	26.9	41	72.6	72.9	17.9	26.5	42.2	65.8	71.8	17.5	59.4	77.8	81.2	87.3
	20.3	26.2	41.6	70.9	74.9	18.8	24	41.3	65.4	74.3	17.8	61.2	75.8	76.1	87.8
	21.4	26.4	42.3	74	77.6	18.8	26.7	41	67.7	73.5	18	58.1	76.9	78.8	91.6
	21.8	27.1	42.1	68.3	77.9	17.8	24.4	41.9	65.8	73	18.1	59.7	80.1	85.2	84.1
	22	27.5	41.1	64.5	73.1	18.9	25.9	41.8	64.3	73.9	18.2	58.1	79	78.2	89.1
	21.8	26.5	41	69.5	75.1	18.1	26.4	40.6	66.1	74	18.3	62.1	78.5	81.2	87.6
	21.8	26.3	41.5	69.9	74.3	18.5	26.6	42.3	67.9	70.8	18.3	59.3	78.2	79.4	87.5
AVG	21.6	26.6	41.6	69.8	75.5	18.4	25.8	41.6	66.1	72.8	18.0	59.3	78.1	80.5	87.3
STD (%)	2.4%	1.7%	1.2%	3.9%	2.6%	2.2%	3.8%	1.4%	1.7%	1.8%	1.4%	2.9%	1.6%	3.4%	2.7%
RCP	N/A	N/A	1586	601	681	N/A	N/A	2488	1049	704	N/A	N/A	719	560	549
	N/A	N/A	1284	662	550	N/A	N/A	1752	1017	835	N/A	N/A	607	659	471
AVG	N/A	N/A	1435	632	616	N/A	N/A	2120	1033	770	N/A	N/A	663	610	510
STD (%)	N/A	N/A	10.5%	4.8%	10.6%	N/A	N/A	17.4%	1.5%	8.5%	N/A	N/A	8.4%	8.1%	7.6%

Lab ID	PSS														
Report ID	Lab#3-2														
Mixing Date	10/2/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	20.5	26.1	40.4	69.9	76	19	23.3	41.6	73	72.9	18.5	60.5	79.4	84.3	90.1
	20.4	27.3	41.1	68.1	74.6	18.7	24.6	42.8	68.1	72	16.3	61.3	77.4	85.7	87.1
	21	25.2	40.4	66.2	74.6	18.5	26.5	42	69	75.3	18	58.5	76.8	82.2	87.1
	21.2	24.8	40	66.2	73.8	18.7	24.5	41.2	65.4	72.3	18.4	57.8	77.5	83	88
	20.9	25.8	40.8	69.9	74.9	18.4	24.1	41.6	64.9	75.8	18.5	61.7	78.6	80	90.5
	20.5	28.7	40.3	72.3	74.1	18.8	25.4	41.7	66.3	72	17.2	57.9	79.2	78.1	86.9
	21.2	26.5	40.4	75	73.6	18.4	26.2	41.7	67.4	75	18.1	62.2	76.5	81.4	88.7
	20.6	26.3	41.3	67.4	74.4	18.8	24.4	41.9	67.9	73.9	17.4	63.4	78.8	84.3	87.3
AVG	20.8	26.3	40.6	69.4	74.5	18.7	24.9	41.8	67.8	73.7	17.8	60.4	78.0	82.4	88.2
STD (%)	1.5%	4.4%	1.0%	4.2%	0.9%	1.1%	4.1%	1.0%	3.5%	2.0%	4.1%	3.3%	1.3%	2.8%	1.5%

Lab ID	PSF														
Report ID	Lab#3-3														
Mixing Date	10/2/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	12.1	15.9	28.6	40.6	56	10.6	14	26.6	36.8	50	8.2	45.8	71.6	62.6	72
	11.6	13.6	27.6	42.3	52.8	10.1	14	26.2	38.4	47.8	8.3	45	71.3	58.5	72.4
	11.4	15.5	28.6	37.5	54.6	10.2	15.1	25.9	37.6	47.2	8.7	43.6	70.4	59.1	69.4
	11.7	17.8	27.7	42.7	53.7	10.9	13.5	28.1	39.1	48.2	9.4	43.2	72	61.6	69.4
	11.8	15.9	29	40.6	53.9	10.2	13.4	27.1	37.5	46.6	8.9	45.6	70.6	62.8	71.3
	11.1	14.4	27.5	42.1	54.3	10.1	13.5	25.5	38.2	47.1	8.6	44.7	71.1	58.8	69.2
	11.2	14.7	28.9	39.7	52.2	10.3	13.9	25.7	36.6	47.8	8.7	46.2	71.6	61	69.7
	11.5	17.1	28.2	41.3	52.5	10	13.4	27.9	38.9	48.3	9	43.1	72	65.7	68.7
AVG	11.6	15.6	28.3	40.9	53.8	10.3	13.9	26.6	37.9	47.9	8.7	44.7	71.3	61.3	70.3
STD (%)	2.6%	8.3%	2.0%	3.9%	2.2%	2.7%	3.8%	3.5%	2.3%	2.0%	4.1%	2.5%	0.8%	3.8%	1.9%
RCP	N/A	N/A	2165	1003	850	N/A	N/A	2488	1049	704	N/A	N/A	719	560	549
	N/A	N/A	1732	1060		N/A	N/A	1752	1017	835	N/A	N/A	607	659	471
AVG	N/A	N/A	1949	1032	850	N/A	N/A	2120	1033	770	N/A	N/A	663	610	510
STD (%)	N/A	N/A	11.1%	2.8%	0.0%	N/A	N/A	17.4%	1.5%	8.5%	N/A	N/A	8.4%	8.1%	7.6%

Lab ID	PSF														
Report ID	Lab#3-3														
Mixing Date	10/2/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014	10/9/2014	10/16/2014	10/30/2014	11/27/2014	12/23/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	11.6	14.9	27.9	37.2	54.9	10.3	14.4	27.2	39.7	50	8.8	43.8	71.7	62.9	70.7
	11.6	14.5	27.8	38.5	54.5	10.2	14.6	28.3	39.7	48.9	9.6	43.3	72	65	71.2
	11.7	13.7	28.7	41.7	49.2	10.8	14.2	27.8	40.2	50.6	9.3	46.5	72.2	59.5	68.3
	11	14.4	30.3	39.1	54.4	9.8	14.4	27.5	37.7	47.6	9	47.9	71.1	62.4	71.3
	11.2	15	28.1	40.8	50.3	10	15	26	40.2	49.8	9.4	43.8	71.6	64.2	69.9
	11.1	13.4	28.7	38.9	52.5	10.1	15.4	27.8	38	46.5	9.6	43.1	72	59.6	70.2
	11.2	13.3	30	39.5	50.7	10.6	14.3	25.8	41.3	46.7	9	42.9	70.8	61.5	73.2
	11.9	14.5	30.9	39.4	54.8	10.2	14	27.6	40.5	49.5	9.3	46.5	70.3	63.6	72.9
AVG	11.4	14.2	29.1	39.4	52.7	10.3	14.5	27.3	39.7	48.7	9.3	44.7	71.5	62.3	71.0
STD (%)	2.7%	4.3%	3.8%	3.3%	4.1%	2.9%	2.9%	3.1%	2.9%	3.0%	3.0%	4.0%	0.9%	3.0%	2.1%

Lab ID	PSFR														
Report ID	Lab#3-4														
Mixing Date	10/3/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	7	10.4	22.8	28.3	41.5	5.5	7.7	20.3	25.4	33.1	4.9	20	52.7	41.4	46.1
	6.8	11.2	24.7	28.1	41.3	5.8	8.1	20.7	21.8	32.7	5.5	23.3	49.6	41.9	43.4
	7.7	10.6	23.9	29.3	42.2	5.9	7.9	24	21.1	33.3	5.1	21.3	53	41.3	44.1
	6.8	10	24.3	28.2	41	5.7	8.1	19.1	19.6	29.3	5.1	21.3	52.8	45	44.2
	7.4	10.9	22.9	27.3	41.8	5.8	8.1	21.7	21.9	34	5	21.8	50.2	41.5	45.4
	6.1	11.1	22.2	27.7	43.7	6	8.2	19.9	22.4	32.8	4.8	22	51.4	36.8	49
	7.5	10.3	23.7	27	41.5	5.4	8	20.5	21.1	32	5.2	21.8	52.1	45.4	46.2
	7.5	10.2	23.4	28.9	42.7	5.5	7.8	20.9	21.1	33.7	5.1	21.5	50.2	42.5	45.8
AVG	7.1	10.6	23.5	28.1	42.0	5.7	8.0	20.9	21.8	32.6	5.1	21.6	51.5	42.0	45.5
STD (%)	7.0%	3.9%	3.3%	2.6%	2.0%	3.5%	2.0%	6.6%	7.2%	4.2%	3.9%	4.0%	2.5%	5.9%	3.6%
RCP	N/A	N/A	2261	1990	1304	N/A	N/A	3153	2270	N/A	N/A	N/A	2026	1643	618
	N/A	N/A	2968	2160	1870	N/A	N/A	4131	2120	N/A	N/A	N/A	1525	1572	1028
AVG	N/A	N/A	2615	2075	1587	N/A	N/A	3642	2195	N/A	N/A	N/A	1776	1608	823
STD (%)	N/A	N/A	13.5%	4.1%	17.8%	N/A	N/A	13.4%	3.4%	N/A	N/A	N/A	14.1%	2.2%	24.9%

Lab ID	PSFR														
Report ID	Lab#3-4														
Mixing Date	10/3/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	7.1	11.3	24	27.9	41.5	5.3	7.5	20.9	21	32.1	6.1	21.6	52.3	40.1	42.5
	6.7	10.3	24.5	28.7	42.5	5.2	8.2	20.4	21.3	33.4	5.7	19.6	51.3	42.2	45.6
	7.2	11.9	24.8	31.7	44.8	5.9	7.5	24.4	22.4	32.3	6.1	21.5	50.7	40.7	44.4
	7.1	10.4	23.6	28.2	41.8	5.2	7.6	20.2	23	34.5	5.5	21	53.5	40.5	43.7
	6.7	10.8	23.2	28.8	40.7	5.3	8	22.3	20.3	31.4	5.5	19.8	50.5	40.3	45.2
	6.9	10.3	25.9	30.9	40	5.8	7.4	19.5	21.6	33.4	5.9	20.2	53.3	41.5	47.9
	7.3	10.8	24	29.7	41.7	5	8.3	21.2	21.5	33.9	5.5	20.6	55	42.5	42.9
	7	10.7	23.6	28.6	41	5.6	7.6	19.9	21.2	33.2	5.4	21.6	52	43.9	45.3
AVG	7.0	10.8	24.2	29.3	41.8	5.4	7.8	21.1	21.5	33.0	5.7	20.7	52.3	41.5	44.7
STD (%)	2.9%	4.8%	3.3%	4.3%	3.2%	5.5%	4.2%	7.0%	3.6%	2.9%	4.7%	3.7%	2.8%	3.0%	3.6%

Lab ID	PSFA														
Report ID	Lab#3-5														
Mixing Date	10/3/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	9	12.9	33.1	37	50.1	9	13.9	28	31.4	50.1	9	29.4	68.1	58.5	63.7
	9.6	13.1	32.8	36.6	49.5	9.4	12.3	27.9	34.1	49	9.2	29.9	65.8	58.4	63.3
	9.2	12.9	33	38.8	48.6	9	12.3	28.6	35.6	48.5	8.9	32.3	68.3	58.6	64.9
	9.4	13.4	33.2	37.1	50.1	9.1	13	28.8	31.9	48.8	9.4	32.8	65.5	54.7	61.6
	9.4	13	31.8	37.3	50.2	9.3	12.3	27	33.1	51	9.4	36.3	64.3	57.6	63
	9.5	13.6	33.3	38.3	50.4	9.4	12.8	26.8	32.9	48.7	8.7	31.8	66.7	60.9	62.4
	9.6	12.7	32.7	38.7	49.8	9.5	12.4	27.7	35.4	48	9	31.1	66.4	54.8	62.1
	9.5	13	33.3	38.1	48.1	9.3	12.7	25.9	32.1	49.5	9.4	30.4	65.3	56.9	63.2
AVG	9.4	13.1	32.9	37.7	49.6	9.3	12.7	27.6	33.3	49.2	9.1	31.8	66.3	57.6	63.0
STD (%)	2.1%	2.1%	1.4%	2.1%	1.6%	1.9%	4.0%	3.3%	4.4%	1.8%	2.7%	6.4%	1.9%	3.4%	1.5%
RCP	N/A	N/A	2115	1122	933	N/A	N/A	2335	1160	1071	N/A	N/A	687	902	666
	N/A	N/A	2173	1167	882	N/A	N/A	1652	1147	798	N/A	N/A	993	829	698
AVG	N/A	N/A	2144	1145	908	N/A	N/A	1994	1154	935	N/A	N/A	840	866	682
STD (%)	N/A	N/A	1.4%	2.0%	2.8%	N/A	N/A	17.1%	0.6%	14.6%	N/A	N/A	18.2%	4.2%	2.3%

