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APPLICATIONS OF SCORIA AGGREGATE POROUS CONCRETE ON COLLAPSIBLE SOILS AND IN COLD CLIMATES TO RECHARGE IMPROVED GROUNDWATER SUPPLIES

by

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To the Graduate Faculty:

The members of the committee appointed to examine the thesis of Kevin Harker find it satisfactory and recommend that it be accepted.

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ABSTRACT

The City of Pocatello, Idaho does not currently treat its stormwater, but rather collects runoff in detention basins or discharges it into the Portneuf River. Petroleum and nitrate contaminants enter local waterways and ultimately groundwater supplies. Porous concrete has stormwater filtering capabilities and can be used to prevent contaminants from entering the groundwater supply which is widely used for agriculture and drinking water purposes. Scoria (vesicular basalt) in porous concrete can be used to enhance the retainment of petroleum products.

Porous concrete differs from conventional concrete, and therefore has different testing standards. There is currently no standard for freeze-thaw weakening tests on porous concrete. Past laboratory experiments show that porous concrete samples do not survive more than 25 freeze-thaw cycle.

The work in this thesis has included development and testing of conventional and scoria porous concrete mix designs, field placement and monitoring of conventional porous concrete and freeze-thaw weakening testing of select porous concrete mixes. The results of this study show that the structural performance of porous concrete depends on aggregate gradation and perimeter confinement. Routine maintenance is also important to sustain the surface water intake capability of the porous concrete.

CHAPTER 1 – Introduction

Porous Concrete

Water quality issues surrounding clean potable groundwater, or water that is stored in the ground in pore spaces between soil particles as well as fissures in rock deposits (Waller, 1994), are increasingly important because water that is passing through a porous concrete medium is not treated (American Concrete Institute [ACI], 2010). The surface water eventually reaches the groundwater table, which is used to supply drinking water and agricultural needs (United States Geological Survey [USGS], 2012). The ACI (2010) defines porous concrete as a type of pavement that has sufficient continuous voids that allow water to pass from the surface to the underlying soil. Porous concrete has many uses, including the ability to reduce the impact of expanding urban development by decreasing or eliminating stormwater runoff rates without tapping into stormwater drainage systems, therefore recharging local groundwater systems (ACI, 2010). Cities like Philadelphia (Duhigg, 2009) and Chicago (Saulny, 2007) are revamping their stormwater management practices to implement porous concrete. Porous concrete is quickly gaining popularity in the United States of America (USA) as a green, or environmentally friendly, pavement material.

In an urban stormwater management application, porous concrete is capturing runoff from impermeable surfaces such as streets or parking lots. The ACI (2010) states that porous concrete has oil contamination filtering capabilities, but only to the extent of small oil drips. The ACI does not consider possible discharging of oil directly onto pavement surfaces or petroleum spills/leaks at gas or lube stations. These contaminants

can and do migrate through porous concrete and into the groundwater supply. Since there is no water treatment plant between contaminated runoffs and porous concrete, petroleum pollutants pose a substantial threat for the quality groundwater systems.

Scoria

Wenjing, Yuling, and Huanchi (2011) conducted a study on an aggregate filter for groundwater flow using scoria, a porous, light-weight silicate aggregate of basaltic composition originating from volcanic eruptions. These rocks have the ability to retain petroleum hydrocarbons in groundwater flows (Wenjing et al., 2011). By implementing scoria into a porous concrete mix, groundwater petroleum contamination can be significantly reduced. It should be noted that scoria is limited to retaining contaminants; it will not break down the pollutants.

Scoria will eventually reach a maximum capacity, which means it will not be able to retain any more pollutants. After this capacity has been reached, any additional petroleum in the stormwater will simply pass through the scoria filter without being captured. Studies have been performed on different oil-degrading bacteria and plants that will break down petroleum and oil products (Sirotkina & Novoselova, 2005). Guerin, Horner, McGovern, and Davey (2002), studied the use of scoria in conjunction with peat to filter petroleum hydrocarbons and found that using scoria in conjunction with hydrocarbon degrading bacteria as part of a porous concrete system helped reduce petroleum contamination by as much as 95% in local groundwater systems. Studies at Idaho State University (ISU) have also been conducted on implementing bioswales or landscaping elements to help improve water quality by removing pollutants before they reach the groundwater supply (Firebaugh, 2012).

Problem Definition

Collapsible Soils

In order to function properly, porous concrete must be placed on a stable subgrade. Performance difficulties arise when porous concrete is placed on certain types of problem soils such as collapsible silts or expansive clays. Soils which have angular grain interlocks or partial cement can undergo significant settlement (collapse) when saturated with water. The buoyant force of the water reduces the contact stress which in turn destroys the soil structure (Zoghi, Mahar, Ebrahimpour, & Katamaneni, 2010). Since porous concrete conveys the water directly to the soil subgrade, saturation is inevitable and will cause severe settlement when the pavement is placed on collapsible soils. Pot-holes and sinkholes are often associated with these types of soils. In addition, the capillary capabilities of collapsible soils could cause severe frost heaves and damage porous concrete (Zoghi et al., 2010 & ACI, 2010). By stabilizing the subgrade beneath porous concrete and transporting stormwater away from the paved surface, the collapse potential beneath the porous concrete can be significantly reduced or eliminated as well as weakening of the concrete and subgrade due to freeze-thaw cycles.

Freeze-Thaw Weakening

The use of porous concrete in cold climates is another concern with the potential durability of porous concrete. The ACI (2010) identifies the need for better understanding of the freeze-thaw characteristics of porous concrete if it is to be used as a green material in the US. Currently, the American Society of Testing Materials (ASTM) has no procedure to test the freeze-thaw deteriorations of porous concrete. Development

of a freeze-thaw standard is important to provide consistent and reproducible results for design and accumulation of performance data.

Scope of Project

Stabilizing the soil beneath porous concrete will help to reduce or even prevent subgrade settlement and possible damage to a porous concrete pavement (Zoghi et al, 2010). In this research, studies have been undertaken to evaluate freeze-thaw behavior of different porous concrete mix designs. Further, porous concrete system was designed to overcome a collapse potential subgrade using lime and fly ash to stabilize the soils, a scoria sub-base to capture potential petroleum contaminants, a porous slab to infiltration of surface runoff and an adjacent leach field to convey water away from the porous concrete pavement.

A site was chosen in a low area of a parking lot that had poor drainage and serious subgrade issues to implement and field test the basic porous concrete design. The location was specifically chosen in an area of the parking lot that showed the greatest pavement damage. The ISU campus has had significant problems with saturation settlement of loess. There have been at least two reported incidents where the soils beneath buildings have caused significant settlement and structural damage to the structures (Harry, 2003 & "ISU's Colonial Hall," 2012).

The scope of this research work also involved development of maintenance requirements for proper infiltration performance of the porous concrete test slab. ACI (2010) suggests that porous concrete be maintained every six months by pressure washing the surface, then using a wet vacuum to finish cleaning out the pore spaces within the slab. Different techniques were tested to find an economic means to help

maintain the infiltration characteristics of porous concrete. These techniques are described further in the ***Maintenance/Infiltration Test*** section of Chapter 3.

Importance of Investigation

Porous concrete is gaining popularity because of its water filtering and recharge capabilities, and its performance as an environmentally friendly pavement material. Since porous concrete is being used to reduce stormwater runoff in urban areas without treatment of the water, its environmental filtering/remediation potential still needs to be studied (ACI, 2010). Placement of porous concrete slabs on unstable soils must be addressed to prevent damage from settlement and frost heave, or frost induced bulges, and/or potholes. Groundwater pollution can potentially be reduced where scoria is used directly as an aggregate in porous concrete and/or as a base course material.

The effect of freezing on the lightly bonded aggregate pore spaces in porous concrete slabs may pose problems in climates where harsh winter environments exist. These pores may hold water that will expand when frozen and therefore break the cementitious bond between the aggregates. Different submersion conditions that may be present in porous concrete slabs were studied to determine the freeze-thaw potential of scoria and conventional aggregate porous concrete.

Assumptions, Limitations, and Delimitations

This study provides results of a preliminary investigation into the performance of a porous concrete slab with a scoria sub base and lime and fly ash treated soil subgrade. The results of this study are limited to both specific porous concrete mix designs and the absence of a standardized test for freeze-thaw evaluation of porous concrete. A procedure is introduced in this thesis for the testing freeze-thaw performance of porous

concrete. Further research will be needed to develop a more complete database for different mix designs and freeze-thaw conditions.

This study was focused on porous concrete pavement placed on top of collapsible silt called loess. The geotechnical setting was chosen because collapsible loess is abundant in the southeast Idaho region where the experimental work was performed. Unconfined compression strength tests were performed to evaluate the quality and engineering properties of the porous concrete mix designs. Weight loss and unconfined strength were used as indexes of freeze-thaw behavior. Porosity measurements were used as an infiltration index. At least six compression tests were performed on each mix design. Only three cylinders were cast at the time of the test slab construction because of the limited amount of materials that were available. As a result, the concrete mix design was replicated and other alternative mix designs were explored.

One significant result from this research will be making suggestions for the method of determining the freeze-thaw potential of porous concrete. This procedure may be adopted by the ASTM as a standard of determining the ability of porous concrete to withstand freeze-thaw weakening.

CHAPTER 2 – Literature Review

As development or expansion of cities continues, so does the installation of low permeable surfaces that could increase stormwater runoff rates entering local waterways. As pavement and building areas increase, recharge to the local groundwater supplies decrease. Instead, the runoff is transported via storm drains and gutters to other locations that are not the area of rainfall. Runoff is usually treated for contaminants and cleaned in water treatment plants before reintroducing them into local waterways. Porous concrete is a stormwater management practice in which local groundwater systems can be recharged with improved water quality (ACI, 2010).

ACI (2010) defines porous concrete as a type of pavement that has interconnected voids, which allow water to pass from its surface into the underlying soil. Moreover, porous concrete provides a means for conveying stormwater runoff into the groundwater system instead of transporting the water to areas downstream. The 2010 ACI report mentions that porous concrete is a material that can be used in stormwater management to filter some contamination, reduce post development storm runoff rates and replenish local groundwater systems. The Environmental Protection Agency ([EPA], 2010) has regulations that require treatment of stormwater runoff before returning the water to nature and mentions that porous concrete is one of their Best Management Practices (BMPs) that will accomplish this objective.

The ACI (2010) also reports that porous concrete has been used in Europe since the middle of the nineteenth century, but it is a relatively new technology in the USA because of our recent increased environmental awareness. Since porous concrete is a relatively new technology in the USA, there is a general lack of standardized testing

procedures (ACI, 2010). Once porous concrete was recognized by the EPA (2010) as a BMP, state and local governments are subsidizing its use (Cohen & Ackerman, 2011). There are some concerns when placing porous concrete that need to be addressed if a porous concrete system is to function effectively and service sufficiently long enough to be economically justified. This research will focus on three specific issues that need to be addressed when placing porous concrete: 1) collapse potential of the subgrade, 2) mix design, 3) strength parameters, and 4) the freeze-thaw cycle characteristics of porous concrete.

Soil Stabilization

The stability of the soil subgrade must be investigated particularly in areas of near surface unstable soils and must be addressed if these soils are weak or susceptible to breakdown (ACI, 2010). Currently there is no standard practice for placing porous concrete on collapsible soil subgrades (ACI, 2010). Collapsible soils are characteristically angular shaped consisting of very small silt particles that have been eroded and transported by wind. The high void ratio and angular interlocks with and without weak cementitious agents are susceptible to saturation collapse. (Jones, White, Harker, & Mahar, 2011). Investigations have been carried out to stabilize these soils by adding lime and/or fly ash and compacting the soil-cement mix to 95% standard proctor compaction (ACI, 2010 & Zoghi et al., 2010). By stabilizing the soils beneath porous concrete subgrade and reducing soil collapse potential settlement or collapse of the porous concrete slab is essentially eliminated. Stabilization can also increase the resistance to freeze-thaw breakdown of the subgrade by bonding the silt particles, thus increasing the intact strength of the soil and reducing the capillary action between the soil

grains (Zoghi et al., 2010). This stabilization can reduce frost heave and development of pot-holes in roadways and parking lots (Zoghi et al., 2010). Since porous concrete has voids which hold water, it is also susceptible to freeze-thaw deterioration (ACI, 2010). Since the lime and/or fly ash addition and the compaction reduce the permeability of the subgrade, it is recommended that a leach field or bioswale be constructed adjacent to the porous pavement.

Freeze-Thaw Characteristics

Concrete is strong in compression, but has limited strength in tension. Because porous concrete has very limited bonding capacity between the aggregates, reinforcing steel is not recommended in porous concrete applications. The brittle nature of unreinforced concrete in addition to the voids makes porous concrete susceptible to freeze-thaw deterioration (ACI, 2010). Water expands when it freezes in the open spaces between the porous concrete particles. The resultant tensile stresses break bond between the coarse aggregate particles. Freeze-thaw cycle tests on porous concrete have shown strength losses of up to 25% after 16 to 25 cycles (ACI, 2010). Present research is underway to investigate the use of non-corrosive polyvinyl alcohol (PVA) reinforcing fibers to increase freeze-thaw durability in masonry mortars (White, 2014). As a result of the fiber reinforcement research, the addition of non-corrosive fibers to porous concrete has been investigated as part of this study. The preliminary tests showed some improvement in tensile and flexural strength of the reinforced porous concrete samples (Harker & White, 2013).

The National Ready Mixed Concrete Association ([NRMCA], 2004) recommends three basic procedures to improve the durability of porous concrete: 1) placing a layer of

loose aggregate beneath the porous concrete slab so that water can drain out of the pore spaces, 2) using an air entrainment admixture to help protect against freeze-thaw weakening, and 3) placing perforated PVC pipe in the aggregate base to help drain excess water away from the area. The NRMCA (2004) goes on to state that all three recommendations are not required in every situation, but are good practice measures. The NRMCA (2004) studied several different porous concrete slabs placed in cold climates using their recommended practice. In all cases, the recommended practice was effective in preventing breakdown of the slabs. The ACI (2010) still recommends that additional research is needed to protect porous concrete from freeze-thaw cycle deterioration in cold climates.

Stormwater Filtering Capabilities

Since porous concrete allows surface runoff to recharge groundwater, water quality is a significant concern (ACI, 2010). According to the USGS (2005), groundwater is a major supply of clean water in the USA. Moreover, groundwater makes up 37% of agricultural water (mostly crop irrigation) and 58% of the drinking water. In large cities such as Philadelphia (Duhigg, 2009) and Chicago (Saulny, 2007), porous concrete it is quickly gaining popularity in the USA. Since porous concrete is being used primarily as drivable surfaces (ACI, 2010), petroleum contamination infiltrating porous concrete and ultimately the groundwater, is a major concern. The ACI (2010) mentions that even small petroleum based spills such as oil drips from vehicles will be quickly retained on the surface or in the pores of porous concrete. Larger petrochemical discharges are possible and both sources are a public health concern. ("Groundwater Concerns," 2012).

Water Quality

Porous concrete systems do not provide conventional water treatment but can and do provide beneficial effects while returning the water to the groundwater table. A porous concrete system is an economical way of migrating contamination in stormwater runoff in urban areas and returning the water to the groundwater table (ACI, 2010). However, in porous concrete systems the water being returned to the ground is not continuously tested for water quality and has the potential of allowing large concentrations of harmful contaminants pass through the slab and into the groundwater supply.

Retention

Sirotkina and Novoselova (2005) recognized the need to capture petroleum contaminants after they have been mixed with water. There are various methods used to purify water, and the retention of unwanted chemicals is a very efficient practice that can ensure any required level of purification (Sirotkina and Novoselova, 2005). Sirotkina and Novoselova (2005) studied many different materials that have retention purification properties, including scoria, which is an economical and natural occurring aggregate.

Wenjing et al. (2012) define scoria as a porous light silicate aggregate of basaltic composition forced during a volcanic eruption. This means that scoria is a natural occurring aggregate that is ready for use with minimal processing such as washing. Wenjing et al. (2012) recognized the need to treat groundwater containing petroleum contamination. The authors conducted tests to find a material that would act as a permeable reactive barrier (PRB), which is an in-situ remediation filter for polluted groundwater that is placed directly in the path of the contaminated flow entering the

ground. Three tests were performed to find the retention characteristics of scoria: 1) removal rate of contaminants from groundwater to design an effective PRB, 2) study the retention process between scoria and petroleum hydrocarbon pollutants, and 3) explore the mechanism of scoria retention.

The results of the studies indicate that scoria can effectively retain petroleum from contaminated groundwater. Moreover, scoria can effectively remove almost 90% of contaminants in only two hours (Wenjing et al., 2012). As concentrations of petroleum contaminants increase, the retention of those impurities in scoria increases. The porous structure and mineral constituents give scoria the ability to retain petroleum hydrocarbons even where other chemicals are present in groundwater. This capability is important since petroleum hydrocarbons easily bond with other chemicals making them difficult to separate the contaminants.

Scoria has been used in the field as a PRB in southeastern Australia in December of 1997 (Guerin et al., 2002). Petroleum in an underground petroleum storage tank was slowly leaking into the surrounding soil at a factory facility in Southeastern Australia in December of 1997. Contaminants began migrating into an adjacent river and into the groundwater supply further downstream. Workers quickly placed a funnel and gate, which is an impermeable barrier to redirect and funnel groundwater flow to a permeable PRB gate. Filtering material is placed in the gate and the contaminated groundwater can pass the remediated system. Scoria with some peat was placed in the gate on the downstream side. Peat, or partially decayed vegetation, is a material with petroleum absorbing capabilities, meaning it will actually absorb petroleum contaminants. Monitoring wells were installed both upstream and downstream of the funnel and gate

PRB. The site was monitored for a 10-month period. Removal efficiencies varied between 63% and 96%. This case history shows that the combination of scoria and peat were able to remove more than half of the contamination entering the PRB and let the improved water pass on the downstream side of the remediation system.

Water Improvement

One of the difficulties of using a non-replacement retaining material to remediate petroleum contaminated groundwater is ultimately reaching an equilibrium state where the scoria cannot absorb any additional oil. Thus the contaminants are allowed to pass by and into the groundwater below. Lei, Yang, Du, and Cao (2011) studied biodegradation of petroleum contaminants by introducing microorganisms into a groundwater site subjected to numerous years' oil pollution. Lei et al. (2011) found three types of bacteria called SX3, SF2 and SZ1, that reduced contamination concentrations up to 90%. The bacteria decompose the oil contaminants. If the bacteria could be used and survive in a porous concrete application, the available space for scoria to absorb more pollutants would increase. Some concerns have risen about how these bacteria will affect the public health such as causing sickness or poisoning (Voosen, 2010).

Paul Voosen (2010) reported bacteria that scientists wanted to use in the 2010 oil spill along the Gulf Coast can potentially cause harm to humans. The harm apparently can only occur when the bacteria are consumed by shellfish, which humans, in turn consume. Since the use of petroleum consuming bacteria would be used in a porous concrete application that returns runoff to the groundwater, the threat to human health is expected to be substantially reduced. It is apparent further studies would be needed to assess any human health issues.

The problem that arises in using bacteria is maintaining a healthy environment for their survival. The environment needed for survival is very sensitive and needs to be controlled (C. Sato, personal communication November 8, 2011). It is unlikely that the conditions needed for survival will be present beneath the porous concrete surface in a parking lot.

Research has been done at ISU on the implementation of bioinfiltration swales, or bioswales as water improvement systems. Bioswales are a component of infiltration systems that use vegetation which thrive on pollutants to help improve the quality of water that is then returned to the local groundwater system. They are designed to capture toxins and degrade them on site to minimize contaminant infiltration. The city of Pocatello has already begun to implement bioswales into several areas where runoff from drivable surfaces has a history of ponding in streets and intersections. These bioswales help to reduce runoff so that improved water can recharge the local groundwater system (Firebaugh, 2012).

CHAPTER 3 – Methods

The purpose of this study was to evaluate the performance of a porous concrete design placed on a collapsible soil, in a cold climate, and in a low area of a parking lot. The intention was to drain the area, prevent continued deterioration of the surrounding asphalt and provide a suitable pavement. The ACI (2010) emphasizes the need for research focusing on porous concrete in a variety of situations and conditions such as applications above problem soils, freeze-thaw resistance/weakening and stormwater management. The American Society for Testing Materials (ASTM) currently publishes the standards for engineering tests. The ASTM (2009) states that because of its porous nature, pervious concrete cannot be tested using the standards applicable for conventional concrete. For this reason, much of this study focused on creating a new standard for evaluating the freeze-thaw potential of porous concrete.

Design Methodology

Since the porous concrete in this study is being used both as a driveway pavement and as a parking lot drain, there were some critical components of the system that needed to be addressed. One of the major concerns was the presence of thick, collapsible soils (loess) at the site. Freeze-thaw durability was studied because of the susceptibility of porous concrete breakdown in cold climates.

Porous Concrete Design

Garrison Hall

In October 2010, a porous concrete test slab, referred to as the Garrison Hall slab, was constructed to study the performance of porous concrete under traffic loads and

environmental conditions. The final design consisted of lime and fly ash treatment of the subgrade to prevent settlement (Figure 1). An adjacent leach field containing a perforated pipe encased in scoria and protected by geotextile fabric was installed to convey infiltrated water away from the slab and the subgrade (Figure 2). The intake area of the leach field under the porous concrete slab was surrounded by half-inch aggregate and geotextile fabric to help prevent sediment from migrating into the leach field (Figure 3). One of the most important design considerations was to place a conventional concrete wall around the porous concrete to provide structural confinement to the weaker material (Figure 4). The porous concrete was placed on an 18-inch thick scoria base course. A group of monitoring wells was placed in the scoria to measure water levels during the study period (Figure 5). A six inch thick porous concrete slab with conventional stone aggregate was placed above the scoria base. The aggregate consisted of one-quarter to one-half inch gravel boded by Type I-II Portland Cement. Pocatello Ready Mix (PRM) supplied the porous concrete and supervised the placement of the mix (Figure 6). The final product merges with the resurfaced asphalt parking lot with the porous slab (Figure 7).

Figure 1: Lime and fly ash mixed into soil using a tiller and then compacted

Figure 2: Leach field consisting of perforated pipe surrounded by scoria and encased in geotextile fabric

Figure 3: Intake side of leach field PVC pipe with ½-inch aggregate and geotextile fabric to help prevent sediment migration

Figure 4: Conventional concrete border for confinement of the porous concrete and direct stormwater runoff onto the porous concrete slab

Figure 5: Monitoring wells installed in scoria base course. Scoria compacted with hand tamper

Figure 6: Porous concrete slab installation and finishing

Figure 7: Porous slab two years after construction

The porous concrete slab design meets the recommendations made by the NRMCA (2004). To help observe the infiltration performance of the test slab, two monitoring wells, (slotted PVC pipes) were installed in the slab to measure water levels below the pavement. Two other monitoring wells were installed in the leach field: one immediately west of the porous slab, and the other at the southwest end of the leach field. The final design of the porous concrete test section is given in Figure 8.

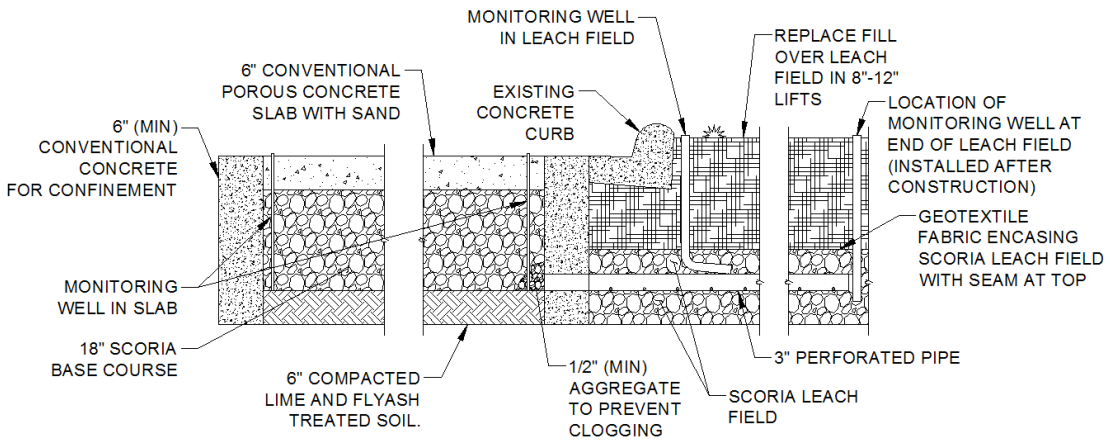

Figure 8: Garrison Hall porous concrete test section at Idaho State University

Testing

Water Infiltration

Since construction of the test pad, water levels in the monitoring wells have been recorded. This provided a means of monitoring the effectiveness of the drainage system. Moreover, the wells provided data on surface water infiltration of the porous concrete slab as well as retention in the scoria base and leach field. The adjacent sprinkler system simulated precipitation events so that the infiltration properties of the system could be evaluated. Water levels in the monitoring wells were measured before, during and after the sprinkler system water flowed into the pad area. Additional infiltration tests were performed to determine the effectiveness of different maintenance procedures had on intake properties of the slab. These procedures are discussed in more detail in the ***Maintenance*** section on page 31 of this chapter.

Settlement

ACI (2010) states that the soils beneath a porous concrete slab should have a percolation rate of one-half inch per hour and are four feet thick. The soils in southeast Idaho consist mainly of wind-blown silts that are four to forty-five feet thick with a percolation rate of 0.6 to 2.0 inches per hour (McGrath, 1987). These percolation rates meet the ACI (2010) design criteria. Because of the collapse potential, the soils must be stabilized to provide a stable subgrade. The stabilization process used in this geologic setting also includes water transported away from the infiltration area so that it does not pond in the porous concrete/base course and saturate the soils below the treated zone.

Zoghi et al. (2010) studied the effects of adding lime and fly ash (LFA) admixtures to regional silts (loess) to stabilize them for use as a road base. Other studies have also taken place to look at the effects of LFA on soils in other regions ("Soil Cement," 2012). By using soil cement such as LFA admixtures, the collapse potential beneath porous concrete is significantly reduced and is thereby reducing the potential damage to the overlying porous concrete slab.

Where LFA treatment is implemented in the high void ratio silty soils, the permeability of those soils is reduced (Zoghi et al, 2010). If the rate of runoff entering the porous concrete system is greater than the rate of subgrade percolation, the water will pond on the slab. In such cases, the water must be transported away from the porous slab and soil cement so it can percolate back into the ground without damaging the porous slab such as by freeze-thaw break down. This can be accompanied by placing a leach field next to the porous slab. The capacity of the leach field must be sufficiently large to

accommodate maximum design storm event so the infiltrating water is not retained in the porous slab.

The settlement of the Garrison Hall porous slab was also monitored comparing the elevations of the confining concrete walls with the porous slab surface and the adjacent surrounding asphalt. The observations were used to evaluate the settlement of the soil cement and the porous slab. Visual observations were also made along the ground surface above the leach field to monitor any surface settlement above the drain.

Porous Concrete Properties

During construction of the test slab, three concrete cylinders were cast that conform to the dimensions required in ASTM C39 (2012) for the compressive strength of conventional concrete. The length-to-diameter ratio was 2 (ASTM C39, 2012). This standard was chosen since no standard has been published for the compressive strength of porous concrete. ASTM C39 (2012) was used to achieve consistency and to provide a baseline for all of the tests on the porous concrete samples. Prior to performing the compressive strength tests, the cylinders were used measure the porosity, unit weight, and void ratio of the porous concrete in the test slab cylinders and in the trial mixes. A summary of the mix designs to make one cubic yard used in this study and their respective names are found in Table 1.

Table 1: Summary of the preliminary mix designs used in this study

	Coarse Aggregate		Fine Aggregate		Cement	Fly Ash	Water/
	Size (in)	Weight (lbs)	Size (in)	Weight (lbs)	Weight (lbs)	Weight (lbs)	Cement Ratio
Garrison Hall	3/4	2693	unknown	unknown	451	114	0.27
3/4" PRM	3/4	2693	-	0	451	114	0.27
3/8" PRM	3/8	2693	-	0	451	114	0.27
50-50 PRM	3/8 & 3/4	1346.5 (each)	-	0	451	114	0.27
2.8-Bag Scoria	1/2	1555	-	0	260	-	0.40
4.8-Bag Scoria	1/2	1555	-	0	453	-	0.40
6.8-Bag Scoria	1/2	1555	-	0	648	-	0.40

The basic mix design was provided by PRM and was provided to ISU under a confidentiality agreement therefore the admixtures that were used in the mixes cannot be mentioned. The PRM mix was used in the field test; however an unknown quantity of sand was inadvertently added to the batch before the slab was poured. The mix design developed and tested in the laboratory was coarse aggregate porous concrete without sand.

The basic types of coarse aggregate that were used in the trial mixes were conventional siliceous aggregates (used in standard concrete) and scoria. The conventional aggregate were hard, dense and durable particles, whereas the scoria was crushed vesicular basalt with pores in a skeletal structure. In addition to the type of aggregate, the cement content was varied. The laboratory samples were tested in unconfined compression to determine the effect of aggregate type, cement content and water/cement ratio on the strength of the porous mixes. In accordance with ASTM C39 (2012), the mix designs with the highest compressive strength were chosen to perform the freeze-thaw tests.

The investigation was extended to include the effect of non-corrosive fibers on the strength and freeze-thaw durability of porous concrete. In this study, two different types of fibers were added to both mixes in an attempt to reinforce the porous concrete. The two fiber types were polypropylene based fibers called Procon and PVA based fibers called Nycon. The lengths of fiber types were 3/4-inch. These lengths were chosen to span the gaps or pores in the porous concrete. The amount of fibers added to the mix was based on past research (Harker & White, 2013). The amount is based on the total mass of the mix design and was 0.1% for the Nycon fibers and 0.25% for the Procon fibers.

The porosity of the porous concrete was measured by first weighing the samples, filling the cylinders with tap water and re-weighing the samples. The porosity is then estimated by converting the weight of the water to volume (using the unit weight of water) and dividing by the volume of the porous concrete cylinder. The porosity is determined using Equation 1 below.

$$\frac{Volume\ of\ Water}{Total\ Volume}\ x\ 100\% \quad (1)$$

Strength Testing Procedures

The compression machine used in laboratory tests is a Gilson Model MC-300M (see Figure 9). The first series of tests were performed to evaluate the relationship between mix design and unconfined compressive strength and to help determine which mix design would be subjected to freeze-thaw testing. The machine was later used to perform both unconfined compression tests (ASTM C39, 2012) and Brazil split tests (ASTM C496, 2011) on the samples subjected to freeze-thaw cycles.

Figure 9: Gilson MC-300M compression machine used in porous concrete studies

ASTM C39 (2012) test procedures for measuring the unconfined compression strength of concrete require that the cylindrical samples have lengths of two to two and a half times the diameter. The samples cast at the time of the Garrison Hall slab pour were 6-inch diameter by 12-inch long. The remaining samples cast in the laboratory were 4-inch diameter by 8-inch long. All were capped with a sulfur compound to meet the end requirements in the ASTM standards (Figure 10).

Figure 10: Scoria porous concrete sample capped with sulfur compound

Prior to testing, the capped samples were centered between the compression machine plates (Figure 11). The rate of loading ranged between 300 and 750 pounds per minute. This loading rate is much slower than recommended by ASTM C39 (2012). The slower rate permitted observation of the progressive failure of the porous concrete.

Figure 11: Scoria porous concrete sample ready for the unconfined compression test (ASTM C39, 2012)

The tensile splitting tests were performed on the porous concrete cylinders in accordance with ASTM C496 (2011). The tensile split tests were also carried out using the Gilson machine on samples 4-inches in diameter and 8-inches long. To help distribute the load evenly, wood strips were placed on the rounded faces bearing against the plates (Figure 12). The loading rate was 300 to 750 pounds per minute to observe the failure mechanisms.

Figure 12: Scoria porous concrete sample in Brazil Tensile test (ASTM 496, 2011)

Freeze-Thaw Durability

Both ASTM (2009) and ACI (2010) have stated the need for standardizing the test procedures for evaluating the freeze-thaw durability of porous concrete. ASTM C666 (2008) is the standard test for freezing and thawing durability of conventional concrete. Porous concrete cannot be tested in the same manner as conventional concrete because the freeze-thaw action takes place in the large voids between the aggregate particles. ASTM C666 (2008) requires the samples to be subjected to 300 freeze-thaw cycles or until 25% of the original mass is lost because of break down. The test procedure also

requires that the samples be fully submerged in water during the freeze-thaw cycles. By combining observations made on the Garrison Hall test pad and the ASTM C666 (2008) testing procedures, the freeze-thaw weakening of porous concrete can be estimated consistent with the design requirements for proper placement of porous concrete. The modified procedure used in this study is described in the following paragraphs.

Porous concrete derives its strength and durability by the confinement provided around the perimeter of the porous slab. The beneficial effects of confinement were verified by the observed performance of the Garrison Hall slab. The slab showed good performance during the winter months where it was subjected to numerous freeze-thaw cycles. The porous slab is confined or surrounded by 6-inch thick conventional concrete walls. The freeze-thaw tests on the porous concrete mix designs were performed on the samples confined in their respective plastic molds to simulate the confinement that is present on the Garrison Hall slab. After curing for the required 14 days (ASTM C666, 2008), the bottoms of the molds were cut out and removed using a Dremel (Figure 13). This procedure simulated the Garrison slab, which is supported by a scoria base. The samples were then freeze-thaw tested in the following moisture conditions: 1) unsubmerged, 2) partially submerged, and 3) fully submerged. A group of control samples were sealed with end caps and stored at room temperature.

Figure 13: Removal of bottom of plastic mold

The freeze-thaw chamber is a Caron Freeze/Thaw unit (Figure 14). The chamber can be programmed at approximately seven cycles in a 24 hour period. ASTM C666 (2008) requires that samples be subjected to a total of 300 freeze-thaw cycles. This was achieved by running 36 freeze-thaw cycle increments, with the last increment consisting of only 12 cycles. At the end of the last cycle, the condition of the porous concrete at the tops and bottoms of the samples were observed for detached particles. Any detached particles on the surfaces of the samples were removed and the samples weighed to measure the weight loss.

Figure 14: Caron Freeze/Thaw Chamber used in porous concrete tests

All weight loss measurements in the freeze-thaw tests were based on the initial dry weight (mass) of the samples. Since the samples were placed in water, the water had to be removed from the pore spaces before weighing the cylinders. The samples were removed from the chamber and placed on a rack where box fans were used to evaporate the water. A drying time of 36 hours was needed to reach a constant weight (mass). After drying, the weight of each sample was measured and recorded. The samples were

then returned to the test conditions and placed into freeze-thaw chamber. Based on ASTM C666 (2008), the samples were subjected to 300 freeze-thaw cycles or until they had lost 25% of their original mass.

The Garrison Hall porous concrete test slab was subjected to natural freeze-thaw cycles during two Idaho winters. The slab performed extremely well during the two freeze-thaw periods. Three cores were taken from the slab to perform additional freeze-thaw tests on the two-year old concrete. The cores were weighed, dimensioned and then subjected to 300 freeze-thaw cycles in the same submersion conditions as the previously mentioned samples (unsubmerged, partially submerged and fully submerged). The slab samples were not able to be confined because the core bit produced slightly smaller diameter cylinders than would fit tight inside of the plastic molds.

Maintenance/Infiltration Tests

Different maintenance techniques for porous concrete were studied to determine their impact on infiltration. The ACI (2010) recommends maintenance of in-place porous concrete by pressure washing followed by wet vacuuming. Once the Garrison Hall porous concrete began to show ponding, four cleaning methods were tested: (1) brushing the dry surface with a hard bristle broom, (2) brushing the wet surface with a hard bristle broom, (3) pressure washing the surface only (4) pressure washing and then wet-vacuuming the surface.

After each treatment, ten gallons of water was poured onto the concrete surface in two five-gallon applications (Figure 15). Once the water surface was level, time and corresponding depth measurements were taken at a specific point on the surface to observe the rate of infiltration into the porous concrete. The data obtained in these tests

were compared with previous infiltration tests made during observation of runoff from the sprinkler system (see page 20).

Figure 15: Water poured onto the test slab during infiltration tests

Part of the maintenance study included tests on concrete surface treatment products designed to reduce maintenance and extend the useful life of the porous concrete. One such product is manufactured by Pervious Solutions (North Carolina) called PC Grout. The epoxy cement mixed with coarse sand was troweled onto the porous concrete surface where the most water was being infiltrated. According to Pervious Solutions (2013), maintenance cycles can be reduced to only one or two times per year. The PC grout was applied to the test pad surface after the core samples were

taken and the holes patched with a pervious scoria mix (Figure 16). To study the effects of the PC Grout on infiltration, the same infiltration tests were performed. This study did not include the freeze-thaw tests on PC Grout coated porous concrete samples.

Figure 16: Application of PC Grout on the area of greatest infiltration on the Garrison Hall test slab

CHAPTER 4 – Results and Discussion

Results

Water Infiltration

Water levels were measured on the Garrison slab for during the 18 month study period. The measurements were taken in four monitoring wells placed in the scoria base below the slab and in the lateral drain. The locations of the wells and the results of the measurements are given in Figure 17 and 18 respectively.

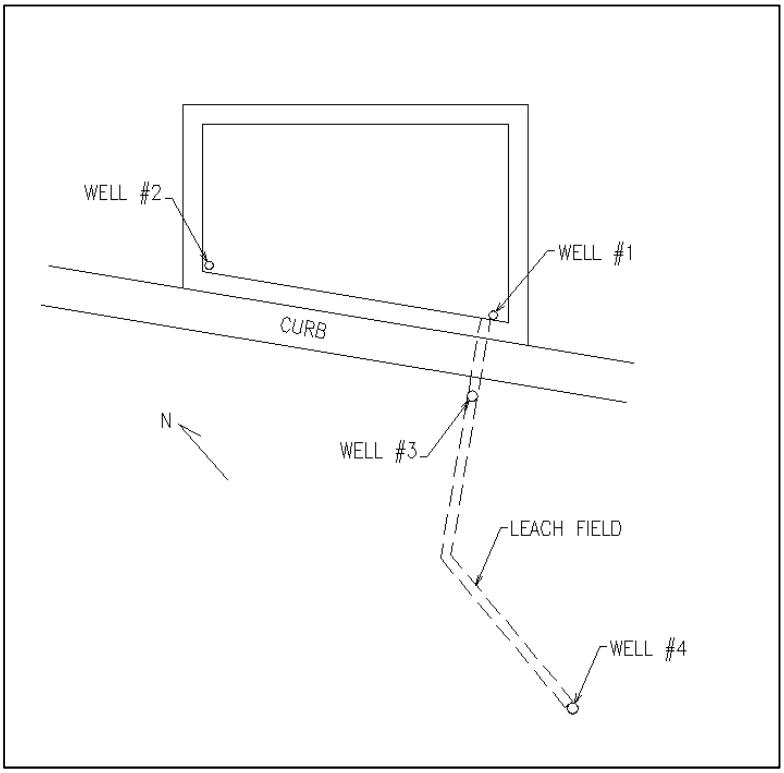

Figure 17: Locations of monitoring wells in the Garrison Hall porous concrete system

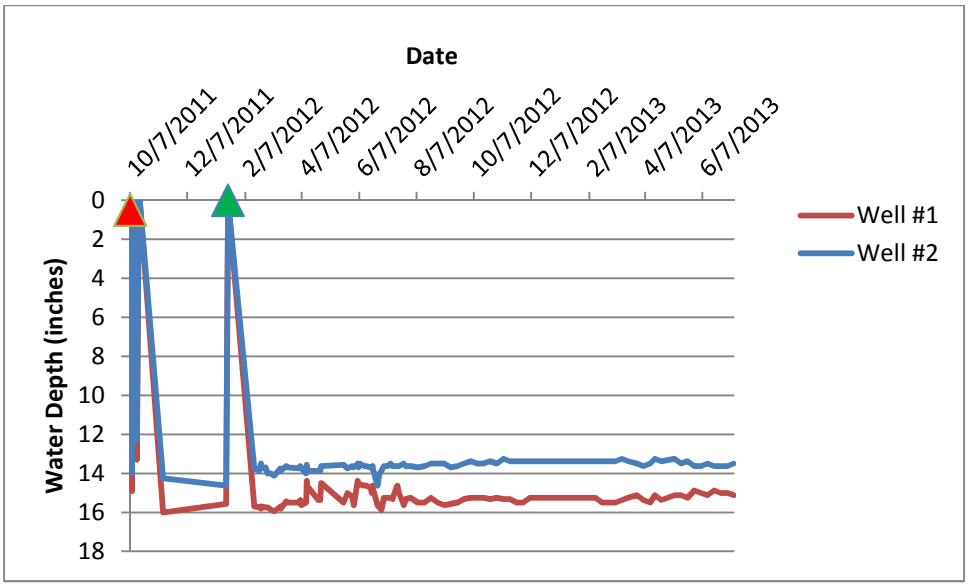

Figure 18: Monitoring well measurements in scoria base

The vertical axis is the depth of the water in the bottom of the well below the surface of the slab. Monitoring Well #3 and Well #4 are located in the scoria drain at the beginning and end of the leach field, respectively. Both monitoring wells showed no measurable water levels during the investigation period. This included times of known infiltration through the porous concrete such as during the maintenance infiltration tests and the irrigation observations, both of which are explained in this section. The leach field was adequately designed and is easily capable of storing any water entering the porous concrete system.

