Influence of Curing Temperature on Strength of Cement-treated Soil and Investigation of Optimum Mix Design for the Wet Method of Deep Mixing

Hwanik Ju

Thesis submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Master of Science
In
Civil Engineering

George M. Filz
Russell A. Green
Matthew Mauldon

November 30, 2018
Blacksburg, VA

Keywords: Deep Mixing, Wet Method, Cement-treated Soil Properties, Curing Temperature, Unconfined Compressive Strength, Consistency, Optimum Mix Design

Influence of Curing Temperature on Strength of Cement-treated Soil and Investigation of Optimum Mix Design for the Wet Method of Deep Mixing

Hwanik Ju

ACADEMIC ABSTRACT

The Deep Mixing Method (DMM) is a widely used, in-situ ground improvement technique that modifies and improves the engineering properties of soil by blending the soil with a cementitious binder. Laboratory specimens were prepared to represent soil improved by the wet method of deep mixing, in which the binder is delivered in the form of a cement-water slurry. To study the influence of curing temperature on the strength of the treated soil, specimens were cured in temperature-controlled water baths for the desired curing time. After curing, unconfined compressive strength (UCS) tests were conducted on the specimens. To investigate the optimum mix design for the wet method of deep mixing, UCS tests were performed to measure the strength of cured specimens, and laboratory miniature vane shear tests were conducted on uncured specimens to measure the undrained shear strength (s_u), which is used to represent the consistency of the mixture right after mixing. The consistency is important for field mixing because a softer mixture is easier to mix thoroughly. Based on the UCS test results, an equation that can provide a good fit to the strength data of the cured binder-treated soil is proposed. When the curing temperature was changed during curing, the UCS of the specimen cured at a low temperature and then cured at a high temperature was greater than the UCS of the specimen cured at a high temperature first. This seems to be due to different effects of elevated curing temperatures at early and late curing times on the cement reaction rates, such that elevating the curing temperature later produces a more constant reaction rate, which contributes to the reaction efficiency. An optimum mix design that minimizes the amount of binder while satisfying both a target strength of the cured mixture and a target consistency of the uncured mixture can be established by using the fitted equations for UCS and s_u. The amount of binder required for the optimum mix design increases as the plasticity of the base soil increases and the water content of the base soil ($w_{base\ soil}$) decreases.

Influence of Curing Temperature on Strength of Cement-treated Soil and Investigation of Optimum Mix Design for the Wet Method of Deep Mixing

Hwanik Ju

GENERAL AUDIENCE ABSTRACT

The Deep Mixing Method (DMM) is a ground improvement technique widely used to improve the strength and stiffness of loose sands, soft clays, and organic soils. The DMM is useful for both inland and coastal construction. There are two types of deep mixing. The dry method of deep mixing involves adding the binder in the form of dry powder, and the wet method of deep mixing involves mixing binder-water slurry with the soil. The strength of the cured mixture is significantly influenced by the amount of added cement and water, the curing time, and the curing temperature. This research evaluates the influence of curing temperature on the strength of cured cement-treated soil mixture. Mixture proportions and curing conditions also influence the consistency of the mixture right after mixing, which is important because it affects the amount of mixing energy necessary to thoroughly mix the binder slurry with the soil. This research developed and evaluated fitting equations that correlate the cured mixture strength and the uncured mixture consistency with mixture proportions and curing conditions. These fitting equations can then be used to select an economical and practical mix design method that minimizes the amount of binder needed to achieve both the desired cured strength and uncured consistency. The amount of binder required for the optimum mix design increases as the plasticity of the base soil increases and the water content of the base soil ($w_{base\ soil}$) decreases.

Dedication

This work is dedicated to my family. I would not be the person I am without them, and I cannot thank them enough. First, to my loving wife Hye-eun, who makes me smile, confident, and happy. I believe that we can complete our academic career supporting and loving each other. To my parents, for trusting me and encouraging me regardless of where I am and what I do. I will keep your love in my mind forever. To my older brother Hwansung, for his assistance and advice sometimes like my father, sometimes like my friend. Messaging with him is an excellent break during my work and gives me the energy to work harder.

Acknowledgment

First, I would like to extend my deepest gratitude to my advisor, Dr. George Filz, for his support and invaluable guidance throughout my research. This work would not have been possible without his expertise, encouragement, and patience. I express my most sincere respect to him, and it is a great honor to work with him and learn from him during this research.

I would also like to thank my committee members, Dr. Russell Green and Dr. Matthew Mauldon, for their advice and feedback on my thesis. Their trust in me and encouragement helped me advance forward throughout my studies at Virginia Tech.

I would like to express special thanks to Dr. Thomas Brandon and Dr. Bernardo Castellanos for allowing me to work in the W. C. English Laboratory and providing laboratory equipment. I have spent a lot of time at the laboratory, and it is the perfect place to study and research. To Brett Farmer for fabricating the specimen curing steel frames. My work would not have been possible without his assistance.

My genuine appreciation also goes to my friend Roberto Nevárez-Garibaldi, for teaching me the mixing and testing procedure, and offering his knowledge and experience about Deep Mixing Method. I really enjoyed discussing my and his results for my thesis with him. Outside of research, talking about Korean culture and food with him made me happy and energetic.

Last but not least, I must thank my wife “Hye-eun”, my parents, my older brother “Hwansung” for their unconditional support and continuous encouragement. Especially to my father, thank you for your advice about the chemical reaction. I am very fortunate to have had the discussion about that part of my research with my father; it definitely is one of the most unforgettable moments in my life.

Table of Contents

List of Figures

List of Tables

1. Introduction

1.1. Background and Motivation

The deep mixing method (DMM) is a widely used in-situ ground improvement technique that is often applied to loose sand, soft clay, and organic soil. The soil is improved by blending it with a cementitious binder to increase the strength and decrease the compressibility of the soil in order to improve its ability to support excavations, buildings, embankments, and other facilities. There are two types of deep mixing. The dry method of deep mixing involves mixing dry cementitious binder with the soil, and the wet method of deep mixing involves mixing a binder-water slurry with the soil. Strength development of the treated soil depends on the characteristics of the untreated soil and the binder, the mixing conditions, and the curing time and conditions (Terashi 1997).

Curing temperature is known to affect the strength of binder-treated soil, and the curing temperature is elevated by the heat of hydration of the binder. Treating the soil with a large amount of binder increases the curing temperature. Curing temperature also varies depending on the region, and weather conditions during the curing period can affect the curing temperature to a limited depth. Unconfined compressive strength (UCS) has been used to represent the strength of treated soil, and many researchers have reported that UCS increases with increasing curing temperature (Bruce et al. 2013; Hirabayashi et al. 2009; Zhang et al. 2014). Nevárez-Garibaldi et al. (2018) studied the influence of the curing time and mixture proportion, and they proposed an equation to correlate UCS with these parameters. They also investigated the influence of curing temperature on UCS, but their data set for temperature was small with some scatter. Therefore, further investigation of the influence of curing temperature on UCS is beneficial to develop a more accurate representation of the effects of temperature over a range of curing times and mixture proportions.

For deep mixing contractors, the consistency of the binder-treated soil right after mixing is important because a softer mixture is easier to mix thoroughly, and thorough mixing promotes higher cured strength. Mixing thoroughness also depends on the mixing equipment and processes that the contractor controls, which means that the contractor will have to select a target consistency that is suitable for the contractor's mixing technology. A softer mixture can be produced by increasing the amount of water in the mixture but adding more water to the mixture tends to decrease the cured strength. The cured strength can be increased by adding more binder, but this increases material costs, and adding too much binder compared to the amount of water and soil produces a stiff mixture, making mixing difficult (Lorenzo and Bergado 2006). Thus, it would be helpful to know how mixture proportions influence mixture consistency before curing. Nevárez-Garibaldi et al. (2018) proposed a relationship for the uncured mixture consistency, which is represented by the undrained shear strength (s_u). Nevárez-Garibaldi et al. (2018) then used their UCS and s_u equations to develop a method to select an optimum mix design that achieves a target cured strength and a target uncured consistency using the smallest amount of cement. However, they used only one type of base soil, a lean clay (CL), in their research. Thus, applying their work to other types of base soil, and developing improved relationships if necessary, has the potential to widen the applicability of the method for optimizing mix design.

1.2. Research objectives and scope

The primary purposes of this research are to investigate: (1) the influence of curing temperature on the unconfined compressive strength (UCS) of the cured cement-treated soil and (2) optimization of the mix design for the wet method of deep mixing by achieving a cured strength target and an uncured consistency target using the least amount of cement. The specific research tasks to accomplish these purposes are as follows:

- Evaluate the UCS equation suggested by Nevárez-Garibaldi et al. (2018) and revise the equation to provide more accurate UCS prediction as a function of curing time, curing temperature, and mixture proportions.
- Investigate the influence of changing curing temperature by using the UCS test data obtained from specimens cured for different amounts of time at low and high curing temperatures and in different temperature change sequences (i.e., 25 then 45 °C, and 45 then 25 °C).
- Evaluate the applicability of the UCS equation and the consistency (s_u) equation developed by Nevárez-Garibaldi et al. (2018) for a fat clay (CH) and revise the equations, so they can apply to a wide range of clay plasticity.
- Update the optimum mix design selecting method established by Nevárez-Garibaldi et al. (2018) with the revised UCS and s_u equations.

- Plot the changes in controlling parameters for optimum mix design (i.e., the cement factor, cement factor in-place, and water-to-cement ratio of the slurry (α_{opt}, $\alpha_{in\text{-}place,opt}$, and $w{:}c_{opt}$, respectively)) corresponding to changing plasticity of the base soil and the water content of the base soil ($w_{base\ soil}$) to investigate their influences on the optimum mix design.

The scope of this research is limited to:

- Only one type of binder, Portland cement type I/II, was used in this research.
- Two types of base soil, a lean clay and a fat clay, were used in this research. Both base soils were designed to be relatively easy to fabricate and mixed with the cement-water slurry for reproducible mixtures and test results.

1.3. Thesis Organization

This thesis is composed of this introductory chapter, four additional chapters, and three appendices, organized as follows:

- Chapter 2 reviews the previous literature associated with the influence of curing temperature on the strength of cement-treated soil, the cured strength and uncured consistency of the soil, and the method to select optimum mix design for the wet method of deep mixing.
- Chapter 3 presents the materials and research methods used in this research, including the characteristics of the base soils, specimen preparation procedures and curing conditions corresponding to the research objectives, and strength testing apparatus and methods.
- Chapter 4 discusses the influence of constant and changing curing temperature, the cured strength and the uncured consistency of the cement-treated soil, the method to select optimum mix design, and the influence of the plasticity of the base soil and the water content of the base soil on the optimum mix design based on the test results.
- Chapter 5 presents conclusions obtained from the test results and recommendations for future research.
- Appendices A and B provide detailed mixing data and unconfined compressive strength (UCS) test results, respectively. Appendix C presents alternative equations for the prediction of UCS and consistency right after mixing with their coefficient of determination (R^2) and coefficient values.

2. Literature Review

The literature review presents an overview of topics related to this research, including: specimen preparation and curing for strength tests, influence of curing temperature on strength, correlating strength to curing time and mixture properties, combined effect of curing time and curing temperature, mixture consistency right after mixing, and optimizing the mix design. The focus of this literature review is on laboratory preparation and testing of specimens to represent the wet method of deep mixing.

2.1. Specimen preparation and curing for strength tests

Laboratory measurements of cured mixture strength performed on specimens that are prepared in a laboratory are significantly influenced by the specimen preparation procedures. The molding technique, which is the procedure used to place uncured mixture in a curing mold, is one of the important parts of specimen preparation for strength tests. Kitazume et al. (2015) studied five different molding techniques (tapping, rodding, dynamic compaction, static compaction, and no compaction). They reported that tapping is suitable for relatively fluid mixtures, rodding is suitable for most mixtures, dynamic compaction is suitable for relatively stiff mixtures, and static compaction and no compaction are not very good molding techniques compare to the previous three techniques. Hodges et al. (2008) found that, for coarse-grained base soils, specimens molded soon after mixing tended to have higher water contents with lower amounts of soil solids than those molded later because less settling of soil solids occurs for specimens molded soon after mixing and more settling occurs for specimens molded later. Hodges et al. (2008) recommend pairing early-molded and late-molded specimens and testing them at the same curing time to minimize the effect of potential differences in the water content, the amount of soil solids, and the solid settling effect.

After the desired curing time, the end-faces of the specimens should be treated to have flat and parallel surfaces on both the top and bottom. Poor end-face treatment can cause unreliable test results due to non-uniform distribution of stress during the strength test. Nevárez-Garibaldi et al. (2018) compared five end-face treatment methods: sawing-and-hand-trimming, machine grinding, sulfur capping, neoprene pads, and gypsum capping. According to their research, sawing-and-hand-trimming and machine grinding produce very similar strength test results. The equipment for sawing-and-hand-trimming is relatively inexpensive, while the machine grinding method is easy to apply and produces smooth end-faces without scratches.

For specimens cured in plastic molds, a completely tight seal is needed to prevent introduction of curing water from outside the mold (Bruce et al. 2013; Hodges et al. 2008; Kitazume and Terashi 2013). After tight sealing, the specimens should be cured under temperature- and humidity-controlled conditions, such as in a humid room or a water bath.

2.2. Influence of curing temperature on strength

Hirabayashi et al. (2009), Zhang et al. (2014), and many other studies about the influence of curing temperature have shown that high curing temperatures accelerate cement hydration reactions and thereby produce high-strength cement-treated soil specimens. However, Zhang et al. (2014) found that strength development after 91 days of curing is minor even if the soil is cured at a high curing temperature. The rate of strength development decreases with time. One exception is that, for some organic soils, increased curing temperatures can degrade the organic material, making it more soluble and more able to interfere with the cementitious reactions (Ahnberg and Holm 1999). Nevárez-Garibaldi et al. (2018) conducted Unconfined Compressive Strength (UCS) tests on cement-treated inorganic soil specimens cured at three different curing temperature (21.1, 43.3, and 65.6 °C) and reported that the UCS is proportional to an exponential function of curing temperature. However, their data is limited and exhibits scatter.

While the influence of constant curing temperature on the strength of binder-treated soil has been widely investigated, few studies have investigated the case of changing curing temperature. Sato et al. (2006) investigated the effect of temperature changes on the UCS of stabilized soil by curing the specimens at various temperatures (-20, 5, and 20 °C) for six months. The test results indicated that specimens initially cured at low temperature and then cured at high temperature had a higher UCS than specimens cured at high temperature during the entire curing time. Sato et al. (2006) also showed that, if the curing temperature is very low (-20 °C), very little strength develops. They did not discuss the reasons for these results, but their findings are quite interesting and valuable.

Kim et al. (1998) studied the influence of changing curing temperature on compressive strength development of concrete. During 28 days of curing, they changed curing temperature from the reference temperature (20 °C) to lower temperature (5 °C) or higher temperature (40 °C) for one day at early ages (0, 1, 2, and 6 days). They reported that when the concrete experiences a high curing temperature at an early age of curing, it has higher strength at early curing times but has lower strength at later curing times. On the other hand, the concrete cured at a low temperature at an early age of curing is weaker at early curing times but has comparable strength to the concrete cured at the reference temperature at later curing times. However, when a one-day curing time was applied at curing times more than 7 days after mixing, there was not a significant impact on strength.

2.3. Correlating strength to curing time and mixture properties

Many factors affect the strength of soil treated with cement-water slurry. To represent the influence of curing time on the strength of the cured mixture, Horpibulsuk et al. (2003), Jacobson et al. (2003), Kitazume et al. (2003), Marzano et al. (2009), Horpibulsuk et al. (2011), and others adopted a logarithmic function of the curing time. Jacobson et al. (2003), Filz et al. (2005), and Hodges et al. (2008) used a power function to represent the influence of total-water-to-cement ratio on the strength of the cured mixture. By combining these two functions and a power function of the dry unit weight of the mixture, Nevárez-Garibaldi et al. (2018) proposed a four-coefficient equation to represent the cured strength of a cement-treated soil (Equation 2-1).

$$\frac{UCS_{pred}}{p_a} = \left[d_1 + d_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t\colon c]^{d_3} * \left[\gamma_{d,mix}\colon \gamma_w\right]^{d_4} \qquad \textit{Equation 2-1}$$

where UCS_{pred} is predicted UCS, p_a is the atmospheric pressure, d_1, d_2, d_3, and d_4 are dimensionless coefficients, t/t_0 is the curing time normalized by a reference time of one day, $w_t{:}c$ is the total-water-to-cement ratio, which is defined as the weight of the water in the mixture divided by the weight of cement, and $\gamma_{d,mix}{:}\gamma_w$ is the dry unit weight of the mixture normalized by the unit weight of water. Equation 2-1 was able to correlate measured and predicted values of UCS for a wide range of mixture proportions for a fabricated, inorganic soil treated with cement-water slurry and cured at room temperature for curing times ranging from 3 to 28 days.

2.4. Combined effect of curing time and curing temperature

As mentioned above, curing time and curing temperature have significant influences on the strength of binder-treated soil. To represent the combined effects of curing time and curing temperature on UCS, a maturity concept is usually applied in concrete engineering (Benaicha et al. 2016; Topcu and Toprak 2005; Yi et al. 2005; Yikici and Chen 2015). The maturity concept is also used for estimating the strength of binder-treated soil (Bearce and Mooney 2015), but maturity is not as commonly used for cement-treated soil as it is for concrete engineering. Equation 2-2 is the most common maturity index equation. In Equation 2-2, M is the maturity index (℃-h or ℃-day), T is average curing temperature during the curing time interval Δt (℃), and T_0 is a reference temperature, which is usually set as -10℃.

$$M = \sum_{0}^{t} (T - T_0)\Delta t \qquad \textit{Equation 2-2}$$

As indicated by the dimensional units of the maturity index, it represents the interaction of curing time and temperature. The strength of the cured material can be determined by Equation 2-3, which is the most common strength-maturity equation. In Equation 2-3, q_u is the unconfined compressive strength, and the values of coefficients a and b depending on the mixture characteristics.

$$q_u = a + b * logM \qquad \textit{Equation 2-3}$$

2.5. Consistency of binder-treated soil right after mixing

The amount of binder and water affect not only the strength of the cured binder-treated soil, but also the consistency right after mixing and before curing. Adding a lot of binder to the soft soil without enough water can make mixing difficult, especially for stiff and/or plastic clay soils, and the result can be a heterogeneous mixture in which clumps of untreated or poorly treated soil diminish the mixture strength (Lorenzo and Bergado 2006). To facilitate thorough mixing, the consistency of the binder-treated soil right after mixing and before curing should be considered in the mix design.

The consistency of the binder-treated soil right after mixing can be represented by the undrained shear strength (s_u) of the mixture. To measure the consistency of the mixture, Wasti and Bezirci (1986), Zreik et al. (1995), Szymkiewicz et al. (2013), and Kang et al. (2017) conducted fall cone tests. The laboratory miniature vane shear test is another common test for measuring the mixture consistency (Marzano et al. 2012).

Nevárez-Garibaldi et al. (2018) developed a three-coefficient equation to represent the consistency of a cement-treated soil in terms of curing time and the water content of the mixture. They fitted Equation 2-4 to s_u data obtained from laboratory miniature vane shear tests for a range of mixture consistencies. However, their three-coefficient equation was not very accurate for a mixture with a low water-to-cement ratio of the slurry (*w:c*). The authors suggested that additional parameters that affect consistency may be necessary for a more accurate prediction of s_u. In addition, they investigated the use of Equation 2-4 for only one type of base soil, which was a lean clay (CL).

$$\frac{s_{u,pred}}{p_a} = \left[f_1 + f_2\left(\frac{t}{t_{0m}}\right)\right] * [w_{mix}]^{f_3} \qquad \textit{Equation 2-4}$$

where $s_{u,pred}$ is predicted s_u, f_1, f_2, and f_3 are dimensionless coefficients, t/t_{0m} is the curing time normalized by a reference time of 60 minutes, w_{mix} is the water content of the mixture.

2.6. Optimum mix design for the wet method of deep mixing

The concept of an optimum mix design for economical and efficient mixing for the wet method of deep mixing has been discussed in the literature. Lorenzo and Bergado (2006) considered the optimum mixing water content ($C_{w,opt}$) of clay soil that provides for the most efficient strength improvement cement-treated soil. The authors suggested that $C_{w,opt}$ is 1.0 to 1.1 times the liquid limit (LL) of the base soil. Szymkiewicz et al. (2013) introduced the workability limit of the deep mixing material, which is the minimum mixture water content for which homogeneous mixing is feasible, and they assumed that the workability limit is equal to the liquid limit of the material. Their study also proposed a method to determine the optimum water content of deep mixing material that depends on the plasticity index (PI) of the base soil but is independent of the cement content.

With Equation 2-1 and 2-4, Nevárez-Garibaldi et al. (2018) proposed a method to select optimum mix design that achieves both a target strength after curing and a target consistency before curing while using the least amount of binder. They selected the cement factor (α), which is defined as the weight of cement divided by the volume of the base soil, and the water-to-cement ratio of the slurry (*w:c*), which is defined as the weight of the water in the slurry divided by the weight of cement, as controlling parameters of mix design. The optimum mix design for the wet method of deep mixing can be determined by the following steps:

(1) Select the target values of unconfined compressive strength (UCS) of the mixture and consistency (s_u) of the uncured mixture.

(2) Select a set of mix designs in terms of α and w:c that are likely to span the optimum mix design for economically achieving the target values of UCS and s_u.

(3) Prepare the binder-treated soil specimens corresponding to the mix designs selected in Step 2.

(3) Conduct unconfined compressive strength tests on specimens that are cured for various curing times (e.g., 7 to 28 days, or longer), and conduct laboratory miniature vane shear tests on specimens without curing (e.g., for 30 to 90 minutes after mixing) to measure consistency right after mixing (s_u).

(4) Reduce the data from the tests and find the coefficients that best fit Equation 2-1 to the UCS data and Equation 2-4 to the s_u data.

(5) Plot a strength contour for the target UCS using Equation 2-1 and plot a consistency contour for the target s_u using Equation 2-4. These contour lines should be plotted on one graph (x-axis is *w:c*, and y-axis is α), as illustrated in Figure 2-1.

(6) Find the optimum mix design, which is the intersection of the strength curve and the consistency curve, as shown by the square in Figure 2-1.

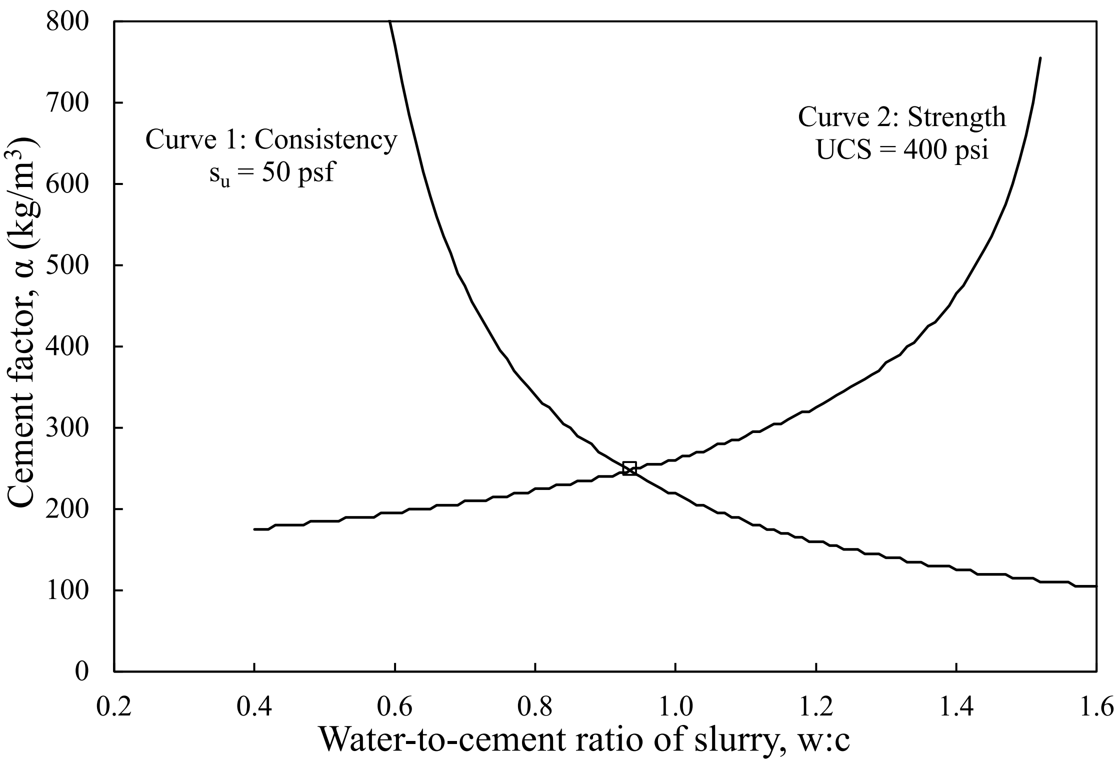


Figure 2-1. Strength & consistency curve and optimum mix design (Nevárez-Garibaldi et al. 2018)

In Figure 2-1, the strength curve (Curve 1) provides combinations of α and *w:c* that produce the target strength, and points above the curve provide combinations of α and *w:c* that produce UCS greater than the target UCS. Similarly, the consistency curve (Curve 2) provides combinations of α and *w:c* that produce the target consistency, and points above the curve provide combinations of α and *w:c* that produce s_u smaller than the target s_u. Nevárez-Garibaldi et al. (2018) selected a 28-day UCS (UCS_{28days}) of 400 psi as the target strength and a 60-minute s_u ($s_{u,60min}$) of 50 psf as the target consistency for the example shown in Figure 2-1. The intersection of the two curves is the optimum mix design, and the mixture at this point satisfies the target strength (UCS_{28days} of 400 psi) and the target consistency ($s_{u,60min}$ of 50 psf) using the minimum amount of cement.

3. Materials and Research Methods

This chapter introduces the materials and research methods used to investigate the influence of curing temperature on the strength of cement-treated soil and the optimum mix design for fat clay (CH). Descriptions of (1) base soil characterization, (2) mixture proportions, (3) cement-treated soil mixing, molding, and specimen preparation procedures for strength tests, (4) curing conditions, and (5) strength testing apparatus and methods are provided. Figure 3-1 provides flow charts that illustrate the processes followed in this research and described in this chapter. Several of the materials and procedures used by Nevárez-Garibaldi et al. (2018) were also used in this research because this research is a continuation of their research.

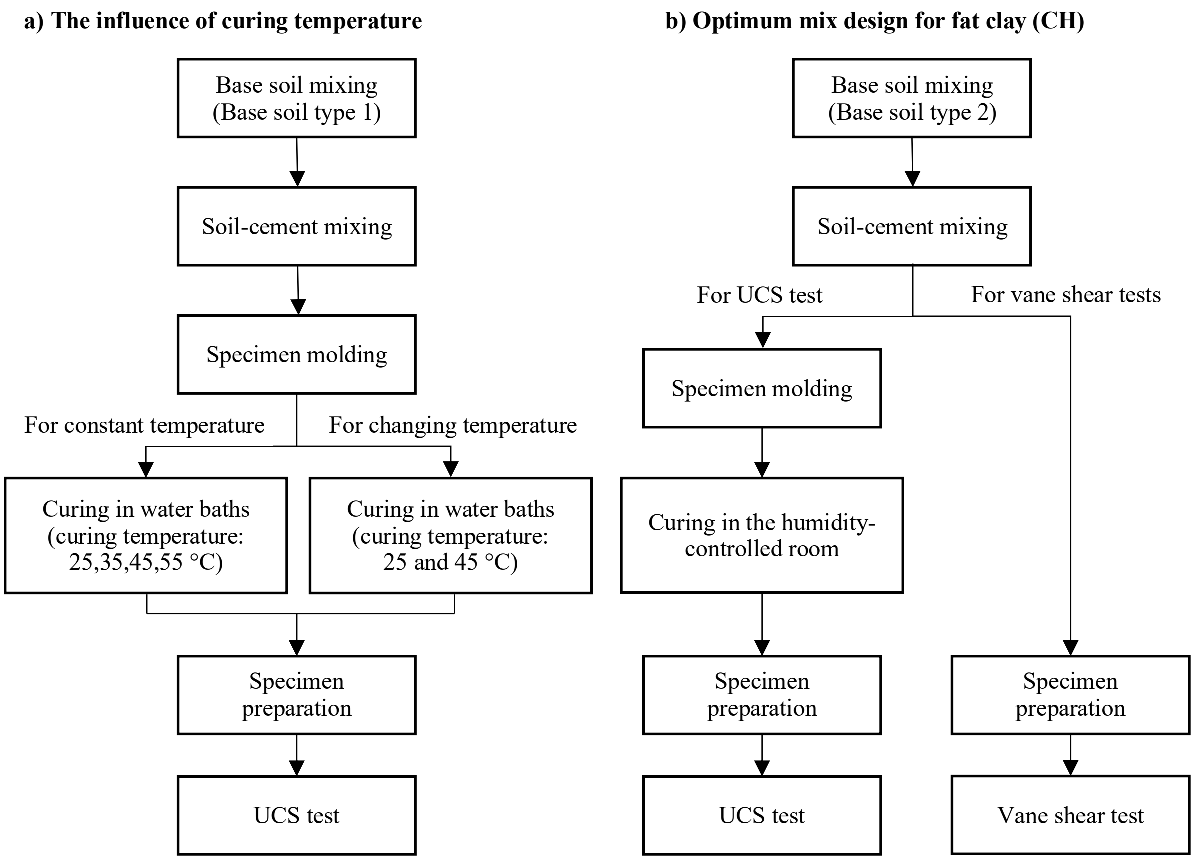


Figure 3-1. Flow charts of the processes for the studies of (a) the influence of curing temperature and (b) optimum mix design for fat clay (CH)

3.1. Base soil characterization

Two types of base soil were fabricated for this research. Base soil type 1 was used to investigate the influence of curing temperature, and base soil type 2 was used to investigate a mix design optimization procedure for fat clay (CH). The base soil used by Nevárez-Garibaldi et al. (2018) was selected as base soil type 1 for this research to permit comparisons with prior work. Base soil type 2 was more plastic than base soil type 1. Both base soils satisfied the following requirements:

- The base soil should represent a soft in-situ soil that could be improved by the wet method of deep mixing for a civil engineering application.
- The base soil should be easily blended with a cement-water slurry to produce consistent results.
- To allow for future research using the same materials, it should be possible to reproduce the base soil.

The base soils consisted of Fine Sand, Silica Flour, Kaolin, and Bentonite in different proportions. Table 3-1 shows the compositions of the two types of base soil by the dry weight percentage of each component.

Table 3-1. Base soil compositions by dry weight of components

Component	% total dry weight	
	Base soil type 1	Base soil type 2
Silica Flour	65	57
Kaolin	20	20
Fine Sand	10	10
Bentonite	5	13

According to the Unified Soil Classification System (USCS) (ASTM D2487), base soil type 1 is classified as a light gray lean clay (CL), and base soil type 2 is classified as a gray fat clay (CH). The USCS classification, the specific gravity of solids (G_s) (ASTM D854), and the Atterberg limits (ASTM D4318) of the two base soils are provided in Table 3-2. The particle size distributions of the two base soils (ASTM D6913 and D7928) are represented in Figure 3-2. The water contents ($w_{base\ soil}$) (ASTM D2166/D2166M) of base soil type 1 and 2 were 35% and 65%, respectively, which were equal to the liquid limit of each base soil.

Table 3-2. Base soil classification tests results

	USCS Classification	G_s	Atterberg Limits			% Fines
			LL	PL	PI	
Base soil type 1	CL	2.66	35	13	22	88.2
Base soil type 2	CH	2.64	65	19	46	85.7

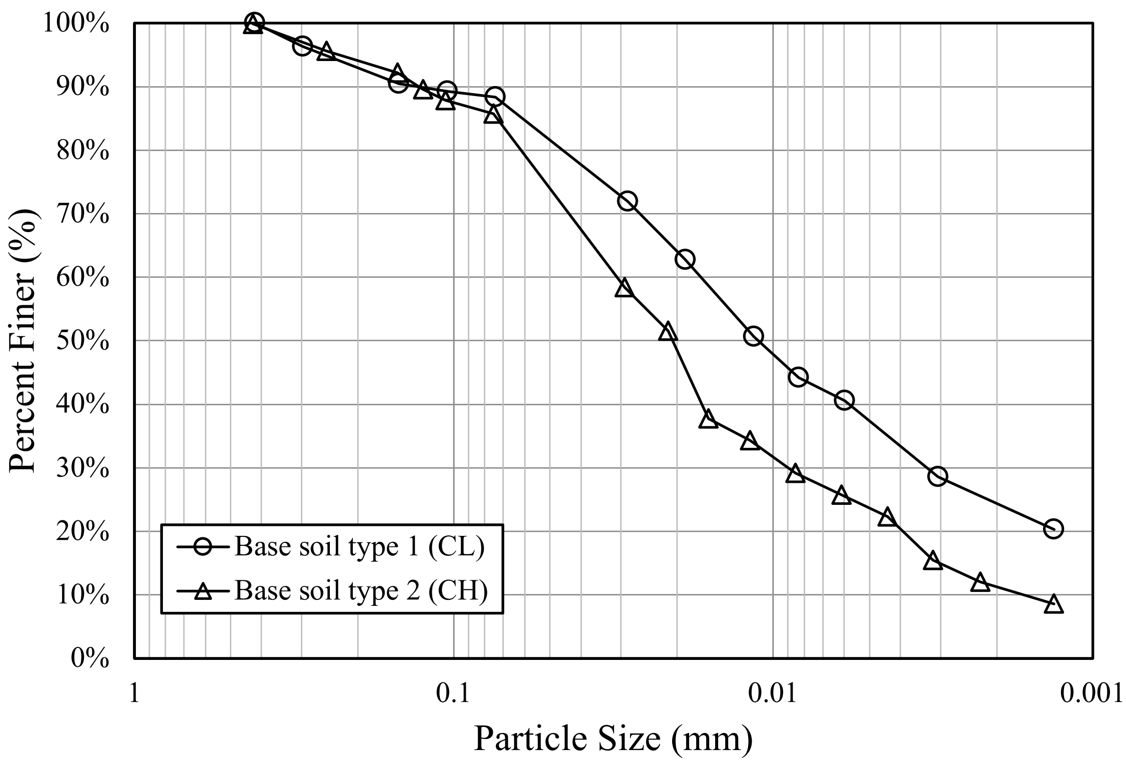


Figure 3-2. Particle size distribution of base soils

3.2. Mixture proportions

The cement factor in-place ($\alpha_{in\text{-}place}$) and the water-to-cement ratio of the slurry ($w{:}c$) were selected as the controlling parameters for the mix designs in this research. The cement factor in-place is defined as the weight of the cement divided by the volume of the mixture, and the water-to-cement ratio of the slurry is defined as the weight of the water in the slurry divided by the weight of cement. To cover practical ranges of mix design parameters, the selected values of $\alpha_{in\text{-}place}$ were 125, 200, 275, and 350, and the selected values of $w{:}c$ were 0.6, 1.0, and 1.4. Therefore, there could be 12 combinations of the two variables in the mix design. However, the mixture of $\alpha_{in\text{-}place}$ of 350 kg/m^3 and $w{:}c$ of 1.4 has an excessive amount of water that makes specimen preparation difficult and causes bleed water in the specimens during curing. On the other hand, in the mixture of $\alpha_{in\text{-}place}$ of 125 kg/m^3 and $w{:}c$ of 0.6, insufficient water makes the mixture very stiff; and the time necessary to prepare high quality specimens for unconfined compressive strength (UCS) tests becomes excessive. For both base soil types 1 and 2, the same difficulties occurred, although they were more pronounced for base soil type 1. For base soil type 2, the mixture with $\alpha_{in\text{-}place}$ of 125 kg/m^3 and $w{:}c$ of 0.6 was included for laboratory miniature vane shear test specimens to increase the range of vane shear strength values so that correlations with mixture proportions would be more robust. Table 3-3 shows the mixture proportions used in this research for UCS tests and laboratory miniature vane shear tests.

Table 3-3. Mixture proportions used for UCS and vane shear tests

UCS test		w:c			Vane shear test		w:c		
		0.6	1.0	1.4			0.6	1.0	1.4
$\alpha_{in\text{-}place}$ (kg/m^3)	125	X	O	O	$\alpha_{in\text{-}place}$ (kg/m^3)	125	O	O	O
	200	O	O	O		200	O	O	O
	275	O	O	O		275	O	O	O
	350	O	O	X		350	O	O	X

3.3. Cement-treated soil mixing, molding, and specimen preparation for strength tests

Throughout the mixing, it is recommended to wear disposable gloves. Soil becomes stickier when water is added so it sticks not only to mixing tools, such as bowls, containers and spatulas, but also to hands. Wearing disposable gloves allows one to remove the wet soil off the mixing tools and hands when handling the wet soil.

3.3.1. Base soil mixing

During the base soil mixing, a perfectly fit half-face respirator and filter must be worn because raised dry soil components, especially silica flour, can cause damage to the respiratory system when a person inhales. Although the respirator is worn, carefulness and slow movement are required whenever dry soil components are moved. Raised dry soil components cannot only harm the respiratory system, but also make it difficult to get an accurate proportion of components which can affect the test results.

More base soil than the amount exactly required was prepared because the wet soil can stick to bowls, containers, spoons, and spatulas, such that a smaller amount of soil than mixed is actually available.

Components of the dry base soil were weighed and combined in a bowl. The dry components were then transferred to a U.S. Stoneware High-Alumina Ceramic Jar (1.5 gallons) and were thoroughly mixed by a U.S. Stoneware 755RMV Jar Mill for 10 minutes at a speed setting of "30." The mixed dry soil was moved to a mixing bowl for a Hobart Legacy HL 120 Kitchen Mixer, and tap water was added to achieve the desired water content. The dry soil and water were mixed mechanically by the kitchen mixer with a dough hook for five minutes at a speed setting of "1." The five minutes of the mechanical mixing procedure was interrupted three or four times to allow for manually scraping soil stuck on the bowl surface to the center with a spatula. The time for manual scraping and mixing was not included in the five minutes required for mechanical mixing. After mixing, the moist base soil was put into a plastic container and stored in the humidity-controlled room overnight to allow for soil hydration.

3.3.2. Soil-cement mixing

After the base soil was hydrated overnight, the moist base soil was blended with cement-water slurry. As with the base soil mixing procedure, more than the required amount of cement-water slurry was produced to cope with slurry loss due to sticking to the inside of the blender.

For the wet method of deep mixing, Portland cement is commonly used as a binder for inorganic soil (Hirabayashi et al. 2009; Kitazume et al. 2015; Marzano et al. 2009; Szymkiewicz et al. 2012). According to Thomas and Jennings (2009), about 10 percent by weight (wt%) of a typical Portland cement particle is greater than 0.05 mm and less than 10 wt% is smaller than 0.002 mm. However, Quikrete Portland Cement Type I/II, which is the cement used in this research, had a few pieces of gravel and cement lumps which were greater than a typical size of Portland cement. Therefore, the cement was sieved, and the particles that only passed through No. 200 sieve (0.074 mm) were used, and the cement particles larger than No. 200 sieve (less than about 5% of total amount) were discarded.

Tap water and cement were combined and blended at the desired water-to-cement ratio of the slurry ($w{:}c$) using an Oster 14 speed blender for three minutes at the highest speed setting. Concurrently, the moist base soil was transferred into the mixing bowl and mixed mechanically with the dough hook for three minutes at a speed setting of "Stir." After calculating the required amount of cement-water slurry to achieve the desired cement factor in-place ($\alpha_{in\text{-}place}$), the cement-water slurry was carefully moved into the bowl. The cement-water slurry was mixed with the moist base soil by the kitchen mixer equipped with the dough hook for 10 minutes at a speed setting of "2." Replicating the base soil mixing procedure, the kitchen mixer was stopped three or four times to permit manual blending of mixture stuck to the bowl. The time for the manual mixing was not included in the 10 minutes required for mechanical mixing.

3.3.3. Specimen molding for unconfined compressive strength (UCS) test

Immediately following mixing of the base soil and the cement-water slurry, specimens for the UCS tests were prepared. This procedure was completed for all specimens from a batch within 30 minutes of completing mechanical mixing to minimize the potential for the mixture to set up before placing the mixture in the specimen molds.

The mixture was placed into 2.0-inch diameter, 4.0-inch tall plastic molds using a spatula in three lifts. After placing each lift, air bubbles in the mixture were removed by tapping the mold against a hard and flat surface. A mixture with a high water content is fluid and prone to slash out when tapping the plastic mold to prepare specimens. In this case, safety glasses can protect eyes. After the mold was filled with the mixture, the top surface of the mixture was leveled by removing overflowing mixture with a straight-edge spatula. The mold was then covered with a plastic lid and sealed tightly with electric tape to prevent moisture loss and intrusion of water from the water baths. The sealed specimens were cleaned and weighed on a scale. When the difference in weight of the heaviest specimen and the lightest specimen was greater than five grams, the lightest specimen was discarded because it may have contained excess air. This only occurred two times out of 38 batches.

In this research, 10 specimens were made per batch to allow for at least two UCS tests to be conducted at each desired curing time. The specimens were labeled in alphabetical order as they were produced (from A to J). The remaining two specimens (I and J) were prepared as extras. Hodges et al. (2008) reported that the specimens molded first typically have higher water contents with lower amounts of soil solids than those molded later. The early-molded and late-molded specimens were paired (excluding the two extra specimens, I and J) and tested at the same curing time (i.e., A & H, B & G, C & F, and D & E) to minimize the effect of potential differences in the water content and the amount of soil solids.

3.3.4. Specimen preparation for strength tests

Specimen preparation for strength testing was completed based on two different types of strength tests, the unconfined compressive strength (UCS) test for cured specimens and the laboratory miniature vane shear test for uncured mixtures.

Specimens for UCS test

After the desired curing time, specimens were prepared right before the UCS test to minimize moisture loss. The specimens were taken out of the water baths or plastic containers of water in the humidity-controlled room (specimen curing is described in Section 3.4). After removing the electric tape and the lid from the mold, the bottom of the plastic mold was removed using a Dewalt DW713 15 Amp Corded 10-inch compound miter saw. Special care was required at this step to prevent the specimens from being damaged by the miter saw. Specimens were extracted from the molds by simply pushing the specimen out of the tube from the bottom. If the specimen could not be pushed out of the tube easily, lengthwise cuts with a utility knife were made in the mold. Care was exercised to keep the blade of the utility knife from penetrating into the specimen. After removing the specimens from the molds, the end faces of the specimens were ground with a rock-core grinder.

Regarding the specimen end-face preparation technique, Nevárez-Garibaldi et al. (2018) reported very similar UCS results for specimens prepared using the grinding method and the sawing-and-hand-trimming method. The sawing-and-hand-trimming method requires less expensive equipment, but it is easier to prepare the end-faces using the grinding method, which does not scratch the end faces as much as the sawing-and-hand-trimming method does. A Vinci Technologies end-face grinder is available in our laboratories, and it was used for grinding the specimens to make the top and bottom ends flat and parallel to each other.

Specimens for laboratory miniature vane shear test

The mixture was placed into a container by a spatula in three lifts, and the air bubbles in the mixture were removed by tapping the container against a hard and flat surface after each lift. In this research, a 4.0-inch-diameter water-content cup was used as a specimen container for the laboratory miniature vane shear tests. After the container was filled with the mixture, the top surface of the mixture was leveled by removing overflowing mixture with a straight edge spatula.

3.4. Curing of specimens for unconfined compressive strength (UCS) test

To achieve the objectives of this research, the specimens for UCS test were cured for the desired curing time in temperature-controlled water baths or plastic containers of water in the humidity-controlled room.

3.4.1. Curing of specimens in temperature-controlled water baths

Curing condition

To investigate the influence of curing temperature on the strength of cement-treated soil, specimens were cured in temperature-controlled water baths. The water temperature in the baths was controlled by LAUDA ECO Heating and Cooling thermostats with a SILVER control head. During curing, the water temperature was monitored twice a day using a Perfect-Prime TC41, 4-Channel K-Type Digital Thermometer Thermocouple Sensor. The temperature was maintained within a range of ± 1.5 °C of the target temperature.

Two different sizes of water baths were used in this research. Appropriately sized steel frames were fabricated to cure the specimens without direct contact with the walls and bottom of the water baths. The steel frames were put into the water baths with three layers of racks that fit in the steel frames. The soil-cement specimens were placed on the racks with enough space to allow the water in the baths to circulate freely, thereby permitting good control of specimen temperature. Figure 3-3 illustrates the arrangement of specimens for curing in the water baths, and Figure 3-4 shows specimens curing in the water baths. Insulated covers were placed on each water bath during the curing period. Table 3-4 provides the dimensions of the water baths, steel frames, and racks, as well as the maximum number of specimens that can be cured at one time.

Figure 3-3. Specimen arrangements for curing in the large and small water baths

Figure 3-4. Specimens curing in the large and small water baths

Table 3-4. Detailed information for curing condition in water baths

	Large water bath	Small water bath
Water bath size (L x W x H) (in)	21.5 x 13.5 x 19.0	14.0 x 13.5 x 19.0
Steel frame size (L x W x H) (in)	20.0 x 12.5 x 12.0	13.0 x 12.5 x 12.0
Rack size (L x W) (in)	18.0 x 11.5	10.0 x 11.5
The max. number of specimens on one layer	15	8
The max. number of specimens in water bath	42	23

Note: The maximum number of specimens on the top layers of the water baths were smaller than those of the other layers for the following reasons: (1) space for the temperature controller in the water baths was needed at the top layers, and (2) the water flow from the temperature controller in the large water bath was strong, and the flow displaced specimens that were placed near the controller.

Although the temperature of the water in the water baths was monitored by the thermocouple sensors during curing, it was uncertain whether the temperature inside the specimens is the same as the temperature in the water bath. Therefore, the temperature uniformity tests were performed by measuring the temperature difference between inside the specimens and the water in the water baths. The temperatures of water in the two water baths were maintained at 25 °C and 45 °C, and two mixture proportions of the cement factor in-place ($\alpha_{in\text{-}place}$) of 125 kg/m^3 with the water-to-cement ratio of the slurry ($w{:}c$) of 1.0 and $\alpha_{in\text{-}place}$ of 275 kg/m^3 with the $w{:}c$ of 1.0 were used to conduct the temperature uniformity tests. As shown in Figure 3-5, the specimen was prepared by the following procedure: (a) A small hole was made on a plastic lid, (b) a thermometer sensor was inserted into the hole, and a needle was attached to the sensor to prevent the sensor from bending when it is penetrated into the mixture, (c) by applying epoxy glue on the top and the bottom of the lid, the sensor was fixed to the lid and the hole was completely sealed (d) after mixing and placing the mixture into a plastic mold, the sensor was penetrated into the center of the mixture, and the mold was covered with the lid, (e) the specimen was tightly sealed with electric tape, and (f) the specimen was placed into the water bath, and the temperatures in the water and inside the specimens were monitored for 14 days.

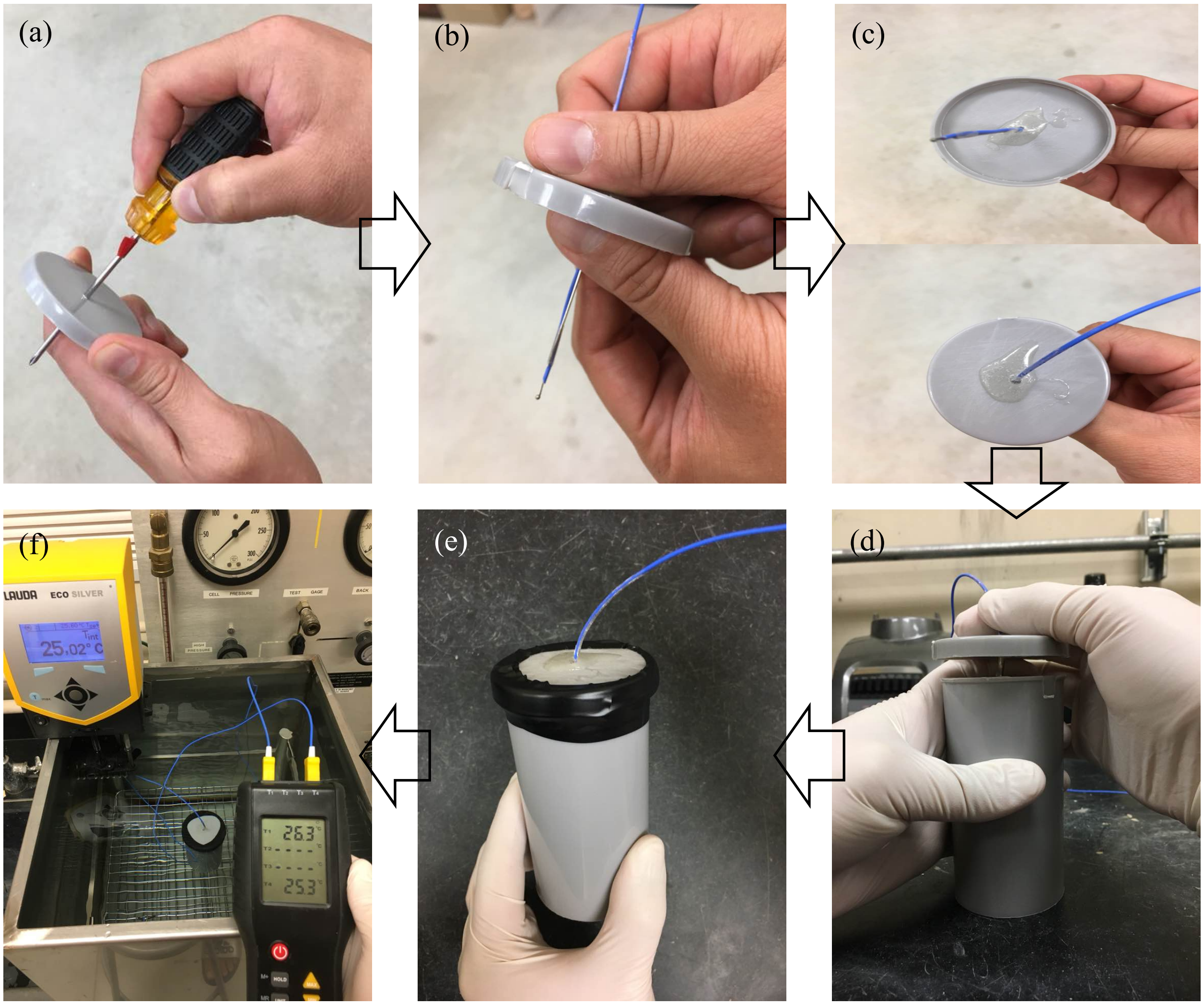


Figure 3-5. Specimen preparation procedure for temperature uniformity test

Figure 3-6 shows the temperature variation results of the temperature uniformity tests. As shown in Figure 3-6, the difference in temperature between inside the specimens and the water in the water baths are less than 2.0 °C which can be considered as negligible. Moreover, the water in the water baths did not enter into the specimens through the hole in the lid or the gap between the plastic mold and the lid. From the result of the temperature uniformity tests, therefore, it was demonstrated that the temperature of water in the water baths can represent the temperature inside specimens regardless of the mixture proportion of the specimens, and the curing temperature, and the properties of the cured mixture were not changed due to the water outside the specimen.

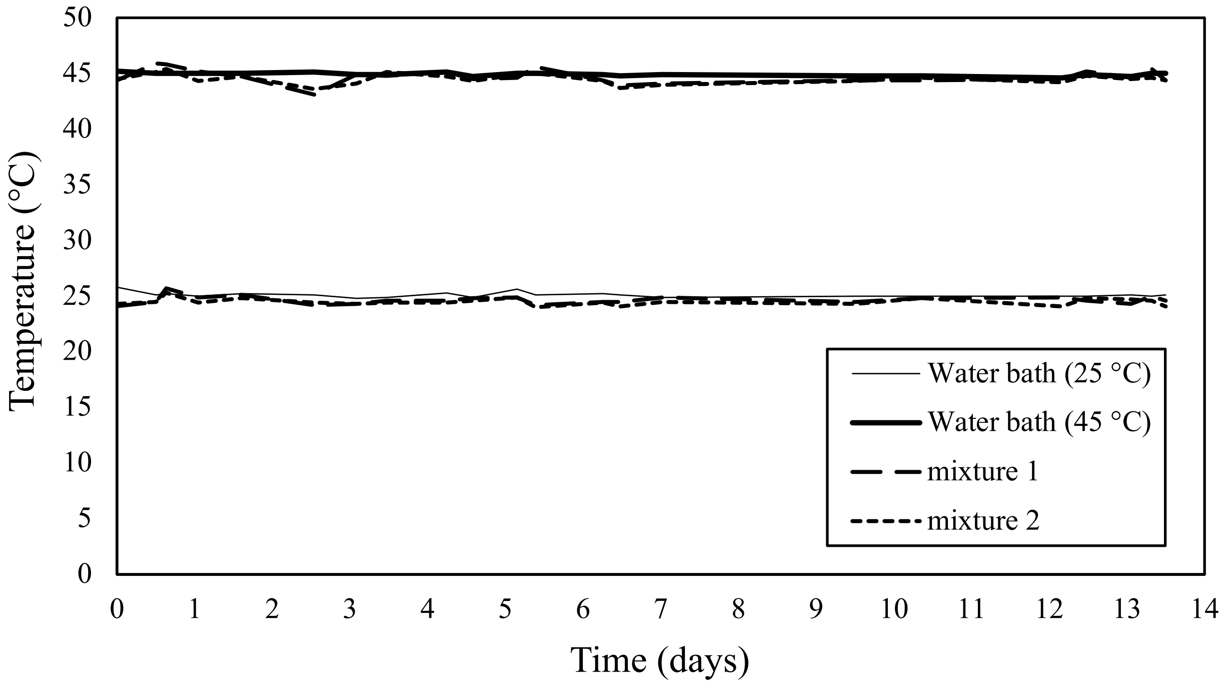


Figure 3-6. Temperature variation results of the temperature uniformity tests (mixture 1: $\alpha_{in\text{-}place}$ = 125 kg/m^3, w:c = 1.0 and mixture 2: $\alpha_{in\text{-}place}$ = 275 kg/m^3, w:c = 1.0)

Curing plan

For the study on the influence of constant curing temperature, the specimens were cured in water baths maintained at 25, 35, 45, and 55 °C. After 3, 7, 14, and 28 days of curing, UCS tests were carried out on the specimens.

For the study on the influence of changing curing temperature, each specimen was cured for 28 days but with different portions of time in 25 and 45 °C water baths. The order of low- and high-temperature curing also varied among specimens. Table 3-5 presents the curing plans for the study of the influence of changing curing temperature.

Table 3-5. Curing plans for the study of the influence of changing curing temperature

Specimen	Curing time (days)		Specimen	Curing time (days)	
	First period at 45 °C	Second period at 25 °C		First period at 25 °C	Second period at 45 °C
A	0	28	--	--	--
B1	7	21	B2	21	7
C1	14	14	C2	14	14
D1	21	7	D2	7	21
--	--	--	E	0	28

3.4.2. Curing of specimens in the humidity-controlled room

For the study on unconfined compressive strength (UCS) of fat clay (CH) mixture, the specimens were cured in plastic containers of water in the humidity-controlled room with a controlled temperature of 21.1 °C. After 3, 7, 14, and 28 days of curing, UCS tests were performed. Although the gap between a mold and a lid was tightly sealed with electric tape, the specimens were not completely submerged. The specimens were submerged only for about two-thirds of their height in order to avoid water from getting into the specimens through the gap. However, from curing the specimens in the water baths, which is described in Section 3.4.1, it was verified that water does not leak into the specimens during curing even if the specimen is completely submerged. Therefore, for future research, it is recommended to tightly seal the specimens with electric tape and completely submerge specimens during curing for more uniform curing over the height of the specimens.

3.5. Strength testing

Unconfined compressive strength (UCS) tests were conducted on cured specimens to measure the strength of the cement-treated soil. The UCS test is the most common strength test for cured soil-cement specimens because the test is quick and simple compared to triaxial compression strength tests. To measure the undrained shear strength of the cement-treated soil right after mixing, laboratory miniature vane shear tests were carried out on uncured specimens. The undrained shear strength provides a representation of consistency that can be useful to contractors, who are required to produce thoroughly mixed materials.

3.5.1. Unconfined compressive strength (UCS) test

The UCS tests were performed in accordance with ASTM D2166 *Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.* The tests were conducted using a GEOTAC Sigma-1 Automated Load Test system. In the test, a strain rate of 1% per minute and a strain limit of 15% were used. The applied maximum compressive stress was selected as the failure criterion, and this typically occurred between 1% and 3% strain based on deformations reported by the testing machine. To remove the effects of slack in the testing equipment, as well as less-than-perfect contact between the top surface of the specimens and the load cap and between the bottom surface of the specimens and the bottom platen, the UCS test data was corrected as suggested by Nevárez-Garibaldi et al. (2018). The correction was accomplished by shifting the strain values by an amount equal to the distance from the intersection of the extended tangent line from the inflection point of the stress-strain curve and the x-axis to the origin (Figure 3-5). The area correction and the height correction from ASTM D2166 and ASTM C42 were also applied to the UCS test data.

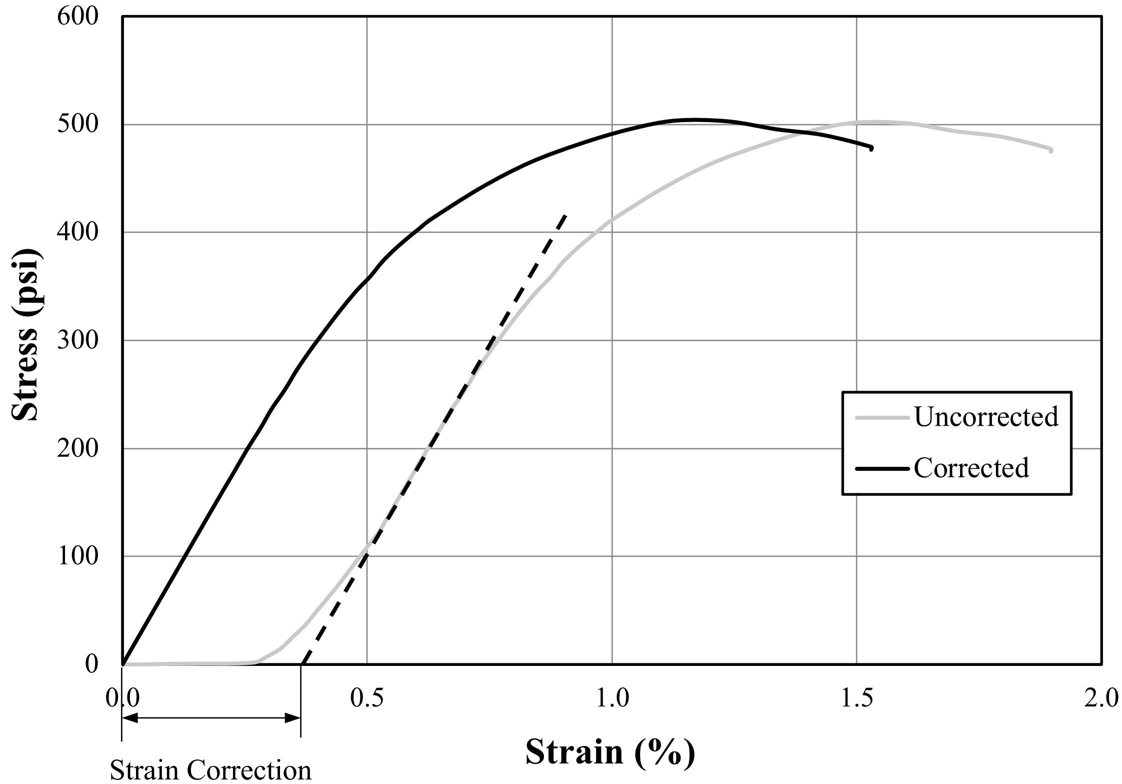


Figure 3-7. UCS test data strain correction (Nevárez-Garibaldi et al. 2018)

A total of 38 batches were mixed for the UCS test and divided into three groups. The first group consisted of 24 batches, and they were used to investigate the influence of constant curing temperature. The specimens in this group were cured at 25, 35, 45, and 55 °C for the desired curing times. Table 3-6 provides mix properties and curing temperatures of the batches for this group.

Table 3-6. Mix properties and curing temperatures of batches to investigate the influence of constant curing temperature

Batch	w:c	$\alpha_{in\text{-}place}$ (kg/m^3)	α (kg/m^3)	w_t:c	Curing temperature (°C)
T-1	0.6	205	252	2.51	25
T-2		351	519	1.53	
T-3	1.0	126	151	4.19	
T-4		350	649	1.74	
T-5	1.4	125	159	4.43	
T-6		276	524	2.32	
T-7	1.0	129	156	4.09	35
T-8		200	272	2.77	
T-9		274	430	2.12	
T-10		350	650	1.74	
T-11	0.6	203	245	2.53	45
T-12		351	519	1.53	
T-13	1.0	125	149	4.23	
T-14		350	650	1.74	
T-15	1.4	125	160	4.42	
T-16		276	524	2.32	
T-17	0.6	206	254	2.49	55
T-18		350	516	1.54	
T-19	1.0	125	150	4.21	
T-20		201	173	2.76	
T-21		275	430	2.12	
T-22		351	653	1.74	
T-23	1.4	133	172	4.21	
T-24		276	526	2.32	

The second group consisted of four batches, and they were for the study of the influence of changing curing temperature. UCS tests in this group were conducted on specimens with the cement factor in-place ($\alpha_{in\text{-}place}$) of 125 kg/m^3 and 275 kg/m^3 and the water-to-cement ratio of the slurry (*w:c*) of 1.0, as indicated in Table 3-7. Two batches were made for each of two mix proportions to obtain two values of UCS for each curing plan so that it was possible to check whether a measured UCS is reasonable or not. The specimens in this group were cured at 25 °C and 45 °C, following the curing plan listed in Table 3-5.

Table 3-7. Mix properties and curing temperatures of batches to investigate the influence of changing curing temperature

Batch	w:c	$\alpha_{\text{in-place}}$ (kg/m^3)	α (kg/m^3)	w_t:c	Curing temperature (°C)
D-1	1.0	125	150	4.22	25 and 45
D-2		125	150	4.23	
D-3		275	432	2.12	
D-4		276	434	2.11	

The last group of UCS tests included 10 batches which were used to study the optimum mix design for fat clay (CH). The specimens in this group were cured in plastic containers of water in the humidity-controlled room maintained at a temperature of 21.1 °C for 3, 7, 14, and 28 days. Table 3-8 presents mix properties and curing temperature of the batches for this group.

Table 3-8. Mix properties and curing temperatures of batches to investigate the optimum mix design for fat clay

Batch	w:c	$\alpha_{in\text{-}place}$ (kg/m^3)	α (kg/m^3)	w_t:c	Curing temperature (°C)
S-1	0.6	200	246	3.17	21.1
S-2		277	372	2.30	
S-3		356	529	1.79	
S-4	1.0	125	150	5.20	
S-5		201	273	3.32	
S-6		276	433	2.46	
S-7		350	650	1.97	
S-8	1.4	126	161	5.32	
S-9		200	305	3.47	
S-10		276	524	2.61	

3.5.2. Laboratory miniature vane shear test

The laboratory miniature vane shear tests were conducted in accordance with ASTM D4648/D4648M-16 *Standard Test Method for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil.* The tests were performed with an ELE International Limited Laboratory Vane Apparatus at 30, 40, 50, and 60 minutes after cement-treated soil mixing. A 1.0-inch diameter and 1.0-inch tall vane blade was used, and spring numbers 1 and 2 were used, depending on the expected undrained shear strength of the mixture.

A total of 11 batches were made using the fat clay (CH) for the laboratory miniature vane shear tests. The tests were carried out on uncured specimens. The mix properties of the batches for the laboratory miniature vane shear tests are shown in Table 3-9.

Table 3-9. Mix properties of batches using fat clay for laboratory miniature vane shear tests

Batch	w:c	$\alpha_{in\text{-}place}$ (kg/m^3)	α (kg/m^3)	w_t:c	w_{mix}
C-0	0.6	127	143	5.01	0.64
C-1		200	246	3.17	0.64
C-2		276	370	2.31	0.64
C-3		349	514	1.83	0.63
C-4	1.0	125	149	5.24	0.70
C-5		202	275	3.30	0.73
C-6		275	431	2.47	0.76
C-7		350	650	1.97	0.79
C-8	1.4	125	160	5.36	0.76
C-9		200	305	3.47	0.83
C-10		275	523	2.61	0.91

4. Results and Discussion

This chapter presents and discusses the results of unconfined compressive strength (UCS) measurement tests on cured specimens and laboratory miniature vane shear tests on uncured specimens. First, the influence of constant curing temperature on UCS is discussed. Several equations that correlate UCS to mixture proportions, curing time, curing temperature are evaluated. Second, the influence of changing curing temperature on UCS is discussed. The result of this study differed from the original expectation but considering the factors that control the chemical reaction rate of cement hydration may help explain the results. Third, equations developed by Nevárez-Garibaldi et al. (2018) for predicting the strength of cured mixture and the consistency of uncured mixture were applied and evaluated for a fat clay (CH). The equation developed by Nevárez-Garibaldi et al. (2018) for the consistency prediction is not applicable to the fat clay mixtures, so a revised equation is proposed. The influence of base soil plasticity on the strength of cured mixtures and on the mixture consistency right after mixing is also discussed. Fourth, the method to select optimum mix design for lean clay (CL) and fat clay (CH) to achieve a target UCS to satisfy strength requirements and a target consistency to enable thorough mixing with the smallest amount of cement is presented. In addition, change of the optimum mix design depending on the water content of the base soil ($w_{base\ soil}$) is discussed.

4.1. Influence of constant curing temperature

To study the influence of constant curing temperature on unconfined compressive strength (UCS), a variety of mix proportions of cement-treated soil specimens for batches T-1 to T-24 (Table 3-6) were cured in water baths maintained at 25, 35, 45, and 55 °C. UCS tests were conducted on the cured specimens after 3, 7, 14, and 28 days of curing. Several different equations applied to the data to determine which functional form best fit the UCS values to the independent variables of curing time (t), curing temperature (T), total-water-to-cement ratio (w_t:c), and dry unit weight of the mixture ($\gamma_{d,mix}$). In all cases, the dimensionless coefficients for the equations were determined by a least squares regression. The coefficients are unique to the conditions of these tests, and they would be expected to vary depending on the soil type and the binder type, as well as the reference curing temperature (T_0) used in some of the equations.

Nevárez-Garibaldi et al. (2018) proposed Equation 2-1, which is repeated below for convenience, to estimate the strength of a binder-treated specimen. Although Equation 2-1 does not represent the influence of curing temperature, the measured UCS data set was analyzed using Equation 2-1 to investigate the significance of the influence of curing temperature on UCS. Figure 4-1 shows the comparison of the predicted UCS (UCS_{pred}) by Equation 2-1 and the measured UCS (UCS_{meas}) for batches T-1 to T-24, and the coefficient values for Equation 2-1 are provided in Table 4-1. As shown in Figure 4-1, the value of the coefficient of determination (R^2) for the relationship between UCS_{pred} and UCS_{meas} is low ($R^2 = 0.71$), and it is apparent that curing temperature (T) affects UCS, in addition to the three independent parameters that are represented in Equation 2-1: curing time (t); total-water-to-cement ratio (w_t:c); and dry unit weight of the mixture ($\gamma_{d,mix}$).

$$\frac{UCS_{pred}}{p_a} = \left[d_1 + d_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t\!:c]^{d_3} * \left[\gamma_{d,mix}\!:\gamma_w\right]^{d_4} \qquad \textit{Equation 2-1}$$

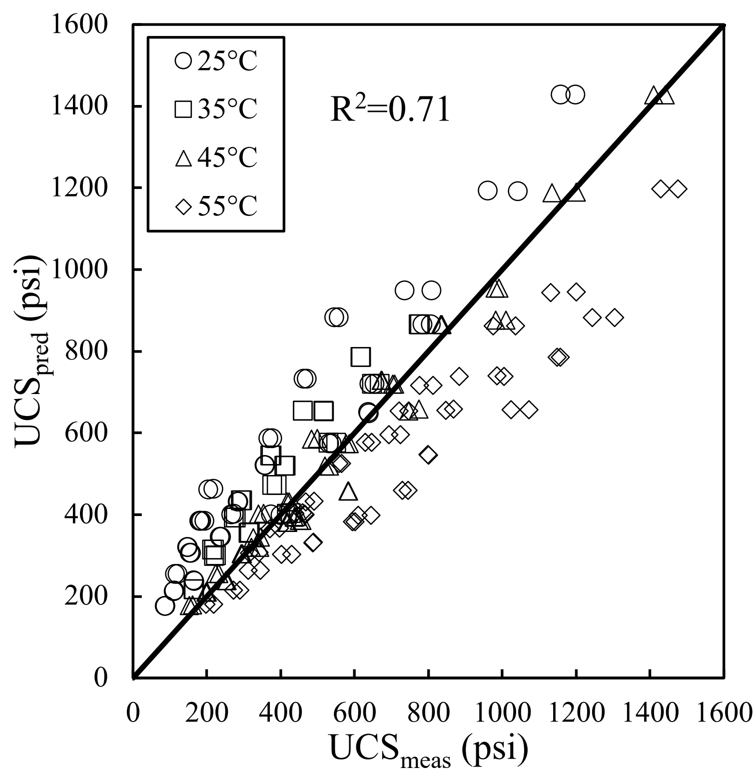


Figure 4-1. Relationship between UCS_{pred} using Equation 2-1 and UCS_{meas} (batches T-1 to T-24)

Table 4-1. Coefficient values for Equation 2-1 (batches T-1 to T-24)

Coefficient	Value
d_1	17.3
d_2	21.4
d_3	-1.10
d_4	2.21

Figure 4-2 shows the relationships between the measured UCS and the curing time for the batch with the cement factor in-place ($\alpha_{in\text{-}place}$) of 125 kg/m^3 and the water-to-cement ratio of the slurry (*w:c*) of 1.0 with different curing temperatures. The UCS increases with increasing curing temperature and curing time following a natural logarithmic function of time, and the rate of strength increase due to curing time is higher at early curing times than at late curing times as many other researchers have reported (Bruce et al. 2013; Hirabayashi et al. 2009; Zhang et al. 2014). On the basis of percent improvement in UCS, however, increasing the curing temperature has a bigger effect at long curing times than at short curing times.

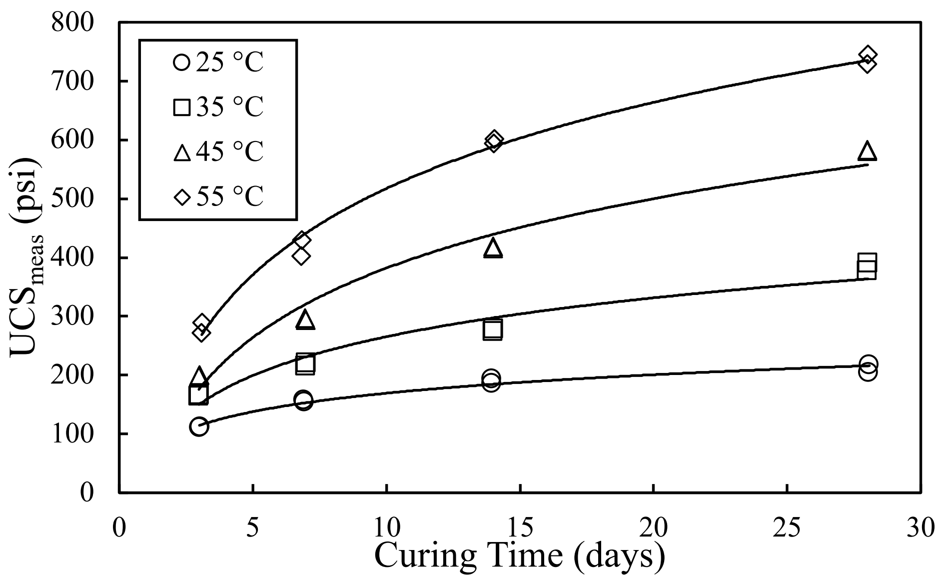


Figure 4-2. Relationship between UCS$_{meas}$ and curing time ($\alpha_{in\text{-}place}$ = 125 kg/m^3 and w:c = 1.0)

Nevárez-Garibaldi et al. (2018) studied the influence of curing temperature. Although they had limited data and the data had some scatter, they suggested that UCS increases as an exponential function of curing temperature. Figure 4-3 depicts the relationships between the measured UCS and the curing temperature for the same data as in Figure 4-2, which also shows that the UCS increases as an exponential function of curing temperature. All the data sets in this study (batches T-1 to T-24) show the same trend, which indicates that the temperature effect on UCS can be represented by adding an exponential function of curing temperature, as presented in Equation 4-1, to Equation 2-1.

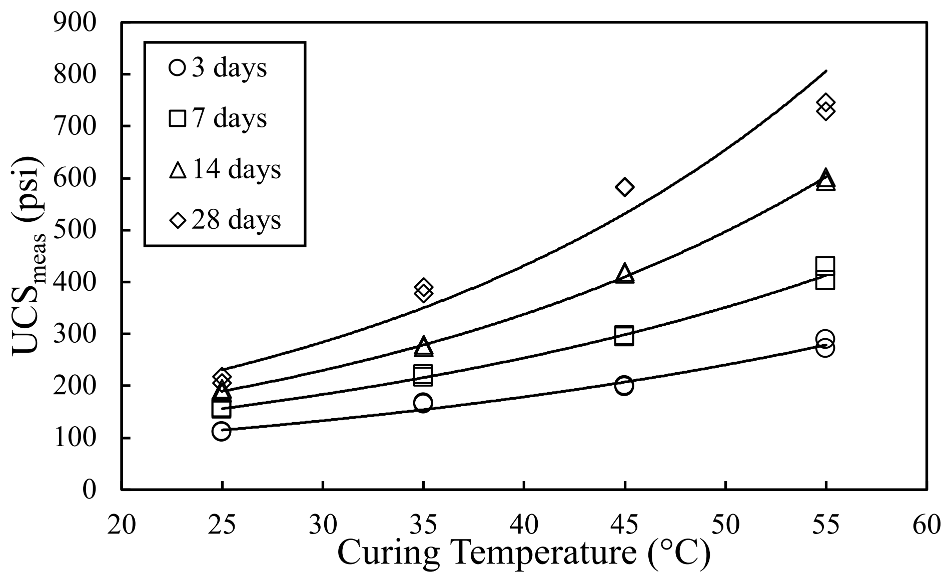


Figure 4-3. Relationship between UCS_{meas} and curing temperature ($\alpha_{in\text{-}place}$ = 125 kg/m^3 and w:c = 1.0)

$$\frac{UCS_{pred}}{p_a} = a_4 * a_5^{\frac{T-T_0}{T_0}} \qquad \textit{Equation 4-1}$$

In Equation 4-1, p_a is atmospheric pressure, which is used to normalize UCS_{pred}, a_4 and a_5 are dimensionless coefficients, T is curing temperature in Celsius (°C), and T_0 is the reference temperature in Celsius. In this research, the reference temperature is set as the room temperature, 21.1 °C. The reference temperature is subtracted from the curing temperature and the result is divided by the reference temperature to normalize the exponent. The influence of curing temperature presented in Equation 4-1 and Equation 2-1 are combined to produce Equation 4-2.

$$\frac{UCS_{pred}}{p_a} = \left[b_1 + b_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t : c]^{b_3} * \left[\gamma_{d,mix} : \gamma_w\right]^{b_4} * b_5^{\frac{T-T_0}{T_0}} \qquad \textit{Equation 4-2}$$

where b_1, b_2, b_3, b_4, and b_5 are dimensionless coefficients, t_0 is a reference time of one day to normalize the curing time (t), and γ_w is unit weight of water to normalize the dry unit weight of the mixture ($\gamma_{d,mix}$). When all tests are cured at room temperature, Equation 4-2 reduces to Equation 2-1, and coefficient c_5 is not evaluated.

Figure 4-4 is a plot of the UCS_{pred} from Equation 4-2 against the UCS_{meas} for batches T-1 to T-24, and Table 4-2 presents the regression coefficient values for Equation 4-2.

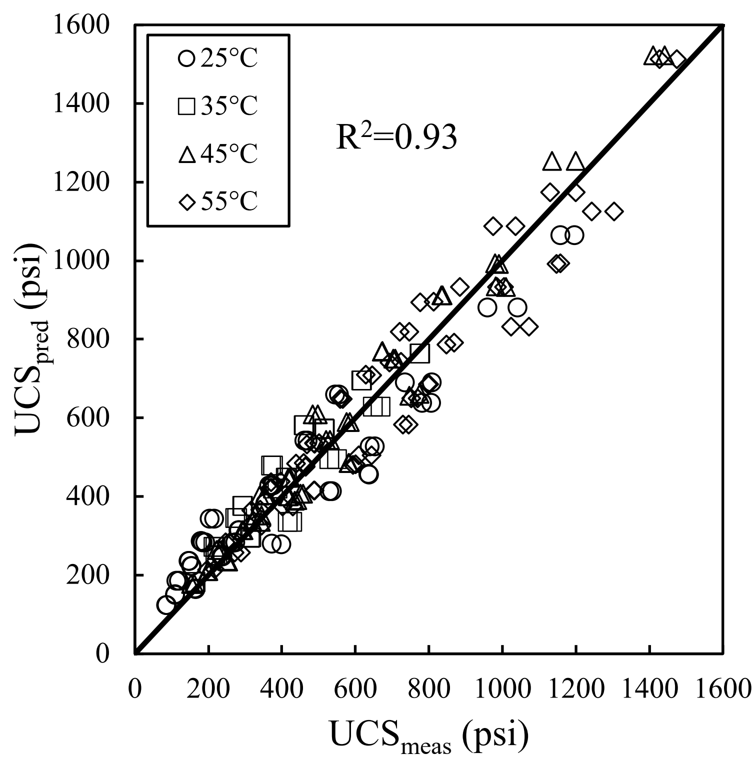


Figure 4-4. Relationship between the UCS_{pred} using Equation 4-2 and UCS_{meas} (batches T-1 to T-24)

Table 4-2. Coefficient values for Equation 4-2 (batches T-1 to T-24)

Coefficient	Value
b_1	9.41
b_2	15.4
b_3	-1.10
b_4	2.27
b_5	1.46

Although Equation 4-2 provides a significantly better fit between UCS_{pred} and the UCS_{meas} (R^2 = 0.93) than Equation 2-1 (R^2 = 0.71), the degree of agreement is still lower than obtained by Nevárez-Garibaldi et al. (2018) using Equation 2-1 for tests without variation in curing temperature. Further trials were done to find an equation that can provide a better fit representing the influence of curing time (t), the total-water-to-cement ratio ($w_t{:}c$), the dry unit weight of the mixture ($\gamma_{d,mix}$) and the curing temperature (T) on UCS. Figure 4-5 presents a plot of UCS_{meas} against the curing time for batches with $\alpha_{in\text{-}place}$ of 125 kg/m^3 and 350 kg/m^3, $w{:}c$ of 1.0, and different curing temperatures. In the figure, the $w_t{:}c$ is 4.20 for the mixture with $\alpha_{in\text{-}place}$ of 125 kg/m^3 and $w{:}c$ of 1.0, with results shown by filled symbols, and the $w_t{:}c$ is 1.74 for the mixture with $\alpha_{in\text{-}place}$ of 350 kg/m^3 and $w{:}c$ of 1.0, with results shown by open symbols. Figure 4-5 shows the trend that the influence of curing temperature on UCS is more significant when the $w_t{:}c$ is high than when the $w_t{:}c$ is low. On this basis, a curing temperature term is added as an exponent to the power function of the $w_t{:}c$ in Equation 4-2 to produce Equation 4-3.

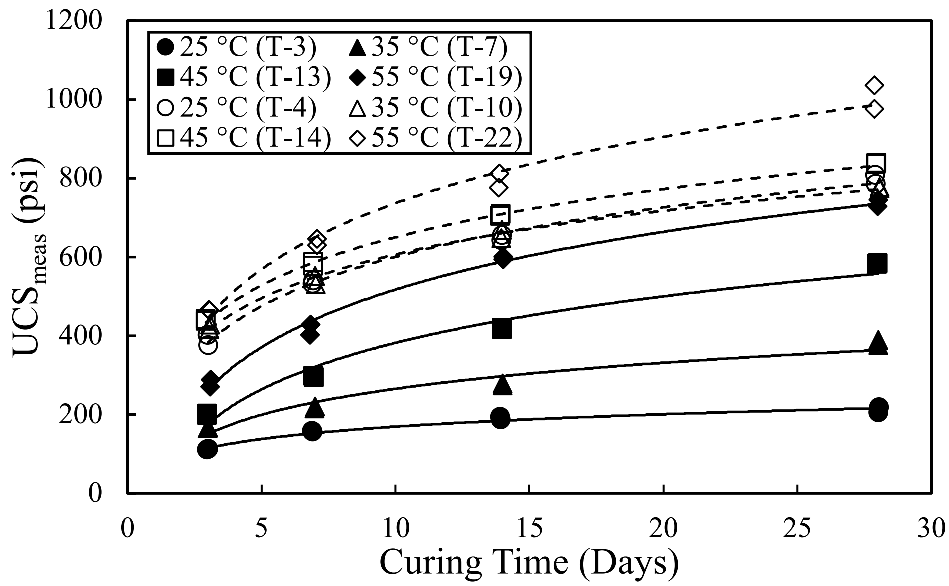


Figure 4-5. Relationship between UCS$_{meas}$ and curing time (w_t:c = 4.20 (filled) and w_t:c = 1.74 (open))

$$\frac{UCS_{pred}}{p_a} = \left[b_1 + b_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t\!:c]^{b_{3,1}+b_{3,2}*\frac{T-T_0}{T_0}} * \left[\gamma_{d,mix}\!:\gamma_w\right]^{b_4} * b_5^{\frac{T-T_0}{T_0}} \qquad \textit{Equation 4-3}$$

Figure 4-6 presents the comparison of UCS_{pred} from Equation 4-3 to UCS_{meas} for batches T-1 to T-24, and Table 4-3 provides the coefficient values for Equation 4-3. Equation 4-3 produces a better fit (R^2 = 0.96) than Equation 4-2 provided (R^2 = 0.93). T-tests were conducted on the coefficients for Equation 4-3 to test the statistical significance of each coefficient in the regression, and the results are included in Table 4-3. The t-test provides values of Standard Error, t-Statistic, and p-Value. Generally, with a large absolute value of t-statistic (greater than 3) or a small p-value (less than 0.05), a coefficient has a statistically significant impact in the regression. The values of t-Statistic and p-Value in Table 4-3 indicate that each coefficient is statistically significant in the regression.

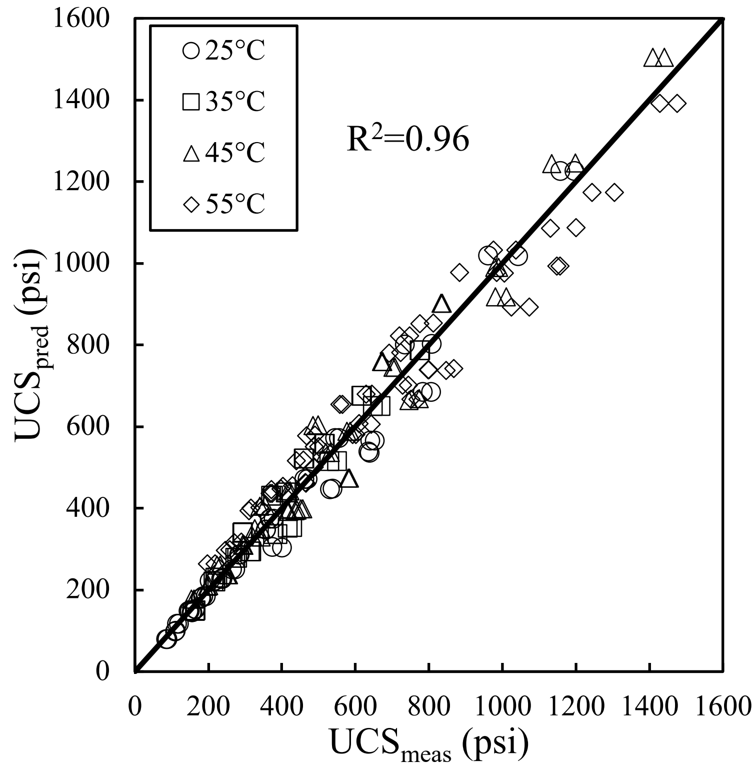


Figure 4-6. Relationship between UCS_{pred} using Equation 4-3 and UCS_{meas} (batches T-1 to T-24)

Table 4-3. Coefficient values and statistical analysis results for Equation 4-3 (batches T-1 to T-24)

Coefficient	Value	Standard Error	t-Statistic	p-Value
b_1	15.8	1.69	9.35	2.96E-17
b_2	24.4	1.29	18.9	3.63E-45
$b_{3,1}$	-1.78	0.0654	-27.3	9.52E-67
$b_{3,2}$	0.586	0.0495	11.8	2.10E-24
b_4	2.23	0.0833	26.8	1.49E-65
b_5	0.969	0.0343	28.2	6.22E-69

In order to increase the size of the data set, the results obtained by Nevárez-Garibaldi et al. (2018) for the same base soil with a curing temperature of 21.1 °C were included with the results from batches T-1 to T-24, and the combined data set was analyzed using Equation 4-3. The correspondence between UCS_{pred} from Equation 4-3 and UCS_{meas} for the combined data set is shown in Figure 4-7, and the coefficient values are listed in Table 4-4. Equation 4-3 produces very good agreement between UCS_{pred} and UCS_{meas} (R^2 = 0.96) for the larger data set. The results of t-tests in Table 4-4 indicate that all coefficients have a statistically significant effect in the regression. The values of the coefficients in Table 4-4 for the combined data set are very similar to the coefficient values in Table 4-3 for batches T-1 to T-24, which indicates that the test results from the two studies are consistent.

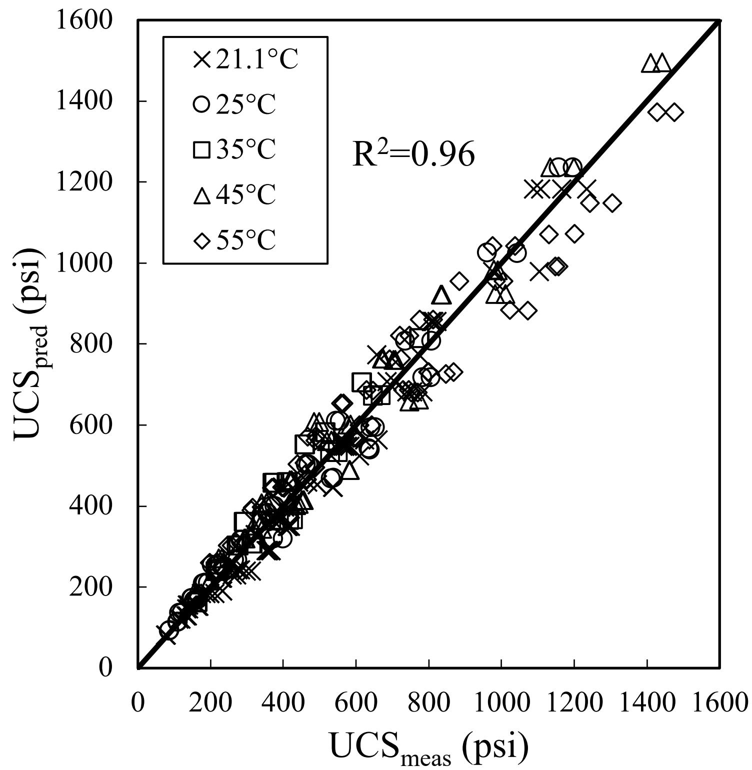


Figure 4-7. Relationship between UCS_{pred} using Equation 4-3 and UCS_{meas} for (combined data)

Table 4-4. Coefficient values and statistical analysis results for Equation 4-3 (combined data)

Coefficient	Value	Standard Error	t-Statistic	p-Value
b_1	16.0	1.39	11.4	4.89E-25
b_2	23.6	0.88	26.6	1.03E-77
$b_{3,1}$	-1.64	0.0397	-41.3	1.95E-119
$b_{3,2}$	0.492	0.0333	14.8	8.37E-37
b_4	2.12	0.0726	29.1	9.23E-86
b_5	0.994	0.0244	40.7	6.60E-118

Even though the t-tests indicate that all six coefficients in Equation 4-3 are statistically significant for batches T-1 to T-24 (Table 4-3) and for the combined data set (Table 4-4), the b_5 term does not have a big impact on UCS_{pred} because b_5, which is the base of an exponential curing temperature term is very close to 1 in both cases. Accordingly, the b_5 term was removed from Equation 4-3 to produce Equation 4-4.

$$\frac{UCS_{pred}}{p_a} = \left[b_1 + b_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t : c]^{b_{3,1}+b_{3,2}*\frac{T-T_0}{T_0}} * \left[\gamma_{d,mix} : \gamma_w\right]^{b_4} \qquad \textit{Equation 4-4}$$

Equation 4-4 was fit to the data from batches T-1 to T-24 and to the larger data set that includes the results from Nevárez-Garibaldi et al. (2018). The results are shown in Figure 4-8 and Table 4-5 for T-1 to T-24 and in Figure 4-9 and Table 4-6 for the larger data set. It can be seen by comparing Figures 4-6 and 4-7, which use Equation 4-3, to Figures 4-8 and 4-9, which use Equation 4-4, that Equation 4-4 works as well as Equation 4-3, with R^2 = 0.96 and has statistically significant coefficients in all cases. Equation 4-4 is preferred because it has one less fitting coefficient than Equation 4-3. Dropping the b_5 term from Equation 4-3 to produce Equation 4-4 does not produce large changes in the values of the remaining coefficients b_1, b_2, $b_{3,1}$, $b_{3,2}$, and b_4, which can be seen by comparing Tables 4-3 and 4-5 for batches T-1 to T-24 and Tables 4-4 and 4-6 for the larger data set. As discussed previously, this occurs because the value of b_5 is close to unity and therefore has a relatively little impact on Equation 4-3.

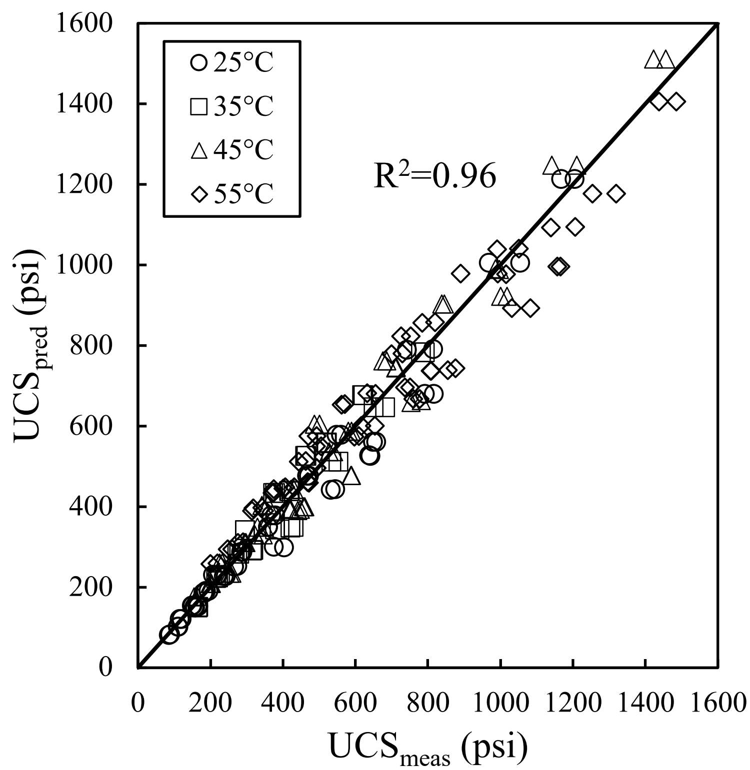


Figure 4-8. Relationship between UCS_{pred} using Equation 4-4 and UCS_{meas} (batches T-1 to T-24)

Table 4-5. Coefficient values and statistical analysis results for Equation 4-4 (batches T-1 to T-24)

Coefficient	Value	Standard Error	t-Statistic	p-Value
b_1	15.2	1.46	10.4	3.27E-20
b_2	23.5	0.821	28.7	3.89E-70
$b_{3,1}$	-1.74	0.0370	-47.0	4.43E-105
$b_{3,2}$	0.546	0.0195	27.9	1.72E-68
b_4	2.24	0.0830	26.9	3.98E-66

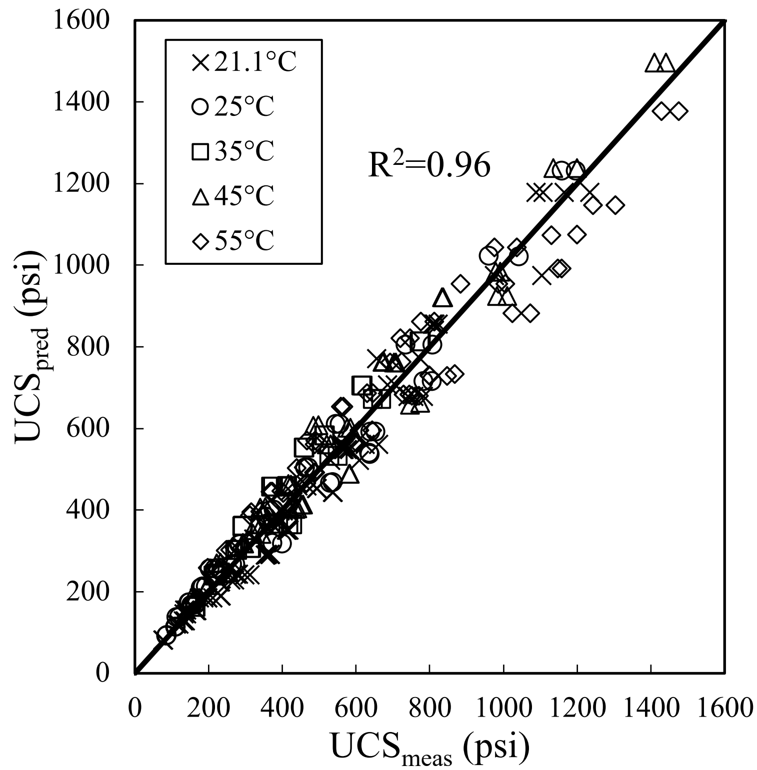


Figure 4-9. Relationship between UCS_{pred} using Equation 4-4 and UCS_{meas} (combined data)

Table 4-6. Coefficient values and statistical analysis results for Equation 4-4 (combined data)

Coefficient	Value	Standard Error	t-Statistic	p-Value
b_1	15.9	1.29	12.3	7.45E-28
b_2	23.5	0.717	32.8	6.94E-97
$b_{3,1}$	-1.63	0.0264	-61.7	9.82E-163
$b_{3,2}$	0.485	0.0125	38.8	2.09E-113
b_4	2.12	0.0717	29.5	3.96E-87

Of the fitting equations considered in this research, Equation 4-4 appears to be the best, for the following reasons:

- It represents the observed trends of increasing UCS with the following independent parameters:

  - Increasing curing time (t)
  - Decreasing total-water-to-cement ratio (w_t:c)
  - Increasing dry unit weight of the mixture ($\gamma_{d,mix}$)
  - Increasing curing temperature (T)

- It provides a good correlation between UCS_{pred} and UCS_{meas}, with $R^2 = 0.96$, while using one less fitting coefficient than Equation 4-3, which also produces $R^2 = 0.96$.
- It reflects the interaction between effects of total-water-to-cement ratio and curing temperature on UCS, as indicated by the data in Figure 4-5, which shows that curing temperature has a bigger impact at high total-water-to-cement ratios than at low total-water-to-cement ratios.
- Statistical analyses using t-tests indicate that all five coefficients are statistically significant, with the absolute value of the t-Statistic greater than 3 and the p-Value less than 0.05 in all cases.
- The curing time term in the equation, $b_1 + b_2\, ln\left(\frac{t}{t_0}\right)$, is consistent with previous studies, such as Circeo et al. (1962), Moretti et al. (2012), Piriyakul and Pochalard (2012), and many others.

On the other hand, the curing temperature component of Equation 4-4 does not appear to be entirely consistent with the data or with a chemical reaction understanding of curing:

- The results in Figure 4-5 suggest that elevated curing temperature has more impact at later curing times than at early curing times. Equation 4-4 does not represent this type of interaction between curing time and curing temperature. The "maturity" expressions described in Chapter 2 were investigated for their ability to represent the combined effects of curing time and temperature, but none of them worked as well as Equation 4-4. In addition, replacing the coefficient b_2 with an expression that involved two coefficients and the normalized curing temperature did not produce the type of time-temperature interaction shown by the data in Figure 4-5 when regression analyses were conducted.

- Regarding the chemical reactions that harden the soil-cement mixture, it is expected that essentially all such reactions would be complete after sufficient curing time and temperature, so that the UCS would reach or asymptotically approach a limiting value. However, Equation 4-4 does not bound the UCS as curing time and temperature increase. This seems less problematic for curing time because of the logarithmic relationship. However, Equation 4-4 incorporates an exponential rate of increase of UCS with curing temperature, which is consistent with the data in Figure 4-3, but it does not seem reasonable that this could hold true for very long curing times.
- Equation 4-4 is applicable only when the curing temperature is constant and no lower than -10 °C. At a curing temperature below -10 °C, there is almost no strength improvement effect for cement-treated soil (Kido et al. 2009).

Based on these considerations, Equation 4-4 should be only be used for curing times and curing temperatures corresponding to data that yield a good fit when the regression analysis is performed. In this research, that would be for curing times of 3 to 28 days and curing temperatures of 21 to 55 °C. Additional research may shed light on the interaction between curing temperature and curing time, particularly for long curing times.

Equation 4-4 can have a different form by extracting the leading coefficient, as presented in Equation 4-5, where $c_0 = b_1 + b_2 ln(28)$, $c_1 = b_1 / c_0$, $c_2 = b_2 / c_0$, $c_{3,1} = b_{3,1}$, $c_{3,2} = b_{3,2}$, and $c_4 = b_4$. Note that the regression analysis is done using Equation 4-4, and extracting c_0 does not introduce an additional fitting coefficient to Equation 4-5. The coefficient values for Equations 4-4 and 4-5 based on the combined data are presented in Table 4-7. The form of Equation 4-5 makes the curing time term, $c_1+c_2 ln(t)$, has the same meaning as the curing factor (f_c) used by Filz et al. (2012) and many others, in which $f_c = 1$ at 28 days of curing time. By comparing c_1 and c_2 values obtained from tests using different soil types and binder types, the influences of curing time on UCS can be compared. Table 4-8 shows the curing factor coefficients determined by this research, Horpibulsuk et al. (2011), Denies and Huybrechts (2012), and Verástegui Flores (2012) using different soil type and binder type, as examples.

$$\frac{UCS_{pred}}{p_a} = c_0 \left[c_1 + c_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t : c]^{c_{3,1} + c_{3,2} * \frac{T - T_0}{T_0}} * \left[\gamma_{d,mix} : \gamma_w\right]^{c_4} \qquad \textit{Equation 4-5}$$

Table 4-7. Coefficient values for Equation 4-4 and 4-5 (combined data)

Equation 4-4		Equation 4-5	
Coefficient	Value	Coefficient	Value
-	-	c_0	94.3
b_1	15.9	c_1	0.168
b_2	23.5	c_2	0.250
$b_{3,1}$	-1.63	$c_{3,1}$	-1.63
$b_{3,2}$	0.485	$c_{3,2}$	0.485
b_4	2.12	c_4	2.12

Table 4-8. Comparison of the curing factor coefficients

Soil/binder type	$f_c = c_1 + c_2 ln(t)$	Obtained from
Artificial clay/Portland cement	$0.168 + 0.250 ln(t)$	This research
Fly ash and Biomass ash blended cement admixed Bangkok clay	$0.026 + 0.293 ln(t)$	Horpibulsuk et al. (2011)
Sand/Blitzdämmer cement	$-0.228 + 0.374 ln(t)$	Denies and Huybrechts (2012)
Black clays, Yangtze River clay, Bangkok clay/Portland cement	$0.215 + 0.238 ln(t)$	Verástegui Flores (2012)
Tokyo Bay clay, Kyushu Island clay/Blast furnace cement	$-0.216 + 0.359 ln(t)$	Verástegui Flores (2012)

4.2. Influence of changing curing temperature

In order to study the influence of changing curing temperature on unconfined compressive strength (UCS) of cement-treated soil, specimens were prepared and cured in water baths maintained at 25 and 45 °C according to the curing plans presented in Table 3-5. In this study, two mixture proportions were chosen: one with a cement factor in-place ($\alpha_{in\text{-}place}$) of 125 and another with $\alpha_{in\text{-}place}$ equal to 275 kg/m^3, and with each using a water-to-cement ratio of the slurry ($w{:}c$) equal to 1.0. After 28 days of curing, UCS tests were performed.

Average values of UCS from two different batches for each set of mixture proportions were obtained for each curing plan. The average difference between UCS values for the two specimens in each case was 2.2 %, and the largest difference was 4.6 %; thus, it is reasonable to suppose that the test results are reliable.

Figure 4-10 represents the average values of UCS of the specimens cured for 28 days, according to the different curing plans and mixture proportions. Figure 4-10 shows that the UCS increases with longer curing time and higher curing temperature. These trends are consistent with findings from the study of the influence of constant curing temperature. Figure 4-10 also shows that the effects of elevated curing temperature are greater at later curing times than at early curing times, which is consistent with the trend shown in Figure 4-5 for curing at a constant temperature but different total curing times. For example, both Specimens B1 and Specimens B2 were cured at 25 °C for 21 days and 45 °C for 7 days. But Specimens B1 were cured first at 45 °C while Specimens B2 were cured first at 25 °C. Figure 4-10 shows that Specimens B2 are stronger than Specimens B1, indicating that the higher curing temperature is more effective at increasing UCS at later curing times. Similar comparisons can be made between Specimens C1 and C2 and between Specimens D1 and D2. These results are similar to the findings of Sato et al. (2006).

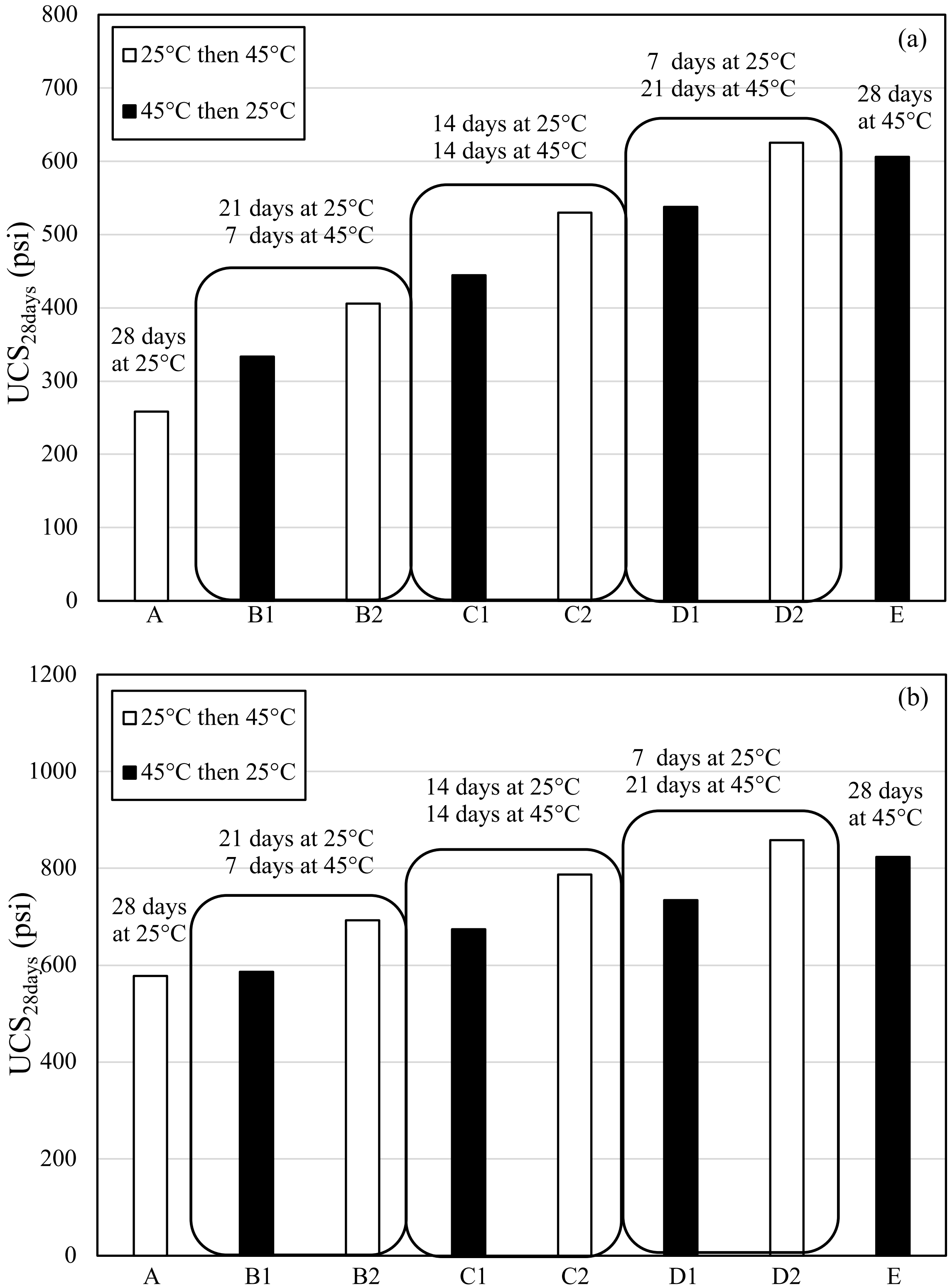


Figure 4-10. UCS_{28days} corresponding to curing plan for (a) $\alpha_{in\text{-}place}$ = 125 kg/m^3 and w:c = 1.0 and (b) $\alpha_{in\text{-}place}$ = 275 kg/m^3 and w:c = 1.0

The chemical reaction of cement hydration and its reaction rate were studied further to explain these results. Cement hydration is an irreversible reaction and lasts until the reactants are exhausted (Fogler 1999). In cement hydration reaction, the reactants are calcium silicate (cement compound*)* and water, and the products are calcium silicate hydrate (CSH) and calcium hydroxide. CSH contributes to stiffening, setting, and hardening of the soil. Based on the concept of the cement hydration reaction rate, two explanations for the test results are introduced.

First, in cement hydration reaction, produced CSH precipitates form coatings around remaining unhydrated calcium silicate. When a reaction rate is high, more precipitates are produced, and they form relatively thick coatings around unhydrated calcium silicate. To react with cement compound, water has to diffuse through the coatings, and this process slows down the reaction. The reaction rate is affected by the thickness of the coatings, and diffusion occurs quickly when a temperature is high. When a specimen is cured at a high temperature during early part of curing, the reaction rate is high, and released precipitates coat much unhydrated calcium silicate and form relatively thick coatings. If the temperature is lowered at later times, water cannot diffuse quickly to react with unhydrated calcium silicate, so reaction rate decreases. As a result, the specimen cured at a high temperature at early times and cured at a low temperature at later times is weaker than a specimen first cured at a low temperature.

The reaction rate also depends on the concentration of reactants and the reaction temperature. At a constant temperature, the reaction rate constant (k) has a fixed value, but the reaction rate slows as the reaction progresses because the concentration of reactants decreases while the concentration of products increases, as shown in Figure 4-11. The gradients of each line represent the reaction rates. At early times, the reaction rate is high even if the temperature is low because the concentration of reactants is high, while the reaction rate decreases at later times due to the lack of the reactants. Based on this concept, the reaction with a low temperature at early times and a high temperature at later times results in the low reaction rate and the high reactant concentration at the early part and vice versa at the late part. In this case, the reaction rate may not be changed significantly during the reaction, and the constant reaction rate seems to contribute to better reaction efficiency.

From the two explanations above, Specimens B2, C2, and D2 should be stronger than Specimens B1, C1, and D1, respectively.

Another finding that can be observed in Figure 4-11 is the concentrations of reactants are close to zero when the reaction time becomes infinite, irrespective of the reaction rate constant (k). That theoretically means, in this study, the UCS of all the specimens with the same mixture proportions will be equal to each other regardless of curing temperatures with extended curing time. However, the curing time in this study is only 28 days, and the values of UCS at 28 days are still dependent on the curing temperature.

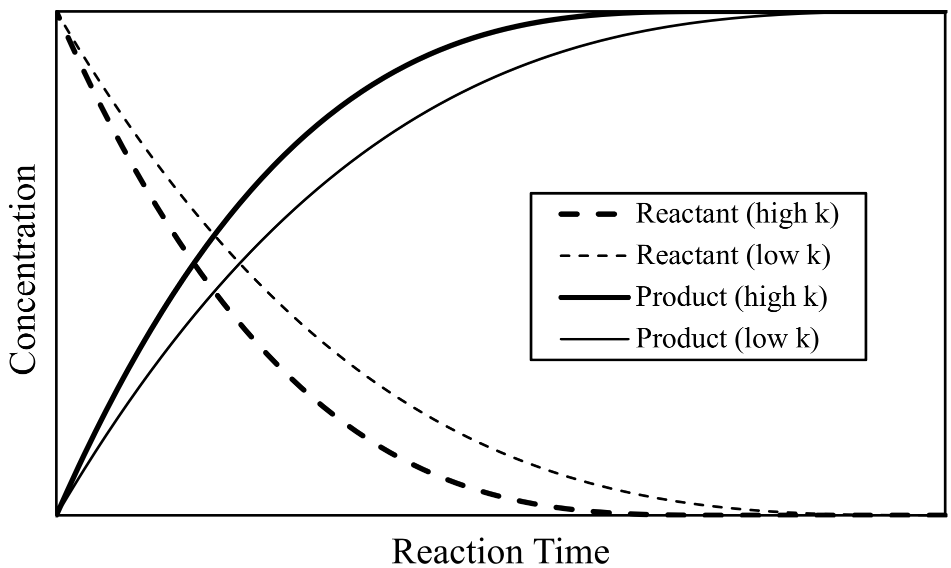


Figure 4-11. Concentration of reactants and products corresponding to reaction time and reaction rate constant (k)

Figure 4-12 presents a schematic drawing of the changes of the concentration of reactants in Specimens D1, D2, and E during 28 days of curing. The reactants in Specimens D1 and H decrease rapidly during 21 days of curing due to the high curing temperature (45 °C); that means the reaction rate is high. After the curing temperature is changed to the low temperature (25 °C), the reaction rate in Specimens D1 is remarkably slowed down. On the other hand, Specimens E were continuously cured in the high temperature overall curing, so the reaction rate in Specimens E is decreased but not as much as the reaction in Specimens D1. In the case of Specimens D2, the reaction rate is relatively low because it was cured at the low temperature until the seventh day of curing, so the reactant concentration at the seventh day is higher than that of Specimens D1 and E. After the seventh day, the curing temperature for Specimens D2 was changed from 25 °C to 45 °C, and the reaction rate increased due to the high curing temperature and relatively high reactant concentration. As shown in Figure 4-12, the amount of products (CSH and calcium hydroxide) in Specimens D2 might be similar or slightly smaller than in Specimens H. However, the reaction rate of Specimens D2 is almost constant during curing compared to that of Specimens D1 and E.

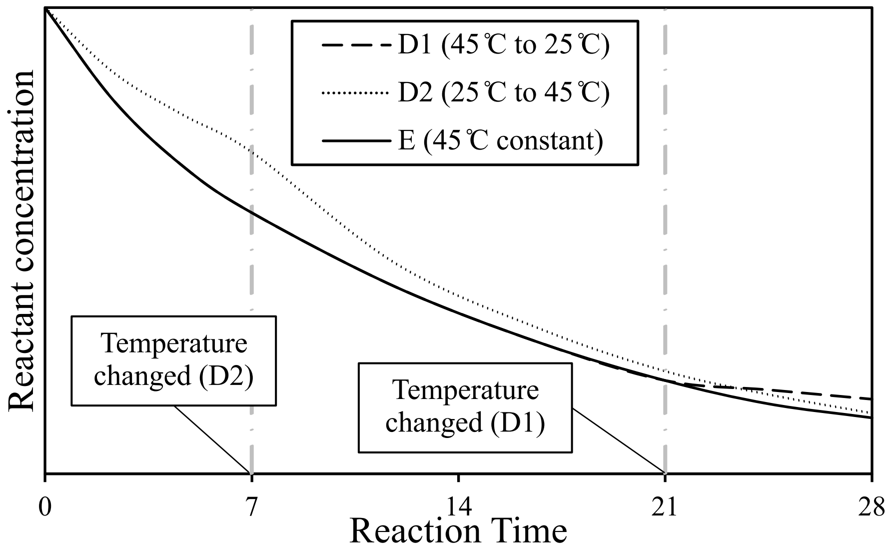


Figure 4-12. Changes of reactants in specimen D1, D2, and E

As mentioned above, limiting deviations in reaction rate makes a positive effect on the reaction by allowing uniform production rate during the reaction. Thus, it is presumed that although Specimens D2 has slightly less products than Specimens E, it was stronger than Specimens E because of its constant reaction rate during 28 days of curing.

However, the differences between the values of UCS of Specimens A and H are less than 5% of the average of two UCS values. Therefore, this outcome could be due to experimental errors or scatter in the small data set. Accordingly, additional research on the effects of changing curing temperatures is recommended.

4.3. Strength of mixture after curing and consistency of mixture right after mixing

In the wet method of deep mixing, binders such as cement and lime are used to increase the strength of soil, and construction specifications typically place a limit on the percentage of test specimens that can exhibit a UCS less than a specified value. Thorough mixing facilitates satisfying such requirements, and more fluid mixtures are easier to mix thoroughly, particularly for clay soils with relatively low in-situ water content. Using more slurry and a higher water-to-binder ratio of the slurry makes the mixture more fluid and easier to mix. However, taking such steps requires that more binder is used to achieve the necessary UCS of the cured mixture, and this would increase material costs. Although mixing equipment and processes also have important impacts on mixing thoroughness, construction contractors must balance the objectives of controlling binder amount and adding sufficient water to permit thorough mixing. Consequently, information about the consistency of mixtures during the time period for field mixing is of interest.

Nevárez-Garibaldi et al. (2018) proposed relationships for the strength of cured mixtures (Equation 2-1) and the mixture consistency right after mixing (Equation 2-4), where the mixture consistency is represented by the undrained shear strength (s_u). Nevárez-Garibaldi et al. (2018) developed the forms of these relationships, which are functions of mixture proportions and time after mixing, for a lean clay (CL). This section examines whether these equations apply to a fat clay (CH), and it was found that the consistency equation did not provide a good fit the data for the fat clay. A revised equation was developed for consistency that provides a better fit to the data for both lean and fat clays. All of the dimensionless coefficients for the equations presented in this section were determined by a least squares regression, and the coefficients can vary depending on the soil type and the binder type. The influence of base soil type (plasticity of base soil) on the strength of cured mixture and the consistency of the uncured mixture is also discussed by comparing the values of the coefficients for the strength and consistency equations.

4.3.1. Strength of mixture after curing

To investigate the cured strength of a fat clay (CH) mixture, base soil type 2 (Section 3.1.) was blended with cement-water slurry in a variety of mix proportions (batches S-1 to S-10 in Table 3-8), and the specimens were cured in plastic containers of water in the humidity-controlled room with a controlled temperature of 21.1 °C. After 3, 7, 14, and 28 days of curing, unconfined compressive strength (UCS) tests were performed. Equation 2-1 is used instead of Equation 4-4 for the prediction of UCS because all of the specimens for this study were cured at room temperature (21.1 °C). When the curing temperature is equal to the room temperature, Equation 4-4 has the same form as Equation 2-1. Equation 2-1 and 4-4 are repeated below for convenience.

$$\frac{UCS_{pred}}{p_a} = \left[d_1 + d_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t\!: c]^{d_3} * \left[\gamma_{d,mix}\!: \gamma_w\right]^{d_4} \qquad \textit{Equation 2-1}$$

$$\frac{UCS_{pred}}{p_a} = \left[b_1 + b_2\, ln\left(\frac{t}{t_0}\right)\right] * [w_t\!: c]^{b_{3,1} + b_{3,2} * \frac{T - T_0}{T_0}} * \left[\gamma_{d,mix}\!: \gamma_w\right]^{b_4} \qquad \textit{Equation 4-4}$$

The UCS data from the fat clay mixture was analyzed using Equation 2-1, and the results are shown in Figure 4-13 and Table 4-9. Equation 2-1 provides excellent agreement between UCS_{pred} and UCS_{meas}, which means that this equation applies to both low the lean and fat clays (CL and CH) mixtures. Therefore, it is concluded that Equation 2-1 can provide a good fit to the data for the strength of cured cement-treated soil when there is no curing temperature variation.

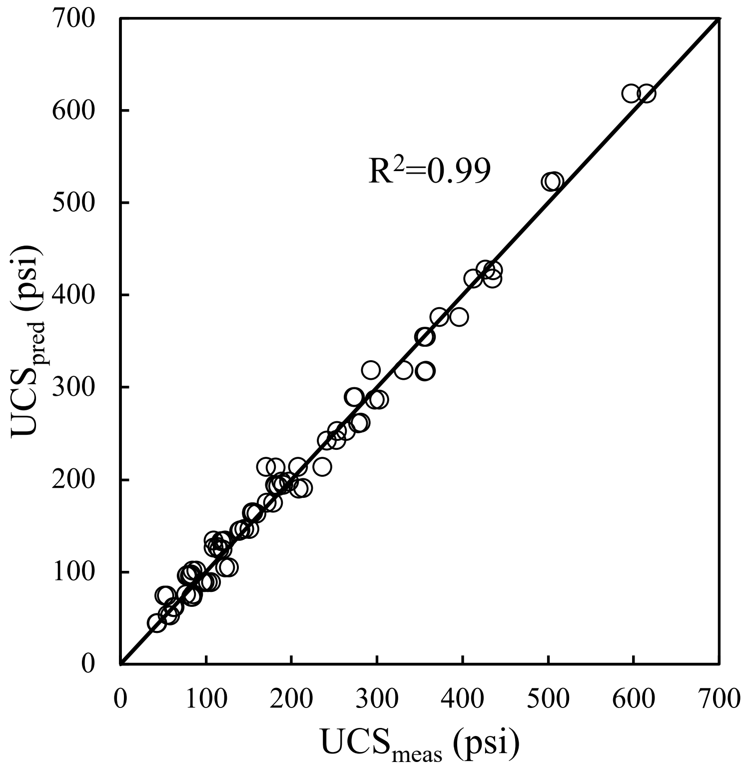


Figure 4-13. Relationship between UCS_{pred} using Equation 2-1 and UCS_{meas} (batches S-1 to S-10)

Table 4-9. Coefficient values for Equation 2-1 (batches S-1 to S-10)

Coefficient	Value
d_1	25.3
d_2	21.5
d_3	-1.49
d_4	2.44

To check if there is an alternative to Equation 2-1 that could provide a more precise prediction of UCS, different equations were evaluated by applying an exponential function of the total-water-to-cement ratio (w_t:c), an exponential function the dry unit weight of the mixture ($\gamma_{d,mix}$), and both. The natural logarithmic function of curing time, $d_1 + d_2\, ln\left(\frac{t}{t_0}\right)$, was fixed in the alternative equations because it has been demonstrated by many researchers as described in Section 4.1. The alternative equations are listed in Appendix C with values of the coefficients (d_1, d_2, d_3, and d_4) and the coefficient of determination (R^2) for each equation. From the evaluation, it is verified that

Equation 2-1 is the best equation of those considered to predict the strength of binder-treated soil as a function of curing time and mixture proportion for lean and fat clays.

4.3.2. Consistency of mixture right after mixing

Laboratory miniature vane shear tests were performed on the fat clay (CH) mixture (batches C-0 to C-10 in Table 3-9) after 30, 40, 50, and 60 minutes following the start of mixing to measure the undrained shear strength (s_u) that represents the consistency of the mixture right after mixing.

Figure 4-14 presents the comparison of the predicted undrained shear strength of the mixture ($s_{u,pred}$) according to Equation 2-4 and the measured undrained shear strength of the mixture ($s_{u,meas}$) for batches C-0 to C-10, and Table 4-10 shows the coefficient values for Equation 2-4, which is repeated below for convenience. Figure 4-14 shows that the undrained shear strength equation suggested by Nevárez-Garibaldi et al. (2018) does not provide a good prediction for the fat clay mixture, especially for a low water-to-cement ratio of the slurry (*w:c* = 0.6). Thus, for a more accurate prediction of the undrained shear strength of the uncured mixture, a different equation with different parameters is needed to cover a wide range of clay plasticity.

$$\frac{s_{u,pred}}{p_a} = \left[f_1 + f_2\left(\frac{t}{t_{0m}}\right)\right] * [w_{mix}]^{f_3} \qquad \textit{Equation 2-4}$$

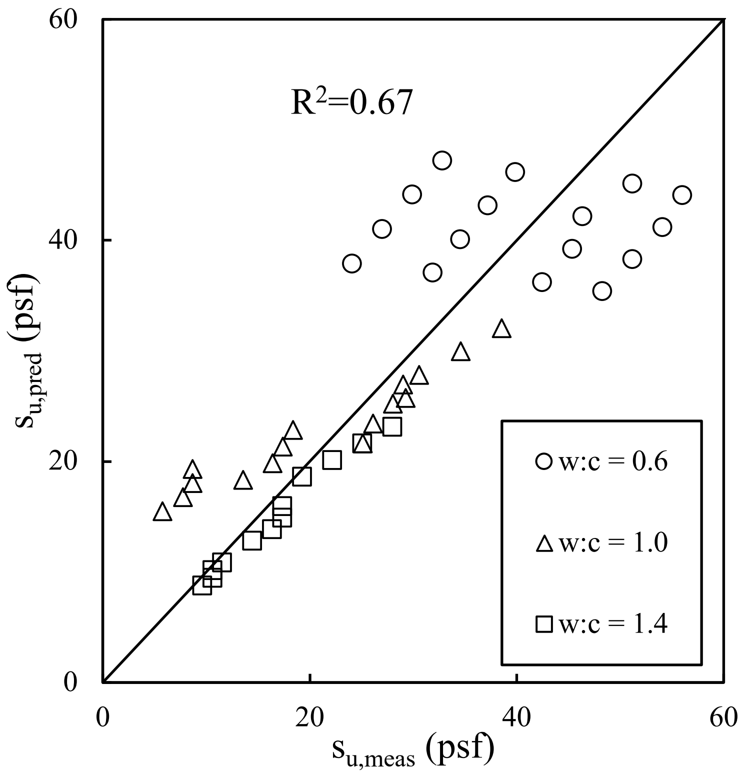


Figure 4-14. Relationship between $s_{u,pred}$ using Equation 2-4 and $s_{u,meas}$ (batches C-0 to C-10)

Table 4-10. Coefficient values for Equation 2-4 (batches C-0 to C-10)

Coefficient	Value
f_1	0.00505
f_2	0.00109
f_3	-6.27

Figure 4-15 presents the relationship between the $s_{u,meas}$ and the time after soil-cement mixing, and the numbers in the legend provide the cement factor in-place ($\alpha_{in\text{-}place}$) in kg/m^3 and the water-to-cement ratio of the slurry (*w:c*) of the mixture. All of the mixtures shown in the figure follow an approximately linear function of time.