Lab ID	PSFA														
Report ID	Lab#3-5														
Mixing Date	10/3/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014	10/10/2014	10/17/2014	10/31/2014	11/28/2014	12/24/2014
Testing Age	7	14	28	56	81	7	14	28	56	81	7	14	28	56	81
SR	10.7	13.3	27.8	34.7	46.2	9.5	11.8	23.6	38.7	43.1	9.3	30.4	67.3	51.8	63.1
	10.6	12.9	28.6	33.1	43.5	9.4	11.6	25.1	35.4	46.4	8.5	29.9	66.1	51.8	64.5
	10.3	13.7	30.7	33.5	45.1	9	12.2	27.3	33.5	47.5	9.2	30.4	66.8	52.7	60.8
	10.6	13	29	33.4	44.4	9.1	12.3	26.3	38.9	43.7	9	31.5	66	54.6	62.9
	10.6	13.5	27.1	31.9	43	9.4	11.4	25.1	33.7	44.2	9.3	32.5	67.5	50.5	63.4
	10.4	12.7	29.4	31.7	42.6	8.5	11.5	25	38.2	45.3	9.3	31.7	66.3	51.5	63.9
	10.2	13.6	31.2	34.2	44.1	8.6	12.4	26.5	36.6	46.2	9.3	30.3	67.3	51.1	64
	10.3	12.8	30.2	34.3	44.4	9.1	11.5	25.7	35.3	46.6	9.4	32.5	63.7	51.2	68.7
AVG	10.5	13.2	29.3	33.4	44.2	9.1	11.8	25.6	36.3	45.4	9.2	31.2	66.4	51.9	63.9
STD (%)	1.7%	2.7%	4.5%	3.1%	2.5%	3.8%	3.2%	4.2%	5.6%	3.2%	3.0%	3.1%	1.7%	2.3%	3.3%

Field HPC NJDOT

Lab ID	RU
Report ID	DOTF7
Mixing Date	7/17/2014

Curing Regime	Lime Bath						Hot Lime Bath				
Testing Date	7/24/2014	7/31/2014	8/14/2014	9/11/2014	10/16/2014	10/16/2014	7/24/2014	7/31/2014	8/14/2014	9/11/2014	10/16/2014
Testing Age	7	14	28	56	91	91	7	14	28	56	91
SR	4.9	10.1	18.6	28.3	47.8	40.3	5	21.9	36.1	49.4	77.4
	5	10.2	19.7	28.9	45.9	39.8	5	23	35.8	48.6	77.4
	4.9	9.4	19.4	28.6	49.1	41.8	4.6	23.1	35.7	48.6	77.2
	5.2	9.6	19.3	27.9	46.2	40	5.1	22.9	36.2	49.6	75
	5.1	10	19.1	29.1	48.3	40.8	5	22.5	35	46.7	77
	5	10	19.2	29	48	38.8	5.3	22.7	35.8	47.3	77.6
	5.1	9.7	19.4	28.9	47.2	40.1	5.2	22.5	36.2	47.1	75.7
	4.8	9.8	19.5	28.2	48.4	38.8	5.1	22.6	34.9	48.3	77.9
AVG	5.0	9.9	19.3	28.6	47.6	40.1	5.0	22.7	35.7	48.2	76.9
STD (%)	2.4%	2.6%	1.6%	1.4%	2.2%	2.3%	3.8%	1.6%	1.3%	2.1%	1.2%
RCP	N/A	N/A	2256	1161	971	N/A	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	2219	1146	993	N/A	N/A	N/A	N/A	N/A	N/A
AVG	N/A	N/A	2238	1154	982	N/A	N/A	N/A	N/A	N/A	N/A
STD (%)	N/A	N/A	0.8%	0.7%	1.1%	N/A	N/A	N/A	N/A	N/A	N/A

Curing Regime	Water Bath						Hot Water Bath				
Testing Date	7/24/2014	7/31/2014	8/14/2014	9/11/2014	10/16/2014	10/16/2014	7/24/2014	7/31/2014	8/14/2014	9/11/2014	10/16/2014
Testing Age	7	14	28	56	91	91	7	14	28	56	91
SR	6.1	10.1	18.8	25.9	44.6	42.5	5.9	32.9	37.2	45.2	79
	6.4	9.8	18.6	26.9	44.2	41.3	5.8	32.1	36.9	44	78.5
	6.3	10.2	17.7	25.2	46.7	39.7	5.7	33.6	37.4	45.7	75.9
	5.9	10.3	17.9	26.2	46.2	41.8	6.2	32.7	38.1	47.3	78.8
	5.9	10.3	16.8	25.1	45.8	41.7	6.1	34.2	37.8	47.4	76.8
	6.2	9.8	18	25.7	45.8	41.1	5.8	32.2	36.1	46.4	76.6
	5.8	9.9	18.1	25.6	45.7	41.5	5.8	31.4	38.2	46.9	75.9
	6.1	10.9	18.3	26.2	45.8	39.6	5.9	33	35.6	47.8	78.2
AVG	6.1	10.2	18.0	25.9	45.6	41.2	5.9	32.8	37.2	46.3	77.5
STD (%)	3.2%	3.3%	3.2%	2.1%	1.7%	2.3%	2.7%	2.5%	2.3%	2.6%	1.6%
RCP	N/A	N/A	2161	1607	1582	N/A	N/A	N/A	N/A	N/A	N/A
	N/A	N/A	2164	1519	1495	N/A	N/A	N/A	N/A	N/A	N/A
AVG	N/A	N/A	2163	1563	1539	N/A	N/A	N/A	N/A	N/A	N/A
STD (%)	N/A	N/A	0.1%	2.8%	2.8%	N/A	N/A	N/A	N/A	N/A	N/A

Lab ID	HPC1						
Report ID	DOTF1						
Mixing Date	9/13/13						
	HPC1N-4-R			HPC1N-4-S			
Curing Regime	Curing Room			Curing Room			
Testing Date	10/11/2013	11/8/2013	12/13/2013	9/20/2013	10/11/2013	11/8/2013	12/13/2013
Testing Age	28	56	91	7	28	56	91
SR	24	N/A	N/A	18.7	16.1	24.1	26.1
	31	N/A	N/A	19.4	18.7	25.7	28.8
	20.1	N/A	N/A	21.6	18.4	33.2	28.1
	22	N/A	N/A	19.2	17.4	27.5	26.7
	24.5	N/A	N/A	18.4	18.1	26.4	25.8
	23.7	N/A	N/A	15.7	17.6	28.8	28.6
	18	N/A	N/A	21.5	17.9	31	28.8
	24.9	N/A	N/A	19.8	17.1	26.9	26.3
AVG	23.5	N/A	N/A	19.3	17.7	28.0	27.4
STD (%)	15.3%	N/A	N/A	9.1%	4.3%	9.9%	4.4%
RCP	2283	1782	1505	N/A	N/A	N/A	N/A
	2072	1654	1433	N/A	N/A	N/A	N/A
AVG	2178	1718	1469	N/A	N/A	N/A	N/A
STD (%)	4.8%	3.7%	2.5%	N/A	N/A	N/A	N/A

Lab ID	HPC2						
Report ID	DOTF2						
Mixing Date	9/27/13						
	HPC2N-4-R			HPC2N-4-S			
Curing Regime	Curing Room			Curing Room			
Testing Date	10/25/2014	11/22/2014	12/27/2014	10/4/2013	10/11/2014	10/25/2014	12/27/2014
Testing Age	28	56	91	7	14	28	91
SR	22.2	N/A	N/A	10.7	14.4	20.9	41
	22.9	N/A	N/A	9.6	14.6	19.3	44.2
	23.2	N/A	N/A	9.6	15.3	21.4	40.5
	21.6	N/A	N/A	9.7	14.2	21.8	45.2
	23.9	N/A	N/A	10	14.6	20.5	42.1
	24.6	N/A	N/A	9.8	14.8	21.9	42.7
	22.4	N/A	N/A	10.2	14.3	21.4	41.2
	21.6	N/A	N/A	10.9	14	21.3	43.6
AVG	22.80	N/A	N/A	10.06	14.53	21.06	42.56
STD (%)	4.4%	N/A	N/A	4.7%	2.6%	3.7%	3.7%
RCP	2878	1367	957	N/A	N/A	N/A	N/A
	2745	1336	917	N/A	N/A	N/A	N/A
AVG	2812	1352	937	N/A	N/A	N/A	N/A
STD (%)	2.4%	1.1%	2.1%	N/A	N/A	N/A	N/A

Lab ID	HPC3					
Report ID	DOTF3					
Mixing Date	9/30/13					
	HPC3N-4-R			HPC3N-4-S		
Curing Regime	Curing Room			Curing Room		
Testing Date	10/28/2013	11/25/2013	12/30/2013	10/28/2013	11/25/2013	12/30/2013
Testing Age	28	56	91	28	56	91
SR	20.9	45.4	N/A	24.9	40.2	47.3
	19.3	42.5	N/A	29.2	40.1	48
	21.4	45.1	N/A	26.8	40.9	46.2
	21.8	35.8	N/A	25.4	36.8	46.6
	20.5	44.8	N/A	25	40.3	45.6
	21.9	41.1	N/A	24.5	40.3	46
	21.4	44.2	N/A	26.7	42	47.6
	21.3	35.5	N/A	26.3	37	47.4
AVG	21.06	41.80	N/A	25.66	39.70	46.84
STD (%)	3.7%	9.1%	N/A	3.4%	4.3%	1.7%
RCP	1953	1289	953	N/A	N/A	N/A
	1841	735	962	N/A	N/A	N/A
AVG	1897	1289	958	N/A	N/A	N/A
STD (%)	3.0%	0.0%	0.5%	N/A	N/A	N/A

Lab ID	HPC4		
Report ID	DOTF4		
Mixing Date	10/16/13		
	HPC4N-4-R		HPC4N-4-S
Curing Regime	Curing Room		Curing Room
Testing Date	11/3/2013	12/11/2013	11/3/2013
Testing Age	28	56	28
SR	14.5	N/A	17.4
	14.8	N/A	18
	14.8	N/A	16.7
	14.1	N/A	15.2
	14.3	N/A	16.4
	14.9	N/A	17.8
	14.5	N/A	16.6
	14	N/A	15.7
AVG	14.49	N/A	16.73
STD (%)	2.2%	N/A	5.5%
RCP	3187	2071	N/A
	1862	2153	N/A
AVG	2525	2112	N/A
STD (%)	26.2%	1.9%	N/A

Lab ID	HPC5	
Report ID	DOTF5	
Mixing Date	10/25/2014	
	HPC5N-4-R	
Curing Regime	Curing Room	
Testing Date	11/22/2013	12/20/2013
Testing Age	28	56
SR	14.2	N/A
	14.7	N/A
	17	N/A
	15.9	N/A
	14.5	N/A
	15.1	N/A
	16.6	N/A
	15.3	N/A
AVG	15.41	N/A
STD (%)	6.1%	N/A
RCP	2858	1984
	2784	2056
AVG	2821	2020
STD (%)	1.3%	1.8%