The two points where the water level is zero correspond with times in which surface water was ponded on the porous concrete slab during a rain event (red triangle) and when ice had formed in the wells (green triangle). The observation well measurements in the scoria base indicate that the porous concrete slab may have been submerged only twice during the monitoring period. This is only true during the winter

months. During the summer months, the university's irrigation system would come on twice a week and overtop the system. It would happen late at night, and the system would drain completely by morning.

Infiltration studies were made during one of the operation periods of the university sprinkler system. The sprinklers closest to the Garrison Hall service road sprayed water onto the asphalt and curb south of the test slab. The excess water flowed onto the west side of the porous concrete adjacent to the curb. Water level measurements were taken in the test pad wells as well as wells #3 and #4 located in the leach field. This investigation was made on two occasions. The resultant monitoring well readings are given in Figures 19 and 20. Zero depth in the figures corresponds with the surface of the porous slab.

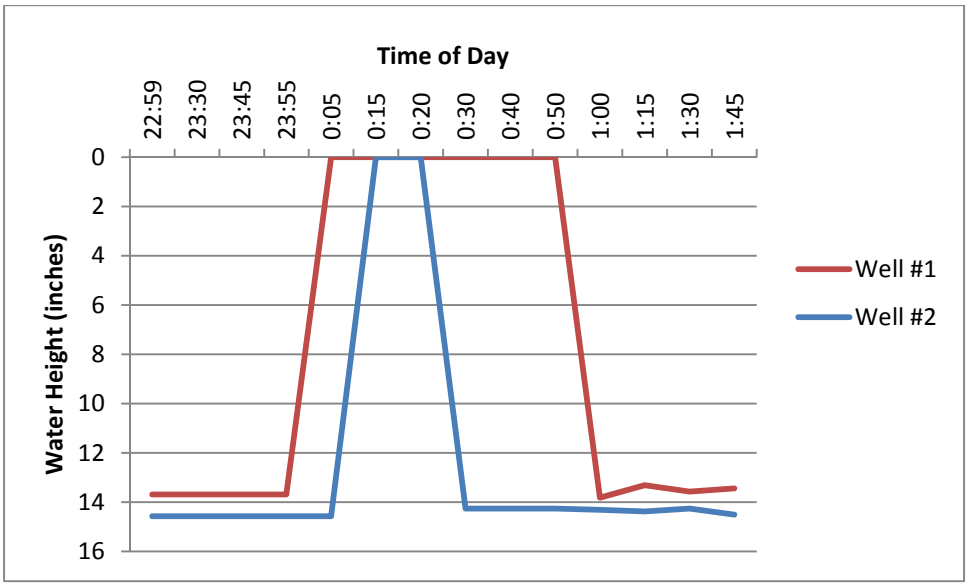

Figure 19: Sprinkler water infiltration Test Number 1 on June 6, 2012

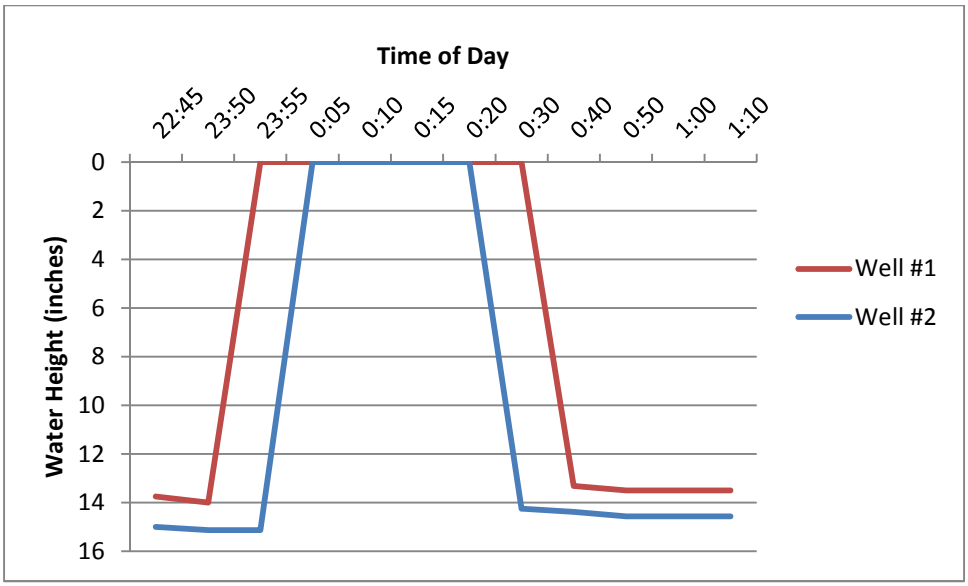

Figure 20: Sprinkler water infiltration Test Number 2 on July 19, 2012

The water level steadily rose to the top of the slab until it was overtopped and ultimately ponded in the depression on the west side of the porous concrete. Even though the runoff rate exceeded the infiltration capacity of the porous concrete, a portion of the surface water infiltrated the concrete. Measurements in Wells #1 and #2 could no longer be taken because the water level was above the tops of the wells. After the sprinklers were turned off, the surface drained and within 10 minutes, the water levels in the wells returned to their pre-test depths. The water drained into the scoria base and likely into a portion of the adjacent leach field. However, Wells #3 and #4 that are located in the leach field, showed no evidence of a water level rise. These results illustrate that the leach field is adequately designed. The spike in Test Number 2 is wider because the sprinklers operated for a longer period than the Test Number 2. The infiltration rate of the porous slab controls the flow of water into the system. Once the intake capacity of the porous concrete is exceeded, the water ponds at the surface.

Settlement

Differential settlement was monitored by comparing the elevation differences between the porous slab and the confining conventional concrete walls with the curb and adjacent asphalt pavement. The porous concrete test slab is south of a loading dock and has been subjected to substantial load from large delivery trucks including 18-wheel vehicles (Figure 21). The measured settlement of the porous concrete slab is less than 1/8-inch during the two-year study period. The leach field showed a small depression in the grass. The slight swale was most likely formed by settlement of the scoria filter zone around the perforated PVC pipe. The scoria was not compacted to prevent break down and a reduction in the permeability of the filter pack.

Figure 21: Garrison Hall slab south of loading dock

Porous Concrete Strength Properties

Six different mix designs were developed and tested in unconfined compression (see Table 2). Three mixes were the basic PRM design with different size and gradations/contents of aggregates. The remaining three mixes had scoria aggregate with different cement contents and water-to-cement ratios. Three samples for each mix design were cast to obtain average strength values. The highest strength mixes were used in the freeze-thaw tests.

Table 2: Summary of the preliminary mix designs used in this study

	Coarse Aggregate		Fine Aggregate		Cement	Fly Ash	Water/ Cement Ratio
	Size (in)	Weight (lbs)	Size (in)	Weight (lbs)	Weight (lbs)	Weight (lbs)	
Garrison Hall	3/4	2693	unknown	unknown	451	114	0.27
3/4" PRM	3/4	2693	-	0	451	114	0.27
3/8" PRM	3/8	2693	-	0	451	114	0.27
50-50 PRM	3/8 & 3/4	1346.5 (each)	-	0	451	114	0.27
2.8-Bag Scoria	1/2	1555	-	0	260	-	0.40
4.8-Bag Scoria	1/2	1555	-	0	453	-	0.40
6.8-Bag Scoria	1/2	1555	-	0	648	-	0.40

Each mix were cast in 4-inch by 8-inch plastic cylinder molds and were tested in unconfined compression after curing for 7 and 28 days (ASTM C39, 2012). The test times were chosen consistent with quality control tests on conventional concrete. The mixes with the highest unconfined compressive strength from each group was chosen to

place in the freeze-thaw chamber. The average of the results of the strength tests are given in Figures 22 and 23 and Table 3. All of the data can be found in the **Appendix**.

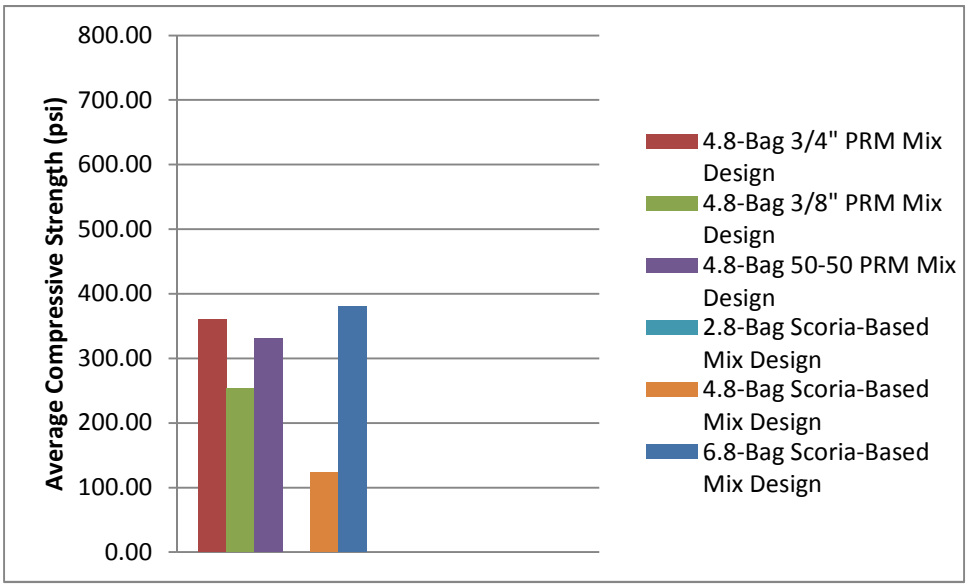

Figure 22: Average 7-day unconfined compressive strengths of porous concrete mix designs

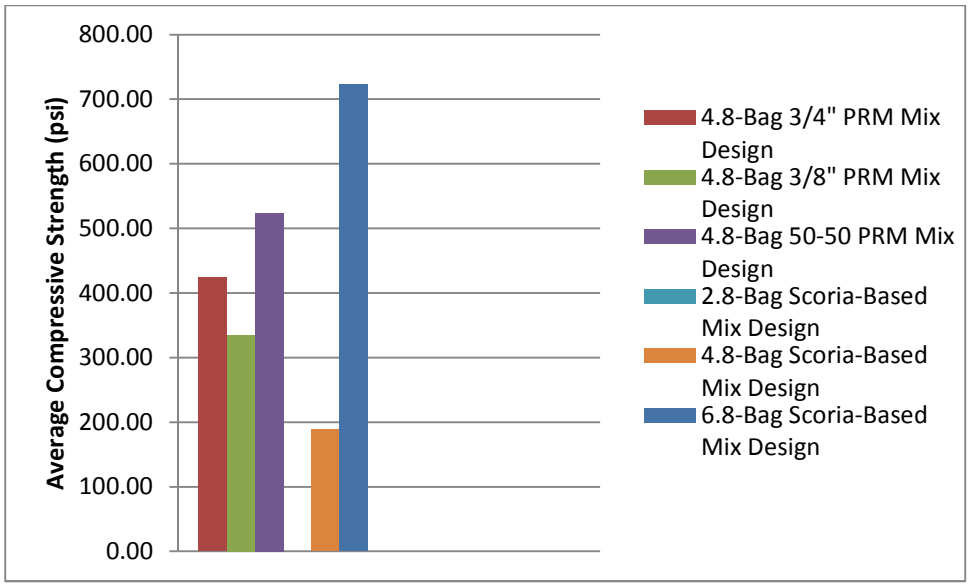

Figure 23: Average 28-day unconfined compressive strengths of porous concrete mix designs

Table 3: Average unconfined compressive strengths of mix designs

	3/4" PRM	3/8" PRM	50-50 PRM	2.8-Bag Scoria	4.8-Bag Scoria	6.8-Bag Scoria
7-Day Strength (psi)	360	253	331	0	123	381
28-Day Strength (psi)	424	335	524	0	189	723
%-Increase	18%	32%	59%	0%	53%	90%

These bar graphs represent the 7-day and 28-day compressive strengths of the porous concrete mixes. The PRM mix design was modified using different sized aggregates. The sizes given in the figures are the average of the aggregate that was used in the mix design. It can be observed that based on the 28-day compressive strengths, the 50-50 PRM and the 6.8-bag scoria-based mix designs were chosen for the freeze-thaw durability tests (ASTM C666, 2008).

The scoria mixes had the highest and lowest unconfined compressive strength values. The 2.8-bag mix samples crumbled when the porous concrete was stripped from the molds. Compressive strength tests could not be performed on these samples. It was also observed that all of the mix designs compressive strength results increased from the 7-day to 28-day results. This was an expected trend, but if more cylinders could have been cast, more values could have been recorded resulting in averages that better represented the mix designs. The unconfined compressive strengths of all mixes increased 18 to 90% from 7 to 28-days.

Unit weight and porosity of the porous concrete mixes were also measured. Unit weight of the six mix designs are summarized in Figure 24. Porosity values give an index of the permeability of the porous concrete mixes (Figure 25).

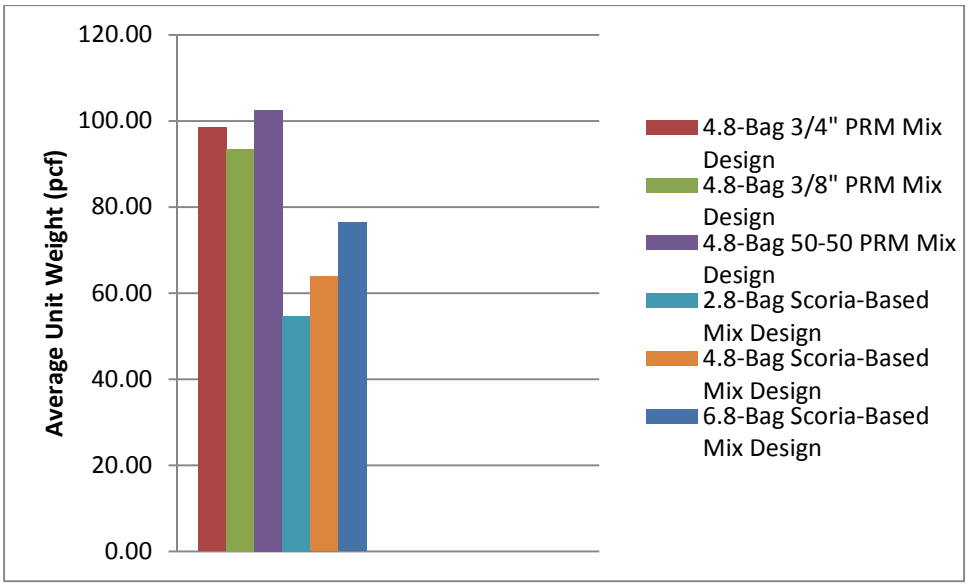

Figure 24: Average unit weights of porous concrete mix designs

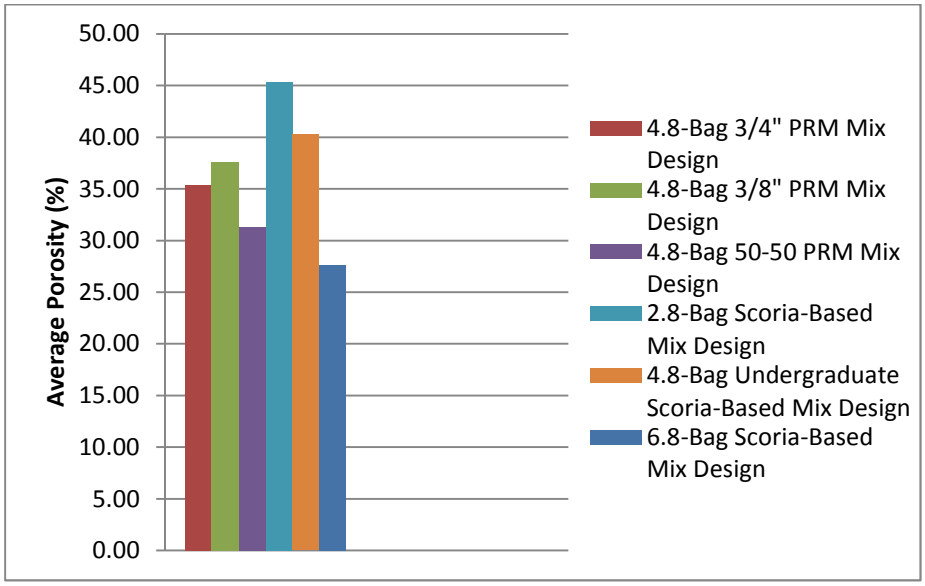

Figure 25: Average porosity of porous concrete mix designs

The values given in Figures 24 and 25 are the average of the unit weights and porosities of the various mix designs in the unconfined compressive strength tests. The two mixes chosen for the freeze-thaw tests (50-50 PRM and 6.8-bag scoria) have the highest unit weights and lowest porosities. The 6.8-bag scoria mix, with the highest cement content would be expected to have the highest unit weight and lowest porosity compared with the other two scoria based mixes. This condition is a direct result of the increased cement content. The cement particles fill the voids within the scoria and the pore spaces between the aggregate particles. Similarly, the 50-50 PRM mix design, with a wider range of grain size (50% 3/4-inch diameter, and 50% 3/8-inch diameter aggregate) had a higher unit weight and lower porosity than the mixes with a more

uniform grain size. The smaller aggregates fill the spaces between the larger particles. The result is a higher unit weight with a corresponding decreased. The 50-50 PRM mix had an average porosity of 31% and the 6.8-bag scoria mix had an average porosity of 27%. The mixes chosen for the freeze-thaw tests had porosities similar to those in the Garrison Hall test slab which was 24%.

Freeze-Thaw Durability – 6.8-Bag Scoria Mix Design

Confinement of the samples significantly improved the performance of the porous concrete samples subjected to freeze-thaw cycles. In the literature on the freeze-thaw durability of porous concrete, none of the samples survived more than 16 to 25 freeze-thaw cycles and before losing 25% of their original mass. Conversely, the samples confined by the plastic molds were able to survive the entire 300 freeze-thaw cycles tested under ASTM 666 (2008). The results of the freeze-thaw tests conducted on the 6.8-bag scoria-based mix design with and without different types of reinforcing fibers and levels of saturation are given in Figures 26 to 28 and are summarized in Table 4.

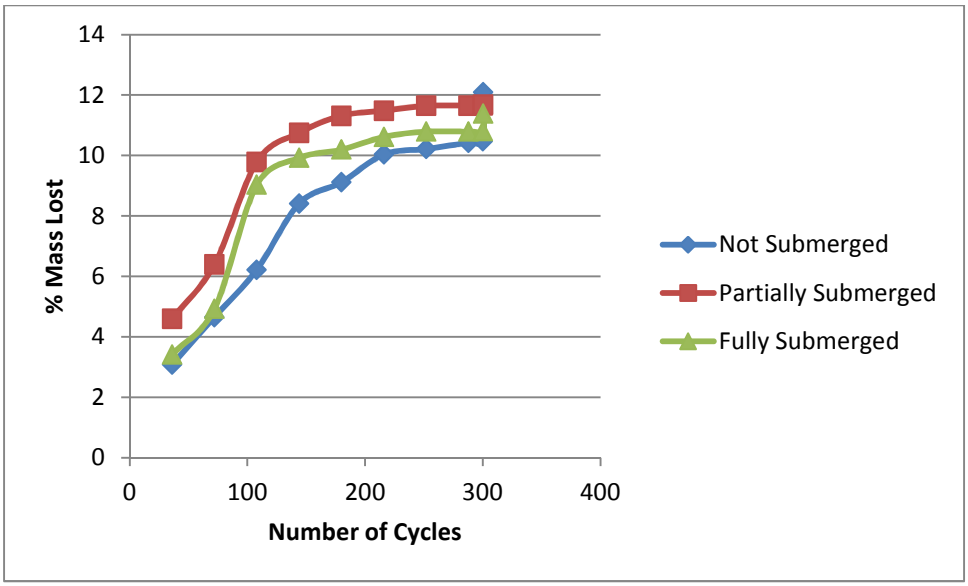

Figure 26: Results of the freeze-thaw tests on the 6.8-bag scoria mix without fibers

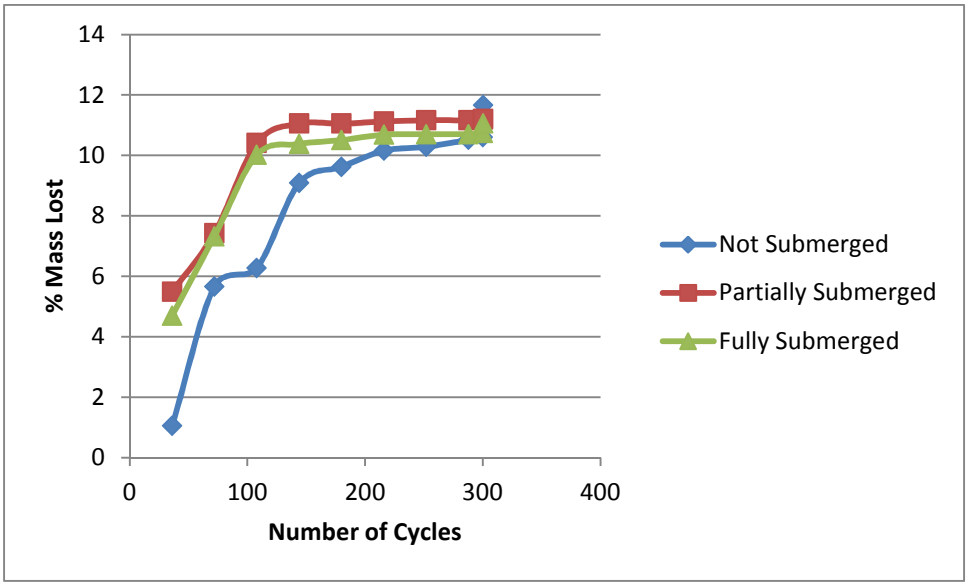

Figure 27: Results of the freeze-thaw tests on the 6.8-bag scoria mix with 0.1% Nycon fibers

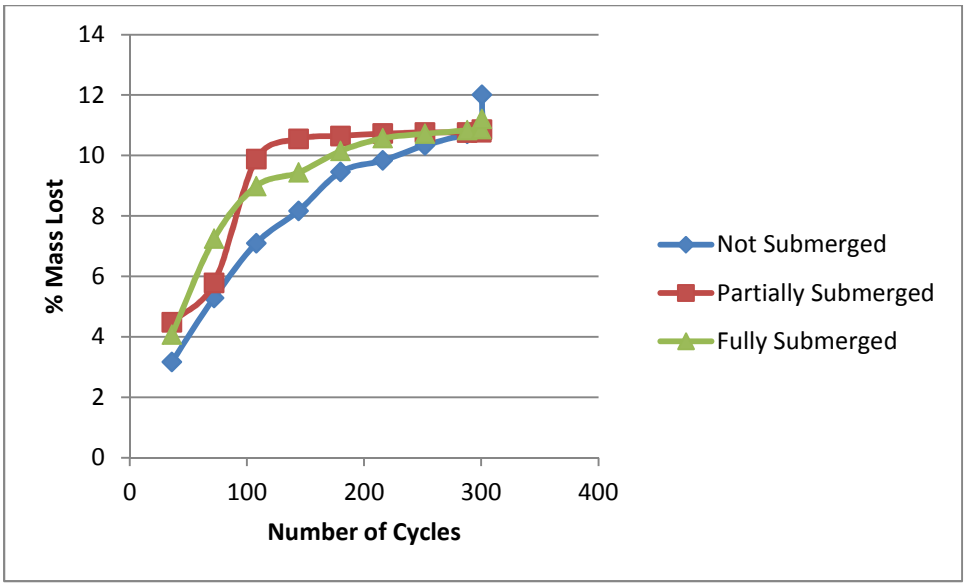

Figure 28: Results of the freeze-thaw tests on the 6.8-bag scoria mix with 0.25% Procon fibers

Table 4: Summary of average percent mass-loss 6.8-bag scoria mix at 300 cycles

	Unsubmerged	Partially Submerged	Fully Submerged
No Fibers %-Mass-Loss	10.47	11.66	10.80
Nycon %-Mass-Loss	10.60	11.19	10.74
Procon %-Mass-Loss	10.86	10.77	10.87

The mass-loss values in Figures 25 to 27 are cumulative percentages of the initial mass lost after each of the eight 36 freeze-thaw increments (with the ninth and last increment being 12 cycles). The graphs show that the mass-loss ramps up during the first 100 to 170 cycles and then tends to level off during the remaining cycles. The samples of all three mixes not place in water had a lower initial mass-loss than the fully and partially submerged specimens. The mass-loss in the partially submerged samples tend to be

slightly higher than in the fully submerged samples. At 300 cycles, the mass-loss of each mix converge at about the same value regardless of the saturation condition.

Table 3 summarizes the average mass for the 6.8-bag scoria mix. The presence of the fibers had no impact on the durability of the scoria mix when the samples were not submerged or fully submerged. In the partially submerged samples, the presence of the fibers may have a slight beneficial effect in improving the freeze-thaw durability of the scoria mix. However, based on the small difference in values (0.5 to 0.9%) additional tests would be needed to validate this conclusion. The impact of freeze-thaw on the unconfined compression strength (ASTM C39, 2012) and tensile splitting strength (ASTM C496, 2011) on the three mixes is shown Figures 29 to 31 and Tables 4 and 5.

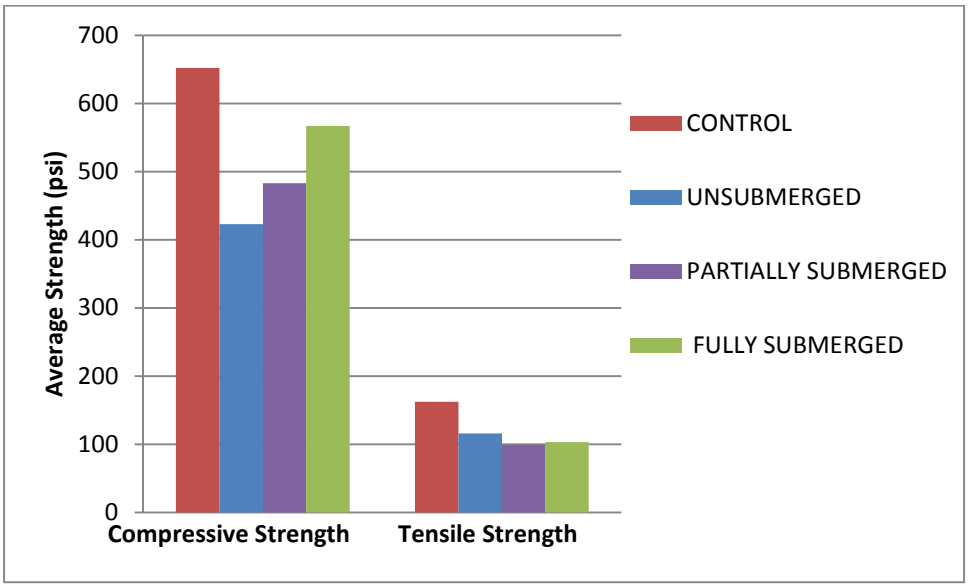

Figure 29: Results of strength tests on the 6.8-bag scoria mix with no fibers after 300 freeze-thaw cycles

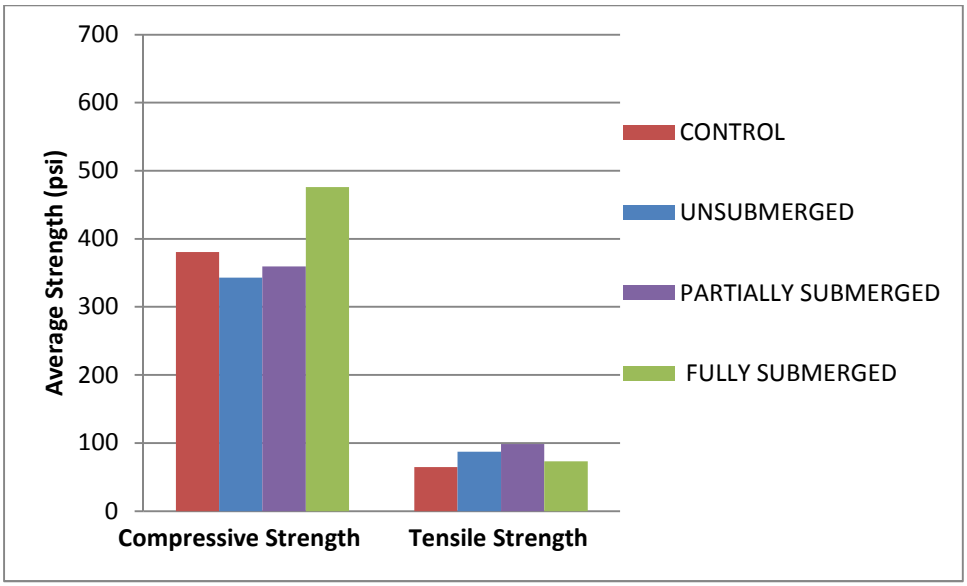

Figure 30: Results of strength tests on the 6.8-bag scoria mix with 0.1% Nycon fibers after 300 freeze-thaw cycles

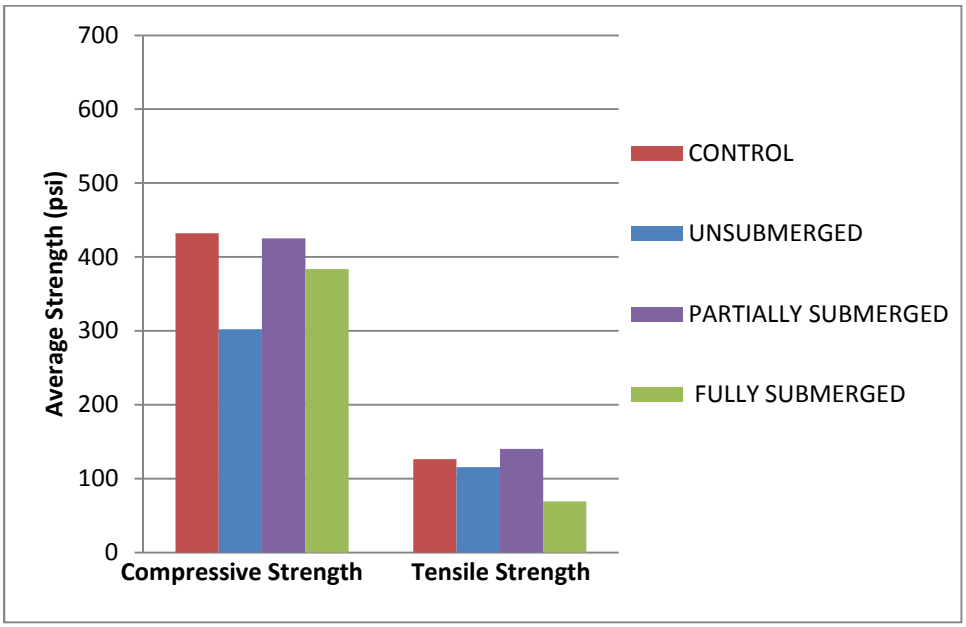

Figure 31: Results of strength tests on the 6.8-bag scoria mix with 0.25% Procon fibers after 300 freeze-thaw cycles

Table 5: 6.8-bag scoria mix average unconfined compressive strength and %-strength lost/gained

	Control	Unsubmerged	Partially Submerged	Fully Submerged
No Fibers Compressive Strength (psi)	652	423 (-35%)	483 (-26%)	567 (-13%)
Nycon Compressive Strength (psi)	381	343 (-10%)	360 (-6%)	476 (+25%)
Procon Compressive Strength (psi)	432	302 (-30%)	425 (-2%)	384 (-11%)

Table 6: 6.8-bag scoria mix average tensile strength and %-strength lost/gained

	Control	Unsubmerged	Partially Submerged	Fully Submerged
No Fibers Tensile Strength (psi)	162	116 (-28%)	99 (-39%)	103 (-36%)
Nycon Tensile Strength (psi)	65	87 (+34%)	98 (+51%)	73 (+12%)
Procon Tensile Strength (psi)	126	116 (-8%)	140 (+11%)	69 (-45%)

The graphs show the average unconfined compressive and tensile strengths of the 6.8-bag scoria mix design with and without fibers subjected to 300 freeze-thaw cycles. The tables give the numerical values in the histograms. In general, all but one set of samples experienced a strength loss of 2 to 35%. The greatest losses (10 to 35%) in unconfined compressive strength occurred in the samples that were not placed in water (unsubmerged in Table 2). Moreover, the unconfined compressive strength loss was significantly lower in the partially and fully submerged samples. One explanation may be the presence of water that hydrated the cement and increased the strength of the concrete. The samples with fibers had lower compressive strengths than their corresponding non-fiber mixes in the control and in the samples subjected to freeze-thaw

breakdown. In summary, the fibers provided no beneficial compressive strength effects and may be detrimental to the freeze-thaw durability of porous concrete. One of the objectives of this study was to determine whether the addition of fibers to the porous concrete mix designs would provide beneficial effects on the strength and freeze-thaw durability of the concrete. The results of the study are given in Figures 32 to 35.

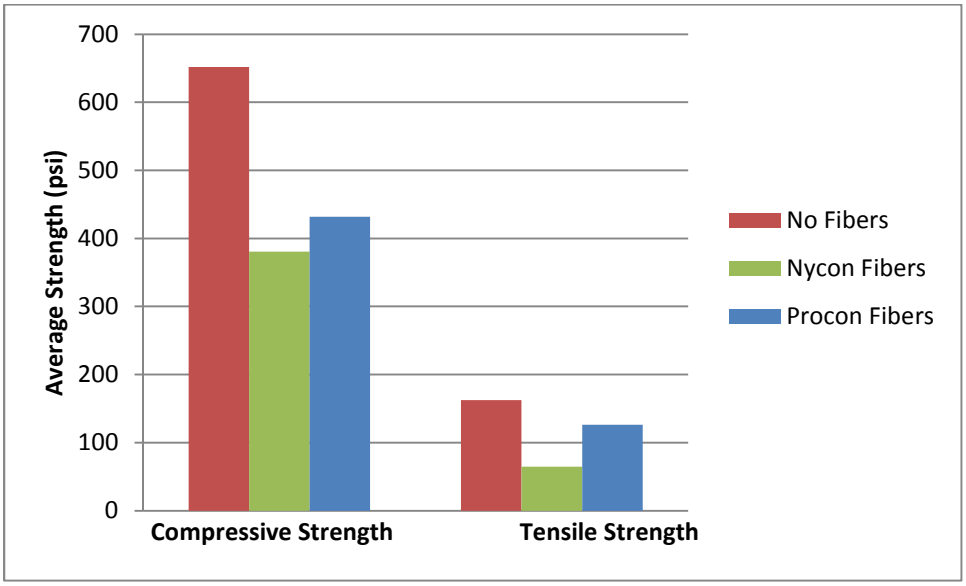

Figure 32: 6.8-bag scoria mix strength test results on the control group samples subjected to no freeze-thaw cycles

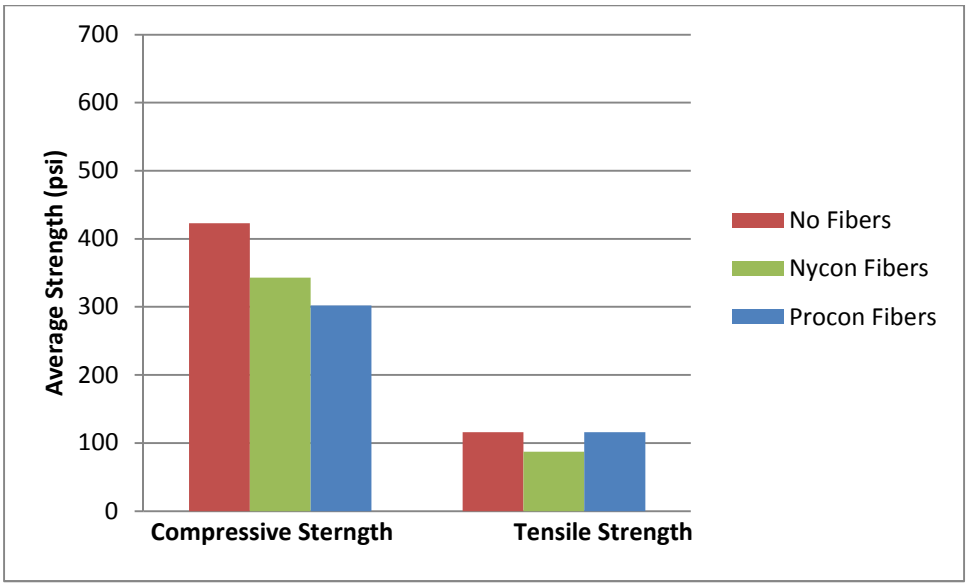

Figure 33: 6.8-bag scoria mix strength test results on the unsubmerged samples subjected to 300 freeze-thaw cycles

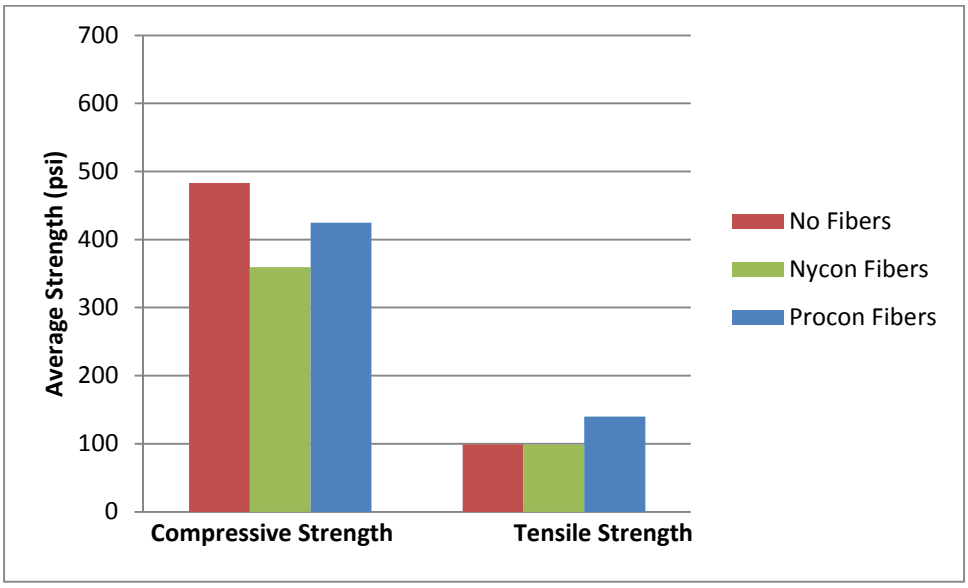

Figure 34: 6.8-bag scoria mix strength test results on the partially submerged samples subjected to 300 freeze-thaw cycles

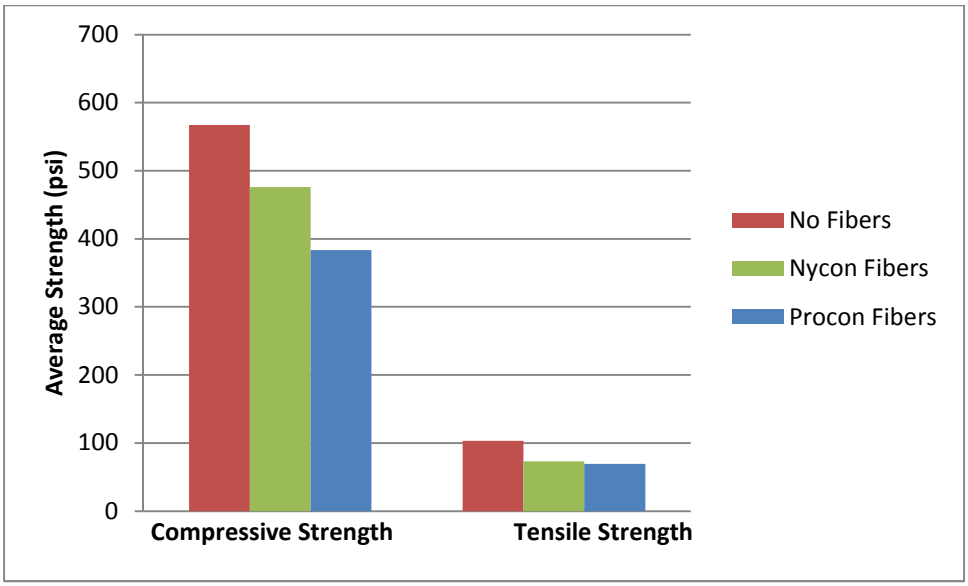

Figure 35: 6.8-bag scoria mix strength test results on the fully submerged samples subjected to 300 freeze-thaw cycles

The graphs give the average compressive and tensile splitting strengths of the 6.8-bag scoria mix design in the control group and in the samples subjected to 300 freeze-thaw cycles. In each test condition, the highest average unconfined compressive strengths were obtained in the scoria aggregate samples without fibers. The lower strengths in the fiber-reinforced mixes may be related to the presence of the fibers interfering with the bond between the cement and the aggregate.