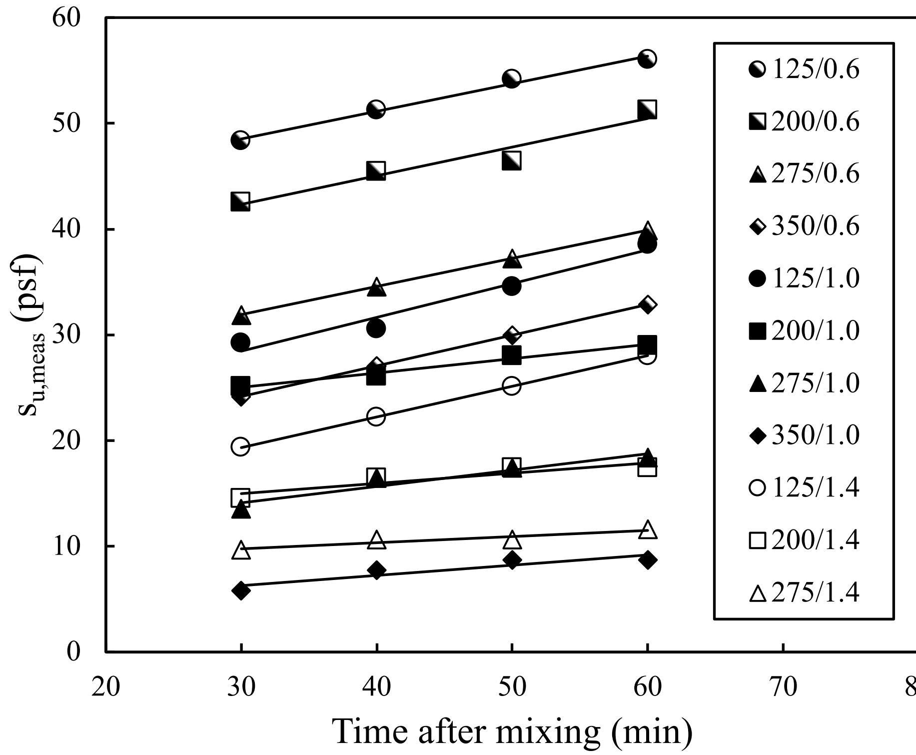


Figure 4-15. Relationship between $s_{u,meas}$ and time after mixing

In addition to the effect of time, the amount of water, soil, and binder noticeably affect the mixture consistency, as discussed previously. The following four parameters represent various ratios of water, soil, and cement.

- Water content of mixture (w_{mix})

$$w_{mix} = \frac{W_{w,soil} + W_{w,slurry}}{W_s + W_c} \quad \text{Equation 4-6}$$

- Total-water- to-soil-solids ratio ($w_t{:}s$)

$$w_t : s = \frac{W_{w,soil} + W_{w,slurry}}{W_s} \quad \text{Equation 4-7}$$

- Total-water-to-cement ratio ($w_t{:}c$)

$$w_t : c = \frac{W_{w,soil} + W_{w,slurry}}{W_c} \quad \text{Equation 4-8}$$

- Cement factor (α)

$$\alpha = \frac{W_c}{V_s} \qquad \textit{Equation 4-9}$$

where $W_{w,soil}$ is the weight of water in the soil, $W_{w,slurry}$ is the weight of water in the slurry, W_s is the weight of soil solids, W_c is the weight of dry cement, and V_s is the volume of soil solids.

To find the best equation for the undrained shear strength of uncured mixture with the minimum number of parameters and coefficients, pairs of the four parameters list above were selected and applied in power and/or exponential forms, and each pairing was combined with a linear function of curing time. All 24 possible combinations of alternative equations were evaluated. The equations, along with values of the coefficients (e_1, e_2, e_3, and e_4) and the coefficient of determination (R^2), for each equation are presented in Appendix C. From among these alternative equations, Equation 4-10 produces the best fit between $s_{u,pred}$ and $s_{u,meas}$ as shown in Figure 4-16. In Equation 4-10, e_1, e_2, e_3, and e_4 are dimensionless coefficients, t is curing time, t_{0m} is reference time (60 minutes in this research) which is used to normalize t. Table 4-11 includes the coefficient values for Equation 4-10 and t-test results on each coefficient that indicate all the coefficients are statistically significant in the regression.

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{0m}}\right)\right] * [w_t : s]^{e_3} * [e_4]^{w_t : c} \qquad \textit{Equation 4-10}$$

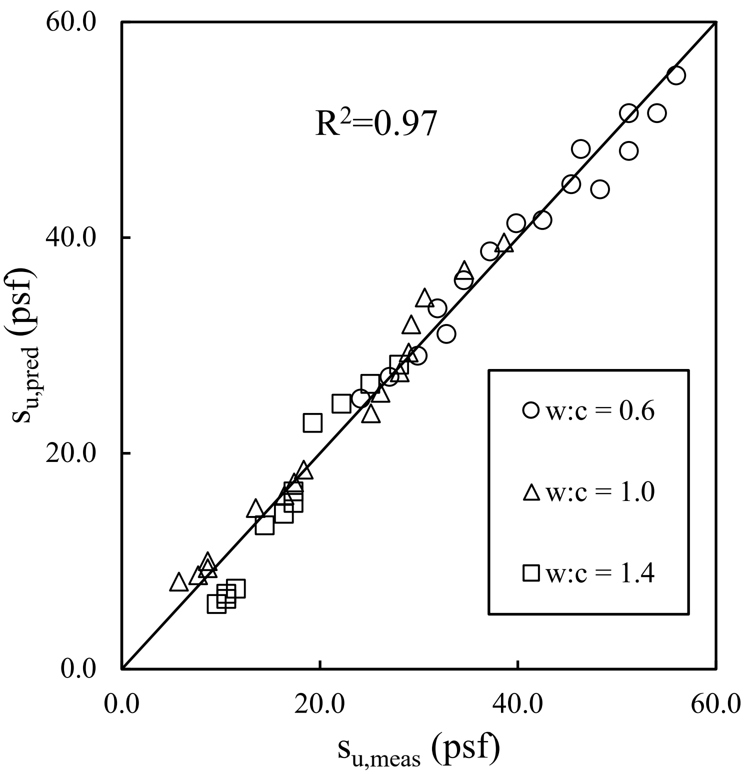


Figure 4-16. Relationship between $s_{u,pred}$ using Equation 4-10 and $s_{u,meas}$ (batches C-0 to C-10)

Table 4-11. Coefficient values and statistical analysis results for Equation 4-10 (batches C-0 to C-10)

Coefficient	Value	Standard Error	t-Statistic	p-Value
e_1	0.0101	0.000823	12.3	3.89E-15
e_2	0.00630	0.000980	6.43	1.17E-07
e_3	-3.59	0.130	-27.7	1.05E-27
e_4	0.881	0.0107	82.3	2.92E-46

The undrained shear strength data set from the lean clay (CL) obtained by Nevárez-Garibaldi et al. (2018) was reanalyzed using Equation 4-10 to access its applicability to lean clay. Figure 4-17 shows the comparison of the $s_{u,pred}$ by Equation 4-10 and the $s_{u,meas}$ for the lean clay. Table 4-12 provides the coefficient values for Equation 4-10 and statistical analysis results for each coefficient. As shown in Figure 4-17, the agreement between the $s_{u,pred}$ and the $s_{u,pred}$ for lean clay fitted by Equation 4-10 is excellent (R^2 = 0.99), and better than for fat clay (R^2 = 0.97). Furthermore, Equation 4-10 produces a better fit for than Equation 2-4 (R^2 = 0.94) for the lean clay. In Table 4-12, t-test results demonstrate that the coefficients have statistically significant impacts on the regression.

Consequently, it appears that Equation 4-10 can be used to predict the consistency of cement-treated soil right after mixing as a function of curing time and mixture proportions, and that the equation can be applied for lean clay and fat clay.

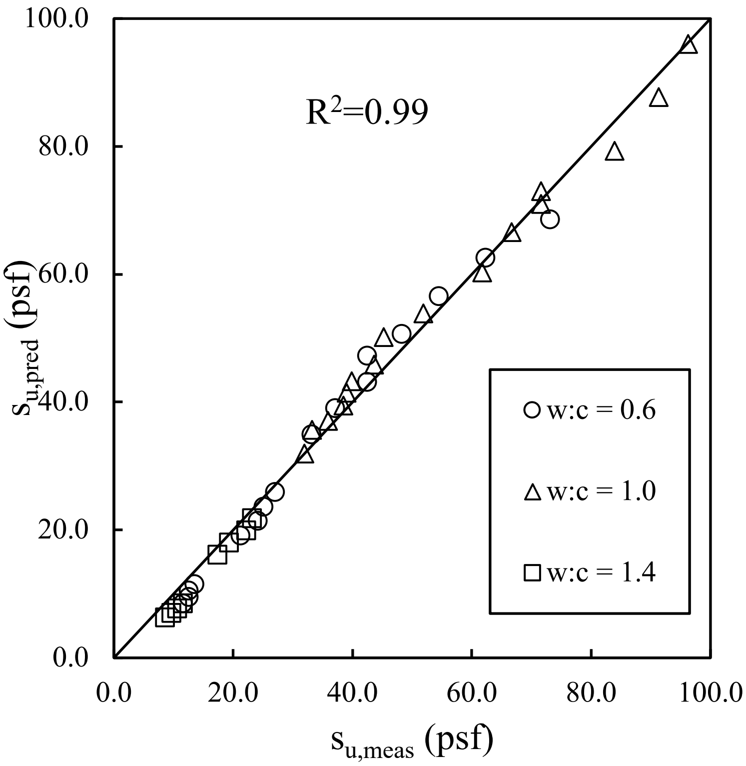


Figure 4-17. Relationship between $s_{u,pred}$ using Equation 4-10 and $s_{u,meas}$ for lean clay

Table 4-12. Coefficient values and statistical analysis results for Equation 4-10 (lean clay)

Coefficient	Value	Standard Error	t-Statistic	p-Value
e_1	0.00180	0.000180	10.0	5.56E-12
e_2	0.00193	0.000216	8.94	1.15E-10
e_3	-3.86	0.101	-38.1	1.10E-30
e_4	0.819	0.00945	86.7	2.16E-43

4.3.3. Influence of base soil plasticity on strength and consistency of mixture

The coefficient values for equations in this chapter depend on the soil type and binder type, as previously described. Two types of base soil, lean and fat clays (CL and CH), were used with Portland cement to study the unconfined compressive strength (UCS) of mixtures after curing and the consistency of mixtures right after mixing, as represented by the undrained shear strength (s_u). The UCS prediction equation (Equation 2-1) and the undrained shear strength prediction equation (Equation 4-10) are discussed and evaluated in Sub-sections 4.3.1 and 4.3.2, respectively, and they have different coefficient values depending on the base soil type. Therefore, the influence of different types of base soil on the strength and consistency can be investigated by comparing the coefficient values for each equation because only Portland cement type I/II was used as a binder in this research.

Table 4-13 presents the coefficient values for UCS and consistency equations. The coefficient values for the UCS equation for lean clay were obtained by Nevárez-Garibaldi et al. (2018), and the values for the fat clay were obtained in the current research. The values of coefficients for the UCS equation obtained from lean and fat clays are similar to each other, with the exception of d_4, which does not have a big effect because the base of the exponent d_4 is the dry unit weight of the mixture, which does not vary by a large amount. The curing time coefficients e_1 and e_2, for the consistency equation are remarkably different. Consequently, it appears that plasticity of the base soil does not significantly influence the coefficient values for the UCS equation, but plasticity does appear to influence the coefficient values for the consistency equation. This finding may not apply to other binder types or to inorganic clays.

.

Table 4-13. Coefficient values for UCS and consistency equation

UCS equation (Equation 2-1)			Consistency equation (Equation 4-10)		
Coefficient	CL	CH	Coefficient	CL	CH
d_1	21.8	25.3	e_1	0.00180	0.0101
d_2	25.2	21.5	e_2	0.00193	0.00630
d_3	-1.57	-1.49	e_3	-3.86	-3.59
d_4	1.48	2.44	e_4	0.819	0.881

4.4. Optimum mix design for wet method of deep mixing

A method for selecting an optimum mix design for a lean clay (CL) satisfying target strength and consistency with the minimum amount of cement was proposed by Nevárez-Garibaldi et al. (2018). To estimate the strength of cured mixtures and the consistency of uncured mixtures, they used Equation 2-1 and Equation 2-4, respectively. They selected the cement factor (α), which is defined as the weight of cement divided by the volume of the base soil, and the water-to-cement ratio of the slurry ($w{:}c$), which is defined as the weight of the water in the slurry divided by the weight of cement, as controlling parameters of mix design.

First, this section provides an example to introduce the procedure for selecting an optimum mix design which can be used for both lean and fat clays (CL and CH). To estimate the consistency of mixture right after mixing, Equation 4-10 is used instead of Equation 2-4 because Equation 2-4 is not applicable to fat clay as demonstrated in Section 4.3.2. Although most of the contractors prefer using α to determine the amount of cement in their project because of its simplicity for calculation, some contractors use the cement factor in-place ($\alpha_{in\text{-}place}$), which is the weight of the cement divided by the volume of the mixture. Accordingly, either α and $w{:}c$ or $\alpha_{in\text{-}place}$ $w{:}c$ can be used to specify the mix design. Second, the influence of the water content of the base soil ($w_{base\ soil}$) on optimum mix design is discussed. In this research, the $w_{base\ soil}$ for lean and fat clays were equal to their liquid limit (LL) values of 35% and 65%, respectively. When the $w_{base\ soil}$ changes, the strength and consistency of mixture are changed, and the optimum mix design is also changed corresponding to changes in the strength and consistency curves.

4.4.1. Method to select optimum mix design for lean and fat clays

The detailed step-by-step procedure to select optimum mix design proposed by Nevárez-Garibaldi et al. (2018) is introduced in Section 2-6. This chapter focuses on the procedure after getting the strength and the consistency measurement from the unconfined compressive strength (UCS) tests and the laboratory miniature vane shear tests, respectively, because the previous steps are the same as those in Section 2-6.

From the UCS test results, coefficient values for Equation 2-1 can be obtained by using a least squares regression. The input parameters for Equation 2-1 are the curing time (t) normalized by the reference time (t_0), the total-water-to-cement ratio ($w_t{:}c$), and the dry unit weight of the mixture ($\gamma_{d,mix}$) normalized by the unit weight of the water (γ_w). To represent ratios the $w_t{:}c$ and the $\gamma_{d,mix}{:}\gamma_w$, Nevárez-Garibaldi et al. (2018) derived Equations 4-11 and 4-12. Except for the cement factor (*α)* and the water-to-cement ratio of the slurry (*w:c*), which are controlling parameters for this method, all the parameters in these equations can be attained from characteristics and the amount of the base soil and the binder.

$$w_t : c = \frac{w\gamma_{d,soil}}{\alpha} + (w : c) \qquad \textit{Equation 4-11}$$

$$\gamma_{d,mix} : \gamma_w = \frac{G_c\left(\gamma_{d,soil} + \alpha\right)}{G_c\gamma_w + \alpha\{1 + G_c(w : c)\}} \qquad \textit{Equation 4-12}$$

where $\gamma_{d,soil}$ is the dry unit weight of the soil and G_c is the specific gravity of the cement.

By using Equations 2-1, 4-11, and 4-12, the value of *α* for a selected *w:c* can be obtained that produces a target UCS at a selected curing time. A target UCS of 400 psi and a curing time of 28 days are chosen for use in this example, which is based on the results presented previously for the fat clay (base soil type 2) with a water content of 65% and Portland cement binder. The coefficient values in Table 4-13 were applied to Equation 2-1 with the UCS_{pred} value equal to the UCS at 28 days of curing (UCS_{28days} = 400 psi). The resulting expression is combined with Equations 4-11 and 4-12 to establish the combinations of *α* and *w:c*, which are shown in Figure 4-18, that produce the target UCS of 400 psi. Any point above the curve represents produces UCS_{28days} values greater than 400 psi.

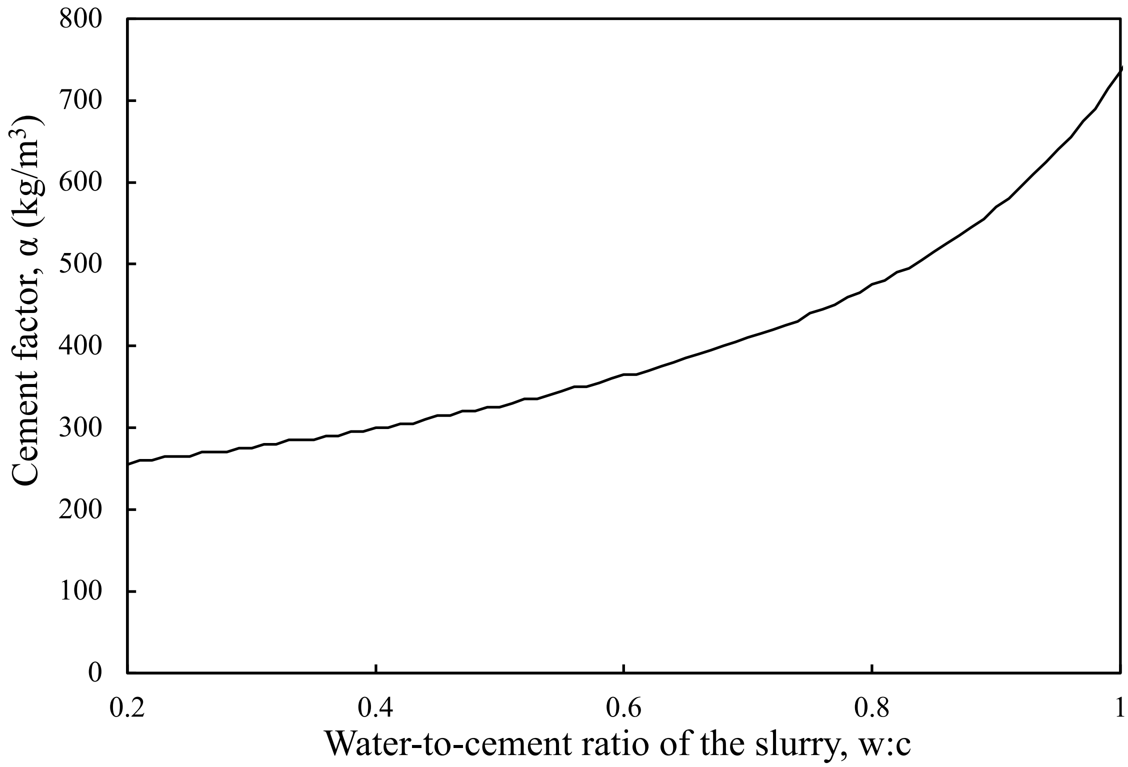


Figure 4-18. Strength curve (UCS_{28days} = 400 psi)

From laboratory miniature vane shear test results on mixtures after blending but before curing, a least squares regression is used to determine coefficient values for Equation 4-10. The input parameters for Equation 4-10 are the curing time (t) normalized by the reference time (t_{0m}), the total-water-to-soil-solids ratio ($w_t{:}s$), and the total-water-to-cement ratio ($w_t{:}c$). The equation for the $w_t{:}c$ is already introduced in Equation 4-11, and Equation 4-13 represents the $w_t{:}s$ with parameters that can be obtained from characteristics and the amount of the base soil and the binder, except for the α and the $w{:}c$, which are the independent parameters.

$$w_t{:}s = \frac{\alpha(w{:}c) + w\gamma_{d,soil}}{\gamma_{d,soil}} \qquad \textit{Equation 4-13}$$

By using Equation 4-10, 4-11, and 4-13, the value of α for a selected $w{:}c$ can be obtained that produces a target undrained shear strength (s_u) at a selected time after mixing. A target s_u of 50 psf and a time after mixing of 60 minutes are selected for this example. Figure 4-19 presents the consistency curve of the combinations of α and $w{:}c$ that satisfy the s_u of 50 psf. The same base soil and binder that were used to generate the strength curve in Figure 4-18 were used, and the coefficient values in Table 4-11 were applied to Equation 4-10 with $s_{u,pred}$ set equal to the target undrained shear strength at 60 minutes after mixing ($s_{u,60min}$ = 50 psf). Any point on the curve in Figure 4-19 represents a combination of α and *w:c* that produces $s_{u,60min}$ of 50 psf, and any point above the curve represents a combination of α and *w:c* that provides $s_{u,60min}$ less than 50 psf.

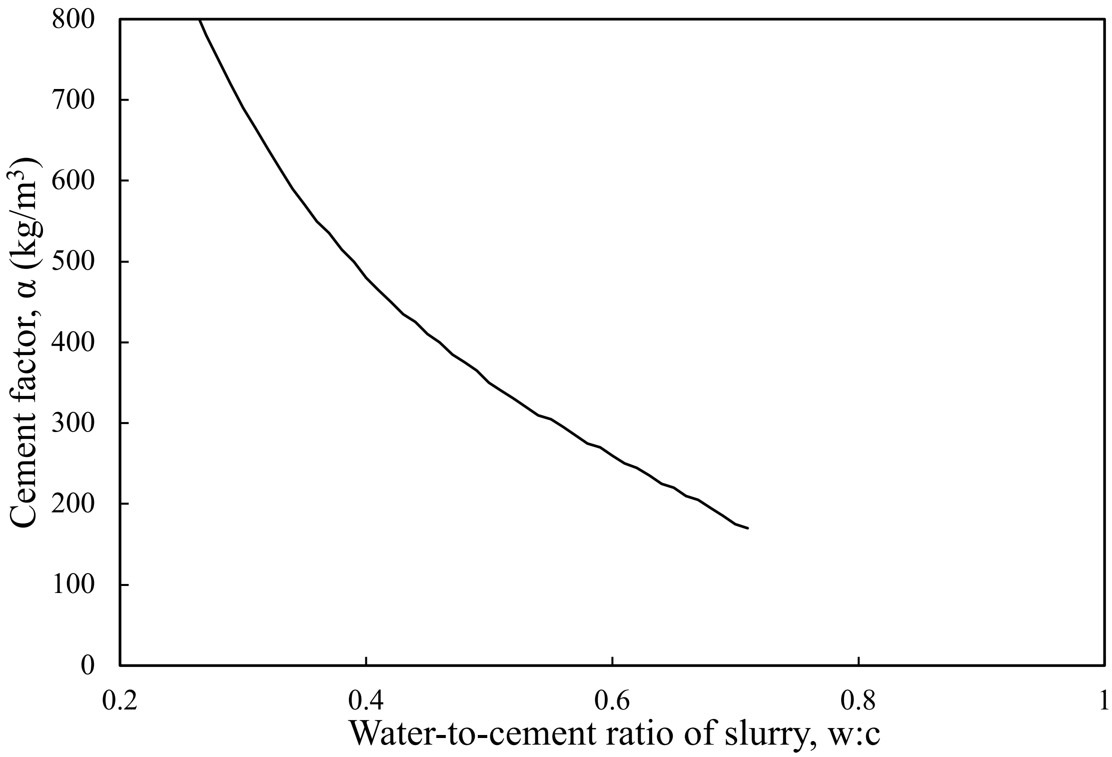


Figure 4-19. Consistency curve ($s_{u,60min}$ = 50 psf)

Figure 4-20 shows both the strength curve and the consistency curve presented in Figures 4-18 and 4-19, respectively. In Figure 4-20, any combination of α and *w:c* above these two curves produces UCS_{28days} greater than 400 psi and $s_{u,60min}$ less than 50 psf. The black square, the intersection of the two curves, indicates the optimum mix design for this example in terms of minimum cement use while satisfying the target USC and s_u. The mixture at this point has the combination of α = 333 kg/m^3 and *w:c* = 0.522. This mix design satisfies the target strength, UCS_{28days} of 400 psi, and the target consistency, $s_{u,60min}$ of 50 psf, using the minimum amount of cement. Any point on Figure 4-20 that lies above both lines would also be satisfactory.

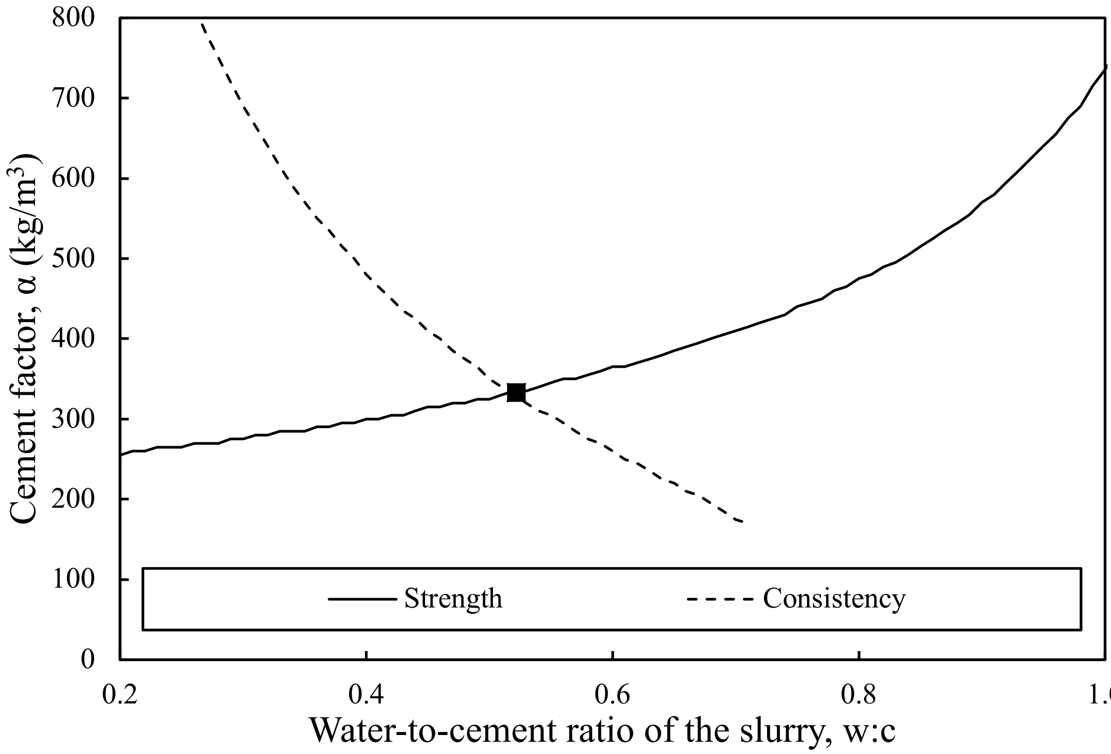


Figure 4-20. Strength & consistency curve and optimum mix design

Following the procedure described above, an optimum mix design can also be in terms of $\alpha_{in\text{-}place}$ and $w{:}c$. When the dry unit weight of the slurry ($\gamma_{d,slurry}$) is known, $\alpha_{in\text{-}place}$ can be calculated from α, and vice versa (Equation 4-14 and 4-15).

$$\alpha = \frac{\gamma_{d,slurry}\alpha_{in-place}}{\gamma_{d,slurry} - \alpha_{in-place}}$$ *Equation 4-14*

$$\alpha_{in-place} = \frac{\gamma_{d,slurry}\alpha}{\gamma_{d,slurry} + \alpha}$$ *Equation 4-15*

However, to represent the input parameters for Equation 2-1 and Equation 4-10 with $\alpha_{in\text{-}place}$ and $w{:}c$, the more complicated Equations 4-16, 4-17, and 4-18 have to be used instead of Equations 4-11, 4-12, and 4-13. Figure 4-21 shows the strength curve and the consistency curve, in terms of $\alpha_{in\text{-}place}$ and $w{:}c$ and the optimum mix design. The same soil type, binder type, and test results as the previous example were used. The black square in Figure 4-21, the intersection of the two curves, indicates the optimum mix design for this example. The mixture at this point has the combination of $\alpha_{in\text{-}place}$ = 260 kg/m^3 and *w:c* = 0.522, and *w:c* is the same as the previous example.

$$w_t\!:c = (w\!:c) - \frac{\left[G_c\{(w\!:c)\alpha_{in-place} - \gamma_w\} + \alpha_{in-place}\right]\gamma_{d,soil}w}{G_c\alpha_{in-place}\gamma_w} \qquad \textit{Equation 4-16}$$

$$\gamma_{d,mix}\!:\gamma_w = \frac{G_c\left[\alpha_{in-place}\{\gamma_w - \gamma_{d,soil}(w\!:c)\} + \gamma_w\gamma_{d,soil}\right] - \gamma_{d,soil}\alpha_{in-place}}{G_c\gamma_w^2} \qquad \textit{Equation 4-17}$$

$$w_t\!:s = w - \frac{G_c(w\!:c)\alpha_{in-place}}{\left[G_c\{(w\!:c)\alpha_{in-place} - \gamma_w\} + \alpha_{in-place}\right]\gamma_{d,soil}} \qquad \textit{Equation 4-18}$$

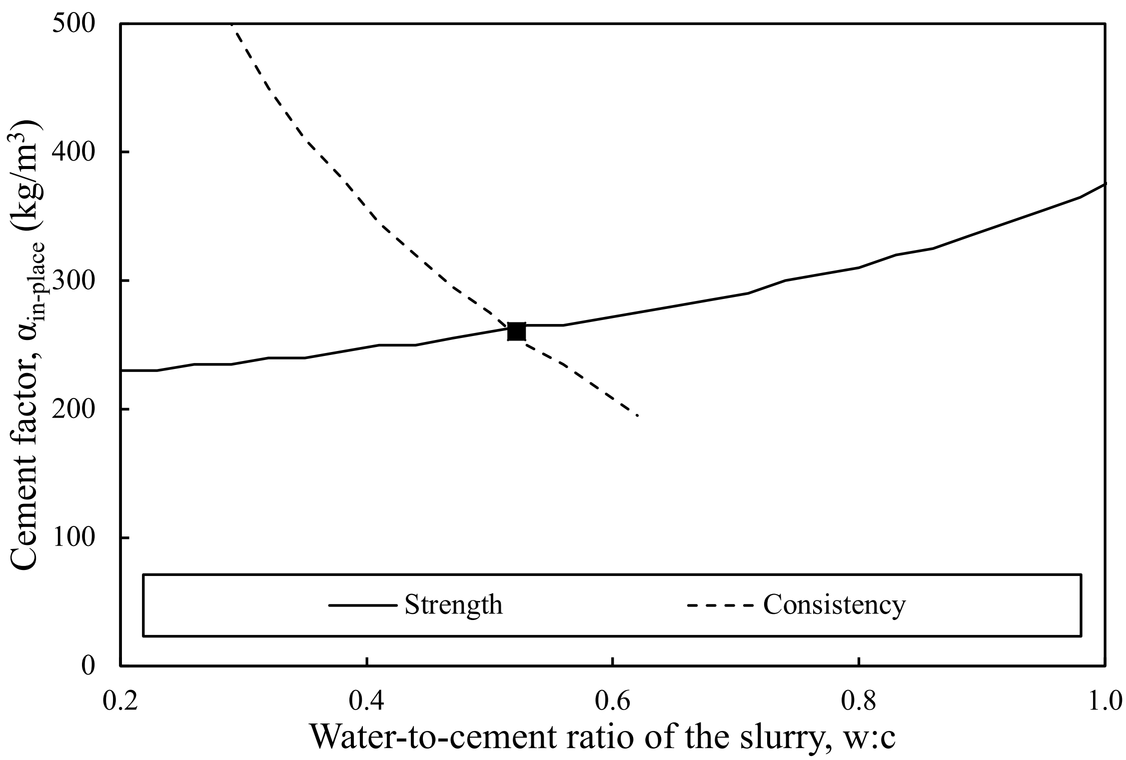


Figure 4-21. Strength & consistency curve and optimum mix design in terms of $\alpha_{in\text{-}place}$ and w:c

4.4.2. Changing optimum mix design depending on water content of the base soil

The strength and consistency curves and the optimum mix design for lean and fat clays (CL and CH) determined by the optimum mix design method are presented in Figure 4-22. The UCS and s_u data for the lean clay were collected by Nevárez-Garibaldi et al. (2018), and the data for the fat clay were generated as part of the current research. The water contents of base soil ($w_{base\ soil}$) were equal to their liquid limit (LL) values, 35% for lean clay and 65% for fat clay. As shown in Figure 4-22, strength and consistency curves vary depending on base soil type.

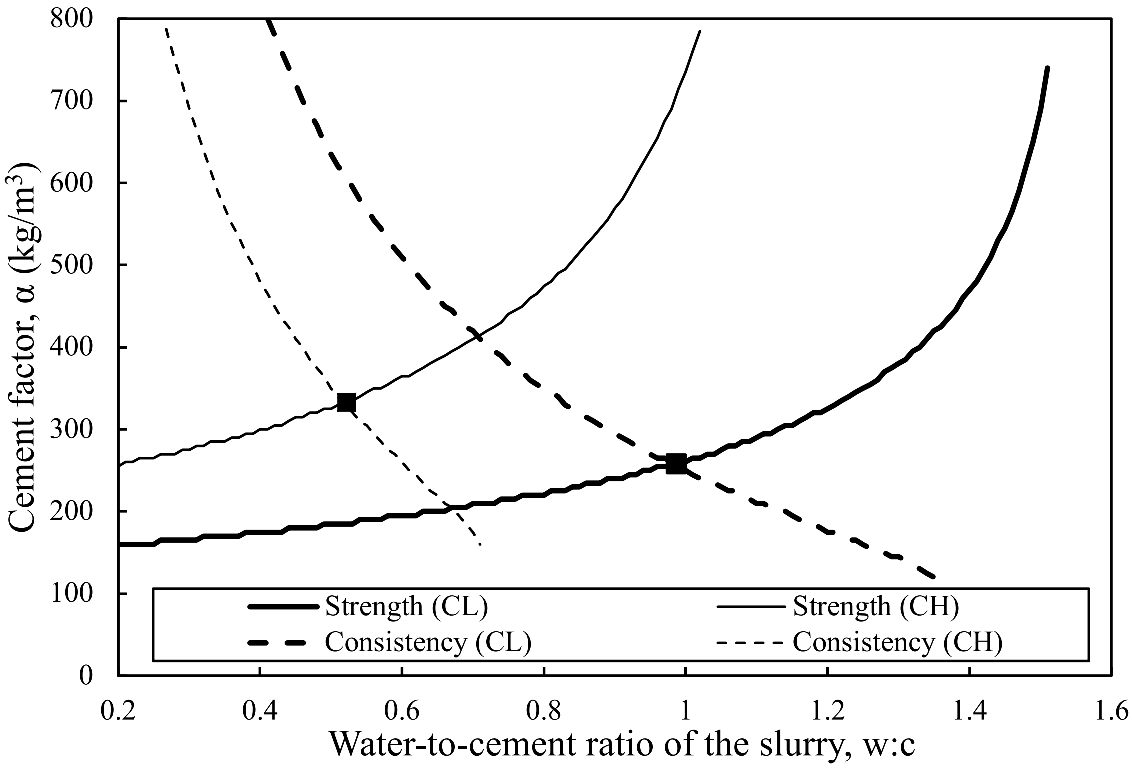


Figure 4-22. Strength & consistency curves and optimum mix design for lean clay ($w_{base\ soil}$ = 35%) and fat clay ($w_{base\ soil}$ = 65%)

The locations of the optimum mix design are not the same even when the $w_{base\ soil}$ for both lean and fat clays are the same, as shown in Figure 4-23, for which $w_{base\ soil}$ = 40% for both soil types. When two different plasticity clays have the same $w_{base\ soil}$, the strength curves for lean and fat clays are close to each other. The strength curve for fat clay moves right-down with decreasing $w_{base\ soil}$ while the curve for lean clay moves left-up with increasing $w_{base\ soil}$. On the other hand, the consistency curves move past each other and get farther away from each other when the $w_{base\ soil}$

for the two soils are the same. The consistency curve for fat clay moves right-up with decreasing $w_{base\ soil}$ while the curve for lean clay moves left-down with increasing $w_{base\ soil}$. Based on the observation in Figure 4-23, it is concluded that the plasticity of the base soil does not significantly affect the strength of the cured mixture but has a significant influence on the consistency of the uncured mixture. This finding is consistent with the discussion in Section 4.3.3.

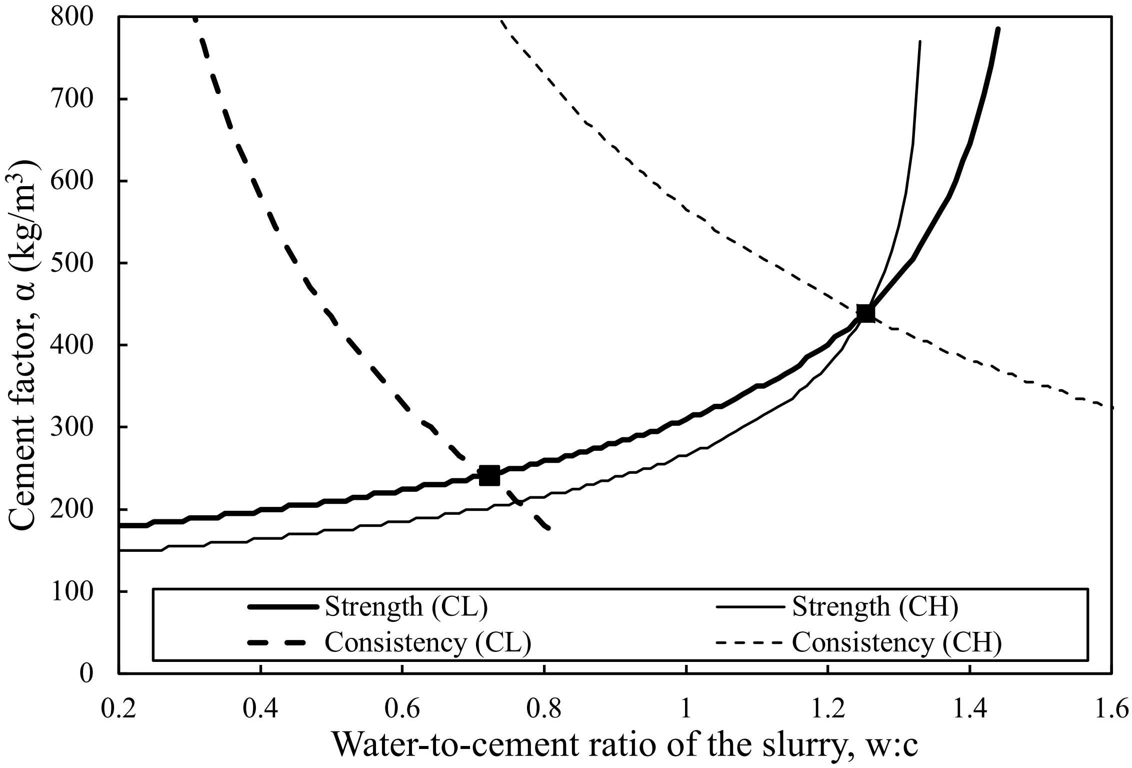


Figure 4-23. Strength & consistency curves and optimum mix design for lean and fat clays ($w_{base\ soil}$ = 40%)

In order to investigate the optimum mix design according to the changing $w_{base\ soil}$, the strength and consistency curves and optimum mix design for fat clay with the $w_{base\ soil}$ of 45, 55, and 65% are plotted in Figure 4-24. For the optimum mix design, both the required α and $w{:}c$ values increase with decreasing $w_{base\ soil}$, if all other factors remain the same. In other words, the soil with low $w_{base\ soil}$ needs more water and cement to satisfy a target strength after curing and a target consistency before curing. Therefore, the lower $w_{base\ soil}$ the soil has, the higher the cost is to treat the soil with the binder. The final in-place mixtures are the same for all of the optimums shown in Figure 4-24. The reason that more cement is required for a base soil with lower in-situ water content is that a larger volume of slurry is necessary to produce the same final in-place mixture, which means that more spoil is produced. It is also worth noting that, if the base soil water content and plasticity both increase, then more cement and mixing water may be necessary to achieve the target UCS and consistency, as shown in Figure 4-22.

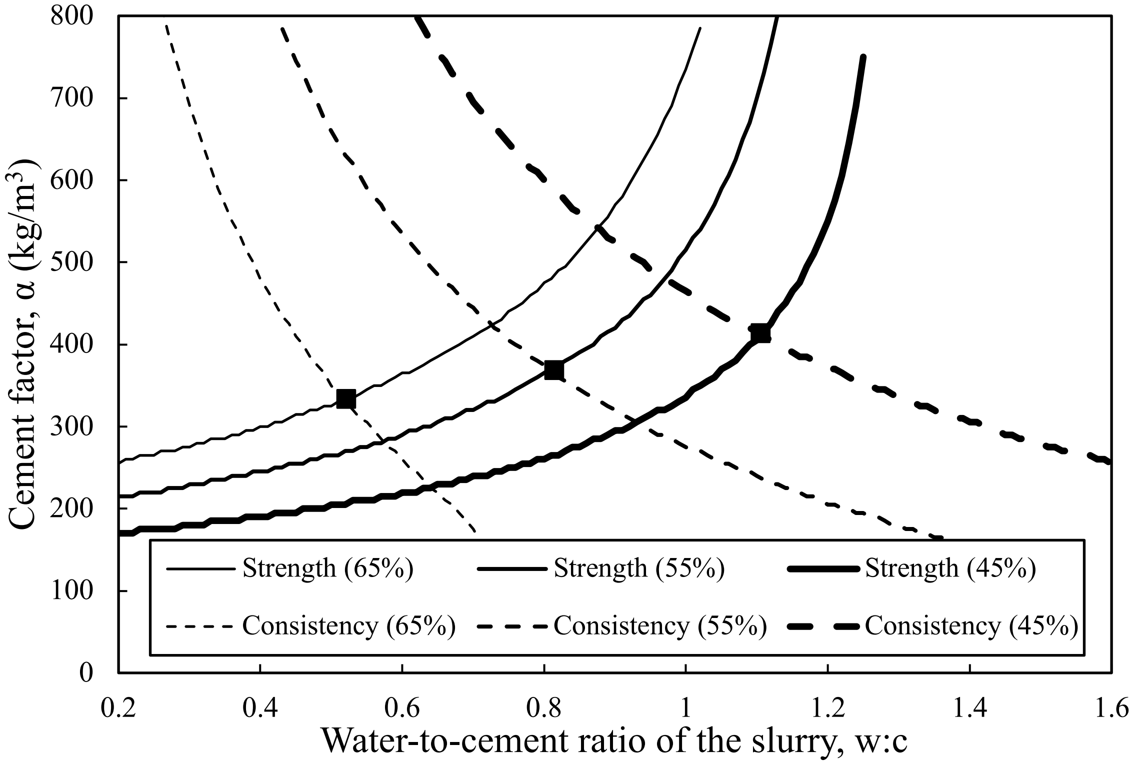


Figure 4-24. Strength & consistency curves and optimum mix design for fat clay in terms of α and w:c ($w_{base\ soil}$ = 45, 55, and 65%)

Figures 4-25 and 4-26 describe the changes in α and $w{:}c$ of optimum mix design (α_{opt} and $w{:}c_{opt}$) for both lean and fat clays corresponding to different values of $w_{base\ soil}$. As demonstrated in Figure 4-24, the α_{opt} and $w{:}c_{opt}$ decrease with increasing $w_{base\ soil}$. Again, it is concluded that the lower $w_{base\ soil}$ requires more cement and water to achieve a target strength and consistency of the mixture for the same soil type. As mentioned, if both the plasticity and the water content of the base soil increase, more cement and water may be necessary to achieve the target UCS and s_u.

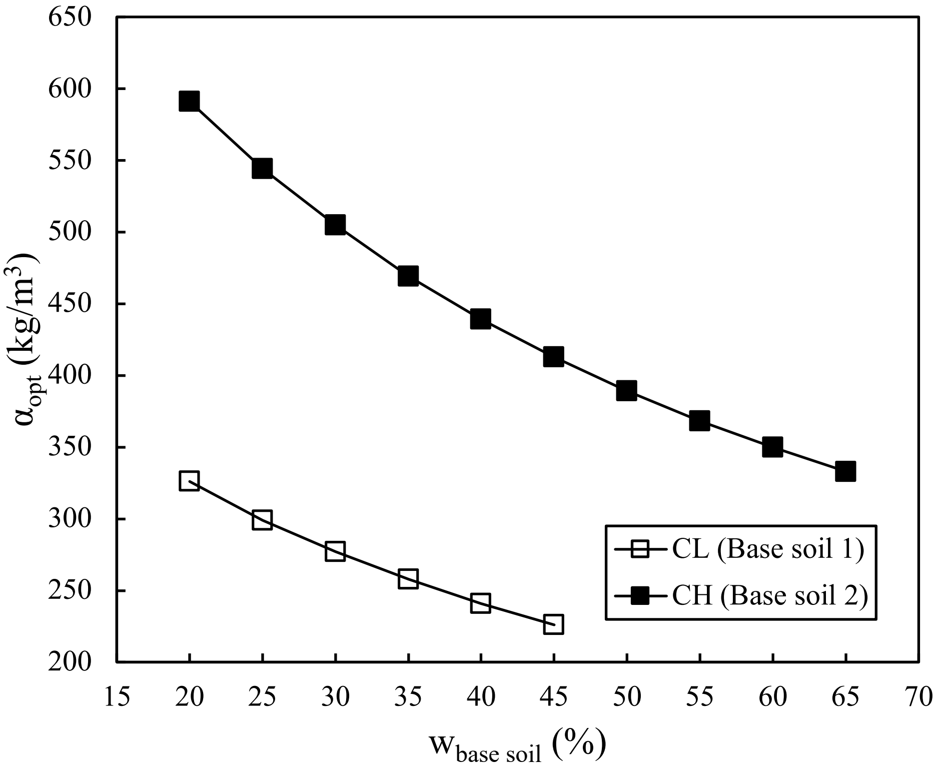


Figure 4-25. α_{opt} corresponding to different $w_{base\ soil}$ for lean and fat clays

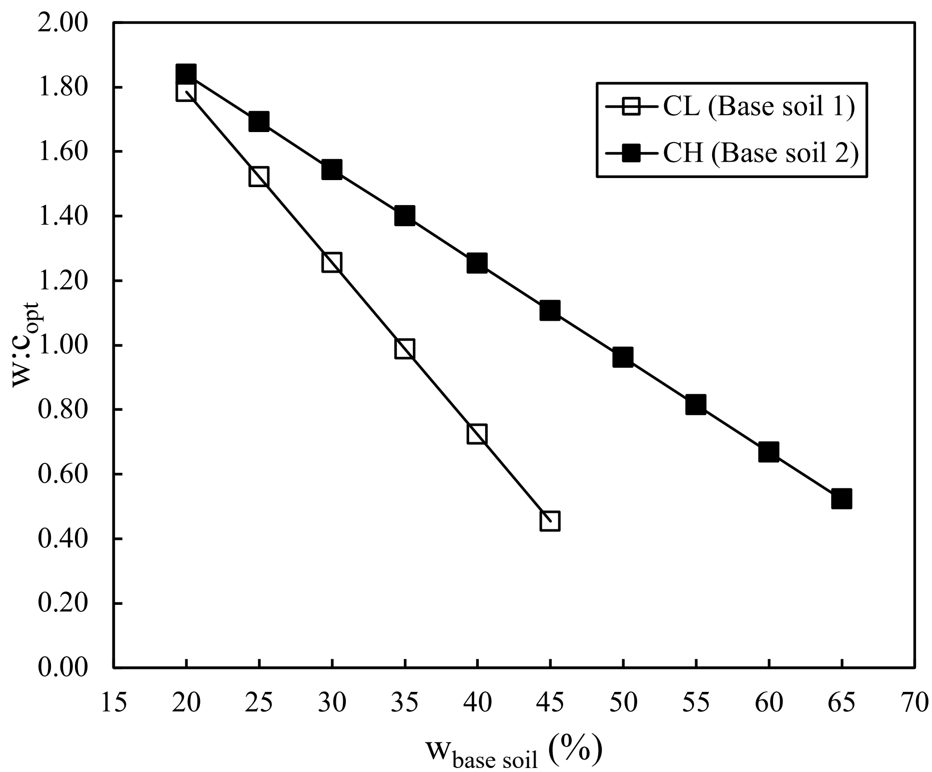


Figure 4-26. $w{:}c_{opt}$ corresponding to different $w_{base\ soil}$ for lean and fat clays

The strength and consistency curves and the optimum mix designs for the fat clay with $w_{base\ soil}$ of 45, 55, and 65% in terms of $\alpha_{in\text{-}place}$ and $w{:}c$ are shown in Figure 4-27. The required $\alpha_{in\text{-}place}$ values to achieve the optimum mix design does not change regardless of the $w_{base\ soil}$, while the required $w{:}c$ values increase with decreasing $w_{base\ soil}$.

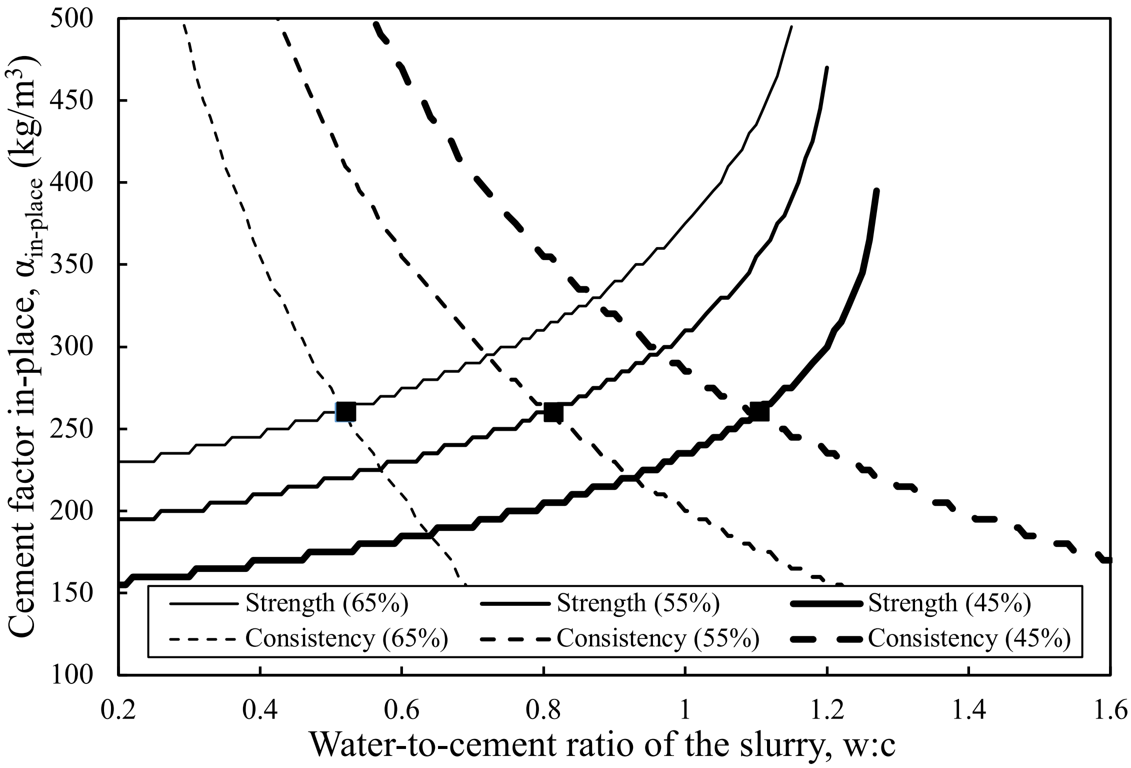


Figure 4-27. Strength & consistency curves and optimum mix design for fat clay in terms of $\alpha_{in\text{-}place}$ and $w{:}c$ ($w_{base\ soil}$ = 45, 55, and 65%)

Figure 4-28 shows values of $\alpha_{in\text{-}place}$ of optimum mix design ($\alpha_{in\text{-}place,opt}$) for both the lean and fat clays at different $w_{base\ soil}$ values. The $\alpha_{in\text{-}place,opt}$ values are not exactly constant because of small numerical inaccuracies in determining the optimum values.

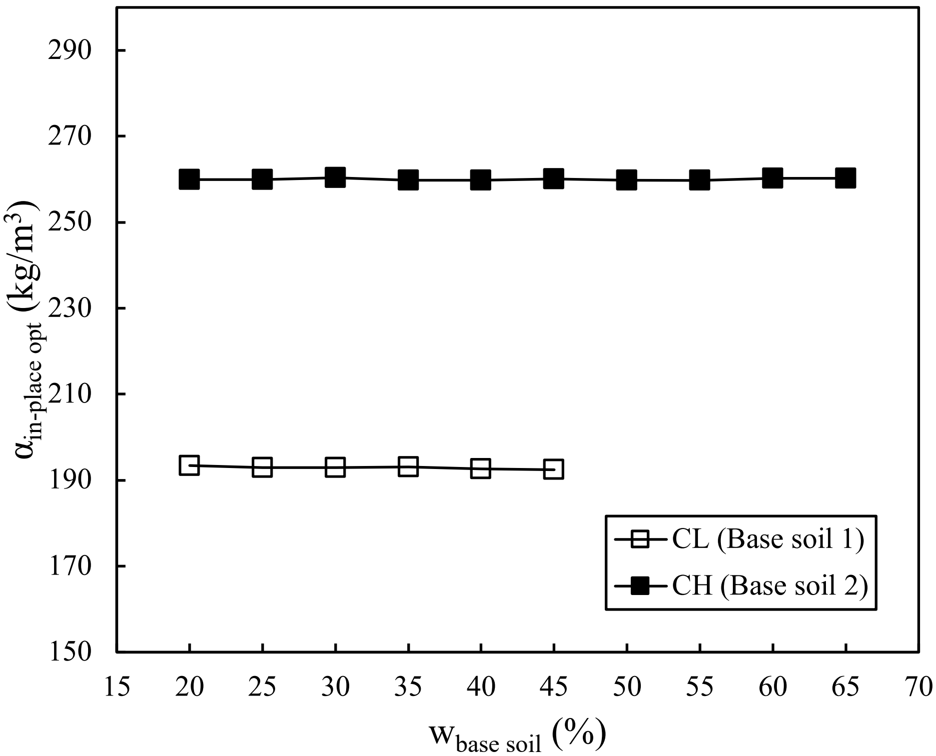


Figure 4-28. $\alpha_{in\text{-}place,opt}$ corresponding to the different $w_{base\ soil}$ for lean and fat clays

When a target strength and consistency are set using the same base soil type and the binder type, the optimum mixture that satisfies the target strength and consistency should be independent of $w_{base\ soil}$. In other words, mixtures that have the same strength and consistency have the same ratio of the soil, water, and cement. In this research, the target strength of 400 psi and the target consistency of 50 psf were fixed, and both base soil type 1 and 2 were used with a fixed binder type, which was cement. Therefore, the $\alpha_{in\text{-}place\ opt}$ value should always be the same, even if $w_{base\ soil}$ is different, while the α_{opt} changes depending on the $w_{base\ soil}$ because $\alpha_{in\text{-}place}$ is the weight of the cement divided by the total volume of the mixture, and α is the weight of the cement divided by the volume of the base soil that does not consider the volume of added water and cement in the mixture. To support this conclusion, plots of the total-water-to-cement ratio ($w_t{:}c$), the dry unit weight of the mixture normalized by the unit weight of the water ($\gamma_{d,mix}{:}\gamma_w$), and the total-water-to-soil-solids ratio ($w_t{:}s$) of the optimum mix design ($w_t{:}c_{opt}$, $\gamma_{d,mix}{:}\gamma_{w,opt}$, and $w_t{:}s_{opt}$) for both lean and fat clays corresponding to different $w_{base\ soil}$ values are presented in Figures 4-29, 4-30, and 4-31, respectively. The ratios $w_t{:}c$, $\gamma_{d,mix}{:}\gamma_w$, and $w_t{:}s$ are the input parameters for the strength equation (Equation 2-1) and the consistency equation (Equation 4-10). These parameters are based on the total amount of the soil, water, and cement, so the values of these for optimum mix design are always constant regardless of the $w_{base\ soil}$. Consequently, to achieve the required strength and consistency with the same base soil and the binder, the same mixture should be produced for any value of $w_{base\ soil}$, which is the same as saying that the values of $\alpha_{in\text{-}place,opt}$ and $w_t{:}c_{opt}$ are independent of $w_{base\ soil}$.

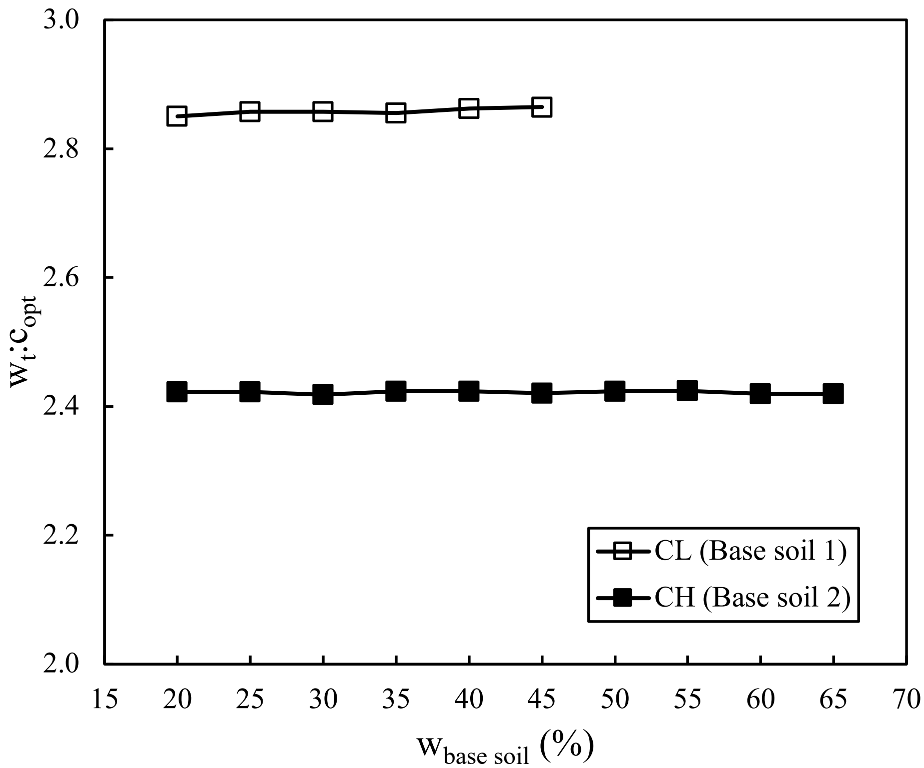


Figure 4-29. $w_t{:}c_{opt}$ corresponding to the different $w_{base\ soil}$ for lean and fat clays

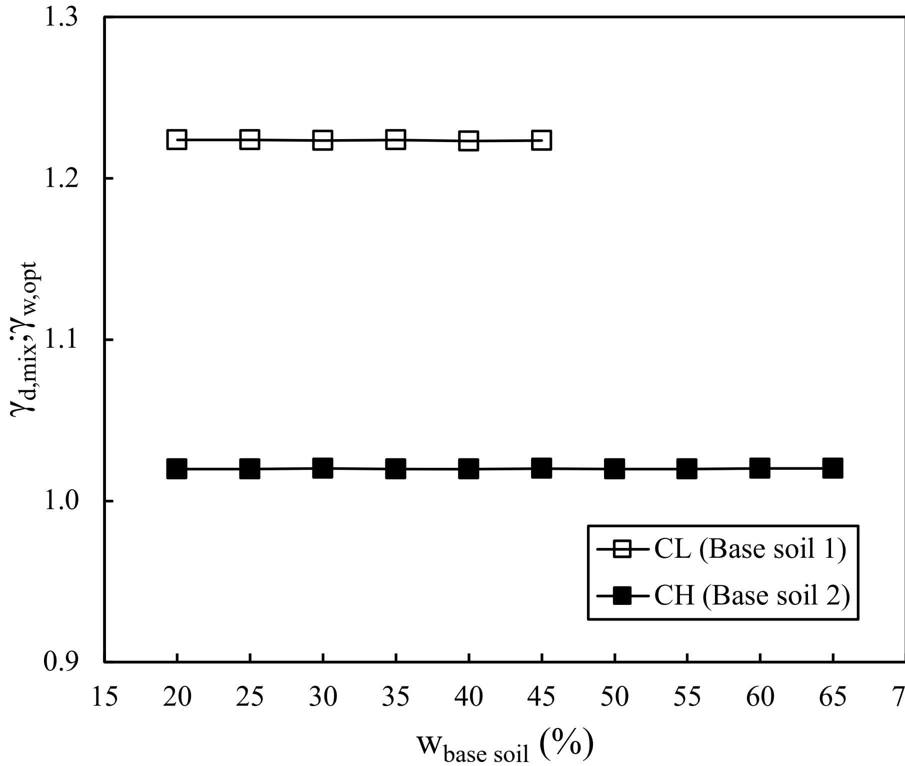


Figure 4-30. $\gamma_{d,mix}$:$\gamma_{w,opt}$ *corresponding to the different* $w_{base\ soil}$ *for lean and fat clays*

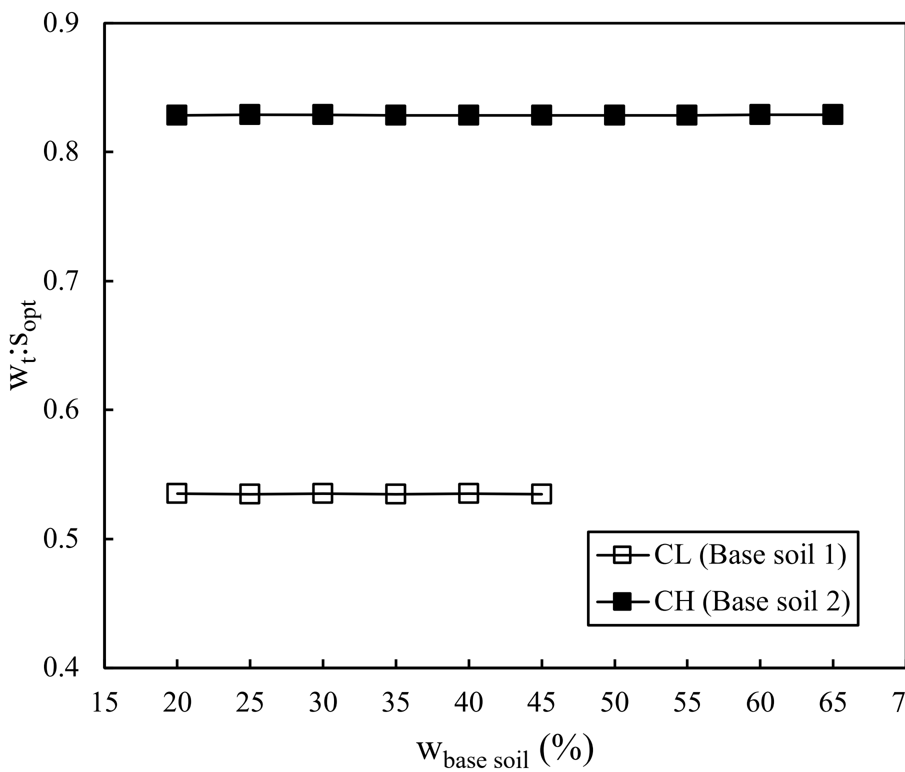


Figure 4-31. w_t:s_{opt} *corresponding to the different* $w_{base\ soil}$ *for lean and fat clays*

5. Conclusions and Recommendations

This research was carried out in order to improve understanding of the influence of curing temperature on the strength of binder-treated soil and the optimum mix design that satisfies a target strength of the mixture after curing and a target consistency of the mixture right after mixing with the smallest amount of binder. The strength of the cured mixture was measured by unconfined compressive strength (UCS) tests. The consistency of the mixture right after mixing is represented by the undrained shear strength (s_u), which was measured using a laboratory miniature vane shear apparatus. This chapter contains the conclusions from the results and discussions in Chapter 4 based on the measured UCS and s_u values, and it presents recommendations for future research based on the author's experience obtained from this research.

5.1. Influence of constant curing temperature on UCS

The UCS prediction equation suggested by Nevárez-Garibaldi et al. (2018) (Equation 2-1) is not applicable when specimens are cured at different temperatures. From the UCS test results, it was found that UCS increases with increasing curing temperature, and the influence of curing temperature on UCS is more significant when the total-water-to-cement ratio (w_t:c) is high. In order to account for the influence of constant curing temperature on UCS, the five-coefficient equation (Equation 4-4) was developed considering the influence of the following parameters: curing time (t); total-water-to-cement ratio, defined as the weight of the water in the mixture divided by the weight of cement; dry unit weight of the mixture ($\gamma_{d,mix}$); and curing temperature (T). Although the equation has not been tested when the curing temperature is outside the range from 25 to 55℃, the equation produces a good agreement between the predicted and measured UCS for the conditions investigated in this research. The five-coefficient equation can be fit to strength measurements of binder-treated soil for different curing times, curing temperatures, and mixture proportion. Using the five-coefficient equation to interpret test results, the total number of batches to design an appropriate mix can be reduced because all of the data from different mixes, different curing times, and different curing temperatures can be interpreted in a consistent framework that represents the impact of each variable parameter in a logical way. If the curing temperature is held constant, the five-coefficient equation reduces to a four-coefficient equation.

The five-coefficient equation that includes the effects of curing temperature can be applied to field-mixed elements if the curing temperature in the field is measured or can be estimated, and if the curing temperature can be approximated as being constant during the period of interest. If the curing temperatures are different at different locations in the field-mixed element, e.g., at different depths or at different radial distances from the center towards the edge of the element, it may be possible to estimate the difference in the strength of the element at these different locations. However, it should be recognized that elevated confining pressure and consolidation of the mixture during field curing could also have an effect on the cured strength, and such effects would be expected to vary with depth, radial location, hydraulic conductivity of the mixture, rate of strength gain of the mixture, and hydraulic and deformation boundary conditions around the element. Additional research is necessary to identify the fundamental processes and the interactions that control the effects of these factors, and to quantify their impacts on the cured strength of field-mixed elements.

5.2. Influence of changing curing temperature on UCS

The UCS test results for the study of the influence of changing curing temperature indicate that UCS increases with longer curing time at higher curing temperature. The test results also show that a cement-treated soil specimen cured at a low temperature and then cured at a high temperature has a higher UCS than a specimen cured at a high temperature first and then at a lower temperature. This outcome may be due to the nature of the cement hydration reactions, in which precipitates from the reaction can coat unhydrated calcium silicate (cement compound), so that water has to diffuse through the coating to react with remaining unhydrated calcium silicate. In high temperature curing, both the hydration reaction and diffusion occur more quickly. When a specimen is cured at a high temperature first, more precipitates are produced due to the high reaction rate, and the precipitates form relatively thick coatings around unhydrated calcium silicate. When curing then continues at low temperature, water diffusion occurs slowly through the thick coating of precipitate around unhydrated calcium silicate, which slows the hydration reaction rate. An additional possible explanation for the test results is that the reaction rate is high during the early part of curing when the amount of reactants (unhydrated calcium silicate and water) is relatively high, and then slows down during the later part of curing due to the reduced amount of the reactants. At a high temperature, the reduction in reaction rate at later times is more significant as curing progresses because more reactants have been consumed during early curing. Therefore, considering the influence of reactant concentration, the reaction rate is more constant when a specimen is cured at a low temperature first and then cured at a high temperature, and the more constant reaction rate contributes to greater reaction efficiency.

Although these qualitative explanations using concepts of chemical reaction rates support the observed test results, these explanations have not yet been transformed to quantitative predictive equations, in part because of the limited size of the data set for changing curing temperature, which prevents evaluating alternative predictive equations. Further research on the influence of changing curing temperature on UCS and additional UCS data with different curing conditions using the same base soil and binder would be necessary. Scanning electron microscope imaging might also shed light on the influence of temperature on the rate, location, and structure of the reaction precipitates. These types of research might establish whether the conceptual approach used to explain the experimental results is appropriate, and this might enable deriving an equation that can quantitatively estimate UCS when the curing temperature changes.

5.3. Cured strength and uncured consistency of mixture

In the wet method of deep mixing, the strength of binder-treated soil after curing and the consistency of the mixture before curing are very important considerations for contractors. While the strength prediction equation suggested by Nevárez-Garibaldi et al. (2018) (Equation 2-1) is applicable to both lean clay (CL) and fat clay (CH) when there is no curing temperature variation, their equation for predicting consistency (Equation 2-4) was not found to adequately represent consistency for a fat clay. A revised consistency equation (Equation 4-10) was developed to account for the amount of water, soil, and cement by using the total-water-to-soil-solids ratio ($w_t{:}s$) and the total-water-to-cement ratio ($w_t{:}c$) with the curing time (t). The revised consistency equation produces an excellent agreement between the predicted and measured consistency with only four coefficients for both lean and fat clays. The strength equation from Nevárez-Garibaldi et al. (2018) and the revised consistency equation can estimate the strength of binder-treated soil after curing and the consistency of the mixture before curing, respectively, for different curing time and mixture proportions for both lean and fat clay. The coefficient values for the strength and the consistency equations vary depending on the base soil type and the binder type. The differences of the coefficient values for the strength and consistency equations, due to the plasticity, indicate that changes in plasticity more significantly affect the consistency of the uncured mixture than the strength of the cured mixture. The coefficient values for the strength equation may be significantly influenced by binder type. To confirm this conclusion, a comparison of the result from this research to future research using a different binder type is recommended.

5.4. Method to select optimum mix design

A method to select optimum mix design (i.e., one that can satisfy target strength and target consistency with the smallest amount of cement) uses the strength equation and the revised consistency equation. The cement factor (α) with the water-to-cement ratio of the slurry ($w{:}c$) or the cement factor in-place ($\alpha_{in\text{-}place}$) with the $w{:}c$ are used in this procedure as controlling parameters of mix design. This procedure allows contractors to reduce the cost in the wet method of deep mixing by selecting the optimum mix design that achieves the required strength of the mixture after curing and the required consistency of the mixture before curing with the minimum amount of binder.

5.5. Influence of water content of base soil on optimum mix design

Changes to the optimum mix design for lean and fat clays (CL and CH), as indicated by the intersection of the strength and consistency curves, are due not only to the plasticity of the base soil but also due to the water content of the base soil ($w_{base\ soil}$). When the $w_{base\ soil}$ is low, the α and the $w{:}c$ for the optimum mix design (α_{opt} and $w{:}c_{opt}$, respectively) are increased, so the mixture requires more cement and water to achieve the target strength and the consistency, thereby increasing the cement cost. However, the value of $\alpha_{in\text{-}place}$, which is defined as the weight of the cement divided by the volume of the mixture, for the optimum mix design ($\alpha_{in\text{-}place,opt}$) is constant regardless of the $w_{base\ soil}$ because only one set of mixture proportions (with one set of ratios of soil solids, water, and cement) will simultaneously achieve both the target strength and the target consistency.

The outcome that a lower value of $w_{base\ soil}$ requires more cement (a higher value of α_{opt}) might seem counter-intuitive because less water in the soil would seem to require less cement to achieve the same total-water-to-cement ratio of the mixture. However, this reasoning does not consider that a drier mixture might be too stiff to mix thoroughly. Consequently, it is the need to achieve both a target cured UCS and a target consistency during mixing that drive the need for more cement for a soil with low $w_{base\ soil}$ when all of the additional mixing water necessary to produce a mixture with a suitable consistency for the contractor's mixing equipment and technology is provided by a slurry with a constant water-to-cement ratio.

An alternative to providing the needed mixing water using only a slurry with a constant water-to-cement ratio is to premix a soil with a low $w_{base\ soil}$ with water, which will effectively increase the $w_{base\ soil}$ without adding cement. Spoils that may be produced by premixing do not contain any wasted cement. After pre-mixing with water, the element can then be treated with lower values of α_{opt} and $w{:}c_{opt}$ to simultaneously achieve the target cured UCS and target consistency during mixing than the values of α_{opt} and $w{:}c_{opt}$ that would be necessary without premixing with water. This process of premixing a soil with low $w_{base\ soil}$ with water can decrease the amount and cost of cement necessary to produce a thoroughly mixed product with the target UCS. However, although premixing of a soil having a low $w_{base\ soil}$ with water reduces the cement material cost, this solution may increase costs for labor and equipment due to the premixing operation. Therefore, deep mixing contractors are motivated to consider overall construction costs and time when deciding whether premixing with water would be beneficial for projects with low $w_{base\ soil}$ of the native soil.

References

ASTM (2010). "Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils." *D4318-10e1*, ASTM International, West Conshohocken, PA.

ASTM (2011). "Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)." *D2487-11*, ASTM International, West Conshohocken, PA.

ASTM (2014). "Standard Test Methods for Specific Gravity of Soil Solids by Water Pycnometer." *D854-14*, ASTM International, West Conshohocken, PA.

ASTM (2016). "Standard Test Methods for Laboratory Miniature Vane Shear Test for Saturated Fine-Grained Clayey Soil." *D4648/D4648M-16*, ASTM International, West Conshohocken, PA.

ASTM (2016). "Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete." *C42/C42M-16*, ASTM International, West Conshohocken, PA.

ASTM (2016). "Standard Test Method for Unconfined Compressive Strength of Cohesive Soil." *D2166/D2166M-16*, ASTM International, West Conshohocken, PA.

ASTM (2017). "Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis." *D7928-17*, ASTM International, West Conshohocken, PA.

ASTM (2017). "Standard Test Method for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis." *D6913/D6913M-17*, ASTM International, West Conshohocken, PA.

Ahnberg, H., and Holm, G. (1999). "Stabilization of some Swedish organic soils with different types of binder." *Dry Mix Methods for Deep Soil Stabilization*, 101.

Bearce, R., and Mooney, M. (2015). "Seismic modulus maturity function for lime and lime–cement stabilized clay." *Journal of Materials in Civil Engineering*, 28(3), 04015150.

Benaicha, M., Burtschell, Y., and Alaoui, A. H. (2016). "Prediction of compressive strength at early age of concrete – Application of maturity." *Journal of Building Engineering*, 6, 119-125.

Bruce, M. E. C., Berg, R. R., Collin, J. G., Filz, G. M., Terashi, M., and Yang, D. S. (2013). "Federal Highway Administration design manual: deep mixing for embankment and foundation support."

Circeo, L. J., Davidson, D., and David, H. (1962). "Strength-maturity relations of soil-cement mixtures." *Highway Research Board Bulletin*(353).

Denies, N., and Huybrechts, N. "DEEP MIXING BBRI research activities Soil mix project - IWT 080736." *Proc., ISSMGE-TC211 International Symposium on Ground Improvement IS-GI*.

Filz, G., Adams, T., Navin, M., and Templeton, A. E. (2012). "Design of Deep Mixing for Support of Levees and Floodwalls." *Grouting and Deep Mixing 2012*, 89-133.

Filz, G. M., Hodges, D. K., Weatherby, D. E., and Marr, W. A. (2005). "Standardized Definitions and Laboratory Procedures for Soil-Cement Specimens Applicable to the Wet Method of Deep Mixing." *Innovations in Grouting and Soil Improvement*.

Hirabayashi, H., Taguchi, H., Tokunaga, S., Shinkawa, N., Fujita, T., Inagawa, H., and Yasuoka, N. "Laboratory mixing tests on cement slurry preparation, specimen preparation and curing temperature." *Proc., Proc., Deep Mixing 2009 Okinawa Symp. and Int. Symp. on Deep Mixing & Admixture Stabilization, Port and Airport Research Institute, Japan Construction Method and Machinery Research Institute, Cement Deep Mixing Association (CDM), Dry Jet Mixing Method Association, Japan*.

Hodges, D. K., Filz, G. M., and Weatherby, D. E. (2008). "Laboratory Mixing, Curing and Strength Testing of Soil-Cement Specimens Applicable to the Wet Method of Deep Mixing." *CGPR Report #48*, Virginia Tech Center for Geotechnical Practice and Research, Blacksburg, VA.

Horpibulsuk, S., Minura, N., and Nagaraj, T. S. (2003). "Assessment of Strength development in cement-admixed high water content clays with abram's law as a basis."

Horpibulsuk, S., Rachan, R., and Suddeepong, A. (2011). "Assessment of strength development in blended cement admixed Bangkok clay." *Construction and Building Materials*, 25(4), 1521-1531.

Jacobson, J. R., Filz, G. M., and Mitchell, J. K. (2003). "Factors affecting strength gain in lime-cement columns and development of a laboratory testing procedure." Virginia Center for Transportation Innovation and Research.

Kang, G., Tsuchida, T., Tang, T., and Kalim, T. (2017). "Consistency measurement of cement-treated marine clay using fall cone test and Casagrande liquid limit test." *Soils and Foundations*, 57(5), 802-814.

Kido, Y., Nishimoto, S., Hayashi, H., and Hashimoto, H. "Effects of curing temperatures on the strength of cement-treated peat." *Proc., Proceedings of International Symposium on Deep Mixing and Admixture Stabilization*.

Kim, J. K., Moon, Y. H., and Eo, S. H. (1998). "Compressive strength development of concrete with different curing time and temperature." *Cement and Concrete Research*, 28(12), 1761-1773.

Kitazume, M., Grisolia, M., Leder, E., Marzano, I. P., Correia, A. A. S., Oliveira, P. J. V., Åhnberg, H., and Andersson, M. (2015). "Applicability of molding procedures in laboratory mix tests for quality control and assurance of the deep mixing method." *Soils and Foundations*, 55(4), 761-777.

Kitazume, M., Nakamura, T., Terashi, M., and Ohishi, K. (2003). "Laboratory tests on long-term strength of cement treated soil." *Grouting and Ground Treatment*, 586-597.

Kitazume, M., and Terashi, M. (2013). *The deep mixing method*, CRC press.

Lorenzo, G. A., and Bergado, D. T. (2006). "Fundamental Characteristics of Cement-Admixed Clay in Deep Mixing." *Journal of Materials in Civil Engineering*, 18(2), 161-174.

Marzano, I. P., Al Tabbaa, A., and Grisolia, M. "Influence of sample preparation on the strength of cement-stabilised clays." *Proc., International Symposium on Soil Mixing and Admixture Stabilisati*.

Marzano, I. P., Leder, E., Grisolia, M., and Danisi, C. "Laboratory study on the molding techniques for QC/QA process of a Deep Mixing work." *Proc., 3rd International Conference on New Developments in Soil Mechanics and Geotechnical Engineering, Near East University, Nicosia, North Cyprus. ISBN*, 975-8359.

Moretti, G., Viana da Fonseca, A., Paschoalin Filho, J. A., and de Carvalho, D. (2012). "Strength increase in time of an alluvial clay, typical of the coast of Brazil's Northeastern, mixed with different dosages of cement." *ISSMGE-TC211 International Symposium on Ground Improvement IS-GI*Brussels, Belgium.

Nevárez-Garibaldi, R., Miller, D., and Filz, G. M. (2018). "Influences of Mixture Proportions and Test Conditions on the Strength and Stiffness of Wet-Mixed Soil and Cement." *DFI Report*, Deep Foundation Institute, Virginia Tech, Blacksburg, VA.

Piriyakul, K., and Pochalard, S. (2012). "Stiffness of Soil-Cement-Fly Ash by means of Shear Wave Velocity." *ISSMGE-TC211 International Symposium on Ground Improvement IS-GI*Brussels, Belgium.

Sato, A., Nishimoto, S., and Suzuki, T. (2006). "Relationship between Curing Temperature and Strength of Stabilized Soil." *Cold Regions Engineering 2006*.

Szymkiewicz, F., Guimond-Barrett, A., Kouby, A. L., and Reiffsteck, P. (2012). "Influence of grain size distribution and cement content on the strength and aging of treated sandy soils."

European Journal of Environmental and Civil Engineering, 16(7), 882-902.

Szymkiewicz, F., Tamga, F.-S., Le Kouby, A., and Reiffsteck, P. (2013). "Optimization of strength and homogeneity of deep mixing material by the determination of workability limit and optimum water content." *Canadian Geotechnical Journal*, 50, 1034+.

Terashi, M. "Theme lecture: deep mixing method–brief state of the art." *Proc., Proceedings of the 14 th International Conference on Soil Mechanics and Foundation Engineering*, 2475-2478.1997.

Thomas, J. J., and Jennings, H. M. (2009). "Materials of Cement Science Primer: The Science of Concrete."

Topcu, I. B., and Toprak, M. U. (2005). "Fine aggregate and curing temperature effect on concrete maturity." *Cement and Concrete Research*, 35(4), 758-762.

Verástegui Flores, R. D. "Mechanical behavior of cement-treated clay." *Proc., ISSMGE-TC211 International Symposium on Ground Improvement IS-GI*.

Wasti, Y., and Bezirci, M. H. (1986). "Determination of the consistency limits of soils by the fall cone test." *Canadian Geotechnical Journal*, 23(2), 241-246.

Yi, S.-T., Moon, Y.-H., and Kim, J.-K. (2005). "Long-term strength prediction of concrete with curing temperature." *Cement and Concrete Research*, 35(10), 1961-1969.

Yikici, T. A., and Chen, H.-L. R. (2015). "Use of maturity method to estimate compressive strength of mass concrete." *Construction and Building Materials*, 95, 802-812.

Zhang, R. J., Lu, Y. T., Tan, T. S., Phoon, K. K., and Santoso, A. M. (2014). "Long-Term Effect of Curing Temperature on the Strength Behavior of Cement-Stabilized Clay." *Journal of Geotechnical and Geoenvironmental Engineering*, 140(8).

Zreik, D., Ladd, C., and Germaine, J. (1995). "A New Fall Cone Device for Measuring the Undrained Strength of Very Weak Cohesive Soils."

Appendix A: Laboratory mixing data sheets

The laboratory mixing data sheets for this research are provided in this appendix. Each data sheet includes data for one batch. The mixture proportions and curing temperatures are based on Tables 3-6 to 3-9. The data sheets provide the necessary weight of soil solids (w_s), soil water ($w_{w,soil}$), dry cement (w_c), and slurry water ($w_{w,slurry}$) to fabricate the required number of specimens (N) for the desired water-to-cement ratio of the slurry ($w{:}c$) and cement factor in-place ($\alpha_{in\text{-}place}$). The laboratory mixing data sheets also provide summarized information about cured specimens and unconfined compressive strength (UCS) tests result.

Laboratory Mixing Data
Batch T-1

Change only black text, red is calculated	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	300.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	3751.8
Weight of Slurry (g)	800.0
Specific Gravity of Solids	2.74
water content of mix	0.39
Dry unit wt. of mix (pcf)	82.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2799.5
Weight of Soil Water, $w_{w,soil}$ (g)	980
Total weight of soil used, W_t (g)	3756.5
Weight of Dry Cement, w_c (g)	509.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	305.4
Soil Water Content, w (%)	35.01
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	18.18%
Cement Factor, α (kg/m3)	251.98
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	204.65
Volume Ratio, VR (%)	23.13
Total-Water-to-Cement Ratio, w_T:c	2.51

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	305.4
Volume Ratio, VR (%)	23.13
Total-Water-to-Cement Ratio, w_T:c	2.51
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	204.6

SAMPLE DATA: Batch T-1

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	10/6 10:00 PM	2.92	10/9 8:09 PM	2.041	3.965	25	100	383.3	0	267.1	2.32	1.9	0.995	265.9	1803.0	
B	10/6 10:00 PM	6.99	10/13 9:39 PM	2.039	3.970	25	100	385.8	0	369.3	1.86	1.9	0.996	367.8	1816.0	
C	10/6 10:00 PM	13.84	10/20 6:08 PM	2.041	3.769	25	100	365.4	0	468.4	1.46	1.8	0.988	462.6	1808.2	
D	10/6 10:00 PM	27.95	11/3 8:43 PM	2.040	3.947	25	100	384.0	0	548.9	1.25	1.9	0.995	546.0	1816.3	
E	10/6 10:00 PM	27.96	11/3 9:08 PM	2.039	3.868	25	100	375.4	0	561.5	1.33	1.9	0.992	556.9	1813.7	
F	10/6 10:00 PM	13.86	10/20 6:38 PM	2.043	3.992	25	100	388.4	0	473.0	1.29	2	0.996	471.2	1811.1	
G	10/6 10:00 PM	7.00	10/13 10:05 PM	2.040	3.971	25	100	386.3	0	379.3	1.39	1.9	0.996	377.7	1816.1	
H	10/6 10:00 PM	2.95	10/9 8:41 PM	2.041	3.878	25	100	376.8	0	276.7	2.43	1.9	0.992	274.4	1812.2	
I	10/6 10:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	10/6 10:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-2

Change only black text, red is calculated	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	520.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	3119.1
Weight of Slurry (g)	1390.0
Specific Gravity of Solids	2.79
water content of mix	0.42
Dry unit wt. of mix (pcf)	80.4

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2399.4
Weight of Soil Water, $w_{w,soil}$ (g)	845.3
Total weight of soil used, W_t (g)	3213.5
Weight of Dry Cement, w_c (g)	896.6
Weight of Slurry Water, $w_{w,slurry}$ (g)	537.9
Soil Water Content, w (%)	35.23
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	37.37%
Cement Factor, α (kg/m3)	518.84
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	351.47
Volume Ratio, VR (%)	47.62
Total-Water-to-Cement Ratio, w_T:c	1.53

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	537.9
Volume Ratio, VR (%)	47.62
Total-Water-to-Cement Ratio, w_T:c	1.53
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	351.5

SAMPLE DATA: **Batch T-2**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	10/7 4:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	10/7 4:00 PM	6.97	10/14 3:18 PM	2.044	3.811	25	100	370.6	0	743.6	0.98	1.9	0.989	735.5	1808.4	
C	10/7 4:00 PM	14.14	10/21 7:23 PM	2.039	3.769	25	100	366.6	0	1056.4	1.33	1.8	0.988	1043.6	1817.7	
D	10/7 4:00 PM	28.01	11/4 4:11 PM	2.039	3.861	25	100	376.4	0	1169.1	1.24	1.9	0.991	1159.2	1821.8	
E	10/7 4:00 PM	28.03	11/4 4:41 PM	2.041	3.904	25	100	380.9	0	1206.2	1.17	1.9	0.993	1197.8	1819.7	
F	10/7 4:00 PM	14.16	10/21 7:56 PM	2.041	3.857	25	100	375.3	0	969.7	1.06	1.9	0.991	961.1	1814.8	
G	10/7 4:00 PM	6.99	10/14 3:50 PM	2.043	3.854	25	100	375.6	0	816.7	1.12	1.9	0.991	809.3	1814.1	
H	10/7 4:00 PM	2.92	10/10 2:08 PM	2.039	3.943	25	100	383.4	0	642.6	1.34	1.9	0.995	639.2	1817.1	
I	10/7 4:00 PM	2.95	10/10 2:41 PM	2.041	3.948	25	100	383.5	0	640.2	1.25	1.9	0.995	636.8	1811.7	
J	10/7 4:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-3

Change only black text, red is calculated	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz
Soil Properties:	
Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7
Binder Properties:	
Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes
Design Mix Values for Batch:	
Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	310.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3838.3
Weight of Slurry (g)	620.0
Specific Gravity of Solids	2.71
water content of mix	0.41
Dry unit wt. of mix (pcf)	79.6

Actual Mix Values for batch:	
As Mixed:	
Weight of Soil Solids, w_s (g)	2899.1
Weight of Soil Water, $w_{w,soil}$ (g)	1015
Total weight of soil used, W_t (g)	3886.4
Weight of Dry Cement, w_c (g)	315.6
Weight of Slurry Water, $w_{w,slurry}$ (g)	315.6
Soil Water Content, w (%)	35.01
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	10.88%
Cement Factor, α (kg/m3)	150.99
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.93
Volume Ratio, VR (%)	19.90
Total-Water-to-Cement Ratio, w_T:c	4.19
As Cured:	
Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	315.6
Volume Ratio, VR (%)	19.90
Total-Water-to-Cement Ratio, w_T:c	4.19
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.9

SAMPLE DATA: Batch T-3

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	10/9 10:00 PM	3.00	10/12 10:02 PM	2.038	3.759	25	100	357.9	0	111.8	1.91	1.8	0.988	110.4	1781.0	
B	10/9 10:00 PM	6.91	10/16 7:44 PM	2.042	3.713	25	100	354.3	0	159.5	1.80	1.8	0.985	157.2	1777.9	
C	10/9 10:00 PM	13.94	10/23 8:28 PM	2.042	3.771	25	100	358.8	0	195.8	1.59	1.8	0.988	193.3	1772.8	
D	10/9 10:00 PM	28.04	11/6 10:57 PM	2.042	3.550	25	100	338.9	0	209.1	1.12	1.7	0.979	204.7	1778.7	
E	10/9 10:00 PM	28.08	11/6 11:49 PM	2.039	3.691	25	100	352.0	0	221.0	1.11	1.8	0.985	217.6	1782.2	
F	10/9 10:00 PM	13.96	10/23 8:59 PM	2.040	3.651	25	100	347.5	0	189.3	1.41	1.8	0.983	186.1	1776.9	
G	10/9 10:00 PM	6.93	10/16 8:19 PM	2.039	3.687	25	100	351.1	0	157.0	1.75	1.8	0.985	154.6	1779.5	
H	10/9 10:00 PM	3.03	10/12 10:39 PM	2.042	3.519	25	100	333.5	0	114.3	2.11	1.7	0.978	111.7	1765.8	
I	10/9 10:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	10/9 10:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-4

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	870.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	2475.5
Weight of Slurry (g)	1740.0
Specific Gravity of Solids	2.82
water content of mix	0.56
Dry unit wt. of mix (pcf)	68.3

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1900.5
Weight of Soil Water, $w_{w,soil}$ (g)	665
Total weight of soil used, W_t (g)	2548.9
Weight of Dry Cement, w_c (g)	890.1
Weight of Slurry Water, $w_{w,slurry}$ (g)	890.1
Soil Water Content, w (%)	34.99
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	46.83%
Cement Factor, α (kg/m3)	649.37
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	349.90
Volume Ratio, VR (%)	85.59
Total-Water-to-Cement Ratio, w_T:c	1.74

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	890.1
Volume Ratio, VR (%)	85.59
Total-Water-to-Cement Ratio, w_T:c	1.74
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	349.9

SAMPLE DATA: Batch T-4

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	10/13 6:30 PM	3.01	10/16 6:38 PM	2.040	3.792	25	100	346.3	0	405.3	1.51	1.9	0.989	400.7	1704.9	
B	10/13 6:30 PM	6.94	10/20 4:58 PM	2.040	3.968	25	100	363.7	0	533.7	1.33	1.9	0.996	531.4	1711.2	
C	10/13 6:30 PM	13.97	10/27 5:51 PM	2.040	3.695	25	100	338.8	0	650.6	1.04	1.8	0.985	640.8	1711.8	
D	10/13 6:30 PM	27.92	11/10 4:29 PM	2.037	3.752	25	100	343.5	0	817.3	1.30	1.8	0.987	806.9	1714.2	
E	10/13 6:30 PM	27.93	11/10 4:56 PM	2.039	3.793	25	100	347.6	0	792.9	1.30	1.9	0.989	784.0	1712.6	
F	10/13 6:30 PM	13.99	10/27 6:15 PM	2.041	3.898	25	100	356.9	0	659.1	1.22	1.9	0.993	654.3	1707.7	
G	10/13 6:30 PM	6.96	10/20 5:35 PM	2.040	3.738	25	100	341.9	0	545.8	1.29	1.8	0.987	538.4	1707.6	
H	10/13 6:30 PM	3.03	10/16 7:10 PM	2.040	3.885	25	100	354.7	0	377.1	1.03	1.9	0.992	374.2	1704.5	
I	10/13 6:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	10/13 6:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-5

Change only black text, red is calculated	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	440.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3608.4
Weight of Slurry (g)	750.0
Specific Gravity of Solids	2.71
water content of mix	0.46
Dry unit wt. of mix (pcf)	75.4

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2699.5
Weight of Soil Water, $w_{w,soil}$ (g)	945
Total weight of soil used, W_t (g)	3620.1
Weight of Dry Cement, w_c (g)	309.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	433.8
Soil Water Content, w (%)	35.01
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	11.48%
Cement Factor, α (kg/m3)	159.18
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.00
Volume Ratio, VR (%)	27.35
Total-Water-to-Cement Ratio, w_T:c	4.43

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	433.8
Volume Ratio, VR (%)	27.35
Total-Water-to-Cement Ratio, w_T:c	4.43
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.0

SAMPLE DATA: Batch T-5

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	10/15 9:30 PM	2.95	10/18 8:21 PM	2.034	3.614	25	100	338.1	0	87.7	2.39	1.8	0.982	86.1	1756.9	
B	10/15 9:30 PM	6.92	10/22 7:33 PM	2.038	3.562	25	100	333.5	0	117.1	1.34	1.7	0.980	114.7	1751.4	
C	10/15 9:30 PM	13.98	10/29 8:55 PM	2.038	3.775	25	100	357.2	0	151.5	1.76	1.9	0.988	149.7	1770.0	
D	10/15 9:30 PM	28.06	11/12 10:49 PM	2.039	3.757	25	100	351.3	0	183.0	1.58	1.8	0.987	180.7	1747.4	
E	10/15 9:30 PM	28.08	11/12 11:24 PM	2.039	3.715	25	100	347.4	0	185.1	1.64	1.8	0.986	182.4	1747.5	
F	10/15 9:30 PM	14.00	10/29 9:25 PM	2.039	3.668	25	100	342.1	0	150.0	1.85	1.8	0.984	147.5	1742.9	
G	10/15 9:30 PM	6.94	10/22 8:07 PM	2.036	3.846	25	100	359.2	0	122.5	1.70	1.9	0.991	121.4	1750.5	
H	10/15 9:30 PM	2.98	10/18 9:05 PM	2.036	3.603	25	100	337.0	0	90.2	2.38	1.8	0.982	88.6	1753.0	
I	10/15 9:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	10/15 9:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-6

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	960.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2424.1
Weight of Slurry (g)	1640.0
Specific Gravity of Solids	2.79
water content of mix	0.64
Dry unit wt. of mix (pcf)	62.6

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1799.7
Weight of Soil Water, $w_{w,soil}$ (g)	630.5
Total weight of soil used, W_t (g)	2411.1
Weight of Dry Cement, w_c (g)	678.8
Weight of Slurry Water, $w_{w,slurry}$ (g)	950.4
Soil Water Content, w (%)	35.03
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	37.72%
Cement Factor, α (kg/m3)	523.58
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.62
Volume Ratio, VR (%)	89.96
Total-Water-to-Cement Ratio, w_T:c	2.32

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	950.4
Volume Ratio, VR (%)	89.96
Total-Water-to-Cement Ratio, w_T:c	2.32
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.6

SAMPLE DATA: Batch T-6

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	10/19 7:15 PM	2.97	10/22 6:26 PM	2.039	3.692	25	100	324.1	0	168.7	1.30	1.8	0.985	166.1	1640.5	
B	10/19 7:15 PM	6.97	10/26 6:38 PM	2.038	3.844	25	100	338.0	0	238.5	1.28	1.9	0.991	236.4	1644.8	
C	10/19 7:15 PM	13.88	11/2 4:20 PM	2.038	3.888	25	100	342.1	0	285.7	1.31	1.9	0.993	283.6	1645.9	
D	10/19 7:15 PM	28.15	11/16 10:50 PM	2.039	3.842	25	100	337.3	0	361.5	1.38	1.9	0.991	358.2	1640.6	
E	10/19 7:15 PM	28.17	11/16 11:18 PM	2.036	3.876	25	100	340.5	0	359.9	1.35	1.9	0.992	357.1	1646.5	
F	10/19 7:15 PM	13.90	11/2 4:47 PM	2.039	3.673	25	100	322.8	0	290.4	1.34	1.8	0.984	285.8	1642.3	
G	10/19 7:15 PM	6.99	10/26 7:06 PM	2.037	3.699	25	100	325.1	0	243.4	1.44	1.8	0.985	239.8	1645.6	
H	10/19 7:15 PM	2.99	10/22 6:59 PM	2.043	3.629	25	100	319.4	0	167.2	1.28	1.8	0.982	164.2	1638.3	
I	10/19 7:15 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	10/19 7:15 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-7

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	310.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3838.3
Weight of Slurry (g)	620.0
Specific Gravity of Solids	2.71
water content of mix	0.42
Dry unit wt. of mix (pcf)	79.5

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2900
Weight of Soil Water, $w_{w,soil}$ (g)	1015
Total weight of soil used, W_t (g)	3892.8
Weight of Dry Cement, w_c (g)	326.5
Weight of Slurry Water, $w_{w,slurry}$ (g)	326.5
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	11.26%
Cement Factor, α (kg/m3)	155.97
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	129.38
Volume Ratio, VR (%)	20.56
Total-Water-to-Cement Ratio, w_T:c	4.09

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	326.5
Volume Ratio, VR (%)	20.56
Total-Water-to-Cement Ratio, w_T:c	4.09
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	129.4

SAMPLE DATA: Batch T-7

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	12/24 12:40 PM	2.99	12/27 12:19 PM	2.038	3.876	35	100	368.9	0	165.7	2.60	1.9	0.992	164.4	1780.3	
B	12/24 12:40 PM	6.98	12/31 12:09 PM	2.038	3.873	35	100	368.8	0	217.2	1.70	1.9	0.992	215.5	1781.2	
C	12/24 12:40 PM	13.99	1/7 12:23 PM	2.040	3.924	35	100	375.1	0	275.3	1.86	1.9	0.994	273.6	1784.6	
D	12/24 12:40 PM	28.01	1/21 12:48 PM	2.042	3.953	35	100	377.2	0	378.8	1.58	1.9	0.995	376.8	1777.9	
E	12/24 12:40 PM	28.03	1/21 1:16 PM	2.041	3.929	35	100	374.4	0	392.1	1.90	1.9	0.994	389.7	1777.3	
F	12/24 12:40 PM	14.01	1/7 12:50 PM	2.041	3.920	35	100	374.2	0	280.4	2.10	1.9	0.994	278.6	1780.4	
G	12/24 12:40 PM	7.00	12/31 12:34 PM	2.039	3.908	35	100	372.0	0	221.7	2.39	1.9	0.993	220.3	1778.8	
H	12/24 12:40 PM	3.00	12/27 12:45 PM	2.041	3.887	35	100	369.5	0	167.3	2.63	1.9	0.992	166.1	1772.9	
I	12/24 12:40 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/24 12:40 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-8

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	500.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	3384.0
Weight of Slurry (g)	1000.0
Specific Gravity of Solids	2.74
water content of mix	0.46
Dry unit wt. of mix (pcf)	75.9

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2600
Weight of Soil Water, $w_{w,soil}$ (g)	921
Total weight of soil used, W_t (g)	3500.6
Weight of Dry Cement, w_c (g)	512.6
Weight of Slurry Water, $w_{w,slurry}$ (g)	512.6
Soil Water Content, w (%)	35.42
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	19.72%
Cement Factor, α (kg/m3)	272.31
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.39
Volume Ratio, VR (%)	35.89
Total-Water-to-Cement Ratio, w_T:c	2.77

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	512.6
Volume Ratio, VR (%)	35.89
Total-Water-to-Cement Ratio, w_T:c	2.77
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.4

SAMPLE DATA: Batch T-8

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	12/24 2:20 PM	2.95	12/27 1:13 PM	2.041	3.829	35	100	358.4	0	221.3	2.68	1.9	0.990	219.1	1745.7	
B	12/24 2:20 PM	6.95	12/31 1:01 PM	2.041	3.845	35	100	360.6	0	295.9	2.02	1.9	0.991	293.1	1749.1	
C	12/24 2:20 PM	13.96	1/7 1:18 PM	2.040	3.884	35	100	364.5	0	379.6	1.92	1.9	0.992	376.7	1752.0	
D	12/24 2:20 PM	28.01	1/21 2:36 PM	2.042	3.940	35	100	371.5	0	462.7	1.46	1.9	0.994	460.1	1756.8	
E	12/24 2:20 PM	28.03	1/21 3:04 PM	2.043	3.830	35	100	360.0	0	465.8	1.56	1.9	0.990	461.1	1749.6	
F	12/24 2:20 PM	13.98	1/7 1:44 PM	2.041	3.937	35	100	370.0	0	373.7	1.64	1.9	0.994	371.6	1752.8	
G	12/24 2:20 PM	6.96	12/31 1:26 PM	2.043	3.949	35	100	371.8	0	296.9	1.96	1.9	0.995	295.3	1752.5	
H	12/24 2:20 PM	2.97	12/27 1:41 PM	2.040	3.874	35	100	363.2	0	227.5	2.10	1.9	0.992	225.7	1750.3	
I	12/24 2:20 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/24 2:20 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-9

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	680.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2929.8
Weight of Slurry (g)	1360.0
Specific Gravity of Solids	2.78
water content of mix	0.50
Dry unit wt. of mix (pcf)	72.2

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2200
Weight of Soil Water, $w_{w,soil}$ (g)	770
Total weight of soil used, W_t (g)	2955.4
Weight of Dry Cement, w_c (g)	683.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	683.0
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	31.05%
Cement Factor, α (kg/m3)	429.77
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	274.36
Volume Ratio, VR (%)	56.65
Total-Water-to-Cement Ratio, w_T:c	2.12

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	683.0
Volume Ratio, VR (%)	56.65
Total-Water-to-Cement Ratio, w_T:c	2.12
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	274.4

SAMPLE DATA: Batch T-9

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	12/31 5:35 PM	2.89	1/3 3:02 PM	2.041	3.935	35	100	363.9	0	315.9	2.16	1.9	0.994	314.1	1724.8	
B	12/31 5:35 PM	6.86	1/7 2:13 PM	2.041	3.581	35	100	330.0	0	419.3	1.77	1.8	0.980	411.0	1718.7	
C	12/31 5:35 PM	13.93	1/14 3:53 PM	2.041	3.962	35	100	367.6	0	520.3	1.65	1.9	0.995	517.8	1730.4	
D	12/31 5:35 PM	27.98	1/28 5:03 PM	2.042	3.928	35	100	365.3	0	620.1	1.26	1.9	0.994	616.3	1732.8	
E	12/31 5:35 PM	28.00	1/28 5:28 PM	2.043	3.916	35	100	364.3	0	623.2	1.45	1.9	0.993	619.1	1731.7	
F	12/31 5:35 PM	13.95	1/14 4:23 PM	2.041	3.806	35	100	352.4	0	521.5	1.71	1.9	0.989	515.9	1726.9	
G	12/31 5:35 PM	6.88	1/7 2:39 PM	2.040	3.856	35	100	357.6	0	418.1	1.58	1.9	0.991	414.4	1731.3	
H	12/31 5:35 PM	2.91	1/3 3:24 PM	2.041	3.918	35	100	362.1	0	319.8	2.04	1.9	0.994	317.8	1723.7	
I	12/31 5:35 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/31 5:35 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-10

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	870.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	2475.5
Weight of Slurry (g)	1740.0
Specific Gravity of Solids	2.82
water content of mix	0.56
Dry unit wt. of mix (pcf)	68.3

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1900
Weight of Soil Water, $w_{w,soil}$ (g)	673.8
Total weight of soil used, W_t (g)	2559.6
Weight of Dry Cement, w_c (g)	895.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	895.0
Soil Water Content, w (%)	35.46
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	47.11%
Cement Factor, α (kg/m3)	650.26
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350.15
Volume Ratio, VR (%)	85.71
Total-Water-to-Cement Ratio, w_T:c	1.74

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	895.0
Volume Ratio, VR (%)	85.71
Total-Water-to-Cement Ratio, w_T:c	1.74
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350.2

SAMPLE DATA: Batch T-10

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	1/7 2:45 PM	3.06	1/10 4:09 PM	2.043	3.828	35	100	348.0	0	421.6	1.58	1.9	0.990	417.3	1692.2	
B	1/7 2:45 PM	7.01	1/14 3:03 PM	2.040	3.921	35	100	357.1	0	554.8	1.40	1.9	0.994	551.3	1700.3	
C	1/7 2:45 PM	13.96	1/21 1:42 PM	2.042	3.922	35	100	357.3	0	651.7	1.38	1.9	0.994	647.6	1697.4	
D	1/7 2:45 PM	28.05	2/4 4:02 PM	2.043	3.619	35	100	330.6	0	791.6	1.60	1.8	0.982	777.1	1700.4	
E	1/7 2:45 PM	28.07	2/4 4:28 PM	2.042	3.856	35	100	352.4	0	781.8	1.37	1.9	0.991	774.8	1702.8	
F	1/7 2:45 PM	13.97	1/21 2:08 PM	2.039	3.555	35	100	322.5	0	683.4	1.57	1.7	0.979	669	1695.3	
G	1/7 2:45 PM	7.03	1/14 3:28 PM	2.043	3.839	35	100	348.7	0	535.2	1.23	1.9	0.990	530.0	1690.8	
H	1/7 2:45 PM	3.08	1/10 4:36 PM	2.039	3.918	35	100	355.5	0	430.9	1.77	1.9	0.994	428.2	1695.6	
I	1/7 2:45 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	1/7 2:45 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-11

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	300.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	3751.8
Weight of Slurry (g)	800.0
Specific Gravity of Solids	2.74
water content of mix	0.39
Dry unit wt. of mix (pcf)	82.8

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2800
Weight of Soil Water, $w_{w,soil}$ (g)	980
Total weight of soil used, W_t (g)	3758.7
Weight of Dry Cement, w_c (g)	504.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	303.0
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	18.03%
Cement Factor, α (kg/m3)	249.82
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	203.22
Volume Ratio, VR (%)	22.93
Total-Water-to-Cement Ratio, w_T:c	2.53

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	303.0
Volume Ratio, VR (%)	22.93
Total-Water-to-Cement Ratio, w_T:c	2.53
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	203.2

SAMPLE DATA: Batch T-11

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments		Adj. UCS (psi)	total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor			
A	12/22 2:00 PM	2.98	12/25 1:25 PM	2.040	3.957	45	100	382.7	0	341.5	1.64	1.9	0.995	339.9	1805.6	
B	12/22 2:00 PM	7.10	12/29 4:29 PM	2.041	3.956	45	100	382.6	0	486.3	1.23	1.9	0.995	483.9	1803.8	
C	12/22 2:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	12/22 2:00 PM	28.07	1/19 3:33 PM	2.040	3.868	45	100	375.2	0	1018.7	1.45	1.9	0.992	1010.3	1810.9	
E	12/22 2:00 PM	28.09	1/19 4:03 PM	2.043	3.602	45	100	348.6	0	1000.9	1.49	1.8	0.981	981.9	1801.5	
F	12/22 2:00 PM	14.02	1/5 2:27 PM	2.045	3.921	45	100	381.1	0	675.7	1.45	1.9	0.993	671.3	1805.7	
G	12/22 2:00 PM	7.12	12/29 4:55 PM	2.043	3.899	45	100	378.3	0	501.6	1.33	1.9	0.993	498.0	1806.0	
H	12/22 2:00 PM	3.00	12/25 1:52 PM	2.043	3.806	45	100	367.8	0	357.6	1.55	1.9	0.989	353.7	1798.8	
I	12/22 2:00 PM	14.04	1/5 2:57 PM	2.043	3.669	45	100	355.5	0	685.6	1.27	1.8	0.984	674.4	1803.6	
J	12/22 2:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-12

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	520.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	3119.1
Weight of Slurry (g)	1390.0
Specific Gravity of Solids	2.79
water content of mix	0.42
Dry unit wt. of mix (pcf)	80.4

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2400
Weight of Soil Water, $w_{w,soil}$ (g)	852
Total weight of soil used, W_t (g)	3235.5
Weight of Dry Cement, w_c (g)	902.4
Weight of Slurry Water, $w_{w,slurry}$ (g)	541.5
Soil Water Content, w (%)	35.50
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	37.60%
Cement Factor, α (kg/m3)	518.69
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	351.40
Volume Ratio, VR (%)	47.61
Total-Water-to-Cement Ratio, w_T:c	1.53

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	541.5
Volume Ratio, VR (%)	47.61
Total-Water-to-Cement Ratio, w_T:c	1.53
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	351.4

SAMPLE DATA: Batch T-12

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	12/22 2:55 PM	2.97	12/25 2:18 PM	2.047	3.866	45	100	372.3	0	752.8	1.71	1.9	0.991	746.1	1785.6	
B	12/22 2:55 PM	7.10	12/29 5:19 PM	2.045	3.895	45	100	376.3	0	998.0	1.49	1.9	0.992	990.4	1794.8	
C	12/22 2:55 PM	14.02	1/5 3:19 PM	2.044	3.905	45	100	378.1	0	1142.6	1.38	1.9	0.993	1134.4	1800.6	
D	12/22 2:55 PM	28.06	1/19 4:28 PM	2.047	3.850	45	100	372.6	0	1423.6	1.56	1.9	0.990	1410.0	1794.4	
E	12/22 2:55 PM	28.08	1/19 4:54 PM	2.045	3.844	45	100	372.3	0	1455.7	1.71	1.9	0.990	1441.7	1799.3	
F	12/22 2:55 PM	14.03	1/5 3:43 PM	2.045	3.836	45	100	370.1	0	1211.6	1.71	1.9	0.990	1199.6	1792.4	
G	12/22 2:55 PM	7.12	12/29 5:42 PM	2.044	3.914	45	100	378.6	0	986.3	1.60	1.9	0.993	979.6	1798.8	
H	12/22 2:55 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	12/22 2:55 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/22 2:55 PM	3.01	12/25 3:06 PM	2.043	3.847	45	100	370.9	0	781.2	1.39	1.9	0.991	773.9	1794.7	

Laboratory Mixing Data

Batch T-13

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	310.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3838.3
Weight of Slurry (g)	620.0
Specific Gravity of Solids	2.71
water content of mix	0.41
Dry unit wt. of mix (pcf)	79.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2900
Weight of Soil Water, $w_{w,soil}$ (g)	1015
Total weight of soil used, W_t (g)	3895.4
Weight of Dry Cement, w_c (g)	312.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	312.9
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	10.79%
Cement Factor, α (kg/m3)	149.38
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	124.81
Volume Ratio, VR (%)	19.69
Total-Water-to-Cement Ratio, w_T:c	4.23

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	312.9
Volume Ratio, VR (%)	19.69
Total-Water-to-Cement Ratio, w_T:c	4.23
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	124.8

SAMPLE DATA: **Batch T-13**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	12/23 3:50 PM	2.98	12/26 3:25 PM	2.043	3.862	45	100	366.0	0	199.5	2.12	1.9	0.991	197.8	1764.1	
B	12/23 3:50 PM	6.96	12/30 2:51 PM	2.039	3.884	45	100	369.6	0	298.7	2.37	1.9	0.992	296.4	1778.3	
C	12/23 3:50 PM	13.99	1/6 3:31 PM	2.041	3.917	45	100	372.8	0	418.5	1.68	1.9	0.994	415.8	1775.1	
D	12/23 3:50 PM	27.99	1/20 3:35 PM	2.040	3.826	45	100	363.8	0	587.0	1.89	1.9	0.990	581.1	1775.2	
E	12/23 3:50 PM	28.01	1/20 4:04 PM	2.042	3.846	45	100	365.2	0	588.8	1.83	1.9	0.991	583.3	1769.3	
F	12/23 3:50 PM	14.00	1/6 3:53 PM	2.040	3.915	45	100	372.6	0	421.7	1.93	1.9	0.994	419.0	1776.8	
G	12/23 3:50 PM	6.98	12/30 3:17 PM	2.043	3.911	45	100	371.1	0	294.9	2.60	1.9	0.993	292.9	1766.2	
H	12/23 3:50 PM	3.00	12/26 3:52 PM	2.041	3.785	45	100	359.2	0	202.5	2.94	1.9	0.988	200.1	1770.0	
I	12/23 3:50 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/23 3:50 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-14

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	870.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	2475.5
Weight of Slurry (g)	1740.0
Specific Gravity of Solids	2.82
water content of mix	0.56
Dry unit wt. of mix (pcf)	68.3

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1900
Weight of Soil Water, $w_{w,soil}$ (g)	665
Total weight of soil used, W_t (g)	2553.2
Weight of Dry Cement, w_c (g)	891.8
Weight of Slurry Water, $w_{w,slurry}$ (g)	891.8
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	46.94%
Cement Factor, α (kg/m3)	649.55
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	349.95
Volume Ratio, VR (%)	85.61
Total-Water-to-Cement Ratio, w_T:c	1.74

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	891.8
Volume Ratio, VR (%)	85.61
Total-Water-to-Cement Ratio, w_T:c	1.74
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350.0

SAMPLE DATA: **Batch T-14**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	12/23 6:00 PM	2.93	12/26 4:19 PM	2.044	3.785	45	100	343.8	0	440.9	1.61	1.9	0.988	435.7	1689.1	
B	12/23 6:00 PM	6.95	12/30 4:41 PM	2.042	3.924	45	100	358.0	0	580.0	1.47	1.9	0.994	576.3	1699.9	
C	12/23 6:00 PM	13.93	1/6 4:19 PM	2.043	3.792	45	100	344.1	0	710.8	1.67	1.9	0.988	702.6	1689.1	
D	12/23 6:00 PM	27.94	1/20 4:33 PM	2.047	3.930	45	100	359.0	0	839.2	1.63	1.9	0.994	833.8	1693.7	
E	12/23 6:00 PM	27.96	1/20 4:59 PM	2.044	3.864	45	100	352.2	0	844.5	1.67	1.9	0.991	837.1	1695.0	
F	12/23 6:00 PM	13.95	1/6 4:44 PM	2.045	3.884	45	100	353.5	0	713.8	1.58	1.9	0.992	708.0	1690.9	
G	12/23 6:00 PM	6.96	12/30 5:03 PM	2.042	3.919	45	100	356.0	0	589.1	1.54	1.9	0.994	585.3	1692.6	
H	12/23 6:00 PM	2.95	12/26 4:53 PM	2.044	3.682	45	100	331.9	0	448.6	1.80	1.8	0.984	441.5	1676.3	
I	12/23 6:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/23 6:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-15

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	440.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3608.4
Weight of Slurry (g)	750.0
Specific Gravity of Solids	2.71
water content of mix	0.46
Dry unit wt. of mix (pcf)	75.4

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2700
Weight of Soil Water, $w_{w,soil}$ (g)	945
Total weight of soil used, W_t (g)	3624.8
Weight of Dry Cement, w_c (g)	310.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	435.3
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	11.52%
Cement Factor, α (kg/m3)	159.51
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.20
Volume Ratio, VR (%)	27.41
Total-Water-to-Cement Ratio, w_T:c	4.42

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	435.3
Volume Ratio, VR (%)	27.41
Total-Water-to-Cement Ratio, w_T:c	4.42
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.2

SAMPLE DATA: Batch T-15

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	12/26 5:50 PM	3.01	12/29 6:09 PM	2.045	3.821	45	100	355.0	0	154.5	2.21	1.9	0.989	152.9	1726.0	
B	12/26 5:50 PM	6.97	1/2 5:10 PM	2.042	3.781	45	100	350.4	0	225.3	2.20	1.9	0.988	222.6	1726.7	
C	12/26 5:50 PM	13.98	1/9 5:21 PM	2.042	3.866	45	100	360.4	0	323.0	1.73	1.9	0.991	320.2	1737.0	
D	12/26 5:50 PM	28.00	1/23 5:47 PM	2.043	3.724	45	100	346.3	0	457.3	1.60	1.8	0.986	450.8	1731.0	
E	12/26 5:50 PM	28.01	1/23 6:09 PM	2.038	3.880	45	100	361.7	0	460.5	1.67	1.9	0.992	456.9	1743.8	
F	12/26 5:50 PM	14.00	1/9 5:52 PM	2.043	3.884	45	100	361.7	0	345.4	2.16	1.9	0.992	342.7	1733.5	
G	12/26 5:50 PM	6.99	1/2 5:37 PM	2.042	3.878	45	100	361.3	0	233.5	1.86	1.9	0.992	231.6	1735.9	
H	12/26 5:50 PM	3.04	12/29 6:43 PM	2.043	3.741	45	100	346.3	0	163.2	2.76	1.8	0.986	161.0	1723.1	
I	12/26 5:50 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/26 5:50 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-16

Change only black text, red is calculated	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	960.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2424.1
Weight of Slurry (g)	1640.0
Specific Gravity of Solids	2.80
water content of mix	0.64
Dry unit wt. of mix (pcf)	62.6

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1800
Weight of Soil Water, $w_{w,soil}$ (g)	630
Total weight of soil used, W_t (g)	2415.8
Weight of Dry Cement, w_c (g)	680.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	953.3
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	37.83%
Cement Factor, α (kg/m3)	524.16
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.79
Volume Ratio, VR (%)	90.06
Total-Water-to-Cement Ratio, w_T:c	2.32

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	953.3
Volume Ratio, VR (%)	90.06
Total-Water-to-Cement Ratio, w_T:c	2.32
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.8

SAMPLE DATA: **Batch T-16**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	12/30 6:30 PM	2.98	1/2 6:03 PM	2.042	3.612	45	100	317.3	0	258.9	1.98	1.8	0.982	254.1	1636.8	
B	12/30 6:30 PM	6.95	1/6 5:14 PM	2.045	3.791	45	100	335.2	0	330.2	1.53	1.9	0.988	326.3	1642.7	
C	12/30 6:30 PM	13.95	1/13 5:13 PM	2.042	3.640	45	100	322.1	0	430.1	1.72	1.8	0.983	422.6	1648.8	
D	12/30 6:30 PM	27.98	1/27 5:56 PM	2.045	3.731	45	100	331.0	0	527.1	1.52	1.8	0.986	519.7	1648.2	
E	12/30 6:30 PM	27.99	1/27 6:22 PM	2.042	3.671	45	100	325.4	0	540.3	1.53	1.8	0.984	531.5	1651.6	
F	12/30 6:30 PM	13.96	1/13 5:38 PM	2.044	3.838	45	100	339.6	0	421.1	1.48	1.9	0.990	416.9	1645.4	
G	12/30 6:30 PM	6.97	1/6 5:41 PM	2.042	3.678	45	100	325.0	0	349.4	1.78	1.8	0.984	343.9	1646.4	
H	12/30 6:30 PM	3.00	1/2 6:29 PM	2.043	3.760	45	100	331.4	0	253.9	1.93	1.8	0.987	250.6	1640.6	
I	12/30 6:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	12/30 6:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-17

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	300.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	3751.8
Weight of Slurry (g)	800.0
Specific Gravity of Solids	2.74
water content of mix	0.39
Dry unit wt. of mix (pcf)	82.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2800
Weight of Soil Water, $w_{w,soil}$ (g)	980
Total weight of soil used, W_t (g)	3751.5
Weight of Dry Cement, w_c (g)	513.3
Weight of Slurry Water, $w_{w,slurry}$ (g)	308.0
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	18.33%
Cement Factor, α (kg/m3)	254.45
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	206.28
Volume Ratio, VR (%)	23.36
Total-Water-to-Cement Ratio, w_T:c	2.49

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	308.0
Volume Ratio, VR (%)	23.36
Total-Water-to-Cement Ratio, w_T:c	2.49
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	206.3

SAMPLE DATA: Batch T-17

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	10/29 8:00 PM	2.91	11/1 5:55 PM	2.047	3.756	55	100	360.6	0	444.4	1.54	1.8	0.987	438.6	1780.1	
B	10/29 8:00 PM	7.14	11/5 11:17 PM	2.043	3.808	55	100	367.0	0	700.4	1.41	1.9	0.989	692.7	1794.0	
C	10/29 8:00 PM	13.89	11/12 5:14 PM	2.046	3.795	55	100	366.9	0	1016.5	1.41	1.9	0.988	1004.7	1794.3	
D	10/29 8:00 PM	27.12	11/25 10:47 PM	2.045	3.857	55	100	373.3	0	1254.7	1.33	1.9	0.991	1243.3	1798.1	
E	10/29 8:00 PM	27.14	11/25 11:18 PM	2.049	3.796	55	100	367.6	0	1319.9	1.64	1.9	0.988	1304.3	1792.0	
F	10/29 8:00 PM	13.91	11/12 5:43 PM	2.047	3.892	55	100	377.7	0	891.2	1.14	1.9	0.992	884.2	1799.4	
G	10/29 8:00 PM	7.16	11/5 11:53 PM	2.047	3.863	55	100	373.5	0	730.5	1.48	1.9	0.991	723.9	1792.7	
H	10/29 8:00 PM	2.93	11/1 6:25 PM	2.048	3.862	55	100	370.8	0	462.8	1.74	1.9	0.991	458.6	1778.5	
I	10/29 8:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	10/29 8:00 PM	13.93	11/12 6:15 PM	2.048	3.883	55	100	375.6	0	993.4	1.33	1.9	0.992	985.2	1791.8	

Laboratory Mixing Data
Batch T-18

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	520.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	3119.1
Weight of Slurry (g)	1390.0
Specific Gravity of Solids	2.79
water content of mix	0.42
Dry unit wt. of mix (pcf)	80.4

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2399.6
Weight of Soil Water, $w_{w,soil}$ (g)	842.5
Total weight of soil used, W_t (g)	3229.1
Weight of Dry Cement, w_c (g)	895.2
Weight of Slurry Water, $w_{w,slurry}$ (g)	537.1
Soil Water Content, w (%)	35.11
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	37.31%
Cement Factor, α (kg/m3)	515.54
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	349.95
Volume Ratio, VR (%)	47.32
Total-Water-to-Cement Ratio, w_T:c	1.54

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	537.1
Volume Ratio, VR (%)	47.32
Total-Water-to-Cement Ratio, w_T:c	1.54
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	349.9

SAMPLE DATA: Batch T-18

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	3/18 3:30 PM	3.02	3/21 4:02 PM	2.043	3.876	55	100	372.0	0	854.8	1.79	1.9	0.992	847.8	1786.5	
B	3/18 3:30 PM	7.02	3/25 4:04 PM	2.046	3.886	55	100	375.2	0	1139.4	1.47	1.9	0.992	1130.2	1792.0	
C	3/18 3:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	3/18 3:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	3/18 3:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	3/18 3:30 PM	14.72	4/2 8:47 AM	2.047	3.926	55	100	380.5	0	1437.8	1.98	1.9	0.993	1428.4	1797.0	
G	3/18 3:30 PM	7.04	3/25 4:30 PM	2.045	3.974	55	100	382.8	0	1205.8	1.55	1.9	0.995	1200.3	1789.5	
H	3/18 3:30 PM	3.06	3/21 4:51 PM	2.044	3.836	55	100	366.8	0	877.0	1.63	1.9	0.990	868.3	1778.2	
I	3/18 3:30 PM	14.74	4/2 9:08 AM	2.047	3.927	55	100	381.5	0	1484.6	2.04	1.9	0.993	1474.9	1801.3	
J	3/18 3:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-19