Lab ID	HPC6					
Report ID	DOTF6					
Mixing Date	11/16/2013					
	HPC6N-4-R			HPC6N-4-S		
Curing Regime	Curing Room			Curing Room		
Testing Date	12/14/2013	1/11/2014	2/15/2014	12/14/2013	1/11/2014	2/15/2014
Testing Age	28	56	91	28	56	91
SR	32.1	41.6	N/A	32.1	39.4	40.4
	34.6	39.7	N/A	34.6	39.5	41.8
	32.3	39	N/A	32.3	39.8	39.9
	36.3	39.1	N/A	36.3	39.1	39.2
	31.6	40.3	N/A	31.6	41.4	38.6
	33.3	40.1	N/A	33.3	41.1	43.9
	32.1	40.2	N/A	32.1	41.9	41.9
	34.2	40	N/A	34.2	40.7	40.6
AVG	32.28	40.00	N/A	32.28	40.36	40.79
STD (%)	1.7%	1.9%	N/A	1.7%	2.4%	3.9%
RCP	1367	1051	959	N/A	N/A	N/A
	1172	1032	906	N/A	N/A	N/A
AVG	1270	1042	933	N/A	N/A	N/A
STD (%)	7.7%	0.9%	2.8%	N/A	N/A	N/A

Field HES NJTA

Lab ID	HES16				
Report ID	HES2				
Mixing Date	6/16/2014				
Curing Regime	Hot Lime Bath				
Testing Date	6/23/2014	6/29/2014	7/14/2014	8/11/2014	9/15/2014
Testing Age	7	14	28	56	91
SR	15.5	130.1	146.9	159.3	164.4
	15.4	139.4	140.9	165.5	162.6
	15.4	132.8	151.2	162.2	160
	15.7	131.8	145.7	159.3	164.7
	15.7	138.8	146.2	152.4	161.5
	15.1	128.4	140.5	158	157.5
	15.2	138.8	149.2	148.1	168.9
	15.8	134.2	149	150.2	168.7
AVG	15.5	134.3	146.2	156.9	163.5
STD (%)	1.5%	3.0%	2.5%	3.6%	2.3%
RCP	N/A	265	204	176	147
	N/A	279	197	167	145
AVG	N/A	272	201	172	146
STD (%)	N/A	2.6%	1.7%	2.6%	0.7%

Lab ID	HES19				
Report ID	HES3				
Mixing Date	6/19/2014				
Curing Regime	Curing Room				
Testing Date	6/26/2014	7/3/2014	7/17/2014	8/14/2014	9/18/2014
Testing Age	7	14	28	56	91
SR	18.3	43.9	79.8	120	131.3
	18.3	44.3	78.5	121.9	139.3
	18.4	44.7	80.5	121.3	141.1
	18.7	44.8	78.5	126.9	130.6
	18.6	45	80.1	118.8	143.9
	18.4	43.2	80.8	119.3	135.9
	18.5	43.9	81	119	137.8
	18.2	45	79.7	121	138.5
AVG	18.4	44.4	79.9	121.0	137.3
STD (%)	0.8%	1.4%	1.1%	2.0%	3.1%
RCP	N/A	N/A	485	309	213
	N/A	N/A	454	280	215
AVG	N/A	N/A	470	295	214
STD (%)	N/A	N/A	3.3%	4.9%	0.5%

Lab ID	HES23				
Report ID	HES4				
Mixing Date	6/23/2014				
Curing Regime	Curing Room				
Testing Date	6/30/2014	7/7/2014	7/21/2014	8/18/2014	9/22/2014
Testing Age	7	14	28	56	91
SR	23.7	43.8	71.5	106.7	120
	23.9	42	74.9	100.9	135.7
	22.6	41.7	68.1	106.3	125.5
	23.1	43.7	67.3	105.5	133.9
	23.7	41.2	73.4	101.8	131.1
	23.9	43.1	74.8	104.5	116.1
	23	40.3	76	102.8	122.6
	23.7	43.8	75	105.2	129.9
AVG	23.5	42.5	72.6	104.2	126.9
STD (%)	1.9%	3.0%	4.3%	1.9%	5.1%
RCP	N/A	N/A	502	304	258
	N/A	N/A	463	268	247
AVG	N/A	N/A	483	286	253
STD (%)	N/A	N/A	4.0%	6.3%	2.2%

Lab ID	S															
Report ID	HES1															
Mixing Date	9/26/2014															
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath					
Testing Date	10/3/2014	10/10/2014	10/24/2014	11/21/2014	12/19/2014	10/3/2014	10/10/2014	10/24/2014	11/21/2014	12/19/2014	10/3/2014	10/10/2014	10/24/2014	11/21/2014	12/
Testing Age	7	14	28	56	80	7	14	28	56	80	7	14	28	56	
SR	16.1	23.2	42.6	65.4	72.4	15.9	22.8	41.1	67.1	70.2	16.8	50.3	69.8	83	
	16.6	23.6	42.9	67.3	71.6	15.5	22.2	35.5	65.1	73.2	14.7	51	68.6	81.4	
	15	23.9	39.1	66.7	74.5	16.5	22.1	37.3	66.1	70.7	15.8	52.1	66.5	79.1	
	15.9	23.1	43.4	68.5	76.4	16	23.3	38.9	67.1	72.6	16.4	51	67.4	78.9	
	16.5	23.2	45	65.2	72.6	14	22.1	39.5	65.5	73.8	17.2	52.6	69	81.4	
	14.9	23.3	41.9	68	74.6	13.7	22.8	36.8	64.3	70.6	16.2	52.9	66.7	81.2	
	17	24.8	42.8	64.2	78.2	15.2	21.7	45.4	64.3	75	17.5	52.6	67.1	81.9	
	16.8	23.6	42.4	67.1	76	14.1	22	35.6	63.1	74.7	15.3	51.5	66.2	79.4	
AVG	16.1	23.6	42.5	66.6	74.5	15.1	22.4	38.8	65.3	72.6	16.2	51.8	67.7	80.8	
STD (%)	4.6%	2.2%	3.6%	2.1%	2.8%	6.5%	2.2%	8.0%	2.0%	2.5%	5.5%	1.7%	1.8%	1.7%	
RCP	N/A	N/A	914	796	786	N/A	N/A	1239	675	744	N/A	N/A	547	509	
	N/A	N/A	959	660	733	N/A	N/A		664	646	N/A	N/A	595	548	
AVG	N/A	N/A	937	728	760	N/A	N/A	1239	670	695	N/A	N/A	571	529	
STD (%)	N/A	N/A	2.4%	9.3%	3.5%	N/A	N/A	0.0%	0.8%	7.1%	N/A	N/A	4.2%	3.7%	

Lab ID	S														
Report ID	HES1														
Mixing Date	9/26/2014														
Curing Regime	Curing Room					Lime Bath					Hot Lime Bath				
Testing Date	10/3/2014	10/10/2014	10/24/2014	11/21/2014	12/19/2014	10/3/2014	10/10/2014	10/24/2014	11/21/2014	12/19/2014	10/3/2014	10/10/2014	10/24/2014	11/21/2014	12/19/2014
Testing Age	7	14	28	56	80	7	14	28	56	80	7	14	28	56	80
SR	15.5	24.7	42.5	66.9	74.9	15.4	20.7	36.7	68.6	74.3	17	51.9	70.9	80.2	87.7
	15.1	25.2	42.6	65.7	75.7	16.6	20.3	39.3	64.3	74	15.6	51.1	65.7	76.2	86.5
	13.8	25.5	43.3	65.5	76.5	15.1	21.4	39.4	64.8	74.1	16.7	51.5	70.9	80.5	87.8
	16.8	25.2	43.3	65.5	74.7	15.5	20.1	38.9	68.2	73	15.4	52.9	63.4	79.7	89.6
	15.9	24.5	40	64	74.9	15.8	19.9	35.9	64.9	74.3	18.8	50.4	63.7	79.7	86.6
	14.4	25.4	43	69.2	77.3	16.8	19.8	36.7	65.8	73.6	16.5	52	67.2	80.8	85.1
	14.8	25.2	42.9	63.9	75.2	15.3	20.6	40.3	66.9	74.9	16.3	52.4	69.4	80.1	88.8
	15.9	24	43	66	74.7	15.5	20	38.7	66.7	75.2	19.6	50.4	66.8	80.8	86.5
AVG	15.3	25.0	42.6	65.8	75.5	15.8	20.4	38.2	66.3	74.2	17.0	51.6	67.3	79.8	87.3
STD (%)	5.8%	1.9%	2.4%	2.4%	1.2%	3.7%	2.4%	3.9%	2.3%	0.9%	8.2%	1.6%	4.1%	1.8%	1.5%

Lab HPC 9.2013 - 12.2013

Lab ID	DOT1										
Report ID	Lab#1-1										
Mixing Date	9/10/2013										
	DOT1N-4-R			DOT1N-4-S					DOT1N-6-S		
Curing Regime	Curing Room			Curing Room					Curing Room		
Testing Date	10/8/2013	11/5/2013	12/10/2013	9/17/2013	9/24/2013	10/8/2013	11/5/2013	12/10/2013	10/8/2013	11/5/2013	12/10/2013
Testing Age	28	56	91	7	14	28	56	91	28	56	91
SR	15.9	17	18.8	11.5	17.3	10.6	16.1	22.2	11.7	14.3	18.7
	17.3	18.6	20.4	11.3	16.2	10.6	15.4	24	11.4	14.6	17.6
	15.5	19	19.6	11.9	17.7	10.6	17.8	22.6	10.1	12.4	16
	17	19.4	17.9	12	15.2	13.2	15.9	22.8	10	12.1	16.6
	17.2	16.7	20.8	10.8	15.9	10.6	15.8	22.7	11.7	14.5	18
	16.8	18.7	19.4	11.1	15.6	10.9	15.2	24.6	11.4	14.7	18.1
	16.6	18.7	18	11.8	17.7	10.5	17.7	22.3	10.4	12.6	15.8
	17.2	20.9	18.9	11.1	15.2	12.9	15.4	23.7	10	12.1	15.5
AVG	16.7	18.6	19.2	11.4	16.4	10.6	16.2	23.1	10.8	13.4	17.0
STD (%)	3.7%	6.7%	5.1%	3.5%	6.1%	1.2%	5.9%	3.5%	6.7%	8.4%	6.7%
RCP	3067	2311									
	N/A	N/A									
AVG	3067	2311									
STD (%)	0.0%	0.0%									

Lab ID	DOT1										
Report ID	Lab#1-1										
Mixing Date	9/10/2013										
	DOT1N-4-R			DOT1N-4-S					DOT1N-6-S		
Curing Regime	Hot Water Bath			Hot Water Bath					Hot Water Bath		
Testing Date	9/24/2013	10/8/2013	11/5/2013	9/17/2013	9/24/2013	10/8/2013	11/5/2013	12/10/2013	10/8/2013	11/5/2013	12/10/2013
Testing Age	14	28	56	7	14	28	56	91	28	56	91
SR	13.2	18	174.7	10.1	13.1	10.6	13.2	20.9	11.1	13.4	15.7
	13.5	20.4	183.1	11.1	16.4	13.4	17.9	24.1	11.8	13.5	18.1
	14	17.3	193.3	9.8	13.7	11.6	14.4	19.3	11.8	14.1	17
	14.5	16.9	177.4	9.9	14.1	12.5	16.5	20.8	11.4	14.7	17.1
	12.9	18.9	169.6	8.9	12.3	10.4	14.3	19.2	11	13	15.3
	13.9	20.3	184.2	10.5	15.3	14	17.3	24	11.8	13.6	16.1
	14	16.9	174.8	9.3	13.1	11.7	14.3	19.7	12.2	14.2	16.7
	13.9	17.2	172.9	9.9	14.3	13	16.3	21.6	11.9	14.9	17.2
AVG	13.7	18.2	178.8	9.9	14.0	11.4	15.5	21.2	11.6	13.9	16.7
STD (%)	3.5%	7.5%	4.0%	6.4%	8.8%	10.7%	10.2%	8.6%	3.4%	4.5%	5.1%
RCP	3982	2687	2910								
	3156	2559	3738								
AVG	3569	2623	3324								
STD (%)	11.6%	2.4%	12.5%								