The results of the freeze-thaw tests on the unreinforced scoria mix show a reduction in strength (10 to 30%) when the samples were subjected to alternate freeze-thaw cycles (see Table 7). The reduction in the average unconfined compressive strength related to freeze-thaw decreases with increased saturation during the test. The decrease in strength loss for the unsubmerged to the fully submerged samples is most likely related to the allowable moisture which facilitates hydration of the Portland Cement. The fiber-

reinforced samples showed no significant trends in unconfined compressive strength in the control group and samples subjected to the freeze-thaw cycles (see table 5).

In conventional reinforced concrete, the purpose of the reinforcing steel is to increase the tensile and flexural strength of concrete. Similar results would be expected for fiber-reinforced porous concrete. However, the test results on the control group and freeze-thaw samples of the scoria mix show no beneficial effect of the fibers on the tensile splitting strength of scoria porous concrete.

Freeze-Thaw Durability - Pocatello Ready Mix Design

The results of the freeze-thaw tests on the 50-50 PRM mix design show a lower mass-loss and reduction in unconfined compressive strength than the scoria concrete mixes. The reduced freeze-thaw effects are explained by the lack of pores and overall strength/durability of the PRM aggregate. The freeze-thaw tests on the PRM samples were carried out for the three conditions of immersion (unsubmerged, partially submerged, and fully submerged). The samples included unreinforced and fiber-reinforced mixes. The wet mass was used for the initial mass of the sample.

The mass-loss results in the freeze-thaw tests on the PRM samples are given in figures 36 to 38. The final mass-loss values at the end of the 300 freeze-thaw cycles are summarized in Table 7. The mass-loss in the unsubmerged samples of all three mixes ramped upward during the first 108 cycles and leveled off at approximately 1% loss. In the partially and fully submerged samples, the mass-loss was at least 0.7% after the first 36 cycles.

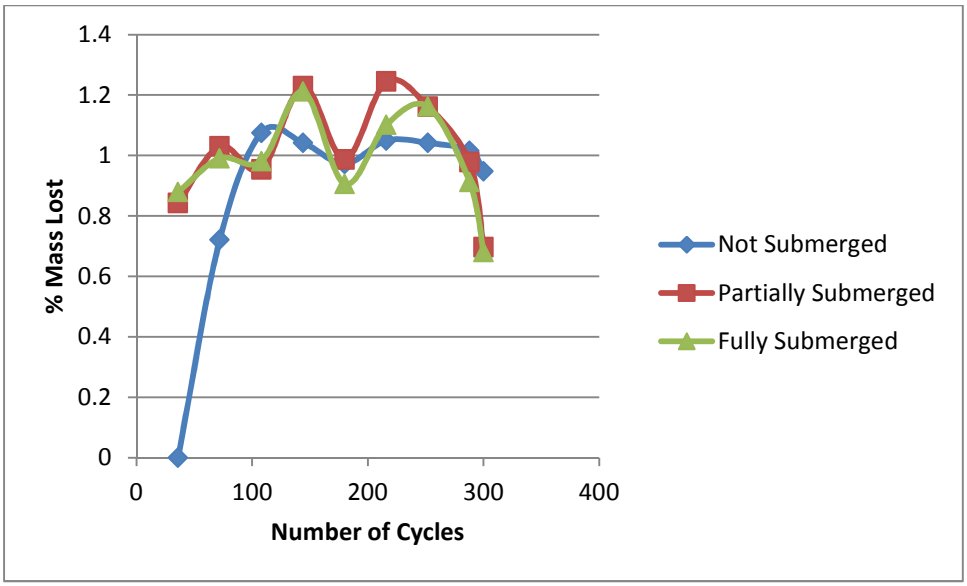

Figure 36: PRM mix freeze-thaw %-mass-loss (no fibers)

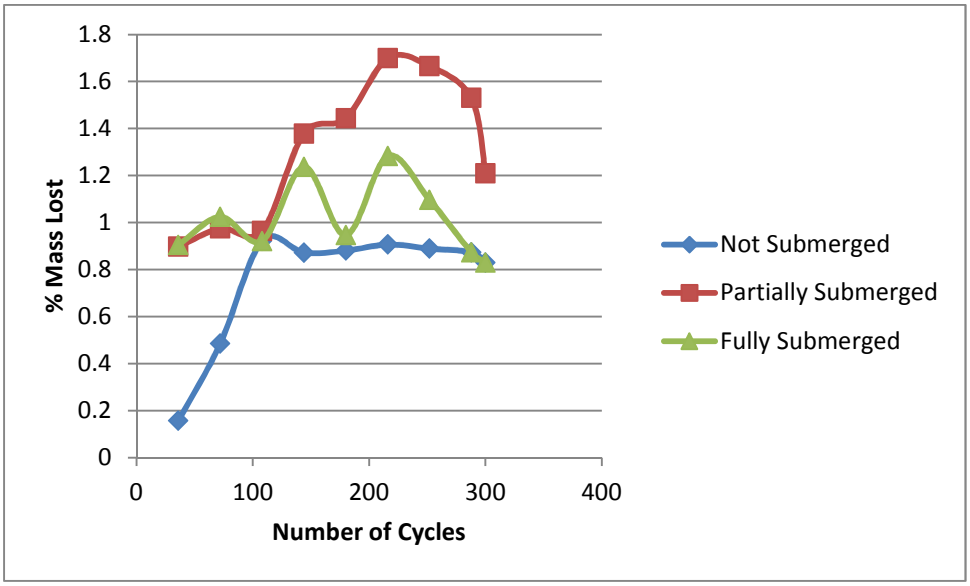

Figure 37: PRM mix freeze-thaw %-mass-loss (Nycon fibers)

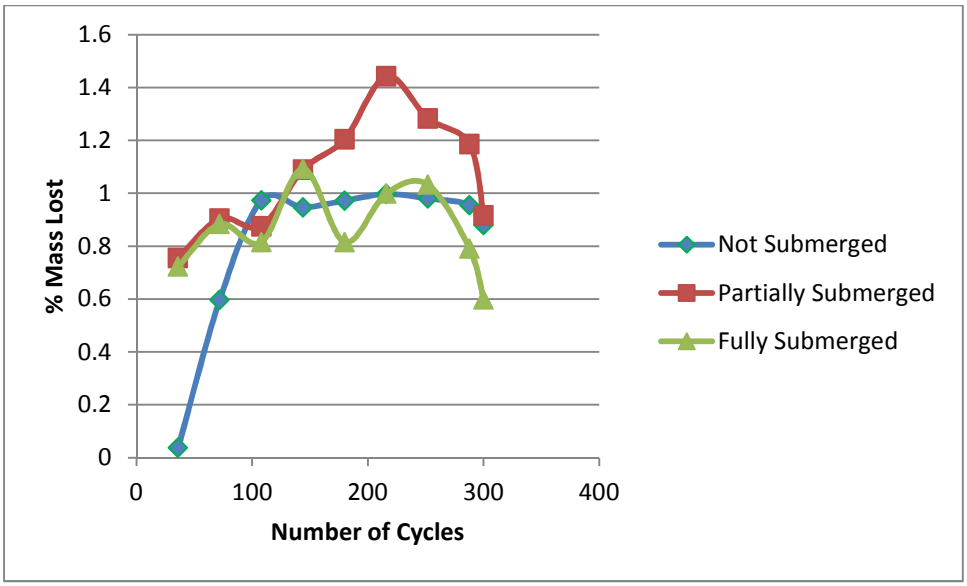

Figure 38: PRM mix freeze-thaw %-mass-loss (Procon fibers)

Table 7: PRM summary of average freeze-thaw %-mass-loss

	Unsubmerged	Partially Submerged	Fully Submerged
No Fibers %-Mass-Loss	0.95	0.70	0.68
Nycon %-Mass-Loss	0.83	1.21	0.83
Procon %-Mass-Loss	0.88	0.92	0.60
Average of Averages	**0.89**	**0.94**	**0.70**

The test results show small positive and negative (typically ±0.1 to 0.3%) lost mass over 36 freeze-thaw cycles (see Figures 36 to 38). The differences are not significant and appear to be related to variations in the saturated surface dry conditions in the porous concrete and cylindrical molds.

Using mass-loss as a measure of freeze-thaw durability, the 50-50 PRM design performed extremely well. After 300 cycles, the average mass-loss ranged between 0.7 to 1.2% (see Table 7). The fully submerged samples consistently showed the lowest

mass-loss. The presence of fiber reinforcement had no effect on increasing the porous concrete freeze-thaw durability.

After 300 freeze-thaw cycles, the mass-loss in the PRM samples was significantly less than in the 6.8 bag scoria mix (see Table 4) Moreover, the mass-loss in the scoria mix was approximately 11% whereas the overall loss in the PRM concrete was less than 1%.

In Figures 39 to 41, the mass-loss test results are grouped by immersion test conditions. In each case, the pattern of mass-loss is similar for the unreinforced and fiber-reinforced mixes. The highest mass-loss occurs in the first 36 to 108 freeze-thaw cycles and tends to level off with small positive and negative fluctuations during subsequent cycles.

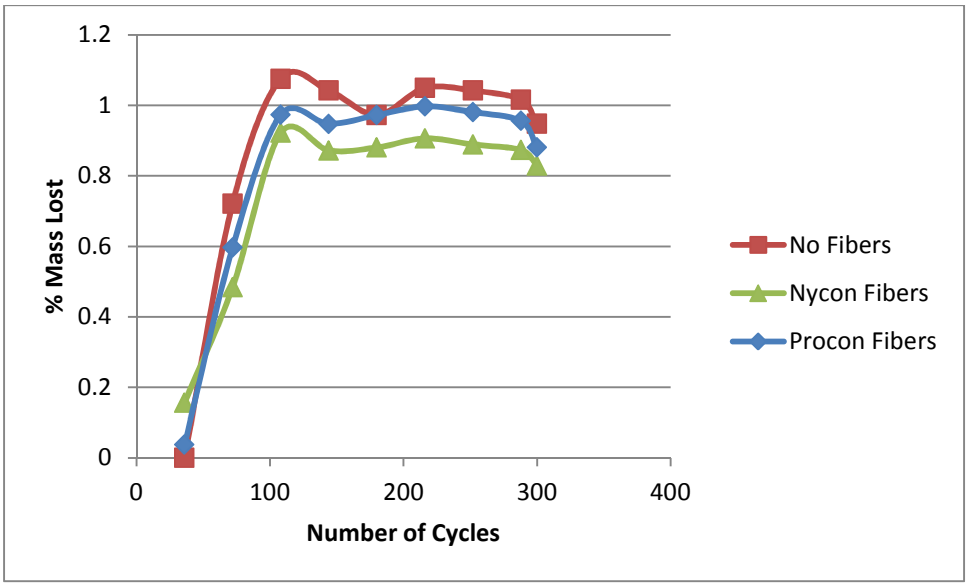

Figure 39: PRM mix freeze-thaw %-mass-loss (unsubmerged)

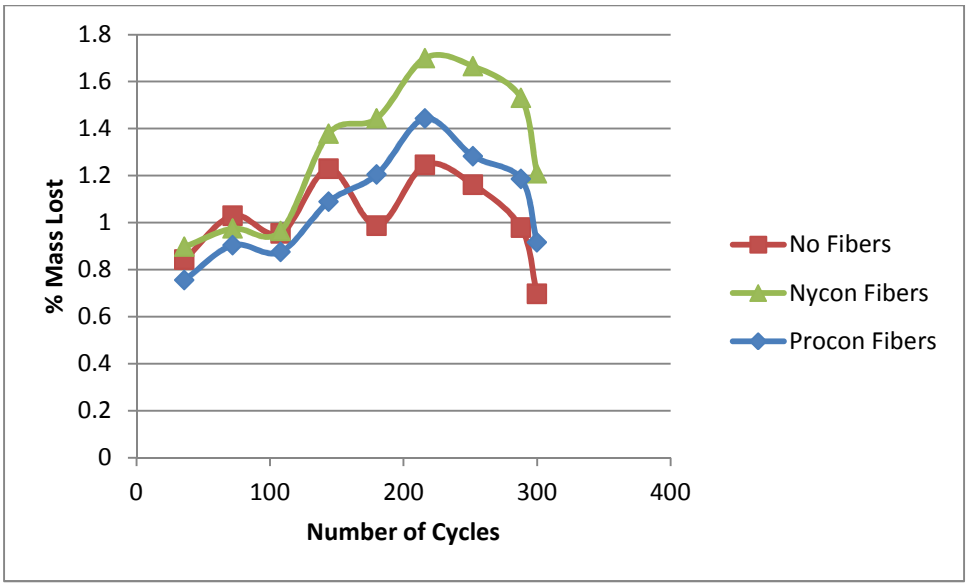

Figure 40: PRM mix freeze-thaw %-mass-loss (partially submerged)

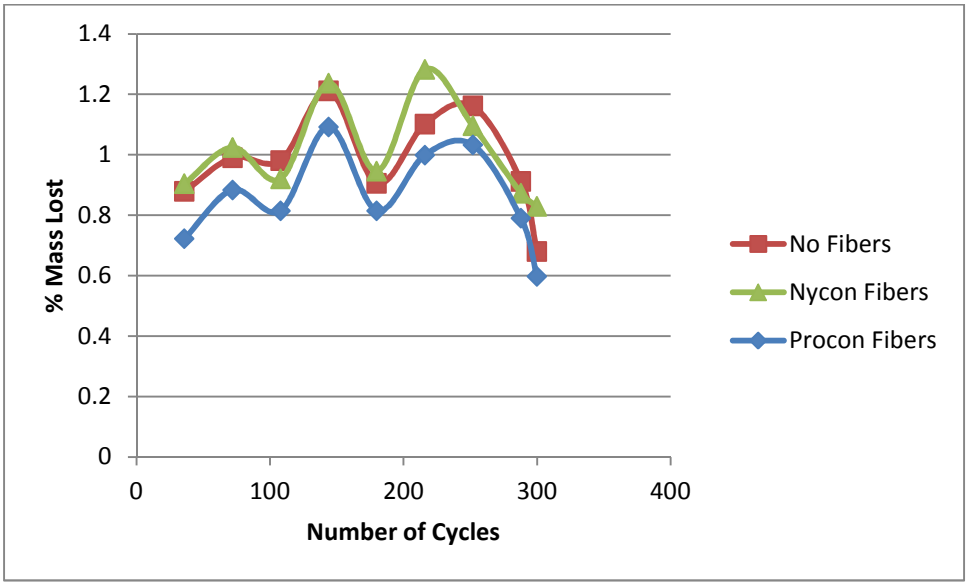

Figure 41: PRM mix freeze-thaw %-mass-loss (fully submerged)

Unconfined compressive strength tests (ASTM C39, 2012) and Brazil split tensile tests (ASTM C496, 2011) were performed on samples of the PRM porous concrete after

300 freeze-thaw cycles. The test results are provided in Figures 42 to 44 and are summarized in Tables 9 and 10. No unconfined compressive strength tests were performed on the fully submerged unreinforced and Nycon fiber-reinforced mixes. The samples broke during extraction from the cylindrical molds and could not be tested in compression. The control samples were not subjected to the freeze-thaw cycles and were tested 150 days after they were cast. The increased curing time explains the difference in compressive strength between the freeze-thaw control samples (1155 to 1200 psi) and the 28-day strengths (524 psi) of the samples tested in the initial mix design trials (see Table 3).

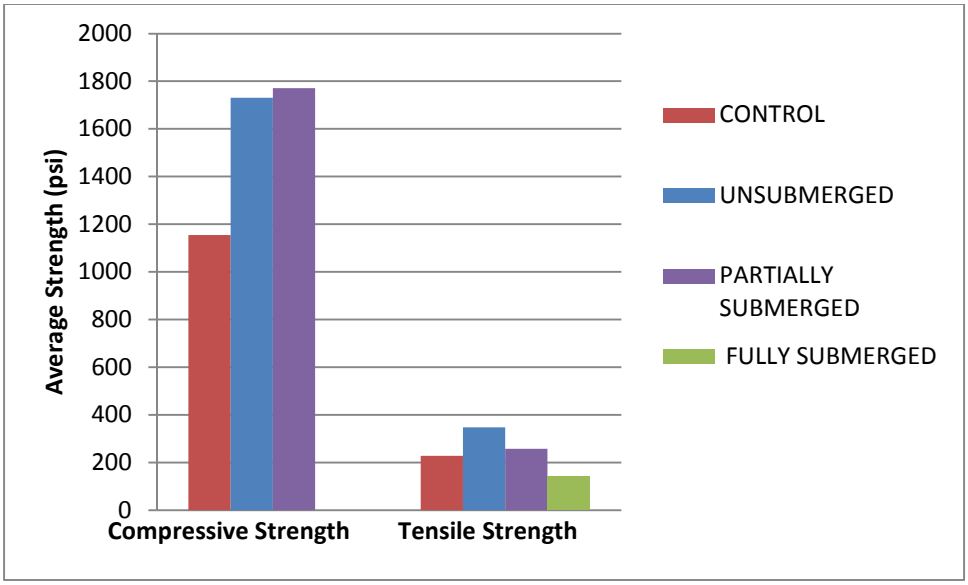

Figure 42: PRM mix strength test results (no fibers)

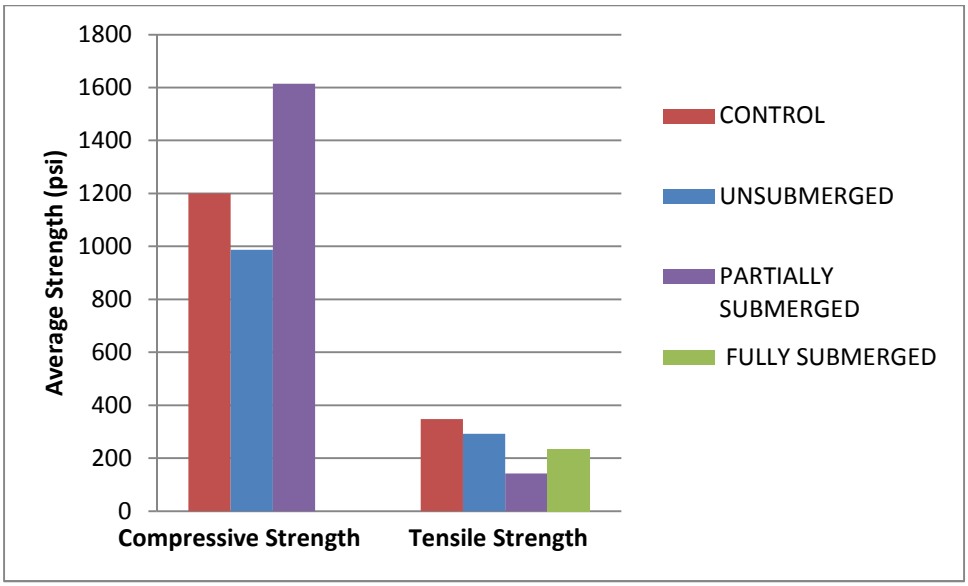

Figure 43: PRM mix strength test results (Nycon fibers)

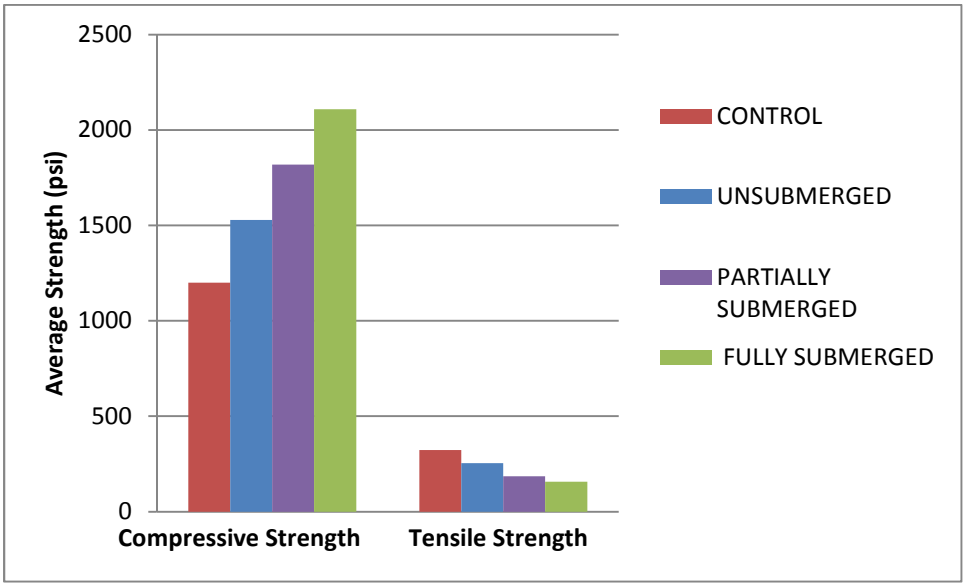

Figure 44: PRM mix strength test results (Procon fibers)

The histograms of compressive and tensile strength are the average values at the end of the freeze-thaw cycles. In all but one test (see Figure 43 and Table 8) the average compressive strength of the samples was higher than the control samples which were not

subjected to freeze-thaw stress conditions. The strength gain ranged from 200 to 900 psi and was highest in the one fully submerged sample (see Figure 44). The strength increase was likely related to increased hydration in the presence of moisture during immersion and/or in the freeze-thaw chamber which overcame any potential negative effects of the freeze-thaw cycles.

The impact of fiber reinforcement on the compressive strength of the PRM porous concrete is graphically illustrated in Figures 45 to 47. The test results show no beneficial effect of fiber-reinforcement, and in the samples with Nycon fibers, a likely detrimental effect on the compressive strength of the PRM design with and without cyclic freeze-thaw loading conditions (see Table 8).

Table 8: PRM mix average compressive strength test results and %-strength lost/gained

	Control	Unsubmerged	Partially Submerged	Fully Submerged
No Fibers Compressive Strength (psi)	1155	1731 (+50%)	1771 (+53%)	Sample Broke
Nycon Compressive Strength (psi)	1200	987 (-18%)	1614 (+35%)	Sample Broke
Procon Compressive Strength (psi)	1200	1529 (+27%)	1819 (+52%)	2108 (+76%)

The effect of the Nycon and Procon fibers on the splitting tensile strength of the PRM design is illustrated in Figures 45 to 47 and in Table 9. In the control group, the fibers increased splitting strength by 42 and 53%. The results of the freeze-thaw tests show a reduction in the splitting strength of the PRM porous concrete (15 to 44%) with the addition of fibers in unsubmerged and partially submerged conditions. In the fully submerged samples, the addition of the fibers increased the splitting strength by 11 and 65%. The highest splitting strength gain was in the PRM 50-50 mix with the Nycon

fibers. Additional tests are needed to verify the effects of the fibers on increasing the splitting strength of fully submerged porous concrete subjected to freeze-thaw cycles.

Table 9: PRM mix average tensile strength test results and %-strength lost/gained

	Control	Unsubmerged	Partially Submerged	Fully Submerged
No Fibers Tensile Strength (psi)	227	348 (+53%)	257 (+13%)	142 (-37%)
Nycon Tensile Strength (psi)	348	293 (-16%)	143 (-59%)	234 (-33%)
Procon Tensile Strength (psi)	323	255 (-21%)	186 (-42%)	157 (-51%)

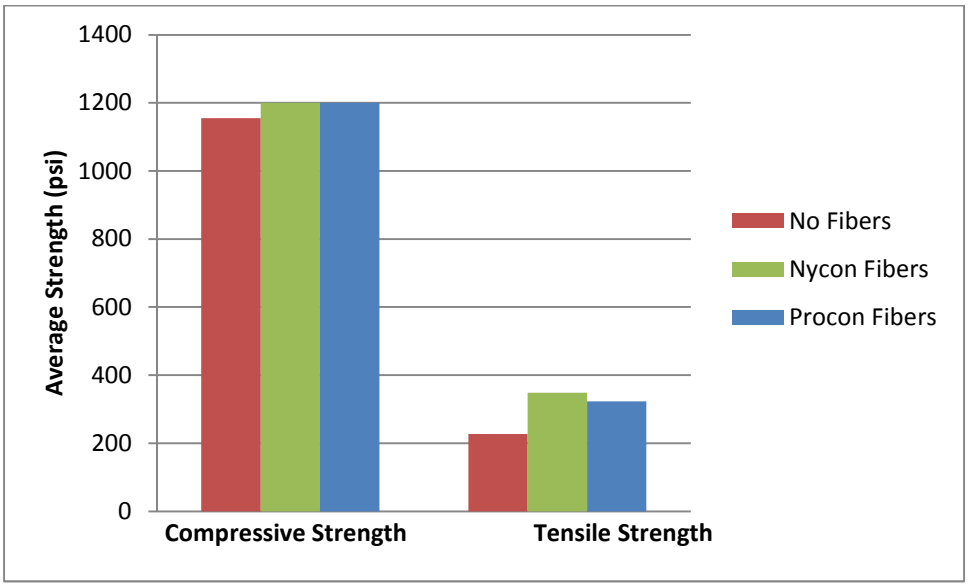

Figure 45: PRM mix strength test results (control group)

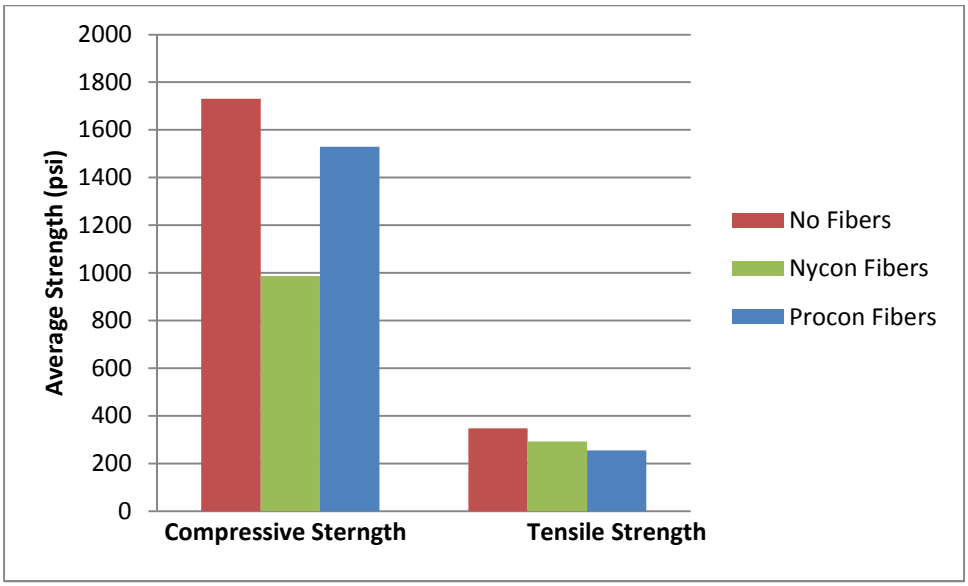

Figure 46: PRM mix strength test results (unsubmerged) on samples subjected to 300 freeze-thaw cycles

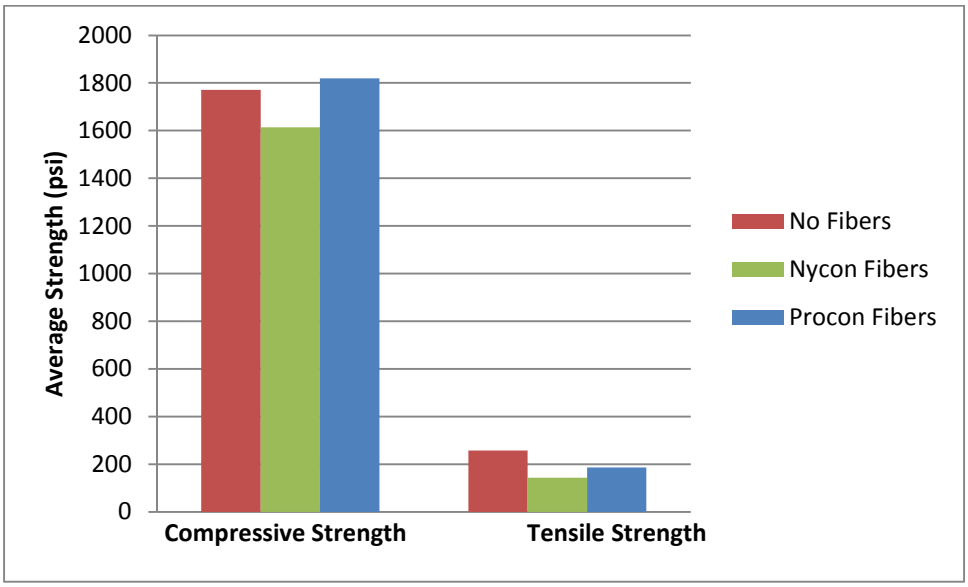

Figure 47: PRM mix strength test results (partially submerged) on samples subjected to 300 freeze-thaw cycles

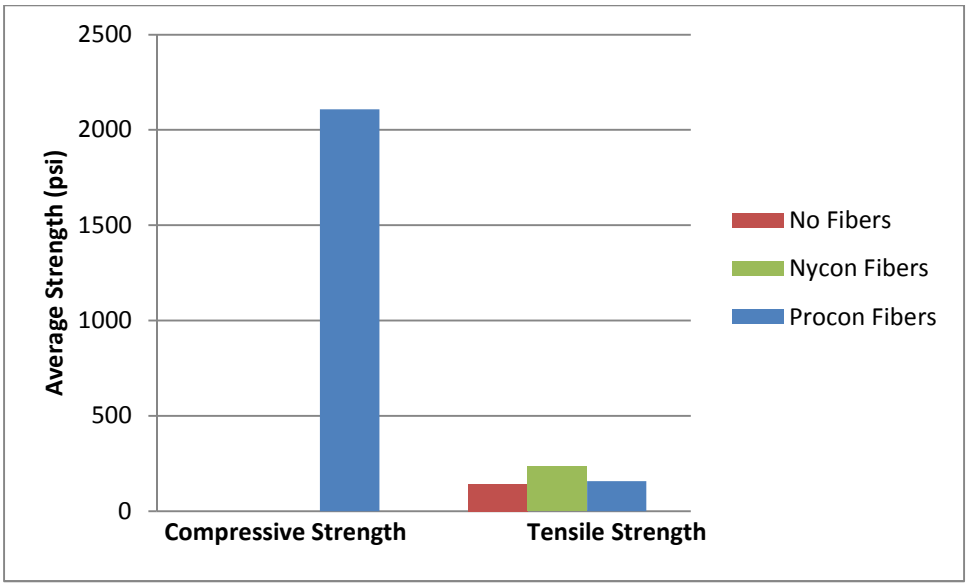

Figure 48: PRM mix strength test results (fully submerged) on samples subjected to 300 freeze-thaw cycles

Freeze-Thaw Durability of Garrison Hall Test Slab

The cores taken from the Garrison Hall slab were also subjected to freeze-thaw cycles. The mass-loss during the tests is given in Figure 49.

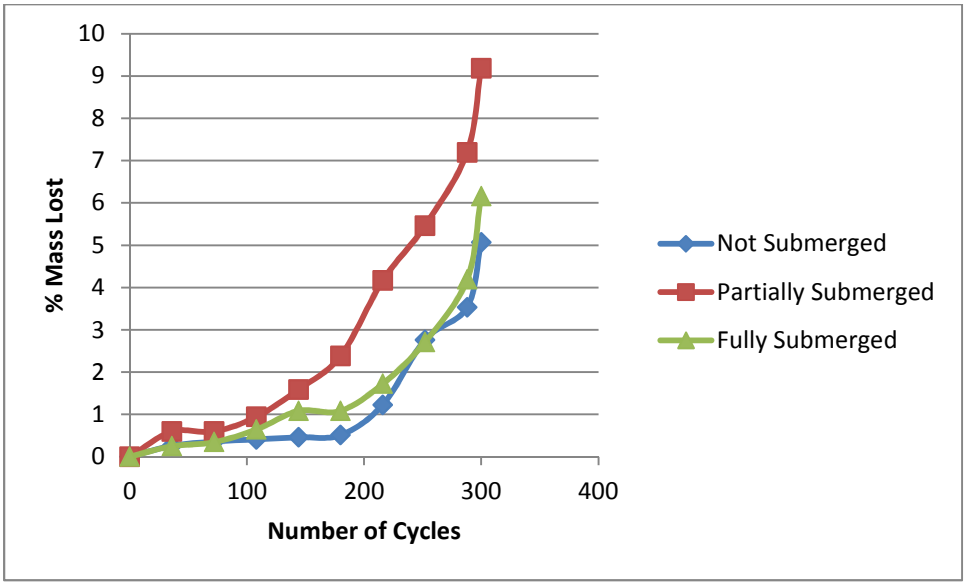

Figure 49: Garrison Hall mix freeze-thaw %-mass-loss test results

The three core samples taken from the Garrison Hall test slab were not confined during the freeze-thaw tests. The cores showed a somewhat linear relationship between mass-loss and number of cycles up to 144 to 180 cycles. Above these threshold values, the rate of mass lost accelerated and reached 5 to 9.2% at 300 cycles (see Figure 49). The greatest loss occurred in the partially submerged sample. The samples were very fragile and pieces of concrete would spall off the surface of the cores as the mass measurements were taken. No unconfined compression or Brazil split tests could be performed on the Garrison Hall samples at the end of the 300 freeze-thaw cycles. The ends of the core samples were not close to tolerance to perform the compression tests and the cores crumbled during preparation for the splitting tests.

The behavior of the unconfined Garrison Hall cores during the freeze-thaw tests is in sharp contrast to the mold-confined PRM samples cast in the laboratory subjected to essentially the same freeze-thaw conditions. In the Garrison Hall cores, the loss of mass continued to increase with each set of 36 cycles whereas the mass-loss in the confined PRM samples increased during the first 36 cycles and then basically leveled off during the remaining cycles. Similar breakdown of unconfined porous concrete slabs have been observed in the Pocatello area.

Maintenance/Infiltration Test

The ACI recommends that porous concrete be maintained every six to eight months (ACI, 2010). This is done by cleaning the slab. Several methods of cleaning porous concrete were tested on the Garrison Hall slab. These included sweeping the surface with a stiff bristle broom without wetting, sweeping the surface after wetting with

the same stiff bristle broom, and then simply pressure washing the surface. After each method, infiltration tests were performed by introducing a known amount of water and then taking depth measurements with corresponding times. The tests were initially done, and then repeated one year later to try and see how the slab is continuing to perform. The results of these infiltration tests can be seen in Figures 50, 51, 52, and 53.