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	310.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3838.3
Weight of Slurry (g)	620.0
Specific Gravity of Solids	2.71
water content of mix	0.41
Dry unit wt. of mix (pcf)	79.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2899.9
Weight of Soil Water, $w_{w,soil}$ (g)	1022.4
Total weight of soil used, W_t (g)	3899.7
Weight of Dry Cement, w_c (g)	314.8
Weight of Slurry Water, $w_{w,slurry}$ (g)	314.8
Soil Water Content, w (%)	35.26
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	10.85%
Cement Factor, α (kg/m3)	150.10
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.31
Volume Ratio, VR (%)	19.78
Total-Water-to-Cement Ratio, w_T:c	4.21

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	314.8
Volume Ratio, VR (%)	19.78
Total-Water-to-Cement Ratio, w_T:c	4.21
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.3

SAMPLE DATA: Batch T-19

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	11/3 10:10 PM	3.09	11/7 12:17 AM	2.042	3.701	55	100	348.8	0	275.3	2.09	1.8	0.985	271.2	1756.0	
B	11/3 10:10 PM	6.82	11/10 5:47 PM	2.046	3.757	55	100	355.0	0	407.4	1.53	1.8	0.987	402.0	1753.7	
C	11/3 10:10 PM	14.01	11/17 10:26 PM	2.039	3.909	55	100	371.3	0	597.3	1.69	1.9	0.993	593.3	1775.0	
D	11/3 10:10 PM	28.00	12/1 10:05 PM	2.046	3.819	55	100	363.5	0	736.5	1.65	1.9	0.989	728.6	1766.5	
E	11/3 10:10 PM	28.01	12/1 10:29 PM	2.046	3.896	55	100	370.4	0	750.5	1.68	1.9	0.992	744.8	1764.5	
F	11/3 10:10 PM	14.03	11/17 10:53 PM	2.043	3.696	55	100	351.0	0	610.2	1.61	1.8	0.985	600.9	1767.7	
G	11/3 10:10 PM	6.83	11/10 6:12 PM	2.044	3.930	55	100	373.2	0	431.7	1.46	1.9	0.994	429.0	1765.9	
H	11/3 10:10 PM	3.10	11/7 12:40 AM	2.040	3.973	55	100	376.1	0	290.2	2.30	1.9	0.996	289.0	1767.3	
I	11/3 10:10 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	11/3 10:10 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-20

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	500.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	3384.0
Weight of Slurry (g)	1000.0
Specific Gravity of Solids	2.74
water content of mix	0.46
Dry unit wt. of mix (pcf)	75.9

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2600
Weight of Soil Water, $w_{w,soil}$ (g)	910
Total weight of soil used, W_t (g)	3489
Weight of Dry Cement, w_c (g)	512.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	512.9
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	19.73%
Cement Factor, α (kg/m3)	273.35
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.95
Volume Ratio, VR (%)	36.03
Total-Water-to-Cement Ratio, w_T:c	2.76

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	512.9
Volume Ratio, VR (%)	36.03
Total-Water-to-Cement Ratio, w_T:c	2.76
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	201.0

SAMPLE DATA: Batch T-20

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	11/3 11:30 PM	3.07	11/7 1:04 AM	2.045	3.936	55	100	367.8	0	317.9	2.00	1.9	0.994	316.0	1736.0	
B	11/3 11:30 PM	6.80	11/10 6:42 PM	2.045	3.939	55	100	368.0	0	470.2	1.56	1.9	0.994	467.4	1735.6	
C	11/3 11:30 PM	13.99	11/17 11:22 PM	2.045	3.844	55	100	360.0	0	808.0	1.75	1.9	0.990	800.2	1739.9	
D	11/3 11:30 PM	27.98	12/1 10:57 PM	2.047	3.875	55	100	364.3	0	1082.2	1.75	1.9	0.991	1072.9	1743.1	
E	11/3 11:30 PM	27.99	12/1 11:19 PM	2.046	3.920	55	100	368.8	0	1031.0	1.63	1.9	0.993	1024.0	1746.1	
F	11/3 11:30 PM	14.02	11/17 11:56 PM	2.047	3.744	55	100	350.2	0	809.0	1.69	1.8	0.986	797.9	1734.3	
G	11/3 11:30 PM	6.82	11/10 7:04 PM	2.048	3.872	55	100	362.4	0	493.6	1.88	1.9	0.991	489.3	1733.7	
H	11/3 11:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	11/3 11:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	11/3 11:30 PM	3.09	11/7 1:36 AM	2.048	3.949	55	100	369.7	0	342.8	2.10	1.9	0.994	340.8	1734.1	

Laboratory Mixing Data
Batch T-21

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	680.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2929.8
Weight of Slurry (g)	1360.0
Specific Gravity of Solids	2.78
water content of mix	0.50
Dry unit wt. of mix (pcf)	72.1

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2199.8
Weight of Soil Water, $w_{w,soil}$ (g)	770
Total weight of soil used, W_t (g)	2955.1
Weight of Dry Cement, w_c (g)	684.1
Weight of Slurry Water, $w_{w,slurry}$ (g)	684.1
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	31.10%
Cement Factor, α (kg/m3)	430.48
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	274.65
Volume Ratio, VR (%)	56.74
Total-Water-to-Cement Ratio, w_T:c	2.12

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	684.1
Volume Ratio, VR (%)	56.74
Total-Water-to-Cement Ratio, w_T:c	2.12
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	274.6

SAMPLE DATA: Batch T-21

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	11/9 8:05 PM	3.07	11/12 9:49 PM	2.047	3.908	55	100	359.8	0	374.0	1.80	1.9	0.993	371.3	1707.1	
B	11/9 8:05 PM	7.10	11/16 10:35 PM	2.048	3.922	55	100	360.5	0	562.2	1.88	1.9	0.993	558.4	1702.6	
C	11/9 8:05 PM	14.01	11/23 8:24 PM	2.046	3.893	55	100	360.6	0	725.7	1.53	1.9	0.992	720.1	1719.1	
D	11/9 8:05 PM	27.96	12/7 7:01 PM	2.049	3.903	55	100	361.2	0	1156.3	1.58	1.9	0.992	1147.5	1712.6	
E	11/9 8:05 PM	27.97	12/7 7:22 PM	2.048	3.907	55	100	362.2	0	1166.4	1.58	1.9	0.993	1157.8	1717.2	
F	11/9 8:05 PM	14.03	11/23 8:47 PM	2.047	3.913	55	100	361.2	0	752.3	1.72	1.9	0.993	746.9	1711.5	
G	11/9 8:05 PM	7.12	11/16 11:03 PM	2.048	3.816	55	100	325.1	0	571.5	1.66	1.9	0.989	565.2	1578.1	
H	11/9 8:05 PM	3.09	11/12 10:18 PM	2.048	3.852	55	100	352.9	0	401.1	2.27	1.9	0.990	397.2	1697.0	
I	11/9 8:05 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	11/9 8:05 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data

Batch T-22

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	870.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	2475.5
Weight of Slurry (g)	1740.0
Specific Gravity of Solids	2.82
water content of mix	0.56
Dry unit wt. of mix (pcf)	68.3

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1899.9
Weight of Soil Water, $w_{w,soil}$ (g)	665
Total weight of soil used, W_t (g)	2552.7
Weight of Dry Cement, w_c (g)	896.2
Weight of Slurry Water, $w_{w,slurry}$ (g)	896.2
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	47.17%
Cement Factor, α (kg/m3)	652.89
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350.92
Volume Ratio, VR (%)	86.05
Total-Water-to-Cement Ratio, w_T:c	1.74

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	896.2
Volume Ratio, VR (%)	86.05
Total-Water-to-Cement Ratio, w_T:c	1.74
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350.9

SAMPLE DATA: Batch T-22

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	11/10 8:00 PM	3.04	11/13 8:57 PM	2.048	3.738	55	100	337.6	0	471.7	1.65	1.8	0.986	465.1	1673.0	
B	11/10 8:00 PM	7.07	11/17 9:39 PM	2.047	3.725	55	100	334.0	0	655.2	1.73	1.8	0.986	645.7	1662.5	
C	11/10 8:00 PM	13.85	11/24 4:29 PM	2.050	3.836	55	100	345.2	0	783.9	1.33	1.9	0.990	775.8	1663.7	
D	11/10 8:00 PM	27.87	12/8 4:51 PM	2.047	3.711	55	100	336.4	0	990.3	1.47	1.8	0.985	975.5	1680.8	
E	11/10 8:00 PM	27.89	12/8 5:15 PM	2.047	3.733	55	100	339.9	0	1051.4	1.79	1.8	0.986	1036.6	1688.3	
F	11/10 8:00 PM	13.87	11/24 4:56 PM	2.047	3.877	55	100	352.1	0	819.2	1.49	1.9	0.992	812.2	1683.9	
G	11/10 8:00 PM	7.08	11/17 10:01 PM	2.047	3.968	55	100	359.3	0	632.3	1.42	1.9	0.995	629.2	1678.9	
H	11/10 8:00 PM	3.06	11/13 9:22 PM	2.049	3.873	55	100	350.4	0	468.4	1.52	1.9	0.991	464.3	1674.2	
I	11/10 8:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	11/10 8:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-23

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	440.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3608.4
Weight of Slurry (g)	750.0
Specific Gravity of Solids	2.71
water content of mix	0.47
Dry unit wt. of mix (pcf)	74.8

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2699.4
Weight of Soil Water, $w_{w,soil}$ (g)	945
Total weight of soil used, W_t (g)	3621.1
Weight of Dry Cement, w_c (g)	334.3
Weight of Slurry Water, $w_{w,slurry}$ (g)	468.0
Soil Water Content, w (%)	35.01
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	12.38%
Cement Factor, α (kg/m3)	171.68
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	132.57
Volume Ratio, VR (%)	29.50
Total-Water-to-Cement Ratio, w_T:c	4.21

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	468.0
Volume Ratio, VR (%)	29.50
Total-Water-to-Cement Ratio, w_T:c	4.21
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	132.6

SAMPLE DATA: Batch T-23

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	11/17 12:00 AM	2.90	11/19 9:28 PM	2.046	3.784	55	100	349.6	0	199.6	2.34	1.8	0.988	197.2	1714.7	
B	11/17 12:00 AM	6.88	11/23 9:13 PM	2.049	3.840	55	100	355.4	0	314.5	1.70	1.9	0.990	311.3	1712.7	
C	11/17 12:00 AM	13.93	11/30 10:15 PM	2.048	3.704	55	100	352.3	0	494.0	2.10	1.8	0.985	486.4	1761.8	
D	11/17 12:00 AM	27.97	12/14 11:09 PM	2.044	3.711	55	100	344.8	0	653.3	1.95	1.8	0.985	643.7	1727.8	
E	11/17 12:00 AM	27.98	12/14 11:37 PM	2.045	3.818	55	100	353.8	0	615.9	1.68	1.9	0.989	609.3	1721.5	
F	11/17 12:00 AM	13.95	11/30 10:49 PM	2.042	3.849	55	100	355.8	0	493.0	1.78	1.9	0.991	488.4	1722.4	
G	11/17 12:00 AM	6.90	11/23 9:37 PM	2.047	3.887	55	100	359.7	0	347.6	2.20	1.9	0.992	344.8	1715.8	
H	11/17 12:00 AM	2.91	11/19 9:56 PM	2.046	3.808	55	100	349.8	0	220.2	3.23	1.9	0.989	217.8	1704.9	
I	11/17 12:00 AM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	11/17 12:00 AM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch T-24

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	960.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2424.1
Weight of Slurry (g)	1640.0
Specific Gravity of Solids	2.80
water content of mix	0.64
Dry unit wt. of mix (pcf)	62.5

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1799.6
Weight of Soil Water, $w_{w,soil}$ (g)	635.6
Total weight of soil used, W_t (g)	2424.2
Weight of Dry Cement, w_c (g)	685.5
Weight of Slurry Water, $w_{w,slurry}$ (g)	959.6
Soil Water Content, w (%)	35.32
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	38.09%
Cement Factor, α (kg/m3)	525.83
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	276.25
Volume Ratio, VR (%)	90.35
Total-Water-to-Cement Ratio, w_T:c	2.32

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	959.6
Volume Ratio, VR (%)	90.35
Total-Water-to-Cement Ratio, w_T:c	2.32
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	276.2

SAMPLE DATA: Batch T-24

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	3/18 4:50 PM	3.02	3/21 5:14 PM	2.047	3.883	55	100	340.0	0	248.3	2.25	1.9	0.992	246.3	1623.5	
B	3/18 4:50 PM	7.00	3/25 4:53 PM	2.045	3.907	55	100	327.8	0	370.8	2.31	1.9	0.993	368.1	1558.7	
C	3/18 4:50 PM	13.94	4/1 3:27 PM	2.048	3.868	55	100	338.4	0	491.9	1.97	1.9	0.991	487.5	1620.6	
D	3/18 4:50 PM	27.97	4/15 4:13 PM	2.050	3.841	55	100	337.7	0	759.4	1.62	1.9	0.990	751.7	1625.4	
E	3/18 4:50 PM	27.99	4/15 4:37 PM	2.045	3.865	55	100	340.2	0	776.7	1.85	1.9	0.991	769.8	1635.2	
F	3/18 4:50 PM	13.96	4/1 3:51 PM	2.048	3.891	55	100	341.8	0	505.1	2.04	1.9	0.992	501.0	1627.2	
G	3/18 4:50 PM	7.02	3/25 5:14 PM	2.047	3.938	55	100	345.0	0	375.1	2.47	1.9	0.994	372.8	1624.4	
H	3/18 4:50 PM	3.03	3/21 5:37 PM	2.044	3.836	55	100	332.8	0	260.6	2.50	1.9	0.990	258.1	1613.3	
I	3/18 4:50 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	3/18 4:50 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch D-1

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	310.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3838.3
Weight of Slurry (g)	620.0
Specific Gravity of Solids	2.71
water content of mix	0.41
Dry unit wt. of mix (pcf)	79.7

Actual Mix Values for batch:

As Mixed:	
Weight of Soil Solids, w_s (g)	2900
Weight of Soil Water, $w_{w,soil}$ (g)	1015
Total weight of soil used, W_t (g)	3906
Weight of Dry Cement, w_c (g)	314.1
Weight of Slurry Water, $w_{w,slurry}$ (g)	314.1
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	10.83%
Cement Factor, α (kg/m3)	149.52
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	124.90
Volume Ratio, VR (%)	19.71
Total-Water-to-Cement Ratio, w_T:c	4.22
As Cured:	
Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	314.1
Volume Ratio, VR (%)	19.71
Total-Water-to-Cement Ratio, w_T:c	4.22
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	124.9

SAMPLE DATA: Batch D-1

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	2/14 3:40 PM	28.05	3/14 4:52 PM	2.039	3.804	35	100	363.4	0	265.2	1.69	1.9	0.989	262.3	1785.2	
B1	2/14 3:40 PM	28.07	3/14 5:23 PM	2.041	3.804	35	100	363.1	0	340.2	1.67	1.9	0.989	336.5	1780.3	
B2	2/14 3:40 PM	28.03	3/14 4:25 PM	2.039	3.907	35	100	371.0	0	415.2	1.84	1.9	0.993	412.4	1774.5	
C1	2/14 3:40 PM	28.09	3/14 5:50 PM	2.046	3.793	35	100	363.3	0	459.7	1.34	1.9	0.988	454.4	1777.7	
C2	2/14 3:40 PM	28.02	3/14 4:04 PM	2.039	3.921	35	100	373.4	0	531.8	1.45	1.9	0.994	528.5	1779.6	
D1	2/14 3:40 PM	28.11	3/14 6:14 PM	2.043	3.942	35	100	377.6	0	539.9	1.31	1.9	0.994	536.8	1783.0	
D2	2/14 3:40 PM	28.00	3/14 3:44 PM	2.039	3.940	35	100	375.2	0	635.0	1.66	1.9	0.995	631.6	1779.6	
E	2/14 3:40 PM	28.12	3/14 6:36 PM	2.044	3.951	35	100	376.0	0	611.0	1.54	1.9	0.995	607.8	1769.7	
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Laboratory Mixing Data
Batch D-2

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	310.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3838.3
Weight of Slurry (g)	620.0
Specific Gravity of Solids	2.71
water content of mix	0.41
Dry unit wt. of mix (pcf)	79.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2900
Weight of Soil Water, $w_{w,soil}$ (g)	1015
Total weight of soil used, W_t (g)	3917.6
Weight of Dry Cement, w_c (g)	314.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	314.9
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	10.86%
Cement Factor, α (kg/m3)	149.48
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	124.88
Volume Ratio, VR (%)	19.70
Total-Water-to-Cement Ratio, w_T:c	4.23

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	314.9
Volume Ratio, VR (%)	19.70
Total-Water-to-Cement Ratio, w_T:c	4.23
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	124.9

SAMPLE DATA: **Batch D-2**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	2/15 12:00 PM	27.97	3/15 11:20 AM	2.036	3.886	35	100	370.1	0	256.2	2.11	1.9	0.993	254.3	1785.0	
B1	2/15 12:00 PM	27.99	3/15 11:48 AM	2.043	3.869	35	100	369.0	0	333.1	1.67	1.9	0.992	330.3	1775.3	
B2	2/15 12:00 PM	27.95	3/15 10:54 AM	2.038	3.944	35	100	374.5	0	401.1	2.07	1.9	0.995	399.0	1776.2	
C1	2/15 12:00 PM	28.01	3/15 12:14 PM	2.044	3.917	35	100	374.0	0	437.4	1.27	1.9	0.993	434.5	1775.6	
C2	2/15 12:00 PM	27.94	3/15 10:35 AM	2.036	3.920	35	100	372.3	0	534.3	1.94	1.9	0.994	531.1	1780.1	
D1	2/15 12:00 PM	28.03	3/15 12:41 PM	2.044	3.819	35	100	365.3	0	544.3	1.43	1.9	0.989	538.5	1778.8	
D2	2/15 12:00 PM	27.93	3/15 10:15 AM	2.037	3.905	35	100	370.0	0	623.1	1.63	1.9	0.993	618.9	1774.1	
E	2/15 12:00 PM	28.04	3/15 1:02 PM	2.042	3.930	35	100	373.4	0	607.9	1.53	1.9	0.994	604.2	1770.3	
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Laboratory Mixing Data
Batch D-3

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	680.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2929.8
Weight of Slurry (g)	1360.0
Specific Gravity of Solids	2.78
water content of mix	0.51
Dry unit wt. of mix (pcf)	72.1

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2200
Weight of Soil Water, $w_{w,soil}$ (g)	770
Total weight of soil used, W_t (g)	2956.5
Weight of Dry Cement, w_c (g)	687.4
Weight of Slurry Water, $w_{w,slurry}$ (g)	687.4
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	31.24%
Cement Factor, α (kg/m3)	432.35
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.41
Volume Ratio, VR (%)	56.98
Total-Water-to-Cement Ratio, w_T:c	2.12

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	687.4
Volume Ratio, VR (%)	56.98
Total-Water-to-Cement Ratio, w_T:c	2.12
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.4

SAMPLE DATA: **Batch D-3**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	2/16 1:30 PM	28.05	3/16 2:42 PM	2.041	3.928	35	100	366.6	0	592.3	1.48	1.9	0.994	588.8	1740.7	
B1	2/16 1:30 PM	28.07	3/16 3:07 PM	2.046	3.920	35	100	365.1	0	597.8	1.70	1.9	0.993	593.8	1728.6	
B2	2/16 1:30 PM	28.04	3/16 2:20 PM	2.041	3.845	35	100	354.8	0	702.1	2.03	1.9	0.991	695.6	1721.0	
C1	2/16 1:30 PM	28.08	3/16 3:30 PM	2.043	3.925	35	100	367.0	0	690.0	1.66	1.9	0.994	685.6	1740.5	
C2	2/16 1:30 PM	28.02	3/16 1:57 PM	2.041	3.954	35	100	367.5	0	789.5	1.84	1.9	0.995	785.5	1733.5	
D1	2/16 1:30 PM	28.10	3/16 3:53 PM	2.042	3.953	35	100	368.8	0	737.7	1.45	1.9	0.995	733.9	1738.3	
D2	2/16 1:30 PM	28.01	3/16 1:39 PM	2.042	3.938	35	100	366.1	0	848.6	1.61	1.9	0.994	843.7	1732.2	
E	2/16 1:30 PM	28.12	3/16 4:17 PM	2.044	3.929	35	100	365.3	0	847.1	2.10	1.9	0.994	841.8	1729.0	
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Laboratory Mixing Data
Batch D-4

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.66
Soil Water Content, w (%)	0.35
Unit Weight, γ_{soil} (kg/m^3)	1859.7

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	680.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2929.8
Weight of Slurry (g)	1360.0
Specific Gravity of Solids	2.78
water content of mix	0.51
Dry unit wt. of mix (pcf)	72.1

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2200
Weight of Soil Water, $w_{w,soil}$ (g)	770
Total weight of soil used, W_t (g)	2952.8
Weight of Dry Cement, w_c (g)	686.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	686.9
Soil Water Content, w (%)	35.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	31.22%
Cement Factor, α (kg/m3)	432.57
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.50
Volume Ratio, VR (%)	57.01
Total-Water-to-Cement Ratio, w_T:c	2.11

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	686.9
Volume Ratio, VR (%)	57.01
Total-Water-to-Cement Ratio, w_T:c	2.11
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.5

SAMPLE DATA: Batch D-4

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	2/17 4:30 PM	28.03	3/17 5:11 PM	2.040	3.956	35	100	369.7	0	569.5	1.45	1.9	0.995	566.7	1744.7	
B1	2/17 4:30 PM	28.04	3/17 5:33 PM	2.044	3.931	35	100	367.4	0	582.4	1.44	1.9	0.994	578.8	1738.0	
B2	2/17 4:30 PM	28.01	3/17 4:50 PM	2.040	3.883	35	100	359.8	0	695.1	2.22	1.9	0.992	689.7	1729.9	
C1	2/17 4:30 PM	28.06	3/17 5:56 PM	2.041	3.923	35	100	366.4	0	666.9	1.49	1.9	0.994	662.7	1741.9	
C2	2/17 4:30 PM	28.00	3/17 4:29 PM	2.039	3.910	35	100	362.8	0	794.0	1.83	1.9	0.993	788.7	1734.0	
D1	2/17 4:30 PM	28.08	3/17 6:18 PM	2.046	3.920	35	100	367.2	0	739.6	1.33	1.9	0.993	734.6	1738.6	
D2	2/17 4:30 PM	27.99	3/17 4:11 PM	2.042	3.936	35	100	365.6	0	877.6	1.74	1.9	0.994	872.6	1730.7	
E	2/17 4:30 PM	28.09	3/17 6:39 PM	2.044	3.926	35	100	365.3	0	810.3	1.84	1.9	0.994	805.2	1730.3	
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Laboratory Mixing Data

Batch S-1

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	300.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	3235.7
Weight of Slurry (g)	800.0
Specific Gravity of Solids	2.74
water content of mix	0.64
Dry unit wt. of mix (pcf)	62.1

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1999.5
Weight of Soil Water, $w_{w,soil}$ (g)	1300
Total weight of soil used, W_t (g)	3266.5
Weight of Dry Cement, w_c (g)	500.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	300.0
Soil Water Content, w (%)	65.02
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	25.01%
Cement Factor, α (kg/m3)	245.50
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	200.35
Volume Ratio, VR (%)	22.53
Total-Water-to-Cement Ratio, w_T:c	3.17

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	300.0
Volume Ratio, VR (%)	22.53
Total-Water-to-Cement Ratio, w_T:c	3.17
Cement Factor In-Place, $\alpha_{in-place}$ (kg/m^3)	200.4

SAMPLE DATA: **Batch S-1**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	9/16 6:45 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	9/16 6:45 PM	6.95	9/23 5:26 PM	2.033	3.924	21.1	100	339.6	0	172.6	1.38	1.9	0.994	171.6	1626.8	
C	9/16 6:45 PM	13.95	9/30 5:27 PM	2.032	3.869	21.1	100	334.2	0	210.2	1.57	1.9	0.992	208.6	1625.3	
D	9/16 6:45 PM	27.96	10/14 5:42 PM	2.033	3.569	21.1	100	308.6	0	258.9	1.29	1.8	0.980	253.8	1625.4	
E	9/16 6:45 PM	27.98	10/14 6:13 PM	2.031	3.634	21.1	100	314.5	0	268.9	1.24	1.8	0.983	264.4	1630.0	
F	9/16 6:45 PM	13.89	9/30 4:09 PM	2.031	3.881	21.1	100	338.4	0	238.2	0.95	1.9	0.993	236.5	1642.3	
G	9/16 6:45 PM	6.97	9/23 6:03 PM	2.034	3.866	21.1	100	333.2	0	180.5	1.89	1.9	0.992	179.1	1618.5	
H	9/16 6:45 PM	2.92	9/19 4:43 PM	2.036	3.670	21.1	100	317.4	0	111.6	1.47	1.8	0.984	109.8	1620.9	
I	9/16 6:45 PM	2.94	9/19 5:17 PM	2.034	3.787	21.1	100	339.4	0	115.7	1.39	1.9	0.989	114.5	1683.0	
J	9/16 6:45 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch S-2

Change only black text, red is calculated	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	410.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2962.9
Weight of Slurry (g)	1090.0
Specific Gravity of Solids	2.78
water content of mix	0.64
Dry unit wt. of mix (pcf)	62.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1800
Weight of Soil Water, $w_{w,soil}$ (g)	1170
Total weight of soil used, W_t (g)	2951
Weight of Dry Cement, w_c (g)	684.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	410.4
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	38.00%
Cement Factor, α (kg/m3)	371.74
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	277.17
Volume Ratio, VR (%)	34.12
Total-Water-to-Cement Ratio, w_T:c	2.30

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	410.4
Volume Ratio, VR (%)	34.12
Total-Water-to-Cement Ratio, w_T:c	2.30
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	277.2

SAMPLE DATA: Batch S-2

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	2/11 6:20 PM	3.07	2/14 7:55 PM	2.028	3.864	21.1	100	338.2	0	183.3	1.40	1.9	0.992	181.9	1653.4	
B	2/11 6:20 PM	6.98	2/18 5:55 PM	2.032	3.699	21.1	100	323.4	0	278.9	1.53	1.8	0.986	274.9	1645.1	
C	2/11 6:20 PM	14.18	2/25 10:36 PM	2.032	3.868	21.1	100	338.6	0	360.9	1.62	1.9	0.992	358.1	1647.2	
D	2/11 6:20 PM	27.99	3/11 6:11 PM	2.031	3.736	21.1	100	326.4	0	441.6	1.49	1.8	0.987	435.9	1645.5	
E	2/11 6:20 PM	28.01	3/11 6:33 PM	2.031	3.803	21.1	100	332.8	0	417.4	1.16	1.9	0.990	413.1	1648.2	
F	2/11 6:20 PM	14.19	2/25 10:59 PM	2.027	3.751	21.1	100	327.7	0	359.6	1.41	1.9	0.988	355.3	1652.0	
G	2/11 6:20 PM	7.00	2/18 6:18 PM	2.030	3.916	21.1	100	342.2	0	274.7	1.69	1.9	0.994	273.2	1647.5	
H	2/11 6:20 PM	3.08	2/14 8:19 PM	2.030	3.820	21.1	100	334.2	0	172.2	1.32	1.9	0.991	170.6	1649.4	
I	2/11 6:20 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	2/11 6:20 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch S-3

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	520.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	2690.1
Weight of Slurry (g)	1390.0
Specific Gravity of Solids	2.82
water content of mix	0.63
Dry unit wt. of mix (pcf)	63.2

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1699.9
Weight of Soil Water, $w_{w,soil}$ (g)	1105
Total weight of soil used, W_t (g)	2780
Weight of Dry Cement, w_c (g)	917.5
Weight of Slurry Water, $w_{w,slurry}$ (g)	550.5
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	53.97%
Cement Factor, α (kg/m3)	529.32
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	356.24
Volume Ratio, VR (%)	48.58
Total-Water-to-Cement Ratio, w_T:c	1.79

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	550.5
Volume Ratio, VR (%)	48.58
Total-Water-to-Cement Ratio, w_T:c	1.79
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	356.2

SAMPLE DATA: Batch S-3

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	9/29 6:00 PM	3.11	10/2 8:34 PM	2.036	3.889	21.1	100	341.5	0	359.1	1.69	1.9	0.993	356.5	1645.8	
B	9/29 6:00 PM	6.92	10/6 4:02 PM	2.035	3.755	21.1	100	329.1	0	441.8	1.53	1.8	0.988	436.3	1644.3	
C	9/29 6:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	9/29 6:00 PM	27.96	10/27 5:03 PM	2.032	3.646	21.1	100	320.2	0	626.3	1.10	1.8	0.984	616.0	1652.5	
E	9/29 6:00 PM	27.97	10/27 5:24 PM	2.033	3.721	21.1	100	327.8	0	606.0	1.07	1.8	0.986	597.7	1656.0	
F	9/29 6:00 PM	13.97	10/13 5:21 PM	2.035	3.792	21.1	100	333.6	0	514.1	1.17	1.9	0.989	508.4	1650.5	
G	9/29 6:00 PM	6.94	10/6 4:32 PM	2.032	3.646	21.1	100	320.5	0	434.7	1.62	1.8	0.984	427.6	1654.0	
H	9/29 6:00 PM	3.12	10/2 8:54 PM	2.033	3.911	21.1	100	343.8	0	359.7	1.70	1.9	0.994	357.5	1652.4	
I	9/29 6:00 PM	13.96	10/13 5:00 PM	2.031	3.735	21.1	100	328.4	0	510.2	1.17	1.8	0.987	503.6	1656.1	
J	9/29 6:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch S-4

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	310.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3310.3
Weight of Slurry (g)	620.0
Specific Gravity of Solids	2.71
water content of mix	0.70
Dry unit wt. of mix (pcf)	58.5

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	2099.5
Weight of Soil Water, $w_{w,soil}$ (g)	1365
Total weight of soil used, W_t (g)	3413
Weight of Dry Cement, w_c (g)	319.9
Weight of Slurry Water, $w_{w,slurry}$ (g)	319.9
Soil Water Content, w (%)	65.02
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	15.23%
Cement Factor, α (kg/m3)	150.30
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.45
Volume Ratio, VR (%)	19.81
Total-Water-to-Cement Ratio, w_T:c	5.20

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	319.9
Volume Ratio, VR (%)	19.81
Total-Water-to-Cement Ratio, w_T:c	5.20
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.5

SAMPLE DATA: Batch S-4

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	9/14 4:00 PM	2.98	9/17 3:29 PM	2.034	3.876	21.1	100	327.2	0	58.9	1.54	1.9	0.992	58.4	1585.3	
B	9/14 4:00 PM	6.99	9/21 3:44 PM	2.036	3.915	21.1	100	330.8	0	84.4	1.19	1.9	0.994	83.8	1583.7	
C	9/14 4:00 PM	14.12	9/28 6:54 PM	2.033	3.904	21.1	100	329.8	0	107.5	1.22	1.9	0.994	106.8	1588.0	
D	9/14 4:00 PM	28.05	10/12 5:10 PM	2.032	3.891	21.1	100	329.0	0	128.5	0.98	1.9	0.993	127.6	1591.0	
E	9/14 4:00 PM	28.07	10/12 5:35 PM	2.034	3.651	21.1	100	307.9	0	125.2	0.98	1.8	0.984	123.2	1583.7	
F	9/14 4:00 PM	14.14	9/28 7:18 PM	2.033	3.905	21.1	100	329.5	0	103.9	1.08	1.9	0.994	103.2	1586.1	
G	9/14 4:00 PM	7.01	9/21 4:10 PM	2.034	3.928	21.1	100	332.0	0	85.2	1.16	1.9	0.994	84.7	1587.3	
H	9/14 4:00 PM	3.00	9/17 3:59 PM	2.036	3.926	21.1	100	330.8	0	56.0	1.34	1.9	0.994	55.7	1579.2	
I	9/14 4:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	9/14 4:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch S-5

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	500.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	2918.5
Weight of Slurry (g)	1000.0
Specific Gravity of Solids	2.75
water content of mix	0.73
Dry unit wt. of mix (pcf)	57.2

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1799.8
Weight of Soil Water, $w_{w,soil}$ (g)	1181.6
Total weight of soil used, W_t (g)	2945.9
Weight of Dry Cement, w_c (g)	501.3
Weight of Slurry Water, $w_{w,slurry}$ (g)	501.3
Soil Water Content, w (%)	65.65
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	27.85%
Cement Factor, α (kg/m3)	272.89
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.70
Volume Ratio, VR (%)	35.97
Total-Water-to-Cement Ratio, w_T:c	3.32

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	501.3
Volume Ratio, VR (%)	35.97
Total-Water-to-Cement Ratio, w_T:c	3.32
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.7

SAMPLE DATA: Batch S-5

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	9/14 9:30 PM	2.80	9/17 4:45 PM	2.030	3.878	21.1	100	324.3	0	82.4	1.94	1.9	0.993	81.8	1576.6	
B	9/14 9:30 PM	6.80	9/21 4:39 PM	2.034	3.674	21.1	100	308.2	0	123.0	1.22	1.8	0.985	121.1	1575.3	
C	9/14 9:30 PM	13.92	9/28 7:42 PM	2.032	3.810	21.1	100	320.7	0	157.4	0.94	1.9	0.990	155.8	1583.8	
D	9/14 9:30 PM	27.98	10/12 9:01 PM	2.032	3.831	21.1	100	322.2	0	193.2	1.02	1.9	0.991	191.4	1582.5	
E	9/14 9:30 PM	28.00	10/12 9:25 PM	2.036	3.831	21.1	100	321.9	0	183.3	1.05	1.9	0.991	181.6	1574.8	
F	9/14 9:30 PM	13.95	9/28 8:17 PM	2.036	3.852	21.1	100	324.2	0	155.6	1.18	1.9	0.991	154.3	1577.4	
G	9/14 9:30 PM	6.82	9/21 5:11 PM	2.034	3.807	21.1	100	319.7	0	111.1	0.97	1.9	0.990	109.9	1577.0	
H	9/14 9:30 PM	2.83	9/17 5:25 PM	2.033	3.677	21.1	100	308.5	0	79.8	1.53	1.8	0.985	78.6	1577.1	
I	9/14 9:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	9/14 9:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch S-6

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	680.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2526.7
Weight of Slurry (g)	1360.0
Specific Gravity of Solids	2.80
water content of mix	0.76
Dry unit wt. of mix (pcf)	55.9

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1599.5
Weight of Soil Water, $w_{w,soil}$ (g)	1040
Total weight of soil used, W_t (g)	2614
Weight of Dry Cement, w_c (g)	705.2
Weight of Slurry Water, $w_{w,slurry}$ (g)	705.2
Soil Water Content, w (%)	65.02
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	44.09%
Cement Factor, α (kg/m3)	432.65
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.53
Volume Ratio, VR (%)	57.02
Total-Water-to-Cement Ratio, w_T:c	2.46

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	705.2
Volume Ratio, VR (%)	57.02
Total-Water-to-Cement Ratio, w_T:c	2.46
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.5

SAMPLE DATA: Batch S-6

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	10/3 6:30 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	10/3 6:30 PM	6.90	10/10 4:06 PM	2.034	3.856	21.1	100	323.8	0	190.4	1.32	1.9	0.992	188.8	1577.0	
C	10/3 6:30 PM	13.95	10/17 5:25 PM	2.033	3.803	21.1	100	318.0	0	244.8	1.95	1.9	0.990	242.3	1571.8	
D	10/3 6:30 PM	27.99	10/31 6:10 PM	2.029	3.713	21.1	100	310.8	0	302.0	1.85	1.8	0.986	297.9	1579.7	
E	10/3 6:30 PM	28.00	10/31 6:36 PM	2.030	3.748	21.1	100	313.6	0	306.8	1.85	1.8	0.988	303.0	1577.5	
F	10/3 6:30 PM	13.98	10/17 5:59 PM	2.032	3.607	21.1	100	301.9	0	257.9	1.91	1.8	0.982	253.3	1574.9	
G	10/3 6:30 PM	6.92	10/10 4:36 PM	2.032	3.840	21.1	100	321.8	0	199.5	1.53	1.9	0.991	197.8	1576.8	
H	10/3 6:30 PM	2.97	10/6 5:54 PM	2.034	3.546	21.1	100	296.9	0	142.8	1.61	1.7	0.979	139.9	1572.4	
I	10/3 6:30 PM	3.00	10/6 6:32 PM	2.034	3.629	21.1	100	304.5	0	143.4	1.64	1.8	0.983	140.9	1575.7	
J	10/3 6:30 PM	--	10/6 5:54 PM	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch S-7

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	870.0
Weight of Dry Cement, w_c (g)	870.0
Weight of Moist Soil, w_{soil} (g)	2135.0
Weight of Slurry (g)	1740.0
Specific Gravity of Solids	2.84
water content of mix	0.79
Dry unit wt. of mix (pcf)	54.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1299.7
Weight of Soil Water, $w_{w,soil}$ (g)	845
Total weight of soil used, W_t (g)	2123.4
Weight of Dry Cement, w_c (g)	860.1
Weight of Slurry Water, $w_{w,slurry}$ (g)	860.1
Soil Water Content, w (%)	65.02
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	66.18%
Cement Factor, α (kg/m3)	649.64
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	349.98
Volume Ratio, VR (%)	85.62
Total-Water-to-Cement Ratio, w_T:c	1.97

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	860.1
Volume Ratio, VR (%)	85.62
Total-Water-to-Cement Ratio, w_T:c	1.97
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350.0

SAMPLE DATA: Batch S-7

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	9/26 4:00 PM	3.00	9/29 4:02 PM	2.034	3.87	21	100	320.0	0	211.1	2.33	1.9	0.992	209.5	1552.0	
B	9/26 4:00 PM	7.03	10/3 4:45 PM	2.037	3.854	21.1	100	320.1	0	280.8	1.88	1.9	0.991	278.4	1555.2	
C	9/26 4:00 PM	13.97	10/10 3:11 PM	2.036	3.665	21.1	100	304.3	0	298.5	1.04	1.8	0.984	293.7	1556.2	
D	9/26 4:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	9/26 4:00 PM	28.04	10/24 5:04 PM	2.033	3.939	21.1	100	328.3	0	398.9	1.30	1.9	0.995	396.9	1566.7	
F	9/26 4:00 PM	13.98	10/10 3:38 PM	2.037	3.901	21.1	100	325.3	0	333.9	1.70	1.9	0.993	331.7	1561.4	
G	9/26 4:00 PM	7.05	10/3 5:16 PM	2.036	3.899	21.1	100	324.1	0	283.7	1.95	1.9	0.993	281.8	1557.9	
H	9/26 4:00 PM	3.03	9/29 4:36 PM	2.034	3.894	21.1	100	323.4	0	215.6	2.17	1.9	0.993	214.1	1559.6	
I	9/26 4:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	9/26 4:00 PM	28.03	10/24 4:40 PM	2.036	3.715	21.1	100	308.8	0	379.2	1.29	1.8	0.986	373.9	1557.9	

Laboratory Mixing Data
Batch S-8

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	440.0
Weight of Dry Cement, w_c (g)	310.0
Weight of Moist Soil, w_{soil} (g)	3112.0
Weight of Slurry (g)	750.0
Specific Gravity of Solids	2.71
water content of mix	0.76
Dry unit wt. of mix (pcf)	55.5

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1899.9
Weight of Soil Water, $w_{w,soil}$ (g)	1268
Total weight of soil used, W_t (g)	3137.5
Weight of Dry Cement, w_c (g)	315.1
Weight of Slurry Water, $w_{w,slurry}$ (g)	441.1
Soil Water Content, w (%)	66.74
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	16.58%
Cement Factor, α (kg/m3)	161.06
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	126.15
Volume Ratio, VR (%)	27.67
Total-Water-to-Cement Ratio, w_T:c	5.32

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	441.1
Volume Ratio, VR (%)	27.67
Total-Water-to-Cement Ratio, w_T:c	5.32
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	126.2

SAMPLE DATA: Batch S-8

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	9/16 8:10 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	9/16 8:10 PM	6.93	9/23 6:34 PM	2.032	3.890	21.1	100	322.2	0	64.2	1.24	1.9	0.993	63.7	1558.5	
C	9/16 8:10 PM	13.96	9/30 7:10 PM	2.032	3.871	21.1	100	320.0	0	86.3	1.17	1.9	0.992	85.6	1555.5	
D	9/16 8:10 PM	28.01	10/14 8:18 PM	2.034	3.681	21.1	100	303.9	0	100.6	1.18	1.8	0.985	99.1	1550.4	
E	9/16 8:10 PM	28.02	10/14 8:41 PM	2.033	3.861	21.1	100	319.4	0	98.1	0.86	1.9	0.992	97.3	1555.0	
F	9/16 8:10 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	9/16 8:10 PM	6.96	9/23 7:07 PM	2.033	3.738	21.1	100	309.0	0	63.0	1.12	1.8	0.987	62.2	1553.9	
H	9/16 8:10 PM	2.91	9/19 5:54 PM	2.036	3.645	21.1	100	299.6	0	44.4	1.31	1.8	0.983	43.7	1540.5	
I	9/16 8:10 PM	2.93	9/19 6:26 PM	2.032	3.713	21.1	100	306.2	0	43.6	1.43	1.8	0.986	43.0	1551.7	
J	9/16 8:10 PM	13.93	9/30 6:24 PM	2.032	3.871	21.1	100	319.8	0	78.5	1.24	1.9	0.992	77.9	1554.5	

Laboratory Mixing Data
Batch S-9

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	700.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	2601.3
Weight of Slurry (g)	1200.0
Specific Gravity of Solids	2.76
water content of mix	0.83
Dry unit wt. of mix (pcf)	52.4

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1600
Weight of Soil Water, $w_{w,soil}$ (g)	1040
Total weight of soil used, W_t (g)	2625.5
Weight of Dry Cement, w_c (g)	500.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	700.0
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	31.25%
Cement Factor, α (kg/m3)	305.43
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.31
Volume Ratio, VR (%)	52.48
Total-Water-to-Cement Ratio, w_T:c	3.47

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	700.0
Volume Ratio, VR (%)	52.48
Total-Water-to-Cement Ratio, w_T:c	3.47
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.3

SAMPLE DATA: Batch S-9

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	2/11 8:20 PM	3.01	2/14 8:41 PM	2.030	3.650	21.1	100	299.4	0	53.1	0.88	1.8	0.984	52.2	1546.5	
B	2/11 8:20 PM	6.93	2/18 6:38 PM	2.031	3.873	21.1	100	318.4	0	85.9	1.36	1.9	0.993	85.3	1548.4	
C	2/11 8:20 PM	14.12	2/25 11:18 PM	2.029	3.896	21.1	100	320.4	0	117.0	0.94	1.9	0.994	116.2	1552.0	
D	2/11 8:20 PM	27.98	3/11 7:54 PM	2.031	3.900	21.1	100	320.4	0	152.4	1.04	1.9	0.994	151.4	1547.4	
E	2/11 8:20 PM	28.00	3/11 8:13 PM	2.033	3.917	21.1	100	322.2	0	146.6	0.96	1.9	0.994	145.7	1546.2	
F	2/11 8:20 PM	14.14	2/25 11:38 PM	2.030	3.860	21.1	100	317.2	0	121.4	1.15	1.9	0.992	120.4	1549.3	
G	2/11 8:20 PM	6.94	2/18 6:58 PM	2.030	3.919	21.1	100	321.9	0	89.7	1.43	1.9	0.994	89.2	1548.6	
H	2/11 8:20 PM	3.03	2/14 9:03 PM	2.034	3.890	21.1	100	319.7	0	55.2	1.45	1.9	0.993	54.8	1543.4	
I	2/11 8:20 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	2/11 8:20 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch S-10

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	960.0
Weight of Dry Cement, w_c (g)	680.0
Weight of Moist Soil, w_{soil} (g)	2090.6
Weight of Slurry (g)	1640.0
Specific Gravity of Solids	2.82
water content of mix	0.91
Dry unit wt. of mix (pcf)	49.2

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1299.8
Weight of Soil Water, $w_{w,soil}$ (g)	845
Total weight of soil used, W_t (g)	2129.1
Weight of Dry Cement, w_c (g)	695.6
Weight of Slurry Water, $w_{w,slurry}$ (g)	973.9
Soil Water Content, w (%)	65.01
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	53.52%
Cement Factor, α (kg/m3)	524.01
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.74
Volume Ratio, VR (%)	90.03
Total-Water-to-Cement Ratio, w_T:c	2.61

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	0.0
Weight of Slurry Water**, $w_{w,slurry}$ (g)	973.9
Volume Ratio, VR (%)	90.03
Total-Water-to-Cement Ratio, w_T:c	2.61
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.7

SAMPLE DATA: **Batch S-10**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	10/4 7:00 PM	2.94	10/7 5:33 PM	2.033	3.862	21.1	100	310.0	0	79.4	0.93	1.9	0.992	78.7	1508.9	
B	10/4 7:00 PM	6.96	10/11 6:07 PM	2.038	3.599	21.1	100	289.5	0	120.9	1.05	1.8	0.981	118.6	1504.7	
C	10/4 7:00 PM	13.97	10/18 6:11 PM	2.035	3.722	21.1	100	298.6	0	156.7	1.34	1.8	0.986	154.6	1505.1	
D	10/4 7:00 PM	27.92	11/1 5:01 PM	2.035	3.669	21.1	100	293.9	0	185.0	1.48	1.8	0.984	182.1	1502.8	
E	10/4 7:00 PM	27.94	11/1 5:26 PM	2.032	3.709	21.1	100	297.5	0	187.5	1.30	1.8	0.986	184.9	1509.3	
F	10/4 7:00 PM	13.99	10/18 6:40 PM	2.037	3.852	21.1	100	309.0	0	161.2	1.54	1.9	0.991	159.8	1502.0	
G	10/4 7:00 PM	6.98	10/11 6:29 PM	2.036	3.818	21.1	100	307.3	0	124.7	0.98	1.9	0.990	123.5	1508.5	
H	10/4 7:00 PM	2.96	10/7 6:06 PM	2.037	3.750	21.1	100	301.9	0	84.2	1.28	1.8	0.987	83.1	1507.4	
I	10/4 7:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	10/4 7:00 PM	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-0

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	150.0
Weight of Dry Cement, w_c (g)	250.0
Weight of Moist Soil, w_{soil} (g)	2806.8
Weight of Slurry (g)	400.0
Specific Gravity of Solids	2.71
water content of mix	0.64
Dry unit wt. of mix (pcf)	61.6

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1800
Weight of Soil Water, $w_{w,soil}$ (g)	1170
Total weight of soil used, W_t (g)	2955.2
Weight of Dry Cement, w_c (g)	264.1
Weight of Slurry Water, $w_{w,slurry}$ (g)	158.4
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	14.67%
Cement Factor, α (kg/m3)	143.31
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	126.65
Volume Ratio, VR (%)	13.15
Total-Water-to-Cement Ratio, w_T:c	5.01

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: **Batch C-0**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (°C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-1

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	240.0
Weight of Dry Cement, w_c (g)	400.0
Weight of Moist Soil, w_{soil} (g)	2588.6
Weight of Slurry (g)	640.0
Specific Gravity of Solids	2.74
water content of mix	0.64
Dry unit wt. of mix (pcf)	62.1

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1600
Weight of Soil Water, $w_{w,soil}$ (g)	1040
Total weight of soil used, W_t (g)	2624.8
Weight of Dry Cement, w_c (g)	402.1
Weight of Slurry Water, $w_{w,slurry}$ (g)	241.3
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	25.13%
Cement Factor, α (kg/m3)	245.71
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.49
Volume Ratio, VR (%)	22.55
Total-Water-to-Cement Ratio, w_T:c	3.17

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: **Batch C-1**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-2

Change only black text, red is calculated	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	330.0
Weight of Dry Cement, w_c (g)	550.0
Weight of Moist Soil, w_{soil} (g)	2370.3
Weight of Slurry (g)	880.0
Specific Gravity of Solids	2.78
water content of mix	0.64
Dry unit wt. of mix (pcf)	62.7

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1500
Weight of Soil Water, $w_{w,soil}$ (g)	975
Total weight of soil used, W_t (g)	2462
Weight of Dry Cement, w_c (g)	567.3
Weight of Slurry Water, $w_{w,slurry}$ (g)	340.4
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	37.82%
Cement Factor, α (kg/m3)	369.53
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.94
Volume Ratio, VR (%)	33.92
Total-Water-to-Cement Ratio, w_T:c	2.31

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: Batch C-2

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-3

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	0.60
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	420.0
Weight of Dry Cement, w_c (g)	700.0
Weight of Moist Soil, w_{soil} (g)	2152.0
Weight of Slurry (g)	1120.0
Specific Gravity of Solids	2.82
water content of mix	0.63
Dry unit wt. of mix (pcf)	63.2

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1400
Weight of Soil Water, $w_{w,soil}$ (g)	910
Total weight of soil used, W_t (g)	2295.2
Weight of Dry Cement, w_c (g)	735.6
Weight of Slurry Water, $w_{w,slurry}$ (g)	441.3
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	0.60
Cement Content, a_W (%)	52.54%
Cement Factor, α (kg/m3)	513.99
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	349.23
Volume Ratio, VR (%)	47.18
Total-Water-to-Cement Ratio, w_T:c	1.83

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: Batch C-3

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-4

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	250.0
Weight of Dry Cement, w_c (g)	250.0
Weight of Moist Soil, w_{soil} (g)	2648.2
Weight of Slurry (g)	500.0
Specific Gravity of Solids	2.71
water content of mix	0.70
Dry unit wt. of mix (pcf)	58.5

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1700
Weight of Soil Water, $w_{w,soil}$ (g)	1105
Total weight of soil used, W_t (g)	2785
Weight of Dry Cement, w_c (g)	258.7
Weight of Slurry Water, $w_{w,slurry}$ (g)	258.7
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	15.21%
Cement Factor, α (kg/m3)	148.95
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	124.51
Volume Ratio, VR (%)	19.63
Total-Water-to-Cement Ratio, w_T:c	5.24

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: Batch C-4

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-5

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	400.0
Weight of Dry Cement, w_c (g)	400.0
Weight of Moist Soil, w_{soil} (g)	2334.8
Weight of Slurry (g)	800.0
Specific Gravity of Solids	2.75
water content of mix	0.73
Dry unit wt. of mix (pcf)	57.2

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1500
Weight of Soil Water, $w_{w,soil}$ (g)	982.3
Total weight of soil used, W_t (g)	2464.3
Weight of Dry Cement, w_c (g)	422.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	422.0
Soil Water Content, w (%)	65.49
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	28.13%
Cement Factor, α (kg/m3)	274.65
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	201.65
Volume Ratio, VR (%)	36.20
Total-Water-to-Cement Ratio, w_T:c	3.30

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: Batch C-5

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-6

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	550.0
Weight of Dry Cement, w_c (g)	550.0
Weight of Moist Soil, w_{soil} (g)	2021.4
Weight of Slurry (g)	1100.0
Specific Gravity of Solids	2.80
water content of mix	0.76
Dry unit wt. of mix (pcf)	56.0

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1300
Weight of Soil Water, $w_{w,soil}$ (g)	845
Total weight of soil used, W_t (g)	2125.1
Weight of Dry Cement, w_c (g)	571.4
Weight of Slurry Water, $w_{w,slurry}$ (g)	571.4
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	43.95%
Cement Factor, α (kg/m3)	431.24
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	274.96
Volume Ratio, VR (%)	56.84
Total-Water-to-Cement Ratio, w_T:c	2.47

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: Batch C-6

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-7

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	1.00
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350
Weight of Slurry Water, $w_{w,slurry}$ (g)	700.0
Weight of Dry Cement, w_c (g)	700.0
Weight of Moist Soil, w_{soil} (g)	1708.0
Weight of Slurry (g)	1400.0
Specific Gravity of Solids	2.84
water content of mix	0.79
Dry unit wt. of mix (pcf)	54.6

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1100
Weight of Soil Water, $w_{w,soil}$ (g)	715
Total weight of soil used, W_t (g)	1799.9
Weight of Dry Cement, w_c (g)	730.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	730.0
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	1.00
Cement Content, a_W (%)	66.36%
Cement Factor, α (kg/m3)	650.48
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	350.22
Volume Ratio, VR (%)	85.73
Total-Water-to-Cement Ratio, w_T:c	1.97

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: **Batch C-7**

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size		Cure Conditions		Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions		Strength Adjustments			total unit weight (kg/m3)	Notes
				Diam. (in)	Height (in)	Temp (C)	Humidity (%)			Peak UCS (psi)	Strain (%)	L/D ratio	Height Correction Factor	Adj. UCS (psi)		
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-8

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125
Weight of Slurry Water, $w_{w,slurry}$ (g)	350.0
Weight of Dry Cement, w_c (g)	250.0
Weight of Moist Soil, w_{soil} (g)	2489.6
Weight of Slurry (g)	600.0
Specific Gravity of Solids	2.71
water content of mix	0.76
Dry unit wt. of mix (pcf)	55.5

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1600
Weight of Soil Water, $w_{w,soil}$ (g)	1040
Total weight of soil used, W_t (g)	2614.4
Weight of Dry Cement, w_c (g)	260.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	364.0
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	16.25%
Cement Factor, α (kg/m3)	159.50
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	125.19
Volume Ratio, VR (%)	27.41
Total-Water-to-Cement Ratio, w_T:c	5.36

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: Batch C-8

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-9

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	10
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200
Weight of Slurry Water, $w_{w,slurry}$ (g)	700.0
Weight of Dry Cement, w_c (g)	500.0
Weight of Moist Soil, w_{soil} (g)	2601.3
Weight of Slurry (g)	1200.0
Specific Gravity of Solids	2.76
water content of mix	0.83
Dry unit wt. of mix (pcf)	52.4

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1600
Weight of Soil Water, $w_{w,soil}$ (g)	1040
Total weight of soil used, W_t (g)	2625.5
Weight of Dry Cement, w_c (g)	500.0
Weight of Slurry Water, $w_{w,slurry}$ (g)	700.0
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	31.25%
Cement Factor, α (kg/m3)	305.43
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	200.31
Volume Ratio, VR (%)	52.48
Total-Water-to-Cement Ratio, w_T:c	3.47

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

SAMPLE DATA: Batch C-9

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Laboratory Mixing Data
Batch C-10

Change only black text, red is calculated

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	Hwanik Ju
Supervisor	George Filz

Soil Properties:

Soil Type	artificial
Soil Solids Specific Gravity	2.64
Soil Water Content, w (%)	0.65
Unit Weight, γ_{soil} (kg/m^3)	1603.8

Binder Properties:

Binder Type	Portland Cement (TypeI/II)
Specific Weight, G_c	3.15
Unit Weight, γ_c (kg/m3)	3149

Mixer Type / Model	Hobart Mixer, Dough Hook
Mixing Time (minutes) for:	
Soil	3 minutes
Soil/Cement	10 minutes
Blender Type / Model	Oster 14-Speed Blender
Mixing Time (minutes) for:	
Binder Slurry	3 minutes

Design Mix Values for Batch:

Number of Specimen, N	8
Water:Cement Ratio of Slurry, w:c	1.40
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275
Weight of Slurry Water, $w_{w,slurry}$ (g)	770.0
Weight of Dry Cement, w_c (g)	550.0
Weight of Moist Soil, w_{soil} (g)	1672.5
Weight of Slurry (g)	1320.0
Specific Gravity of Solids	2.82
water content of mix	0.91
Dry unit wt. of mix (pcf)	49.2

Actual Mix Values for batch:

As Mixed:

Weight of Soil Solids, w_s (g)	1100
Weight of Soil Water, $w_{w,soil}$ (g)	715
Total weight of soil used, W_t (g)	1803.3
Weight of Dry Cement, w_c (g)	587.6
Weight of Slurry Water, $w_{w,slurry}$ (g)	822.6
Soil Water Content, w (%)	65.00
Water:Cement Ratio, w:c	1.40
Cement Content, a_W (%)	53.42%
Cement Factor, α (kg/m3)	522.59
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	275.35
Volume Ratio, VR (%)	89.79
Total-Water-to-Cement Ratio, w_T:c	2.61

As Cured:

Weight of Bleed Water*, $w_{w,bleed}$ (g)	--
Weight of Slurry Water**, $w_{w,slurry}$ (g)	--
Volume Ratio, VR (%)	--
Total-Water-to-Cement Ratio, w_T:c	--
Cement Factor In-Place, $\alpha_{in\text{-}place}$ (kg/m^3)	--

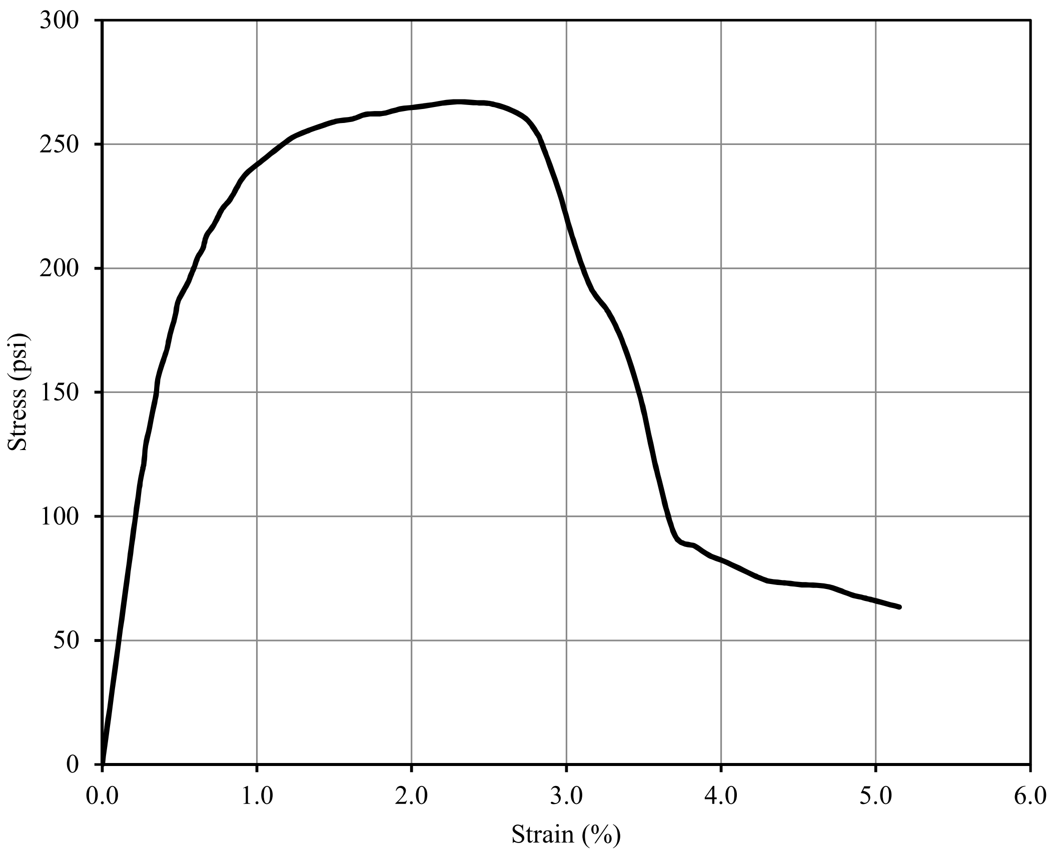
SAMPLE DATA: Batch C-10

Sample ID	Time Molded (date / Time)	Curing Period (Days)	Time Tested (date/time)	Sample Size: Diam. (in)	Sample Size: Height (in)	Cure Conditions: Temp (C)	Cure Conditions: Humidity (%)	Specimen wt. after cure (g)	Bleed Water (g)	Failure Conditions: Peak UCS (psi)	Failure Conditions: Strain (%)	Strength Adjustments: L/D ratio	Strength Adjustments: Height Correction Factor	Strength Adjustments: Adj. UCS (psi)	total unit weight (kg/m3)	Notes
A	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
B	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
C	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
E	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
F	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
G	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
H	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
I	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	
J	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	

Appendix B: Unconfined compressive strength (UCS) tests data and result sheets

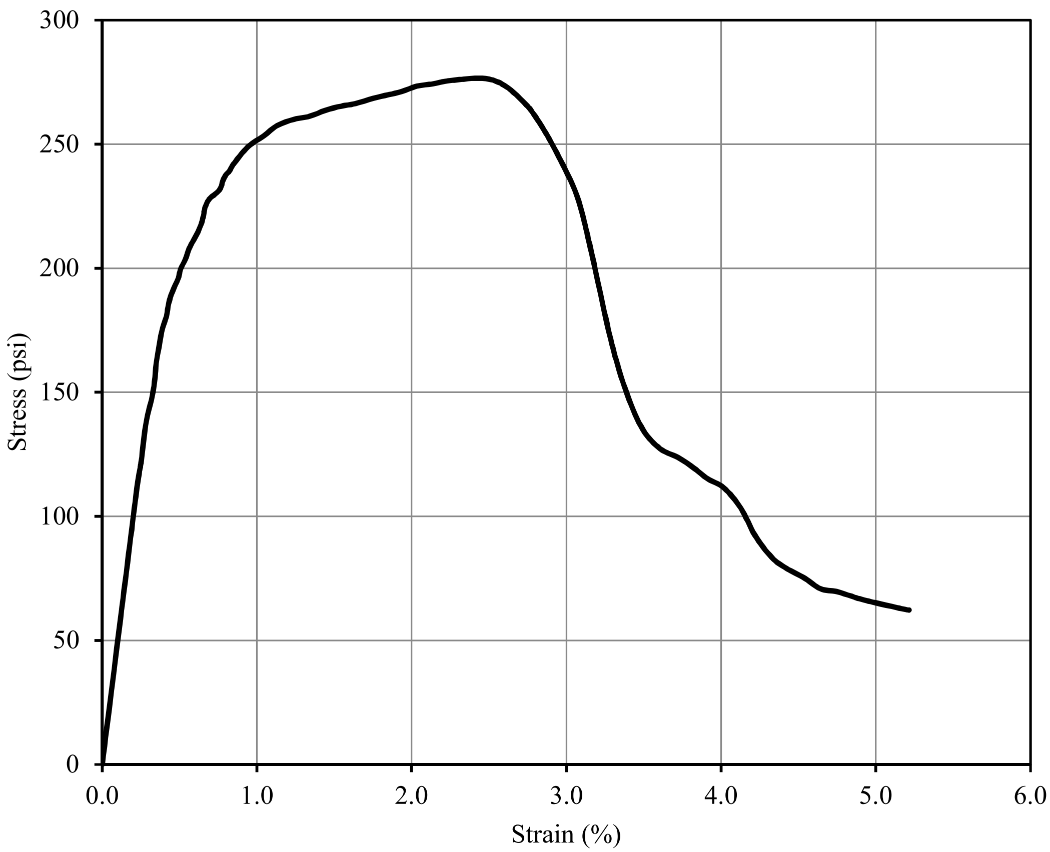
The unconfined compressive strength (UCS) tests data and result sheets are provided in this appendix. Each data sheet includes data for one specimen and its UCS test results. The data sheets present information about test conditions, mixture proportions, curing conditions, specimen characteristics, strain-stress curves, and test results. The peak deviator stress, corrected after applying the height correction, is used to calculate the UCS of the specimen.

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-1-A	**Specimen Information**		
Test Date:	2017-10-09	Initial Height:	3.965	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	383.3	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



Test Result					
Peak deviator stress (w/ Height correction)	266	psi	Strain at failure, εf :	2.32	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-1-H	**Specimen Information**		
Test Date:	2017-10-09	Initial Height:	3.878	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	376.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf

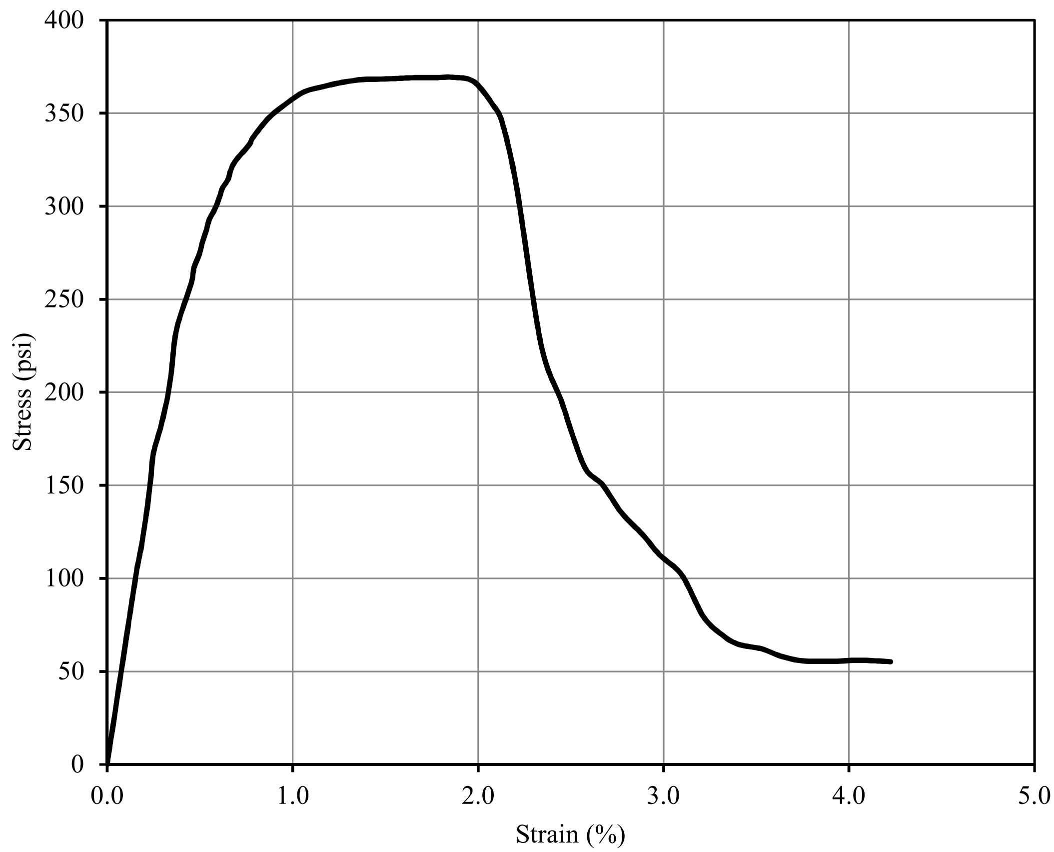


Test Result					
Peak deviator stress (w/ Height correction)	274	psi	Strain at failure, εf :	2.43	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C

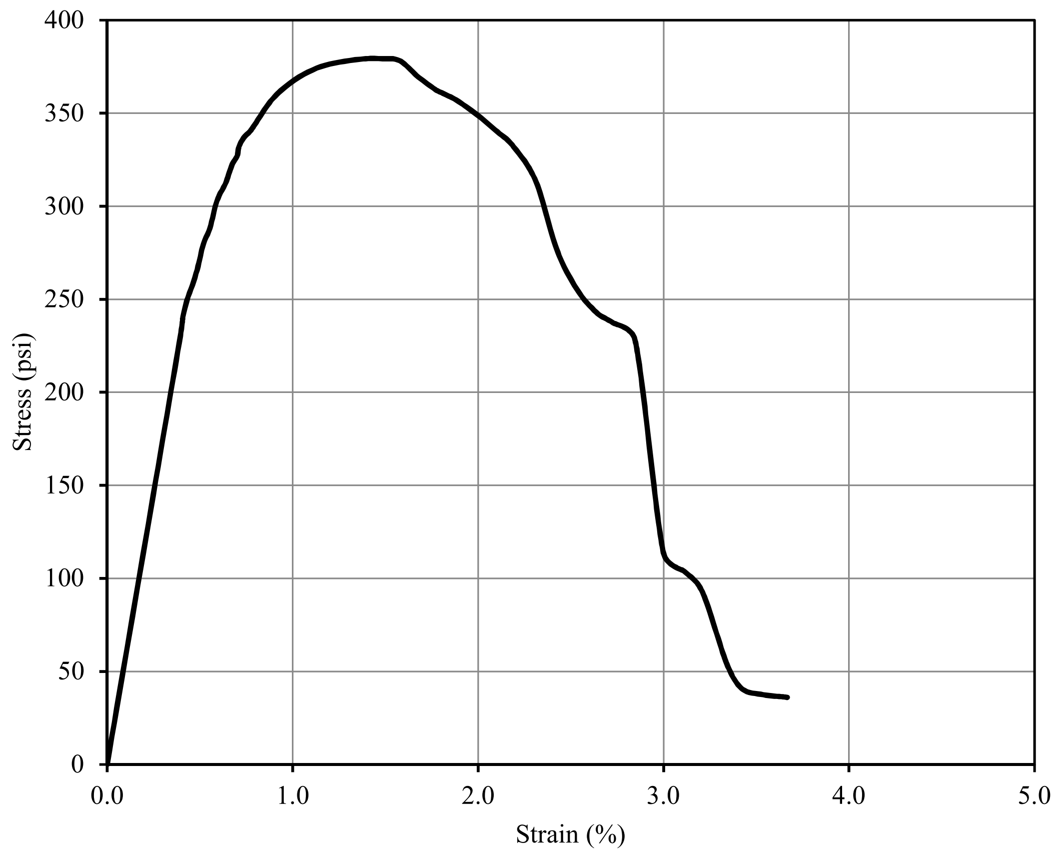
Test Information		Specimen Information		
I.D.:	T-1-B	Initial Height:	3.97	in
Test Date:	2017-10-13	Initial Diameter:	2.039	in
Strain Rate:	1 %/min	Initial Area:	3.265	in

Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	385.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



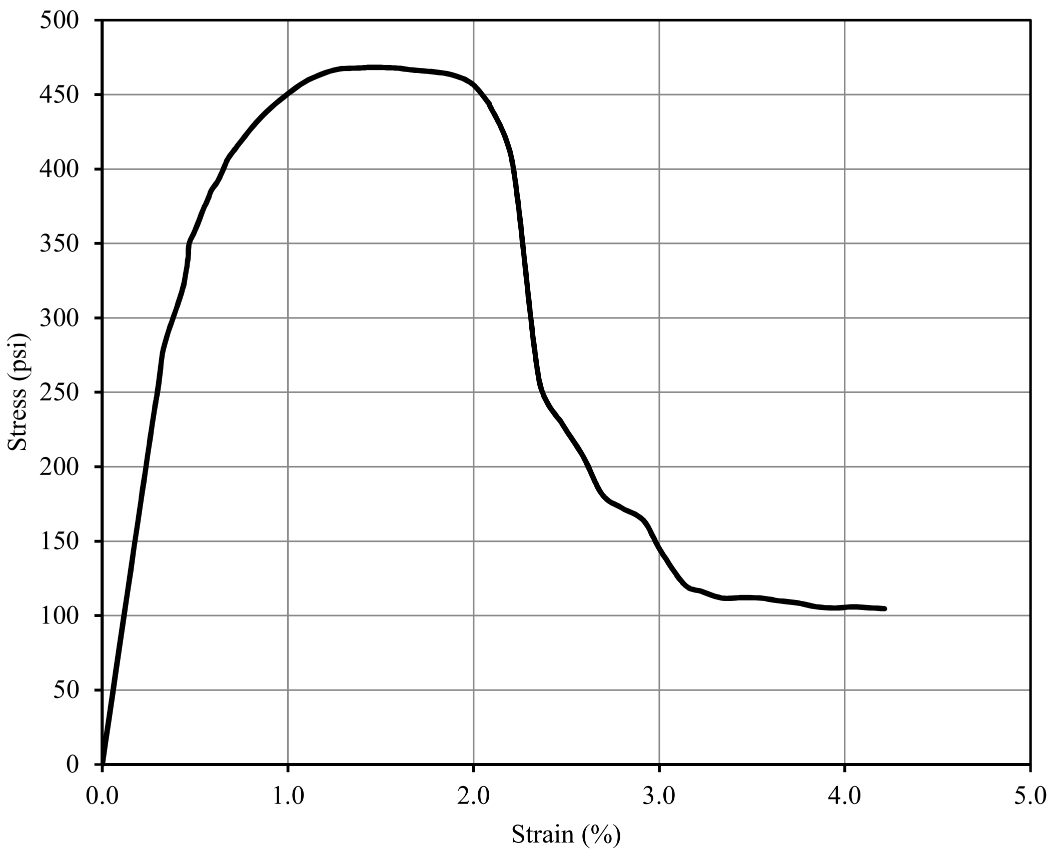
Test Result					
Peak deviator stress (w/ Height correction)	368	psi	Strain at failure, εf :	1.86	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-1-G	**Specimen Information**		
Test Date:	2017-10-13	Initial Height:	3.971	in
Strain Rate:	1 %/min	Initial Diameter:	2.040	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	386.3	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



Test Result					
Peak deviator stress (w/ Height correction)	378	psi	Strain at failure, εf :	1.39	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.8	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
		Specimen Information		
I.D.:	T-1-C	Initial Height:	3.769	in
Test Date:	2017-10-20	Initial Diameter:	2.041	in
Strain Rate:	1 %/min	Initial Area:	3.272	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	365.4	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf

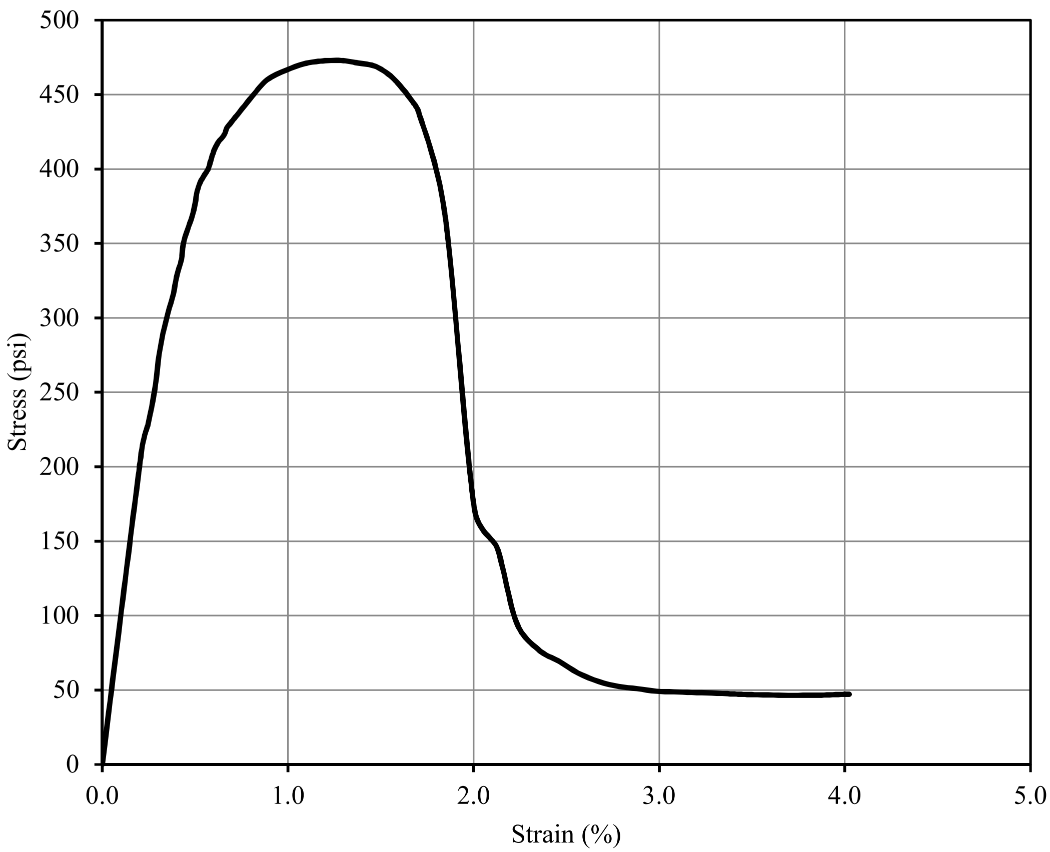


Test Result					
Peak deviator stress (w/ Height correction)	463	psi	Strain at failure, εf :	1.46	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C

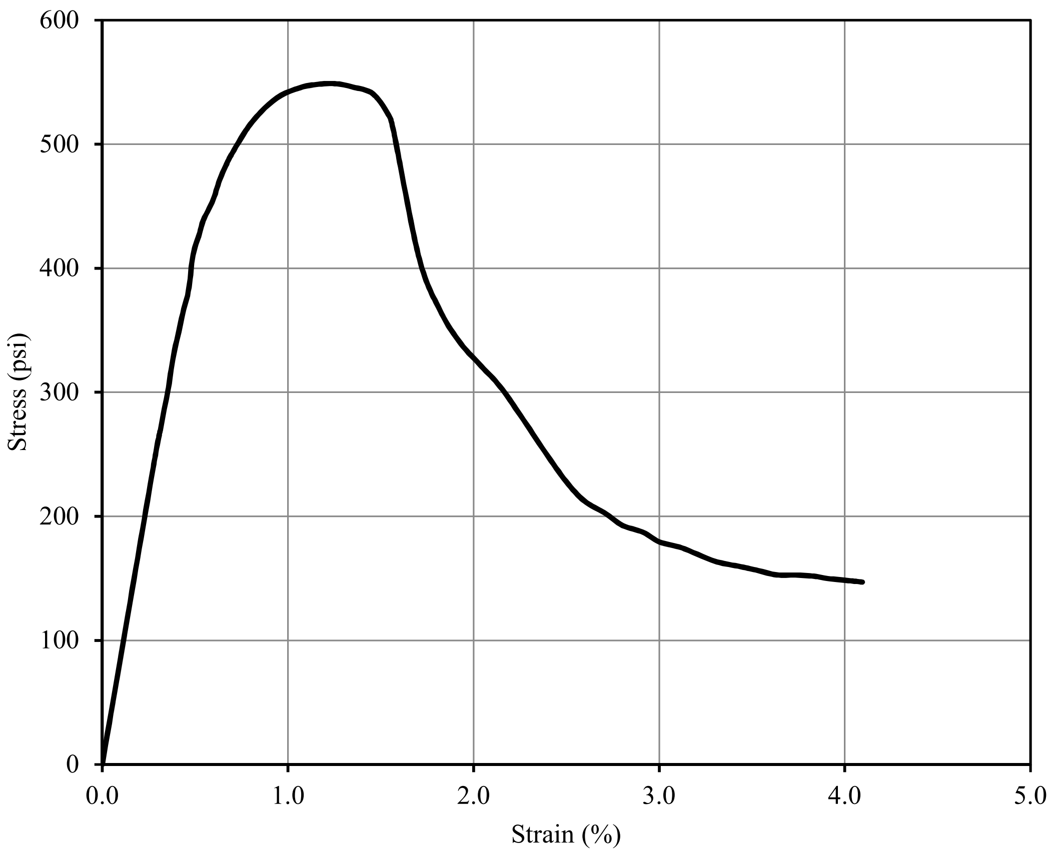
Test Information		Specimen Information		
I.D.:	T-1-F	Initial Height:	3.992	in
Test Date:	2017-10-20	Initial Diameter:	2.043	in
Strain Rate:	1 %/min	Initial Area:	3.278	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	388.4	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



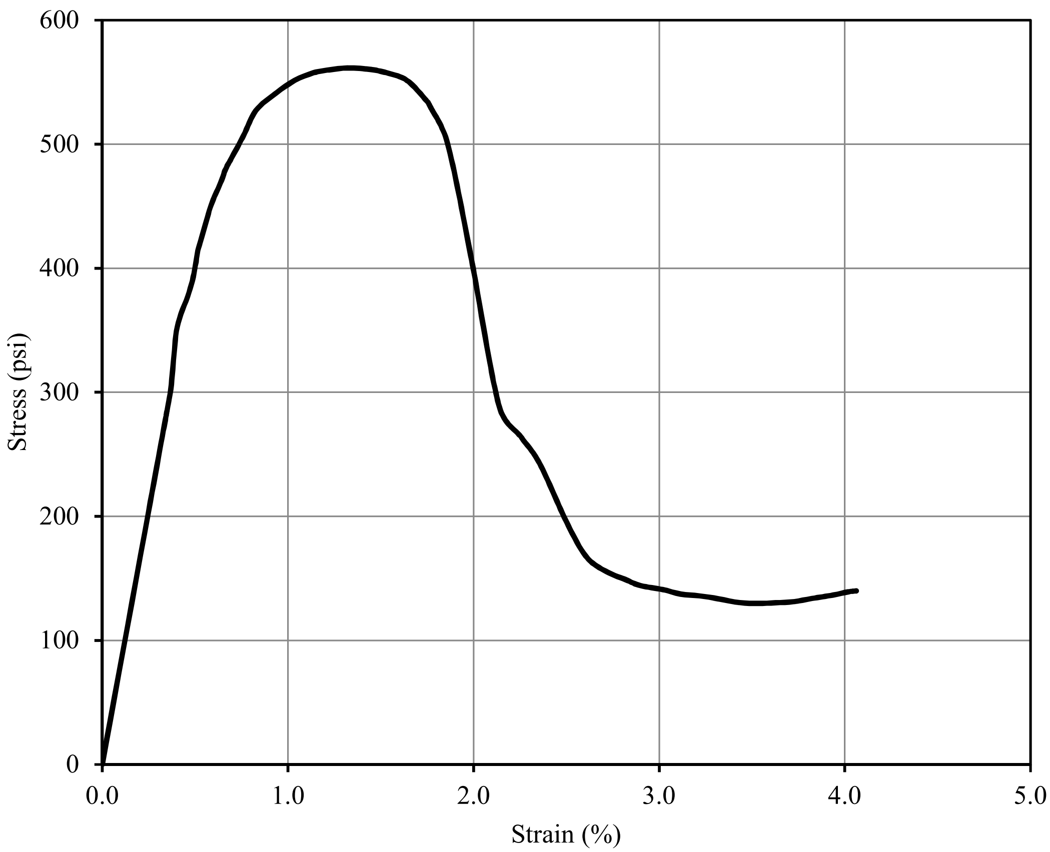
Test Result					
Peak deviator stress (w/ Height correction)	471	psi	Strain at failure, εf :	1.29	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-1-D	**Specimen Information**		
Test Date:	2017-11-03	Initial Height:	3.947	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	384.0	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



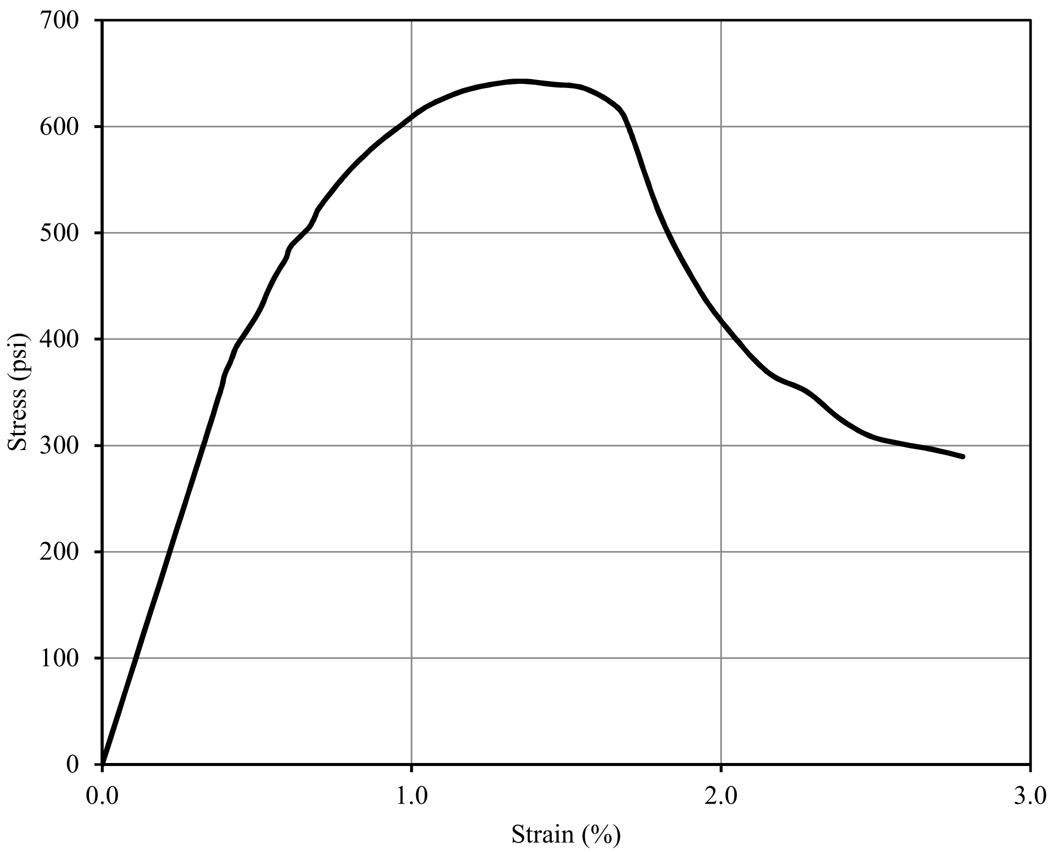
Test Result					
Peak deviator stress (w/ Height correction)	546	psi	Strain at failure, εf :	1.25	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-1-E	**Specimen Information**		
Test Date:	2017-11-03	Initial Height:	3.868	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	375.4	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	113	pcf



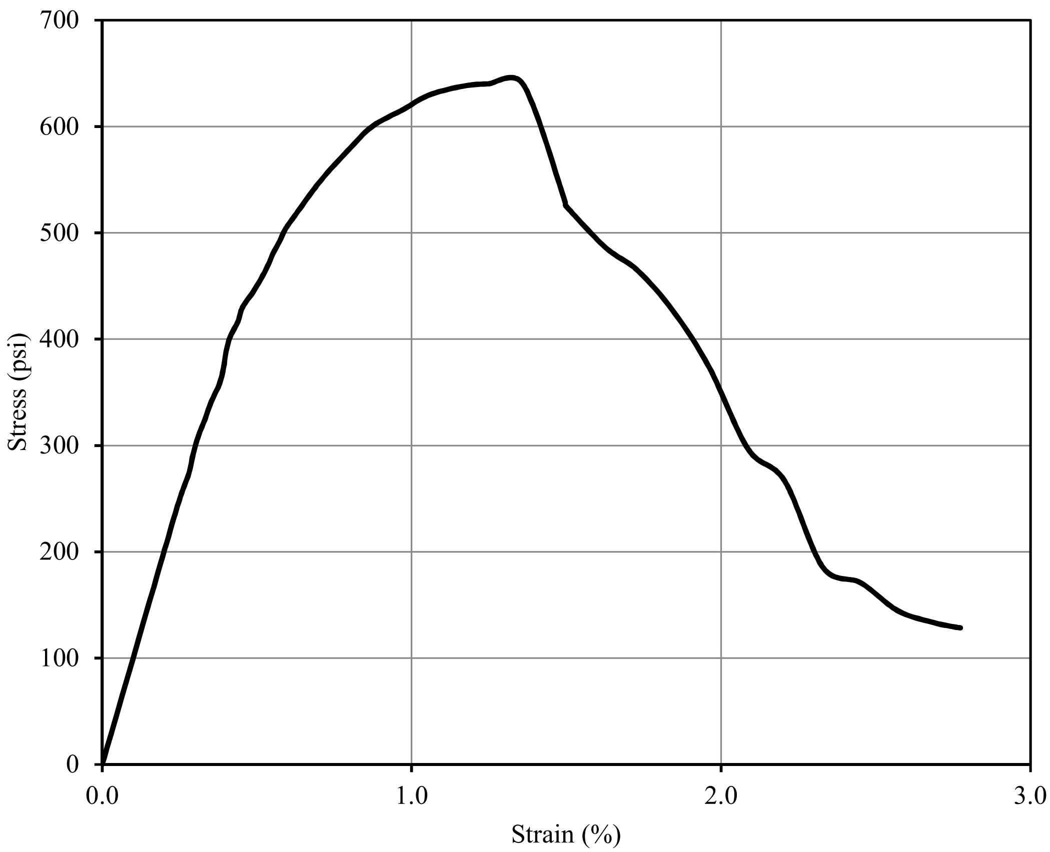
Test Result					
Peak deviator stress (w/ Height correction)	557	psi	Strain at failure, εf :	1.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-2-H	**Specimen Information**		
Test Date:	2017-10-10	Initial Height:	3.943	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	383.4	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	113	pcf



Test Result					
Peak deviator stress (w/ Height correction)	639	psi	Strain at failure, εf :	1.34	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-2-I	**Specimen Information**		
Test Date:	2017-10-10	Initial Height:	3.948	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	383.5	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf

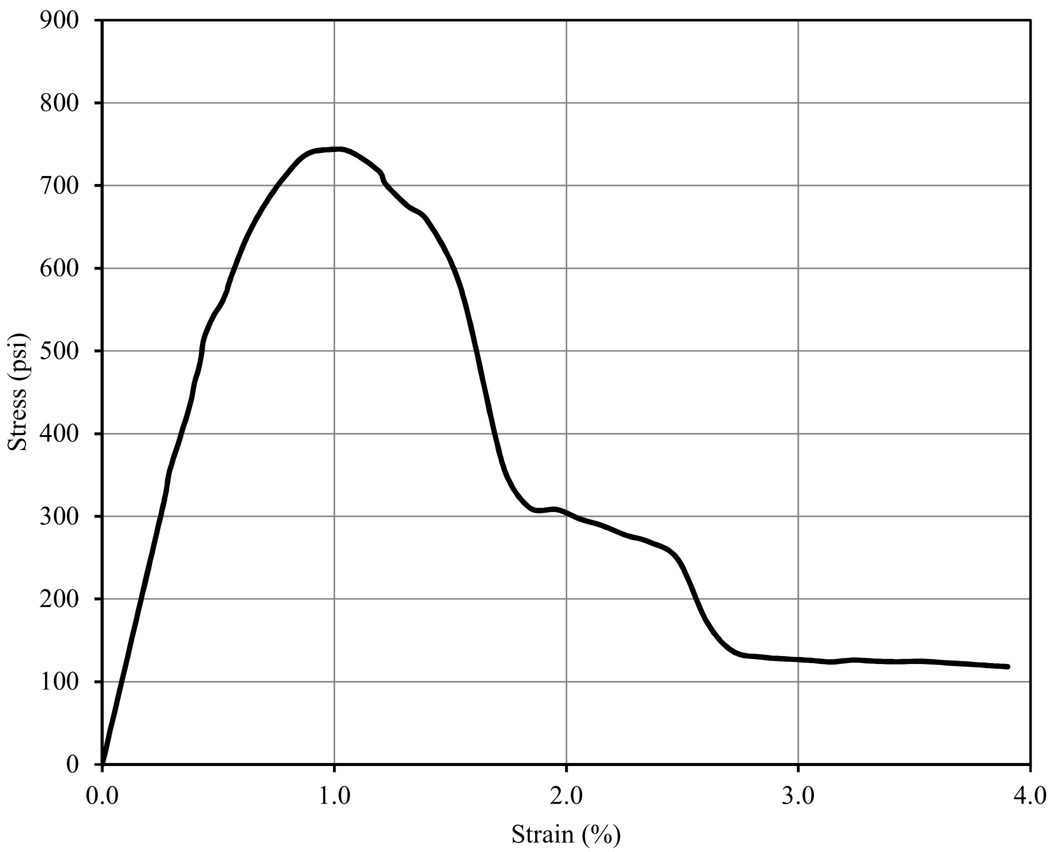


Test Result					
Peak deviator stress (w/ Height correction)	637	psi	Strain at failure, εf :	1.25	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C

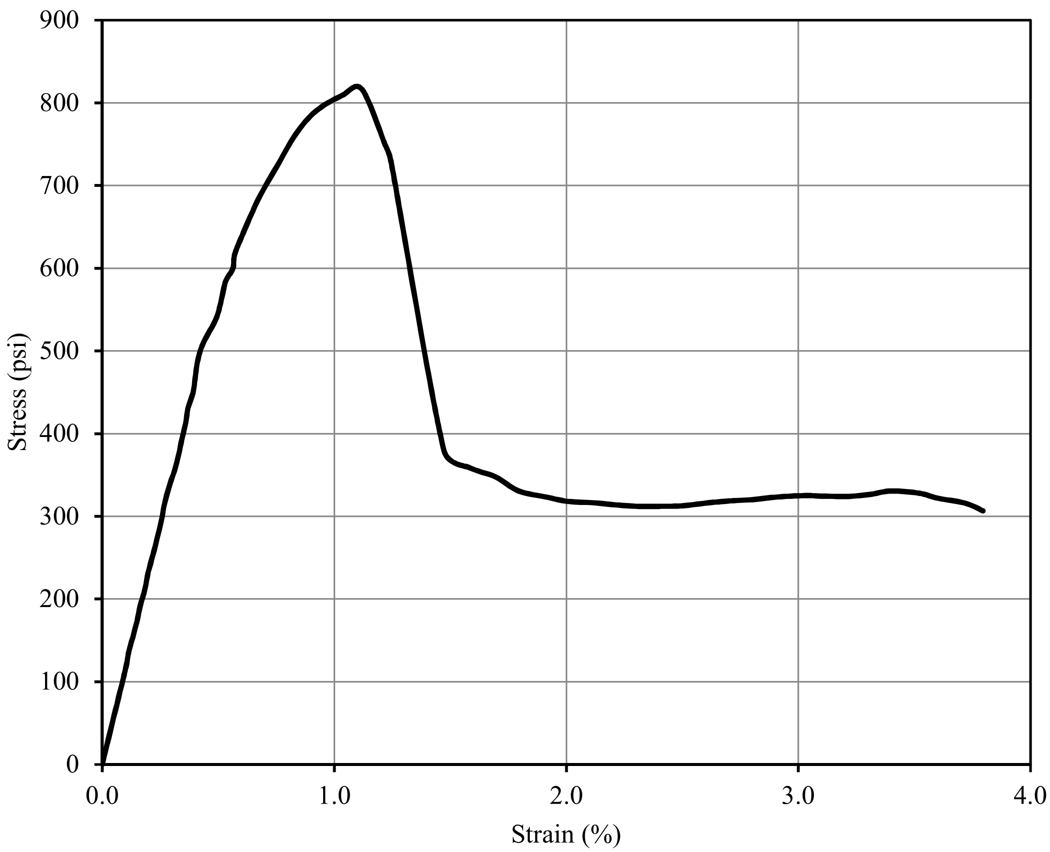
Test Information		Specimen Information		
I.D.:	T-2-B	Initial Height:	3.811	in
Test Date:	2017-10-14	Initial Diameter:	2.044	in
Strain Rate:	1 %/min	Initial Area:	3.281	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	370.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



Test Result					
Peak deviator stress (w/ Height correction)	736	psi	Strain at failure, εf :	0.98	%

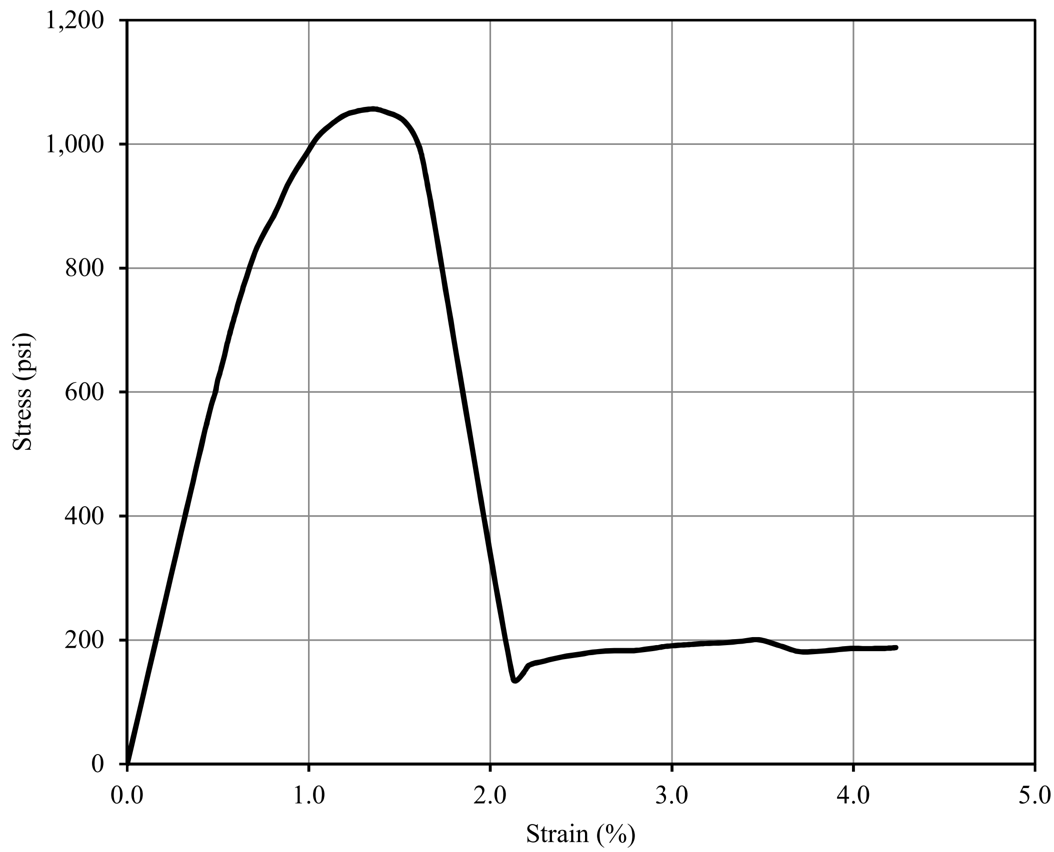
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-2-G	**Specimen Information**		
Test Date:	2017-10-14	Initial Height:	3.854	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	375.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



Test Result					
Peak deviator stress (w/ Height correction)	809	psi	Strain at failure, εf :	1.12	%

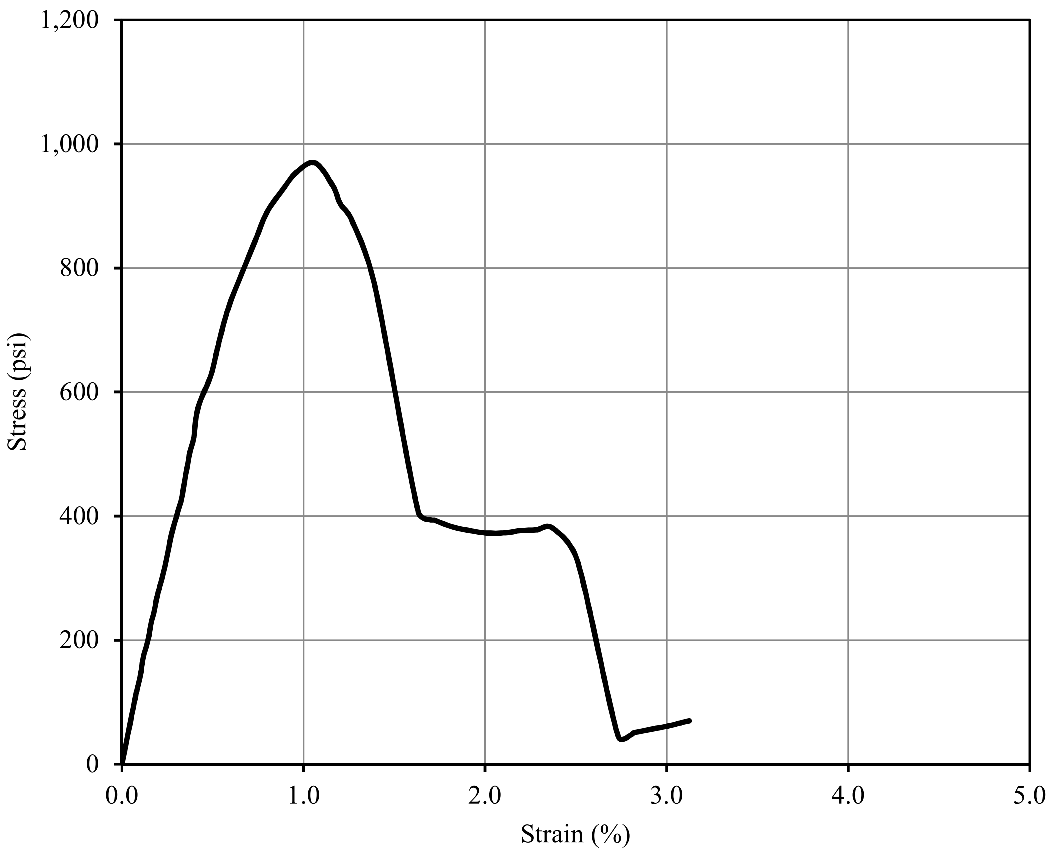
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.1	days
Tested by:	Hwanik Ju	Curing temperature	25	°C

Test Information		Specimen Information		
I.D.:	T-2-C	Initial Height:	3.769	in
Test Date:	2017-10-21	Initial Diameter:	2.039	in
Strain Rate:	1 %/min	Initial Area:	3.265	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	366.6	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	113	pcf



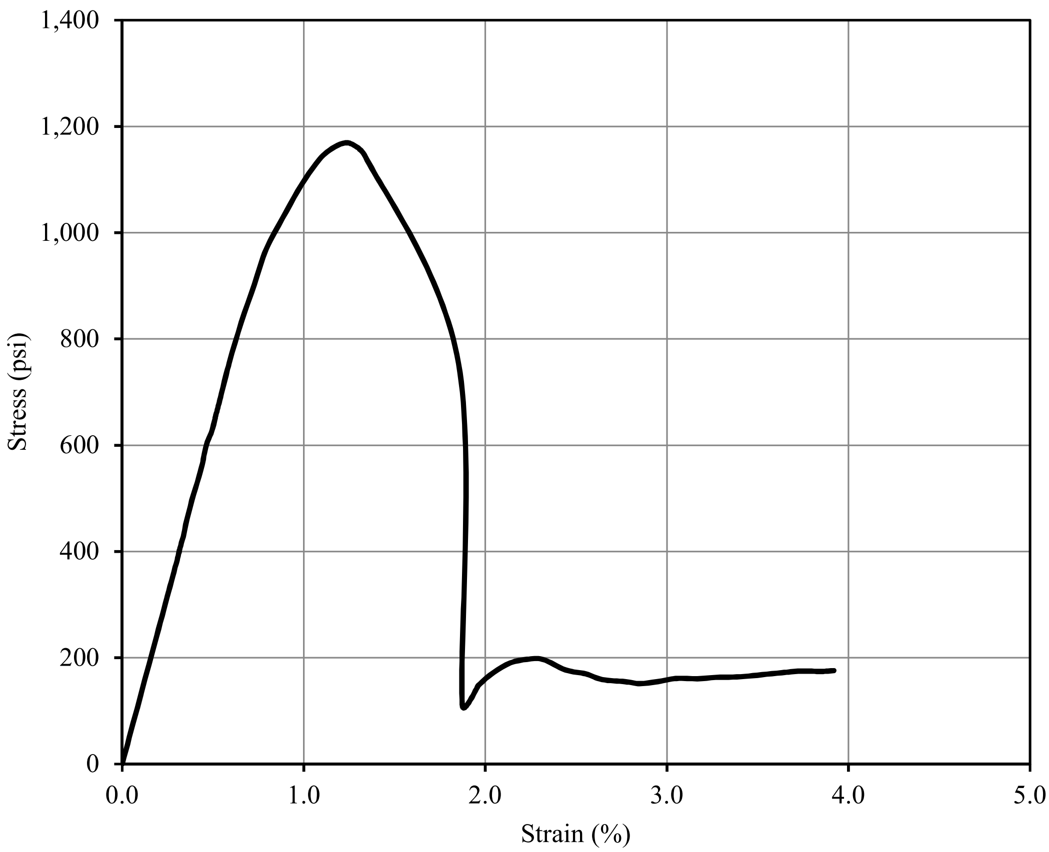
Test Result					
Peak deviator stress (w/ Height correction)	1,044	psi	Strain at failure, εf :	1.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.2	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-2-F	**Specimen Information**		
Test Date:	2017-10-21	Initial Height:	3.857	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	375.3	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



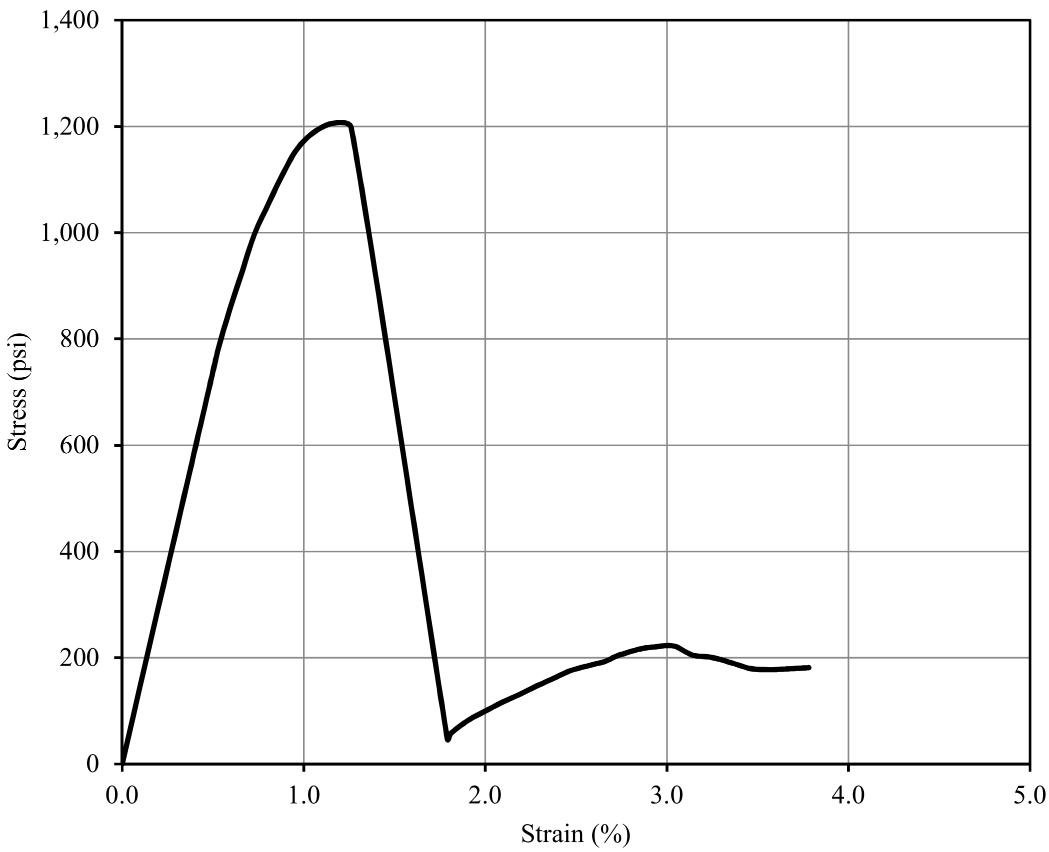
Test Result					
Peak deviator stress (w/ Height correction)	961	psi	Strain at failure, εf :	1.06	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-2-D	**Specimen Information**		
Test Date:	2017-11-04	Initial Height:	3.861	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	376.4	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	114	pcf



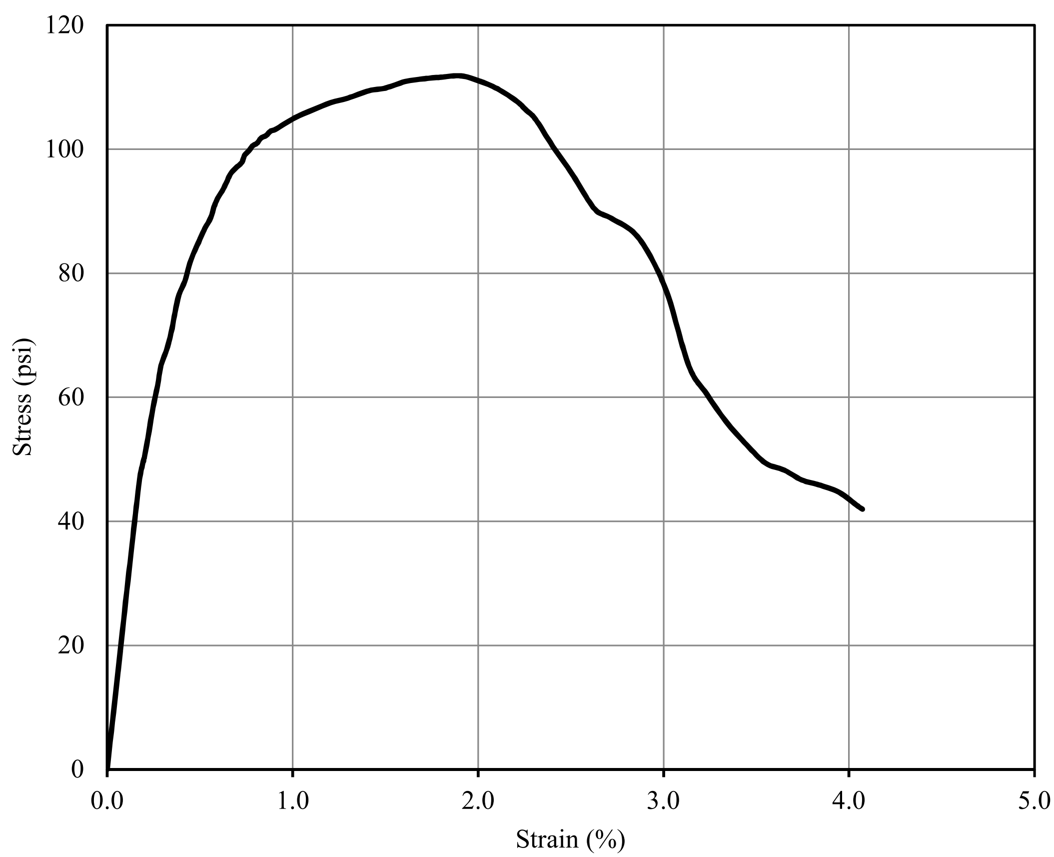
Test Result					
Peak deviator stress (w/ Height correction)	1,159	psi	Strain at failure, εf :	1.24	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
		Specimen Information		
I.D.:	T-2-E	Initial Height:	3.904	in
Test Date:	2017-11-04	Initial Diameter:	2.041	in
Strain Rate:	1 %/min	Initial Area:	3.272	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	380.9	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	114	pcf



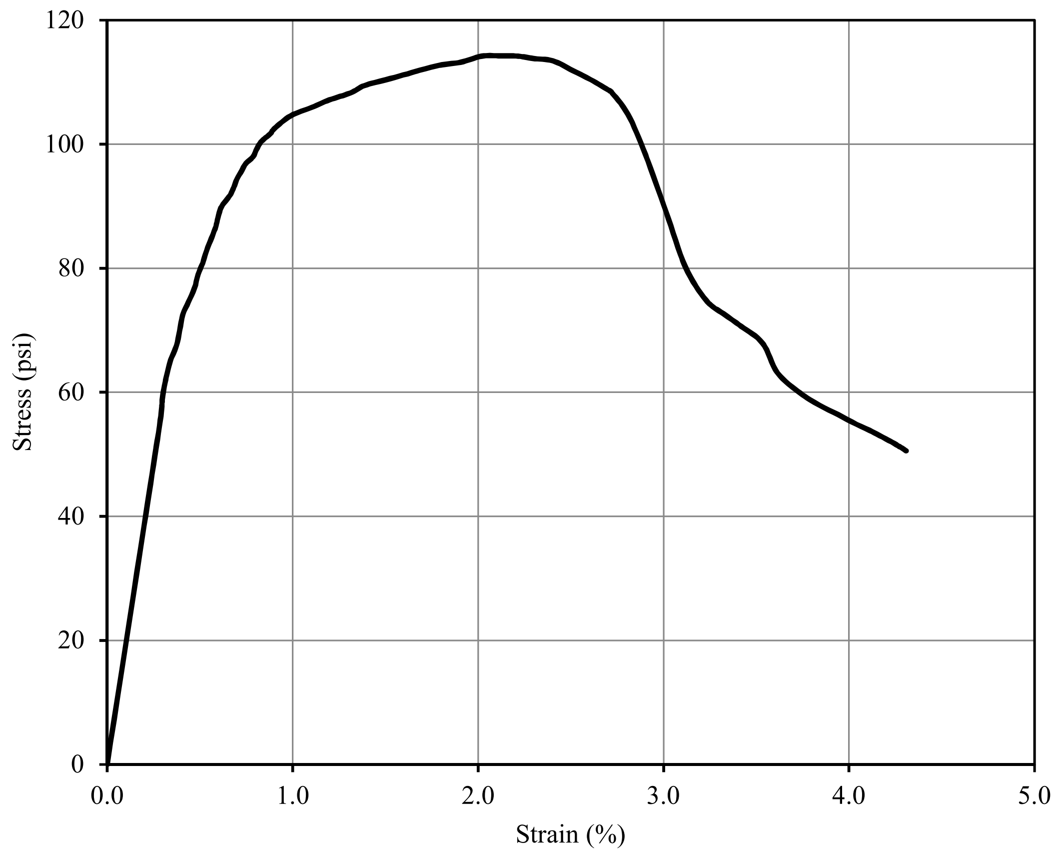
Test Result					
Peak deviator stress (w/ Height correction)	1,198	psi	Strain at failure, εf :	1.17	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-3-A	**Specimen Information**		
Test Date:	2017-10-12	Initial Height:	3.759	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	357.9	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	111	pcf



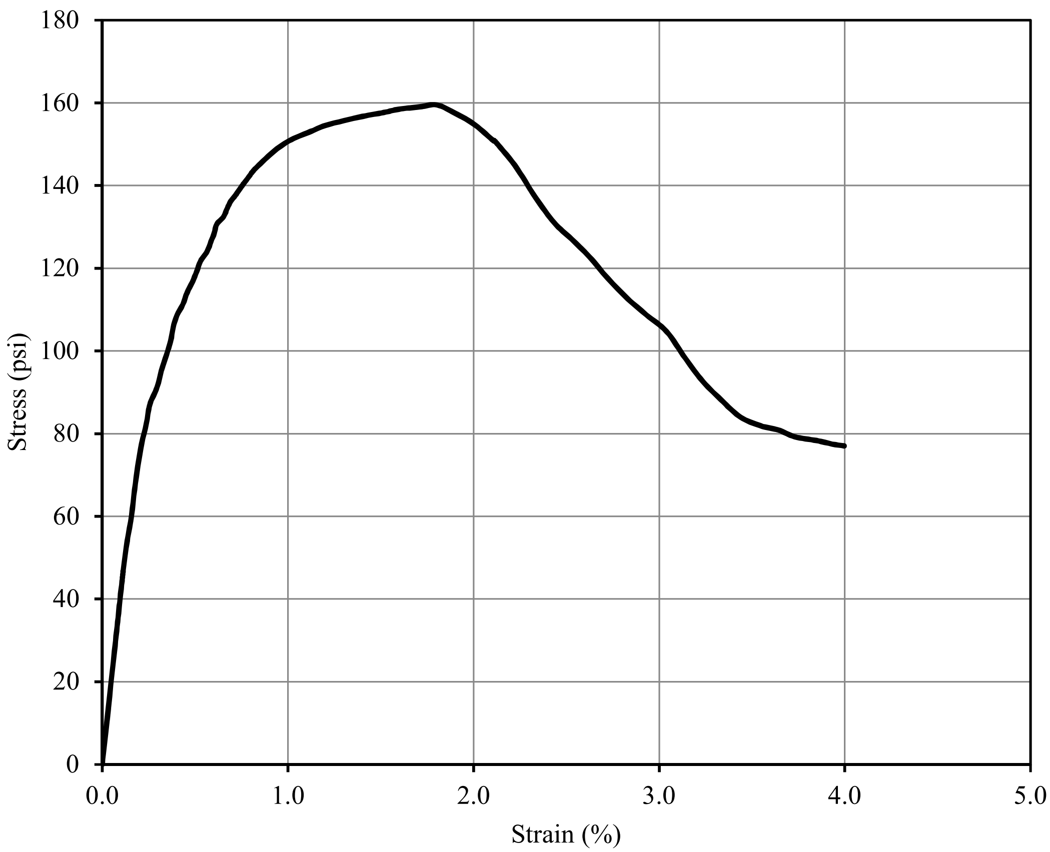
Test Result					
Peak deviator stress (w/ Height correction)	110	psi	Strain at failure, εf :	1.91	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-3-H	**Specimen Information**		
Test Date:	2017-10-12	Initial Height:	3.519	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	333.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf



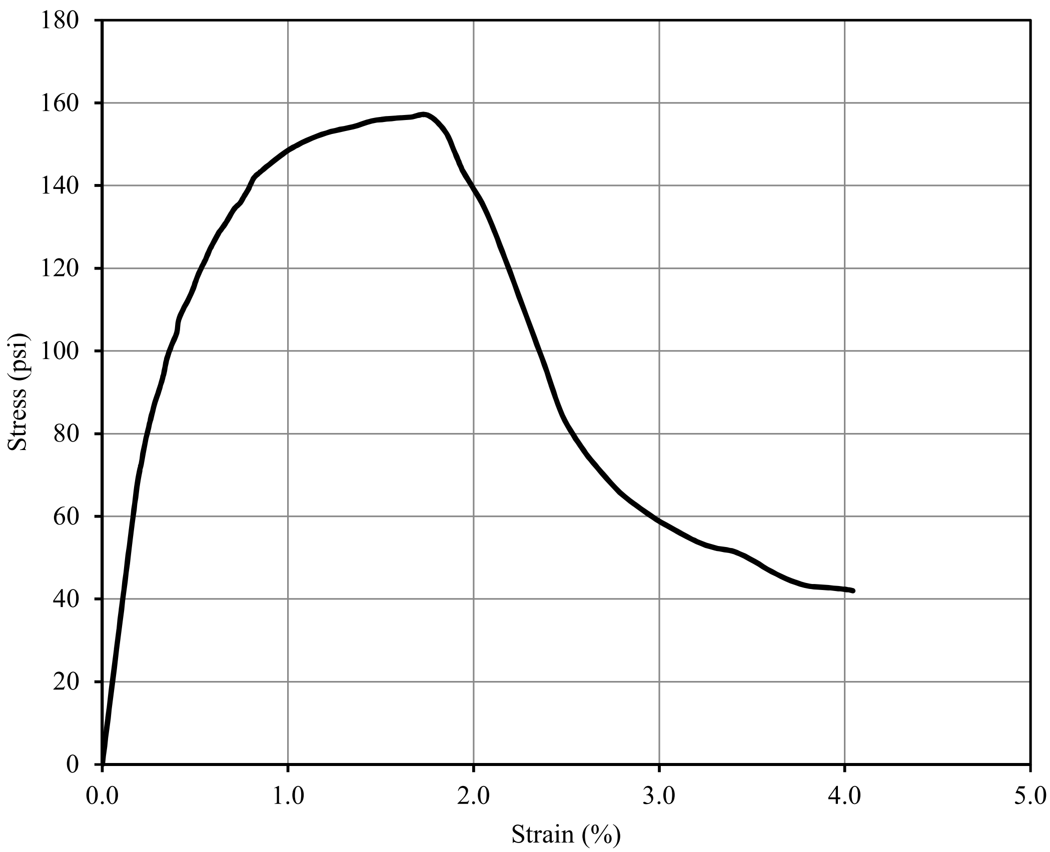
Test Result					
Peak deviator stress (w/ Height correction)	112	psi	Strain at failure, εf :	2.11	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-3-B	**Specimen Information**		
Test Date:	2017-10-16	Initial Height:	3.713	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	354.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



Test Result					
Peak deviator stress (w/ Height correction)	157	psi	Strain at failure, εf :	1.80	%

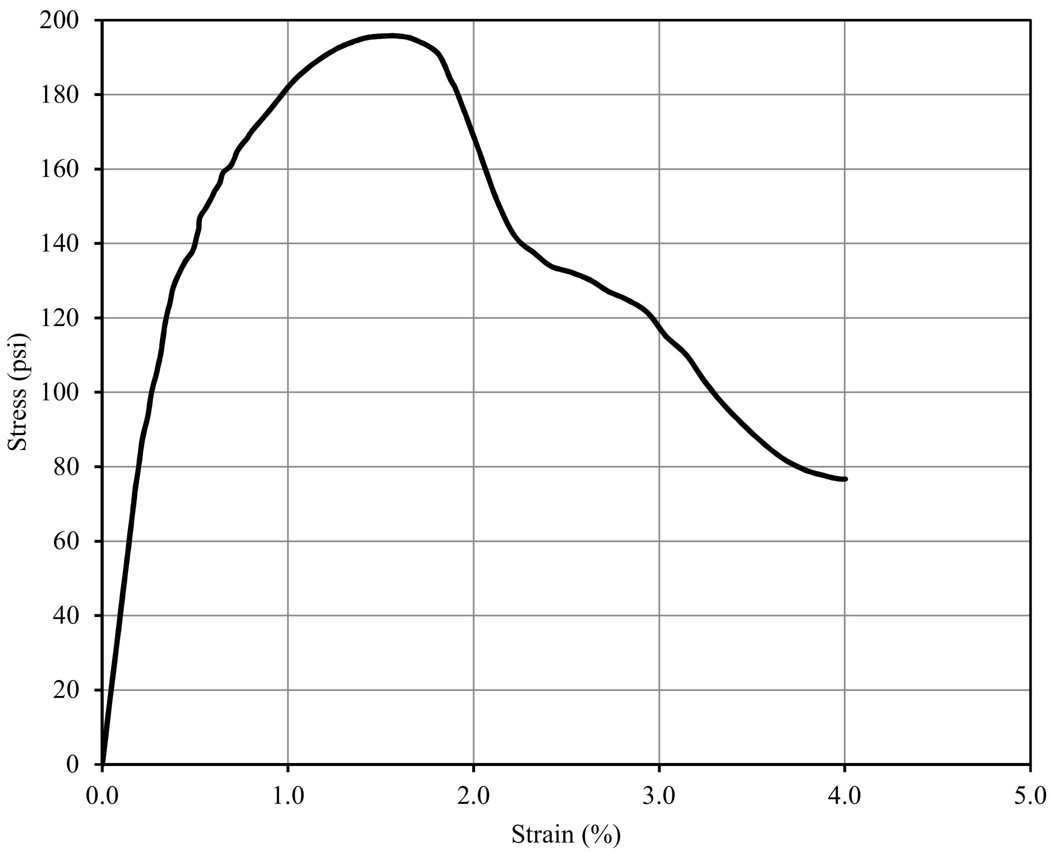
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-3-G	**Specimen Information**		
Test Date:	2017-10-16	Initial Height:	3.687	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	351.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



Test Result					
Peak deviator stress (w/ Height correction)	155	psi	Strain at failure, εf :	1.75	%