Lab ID	DOT2											
Report ID	Lab#1-2											
Mixing Date	9/17/2013			SF+FA+SL								
	DOT2N-4-R			DOT2N-4-S					DOT2N-6-S			
Curing Regime	Curing Room			Curing Room					Curing Room			
Testing Date	10/15/2013	11/12/2013	12/17/2013	9/24/2013	10/1/2013	10/15/2013	11/12/2013	12/17/2013	10/1/2013	10/15/2013	11/12/2013	12/17/2013
Testing Age	28	56	91	7	14	28	56	91	14	28	56	91
SR	51.9	103.4	117.6	15.1	25.7	55	103	129.2	20.4	37.9	81.2	109.8
	54.4	87.8	105.9	13.3	26	61.2	90.5	134.3	20.6	38.5	82.5	104
	50.8	90.5	94.8	13.8	21.9	59.3	101.6	128.2	21.9	40.9	85.7	104.2
	51.8	95.2	109.3	14.8	29.3	56	101.2	121.8	21.2	42.9	80.7	102.8
	57.9	98	105.9	14.7	N/A	53.8	98	128.8	N/A	37.5	80.1	109.1
	53.7	85.8	99.4	13.6	N/A	60.5	97.6	127.8	N/A	41.4	85.2	107
	52.2	102.5	106	13.7	N/A	59.7	91.3	114.1	N/A	42	85.3	99.2
	52	90	102.6	14.9	N/A	55.6	93	130.7	N/A	44	81.3	104.1
AVG	53.1	94.2	105.2	14.2	25.9	57.6	97.0	126.9	21.0	40.6	82.8	105.0
STD (%)	4.0%	6.6%	6.0%	4.6%	0.6%	4.6%	4.7%	4.6%	2.8%	5.6%	2.6%	3.1%
RCP	404	518	386									
	326	471	326									
AVG	N/A	495	356									
STD (%)	N/A	4.8%	8.4%									

Lab ID	DOT2											
Report ID	Lab#1-2											
Mixing Date	9/17/2013			SF+FA+SL								
	DOT2N-4-R			DOT2N-4-S					DOT2N-6-S			
Curing Regime	Hot Water Bath			Hot Water Bath					Hot Water Bath			
Testing Date	10/1/2013	10/15/2013	11/12/2013	9/24/2013	10/1/2013	10/15/2013	11/12/2013	12/17/2013	10/1/2013	10/15/2013	11/12/2013	12/17/2013
Testing Age	14	28	56	7	14	28	56	91	14	28	56	91
SR	105.1	148.3	169.2	67.6	141.7	192.3	187.9	182.8	82.3	123.3	160	143.6
	102.5	150.4	165	68	145.8	179.3	192.1	166.2	80.6	115.1	154.7	152.7
	90.7	162	165.2	62.3	144.4	172.5	191.5	170.3	98.4	100.8	149.9	146.5
	94	153.9	161.3	69.6	143.2	180.8	198.5	150.2	97.1	105.3	153.6	152.5
	95	162.3	152.8	67	N/A	194.9	199.1	153.2	N/A	122.7	161.5	145.4
	97.6	161.5	169.1	64.2	N/A	193.1	193.2	142.5	N/A	116.2	163	152.2
	94.3	169.4	155	61.9	N/A	192.7	201	162.2	N/A	103.7	155.2	146.2
	98	158.8	150.3	67.1	N/A	164.9	201	154	N/A	102.6	150.8	131
AVG	97.2	158.3	161.0	66.0	143.8	183.8	195.5	160.2	89.6	111.2	156.1	146.3
STD (%)	4.6%	4.1%	4.3%	4.0%	1.1%	5.7%	2.4%	7.5%	9.1%	7.7%	2.9%	4.6%
RCP	363	198	481									
	426	182	298									
AVG	395	190	390									
STD (%)	8.0%	4.2%	23.5%									

Lab ID	DOT3												
Report ID	Lab#1-3												
Mixing Date	9/19/2013		SF+FA										
	DOT3N-4-R					DOT3N-4-S					DOT3N-6-S		
Curing Regime	Curing Room					Curing Room					Curing Room		
Testing Date	10/17/2013	11/14/2013	12/19/2013	9/26/2013	10/3/2013	10/17/2013	11/14/2013	12/19/2013	9/26/2013	10/3/2013	10/17/2013	11/14/2013	12/19/2013
Testing Age	28	56	91	7	14	28	56	91	7	14	28	56	91
SR	32.9	61	55.7	8.1	9.5	18.7	44.8	77.5	6.1	7.6	14	37.3	54.4
	29.8	57.3	57.1	8.6	11	18.3	45.2	72	6.6	8.8	16.8	37	58.8
	28.9	56.2	50.1	8	10.6	19.6	44.3	72.5	6.4	7.7	16.4	36.8	56.8
	31.7	56.8	47.2	7	11.2	16.8	40.7	74.9	5.8	6.9	14.7	35.9	58.4
	31.9	57.4	43.2	7.5	11	17.3	42.4	73.8	5.9	7.4	14.2	36.2	55
	28.7	54.3	39.1	8.4	11.1	19.4	46.4	70.3	6.1	8.2	17.1	37.1	59.4
	29.9	57.5	50.6	7.9	11.3	19.3	45.8	73.8	6.2	8.1	16.4	35.6	54.6
	30.7	60.5	43	7	11.4	17	47.1	73.2	5.7	7.6	14	32.8	55.6
AVG	30.6	57.6	N/A	7.8	10.9	18.3	44.6	73.5	6.1	7.8	15.5	36.1	56.6
STD (%)	4.6%	3.6%	N/A	7.2%	5.2%	5.8%	4.4%	2.7%	4.6%	6.9%	8.1%	3.8%	3.3%
RCP	1976	1051	744										
	2173	1015	445										
AVG	2075	1033	595										
STD (%)	4.7%	1.7%	25.1%										

Lab ID	DOT3												
Report ID	Lab#1-3												
Mixing Date	9/19/2013			SF+FA									
	DOT3N-4-R			DOT3N-4-S					DOT3N-6-S				
Curing Regime	Hot Water Bath			Hot Water Bath					Hot Water Bath				
Testing Date	10/3/2013	10/17/2013	11/14/2013	9/26/2013	10/3/2013	10/17/2013	11/14/2013	12/19/2013	9/26/2013	10/3/2013	10/17/2013	11/14/2013	12/19/2013
Testing Age	14	28	56	7	14	28	56	91	7	14	28	56	91
SR	37.7	76.9	81.4	17.4	48.8	49.6	77.2	91.5	11.6	32.2	39.2	58.5	80.2
	36.7	73.9	81.8	20.2	49.4	57	73	101.2	11.5	34.9	41.4	59.8	78.5
	41.4	75.4	80	19.5	50.3	52.5	71.3	97.4	13.5	29.3	38.7	59.7	77.1
	41.7	75.5	80	19.2	47	49.5	69.9	91.6	14	37.3	40.5	59.1	80.1
	39.2	72.9	80.7	18.1	48.6	48.1	82.9	93.5	12.3	35.6	39.1	58.4	81
	37.6	70.3	80.7	20	48.7	56.4	69.6	84.5	10.4	33.7	41.7	58.5	79.6
	38.5	74.6	82.5	19.7	48	50.4	70.1	96.8	14.8	34.5	36	59.5	75.6
	42	71.2	78.9	19.1	46.4	48.2	71.1	93.9	11.4	35.5	40.3	59.5	74.8
AVG	39.4	73.8	80.8	19.2	48.4	51.5	73.1	93.8	11.8	34.1	39.6	59.1	78.4
STD (%)	4.9%	2.9%	1.3%	4.7%	2.4%	6.4%	6.0%	5.0%	8.0%	6.7%	4.3%	0.9%	2.7%
RCP	1238	721	595										
	987	946	544										
AVG	1113	834	570										
STD (%)	11.3%	13.5%	4.5%										

Lab ID	DOT4												
Report ID	Lab#1-4												
Mixing Date	9/24/2013		SF+SL										
	DOT4N-4-R			DOT4N-4-S					DOT4N-6-S				
Curing Regime	Curing Room			Curing Room					Curing Room				
Testing Date	10/22/2013	11/19/2013	12/24/2013	10/1/2013	10/8/2013	10/22/2013	11/19/2013	12/24/2013	10/1/2013	10/8/2013	10/22/2013	11/19/2013	12/24/2013
Testing Age	28	56	91	7	14	28	56	91	7	14	28	56	91
SR	32.9	61	55.7	8.1	9.5	18.7	44.8	77.5	6.1	7.6	14	37.3	54.4
	29.8	57.3	57.1	8.6	11	18.3	45.2	72	6.6	8.8	16.8	37	58.8
	28.9	56.2	50.1	8	10.6	19.6	44.3	72.5	6.4	7.7	16.4	36.8	56.8
	31.7	56.8	47.2	7	11.2	16.8	40.7	74.9	5.8	6.9	14.7	35.9	58.4
	31.9	57.4	43.2	7.5	11	17.3	42.4	73.8	5.9	7.4	14.2	36.2	55
	28.7	54.3	39.1	8.4	11.1	19.4	46.4	70.3	6.1	8.2	17.1	37.1	59.4
	29.9	57.5	50.6	7.9	11.3	19.3	45.8	73.8	6.2	8.1	16.4	35.6	54.6
	30.7	60.5	43	7	11.4	17	47.1	73.2	5.7	7.6	14	32.8	55.6
AVG	30.6	57.6	N/A	7.8	10.9	18.3	44.6	73.5	6.1	7.8	15.5	36.1	56.6
STD (%)	4.6%	3.6%	N/A	7.2%	5.2%	5.8%	4.4%	2.7%	4.6%	6.9%	8.1%	3.8%	3.3%
RCP	1976	1051	744										
	2173	1015	445										
AVG	2075	1033	595										
STD (%)	4.7%	1.7%	25.1%										

Lab ID	DOT4												
Report ID	Lab#1-4												
Mixing Date	9/24/2013		SF+SL										
	DOT4N-4-R			DOT4N-4-S					DOT4N-6-S				
Curing Regime	Hot Water Bath			Hot Water Bath					Hot Water Bath				
Testing Date	10/8/2013	10/22/2013	11/19/2013	10/1/2013	10/8/2013	10/22/2013	11/19/2013	12/24/2013	10/1/2013	10/8/2013	10/22/2013	11/19/2013	12/24/2013
Testing Age	14	28	56	7	14	28	56	91	7	14	28	56	91
SR	64.7	81.2	76.4	39.9	64.6	74.9	90.5	79.4	26.8	40.5	57.7	53.8	58.6
	58.5	74	72	43.1	59.2	71.3	84.3	73.6	22.7	41.3	52.5	55.1	61
	62.7	76.5	71	41.8	54.3	70.7	96.3	82.6	23.3	42.3	50.2	61.8	52
	64.9	78.2	73.2	41.3	65.4	74.1	97.6	83.1	22.8	44.7	50.5	55.4	52.5
	68.9	82.4	69.9	N/A	65	79.5	95.9	77.9	N/A	40.4	52.2	53.1	54
	55.5	71.9	68.4	N/A	56.8	70.2	89.8	83.2	N/A	39.6	50.8	56	57.1
	66.7	74	68	N/A	62.3	67.7	92.3	78.1	N/A	43.8	48.3	64.1	51.2
	69.4	75.3	75.6	N/A	62.6	74.6	95.6	86.7	N/A	43.9	52.7	56.5	52.5
AVG	63.9	76.7	71.8	41.5	61.3	72.9	92.8	80.6	23.9	42.1	51.9	57.0	54.9
STD (%)	7.1%	4.5%	4.1%	2.8%	6.3%	4.7%	4.5%	4.8%	7.1%	4.2%	5.0%	6.4%	6.1%
RCP	693	1093	691										
	821	666	644										
AVG	757	880	668										
STD (%)	8.5%	24.3%	3.5%										