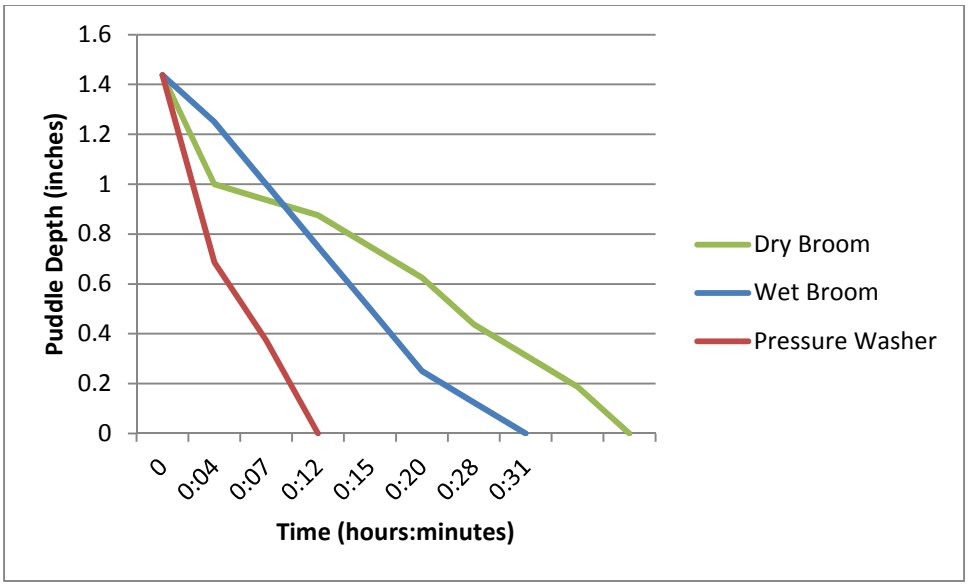

Figure 50: Infiltration maintenance tests performed June 9, 2012

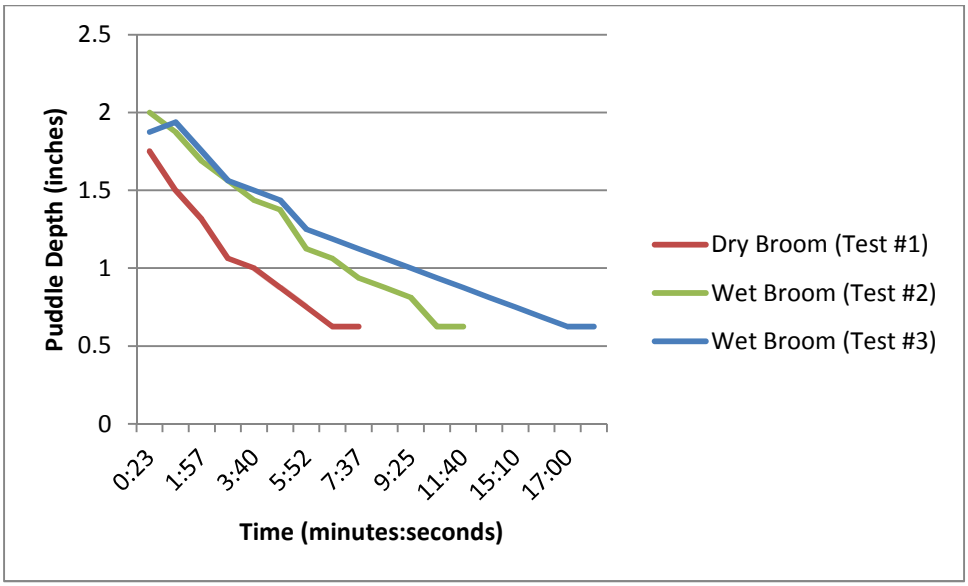

Figure 51: Maintenance infiltration tests (dry broom and wet broom) performed June 11, 2013

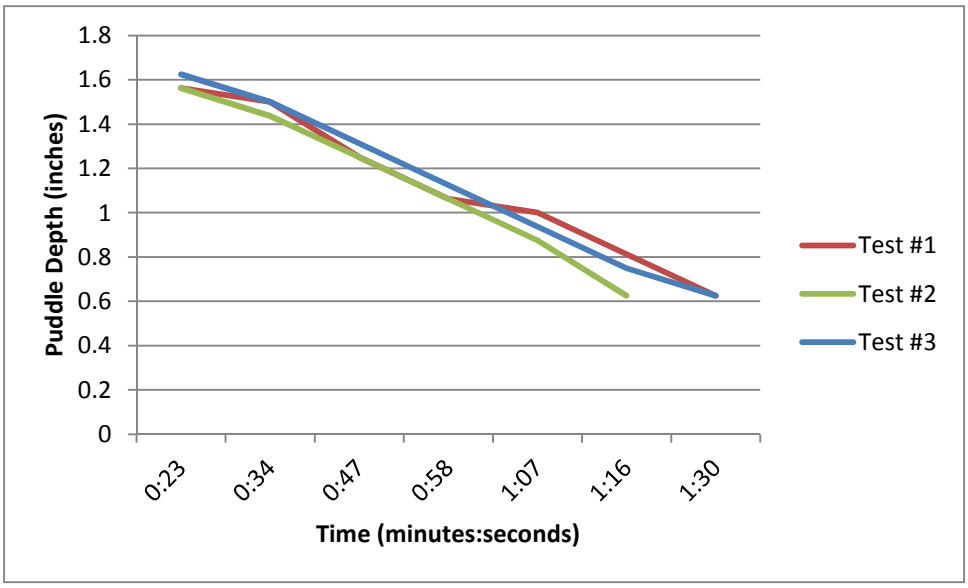

Figure 52: Maintenance infiltration tests (pressure washer) performed June 11, 2013

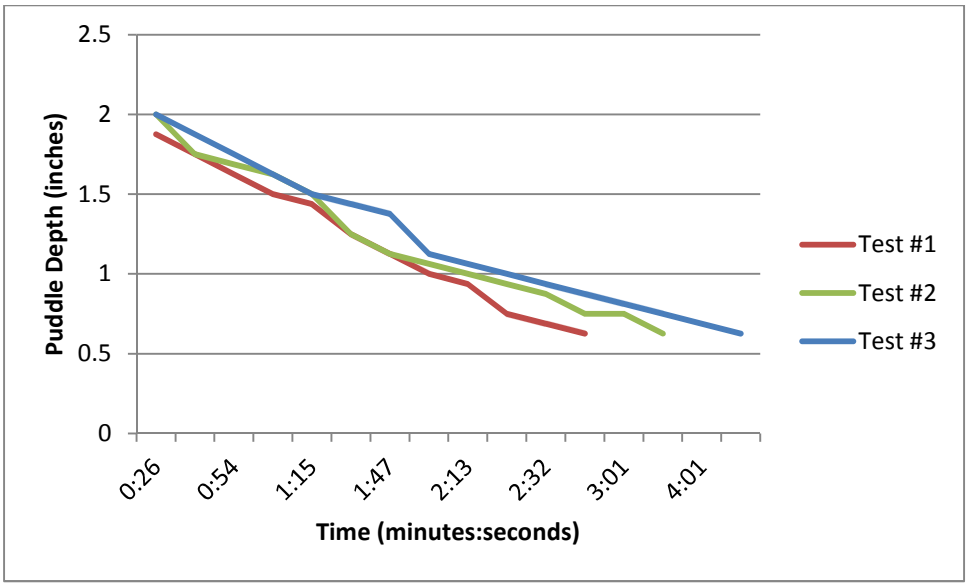

Figure 53: Maintenance infiltration tests (pressure washer) performed July 23, 2013

A surface overlay of epoxy resin was applied to the test slab. According to the manufacturer, the purpose of the resin is to reduce the maintenance requirements in porous concrete applications. The overlay was placed on the section of the slab closest to the curb where the surface water flows during rainfall or sprinkler events. The results of the infiltration tests are given in Figures 54 and 55.

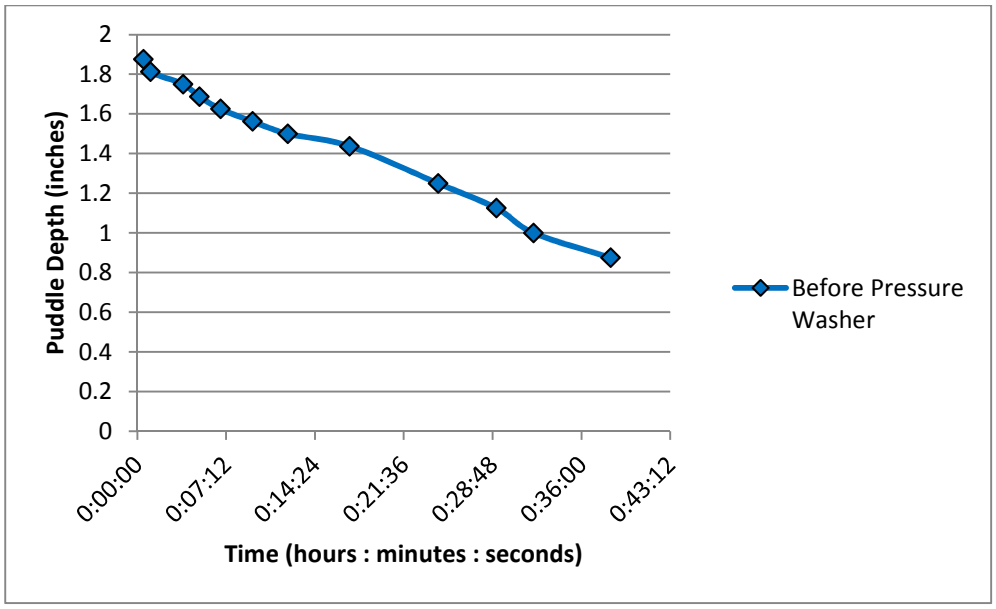

Figure 54: Maintenance infiltration test after the application of PC Grout and before pressure washing the test slab surface

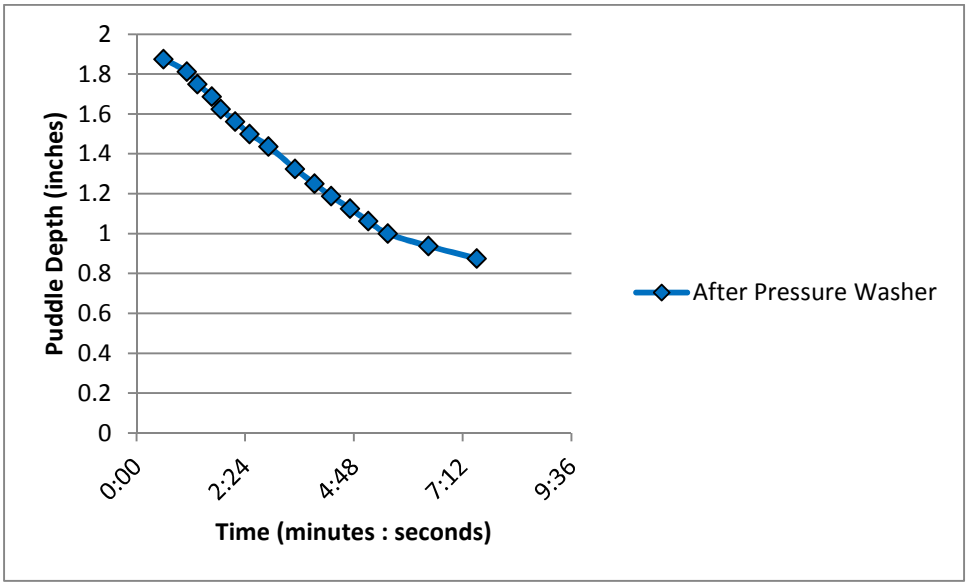

Figure 55: Maintenance infiltration test after the application of PC Grout and after pressure washing the surface

The first test was carried out after the overlay hardened, but without pressure washing the surface (Figure 54). The time needed to lower the water level from 1.6 to

0.8 inches was approximately 36 minutes. After the surface was pressure washed, the time to lower the water to 0.8 inches at the same head was roughly 6 minutes (Figure 55). Once again, pressure washing is very important in maintaining the high infiltration rate of porous concrete.

The application of the resin grout onto the surface of the porous concrete significantly reduced its surface water infiltration. In the absence of the resin, the surface water droppe4d from 1.6 to 0.8 inches in less than 90 seconds (figure 52) compared with 6 minutes when the surface was coated (Figure 55). Any beneficial effect of the resin on reduced maintenance could not be determined because of the relatively short time period between the non-resin and resin coated tests.

Discussion

Both the scoria and the PRM porous concrete performed very well when subjected to confined freeze-thaw cycles. The key to successful performance is the confinement, which was simulated by confining the samples in the plastic molds. The confined samples not only survived 300 freeze-thaw cycles in adverse moisture conditions, but also retained at least 65% of their unconfined compressive strength. Nearly all of the PRM samples gained strength in the freeze-thaw tests because additional water was available to facilitate hydration.

Without the confinement provided by the molds, the samples would have failed. Such was the case of the core samples taken from the Garrison hall test slat. At the end of 300 freeze-thaw cycles, the mass-loss was 6 to 9% and the porous concrete had essentially no unconfined compressive strength.

The Garrison Hall slab is continuing to perform well, and providing a means to reduce surface runoff and increase groundwater infiltration. However, it is important to perform periodic maintenance on a regular basis, or the water will tend to pond on the porous concrete surface. It is proposed that the existing design for porous concrete drainage be modified to improve the infiltration characteristics and implement bioswale best management practices.

Proposed Conceptual Design

The test slab placed in the Garrison Hall parking lot was an outgrowth of a senior design project. The site was selected in a driveway entrance where the pavement was badly damaged and water ponded on the surface. In addition, the test slab is located immediately southeast of a loading dock serviced by tractor trailer vehicles.

The fundamental concept was to cast a 6 inch thick porous concrete slab above 18 inch thick scoria base course (Figure 56). The loess beneath the scoria was stabilized using a lime/fly ash additive. Any surface water reaching the subgrade was conveyed laterally to a scoria leach filed where it would infiltrate into the native soil.

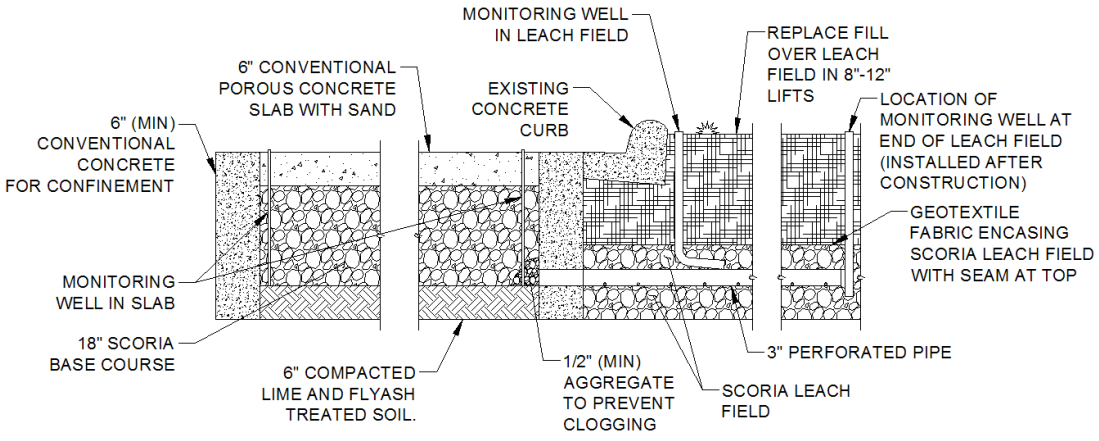

Figure 56: Garrison Hall porous concrete test slab at Idaho State University

During the study, numerous trips were made to observe the performance of the test slab after a rainfall or sprinkler event. In many cases, the surface runoff would overtop the porous concrete slab and flow into lower areas adjacent to the test slab. At the end of the runoff event, water would pond along the interface between the conventional concrete curb and the porous concrete slab. The reasons for ponding of the water were accumulations of soil and grass which plugged the porous concrete and the lack of infiltration through the curb. The rate of infiltration increased significantly where the scoria mix was used to backfill the core holes drilled in the original PRM porous concrete slab.

To improve the performance and to enhance the bioremediation properties of a porous concrete system, the Garrison Hall design should be modified to improve infiltration and to incorporate a bioswale above the leach field (Figure 57). The conventional porous concrete slab should be replaced with the 6.8-bag scoria porous concrete mix, which has a higher permeability and porosity. In order to more effectively drain the interface area, the scoria porous concrete mix should extend into the gutter and conventional concrete cast to form the curb and the lateral wall confinement. The remainder of the porous concrete system in the pavement area, including the scoria leach field, would be retained. The leach field was designed to hold runoff from a 50-year storm event and would not overflow until more than 2½ inches of rain falls on the parking lot/driveway area. The porous concrete surfaces should be pressure washed a minimum of three times during the March to October period.

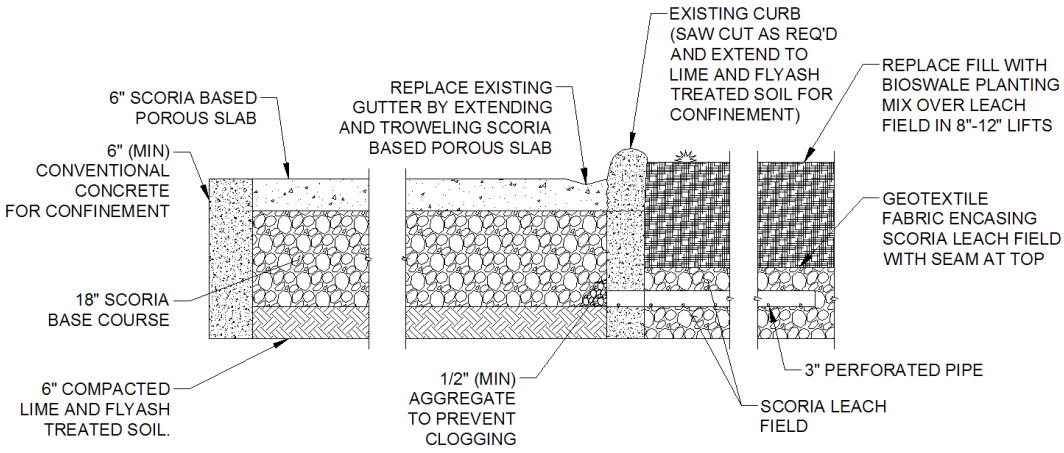

Figure 57: Proposed conceptual porous concrete system design

The scoria base course and leach field have pore spaces which can sequester contaminants such as petroleum based products. In order to increase the contaminant retention of the system, the native soil backfill above the leach field should be replaced by a bioswale (Figure 57). The bioswale should be designed to sequester, or if possible, degrade the contaminants.

CHAPTER 5 – Conclusion

Summary

This study is a comprehensive investigation on the use of scoria aggregate in porous concrete. The intent was to develop mix designs based on engineering properties determined from laboratory tests, make engineering comparisons with conventional aggregate porous concrete and monitor the performance of a conventional porous concrete test slab constructed in a heavily trafficked driveway on the ISU campus.

Some of the main concerns, even with the use of conventional aggregate in temperate regions, are strength, infiltration and freeze-thaw durability of porous concrete. The performance concerns are heightened when scoria is used in porous concrete because the individual particles contain pores (vugs) surrounded by a thin skeletal structure. The mix designs for scoria porous concrete were developed using only the coarse aggregate size fraction (1/2-inch nominal size) which was held constant (1550 lbs) and increasing the cement content. The water/cement ratio was also held constant. Laboratory dry unit weight, porosity and unconfined compressive strength were the engineering parameters used to evaluate the mix designs. The results of the mix design studies are summarized in Tables 10 and 11. At least three specimens were cast for each mix.

Table 10: Comparison of conventional aggregate and scoria aggregate porous concrete

Mix	Nominal Coarse Aggregate		Cement/Fly Ash Weight		Water/Cement Ratio	Average Unit Weight (lb/ft^3)
	Size (in)	Weight (lbs)	Cement (lbs)	Fly Ash (lbs)		
3/4" PRM	3/4	2693	451	114	0.27	98.2
3/8" PRM	3/8	2693	451	114	0.27	93.1
50-50 PRM	3/4 & 3/8	2693	451	114	0.27	102.8
6.8-Bag Scoria Mix	1/2	1550	648	0	0.40	77

Table 11: Comparison of conventional aggregate and scoria aggregate porous concrete

Mix	Average Porosity (%)	Average Unconfined Compressive Strength (psi)		Freeze-Thaw Durability		
				Average Mass Lost (%)	Average Unconfined Compressive Strength	
		7-Day	28-day		Control (psi)	300 Cycles (psi)
3/4" PRM	35.4	355	420	-----	-----	-----
3/8" PRM	37.2	250	320	-----	-----	-----
50-50 PRM	31.1	330	510	0.77	1150	1730
6.8-Bag Scoria Mix	27.9	380	720	10.5	652	423

Freeze-thaw durability tests were performed on both the 6.8-bag scoria aggregate porous concrete mix and the 50-50 conventional aggregate mix. The samples were subjected to 300 freeze-thaw cycles in a temperature controlled Canon freeze-thaw chamber. The samples were placed in three conditions of saturation: unsubmerged, partially submerged and fully submerged. The tests were carried out in general

accordance with ASTM C666 (2008), except that all of the samples were retained in the cylindrical portion of their plastic molds to simulate confinement needed for its long-term performance. Weight (mass) loss was recorded at the end of each 36-freeze-thaw interval and the unconfined compressive strength measured at the end of the 300 cycles.

Engineering property tests were also performed on plastic fiber reinforced porous concrete on both aggregate types to determine if the addition of fiber reinforcement improved the strength of the samples. The results showed that there was no benefit from the addition of the two different fiber types. In fact in some cases, the strength was decreased because of the addition of the fiber reinforcement.

The scope of this project also included the monitoring of the Garrison Hall test slab that was poured in October 2010. Infiltration, water levels, and settlement were monitored for nearly two years. Maintenance techniques were also tested to optimize the performance of the porous concrete slab.

Conclusions

The engineering property tests on the scoria aggregate porous concrete show the most suitable mix design has an aggregate/cement ratio of 2.4:1 by weight (6.8-bag scoria mix). The sam0ples showed no visible evidence of shrinkage in the molds even though the cement content is at or close to the limit for conventional concrete. The reduction in porosity from 45 to 28% at the higher cement content had no visible effect on the infiltration rate when the samples were filled with water. In the absence of fine aggregate, the cement content has to be sufficiently high to coat the particles and bond the twin skeletal structure of the grains without filling all the pores. The average 7-day

and 28-day unconfined compressive strength of the scoria aggregate porous concrete was 380 and 720 psi, respectively (see Table 11).

In the freeze-thaw tests, the confined samples of unreinforced scoria porous concrete had a final mass loss of 10 to 12% after 300 cycles. The loss of mass typically ramped up and then tended to level off between 100 and 170 freeze-thaw cycles.

Both the scoria and conventional aggregate porous concrete mixes had better freeze-thaw durability performance than previous conventional aggregate porous concrete mixes reported in the literature. Based on ASTM (2010) none of the porous concrete in other freeze-thaw tests survived more than 16 to 25 cycles, and lost up to 25% of their original mass. The difference appears to be related to the modified testing procedures presented in this paper: the porous concrete samples were confined by the plastic molds. Based on the test results and field investigations, boundary confinement is key in the successful performance of porous concrete.

As for the Garrison Hall slab, it is still performing well. It is showing little to no signs of settlement on the slab and around the leach field. Since the scoria mix replacement cores were put in place, the slab drains much more effectively. The evidence of their presence can be seen through the PC Grout maintenance product by grass and sediment buildups that are visible. The sample cores were able to endure all 300 freeze-thaw cycles without losing more than the recommended 25% mass (ASTM, 2008), but in the end were much too fragile to have destructive tests performed. This reaffirms that confinement is necessary. All the samples that had confinement were able to last the entire freeze-thaw test period and have destructive tests performed. The Garrison Hall

slab continues to perform well and shows little to no sign of weakening from the harsh Idaho winters.

It was found that using a pressure washer is an effective method of maintaining porous concrete. The pressure washer can break up sediment that clog the pores and pushes it through the slab. After the PC Grout maintenance product was applied, infiltration rates were tested again. The results showed that infiltration was still slowed down. This became apparent after pressure washing the surface and observing a much quicker time to complete the infiltration test. PC Grout is a good product, but it seems that the maintenance is not really reduced.

During the preliminary exploration into a suitable mix design, the scoria mix that was chosen showed the highest 7-day and 28-day compressive strengths when compared to the other mixes. After both mix designs were subjected to the freeze-thaw cycles, it was easily seen that the PRM mix design had the highest strengths. However, these strengths are based on the unconfined condition, which is much different than that at the Garrison Hall test slab. Since the confinement is achieved with the conventional concrete that surrounds the Garrison Hall system, and the fact that the scoria aggregate has petroleum contaminant retaining capabilities, it is concluded that the scoria mix design should be used in the system. It will help to both improve the water treatment of runoff and to reduce construction costs by eliminating an item from the materials list since it is being used as the base course.

The non-corrosive reinforcing fibers didn't do much for improving the strength properties of the two mix designs from this study. In the case of the scoria mix design, the tensile strength was virtually the same for unreinforced and reinforced samples. The

compressive strength was actually reduced when there were fibers present in the sample being crushed. The same goes for the PRM mix design. The fibers did not show any improvement in either the compressive or the tensile strength of the samples. If there was an improvement, it was unnoticeable.

All of the different submersion groups showed signs of freeze-thaw weakening when compared with the control group not subjected to the freeze-thaw cycles. Those that showed the greatest reduction of strength were those that were unsubmerged. This is most likely because of hydration reactions that result in stronger concrete. The groups that lost the most mass tended to be those that were only partially submerged. This is explained by the fact that water will expand as it freezes. Since there is space for the water to expand within the porous concrete sample, ice will begin to break the sample down. The fully submerged samples still lost notable masses, but since there was already water in the samples' pores, it only expanded up as the water would freeze.

Future Studies

More studies using this method or a modified method of subjecting porous concrete to freeze-thaw cycles should be carried out. Porous concrete is a relatively new building material that is quickly gaining popularity in the U.S., but the lack of standardized testing procedures is preventing it from progressing. Even Europe, where porous concrete began to gain popularity as a building material, does not have a testing standard for freeze-thaw weakening of porous concrete. The tests performed in this study do not have an ASTM standard; the standard for testing conventional concrete was sampled from to achieve consistency in the results.

The non-corrosive reinforcing fibers that were added to both mixes may need different mixing techniques applied to achieve strength improvement. Soaking some of the fibers before adding to the mix may help distribute them more evenly throughout the batch. Also adding some extra fibers may help improve strength since a lot of them would stick to the sides of the cement mixer when mixing for this study. Different lengths of fibers may need to be explored to better bridge the pores within the pervious concrete.

The proposed conceptual design should also be looked at. There is still ponding occurring on the Garrison Slab. It is suggested this low permeability slab be removed and replaced with the scoria mix from this study, while leaving the monitoring wells in place. It was observed that after the cores were taken from the slab and replaced with the scoria mix, the infiltration tests didn't take nearly as much time to drain. The ponding issue would be almost eliminated depending on the performance of the leach field that is already in place.

Other maintenance products could also be looked at to help reduce costs that are associated with porous concrete. The PC Grout product could be studied more in depth to better understand the product and back up some of the advantages that it boasts about.

The implementation of a bioswale for the porous drain could also be studied. Water quality comparisons could be conducted between the stormwater before entering the system with water samples that could be taken from the monitoring wells that are already in place. After time, scoria samples may be dug up to observe if the bioswale is in fact performing at its full potential in helping to extend the life of the slab.

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Appendix: Lab Data

Preliminary Mix Design Results

Garrison Hall Slab

9/19/2012

Sample 1			Sample 2			Sample 3 (rodded)		
Height =	11.875	inches	Height =	11.75	inches	Height =	12	inches
Dia =	6	inches	Dia =	6	inches	Dia =	6	inches
Weight (+mold) =	10395	grams	Weight (+mold) =	10269	grams	Weight (+mold) =	10592	grams
Weight mold =	260	grams	Weight mold =	260	grams	Weight mold =	260	grams
Total +Water =	11723	grams	Total +Water =	11466	grams	Total +Water =	12071	grams
Total Volume =	5502.083	cm^3	Total Volume =	5444.166	cm^3	Total Volume =	5560	cm^3
Total Volume =	335.7577	in^3	Total Volume =	332.2234	in^3	Total Volume =	339.292	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	1328	cm^3	Volume Water =	1197	cm^3	Volume Water =	1479	cm^3
γ Concrete =	1.84203	gm/cm^3	γ Concrete =	1.838482	gm/cm^3	γ Concrete =	1.858273	gm/cm^3
γ Concrete =	114.9942	lb/ft^3	γ Concrete =	114.7727	lb/ft^3	γ Concrete =	116.0082	lb/ft^3
Volume Solids =	4174.083	cm^3	Volume Solids =	4247.166	cm^3	Volume Solids =	4081	cm^3
Porosity =	24.13631	%	Porosity =	21.98684	%	Porosity =	26.60072	%
Strength =	2403.593	psi	Strength =	2715.891	psi	Strength =	4416.727	psi
	24.24129							

3/4" PRM Mix Design 7-Day Compressive Strength

9/21/2012

Sample 1 (coarse)			Sample 2 (fine)			Sample 3 (fine)		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2640	grams	Weight (+mold) =	2799	grams	Weight (+mold) =	2825	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	3253	grams	Total +Water =	3349	grams	Total +Water =	3375	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	613	cm^3	Volume Water =	550	cm^3	Volume Water =	550	cm^3
γ Concrete =	1.521178	gm/cm^3	γ Concrete =	1.617693	gm/cm^3	γ Concrete =	1.633476	gm/cm^3
γ Concrete =	94.96405	lb/ft^3	γ Concrete =	100.9893	lb/ft^3	γ Concrete =	101.9746	lb/ft^3
Volume Solids =	1034.407	cm^3	Volume Solids =	1097.407	cm^3	Volume Solids =	1097.407	cm^3
Porosity =	37.20998	%	Porosity =	33.38579	%	Porosity =	33.38579	%
Strength =	265.7888	psi	Strength =	365.2606	psi	Strength =	448.8169	psi
	34.66052							

*NOTE: As cylinders were being crushed, small pieces would crumble at ~ 100psi slowly until the cylinder would fail with a loud crack.

3/4" PRM Mix Design 28-Day Compressive Strength

10/22/2012

Sample 1 (coarse)			Sample 2 (coarse)			Sample 3 (fine)		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2701	grams	Weight (+mold) =	2669	grams	Weight (+mold) =	2761	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	3306	grams	Total +Water =	3261	grams	Total +Water =	3346	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	605	cm^3	Volume Water =	592	cm^3	Volume Water =	585	cm^3
γ Concrete =	1.558206	gm/cm^3	γ Concrete =	1.538782	gm/cm^3	γ Concrete =	1.594627	gm/cm^3
γ Concrete =	97.27562	lb/ft^3	γ Concrete =	96.06299	lb/ft^3	γ Concrete =	99.5493	lb/ft^3
Volume Solids =	1042.407	cm^3	Volume Solids =	1055.407	cm^3	Volume Solids =	1062.407	cm^3
Porosity =	36.72437	%	Porosity =	35.93525	%	Porosity =	35.51034	%
Strength =	408.2324	psi	Strength =	374.0141	psi	Strength =	488.6057	psi
	36.05666							

*NOTE: As cylinders were being crushed, small pieces would crumble at ~100psi slowly until the cylinder would fail with a loud crack.

3/8" PRM Mix Design 7-Day Compressive Strength

10/8/2012

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2609	grams	Weight (+mold) =	2631	grams	Weight (+mold) =	2592	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	3238	grams	Total +Water =	3238	grams	Total +Water =	3206	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	629	cm^3	Volume Water =	607	cm^3	Volume Water =	614	cm^3
γ Concrete =	1.502361	gm/cm^3	γ Concrete =	1.515715	gm/cm^3	γ Concrete =	1.492041	gm/cm^3
γ Concrete =	93.78931	lb/ft^3	γ Concrete =	94.62299	lb/ft^3	γ Concrete =	93.1451	lb/ft^3
Volume Solids =	1018.407	cm^3	Volume Solids =	1040.407	cm^3	Volume Solids =	1033.407	cm^3
Porosity =	38.18121	%	Porosity =	36.84577	%	Porosity =	37.27068	%
Strength =	252.2606	psi	Strength =	253.0564	psi	Strength =	254.6479	psi

*NOTE: As cylinders were being crushed, small pieces would crumble at ~ 100psi slowly until the cylinder would fail with a loud crack.

3/8" PRM Mix Design 28-Day Compressive Strength

10/29/2012

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2549	grams	Weight (+mold) =	2578	grams	Weight (+mold) =	2653	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	3191	grams	Total +Water =	3206	grams	Total +Water =	3252	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	642	cm^3	Volume Water =	628	cm^3	Volume Water =	599	cm^3
γ Concrete =	1.46594	gm/cm^3	γ Concrete =	1.483543	gm/cm^3	γ Concrete =	1.529069	gm/cm^3
γ Concrete =	91.51563	lb/ft^3	γ Concrete =	92.61458	lb/ft^3	γ Concrete =	95.45668	lb/ft^3
Volume Solids =	1005.407	cm^3	Volume Solids =	1019.407	cm^3	Volume Solids =	1048.407	cm^3
Porosity =	38.97032	%	Porosity =	38.1205	%	Porosity =	36.36016	%
Strength =	288.8662	psi	Strength =	374.0141	psi	Strength =	342.9789	psi

*NOTE: As cylinders were being crushed, small pieces would crumble at ~ 100psi slowly until the cylinder would fail with a loud crack.

50-50 PRM Mix Design 7-Day Compressive Strength

1/23/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2822	grams	Weight (+mold) =	2834	grams	Weight (+mold) =	2851	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	3348	grams	Total +Water =	3361	grams	Total +Water =	3383	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	526	cm^3	Volume Water =	527	cm^3	Volume Water =	532	cm^3
γ Concrete =	1.631655	gm/cm^3	γ Concrete =	1.638939	gm/cm^3	γ Concrete =	1.649258	gm/cm^3
γ Concrete =	101.8609	lb/ft^3	γ Concrete =	102.3156	lb/ft^3	γ Concrete =	102.9598	lb/ft^3
Volume Solids =	1121.407	cm^3	Volume Solids =	1120.407	cm^3	Volume Solids =	1115.407	cm^3
Porosity =	31.92896	%	Porosity =	31.98966	%	Porosity =	32.29317	%
Strength =	361.2817	psi	Strength =	398.6831	psi	Strength =	231.5704	psi

*NOTE: As cylinders were being crushed, small pieces would crumble at ~ 100psi slowly until the cylinder would fail with a loud crack.

50-50 PRM Mix Design 28-Day Compressive Strength

1/23/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2969	grams	Weight (+mold) =	2740	grams	Weight (+mold) =	2816	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	3452	grams	Total +Water =	3293	grams	Total +Water =	3313	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	483	cm^3	Volume Water =	553	cm^3	Volume Water =	497	cm^3
γ Concrete =	1.720886	gm/cm^3	γ Concrete =	1.58188	gm/cm^3	γ Concrete =	1.628013	gm/cm^3
γ Concrete =	107.4314	lb/ft^3	γ Concrete =	98.75351	lb/ft^3	γ Concrete =	101.6335	lb/ft^3
Volume Solids =	1164.407	cm^3	Volume Solids =	1094.407	cm^3	Volume Solids =	1150.407	cm^3
Porosity =	29.3188	%	Porosity =	33.5679	%	Porosity =	30.16862	%
Strength =	535.5564	psi	Strength =	342.1831	psi	Strength =	693.9156	psi

*NOTE: As cylinders were being crushed, small pieces would crumble at ~ 100psi slowly until the cylinder would fail with a loud crack.