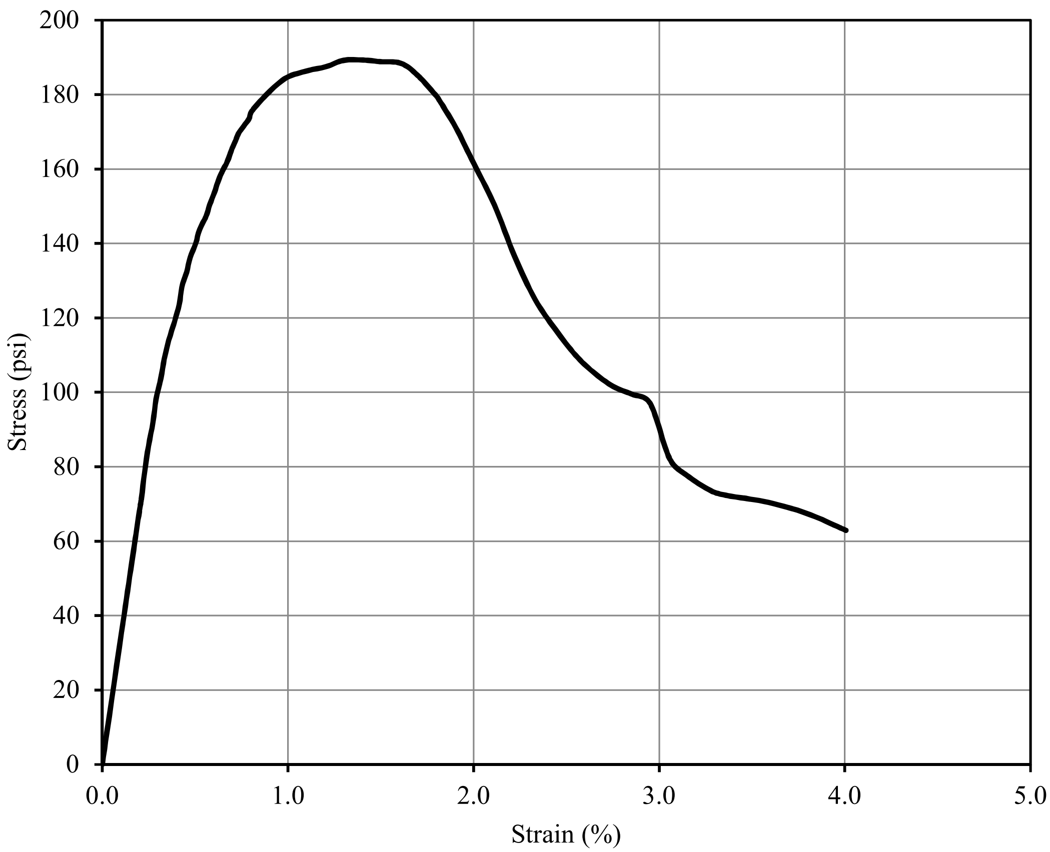
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C

Test Information		Specimen Information		
I.D.:	T-3-C	Initial Height:	3.771	in
Test Date:	2017-10-23	Initial Diameter:	2.042	in
Strain Rate:	1 %/min	Initial Area:	3.275	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	358.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



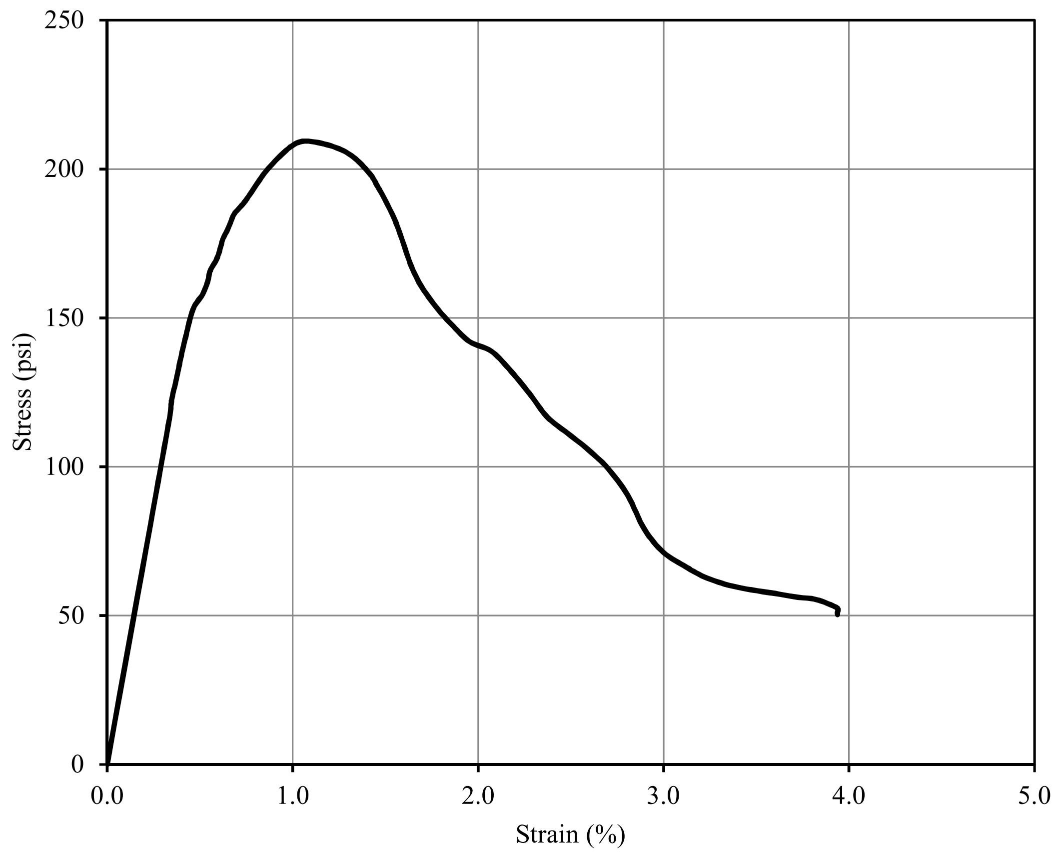
Test Result					
Peak deviator stress (w/ Height correction)	193	psi	Strain at failure, εf :	1.59	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-3-F	**Specimen Information**		
Test Date:	2017-10-23	Initial Height:	3.651	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	347.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



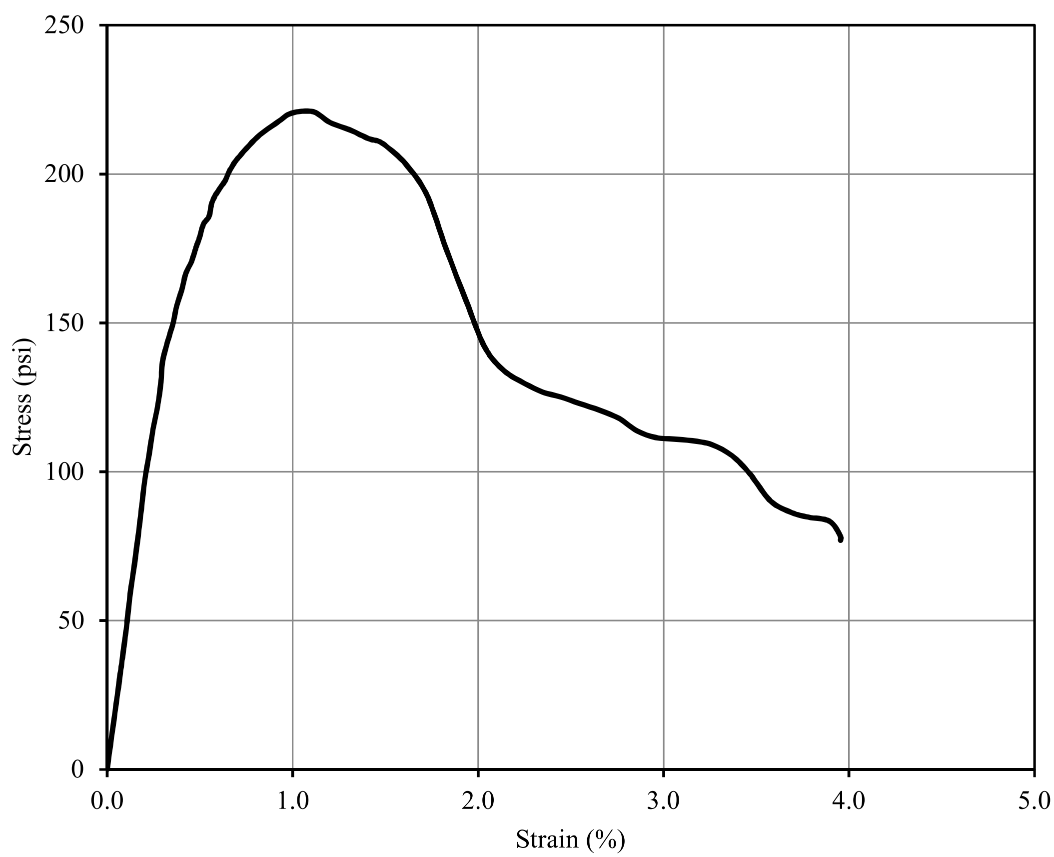
Test Result					
Peak deviator stress (w/ Height correction)	186	psi	Strain at failure, εf :	1.41	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-3-D	**Specimen Information**		
Test Date:	2017-11-06	Initial Height:	3.55	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	338.9	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



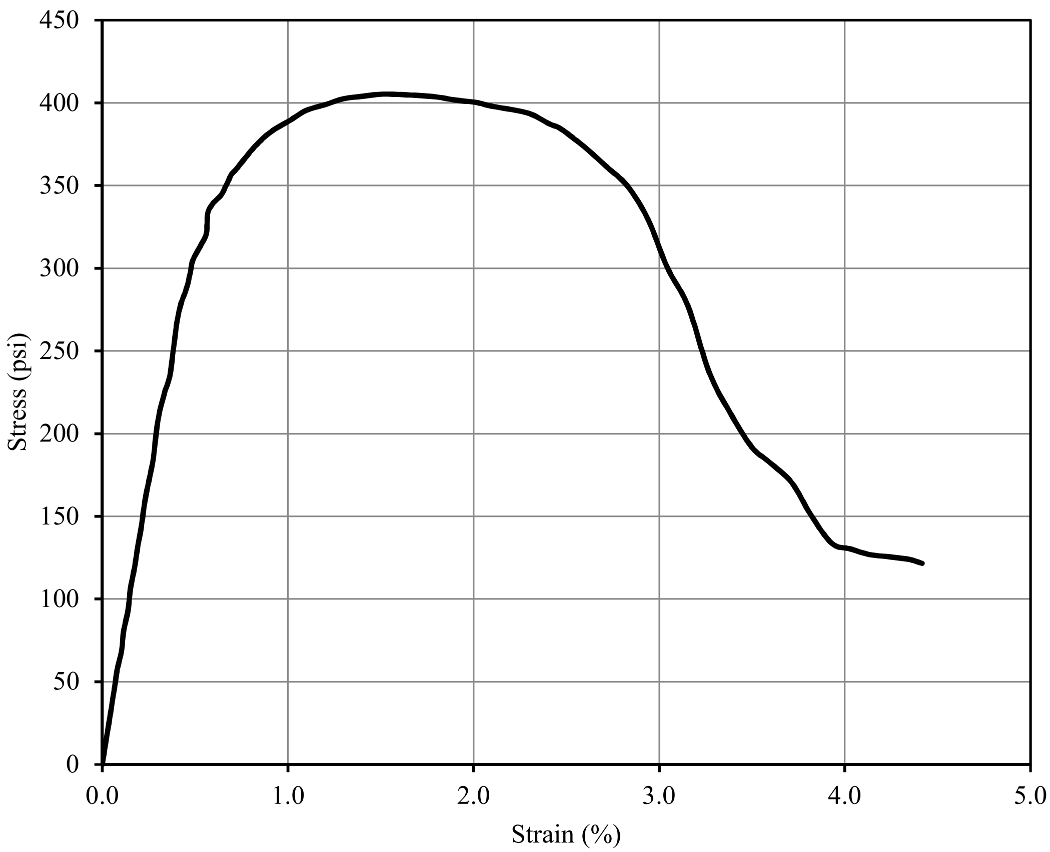
Test Result					
Peak deviator stress (w/ Height correction)	205	psi	Strain at failure, εf :	1.12	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-3-E	**Specimen Information**		
Test Date:	2017-11-06	Initial Height:	3.691	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	352.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



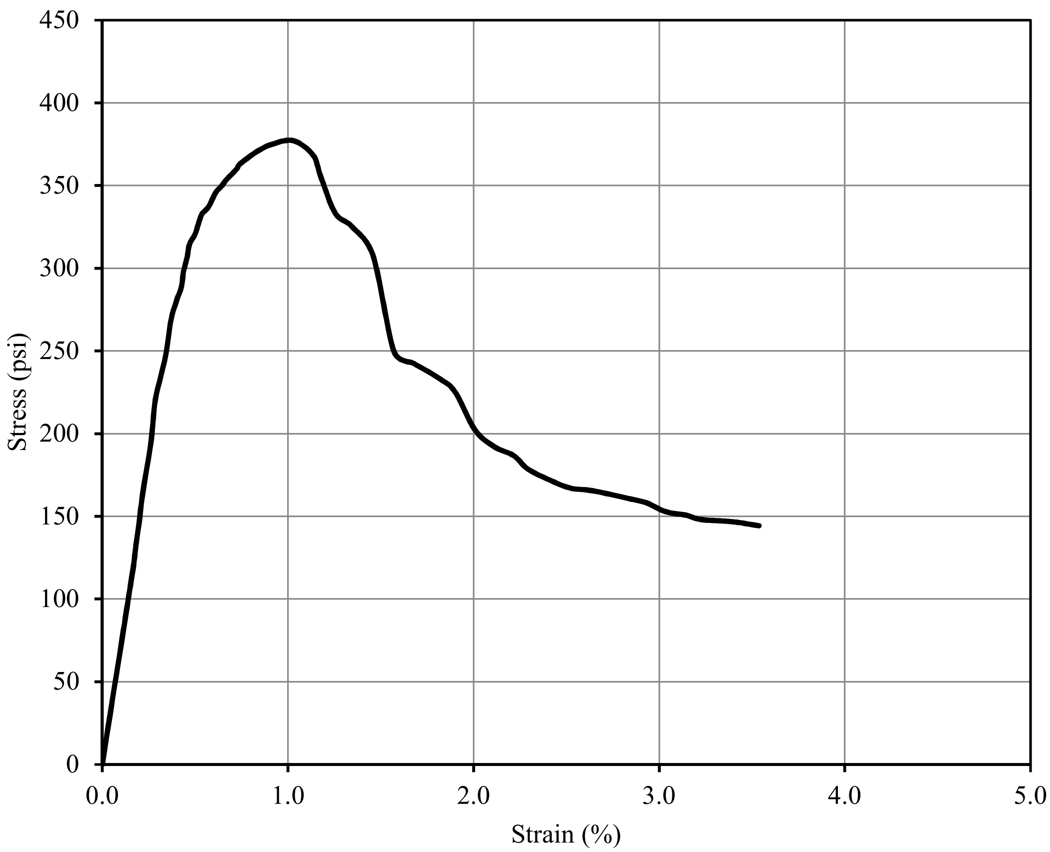
Test Result					
Peak deviator stress (w/ Height correction)	218	psi	Strain at failure, εf :	1.11	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-A	**Specimen Information**		
Test Date:	2017-10-16	Initial Height:	3.792	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	346.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



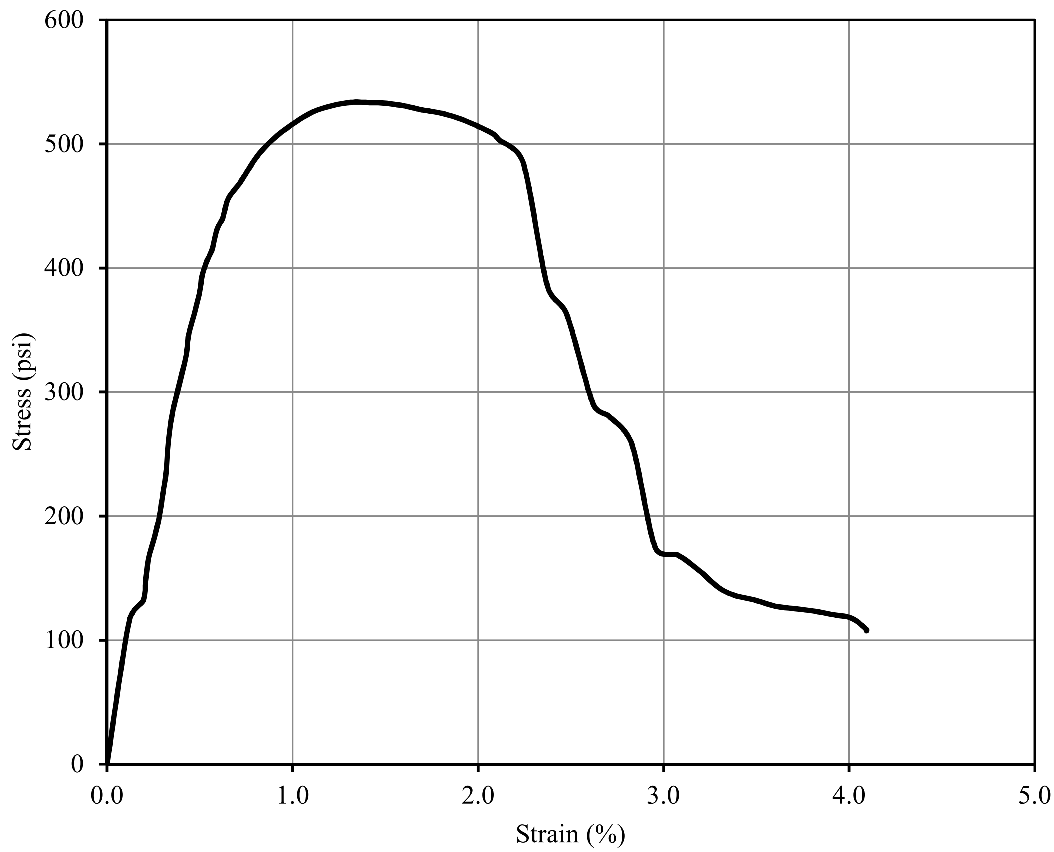
Test Result					
Peak deviator stress (w/ Height correction)	401	psi	Strain at failure, εf :	1.51	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-H	**Specimen Information**		
Test Date:	2017-10-16	Initial Height:	3.885	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	354.7	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



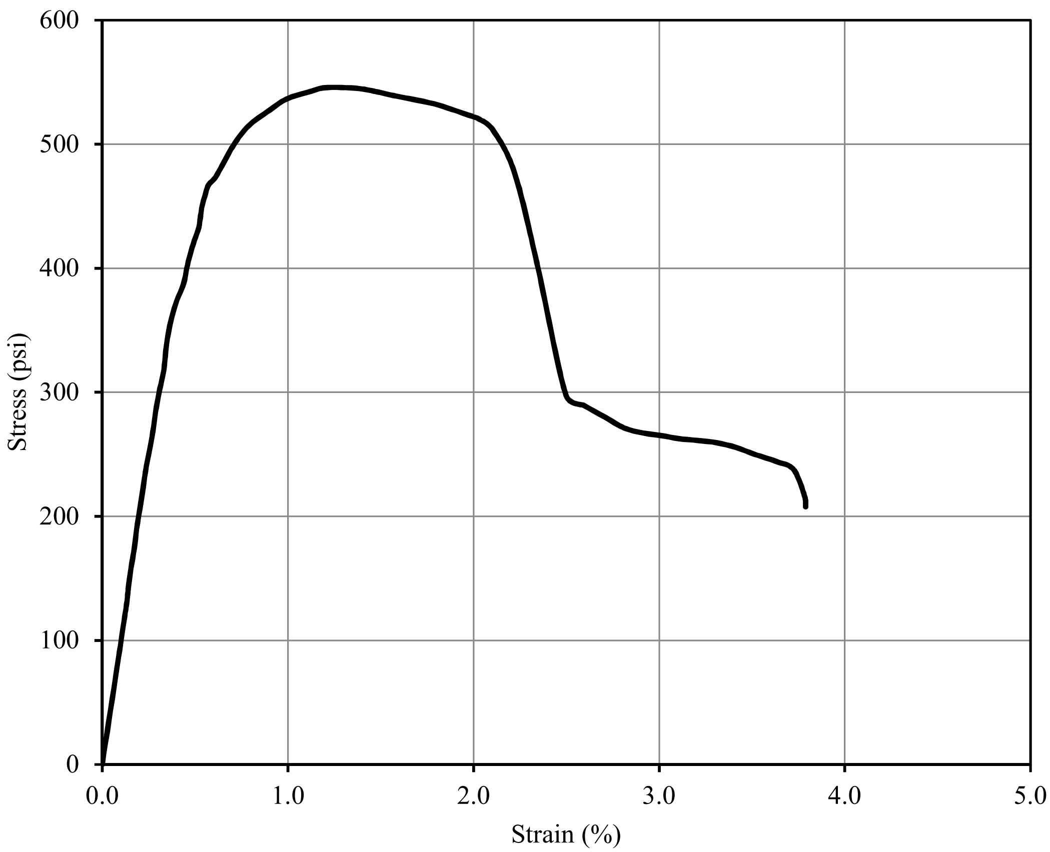
Test Result					
Peak deviator stress (w/ Height correction)	374	psi	Strain at failure, εf :	1.03	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-B	**Specimen Information**		
Test Date:	2017-10-20	Initial Height:	3.968	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	363.7	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



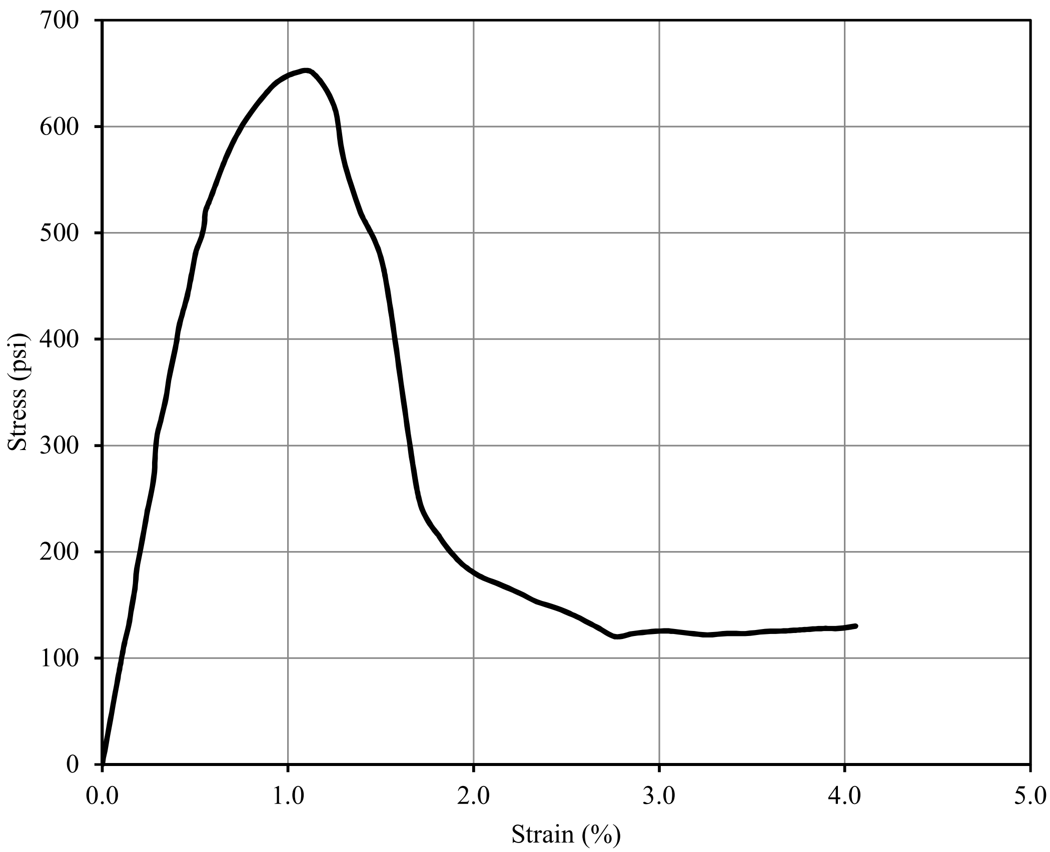
Test Result					
Peak deviator stress (w/ Height correction)	531	psi	Strain at failure, εf :	1.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-G	**Specimen Information**		
Test Date:	2017-10-20	Initial Height:	3.738	in
Strain Rate:	1 %/min	Initial Diameter:	2.040	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	341.9	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	107	pcf



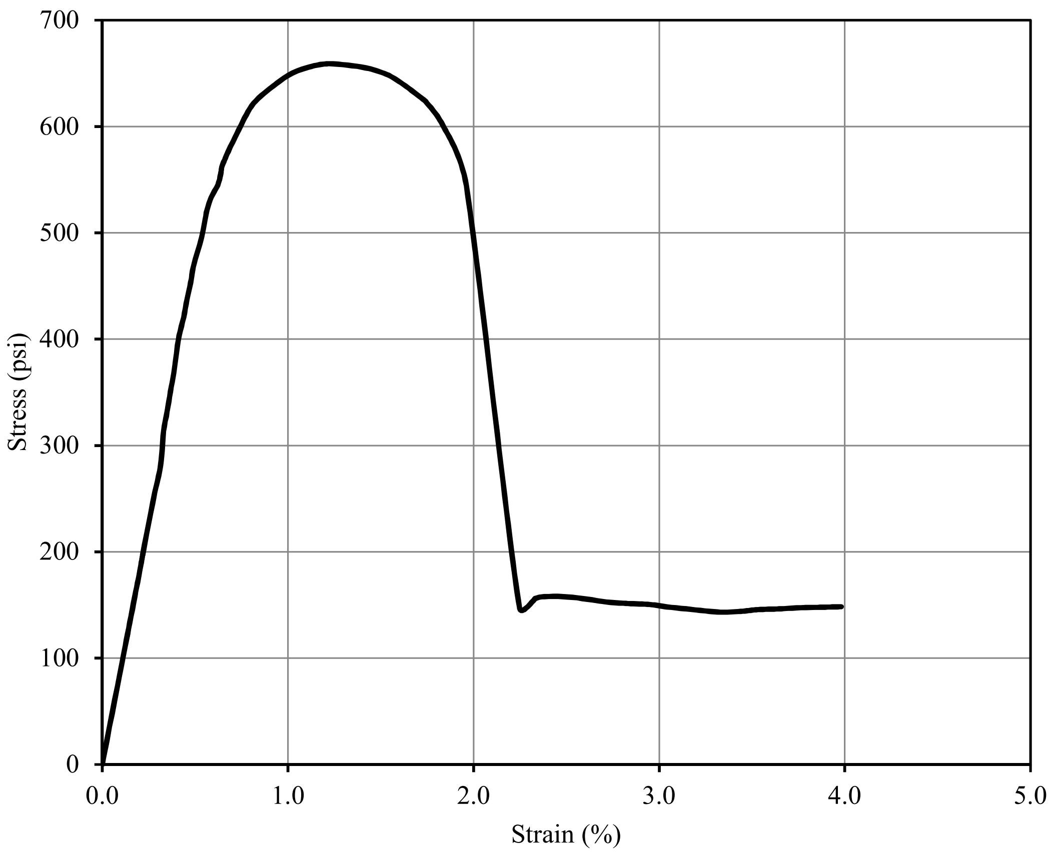
Test Result					
Peak deviator stress (w/ Height correction)	538	psi	Strain at failure, εf :	1.29	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-C	**Specimen Information**		
Test Date:	2017-10-27	Initial Height:	3.695	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	338.8	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	107	pcf



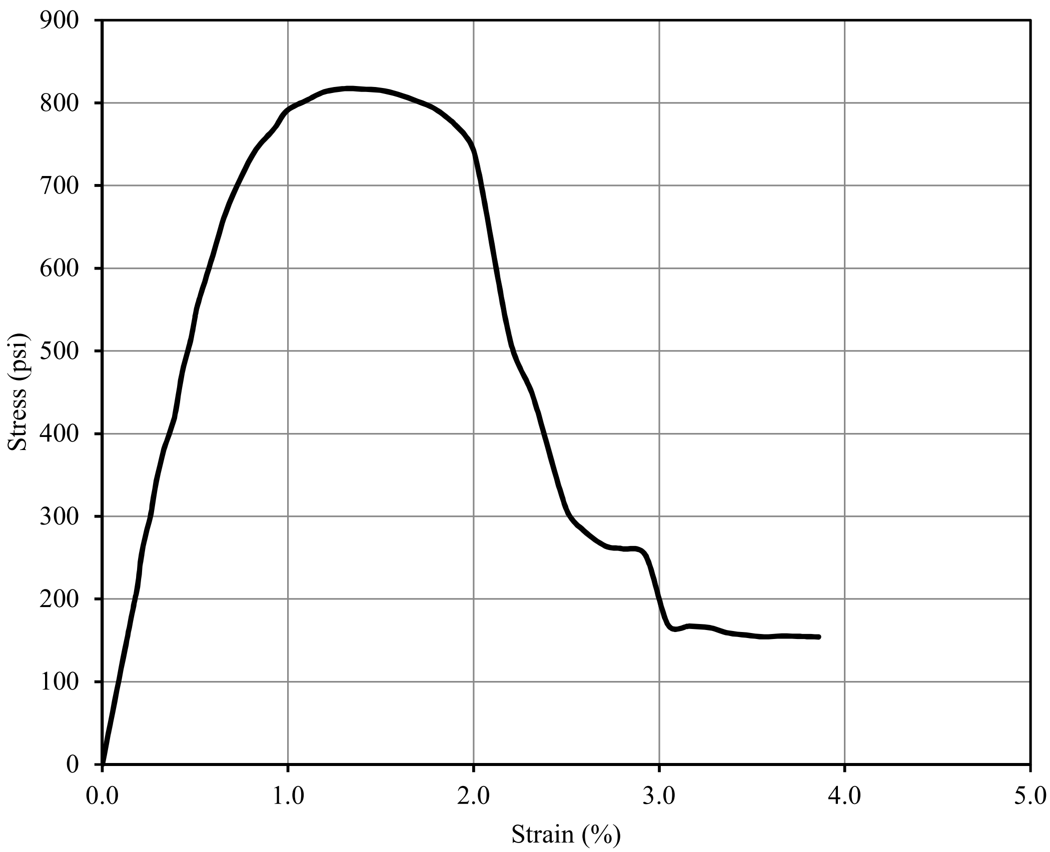
Test Result					
Peak deviator stress (w/ Height correction)	641	psi	Strain at failure, εf :	1.04	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-F	**Specimen Information**		
Test Date:	2017-10-27	Initial Height:	3.898	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	356.9	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



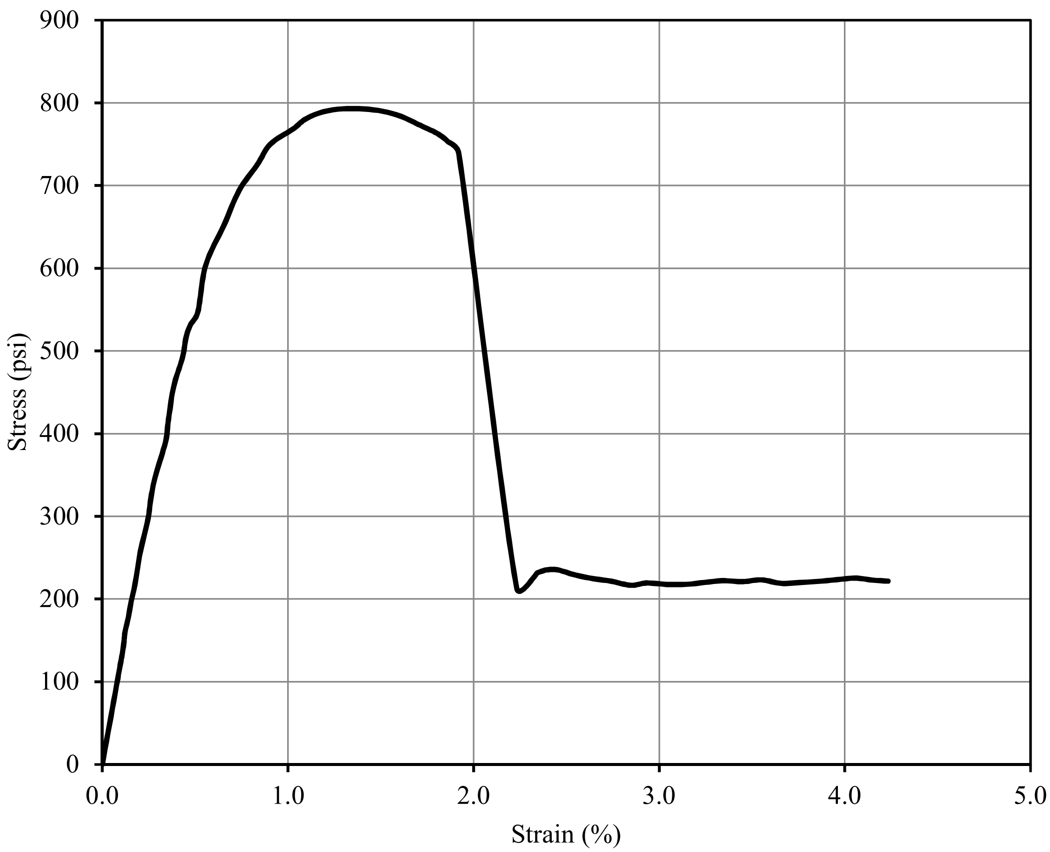
Test Result					
Peak deviator stress (w/ Height correction)	654	psi	Strain at failure, εf :	1.22	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-D	**Specimen Information**		
Test Date:	2017-11-10	Initial Height:	3.752	in
Strain Rate:	1 %/min	Initial Diameter:	2.037	in
Mixture Proportion		Initial Area:	3.259	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	343.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



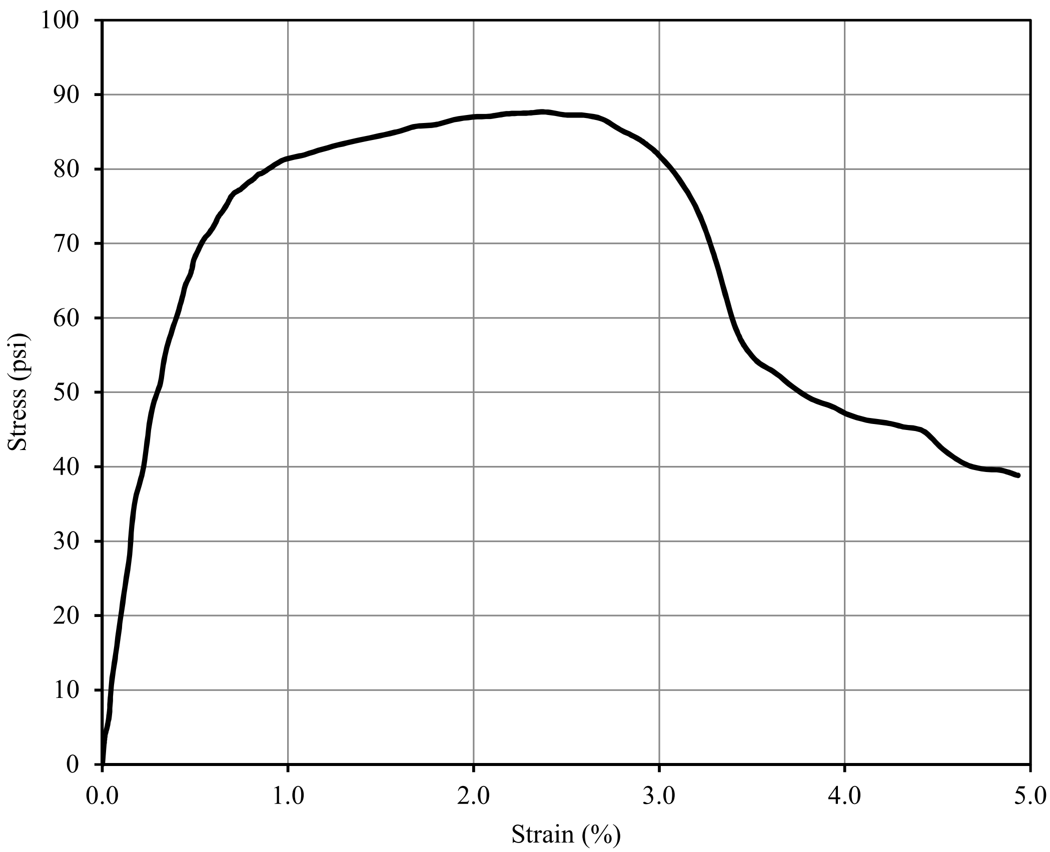
Test Result					
Peak deviator stress (w/ Height correction)	807	psi	Strain at failure, εf :	1.30	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-4-E	**Specimen Information**		
Test Date:	2017-11-10	Initial Height:	3.793	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	347.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



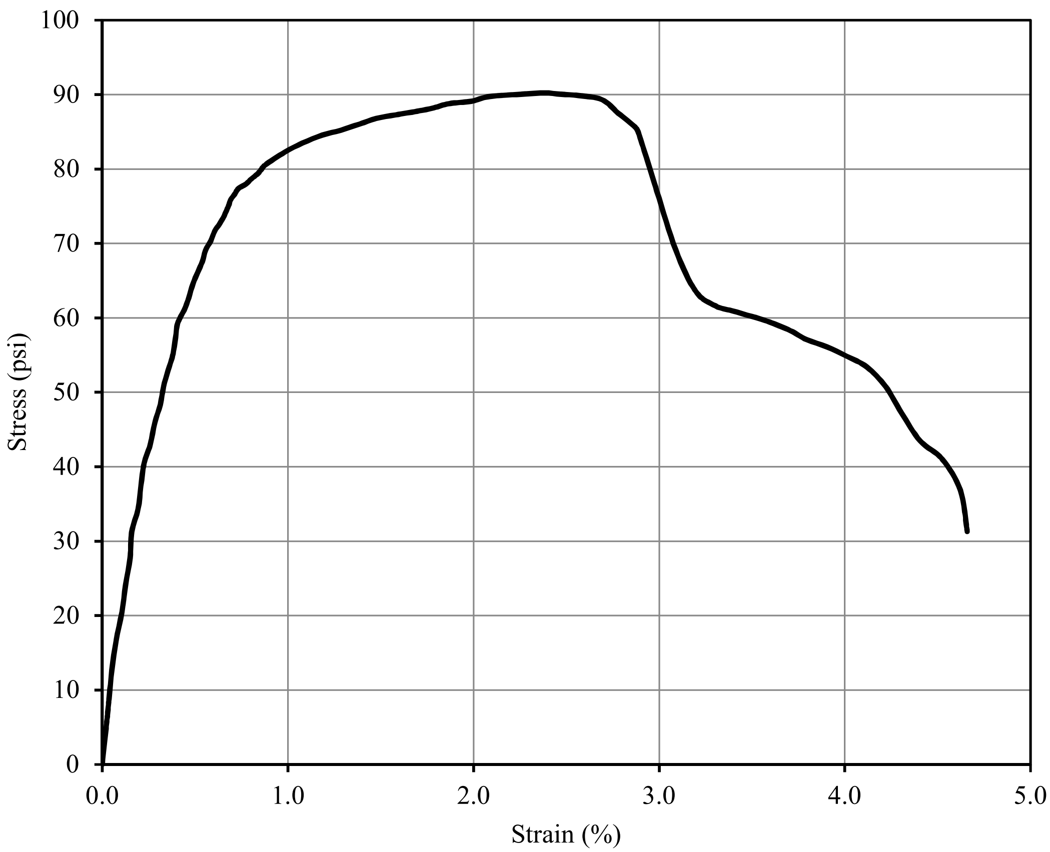
Test Result					
Peak deviator stress (w/ Height correction)	784	psi	Strain at failure, εf :	1.30	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-5-A	**Specimen Information**		
Test Date:	2017-10-18	Initial Height:	3.614	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	338.1	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	110	pcf



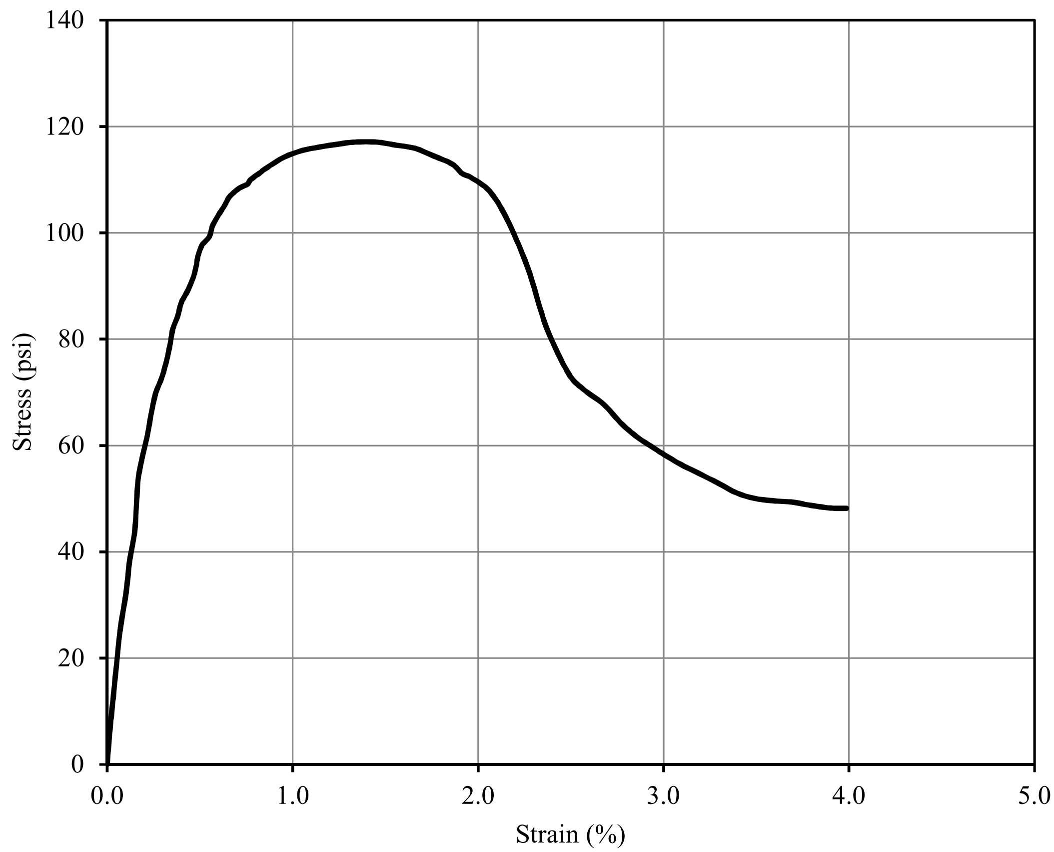
Test Result					
Peak deviator stress (w/ Height correction)	86	psi	Strain at failure, εf :	2.39	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-5-H	**Specimen Information**		
Test Date:	2017-10-18	Initial Height:	3.603	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	337.0	g
(w:c)$_{slurry}$:	1.4	Unit Weight:	109	pcf



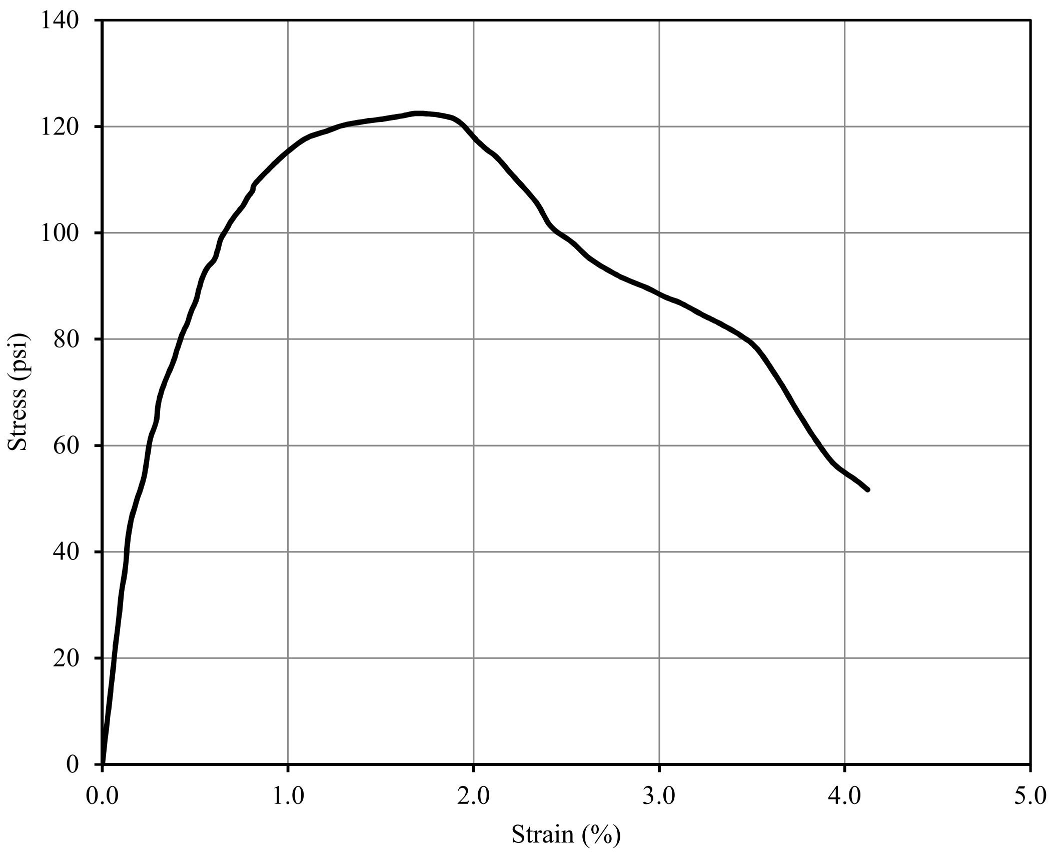
Test Result					
Peak deviator stress (w/ Height correction)	89	psi	Strain at failure, εf :	2.38	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-5-B	**Specimen Information**		
Test Date:	2017-10-22	Initial Height:	3.562	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	333.5	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	109	pcf



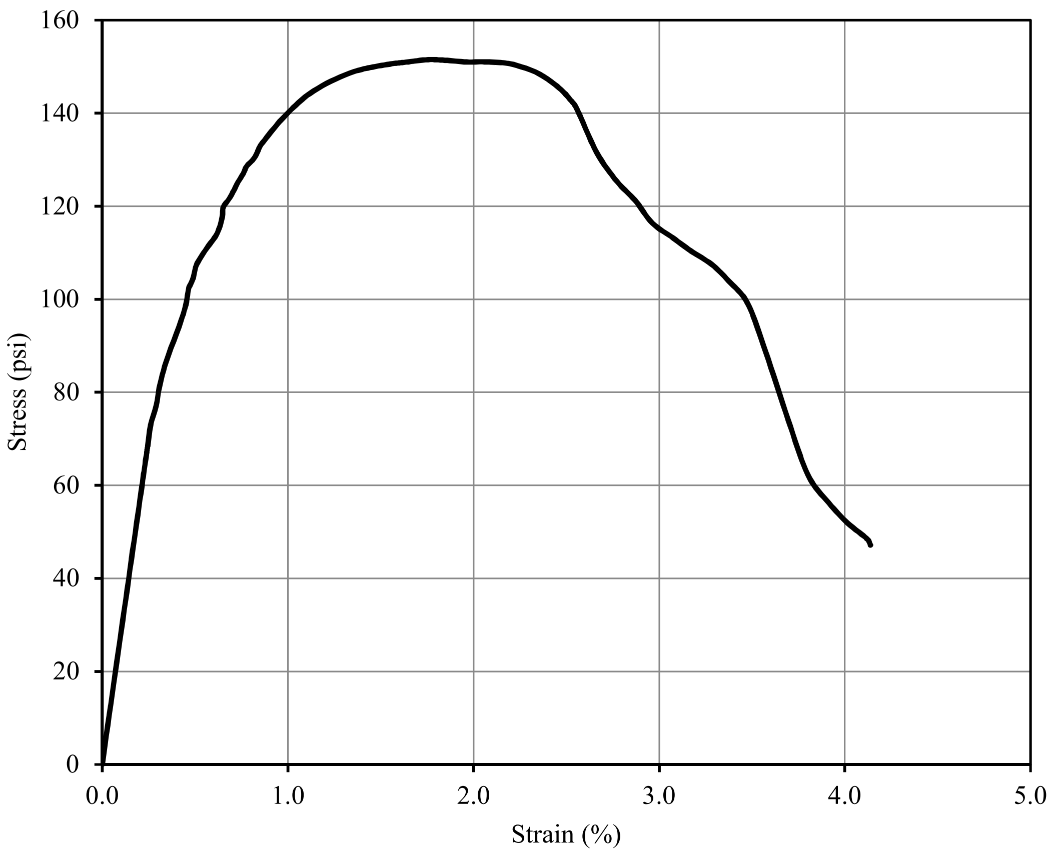
Test Result					
Peak deviator stress (w/ Height correction)	115	psi	Strain at failure, εf :	1.34	%

<table>
<tr><th colspan="2">Test Information</th><th colspan="3">Curing Condition</th></tr>
<tr><td>Type of Test:</td><td>UCS Test</td><td>Curing Period</td><td>6.9</td><td>days</td></tr>
<tr><td>Tested by:</td><td>Hwanik Ju</td><td>Curing temperature</td><td>25</td><td>°C</td></tr>
<tr><td>I.D.:</td><td>T-5-G</td><th colspan="3">Specimen Information</th></tr>
<tr><td>Test Date:</td><td>2017-10-22</td><td>Initial Height:</td><td>3.846</td><td>in</td></tr>
<tr><td>Strain Rate:</td><td>1 %/min</td><td>Initial Diameter:</td><td>2.036</td><td>in</td></tr>
<tr><th colspan="2">Mixture Proportion</th><td>Initial Area:</td><td>3.256</td><td>in</td></tr>
<tr><td>$\alpha_{in\text{-}place}$ (kg/m^3):</td><td>125</td><td>Weight:</td><td>359.2</td><td>g</td></tr>
<tr><td>$(w:c)_{slurry}$:</td><td>1.4</td><td>Unit Weight:</td><td>109</td><td>pcf</td></tr>
</table>



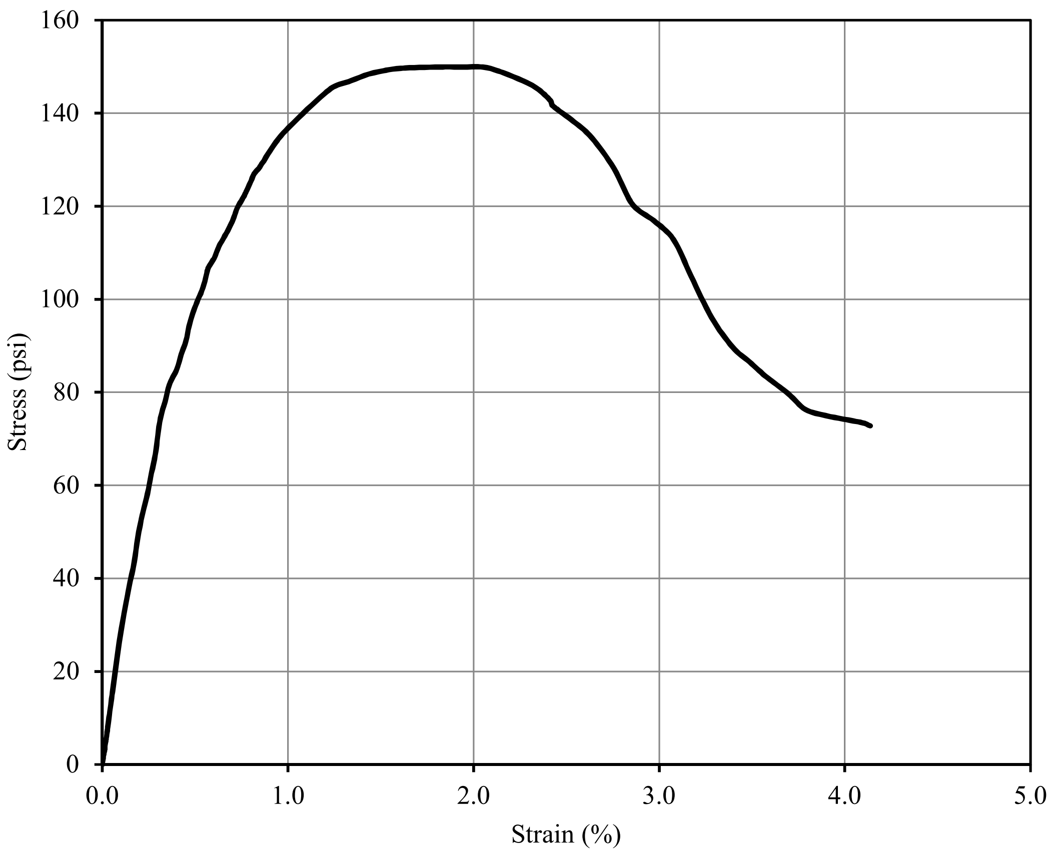
<table>
<tr><th colspan="6">Test Result</th></tr>
<tr><td>Peak deviator stress
(w/ Height correction)</td><td>121</td><td>psi</td><td>Strain at failure, εf :</td><td>1.70</td><td>%</td></tr>
</table>

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-5-C	**Specimen Information**		
Test Date:	2017-10-29	Initial Height:	3.775	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	357.2	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	111	pcf



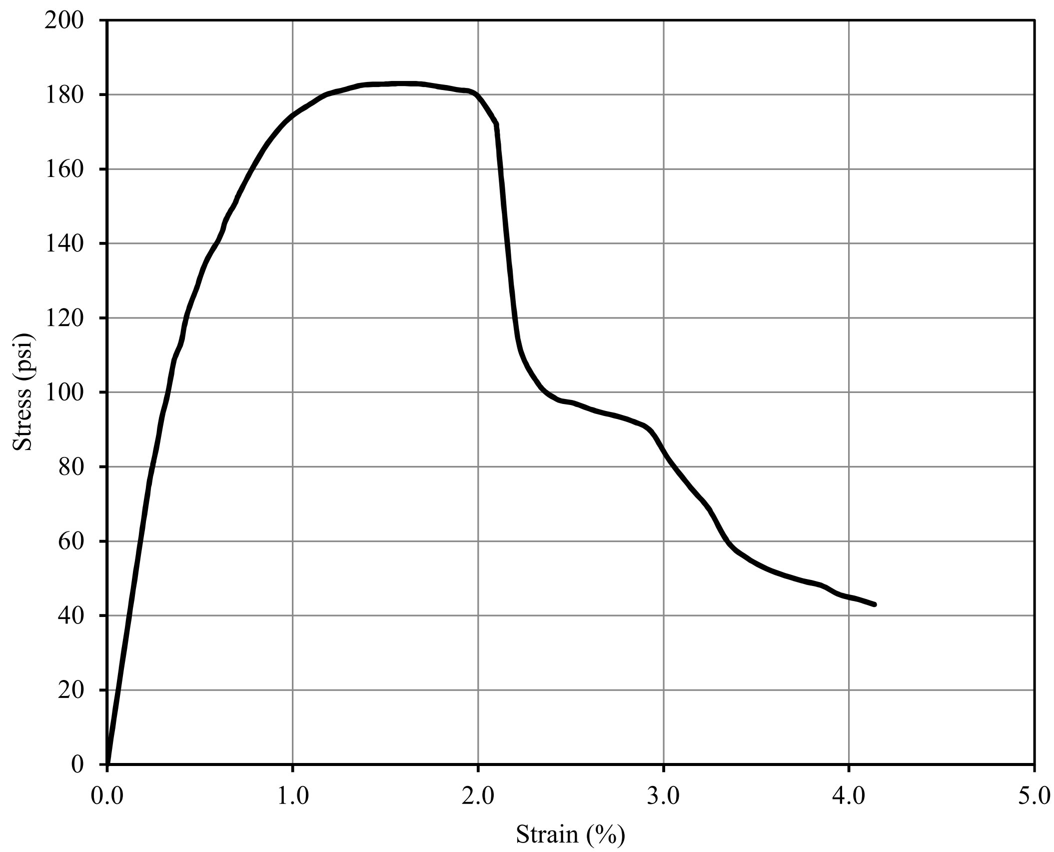
Test Result					
Peak deviator stress (w/ Height correction)	150	psi	Strain at failure, εf :	1.76	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-5-F	**Specimen Information**		
Test Date:	2017-10-29	Initial Height:	3.668	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	342.1	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	109	pcf



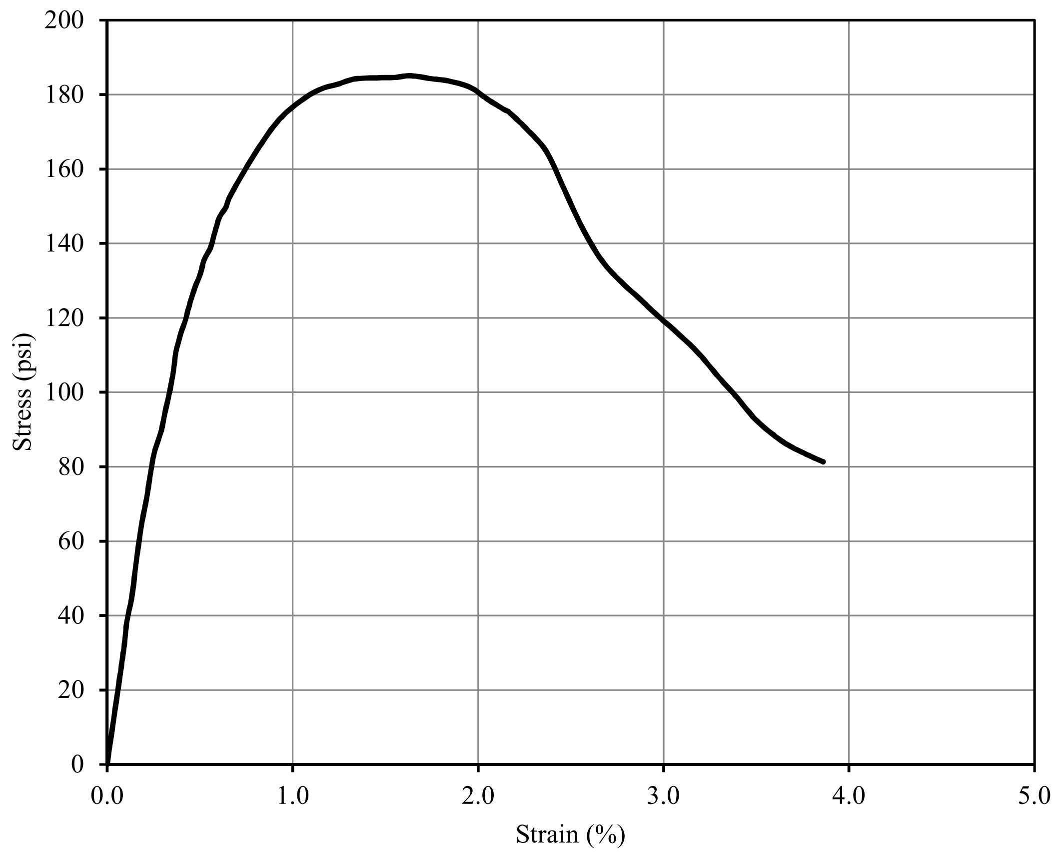
Test Result					
Peak deviator stress (w/ Height correction)	148	psi	Strain at failure, εf :	1.85	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-5-D	**Specimen Information**		
Test Date:	2017-11-12	Initial Height:	3.757	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	351.3	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	109	pcf



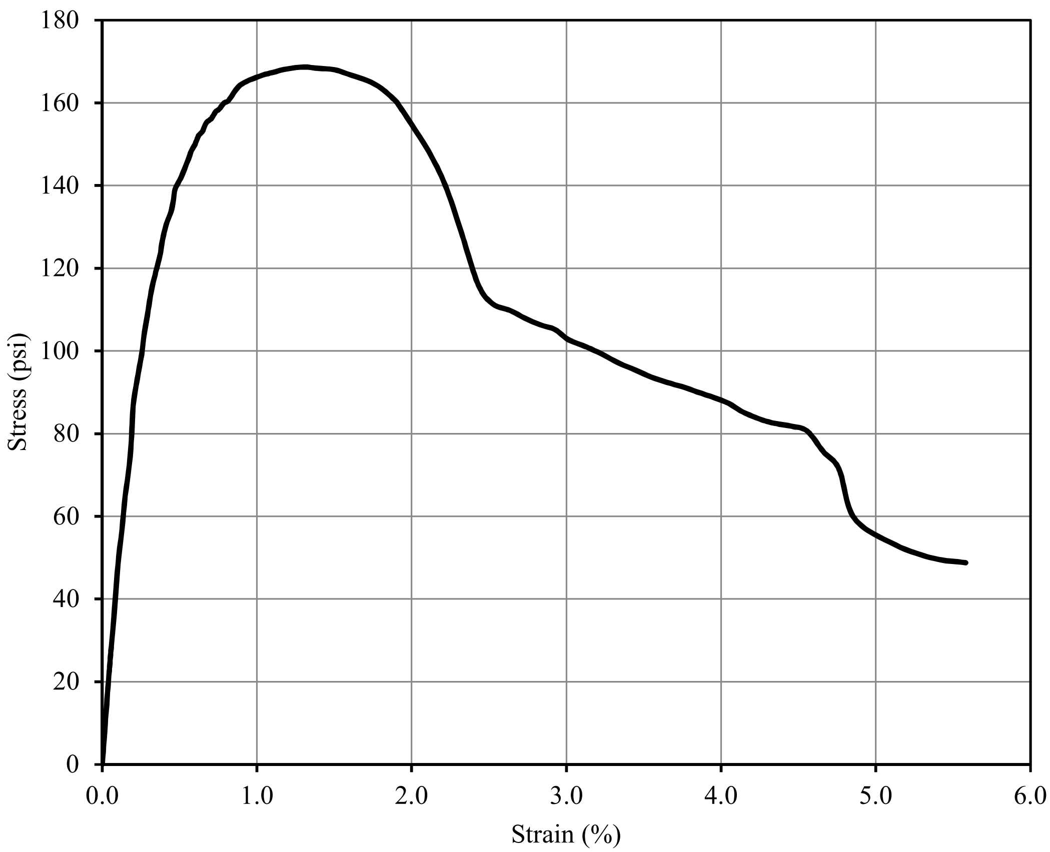
Test Result					
Peak deviator stress (w/ Height correction)	181	psi	Strain at failure, εf :	1.58	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-5-E	**Specimen Information**		
Test Date:	2017-11-12	Initial Height:	3.715	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	347.4	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	109	pcf



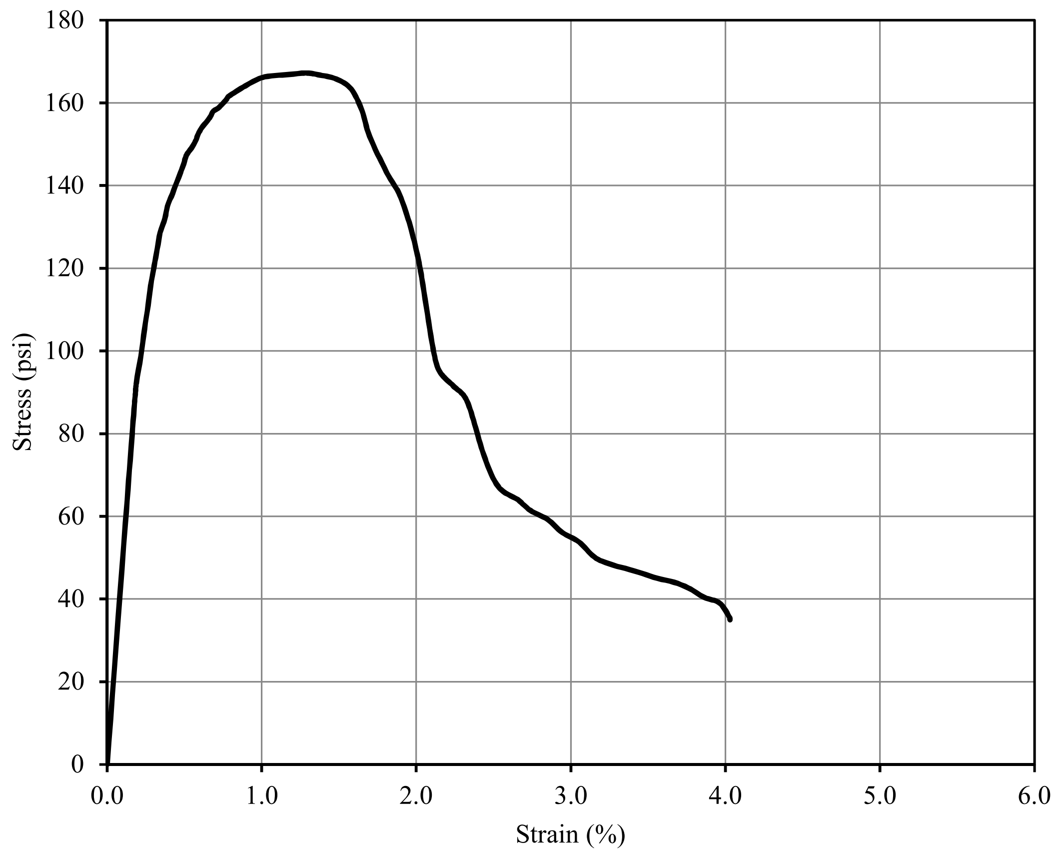
Test Result					
Peak deviator stress (w/ Height correction)	182	psi	Strain at failure, εf :	1.64	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-A	**Specimen Information**		
Test Date:	2017-10-22	Initial Height:	3.692	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	324.1	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	102	pcf



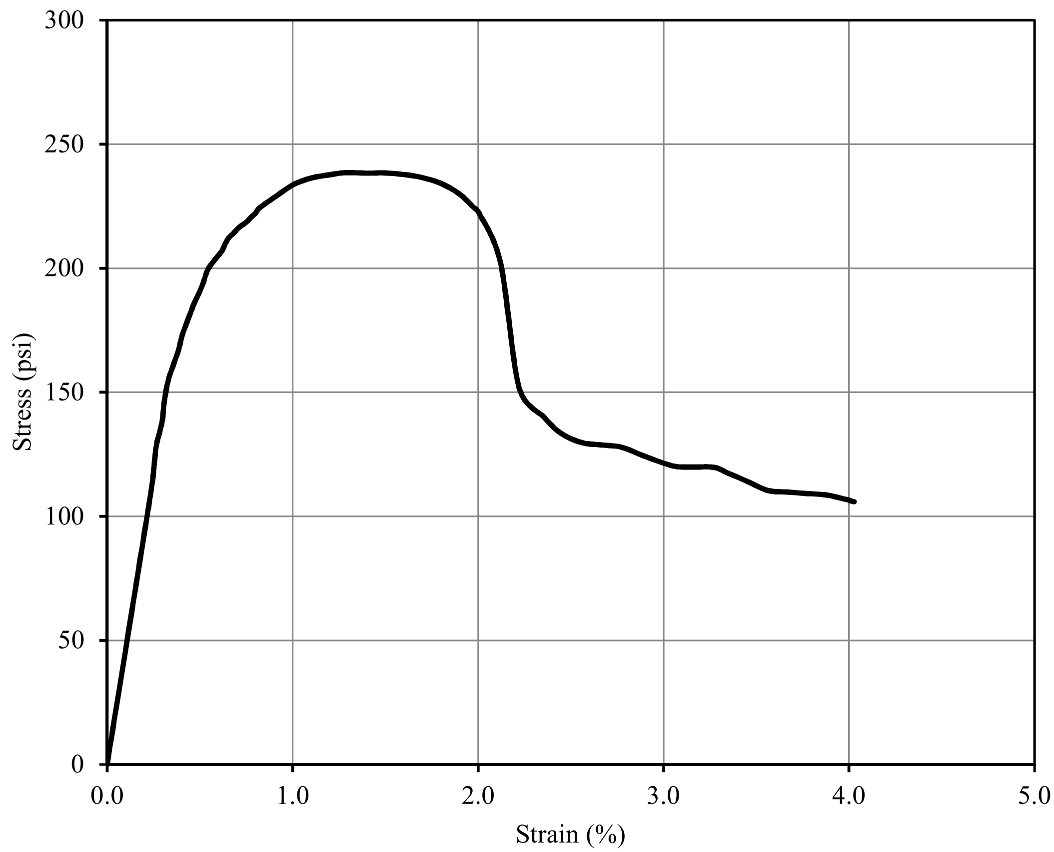
Test Result					
Peak deviator stress (w/ Height correction)	166	psi	Strain at failure, εf :	1.30	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-H	**Specimen Information**		
Test Date:	2017-10-22	Initial Height:	3.629	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	319.4	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	102	pcf



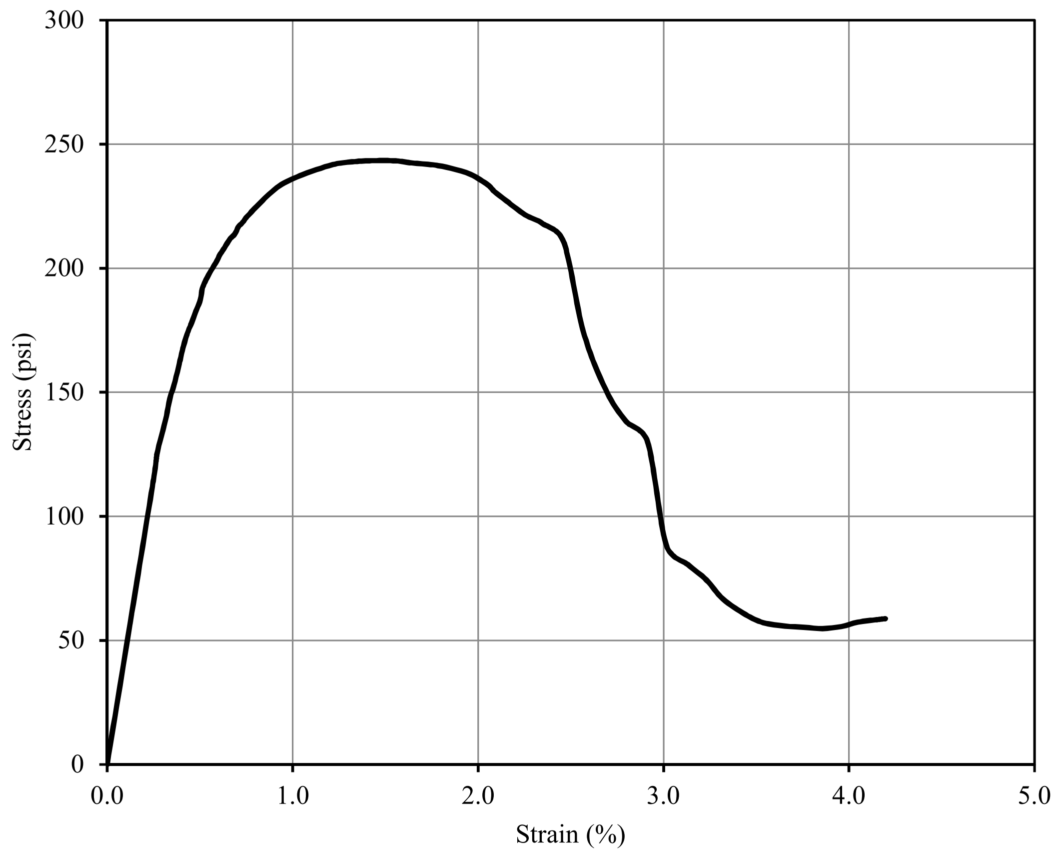
Test Result					
Peak deviator stress (w/ Height correction)	164	psi	Strain at failure, εf :	1.28	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-B	**Specimen Information**		
Test Date:	2017-10-26	Initial Height:	3.699	in
Strain Rate:	1 %/min	Initial Diameter:	2.037	in
Mixture Proportion		Initial Area:	3.259	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	325.1	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



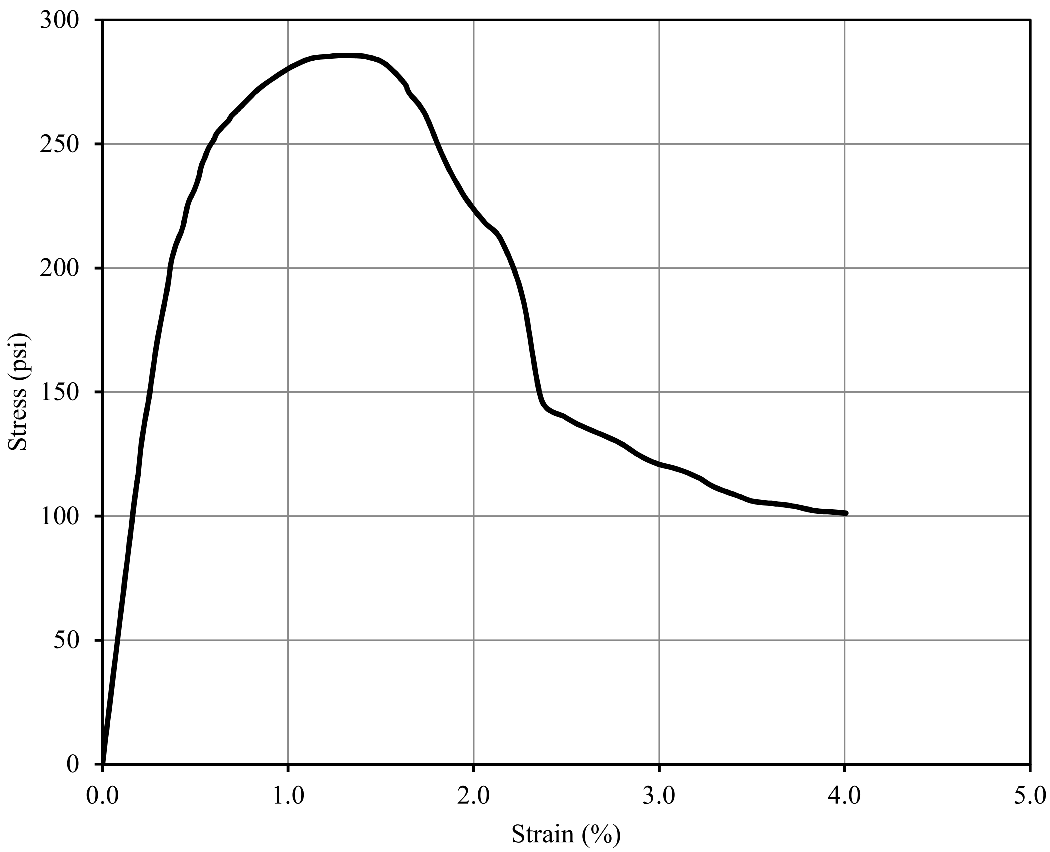
Test Result					
Peak deviator stress (w/ Height correction)	240	psi	Strain at failure, εf :	1.44	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-G	**Specimen Information**		
Test Date:	2017-10-26	Initial Height:	3.699	in
Strain Rate:	1 %/min	Initial Diameter:	2.037	in
Mixture Proportion		Initial Area:	3.259	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	325.1	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



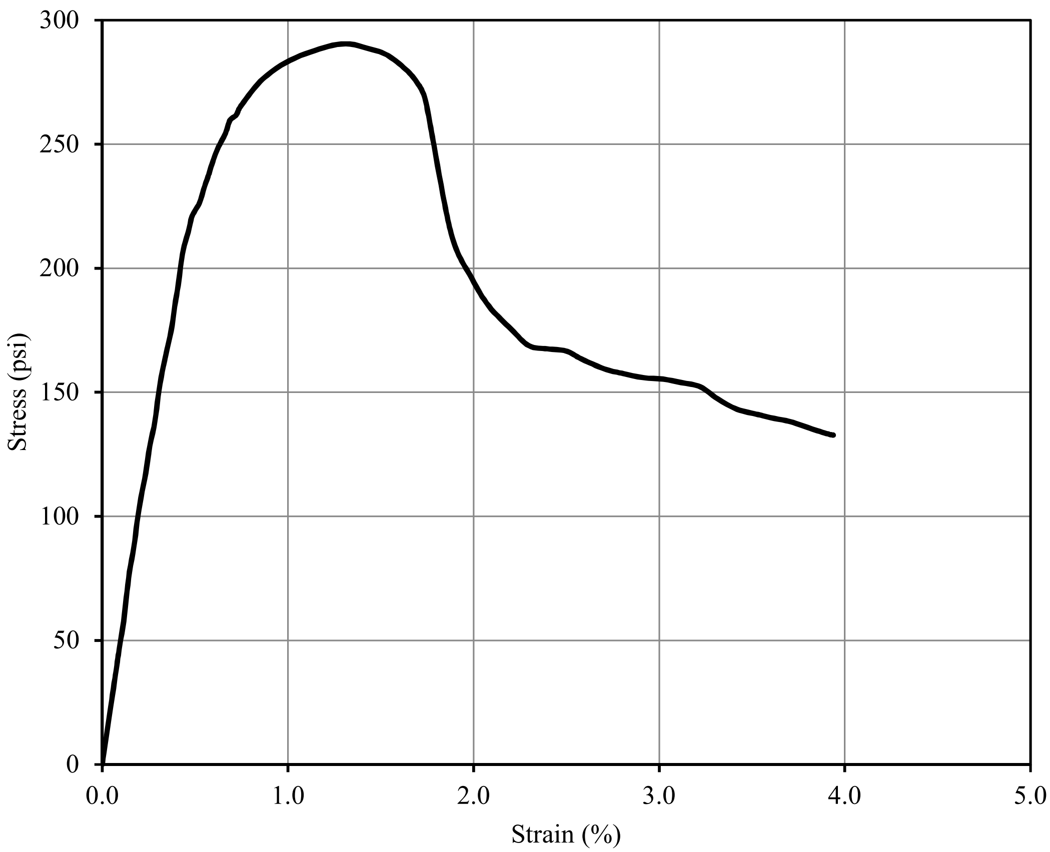
Test Result					
Peak deviator stress (w/ Height correction)	240	psi	Strain at failure, εf :	1.44	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-C	**Specimen Information**		
Test Date:	2017-11-02	Initial Height:	3.888	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	342.1	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



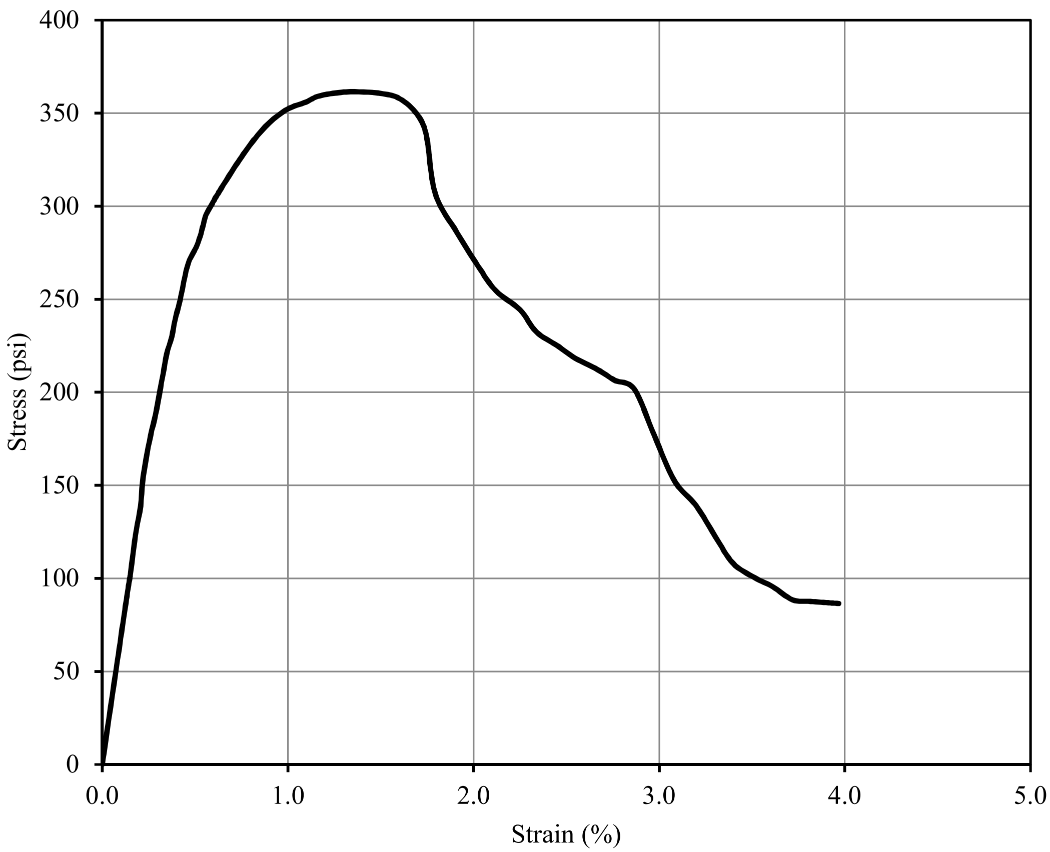
Test Result					
Peak deviator stress (w/ Height correction)	284	psi	Strain at failure, εf :	1.31	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-F	**Specimen Information**		
Test Date:	2017-11-02	Initial Height:	3.673	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	322.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



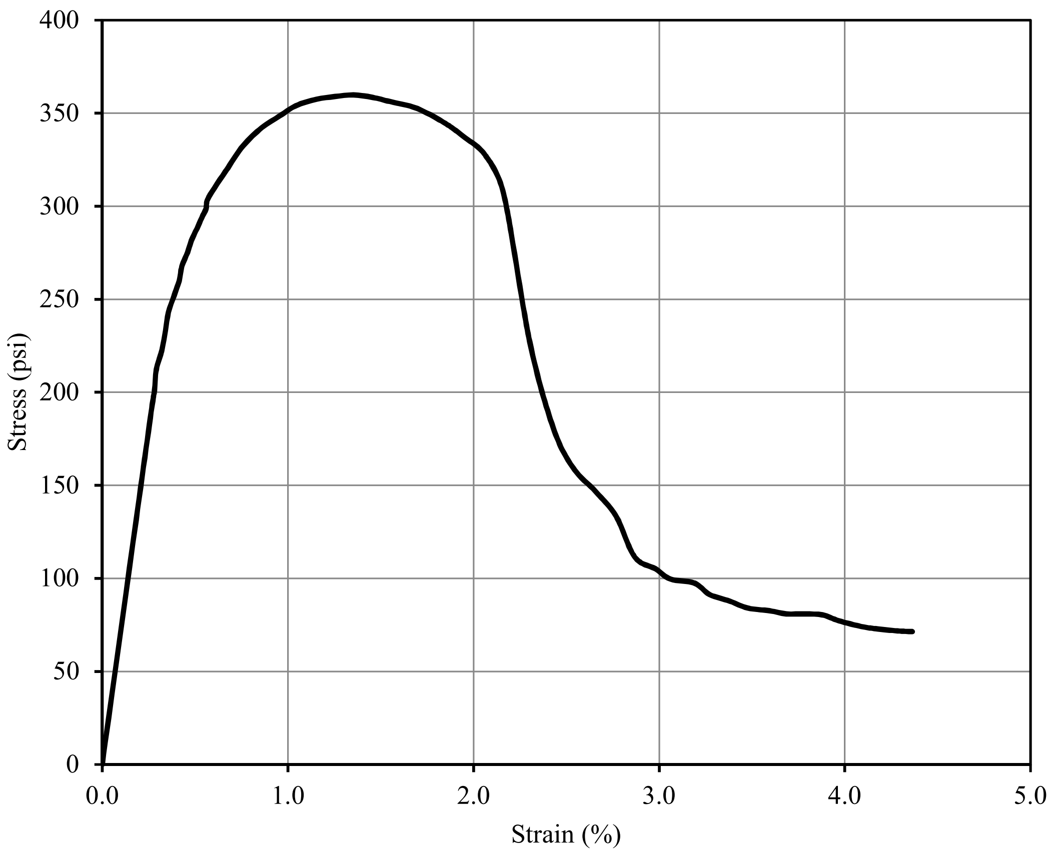
Test Result					
Peak deviator stress (w/ Height correction)	286	psi	Strain at failure, εf :	1.34	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-D	**Specimen Information**		
Test Date:	2017-11-16	Initial Height:	3.842	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	337.3	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	102	pcf



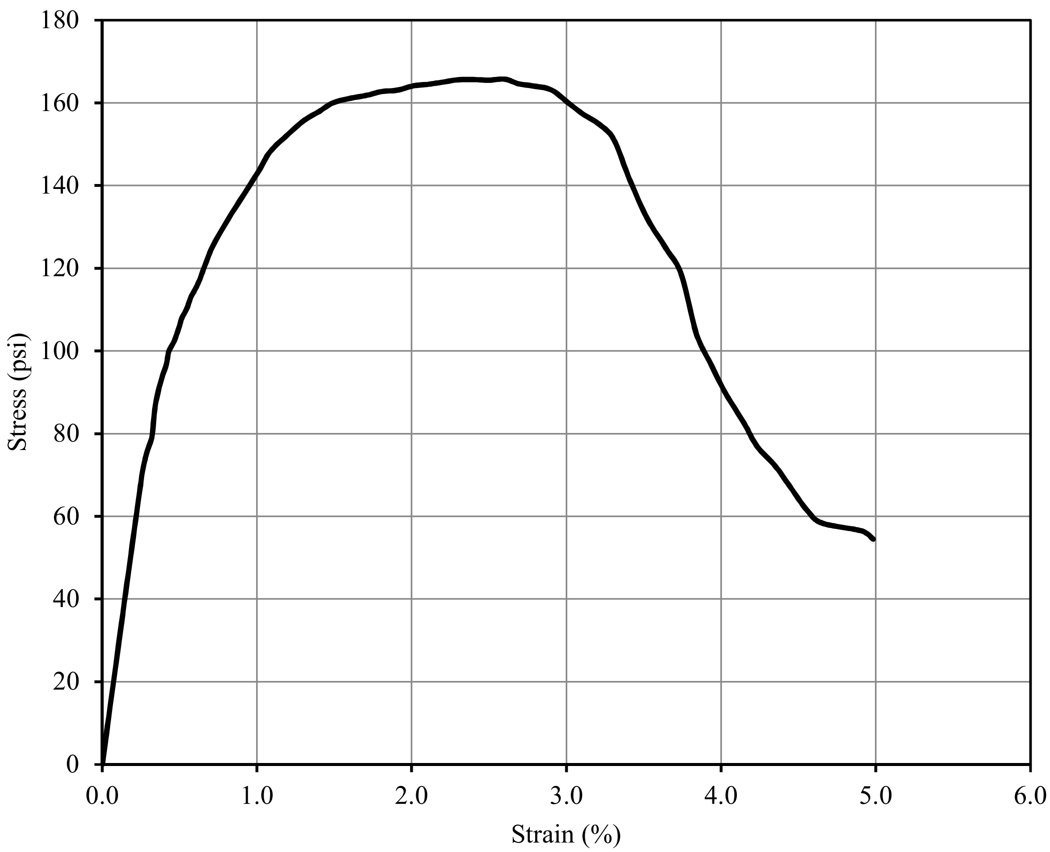
Test Result					
Peak deviator stress (w/ Height correction)	358	psi	Strain at failure, εf :	1.38	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.2	days
Tested by:	Hwanik Ju	Curing temperature	25	°C
I.D.:	T-6-E	**Specimen Information**		
Test Date:	2017-11-16	Initial Height:	3.876	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	340.5	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



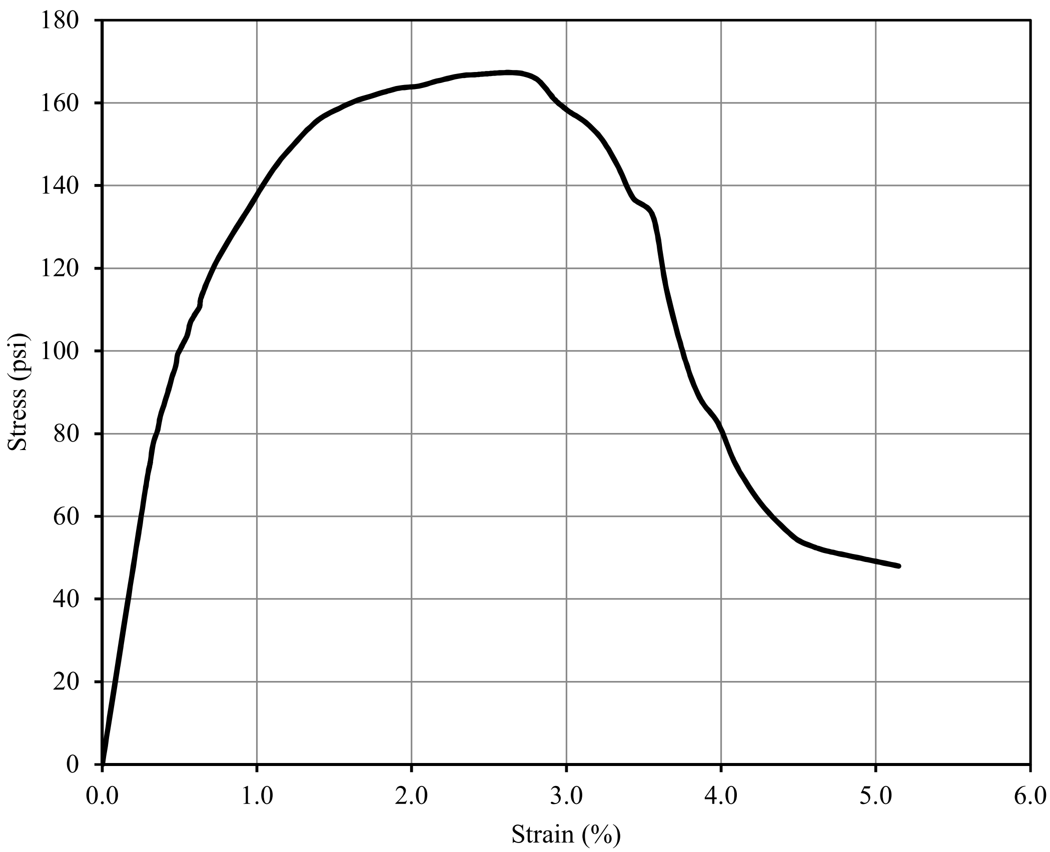
Test Result					
Peak deviator stress (w/ Height correction)	357	psi	Strain at failure, εf :	1.35	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-A	**Specimen Information**		
Test Date:	2017-12-27	Initial Height:	3.876	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	368.9	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



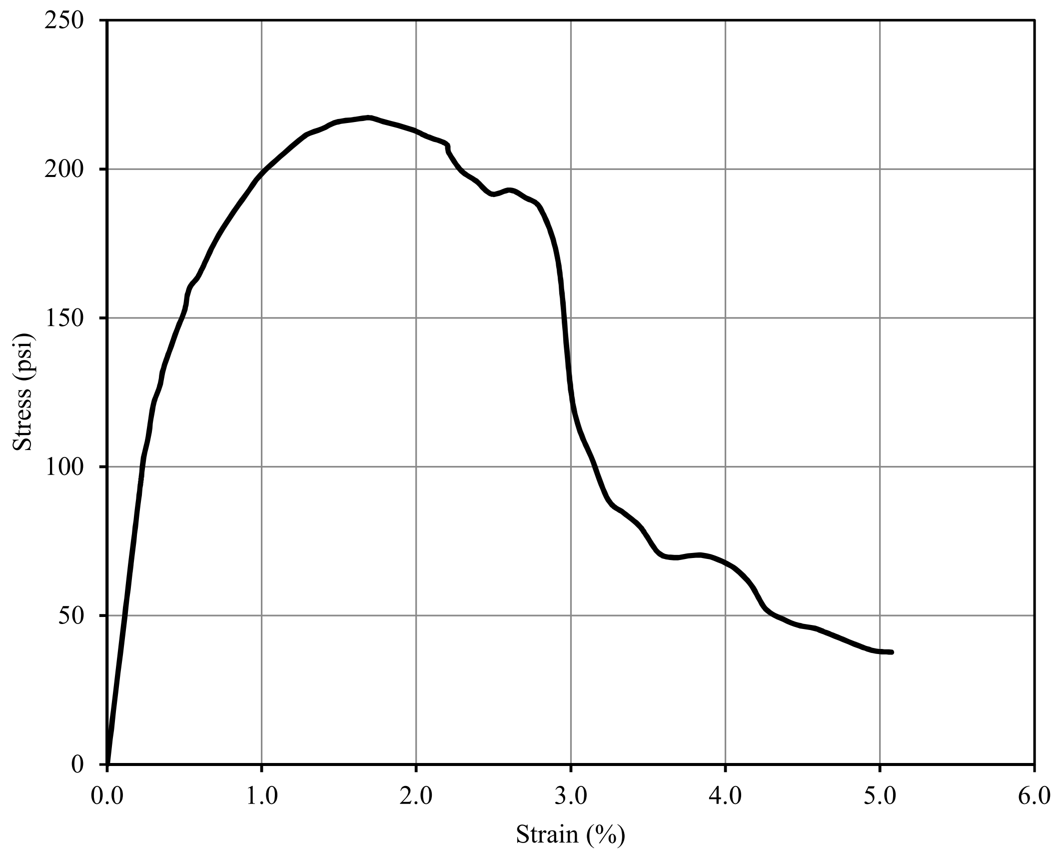
Test Result					
Peak deviator stress (w/ Height correction)	164	psi	Strain at failure, εf :	2.60	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-H	**Specimen Information**		
Test Date:	2017-12-27	Initial Height:	3.887	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	369.5	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	111	pcf



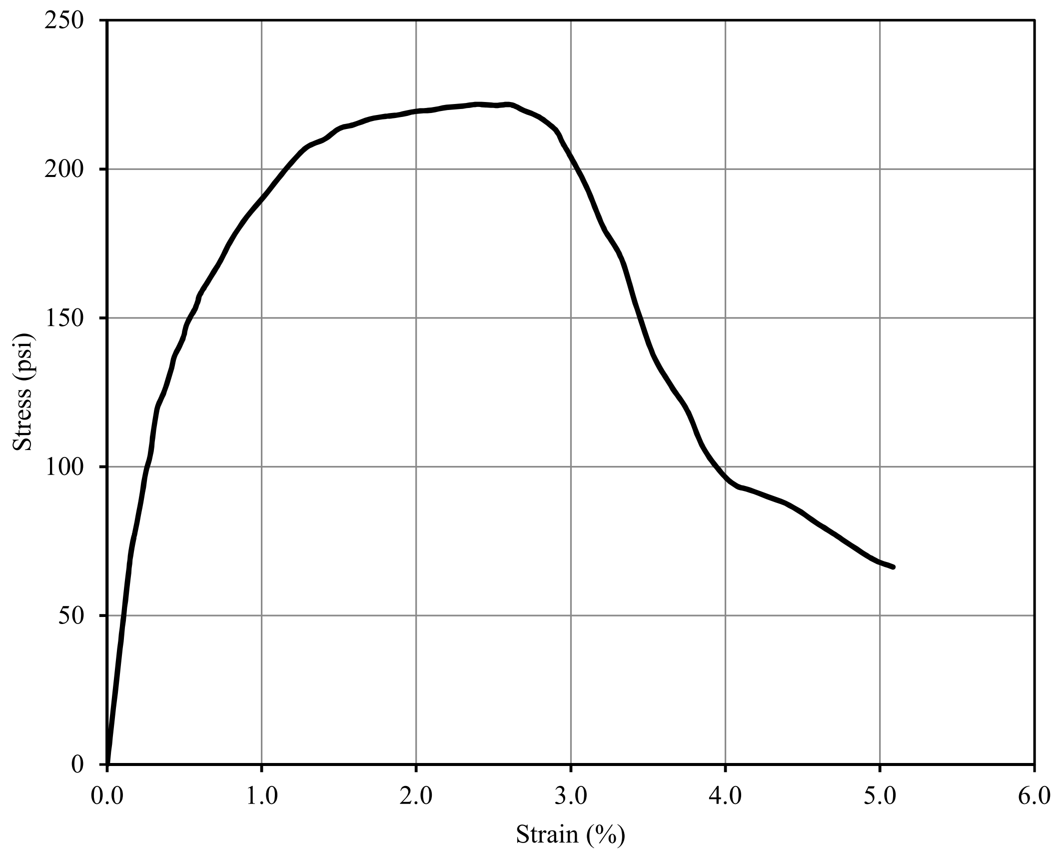
Test Result					
Peak deviator stress (w/ Height correction)	166	psi	Strain at failure, εf :	2.63	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-B	**Specimen Information**		
Test Date:	2017-12-31	Initial Height:	3.873	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	368.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



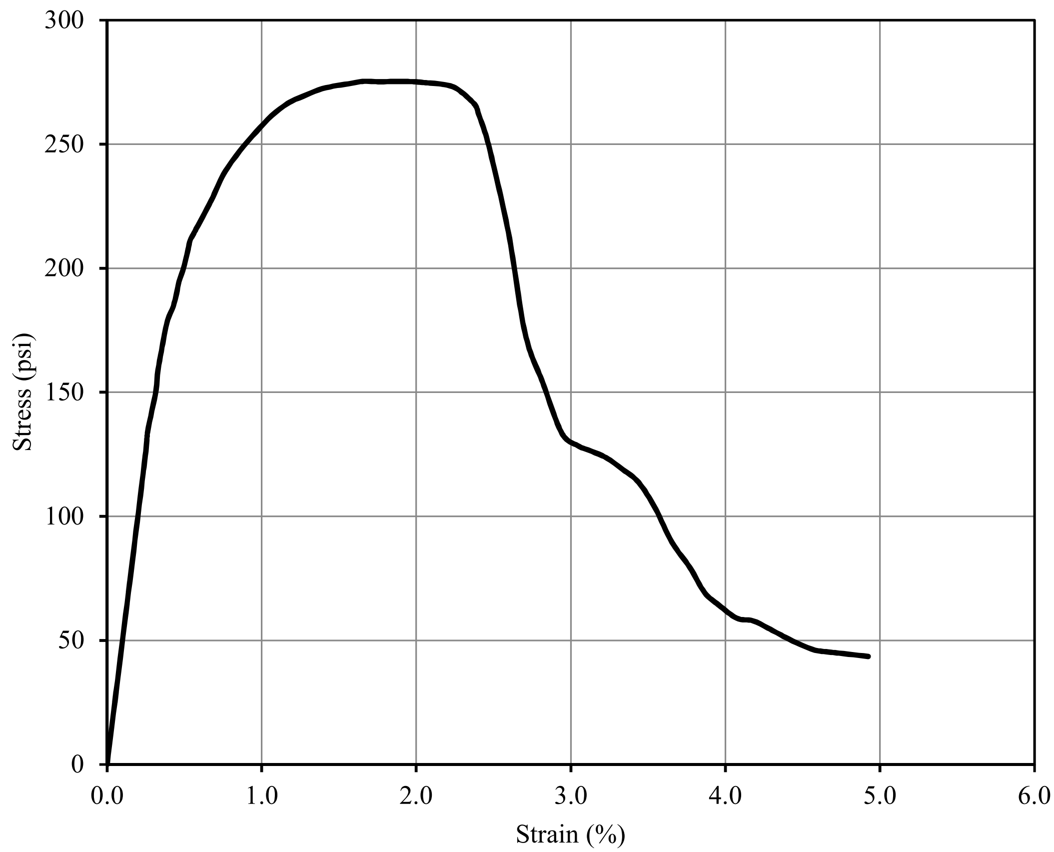
Test Result					
Peak deviator stress (w/ Height correction)	215	psi	Strain at failure, εf :	1.70	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-G	**Specimen Information**		
Test Date:	2017-12-31	Initial Height:	3.908	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	372.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



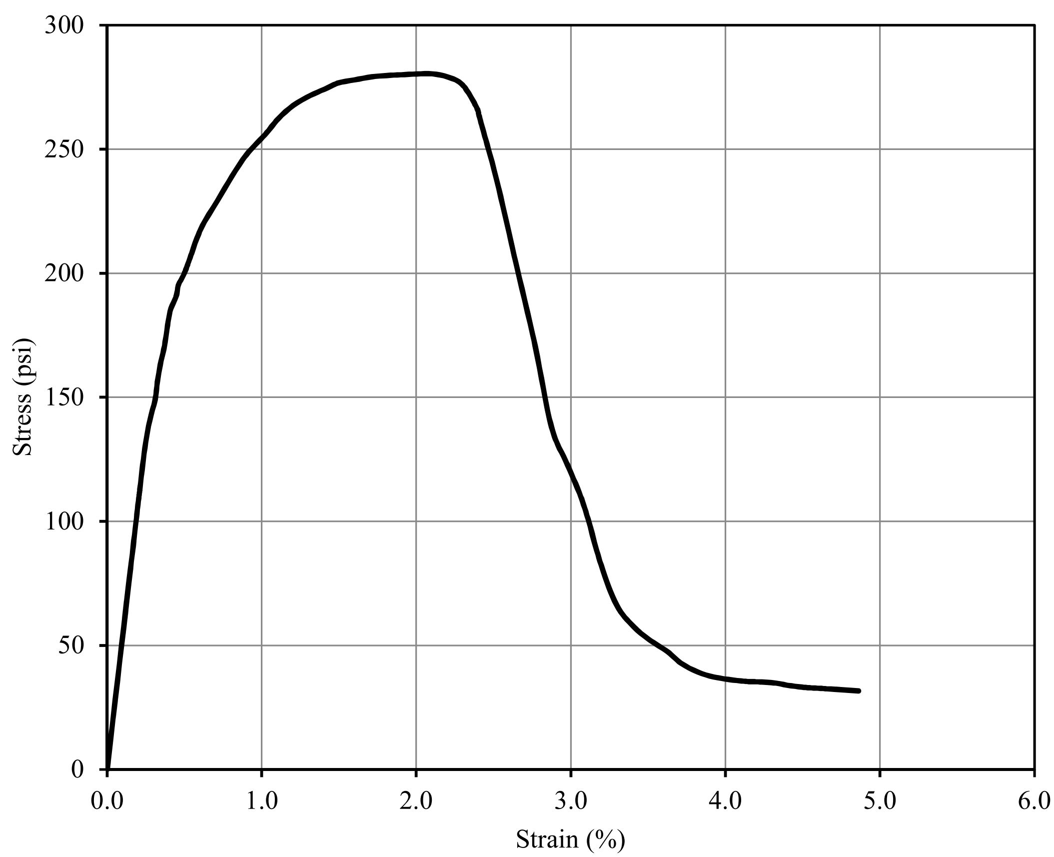
Test Result					
Peak deviator stress (w/ Height correction)	220	psi	Strain at failure, εf :	2.39	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-C	**Specimen Information**		
Test Date:	2018-01-07	Initial Height:	3.924	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	375.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



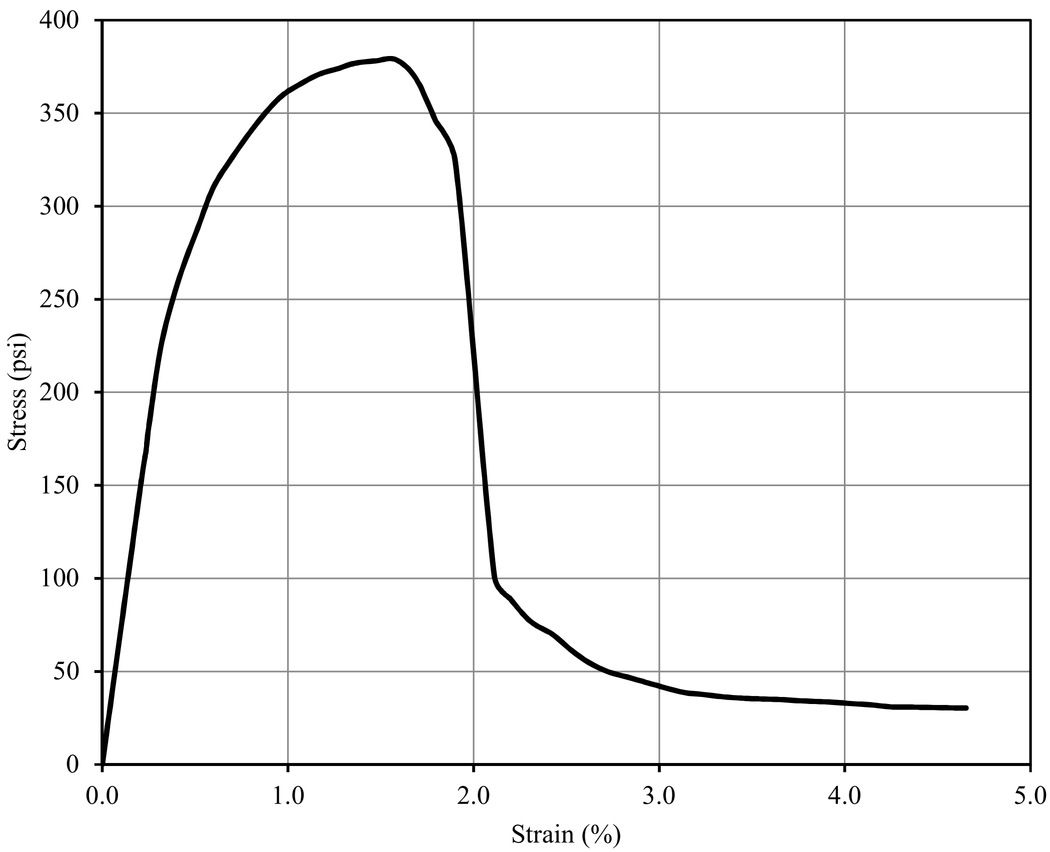
Test Result					
Peak deviator stress (w/ Height correction)	274	psi	Strain at failure, εf :	1.86	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-F	**Specimen Information**		
Test Date:	2018-01-07	Initial Height:	3.92	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	374.2	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	111	pcf



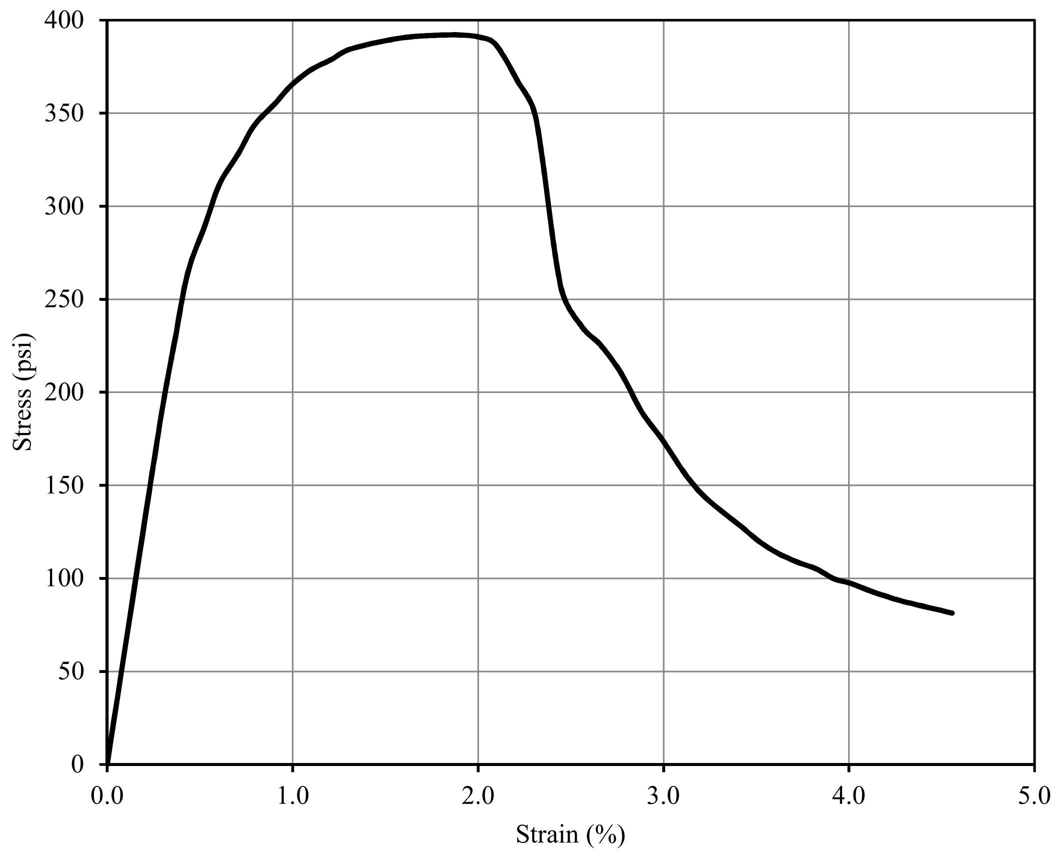
Test Result					
Peak deviator stress (w/ Height correction)	279	psi	Strain at failure, εf :	2.10	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-D	**Specimen Information**		
Test Date:	2018-01-21	Initial Height:	3.953	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	377.2	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	111	pcf



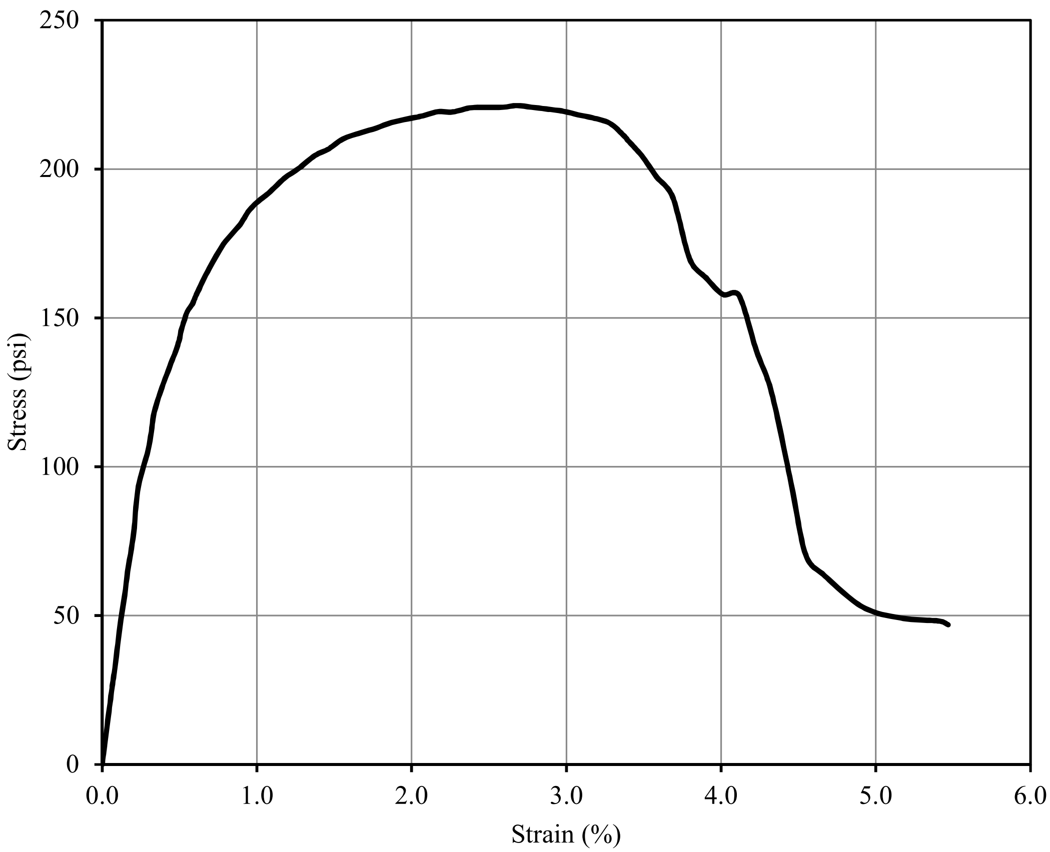
Test Result					
Peak deviator stress (w/ Height correction)	377	psi	Strain at failure, εf :	1.58	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-7-E	**Specimen Information**		
Test Date:	2018-01-21	Initial Height:	3.929	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	374.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



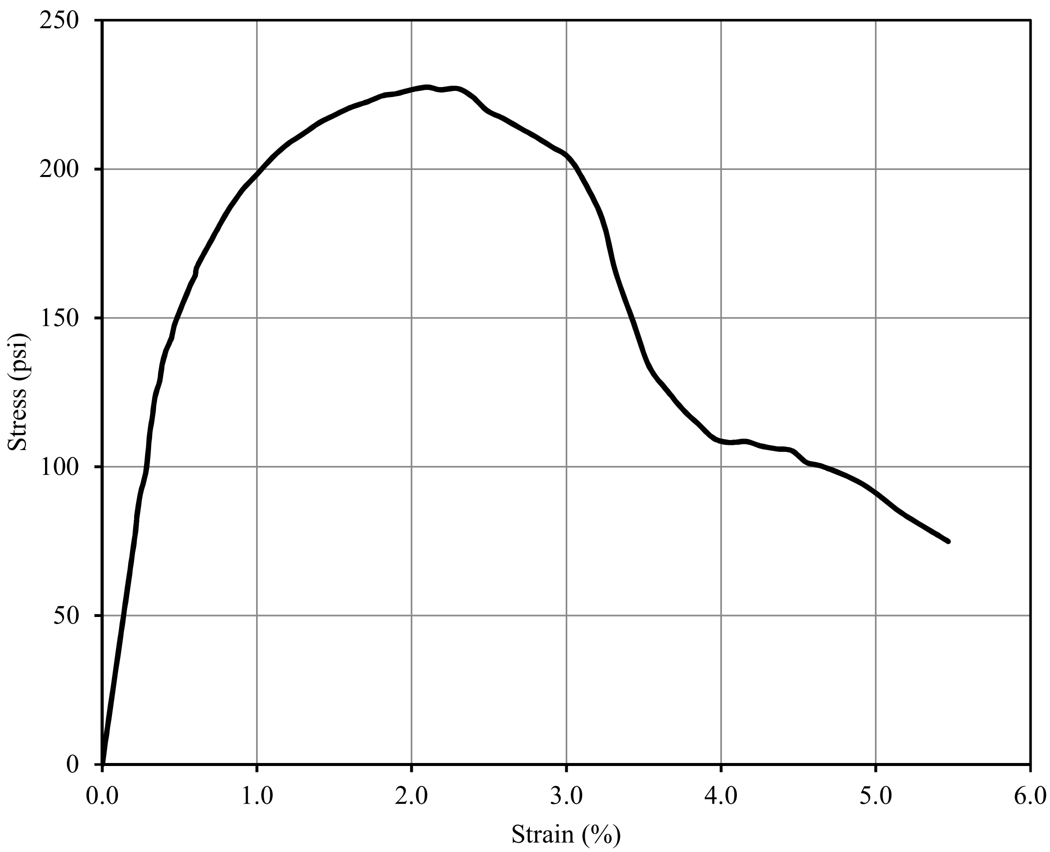
Test Result					
Peak deviator stress (w/ Height correction)	390	psi	Strain at failure, εf :	1.90	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-8-A	**Specimen Information**		
Test Date:	2017-12-27	Initial Height:	3.829	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	358.4	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	109	pcf



Test Result					
Peak deviator stress (w/ Height correction)	219	psi	Strain at failure, εf :	2.68	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-8-H	**Specimen Information**		
Test Date:	2017-12-27	Initial Height:	3.874	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	363.2	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	109	pcf

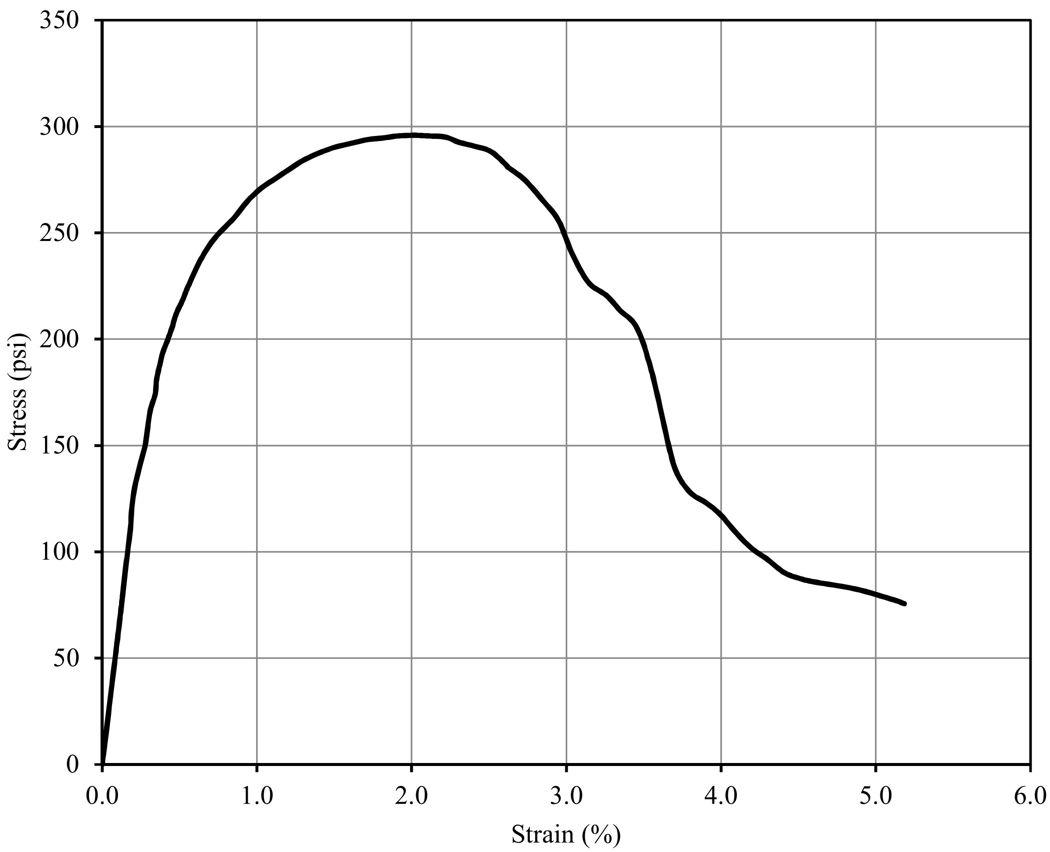


Test Result					
Peak deviator stress (w/ Height correction)	226	psi	Strain at failure, εf :	2.10	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	35	°C

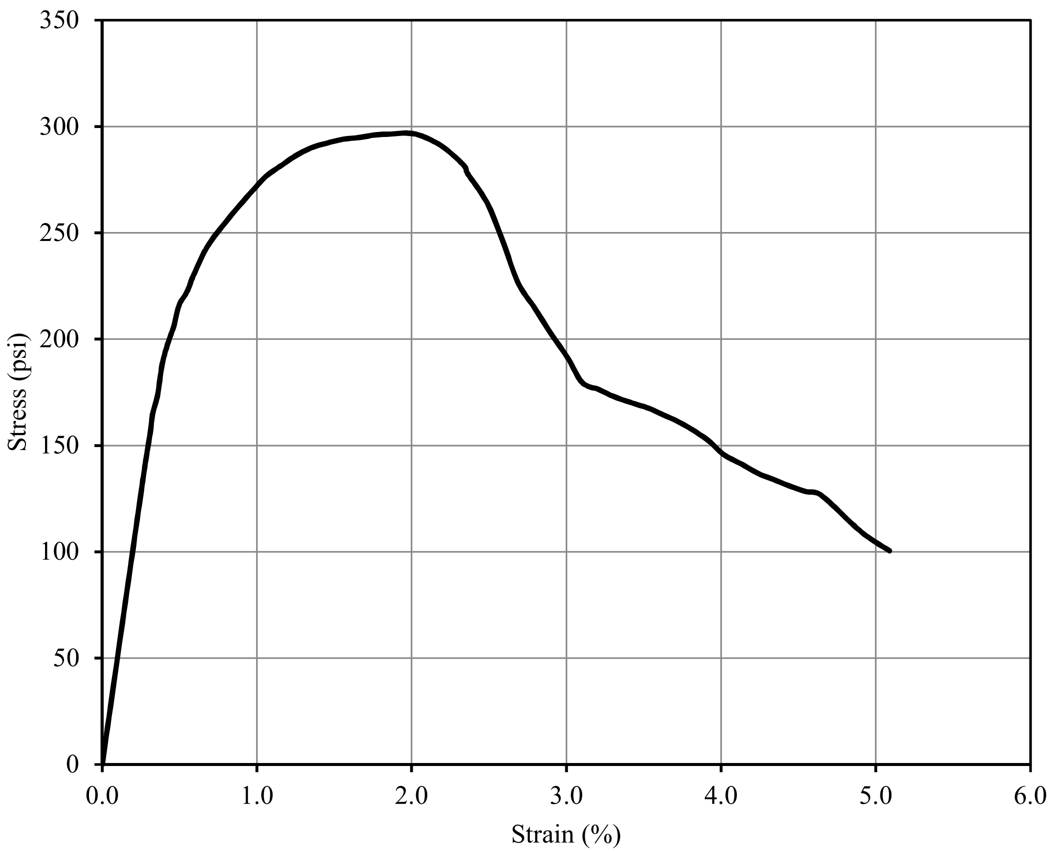
Test Information		Specimen Information		
I.D.:	T-8-B	Initial Height:	3.845	in
Test Date:	2017-12-31	Initial Diameter:	2.041	in
Strain Rate:	1 %/min	Initial Area:	3.272	in

Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	360.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



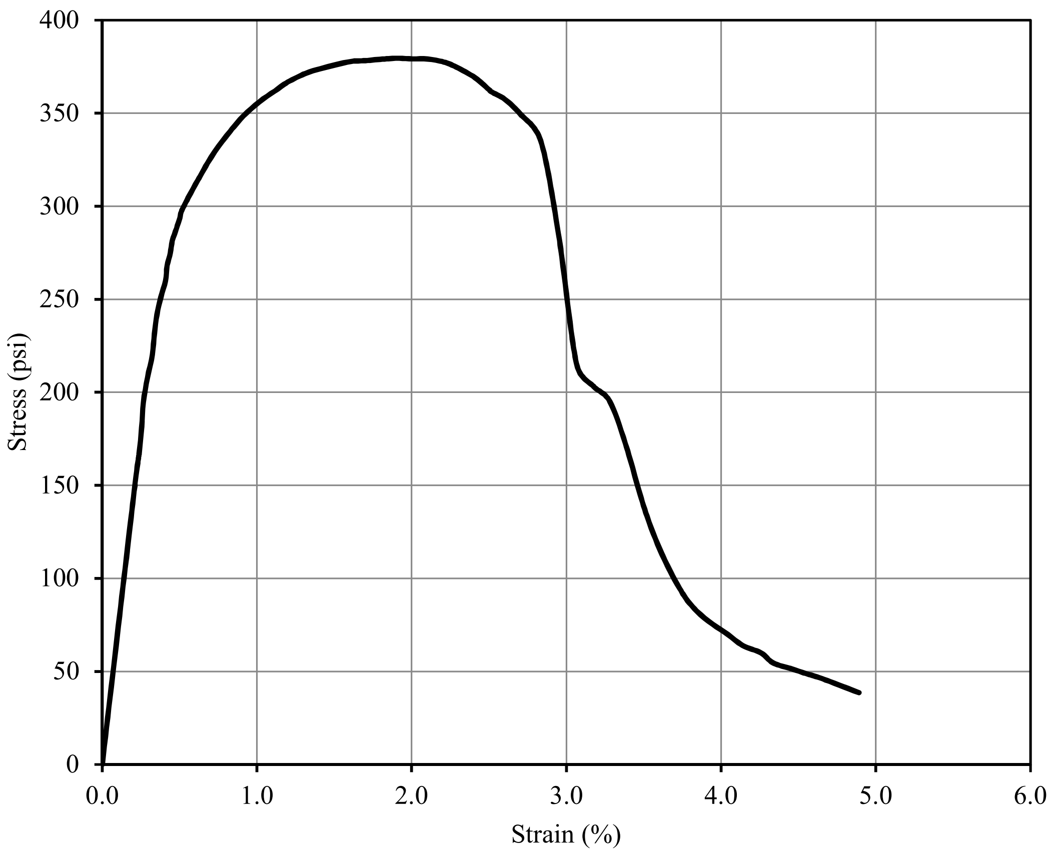
Test Result					
Peak deviator stress (w/ Height correction)	293	psi	Strain at failure, εf :	2.02	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-8-G	**Specimen Information**		
Test Date:	2017-12-31	Initial Height:	3.949	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	371.8	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	109	pcf