Lab ID	DOT5														
Report ID	Lab#1-5														
Mixing Date	9/26/2013			FA+SL											
	DOT5N-4-R			DOT5N-4-S						DOT5N-6-S					
Curing Regime	Curing Room			Curing Room						Curing Room					
Testing Date	10/24/2013	11/21/2013	12/26/2013	10/3/2013	10/10/2013	10/24/2013	11/21/2013	12/26/2013	1/16/2014	10/3/2013	10/10/2013	10/24/2013	11/21/2013	12/26/2013	1/16/2014
Testing Age	28	56	91	7	14	28	56	91	113	7	14	28	56	91	113
SR	31.6	49.2	N/A	9.5	15	26.7	54.3	60.3	81.4	5.7	14.3	23.5	40.4	57.5	77.9
	34.2	50.1	N/A	8.1	12.5	29.9	52.3	64.6	76.3	7.8	14.7	25.2	41.5	58.6	80.7
	33.8	47.8	N/A	8.5	14.8	31.9	59.7	67.4	83.7	5.6	15.4	22.4	43	58.7	72.1
	31.3	54.4	N/A	8.2	15.1	29.5	53.8	62.1	71.6	6.7	14.7	24.1	48.6	46.3	79.7
	32.3	49.1	N/A	8.7	14	27	55.4	52.8	79.4	6.1	12.8	24.5	43.1	53.5	77.7
	34.3	51.3	N/A	8.6	14	30.6	54	51.4	75.2	6.8	14.6	25.8	45.1	51.1	80.8
	33.8	48.9	N/A	8.6	13.8	32.1	56	58.7	82.5	6.1	15.9	27	44.9	52.6	71.3
	32.4	56.1	N/A	8.9	15.8	30.8	54.7	51	70.2	6.7	15.3	22.3	47.2	53.4	79.4
AVG	33.0	50.9	N/A	8.6	14.4	29.8	55.0	61.4	77.5	6.4	14.7	24.4	44.2	54.0	77.5
STD (%)	3.4%	5.4%	N/A	4.7%	6.6%	6.4%	3.7%	3.6%	6.1%	6.4%	5.9%	6.3%	5.9%	7.3%	4.5%
RCP	1398	1128	797												
	N/A	1084	545												
AVG	1398	1106	671												
STD (%)	0.0%	2.0%	18.8%												

Lab ID	DOT5												
Report ID	Lab#1-5												
Mixing Date	9/26/2013		FA+SL										
	DOT5N-4-R			DOT5N-4-S					DOT5N-6-S				
Curing Regime	Hot Water Bath			Hot Water Bath					Hot Water Bath				
Testing Date	10/10/2013	10/24/2013	11/21/2013	10/3/2013	10/10/2013	10/24/2013	11/21/2013	12/26/2013	10/3/2013	10/10/2013	10/24/2013	11/21/2013	12/26/2013
Testing Age	14	28	56	7	14	28	56	91	7	14	28	56	91
SR	77.5	111.4	117.5	45.2	55.1	106.9	141.7	111.4	35.6	81	88	103.3	87.7
	75.6	112.4	119.2	44.3	69.6	108.1	134.2	109.8	29.6	88.6	78.5	103.9	86.3
	81.2	101	117.7	44	67.8	102.5	134	110.5	32.3	90.2	79.1	109.2	99.6
	84	118.9	118.7	41.5	61.8	101.6	117.8	115.5	35.9	85.6	87.1	103.3	99.8
	73.1	115.3	118.5	47.5	69.4	104.4	136.2	110.4	31.7	69.9	77.3	92.1	94.7
	55.5	117.6	127.7	40.9	69	105.4	123	108.7	27.3	78.5	75.3	108.6	86.5
	57.4	101.8	119.5	45.8	77.8	104.6	130.3	113.3	30.5	78.3	75.6	103.3	85.2
	72.1	122.6	119.1	46.1	74.9	104.3	123.5	109.1	32.8	87.4	80.6	100.7	91.1
AVG	77.3	112.6	119.7	44.4	70.0	104.7	130.1	111.1	32.0	82.4	80.2	103.1	91.4
STD (%)	5.5%	6.5%	2.6%	4.8%	6.8%	1.9%	5.8%	1.9%	8.5%	7.7%	5.7%	4.8%	6.1%
RCP	888	520	339										
	778	665	369										
AVG	833	593	354										
STD (%)	6.6%	12.2%	4.2%										

Lab ID	DOT6													
Report ID	Lab#1-6													
Mixing Date	10/1/2013		650lbs											
	DOT6N-4-R			DOT6N-4-S						DOT6N-6-S				
Curing Regime	Curing Room			Curing Room						Curing Room				
Testing Date	10/29/2013	11/26/2013	12/31/2013	10/8/2013	10/15/2013	10/29/2013	11/26/2013	12/31/2013	1/18/2014	10/8/2013	10/15/2013	10/29/2013	11/26/2013	12/31/2013
Testing Age	28	56	91	7	14	28	56	91	108	7	14	28	56	91
SR	58.7	89.2	N/A	11.1	34.7	58.8	171.1	185.2	219	8.5	22.2	52.6	131.1	146.9
	57.3	91.7	N/A	11.7	38.6	66.6	192.1	192	214	9.1	21.1	54.1	144	140
	58.8	94.5	N/A	12	31	60.1	163.3	191.6	195.8	9.9	23.6	51.4	141.3	143.6
	58.8	91.3	N/A	11.5	34	61.5	163.4	184.3	194.9	10.3	24.1	52.8	135.7	142.6
	57.8	88.9	N/A	10.6	30	57.7	175.7	188	220	8.4	23	54.9	130.2	137
	53.3	93.2	N/A	12.1	32.1	71.7	184	182.2	214	9.7	21.9	49.3	139.2	141.5
	56.3	96.2	N/A	11.7	33.2	60.2	163	183.4	195.8	9.4	23.8	52.2	142.1	139.8
	60.5	90.8	N/A	11.4	32.7	60.9	168.4	185.7	193.9	10.6	23.5	51.2	148.6	142.6
AVG	57.7	92.0	N/A	11.5	33.3	62.2	172.6	186.6	205.9	9.5	22.9	52.3	139.0	141.8
STD (%)	3.5%	2.6%	N/A	4.0%	7.4%	7.0%	5.8%	1.8%	5.3%	7.8%	4.3%	3.1%	4.3%	1.9%
RCP	316	471	278											
	708	N/A	196											
AVG	512	471	237											
STD (%)	38.3%	0.0%	17.3%											

Lab ID	DOT6										
Report ID	Lab#1-6										
Mixing Date	10/1/2013		650 lbs								
	DOT6N-4-R			DOT6N-4-S				DOT6N-6-S			
Curing Regime	Hot Water Bath			Hot Water Bath				Hot Water Bath			
Testing Date	10/15/2013	10/29/2013	11/26/2013	10/8/2013	10/15/2013	10/29/2013	11/26/2013	10/8/2013	10/15/2013	10/29/2013	11/26/2013
Testing Age	14	28	56	7	14	28	56	7	14	28	56
SR	283	331	195	175.8	524	362	449	159.2	281	318	393
	274	328	287	146.9	472	342	424	135.7	305	321	415
	297	312	297	164.4	471	324	414	136.5	299	306	378
	274	311	260	161.2	510	377	447	127.4	301	277	355
	283	321	198.7	145.6	529	362	446	159.3	294	295	401
	272	306	295	145.4	451	343	419	140.6	312	314	427
	263	283	296	157.1	461	322	408	125.8	318	296	386
	262	295	268	160	541	364	449	126.9	307	286	364
AVG	276.0	310.9	283.8	157.1	494.9	349.5	432.0	132.2	302.1	301.6	389.9
STD (%)	3.9%	4.9%	5.1%	6.4%	6.6%	5.3%	3.8%	4.3%	3.5%	4.9%	5.9%
RCP	930	211	171								
	963	375	292								
AVG	947	293	232								
STD (%)	1.7%	28.0%	26.1%								

Lab ID	DOT7												
Report ID	Lab#1-7												
Mixing Date	10/3/2013		750 lbs										
	DOT7N-4-R			DOT7N-4-S					DOT7N-6-S				
Curing Regime	Curing Room			Curing Room					Curing Room				
Testing Date	10/31/2013	11/28/2013	1/2/2014	10/10/2013	10/17/2013	10/31/2013	11/28/2013	1/2/2014	10/10/2013	10/17/2013	10/31/2013	11/28/2013	1/2/2014
Testing Age	28	56	91	7	14	28	56	91	7	14	28	56	91
SR	45.9	77.2	N/A	19	27.4	53.7	111	161	16.1	21.2	41.2	82.8	120.9
	53.9	83.6	N/A	16.2	26.2	51.1	106.5	159.9	15.6	22.1	37.8	84.2	118.6
	53.9	80.8	N/A	20.1	28.6	60.2	114.4	157.5	13.2	21.3	39.8	83.4	120.8
	44.9	83	N/A	20.2	28.9	57.8	120.9	158.7	15.3	21.6	41.2	76.7	120.1
	52.2	77.4	N/A	18.2	26.6	52.2	119.3	157.1	14.4	21.3	39.8	79	122.4
	43.7	82.4	N/A	17.1	25.3	52.9	106.9	159.1	17.9	22.5	38	82.1	122.3
	50.9	72.3	N/A	19.9	28.9	54.8	111.8	163	15.4	20.3	44	78.2	121.2
	51.1	81.8	N/A	20.7	28.6	56.4	119.5	156.2	16.3	21.2	40.5	76.2	122.2
AVG	49.6	79.8	N/A	19.3	27.6	54.9	113.8	159.1	15.9	21.4	40.3	80.3	121.1
STD (%)	7.8%	4.5%	N/A	6.2%	4.7%	5.2%	4.7%	1.3%	6.4%	2.9%	4.6%	3.7%	1.0%
RCP	761	779	512										
	1163	N/A	325										
AVG	1163	779	419										
STD (%)	0.0%	0.0%	22.3%										

Lab ID	DOT7												
Report ID	Lab#1-7												
Mixing Date	10/3/2013		750 lbs										
	DOT7N-4-R			DOT7N-4-S					DOT7N-6-S				
Curing Regime	Hot Water Bath			Hot Water Bath					Hot Water Bath				
Testing Date	10/17/2013	10/31/2013	11/28/2013	10/10/2013	10/17/2013	10/31/2013	11/28/2013	1/2/2014	10/10/2013	10/17/2013	10/31/2013	11/28/2013	1/2/2014
Testing Age	14	28	56	7	14	28	56	91	7	14	28	56	91
SR	161.7	167.2	252	113.6	152.2	281	245	208	74.7	121.7	142.3	190.9	178.2
	165.2	189	240	116.5	156.3	250	240	211	68.7	131.8	143.3	205	178.2
	160.8	185.8	218	108	163.6	268	241	209	74	131.4	147	205	176.1
	172.3	187.1	219	106	146.4	249	237	210	70.6	111.5	138	193.4	177.2
	164	194.9	187.7	116	163.3	252	237	207	74.1	120.9	149.9	182	175.7
	167.3	193.3	245	110.7	152.9	248	242	211	69.7	130.5	142.7	193.6	176.3
	164.8	169.2	212	115.5	159.1	259	232	214	72.6	132.7	149.1	205	179.4
	167	163.9	221	108.1	145.8	248	227	209	73.5	109.7	146.5	185.1	180.3
AVG	165.4	181.3	229.6	111.8	155.0	256.9	237.6	209.9	72.2	123.8	144.9	195.0	177.7
STD (%)	2.0%	6.4%	6.3%	3.5%	4.2%	4.4%	2.3%	1.0%	2.9%	7.0%	2.6%	4.4%	0.9%
RCP	266	246	334										
	564	254	244										
AVG	415	250	289										
STD (%)	35.9%	1.6%	15.6%										

Lab ID	DOT8											
Report ID	Lab#1-8											
Mixing Date	10/8/2013		0.3w/c									
	DOT8N-4-R		DOT8N-4-S					DOT8N-6-S				
Curing Regime	Curing Room		Curing Room					Curing Room				
Testing Date	11/5/2013	12/3/2013	10/15/2013	10/22/2013	11/5/2013	12/3/2013	1/7/2014	10/15/2013	10/22/2013	11/5/2013	12/3/2013	1/7/2014
Testing Age	28	56	7	14	28	56	91	7	14	28	56	91
SR	83	141.3	29.5	56.2	65.8	159.1	227	19.7	40.8	75.7	115.8	170.4
	82.3	131.2	32.7	55.3	66.9	188.8	229	17.5	36.6	83.3	106.2	160.4
	93.3	136.4	32.8	56.4	68.7	195.4	262	18.2	43.7	88.6	111.5	152.6
	87.7	130.9	29.5	54.4	71.9	143.6	193.4	20.8	42.5	79.2	123.7	152.5
	81.1	131	30.8	56.7	67.3	162.4	219	19.9	40.1	77.3	132.1	174.3
	79.1	126.9	32.9	55.2	65.6	193.7	226	20.2	41.7	87.3	103.2	144.2
	80.9	125.9	34.2	59.5	65	179.8	249	23.3	41.8	76.1	130.2	151.2
	79.2	139.4	31.3	55.3	68.7	159.4	204	21	45.6	82.7	124.2	175.8
AVG	83.3	132.9	31.7	56.1	67.5	189.4	235.3	19.6	41.6	81.3	118.4	160.2
STD (%)	5.5%	4.0%	5.1%	2.6%	3.1%	3.2%	6.4%	6.2%	6.0%	5.7%	8.6%	7.0%
RCP	817	348										
	898	494										
AVG	858	421										
STD (%)	4.7%	17.3%										