2.8-Bag Undergraduate Scoria-Based Mix Design 7-Day Compressive Strength

2/8/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	1561	grams	Weight (+mold) =	1610	grams	Weight (+mold) =	1571	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	2349	grams	Total +Water =	2379	grams	Total +Water =	2328	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	788	cm^3	Volume Water =	769	cm^3	Volume Water =	757	cm^3
γ Concrete =	0.86621	gm/cm^3	γ Concrete =	0.895953	gm/cm^3	γ Concrete =	0.87228	gm/cm^3
γ Concrete =	54.0757	lb/ft^3	γ Concrete =	55.93254	lb/ft^3	γ Concrete =	54.45464	lb/ft^3
Volume Solids =	859.4074	cm^3	Volume Solids =	878.4074	cm^3	Volume Solids =	890.4074	cm^3
Porosity =	47.83274	%	Porosity =	46.67941	%	Porosity =	45.95099	%
Strength =	0	psi	Strength =	0	psi	Strength =	0	psi

*NOTE: As cylinders were being taken from the mold, the cylinder would crumble before placing in crusher

2.8-Bag Undergraduate Scoria-Based Mix Design 28-Day Compressive Strength

3/1/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	1560	grams	Weight (+mold) =	1560	grams	Weight (+mold) =	1620	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	2310	grams	Total +Water =	2280	grams	Total +Water =	2320	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	750	cm^3	Volume Water =	720	cm^3	Volume Water =	700	cm^3
γ Concrete =	0.865603	gm/cm^3	γ Concrete =	0.865603	gm/cm^3	γ Concrete =	0.902023	gm/cm^3
γ Concrete =	54.0378	lb/ft^3	γ Concrete =	54.0378	lb/ft^3	γ Concrete =	56.31148	lb/ft^3
Volume Solids =	897.4074	cm^3	Volume Solids =	927.4074	cm^3	Volume Solids =	947.4074	cm^3
Porosity =	45.52608	%	Porosity =	43.70504	%	Porosity =	42.49101	%
Strength =	0	psi	Strength =	0	psi	Strength =	0	psi

*NOTE: As cylinders were being taken from the mold, the cylinder would crumble before placing in crusher

4.8-Bag Undergraduate Scoria-Based Mix Design 7-Day Compressive Strength

2/25/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	1794	grams	Weight (+mold) =	1873	grams	Weight (+mold) =	1879	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	2464	grams	Total +Water =	2517	grams	Total +Water =	2539	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	670	cm^3	Volume Water =	644	cm^3	Volume Water =	660	cm^3
γ Concrete =	1.007644	gm/cm^3	γ Concrete =	1.055598	gm/cm^3	γ Concrete =	1.05924	gm/cm^3
γ Concrete =	62.90515	lb/ft^3	γ Concrete =	65.89883	lb/ft^3	γ Concrete =	66.1262	lb/ft^3
Volume Solids =	977.4074	cm^3	Volume Solids =	1003.407	cm^3	Volume Solids =	987.4074	cm^3
Porosity =	40.66997	%	Porosity =	39.09173	%	Porosity =	40.06295	%
Strength =	107.4296	psi	Strength =	148.8099	psi	Strength =	113.7958	psi

*NOTE: As cylinders were being taken from the mold, the cylinder would crumble before placing in crusher

4.8-Bag Undergraduate Scoria-Based Mix Design 28-Day Compressive Strength

3/18/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	1780	grams	Weight (+mold) =	1759	grams	Weight (+mold) =	1834	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	2462	grams	Total +Water =	2439	grams	Total +Water =	2477	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	682	cm^3	Volume Water =	680	cm^3	Volume Water =	643	cm^3
γ Concrete =	0.999146	gm/cm^3	γ Concrete =	0.986398	gm/cm^3	γ Concrete =	1.031924	gm/cm^3
γ Concrete =	62.37463	lb/ft^3	γ Concrete =	61.57884	lb/ft^3	γ Concrete =	64.42094	lb/ft^3
Volume Solids =	965.4074	cm^3	Volume Solids =	967.4074	cm^3	Volume Solids =	1004.407	cm^3
Porosity =	41.39838	%	Porosity =	41.27698	%	Porosity =	39.03103	%
Strength =	226	psi	Strength =	148.0141	psi	Strength =	191.7817	psi

*NOTE: As cylinders were being taken from the mold, the cylinder would crumble before placing in crusher

6.8-Bag Undergraduate Scoria-Based Mix Design 7-Day Compressive Strength

2/8/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2210	grams	Weight (+mold) =	2040	grams	Weight (+mold) =	2231	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	2634	grams	Total +Water =	2576	grams	Total +Water =	2620	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	424	cm^3	Volume Water =	536	cm^3	Volume Water =	389	cm^3
γ Concrete =	1.260162	gm/cm^3	γ Concrete =	1.156969	gm/cm^3	γ Concrete =	1.272909	gm/cm^3
γ Concrete =	78.66934	lb/ft^3	γ Concrete =	72.22724	lb/ft^3	γ Concrete =	79.46513	lb/ft^3
Volume Solids =	1223.407	cm^3	Volume Solids =	1111.407	cm^3	Volume Solids =	1258.407	cm^3
Porosity =	25.73741	%	Porosity =	32.53597	%	Porosity =	23.61286	%
Strength =	393.9085	psi	Strength =	342.1831	psi	Strength =	406.6409	psi

*NOTE: As cylinders were being crushed, small pieces would crumble at ~ 100psi slowly until the cylinder would fail with a loud crack.
samples were damp for initial weigh

6.8-Bag Undergraduate Scoria-Based Mix Design 28-Day Compressive Strength

3/1/2013

Sample 1			Sample 2			Sample 3		
Height =	8	inches	Height =	8	inches	Height =	8	inches
Dia =	4	inches	Dia =	4	inches	Dia =	4	inches
Weight (+mold) =	2420	grams	Weight (+mold) =	2100	grams	Weight (+mold) =	1900	grams
Weight mold =	134	grams	Weight mold =	134	grams	Weight mold =	134	grams
Total +Water =	2720	grams	Total +Water =	2580	grams	Total +Water =	2500	grams
Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3	Total Volume =	1647.407	cm^3
Total Volume =	100.531	in^3	Total Volume =	100.531	in^3	Total Volume =	100.531	in^3
γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3	γ Water =	1	gm/cm^3
Volume Water =	300	cm^3	Volume Water =	480	cm^3	Volume Water =	600	cm^3
γ Concrete =	1.387635	gm/cm^3	γ Concrete =	1.19339	gm/cm^3	γ Concrete =	1.071987	gm/cm^3
γ Concrete =	86.62722	lb/ft^3	γ Concrete =	74.50092	lb/ft^3	γ Concrete =	66.92199	lb/ft^3
Volume Solids =	1347.407	cm^3	Volume Solids =	1167.407	cm^3	Volume Solids =	1047.407	cm^3
Porosity =	18.21043	%	Porosity =	29.13669	%	Porosity =	36.42086	%
Strength =	1063.951	psi	Strength =	689.9367	psi	Strength =	413.8029	psi

*NOTE: As cylinders were being crushed, small pieces would crumble at ~ 100psi slowly until the cylinder would fail with a loud crack.

samples were damp for initial weigh

Preliminary Mix Design Summary

AVERAGES								
	PRM (undisturbed) Garrison Hall Mix	PRM (rodded) Garrison Hall Mix	3/4" Aggregate Recreated Mix #1	3/8" Aggregate Recreated Mix #2	50% 3/8" & 50% 3/4" 50-50 Mix	PRM Scoria (3-bag) PRM Scoria-1	Kyle's Scoria Mix KJ Scoria-1	PRM Scoria (4.5-bag) PRM Scoria-1
7-Day Strength (psi)	--	--	359.96	253.32	330.51	0.00	380.91	123.35
28-Day Strength (psi)	2559.74	4416.73	423.62	335.29	523.89	0.00	722.56	188.60
Unit Weight (pcf)	114.88	116.01	98.47	93.52	102.49	54.81	76.40	63.88
Porosity (%)	23.06	26.60	35.36	37.62	31.28	45.36	27.61	40.26

INDIVIDUALS (Garrison Hall) Mix Date: October 2011			
	FS-1	FS-2	FS-3 (rodded)
7-Day Strength (psi)	--	--	--
28-Day Strength (psi)	2403.59	2715.89	4416.73
Unit Weight (pcf)	114.99	114.77	116.01
Porosity (%)	24.14	21.99	26.60

INDIVIDUALS (Recreated #1) Mix Date: 9/14/2012						
	LS1-1	LS1-2	LS1-3	LS1-4	LS1-5	LS1-6
7-Day Strength (psi)	265.79	365.26	448.82	--	--	--
28-Day Strength (psi)	--	--	--	408.23	374.01	488.61
Unit Weight (pcf)	94.96	100.99	101.97	97.28	96.06	99.55
Porosity (%)	37.21	33.39	33.39	36.72	35.94	35.51

INDIVIDUALS (Recreated #2) Mix Date: 10/1/2012						
	LS2-1	LS2-2	LS2-3	LS2-4	LS2-5	LS2-6
7-Day Strength (psi)	252.26	253.06	254.65	--	--	--
28-Day Strength (psi)	--	--	--	288.87	374.01	342.98
Unit Weight (pcf)	93.79	94.62	93.15	91.52	92.61	95.46
Porosity (%)	38.18	36.85	37.27	38.97	38.12	36.36

INDIVIDUALS (50-50 Mix) Mix Date: 1/16/2013						
	LS3-1	LS3-2	LS3-3	LS3-4	LS3-5	LS3-6
7-Day Strength (psi)	361.28	398.68	231.57	--	--	--
28-Day Strength (psi)	--	--	--	535.56	342.18	693.92
Unit Weight (pcf)	101.86	102.32	102.96	107.43	98.75	101.63
Porosity (%)	31.93	31.99	32.29	29.32	31.99	30.17

PRM Recreated w/ Scoria (PRM Scoria-1) Mix Date: 2/1/2013 (3-Bag Mix)						
	LS4-1	LS4-2	LS4-3	LS4-4	LS4-5	LS4-6
7-Day Strength (psi)	0.00	0.00	0.00	--	--	--
28-Day Strength (psi)	--	--	--	0.00	0.00	0.00
Unit Weight (pcf)	54.08	55.93	54.45	54.04	54.04	56.31
Porosity (%)	47.83	46.68	45.95	45.53	43.71	42.49

Kyle Jones Mix Design (KJ Scoria-1) Mix Date: 2/1/2013						
	LS5-1	LS5-2	LS5-3	LS5-4	LS5-5	LS5-6
7-Day Strength (psi)	393.91	342.18	406.64	--	--	--
28-Day Strength (psi)	--	--	--	1063.95	689.94	413.80
Unit Weight (pcf)	78.67	72.23	79.47	86.63	74.50	66.92
Porosity (%)	25.74	32.54	23.61	18.21	29.14	36.42

PRM Recreated w/ Scoria (PRM Scoria-2) Mix Date: 2/18/2013 (4.5 Bag Mix)						
	LS4-1	LS4-2	LS4-3	LS4-4	LS4-5	LS4-6
7-Day Strength (psi)	107.43	148.81	113.80	--	--	--
28-Day Strength (psi)	--	--	--	226.00	148.01	191.78
Unit Weight (pcf)	62.91	65.90	66.13	62.37	61.58	64.42
Porosity (%)	40.67	39.09	40.06	41.40	41.28	39.03

Scoria Mix with No Fibers

Control

4/5/2013 MIX DATE; 4/19/2013 INTO CHAMBER

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	2105 grams	Weight (+mold) =	2081 grams	Weight (+mold) =	2098 grams	Weight (+mold) =	2053 grams
Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams
Total +Water =	2621 grams	Total +Water =	2625 grams	Total +Water =	2600 grams	Total +Water =	2604 grams
Total Volume =	1647.4074 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3
Total Volume =	100.53096 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3
Volume Water =	516 cm^3	Volume Water =	544 cm^3	Volume Water =	502 cm^3	Volume Water =	551 cm^3
γ Concrete =	1.1933903 gm/cm^3	γ Concrete =	1.178822 gm/cm^3	γ Concrete =	1.189141 gm/cm^3	γ Concrete =	1.161826 gm/cm^3
γ Concrete =	74.500924 lb/ft^3	γ Concrete =	73.59145 lb/ft^3	γ Concrete =	74.23566 lb/ft^3	γ Concrete =	72.5304 lb/ft^3
Volume Solids =	1131.4074 cm^3	Volume Solids =	1103.407 cm^3	Volume Solids =	1145.407 cm^3	Volume Solids =	1096.407 cm^3
Porosity =	31.321943 %	Porosity =	33.02158 %	Porosity =	30.47212 %	Porosity =	33.44649 %

C = CONTROL (NO CHAMBER)
N = NO SUBMERSION
P = PARTIALLY SUBMERSED
F = FULLY SUBMERSED

0.3132194

AVG POROSITY = 33.46167

CONFINEMENT ACHIEVED BY CUTTING OFF BOTTOM OF PLASTIC CYLINDER WITH A DREMEL TOOL

4/26/2012 (After 36 cylcles)

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Weight mold =	131 grams	Weight mold =	126 grams	Weight mold =	128 grams	Weight mold =	129 grams
Original weight =	1966 grams	Original weight =	1942 grams	Original weight =	1959 grams	Original weight =	1914 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	20 grams	Mass lost =	0 grams
% lost =	0 %	% lost =	0 %	% lost =	1.020929 %	% lost =	0 %

5/5/2013 (After 72 cycles)

Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	-20 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	-1.02093 %	total % lost	0 %

5/12/2013 (After 108 cycles)

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	20 grams	Mass lost =	0 grams
total % lost =	0 %	total % lost =	0 %	total % lost =	1.020929 %	total % lost =	0 %

5/21/2013 (After 144 cycles)

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	-20 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	-1.02093 %	total % lost	0 %

5/28/2013 (After 180 cycles)

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	20 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	1.020929 %	total % lost	0 %

6/4/2013 **(After 216 cycles)**

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	-20 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	-1.02093 %	total % lost	0 %

6/11/2013 **(After 252 cycles)**

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	20 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	1.020929 %	total % lost	0 %

6/18/2013 **(After 288 cycles)**

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	-20 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	-1.02093 %	total % lost	0 %

6/21/2013 **(After 300 cycles)**

KJNF-C-1		KJNF-C-2		KJNF-C-3		KJNF-C-4	
Weight (+mold) =	2097 grams	Weight (+mold) =	2068 grams	Weight (+mold) =	2067 grams	Weight (+mold) =	2043 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	20 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	1.020929 %	total % lost	0 %

CRUSH TESTS 7/9/2013

KJNF-C-1	
Weight Alone	1978 grams
Weight mold =	131 grams
Final Mass lost =	-12 grams
total % lost	-0.610376 %
Comp Strength	595 psi
XXX	XXX XXX
Tensile Strength	XXX psi

KJNF-C-2	
Weight Alone	1942 grams
Weight mold =	126 grams
Final Mass lost =	0 grams
total % lost	0 %
Comp Strength	XXX psi
Load (P)	8030 lbs
Tensile Strength	159.8801 psi

KJNF-C-3	
Weight Alone	1960 grams
Weight mold =	128 grams
Final Mass lost =	-1 grams
total % lost	-0.05105 %
Comp Strength	709 psi
XXX	XXX XXX
Tensile Strength	XXX psi

KJNF-C-4	
Weight Alone	1913 grams
Weight mold =	129 grams
Final Mass lost =	1 grams
total % lost	0.052247 %
Comp Strength	XXX psi
Load (P)	8290 lbs
Tensile Strength	165.0526 psi

Average Comp Strength =	652 psi
Average Tensile Strength =	162.46636 psi

Unsubmerged

KJNF-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2083 grams
Weight mold =	139 grams
Total +Water =	2642 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	559 cm^3
γ Concrete =	1.180036 gm/cm^3
γ Concrete =	73.66724 lb/ft^3
Volume Solids =	1088.407 cm^3
Porosity =	33.93211 %

KJNF-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1996 grams
Weight mold =	139 grams
Total +Water =	2589 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	593 cm^3
γ Concrete =	1.127226 gm/cm^3
γ Concrete =	70.3704 lb/ft^3
Volume Solids =	1054.407 cm^3
Porosity =	35.99595 %

KJNF-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2042 grams
Weight mold =	139 grams
Total +Water =	2637 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	595 cm^3
γ Concrete =	1.155148 gm/cm^3
γ Concrete =	72.11356 lb/ft^3
Volume Solids =	1052.407 cm^3
Porosity =	36.11736 %

KJNF-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2099 grams
Weight mold =	139 grams
Total +Water =	2648 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	549 cm^3
γ Concrete =	1.189748 gm/cm^3
γ Concrete =	74.27356 lb/ft^3
Volume Solids =	1098.407 cm^3
Porosity =	33.32509 %

KJNF-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1995 grams
Weight mold =	104 grams
Original weight =	1944 grams
Mass lost =	53 grams
% lost =	2.726337 %

3.078133312

Weight (+mold) =	1972 grams
Mass lost =	76 grams
total % lost	3.909465 %

4.654096394

KJNF-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1891 grams
Weight mold =	104 grams
Original weight =	1857 grams
Mass lost =	70 grams
% lost =	3.769521 %

Weight (+mold) =	1864 grams
Mass lost =	97 grams
total % lost	5.223479 %

KJNF-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1940 grams
Weight mold =	104 grams
Original weight =	1903 grams
Mass lost =	67 grams
% lost =	3.520757 %

Weight (+mold) =	1911 grams
Mass lost =	96 grams
total % lost	5.044666 %

KJNF-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2019 grams
Weight mold =	104 grams
Original weight =	1960 grams
Mass lost =	45 grams
% lost =	2.295918 %

Weight (+mold) =	1977 grams
Mass lost =	87 grams
total % lost	4.438776 %

KJNF-N-1	
Weight (+mold) =	1958 grams
Mass lost =	90 grams
total % lost =	4.62963 %

KJNF-N-2	
Weight (+mold) =	1821 grams
Mass lost =	140 grams
total % lost =	7.539041 %

KJNF-N-3	
Weight (+mold) =	1874 grams
Mass lost =	133 grams
total % lost =	6.988965 %

KJNF-N-4	
Weight (+mold) =	1952 grams
Mass lost =	112 grams
total % lost =	5.714286 %

6.2179804

KJNF-N-1	
Weight (+mold) =	1905 grams
Mass lost =	143 grams
total % lost	7.355967 %

KJNF-N-2	
Weight (+mold) =	1770 grams
Mass lost =	191 grams
total % lost	10.28541 %

KJNF-N-3	
Weight (+mold) =	1820 grams
Mass lost =	187 grams
total % lost	9.82659 %

KJNF-N-4	
Weight (+mold) =	1943 grams
Mass lost =	121 grams
total % lost	6.173469 %

8.410358158

KJNF-N-1	
Weight (+mold) =	1882 grams
Mass lost =	166 grams
total % lost	8.539095 %

KJNF-N-2	
Weight (+mold) =	1753 grams
Mass lost =	208 grams
total % lost	11.20086 %

KJNF-N-3	
Weight (+mold) =	1813 grams
Mass lost =	194 grams
total % lost	10.19443 %

KJNF-N-4	
Weight (+mold) =	1936 grams
Mass lost =	128 grams
total % lost	6.530612 %

9.116249587

KJNF-N-1	
Weight (+mold) =	1861 grams
Mass lost =	187 grams
total % lost	9.619342 %

KJNF-N-2	
Weight (+mold) =	1744 grams
Mass lost =	217 grams
total % lost	11.68551 %

KJNF-N-3	
Weight (+mold) =	1798 grams
Mass lost =	209 grams
total % lost	10.98266 %

KJNF-N-4	
Weight (+mold) =	1910 grams
Mass lost =	154 grams
total % lost	7.857143 %

10.03616441

KJNF-N-1	
Weight (+mold) =	1851 grams
Mass lost =	197 grams
total % lost	10.13374 %

KJNF-N-2	
Weight (+mold) =	1745 grams
Mass lost =	216 grams
total % lost	11.63166 %

KJNF-N-3	
Weight (+mold) =	1797 grams
Mass lost =	210 grams
total % lost	11.03521 %

KJNF-N-4	
Weight (+mold) =	1906 grams
Mass lost =	158 grams
total % lost	8.061224 %

10.21546022

KJNF-N-1	
Weight (+mold) =	1846 grams
Mass lost =	202 grams
total % lost	10.39095 %

KJNF-N-2	
Weight (+mold) =	1742 grams
Mass lost =	219 grams
total % lost	11.79321 %

KJNF-N-3	
Weight (+mold) =	1794 grams
Mass lost =	213 grams
total % lost	11.19285 %

KJNF-N-4	
Weight (+mold) =	1901 grams
Mass lost =	163 grams
total % lost	8.316327 %

10.42333532

KJNF-N-1	
Weight (+mold) =	1845 grams
Mass lost =	203 grams
total % lost	10.44239 %

KJNF-N-2	
Weight (+mold) =	1742 grams
Mass lost =	219 grams
total % lost	11.79321 %

KJNF-N-3	
Weight (+mold) =	1793 grams
Mass lost =	214 grams
total % lost	11.2454 %

KJNF-N-4	
Weight (+mold) =	1899 grams
Mass lost =	165 grams
total % lost	8.418367 %

KJNF-N-1	
Weight Alone	1714 grams
Weight mold =	104 grams
Final Mass lost =	230 grams
total % lost	11.83128 %
Comp Strength	442 psi
XXX	XXX XXX
Tensile Strength	XXX psi

KJNF-N-2	
Weight Alone	1619 grams
Weight mold =	104 grams
Final Mass lost =	238 grams
total % lost	12.81637 %
Comp Strength	XXX psi
Load (P)	5180 lbs
Tensile Strength	103.1811 psi

KJNF-N-3	
Weight Alone	1668 grams
Weight mold =	104 grams
Final Mass lost =	235 grams
total % lost	12.34892 %
Comp Strength	404 psi
XXX	XXX XXX
Tensile Strength	XXX psi

KJNF-N-4	
Weight Alone	1737 grams
Weight mold =	104 grams
Final Mass lost =	223 grams
total % lost	11.37755 %
Comp Strength	XXX psi
Load (P)	6450 lbs
Tensile Strength	128.447 psi

12.09353

Average Comp Strength =	423 psi
Average Tensile Strength =	115.8141 psi

Partially Submerged

KJNF-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2082 grams
Weight mold =	139 grams
Total +Water =	2646 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	564 cm^3
γ Concrete =	1.179429 gm/cm^3
γ Concrete =	73.62935 lb/ft^3
Volume Solids =	1083.407 cm^3
Porosity =	34.23561 %

KJNF-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2131 grams
Weight mold =	139 grams
Total +Water =	2658 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	527 cm^3
γ Concrete =	1.209173 gm/cm^3
γ Concrete =	75.48619 lb/ft^3
Volume Solids =	1120.407 cm^3
Porosity =	31.98966 %

KJNF-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2037 grams
Weight mold =	139 grams
Total +Water =	2610 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	573 cm^3
γ Concrete =	1.152113 gm/cm^3
γ Concrete =	71.92409 lb/ft^3
Volume Solids =	1074.407 cm^3
Porosity =	34.78193 %

KJNF-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2098 grams
Weight mold =	139 grams
Total +Water =	2666 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	568 cm^3
γ Concrete =	1.189141 gm/cm^3
γ Concrete =	74.23566 lb/ft^3
Volume Solids =	1079.407 cm^3
Porosity =	34.47842 %

KJNF-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1971 grams
Weight mold =	104 grams
Original weight =	1943 grams
Mass lost =	76 grams
% lost =	3.911477 %

KJNF-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2006 grams
Weight mold =	104 grams
Original weight =	1992 grams
Mass lost =	90 grams
% lost =	4.518072 %

KJNF-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1908 grams
Weight mold =	105 grams
Original weight =	1898 grams
Mass lost =	95 grams
% lost =	5.005269 %

KJNF-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1964 grams
Weight mold =	102 grams
Original weight =	1959 grams
Mass lost =	97 grams
% lost =	4.951506 %

4.59658099

Weight (+mold) =	1936 grams
Mass lost =	111 grams
total % lost	5.712815 %

Weight (+mold) =	1964 grams
Mass lost =	132 grams
total % lost	6.626506 %

Weight (+mold) =	1888 grams
Mass lost =	115 grams
total % lost	6.091102 %

Weight (+mold) =	1921 grams
Mass lost =	140 grams
total % lost	7.146503 %

6.394231568

KJNF-P-1	
Weight (+mold) =	1841 grams
Mass lost =	206 grams
total % lost =	10.60216 %

KJNF-P-2	
Weight (+mold) =	1914 grams
Mass lost =	182 grams
total % lost =	9.136546 %

KJNF-P-3	
Weight (+mold) =	1811 grams
Mass lost =	192 grams
total % lost =	10.16949 %

KJNF-P-4	
Weight (+mold) =	1880 grams
Mass lost =	181 grams
total % lost =	9.239408 %

9.786901794

KJNF-P-1	
Weight (+mold) =	1830 grams
Mass lost =	217 grams
total % lost	11.1683 %

KJNF-P-2	
Weight (+mold) =	1892 grams
Mass lost =	204 grams
total % lost	10.24096 %

KJNF-P-3	
Weight (+mold) =	1790 grams
Mass lost =	213 grams
total % lost	11.28178 %

KJNF-P-4	
Weight (+mold) =	1859 grams
Mass lost =	202 grams
total % lost	10.31138 %

10.75060583

KJNF-P-1	
Weight (+mold) =	1825 grams
Mass lost =	222 grams
total % lost	11.42563 %

KJNF-P-2	
Weight (+mold) =	1878 grams
Mass lost =	218 grams
total % lost	10.94378 %

KJNF-P-3	
Weight (+mold) =	1780 grams
Mass lost =	223 grams
total % lost	11.81144 %

KJNF-P-4	
Weight (+mold) =	1844 grams
Mass lost =	217 grams
total % lost	11.07708 %

11.3144816

KJNF-P-1	
Weight (+mold) =	1825 grams
Mass lost =	222 grams
total % lost	11.42563 %

KJNF-P-2	
Weight (+mold) =	1872 grams
Mass lost =	224 grams
total % lost	11.24498 %

KJNF-P-3	
Weight (+mold) =	1777 grams
Mass lost =	226 grams
total % lost	11.97034 %

KJNF-P-4	
Weight (+mold) =	1840 grams
Mass lost =	221 grams
total % lost	11.28127 %

11.48055383

KJNF-P-1	
Weight (+mold) =	1821 grams
Mass lost =	226 grams
total % lost	11.6315 %

KJNF-P-2	
Weight (+mold) =	1869 grams
Mass lost =	227 grams
total % lost	11.39558 %

KJNF-P-3	
Weight (+mold) =	1777 grams
Mass lost =	226 grams
total % lost	11.97034 %

KJNF-P-4	
Weight (+mold) =	1834 grams
Mass lost =	227 grams
total % lost	11.58754 %

11.64624092

KJNF-P-1	
Weight (+mold) =	1821 grams
Mass lost =	226 grams
total % lost	11.6315 %

KJNF-P-2	
Weight (+mold) =	1869 grams
Mass lost =	227 grams
total % lost	11.39558 %

KJNF-P-3	
Weight (+mold) =	1777 grams
Mass lost =	226 grams
total % lost	11.97034 %

KJNF-P-4	
Weight (+mold) =	1834 grams
Mass lost =	227 grams
total % lost	11.58754 %

11.64624092

KJNF-P-1	
Weight (+mold) =	1821 grams
Mass lost =	226 grams
total % lost	11.6315 %

KJNF-P-2	
Weight (+mold) =	1869 grams
Mass lost =	227 grams
total % lost	11.39558 %

KJNF-P-3	
Weight (+mold) =	1776 grams
Mass lost =	227 grams
total % lost	12.02331 %

KJNF-P-4	
Weight (+mold) =	1834 grams
Mass lost =	227 grams
total % lost	11.58754 %

11.65948244

KJNF-P-1		KJNF-P-2		KJNF-P-3		KJNF-P-4	
Weight Alone	1717 grams	Weight Alone	1760 grams	Weight Alone	1673 grams	Weight Alone	1732 grams
Weight mold =	104 grams	Weight mold =	104 grams	Weight mold =	105 grams	Weight mold =	102 grams
Final Mass lost =	226 grams	Final Mass lost =	232 grams	Final Mass lost =	225 grams	Final Mass lost =	227 grams
total % lost	11.6315 %	total % lost	11.64659 %	total % lost	11.85458 %	total % lost	11.58754 %
Comp Strength	501 psi	Comp Strength	XXX psi	Comp Strength	465 psi	Comp Strength	XXX psi
XXX	XXX XXX	Load (P)	5450 lbs	XXX	XXX XXX	Load (P)	4470 lbs
Tensile Strength	XXX psi	Tensile Strength	108.5526 psi	Tensile Strength	XXX psi	Tensile Strength	89.05614 psi

11.68005312

Average Comp Strength =	483 psi
Average Tensile Strength =	98.80438 psi

Fully Submerged

KJNF-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2119 grams
Weight mold =	139 grams
Total +Water =	2656 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	537 cm^3
γ Concrete =	1.201889 gm/cm^3
γ Concrete =	75.03145 lb/ft^3
Volume Solids =	1110.407 cm^3
Porosity =	32.59667 %

KJNF-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2105 grams
Weight mold =	139 grams
Total +Water =	2641 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	536 cm^3
γ Concrete =	1.19339 gm/cm^3
γ Concrete =	74.50092 lb/ft^3
Volume Solids =	1111.407 cm^3
Porosity =	32.53597 %

KJNF-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2168 grams
Weight mold =	139 grams
Total +Water =	2693 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	525 cm^3
γ Concrete =	1.231632 gm/cm^3
γ Concrete =	76.88829 lb/ft^3
Volume Solids =	1122.407 cm^3
Porosity =	31.86826 %

KJNF-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2064 grams
Weight mold =	139 grams
Total +Water =	2645 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	581 cm^3
γ Concrete =	1.168503 gm/cm^3
γ Concrete =	72.94724 lb/ft^3
Volume Solids =	1066.407 cm^3
Porosity =	35.26754 %

KJNF-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2017 grams
Weight mold =	105 grams
Original weight =	1980 grams
Mass lost =	68 grams
% lost =	3.434343 %

3.413045774

Weight (+mold) =	1990 grams
Mass lost =	95 grams
total % lost	4.79798 %

4.928877963

KJNF-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2024 grams
Weight mold =	106 grams
Original weight =	1966 grams
Mass lost =	48 grams
% lost =	2.441506 %

Weight (+mold) =	1985 grams
Mass lost =	87 grams
total % lost	4.425229 %

KJNF-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2048 grams
Weight mold =	103 grams
Original weight =	2029 grams
Mass lost =	84 grams
% lost =	4.13997 %

Weight (+mold) =	2034 grams
Mass lost =	98 grams
total % lost	4.829966 %

KJNF-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1959 grams
Weight mold =	104 grams
Original weight =	1925 grams
Mass lost =	70 grams
% lost =	3.636364 %

Weight (+mold) =	1920 grams
Mass lost =	109 grams
total % lost	5.662338 %

KJNF-F-1	
Weight (+mold) =	1927 grams
Mass lost =	158 grams
total % lost =	7.979798 %

KJNF-F-2	
Weight (+mold) =	1906 grams
Mass lost =	166 grams
total % lost =	8.44354 %

KJNF-F-3	
Weight (+mold) =	1946 grams
Mass lost =	186 grams
total % lost =	9.167077 %

KJNF-F-4	
Weight (+mold) =	1826 grams
Mass lost =	203 grams
total % lost =	10.54545 %

9.033967522

KJNF-F-1	
Weight (+mold) =	1910 grams
Mass lost =	175 grams
total % lost	8.838384 %

KJNF-F-2	
Weight (+mold) =	1878 grams
Mass lost =	194 grams
total % lost	9.867752 %

KJNF-F-3	
Weight (+mold) =	1930 grams
Mass lost =	202 grams
total % lost	9.955643 %

KJNF-F-4	
Weight (+mold) =	1817 grams
Mass lost =	212 grams
total % lost	11.01299 %

9.918691451

KJNF-F-1	
Weight (+mold) =	1903 grams
Mass lost =	182 grams
total % lost	9.191919 %

KJNF-F-2	
Weight (+mold) =	1872 grams
Mass lost =	200 grams
total % lost	10.17294 %

KJNF-F-3	
Weight (+mold) =	1920 grams
Mass lost =	212 grams
total % lost	10.4485 %

KJNF-F-4	
Weight (+mold) =	1818 grams
Mass lost =	211 grams
total % lost	10.96104 %

10.19359873

KJNF-F-1	
Weight (+mold) =	1896 grams
Mass lost =	189 grams
total % lost	9.545455 %

KJNF-F-2	
Weight (+mold) =	1864 grams
Mass lost =	208 grams
total % lost	10.57986 %

KJNF-F-3	
Weight (+mold) =	1913 grams
Mass lost =	219 grams
total % lost	10.79349 %

KJNF-F-4	
Weight (+mold) =	1807 grams
Mass lost =	222 grams
total % lost	11.53247 %

10.6128185

KJNF-F-1	
Weight (+mold) =	1887 grams
Mass lost =	198 grams
total % lost	10 %

KJNF-F-2	
Weight (+mold) =	1861 grams
Mass lost =	211 grams
total % lost	10.73245 %

KJNF-F-3	
Weight (+mold) =	1911 grams
Mass lost =	221 grams
total % lost	10.89207 %

KJNF-F-4	
Weight (+mold) =	1807 grams
Mass lost =	222 grams
total % lost	11.53247 %

10.78924607

KJNF-F-1	
Weight (+mold) =	1887 grams
Mass lost =	198 grams
total % lost	10 %

KJNF-F-2	
Weight (+mold) =	1861 grams
Mass lost =	211 grams
total % lost	10.73245 %

KJNF-F-3	
Weight (+mold) =	1911 grams
Mass lost =	221 grams
total % lost	10.89207 %

KJNF-F-4	
Weight (+mold) =	1807 grams
Mass lost =	222 grams
total % lost	11.53247 %

10.78924607

KJNF-F-1	
Weight (+mold) =	1886 grams
Mass lost =	199 grams
total % lost	10.05051 %

KJNF-F-2	
Weight (+mold) =	1861 grams
Mass lost =	211 grams
total % lost	10.73245 %

KJNF-F-3	
Weight (+mold) =	1911 grams
Mass lost =	221 grams
total % lost	10.89207 %

KJNF-F-4	
Weight (+mold) =	1807 grams
Mass lost =	222 grams
total % lost	11.53247 %

10.80187233

KJNF-F-1		KJNF-F-2		KJNF-F-3		KJNF-F-4	
Weight Alone	1761 grams	Weight Alone	1745 grams	Weight Alone	1799 grams	Weight Alone	1696 grams
Weight mold =	105 grams	Weight mold =	106 grams	Weight mold =	103 grams	Weight mold =	104 grams
Final Mass lost =	219 grams	Final Mass lost =	221 grams	Final Mass lost =	230 grams	Final Mass lost =	229 grams
total % lost	11.06061 %	total % lost	11.2411 %	total % lost	11.33563 %	total % lost	11.8961 %
Comp Strength	507 psi	Comp Strength	XXX psi	Comp Strength	627 psi	Comp Strength	XXX psi
XXX	XXX XXX	Load (P)	6330 lbs	XXX	XXX XXX	Load (P)	2810 lbs
Tensile Strength	XXX psi	Tensile Strength	126.0597 psi	Tensile Strength	XXX psi	Tensile Strength	80.04499 psi

11.38336049

Broken during tensile test prep

Average Comp Strength =	567 psi
Average Tensile Strength =	103.0523 psi

Scoria Mix with Nycon Fibers

Control

4/5/2013 MIX DATE; 4/19/2013 INTO CHAMBER

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	1989 grams	Weight (+mold) =	1898 grams	Weight (+mold) =	1943 grams	Weight (+mold) =	1816 grams
Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams
Total +Water =	2569 grams	Total +Water =	2517 grams	Total +Water =	2530 grams	Total +Water =	2490 grams
Total Volume =	1647.4074 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3
Total Volume =	100.53096 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3
Volume Water =	580 cm^3	Volume Water =	619 cm^3	Volume Water =	587 cm^3	Volume Water =	674 cm^3
γ Concrete =	1.1229767 gm/cm^3	γ Concrete =	1.067738 gm/cm^3	γ Concrete =	1.095054 gm/cm^3	γ Concrete =	1.017963 gm/cm^3
γ Concrete =	70.105142 lb/ft^3	γ Concrete =	66.65673 lb/ft^3	γ Concrete =	68.36199 lb/ft^3	γ Concrete =	63.54936 lb/ft^3
Volume Solids =	1067.4074 cm^3	Volume Solids =	1028.407 cm^3	Volume Solids =	1060.407 cm^3	Volume Solids =	973.4074 cm^3
Porosity =	35.206836 %	Porosity =	37.57419 %	Porosity =	35.63175 %	Porosity =	40.91277 %

C = CONTROL (NO CHAMBER)
N = NO SUBMERSION
P = PARTIALLY SUBMERSED
F = FULLY SUBMERSED

AVG POROSITY = 36.67505

CONFINEMENT ACHIEVED BY CUTTING OFF BOTTOM OF PLASTIC CYLINDER WITH A DREMEL TOOL

4/26/2012 (After 36 cylcles)

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Weight mold =	103 grams	Weight mold =	103 grams	Weight mold =	119 grams	Weight mold =	103 grams
Original weight =	1850 grams	Original weight =	1759 grams	Original weight =	1804 grams	Original weight =	1677 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
% lost =	0 %	% lost =	0 %	% lost =	0 %	% lost =	0 %

5/5/2013 After 72 cycles)

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

5/12/2013 After 108 cycles)

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

5/21/2013 After 144 cycles)

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

5/28/2013 (After 180 cycles)

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/4/2013 **(After 216 cycles)**

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/11/2013 **(After 252 cycles)**

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/18/2013 **(After 288 cycles)**

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/21/2013 **(After 300 cycles)**

KJ-NY-C-1		KJ-NY-C-2		KJ-NY-C-3		KJ-NY-C-4	
Weight (+mold) =	1953 grams	Weight (+mold) =	1862 grams	Weight (+mold) =	1923 grams	Weight (+mold) =	1780 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

Unsubmerged

KJ-NY-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1999 grams
Weight mold =	139 grams
Total +Water =	2582 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	583 cm^3
γ Concrete =	1.129047 gm/cm^3
γ Concrete =	70.48409 lb/ft^3
Volume Solids =	1064.407 cm^3
Porosity =	35.38894 %

KJ-NY-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1970 grams
Weight mold =	139 grams
Total +Water =	2578 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	608 cm^3
γ Concrete =	1.111443 gm/cm^3
γ Concrete =	69.38514 lb/ft^3
Volume Solids =	1039.407 cm^3
Porosity =	36.90648 %

KJ-NY-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1991 grams
Weight mold =	139 grams
Total +Water =	2569 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	578 cm^3
γ Concrete =	1.124191 gm/cm^3
γ Concrete =	70.18093 lb/ft^3
Volume Solids =	1069.407 cm^3
Porosity =	35.08543 %

KJ-NY-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1912 grams
Weight mold =	139 grams
Total +Water =	2538 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	626 cm^3
γ Concrete =	1.076237 gm/cm^3
γ Concrete =	67.18725 lb/ft^3
Volume Solids =	1021.407 cm^3
Porosity =	37.9991 %

KJ-NY-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1939 grams
Weight mold =	102 grams
Original weight =	1860 grams
Mass lost =	23 grams
% lost =	1.236559 %

KJ-NY-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1915 grams
Weight mold =	101 grams
Original weight =	1831 grams
Mass lost =	17 grams
% lost =	0.928454 %

KJ-NY-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1937 grams
Weight mold =	103 grams
Original weight =	1852 grams
Mass lost =	18 grams
% lost =	0.971922 %

KJ-NY-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1856 grams
Weight mold =	102 grams
Original weight =	1773 grams
Mass lost =	19 grams
% lost =	1.07163 %

1.052141447

KJ-NY-N-1	
Weight (+mold) =	1867 grams
Mass lost =	95 grams
total % lost	5.107527 %

KJ-NY-N-2	
Weight (+mold) =	1827 grams
Mass lost =	105 grams
total % lost	5.734571 %

KJ-NY-N-3	
Weight (+mold) =	1854 grams
Mass lost =	101 grams
total % lost	5.453564 %

KJ-NY-N-4	
Weight (+mold) =	1763 grams
Mass lost =	112 grams
total % lost	6.316977 %

5.653159686

KJ-NY-N-1	
Weight (+mold) =	1858 grams
Mass lost =	104 grams
total % lost	5.591398 %

KJ-NY-N-2	
Weight (+mold) =	1814 grams
Mass lost =	118 grams
total % lost	6.444566 %

KJ-NY-N-3	
Weight (+mold) =	1847 grams
Mass lost =	108 grams
total % lost	5.831533 %

KJ-NY-N-4	
Weight (+mold) =	1747 grams
Mass lost =	128 grams
total % lost	7.219402 %

6.27172482

KJ-NY-N-1	
Weight (+mold) =	1809 grams
Mass lost =	153 grams
total % lost	8.225806 %

KJ-NY-N-2	
Weight (+mold) =	1757 grams
Mass lost =	175 grams
total % lost	9.557619 %

KJ-NY-N-3	
Weight (+mold) =	1793 grams
Mass lost =	162 grams
total % lost	8.7473 %

KJ-NY-N-4	
Weight (+mold) =	1701 grams
Mass lost =	174 grams
total % lost	9.813875 %

9.086150061

KJ-NY-N-1	
Weight (+mold) =	1800 grams
Mass lost =	162 grams
total % lost	8.709677 %

KJ-NY-N-2	
Weight (+mold) =	1750 grams
Mass lost =	182 grams
total % lost	9.939924 %

KJ-NY-N-3	
Weight (+mold) =	1782 grams
Mass lost =	173 grams
total % lost	9.341253 %

KJ-NY-N-4	
Weight (+mold) =	1689 grams
Mass lost =	186 grams
total % lost	10.49069 %

9.620386849

KJ-NY-N-1	
Weight (+mold) =	1795 grams
Mass lost =	167 grams
total % lost	8.978495 %

KJ-NY-N-2	
Weight (+mold) =	1733 grams
Mass lost =	199 grams
total % lost	10.86838 %

KJ-NY-N-3	
Weight (+mold) =	1769 grams
Mass lost =	186 grams
total % lost	10.0432 %

KJ-NY-N-4	
Weight (+mold) =	1685 grams
Mass lost =	190 grams
total % lost	10.7163 %

10.15159229

KJ-NY-N-1	
Weight (+mold) =	1788 grams
Mass lost =	174 grams
total % lost	9.354839 %

KJ-NY-N-2	
Weight (+mold) =	1733 grams
Mass lost =	199 grams
total % lost	10.86838 %

KJ-NY-N-3	
Weight (+mold) =	1767 grams
Mass lost =	188 grams
total % lost	10.15119 %

KJ-NY-N-4	
Weight (+mold) =	1684 grams
Mass lost =	191 grams
total % lost	10.7727 %

10.28677655

KJ-NY-N-1	
Weight (+mold) =	1773 grams
Mass lost =	189 grams
total % lost	10.16129 %

KJ-NY-N-2	
Weight (+mold) =	1732 grams
Mass lost =	200 grams
total % lost	10.92299 %

KJ-NY-N-3	
Weight (+mold) =	1764 grams
Mass lost =	191 grams
total % lost	10.31317 %

KJ-NY-N-4	
Weight (+mold) =	1686 grams
Mass lost =	189 grams
total % lost	10.6599 %

10.51433916

KJ-NY-N-1	
Weight (+mold) =	1771 grams
Mass lost =	191 grams
total % lost	10.26882 %

KJ-NY-N-2	
Weight (+mold) =	1731 grams
Mass lost =	201 grams
total % lost	10.97761 %

KJ-NY-N-3	
Weight (+mold) =	1763 grams
Mass lost =	192 grams
total % lost	10.36717 %

KJ-NY-N-4	
Weight (+mold) =	1684 grams
Mass lost =	191 grams
total % lost	10.7727 %

10.59657433

KJ-NY-N-1	
Weight Alone	1644 grams
Weight mold =	102 grams
Final Mass lost =	216 grams
total % lost	11.6129 %
Comp Strength	346 psi
XXX	XXX XXX
Tensile Strength	XXX psi

KJ-NY-N-2	
Weight Alone	1613 grams
Weight mold =	101 grams
Final Mass lost =	218 grams
total % lost	11.90606 %
Comp Strength	XXX psi
Load (P)	5020 lbs
Tensile Strength	99.99805 psi

KJ-NY-N-3	
Weight Alone	1641 grams
Weight mold =	103 grams
Final Mass lost =	211 grams
total % lost	11.39309 %
Comp Strength	340 psi
XXX	XXX XXX
Tensile Strength	XXX psi

KJ-NY-N-4	
Weight Alone	1565 grams
Weight mold =	102 grams
Final Mass lost =	208 grams
total % lost	11.73153 %
Comp Strength	XXX psi
Load (P)	3760 lbs
Tensile Strength	74.93114 psi