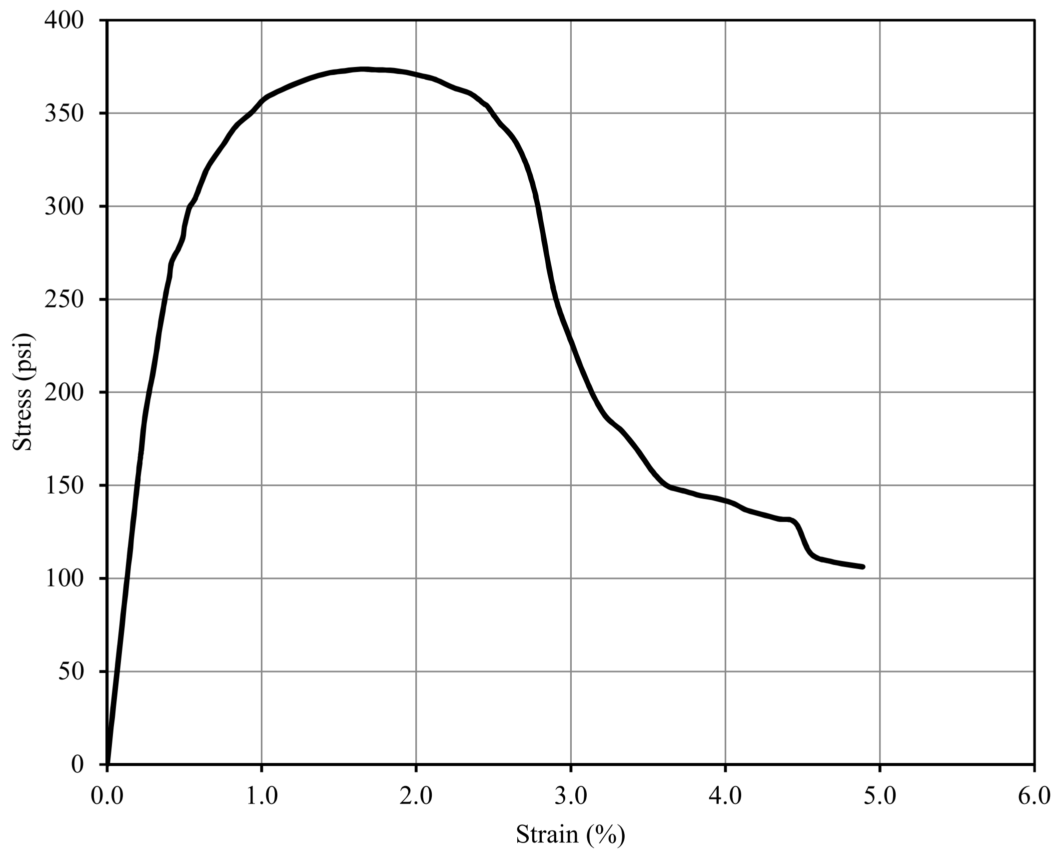
Test Result					
Peak deviator stress (w/ Height correction)	295	psi	Strain at failure, εf :	1.96	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-8-C	**Specimen Information**		
Test Date:	2018-01-07	Initial Height:	3.884	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	364.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



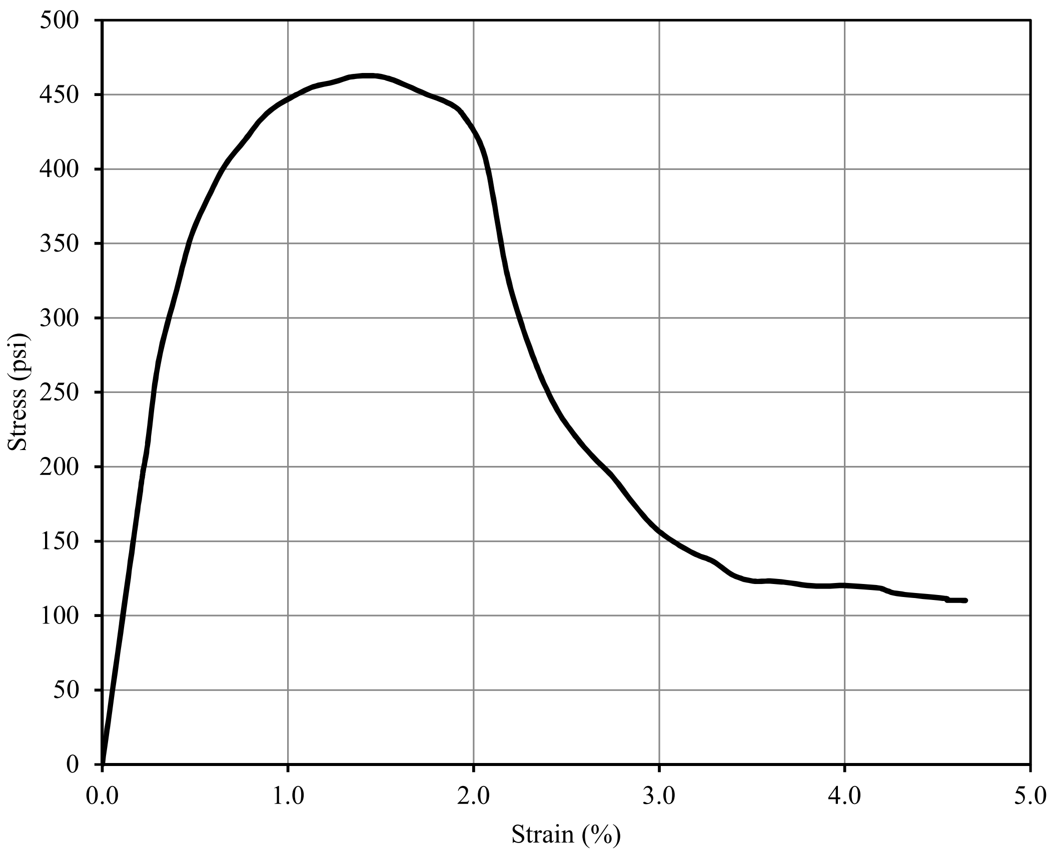
Test Result					
Peak deviator stress (w/ Height correction)	377	psi	Strain at failure, εf :	1.92	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-8-F	**Specimen Information**		
Test Date:	2018-01-07	Initial Height:	3.937	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	370.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



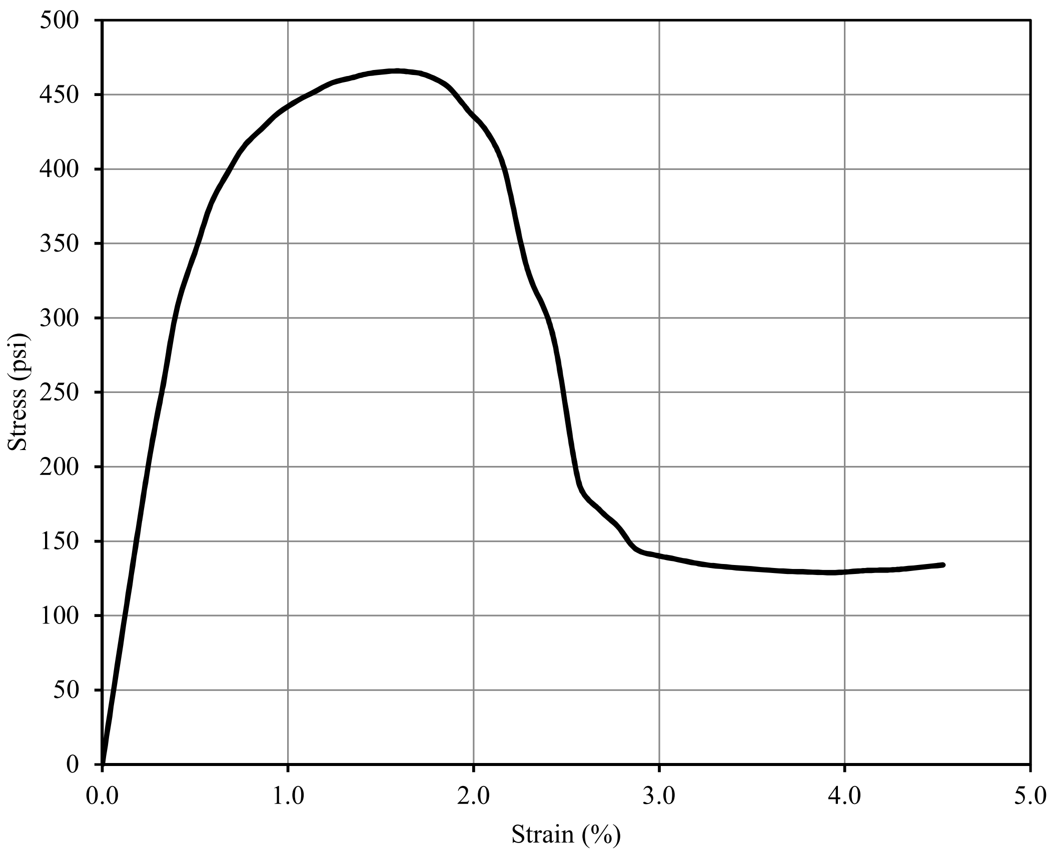
Test Result					
Peak deviator stress (w/ Height correction)	372	psi	Strain at failure, εf :	1.64	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-8-D	**Specimen Information**		
Test Date:	2018-01-21	Initial Height:	3.94	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	371.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf



Test Result					
Peak deviator stress (w/ Height correction)	460	psi	Strain at failure, εf :	1.46	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-8-E	**Specimen Information**		
Test Date:	2018-01-21	Initial Height:	3.83	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	360.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf

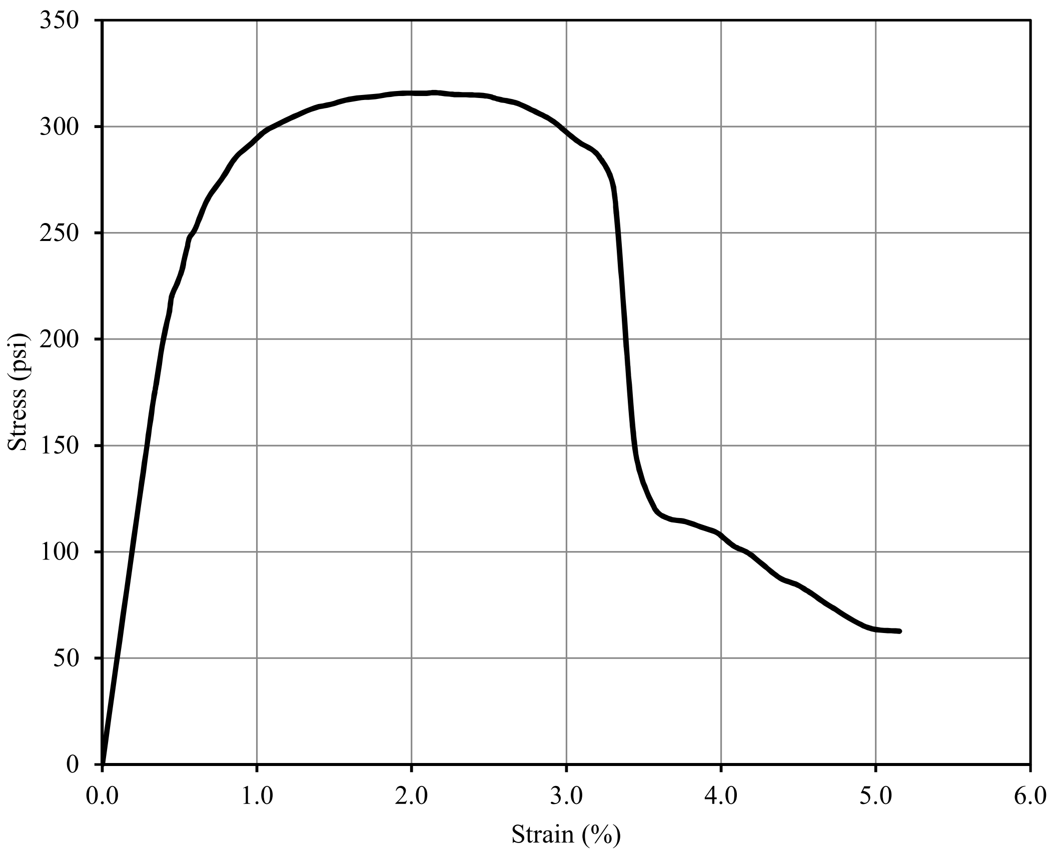


Test Result					
Peak deviator stress (w/ Height correction)	461	psi	Strain at failure, εf :	1.56	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	35	°C

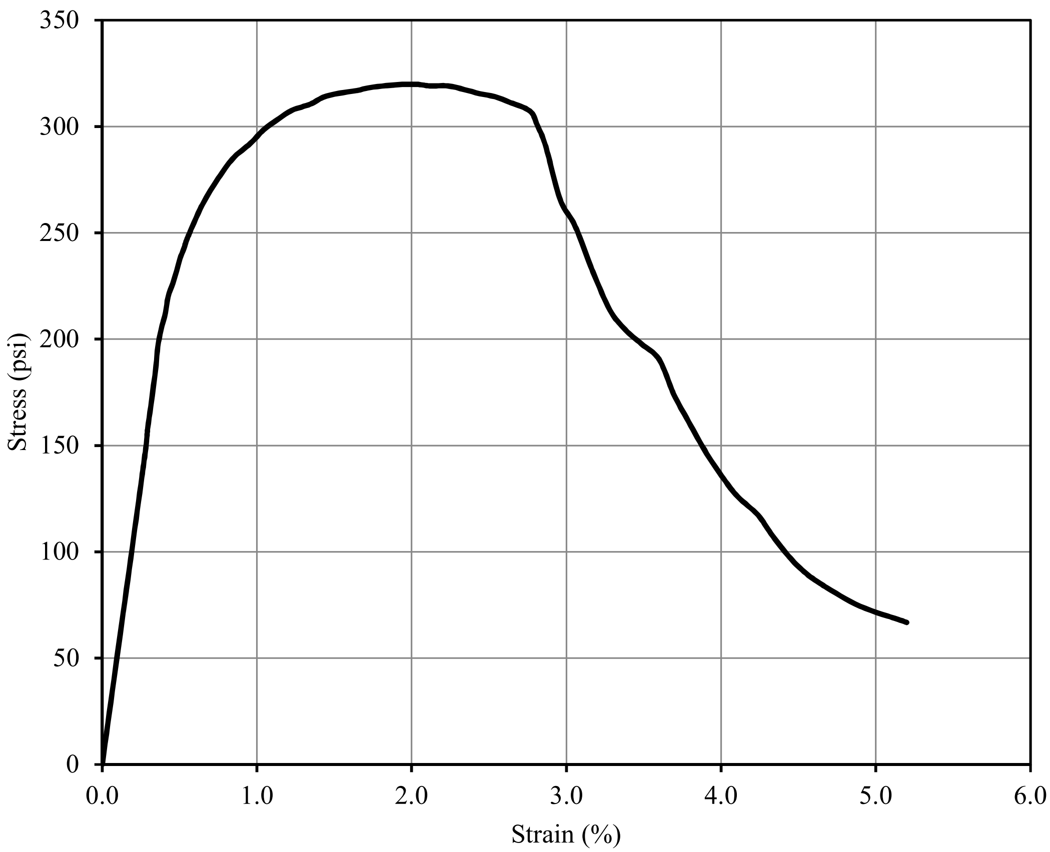
Test Information		Specimen Information		
I.D.:	T-9-A	Initial Height:	3.935	in
Test Date:	2018-01-03	Initial Diameter:	2.041	in
Strain Rate:	1 %/min	Initial Area:	3.272	in

Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	363.9	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	108	pcf



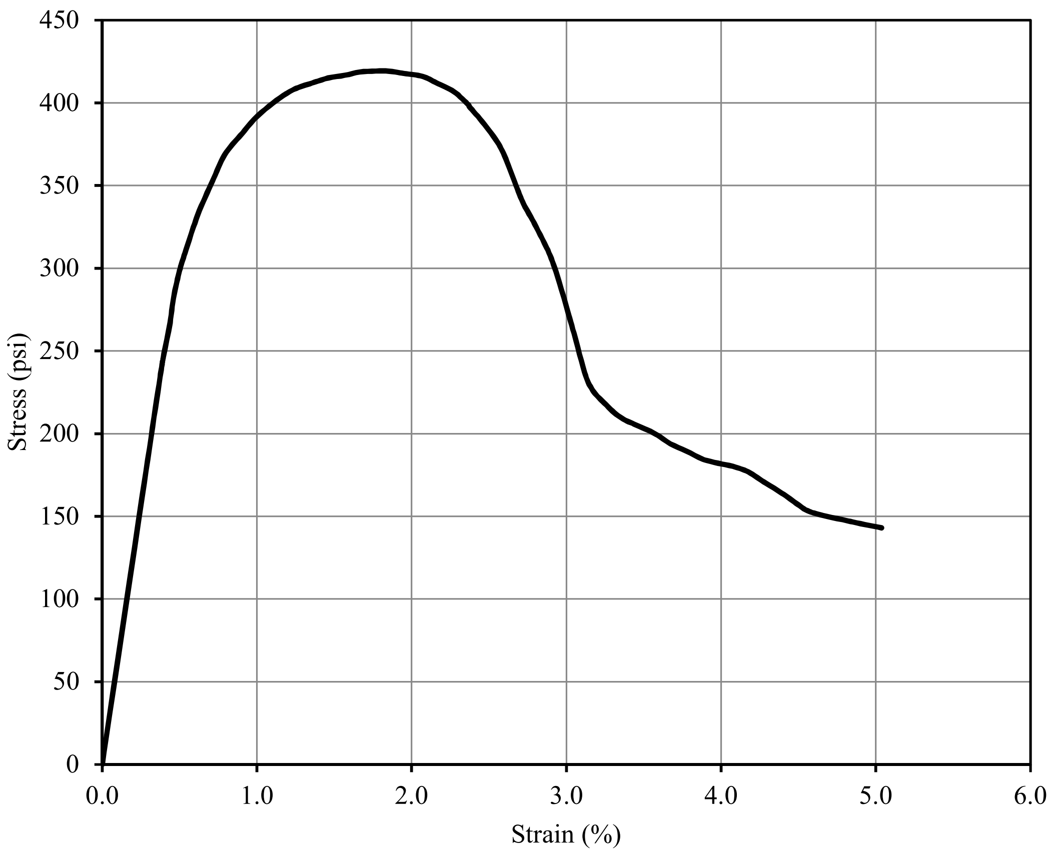
Test Result					
Peak deviator stress (w/ Height correction)	314	psi	Strain at failure, εf :	2.16	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
		Specimen Information		
I.D.:	T-9-H	Initial Height:	3.918	in
Test Date:	2018-01-03	Initial Diameter:	2.041	in
Strain Rate:	1 %/min	Initial Area:	3.272	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	362.1	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	108	pcf



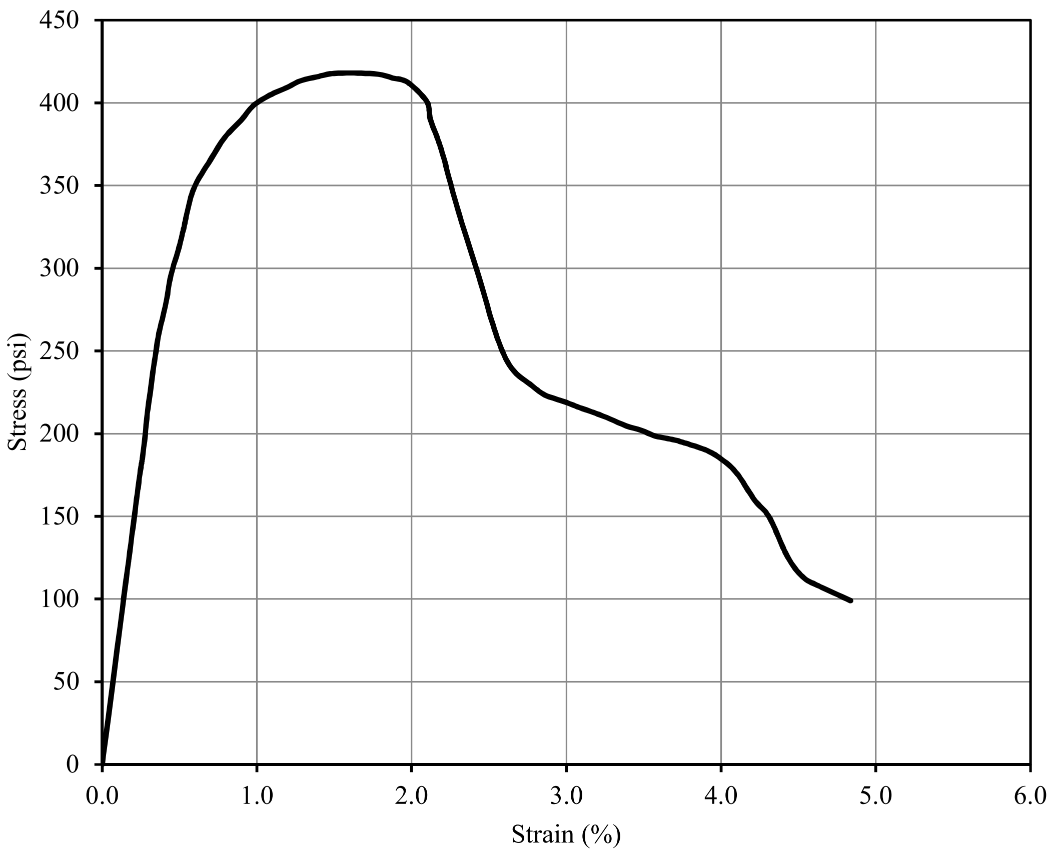
Test Result					
Peak deviator stress (w/ Height correction)	318	psi	Strain at failure, εf :	2.04	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
		Specimen Information		
I.D.:	T-9-B	Initial Height:	3.581	in
Test Date:	2018-01-07	Initial Diameter:	2.041	in
Strain Rate:	1 %/min	Initial Area:	3.272	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	330.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



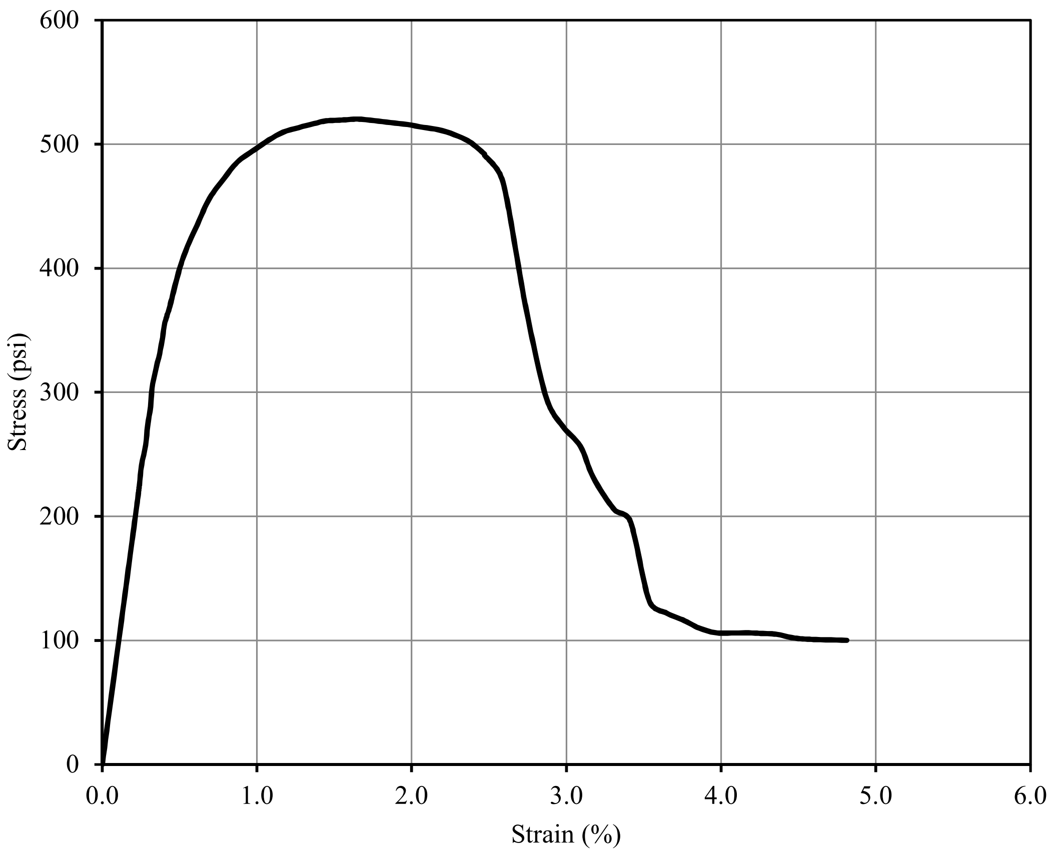
Test Result					
Peak deviator stress (w/ Height correction)	411	psi	Strain at failure, εf :	1.77	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-9-G	**Specimen Information**		
Test Date:	2018-01-07	Initial Height:	3.856	in
Strain Rate:	1 %/min	Initial Diameter:	2.040	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	357.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



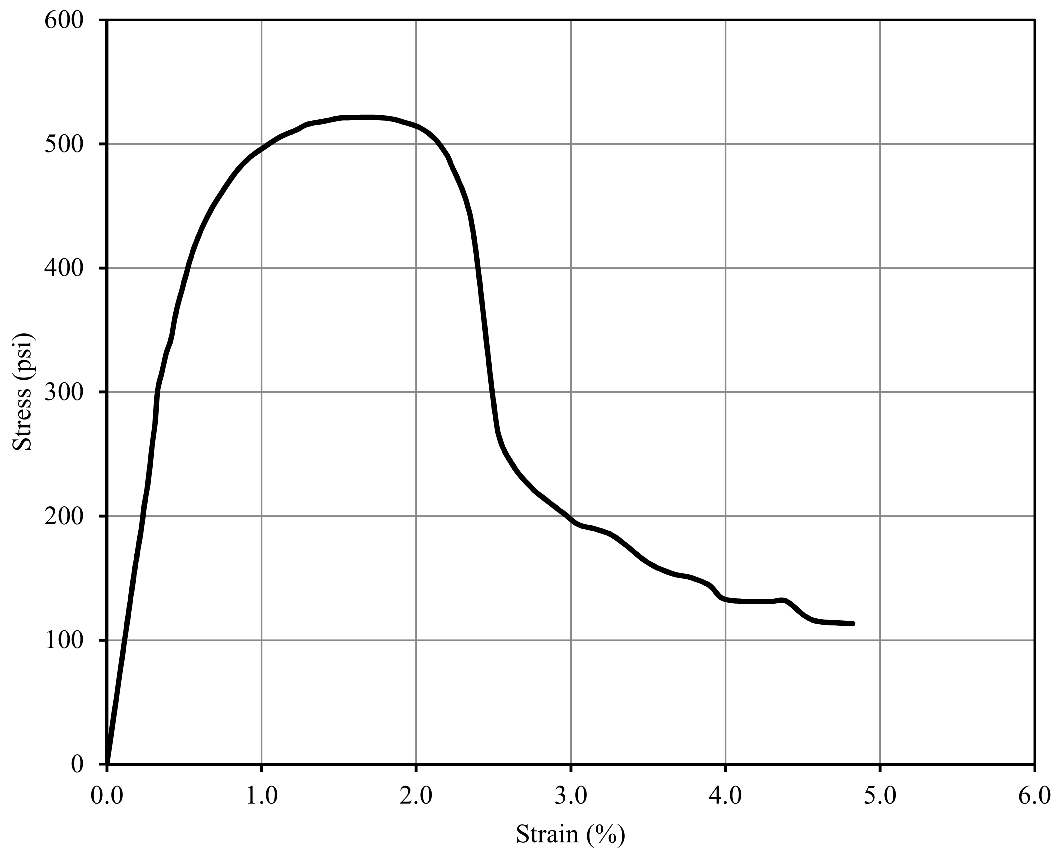
Test Result					
Peak deviator stress (w/ Height correction)	414	psi	Strain at failure, εf :	1.58	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-9-C	**Specimen Information**		
Test Date:	2018-01-14	Initial Height:	3.962	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	367.6	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	108	pcf



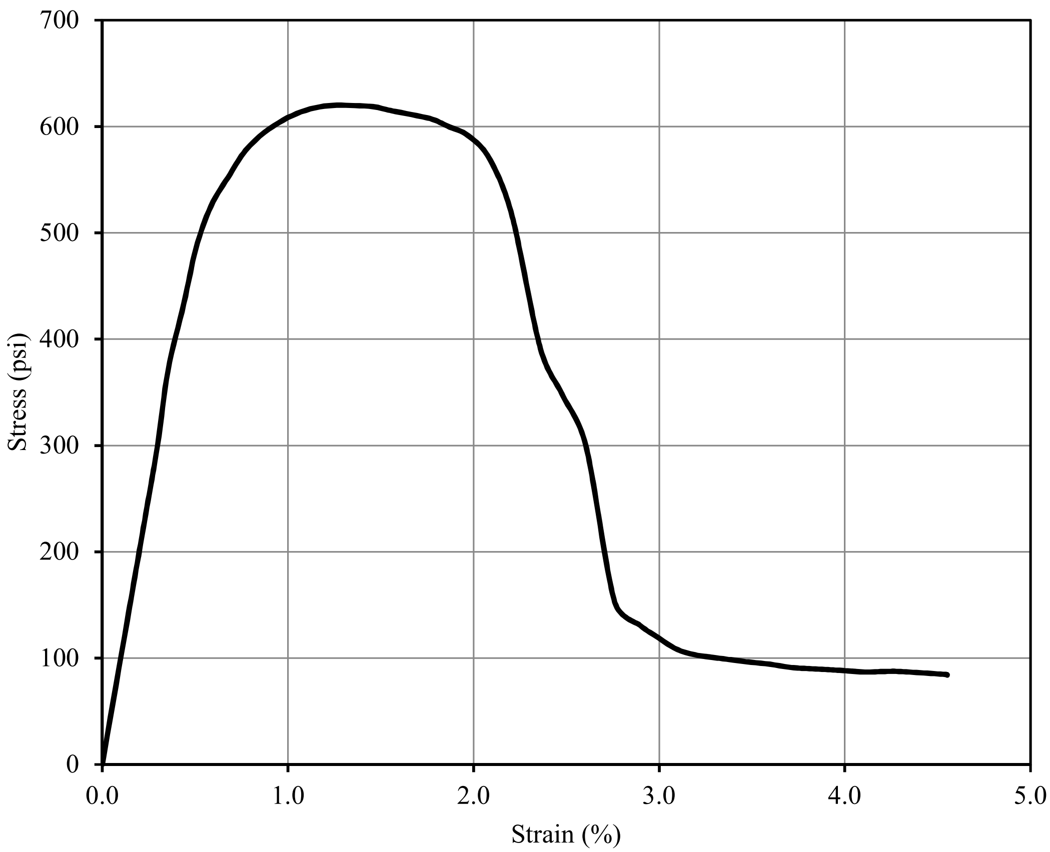
Test Result					
Peak deviator stress (w/ Height correction)	518	psi	Strain at failure, εf :	1.65	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-9-F	**Specimen Information**		
Test Date:	2018-01-14	Initial Height:	3.806	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	352.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



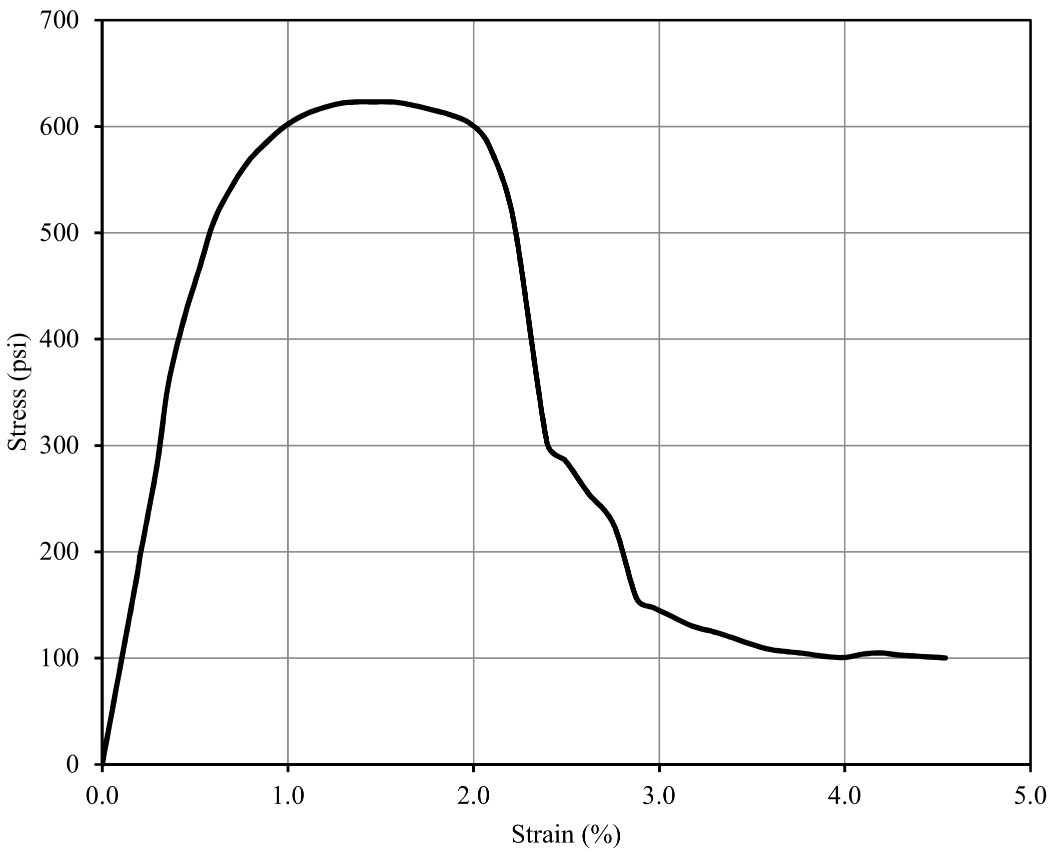
Test Result					
Peak deviator stress (w/ Height correction)	516	psi	Strain at failure, εf :	1.71	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-9-D	**Specimen Information**		
Test Date:	2018-01-28	Initial Height:	3.928	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	365.3	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	108	pcf



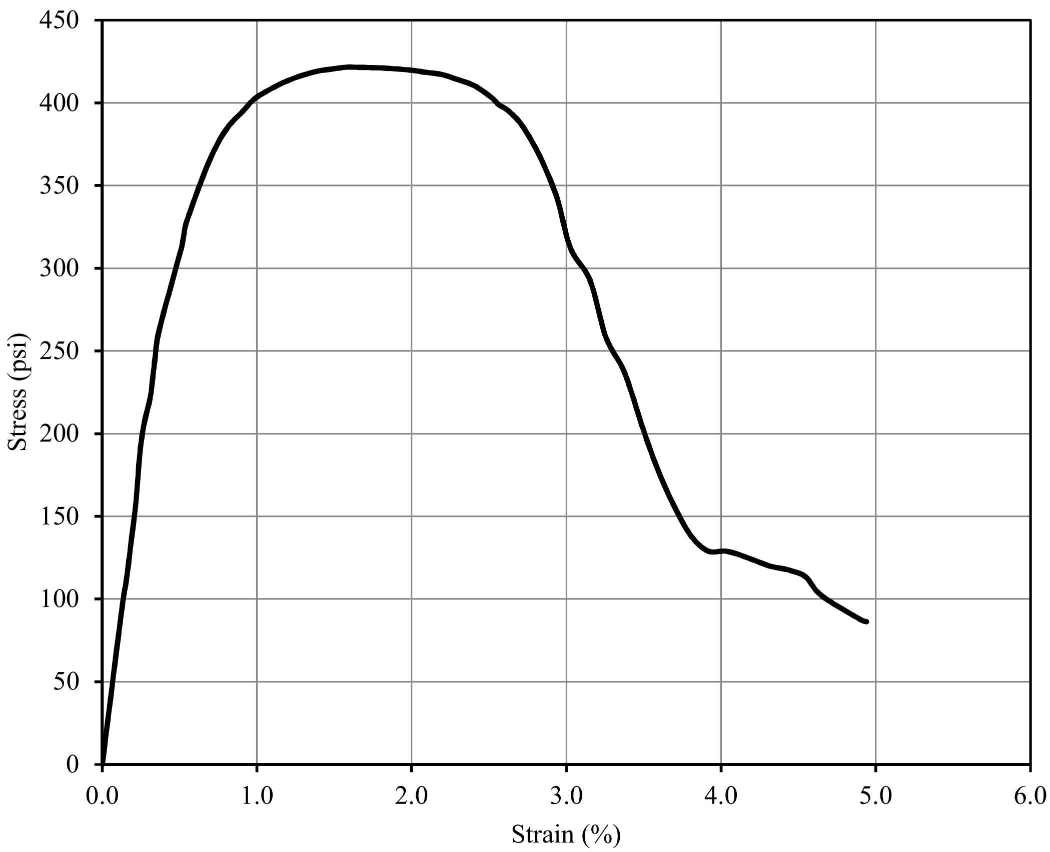
Test Result					
Peak deviator stress (w/ Height correction)	616	psi	Strain at failure, εf :	1.26	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-9-E	**Specimen Information**		
Test Date:	2018-01-28	Initial Height:	3.916	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	364.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



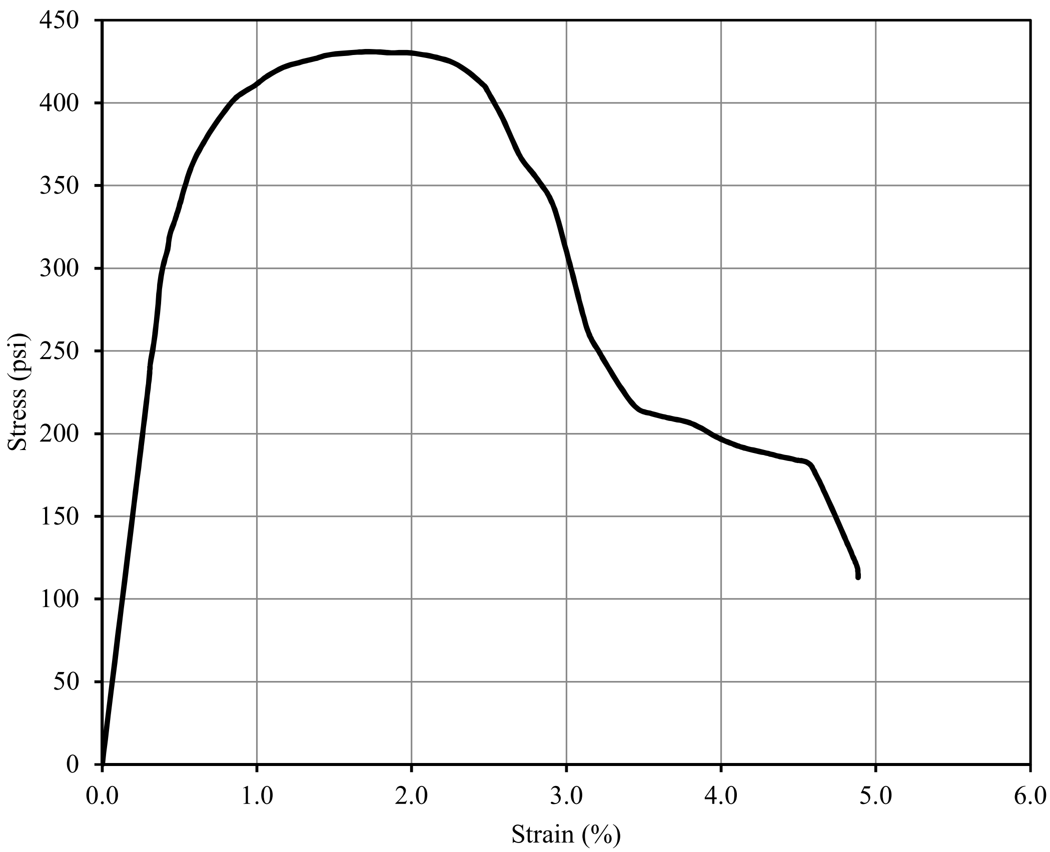
Test Result					
Peak deviator stress (w/ Height correction)	619	psi	Strain at failure, εf :	1.45	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-A	**Specimen Information**		
Test Date:	2018-01-10	Initial Height:	3.828	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	348.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



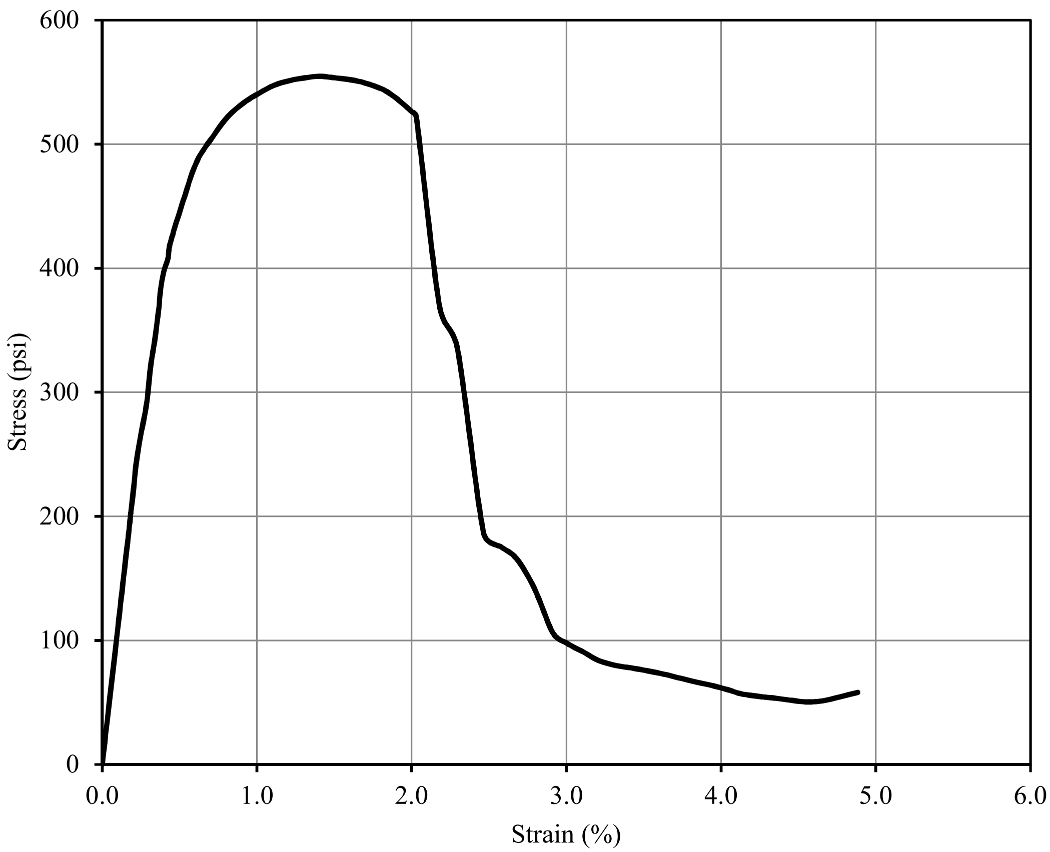
Test Result					
Peak deviator stress (w/ Height correction)	417	psi	Strain at failure, εf :	1.58	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-H	**Specimen Information**		
Test Date:	2018-01-10	Initial Height:	3.918	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	355.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



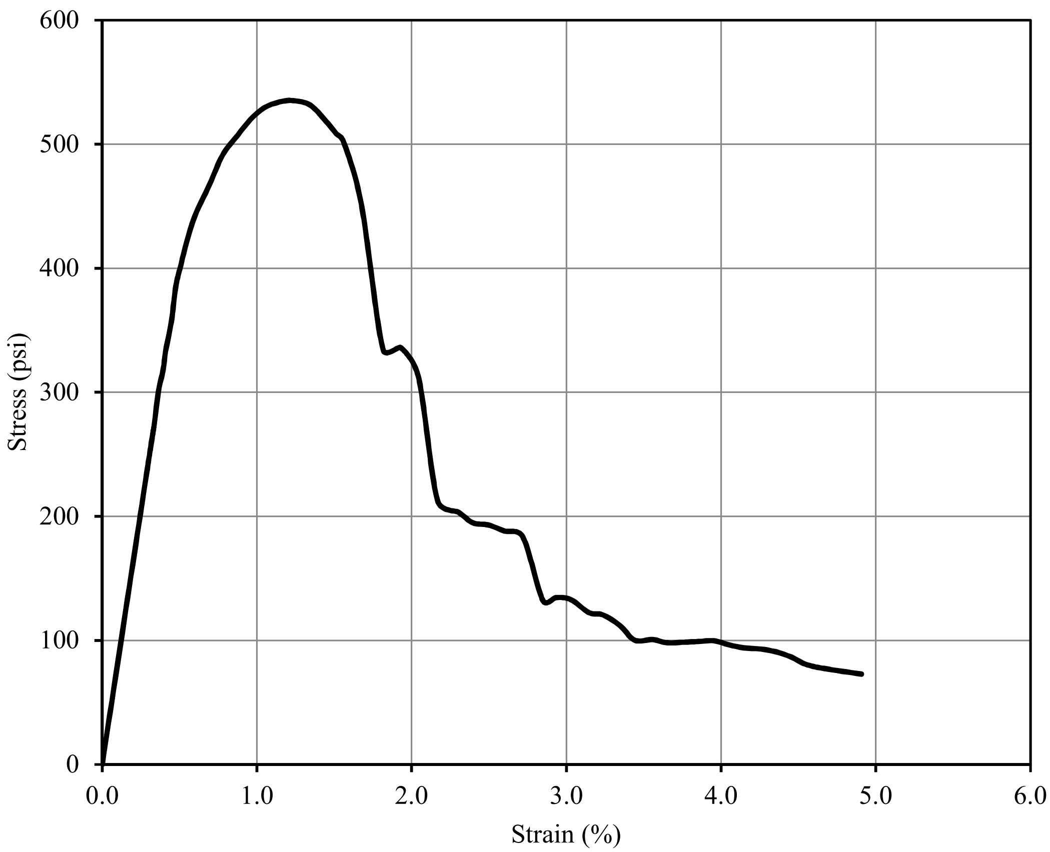
Test Result					
Peak deviator stress (w/ Height correction)	428	psi	Strain at failure, εf :	1.77	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-B	**Specimen Information**		
Test Date:	2018-01-14	Initial Height:	3.921	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	357.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



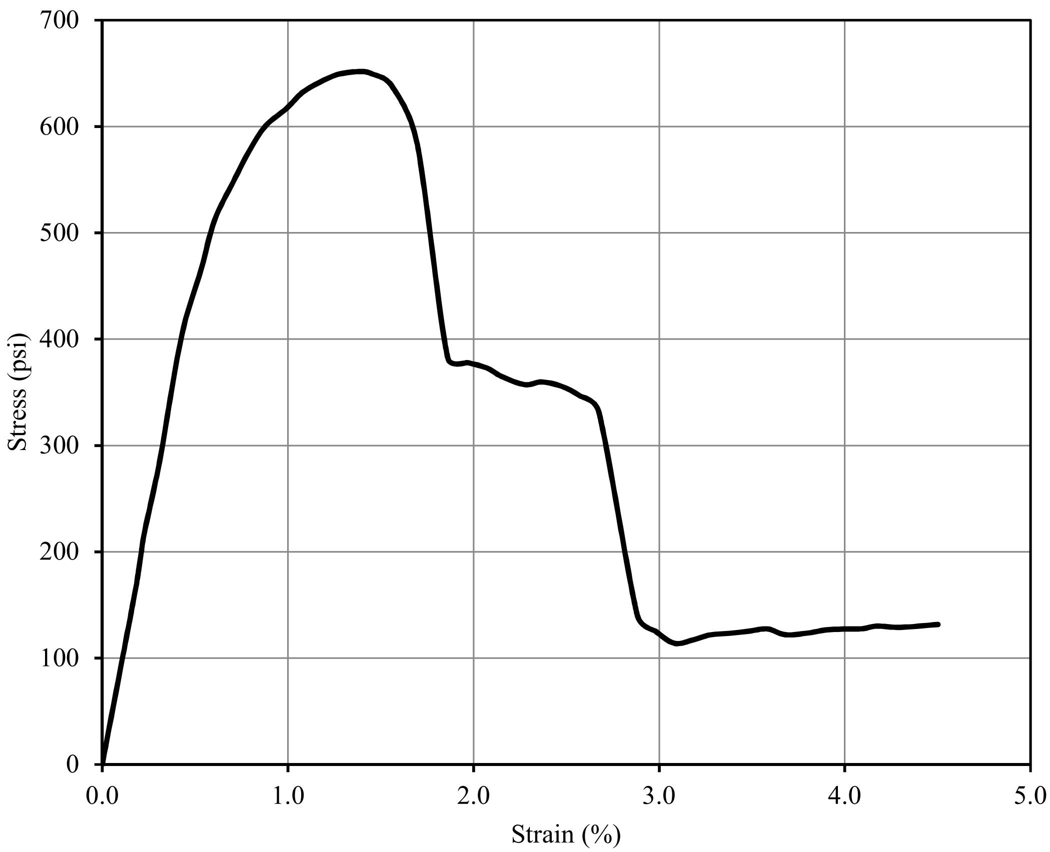
Test Result					
Peak deviator stress (w/ Height correction)	551	psi	Strain at failure, εf :	1.40	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-G	**Specimen Information**		
Test Date:	2018-01-14	Initial Height:	3.839	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	348.7	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



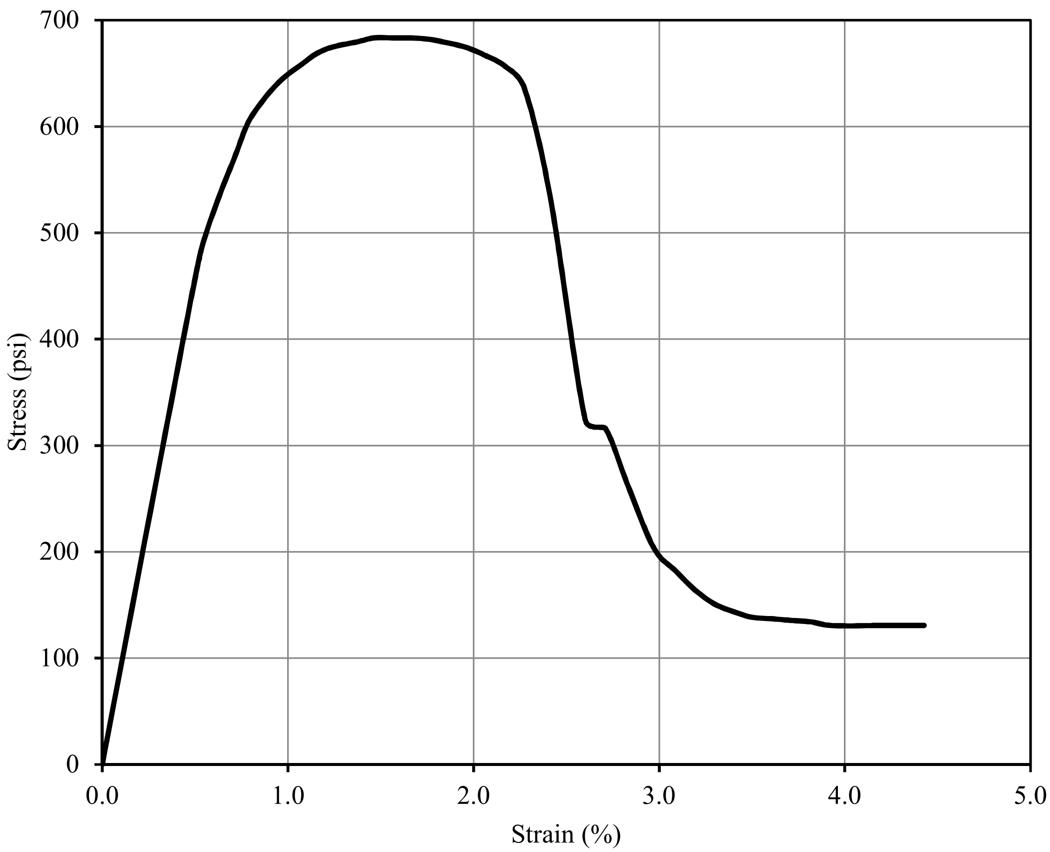
Test Result					
Peak deviator stress (w/ Height correction)	530	psi	Strain at failure, εf :	1.23	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-C	**Specimen Information**		
Test Date:	2018-01-21	Initial Height:	3.922	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	357.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



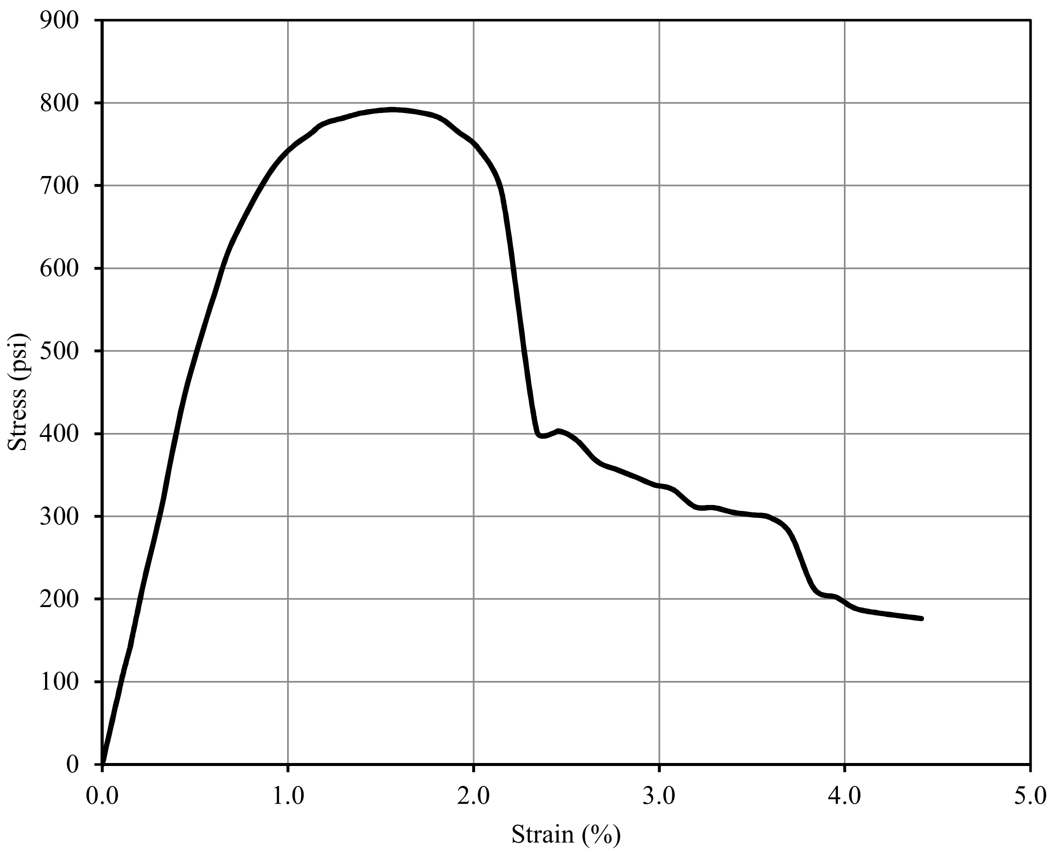
Test Result					
Peak deviator stress (w/ Height correction)	648	psi	Strain at failure, εf :	1.38	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-F	**Specimen Information**		
Test Date:	2018-01-21	Initial Height:	3.555	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	322.5	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	106	pcf



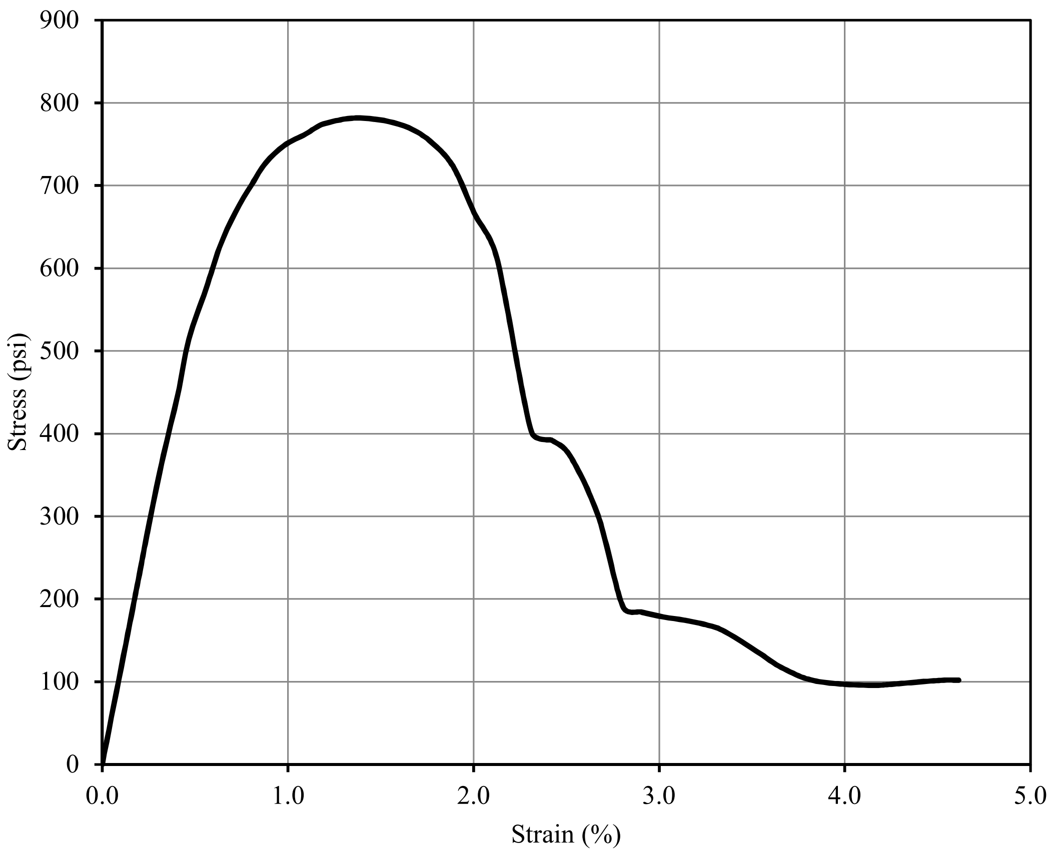
Test Result					
Peak deviator stress (w/ Height correction)	669	psi	Strain at failure, εf :	1.57	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-D	**Specimen Information**		
Test Date:	2018-02-04	Initial Height:	3.619	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	330.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



Test Result					
Peak deviator stress (w/ Height correction)	777	psi	Strain at failure, εf :	1.60	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	35	°C
I.D.:	T-10-E	**Specimen Information**		
Test Date:	2018-02-04	Initial Height:	3.856	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	352.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf

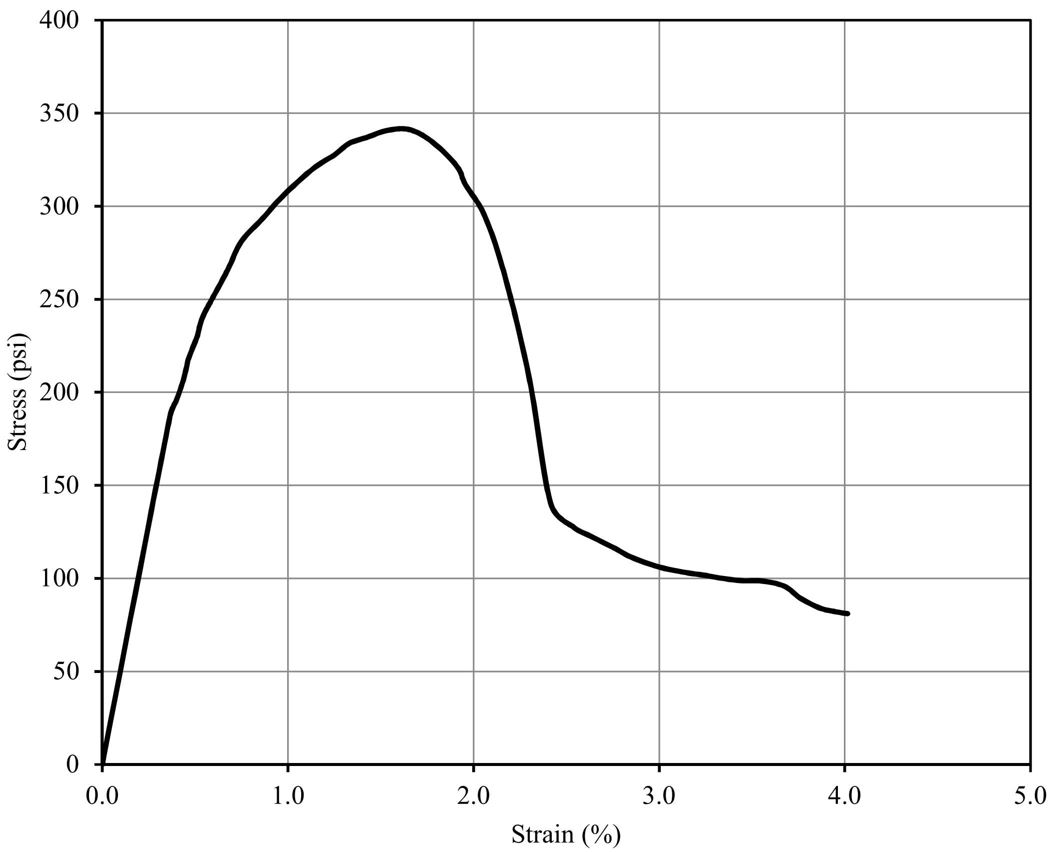


Test Result					
Peak deviator stress (w/ Height correction)	775	psi	Strain at failure, εf :	1.37	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C

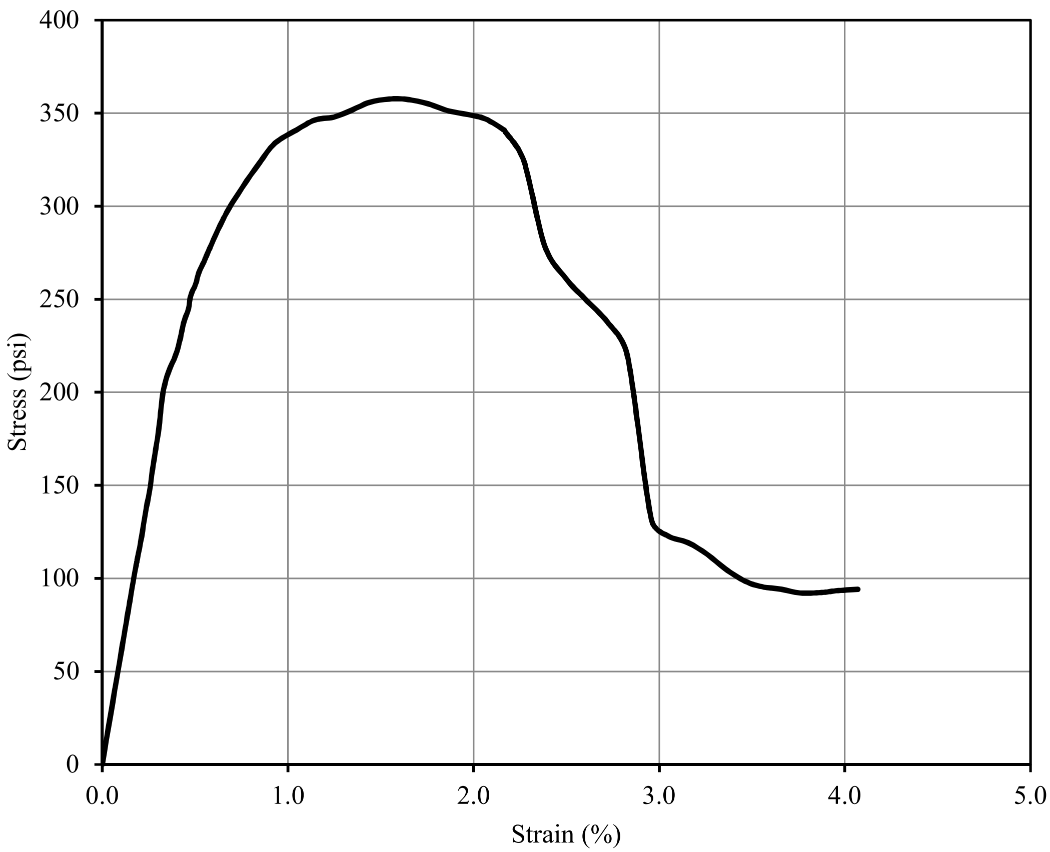
Test Information		Specimen Information		
I.D.:	T-11-A	Initial Height:	3.957	in
Test Date:	2017-12-25	Initial Diameter:	2.04	in
Strain Rate:	1 %/min	Initial Area:	3.269	in

Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	382.7	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



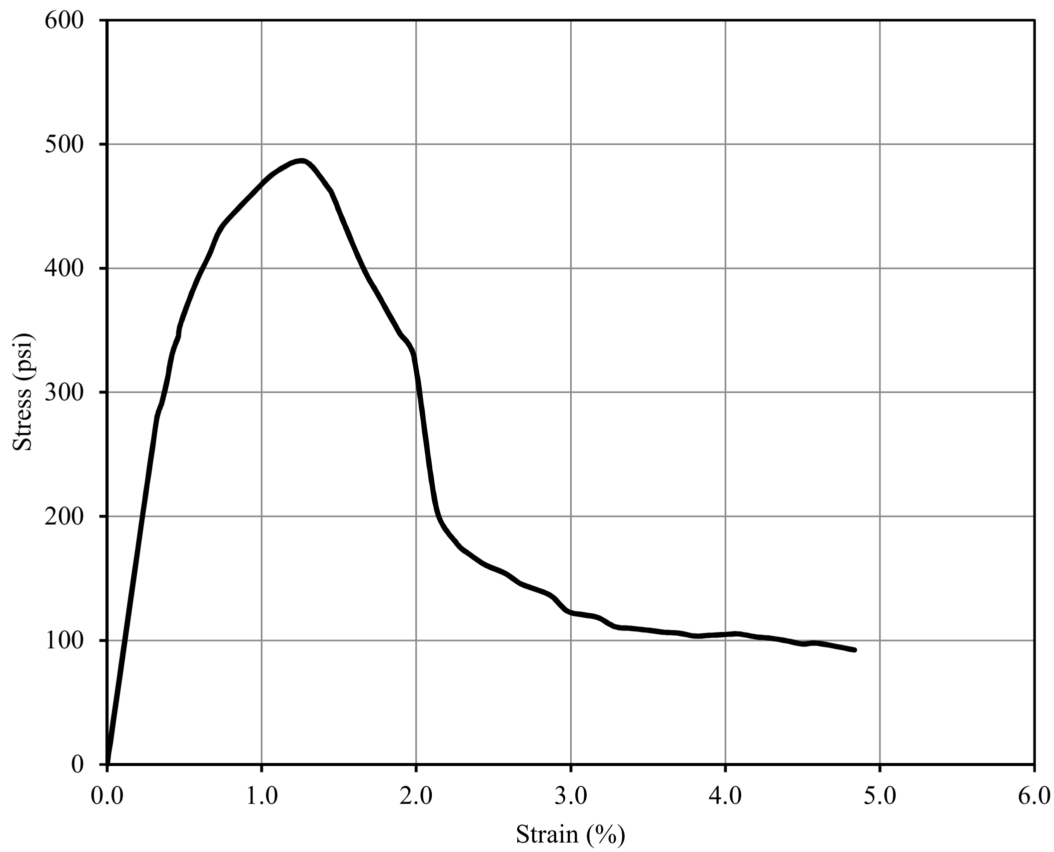
Test Result					
Peak deviator stress (w/ Height correction)	340	psi	Strain at failure, εf :	1.64	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-11-H	**Specimen Information**		
Test Date:	2017-12-25	Initial Height:	3.806	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	367.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



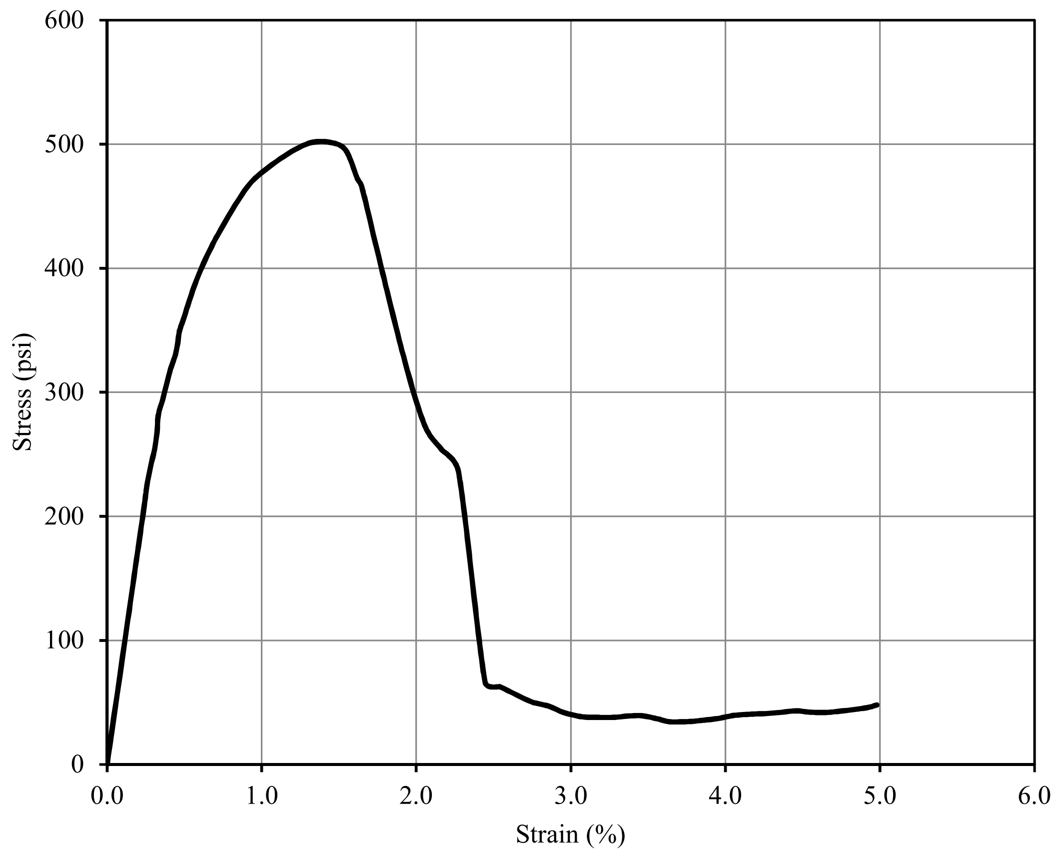
Test Result					
Peak deviator stress (w/ Height correction)	354	psi	Strain at failure, εf :	1.55	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-11-B	**Specimen Information**		
Test Date:	2017-12-29	Initial Height:	3.956	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	382.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



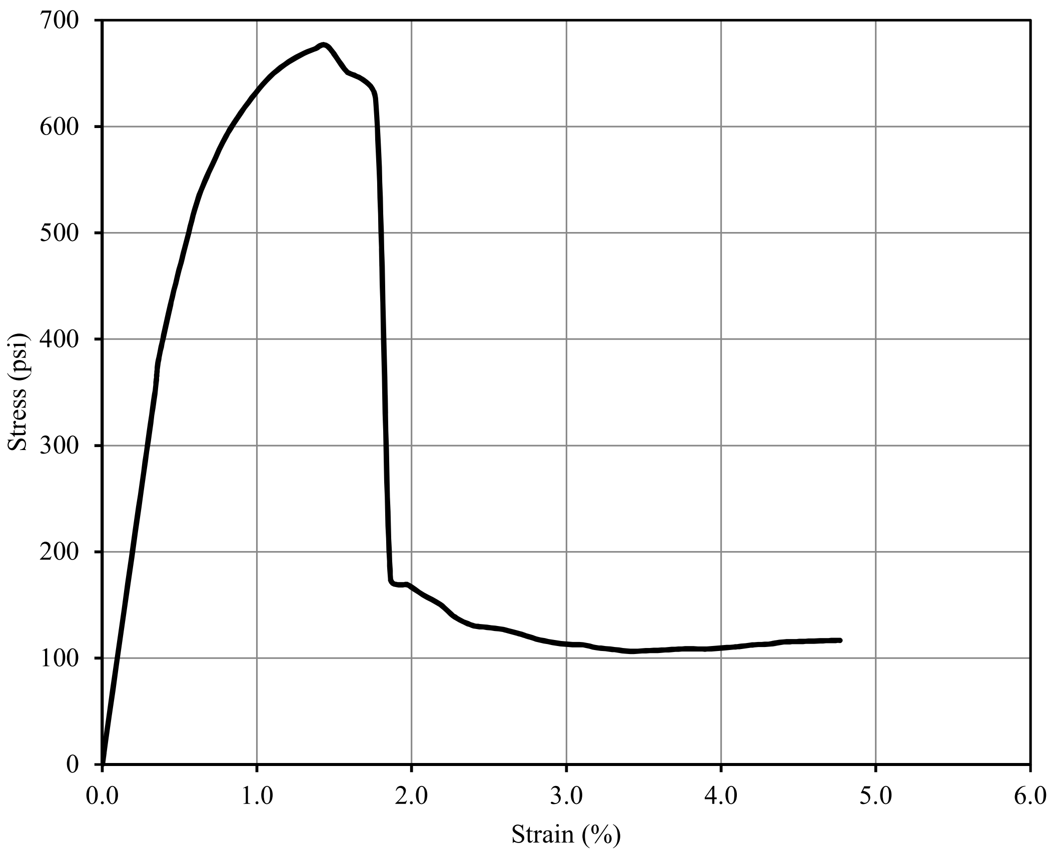
Test Result					
Peak deviator stress (w/ Height correction)	484	psi	Strain at failure, εf :	1.23	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-11-G	**Specimen Information**		
Test Date:	2017-12-29	Initial Height:	3.899	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	378.3	g
(w:c)$_{slurry}$:	0.6	Unit Weight:	113	pcf



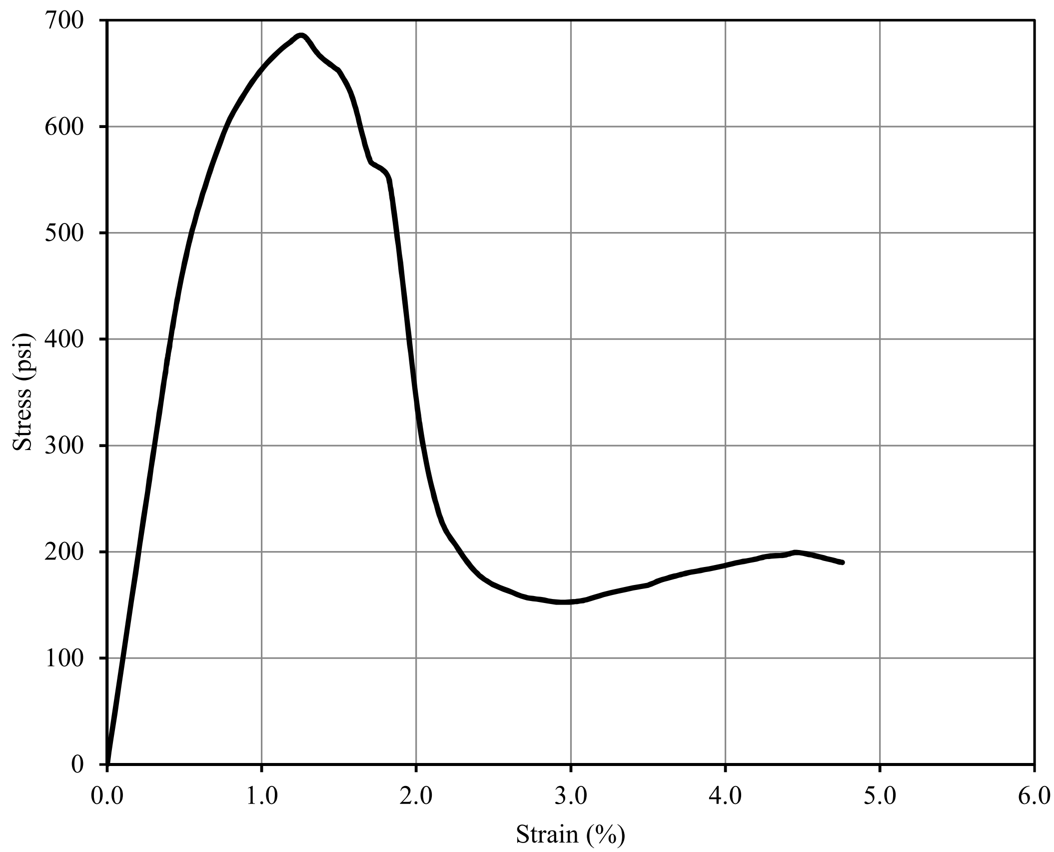
Test Result					
Peak deviator stress (w/ Height correction)	498	psi	Strain at failure, εf :	1.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-11-F	**Specimen Information**		
Test Date:	2018-01-05	Initial Height:	3.921	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	381.1	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



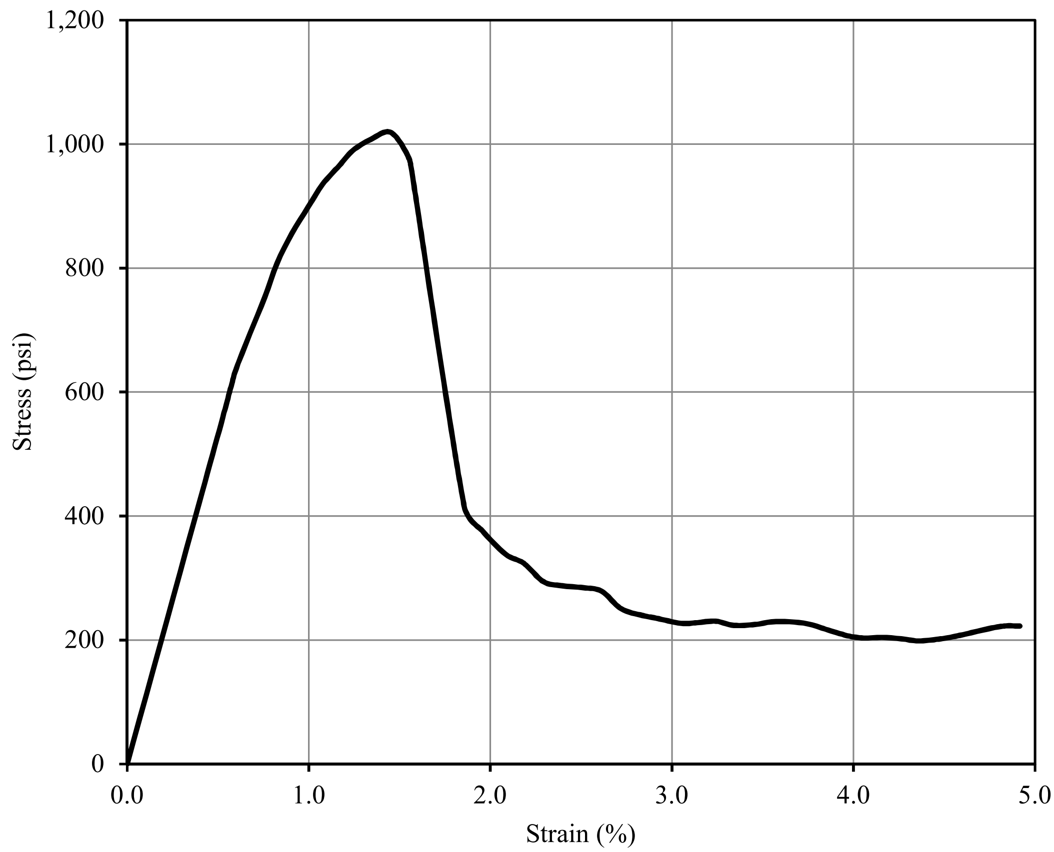
Test Result					
Peak deviator stress (w/ Height correction)	671	psi	Strain at failure, εf :	1.45	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-11-I	**Specimen Information**		
Test Date:	2018-01-05	Initial Height:	3.669	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	355.5	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf



Test Result					
Peak deviator stress (w/ Height correction)	674	psi	Strain at failure, εf :	1.27	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-11-D	**Specimen Information**		
Test Date:	2018-01-19	Initial Height:	3.868	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	375.2	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	113	pcf

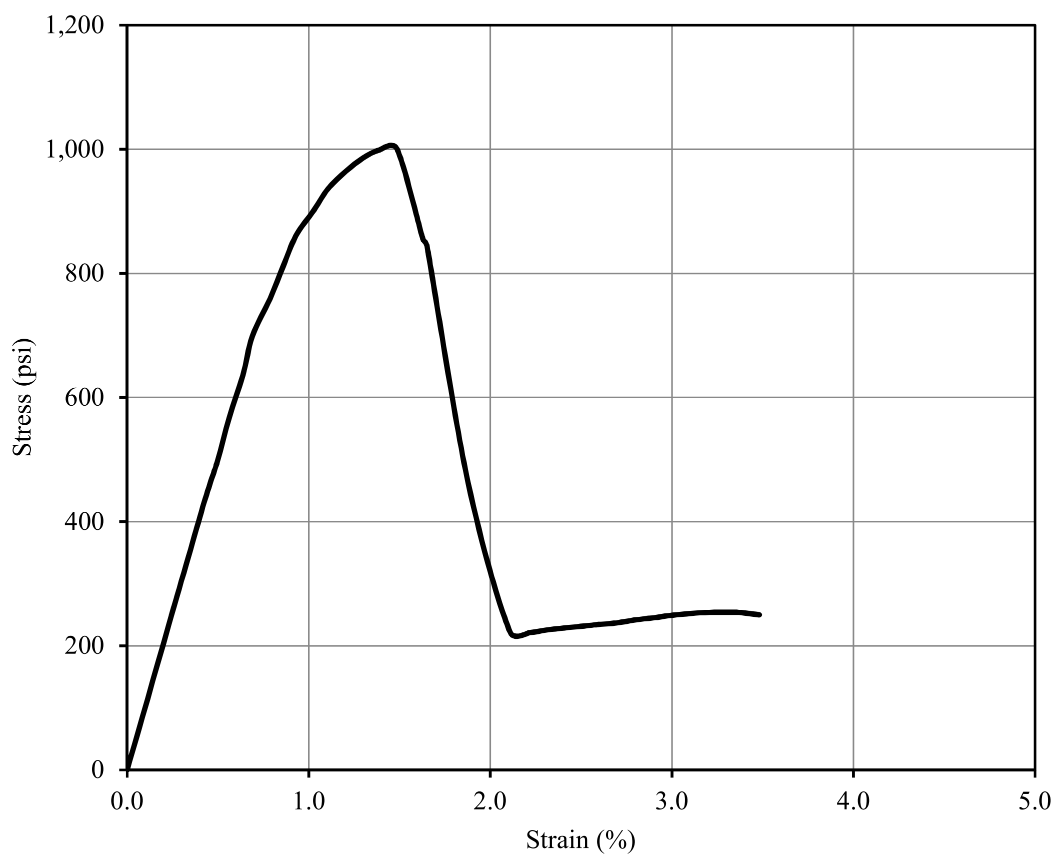


Test Result					
Peak deviator stress (w/ Height correction)	1,010	psi	Strain at failure, εf :	1.45	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C

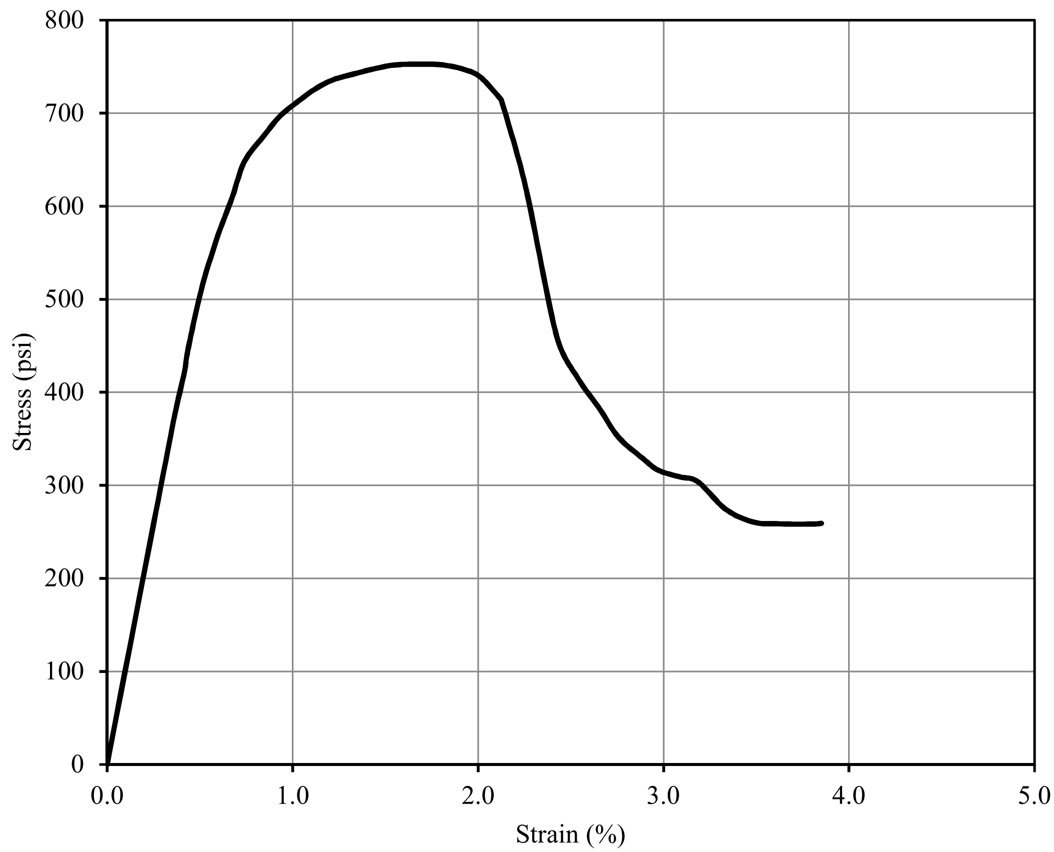
Test Information		Specimen Information		
I.D.:	T-11-E	Initial Height:	3.602	in
Test Date:	2018-01-19	Initial Diameter:	2.043	in
Strain Rate:	1 %/min	Initial Area:	3.278	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	348.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



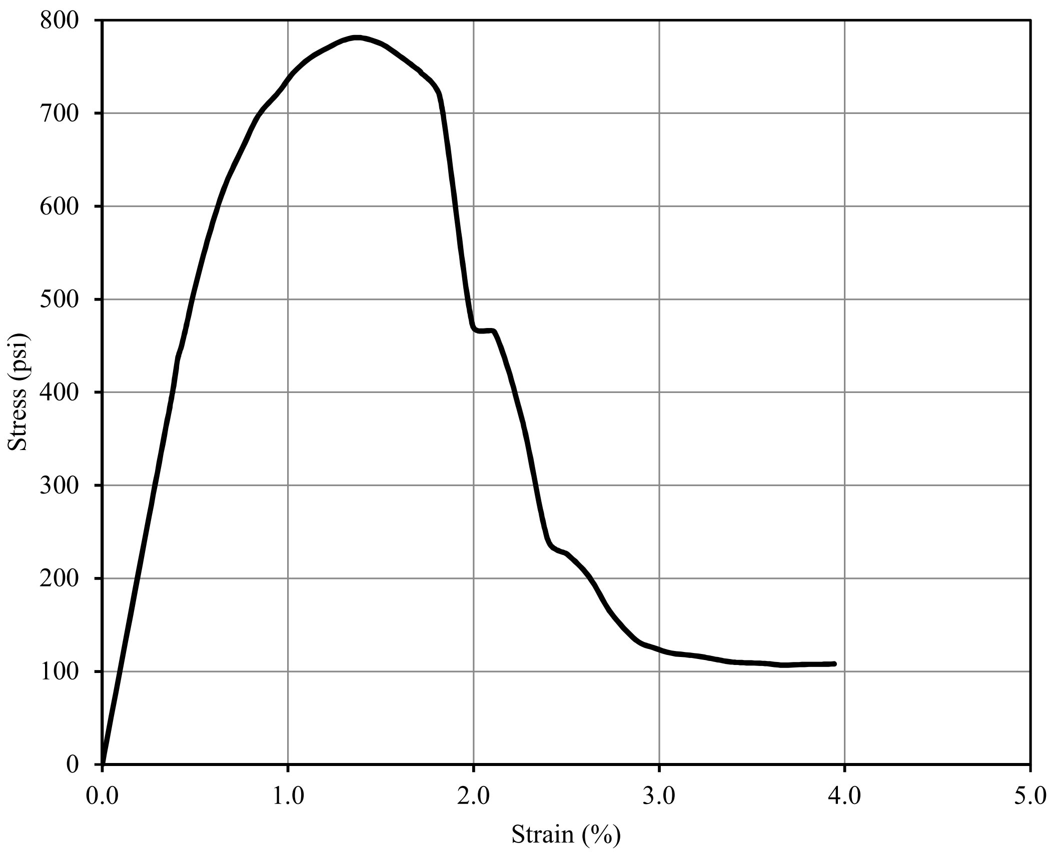
Test Result					
Peak deviator stress (w/ Height correction)	982	psi	Strain at failure, εf :	1.49	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-12-A	**Specimen Information**		
Test Date:	2017-12-25	Initial Height:	3.866	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	372.3	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	111	pcf



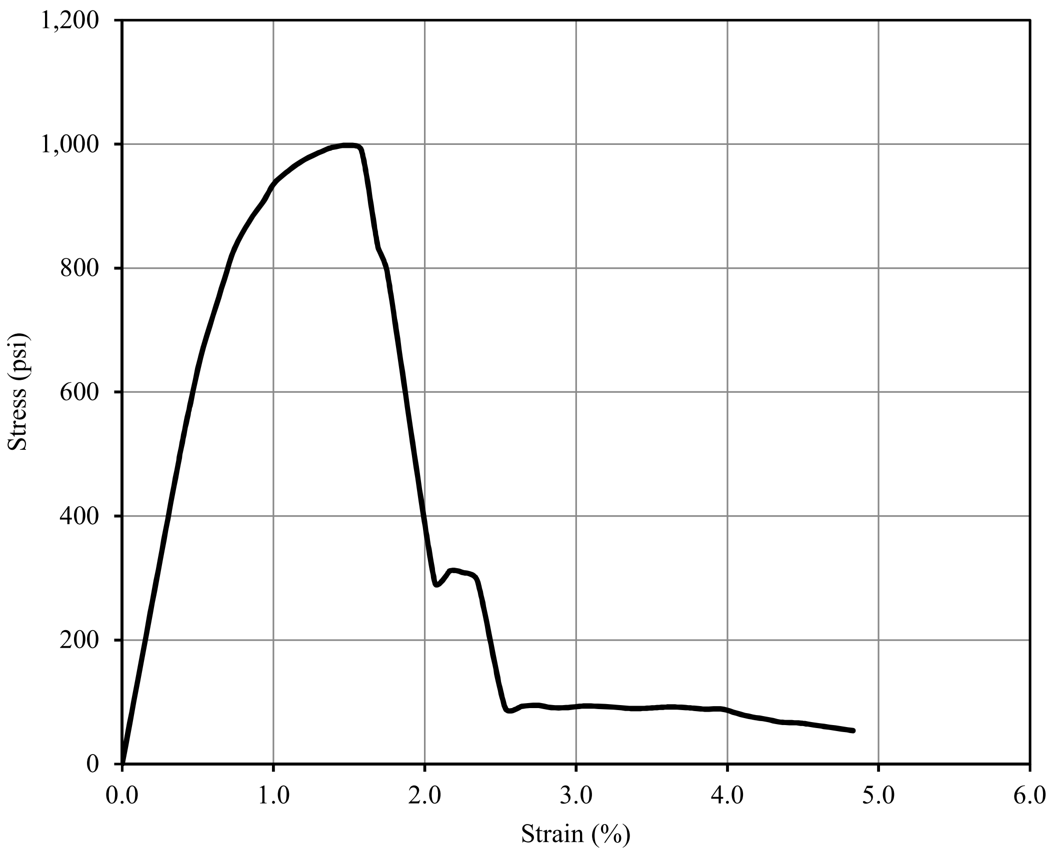
Test Result					
Peak deviator stress (w/ Height correction)	746	psi	Strain at failure, εf :	1.71	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-12-J	**Specimen Information**		
Test Date:	2017-12-25	Initial Height:	3.847	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	370.9	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



Test Result					
Peak deviator stress (w/ Height correction)	774	psi	Strain at failure, εf :	1.39	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-12-B	**Specimen Information**		
Test Date:	2017-12-29	Initial Height:	3.895	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	376.3	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf

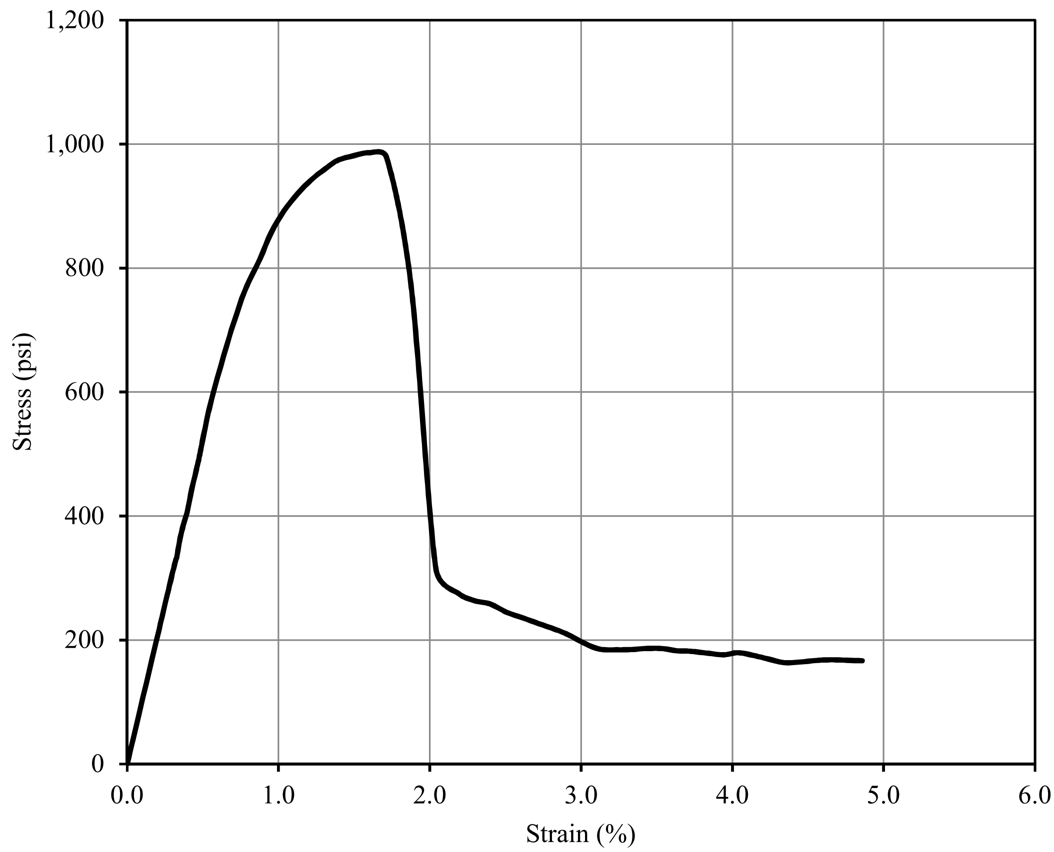


Test Result					
Peak deviator stress (w/ Height correction)	990	psi	Strain at failure, εf :	1.49	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C

Test Information		Specimen Information		
I.D.:	T-12-G	Initial Height:	3.914	in
Test Date:	2017-12-29	Initial Diameter:	2.044	in
Strain Rate:	1 %/min	Initial Area:	3.281	in

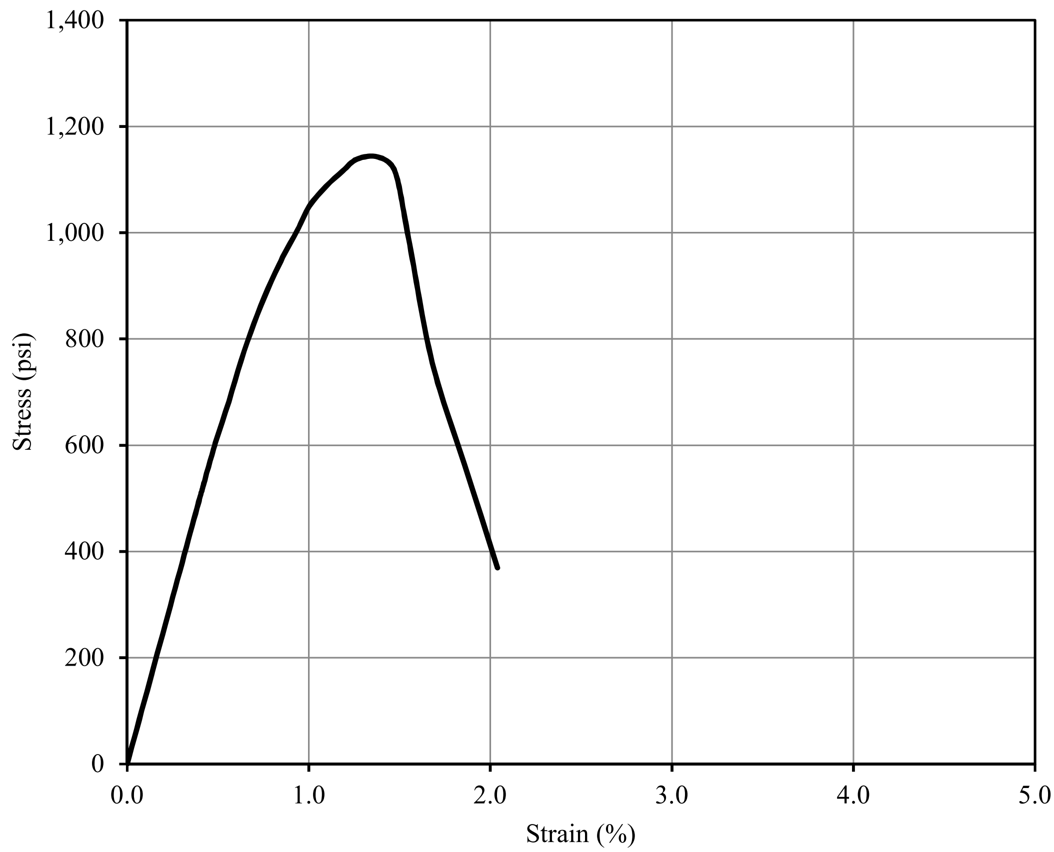
Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	378.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



Test Result					
Peak deviator stress (w/ Height correction)	980	psi	Strain at failure, εf :	1.60	%

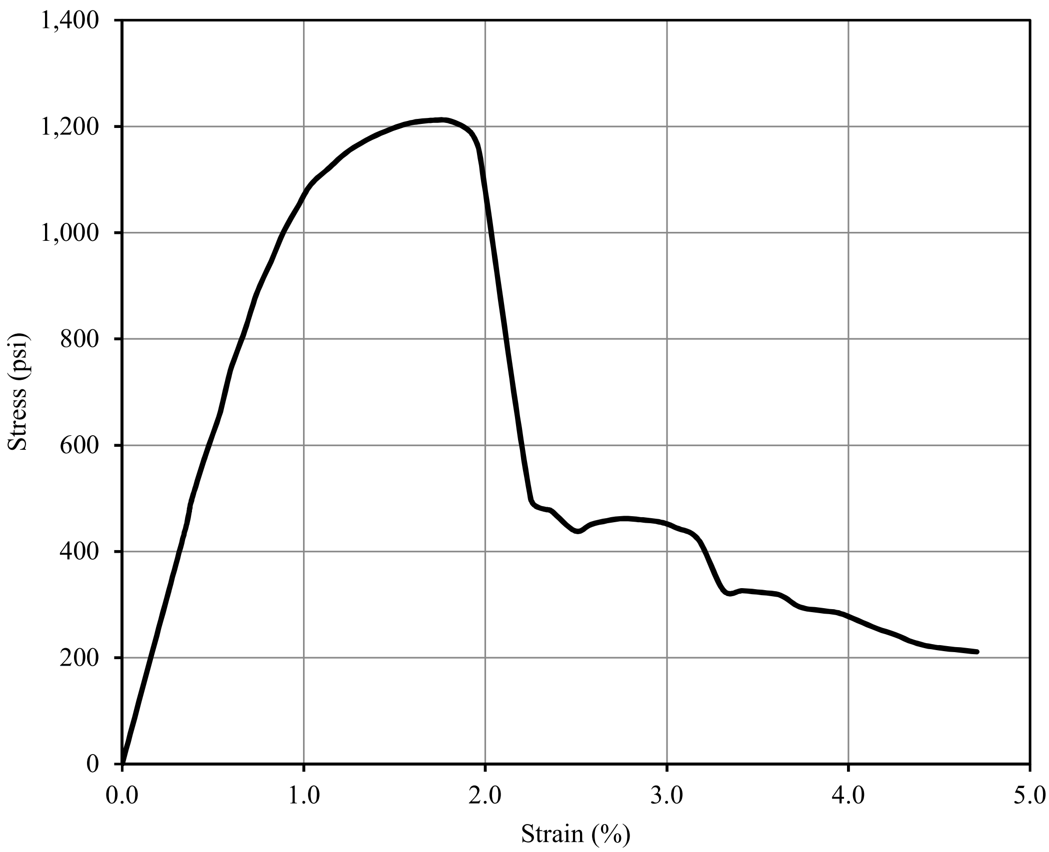
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C

Test Information		Specimen Information		
I.D.:	T-12-C	Initial Height:	3.905	in
Test Date:	2018-01-05	Initial Diameter:	2.044	in
Strain Rate:	1 %/min	Initial Area:	3.281	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	378.1	g
(w:c)$_{slurry}$:	0.6	Unit Weight:	112	pcf



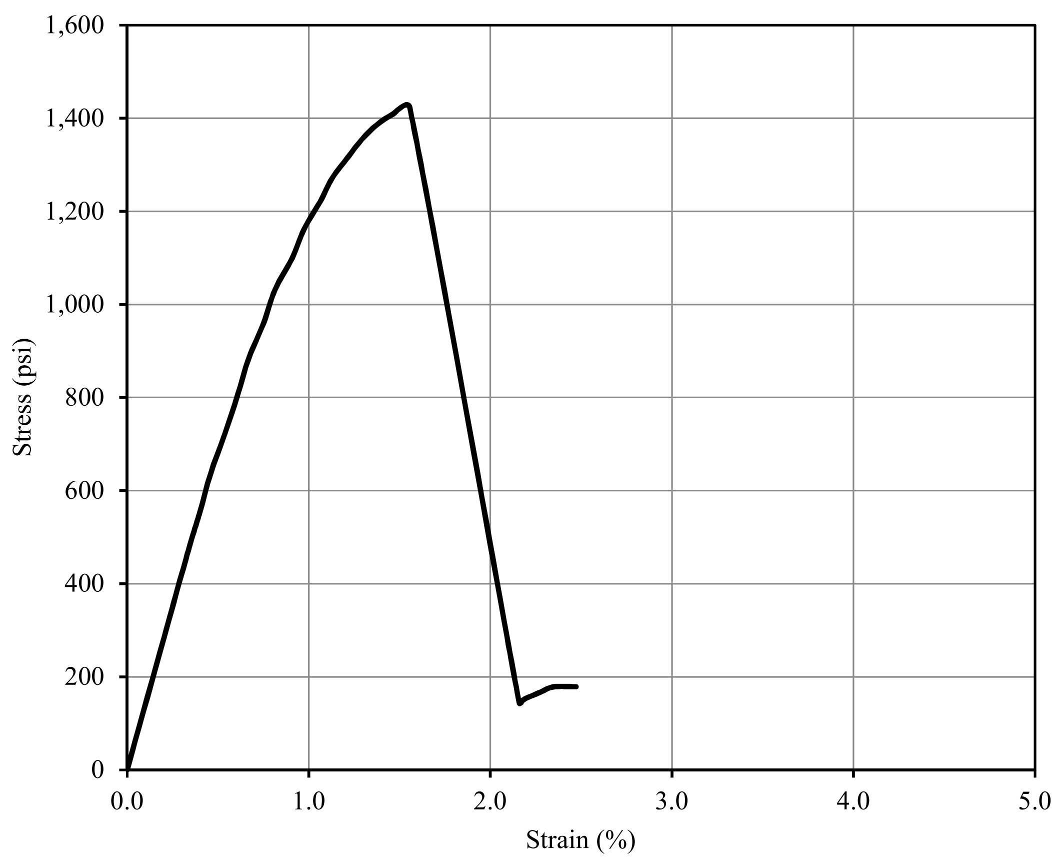
Test Result					
Peak deviator stress (w/ Height correction)	1,134	psi	Strain at failure, εf :	1.38	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-12-F	**Specimen Information**		
Test Date:	2018-01-05	Initial Height:	3.836	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	370.1	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



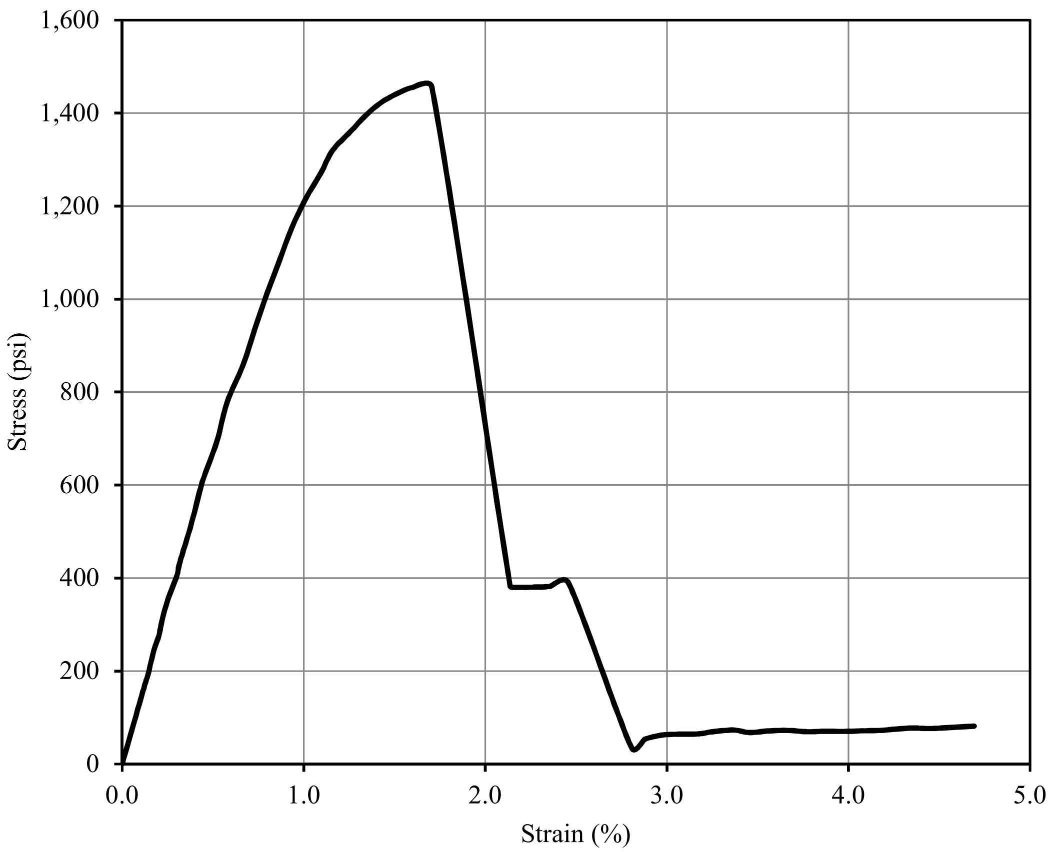
Test Result					
Peak deviator stress (w/ Height correction)	1,200	psi	Strain at failure, εf :	1.71	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-12-D	**Specimen Information**		
Test Date:	2018-01-19	Initial Height:	3.85	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	372.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



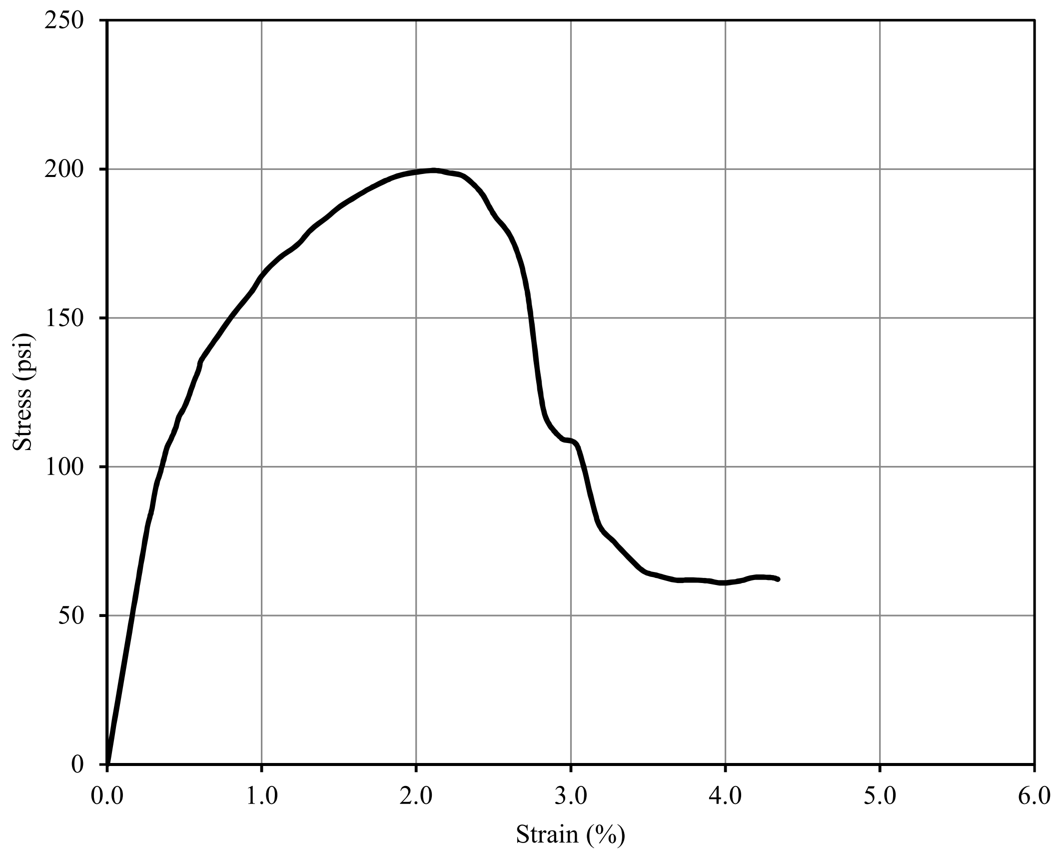
Test Result					
Peak deviator stress (w/ Height correction)	1,410	psi	Strain at failure, εf :	1.56	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-12-E	**Specimen Information**		
Test Date:	2018-01-19	Initial Height:	3.844	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	372.3	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



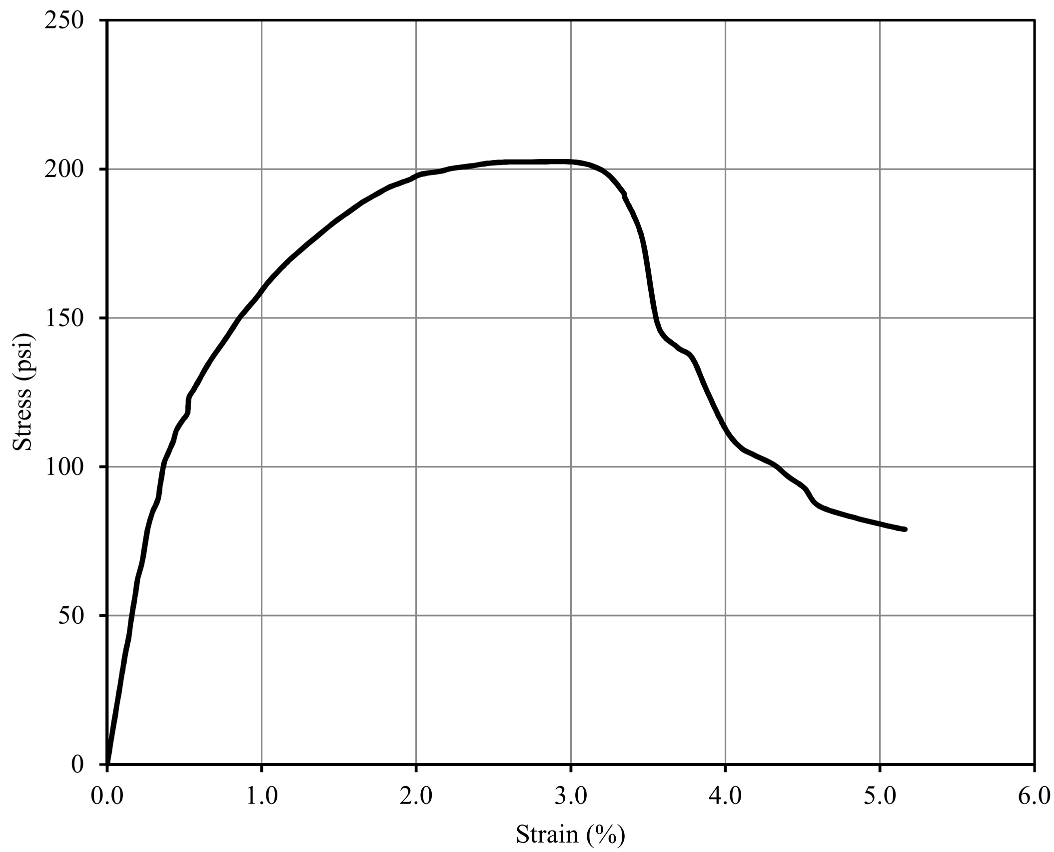
Test Result					
Peak deviator stress (w/ Height correction)	1,442	psi	Strain at failure, εf :	1.71	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-13-A	**Specimen Information**		
Test Date:	2017-12-26	Initial Height:	3.862	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	366.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf



Test Result					
Peak deviator stress (w/ Height correction)	198	psi	Strain at failure, εf :	2.12	%

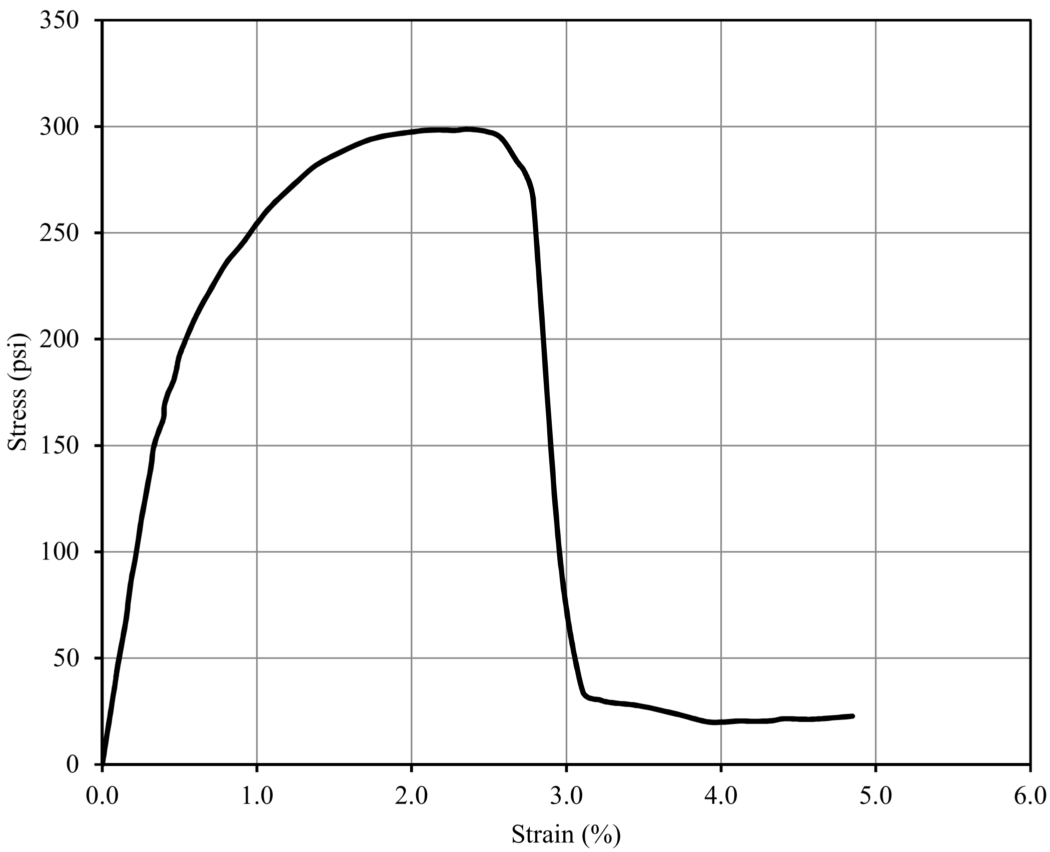
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-13-H	**Specimen Information**		
Test Date:	2017-12-26	Initial Height:	3.785	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	359.2	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	111	pcf



Test Result					
Peak deviator stress (w/ Height correction)	200	psi	Strain at failure, εf :	2.94	%

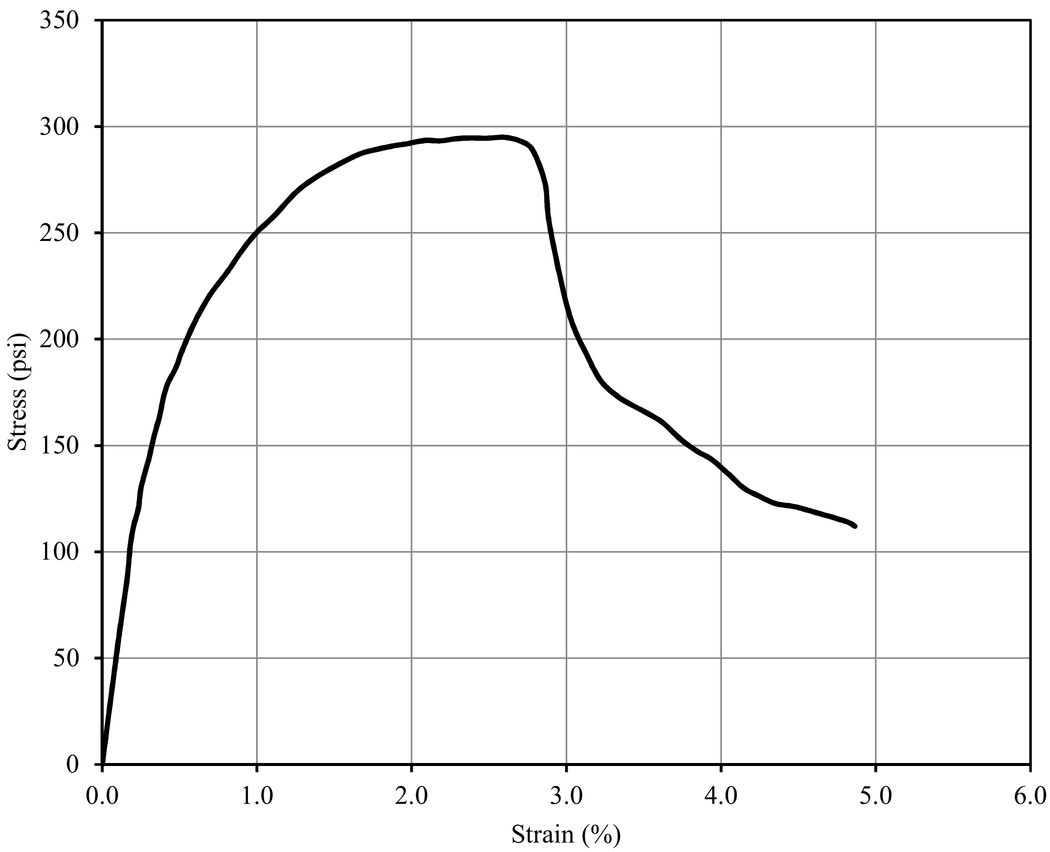
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C

Test Information		Specimen Information		
I.D.:	T-13-B	Initial Height:	3.884	in
Test Date:	2017-12-30	Initial Diameter:	2.039	in
Strain Rate:	1 %/min	Initial Area:	3.265	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	369.6	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	111	pcf



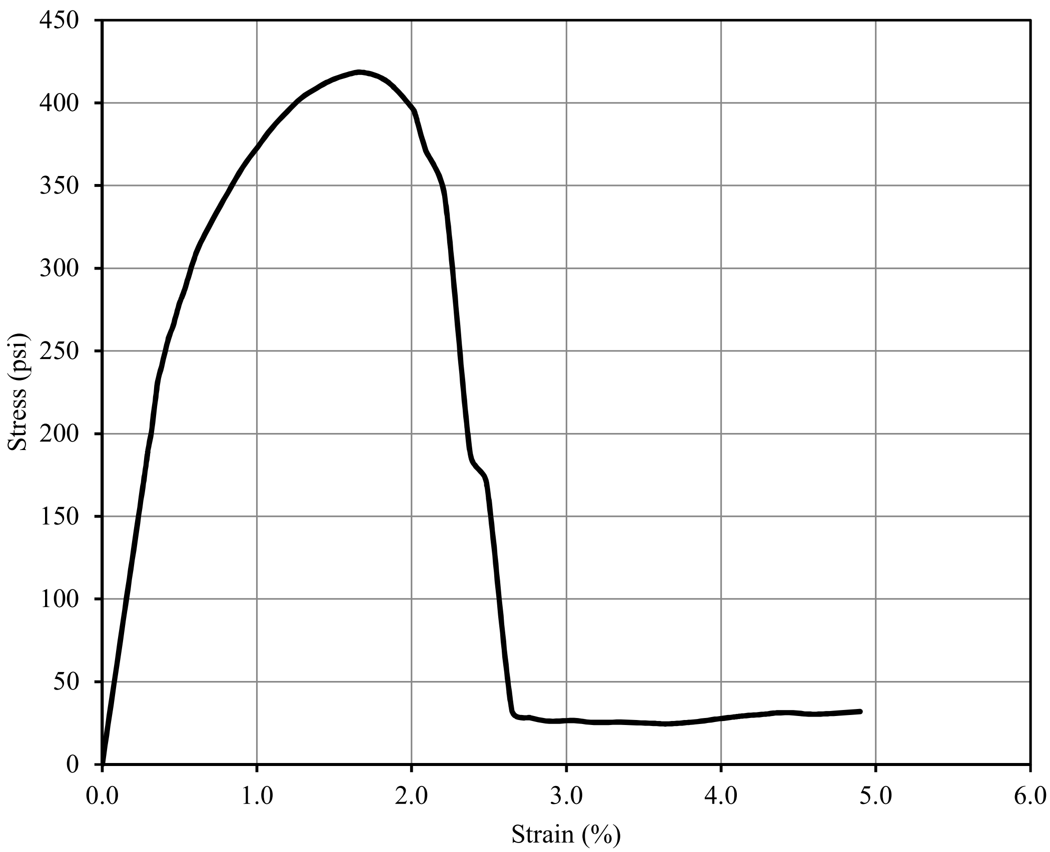
Test Result					
Peak deviator stress (w/ Height correction)	296	psi	Strain at failure, εf :	2.37	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-13-G	**Specimen Information**		
Test Date:	2017-12-30	Initial Height:	3.911	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	371.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf



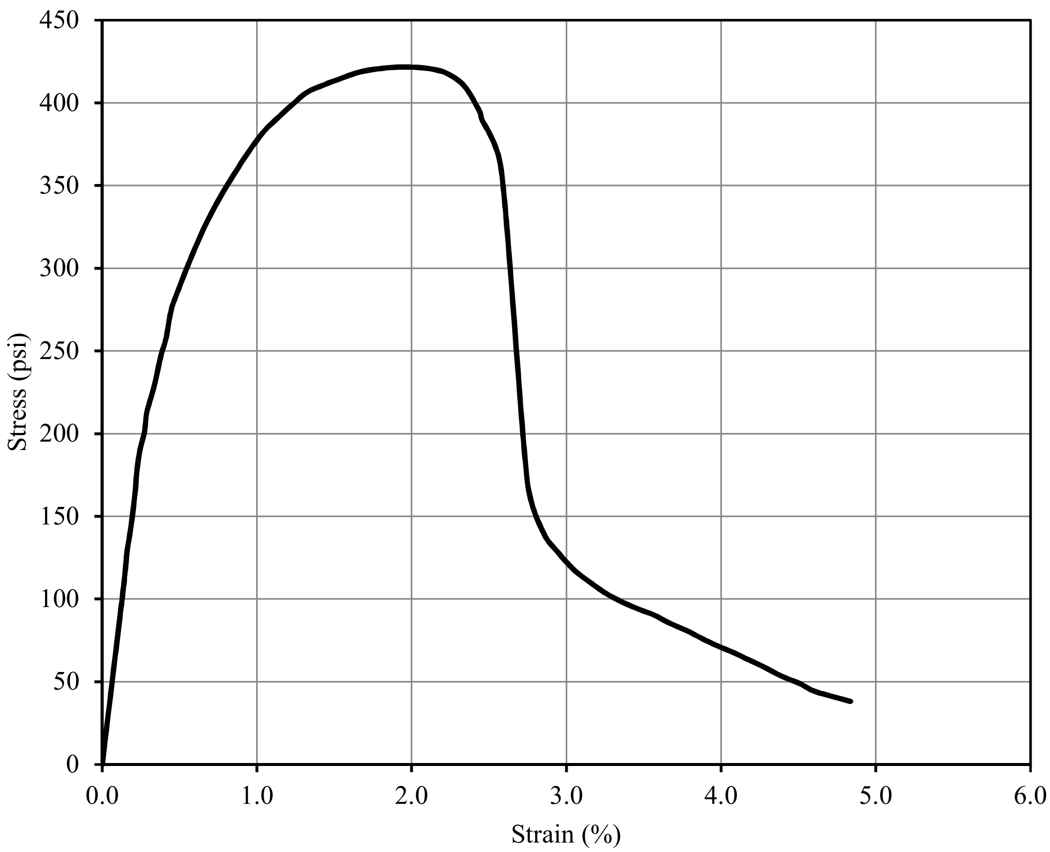
Test Result					
Peak deviator stress (w/ Height correction)	293	psi	Strain at failure, εf :	2.60	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-13-C	**Specimen Information**		
Test Date:	2018-01-06	Initial Height:	3.917	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	372.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



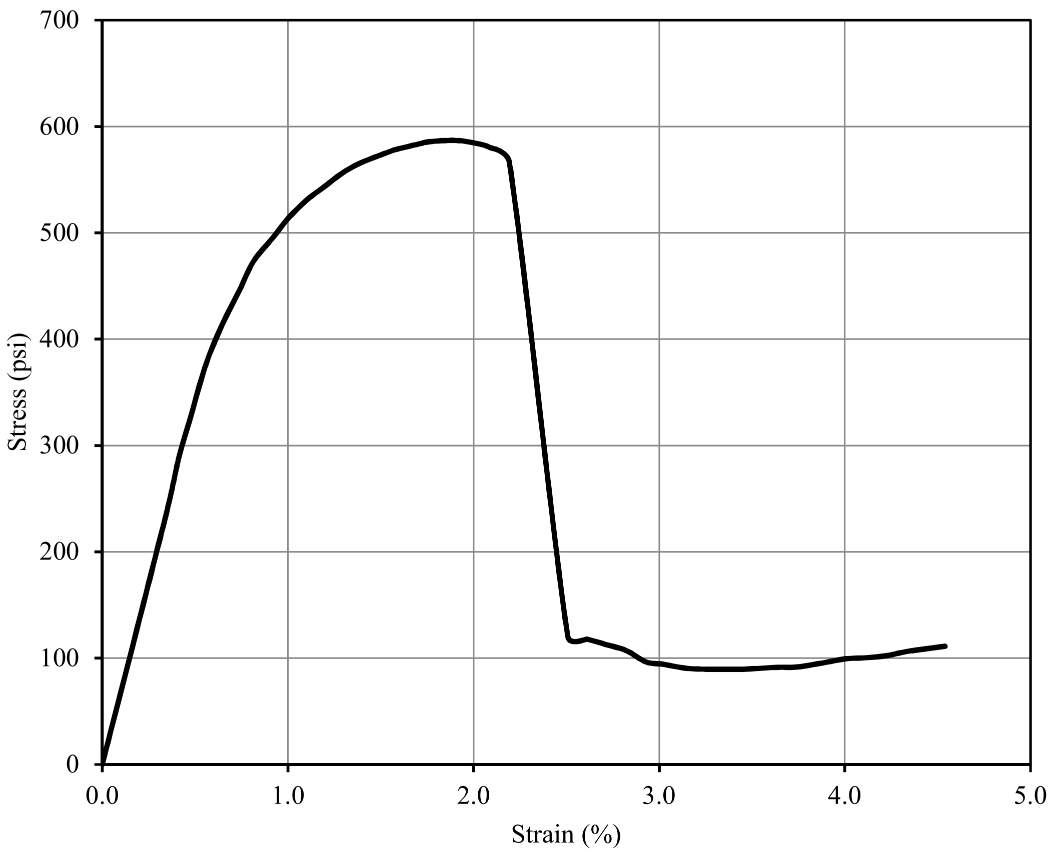
Test Result					
Peak deviator stress (w/ Height correction)	416	psi	Strain at failure, εf :	1.68	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-13-F	**Specimen Information**		
Test Date:	2018-01-06	Initial Height:	3.915	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	372.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



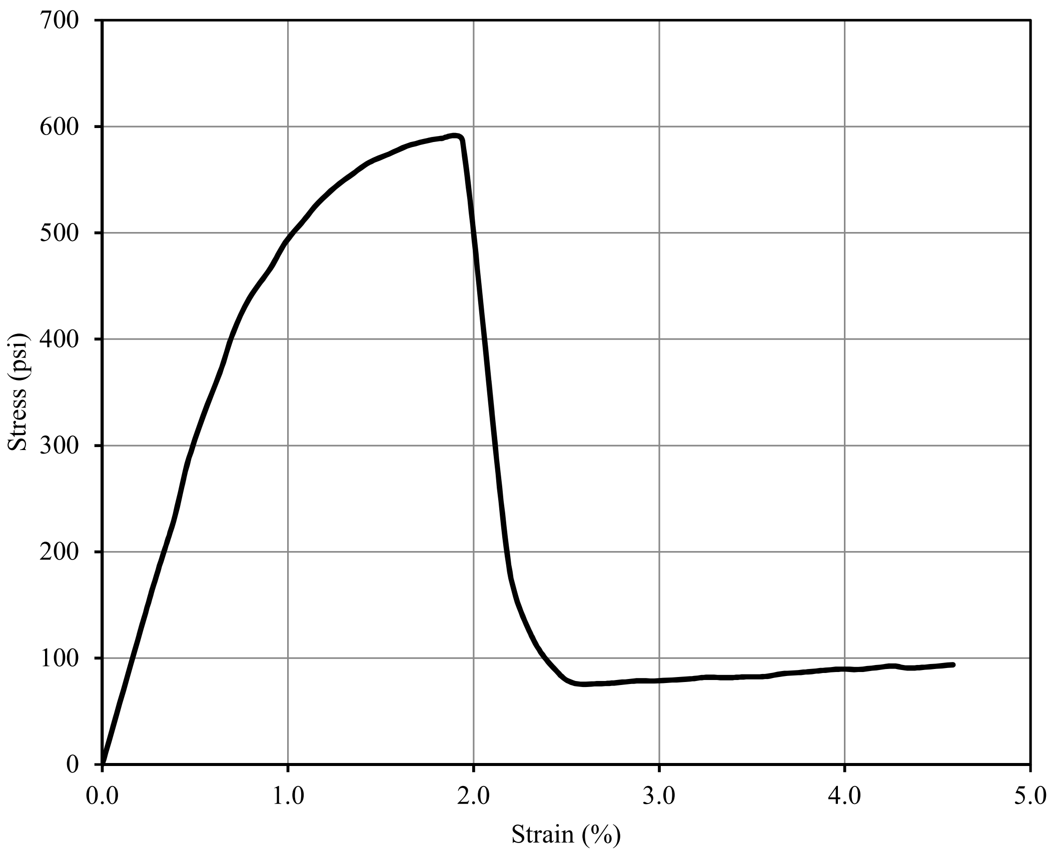
Test Result					
Peak deviator stress (w/ Height correction)	419	psi	Strain at failure, εf :	1.93	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-13-D	**Specimen Information**		
Test Date:	2018-01-20	Initial Height:	3.826	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	363.8	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	111	pcf



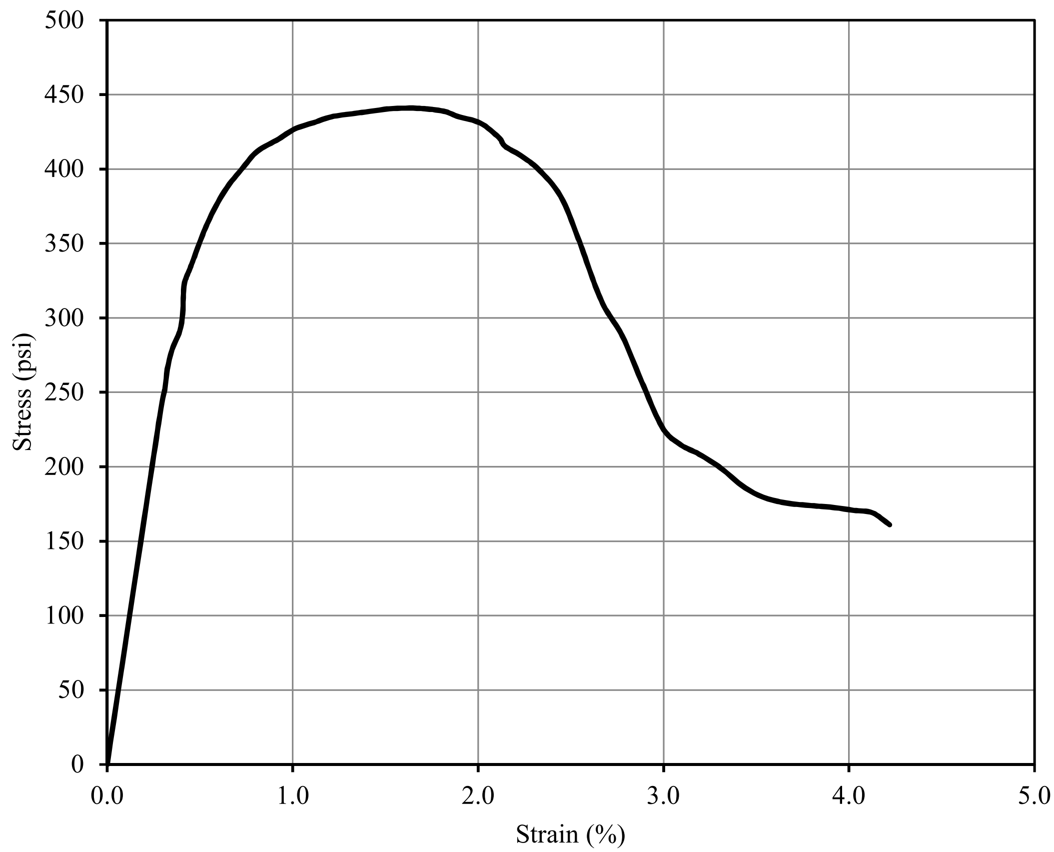
Test Result					
Peak deviator stress (w/ Height correction)	581	psi	Strain at failure, εf :	1.89	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-13-E	**Specimen Information**		
Test Date:	2018-01-20	Initial Height:	3.846	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	365.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf



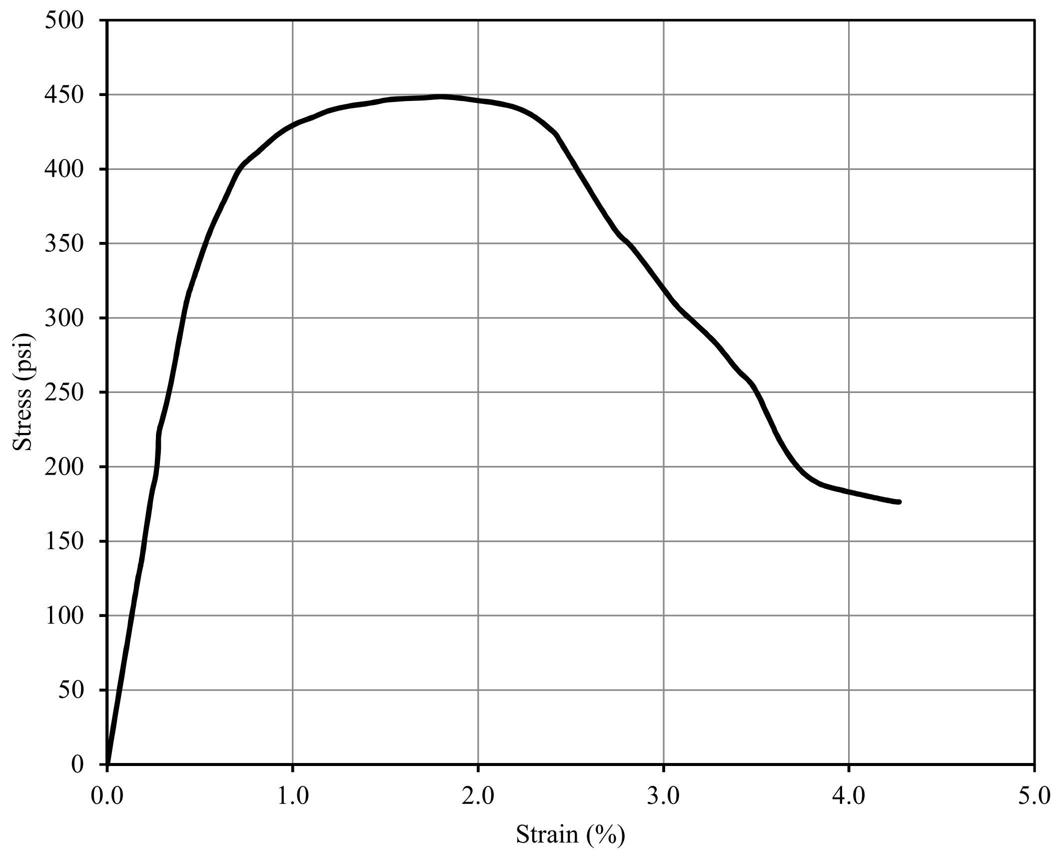
Test Result					
Peak deviator stress (w/ Height correction)	583	psi	Strain at failure, εf :	1.83	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-A	**Specimen Information**		
Test Date:	2017-12-26	Initial Height:	3.785	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	343.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



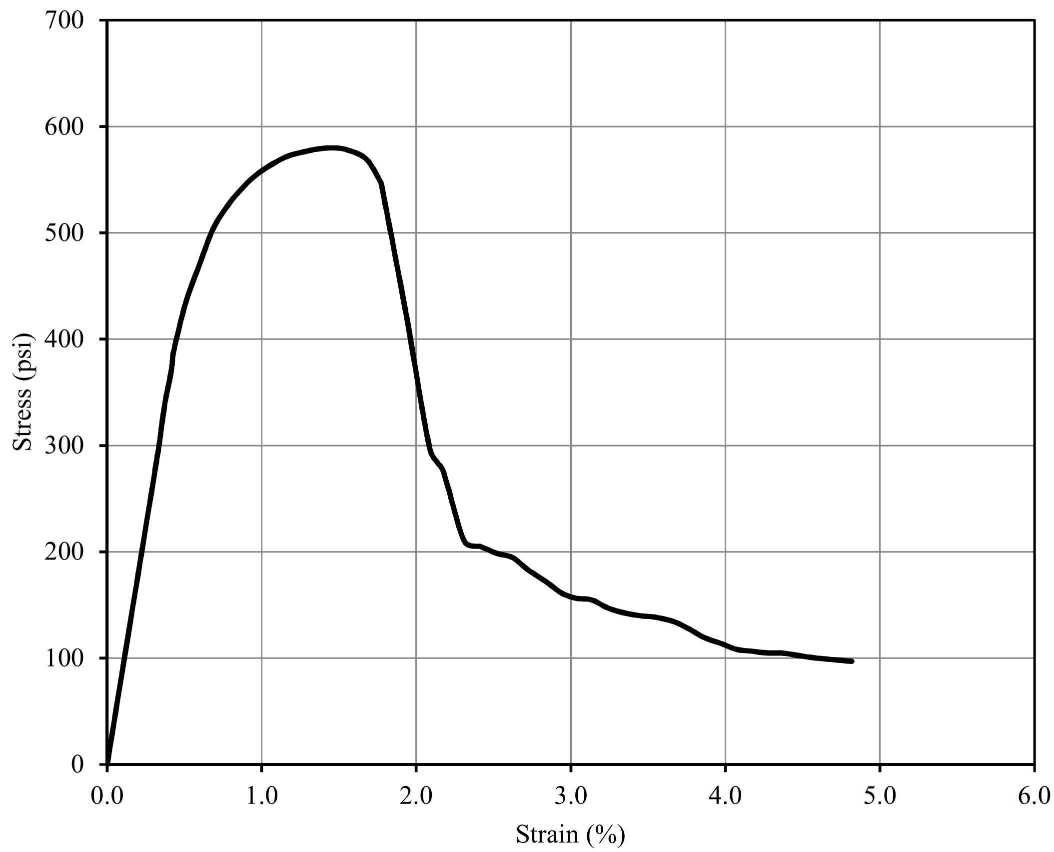
Test Result					
Peak deviator stress (w/ Height correction)	436	psi	Strain at failure, εf :	1.61	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-H	**Specimen Information**		
Test Date:	2017-12-26	Initial Height:	3.682	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	331.9	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



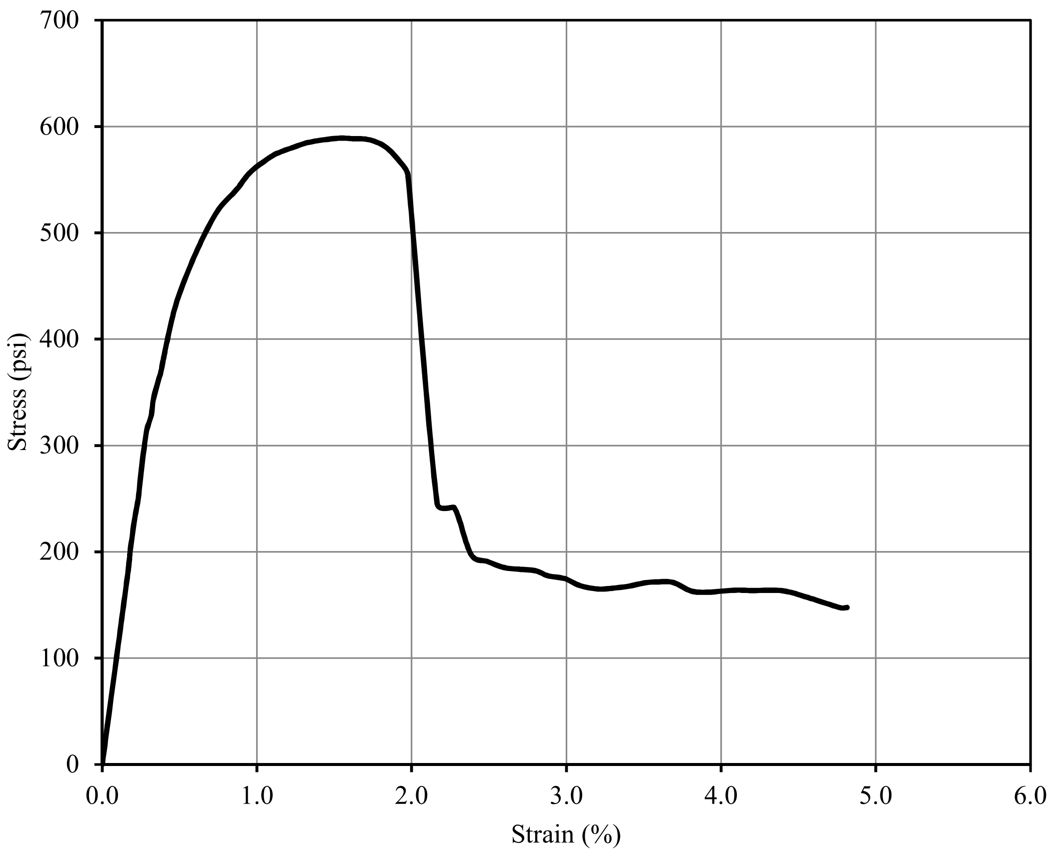
Test Result					
Peak deviator stress (w/ Height correction)	441	psi	Strain at failure, εf :	1.80	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-B	**Specimen Information**		
Test Date:	2017-12-30	Initial Height:	3.924	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	358.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



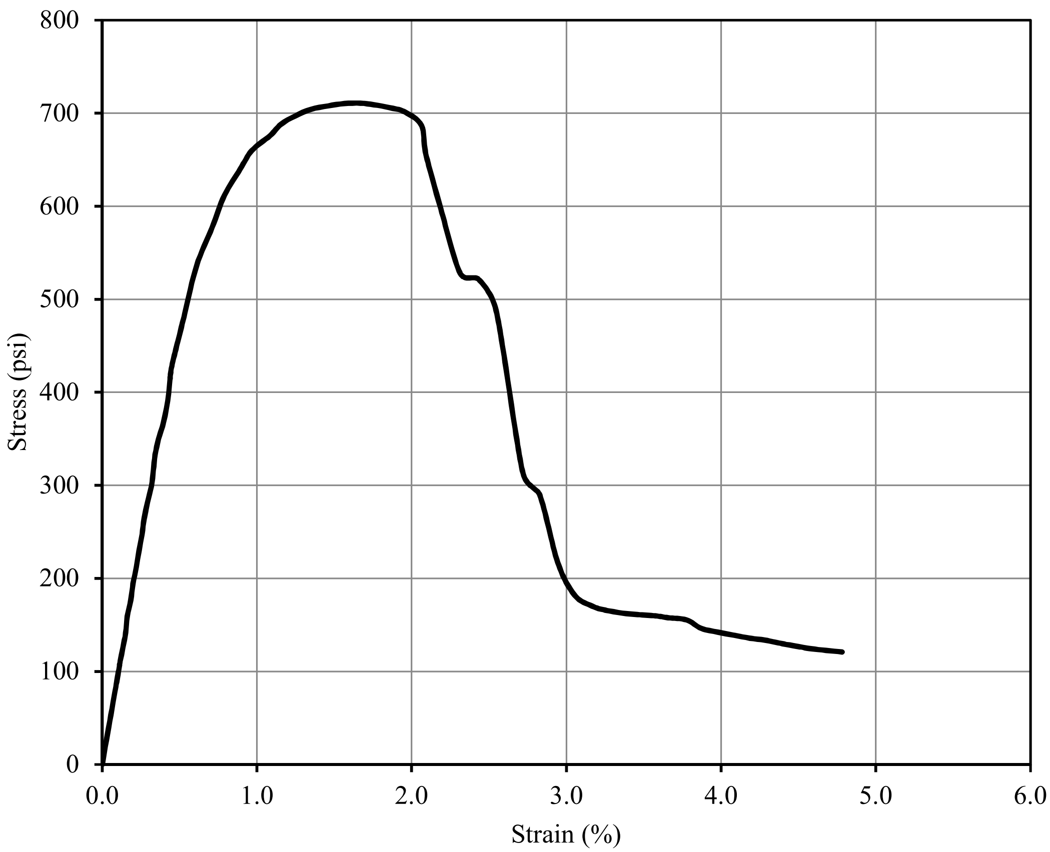
Test Result					
Peak deviator stress (w/ Height correction)	576	psi	Strain at failure, εf :	1.47	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-G	**Specimen Information**		
Test Date:	2017-12-30	Initial Height:	3.919	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	356.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



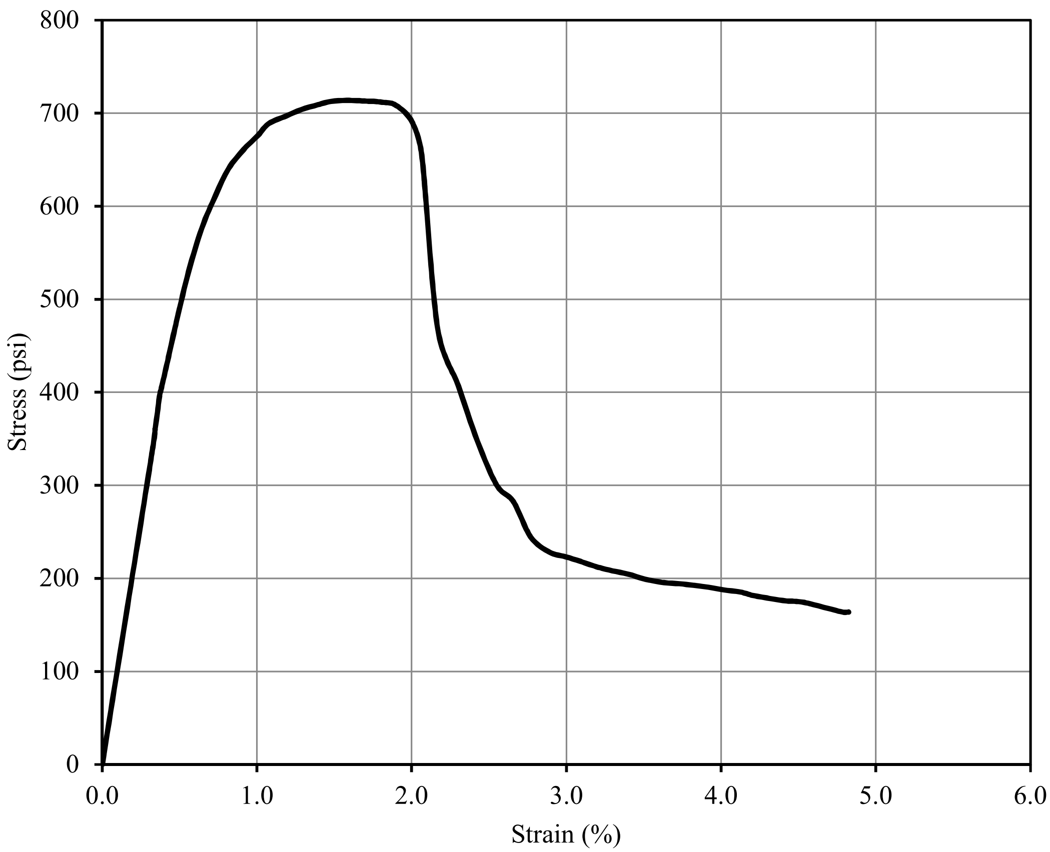
Test Result					
Peak deviator stress (w/ Height correction)	585	psi	Strain at failure, εf :	1.54	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-C	**Specimen Information**		
Test Date:	2018-01-06	Initial Height:	3.792	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	344.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



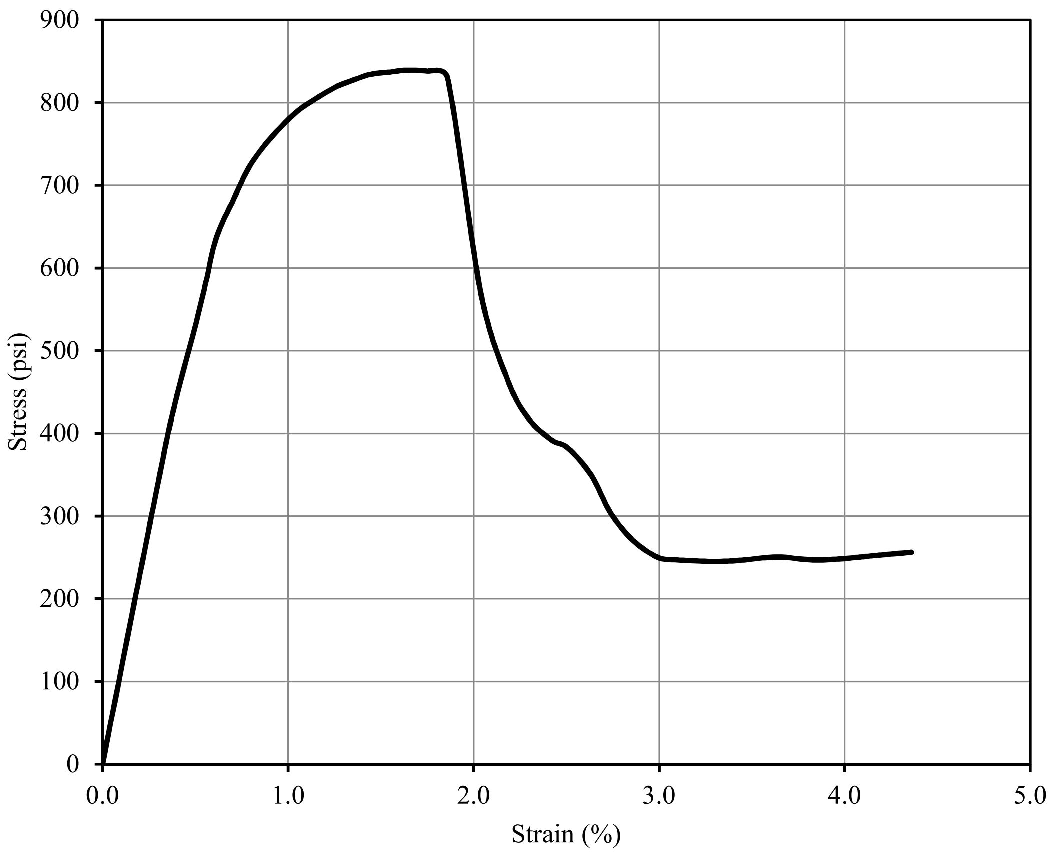
Test Result					
Peak deviator stress (w/ Height correction)	703	psi	Strain at failure, εf :	1.67	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-F	**Specimen Information**		
Test Date:	2018-01-06	Initial Height:	3.884	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	353.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



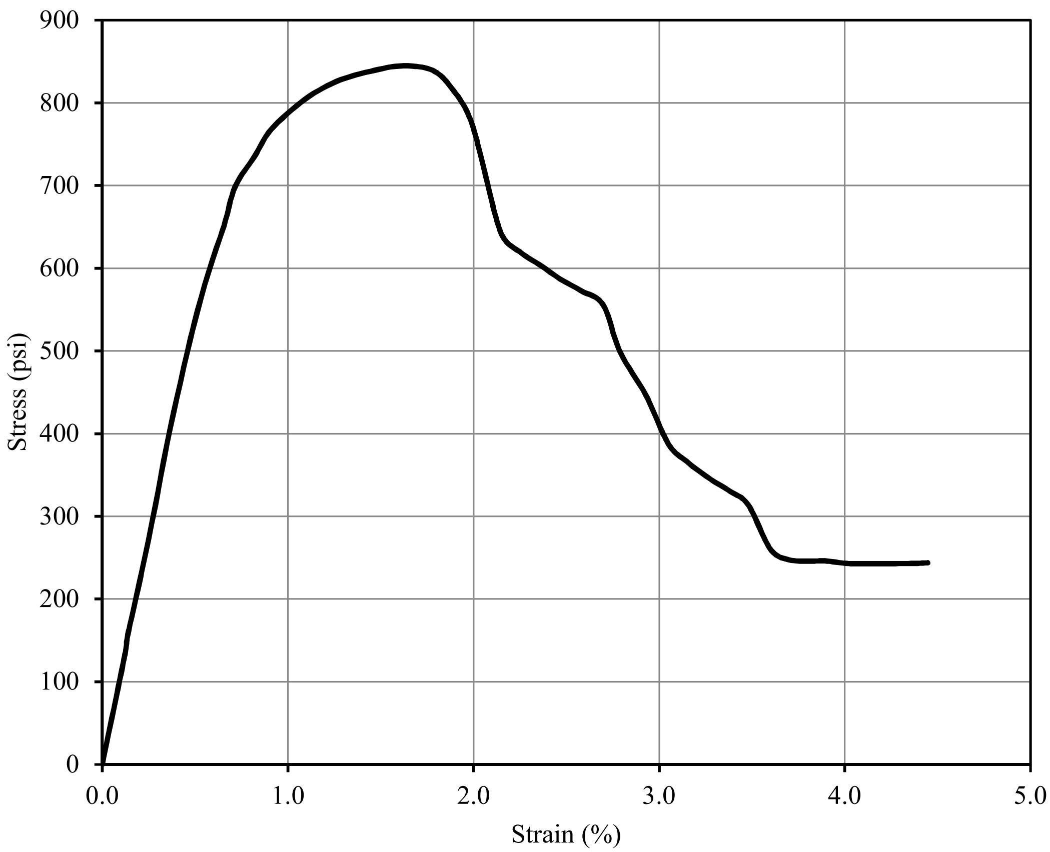
Test Result					
Peak deviator stress (w/ Height correction)	708	psi	Strain at failure, εf :	1.58	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-D	**Specimen Information**		
Test Date:	2018-01-20	Initial Height:	3.93	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	359.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



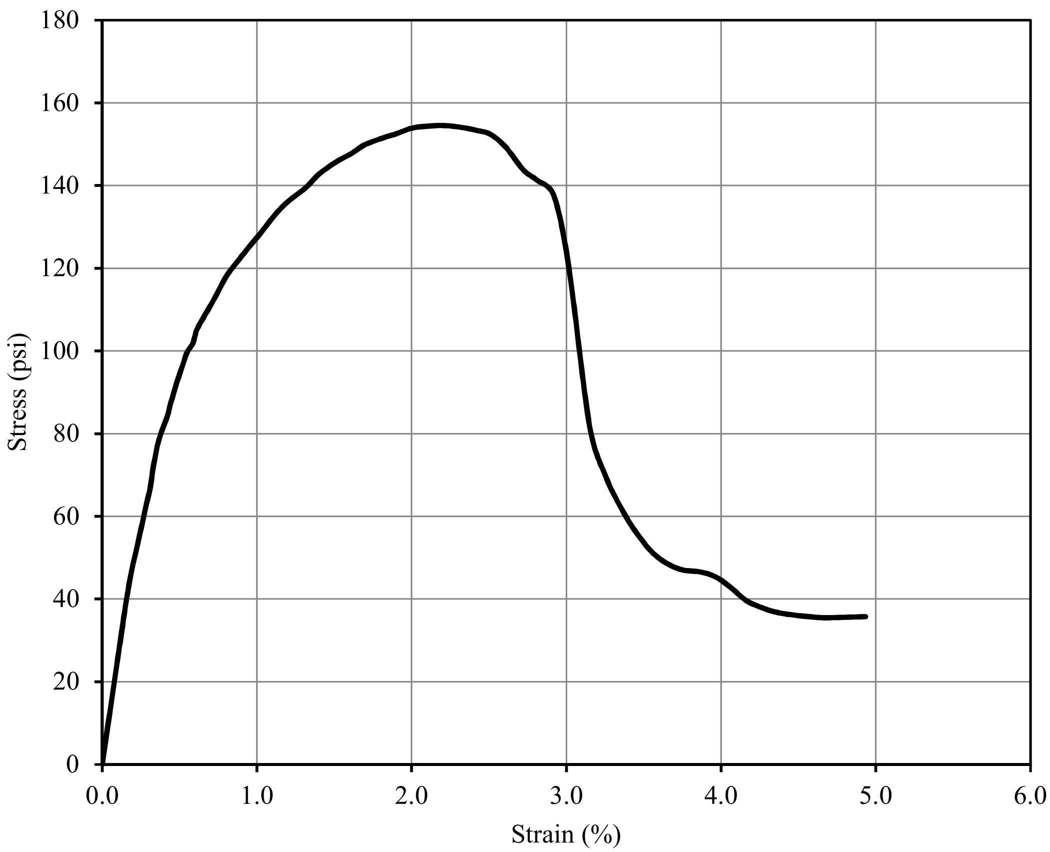
Test Result					
Peak deviator stress (w/ Height correction)	834	psi	Strain at failure, εf :	1.63	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-14-E	**Specimen Information**		
Test Date:	2018-01-20	Initial Height:	3.864	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	352.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



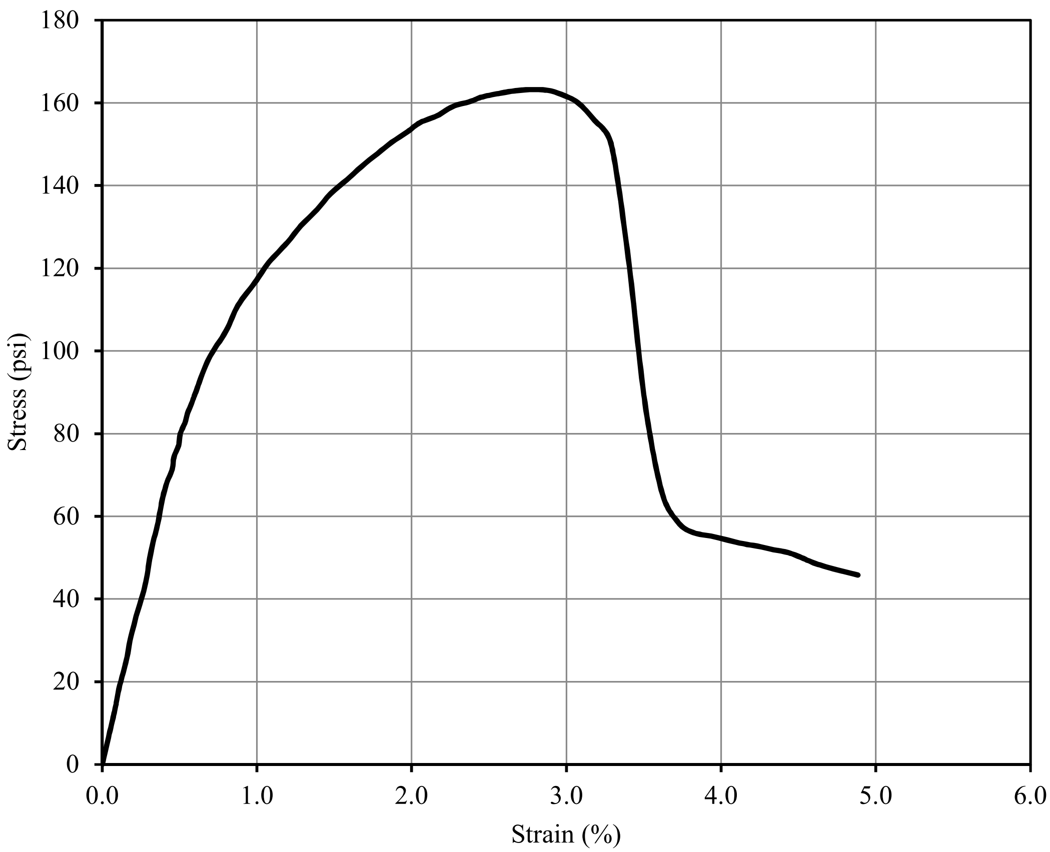
Test Result					
Peak deviator stress (w/ Height correction)	837	psi	Strain at failure, εf :	1.67	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-A	**Specimen Information**		
Test Date:	2017-12-29	Initial Height:	3.821	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	355.0	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	108	pcf



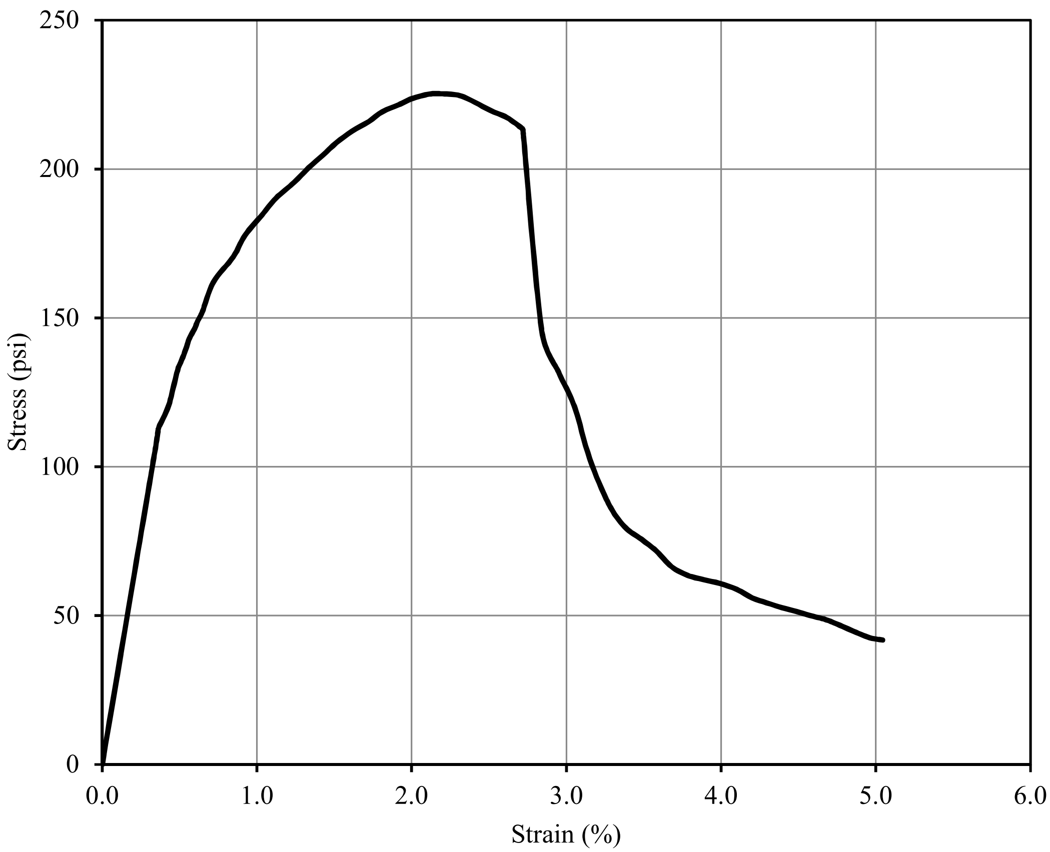
Test Result					
Peak deviator stress (w/ Height correction)	153	psi	Strain at failure, εf :	2.21	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-H	**Specimen Information**		
Test Date:	2017-12-29	Initial Height:	3.741	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	346.3	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	108	pcf



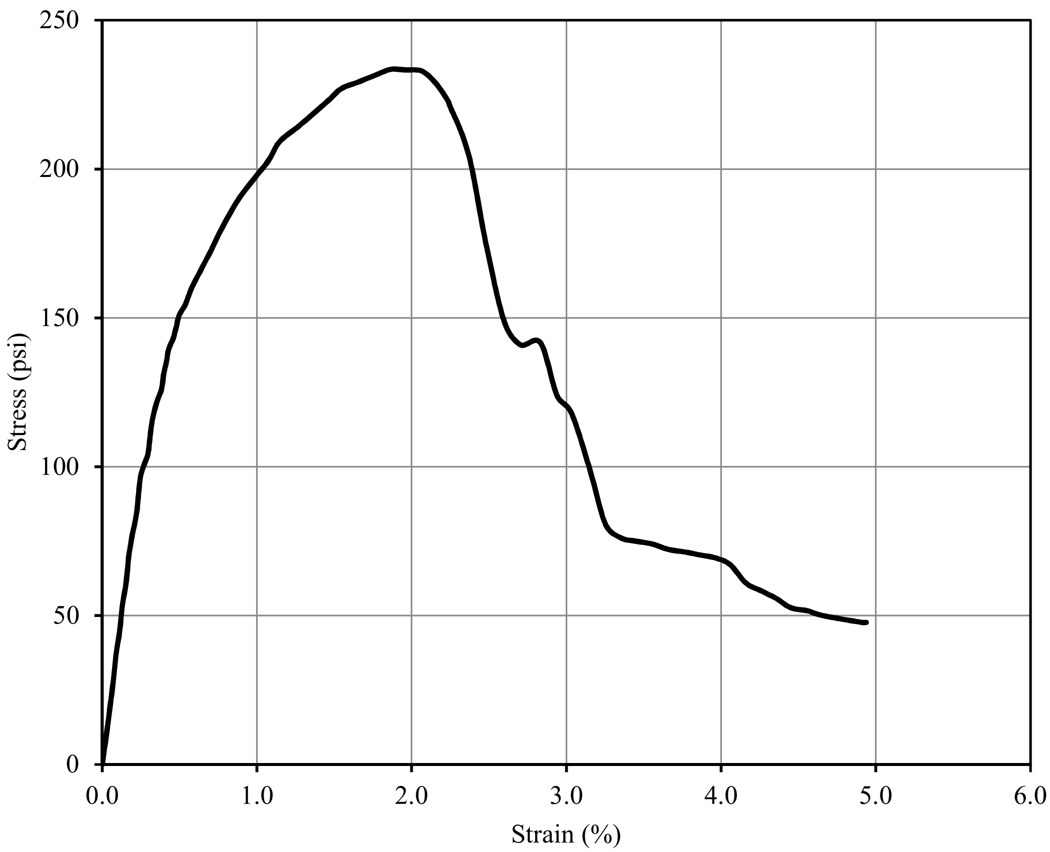
Test Result					
Peak deviator stress (w/ Height correction)	161	psi	Strain at failure, εf :	2.76	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-B	**Specimen Information**		
Test Date:	2018-01-02	Initial Height:	3.781	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	350.4	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	108	pcf



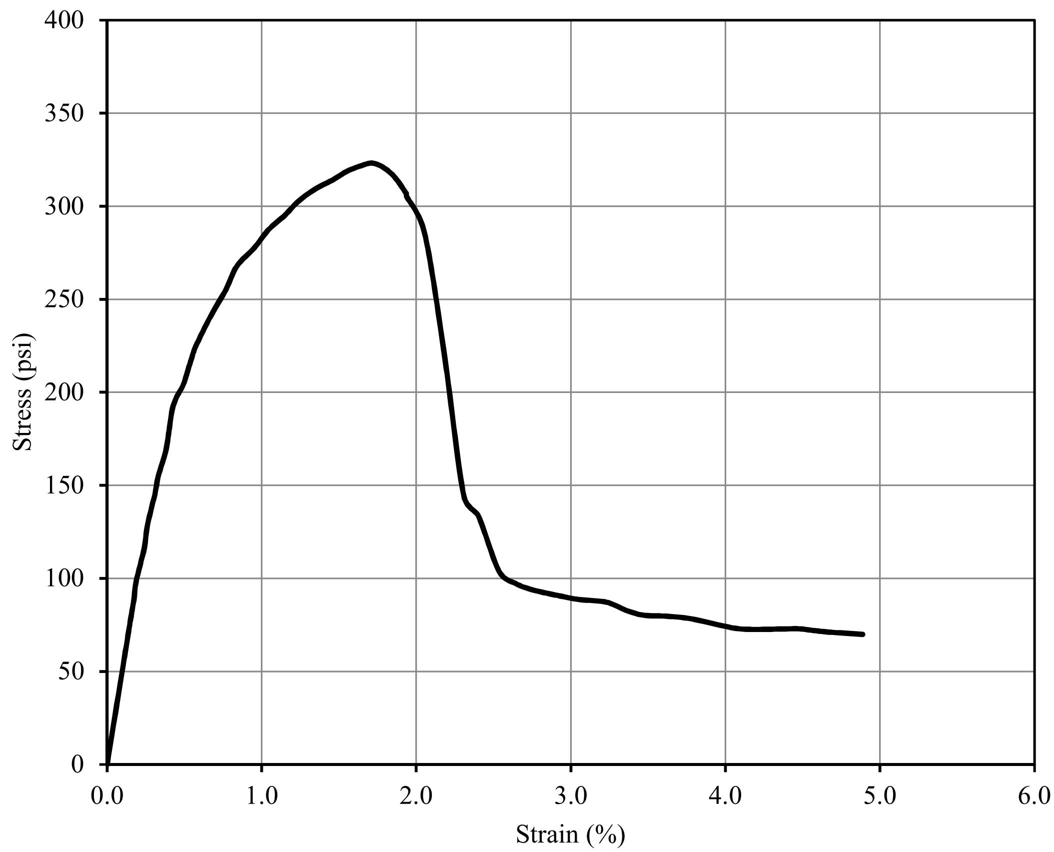
Test Result					
Peak deviator stress (w/ Height correction)	223	psi	Strain at failure, εf :	2.20	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-G	**Specimen Information**		
Test Date:	2018-01-02	Initial Height:	3.878	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	361.3	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	108	pcf



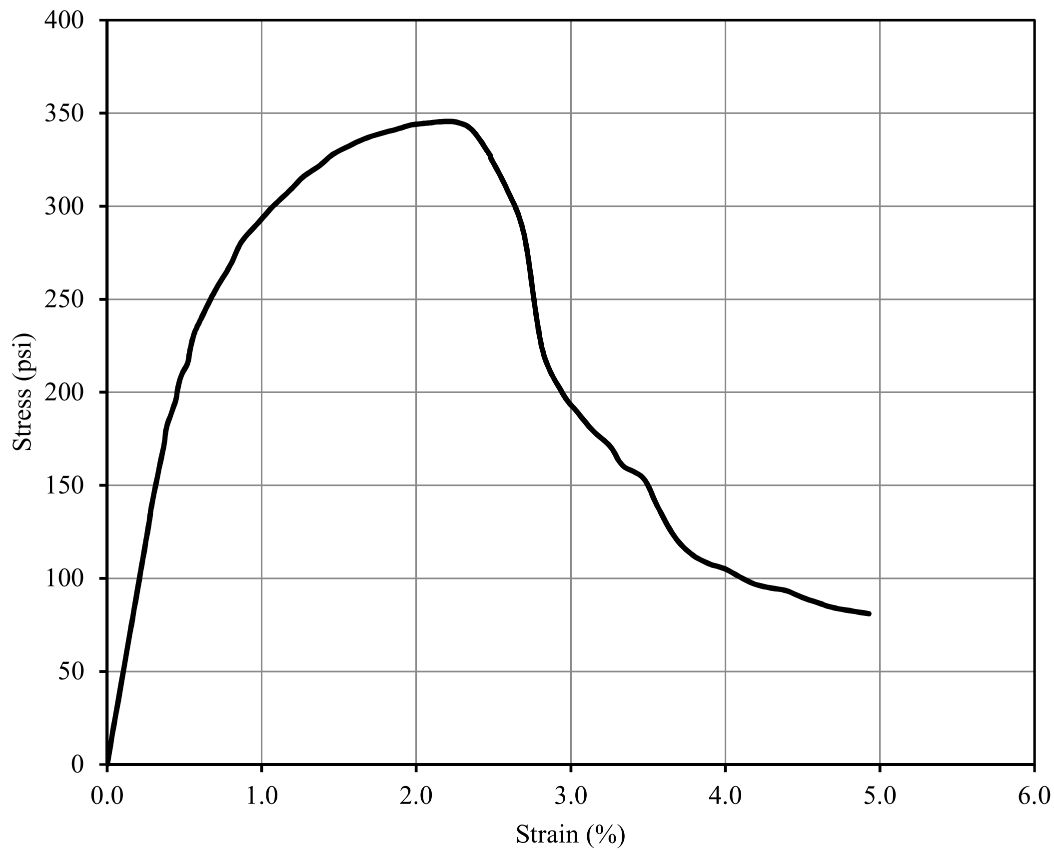
Test Result					
Peak deviator stress (w/ Height correction)	232	psi	Strain at failure, εf :	1.86	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-C	**Specimen Information**		
Test Date:	2018-01-09	Initial Height:	3.866	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	360.4	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	108	pcf



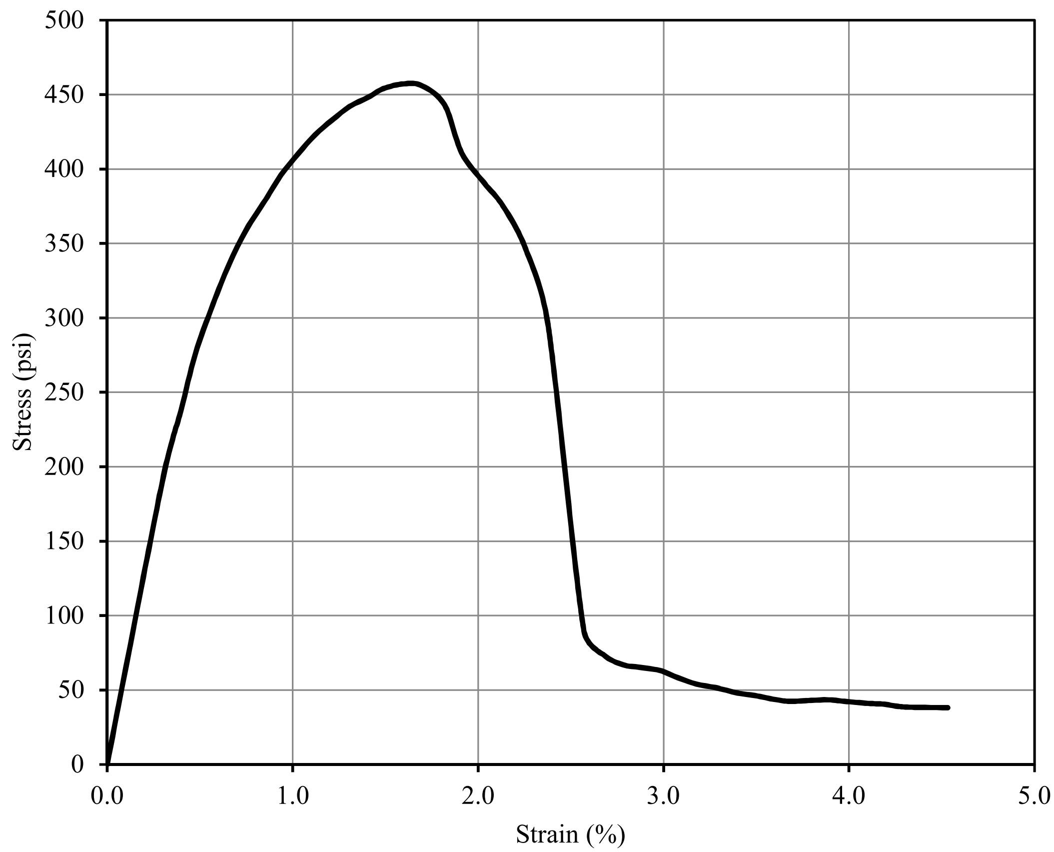
Test Result					
Peak deviator stress (w/ Height correction)	320	psi	Strain at failure, εf :	1.73	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-F	**Specimen Information**		
Test Date:	2018-01-09	Initial Height:	3.884	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	361.7	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	108	pcf



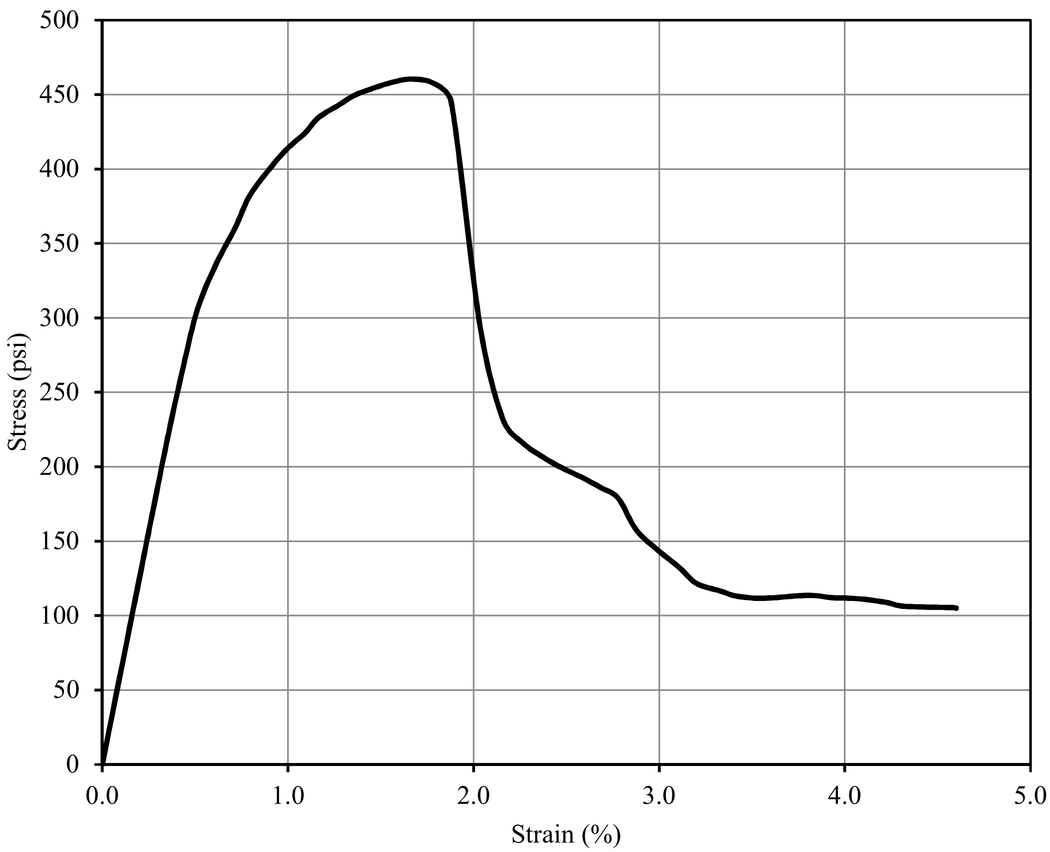
Test Result					
Peak deviator stress (w/ Height correction)	343	psi	Strain at failure, εf :	2.16	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-D	**Specimen Information**		
Test Date:	2018-01-23	Initial Height:	3.724	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	346.3	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	108	pcf



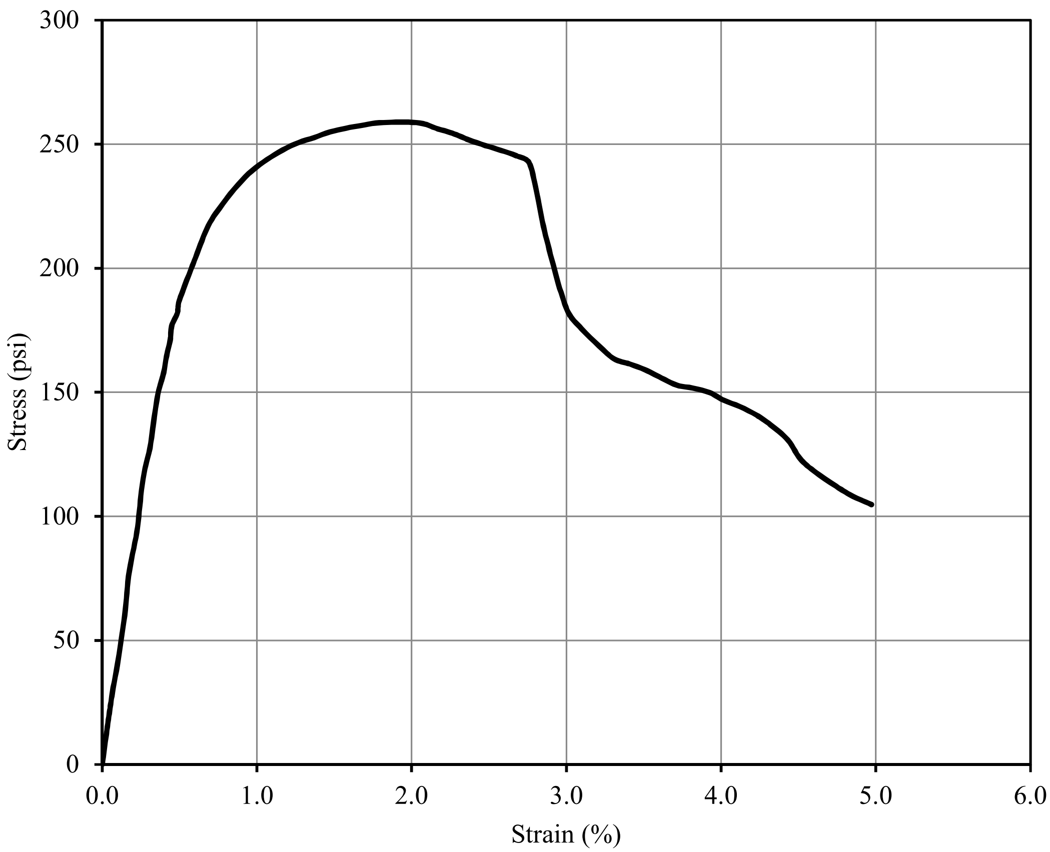
Test Result					
Peak deviator stress (w/ Height correction)	451	psi	Strain at failure, εf :	1.60	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-15-E	**Specimen Information**		
Test Date:	2018-01-23	Initial Height:	3.88	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	361.7	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	109	pcf



Test Result					
Peak deviator stress (w/ Height correction)	457	psi	Strain at failure, εf :	1.67	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-16-A	**Specimen Information**		
Test Date:	2018-01-02	Initial Height:	3.612	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	317.3	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	102	pcf

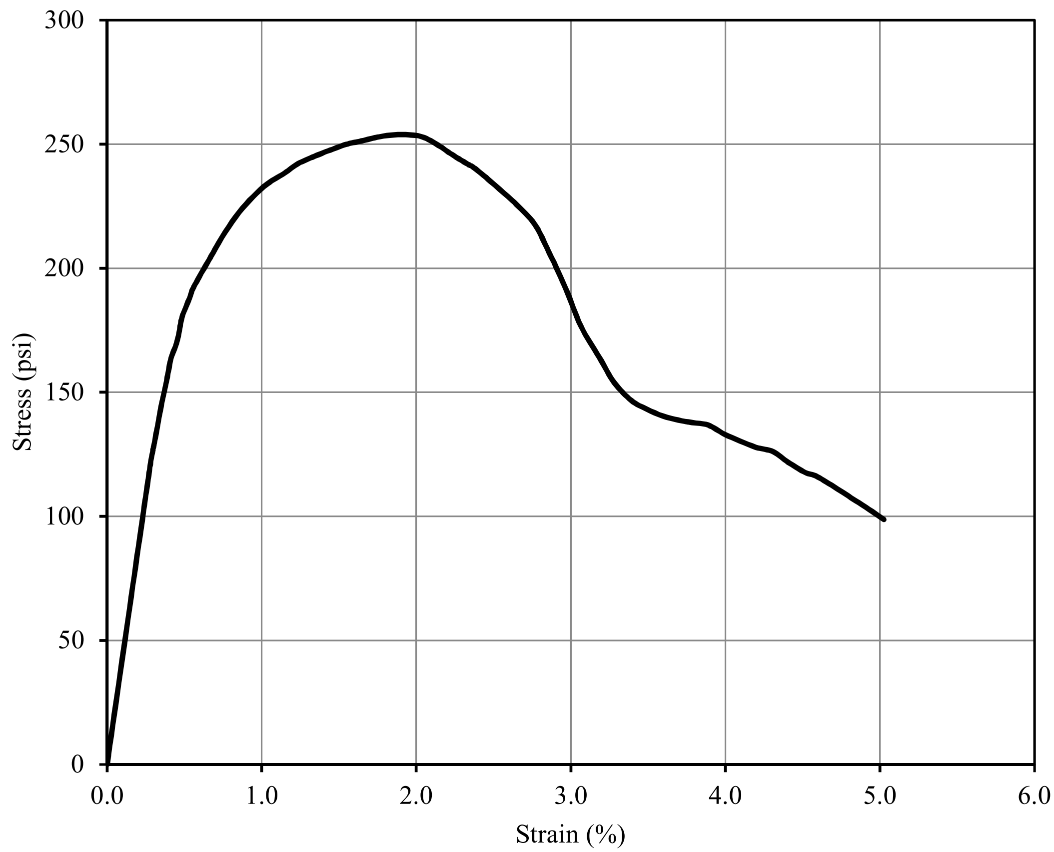


Test Result					
Peak deviator stress (w/ Height correction)	254	psi	Strain at failure, εf :	1.98	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C

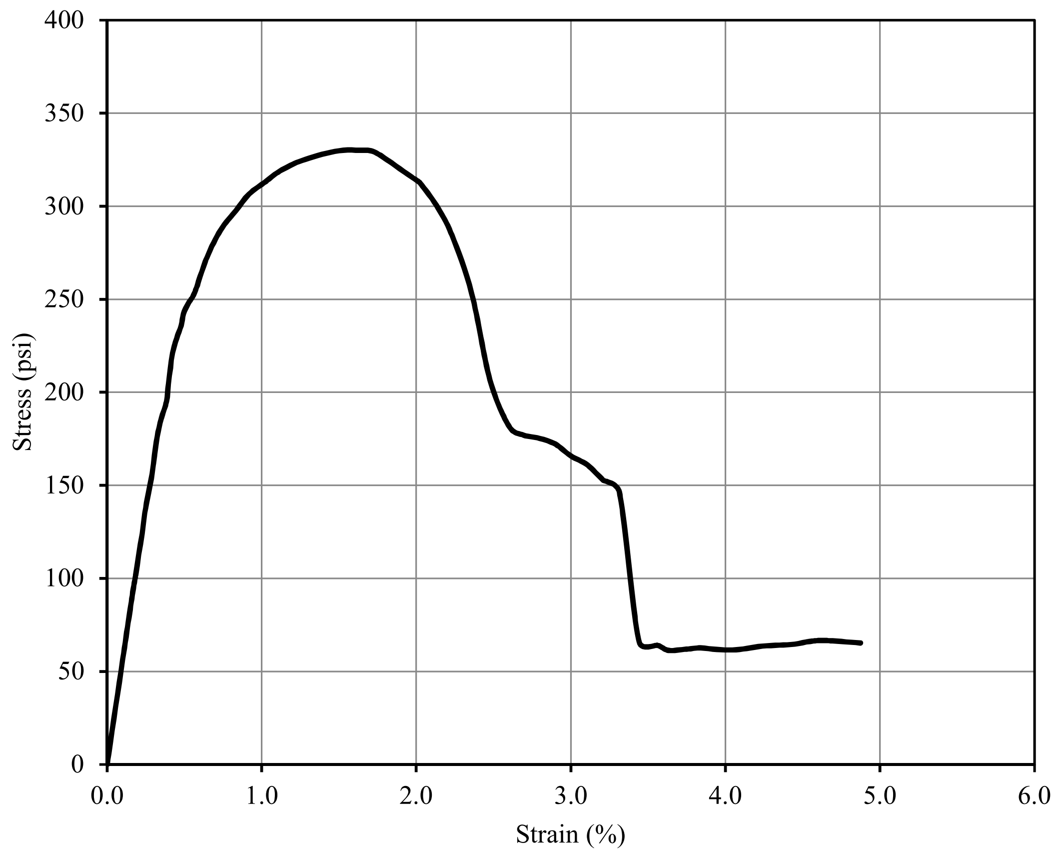
		Specimen Information		
I.D.:	T-16-H	Initial Height:	3.76	in
Test Date:	2018-01-02	Initial Diameter:	2.043	in
Strain Rate:	1 %/min	Initial Area:	3.278	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	331.4	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	102	pcf



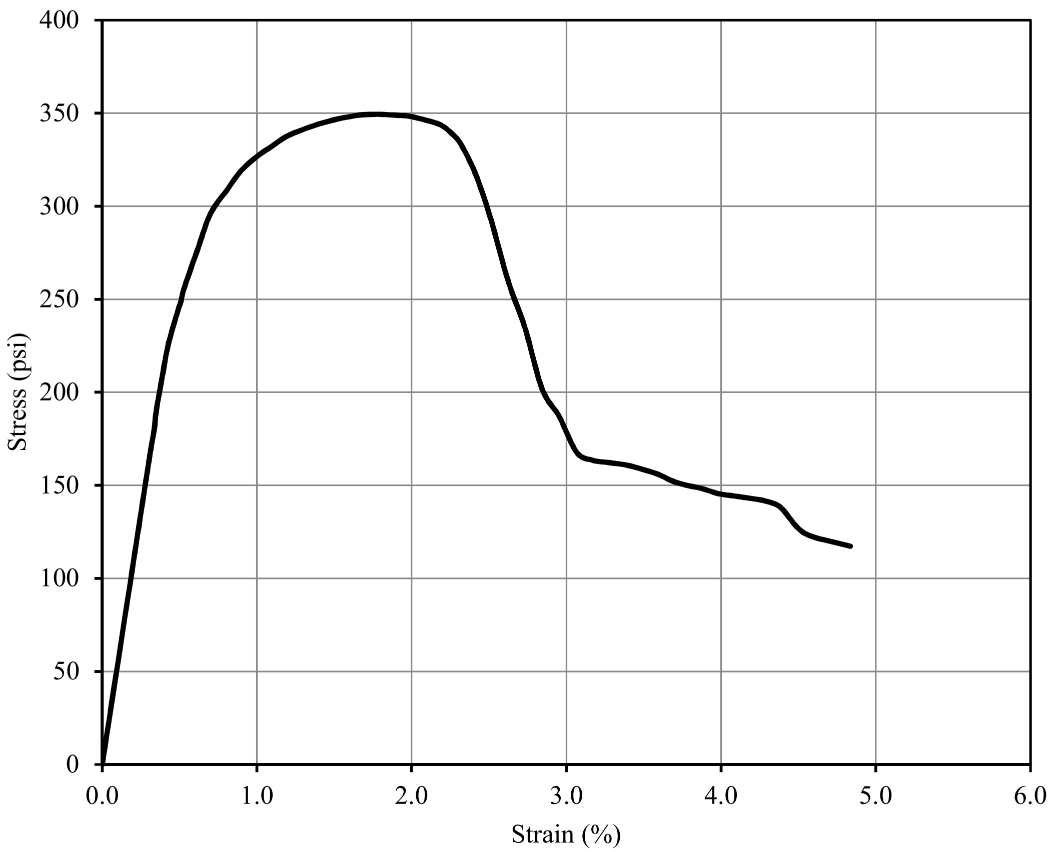
Test Result					
Peak deviator stress (w/ Height correction)	251	psi	Strain at failure, εf :	1.93	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-16-B	**Specimen Information**		
Test Date:	2018-01-06	Initial Height:	3.791	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	335.2	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



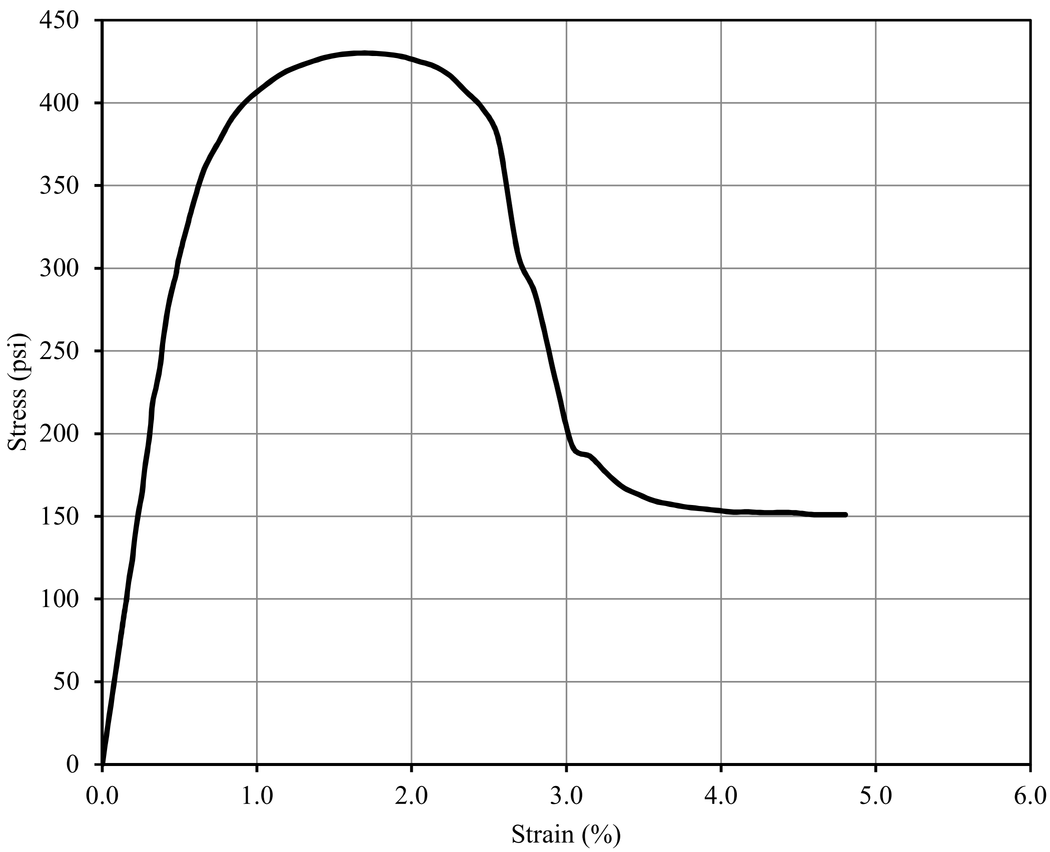
Test Result					
Peak deviator stress (w/ Height correction)	326	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-16-G	**Specimen Information**		
Test Date:	2018-01-06	Initial Height:	3.678	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	325.0	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



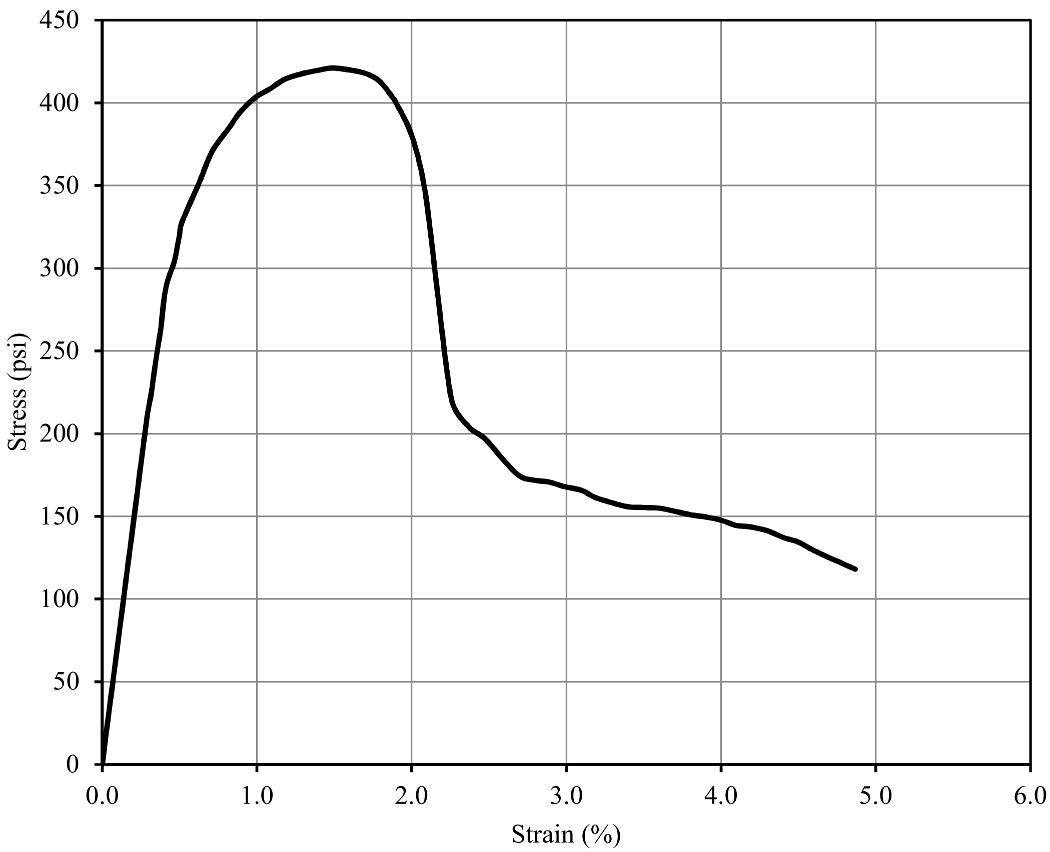
Test Result					
Peak deviator stress (w/ Height correction)	344	psi	Strain at failure, εf :	1.78	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-16-C	**Specimen Information**		
Test Date:	2018-01-13	Initial Height:	3.64	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	322.1	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



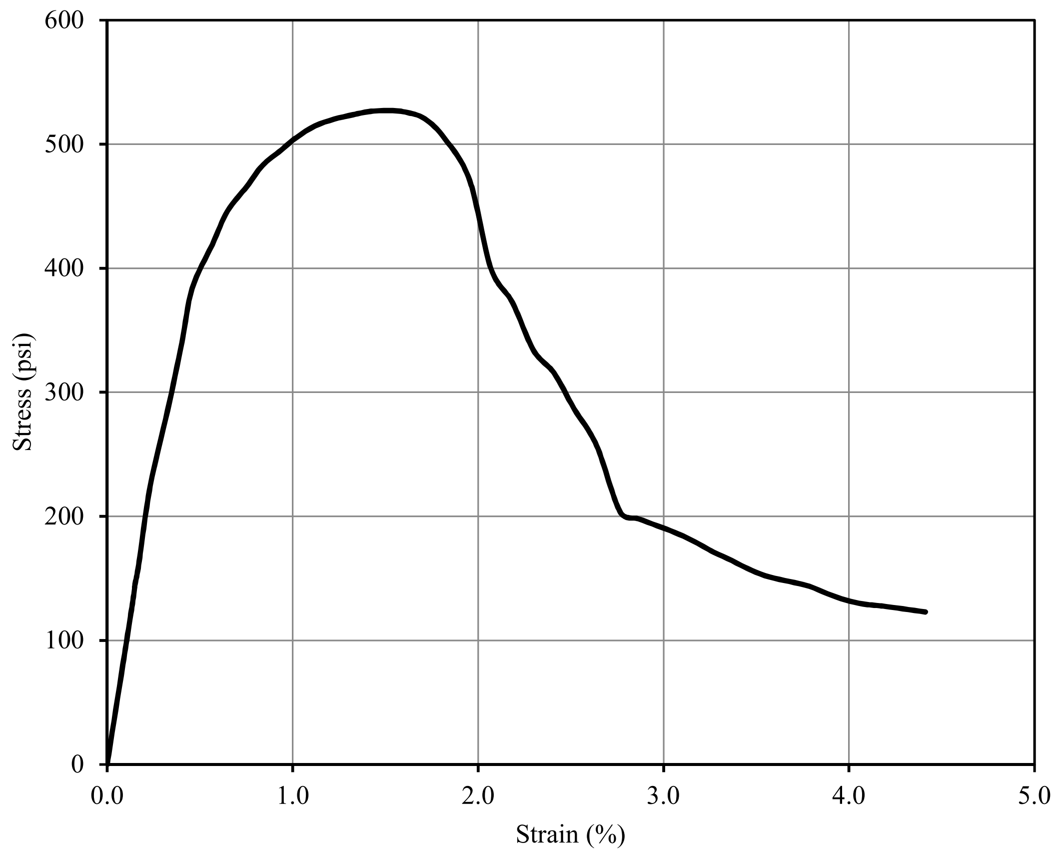
Test Result					
Peak deviator stress (w/ Height correction)	423	psi	Strain at failure, εf :	1.72	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-16-F	**Specimen Information**		
Test Date:	2018-01-13	Initial Height:	3.838	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	339.6	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



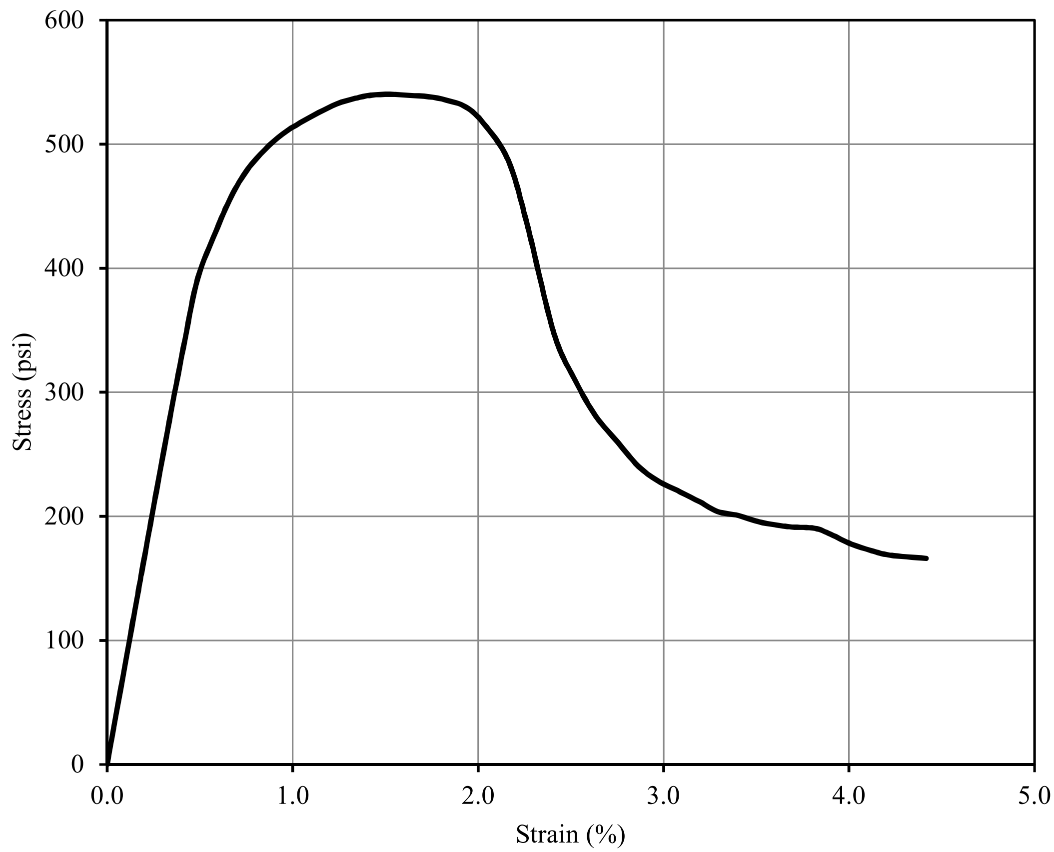
Test Result					
Peak deviator stress (w/ Height correction)	417	psi	Strain at failure, εf :	1.48	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-16-D	**Specimen Information**		
Test Date:	2018-01-27	Initial Height:	3.731	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	331.0	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	103	pcf



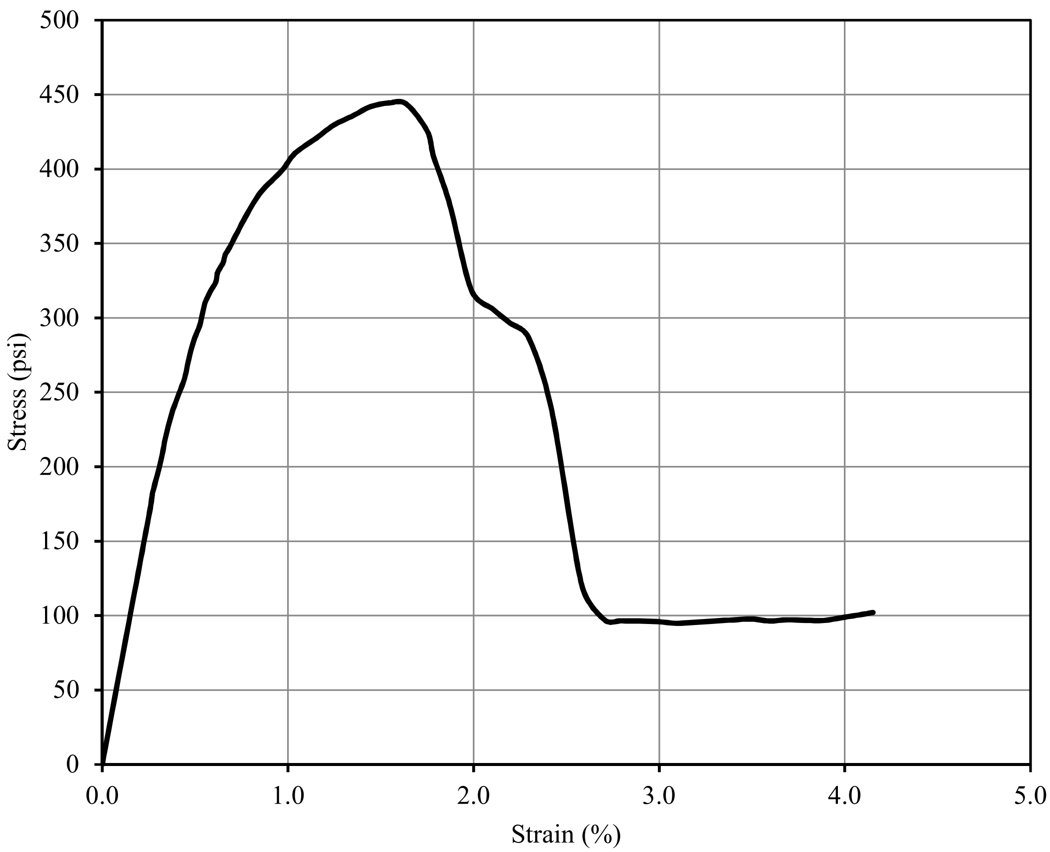
Test Result					
Peak deviator stress (w/ Height correction)	520	psi	Strain at failure, εf :	1.52	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45	°C
I.D.:	T-16-E	**Specimen Information**		
Test Date:	2018-01-27	Initial Height:	3.671	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	325.4	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	103	pcf



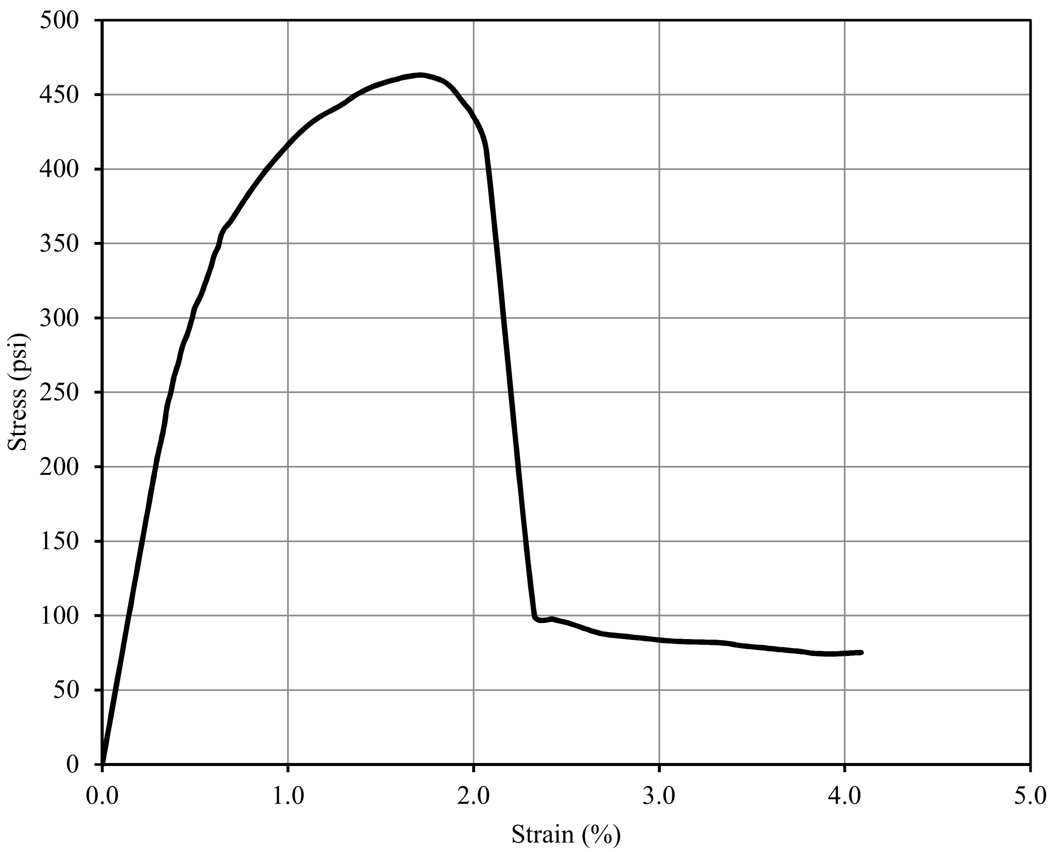
Test Result					
Peak deviator stress (w/ Height correction)	532	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-17-A	**Specimen Information**		
Test Date:	2017-11-01	Initial Height:	3.756	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	360.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	111	pcf



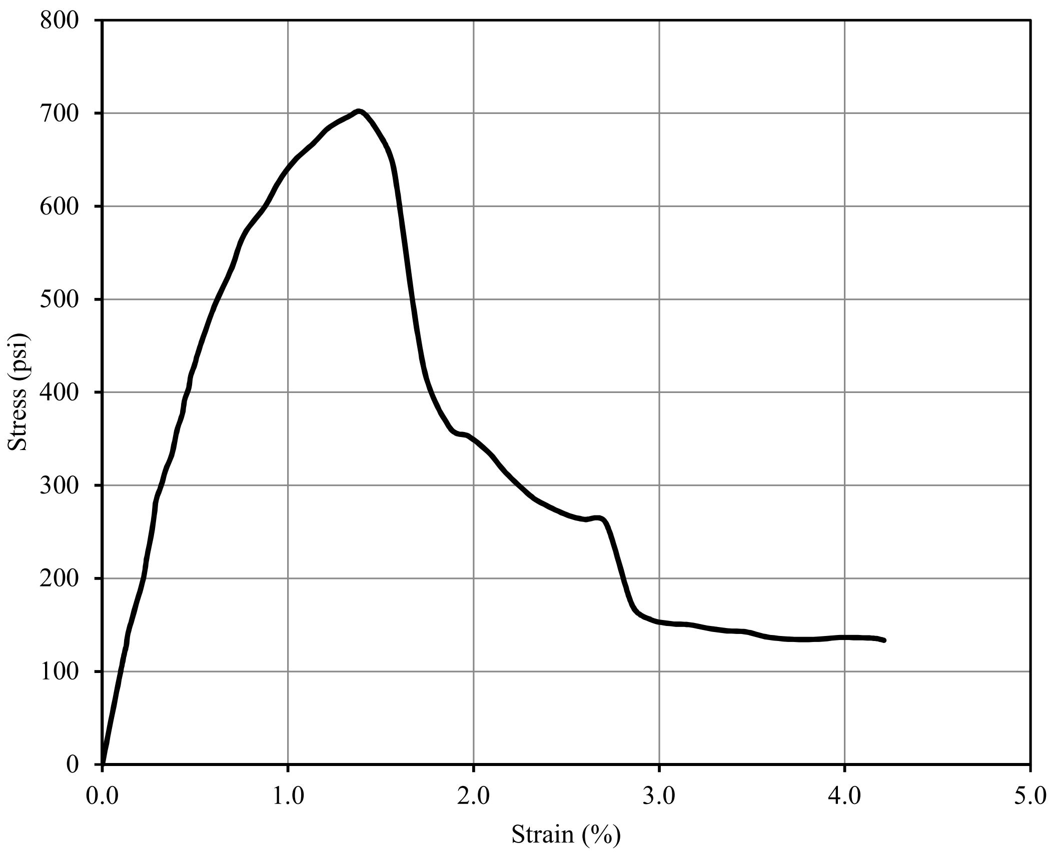
Test Result					
Peak deviator stress (w/ Height correction)	439	psi	Strain at failure, εf :	1.54	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-17-H	**Specimen Information**		
Test Date:	2017-11-01	Initial Height:	3.862	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	370.8	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	111	pcf



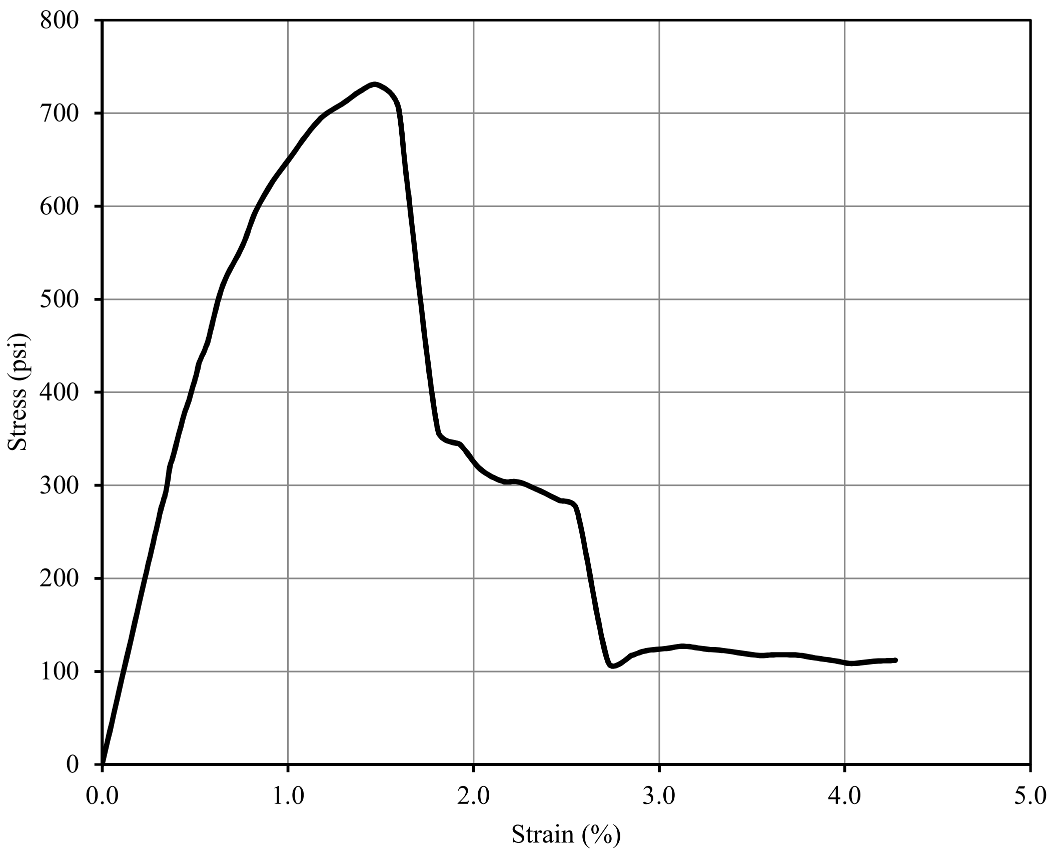
Test Result					
Peak deviator stress (w/ Height correction)	459	psi	Strain at failure, εf :	1.74	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-17-B	**Specimen Information**		
Test Date:	2017-11-05	Initial Height:	3.808	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	367.0	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



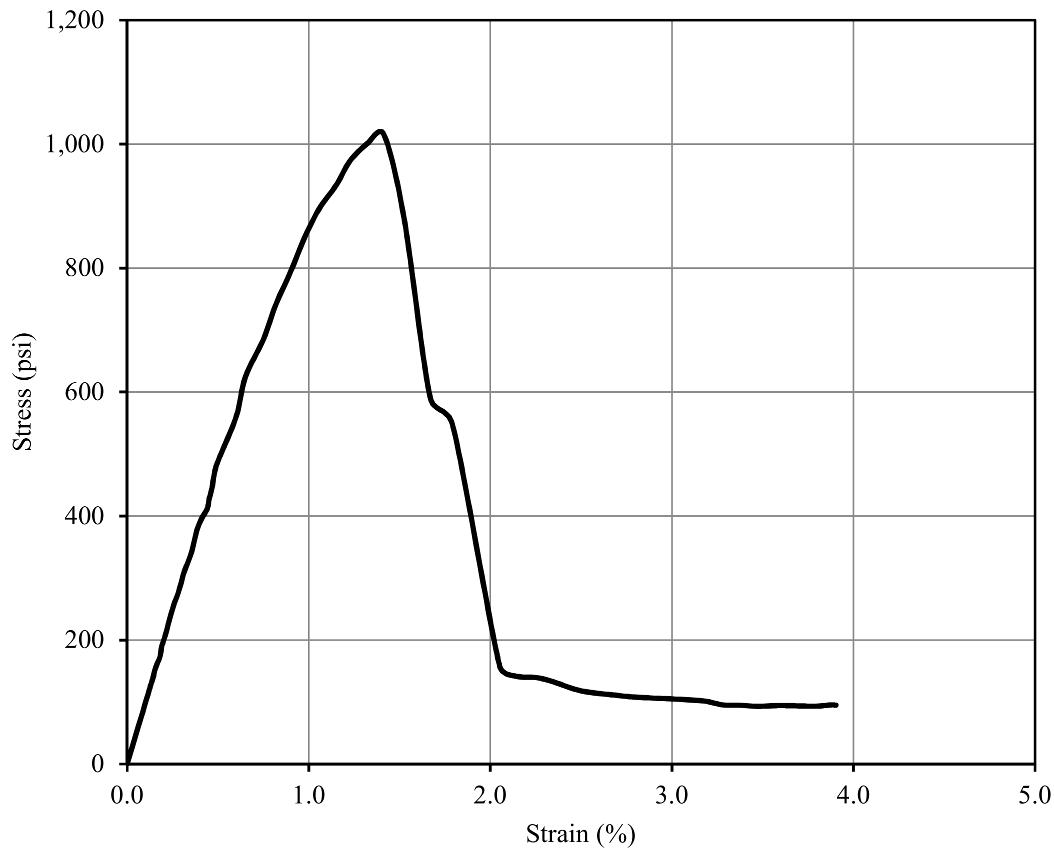
Test Result					
Peak deviator stress (w/ Height correction)	693	psi	Strain at failure, εf :	1.41	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.2	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-17-G	**Specimen Information**		
Test Date:	2017-11-05	Initial Height:	3.863	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	373.5	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	112	pcf



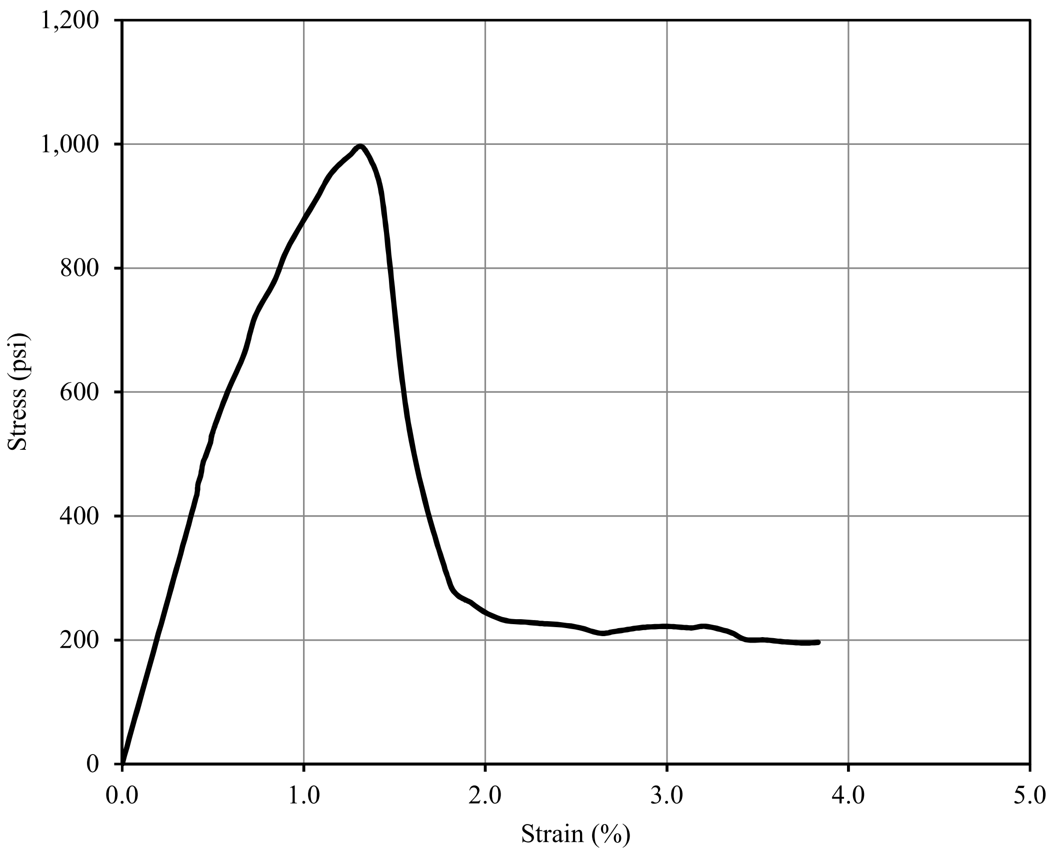
Test Result					
Peak deviator stress (w/ Height correction)	724	psi	Strain at failure, εf :	1.48	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-17-C	**Specimen Information**		
Test Date:	2017-11-12	Initial Height:	3.795	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	366.9	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	112	pcf



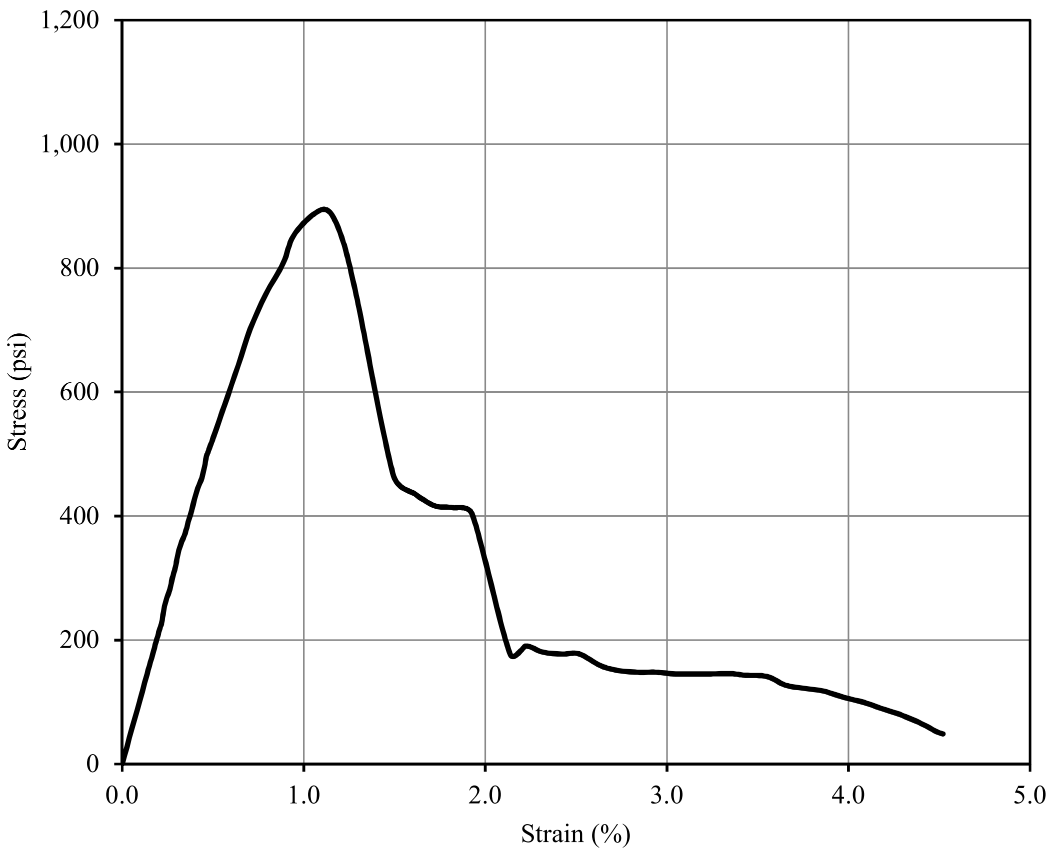
Test Result					
Peak deviator stress (w/ Height correction)	1,005	psi	Strain at failure, εf :	1.41	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-14-J	**Specimen Information**		
Test Date:	2017-11-12	Initial Height:	3.883	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	375.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



Test Result					
Peak deviator stress (w/ Height correction)	985	psi	Strain at failure, εf :	1.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-17-F	**Specimen Information**		
Test Date:	2017-11-12	Initial Height:	3.892	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	377.7	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf

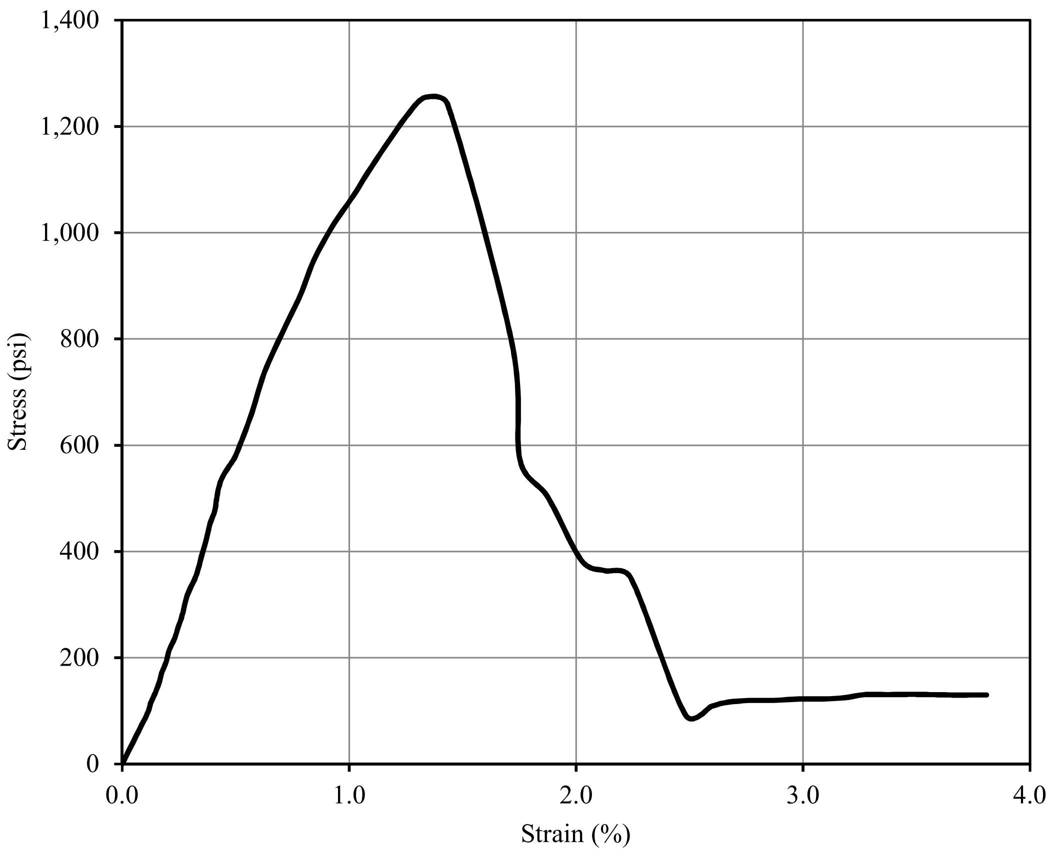


Test Result					
Peak deviator stress (w/ Height correction)	884	psi	Strain at failure, εf :	1.14	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C

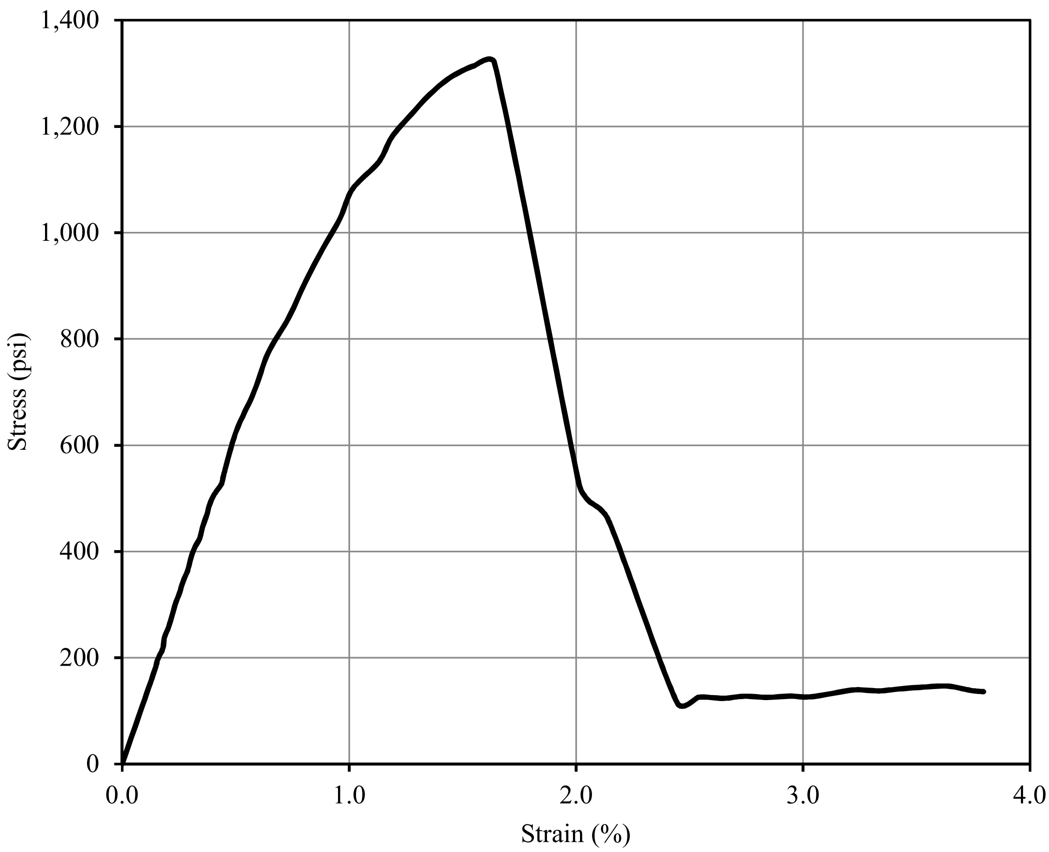
Test Information		Specimen Information		
I.D.:	T-17-D	Initial Height:	3.857	in
Test Date:	2017-11-25	Initial Diameter:	2.045	in
Strain Rate:	1 %/min	Initial Area:	3.285	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	373.3	g
(w:c)$_{slurry}$:	0.6	Unit Weight:	112	pcf



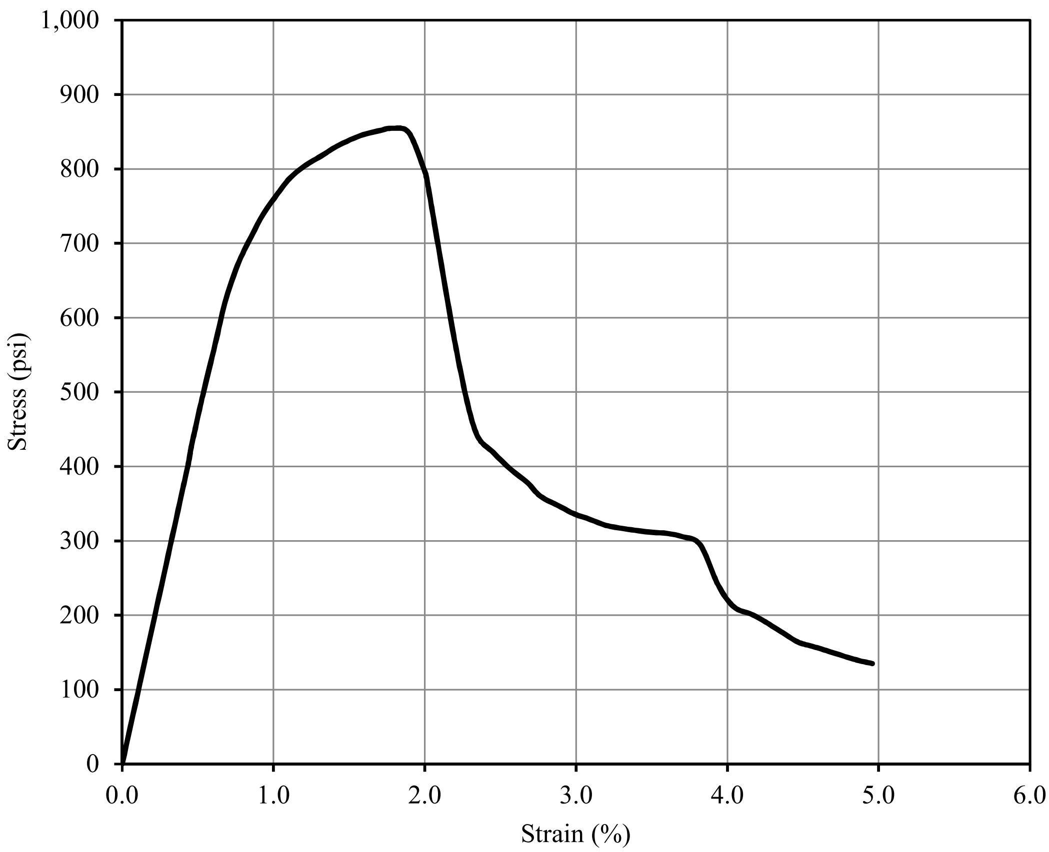
Test Result					
Peak deviator stress (w/ Height correction)	1,243	psi	Strain at failure, εf :	1.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-17-E	**Specimen Information**		
Test Date:	2017-11-25	Initial Height:	3.796	in
Strain Rate:	1 %/min	Initial Diameter:	2.049	in
Mixture Proportion		Initial Area:	3.297	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	367.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



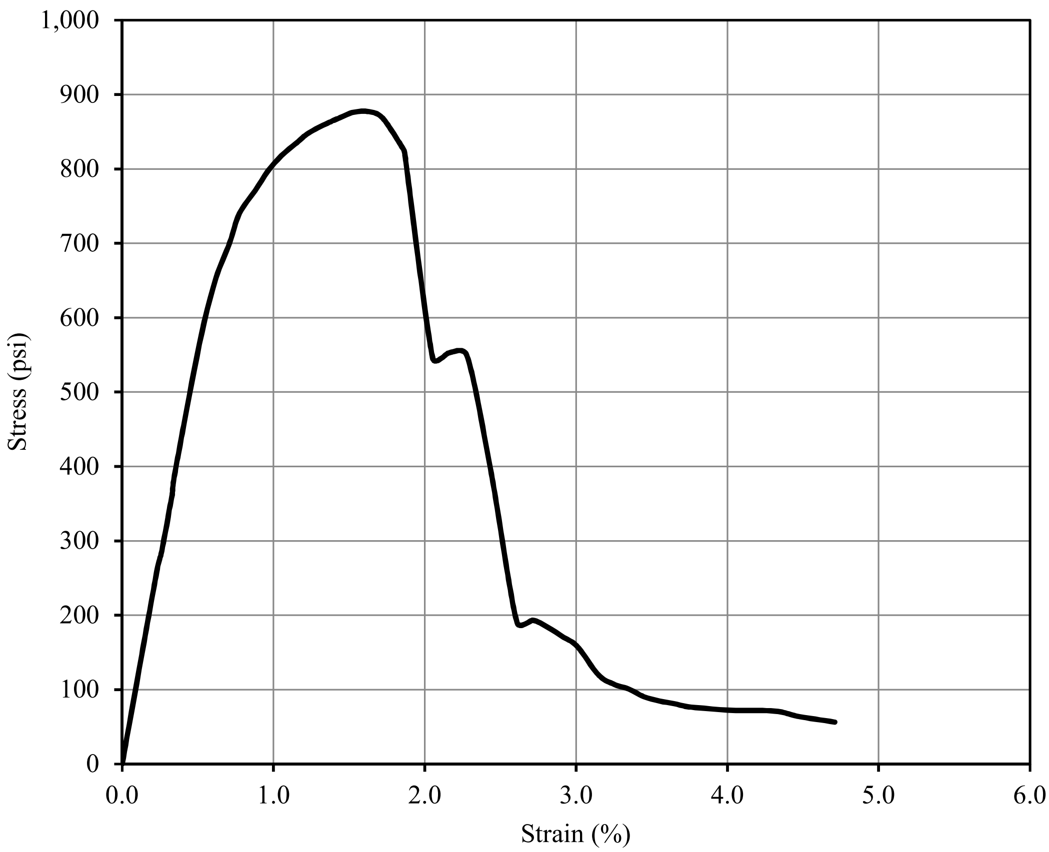
Test Result					
Peak deviator stress (w/ Height correction)	1,304	psi	Strain at failure, εf :	1.64	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-18-A	**Specimen Information**		
Test Date:	2018-03-21	Initial Height:	3.876	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	372.0	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	112	pcf



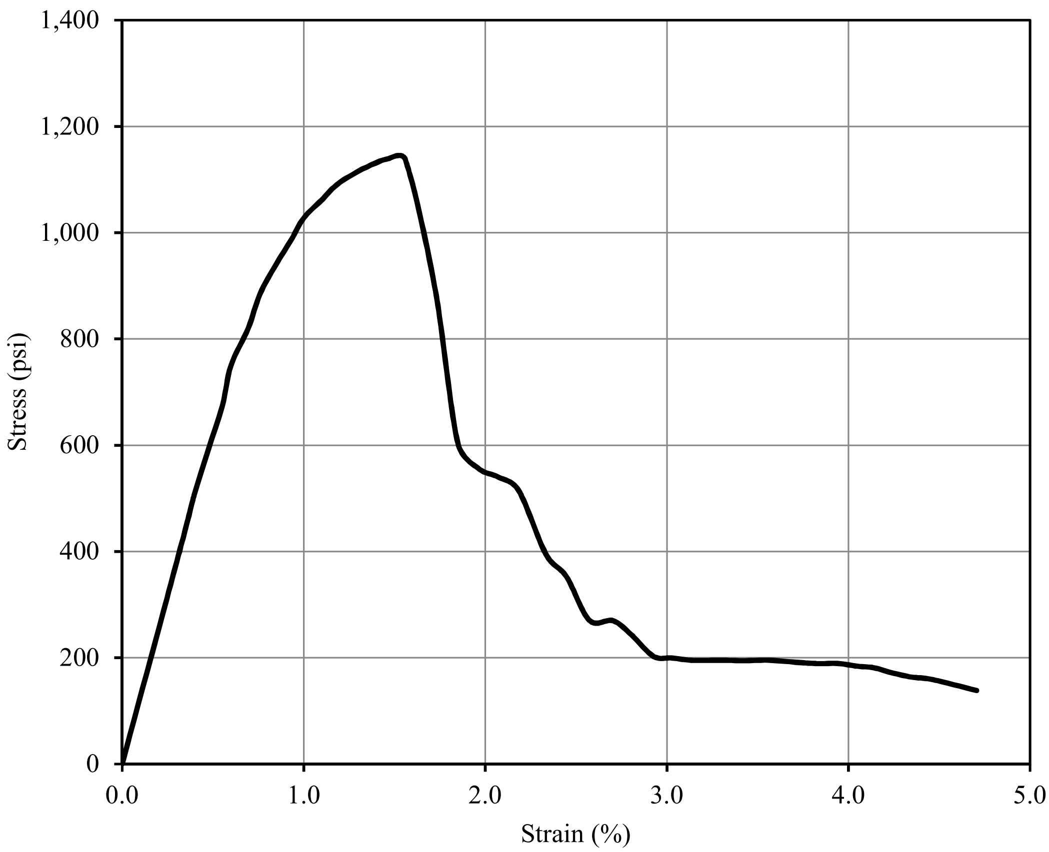
Test Result					
Peak deviator stress (w/ Height correction)	848	psi	Strain at failure, εf :	1.79	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
		Specimen Information		
I.D.:	T-18-H	Initial Height:	3.836	in
Test Date:	2018-03-21	Initial Diameter:	2.044	in
Strain Rate:	1 %/min	Initial Area:	3.281	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	366.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	111	pcf