Lab ID	DOT8										
Report ID	Lab#1-8										
Mixing Date	10/8/2013		0.3w/c								
	DOT8N-4-R			DOT8N-4-S				DOT8N-6-S			
Curing Regime	Hot Water Bath			Hot Water Bath				Hot Water Bath			
Testing Date	10/22/2013	11/5/2013	12/3/2013	10/15/2013	10/22/2013	11/5/2013	12/3/2013	10/15/2013	10/22/2013	11/5/2013	12/3/2013
Testing Age	14	28	56	7	14	28	56	7	14	28	56
SR	346	319	318	165.2	249	214	318	130.2	215	194.1	273
	315	289	315	174.8	275	222	320	142.1	221	211	296
	297	272	363	172.2	238	207	345	129.1	233	216	279
	316	279	295	190	254	227	373	144.4	214	210	266
	359	297	299	150.8	222	203	325	128.2	200	180.4	286
	316	290	353	173.8	250	215	336	133	224	203	292
	299	288	324	177.1	233	212	348	123.9	227	206	317
	313	292	305	178.4	257	220	370	139.5	213	182.8	289
AVG	320.1	290.8	321.5	172.8	247.3	215.0	341.9	133.8	218.4	200.4	287.3
STD (%)	6.3%	4.5%	7.2%	6.1%	6.1%	3.4%	5.8%	5.1%	4.4%	6.2%	5.1%
RCP	178	N/A	169								
	279	399	558								
AVG	229	399	364								
STD (%)	22.1%	0.0%	53.5%								

Lab ID	DOT9														
Report ID	Lab#1-9														
Mixing Date	10/10/2013		Retarder												
	DOT9N-4-R			DOT9N-4-S						DOT9N-6-S					
Curing Regime	Curing Room			Curing Room						Curing Room					
Testing Date	11/7/2013	12/5/2013	1/9/2014	10/17/2013	10/24/2013	11/7/2013	12/5/2013	1/9/2014	1/17/2014	10/17/2013	10/24/2013	11/7/2013	12/5/2013	1/9/2014	1/17/2014
Testing Age	28	56	91	7	14	28	56	91	99	7	14	28	56	91	99
SR	55.9	159.3	126.9	11.5	34.5	75.1	159.3	132.8	168.4	9.4	22.8	60.8	114.8	137.8	194.9
	51	150.1	127.3	11.7	31.8	72.9	150.1	128.4	176.3	10.3	25.1	57.8	120.5	138.8	187.4
	50.4	151.4	128.4	12.9	33.9	71.4	151.4	129.6	168.9	9.8	23.7	58.1	120.8	140.4	185.8
	50.8	154.2	127.4	12.1	33.8	74	154.2	127.9	158.4	10.2	26.3	59.8	119.8	141.1	201
	56.4	154.2	129	11.9	31.5	74.9	154.2	129.6	167.6	10	23	56.8	108.1	140.1	190.6
	49.5	152.9	129.7	11.7	30.5	72.8	152.9	131	174.3	10.5	24.4	57.1	111.5	141.6	187.9
	51	148.5	129.6	12.7	34.4	76	148.5	130	169.4	9.9	24.6	57.5	120	141.8	191.7
	51.9	138	130.7	11.1	33.5	74	138	132.9	155	10.8	23.1	59.7	123.8	142.3	201
AVG	52.1	151.1	128.6	12.0	33.0	73.9	151.1	N/A	167.3	10.1	24.1	58.5	117.4	140.5	192.5
STD (%)	4.6%	3.8%	1.0%	4.7%	4.3%	1.9%	3.8%	N/A	4.1%	4.0%	4.7%	2.3%	4.3%	1.0%	2.9%
RCP	1606	415	336												
	1736	365	472												
AVG	1671	390	404												
STD (%)	3.9%	6.4%	16.8%												

Lab ID	DOT9												
Report ID	Lab#1-9												
Mixing Date	10/10/2013		Retarder										
	DOT9N-4-R			DOT9N-4-S					DOT9N-6-S				
Curing Regime	Hot Water Bath			Hot Water Bath					Hot Water Bath				
Testing Date	10/24/2013	11/7/2013	12/5/2013	10/17/2013	10/24/2013	11/7/2013	12/5/2013	1/9/2014	10/17/2013	10/24/2013	11/7/2013	12/5/2013	1/9/2014
Testing Age	14	28	56	7	14	28	56	91	7	14	28	56	91
SR	282	238	327	108.9	288	248	327	160.5	94.6	248	223	247	190.8
	285	254	315	109.8	288	243	315	159.9	97.3	248	216	288	190.4
	303	225	352	115.3	314	238	352	158	96	248	221	286	190.6
	288	246	340	113.7	307	229	340	159.1	101.9	249	230	306	191.6
	292	212	326	109.3	285	235	326	159	94.6	242	227	248	190.9
	284	255	311	107.7	279	217	311	159.6	98.8	252	224	280	190.3
	296	237	342	117.7	307	236	342	192	100.6	257	223	280	191.4
	292	202	341	113.8	311	227	341	160.2	101.2	250	238	298	191.3
AVG	290.3	233.6	331.8	112.0	297.4	234.1	331.8	163.5	98.1	249.3	225.3	279.1	190.9
STD (%)	2.3%	7.7%	4.0%	3.0%	4.3%	3.9%	4.0%	6.6%	2.8%	1.6%	2.7%	7.2%	0.2%
RCP	219	N/A	229										
	483	N/A	222										
AVG	351	N/A	226										
STD (%)	37.6%	N/A	1.6%										

Lab ID	DOT10									
Report ID	Lab#1-10									
Mixing Date	10/17/2013		Accelerator							
	DOT10N-4-R		DOT10N-4-S				DOT10N-6-S			
Curing Regime	Curing Room		Curing Room				Curing Room			
Testing Date	11/14/2013	12/12/2013	10/24/2013	10/31/2013	11/14/2013	12/12/2013	10/24/2013	10/31/2013	11/14/2013	12/12/2013
Testing Age	28	56	7	14	28	56	7	14	28	56
SR	40.3	65.4	11.7	21	38.8	103.3	8.9	16.4	38.5	94.5
	34.4	67.2	10.5	21.9	50.3	101.9	8.9	19.4	37.2	93.6
	36.6	64.7	10.2	23	46.5	110.8	9.2	18.7	38.4	90.7
	43	62.6	9.4	22.8	46.6	108.3	8.2	19.3	41.4	94.4
	40.7	61.6	9.8	20.3	41.1	101.8	11.1	17.4	33.8	98.5
	34.4	68	9.6	21.8	51.9	103.1	8.7	18.3	37.9	94
	40.5	64.5	11.2	22.7	47	108.8	7.9	17.2	40.9	88.3
	42.1	64.9	10.5	19.9	46.1	107.6	8.2	19.8	38.7	94.1
AVG	40.5	64.9	10.4	21.7	47.1	105.7	8.6	18.3	38.4	93.5
STD (%)	4.9%	3.1%	7.1%	5.1%	6.8%	3.1%	5.1%	6.2%	5.7%	3.0%
RCP	1247	1166								
	N/A	1232								
AVG	1247	1199								
STD (%)	0.0%	2.8%								

Lab ID	DOT10										
Report ID	Lab#1-10										
Mixing Date	10/17/2013		Accelerator								
	DOT10N-4-R			DOT10N-4-S				DOT10N-6-S			
Curing Regime	Hot Water Bath			Hot Water Bath				Hot Water Bath			
Testing Date	10/31/2013	11/14/2013	12/12/2013	10/24/2013	10/31/2013	11/14/2013	12/12/2013	10/24/2013	10/31/2013	11/14/2013	12/12/2013
Testing Age	14	28	56	7	14	28	56	7	14	28	56
SR	192.5	230	248	132	184.4	201	225	92.2	166.3	154.1	206
	171.1	219	278	121.1	178.4	187.2	223	93.6	176	140.6	209
	176.9	216	216	118.5	170	182.9	219	98.3	156.1	145.3	204
	184.6	224	227	134.2	171.1	181.8	218	102.4	175.3	154.1	201
	193.6	236	254	109.8	173.6	199.1	219	101.3	150	166	192.3
	164.6	238	201	118.9	172.2	181.3	215	93.4	169.5	138.8	205
	171.7	214	219	115.3	162.7	185.8	208	98.7	156.5	137.1	198.8
	162.7	227	213	131.8	157.1	183.1	212	95.6	177.2	163.9	215
AVG	177.2	225.5	215.2	122.7	171.2	187.8	217.4	96.9	165.9	150.0	203.9
STD (%)	6.3%	3.7%	3.9%	6.8%	4.6%	3.9%	2.4%	3.7%	5.9%	7.0%	3.1%
RCP	549	410	559								
	468	334	222								
AVG	509	372	391								
STD (%)	8.0%	10.2%	43.1%								

Lab ID	DOT11									
Report ID	Lab#1-11									
Mixing Date	10/22/2013		#8 Aggregate Size							
	DOT11N-4-R		DOT11N-4-S				DOT11N-6-S			
Curing Regime	Curing Room		Curing Room				Curing Room			
Testing Date	11/19/2013	12/17/2013	10/29/2013	11/5/2013	11/19/2013	12/17/2013	10/29/2013	11/5/2013	11/19/2013	12/17/2013
Testing Age	28	56	7	14	28	56	7	14	28	56
SR	31.3	50.2	8.3	17.4	42.3	71.9	7	13	30.1	54.5
	31.6	46.6	8.1	18.1	48.9	60.2	8	13.8	30.6	54.5
	31	45.3	8.9	18.2	44.4	66	6.7	13.1	31.3	55.1
	32.3	52.3	8.4	18	41.7	67	6.6	14.3	29.1	53.8
	30.7	48.1	8.5	16.9	48	60	7	13	30.3	52.2
	31.9	44.7	9	18.1	48.7	61.8	6.6	13.5	31.9	53.2
	29.7	49.9	8.8	17.8	48.6	64.8	7	14	32.7	48.8
	29.9	47.1	8.2	17.3	40.7	67.3	6.3	13.8	29.7	43.9
AVG	31.1	48.0	8.5	17.7	45.4	64.9	6.9	13.6	30.7	52.0
STD (%)	2.8%	5.1%	3.7%	2.5%	7.2%	5.9%	6.9%	3.4%	3.6%	6.9%
RCP	1673	1082								
	1606	770								
AVG	1640	1082								
STD (%)	2.0%	0.0%								

Lab ID	DOT11										
Report ID	Lab#1-11										
Mixing Date	10/22/2013			#8 Aggregate Size							
	DOT11N-4-R			DOT11N-4-S				DOT11N-6-S			
Curing Regime	Hot Water Bath			Hot Water Bath				Hot Water Bath			
Testing Date	11/5/2013	11/19/2013	12/17/2013	10/29/2013	11/5/2013	11/19/2013	12/17/2013	10/29/2013	11/5/2013	11/19/2013	12/17/2013
Testing Age	14	28	56	7	14	28	56	7	14	28	56
SR	174.7	204	N/A	70.9	172.8	206	163.2	66.2	143.2	165.9	151.5
	183.1	202	N/A	72.5	174.3	210	172.5	64.1	141.5	153.1	146
	193.3	191.4	N/A	81.9	169.3	213	142.1	67.4	136.9	154.7	120.6
	177.4	195.7	N/A	83.7	158.8	209	131.3	68.8	136.6	166.8	109.8
	169.6	193.2	N/A	82.9	160.3	192.9	144.4	67.6	128.8	162.9	157.5
	184.2	200	N/A	79.4	163.6	206	148.7	65.1	123.2	162.7	155.3
	174.8	192.5	N/A	81.8	170.8	198.2	131.1	68.1	129	160.3	143.8
	172.9	196.8	N/A	84.3	161.8	195.2	119.2	70.3	127.8	165.9	148.7
AVG	178.8	197.0	N/A	82.3	166.5	203.8	139.5	67.2	133.4	161.5	150.5
STD (%)	4.0%	2.2%	N/A	1.9%	3.4%	3.4%	5.1%	2.8%	5.0%	3.0%	3.2%
RCP	N/A	492	205								
	N/A	837	172								
AVG	N/A	665	189								
STD (%)	N/A	26.0%	8.8%								