11.66089563

Average Comp Strength =	343 psi
Average Tensile Strength =	87.46459 psi

Partially Submerged

KJ-NY-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1972 grams
Weight mold =	139 grams
Total +Water =	2586 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	614 cm^3
γ Concrete =	1.112657 gm/cm^3
γ Concrete =	69.46093 lb/ft^3
Volume Solids =	1033.407 cm^3
Porosity =	37.27068 %

KJ-NY-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1880 grams
Weight mold =	139 grams
Total +Water =	2530 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	650 cm^3
γ Concrete =	1.056812 gm/cm^3
γ Concrete =	65.97462 lb/ft^3
Volume Solids =	997.4074 cm^3
Porosity =	39.45594 %

KJ-NY-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2030 grams
Weight mold =	139 grams
Total +Water =	2599 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	569 cm^3
γ Concrete =	1.147864 gm/cm^3
γ Concrete =	71.65882 lb/ft^3
Volume Solids =	1078.407 cm^3
Porosity =	34.53912 %

KJ-NY-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2028 grams
Weight mold =	139 grams
Total +Water =	2577 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	549 cm^3
γ Concrete =	1.14665 gm/cm^3
γ Concrete =	71.58303 lb/ft^3
Volume Solids =	1098.407 cm^3
Porosity =	33.32509 %

KJ-NY-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1866 grams
Weight mold =	102 grams
Original weight =	1833 grams
Mass lost =	69 grams
% lost =	3.764321 %

KJ-NY-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1735 grams
Weight mold =	103 grams
Original weight =	1741 grams
Mass lost =	109 grams
% lost =	6.26077 %

KJ-NY-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1891 grams
Weight mold =	102 grams
Original weight =	1891 grams
Mass lost =	102 grams
% lost =	5.393971 %

KJ-NY-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1867 grams
Weight mold =	101 grams
Original weight =	1889 grams
Mass lost =	123 grams
% lost =	6.511382 %

5.482610896

KJ-NY-P-1	
Weight (+mold) =	1823 grams
Mass lost =	112 grams
total % lost	6.110202 %

KJ-NY-P-2	
Weight (+mold) =	1703 grams
Mass lost =	141 grams
total % lost	8.098794 %

KJ-NY-P-3	
Weight (+mold) =	1846 grams
Mass lost =	147 grams
total % lost	7.963164 %

KJ-NY-P-4	
Weight (+mold) =	1848 grams
Mass lost =	142 grams
total % lost	7.517205 %

7.42234103

KJ-NY-P-1	
Weight (+mold) =	1736 grams
Mass lost =	199 grams
total % lost	10.85652 %

KJ-NY-P-2	
Weight (+mold) =	1649 grams
Mass lost =	195 grams
total % lost	11.20046 %

KJ-NY-P-3	
Weight (+mold) =	1795 grams
Mass lost =	198 grams
total % lost	10.72589 %

KJ-NY-P-4	
Weight (+mold) =	1823 grams
Mass lost =	167 grams
total % lost	8.840656 %

10.40588228

KJ-NY-P-1	
Weight (+mold) =	1735 grams
Mass lost =	200 grams
total % lost	10.91107 %

KJ-NY-P-2	
Weight (+mold) =	1642 grams
Mass lost =	202 grams
total % lost	11.60253 %

KJ-NY-P-3	
Weight (+mold) =	1790 grams
Mass lost =	203 grams
total % lost	10.99675 %

KJ-NY-P-4	
Weight (+mold) =	1788 grams
Mass lost =	202 grams
total % lost	10.69349 %

11.05096009

KJ-NY-P-1	
Weight (+mold) =	1737 grams
Mass lost =	198 grams
total % lost	10.80196 %

KJ-NY-P-2	
Weight (+mold) =	1640 grams
Mass lost =	204 grams
total % lost	11.7174 %

KJ-NY-P-3	
Weight (+mold) =	1790 grams
Mass lost =	203 grams
total % lost	10.99675 %

KJ-NY-P-4	
Weight (+mold) =	1788 grams
Mass lost =	202 grams
total % lost	10.69349 %

11.05240153

KJ-NY-P-1	
Weight (+mold) =	1737 grams
Mass lost =	198 grams
total % lost	10.80196 %

KJ-NY-P-2	
Weight (+mold) =	1637 grams
Mass lost =	207 grams
total % lost	11.88972 %

KJ-NY-P-3	
Weight (+mold) =	1790 grams
Mass lost =	203 grams
total % lost	10.99675 %

KJ-NY-P-4	
Weight (+mold) =	1786 grams
Mass lost =	204 grams
total % lost	10.79936 %

11.12194925

KJ-NY-P-1	
Weight (+mold) =	1737 grams
Mass lost =	198 grams
total % lost	10.80196 %

KJ-NY-P-2	
Weight (+mold) =	1637 grams
Mass lost =	207 grams
total % lost	11.88972 %

KJ-NY-P-3	
Weight (+mold) =	1790 grams
Mass lost =	203 grams
total % lost	10.99675 %

KJ-NY-P-4	
Weight (+mold) =	1783 grams
Mass lost =	207 grams
total % lost	10.95818 %

11.1616528

KJ-NY-P-1	
Weight (+mold) =	1737 grams
Mass lost =	198 grams
total % lost	10.80196 %

KJ-NY-P-2	
Weight (+mold) =	1637 grams
Mass lost =	207 grams
total % lost	11.88972 %

KJ-NY-P-3	
Weight (+mold) =	1790 grams
Mass lost =	203 grams
total % lost	10.99675 %

KJ-NY-P-4	
Weight (+mold) =	1783 grams
Mass lost =	207 grams
total % lost	10.95818 %

11.1616528

KJ-NY-P-1	
Weight (+mold) =	1737 grams
Mass lost =	198 grams
total % lost	10.80196 %

KJ-NY-P-2	
Weight (+mold) =	1637 grams
Mass lost =	207 grams
total % lost	11.88972 %

KJ-NY-P-3	
Weight (+mold) =	1789 grams
Mass lost =	204 grams
total % lost	11.05092 %

KJ-NY-P-4	
Weight (+mold) =	1782 grams
Mass lost =	208 grams
total % lost	11.01112 %

11.18843011

KJ-NY-P-1		KJ-NY-P-2		KJ-NY-P-3		KJ-NY-P-4	
Weight Alone	1631 grams	Weight Alone	1537 grams	Weight Alone	1685 grams	Weight Alone	1678 grams
Weight mold =	102 grams	Weight mold =	103 grams	Weight mold =	102 grams	Weight mold =	101 grams
Final Mass lost =	202 grams	Final Mass lost =	204 grams	Final Mass lost =	206 grams	Final Mass lost =	211 grams
total % lost	11.02019 %	total % lost	11.7174 %	total % lost	10.89371 %	total % lost	11.16993 %
Comp Strength	368 psi	Comp Strength	XXX psi	Comp Strength	351 psi	Comp Strength	XXX psi
XXX	XXX XXX	Load (P)	5220 lbs	XXX	XXX XXX	Load (P)	4660 lbs
Tensile Strength	XXX psi	Tensile Strength	103.9769 psi	Tensile Strength	XXX psi	Tensile Strength	92.83607 psi

11.20030687

Average Comp Strength =	359.5 psi
Average Tensile Strength =	98.4065 psi

Fully Submerged

KJ-NY-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1934 grams
Weight mold =	139 grams
Total +Water =	2539 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	605 cm^3
γ Concrete =	1.089591 gm/cm^3
γ Concrete =	68.02094 lb/ft^3
Volume Solids =	1042.407 cm^3
Porosity =	36.72437 %

KJ-NY-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1858 grams
Weight mold =	139 grams
Total +Water =	2520 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	662 cm^3
γ Concrete =	1.043458 gm/cm^3
γ Concrete =	65.14094 lb/ft^3
Volume Solids =	985.4074 cm^3
Porosity =	40.18435 %

KJ-NY-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2109 grams
Weight mold =	139 grams
Total +Water =	2647 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	538 cm^3
γ Concrete =	1.195818 gm/cm^3
γ Concrete =	74.6525 lb/ft^3
Volume Solids =	1109.407 cm^3
Porosity =	32.65738 %

KJ-NY-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1941 grams
Weight mold =	139 grams
Total +Water =	2566 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	625 cm^3
γ Concrete =	1.09384 gm/cm^3
γ Concrete =	68.2862 lb/ft^3
Volume Solids =	1022.407 cm^3
Porosity =	37.9384 %

KJ-NY-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1805 grams
Weight mold =	99 grams
Original weight =	1795 grams
Mass lost =	89 grams
% lost =	4.958217 %

KJ-NY-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1759 grams
Weight mold =	102 grams
Original weight =	1719 grams
Mass lost =	62 grams
% lost =	3.606748 %

KJ-NY-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1977 grams
Weight mold =	102 grams
Original weight =	1970 grams
Mass lost =	95 grams
% lost =	4.822335 %

KJ-NY-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1807 grams
Weight mold =	102 grams
Original weight =	1802 grams
Mass lost =	97 grams
% lost =	5.382908 %

4.692552071

KJ-NY-F-1	
Weight (+mold) =	1728 grams
Mass lost =	166 grams
total % lost	9.247911 %

KJ-NY-F-2	
Weight (+mold) =	1720 grams
Mass lost =	101 grams
total % lost	5.875509 %

KJ-NY-F-3	
Weight (+mold) =	1958 grams
Mass lost =	114 grams
total % lost	5.786802 %

KJ-NY-F-4	
Weight (+mold) =	1753 grams
Mass lost =	151 grams
total % lost	8.379578 %

7.322450039

KJ-NY-F-1	
Weight (+mold) =	1695 grams
Mass lost =	199 grams
total % lost	11.08635 %

KJ-NY-F-2	
Weight (+mold) =	1648 grams
Mass lost =	173 grams
total % lost	10.06399 %

KJ-NY-F-3	
Weight (+mold) =	1895 grams
Mass lost =	177 grams
total % lost	8.984772 %

KJ-NY-F-4	
Weight (+mold) =	1725 grams
Mass lost =	179 grams
total % lost	9.933407 %

10.01713014

KJ-NY-F-1	
Weight (+mold) =	1690 grams
Mass lost =	204 grams
total % lost	11.3649 %

KJ-NY-F-2	
Weight (+mold) =	1638 grams
Mass lost =	183 grams
total % lost	10.64572 %

KJ-NY-F-3	
Weight (+mold) =	1887 grams
Mass lost =	185 grams
total % lost	9.390863 %

KJ-NY-F-4	
Weight (+mold) =	1722 grams
Mass lost =	182 grams
total % lost	10.09989 %

10.37534468

KJ-NY-F-1	
Weight (+mold) =	1690 grams
Mass lost =	204 grams
total % lost	11.3649 %

KJ-NY-F-2	
Weight (+mold) =	1638 grams
Mass lost =	183 grams
total % lost	10.64572 %

KJ-NY-F-3	
Weight (+mold) =	1880 grams
Mass lost =	192 grams
total % lost	9.746193 %

KJ-NY-F-4	
Weight (+mold) =	1719 grams
Mass lost =	185 grams
total % lost	10.26637 %

10.50579759

KJ-NY-F-1	
Weight (+mold) =	1687 grams
Mass lost =	207 grams
total % lost	11.53203 %

KJ-NY-F-2	
Weight (+mold) =	1638 grams
Mass lost =	183 grams
total % lost	10.64572 %

KJ-NY-F-3	
Weight (+mold) =	1879 grams
Mass lost =	193 grams
total % lost	9.796954 %

KJ-NY-F-4	
Weight (+mold) =	1710 grams
Mass lost =	194 grams
total % lost	10.76582 %

10.68513194

KJ-NY-F-1	
Weight (+mold) =	1686 grams
Mass lost =	208 grams
total % lost	11.58774 %

KJ-NY-F-2	
Weight (+mold) =	1638 grams
Mass lost =	183 grams
total % lost	10.64572 %

KJ-NY-F-3	
Weight (+mold) =	1879 grams
Mass lost =	193 grams
total % lost	9.796954 %

KJ-NY-F-4	
Weight (+mold) =	1710 grams
Mass lost =	194 grams
total % lost	10.76582 %

10.69905952

KJ-NY-F-1	
Weight (+mold) =	1686 grams
Mass lost =	208 grams
total % lost	11.58774 %

KJ-NY-F-2	
Weight (+mold) =	1638 grams
Mass lost =	183 grams
total % lost	10.64572 %

KJ-NY-F-3	
Weight (+mold) =	1879 grams
Mass lost =	193 grams
total % lost	9.796954 %

KJ-NY-F-4	
Weight (+mold) =	1710 grams
Mass lost =	194 grams
total % lost	10.76582 %

10.69905952

KJ-NY-F-1	
Weight (+mold) =	1686 grams
Mass lost =	208 grams
total % lost	11.58774 %

KJ-NY-F-2	
Weight (+mold) =	1638 grams
Mass lost =	183 grams
total % lost	10.64572 %

KJ-NY-F-3	
Weight (+mold) =	1877 grams
Mass lost =	195 grams
total % lost	9.898477 %

KJ-NY-F-4	
Weight (+mold) =	1709 grams
Mass lost =	195 grams
total % lost	10.82131 %

10.7383137

Scoria Mix with Procon Fibers

Control Group

4/5/2013 MIX DATE; 4/19/2013 INTO CHAMBER

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	2072 grams	Weight (+mold) =	2057 grams	Weight (+mold) =	2062 grams	Weight (+mold) =	2104 grams
Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams
Total +Water =	2635 grams	Total +Water =	2640 grams	Total +Water =	2643 grams	Total +Water =	2646 grams
Total Volume =	1647.4074 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3
Total Volume =	100.53096 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3
Volume Water =	563 cm^3	Volume Water =	583 cm^3	Volume Water =	581 cm^3	Volume Water =	542 cm^3
γ Concrete =	1.1733588 gm/cm^3	γ Concrete =	1.164254 gm/cm^3	γ Concrete =	1.167289 gm/cm^3	γ Concrete =	1.192783 gm/cm^3
γ Concrete =	73.2504 lb/ft^3	γ Concrete =	72.68198 lb/ft^3	γ Concrete =	72.87145 lb/ft^3	γ Concrete =	74.46303 lb/ft^3
Volume Solids =	1084.4074 cm^3	Volume Solids =	1064.407 cm^3	Volume Solids =	1066.407 cm^3	Volume Solids =	1105.407 cm^3
Porosity =	34.174911 %	Porosity =	35.38894 %	Porosity =	35.26754 %	Porosity =	32.90018 %

C = CONTROL (NO CHAMBER)
N = NO SUBMERSION
P = PARTIALLY SUBMERSED
F = FULLY SUBMERSED

AVG POROSITY = 35.05129

CONFINEMENT ACHIEVED BY CUTTING OFF BOTTOM OF PLASTIC CYLINDER WITH A DREMEL TOOL

4/26/2013 (After 36 cylcles)

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Weight mold =	105 grams	Weight mold =	102 grams	Weight mold =	103 grams	Weight mold =	103 grams
Original weight =	1933 grams	Original weight =	1918 grams	Original weight =	1923 grams	Original weight =	1965 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

5/5/2013 After 72 cycles)

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

5/12/2013 After 108 cycles)

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

5/21/2013 After 144 cycles)

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

5/28/2013 (After 180 cycles)

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/4/2013 **(After 216 cycles)**

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/11/2013 **(After 252 cycles)**

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/18/2013 **(After 288 cycles)**

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

6/21/2013 **(After 300 cycles)**

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight (+mold) =	2038 grams	Weight (+mold) =	2020 grams	Weight (+mold) =	2026 grams	Weight (+mold) =	2068 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

CRUSH TESTS 7/9/2013

KJ-PRO-C-1		KJ-PRO-C-2		KJ-PRO-C-3		KJ-PRO-C-4	
Weight Alone	1915 grams	Weight Alone	1901 grams	Weight Alone	1913 grams	Weight Alone	1960 grams
Weight mold =	105 grams	Weight mold =	102 grams	Weight mold =	103 grams	Weight mold =	103 grams
Final Mass lost =	18 grams	Final Mass lost =	17 grams	Final Mass lost =	10 grams	Final Mass lost =	5 grams
total % lost	0.931195 %	total % lost	0.88634 %	total % lost	0.520021 %	total % lost	0.254453 %
Comp Strength	508 psi	Comp Strength	XXX psi	Comp Strength	356 psi	Comp Strength	XXX psi
XXX	XXX XXX	Load (P)	7320 lbs	XXX	XXX XXX	Load (P)	5360 lbs
Tensile Strength	XXX psi	Tensile Strength	145.7551 psi	Tensile Strength	XXX psi	Tensile Strength	106.7621 psi

Load Rate = 500 to 1000 lb/ minute
hear scoria crushing, no sudden failure, very subtle

Average Comp Strength =	432 psi
Average Tensile Strength =	126.25861 psi

Unsubmerged

KJ-PRO-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2114 grams
Weight mold =	139 grams
Total +Water =	2685 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	571 cm^3
γ Concrete =	1.198853 gm/cm^3
γ Concrete =	74.84198 lb/ft^3
Volume Solids =	1076.407 cm^3
Porosity =	34.66052 %

KJ-PRO-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2094 grams
Weight mold =	139 grams
Total +Water =	2671 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	577 cm^3
γ Concrete =	1.186713 gm/cm^3
γ Concrete =	74.08408 lb/ft^3
Volume Solids =	1070.407 cm^3
Porosity =	35.02473 %

KJ-PRO-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1997 grams
Weight mold =	139 grams
Total +Water =	2618 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	621 cm^3
γ Concrete =	1.127833 gm/cm^3
γ Concrete =	70.4083 lb/ft^3
Volume Solids =	1026.407 cm^3
Porosity =	37.69559 %

KJ-PRO-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2018 grams
Weight mold =	139 grams
Total +Water =	2624 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	606 cm^3
γ Concrete =	1.14058 gm/cm^3
γ Concrete =	71.20409 lb/ft^3
Volume Solids =	1041.407 cm^3
Porosity =	36.78507 %

KJ-PRO-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2014 grams
Weight mold =	103 grams
Original weight =	1975 grams
Mass lost =	64 grams
total % lost	3.240506 %

KJ-PRO-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1997 grams
Weight mold =	101 grams
Original weight =	1955 grams
Mass lost =	59 grams
total % lost	3.017903 %

KJ-PRO-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1904 grams
Weight mold =	101 grams
Original weight =	1858 grams
Mass lost =	55 grams
total % lost	2.960172 %

KJ-PRO-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1916 grams
Weight mold =	102 grams
Original weight =	1879 grams
Mass lost =	65 grams
total % lost	3.459287 %

3.169467056

KJ-PRO-N-1	
Weight (+mold) =	1964 grams
Mass lost =	114 grams
total % lost	5.772152 %

KJ-PRO-N-2	
Weight (+mold) =	1952 grams
Mass lost =	104 grams
total % lost	5.319693 %

KJ-PRO-N-3	
Weight (+mold) =	1859 grams
Mass lost =	100 grams
total % lost	5.382131 %

KJ-PRO-N-4	
Weight (+mold) =	1893 grams
Mass lost =	88 grams
total % lost	4.683342 %

5.28932963

KJ-PRO-N-1	
Weight (+mold) =	1930 grams
Mass lost =	148 grams
total % lost	7.493671 %

KJ-PRO-N-2	
Weight (+mold) =	1931 grams
Mass lost =	125 grams
total % lost	6.393862 %

KJ-PRO-N-3	
Weight (+mold) =	1820 grams
Mass lost =	139 grams
total % lost	7.481163 %

KJ-PRO-N-4	
Weight (+mold) =	1849 grams
Mass lost =	132 grams
total % lost	7.025013 %

7.098427156

KJ-PRO-N-1	
Weight (+mold) =	1914 grams
Mass lost =	164 grams
total % lost	8.303797 %

KJ-PRO-N-2	
Weight (+mold) =	1921 grams
Mass lost =	135 grams
total % lost	6.905371 %

KJ-PRO-N-3	
Weight (+mold) =	1784 grams
Mass lost =	175 grams
total % lost	9.41873 %

KJ-PRO-N-4	
Weight (+mold) =	1830 grams
Mass lost =	151 grams
total % lost	8.036189 %

8.166021898

KJ-PRO-N-1	
Weight (+mold) =	1889 grams
Mass lost =	189 grams
total % lost	9.56962 %

KJ-PRO-N-2	
Weight (+mold) =	1891 grams
Mass lost =	165 grams
total % lost	8.439898 %

KJ-PRO-N-3	
Weight (+mold) =	1765 grams
Mass lost =	194 grams
total % lost	10.44133 %

KJ-PRO-N-4	
Weight (+mold) =	1805 grams
Mass lost =	176 grams
total % lost	9.366684 %

9.454384282

KJ-PRO-N-1	
Weight (+mold) =	1882 grams
Mass lost =	196 grams
total % lost	9.924051 %

KJ-PRO-N-2	
Weight (+mold) =	1885 grams
Mass lost =	171 grams
total % lost	8.746803 %

KJ-PRO-N-3	
Weight (+mold) =	1758 grams
Mass lost =	201 grams
total % lost	10.81808 %

KJ-PRO-N-4	
Weight (+mold) =	1796 grams
Mass lost =	185 grams
total % lost	9.845663 %

9.833650062

KJ-PRO-N-1	
Weight (+mold) =	1870 grams
Mass lost =	208 grams
total % lost	10.53165 %

KJ-PRO-N-2	
Weight (+mold) =	1869 grams
Mass lost =	187 grams
total % lost	9.565217 %

KJ-PRO-N-3	
Weight (+mold) =	1756 grams
Mass lost =	203 grams
total % lost	10.92573 %

KJ-PRO-N-4	
Weight (+mold) =	1787 grams
Mass lost =	194 grams
total % lost	10.32464 %

10.33680758

KJ-PRO-N-1	
Weight (+mold) =	1863 grams
Mass lost =	215 grams
total % lost	10.88608 %

KJ-PRO-N-2	
Weight (+mold) =	1857 grams
Mass lost =	199 grams
total % lost	10.17903 %

KJ-PRO-N-3	
Weight (+mold) =	1752 grams
Mass lost =	207 grams
total % lost	11.14101 %

KJ-PRO-N-4	
Weight (+mold) =	1781 grams
Mass lost =	200 grams
total % lost	10.64396 %

10.71251887

KJ-PRO-N-1	
Weight (+mold) =	1862 grams
Mass lost =	216 grams
total % lost	10.93671 %

KJ-PRO-N-2	
Weight (+mold) =	1851 grams
Mass lost =	205 grams
total % lost	10.48593 %

KJ-PRO-N-3	
Weight (+mold) =	1750 grams
Mass lost =	209 grams
total % lost	11.24865 %

KJ-PRO-N-4	
Weight (+mold) =	1779 grams
Mass lost =	202 grams
total % lost	10.7504 %

10.855424

KJ-PRO-N-1		KJ-PRO-N-2		KJ-PRO-N-3		KJ-PRO-N-4	
Weight Alone	1742 grams	Weight Alone	1723 grams	Weight Alone	1621 grams	Weight Alone	1661 grams
Weight mold =	103 grams	Weight mold =	101 grams	Weight mold =	101 grams	Weight mold =	102 grams
Final Mass lost =	233 grams	Final Mass lost =	232 grams	Final Mass lost =	237 grams	Final Mass lost =	218 grams
total % lost	11.79747 %	total % lost	11.86701 %	total % lost	12.75565 %	total % lost	11.60192 %
Comp Strength	XXX psi	Comp Strength	XXX psi	Comp Strength	302 psi	Comp Strength	352 psi
Load (P)	5430 lbs	Load (P)	5810 lbs	XXX	XXX XXX	XXX	XXX XXX
Tensile Strength	121.8645 psi	Tensile Strength	115.7146 psi	Tensile Strength	XXX psi	Tensile Strength	XXX psi

12.00551079

Broken during tensile test prep

Average Comp Strength =	302 psi
Average Tensile Strength =	115.7146 psi

Partially Submerged

KJ-PRO-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2108 grams
Weight mold =	139 grams
Total +Water =	2684 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	576 cm^3
γ Concrete =	1.195211 gm/cm^3
γ Concrete =	74.61461 lb/ft^3
Volume Solids =	1071.407 cm^3
Porosity =	34.96403 %

KJ-PRO-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2143 grams
Weight mold =	139 grams
Total +Water =	2648 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	505 cm^3
γ Concrete =	1.216457 gm/cm^3
γ Concrete =	75.94092 lb/ft^3
Volume Solids =	1142.407 cm^3
Porosity =	30.65423 %

KJ-PRO-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2108 grams
Weight mold =	139 grams
Total +Water =	2665 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	557 cm^3
γ Concrete =	1.195211 gm/cm^3
γ Concrete =	74.61461 lb/ft^3
Volume Solids =	1090.407 cm^3
Porosity =	33.8107 %

KJ-PRO-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2060 grams
Weight mold =	139 grams
Total +Water =	2639 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	579 cm^3
γ Concrete =	1.166075 gm/cm^3
γ Concrete =	72.79566 lb/ft^3
Volume Solids =	1068.407 cm^3
Porosity =	35.14613 %

KJ-PRO-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1984 grams
Weight mold =	99 grams
Original weight =	1969 grams
Mass lost =	84 grams
total % lost	4.266125 %

KJ-PRO-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2027 grams
Weight mold =	101 grams
Original weight =	2004 grams
Mass lost =	78 grams
total % lost	3.892216 %

KJ-PRO-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1981 grams
Weight mold =	101 grams
Original weight =	1969 grams
Mass lost =	89 grams
total % lost	4.520061 %

KJ-PRO-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1920 grams
Weight mold =	100 grams
Original weight =	1921 grams
Mass lost =	101 grams
total % lost	5.257678 %

4.484019936

KJ-PRO-P-1	
Weight (+mold) =	1943 grams
Mass lost =	125 grams
total % lost	6.3484 %

KJ-PRO-P-2	
Weight (+mold) =	2008 grams
Mass lost =	97 grams
total % lost	4.840319 %

KJ-PRO-P-3	
Weight (+mold) =	1952 grams
Mass lost =	118 grams
total % lost	6.045082 %

KJ-PRO-P-4	
Weight (+mold) =	1908 grams
Mass lost =	113 grams
total % lost	5.882353 %

5.779038618

KJ-PRO-P-1	
Weight (+mold) =	1865 grams
Mass lost =	203 grams
total % lost	10.3098 %

KJ-PRO-P-2	
Weight (+mold) =	1923 grams
Mass lost =	182 grams
total % lost	9.081836 %

KJ-PRO-P-3	
Weight (+mold) =	1873 grams
Mass lost =	197 grams
total % lost	10.09221 %

KJ-PRO-P-4	
Weight (+mold) =	1828 grams
Mass lost =	193 grams
total % lost	10.04685 %

9.882675493

KJ-PRO-P-1	
Weight (+mold) =	1856 grams
Mass lost =	212 grams
total % lost	10.76689 %

KJ-PRO-P-2	
Weight (+mold) =	1907 grams
Mass lost =	198 grams
total % lost	9.88024 %

KJ-PRO-P-3	
Weight (+mold) =	1865 grams
Mass lost =	205 grams
total % lost	10.50205 %

KJ-PRO-P-4	
Weight (+mold) =	1809 grams
Mass lost =	212 grams
total % lost	11.03592 %

10.54627356

KJ-PRO-P-1	
Weight (+mold) =	1856 grams
Mass lost =	212 grams
total % lost	10.76689 %

KJ-PRO-P-2	
Weight (+mold) =	1901 grams
Mass lost =	204 grams
total % lost	10.17964 %

KJ-PRO-P-3	
Weight (+mold) =	1864 grams
Mass lost =	206 grams
total % lost	10.55328 %

KJ-PRO-P-4	
Weight (+mold) =	1808 grams
Mass lost =	213 grams
total % lost	11.08798 %

10.64694529

KJ-PRO-P-1	
Weight (+mold) =	1856 grams
Mass lost =	212 grams
total % lost	10.76689 %

KJ-PRO-P-2	
Weight (+mold) =	1900 grams
Mass lost =	205 grams
total % lost	10.22954 %

KJ-PRO-P-3	
Weight (+mold) =	1860 grams
Mass lost =	210 grams
total % lost	10.7582 %

KJ-PRO-P-4	
Weight (+mold) =	1807 grams
Mass lost =	214 grams
total % lost	11.14003 %

10.7236639

KJ-PRO-P-1	
Weight (+mold) =	1855 grams
Mass lost =	213 grams
total % lost	10.81767 %

KJ-PRO-P-2	
Weight (+mold) =	1900 grams
Mass lost =	205 grams
total % lost	10.22954 %

KJ-PRO-P-3	
Weight (+mold) =	1860 grams
Mass lost =	210 grams
total % lost	10.7582 %

KJ-PRO-P-4	
Weight (+mold) =	1805 grams
Mass lost =	216 grams
total % lost	11.24414 %

10.76238882

KJ-PRO-P-1	
Weight (+mold) =	1855 grams
Mass lost =	213 grams
total % lost	10.81767 %

KJ-PRO-P-2	
Weight (+mold) =	1900 grams
Mass lost =	205 grams
total % lost	10.22954 %

KJ-PRO-P-3	
Weight (+mold) =	1860 grams
Mass lost =	210 grams
total % lost	10.7582 %

KJ-PRO-P-4	
Weight (+mold) =	1805 grams
Mass lost =	216 grams
total % lost	11.24414 %

10.76238882

KJ-PRO-P-1	
Weight (+mold) =	1855 grams
Mass lost =	213 grams
total % lost	10.81767 %

KJ-PRO-P-2	
Weight (+mold) =	1899 grams
Mass lost =	206 grams
total % lost	10.27944 %

KJ-PRO-P-3	
Weight (+mold) =	1860 grams
Mass lost =	210 grams
total % lost	10.7582 %

KJ-PRO-P-4	
Weight (+mold) =	1805 grams
Mass lost =	216 grams
total % lost	11.24414 %

10.77486387

KJ-PRO-P-1		KJ-PRO-P-2		KJ-PRO-P-3		KJ-PRO-P-4	
Weight Alone	1749 grams	Weight Alone	1795 grams	Weight Alone	1762 grams	Weight Alone	1704 grams
Weight mold =	99 grams	Weight mold =	101 grams	Weight mold =	101 grams	Weight mold =	100 grams
Final Mass lost =	220 grams	Final Mass lost =	209 grams	Final Mass lost =	207 grams	Final Mass lost =	217 grams
total % lost	11.17318 %	total % lost	10.42914 %	total % lost	10.51295 %	total % lost	11.2962 %
Comp Strength	405 psi	Comp Strength	XXX psi	Comp Strength	445 psi	Comp Strength	XXX psi
XXX	XXX XXX	Load (P)	7610 lbs	XXX	XXX XXX	Load (P)	6460 lbs
Tensile Strength	XXX psi	Tensile Strength	151.5245 psi	Tensile Strength	XXX psi	Tensile Strength	128.6459 psi

10.85286918

Average Comp Strength =	425 psi
Average Tensile Strength =	140.0852 psi

Fully Submerged

KJ-PRO-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2095 grams
Weight mold =	139 grams
Total +Water =	2656 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	561 cm^3
γ Concrete =	1.18732 gm/cm^3
γ Concrete =	74.12198 lb/ft^3
Volume Solids =	1086.407 cm^3
Porosity =	34.05351 %

KJ-PRO-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2010 grams
Weight mold =	139 grams
Total +Water =	2619 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	609 cm^3
γ Concrete =	1.135724 gm/cm^3
γ Concrete =	70.90093 lb/ft^3
Volume Solids =	1038.407 cm^3
Porosity =	36.96718 %

KJ-PRO-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2043 grams
Weight mold =	139 grams
Total +Water =	2633 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	590 cm^3
γ Concrete =	1.155755 gm/cm^3
γ Concrete =	72.15145 lb/ft^3
Volume Solids =	1057.407 cm^3
Porosity =	35.81385 %

KJ-PRO-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1991 grams
Weight mold =	139 grams
Total +Water =	2609 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	618 cm^3
γ Concrete =	1.124191 gm/cm^3
γ Concrete =	70.18093 lb/ft^3
Volume Solids =	1029.407 cm^3
Porosity =	37.51349 %

KJ-PRO-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1985 grams
Weight mold =	104 grams
Original weight =	1956 grams
Mass lost =	75 grams
total % lost	3.834356 %

KJ-PRO-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1882 grams
Weight mold =	101 grams
Original weight =	1871 grams
Mass lost =	90 grams
total % lost	4.810262 %

KJ-PRO-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1923 grams
Weight mold =	100 grams
Original weight =	1904 grams
Mass lost =	81 grams
total % lost	4.254202 %

KJ-PRO-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	1893 grams
Weight mold =	103 grams
Original weight =	1852 grams
Mass lost =	62 grams
total % lost	3.347732 %

4.061637896

KJ-PRO-F-1	
Weight (+mold) =	1926 grams
Mass lost =	134 grams
total % lost	6.850716 %

KJ-PRO-F-2	
Weight (+mold) =	1811 grams
Mass lost =	161 grams
total % lost	8.605024 %

KJ-PRO-F-3	
Weight (+mold) =	1867 grams
Mass lost =	137 grams
total % lost	7.195378 %

KJ-PRO-F-4	
Weight (+mold) =	1838 grams
Mass lost =	117 grams
total % lost	6.317495 %

7.242153137

KJ-PRO-F-1	
Weight (+mold) =	1900 grams
Mass lost =	160 grams
total % lost	8.179959 %

KJ-PRO-F-2	
Weight (+mold) =	1798 grams
Mass lost =	174 grams
total % lost	9.29984 %

KJ-PRO-F-3	
Weight (+mold) =	1819 grams
Mass lost =	185 grams
total % lost	9.716387 %

KJ-PRO-F-4	
Weight (+mold) =	1793 grams
Mass lost =	162 grams
total % lost	8.7473 %

8.985871382

KJ-PRO-F-1	
Weight (+mold) =	1886 grams
Mass lost =	174 grams
total % lost	8.895706 %

KJ-PRO-F-2	
Weight (+mold) =	1788 grams
Mass lost =	184 grams
total % lost	9.834313 %

KJ-PRO-F-3	
Weight (+mold) =	1814 grams
Mass lost =	190 grams
total % lost	9.978992 %

KJ-PRO-F-4	
Weight (+mold) =	1788 grams
Mass lost =	167 grams
total % lost	9.017279 %

9.431572234

KJ-PRO-F-1	
Weight (+mold) =	1874 grams
Mass lost =	186 grams
total % lost	9.509202 %

KJ-PRO-F-2	
Weight (+mold) =	1776 grams
Mass lost =	196 grams
total % lost	10.47568 %

KJ-PRO-F-3	
Weight (+mold) =	1806 grams
Mass lost =	198 grams
total % lost	10.39916 %

KJ-PRO-F-4	
Weight (+mold) =	1766 grams
Mass lost =	189 grams
total % lost	10.20518 %

10.14730679

KJ-PRO-F-1	
Weight (+mold) =	1864 grams
Mass lost =	196 grams
total % lost	10.02045 %

KJ-PRO-F-2	
Weight (+mold) =	1767 grams
Mass lost =	205 grams
total % lost	10.95671 %

KJ-PRO-F-3	
Weight (+mold) =	1801 grams
Mass lost =	203 grams
total % lost	10.66176 %

KJ-PRO-F-4	
Weight (+mold) =	1758 grams
Mass lost =	197 grams
total % lost	10.63715 %

10.56901782

KJ-PRO-F-1	
Weight (+mold) =	1864 grams
Mass lost =	196 grams
total % lost	10.02045 %

KJ-PRO-F-2	
Weight (+mold) =	1760 grams
Mass lost =	212 grams
total % lost	11.33084 %

KJ-PRO-F-3	
Weight (+mold) =	1800 grams
Mass lost =	204 grams
total % lost	10.71429 %

KJ-PRO-F-4	
Weight (+mold) =	1755 grams
Mass lost =	200 grams
total % lost	10.79914 %

10.7161777

KJ-PRO-F-1	
Weight (+mold) =	1855 grams
Mass lost =	205 grams
total % lost	10.48057 %

KJ-PRO-F-2	
Weight (+mold) =	1760 grams
Mass lost =	212 grams
total % lost	11.33084 %

KJ-PRO-F-3	
Weight (+mold) =	1800 grams
Mass lost =	204 grams
total % lost	10.71429 %

KJ-PRO-F-4	
Weight (+mold) =	1755 grams
Mass lost =	200 grams
total % lost	10.79914 %

10.83120838

KJ-PRO-F-1	
Weight (+mold) =	1854 grams
Mass lost =	206 grams
total % lost	10.5317 %

KJ-PRO-F-2	
Weight (+mold) =	1759 grams
Mass lost =	213 grams
total % lost	11.38429 %

KJ-PRO-F-3	
Weight (+mold) =	1799 grams
Mass lost =	205 grams
total % lost	10.76681 %

KJ-PRO-F-4	
Weight (+mold) =	1755 grams
Mass lost =	200 grams
total % lost	10.79914 %

10.87048165

KJ-PRO-F-1		KJ-PRO-F-2		KJ-PRO-F-3		KJ-PRO-F-4	
Weight Alone	1746 grams	Weight Alone	1652 grams	Weight Alone	1690 grams	Weight Alone	1646 grams
Weight mold =	104 grams	Weight mold =	101 grams	Weight mold =	100 grams	Weight mold =	103 grams
Final Mass lost =	210 grams	Final Mass lost =	219 grams	Final Mass lost =	214 grams	Final Mass lost =	206 grams
total % lost	10.7362 %	total % lost	11.70497 %	total % lost	11.2395 %	total % lost	11.12311 %
Comp Strength	385 psi	Comp Strength	XXX psi	Comp Strength	382 psi	Comp Strength	XXX psi
XXX	XXX XXX	Load (P)	3090 lbs	XXX	XXX XXX	Load (P)	3870 lbs
Tensile Strength	XXX psi	Tensile Strength	61.60192 psi	Tensile Strength	XXX psi	Tensile Strength	77.11952 psi

11.20094322

Average Comp Strength =	383.5 psi
Average Tensile Strength =	69.36072 psi

PRM with No Fibers

Control

6/11/2013 MIX DATE; 6/25/2013 INTO CHAMBER

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams
Total +Water =	3432 grams	Total +Water =	3446 grams	Total +Water =	3424 grams	Total +Water =	3506 grams
Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3
Volume Water =	487 cm^3	Volume Water =	470 cm^3	Volume Water =	447 cm^3	Volume Water =	429 cm^3
γ Concrete =	1.703282 gm/cm^3	γ Concrete =	1.7221 gm/cm^3	γ Concrete =	1.722707 gm/cm^3	γ Concrete =	1.783408 gm/cm^3
γ Concrete =	106.3324 lb/ft^3	γ Concrete =	107.5072 lb/ft^3	γ Concrete =	107.5451 lb/ft^3	γ Concrete =	111.3345 lb/ft^3
Volume Solids =	1160.407 cm^3	Volume Solids =	1177.407 cm^3	Volume Solids =	1200.407 cm^3	Volume Solids =	1218.407 cm^3
Porosity =	29.5616 %	Porosity =	28.52968 %	Porosity =	27.13354 %	Porosity =	26.04092 %

C = CONTROL (NO CHAMBER)
N = NO SUBMERSION
P = PARTIALLY SUBMERSED
F = FULLY SUBMERSED

AVG POROSITY = 26.00298

CONFINEMENT ACHIEVED BY CUTTING OFF BOTTOM OF PLASTIC CYLINDER WITH A DREMEL TOOL

7/2/13 (After 36 cylcles)

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Weight mold =	100 grams	Weight mold =	100 grams	Weight mold =	100 grams	Weight mold =	100 grams
Original weight =	2845 grams	Original weight =	2876 grams	Original weight =	2877 grams	Original weight =	2977 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
% lost =	0 %	% lost =	0 %	% lost =	0 %	% lost =	0 %

7/9/2013 (After 72 cycles)

Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

7/16/2013 (After 108 cycles)

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost =	0 %	total % lost =	0 %	total % lost =	0 %	total % lost =	0 %

7/23/2013 (After 144 cycles)

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

7/30/2013 (After 180 cycles)

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

8/6/2013 (After 216 cycles)

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

8/14/2013 (After 252 cycles)

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

8/21/2013 (After 288 cycles)

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

(After 300 cycles) Freeze-thaw machine broke!