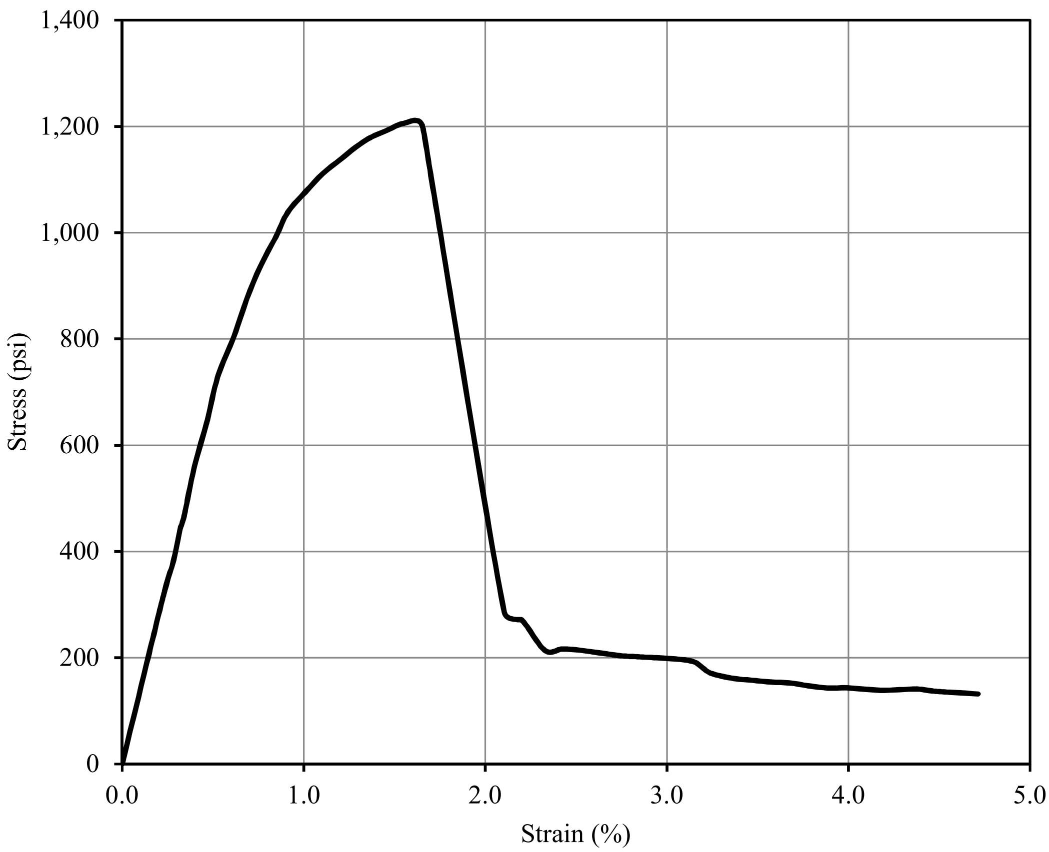
Test Result					
Peak deviator stress (w/ Height correction)	868	psi	Strain at failure, εf :	1.63	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-18-B	**Specimen Information**		
Test Date:	2018-03-25	Initial Height:	3.886	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	375.2	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	112	pcf



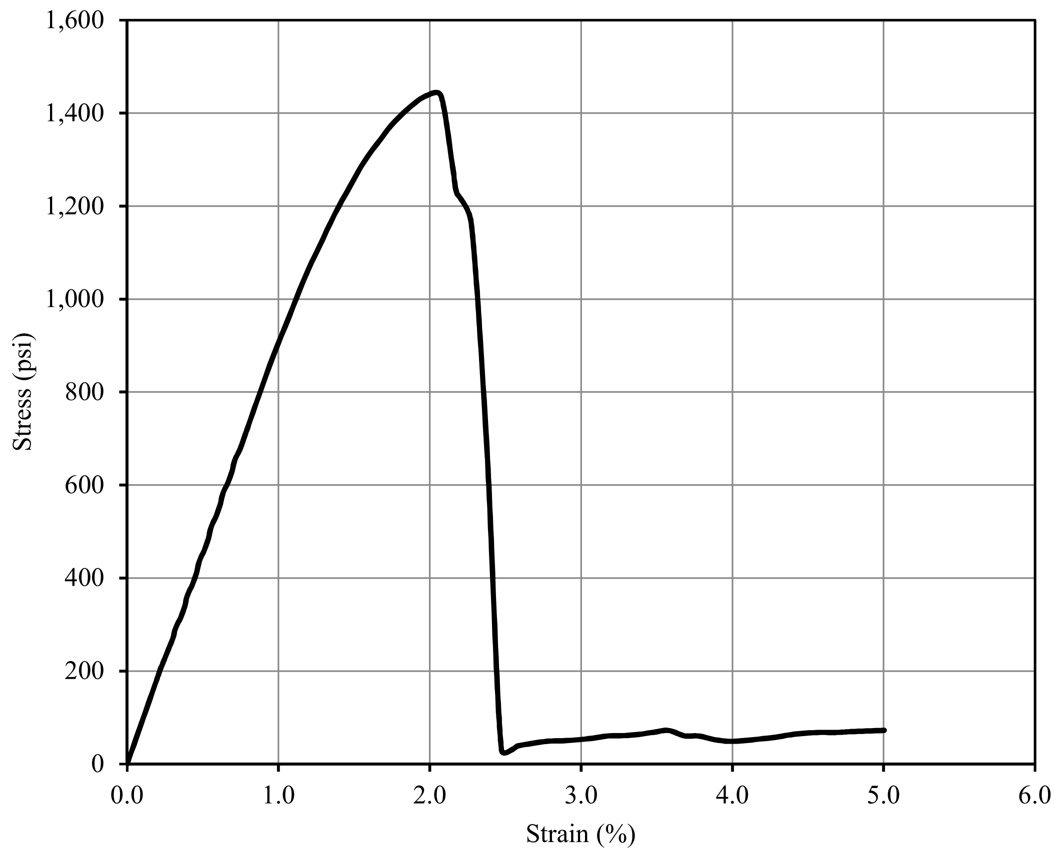
Test Result					
Peak deviator stress (w/ Height correction)	1,130	psi	Strain at failure, εf :	1.47	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-18-G	**Specimen Information**		
Test Date:	2018-03-25	Initial Height:	3.974	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	382.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



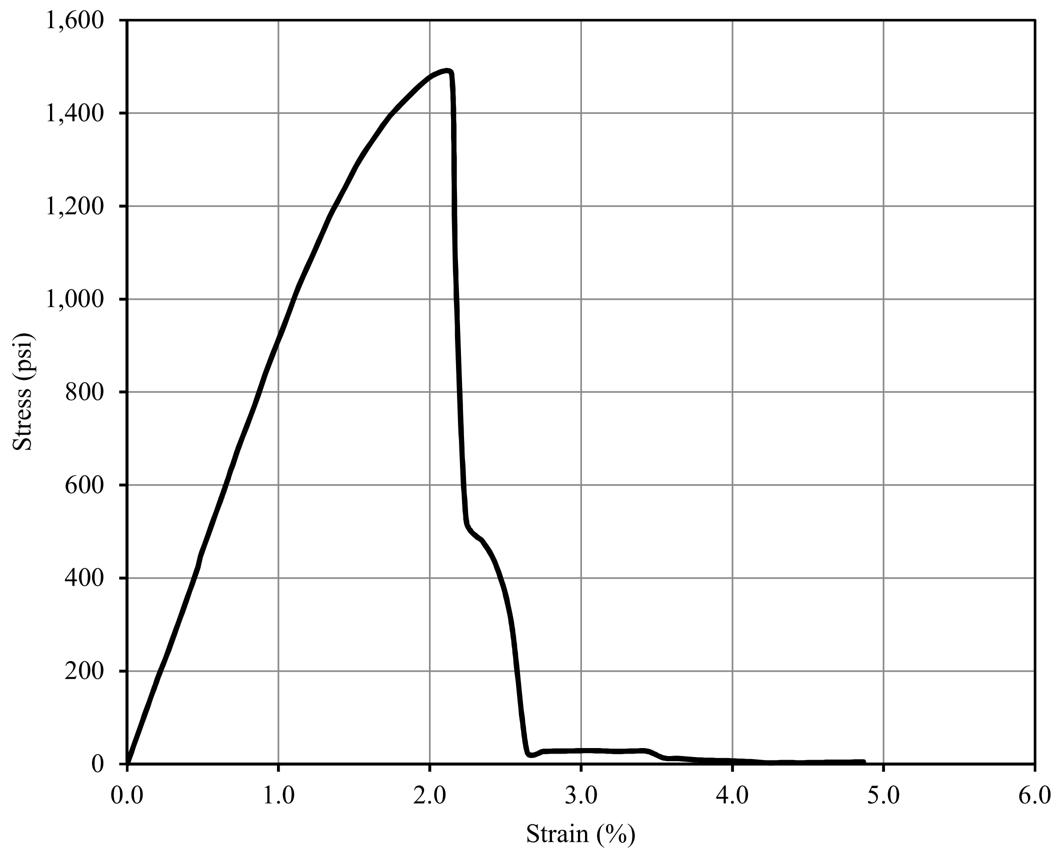
Test Result					
Peak deviator stress (w/ Height correction)	1,200	psi	Strain at failure, εf :	1.55	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.7	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-18-F	**Specimen Information**		
Test Date:	2018-04-02	Initial Height:	3.926	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	380.5	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



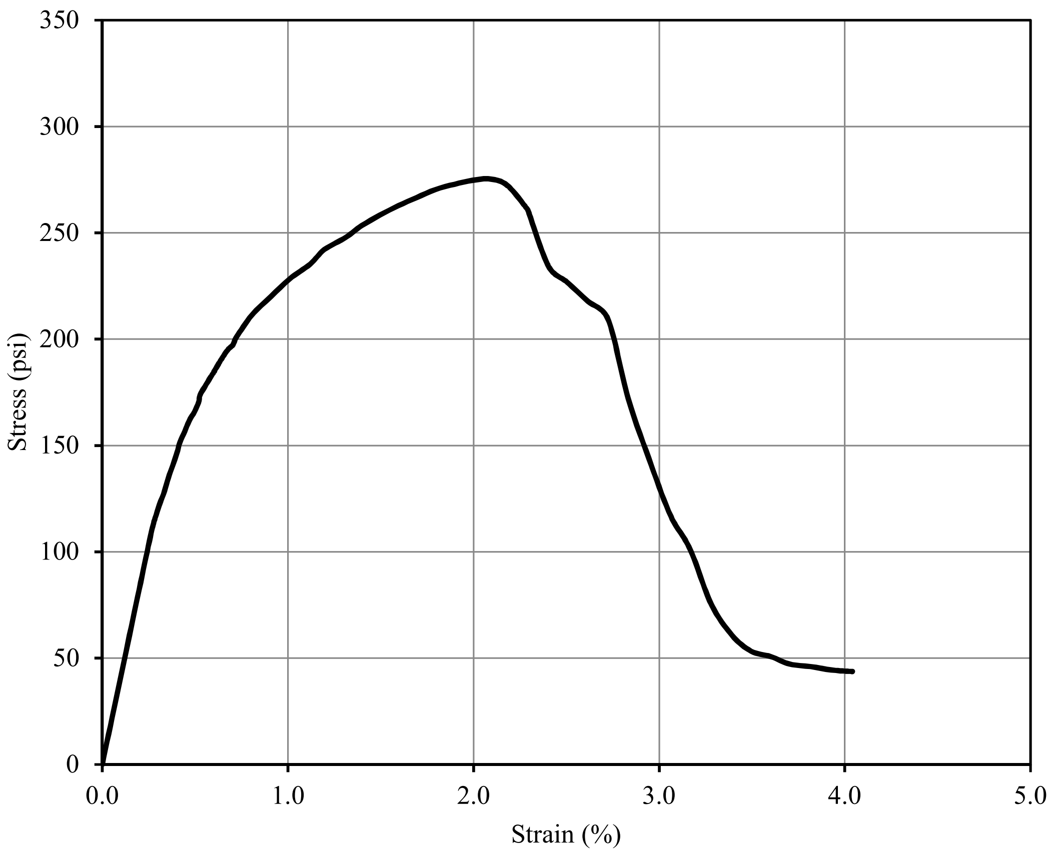
Test Result					
Peak deviator stress (w/ Height correction)	1,428	psi	Strain at failure, εf :	1.98	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.7	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-18-I	**Specimen Information**		
Test Date:	2018-04-02	Initial Height:	3.927	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	381.5	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	112	pcf



Test Result					
Peak deviator stress (w/ Height correction)	1,475	psi	Strain at failure, εf :	2.04	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-19-A	**Specimen Information**		
Test Date:	2017-11-07	Initial Height:	3.701	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	348.8	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	110	pcf

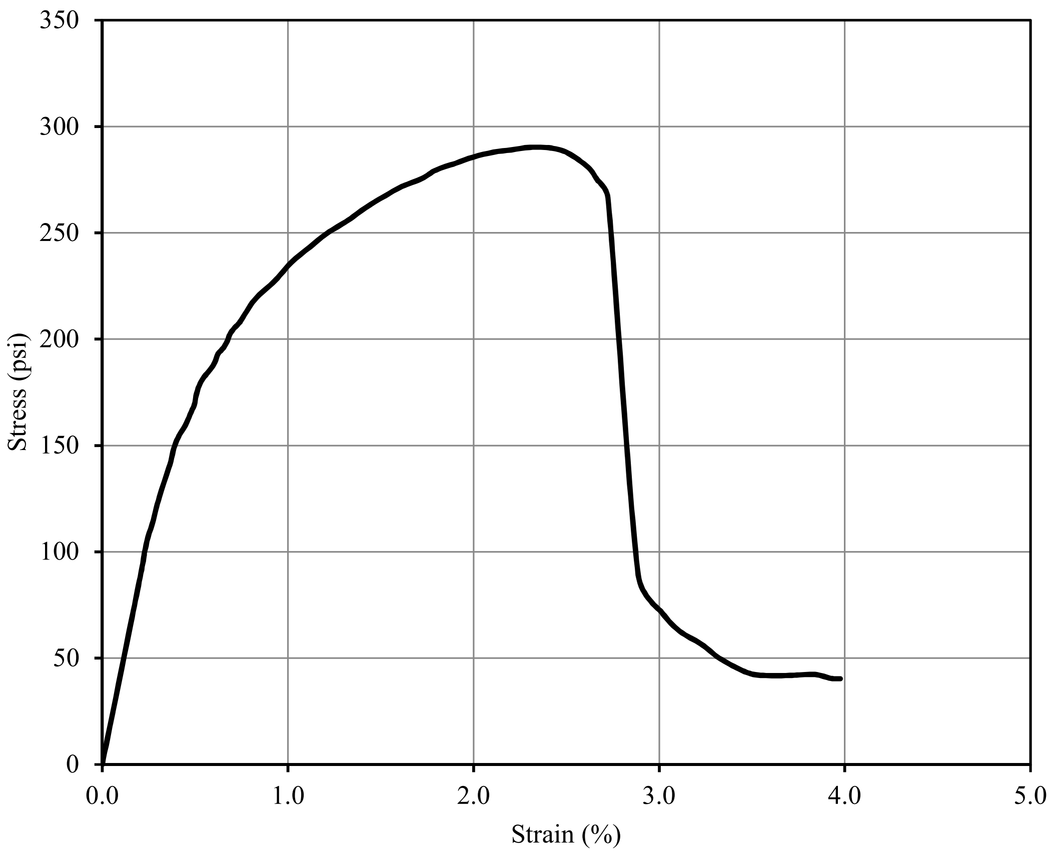


Test Result					
Peak deviator stress (w/ Height correction)	271	psi	Strain at failure, εf :	2.09	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C

Test Information		Specimen Information		
I.D.:	T-19-H	Initial Height:	3.973	in
Test Date:	2017-11-07	Initial Diameter:	2.04	in
Strain Rate:	1 %/min	Initial Area:	3.269	in

Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	376.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf

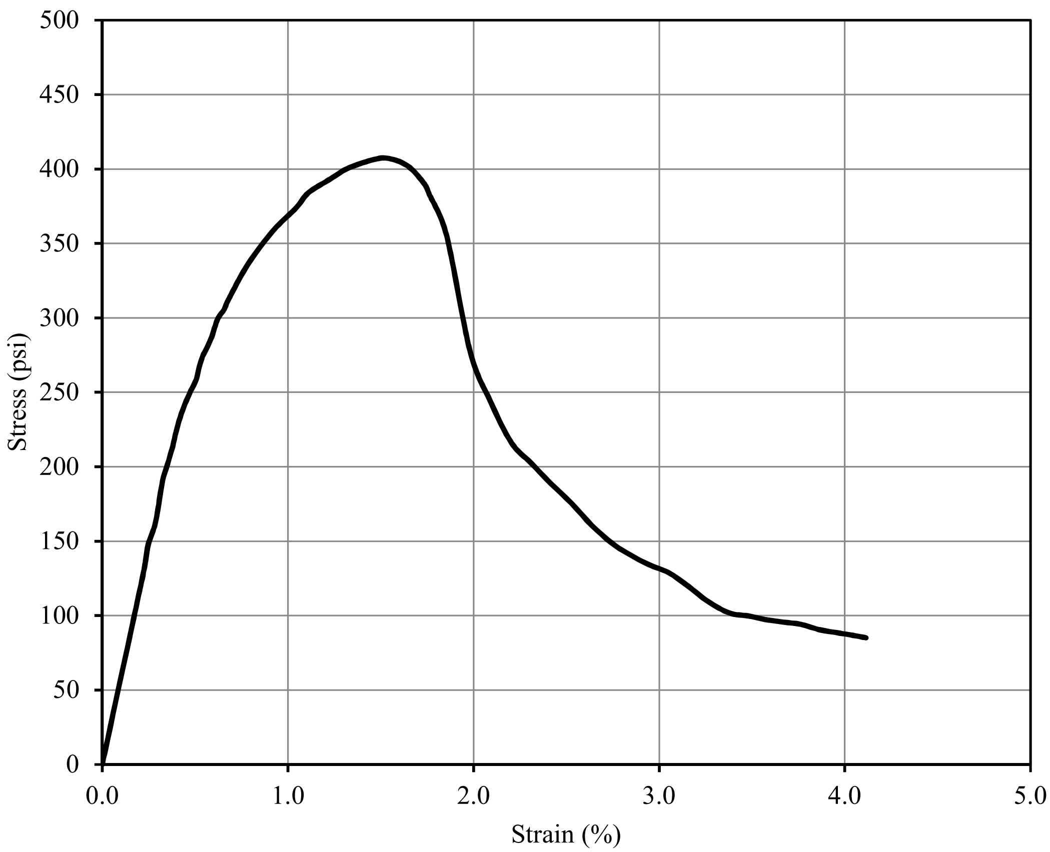


Test Result					
Peak deviator stress (w/ Height correction)	289	psi	Strain at failure, εf :	2.30	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.8	days
Tested by:	Hwanik Ju	Curing temperature	55	°C

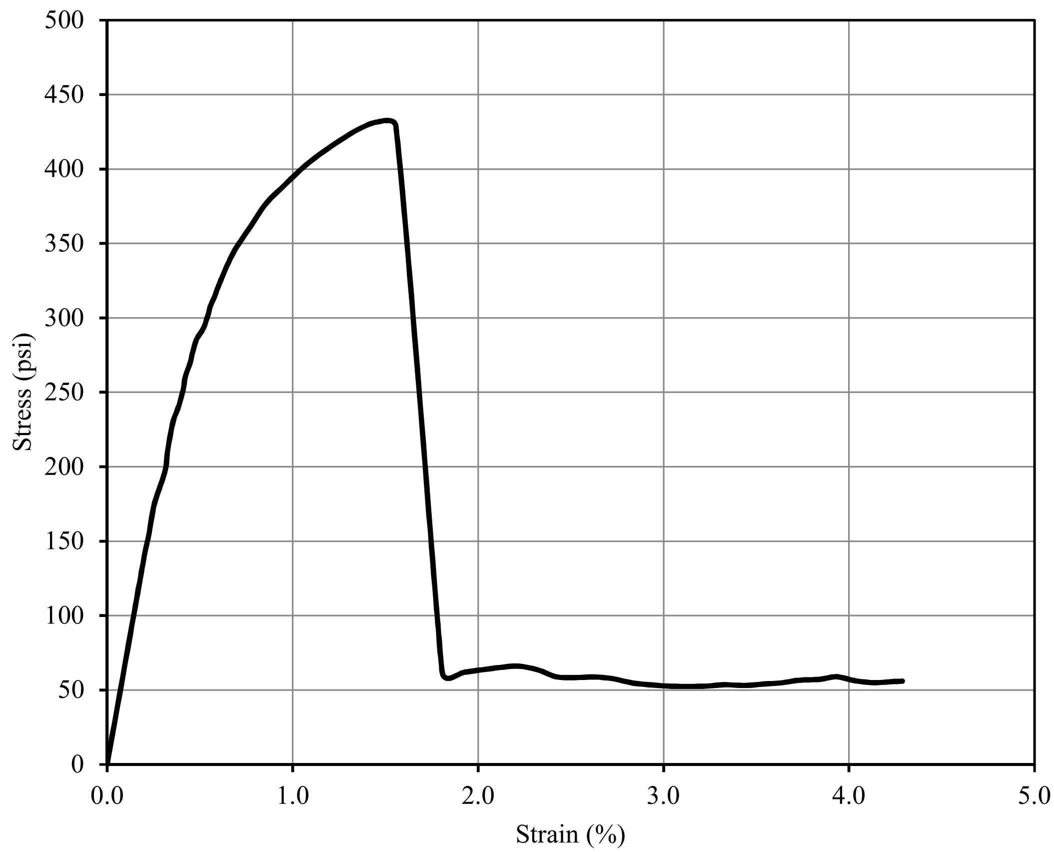
Test Information		Specimen Information		
I.D.:	T-19-B	Initial Height:	3.757	in
Test Date:	2017-11-10	Initial Diameter:	2.046	in
Strain Rate:	1 %/min	Initial Area:	3.288	in

Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	355.0	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	110	pcf



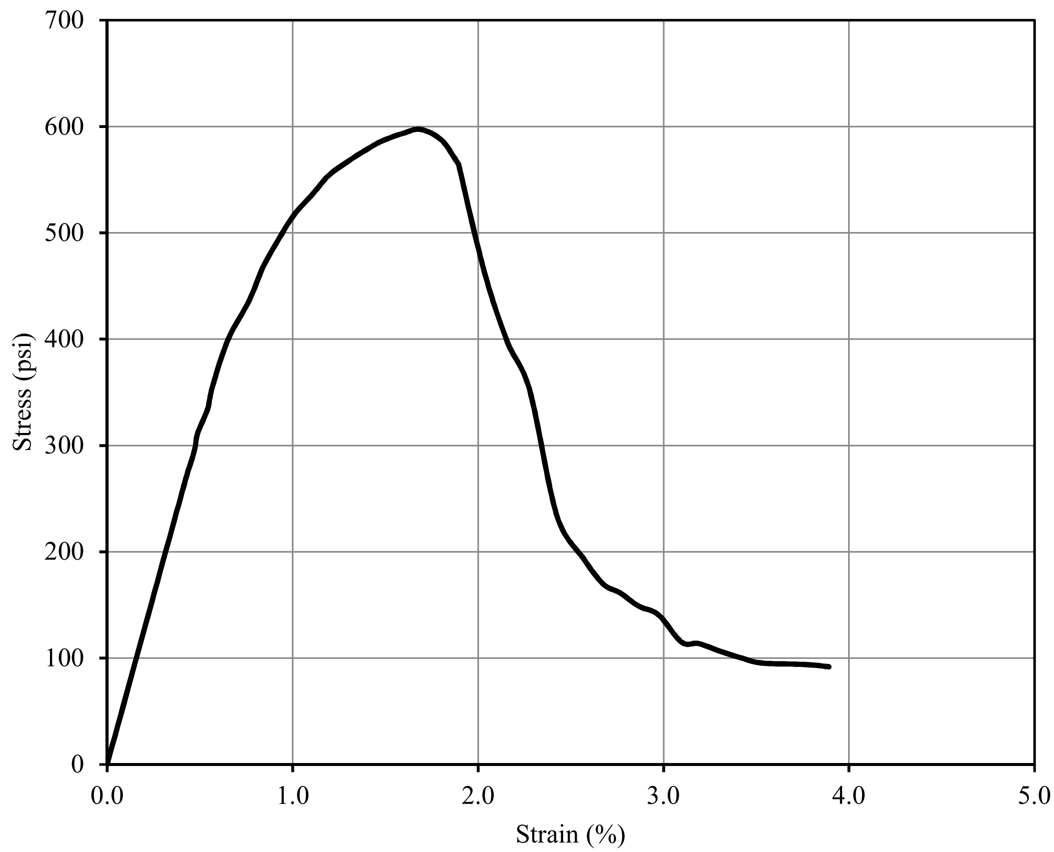
Test Result					
Peak deviator stress (w/ Height correction)	402	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.8	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-19-G	**Specimen Information**		
Test Date:	2017-11-10	Initial Height:	3.93	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	373.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf



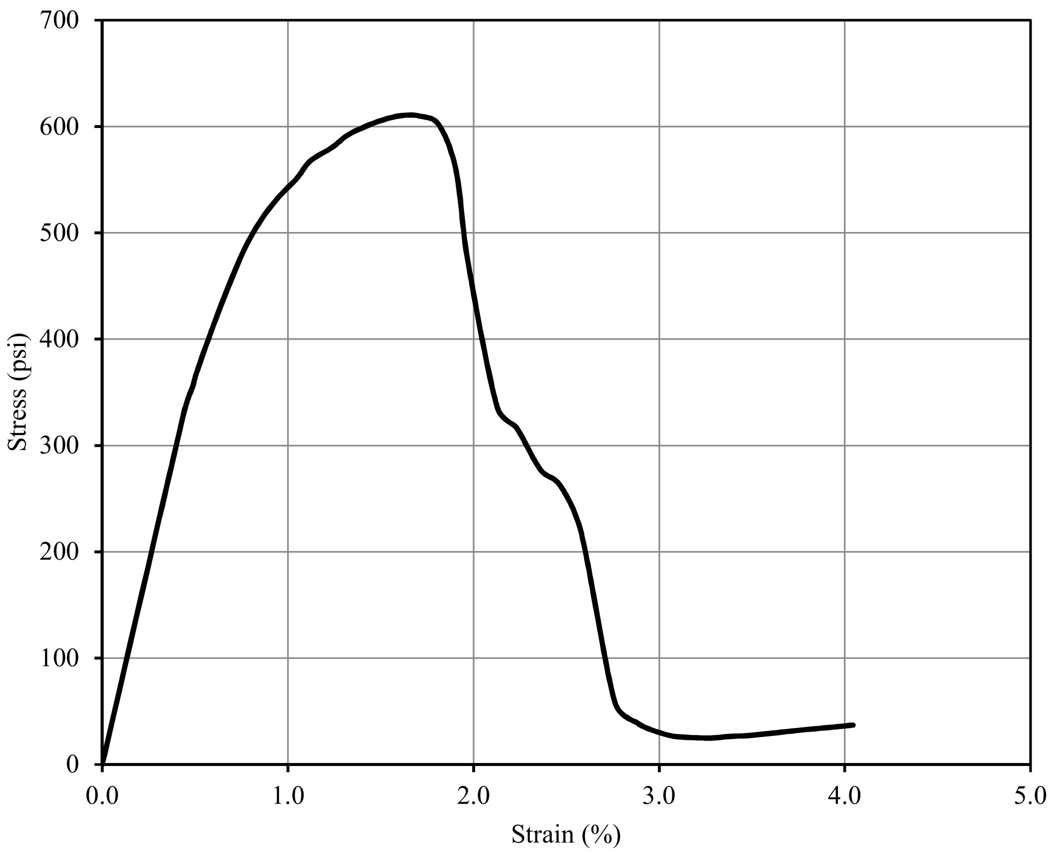
Test Result					
Peak deviator stress (w/ Height correction)	429	psi	Strain at failure, εf :	1.46	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-19-C	**Specimen Information**		
Test Date:	2017-11-17	Initial Height:	3.909	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	371.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



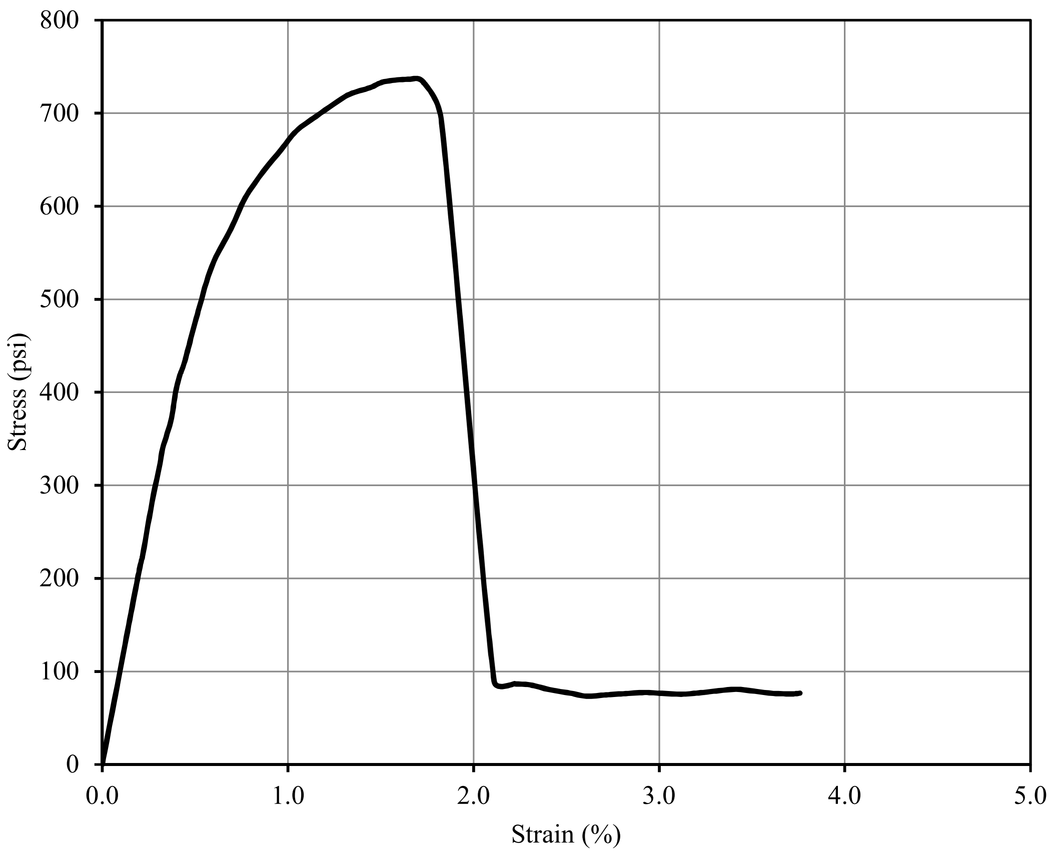
Test Result					
Peak deviator stress (w/ Height correction)	593	psi	Strain at failure, εf :	1.69	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-19-F	**Specimen Information**		
Test Date:	2017-11-17	Initial Height:	3.696	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	351.0	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	110	pcf



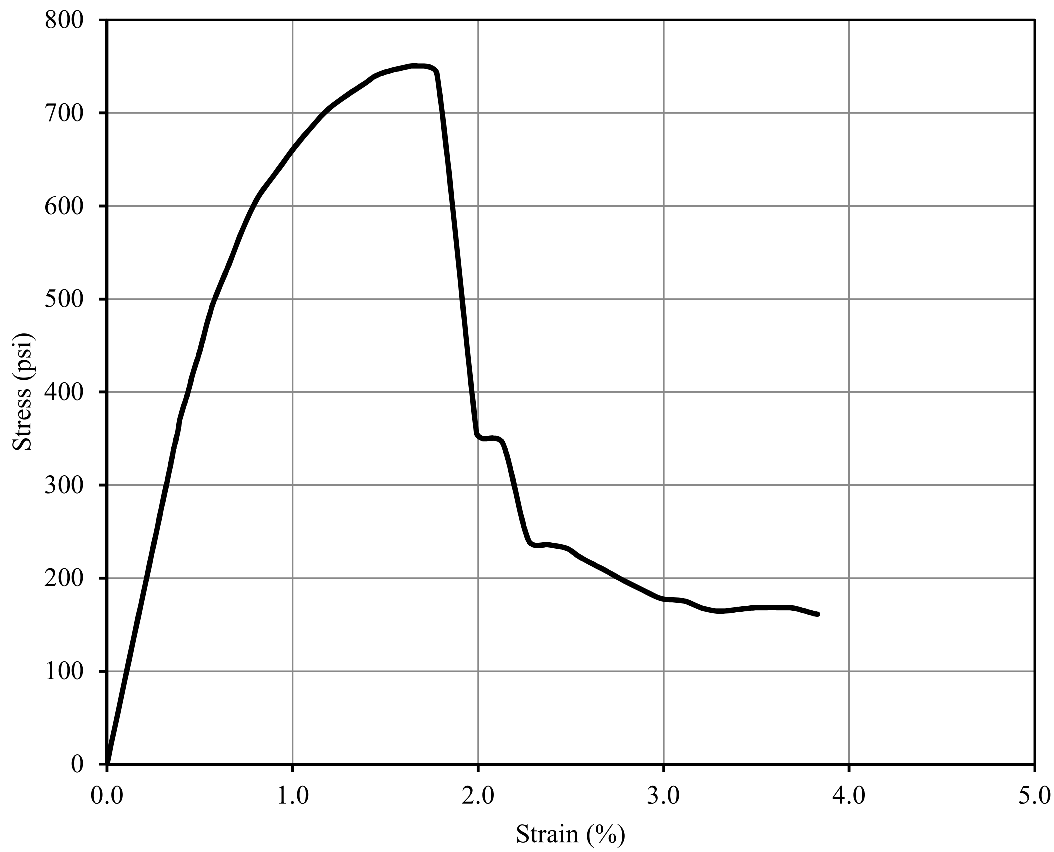
Test Result					
Peak deviator stress (w/ Height correction)	601	psi	Strain at failure, εf :	1.61	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-19-D	**Specimen Information**		
Test Date:	2017-12-01	Initial Height:	3.819	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	363.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	110	pcf



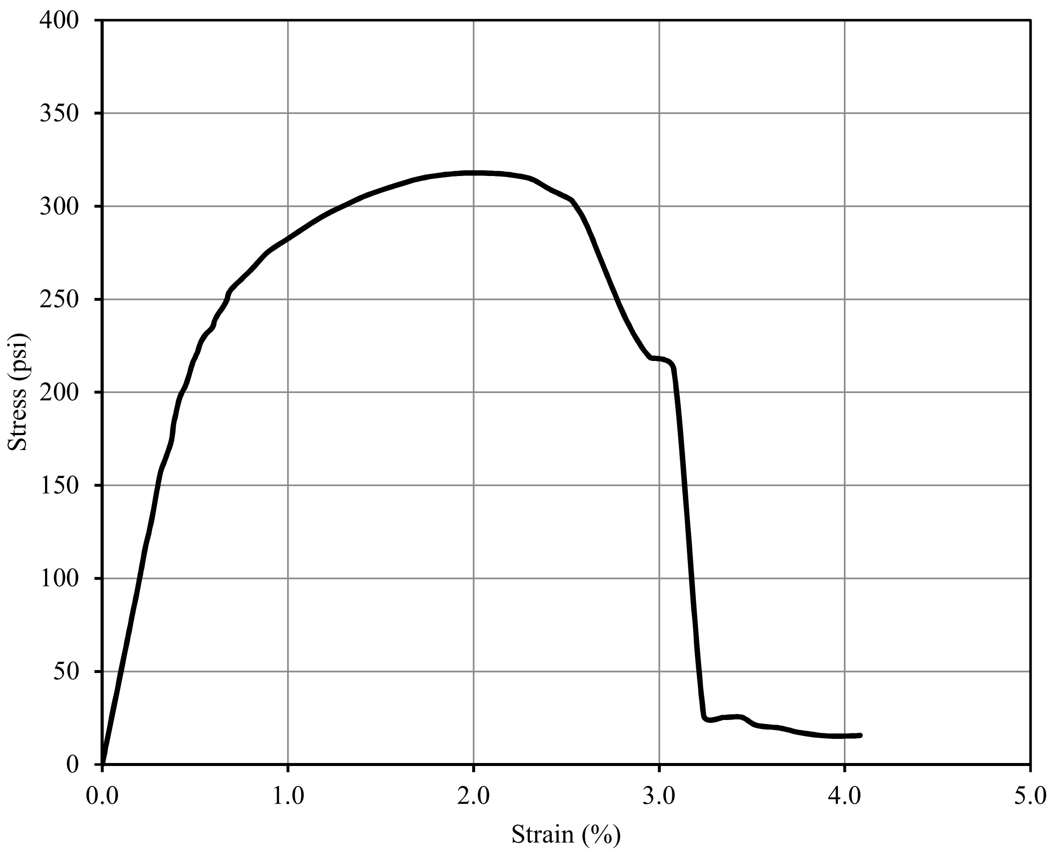
Test Result					
Peak deviator stress (w/ Height correction)	729	psi	Strain at failure, εf :	1.65	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-19-E	**Specimen Information**		
Test Date:	2017-12-01	Initial Height:	3.896	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	370.4	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	110	pcf



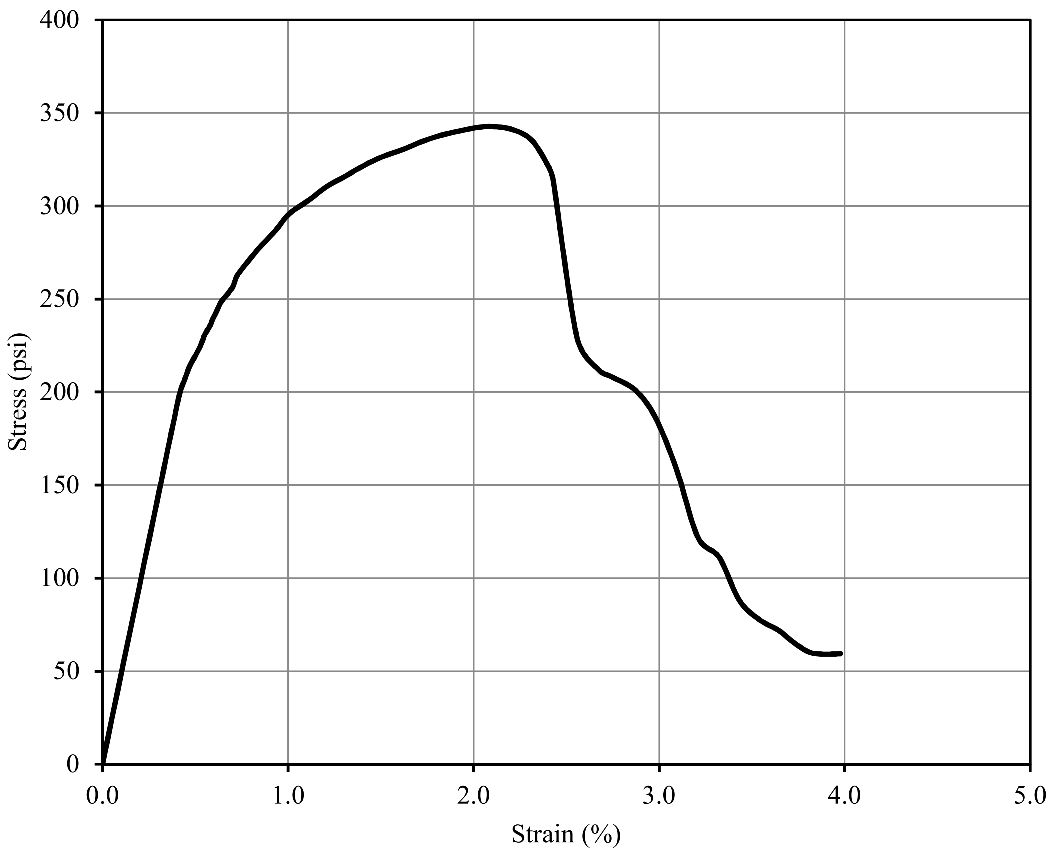
Test Result					
Peak deviator stress (w/ Height correction)	745	psi	Strain at failure, εf :	1.68	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-A	**Specimen Information**		
Test Date:	2017-11-07	Initial Height:	3.936	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	367.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



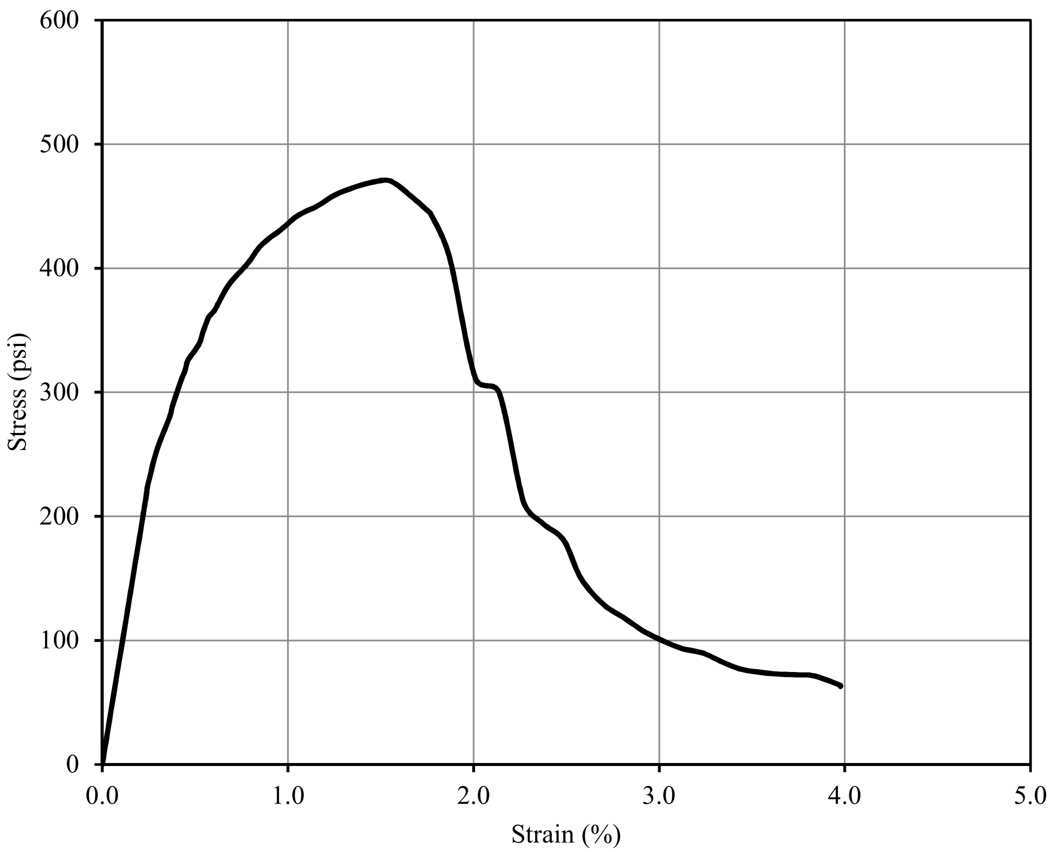
Test Result					
Peak deviator stress (w/ Height correction)	316	psi	Strain at failure, εf :	2.00	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-J	**Specimen Information**		
Test Date:	2017-11-07	Initial Height:	3.949	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	369.7	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



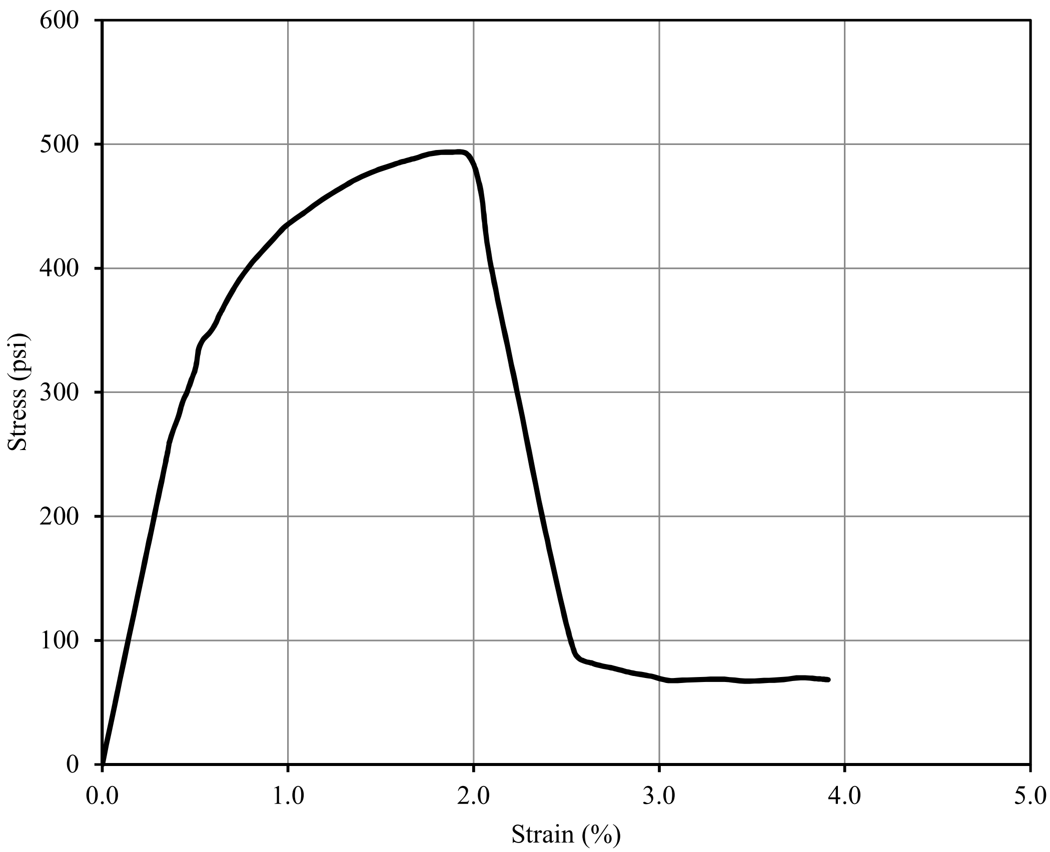
Test Result					
Peak deviator stress (w/ Height correction)	341	psi	Strain at failure, εf :	2.10	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.8	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-B	**Specimen Information**		
Test Date:	2017-11-10	Initial Height:	3.939	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	368.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



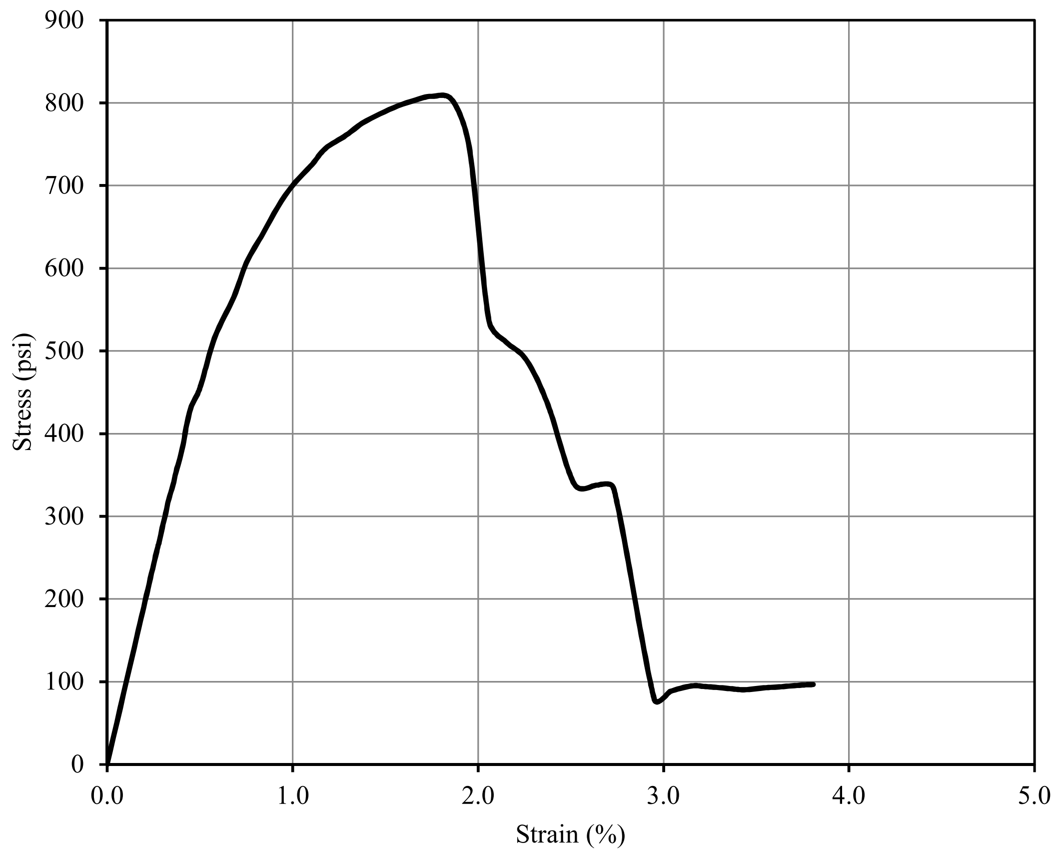
Test Result					
Peak deviator stress (w/ Height correction)	467	psi	Strain at failure, εf :	1.56	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.8	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-G	**Specimen Information**		
Test Date:	2017-11-10	Initial Height:	3.872	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	362.4	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	108	pcf



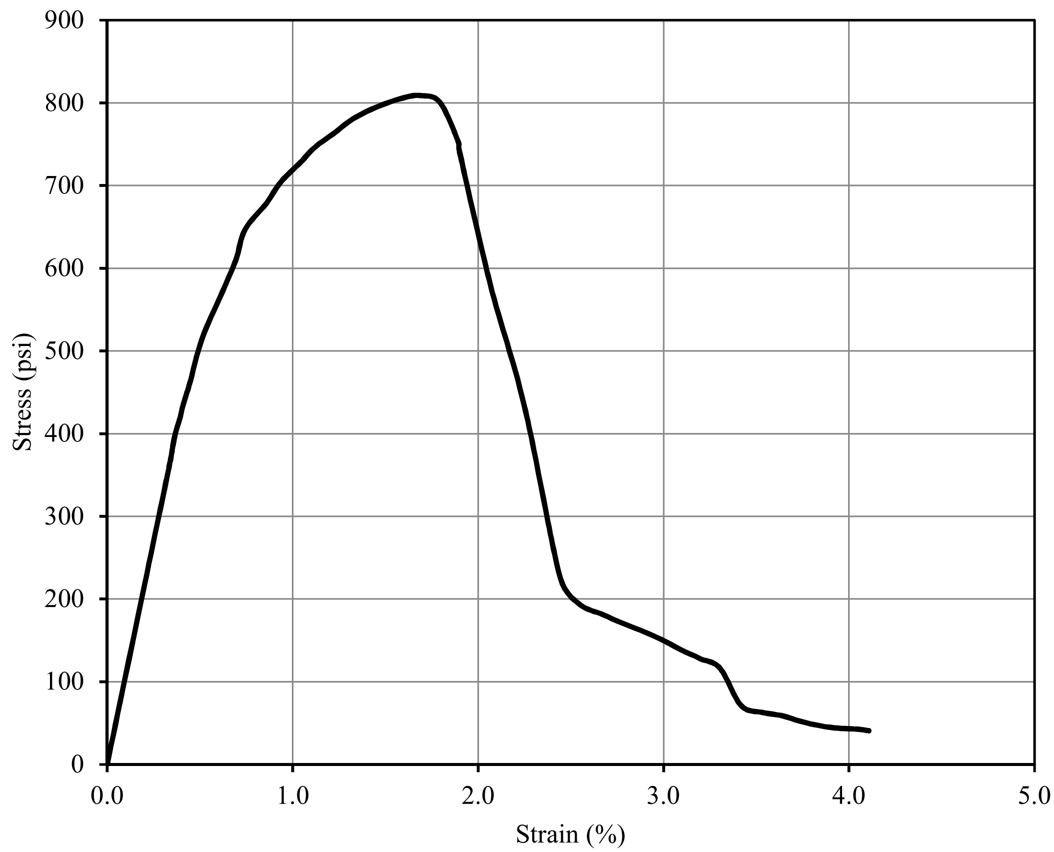
Test Result					
Peak deviator stress (w/ Height correction)	489	psi	Strain at failure, εf :	1.88	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-C	**Specimen Information**		
Test Date:	2017-11-17	Initial Height:	3.844	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	360.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



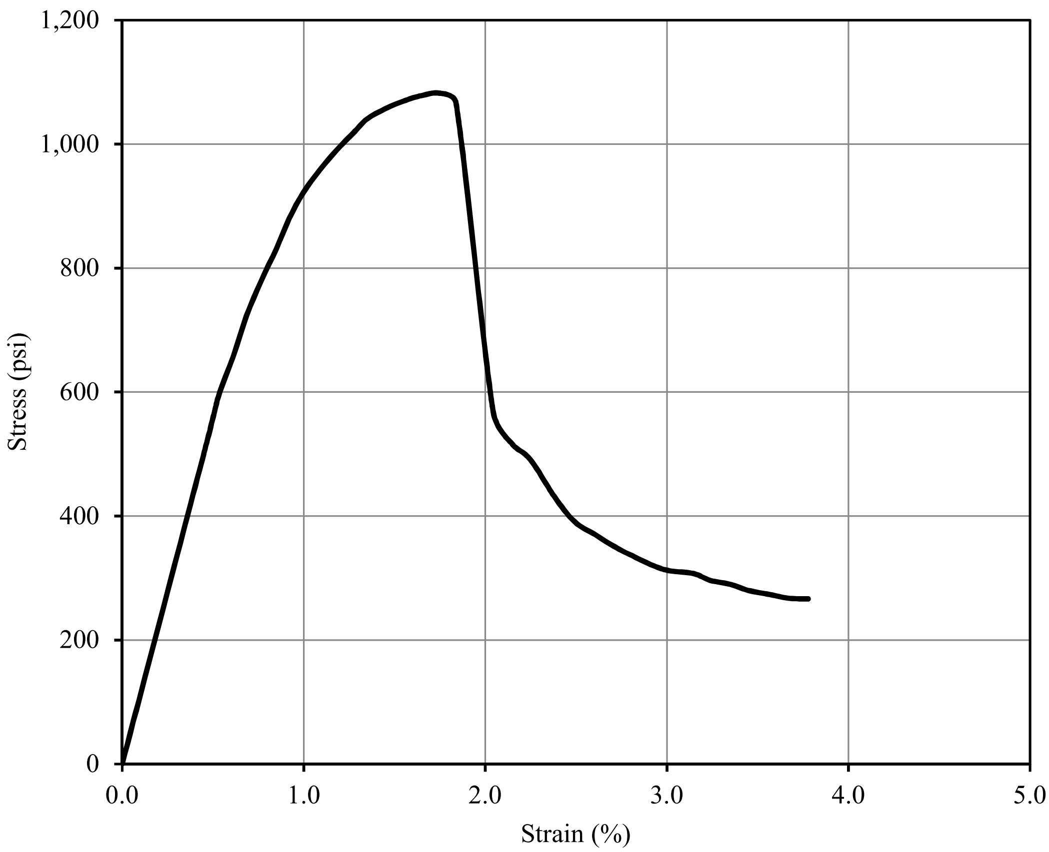
Test Result					
Peak deviator stress (w/ Height correction)	800	psi	Strain at failure, εf :	1.75	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-F	**Specimen Information**		
Test Date:	2017-11-17	Initial Height:	3.744	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	350.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



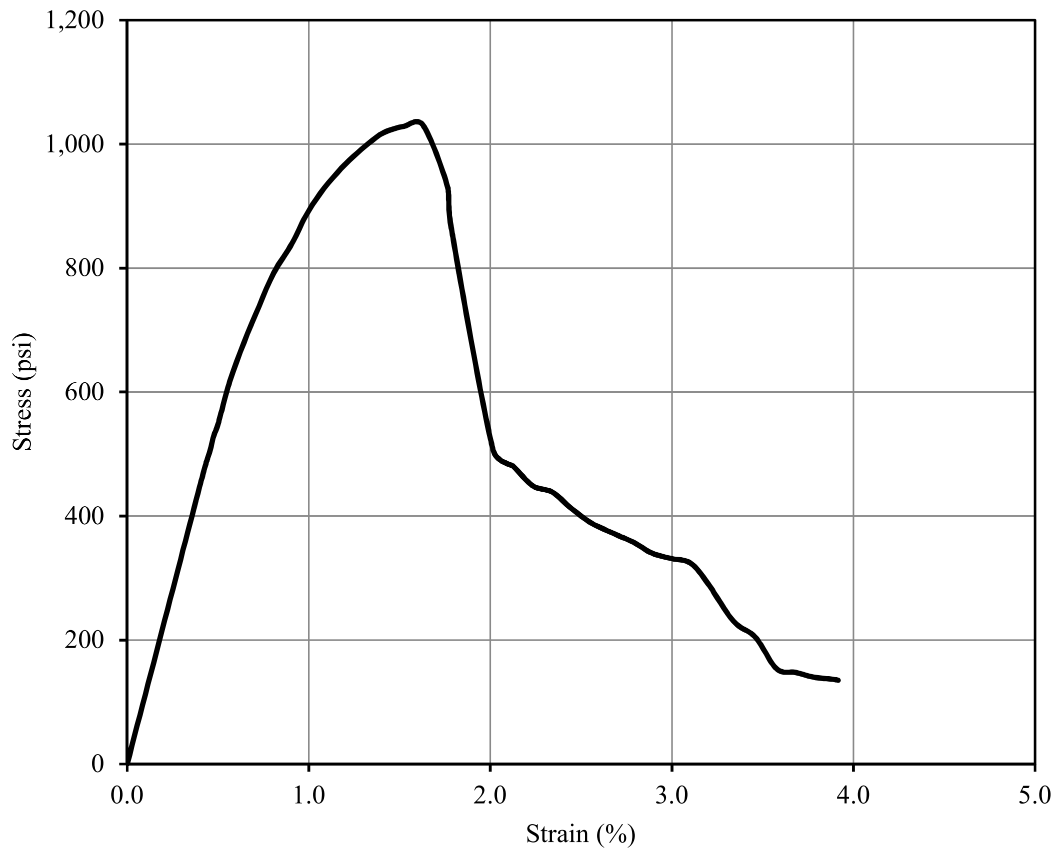
Test Result					
Peak deviator stress (w/ Height correction)	798	psi	Strain at failure, εf :	1.69	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-D	**Specimen Information**		
Test Date:	2017-12-01	Initial Height:	3.875	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	364.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



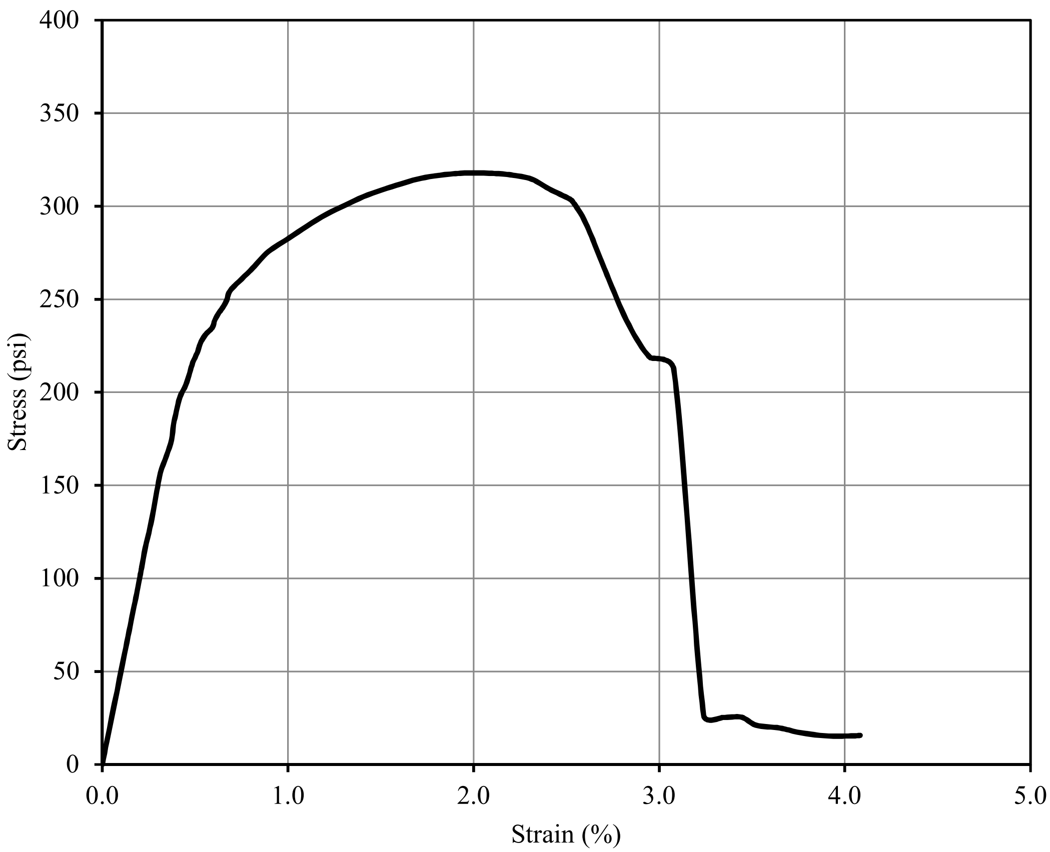
Test Result					
Peak deviator stress (w/ Height correction)	1,073	psi	Strain at failure, εf :	1.75	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-20-E	**Specimen Information**		
Test Date:	2017-12-01	Initial Height:	3.92	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	368.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



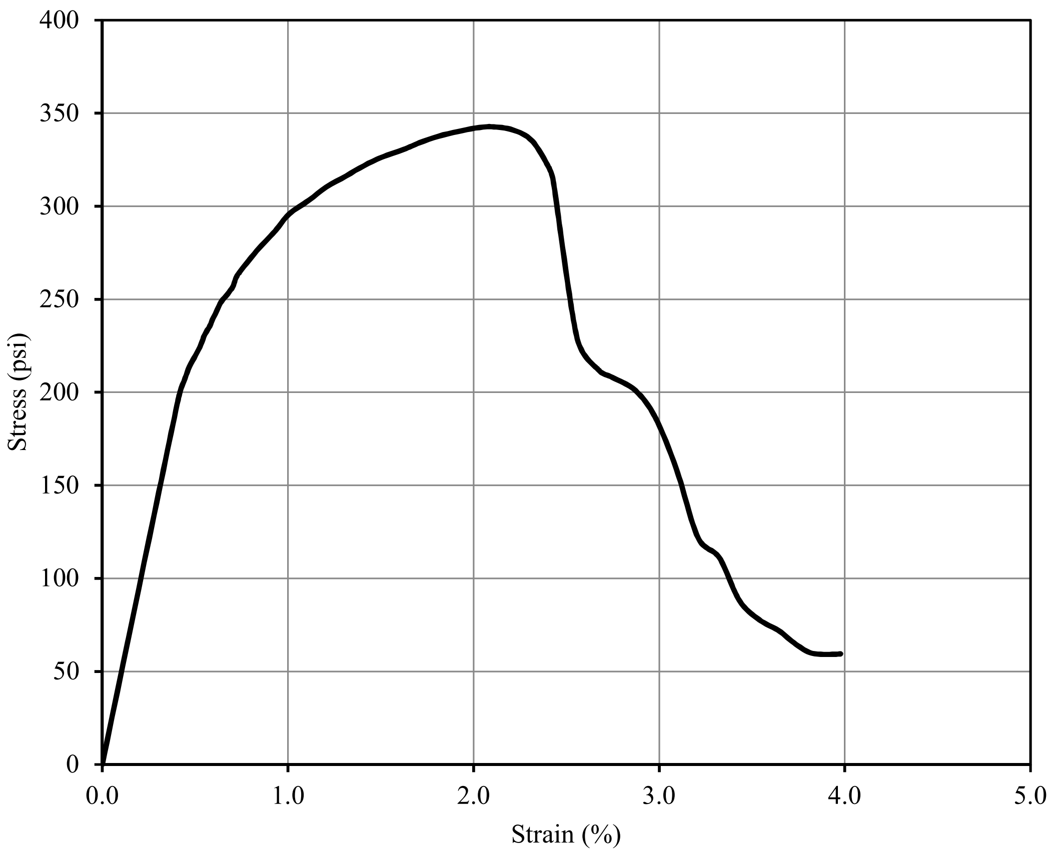
Test Result					
Peak deviator stress (w/ Height correction)	1,024	psi	Strain at failure, εf :	1.63	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-A	**Specimen Information**		
Test Date:	2017-11-12	Initial Height:	3.908	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	359.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



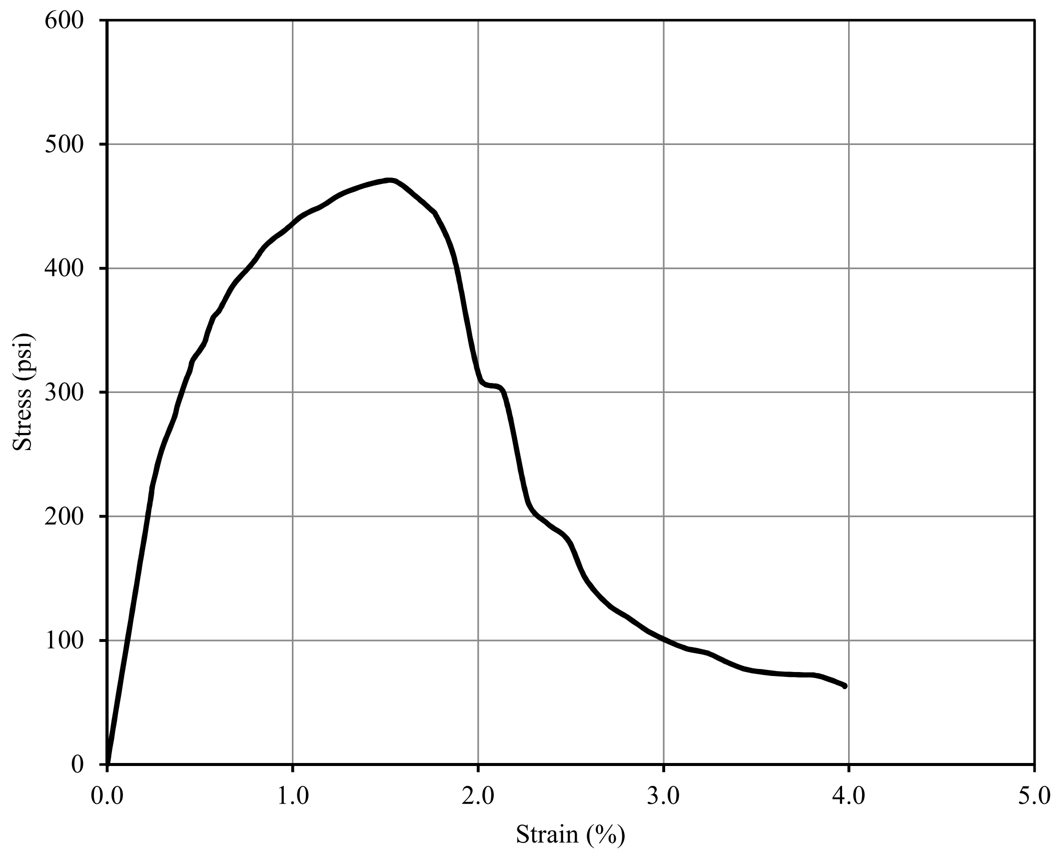
Test Result					
Peak deviator stress (w/ Height correction)	371	psi	Strain at failure, εf :	1.80	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-H	**Specimen Information**		
Test Date:	2017-11-12	Initial Height:	3.852	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	352.9	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	106	pcf



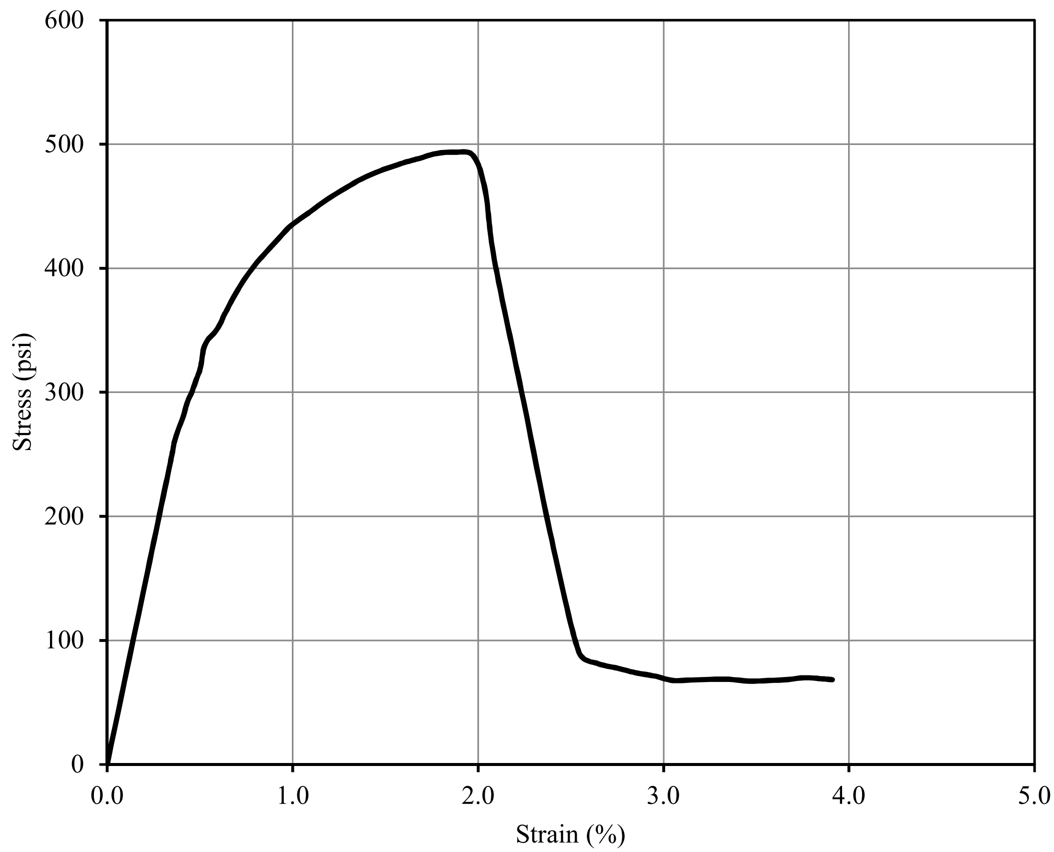
Test Result					
Peak deviator stress (w/ Height correction)	397	psi	Strain at failure, εf :	2.27	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-B	**Specimen Information**		
Test Date:	2017-11-16	Initial Height:	3.922	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	360.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	106	pcf



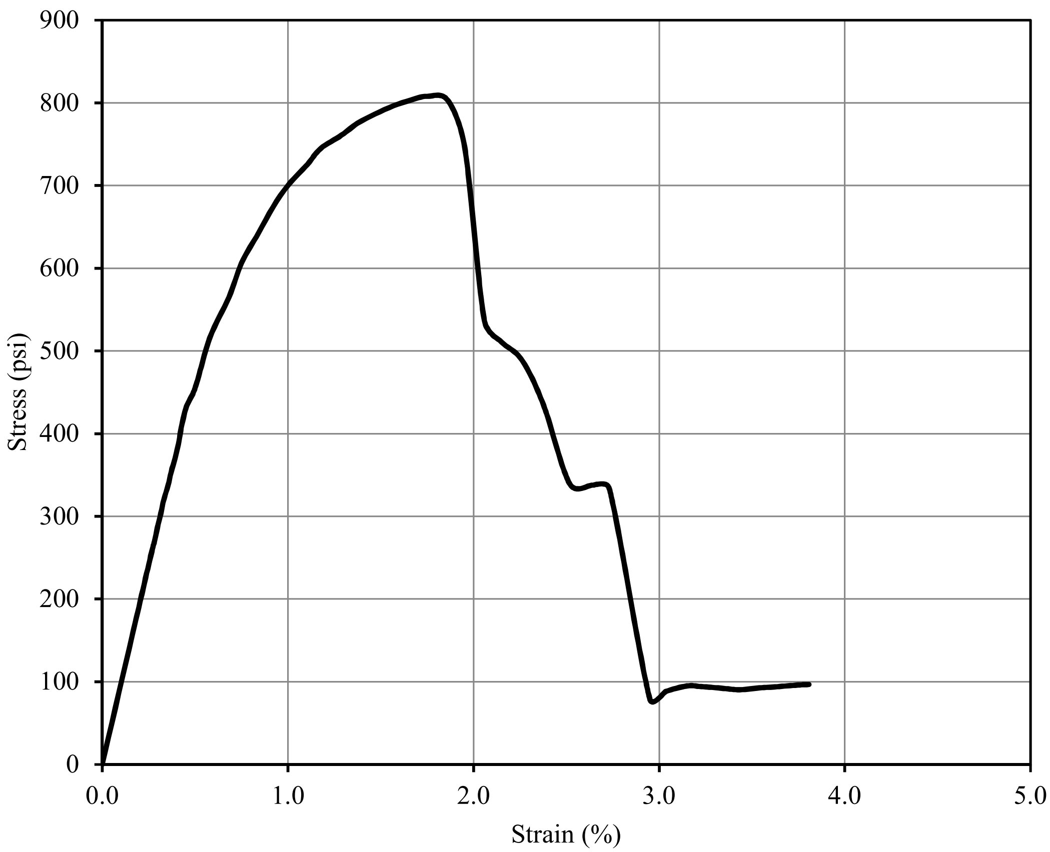
Test Result					
Peak deviator stress (w/ Height correction)	558	psi	Strain at failure, εf :	1.88	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-G	**Specimen Information**		
Test Date:	2017-11-16	Initial Height:	3.816	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	325.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



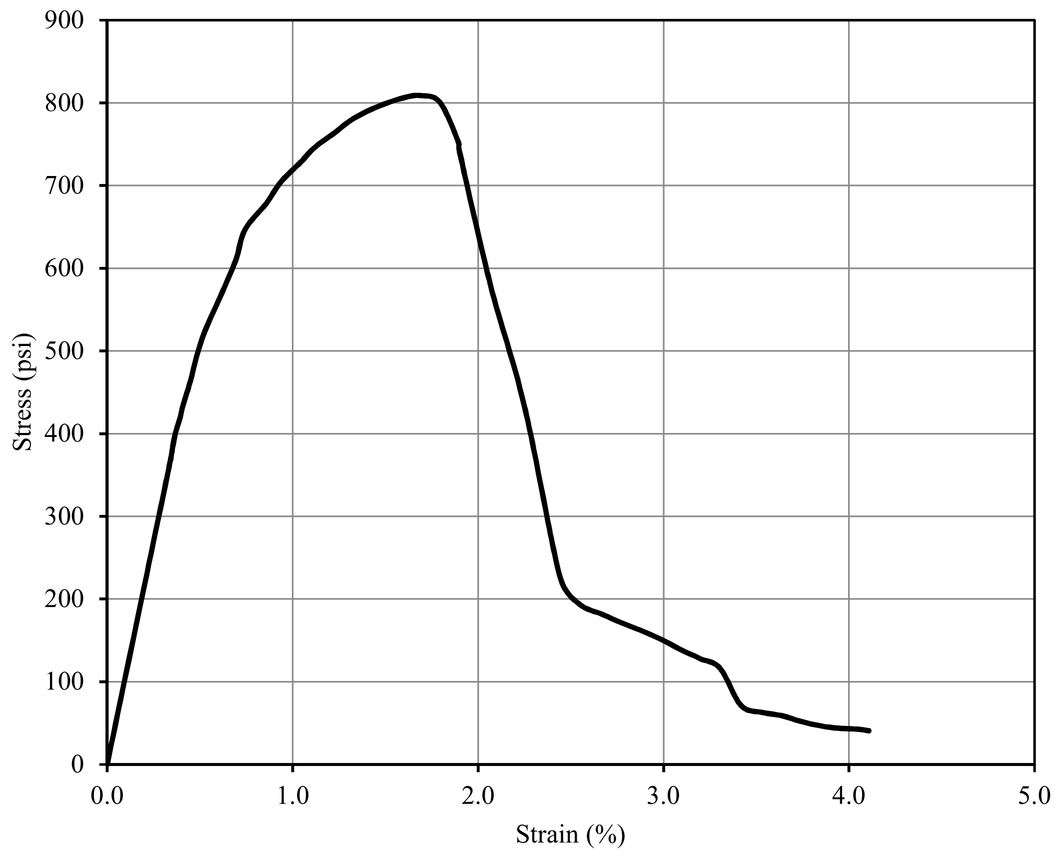
Test Result					
Peak deviator stress (w/ Height correction)	565	psi	Strain at failure, εf :	1.66	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-C	**Specimen Information**		
Test Date:	2017-11-23	Initial Height:	3.893	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	360.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



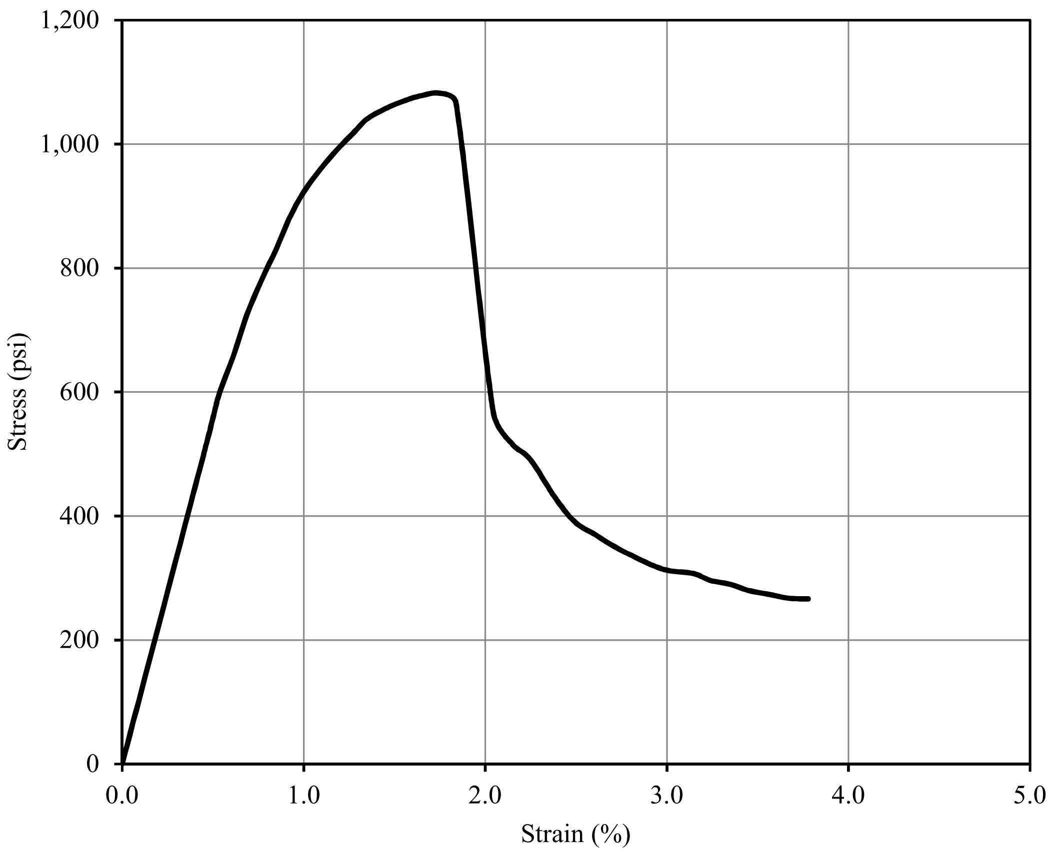
Test Result					
Peak deviator stress (w/ Height correction)	720	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-F	**Specimen Information**		
Test Date:	2017-11-23	Initial Height:	3.913	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	361.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



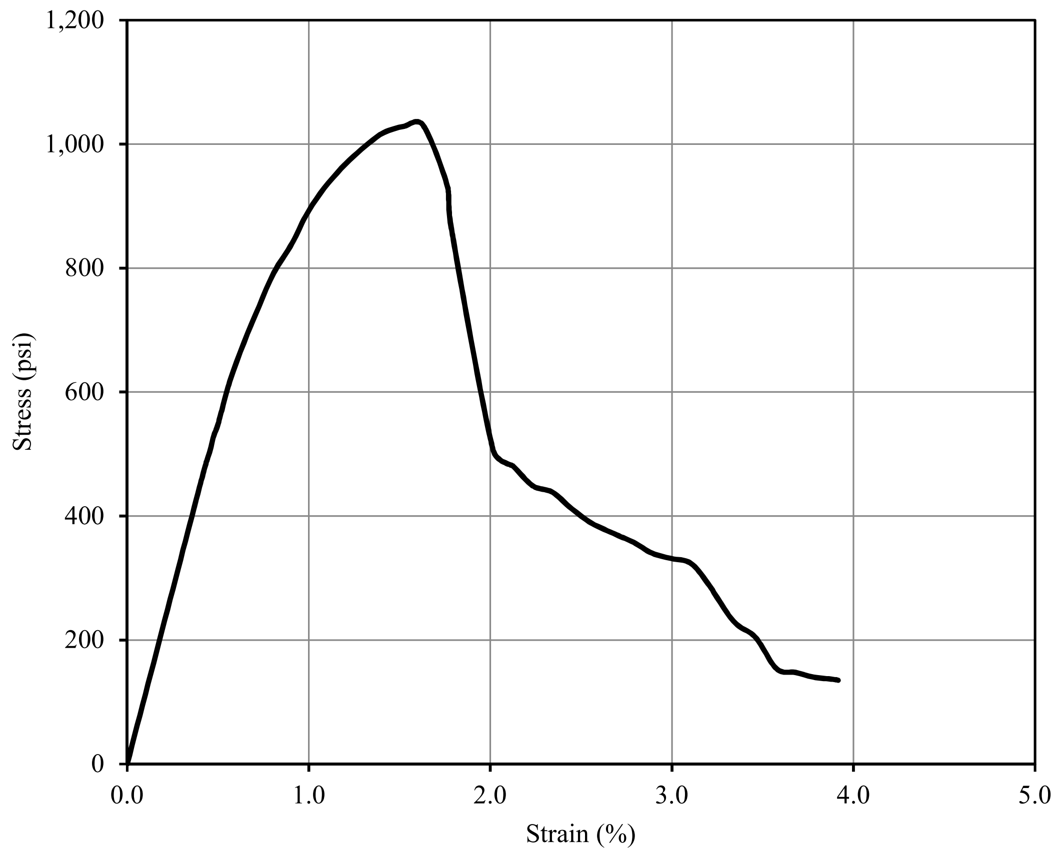
Test Result					
Peak deviator stress (w/ Height correction)	747	psi	Strain at failure, εf :	1.72	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-D	**Specimen Information**		
Test Date:	2017-12-07	Initial Height:	3.903	in
Strain Rate:	1 %/min	Initial Diameter:	2.049	in
Mixture Proportion		Initial Area:	3.297	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	361.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



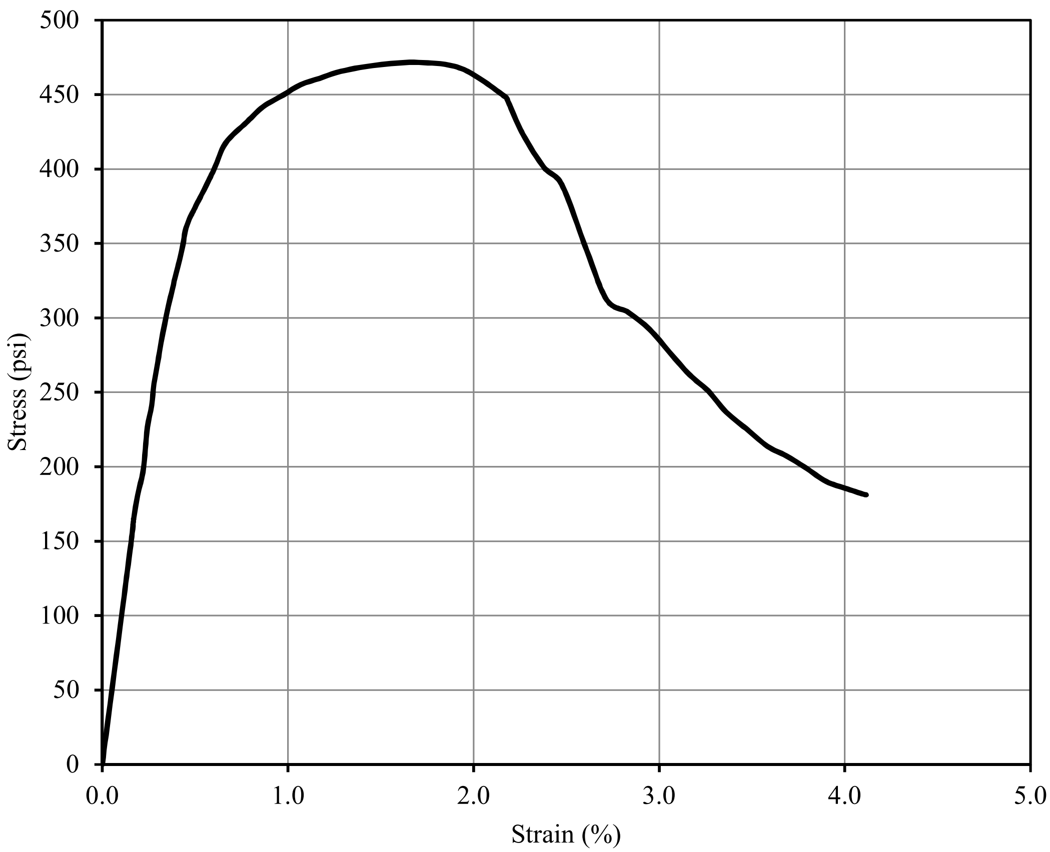
Test Result					
Peak deviator stress (w/ Height correction)	1,148	psi	Strain at failure, εf :	1.58	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-21-E	**Specimen Information**		
Test Date:	2017-12-07	Initial Height:	3.907	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	362.2	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	107	pcf



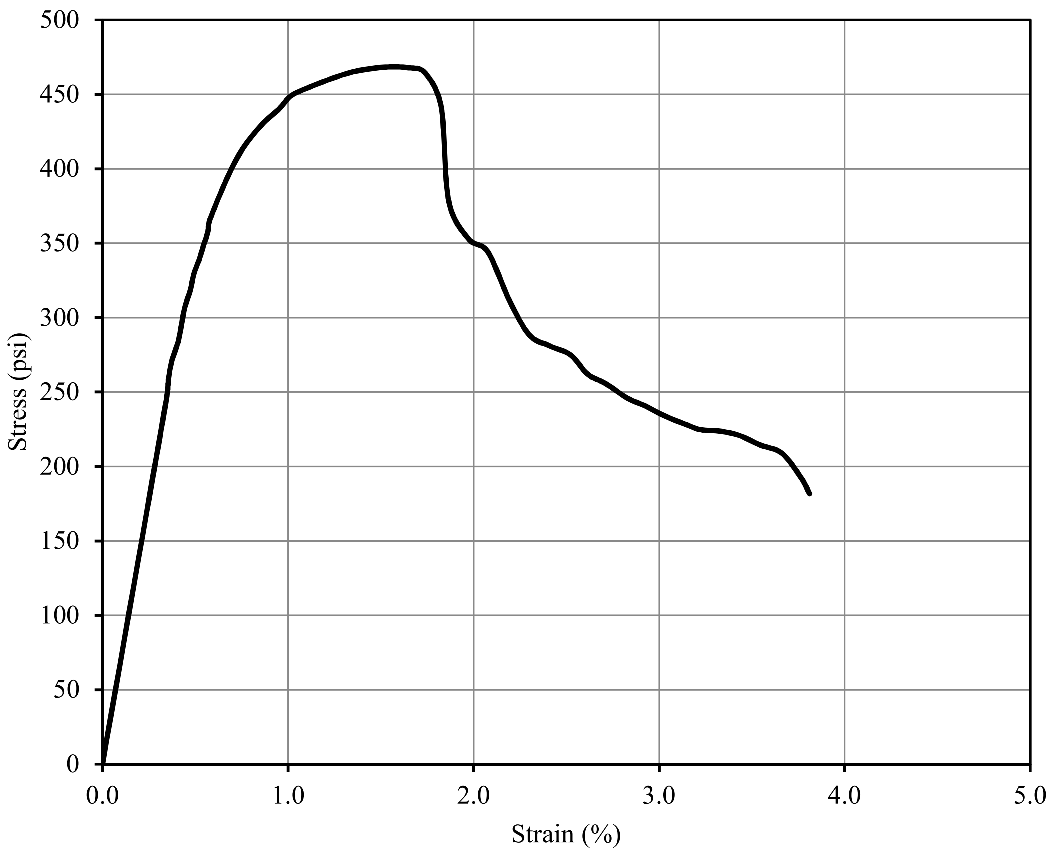
Test Result					
Peak deviator stress (w/ Height correction)	1,158	psi	Strain at failure, εf :	1.58	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-22-A	**Specimen Information**		
Test Date:	2017-11-13	Initial Height:	3.738	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	337.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	104	pcf



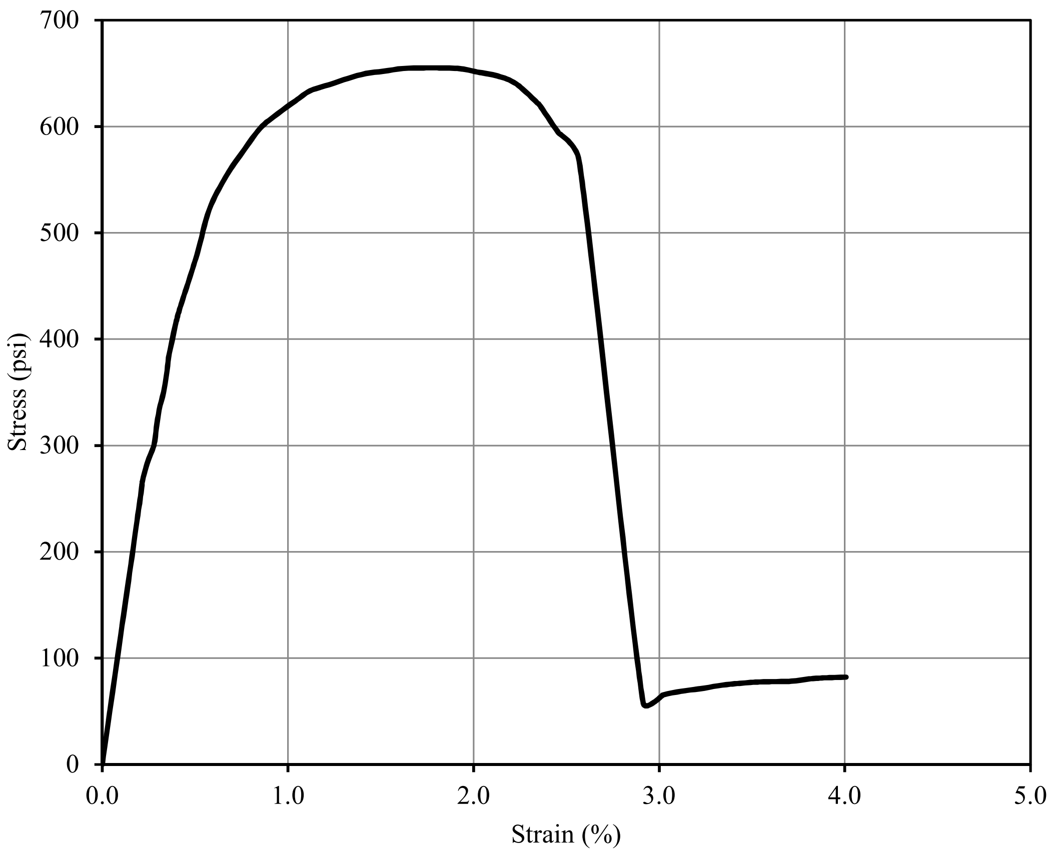
Test Result					
Peak deviator stress (w/ Height correction)	465	psi	Strain at failure, εf :	1.65	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-22-H	**Specimen Information**		
Test Date:	2017-11-13	Initial Height:	3.873	in
Strain Rate:	1 %/min	Initial Diameter:	2.049	in
Mixture Proportion		Initial Area:	3.297	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	350.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



Test Result					
Peak deviator stress (w/ Height correction)	464	psi	Strain at failure, εf :	1.52	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-22-B	**Specimen Information**		
Test Date:	2017-11-17	Initial Height:	3.725	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	334.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	104	pcf

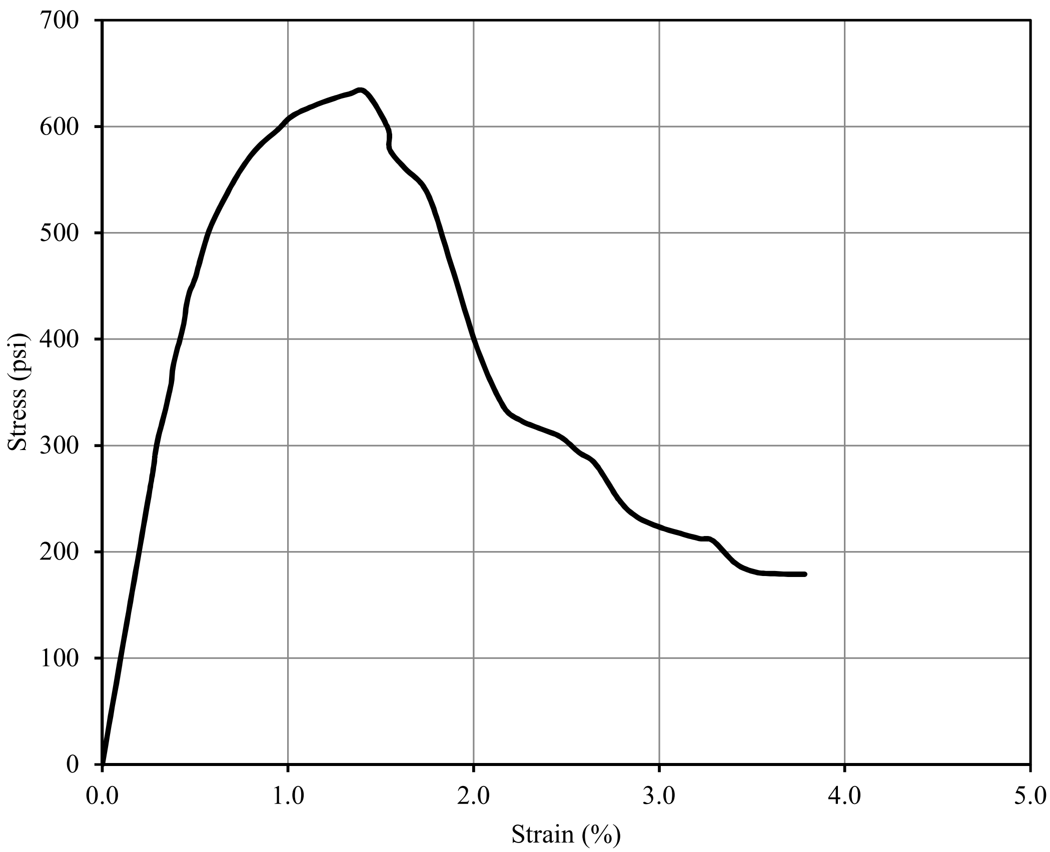


Test Result					
Peak deviator stress (w/ Height correction)	646	psi	Strain at failure, εf :	1.73	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	55	°C

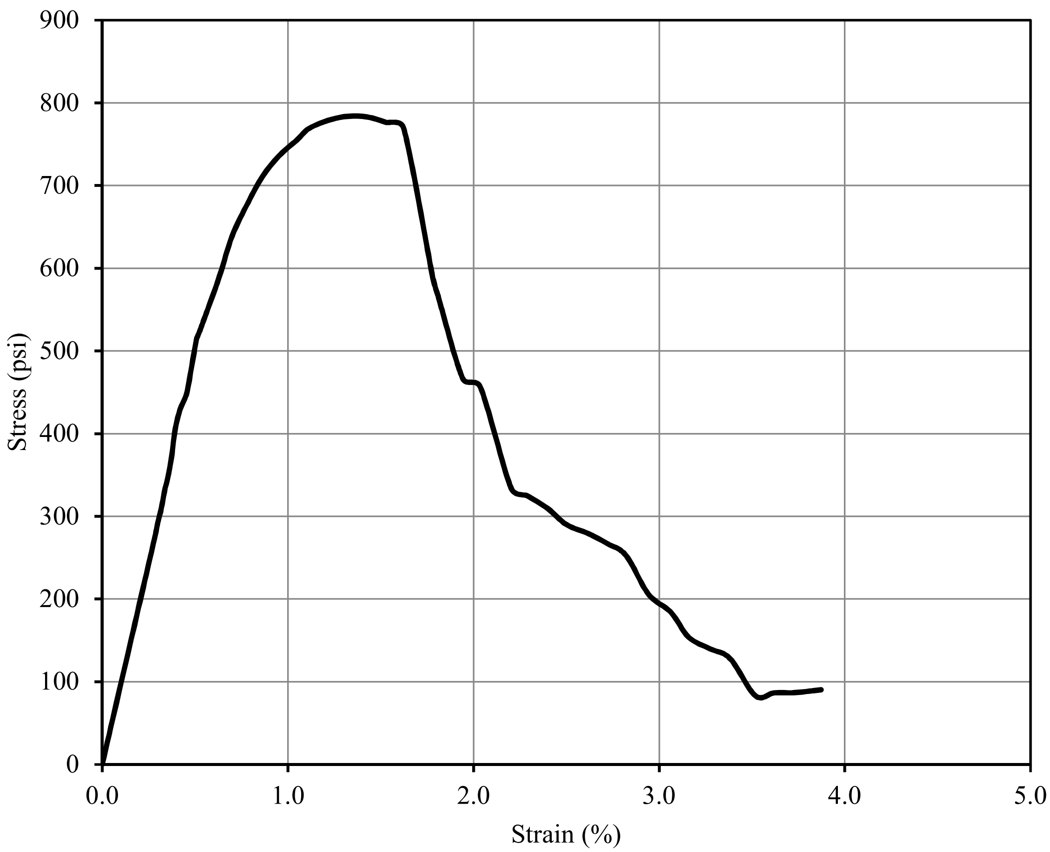
Test Information		Specimen Information		
I.D.:	T-22-G	Initial Height:	3.968	in
Test Date:	2017-11-17	Initial Diameter:	2.047	in
Strain Rate:	1 %/min	Initial Area:	3.291	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	359.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



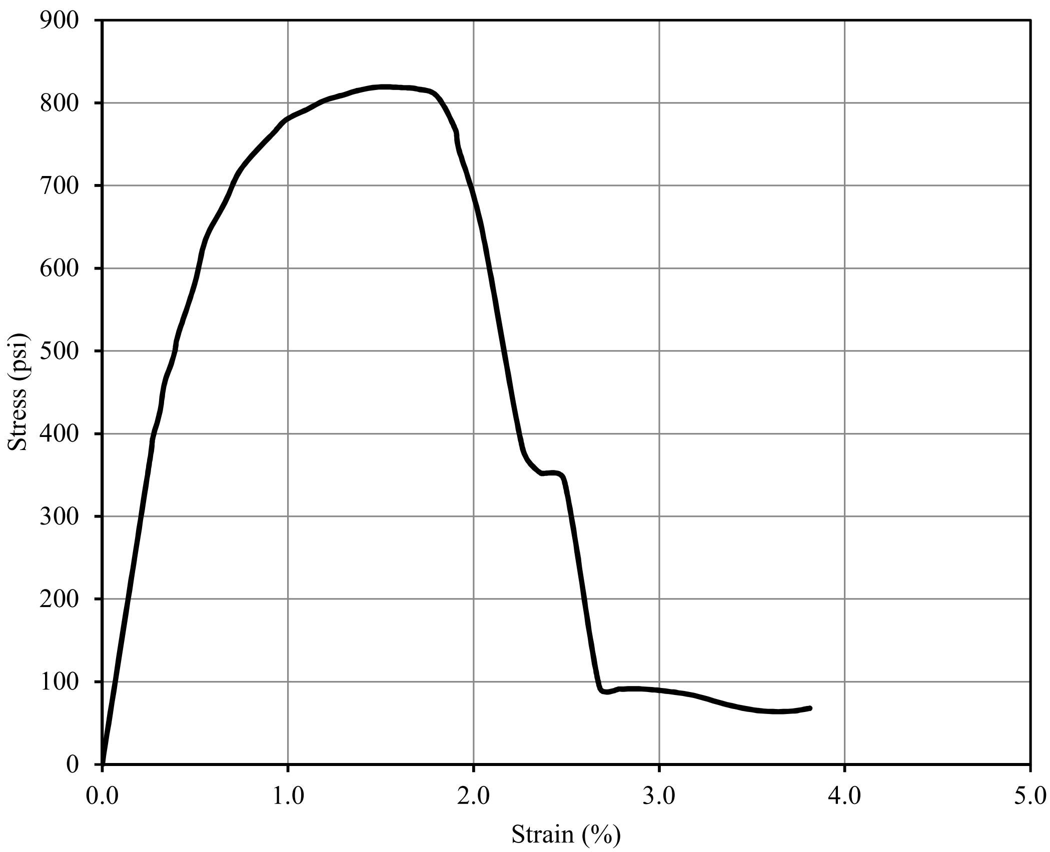
Test Result					
Peak deviator stress (w/ Height correction)	629	psi	Strain at failure, εf :	1.42	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-22-C	**Specimen Information**		
Test Date:	2017-11-24	Initial Height:	3.836	in
Strain Rate:	1 %/min	Initial Diameter:	2.05	in
Mixture Proportion		Initial Area:	3.301	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	345.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	104	pcf



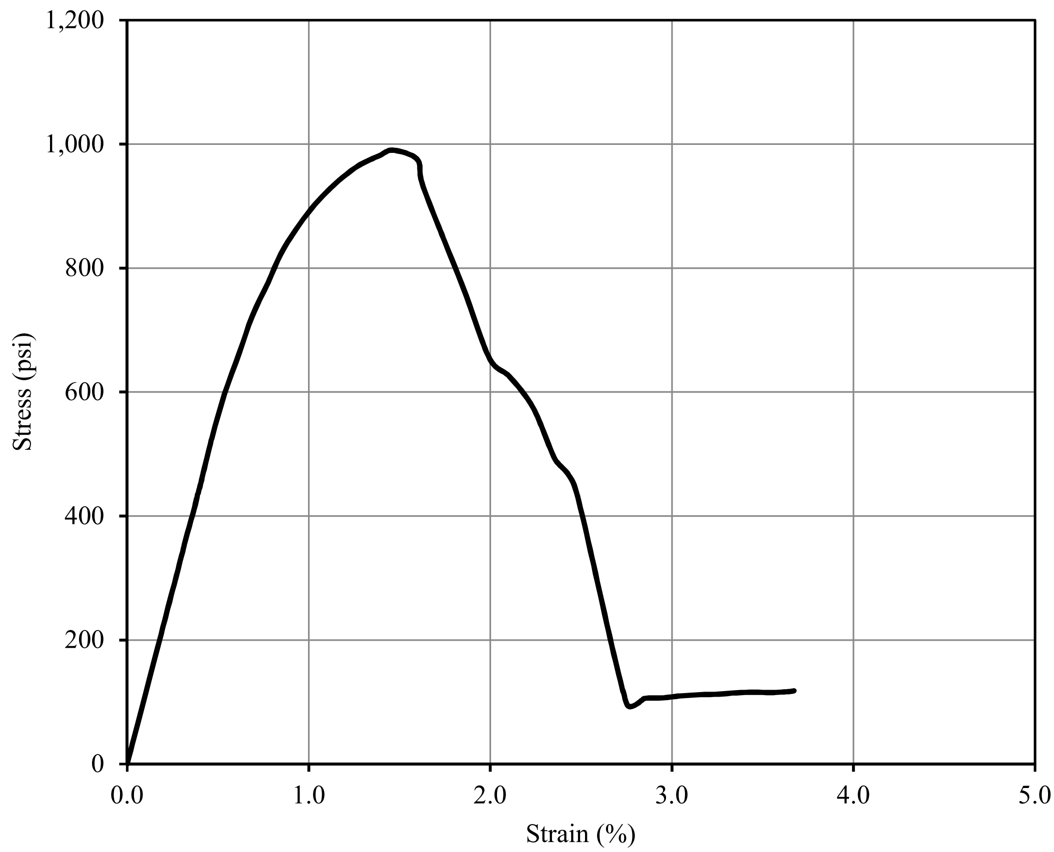
Test Result					
Peak deviator stress (w/ Height correction)	776	psi	Strain at failure, εf :	1.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-22-F	**Specimen Information**		
Test Date:	2017-11-24	Initial Height:	3.877	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	352.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



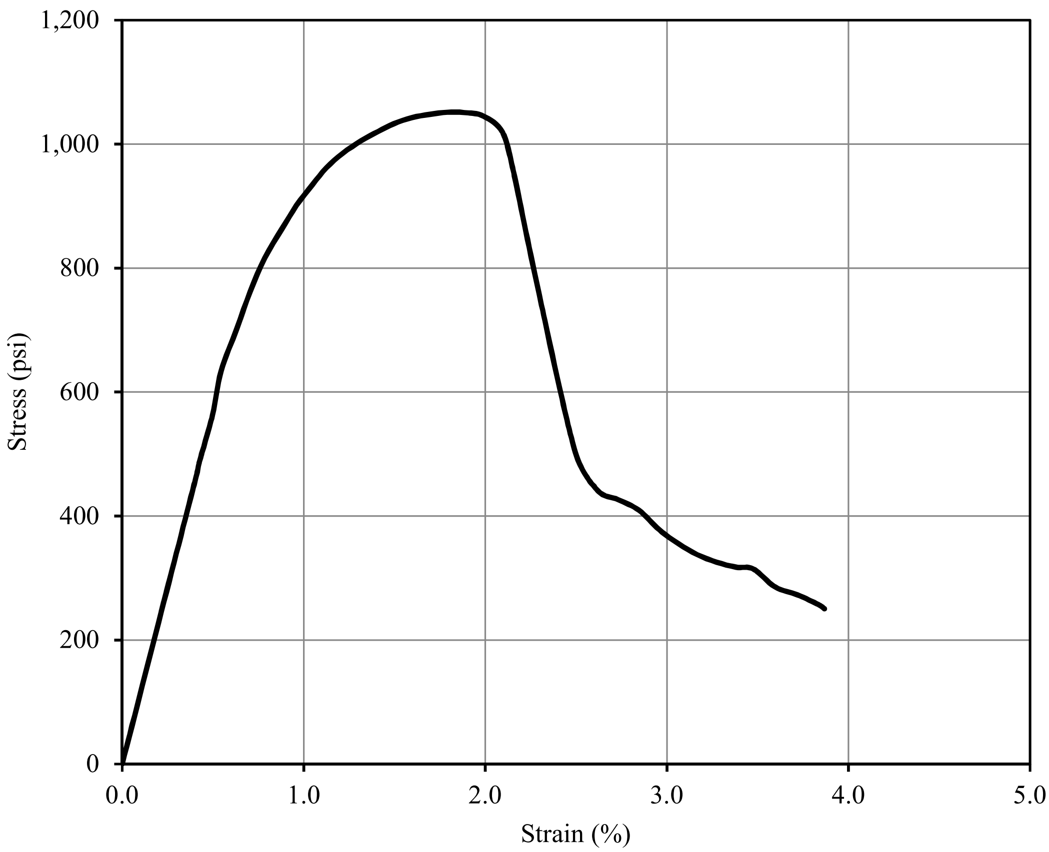
Test Result					
Peak deviator stress (w/ Height correction)	812	psi	Strain at failure, εf :	1.49	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-22-D	**Specimen Information**		
Test Date:	2017-12-08	Initial Height:	3.711	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	336.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



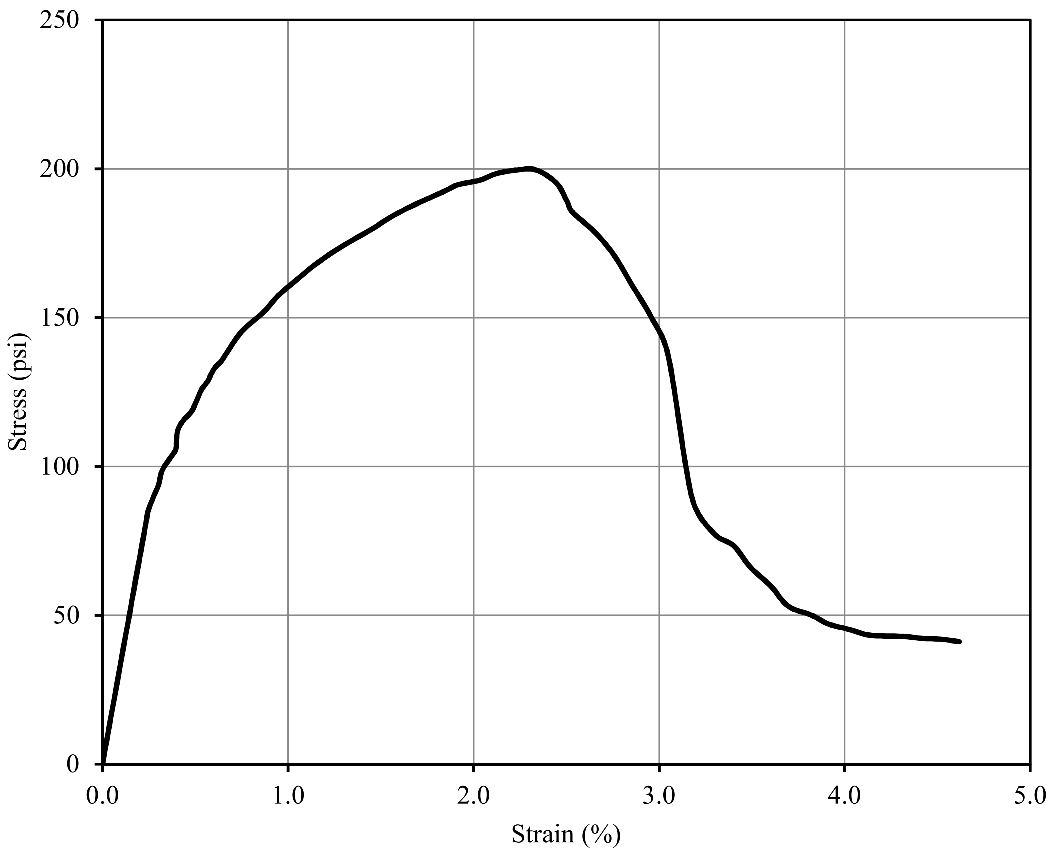
Test Result					
Peak deviator stress (w/ Height correction)	975	psi	Strain at failure, εf :	1.47	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-22-E	**Specimen Information**		
Test Date:	2017-12-08	Initial Height:	3.733	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	339.9	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	105	pcf



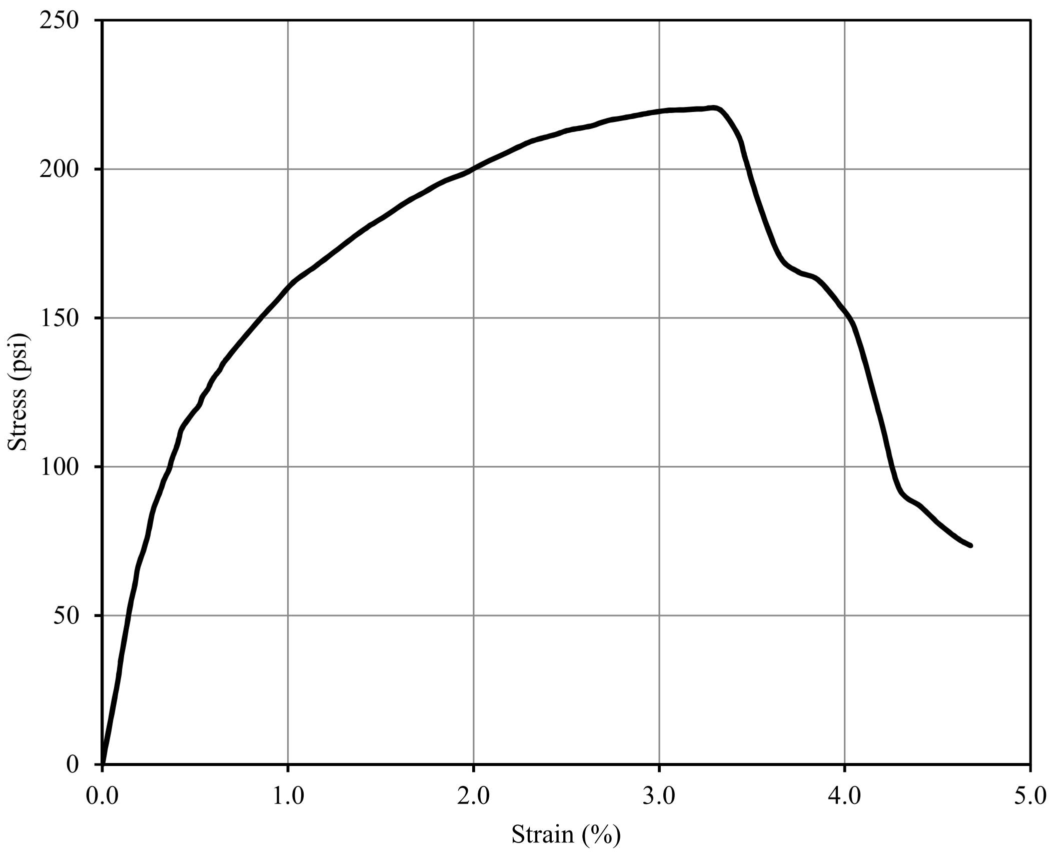
Test Result					
Peak deviator stress (w/ Height correction)	1,037	psi	Strain at failure, εf :	1.79	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
		Specimen Information		
I.D.:	T-23-A	Initial Height:	3.784	in
Test Date:	2017-11-19	Initial Diameter:	2.046	in
Strain Rate:	1 %/min	Initial Area:	3.288	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	349.6	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	107	pcf



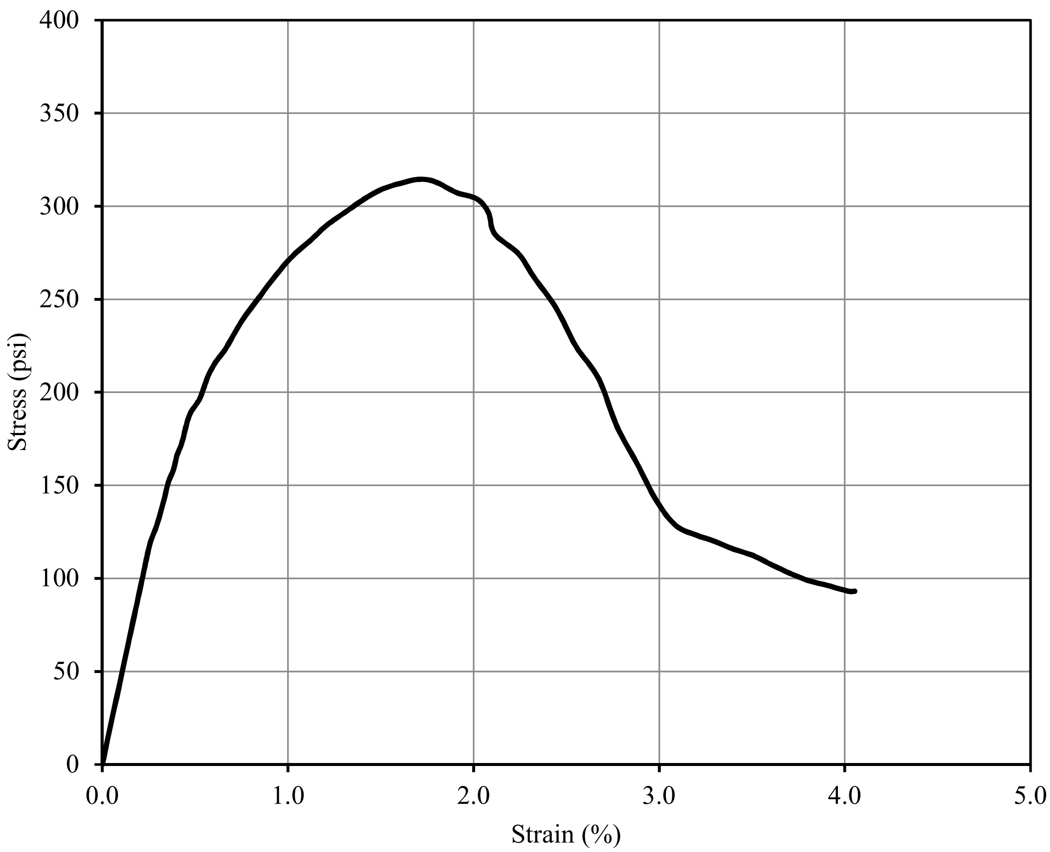
Test Result					
Peak deviator stress (w/ Height correction)	197	psi	Strain at failure, εf :	2.34	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-23-H	**Specimen Information**		
Test Date:	2017-11-19	Initial Height:	3.808	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	349.8	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	106	pcf



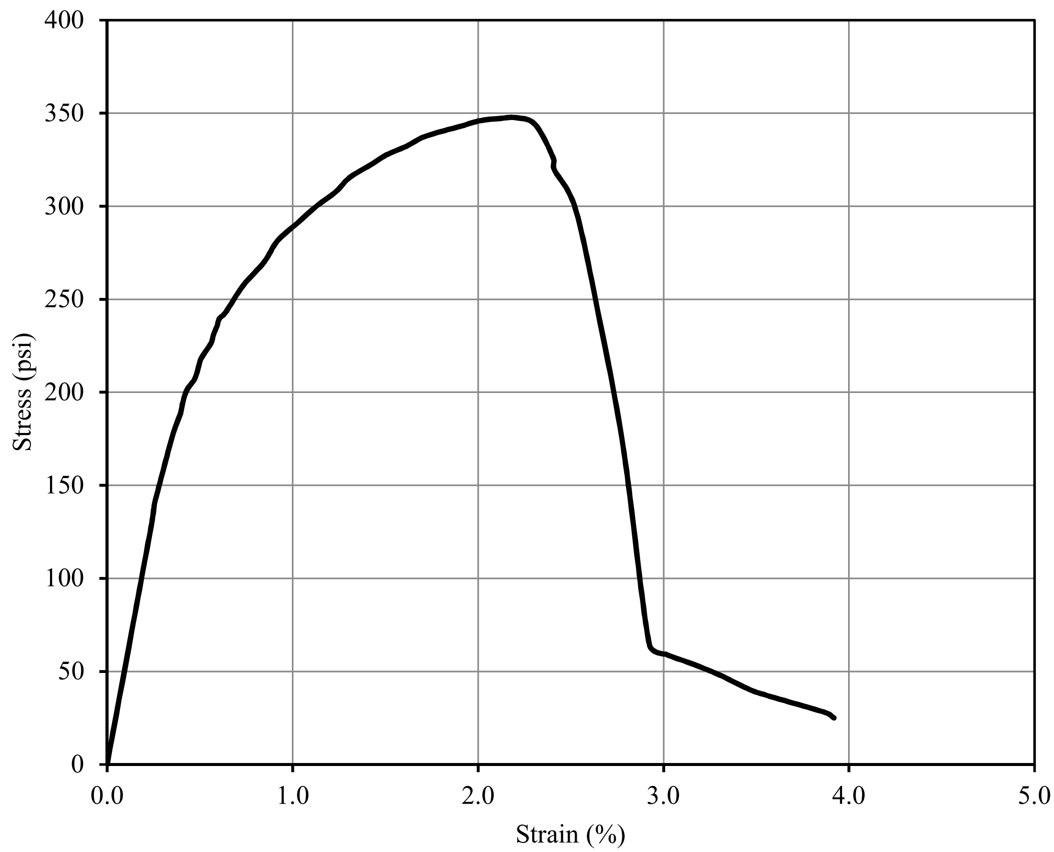
Test Result					
Peak deviator stress (w/ Height correction)	218	psi	Strain at failure, εf :	3.23	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-23-B	**Specimen Information**		
Test Date:	2017-11-23	Initial Height:	3.84	in
Strain Rate:	1 %/min	Initial Diameter:	2.049	in
Mixture Proportion		Initial Area:	3.297	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	355.4	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	107	pcf



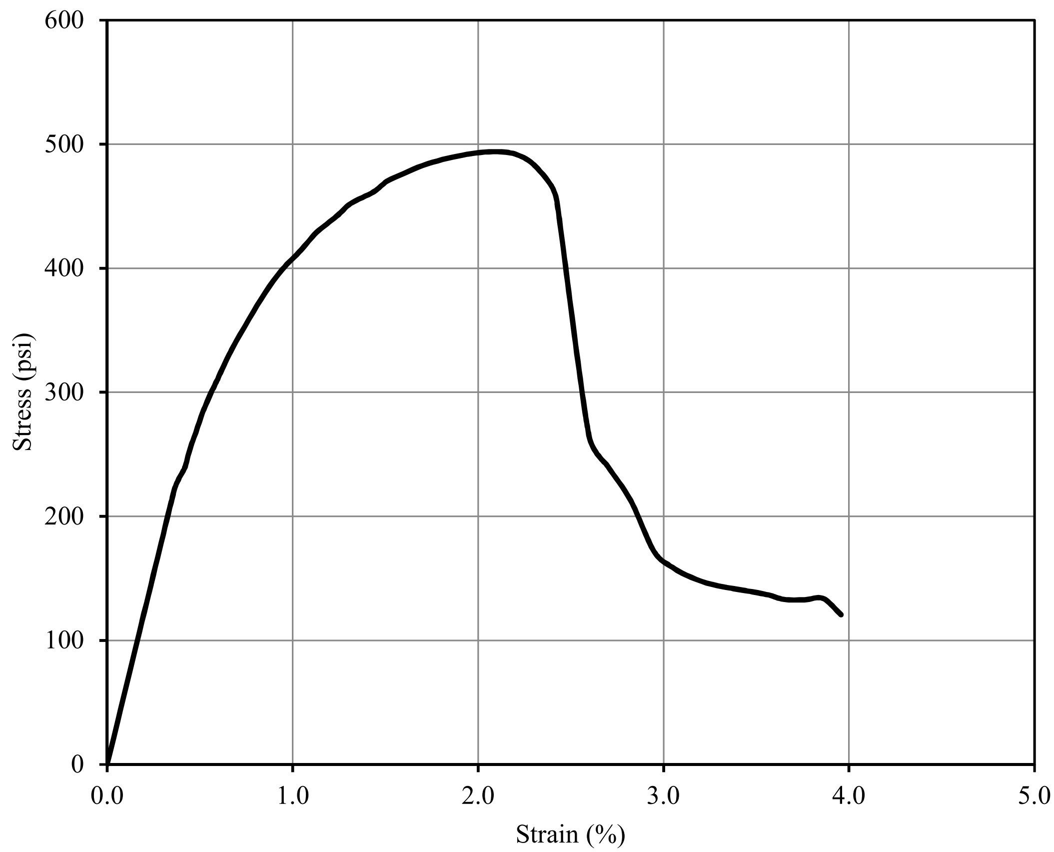
Test Result					
Peak deviator stress (w/ Height correction)	311	psi	Strain at failure, εf :	1.70	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-23-G	**Specimen Information**		
Test Date:	2017-11-23	Initial Height:	3.887	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	359.7	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	107	pcf