Lab ID	DOT12									
Report ID	Lab#1-12									
Mixing Date	10/24/2013		605lbs (2)							
	DOT12N-4-R		DOT12N-4-S				DOT12N-6-S			
Curing Regime	Curing Room		Curing Room				Curing Room			
Testing Date	11/21/2013	12/19/2013	10/31/2013	11/7/2013	11/21/2013	12/19/2013	10/31/2013	11/7/2013	11/21/2013	12/19/2013
Testing Age	28	56	7	14	28	56	7	14	28	56
SR	43.3	80.8	15.7	33.8	59.7	85.7	15.1	28.2	53.6	76.8
	44.6	76.2	15.2	30	54.7	86	12.2	26.8	48.1	87.4
	44.9	75.5	14.9	28.7	59.4	90.5	11.3	26.7	42.8	83.7
	48.4	71.1	14.9	29.5	57.9	84.9	11.5	23.9	52.4	77.9
	49.5	66	15	31.6	55.6	85.1	11	26.9	49.1	80.3
	46.6	58.4	17	30.8	52.8	81	11.2	24.9	49.8	83.4
	44.8	67.3	15.2	28.9	57.4	89.9	13.5	26.3	50.4	90.3
	47	66.7	15.2	29.5	57.7	84.5	13.2	24.3	49.4	81
AVG	46.1	70.5	15.4	30.4	56.9	86.0	12.0	26.0	49.5	82.6
STD (%)	4.3%	5.9%	4.3%	5.2%	3.9%	3.3%	7.8%	5.3%	6.1%	5.2%
RCP	1268	1048								
	2050	761								
AVG	1659	905								
STD (%)	23.6%	15.9%								

Report ID	Lab#1-12										
Mixing Date	10/24/2013			605lbs (2)							
	DOT12N-4-R			DOT12N-4-S				DOT12N-6-S			
Curing Regime	Hot Water Bath			Hot Water Bath				Hot Water Bath			
Testing Date	11/7/2013	11/21/2013	12/19/2013	10/31/2013	11/7/2013	11/21/2013	12/19/2013	10/31/2013	11/7/2013	11/21/2013	12/19/2013
Testing Age	14	28	56	7	14	28	56	7	14	28	56
SR	209	290	N/A	116.6	191.9	281	195.9	99.7	150.7	216	169.4
	199.6	310	N/A	126.8	183.1	260	177.3	92.2	162.3	224	167.2
	192.6	301	N/A	131.7	185.5	247	177.5	99.5	169.4	231	157.5
	210	294	N/A	119.8	194.3	245	184.5	98.7	180.3	208	153.2
	196.2	294	N/A	119.2	177.3	253	194.2	94.8	154.9	223	165.2
	192.1	306	N/A	112.9	188.7	241	181.9	93.6	168.1	217	162.5
	196.6	314	N/A	130.3	184	236	181.4	99.4	178.2	224	155.8
	188.5	299	N/A	117.7	187.3	235	173.7	97.4	184.5	224	146.4
AVG	198.1	301.0	N/A	121.9	186.5	249.8	183.3	96.9	171.1	220.9	159.7
STD (%)	3.7%	2.6%	N/A	5.3%	2.7%	5.7%	4.1%	2.9%	5.7%	3.0%	4.6%
RCP	715	434	270								
	401	N/A	236								
AVG	558	434	253								
STD (%)	28.1%	0.0%	6.7%								

Lab HPC 2.2014 - 5.2014

Lab ID	DOTF1								
Report ID	Lab#2-1								
Mixing Date	2/4/2014								
	DOTF1N-4-R			DOTF1N-4-S				DOTF1N-6-S	
Curing Regime	Curing Room			Curing Room				Curing Room	
Testing Date	3/4/2014	4/1/2014	5/6/2014	2/11/2014	2/18/2014	4/1/2014	5/6/2014	2/11/2014	2/18/2014
Testing Age	28	56	91	7	14	56	91	7	14
SR	N/A	66.2	N/A	18	33.8	N/A	N/A	20.8	27
	N/A	71.4	N/A	15.9	34	N/A	N/A	19.8	24
	N/A	59.3	N/A	17.8	31.5	N/A	N/A	20.7	25.4
	N/A	51.9	N/A	15.5	31.2	N/A	N/A	20.4	25.7
	N/A	67.3	N/A	17.6	31.9	N/A	N/A	20.4	23.5
	N/A	63.8	N/A	15.6	34.8	N/A	N/A	20.6	25.6
	N/A	63.4	N/A	17.8	31.3	N/A	N/A	20.6	23.9
	N/A	52.6	N/A	15.7	31.3	N/A	N/A	20.1	26.7
AVG	N/A	62.0	N/A	16.7	32.5	56.0	70.0	20.4	25.2
STD (%)	N/A	10.5%	N/A	6.4%	4.2%	N/A	N/A	1.5%	4.8%
RCP	2319	795	657						
	2514	994	1038						
AVG	2417	895	657						
STD (%)	4.0%	11.1%	0.0%						

Lab ID	DOTF1						
Report ID	Lab#2-1						
Mixing Date	2/4/2014						
	DOTF1N-4-R		DOTF1N-4-S			DOTF1N-6-S	
Curing Regime	Hot Water Bath		Hot Water Bath			Hot Water Bath	
Testing Date	2/18/2014	4/1/2014	2/11/2014	2/18/2014	3/4/2014	2/11/2014	2/18/2014
Testing Age	14	56	7	14	28	7	14
SR	69.6	112.8	52.1	69.9	73.7	49.2	68.7
	62.8	78.8	55	75.2	74.4	45.7	65.8
	70.2	96.9	40.7	76.2	61	40.9	64.3
	67.1	93.2	34.7	65.1	66	38.7	57.6
	69.3	99	39.5	68.4	72.6	47.8	48.4
	61.7	95.1	42.7	70.2	69.3	44	44.5
	69.3	85.8	45.2	72.3	69.7	44.3	43.8
	66.7	87.2	37.9	64.3	64.1	43.4	50.3
AVG	67.1	93.6	43.5	70.2	68.9	44.3	55.4
STD (%)	4.5%	10.2%	15.0%	5.7%	6.5%	7.2%	16.8%

Lab ID	DOTF2								
Report ID	Lab#2-2								
Mixing Date	2/6/2014								
	DOTF2N-4-R			DOTF2N-4-S			DOTF2N-6-S		
Curing Regime	Curing Room			Curing Room			Curing Room		
Testing Date	3/6/2014	4/3/2014	5/8/2014	2/20/2014	3/6/2014	4/3/2014	2/20/2014	3/6/2014	5/8/2014
Testing Age	28	56	91	14	28	56	14	28	91
SR	31.5	N/A	N/A	23.8	39.7	N/A	17.1	25.4	N/A
	31.8	N/A	N/A	23.1	35.9	N/A	15.8	25.2	N/A
	32.1	N/A	N/A	22.6	36	N/A	16.6	25	N/A
	29.9	N/A	N/A	25.2	35.5	N/A	15.9	25.3	N/A
	31.1	N/A	N/A	23.1	42.6	N/A	17.6	27.6	N/A
	35.2	N/A	N/A	23.5	36	N/A	15	23.9	N/A
	34.3	N/A	N/A	22.1	37.4	N/A	16.6	25.6	N/A
	30.4	N/A	N/A	25.5	37	N/A	15.8	24.3	N/A
AVG	32.0	N/A	N/A	23.6	37.5	54.0	16.3	25.3	36.0
STD (%)	5.4%	N/A	N/A	4.7%	6.1%	N/A	4.8%	4.1%	N/A
RCP	2138	1491	1013						
	2150	1279	1244						
AVG	2144	1385	1129						
STD (%)	0.3%	7.7%	10.2%						

Lab ID	DOTF2					
Report ID	Lab#2-2					
Mixing Date	2/6/2014					
	DOTF2N-4-R		DOTF2N-4-S		DOTF2N-6-S	
Curing Regime	Hot Water Bath		Hot Water Bath		Hot Water Bath	
Testing Date	2/20/2014	3/6/2014	2/20/2014	3/6/2014	2/20/2014	3/6/2014
Testing Age	14	28	14	28	14	28
SR	28.5	36.8	29.8	36.4	20.2	31.1
	28.9	33.5	28.6	34	22	29.3
	25.5	35.4	29	40.9	20.1	25.2
	26.4	37.9	28.1	33.3	20.7	29.4
	28.9	37.8	29.9	35.1	20.6	30.6
	28.8	36.2	27.8	35.6	21.7	27.7
	25.6	34.8	28.8	39.6	20.5	29.8
	26.2	36.1	28.5	33.1	20.2	29
AVG	27.4	36.1	28.8	36.0	20.8	29.0
STD (%)	5.3%	3.9%	2.4%	7.5%	3.2%	6.0%
RCP	1304					
	1274					
AVG	1289					
STD (%)	1.2%					

Lab ID	DOTF3										
Report ID	Lab#2-3										
Mixing Date	2/11/2014										
	DOTF3N-4-R				DOTF3N-4-S					DOTF3N-6-S	
Curing Regime	Curing Room				Curing Room					Curing Room	
Testing Date	2/25/2014	3/11/2014	4/8/2014	5/13/2014	2/18/2014	2/25/2014	3/11/2014	4/8/2014	5/13/2014	2/18/2014	2/25/2014
Testing Age	14	28	56	91	7	14	28	56	91	7	14
SR	9.5	27.3	N/A	N/A	17.1	27.3	N/A	N/A	N/A	10.8	19.7
	9.1	27.3	N/A	N/A	14.7	27.9	N/A	N/A	N/A	10.4	19.7
	10.6	30.9	N/A	N/A	14.3	23.1	N/A	N/A	N/A	9.8	20
	11.6	28.3	N/A	N/A	17	25	N/A	N/A	N/A	10.4	19.8
	9.5	26.9	N/A	N/A	16.4	27.5	N/A	N/A	N/A	10.4	21.3
	9.3	28.1	N/A	N/A	15.3	27.7	N/A	N/A	N/A	10.1	20
	10.3	31.5	N/A	N/A	14.3	24	N/A	N/A	N/A	9.6	20
	10	26.2	N/A	N/A	15.8	24.9	N/A	N/A	N/A	10.3	19.7
AVG	10.0	28.3	N/A	N/A	15.6	25.9	28.3	33.0	43.0	10.2	20.5
STD (%)	7.8%	6.3%	N/A	N/A	6.9%	6.8%	N/A	N/A	N/A	3.5%	2.4%
RCP	N/A	2252	1810	1592							
	N/A	1877	1654	1524							
AVG	N/A	2065	1732	1558							
STD (%)	N/A	9.1%	4.5%	2.2%							

Lab ID	DOTF3				
Report ID	Lab#2-3				
Mixing Date	2/11/2014				
	DOTF3N-4-R	DOTF3N-4-S		DOTF3N-6-S	
Curing Regime	Hot Water Bath	Hot Water Bath		Hot Water Bath	
Testing Date	2/25/2014	2/18/2014	2/25/2014	2/18/2014	2/25/2014
Testing Age	14	7	14	7	14
SR	23.5	25.9	27.3	20.2	26.4
	21	26.5	28.2	19.2	28.7
	24.4	24.7	27.4	19.8	28.6
	25.1	25.1	29.1	18.5	23.9
	22.8	24.8	28.3	18.7	27.7
	21.7	26.2	28.9	18	28.2
	25.2	24.5	29.9	19.4	29.2
	28.2	26.1	28.5	17.8	27.3
AVG	24.0	25.5	28.5	19.0	27.5
STD (%)	8.9%	2.9%	2.8%	4.2%	5.8%
RCP	1323				
	1966				
AVG	1645				
STD (%)	19.6%				