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight (+mold) =	2945 grams	Weight (+mold) =	2976 grams	Weight (+mold) =	2977 grams	Weight (+mold) =	3077 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

CRUSH TESTS 11/8/2013

PRM-NF-C-1		PRM-NF-C-2		PRM-NF-C-3		PRM-NF-C-4	
Weight Alone	2795 grams	Weight Alone	2835 grams	Weight Alone	2826 grams	Weight Alone	2930 grams
Weight mold =	150 grams	Weight mold =	141 grams	Weight mold =	151 grams	Weight mold =	147 grams
Final Mass lost =	0 grams	Final Mass lost =	0 grams	Final Mass lost =	0 grams	Final Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %
Comp Strength	1110 psi	Comp Strength	1200 psi	Comp Strength	XXX psi	Comp Strength	XXX psi
XXX	XXX XXX	XXX	XXX XXX	XXX	11560 XXX	Load (P)	11280 lbs
Tensile Strength	XXX psi	Tensile Strength	XXX psi	Tensile Strength	230.1072 psi	Tensile Strength	224.5368 psi

Load Rate = 500 to 1000 lb/ minute
hear scoria crushing, no sudden failure, very subtle

Average Comp Strength =	1155 psi
Average Tensile Strength =	227.322 psi

Unsubmerged

PRM-NF-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3103 grams
Weight mold =	139 grams
Total +Water =	3525 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	422 cm^3
γ Concrete =	1.799191 gm/cm^3
γ Concrete =	112.3198 lb/ft^3
Volume Solids =	1225.407 cm^3
Porosity =	25.61601 %

PRM-NF-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2982 grams
Weight mold =	139 grams
Total +Water =	3442 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	460 cm^3
γ Concrete =	1.725742 gm/cm^3
γ Concrete =	107.7346 lb/ft^3
Volume Solids =	1187.407 cm^3
Porosity =	27.92266 %

PRM-NF-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3026 grams
Weight mold =	139 grams
Total +Water =	3458 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	432 cm^3
γ Concrete =	1.752451 gm/cm^3
γ Concrete =	109.4019 lb/ft^3
Volume Solids =	1215.407 cm^3
Porosity =	26.22302 %

PRM-NF-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3203 grams
Weight mold =	139 grams
Total +Water =	3566 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	363 cm^3
γ Concrete =	1.859892 gm/cm^3
γ Concrete =	116.1093 lb/ft^3
Volume Solids =	1284.407 cm^3
Porosity =	22.03462 %

PRM-NF-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3087 grams
Weight mold =	100 grams
Original weight =	2964 grams
Mass lost =	-23 grams
% lost =	-0.77598 %
-0.69708096	
Weight (+mold) =	3076 grams
Mass lost =	12 grams
total % lost	0.404858 %
0.023743401	

PRM-NF-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2963 grams
Weight mold =	100 grams
Original weight =	2843 grams
Mass lost =	-20 grams
% lost =	-0.70348 %
Weight (+mold) =	2947 grams
Mass lost =	-4 grams
total % lost	-0.1407 %

PRM-NF-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3005 grams
Weight mold =	100 grams
Original weight =	2887 grams
Mass lost =	-18 grams
% lost =	-0.62348 %
Weight (+mold) =	2990 grams
Mass lost =	-3 grams
total % lost	-0.10391 %

PRM-NF-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3185 grams
Weight mold =	100 grams
Original weight =	3064 grams
Mass lost =	-21 grams
% lost =	-0.68538 %
Weight (+mold) =	3166 grams
Mass lost =	-2 grams
total % lost	-0.06527 %

PRM-NF-N-1	
Weight (+mold) =	3060 grams
Mass lost =	4 grams
total % lost =	0.134953 %

PRM-NF-N-2	
Weight (+mold) =	2936 grams
Mass lost =	7 grams
total % lost =	0.246219 %

PRM-NF-N-3	
Weight (+mold) =	2960 grams
Mass lost =	27 grams
total % lost =	0.935227 %

PRM-NF-N-4	
Weight (+mold) =	3158 grams
Mass lost =	6 grams
total % lost =	0.195822 %

0.378055221

PRM-NF-N-1	
Weight (+mold) =	3062 grams
Mass lost =	2 grams
total % lost	0.067476 %

PRM-NF-N-2	
Weight (+mold) =	2936 grams
Mass lost =	7 grams
total % lost	0.246219 %

PRM-NF-N-3	
Weight (+mold) =	2960 grams
Mass lost =	27 grams
total % lost	0.935227 %

PRM-NF-N-4	
Weight (+mold) =	3160 grams
Mass lost =	4 grams
total % lost	0.130548 %

0.344867587

PRM-NF-N-1	
Weight (+mold) =	3062 grams
Mass lost =	2 grams
total % lost	0.067476 %

PRM-NF-N-2	
Weight (+mold) =	2940 grams
Mass lost =	3 grams
total % lost	0.105522 %

PRM-NF-N-3	
Weight (+mold) =	2963 grams
Mass lost =	24 grams
total % lost	0.831313 %

PRM-NF-N-4	
Weight (+mold) =	3161 grams
Mass lost =	3 grams
total % lost	0.097911 %

0.275555682

PRM-NF-N-1	
Weight (+mold) =	3061 grams
Mass lost =	3 grams
total % lost	0.101215 %

PRM-NF-N-2	
Weight (+mold) =	2937 grams
Mass lost =	6 grams
total % lost	0.211045 %

PRM-NF-N-3	
Weight (+mold) =	2961 grams
Mass lost =	26 grams
total % lost	0.900589 %

PRM-NF-N-4	
Weight (+mold) =	3158 grams
Mass lost =	6 grams
total % lost	0.195822 %

0.352167637

PRM-NF-N-1	
Weight (+mold) =	3062 grams
Mass lost =	2 grams
total % lost	0.067476 %

PRM-NF-N-2	
Weight (+mold) =	2937 grams
Mass lost =	6 grams
total % lost	0.211045 %

PRM-NF-N-3	
Weight (+mold) =	2959 grams
Mass lost =	28 grams
total % lost	0.969865 %

PRM-NF-N-4	
Weight (+mold) =	3160 grams
Mass lost =	4 grams
total % lost	0.130548 %

0.344733567

PRM-NF-N-1	
Weight (+mold) =	3062 grams
Mass lost =	2 grams
total % lost	0.067476 %

PRM-NF-N-2	
Weight (+mold) =	2938 grams
Mass lost =	5 grams
total % lost	0.175871 %

PRM-NF-N-3	
Weight (+mold) =	2961 grams
Mass lost =	26 grams
total % lost	0.900589 %

PRM-NF-N-4	
Weight (+mold) =	3160 grams
Mass lost =	4 grams
total % lost	0.130548 %

0.318621023

PRM-NF-N-1	
Weight (+mold) =	3064 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NF-N-2	
Weight (+mold) =	2940 grams
Mass lost =	3 grams
total % lost	0.105522 %

PRM-NF-N-3	
Weight (+mold) =	2963 grams
Mass lost =	24 grams
total % lost	0.831313 %

PRM-NF-N-4	
Weight (+mold) =	3162 grams
Mass lost =	2 grams
total % lost	0.065274 %

0.250527317

PRM-NF-N-1	
Weight Alone	3060 grams
Weight mold =	101 grams
Final Mass lost =	-3161 grams
total % lost	-106.646 %
Comp Strength	XXX psi
Load (P)	18860 lbs
Tensile Strength	422.9139 psi

PRM-NF-N-2	
Weight Alone	2836 grams
Weight mold =	104 grams
Final Mass lost =	-2936.89 grams
total % lost	-103.303 %
Comp Strength	XXX psi
Load (P)	13720 lbs
Tensile Strength	273.079 psi

PRM-NF-N-3	
Weight Alone	2860 grams
Weight mold =	103 grams
Final Mass lost =	-2938.17 grams
total % lost	-101.772 %
Comp Strength	1390 psi
Load (P)	XXX
Tensile Strength	XXX psi

PRM-NF-N-4	
Weight Alone	2961 grams
Weight mold =	101 grams
Final Mass lost =	-3059.93 grams
total % lost	-99.8673 %
Comp Strength	2072 psi
Load (P)	XXX
Tensile Strength	XXX psi

-102.897196

Broken during tensile test prep

Average Comp Strength =	1731 psi
Average Tensile Strength =	347.9965 psi

Partially Submerged

PRM-NF-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3100 grams
Weight mold =	139 grams
Total +Water =	3508 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	408 cm^3
γ Concrete =	1.79737 gm/cm^3
γ Concrete =	112.2061 lb/ft^3
Volume Solids =	1239.407 cm^3
Porosity =	24.76619 %

PRM-NF-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3085 grams
Weight mold =	139 grams
Total +Water =	3521 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	436 cm^3
γ Concrete =	1.788264 gm/cm^3
γ Concrete =	111.6377 lb/ft^3
Volume Solids =	1211.407 cm^3
Porosity =	26.46583 %

PRM-NF-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3086 grams
Weight mold =	139 grams
Total +Water =	3530 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	444 cm^3
γ Concrete =	1.788871 gm/cm^3
γ Concrete =	111.6756 lb/ft^3
Volume Solids =	1203.407 cm^3
Porosity =	26.95144 %

PRM-NF-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3220 grams
Weight mold =	139 grams
Total +Water =	3586 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	366 cm^3
γ Concrete =	1.870211 gm/cm^3
γ Concrete =	116.7535 lb/ft^3
Volume Solids =	1281.407 cm^3
Porosity =	22.21673 %

PRM-NF-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3053 grams
Weight mold =	100 grams
Original weight =	2961 grams
Mass lost =	8 grams
% lost =	0.270179 %
0.145383794	
Weight (+mold) =	3050 grams
Mass lost =	11 grams
total % lost	0.371496 %
0.332959728	

PRM-NF-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3041 grams
Weight mold =	100 grams
Original weight =	2946 grams
Mass lost =	5 grams
% lost =	0.169722 %
Weight (+mold) =	3038 grams
Mass lost =	8 grams
total % lost	0.271555 %

PRM-NF-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3039 grams
Weight mold =	100 grams
Original weight =	2947 grams
Mass lost =	8 grams
% lost =	0.271463 %
Weight (+mold) =	3033 grams
Mass lost =	14 grams
total % lost	0.461589 %

PRM-NF-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3185 grams
Weight mold =	100 grams
Original weight =	3081 grams
Mass lost =	-4 grams
% lost =	-0.12983 %
Weight (+mold) =	3174 grams
Mass lost =	7 grams
total % lost	0.227199 %

PRM-NF-P-1	
Weight (+mold) =	3054 grams
Mass lost =	7 grams
total % lost =	0.236407 %

PRM-NF-P-2	
Weight (+mold) =	3042 grams
Mass lost =	4 grams
total % lost =	0.135777 %

PRM-NF-P-3	
Weight (+mold) =	3035 grams
Mass lost =	12 grams
total % lost =	0.395648 %

PRM-NF-P-4	
Weight (+mold) =	3173 grams
Mass lost =	8 grams
total % lost =	0.259656 %

0.256871943

PRM-NF-P-1	
Weight (+mold) =	3046 grams
Mass lost =	15 grams
total % lost	0.506586 %

PRM-NF-P-2	
Weight (+mold) =	3032 grams
Mass lost =	14 grams
total % lost	0.475221 %

PRM-NF-P-3	
Weight (+mold) =	3027 grams
Mass lost =	20 grams
total % lost	0.659413 %

PRM-NF-P-4	
Weight (+mold) =	3166 grams
Mass lost =	15 grams
total % lost	0.486855 %

0.532018573

PRM-NF-P-1	
Weight (+mold) =	3051 grams
Mass lost =	10 grams
total % lost	0.337724 %

PRM-NF-P-2	
Weight (+mold) =	3043 grams
Mass lost =	3 grams
total % lost	0.101833 %

PRM-NF-P-3	
Weight (+mold) =	3034 grams
Mass lost =	13 grams
total % lost	0.428619 %

PRM-NF-P-4	
Weight (+mold) =	3172 grams
Mass lost =	9 grams
total % lost	0.292113 %

0.290072054

PRM-NF-P-1	
Weight (+mold) =	3045 grams
Mass lost =	16 grams
total % lost	0.540358 %

PRM-NF-P-2	
Weight (+mold) =	3034 grams
Mass lost =	12 grams
total % lost	0.407332 %

PRM-NF-P-3	
Weight (+mold) =	3024 grams
Mass lost =	23 grams
total % lost	0.758325 %

PRM-NF-P-4	
Weight (+mold) =	3166 grams
Mass lost =	15 grams
total % lost	0.486855 %

0.548217493

PRM-NF-P-1	
Weight (+mold) =	3048 grams
Mass lost =	13 grams
total % lost	0.439041 %

PRM-NF-P-2	
Weight (+mold) =	3037 grams
Mass lost =	9 grams
total % lost	0.305499 %

PRM-NF-P-3	
Weight (+mold) =	3025 grams
Mass lost =	22 grams
total % lost	0.725354 %

PRM-NF-P-4	
Weight (+mold) =	3169 grams
Mass lost =	12 grams
total % lost	0.389484 %

0.464844554

PRM-NF-P-1	
Weight (+mold) =	3050 grams
Mass lost =	11 grams
total % lost	0.371496 %

PRM-NF-P-2	
Weight (+mold) =	3046 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NF-P-3	
Weight (+mold) =	3031 grams
Mass lost =	16 grams
total % lost	0.52753 %

PRM-NF-P-4	
Weight (+mold) =	3174 grams
Mass lost =	7 grams
total % lost	0.227199 %

0.281556394

PRM-NF-P-1	
Weight (+mold) =	3057 grams
Mass lost =	4 grams
total % lost	0.135089 %

PRM-NF-P-2	
Weight (+mold) =	3054 grams
Mass lost =	-8 grams
total % lost	-0.27155 %

PRM-NF-P-3	
Weight (+mold) =	3037 grams
Mass lost =	10 grams
total % lost	0.329707 %

PRM-NF-P-4	
Weight (+mold) =	3187 grams
Mass lost =	-6 grams
total % lost	-0.19474 %

-0.00037514

PRM-NF-P-1		PRM-NF-P-2		PRM-NF-P-3		PRM-NF-P-4	
Weight Alone	3087 grams	Weight Alone	2947 grams	Weight Alone	2927 grams	Weight Alone	2947 grams
Weight mold =	102 grams	Weight mold =	105 grams	Weight mold =	101 grams	Weight mold =	102 grams
Final Mass lost =	-3184.86 grams	Final Mass lost =	-3060.27 grams	Final Mass lost =	-3017.67 grams	Final Mass lost =	-3055.19 grams
total % lost	-107.56 %	total % lost	-103.879 %	total % lost	-102.398 %	total % lost	-99.1624 %
Comp Strength	XXX psi	Comp Strength	XXX psi	Comp Strength	1110 psi	Comp Strength	2432 psi
XXX	16720 XXX	Load (P)	9150 lbs	XXX	XXX	XXX	XXX
Tensile Strength	332.7621 psi	Tensile Strength	182.1618 psi	Tensile Strength	XXX psi	Tensile Strength	XXX psi

-103.24995

Average Comp Strength =	1771 psi
Average Tensile Strength =	257.462 psi

Fully Submerged

PRM-NF-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2938 grams
Weight mold =	139 grams
Total +Water =	3421 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	483 cm^3
γ Concrete =	1.699033 gm/cm^3
γ Concrete =	106.0672 lb/ft^3
Volume Solids =	1164.407 cm^3
Porosity =	29.3188 %

PRM-NF-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3060 grams
Weight mold =	139 grams
Total +Water =	3488 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	428 cm^3
γ Concrete =	1.773089 gm/cm^3
γ Concrete =	110.6903 lb/ft^3
Volume Solids =	1219.407 cm^3
Porosity =	25.98022 %

PRM-NF-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3067 grams
Weight mold =	139 grams
Total +Water =	3471 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	404 cm^3
γ Concrete =	1.777338 gm/cm^3
γ Concrete =	110.9556 lb/ft^3
Volume Solids =	1243.407 cm^3
Porosity =	24.52338 %

PRM-NF-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3141 grams
Weight mold =	139 grams
Total +Water =	3516 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	375 cm^3
γ Concrete =	1.822257 gm/cm^3
γ Concrete =	113.7598 lb/ft^3
Volume Solids =	1272.407 cm^3
Porosity =	22.76304 %

PRM-NF-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2891 grams
Weight mold =	100 grams
Original weight =	2799 grams
Mass lost =	8 grams
% lost =	0.285816 %
0.181670863	
Weight (+mold) =	2884 grams
Mass lost =	15 grams
total % lost	0.535906 %
0.293636635	

PRM-NF-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3018 grams
Weight mold =	100 grams
Original weight =	2921 grams
Mass lost =	3 grams
% lost =	0.102705 %
Weight (+mold) =	3023 grams
Mass lost =	-2 grams
total % lost	-0.06847 %

PRM-NF-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3022 grams
Weight mold =	100 grams
Original weight =	2928 grams
Mass lost =	6 grams
% lost =	0.204918 %
Weight (+mold) =	3019 grams
Mass lost =	9 grams
total % lost	0.307377 %

PRM-NF-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3098 grams
Weight mold =	100 grams
Original weight =	3002 grams
Mass lost =	4 grams
% lost =	0.133245 %
Weight (+mold) =	3090 grams
Mass lost =	12 grams
total % lost	0.399734 %

PRM-NF-F-1	
Weight (+mold) =	2888 grams
Mass lost =	11 grams
total % lost =	0.392997 %

PRM-NF-F-2	
Weight (+mold) =	3019 grams
Mass lost =	2 grams
total % lost =	0.06847 %

PRM-NF-F-3	
Weight (+mold) =	3019 grams
Mass lost =	9 grams
total % lost =	0.307377 %

PRM-NF-F-4	
Weight (+mold) =	3091 grams
Mass lost =	11 grams
total % lost =	0.366422 %

0.283816659

PRM-NF-F-1	
Weight (+mold) =	2883 grams
Mass lost =	16 grams
total % lost	0.571633 %

PRM-NF-F-2	
Weight (+mold) =	3013 grams
Mass lost =	8 grams
total % lost	0.273879 %

PRM-NF-F-3	
Weight (+mold) =	3014 grams
Mass lost =	14 grams
total % lost	0.478142 %

PRM-NF-F-4	
Weight (+mold) =	3080 grams
Mass lost =	22 grams
total % lost	0.732845 %

0.514124595

PRM-NF-F-1	
Weight (+mold) =	2886 grams
Mass lost =	13 grams
total % lost	0.464452 %

PRM-NF-F-2	
Weight (+mold) =	3022 grams
Mass lost =	-1 grams
total % lost	-0.03423 %

PRM-NF-F-3	
Weight (+mold) =	3024 grams
Mass lost =	4 grams
total % lost	0.136612 %

PRM-NF-F-4	
Weight (+mold) =	3094 grams
Mass lost =	8 grams
total % lost	0.266489 %

0.208329442

PRM-NF-F-1	
Weight (+mold) =	2884 grams
Mass lost =	15 grams
total % lost	0.535906 %

PRM-NF-F-2	
Weight (+mold) =	3015 grams
Mass lost =	6 grams
total % lost	0.205409 %

PRM-NF-F-3	
Weight (+mold) =	3018 grams
Mass lost =	10 grams
total % lost	0.34153 %

PRM-NF-F-4	
Weight (+mold) =	3086 grams
Mass lost =	16 grams
total % lost	0.532978 %

0.403955714

PRM-NF-F-1	
Weight (+mold) =	2882 grams
Mass lost =	17 grams
total % lost	0.60736 %

PRM-NF-F-2	
Weight (+mold) =	3012 grams
Mass lost =	9 grams
total % lost	0.308114 %

PRM-NF-F-3	
Weight (+mold) =	3017 grams
Mass lost =	11 grams
total % lost	0.375683 %

PRM-NF-F-4	
Weight (+mold) =	3085 grams
Mass lost =	17 grams
total % lost	0.566289 %

0.464361408

PRM-NF-F-1	
Weight (+mold) =	2889 grams
Mass lost =	10 grams
total % lost	0.35727 %

PRM-NF-F-2	
Weight (+mold) =	3022 grams
Mass lost =	-1 grams
total % lost	-0.03423 %

PRM-NF-F-3	
Weight (+mold) =	3022 grams
Mass lost =	6 grams
total % lost	0.204918 %

PRM-NF-F-4	
Weight (+mold) =	3092 grams
Mass lost =	10 grams
total % lost	0.333111 %

0.215266224

PRM-NF-F-1	
Weight (+mold) =	2895 grams
Mass lost =	4 grams
total % lost	0.142908 %

PRM-NF-F-2	
Weight (+mold) =	3028 grams
Mass lost =	-7 grams
total % lost	-0.23964 %

PRM-NF-F-3	
Weight (+mold) =	3033 grams
Mass lost =	-5 grams
total % lost	-0.17077 %

PRM-NF-F-4	
Weight (+mold) =	3096 grams
Mass lost =	6 grams
total % lost	0.199867 %

-0.01690851

PRM-NF-F-1		PRM-NF-F-2		PRM-NF-F-3		PRM-NF-F-4	
Weight Alone	2467 grams	Weight Alone	2930 grams	Weight Alone	2841 grams	Weight Alone	2991 grams
Weight mold =	102 grams	Weight mold =	102 grams	Weight mold =	103 grams	Weight mold =	102 grams
Final Mass lost =	-2564.86 grams	Final Mass lost =	-3039.24 grams	Final Mass lost =	-2949.17 grams	Final Mass lost =	-3086.8 grams
total % lost	-91.6348 %	total % lost	-104.048 %	total % lost	-100.723 %	total % lost	-102.825 %
Comp Strength	XXX psi	Comp Strength	XXX psi	Comp Strength	XXX psi	Comp Strength	1725 psi
XXX	XXX	Load (P)	3120 lbs	XXX	XXX	XXX	XXX
Tensile Strength	XXX psi	Tensile Strength	142.1686 psi	Tensile Strength	XXX psi	Tensile Strength	XXX psi
Broken, cannot test		Broken, Cannot test		Broken, Cannot test			
-99.8076289							

Average Comp Strength =	--- psi
Average Tensile Strength =	142.1686 psi

PRM with Nycon Fibers

Control

6/11\/2013 MIX DATE; 6/25/2013 INTO CHAMBER

PRM-NY-C-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2954 grams
Weight mold =	139 grams
Total +Water =	3425 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	471 cm^3
γ Concrete =	1.708746 gm/cm^3
γ Concrete =	106.6735 lb/ft^3
Volume Solids =	1176.407 cm^3
Porosity =	28.59038 %

PRM-NY-C-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3073 grams
Weight mold =	139 grams
Total +Water =	3511 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	438 cm^3
γ Concrete =	1.78098 gm/cm^3
γ Concrete =	111.183 lb/ft^3
Volume Solids =	1209.407 cm^3
Porosity =	26.58723 %

PRM-NY-C-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3025 grams
Weight mold =	139 grams
Total +Water =	3467 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	442 cm^3
γ Concrete =	1.751844 gm/cm^3
γ Concrete =	109.364 lb/ft^3
Volume Solids =	1205.407 cm^3
Porosity =	26.83004 %

PRM-NY-C-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3063 grams
Weight mold =	139 grams
Total +Water =	3481 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	418 cm^3
γ Concrete =	1.77491 gm/cm^3
γ Concrete =	110.804 lb/ft^3
Volume Solids =	1229.407 cm^3
Porosity =	25.3732 %

C = CONTROL (NO CHAMBER)
N = NO SUBMERSION
P = PARTIALLY SUBMERSED
F = FULLY SUBMERSED

AVG POROSITY = 26.18888

CONFINEMENT ACHIEVED BY CUTTING OFF BOTTOM OF PLASTIC CYLINDER WITH A DREMEL TOOL

7/2/13 (After 36 cylcles)

PRM-NY-C-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2954 grams
Weight mold =	100 grams
Original weight =	2854 grams
Mass lost =	0 grams
% lost =	0 %

PRM-NY-C-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3073 grams
Weight mold =	100 grams
Original weight =	2973 grams
Mass lost =	0 grams
% lost =	0 %

PRM-NY-C-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3025 grams
Weight mold =	100 grams
Original weight =	2925 grams
Mass lost =	0 grams
% lost =	0 %

PRM-NY-C-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3063 grams
Weight mold =	100 grams
Original weight =	2963 grams
Mass lost =	0 grams
% lost =	0 %

7/9/2013 (After 72 cycles)

Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost	0 %

Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost	0 %

Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost	0 %

Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost	0 %

7/16/2013 (After 108 cycles)

PRM-NY-C-1	
Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost =	0 %

PRM-NY-C-2	
Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost =	0 %

PRM-NY-C-3	
Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost =	0 %

PRM-NY-C-4	
Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost =	0 %

7/23/2013 (After 144 cycles)

PRM-NY-C-1	
Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-2	
Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-3	
Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-4	
Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost	0 %

7/30/2013 (After 180 cycles)

PRM-NY-C-1	
Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-2	
Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-3	
Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-4	
Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost	0 %

8/6/2013 (After 216 cycles)

PRM-NY-C-1	
Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-2	
Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-3	
Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-4	
Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost	0 %

8/14/2013 (After 252 cycles)

PRM-NY-C-1	
Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-2	
Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-3	
Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-4	
Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost	0 %

8/21/2013 (After 288 cycles)

PRM-NY-C-1	
Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-2	
Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-3	
Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-4	
Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost	0 %

(After 300 cycles) Freeze-thaw machine broke!

PRM-NY-C-1	
Weight (+mold) =	2954 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-2	
Weight (+mold) =	3073 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-3	
Weight (+mold) =	3025 grams
Mass lost =	0 grams
total % lost	0 %

PRM-NY-C-4	
Weight (+mold) =	3063 grams
Mass lost =	0 grams
total % lost	0 %

CRUSH TESTS 11/8/2013

PRM-NY-C-1		PRM-NY-C-2		PRM-NY-C-3		PRM-NY-C-4	
Weight Alone	2801 grams	Weight Alone	2926 grams	Weight Alone	2872 grams	Weight Alone	2913 grams
Weight mold =	153 grams	Weight mold =	147 grams	Weight mold =	153 grams	Weight mold =	150 grams
Final Mass lost =	0 grams	Final Mass lost =	0 grams	Final Mass lost =	0 grams	Final Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %
Comp Strength	1050 psi	Comp Strength	1350 psi	Comp Strength	XXX psi	Comp Strength	XXX psi
XXX	XXX XXX	XXX	XXX XXX	Load (P)	13780 lbs	Load (P)	21190 lbs
Tensile Strength	XXX psi	Tensile Strength	XXX psi	Tensile Strength	274.2727 psi	Tensile Strength	421.69 psi

Load Rate = 500 to 1000 lb/ minute
hear scoria crushing, no sudden failure, very subtle

Average Comp Strength =	1200 psi
Average Tensile Strength =	347.981341 psi

Unsubmerged

PRM-NY-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2953 grams
Weight mold =	139 grams
Total +Water =	3437 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	484 cm^3
γ Concrete =	1.708139 gm/cm^3
γ Concrete =	106.6356 lb/ft^3
Volume Solids =	1163.407 cm^3
Porosity =	29.3795 %

PRM-NY-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2985 grams
Weight mold =	139 grams
Total +Water =	3412 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	427 cm^3
γ Concrete =	1.727563 gm/cm^3
γ Concrete =	107.8482 lb/ft^3
Volume Solids =	1220.407 cm^3
Porosity =	25.91952 %

PRM-NY-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3081 grams
Weight mold =	139 grams
Total +Water =	3497 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	416 cm^3
γ Concrete =	1.785836 gm/cm^3
γ Concrete =	111.4861 lb/ft^3
Volume Solids =	1231.407 cm^3
Porosity =	25.2518 %

PRM-NY-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3137 grams
Weight mold =	139 grams
Total +Water =	3520 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	383 cm^3
γ Concrete =	1.819829 gm/cm^3
γ Concrete =	113.6082 lb/ft^3
Volume Solids =	1264.407 cm^3
Porosity =	23.24865 %

PRM-NY-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2925 grams
Weight mold =	100 grams
Original weight =	2814 grams
Mass lost =	-11 grams
% lost =	-0.3909 %
-0.54088567	
Weight (+mold) =	2916 grams
Mass lost =	-2 grams
total % lost	-0.07107 %
-0.21293158	

PRM-NY-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2961 grams
Weight mold =	100 grams
Original weight =	2846 grams
Mass lost =	-15 grams
% lost =	-0.52706 %
Weight (+mold) =	2950 grams
Mass lost =	-4 grams
total % lost	-0.14055 %

PRM-NY-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3060 grams
Weight mold =	100 grams
Original weight =	2942 grams
Mass lost =	-18 grams
% lost =	-0.61183 %
Weight (+mold) =	3052 grams
Mass lost =	-10 grams
total % lost	-0.3399 %

PRM-NY-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3117 grams
Weight mold =	100 grams
Original weight =	2998 grams
Mass lost =	-19 grams
% lost =	-0.63376 %
Weight (+mold) =	3107 grams
Mass lost =	-9 grams
total % lost	-0.3002 %

PRM-NY-N-1	
Weight (+mold) =	2906 grams
Mass lost =	8 grams
total % lost =	0.284293 %

PRM-NY-N-2	
Weight (+mold) =	2940 grams
Mass lost =	6 grams
total % lost =	0.210822 %

PRM-NY-N-3	
Weight (+mold) =	3036 grams
Mass lost =	6 grams
total % lost =	0.203943 %

PRM-NY-N-4	
Weight (+mold) =	3092 grams
Mass lost =	6 grams
total % lost =	0.200133 %

0.224797837

PRM-NY-N-1	
Weight (+mold) =	2906 grams
Mass lost =	8 grams
total % lost	0.284293 %

PRM-NY-N-2	
Weight (+mold) =	2939 grams
Mass lost =	7 grams
total % lost	0.245959 %

PRM-NY-N-3	
Weight (+mold) =	3039 grams
Mass lost =	3 grams
total % lost	0.101971 %

PRM-NY-N-4	
Weight (+mold) =	3096 grams
Mass lost =	2 grams
total % lost	0.066711 %

0.174733663

PRM-NY-N-1	
Weight (+mold) =	2906 grams
Mass lost =	8 grams
total % lost	0.284293 %

PRM-NY-N-2	
Weight (+mold) =	2939 grams
Mass lost =	7 grams
total % lost	0.245959 %

PRM-NY-N-3	
Weight (+mold) =	3038 grams
Mass lost =	4 grams
total % lost	0.135962 %

PRM-NY-N-4	
Weight (+mold) =	3096 grams
Mass lost =	2 grams
total % lost	0.066711 %

0.183231284

PRM-NY-N-1	
Weight (+mold) =	2904 grams
Mass lost =	10 grams
total % lost	0.355366 %

PRM-NY-N-2	
Weight (+mold) =	2939 grams
Mass lost =	7 grams
total % lost	0.245959 %

PRM-NY-N-3	
Weight (+mold) =	3039 grams
Mass lost =	3 grams
total % lost	0.101971 %

PRM-NY-N-4	
Weight (+mold) =	3094 grams
Mass lost =	4 grams
total % lost	0.133422 %

0.209179749

PRM-NY-N-1	
Weight (+mold) =	2905 grams
Mass lost =	9 grams
total % lost	0.319829 %

PRM-NY-N-2	
Weight (+mold) =	2939 grams
Mass lost =	7 grams
total % lost	0.245959 %

PRM-NY-N-3	
Weight (+mold) =	3040 grams
Mass lost =	2 grams
total % lost	0.067981 %

PRM-NY-N-4	
Weight (+mold) =	3094 grams
Mass lost =	4 grams
total % lost	0.133422 %

0.191797978

PRM-NY-N-1	
Weight (+mold) =	2904 grams
Mass lost =	10 grams
total % lost	0.355366 %

PRM-NY-N-2	
Weight (+mold) =	2938 grams
Mass lost =	8 grams
total % lost	0.281096 %

PRM-NY-N-3	
Weight (+mold) =	3041 grams
Mass lost =	1 grams
total % lost	0.03399 %

PRM-NY-N-4	
Weight (+mold) =	3097 grams
Mass lost =	1 grams
total % lost	0.033356 %

0.175952089

PRM-NY-N-1	
Weight (+mold) =	2907 grams
Mass lost =	7 grams
total % lost	0.248756 %

PRM-NY-N-2	
Weight (+mold) =	2940 grams
Mass lost =	6 grams
total % lost	0.210822 %

PRM-NY-N-3	
Weight (+mold) =	3041 grams
Mass lost =	1 grams
total % lost	0.03399 %

PRM-NY-N-4	
Weight (+mold) =	3097 grams
Mass lost =	1 grams
total % lost	0.033356 %

PRM-NY-N-1		PRM-NY-N-2		PRM-NY-N-3		PRM-NY-N-4	
Weight Alone	2801 grams	Weight Alone	2826 grams	Weight Alone	2936 grams	Weight Alone	2993 grams
Weight mold =	101 grams	Weight mold =	102 grams	Weight mold =	102 grams	Weight mold =	100 grams
Final Mass lost =	-2894.75 grams	Final Mass lost =	-2921.79 grams	Final Mass lost =	-3036.97 grams	Final Mass lost =	-3091.97 grams
total % lost	-102.87 %	total % lost	-102.663 %	total % lost	-103.228 %	total % lost	-103.134 %
Comp Strength	1050 psi	Comp Strength	924 psi	Comp Strength	XXX psi	Comp Strength	XXX psi
XXX	XXX	XXX	XXX	Load (P)	8450 lbs	Load (P)	XXX lbs
Tensile Strength	XXX psi	Tensile Strength	XXX psi	Tensile Strength	292.5839 psi	Tensile Strength	XXX psi
				Reduced L		Broken, cannot test	
-102.973721							
		SULFER CAP ON CROOKED					
Average Comp Strength =	987 psi						
Average Tensile Strength =	292.5839 psi						

Partially Submerged

PRM-NY-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2970 grams
Weight mold =	139 grams
Total +Water =	3453 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	483 cm^3
γ Concrete =	1.718458 gm/cm^3
γ Concrete =	107.2798 lb/ft^3
Volume Solids =	1164.407 cm^3
Porosity =	29.3188 %

PRM-NY-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3019 grams
Weight mold =	139 grams
Total +Water =	3489 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	470 cm^3
γ Concrete =	1.748201 gm/cm^3
γ Concrete =	109.1367 lb/ft^3
Volume Solids =	1177.407 cm^3
Porosity =	28.52968 %

PRM-NY-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3091 grams
Weight mold =	139 grams
Total +Water =	3505 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	414 cm^3
γ Concrete =	1.791907 gm/cm^3
γ Concrete =	111.8651 lb/ft^3
Volume Solids =	1233.407 cm^3
Porosity =	25.1304 %

PRM-NY-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3154 grams
Weight mold =	139 grams
Total +Water =	3555 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	401 cm^3
γ Concrete =	1.830148 gm/cm^3
γ Concrete =	114.2524 lb/ft^3
Volume Solids =	1246.407 cm^3
Porosity =	24.34128 %

PRM-NY-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2923 grams
Weight mold =	100 grams
Original weight =	2831 grams
Mass lost =	8 grams
% lost =	0.282586 %

PRM-NY-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2969 grams
Weight mold =	100 grams
Original weight =	2880 grams
Mass lost =	11 grams
% lost =	0.381944 %

PRM-NY-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3049 grams
Weight mold =	100 grams
Original weight =	2952 grams
Mass lost =	3 grams
% lost =	0.101626 %

PRM-NY-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3114 grams
Weight mold =	100 grams
Original weight =	3015 grams
Mass lost =	1 grams
% lost =	0.033167 %

0.199830904

Weight (+mold) =	2923 grams
Mass lost =	8 grams
total % lost	0.282586 %

Weight (+mold) =	2960 grams
Mass lost =	20 grams
total % lost	0.694444 %

Weight (+mold) =	3051 grams
Mass lost =	1 grams
total % lost	0.032776 %

Weight (+mold) =	3112 grams
Mass lost =	3 grams
total % lost	0.099502 %

0.277327182

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight (+mold) =	2923 grams	Weight (+mold) =	2964 grams	Weight (+mold) =	3047 grams	Weight (+mold) =	3113 grams
Mass lost =	8 grams	Mass lost =	16 grams	Mass lost =	5 grams	Mass lost =	2 grams
total % lost =	0.282586 %	total % lost =	0.555556 %	total % lost =	0.163881 %	total % lost =	0.066335 %

0.267089225

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight (+mold) =	2912 grams	Weight (+mold) =	2955 grams	Weight (+mold) =	3033 grams	Weight (+mold) =	3098 grams
Mass lost =	19 grams	Mass lost =	25 grams	Mass lost =	19 grams	Mass lost =	17 grams
total % lost	0.671141 %	total % lost	0.868056 %	total % lost	0.622747 %	total % lost	0.563847 %

0.681447641 (sample fell off cart and broke a little off)

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight (+mold) =	2879 grams	Weight (+mold) =	2963 grams	Weight (+mold) =	3042 grams	Weight (+mold) =	3108 grams
Mass lost =	52 grams	Mass lost =	17 grams	Mass lost =	10 grams	Mass lost =	7 grams
total % lost	1.836807 %	total % lost	0.590278 %	total % lost	0.327761 %	total % lost	0.232172 %

0.746754605

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight (+mold) =	2874 grams	Weight (+mold) =	2950 grams	Weight (+mold) =	3036 grams	Weight (+mold) =	3102 grams
Mass lost =	57 grams	Mass lost =	30 grams	Mass lost =	16 grams	Mass lost =	13 grams
total % lost	2.013423 %	total % lost	1.041667 %	total % lost	0.524418 %	total % lost	0.431177 %

1.002671289

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight (+mold) =	2873 grams	Weight (+mold) =	2954 grams	Weight (+mold) =	3036 grams	Weight (+mold) =	3103 grams
Mass lost =	58 grams	Mass lost =	26 grams	Mass lost =	16 grams	Mass lost =	12 grams
total % lost	2.048746 %	total % lost	0.902778 %	total % lost	0.524418 %	total % lost	0.39801 %

0.968487994

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight (+mold) =	2877 grams	Weight (+mold) =	2957 grams	Weight (+mold) =	3040 grams	Weight (+mold) =	3108 grams
Mass lost =	54 grams	Mass lost =	23 grams	Mass lost =	12 grams	Mass lost =	7 grams
total % lost	1.907453 %	total % lost	0.798611 %	total % lost	0.393314 %	total % lost	0.232172 %

0.832887612

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight (+mold) =	2886 grams	Weight (+mold) =	2963 grams	Weight (+mold) =	3050 grams	Weight (+mold) =	3121 grams
Mass lost =	45 grams	Mass lost =	17 grams	Mass lost =	2 grams	Mass lost =	-6 grams
total % lost	1.589544 %	total % lost	0.590278 %	total % lost	0.065552 %	total % lost	-0.199 %

0.511592353

PRM-NY-P-1		PRM-NY-P-2		PRM-NY-P-3		PRM-NY-P-4	
Weight Alone	2530 grams	Weight Alone	2785 grams	Weight Alone	2944 grams	Weight Alone	2974 grams
Weight mold =	100 grams	Weight mold =	101 grams	Weight mold =	102 grams	Weight mold =	102 grams
Final Mass lost =	-2583.41 grams	Final Mass lost =	-2868.41 grams	Final Mass lost =	-3043.93 grams	Final Mass lost =	-3082.2 grams
total % lost	-91.2543 %	total % lost	-99.5976 %	total % lost	-103.114 %	total % lost	-102.229 %
Comp Strength	1684 psi	Comp Strength	XXX psi	Comp Strength	1544 psi	Comp Strength	XXX psi
XXX	XXX	Load (P)	3820 lbs	XXX	XXX	Load (P)	6640 lbs
Tensile Strength	XXX psi	Tensile Strength	113.8315 psi	Tensile Strength	XXX psi	Tensile Strength	171.7233 psi
		Reduced L				Reduced L	

-99.0487591

SAMPLE BROKEN:NO EXAM

Average Comp Strength =	1614 psi
Average Tensile Strength =	142.7774 psi

Fully Submerged

PRM-NY-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2987 grams
Weight mold =	139 grams
Total +Water =	3427 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	440 cm^3
γ Concrete =	1.728777 gm/cm^3
γ Concrete =	107.924 lb/ft^3
Volume Solids =	1207.407 cm^3
Porosity =	26.70863 %

PRM-NY-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3051 grams
Weight mold =	139 grams
Total +Water =	3456 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	405 cm^3
γ Concrete =	1.767626 gm/cm^3
γ Concrete =	110.3493 lb/ft^3
Volume Solids =	1242.407 cm^3
Porosity =	24.58408 %

PRM-NY-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3081 grams
Weight mold =	139 grams
Total +Water =	3500 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	419 cm^3
γ Concrete =	1.785836 gm/cm^3
γ Concrete =	111.4861 lb/ft^3
Volume Solids =	1228.407 cm^3
Porosity =	25.4339 %

PRM-NY-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3108 grams
Weight mold =	139 grams
Total +Water =	3500 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	392 cm^3
γ Concrete =	1.802226 gm/cm^3
γ Concrete =	112.5093 lb/ft^3
Volume Solids =	1255.407 cm^3
Porosity =	23.79496 %

PRM-NY-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2939 grams
Weight mold =	100 grams
Original weight =	2848 grams
Mass lost =	9 grams
% lost =	0.316011 %
0.207177739	
Weight (+mold) =	2936 grams
Mass lost =	12 grams
total % lost	0.421348 %
0.327037172	

PRM-NY-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3003 grams
Weight mold =	100 grams
Original weight =	2912 grams
Mass lost =	9 grams
% lost =	0.309066 %
Weight (+mold) =	2998 grams
Mass lost =	14 grams
total % lost	0.480769 %

PRM-NY-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3037 grams
Weight mold =	100 grams
Original weight =	2942 grams
Mass lost =	5 grams
% lost =	0.169952 %
Weight (+mold) =	3036 grams
Mass lost =	6 grams
total % lost	0.203943 %

PRM-NY-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3068 grams
Weight mold =	100 grams
Original weight =	2969 grams
Mass lost =	1 grams
% lost =	0.033681 %
Weight (+mold) =	3063 grams
Mass lost =	6 grams
total % lost	0.202088 %

PRM-NY-F-1	
Weight (+mold) =	2939 grams
Mass lost =	9 grams
total % lost =	0.316011 %

PRM-NY-F-2	
Weight (+mold) =	3005 grams
Mass lost =	7 grams
total % lost =	0.240385 %

PRM-NY-F-3	
Weight (+mold) =	3038 grams
Mass lost =	4 grams
total % lost =	0.135962 %

PRM-NY-F-4	
Weight (+mold) =	3063 grams
Mass lost =	6 grams
total % lost =	0.202088 %

0.223611507

PRM-NY-F-1	
Weight (+mold) =	2932 grams
Mass lost =	16 grams
total % lost	0.561798 %

PRM-NY-F-2	
Weight (+mold) =	2997 grams
Mass lost =	15 grams
total % lost	0.51511 %

PRM-NY-F-3	
Weight (+mold) =	3028 grams
Mass lost =	14 grams
total % lost	0.475867 %

PRM-NY-F-4	
Weight (+mold) =	3051 grams
Mass lost =	18 grams
total % lost	0.606265 %

0.539759784

PRM-NY-F-1	
Weight (+mold) =	2939 grams
Mass lost =	9 grams
total % lost	0.316011 %

PRM-NY-F-2	
Weight (+mold) =	3006 grams
Mass lost =	6 grams
total % lost	0.206044 %

PRM-NY-F-3	
Weight (+mold) =	3037 grams
Mass lost =	5 grams
total % lost	0.169952 %

PRM-NY-F-4	
Weight (+mold) =	3060 grams
Mass lost =	9 grams
total % lost	0.303132 %

0.248784993 (sample broke in half)

PRM-NY-F-1	
Weight (+mold) =	2920 grams
Mass lost =	28 grams
total % lost	0.983146 %

PRM-NY-F-2	
Weight (+mold) =	2999 grams
Mass lost =	13 grams
total % lost	0.446429 %

PRM-NY-F-3	
Weight (+mold) =	3030 grams
Mass lost =	12 grams
total % lost	0.407886 %

PRM-NY-F-4	
Weight (+mold) =	3054 grams
Mass lost =	15 grams
total % lost	0.505221 %

0.585670261

PRM-NY-F-1	
Weight (+mold) =	2922 grams
Mass lost =	26 grams
total % lost	0.912921 %

PRM-NY-F-2	
Weight (+mold) =	2998 grams
Mass lost =	14 grams
total % lost	0.480769 %

PRM-NY-F-3	
Weight (+mold) =	3047 grams
Mass lost =	-5 grams
total % lost	-0.16995 %

PRM-NY-F-4	
Weight (+mold) =	3058 grams
Mass lost =	11 grams
total % lost	0.370495 %

0.39855832

PRM-NY-F-1	
Weight (+mold) =	2929 grams
Mass lost =	19 grams
total % lost	0.667135 %

PRM-NY-F-2	
Weight (+mold) =	3005 grams
Mass lost =	7 grams
total % lost	0.240385 %

PRM-NY-F-3	
Weight (+mold) =	3049 grams
Mass lost =	-7 grams
total % lost	-0.23793 %

PRM-NY-F-4	
Weight (+mold) =	3068 grams
Mass lost =	1 grams
total % lost	0.033681 %

0.175816861

PRM-NY-F-1	
Weight (+mold) =	2929 grams
Mass lost =	19 grams
total % lost	0.667135 %

PRM-NY-F-2	
Weight (+mold) =	3017 grams
Mass lost =	-5 grams
total % lost	-0.1717 %

PRM-NY-F-3	
Weight (+mold) =	3044 grams
Mass lost =	-2 grams
total % lost	-0.06798 %

PRM-NY-F-4	
Weight (+mold) =	3066 grams
Mass lost =	3 grams
total % lost	0.101044 %

PRM-NY-F-1			PRM-NY-F-2			PRM-NY-F-3			PRM-NY-F-4		
Weight Alone	2716 grams		Weight Alone	2883 grams		Weight Alone	2900 grams		Weight Alone	2915 grams	
Weight mold =	102 grams		Weight mold =	102 grams		Weight mold =	101 grams		Weight mold =	102 grams	
Final Mass lost =	-2798.33 grams		Final Mass lost =	-2990.17 grams		Final Mass lost =	-3003.07 grams		Final Mass lost =	-3013.9 grams	
total % lost	-98.2561 %		total % lost	-102.684 %		total % lost	-102.076 %		total % lost	-101.512 %	
Comp Strength	psi		Comp Strength	XXX psi		Comp Strength	psi		Comp Strength	XXX psi	
XXX	XXX		Load (P)	6270 lbs		XXX	XXX		Load (P)	5570 lbs	
Tensile Strength	XXX psi		Tensile Strength	236.7128 psi		Tensile Strength	XXX psi		Tensile Strength	230.5246 psi	
Broken, Cannot test			Reduced L			Broken, Cannot test			Reduced L		
-101.132132											
Average Comp Strength =	---- psi										
Average Tensile Strength =	233.6187 psi										

PRM with Procon Fibers

Control

6/11\/2013 MIX DATE; 6/25/2013 INTO CHAMBER

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams	Weight mold =	139 grams
Total +Water =	3457 grams	Total +Water =	3521 grams	Total +Water =	3493 grams	Total +Water =	3399 grams
Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3	Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3	Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3	γ Water =	1 gm/cm^3
Volume Water =	435 cm^3	Volume Water =	411 cm^3	Volume Water =	473 cm^3	Volume Water =	432 cm^3
γ Concrete =	1.750023 gm/cm^3	γ Concrete =	1.80344 gm/cm^3	γ Concrete =	1.748809 gm/cm^3	γ Concrete =	1.716637 gm/cm^3
γ Concrete =	109.2503 lb/ft^3	γ Concrete =	112.5851 lb/ft^3	γ Concrete =	109.1745 lb/ft^3	γ Concrete =	107.1661 lb/ft^3
Volume Solids =	1212.407 cm^3	Volume Solids =	1236.407 cm^3	Volume Solids =	1174.407 cm^3	Volume Solids =	1215.407 cm^3
Porosity =	26.40513 %	Porosity =	24.94829 %	Porosity =	28.71178 %	Porosity =	26.22302 %

C = CONTROL (NO CHAMBER)
N = NO SUBMERSION
P = PARTIALLY SUBMERSED
F = FULLY SUBMERSED

AVG POROSITY = 24.98244

CONFINEMENT ACHIEVED BY CUTTING OFF BOTTOM OF PLASTIC CYLINDER WITH A DREMEL TOOL

7/2/13 (After 36 cylcles)

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Height =	8 inches	Height =	8 inches	Height =	8 inches	Height =	8 inches
Dia =	4 inches	Dia =	4 inches	Dia =	4 inches	Dia =	4 inches
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Weight mold =	100 grams	Weight mold =	100 grams	Weight mold =	100 grams	Weight mold =	100 grams
Original weight =	2922 grams	Original weight =	3010 grams	Original weight =	2920 grams	Original weight =	2867 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
% lost =	0 %	% lost =	0 %	% lost =	0 %	% lost =	0 %

7/9/2013 (After 72 cycles)

Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

7/16/2013 (After 108 cycles)

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost =	0 %	total % lost =	0 %	total % lost =	0 %	total % lost =	0 %

7/23/2013 (After 144 cycles)

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

7/30/2013 (After 180 cycles)

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

8/6/2013 (After 216 cycles)

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

8/14/2013 (After 252 cycles)

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

8/21/2013 (After 288 cycles)

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

(After 300 cycles) Freeze-thaw machine broke!

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight (+mold) =	3022 grams	Weight (+mold) =	3110 grams	Weight (+mold) =	3020 grams	Weight (+mold) =	2967 grams
Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams	Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %

CRUSH TESTS 11/8/2013

PRM-PRO-C-1		PRM-PRO-C-2		PRM-PRO-C-3		PRM-PRO-C-4	
Weight Alone	2876 grams	Weight Alone	2961 grams	Weight Alone	2867 grams	Weight Alone	2825 grams
Weight mold =	146 grams	Weight mold =	149 grams	Weight mold =	153 grams	Weight mold =	142 grams
Final Mass lost =	0 grams	Final Mass lost =	0 grams	Final Mass lost =	0 grams	Final Mass lost =	0 grams
total % lost	0 %	total % lost	0 %	total % lost	0 %	total % lost	0 %
Comp Strength	XXX psi	Comp Strength	XXX psi	Comp Strength	1103 psi	Comp Strength	1297 psi
XXX	11270 XXX	Load (P)	21210 lbs	XXX	XXX	XXX	XXX
Tensile Strength	224.337845 psi	Tensile Strength	422.0879 psi	Tensile Strength	XXX psi	Tensile Strength	XXX psi

Load Rate = 500 to 1000 lb/ minute
hear scoria crushing, no sudden failure, very subtle

Average Comp Strength =	1200 psi
Average Tensile Strength =	323.212853 psi

Unsubmerged

PRM-PRO-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3085 grams
Weight mold =	139 grams
Total +Water =	3510 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	425 cm^3
γ Concrete =	1.788264 gm/cm^3
γ Concrete =	111.6377 lb/ft^3
Volume Solids =	1222.407 cm^3
Porosity =	25.79811 %

PRM-PRO-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3217 grams
Weight mold =	139 grams
Total +Water =	3598 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	381 cm^3
γ Concrete =	1.86839 gm/cm^3
γ Concrete =	116.6398 lb/ft^3
Volume Solids =	1266.407 cm^3
Porosity =	23.12725 %

PRM-PRO-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3105 grams
Weight mold =	139 grams
Total +Water =	3527 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	422 cm^3
γ Concrete =	1.800405 gm/cm^3
γ Concrete =	112.3956 lb/ft^3
Volume Solids =	1225.407 cm^3
Porosity =	25.61601 %

PRM-PRO-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3116 grams
Weight mold =	139 grams
Total +Water =	3525 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	409 cm^3
γ Concrete =	1.807082 gm/cm^3
γ Concrete =	112.8124 lb/ft^3
Volume Solids =	1238.407 cm^3
Porosity =	24.82689 %

PRM-PRO-N-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3068 grams
Weight mold =	100 grams
Original weight =	2946 grams
Mass lost =	-22 grams
% lost =	-0.74678 %

-0.66010635

Weight (+mold) =	3055 grams
Mass lost =	-9 grams
total % lost	-0.3055 %

-0.10046566

PRM-PRO-N-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3199 grams
Weight mold =	100 grams
Original weight =	3078 grams
Mass lost =	-21 grams
% lost =	-0.68226 %

Weight (+mold) =	3182 grams
Mass lost =	-4 grams
total % lost	-0.12995 %

PRM-PRO-N-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3083 grams
Weight mold =	100 grams
Original weight =	2966 grams
Mass lost =	-17 grams
% lost =	-0.57316 %

Weight (+mold) =	3066 grams
Mass lost =	0 grams
total % lost	0 %

PRM-PRO-N-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3096 grams
Weight mold =	100 grams
Original weight =	2977 grams
Mass lost =	-19 grams
% lost =	-0.63823 %

Weight (+mold) =	3076 grams
Mass lost =	1 grams
total % lost	0.033591 %

PRM-PRO-N-1	
Weight (+mold) =	3040 grams
Mass lost =	6 grams
total % lost =	0.203666 %

PRM-PRO-N-2	
Weight (+mold) =	3170 grams
Mass lost =	8 grams
total % lost =	0.259909 %

PRM-PRO-N-3	
Weight (+mold) =	3052 grams
Mass lost =	14 grams
total % lost =	0.472016 %

PRM-PRO-N-4	
Weight (+mold) =	3072 grams
Mass lost =	5 grams
total % lost =	0.167954 %

0.27588638

PRM-PRO-N-1	
Weight (+mold) =	3042 grams
Mass lost =	4 grams
total % lost	0.135777 %

PRM-PRO-N-2	
Weight (+mold) =	3168 grams
Mass lost =	10 grams
total % lost	0.324886 %

PRM-PRO-N-3	
Weight (+mold) =	3053 grams
Mass lost =	13 grams
total % lost	0.438301 %

PRM-PRO-N-4	
Weight (+mold) =	3074 grams
Mass lost =	3 grams
total % lost	0.100773 %

0.249934237

PRM-PRO-N-1	
Weight (+mold) =	3042 grams
Mass lost =	4 grams
total % lost	0.135777 %

PRM-PRO-N-2	
Weight (+mold) =	3168 grams
Mass lost =	10 grams
total % lost	0.324886 %

PRM-PRO-N-3	
Weight (+mold) =	3052 grams
Mass lost =	14 grams
total % lost	0.472016 %

PRM-PRO-N-4	
Weight (+mold) =	3072 grams
Mass lost =	5 grams
total % lost	0.167954 %

0.275158529

PRM-PRO-N-1	
Weight (+mold) =	3040 grams
Mass lost =	6 grams
total % lost	0.203666 %

PRM-PRO-N-2	
Weight (+mold) =	3166 grams
Mass lost =	12 grams
total % lost	0.389864 %

PRM-PRO-N-3	
Weight (+mold) =	3052 grams
Mass lost =	14 grams
total % lost	0.472016 %

PRM-PRO-N-4	
Weight (+mold) =	3073 grams
Mass lost =	4 grams
total % lost	0.134363 %

0.299977293

PRM-PRO-N-1	
Weight (+mold) =	3041 grams
Mass lost =	5 grams
total % lost	0.169722 %

PRM-PRO-N-2	
Weight (+mold) =	3167 grams
Mass lost =	11 grams
total % lost	0.357375 %

PRM-PRO-N-3	
Weight (+mold) =	3051 grams
Mass lost =	15 grams
total % lost	0.505732 %

PRM-PRO-N-4	
Weight (+mold) =	3074 grams
Mass lost =	3 grams
total % lost	0.100773 %

0.283400198

PRM-PRO-N-1	
Weight (+mold) =	3042 grams
Mass lost =	4 grams
total % lost	0.135777 %

PRM-PRO-N-2	
Weight (+mold) =	3168 grams
Mass lost =	10 grams
total % lost	0.324886 %

PRM-PRO-N-3	
Weight (+mold) =	3052 grams
Mass lost =	14 grams
total % lost	0.472016 %

PRM-PRO-N-4	
Weight (+mold) =	3074 grams
Mass lost =	3 grams
total % lost	0.100773 %

0.258363097

PRM-PRO-N-1	
Weight (+mold) =	3043 grams
Mass lost =	3 grams
total % lost	0.101833 %

PRM-PRO-N-2	
Weight (+mold) =	3171 grams
Mass lost =	7 grams
total % lost	0.22742 %

PRM-PRO-N-3	
Weight (+mold) =	3055 grams
Mass lost =	11 grams
total % lost	0.37087 %

PRM-PRO-N-4	
Weight (+mold) =	3076 grams
Mass lost =	1 grams
total % lost	0.033591 %

PRM-PRO-N-1	
Weight Alone	2971 grams
Weight mold =	102 grams
Final Mass lost =	-3069.9 grams
total % lost	-104.206 %
Comp Strength	XXX psi
Load (P)	9820 lbs
Tensile Strength	220.2716 psi

PRM-PRO-N-2	
Weight Alone	2935 grams
Weight mold =	100 grams
Final Mass lost =	-3027.77 grams
total % lost	-98.3682 %
Comp Strength	XXX psi
Load (P)	14560 lbs
Tensile Strength	289.7903 psi

PRM-PRO-N-3	
Weight Alone	2947 grams
Weight mold =	100 grams
Final Mass lost =	-3035.63 grams
total % lost	-102.348 %
Comp Strength	1434 psi
XXX	XXX
Tensile Strength	XXX psi

PRM-PRO-N-4	
Weight Alone	3065 grams
Weight mold =	101 grams
Final Mass lost =	-3164.97 grams
total % lost	-106.314 %
Comp Strength	1624 psi
XXX	XXX
Tensile Strength	XXX psi

-102.808838

Average Comp Strength =	1529 psi
Average Tensile Strength =	255.0309 psi

Partially Submerged

PRM-PRO-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2969 grams
Weight mold =	139 grams
Total +Water =	3436 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	467 cm^3
γ Concrete =	1.717851 gm/cm^3
γ Concrete =	107.2419 lb/ft^3
Volume Solids =	1180.407 cm^3
Porosity =	28.34757 %

PRM-PRO-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3147 grams
Weight mold =	139 grams
Total +Water =	3540 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	393 cm^3
γ Concrete =	1.825899 gm/cm^3
γ Concrete =	113.9872 lb/ft^3
Volume Solids =	1254.407 cm^3
Porosity =	23.85567 %

PRM-PRO-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3098 grams
Weight mold =	139 grams
Total +Water =	3516 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	418 cm^3
γ Concrete =	1.796156 gm/cm^3
γ Concrete =	112.1303 lb/ft^3
Volume Solids =	1229.407 cm^3
Porosity =	25.3732 %

PRM-PRO-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3301 grams
Weight mold =	139 grams
Total +Water =	3646 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	345 cm^3
γ Concrete =	1.91938 gm/cm^3
γ Concrete =	119.823 lb/ft^3
Volume Solids =	1302.407 cm^3
Porosity =	20.942 %

PRM-PRO-P-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	2921 grams
Weight mold =	100 grams
Original weight =	2830 grams
Mass lost =	9 grams
% lost =	0.318021 %
0.058352456	
Weight (+mold) =	2918 grams
Mass lost =	12 grams
total % lost	0.424028 %
0.20684878	

PRM-PRO-P-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3103 grams
Weight mold =	100 grams
Original weight =	3008 grams
Mass lost =	5 grams
% lost =	0.166223 %
Weight (+mold) =	3096 grams
Mass lost =	12 grams
total % lost	0.398936 %

PRM-PRO-P-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3058 grams
Weight mold =	100 grams
Original weight =	2959 grams
Mass lost =	1 grams
% lost =	0.033795 %
Weight (+mold) =	3055 grams
Mass lost =	4 grams
total % lost	0.130933 %

PRM-PRO-P-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3271 grams
Weight mold =	100 grams
Original weight =	3162 grams
Mass lost =	-9 grams
% lost =	-0.28463 %
Weight (+mold) =	3266 grams
Mass lost =	-4 grams
total % lost	-0.1265 %

PRM-PRO-P-1	
Weight (+mold) =	2921 grams
Mass lost =	9 grams
total % lost =	0.318021 %

PRM-PRO-P-2	
Weight (+mold) =	3101 grams
Mass lost =	7 grams
total % lost =	0.232713 %

PRM-PRO-P-3	
Weight (+mold) =	3055 grams
Mass lost =	4 grams
total % lost =	0.130933 %

PRM-PRO-P-4	
Weight (+mold) =	3261 grams
Mass lost =	1 grams
total % lost =	0.031626 %

0.178323104

PRM-PRO-P-1	
Weight (+mold) =	2916 grams
Mass lost =	14 grams
total % lost	0.4947 %

PRM-PRO-P-2	
Weight (+mold) =	3097 grams
Mass lost =	11 grams
total % lost	0.365691 %

PRM-PRO-P-3	
Weight (+mold) =	3047 grams
Mass lost =	12 grams
total % lost	0.392799 %

PRM-PRO-P-4	
Weight (+mold) =	3252 grams
Mass lost =	10 grams
total % lost	0.316256 %

0.39236134 (sample fell down and a chunk broke off)

PRM-PRO-P-1	
Weight (+mold) =	2891 grams
Mass lost =	39 grams
total % lost	1.378092 %

PRM-PRO-P-2	
Weight (+mold) =	3099 grams
Mass lost =	9 grams
total % lost	0.299202 %

PRM-PRO-P-3	
Weight (+mold) =	3054 grams
Mass lost =	5 grams
total % lost	0.163666 %

PRM-PRO-P-4	
Weight (+mold) =	3256 grams
Mass lost =	6 grams
total % lost	0.189753 %

0.507678361

PRM-PRO-P-1	
Weight (+mold) =	2886 grams
Mass lost =	44 grams
total % lost	1.55477 %

PRM-PRO-P-2	
Weight (+mold) =	3093 grams
Mass lost =	15 grams
total % lost	0.49867 %

PRM-PRO-P-3	
Weight (+mold) =	3048 grams
Mass lost =	11 grams
total % lost	0.360065 %

PRM-PRO-P-4	
Weight (+mold) =	3244 grams
Mass lost =	18 grams
total % lost	0.56926 %

0.74569149

PRM-PRO-P-1	
Weight (+mold) =	2896 grams
Mass lost =	34 grams
total % lost	1.201413 %

PRM-PRO-P-2	
Weight (+mold) =	3093 grams
Mass lost =	15 grams
total % lost	0.49867 %

PRM-PRO-P-3	
Weight (+mold) =	3048 grams
Mass lost =	11 grams
total % lost	0.360065 %

PRM-PRO-P-4	
Weight (+mold) =	3253 grams
Mass lost =	9 grams
total % lost	0.28463 %

0.586194772

PRM-PRO-P-1	
Weight (+mold) =	2894 grams
Mass lost =	36 grams
total % lost	1.272085 %

PRM-PRO-P-2	
Weight (+mold) =	3098 grams
Mass lost =	10 grams
total % lost	0.332447 %

PRM-PRO-P-3	
Weight (+mold) =	3054 grams
Mass lost =	5 grams
total % lost	0.163666 %

PRM-PRO-P-4	
Weight (+mold) =	3256 grams
Mass lost =	6 grams
total % lost	0.189753 %

0.489487764

PRM-PRO-P-1	
Weight (+mold) =	2897 grams
Mass lost =	33 grams
total % lost	1.166078 %

PRM-PRO-P-2	
Weight (+mold) =	3110 grams
Mass lost =	-2 grams
total % lost	-0.06649 %

PRM-PRO-P-3	
Weight (+mold) =	3062 grams
Mass lost =	-3 grams
total % lost	-0.0982 %

PRM-PRO-P-4	
Weight (+mold) =	3266 grams
Mass lost =	-4 grams
total % lost	-0.1265 %

0.218721623

PRM-PRO-P-1			PRM-PRO-P-2			PRM-PRO-P-3			PRM-PRO-P-4		
Weight Alone	3159 grams		Weight Alone	3004 grams		Weight Alone	2955 grams		Weight Alone	2045 grams	
Weight mold =	102 grams		Weight mold =	103 grams		Weight mold =	102 grams		Weight mold =	102 grams	
Final Mass lost =	-3226.83 grams		Final Mass lost =	-3109.07 grams		Final Mass lost =	-3060.1 grams		Final Mass lost =	-2151.13 grams	
total % lost	-114.022 %		total % lost	-103.36 %		total % lost	-103.417 %		total % lost	-68.0306 %	
Comp Strength	XXX psi		Comp Strength	XXX psi		Comp Strength	1234 psi		Comp Strength	2404 psi	
XXX	5470 XXX		Load (P)	10800 lbs		XXX	XXX		XXX	XXX	
Tensile Strength	157.6138 psi		Tensile Strength	214.9875 psi		Tensile Strength	XXX psi		Tensile Strength	XXX psi	
Reduced L											
-97.2073809											
Average Comp Strength =	1819 psi										
Average Tensile Strength =	186.3006 psi										

Fully Submerged

PRM-PRO-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3052 grams
Weight mold =	139 grams
Total +Water =	3474 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	422 cm^3
γ Concrete =	1.768233 gm/cm^3
γ Concrete =	110.3872 lb/ft^3
Volume Solids =	1225.407 cm^3
Porosity =	25.61601 %

PRM-PRO-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3127 grams
Weight mold =	139 grams
Total +Water =	3527 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	400 cm^3
γ Concrete =	1.813759 gm/cm^3
γ Concrete =	113.2293 lb/ft^3
Volume Solids =	1247.407 cm^3
Porosity =	24.28058 %

PRM-PRO-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3208 grams
Weight mold =	139 grams
Total +Water =	3576 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	368 cm^3
γ Concrete =	1.862927 gm/cm^3
γ Concrete =	116.2987 lb/ft^3
Volume Solids =	1279.407 cm^3
Porosity =	22.33813 %

PRM-PRO-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3128 grams
Weight mold =	139 grams
Total +Water =	3512 grams
Total Volume =	1647.407 cm^3
Total Volume =	100.531 in^3
γ Water =	1 gm/cm^3
Volume Water =	384 cm^3
γ Concrete =	1.814366 gm/cm^3
γ Concrete =	113.2672 lb/ft^3
Volume Solids =	1263.407 cm^3
Porosity =	23.30935 %

PRM-PRO-F-1	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3011 grams
Weight mold =	100 grams
Original weight =	2913 grams
Mass lost =	2 grams
% lost =	0.068658 %
0.025531236	
Weight (+mold) =	3001 grams
Mass lost =	12 grams
total % lost	0.411946 %
0.186425395	

PRM-PRO-F-2	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3087 grams
Weight mold =	100 grams
Original weight =	2988 grams
Mass lost =	1 grams
% lost =	0.033467 %
Weight (+mold) =	3082 grams
Mass lost =	6 grams
total % lost	0.200803 %

PRM-PRO-F-3	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3169 grams
Weight mold =	100 grams
Original weight =	3069 grams
Mass lost =	0 grams
% lost =	0 %
Weight (+mold) =	3168 grams
Mass lost =	1 grams
total % lost	0.032584 %

PRM-PRO-F-4	
Height =	8 inches
Dia =	4 inches
Weight (+mold) =	3089 grams
Weight mold =	100 grams
Original weight =	2989 grams
Mass lost =	0 grams
% lost =	0 %
Weight (+mold) =	3086 grams
Mass lost =	3 grams
total % lost	0.100368 %

PRM-PRO-F-1	
Weight (+mold) =	3008 grams
Mass lost =	5 grams
total % lost =	0.171644 %

PRM-PRO-F-2	
Weight (+mold) =	3088 grams
Mass lost =	0 grams
total % lost =	0 %

PRM-PRO-F-3	
Weight (+mold) =	3167 grams
Mass lost =	2 grams
total % lost =	0.065168 %

PRM-PRO-F-4	
Weight (+mold) =	3082 grams
Mass lost =	7 grams
total % lost =	0.234192 %

0.117751049

PRM-PRO-F-1	
Weight (+mold) =	2997 grams
Mass lost =	16 grams
total % lost	0.549262 %

PRM-PRO-F-2	
Weight (+mold) =	3082 grams
Mass lost =	6 grams
total % lost	0.200803 %

PRM-PRO-F-3	
Weight (+mold) =	3162 grams
Mass lost =	7 grams
total % lost	0.228087 %

PRM-PRO-F-4	
Weight (+mold) =	3071 grams
Mass lost =	18 grams
total % lost	0.602208 %

0.395090141

PRM-PRO-F-1	
Weight (+mold) =	3009 grams
Mass lost =	4 grams
total % lost	0.137315 %

PRM-PRO-F-2	
Weight (+mold) =	3090 grams
Mass lost =	-2 grams
total % lost	-0.06693 %

PRM-PRO-F-3	
Weight (+mold) =	3168 grams
Mass lost =	1 grams
total % lost	0.032584 %

PRM-PRO-F-4	
Weight (+mold) =	3078 grams
Mass lost =	11 grams
total % lost	0.368016 %

0.11774526

PRM-PRO-F-1	
Weight (+mold) =	3004 grams
Mass lost =	9 grams
total % lost	0.30896 %

PRM-PRO-F-2	
Weight (+mold) =	3082 grams
Mass lost =	6 grams
total % lost	0.200803 %

PRM-PRO-F-3	
Weight (+mold) =	3162 grams
Mass lost =	7 grams
total % lost	0.228087 %

PRM-PRO-F-4	
Weight (+mold) =	3075 grams
Mass lost =	14 grams
total % lost	0.468384 %

0.301558612

PRM-PRO-F-1	
Weight (+mold) =	3001 grams
Mass lost =	12 grams
total % lost	0.411946 %

PRM-PRO-F-2	
Weight (+mold) =	3082 grams
Mass lost =	6 grams
total % lost	0.200803 %

PRM-PRO-F-3	
Weight (+mold) =	3160 grams
Mass lost =	9 grams
total % lost	0.293255 %

PRM-PRO-F-4	
Weight (+mold) =	3076 grams
Mass lost =	13 grams
total % lost	0.434928 %

0.335233215

PRM-PRO-F-1	
Weight (+mold) =	3006 grams
Mass lost =	7 grams
total % lost	0.240302 %

PRM-PRO-F-2	
Weight (+mold) =	3088 grams
Mass lost =	0 grams
total % lost	0 %

PRM-PRO-F-3	
Weight (+mold) =	3166 grams
Mass lost =	3 grams
total % lost	0.097752 %

PRM-PRO-F-4	
Weight (+mold) =	3088 grams
Mass lost =	1 grams
total % lost	0.033456 %

0.092877453

PRM-PRO-F-1	
Weight (+mold) =	3011 grams
Mass lost =	2 grams
total % lost	0.068658 %

PRM-PRO-F-2	
Weight (+mold) =	3094 grams
Mass lost =	-6 grams
total % lost	-0.2008 %

PRM-PRO-F-3	
Weight (+mold) =	3172 grams
Mass lost =	-3 grams
total % lost	-0.09775 %

PRM-PRO-F-4	
Weight (+mold) =	3094 grams
Mass lost =	-5 grams
total % lost	-0.16728 %

-0.0992943

PRM-PRO-F-1			PRM-PRO-F-2			PRM-PRO-F-3			PRM-PRO-F-4		
Weight Alone	1662 grams		Weight Alone	1419 grams		Weight Alone	3067 grams		Weight Alone	2986 grams	
Weight mold =	101 grams		Weight mold =	101 grams		Weight mold =	102 grams		Weight mold =	102 grams	
Final Mass lost =	-1760.93 grams		Final Mass lost =	-1526.2 grams		Final Mass lost =	-3172.1 grams		Final Mass lost =	-3093.17 grams	
total % lost	-60.4508 %		total % lost	-51.0777 %		total % lost	-103.359 %		total % lost	-103.485 %	
Comp Strength	XXX psi		Comp Strength	XXX psi		Comp Strength	2108 psi		Comp Strength	XXX psi	
XXX	XXX		Load (P)	lbs		XXX	XXX		Load (P)	4080 lbs	
Tensile Strength	XXX psi		Tensile Strength	XXX psi		Tensile Strength	XXX psi		Tensile Strength	157.0963 psi	
Broken, cannot test			Broken, cannot test						Reduced L		
-79.5932008											
Average Comp Strength =	2108 psi										
Average Tensile Strength =	157.0963 psi										

Garrison Hall Sample Cores

6/4/2013 (After 0 cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Dry Weight =	2030 gm	Dry Weight =	1954 grams	Dry Weight =	2015 grams
Wt Mold =	117 gm	Wt Mold =	117 gm	Wt Mold =	117 gm
Mold Dia =	10.24636 cm	Mold Dia =	10.24636 cm	Mold Dia =	10.24636 cm
Top Dia =	9.5123 cm	Top Dia =	9.51484 cm	Top Dia =	9.48944 cm
Bottom Dia =	9.50722 cm	Bottom Dia =	9.49452 cm	Bottom Dia =	9.52754 cm
Average Dia =	9.50976 cm	Average Dia =	9.50468 cm	Average Dia =	9.50849 cm
Rt Side Ht =	13.57884 cm	Rt Side Ht =	13.51534 cm	Rt Side Ht =	15.3162 cm
Lft Side Ht =	15.52448 cm	Lft Side Ht =	15.40764 cm	Lft Side Ht =	15.51432 cm
Rear Ht =	14.86916 cm	Rear Ht =	14.86916 cm	Rear Ht =	15.48892 cm
Front Ht =	14.59484 cm	Front Ht =	13.9954 cm	Front Ht =	15.367 cm
Average Ht =	14.64183 cm	Average Ht =	14.44689 cm	Average Ht =	15.42161 cm
Psuedo H20 Ht =	15.52448 cm	Psuedo H20 Ht =	15.40764 cm	Psuedo H20 Ht =	15.51432 cm
Actual H20 Ht =	16.9 cm	Actual H20 Ht =	16.6 cm	Actual H20 Ht =	16.6 cm
Wet Wt (w/ mold & Psuedo) =	2633 gm	Wet Wt (w/ mold & Psuedo) =	2573 grams	Wet Wt (w/ mold & Psuedo) =	2623 grams
Volume Core =	1039.978 cm^3	Volume Core =	1025.036 cm^3	Volume Core =	1095.072 cm^3
Unit Weight of Core =	1.951963 gm/cm^3	Unit Weight of Core =	1.906275 gm/cm^3	Unit Weight of Core =	1.840062 gm/cm^3
Unit Weight of Core (English) =	121.8025 gm/cm^3	Unit Weight of Core (English) =	118.9515 gm/cm^3	Unit Weight of Core (English) =	114.8198 gm/cm^3
Volume Core + Total Water =	1393.528 cm^3	Volume Core + Total Water =	1368.791 cm^3	Volume Core + Total Water =	1368.791 cm^3
Volume Bottom Water =	97.7003 cm^3	Volume Bottom Water =	84.60037 cm^3	Volume Bottom Water =	77.09298 cm^3
Volume Water Surrounding Core	255.8496 cm^3	Volume Water Surrounding Core	259.1548 cm^3	Volume Water Surrounding Core	196.6261 cm^3
Wt Water =	1 gm/cm^3	Wt Water =	1 gm/cm^3	Wt Water =	1 gm/cm^3
Wt Excess Water =	353.5499 gm	Wt Excess Water =	343.7552 gm	Wt Excess Water =	273.7191 gm
Wt Core + Water =	2279.45 gm	Wt Core + Water =	2229.245 gm	Wt Core + Water =	2349.281 gm
Wt Water in Core =	249.4501 gm	Wt Water in Core =	275.2448 gm	Wt Water in Core =	334.2809 gm
Porosity =	33.99588 %	Porosity =	33.53592 %	Porosity =	24.99553 %

6/11/2013 (After 36 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	2025 grams	Weight =	1949 grams	Weight =	2003 grams
Mass lost =	5 grams	Mass lost =	5 grams	Mass lost =	12 grams
total % lost =	0.246305 %	total % lost =	0.255885 %	total % lost =	0.595533 %

6/18/2013 (After 72 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	2023 grams	Weight =	1947 grams	Weight =	2003 grams
Mass lost =	7 grams	Mass lost =	7 grams	Mass lost =	12 grams
total % lost =	0.344828 %	total % lost =	0.35824 %	total % lost =	0.595533 %

6/25/2013 (After 108 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	2017 grams	Weight =	1946 grams	Weight =	1996 grams
Mass lost =	13 grams	Mass lost =	8 grams	Mass lost =	19 grams
total % lost =	0.640394 %	total % lost =	0.409417 %	total % lost =	0.942928 %

7/2/2013 (After 144 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	2008 grams	Weight =	1945 grams	Weight =	1983 grams
Mass lost =	22 grams	Mass lost =	9 grams	Mass lost =	32 grams
total % lost =	1.083744 %	total % lost =	0.460594 %	total % lost =	1.588089 %

7/9/2013 (After 180 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	2008 grams	Weight =	1944 grams	Weight =	1967 grams
Mass lost =	22 grams	Mass lost =	10 grams	Mass lost =	48 grams
total % lost =	1.083744 %	total % lost =	0.511771 %	total % lost =	2.382134 %

7/16/2013 (After 216 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	1995 grams	Weight =	1930 grams	Weight =	1931 grams
Mass lost =	35 grams	Mass lost =	24 grams	Mass lost =	84 grams
total % lost =	1.724138 %	total % lost =	1.22825 %	total % lost =	4.168734 %

7/232013 (After 252 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	1975 grams	Weight =	1900 grams	Weight =	1905 grams
Mass lost =	55 grams	Mass lost =	54 grams	Mass lost =	110 grams
total % lost =	2.70936 %	total % lost =	2.763562 %	total % lost =	5.459057 %

8/2/2013 (After 288 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	1945 grams	Weight =	1885 grams	Weight =	1870 grams
Mass lost =	85 grams	Mass lost =	69 grams	Mass lost =	145 grams
total % lost =	4.187192 %	total % lost =	3.531218 %	total % lost =	7.19603 %

(After 300 Cycles)

South Core		Middle Core		North Core	
Fully Submerged		Unsubmerged		Partially Submerged	
Weight =	1905 grams	Weight =	1855 grams	Weight =	1830 grams
Mass lost =	125 grams	Mass lost =	99 grams	Mass lost =	185 grams
total % lost =	6.157635 %	total % lost =	5.06653 %	total % lost =	9.181141 %