Lab ID	DOTF4						
Report ID	Lab#2-4						
Mixing Date	2/18/2014						
	DOTF4N-4-R		DOTF4N-4-S			DOTF4\N-6-S	
Curing Regime	Curing Room		Curing Room			Curing Room	
Testing Date	3/18/2014	4/15/2014	2/25/2014	3/18/2014	4/15/2014	2/25/2014	3/18/2014
Testing Age	28	56	7	28	56	7	28
SR	26.9	N/A	14.2	36	N/A	12.9	23.4
	25.3	N/A	13.9	41.3	N/A	10.9	23.6
	29	N/A	14.8	32.7	N/A	11.9	21.8
	27.5	N/A	15.1	36.3	N/A	11.4	23.7
	26.8	N/A	15	35.7	N/A	12.6	23.4
	25.6	N/A	13.9	41.3	N/A	11	23.6
	28.7	N/A	14.6	33	N/A	N/A	22.1
	27	N/A	15.1	36.5	N/A	N/A	23.8
AVG	27.1	N/A	14.6	36.6	44.0	11.8	23.2
STD (%)	4.5%	N/A	3.3%	8.3%	N/A	6.5%	3.1%
RCP	2137	1222					
	N/A	1049					
AVG	2137	1136					
STD (%)	0.0%	7.6%					

Lab ID	DOTF4					
Report ID	Lab#2-4					
Mixing Date	2/18/2014					
	DOTF4N-4-R	DOTF4N-4-S			DOTF4\N-6-S	
Curing Regime	Hot Water Bath	Hot Water Bath			Hot Water Bath	
Testing Date	3/18/2014	2/25/2014	3/4/2014	3/18/2014	2/25/2014	3/18/2014
Testing Age	28	7	14	28	7	28
SR	85.3	28.1	44.4	93.9	26.8	80.3
	89.6	32	48.5	99	25	76.7
	91.6	32	44.7	95.4	24.3	80.3
	86	29.5	45.6	90.9	27.9	77.4
	85.5	28.9	44	92.9	26.8	80.4
	89.4	30.2	44.5	99.6	25.8	76.9
	91.2	32.3	48.8	96	25.1	80.3
	85.9	33.8	42	93.4	29	77.4
AVG	88.1	30.9	45.3	95.1	26.3	78.7
STD (%)	2.8%	6.0%	4.7%	3.0%	5.7%	2.1%

Lab ID	DOTF5						
Report ID	Lab#2-5						
Mixing Date	2/20/2014						
	DOTF5N-4-R			DOTF5N-4-S		DOTF5N-6-S	
Curing Regime	Curing Room			Curing Room		Curing Room	
Testing Date	3/20/2014	4/17/2014	5/22/2014	3/6/2014	3/20/2014	3/6/2014	3/20/2014
Testing Age	28	56	91	14	28	14	28
SR	17.3	N/A	N/A	14.6	16.8	11.5	16.1
	15.2	N/A	N/A	14.9	20	13.3	17.7
	17.5	N/A	N/A	15.1	19.2	10.9	14.3
	19.1	N/A	N/A	14.2	19	11.4	15.1
	19.6	N/A	N/A	13.9	16.2	11.8	16.6
	15.1	N/A	N/A	14.5	22.9	13.3	20.6
	18	N/A	N/A	14.4	21.8	10.9	14.8
	19.4	N/A	N/A	13.8	18.2	11.9	16.3
AVG	17.7	N/A	N/A	14.4	19.3	11.9	16.4
STD (%)	9.3%	N/A	N/A	2.9%	11.1%	7.5%	11.4%
RCP	N/A	2262	1575				
	3081	2361	1372				
AVG	3081	2312	1474				
STD (%)	0.0%	2.1%	6.9%				

Lab ID	DOTF5				
Report ID	Lab#2-5				
Mixing Date	2/20/2014				
	DOTF5N-4-R	DOTF5N-4-S		DOTF5N-6-S	
Curing Regime	Hot Water Bath	Hot Water Bath		Hot Water Bath	
Testing Date	3/20/2014	3/6/2014	3/20/2014	3/6/2014	3/20/2014
Testing Age	28	14	28	14	28
SR	55.2	13.7	19	11.8	15.9
	54.1	14.5	17.1	11.6	14.8
	53.8	14.1	18.8	10.6	17.1
	52	13.5	21.2	10.7	15.8
	54.2	13.8	21.9	11.2	17
	50.9	14.3	22.7	10.5	17.5
	54.8	14.3	20.1	10.6	16.9
	52.9	13.5	21.5	10.5	15.5
AVG	53.5	14.0	20.3	10.9	16.3
STD (%)	2.6%	2.6%	8.7%	4.5%	5.4%
RCP	715				
	592				
AVG	654				
STD (%)	9.4%				

Lab ID	DOTF6								
Report ID	Lab#2-6								
Mixing Date	3/4/2014								
	DOTF6N-4-R				DOTF6N-4-S			DOTF6N-6-S	
Curing Regime	Curing Room				Curing Room			Curing Room	
Testing Date	3/18/2014	4/1/2014	4/29/2014	6/3/2014	3/18/2014	4/29/2014	6/3/2014	3/18/2014	6/3/2014
Testing Age	14	28	56	91	14	56	91	14	91
SR	36	29.9	N/A	N/A	18.6	N/A	59.2	18.4	56.1
	40.4	33.1	N/A	N/A	19.6	N/A	61.8	19.5	49.5
	40.5	32.3	N/A	N/A	19.7	N/A	61.3	18.8	58.9
	38.8	31.9	N/A	N/A	18.2	N/A	59.3	16.9	49.8
	36.6	32	N/A	N/A	18.8	N/A	55	18.1	52.6
	40.4	33.3	N/A	N/A	19.5	N/A	54.8	19.4	52.3
	38	33	N/A	N/A	19.6	N/A	52.8	18.6	49.3
	40.7	30	N/A	N/A	18.8	N/A	50.2	17.1	45
AVG	38.9	31.9	43.0	N/A	19.1	33.0	56.8	18.4	51.7
STD (%)	4.5%	3.9%	N/A	N/A	2.8%	N/A	6.9%	4.9%	7.8%
RCP	N/A	671	815	637					
	N/A	1100	719	634					
AVG	N/A	886	767	636					
STD (%)	N/A	24.2%	6.3%	0.2%					

Lab ID	DOTF6				
Report ID	Lab#2-6				
Mixing Date	3/4/2014				
	DOTF6N-4-R		DOTF6N-4-S		DOTF6N-6-S
Curing Regime	Hot Water Bath		Hot Water Bath		Hot Water
Testing Date	3/18/2014	4/1/2014	3/18/2014	6/3/2014	3/18/2014
Testing Age	14	28	14	91	14
SR	40.8	107.9	59.6	74.4	51.1
	38.3	103.6	60.4	78.3	48.5
	37.3	100.8	56	69.6	45.2
	41.9	101	57.8	67.8	51.5
	40.2	102.1	59.5	73.2	47.3
	39.4	100	60.2	56.2	48.4
	36.8	101.3	61.9	68.9	45.6
	39.4	105	58.6	69.4	51.4
AVG	36.3	102.7	59.3	69.7	51.5
STD (%)	4.5%	2.4%	2.8%	8.7%	4.6%

Lab ID	DOTF7					
Report ID	Lab#2-7					
Mixing Date	3/11/2014					
	DOTF7N-4-R			DOTF7N-4-S		
Curing Regime	Curing Room			Curing Room		
Testing Date	4/8/2014	5/6/2014	6/10/2014	3/25/2014	5/6/2014	6/10/2014
Testing Age	28	56	91	14	56	91
SR	N/A	N/A	N/A	N/A	N/A	39.4
	N/A	N/A	N/A	N/A	N/A	41.5
	N/A	N/A	N/A	N/A	N/A	39
	N/A	N/A	N/A	N/A	N/A	36.5
	N/A	N/A	N/A	N/A	N/A	38.2
	N/A	N/A	N/A	N/A	N/A	37.3
	N/A	N/A	N/A	N/A	N/A	36.8
	N/A	N/A	N/A	N/A	N/A	37.6
AVG	N/A	29.0	N/A	19.0	35.0	38.3
STD (%)	N/A	N/A	N/A	N/A	N/A	4.0%
RCP	N/A	1133	1196			
	1654	1142	1040			
AVG	1654	1138	1118			
STD (%)	0.0%	0.4%	7.0%			

Lab ID	DOTF7					
Report ID	Lab#2-7					
Mixing Date	3/11/2014					
	DOTF7N-4-R			DOTF7N-4-S		
Curing Regime	Hot Water Bath			Hot Water Bath		
Testing Date	4/8/2014	5/6/2014	6/10/2014	3/25/2014	5/6/2014	6/10/2014
Testing Age	28	56	91	14	56	91
SR	N/A	N/A	N/A	N/A	N/A	39.4
	N/A	N/A	N/A	N/A	N/A	41.5
	N/A	N/A	N/A	N/A	N/A	39
	N/A	N/A	N/A	N/A	N/A	36.5
	N/A	N/A	N/A	N/A	N/A	38.2
	N/A	N/A	N/A	N/A	N/A	37.3
	N/A	N/A	N/A	N/A	N/A	36.8
	N/A	N/A	N/A	N/A	N/A	37.6
AVG	N/A	29.0	N/A	19.0	35.0	38.3
STD (%)	N/A	N/A	N/A	N/A	N/A	4.0%
RCP	N/A	1133	1196			
	1654	1142	1040			
AVG	1654	1138	1118			
STD (%)	0.0%	0.4%	7.0%			

Lab ID	DOTF8										
Report ID	Lab#2-8										
Mixing Date	3/6/2014										
	DOTF8N-4-R			DOTF8N-4-S					DOTF8N-6-S		
Curing Regime	Curing Room			Curing Room					Curing Room		
Testing Date	4/3/2014	5/1/2014	6/5/2014	3/13/2014	3/20/2014	4/3/2014	5/1/2014	6/5/2014	3/13/2014	4/3/2014	6/5/2014
Testing Age	28	56	91	7	14	28	56	91	7	28	91
SR	N/A	N/A	N/A	10.1	N/A	17.6	N/A	48	9.8	15.3	47.7
	N/A	N/A	N/A	11	N/A	17.2	N/A	45.8	9.3	14.8	46.2
	N/A	N/A	N/A	11.4	N/A	17.4	N/A	43.6	10.9	16.7	43.4
	N/A	N/A	N/A	10.5	N/A	15.3	N/A	45.2	9.8	13.9	41.9
	N/A	N/A	N/A	10.4	N/A	17	N/A	43.6	9.9	15.6	43.3
	N/A	N/A	N/A	10.6	N/A	16.6	N/A	44.1	9.2	14.7	42.3
	N/A	N/A	N/A	11.4	N/A	17	N/A	42.5	9.9	15.4	43.9
	N/A	N/A	N/A	10.2	N/A	15.4	N/A	40.3	10	14	38.8
AVG	N/A	39.0	N/A	10.7	16.0	16.7	27.0	44.1	9.9	15.1	43.4
STD (%)	N/A	N/A	N/A	4.5%	N/A	4.9%	N/A	4.9%	4.9%	5.7%	5.8%
RCP	1836	1452	841								
	1866	1119	877								
AVG	1851	1286	859								
STD (%)	0.8%	13.0%	2.1%								

Lab ID	DOTF8							
Report ID	Lab#2-8							
Mixing Date	3/6/2014							
	DOTF8N-4-R	DOTF8N-4-S					DOTF8N-6-S	
Curing Regime	Hot Water Bath	Hot Water Bath					Hot Water Bath	
Testing Date	6/5/2014	3/13/2014	3/20/2014	4/3/2014	5/1/2014	6/5/2014	3/13/2014	4/3/2014
Testing Age	91	7	14	28	56	91	7	28
SR	N/A	31.9	N/A	66.9	N/A	86.8	22.5	62.3
	N/A	30	N/A	62.7	N/A	88.7	21.7	59.5
	N/A	31.6	N/A	61.3	N/A	78.8	21.7	53.9
	N/A	35.2	N/A	55.7	N/A	78.1	21.6	51.4
	N/A	30.7	N/A	59.3	N/A	81	22.2	51.2
	N/A	30.7	N/A	57.3	N/A	74.5	22.1	55.7
	N/A	31.6	N/A	60.4	N/A	70.6	22.8	49.2
	N/A		N/A		N/A	71.2	22.1	51.7
AVG	N/A	31.7	N/A	60.5	N/A	78.7	22.1	54.4
STD (%)	N/A	4.9%	N/A	5.6%	N/A	7.9%	1.8%	7.8%
RCP	383							
	N/A							
AVG	383							
STD (%)	0.0%							