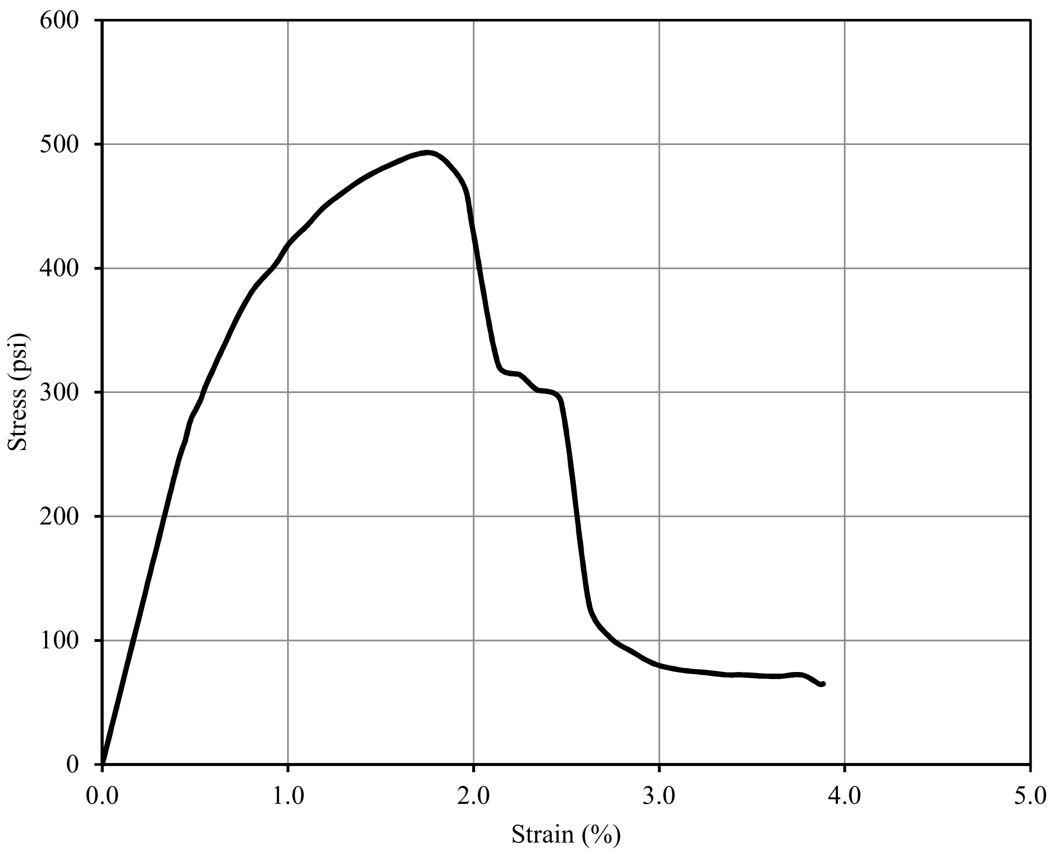
Test Result					
Peak deviator stress (w/ Height correction)	345	psi	Strain at failure, εf :	2.20	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-23-C	**Specimen Information**		
Test Date:	2017-11-30	Initial Height:	3.704	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	352.3	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	110	pcf



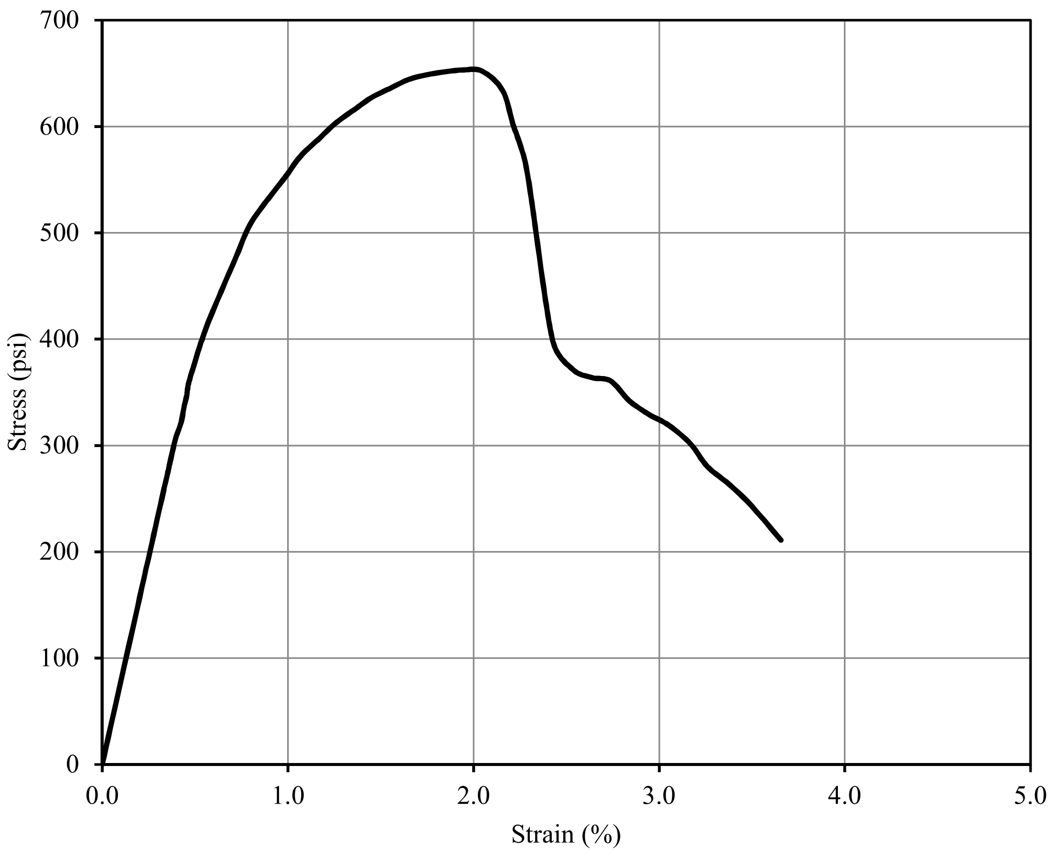
Test Result					
Peak deviator stress (w/ Height correction)	486	psi	Strain at failure, εf :	2.10	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-23-F	**Specimen Information**		
Test Date:	2017-11-30	Initial Height:	3.849	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	355.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	108	pcf



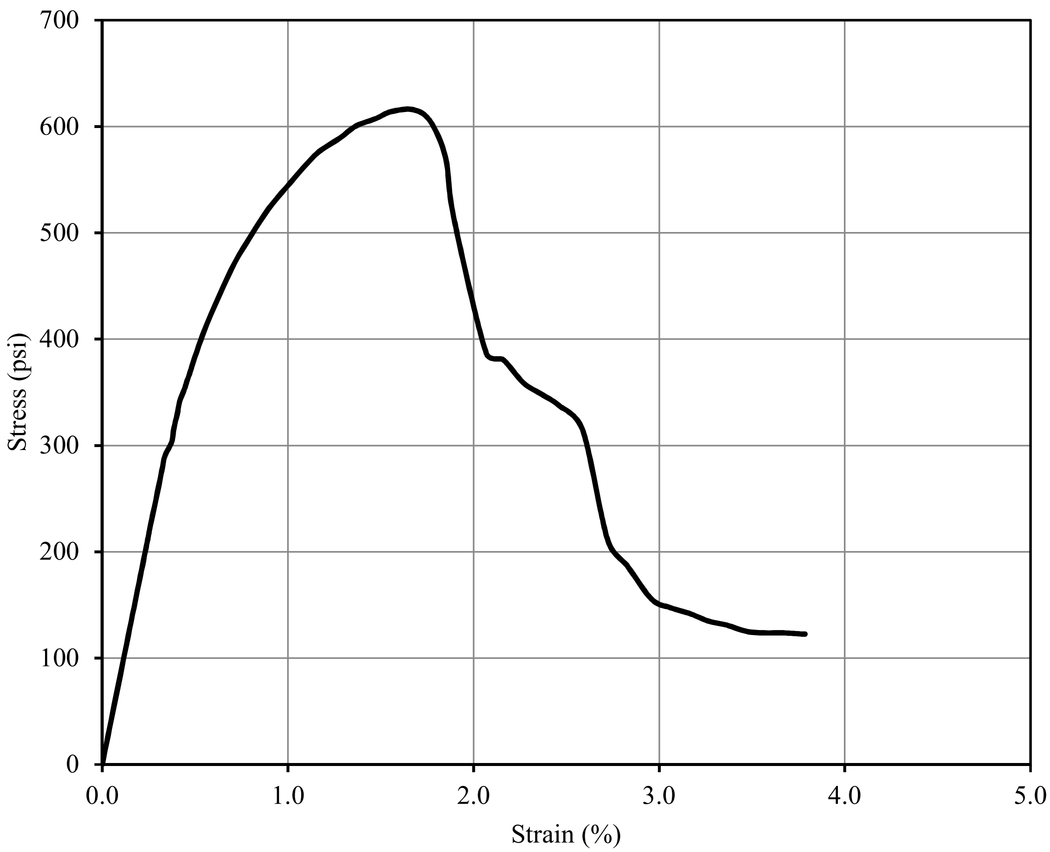
Test Result					
Peak deviator stress (w/ Height correction)	488	psi	Strain at failure, εf :	1.78	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-23-D	**Specimen Information**		
Test Date:	2017-12-14	Initial Height:	3.711	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	344.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	108	pcf



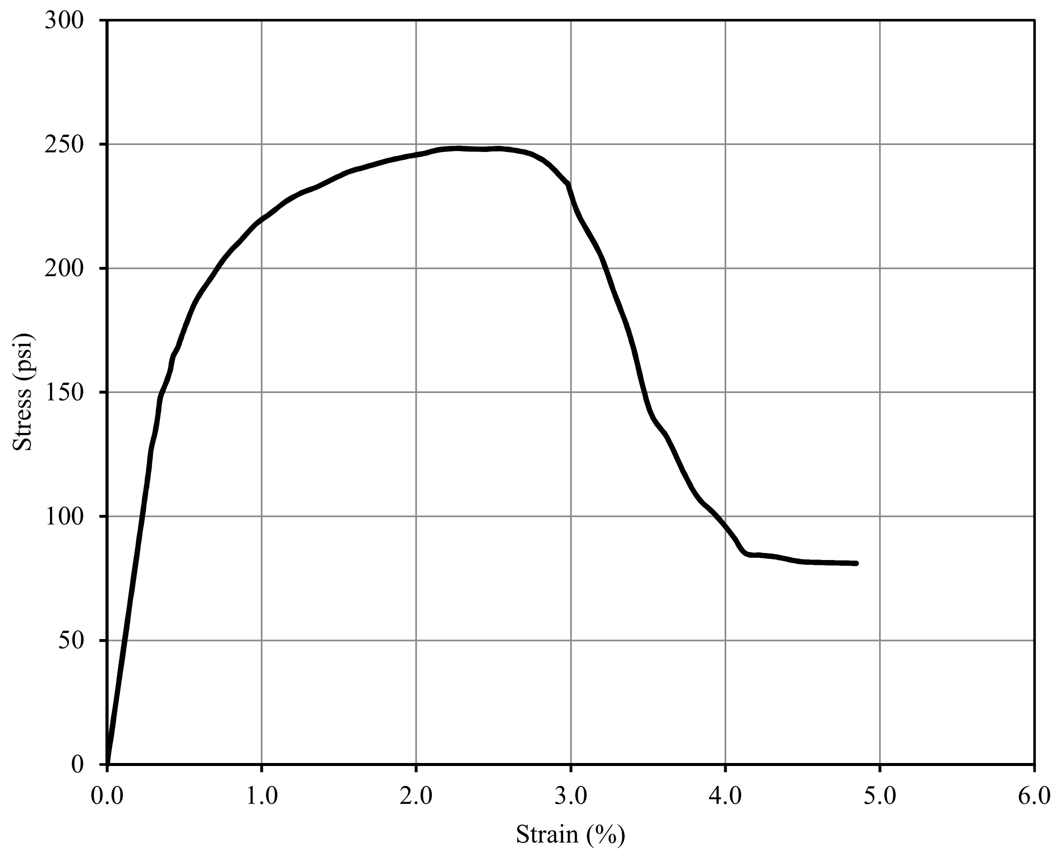
Test Result					
Peak deviator stress (w/ Height correction)	644	psi	Strain at failure, εf :	1.95	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-23-E	**Specimen Information**		
Test Date:	2017-12-14	Initial Height:	3.818	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	353.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	107	pcf



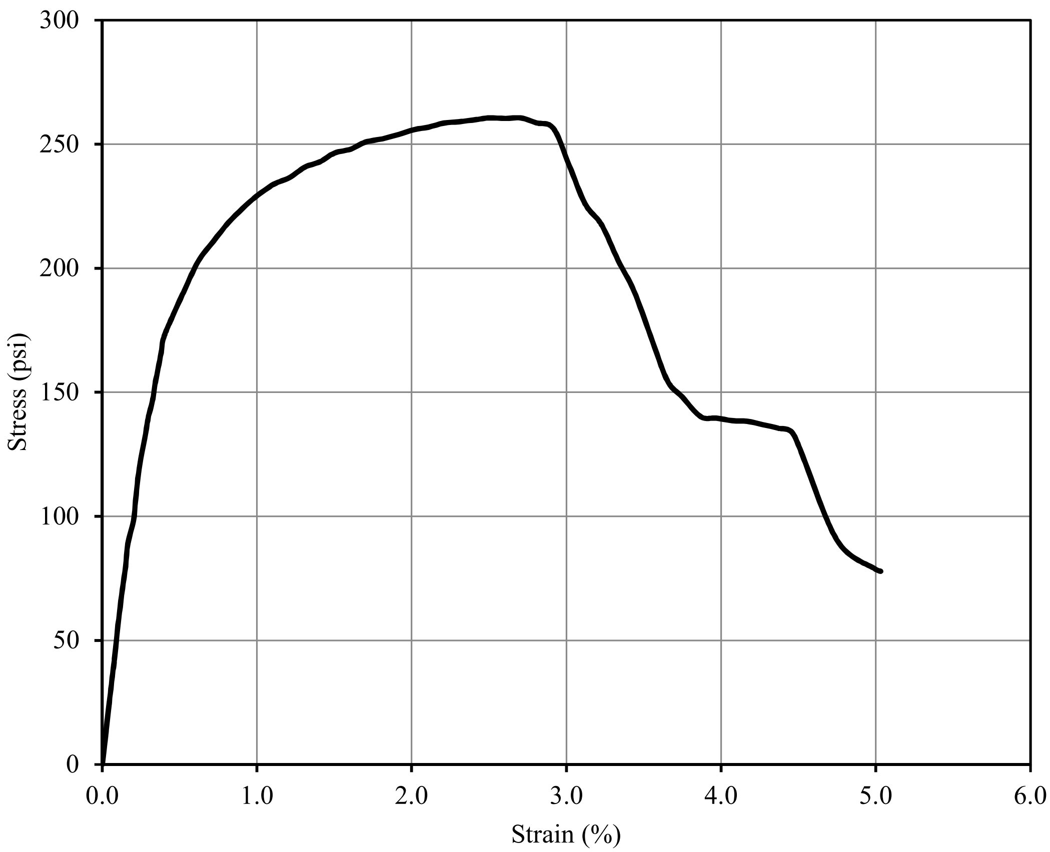
Test Result					
Peak deviator stress (w/ Height correction)	609	psi	Strain at failure, εf :	1.68	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-A	**Specimen Information**		
Test Date:	2018-03-21	Initial Height:	3.883	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	340.0	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	101	pcf



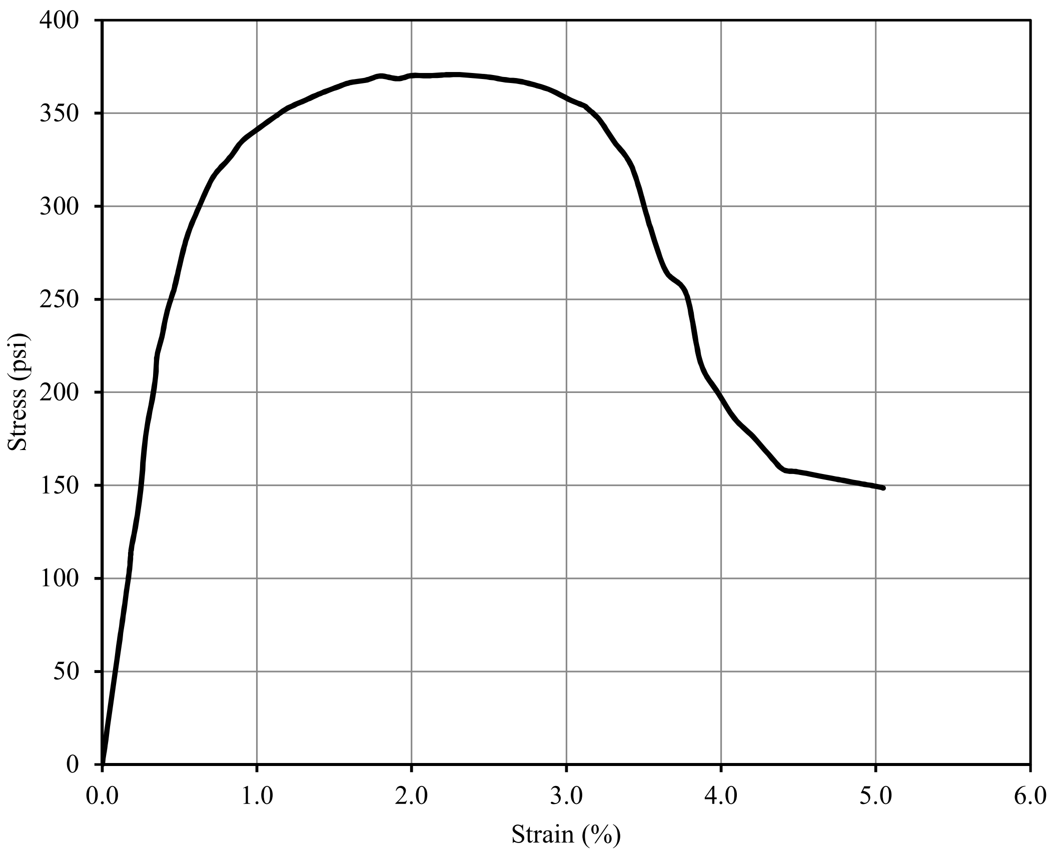
Test Result					
Peak deviator stress (w/ Height correction)	246	psi	Strain at failure, εf :	2.25	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-H	**Specimen Information**		
Test Date:	2018-03-21	Initial Height:	3.836	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	332.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	101	pcf



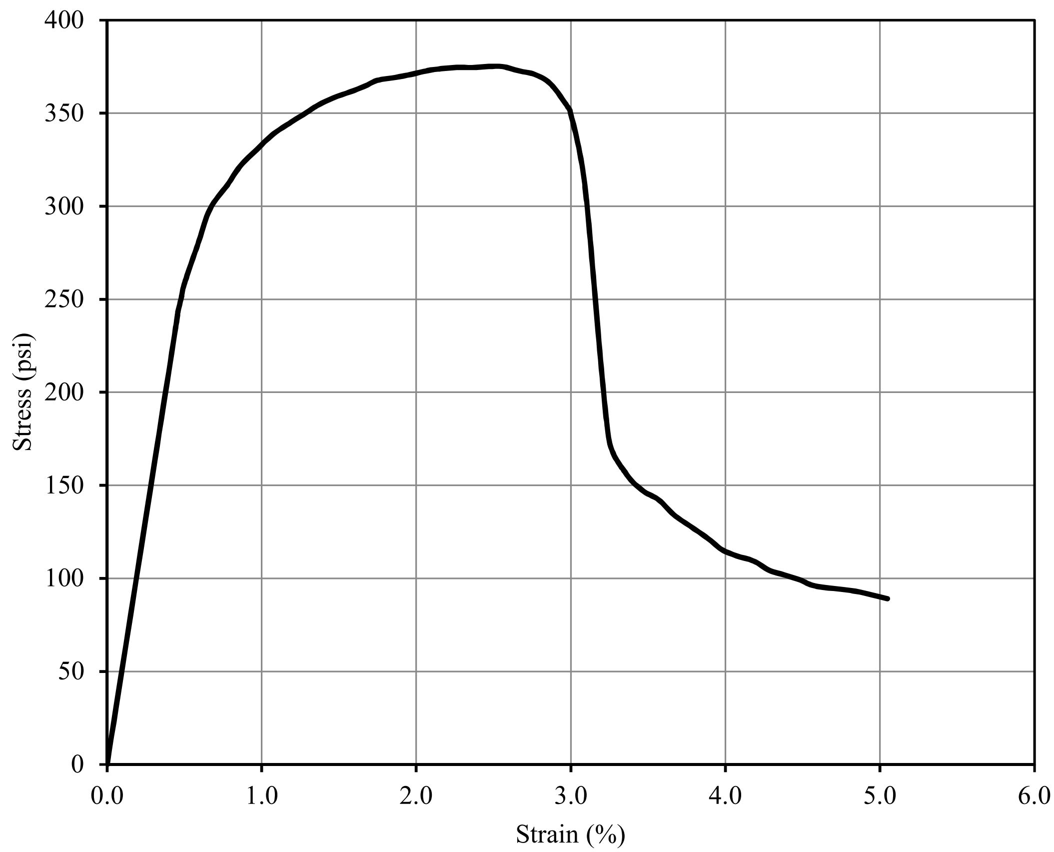
Test Result					
Peak deviator stress (w/ Height correction)	258	psi	Strain at failure, εf :	2.50	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-B	**Specimen Information**		
Test Date:	2018-03-25	Initial Height:	3.907	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	327.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



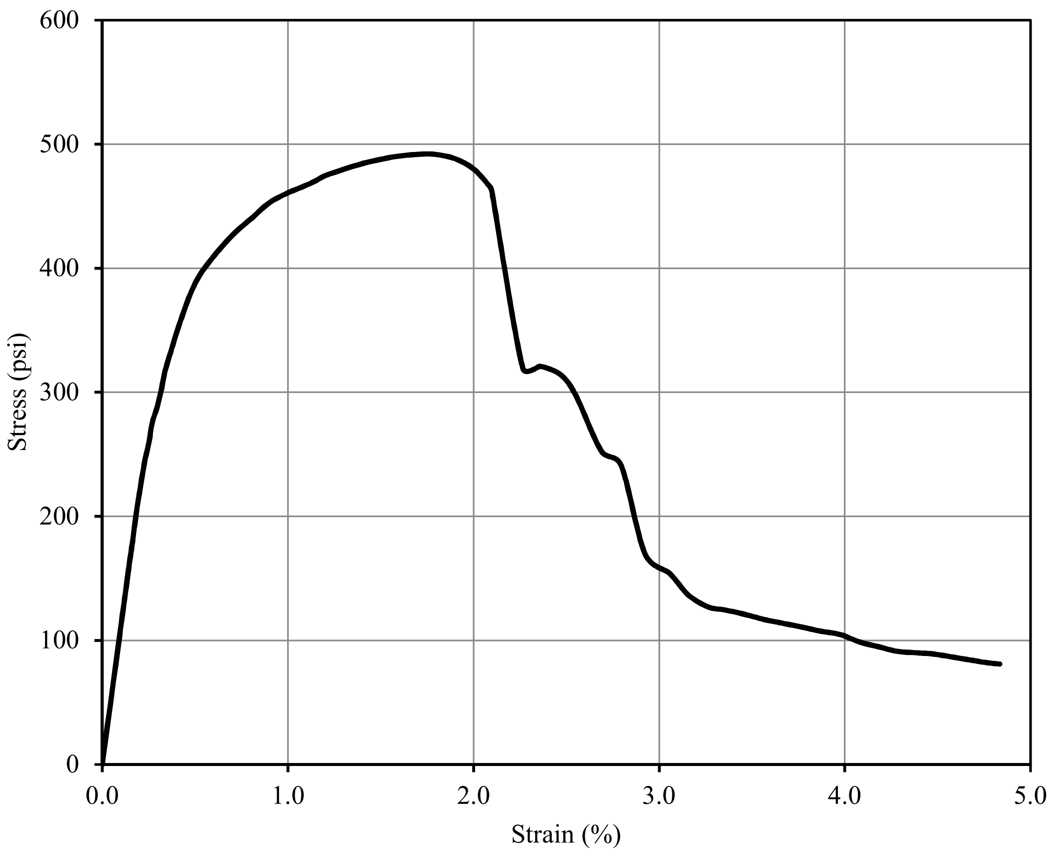
Test Result					
Peak deviator stress (w/ Height correction)	368	psi	Strain at failure, εf :	2.31	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-G	**Specimen Information**		
Test Date:	2018-03-25	Initial Height:	3.938	in
Strain Rate:	1 %/min	Initial Diameter:	2.047	in
Mixture Proportion		Initial Area:	3.291	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	345.0	g
(w:c)$_{slurry}$:	1.4	Unit Weight:	101	pcf



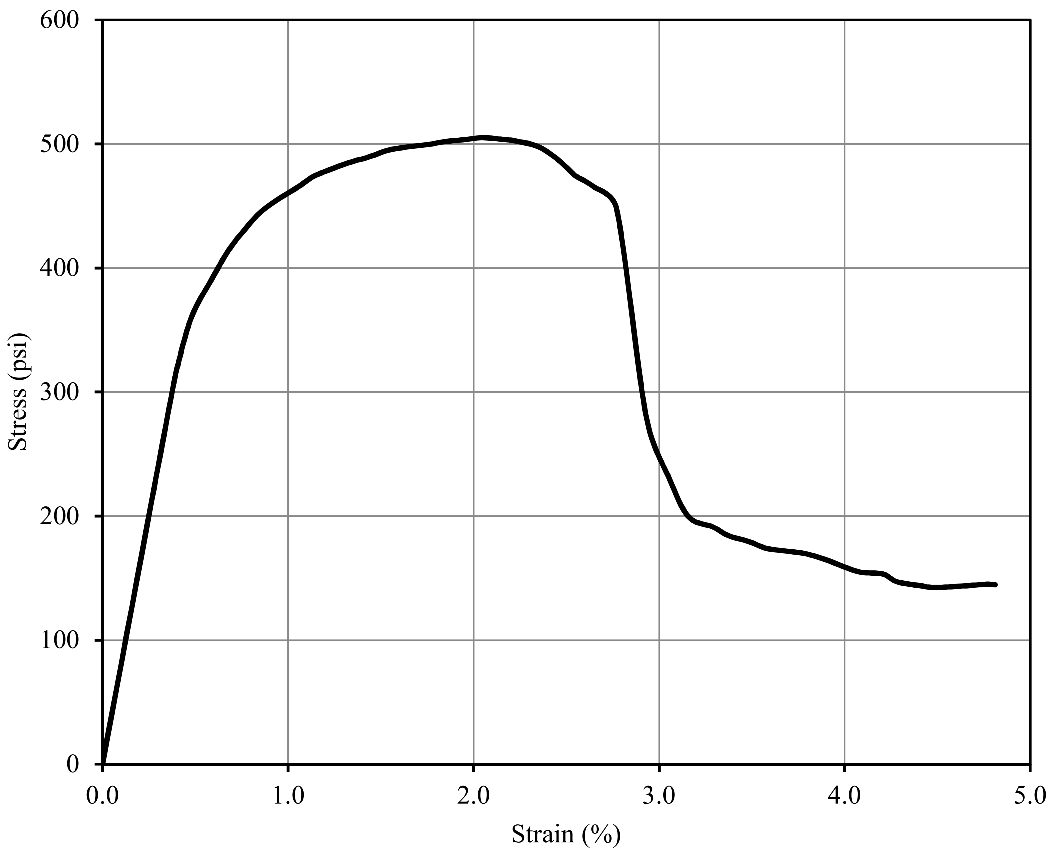
Test Result					
Peak deviator stress (w/ Height correction)	373	psi	Strain at failure, εf :	2.47	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-C	**Specimen Information**		
Test Date:	2018-04-01	Initial Height:	3.868	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	338.4	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	101	pcf



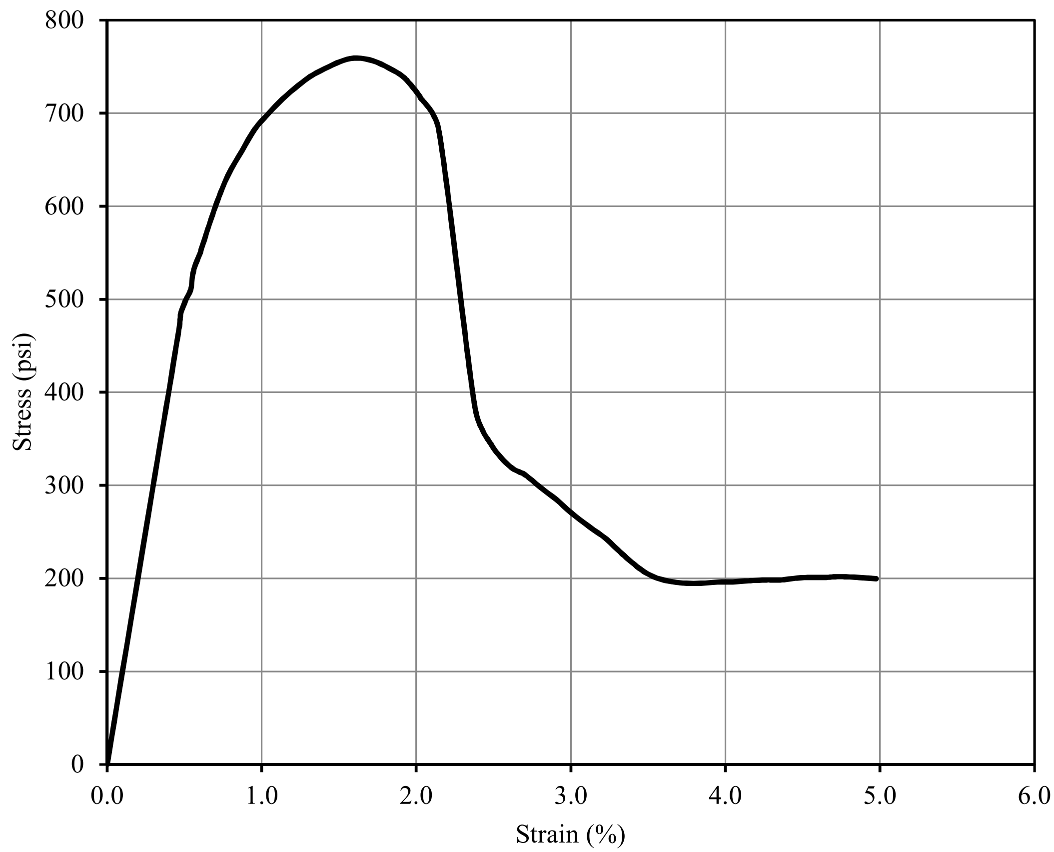
Test Result					
Peak deviator stress (w/ Height correction)	488	psi	Strain at failure, εf :	1.79	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-F	**Specimen Information**		
Test Date:	2018-04-01	Initial Height:	3.891	in
Strain Rate:	1 %/min	Initial Diameter:	2.048	in
Mixture Proportion		Initial Area:	3.294	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	341.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	102	pcf



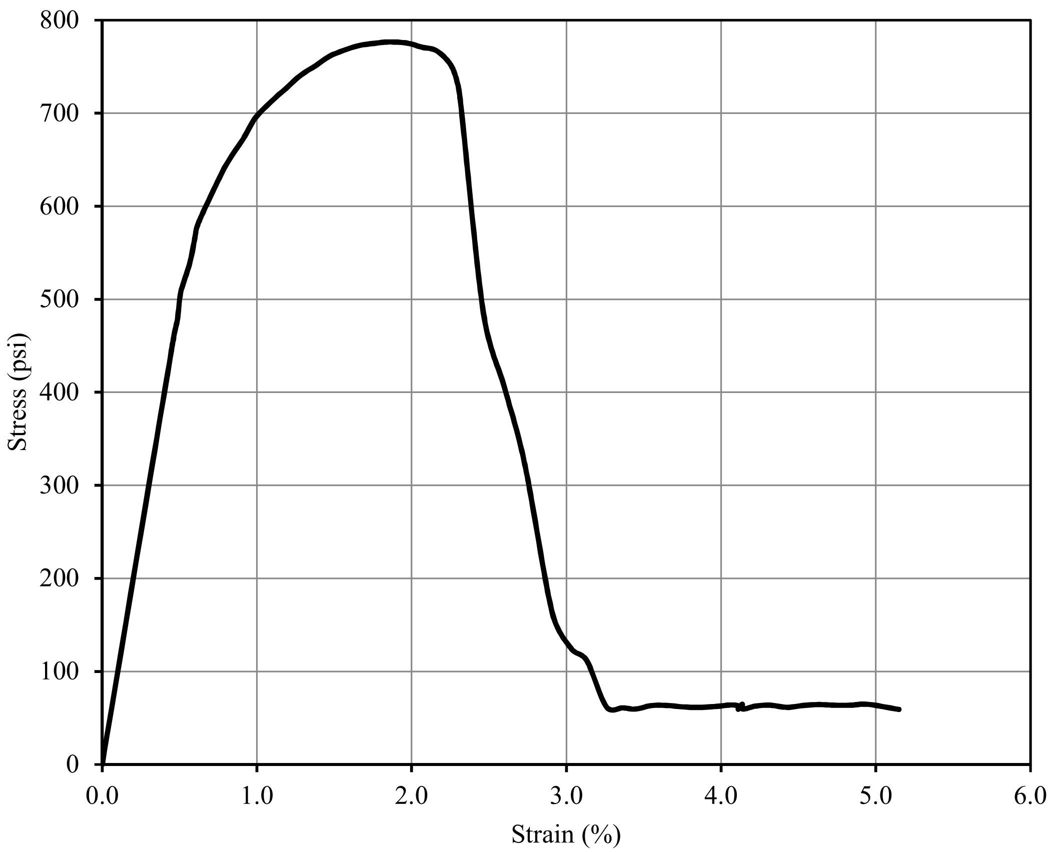
Test Result					
Peak deviator stress (w/ Height correction)	501	psi	Strain at failure, εf :	2.04	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-D	**Specimen Information**		
Test Date:	2018-04-15	Initial Height:	3.841	in
Strain Rate:	1 %/min	Initial Diameter:	2.05	in
Mixture Proportion		Initial Area:	3.301	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	337.7	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	101	pcf



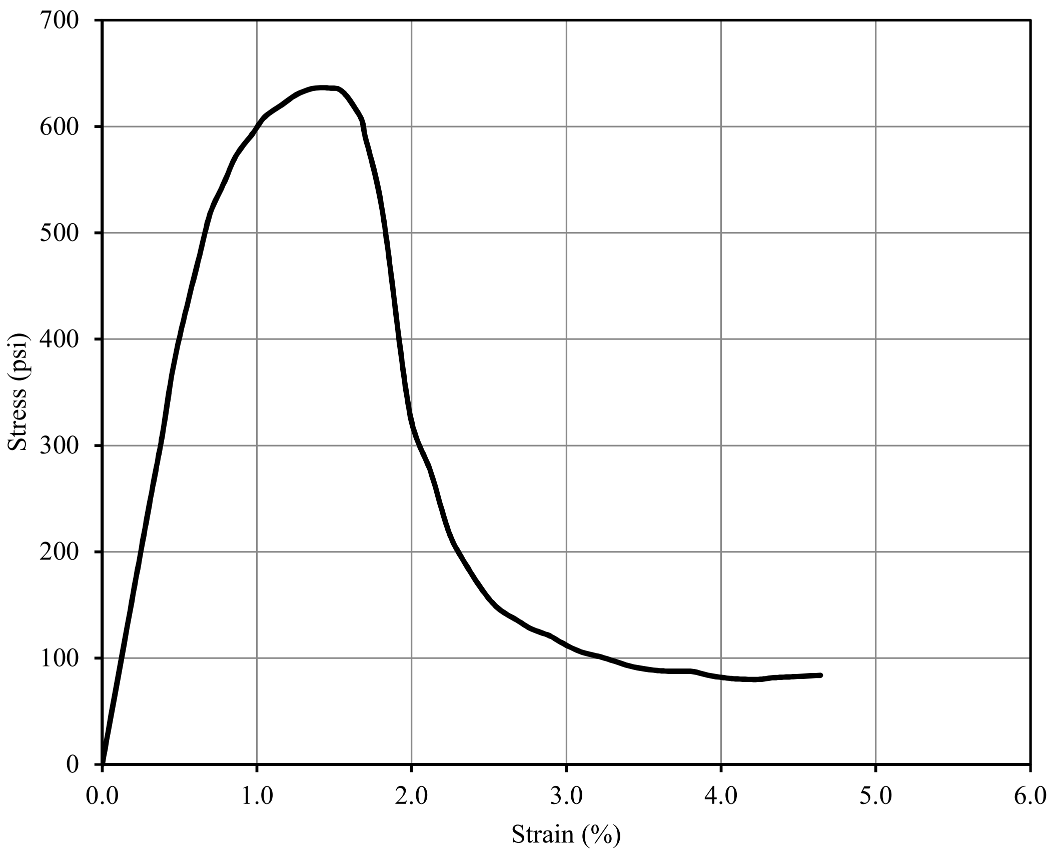
Test Result					
Peak deviator stress (w/ Height correction)	752	psi	Strain at failure, εf :	1.62	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	T-24-E	**Specimen Information**		
Test Date:	2018-04-15	Initial Height:	3.865	in
Strain Rate:	1 %/min	Initial Diameter:	2.045	in
Mixture Proportion		Initial Area:	3.285	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	340.2	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	102	pcf



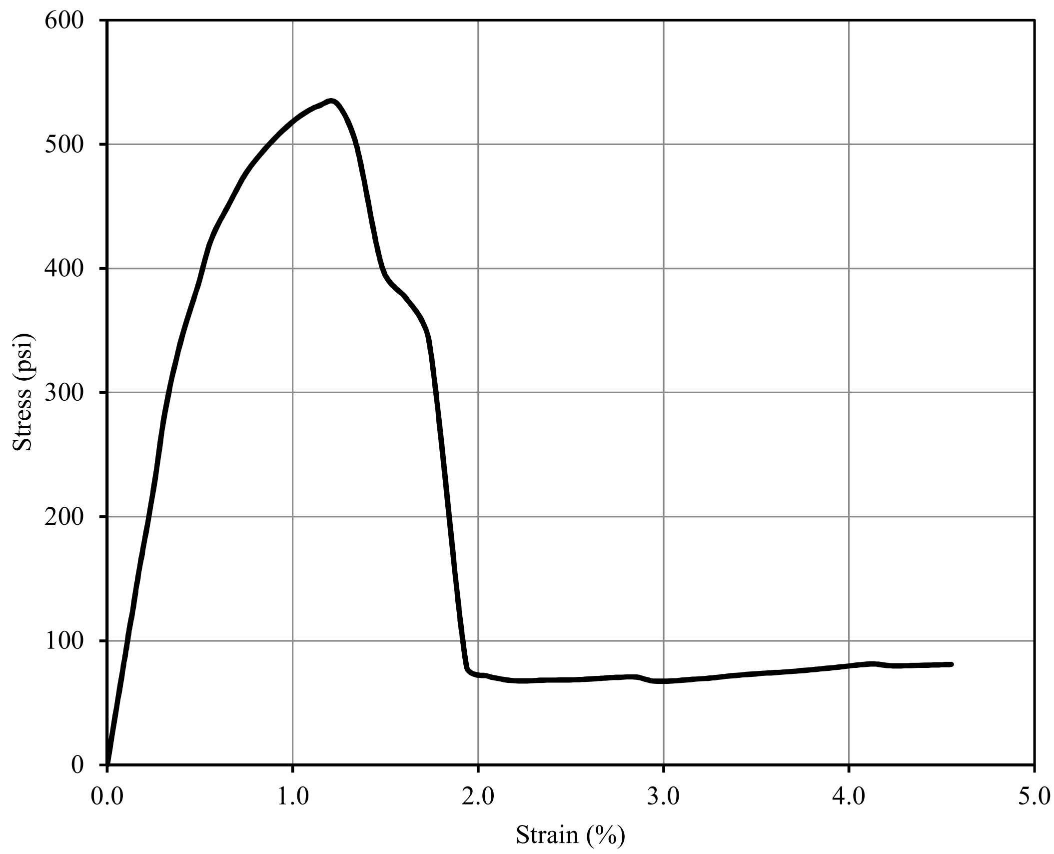
Test Result					
Peak deviator stress (w/ Height correction)	770	psi	Strain at failure, εf :	1.85	%

Test Information		**Curing Condition**		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(7) then 45(21)	°C(days)
I.D.:	D-1-D2	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.94	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	375.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



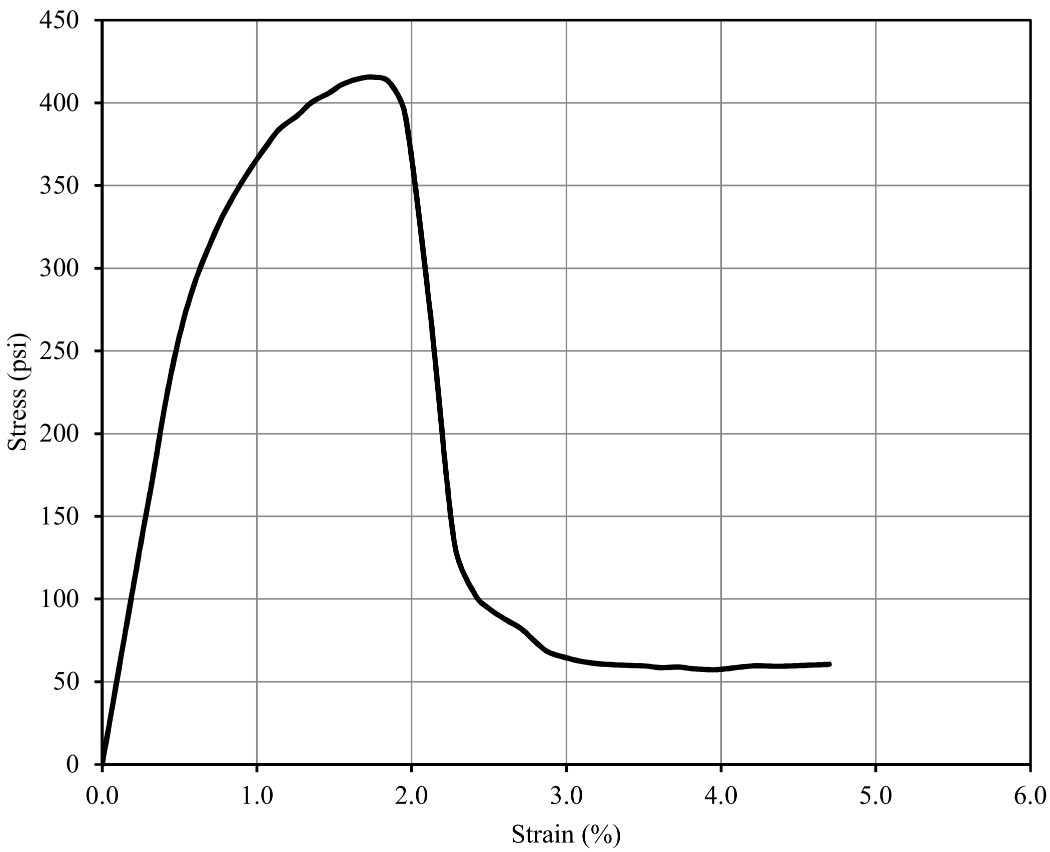
Test Result					
Peak deviator stress (w/ Height correction)	633	psi	Strain at failure, εf :	1.47	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(14) then 45(14)	°C(days)
I.D.:	D-1-C2	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.921	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	373.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



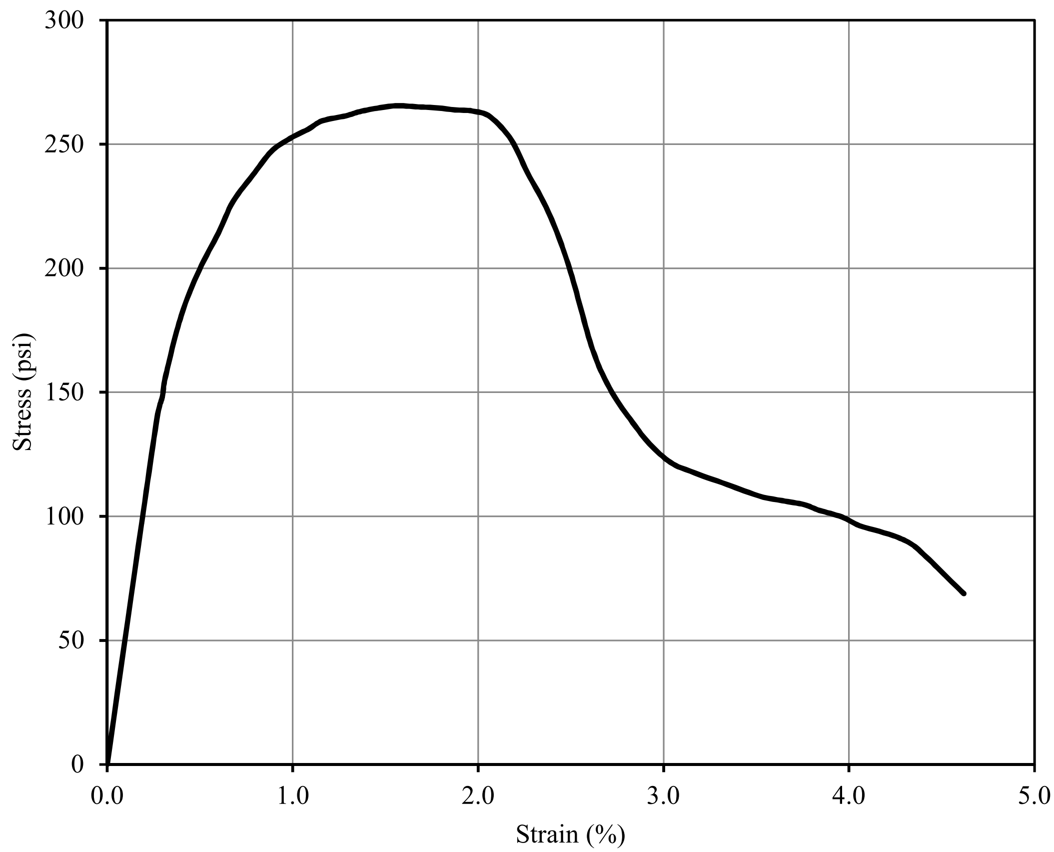
Test Result					
Peak deviator stress (w/ Height correction)	530	psi	Strain at failure, εf :	1.24	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(21) then 45(7)	°C(days)
I.D.:	D-1-B2	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.907	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	371.0	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	111	pcf



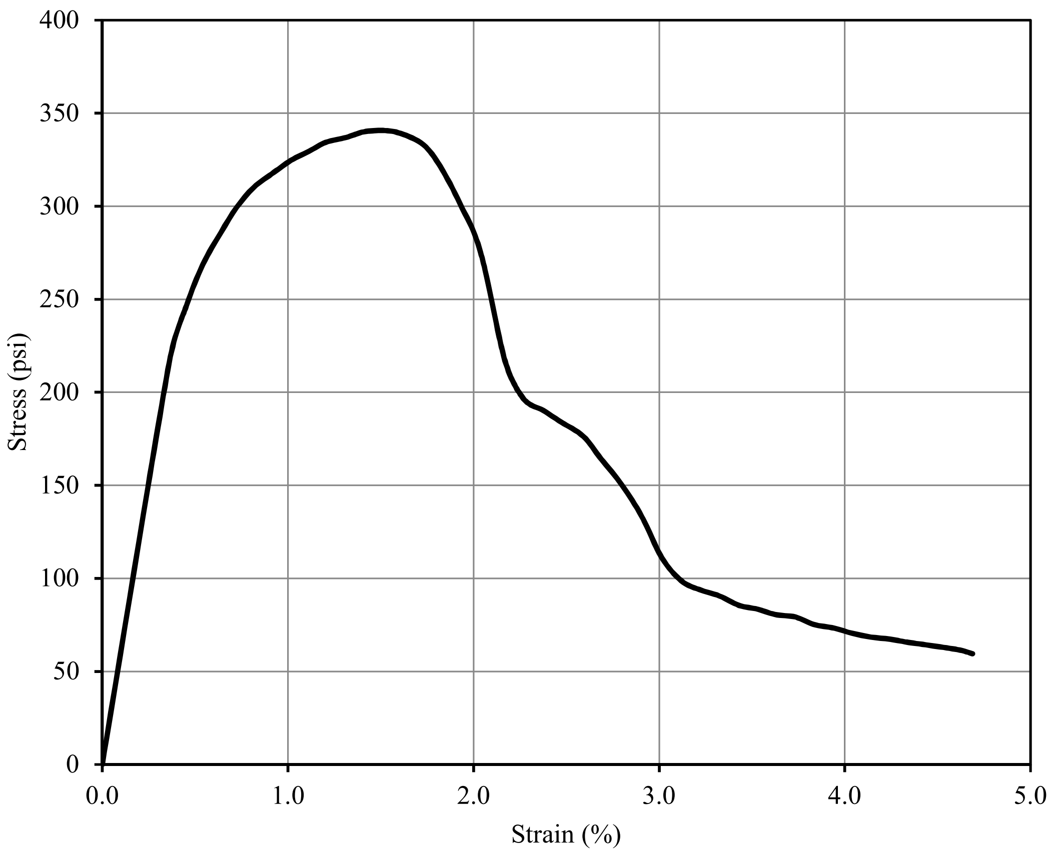
Test Result					
Peak deviator stress (w/ Height correction)	413	psi	Strain at failure, εf :	1.75	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	25(28)	°C(days)
I.D.:	D-1-A	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.804	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	363.4	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	111	pcf



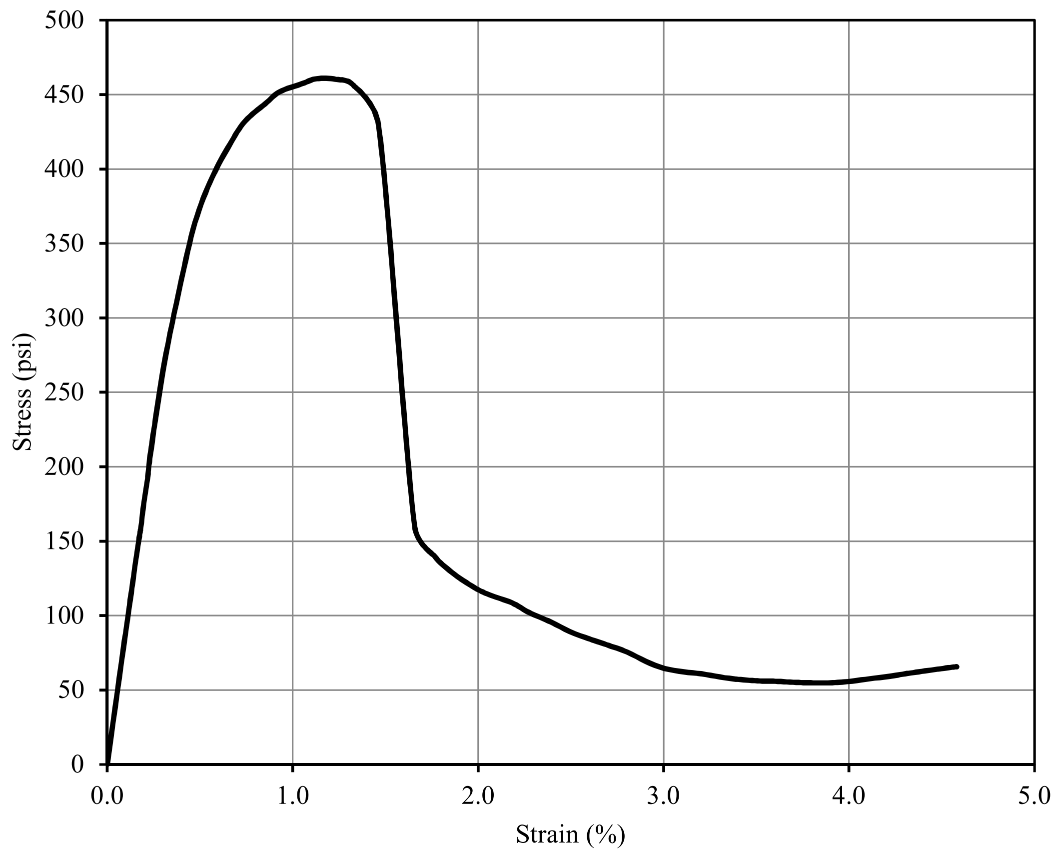
Test Result					
Peak deviator stress (w/ Height correction)	263	psi	Strain at failure, εf :	1.57	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(7) then 25(21)	°C(days)
I.D.:	D-1-B1	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.804	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	363.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



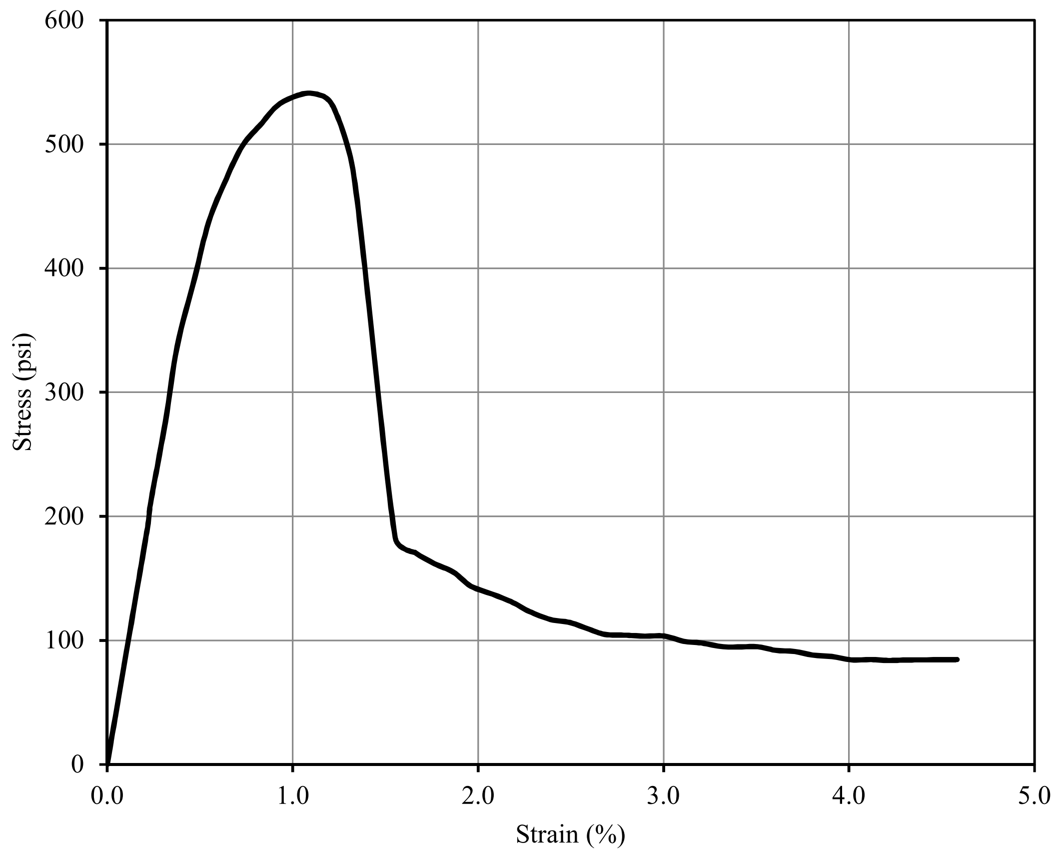
Test Result					
Peak deviator stress (w/ Height correction)	337	psi	Strain at failure, εf :	1.51	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(14) then 25(14)	°C(days)
I.D.:	D-1-C1	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.793	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	363.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



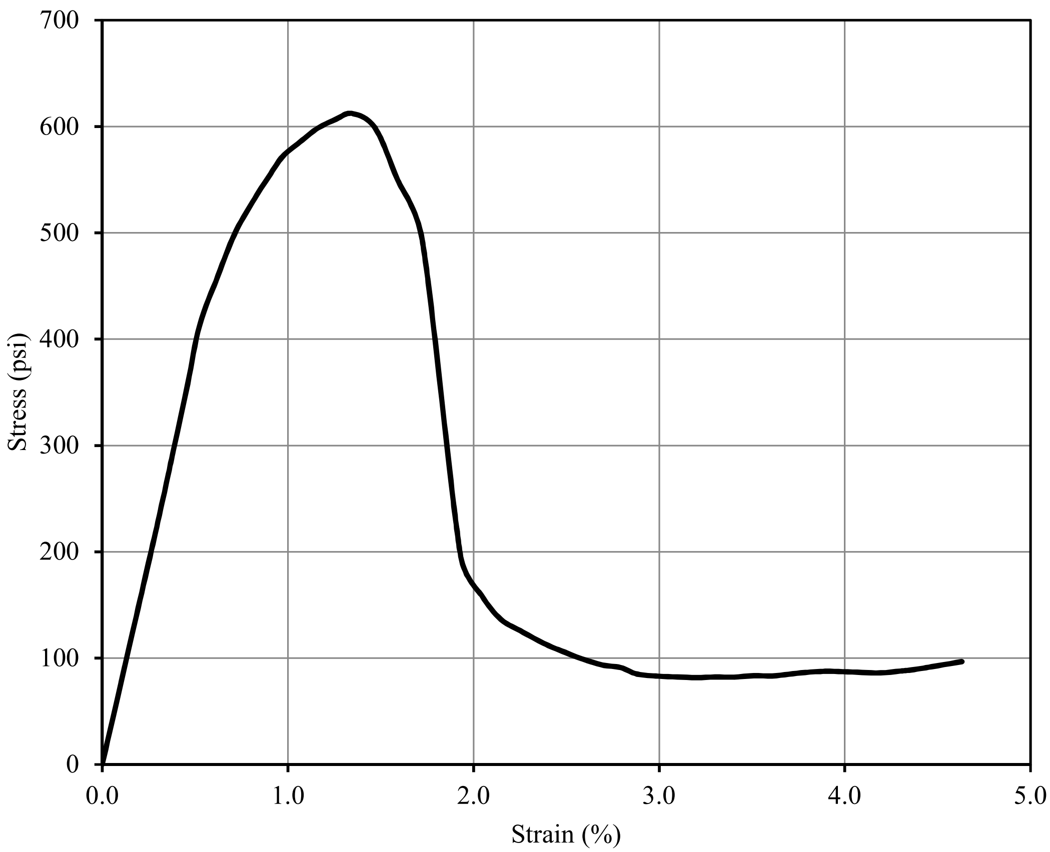
Test Result					
Peak deviator stress (w/ Height correction)	455	psi	Strain at failure, εf :	1.13	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(21) then 25(7)	°C(days)
I.D.:	D-1-D1	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.942	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	377.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



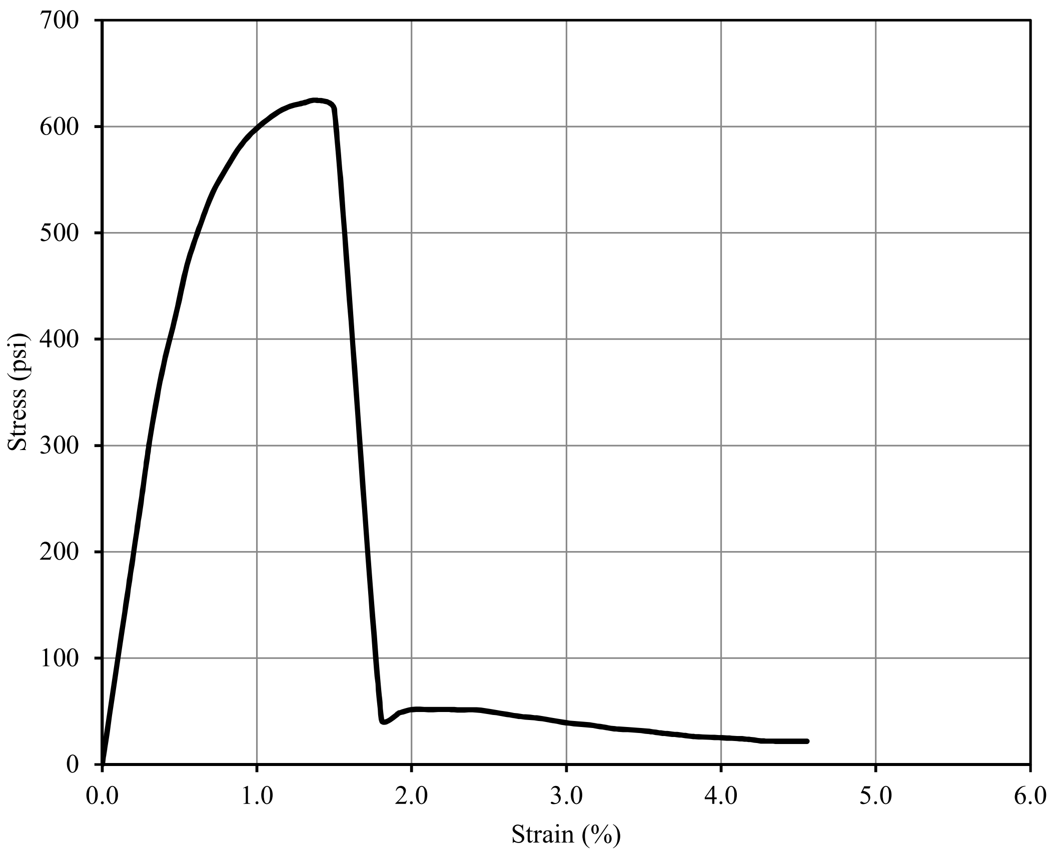
Test Result					
Peak deviator stress (w/ Height correction)	538	psi	Strain at failure, εf :	1.11	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(28)	°C(days)
I.D.:	D-1-E	**Specimen Information**		
Test Date:	2018-03-14	Initial Height:	3.951	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	376.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



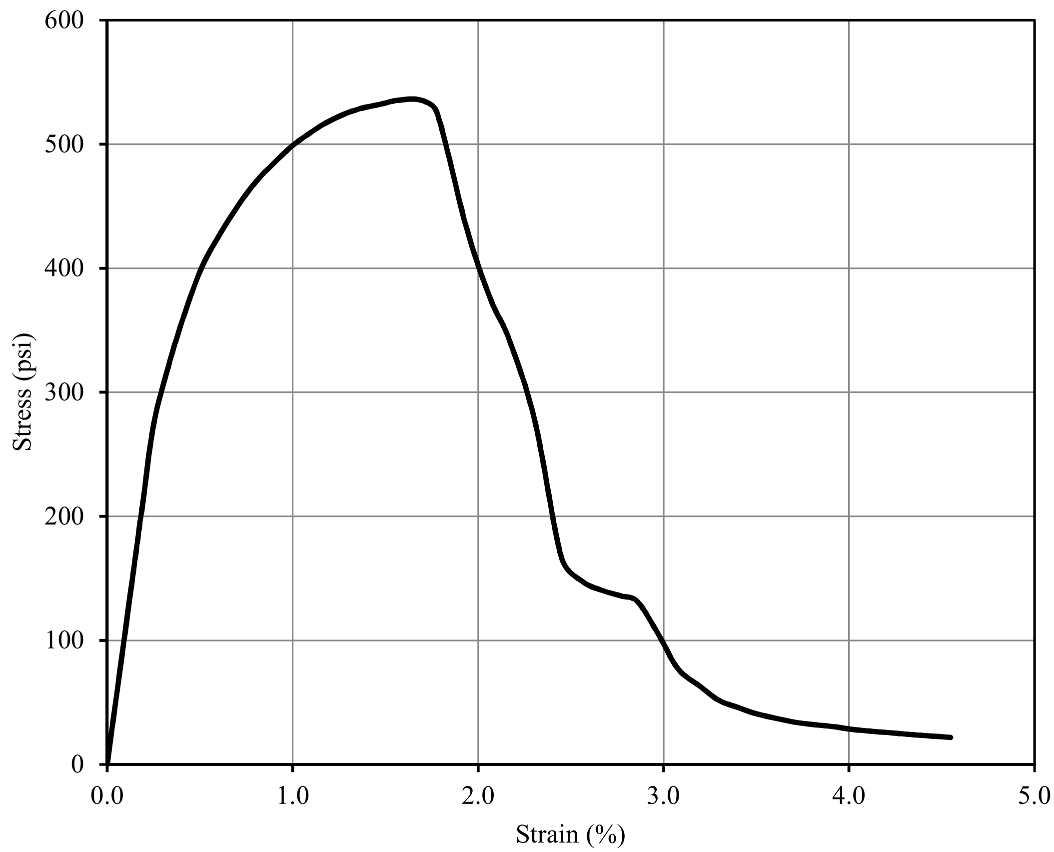
Test Result					
Peak deviator stress (w/ Height correction)	609	psi	Strain at failure, εf :	1.35	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	25(7) then 45(21)	°C(days)
I.D.:	D-2-D2	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.905	in
Strain Rate:	1 %/min	Initial Diameter:	2.037	in
Mixture Proportion		Initial Area:	3.259	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	370.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



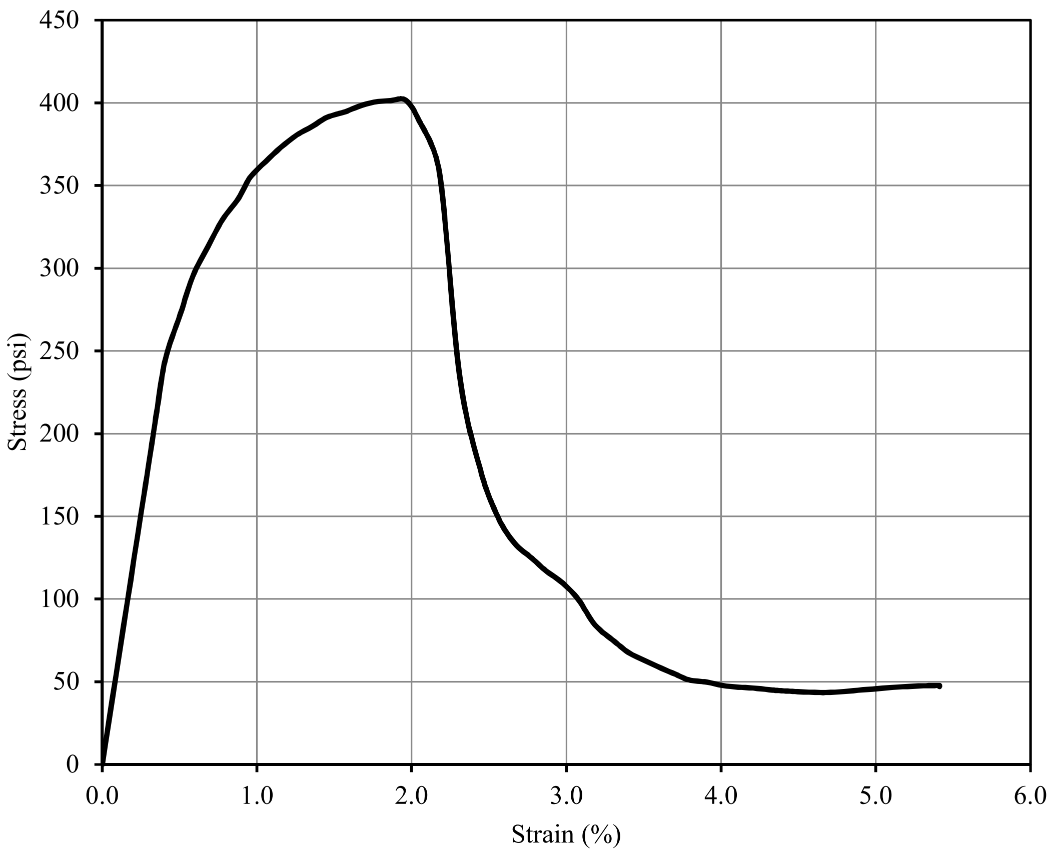
Test Result					
Peak deviator stress (w/ Height correction)	620	psi	Strain at failure, εf :	1.39	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	25(14) then 45(14)	°C(days)
I.D.:	D-2-C2	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.92	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	372.3	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	111	pcf



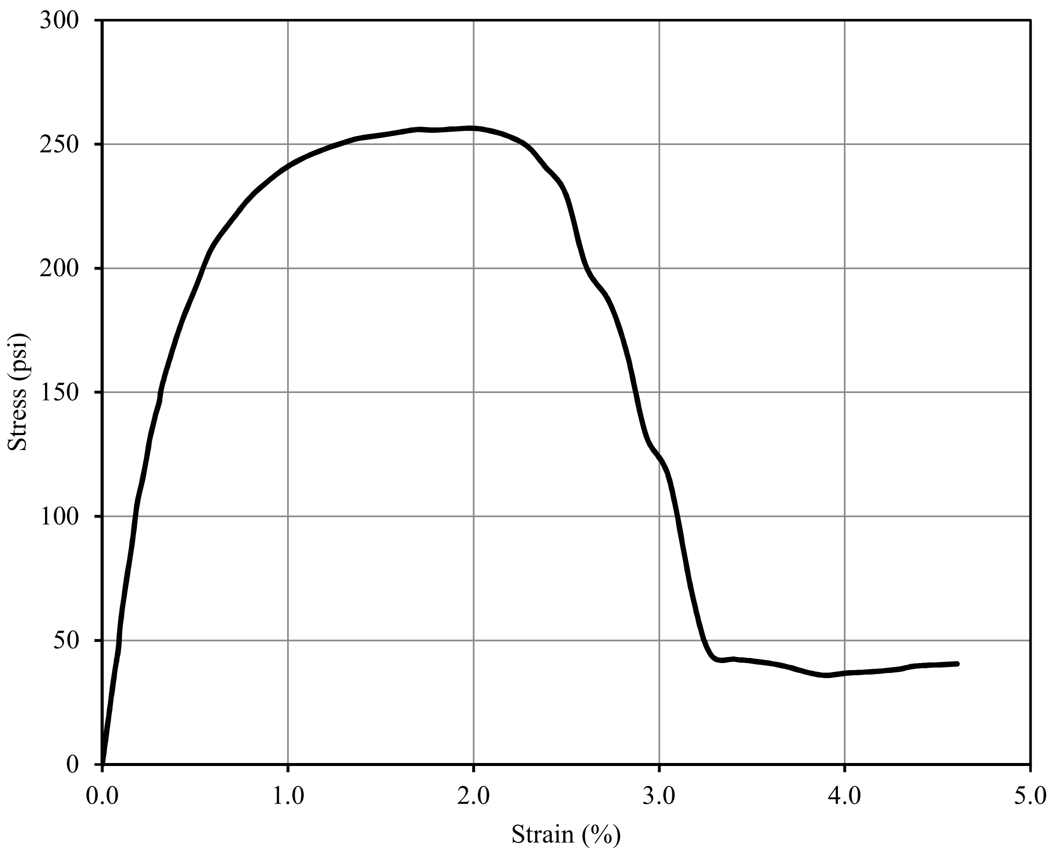
Test Result					
Peak deviator stress (w/ Height correction)	533	psi	Strain at failure, εf :	1.69	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(21) then 45(7)	°C(days)
I.D.:	D-2-B2	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.944	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	374.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



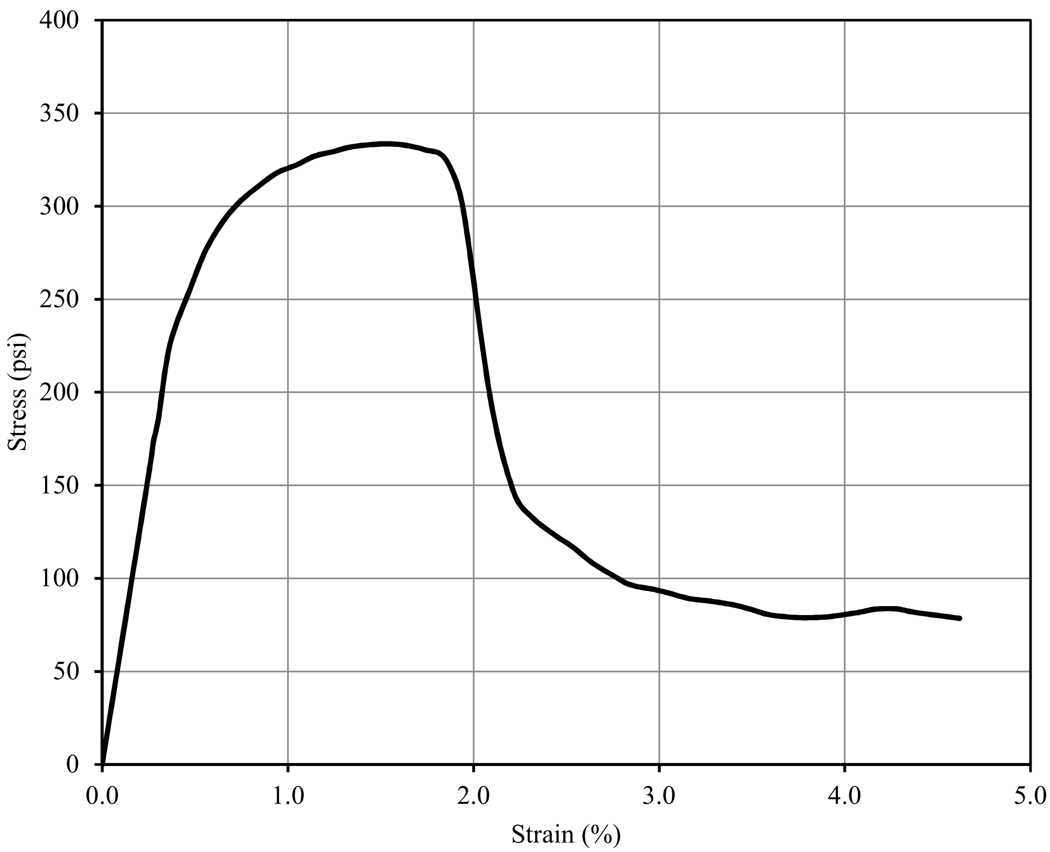
Test Result					
Peak deviator stress (w/ Height correction)	399	psi	Strain at failure, εf :	1.96	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(28)	°C(days)
I.D.:	D-2-A	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.886	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	370.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



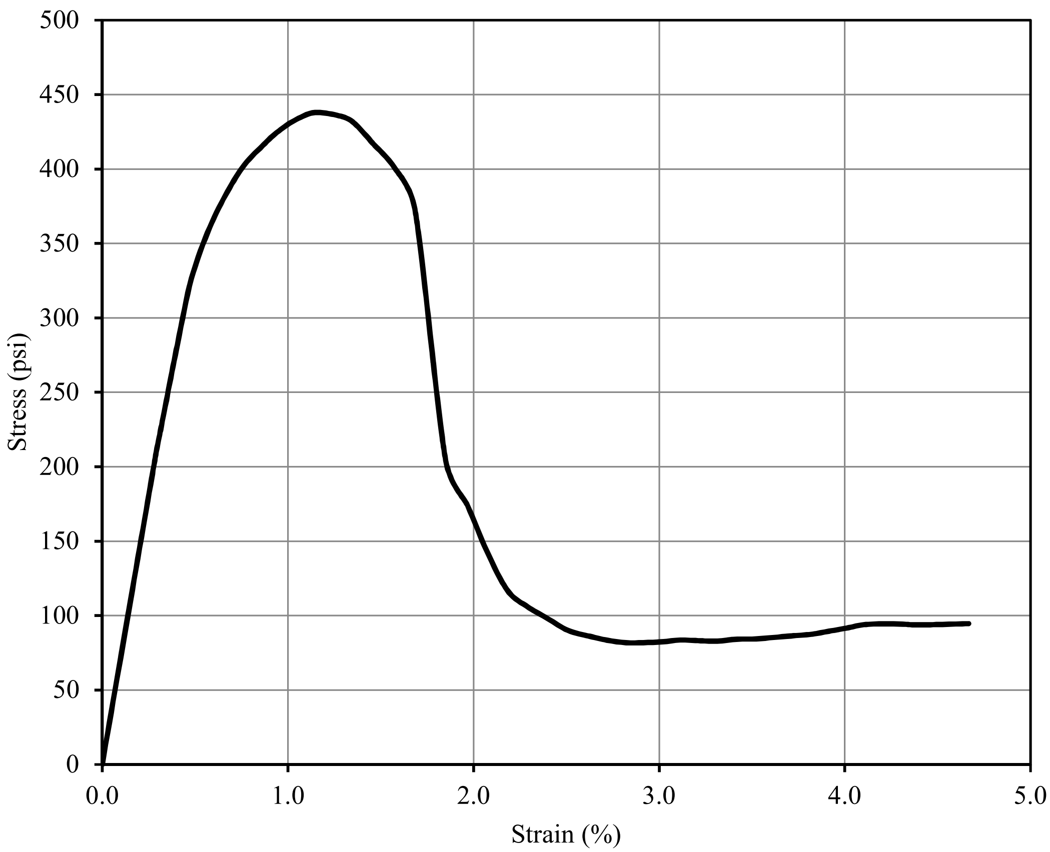
Test Result					
Peak deviator stress (w/ Height correction)	255	psi	Strain at failure, εf :	2.00	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45(7) then 25(21)	°C(days)
I.D.:	D-2-B1	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.869	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	369.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



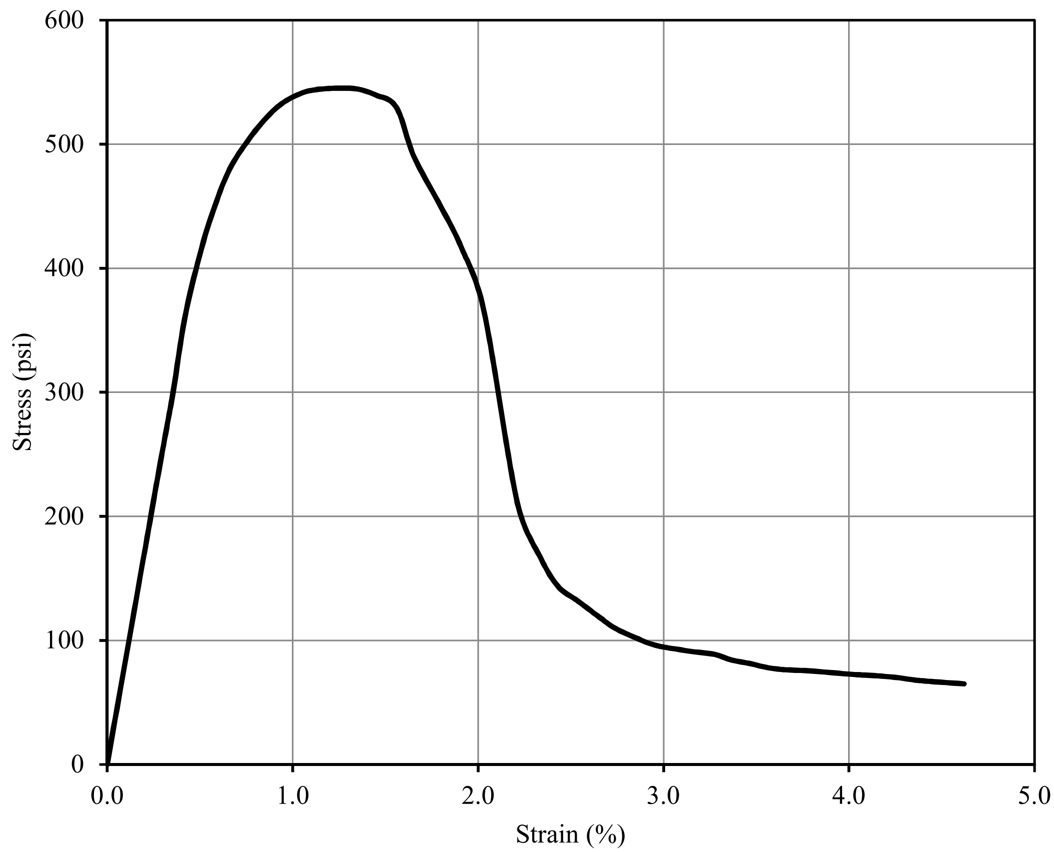
Test Result					
Peak deviator stress (w/ Height correction)	331	psi	Strain at failure, εf :	1.55	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45(14) then 25(14)	°C(days)
I.D.:	D-2-C1	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.917	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	374.0	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	111	pcf



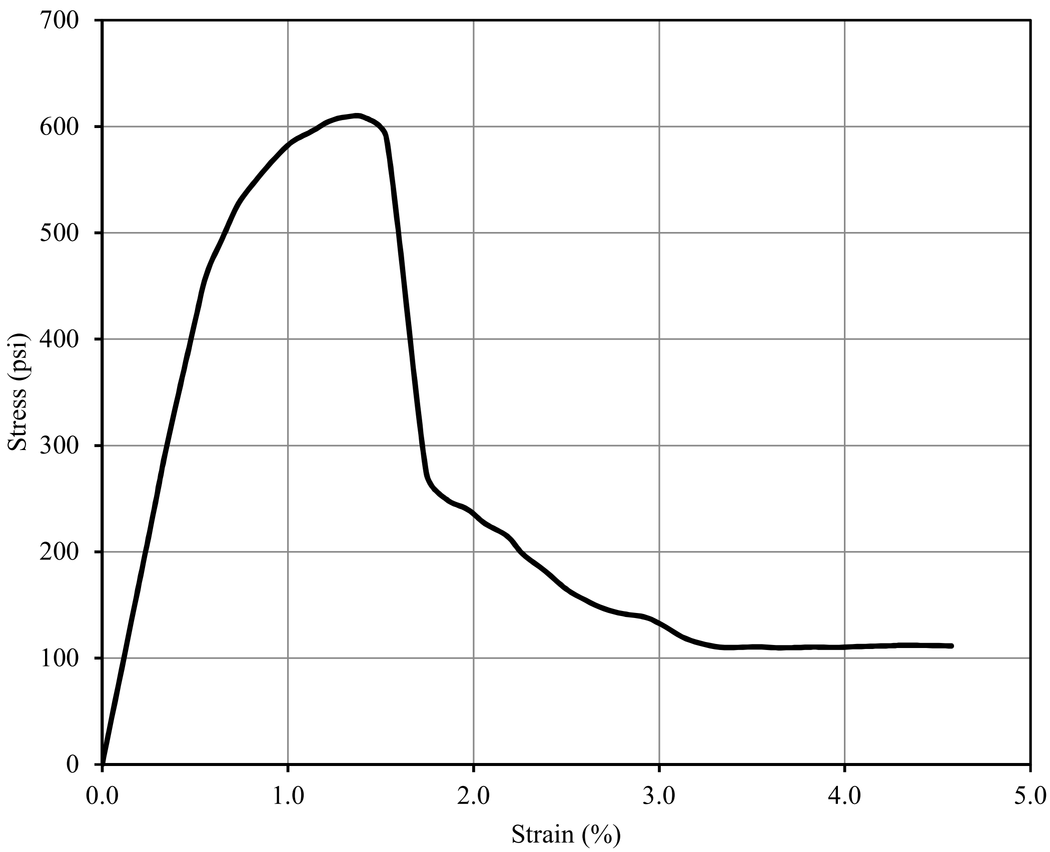
Test Result					
Peak deviator stress (w/ Height correction)	435	psi	Strain at failure, εf :	1.15	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45(21) then 25(7)	°C(days)
I.D.:	D-2-D1	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.819	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	365.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



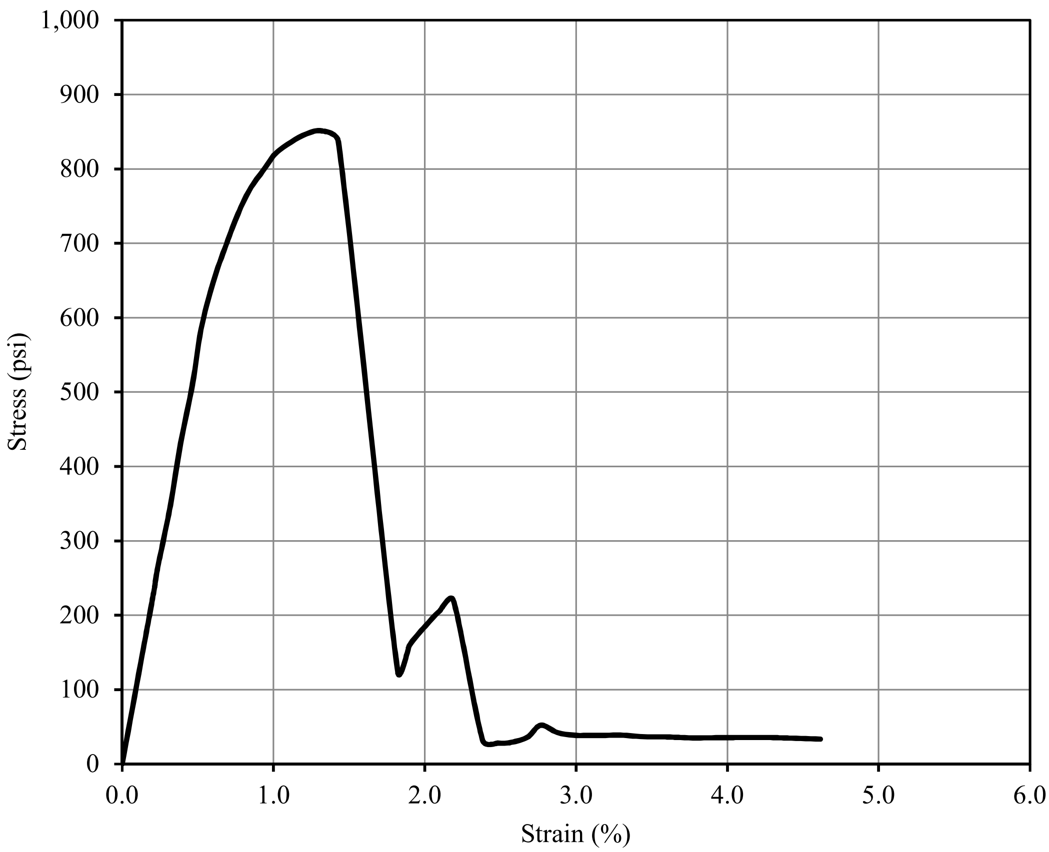
Test Result					
Peak deviator stress (w/ Height correction)	539	psi	Strain at failure, εf :	1.26	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45(28)	°C(days)
I.D.:	D-2-E	**Specimen Information**		
Test Date:	2018-03-15	Initial Height:	3.93	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	373.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	111	pcf



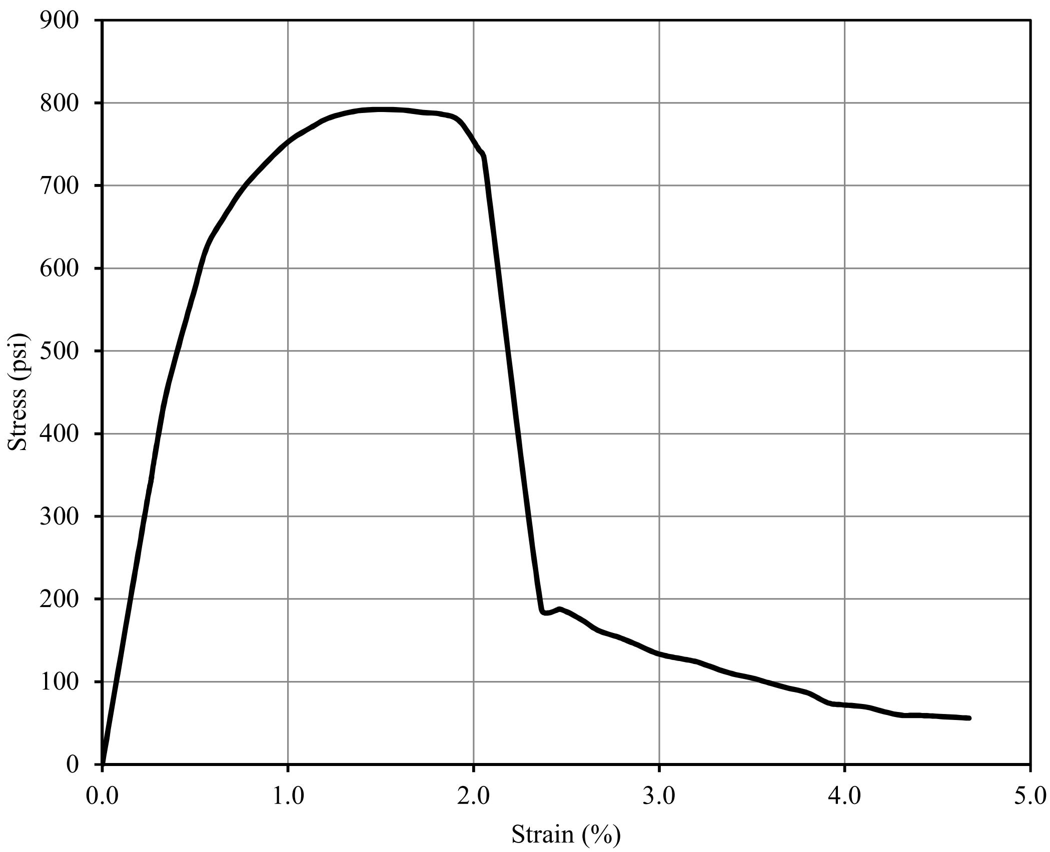
Test Result					
Peak deviator stress (w/ Height correction)	606	psi	Strain at failure, εf :	1.32	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(7) then 45(21)	°C(days)
I.D.:	D-3-D2	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.938	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	366.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



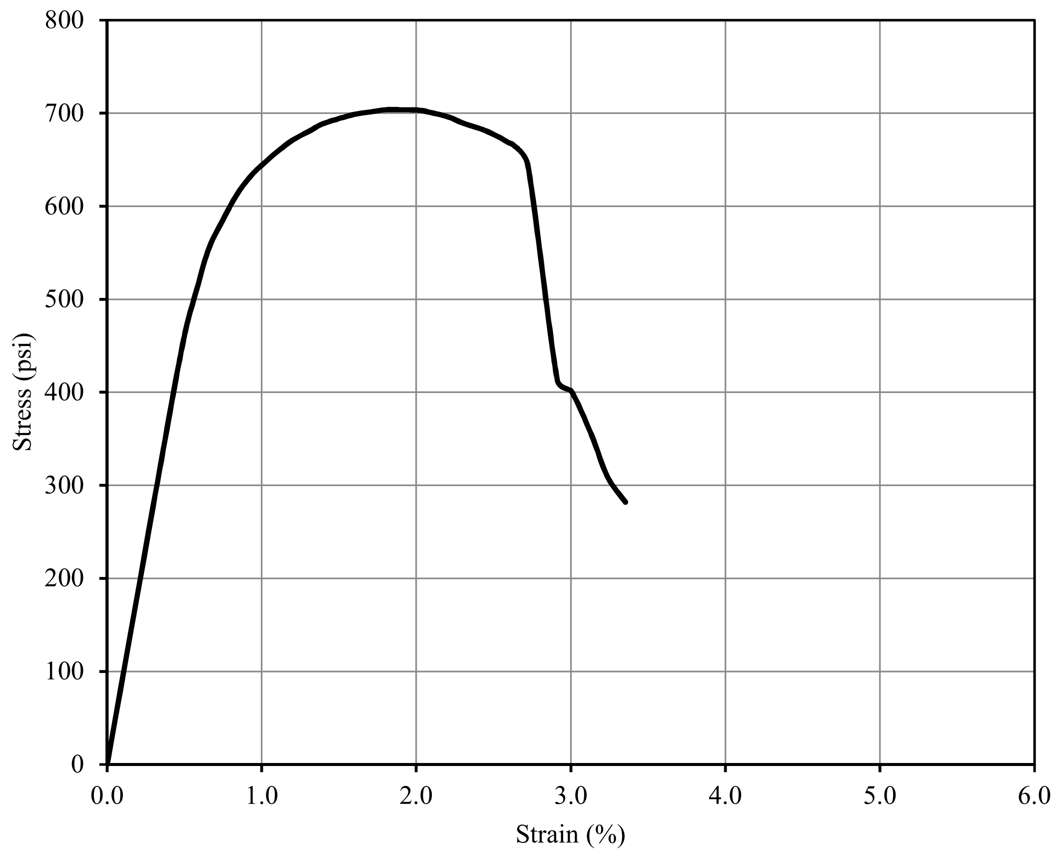
Test Result					
Peak deviator stress (w/ Height correction)	846	psi	Strain at failure, εf :	1.32	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(14) then 45(14)	°C(days)
I.D.:	D-3-C2	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.954	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	367.5	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	108	pcf



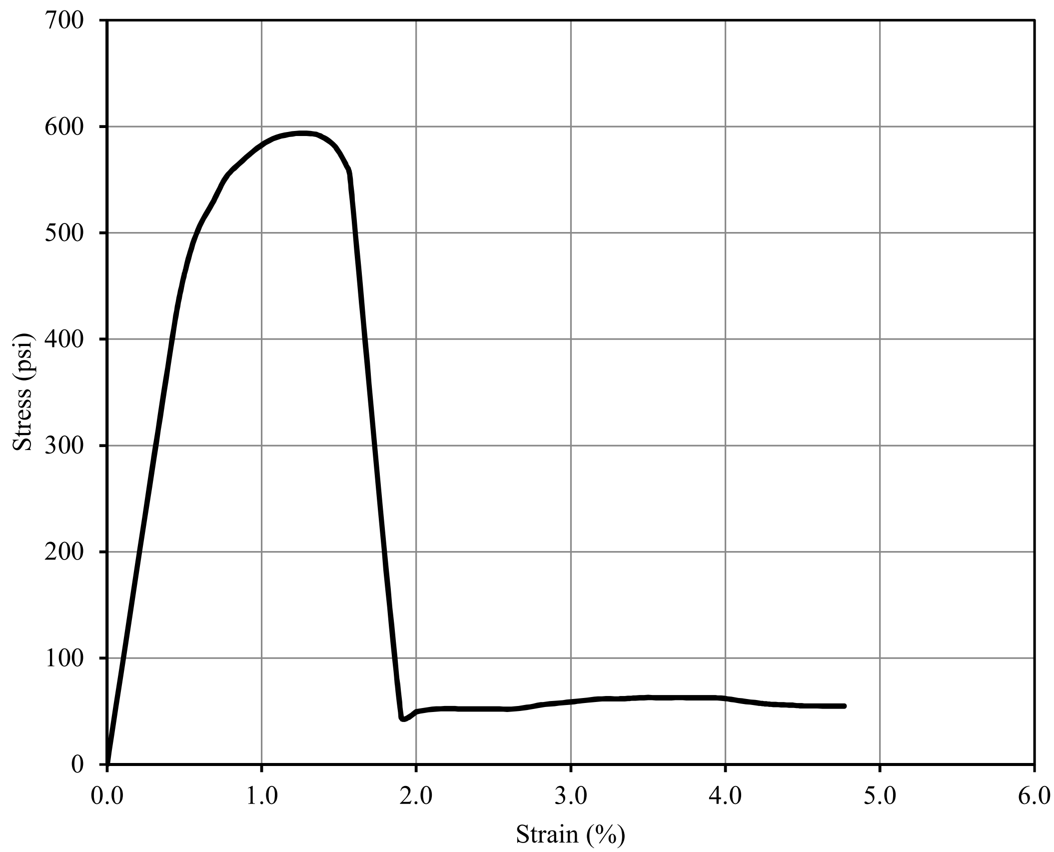
Test Result					
Peak deviator stress (w/ Height correction)	788	psi	Strain at failure, εf :	1.51	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(21) then 45(7)	°C(days)
I.D.:	D-3-B2	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.845	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	354.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	107	pcf



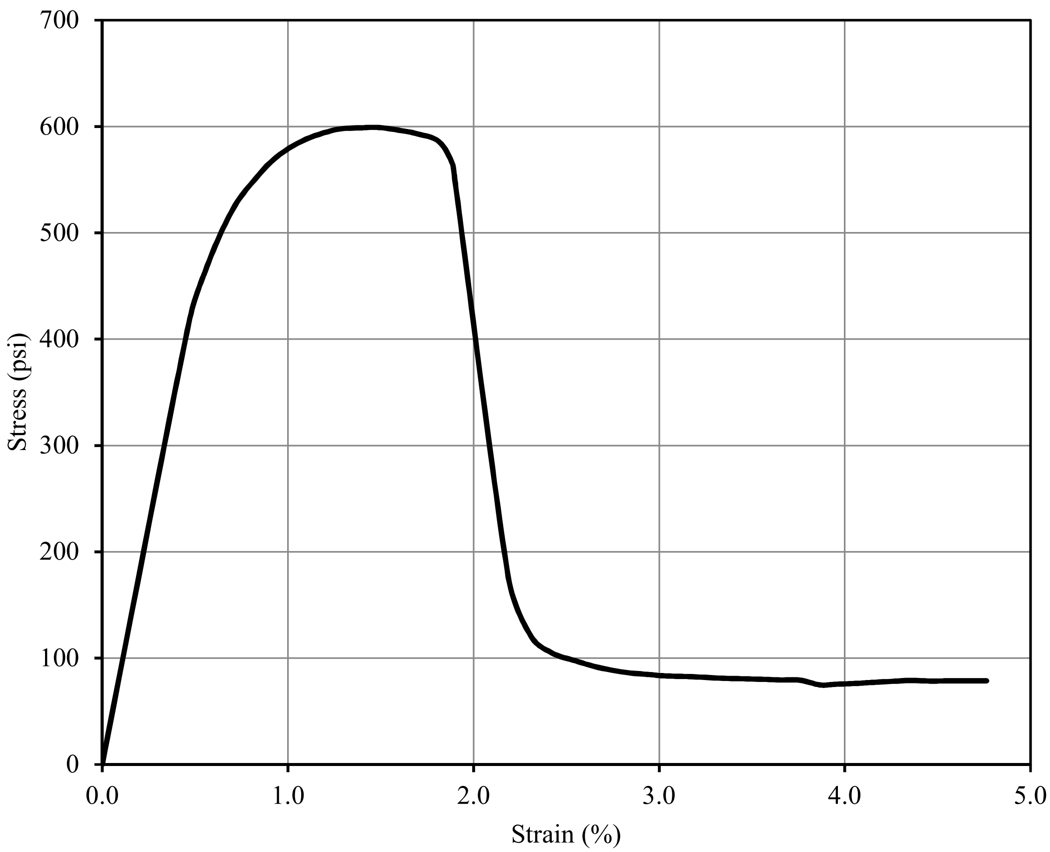
Test Result					
Peak deviator stress (w/ Height correction)	697	psi	Strain at failure, εf :	1.89	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	25(28)	°C(days)
I.D.:	D-3-A	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.928	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	366.6	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	109	pcf



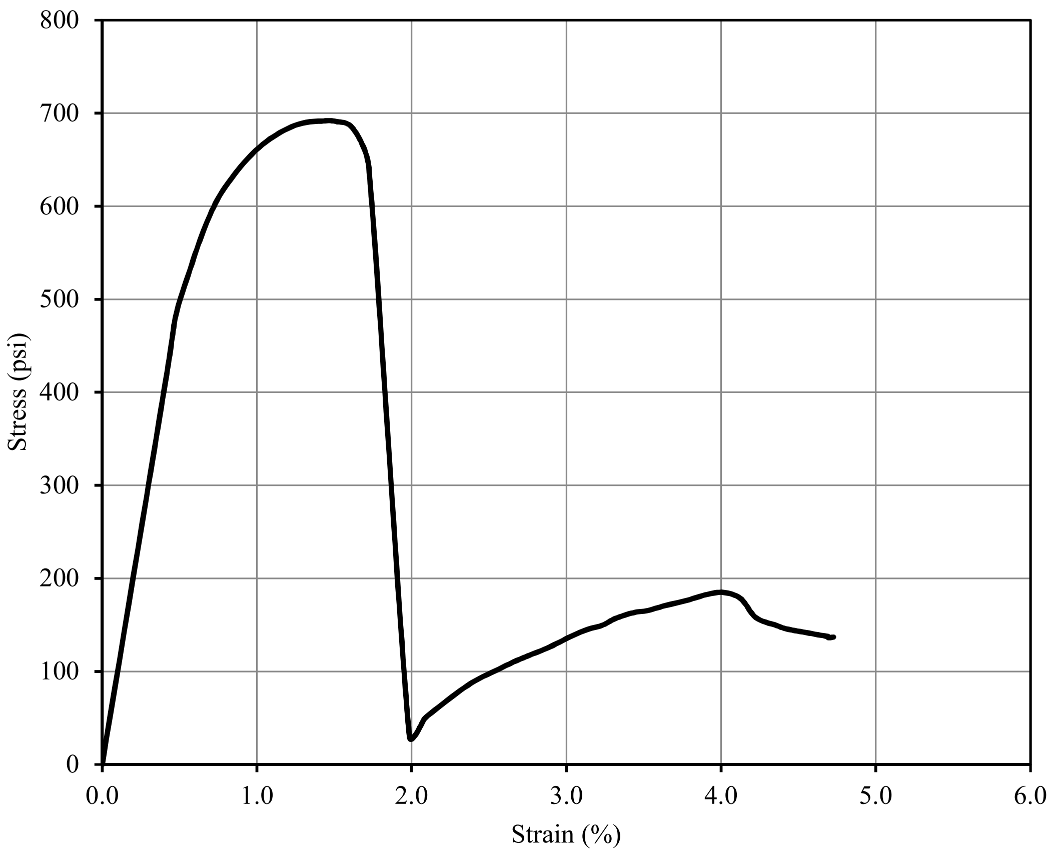
Test Result					
Peak deviator stress (w/ Height correction)	590	psi	Strain at failure, εf :	1.27	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(7) then 25(21)	°C(days)
I.D.:	D-3-B1	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.92	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	365.1	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	108	pcf



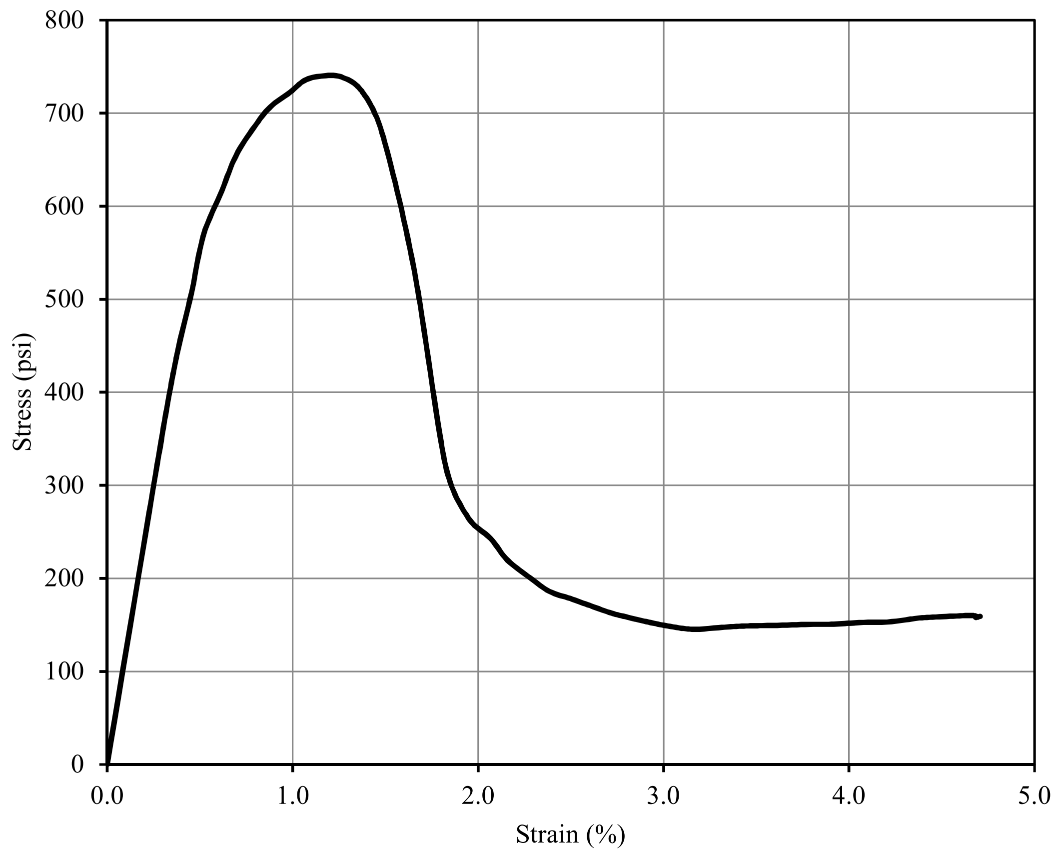
Test Result					
Peak deviator stress (w/ Height correction)	595	psi	Strain at failure, εf :	1.49	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(14) then 25(14)	°C(days)
I.D.:	D-3-C1	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.925	in
Strain Rate:	1 %/min	Initial Diameter:	2.043	in
Mixture Proportion		Initial Area:	3.278	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	367.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



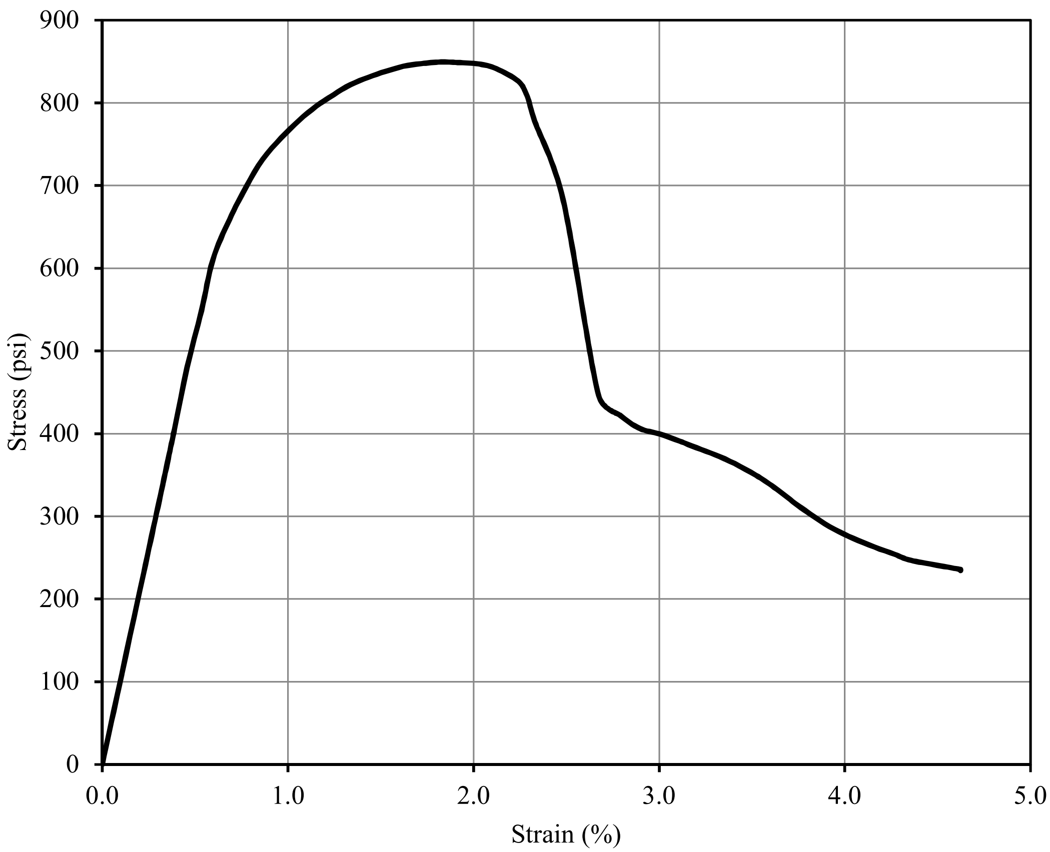
Test Result					
Peak deviator stress (w/ Height correction)	687	psi	Strain at failure, εf :	1.42	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(21) then 25(7)	°C(days)
I.D.:	D-3-D1	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.953	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	368.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



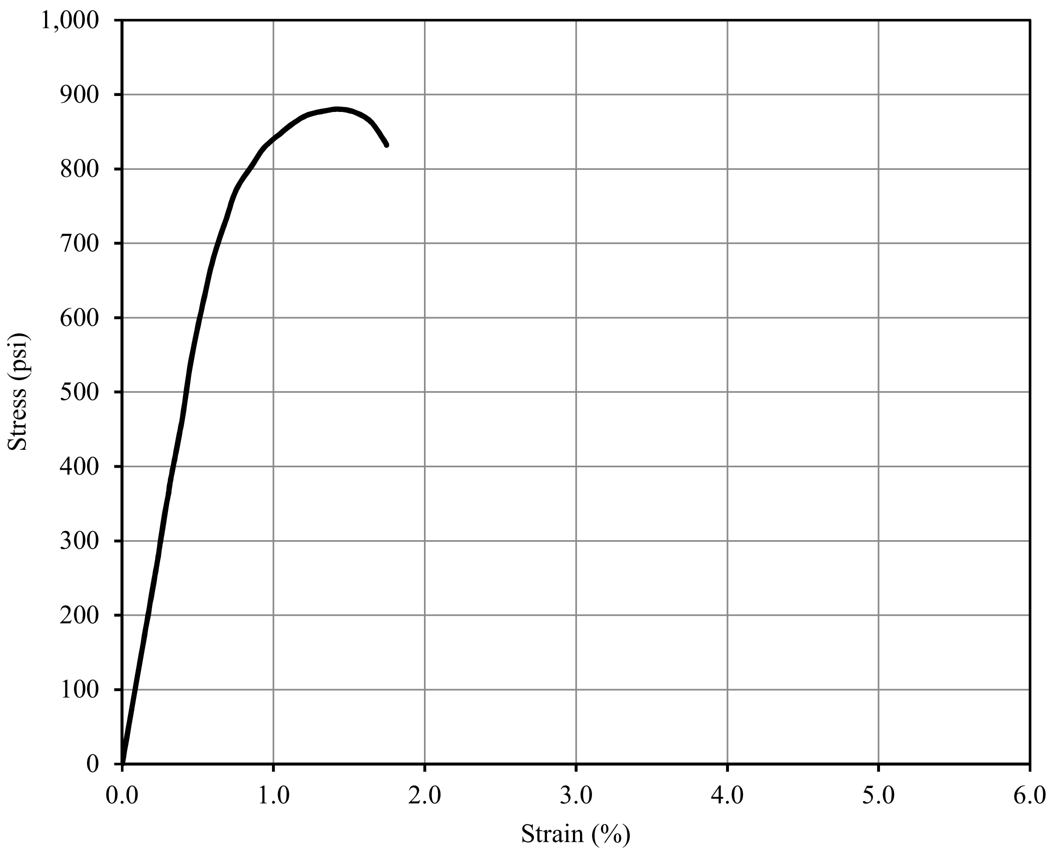
Test Result					
Peak deviator stress (w/ Height correction)	736	psi	Strain at failure, εf :	1.15	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(28)	°C(days)
I.D.:	D-3-E	**Specimen Information**		
Test Date:	2018-03-16	Initial Height:	3.929	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	365.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



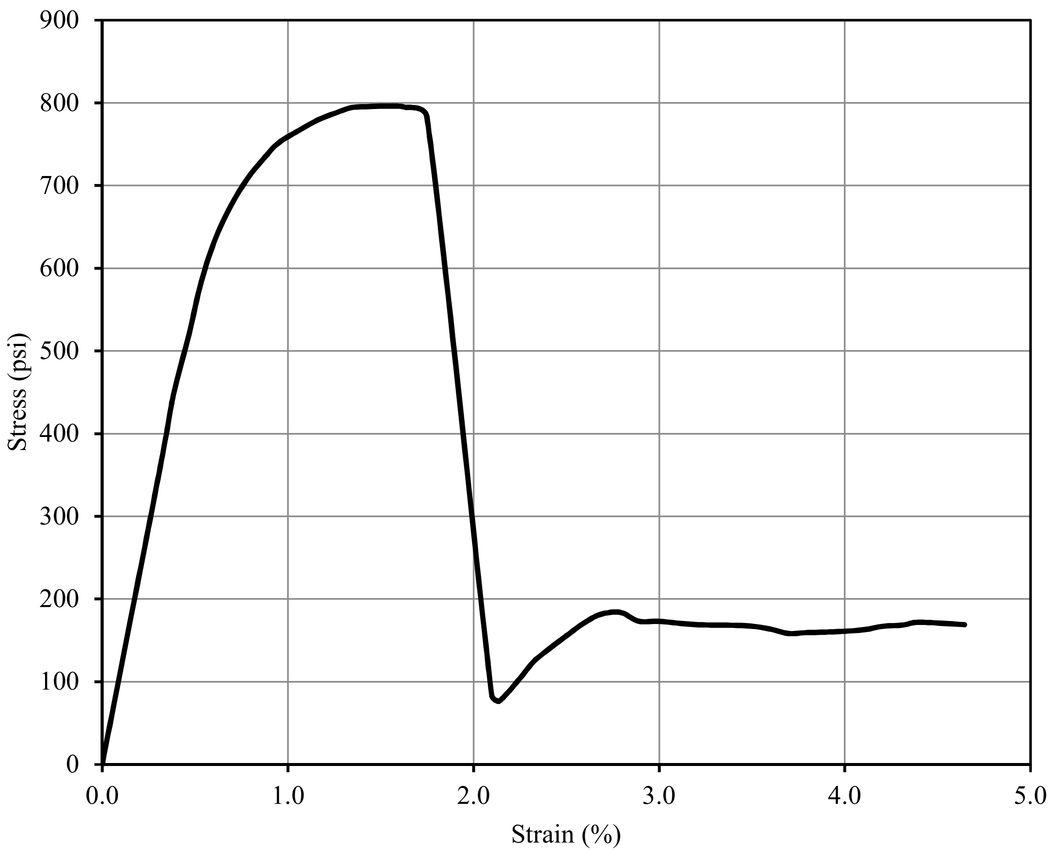
Test Result					
Peak deviator stress (w/ Height correction)	844	psi	Strain at failure, εf :	1.82	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(7) then 45(21)	°C(days)
I.D.:	D-4-D2	**Specimen Information**		
Test Date:	2018-03-17	Initial Height:	3.936	in
Strain Rate:	1 %/min	Initial Diameter:	2.042	in
Mixture Proportion		Initial Area:	3.275	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	365.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



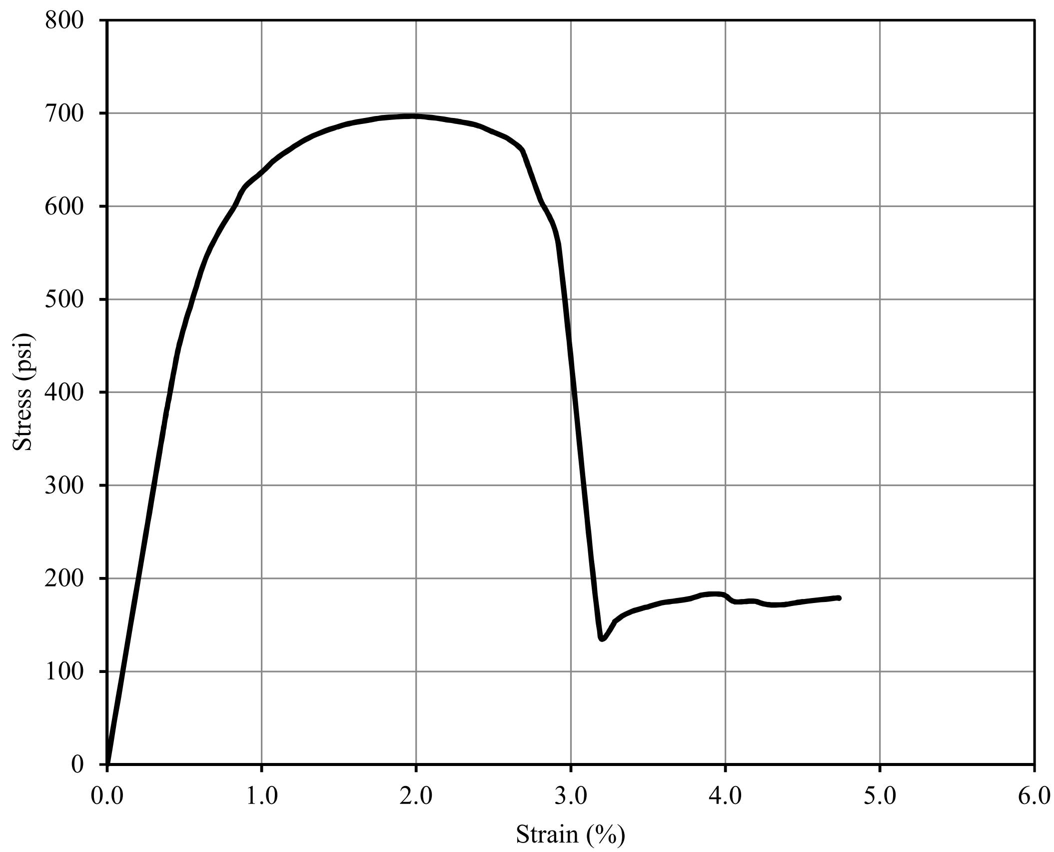
Test Result					
Peak deviator stress (w/ Height correction)	875	psi	Strain at failure, εf :	1.43	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(14) then 45(14)	°C(days)
I.D.:	D-4-C2	**Specimen Information**		
Test Date:	2018-03-17	Initial Height:	3.91	in
Strain Rate:	1 %/min	Initial Diameter:	2.039	in
Mixture Proportion		Initial Area:	3.265	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	362.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



Test Result					
Peak deviator stress (w/ Height correction)	791	psi	Strain at failure, εf :	1.55	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(21) then 45(7)	°C(days)
I.D.:	D-4-B2	**Specimen Information**		
Test Date:	2018-03-17	Initial Height:	3.883	in
Strain Rate:	1 %/min	Initial Diameter:	2.04	in
Mixture Proportion		Initial Area:	3.269	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	359.8	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	108	pcf

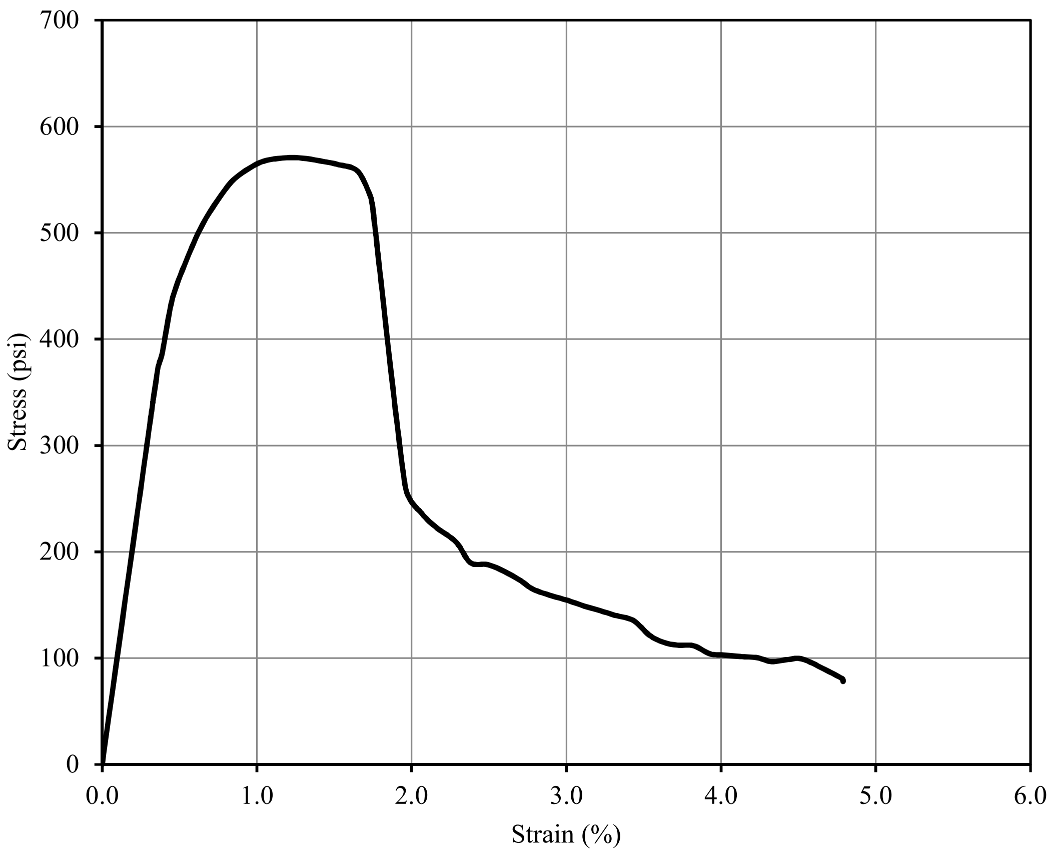


Test Result					
Peak deviator stress (w/ Height correction)	691	psi	Strain at failure, εf :	1.97	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	25(28)	°C(days)

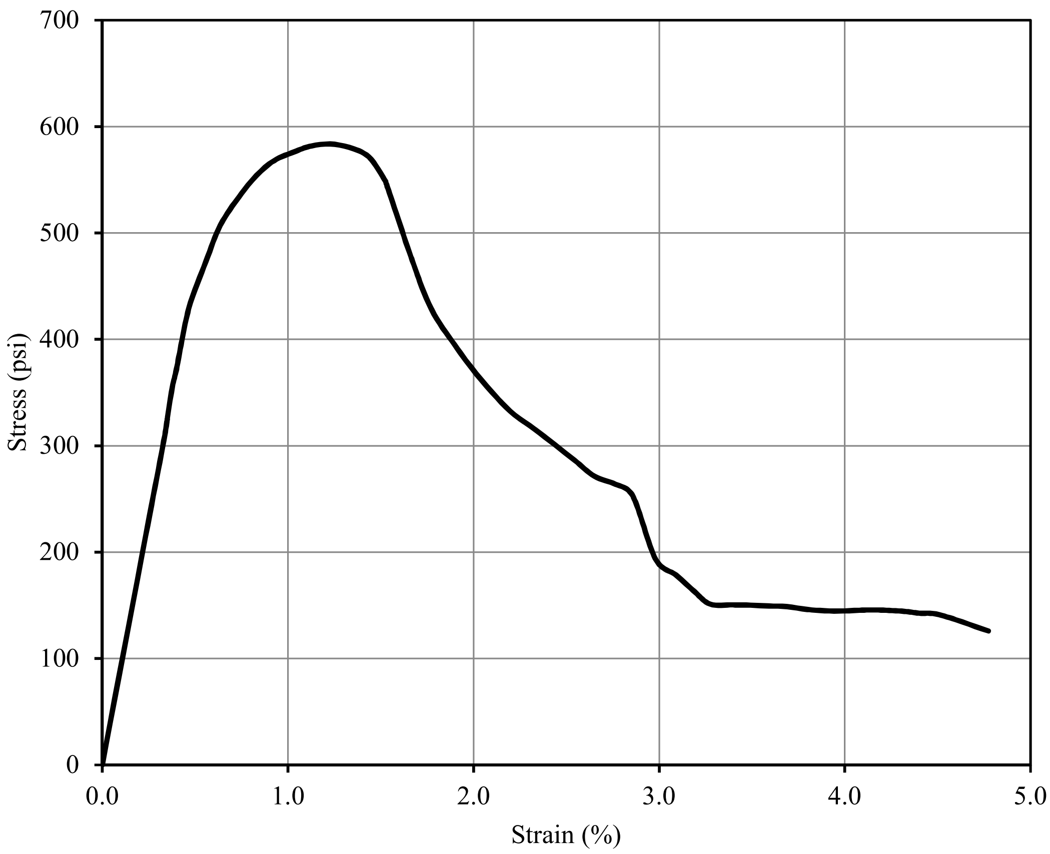
Test Information		Specimen Information		
I.D.:	D-4-A	Initial Height:	3.956	in
Test Date:	2018-03-17	Initial Diameter:	2.040	in
Strain Rate:	1 %/min	Initial Area:	3.269	in

Mixture Proportion		Specimen Information		
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	369.7	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



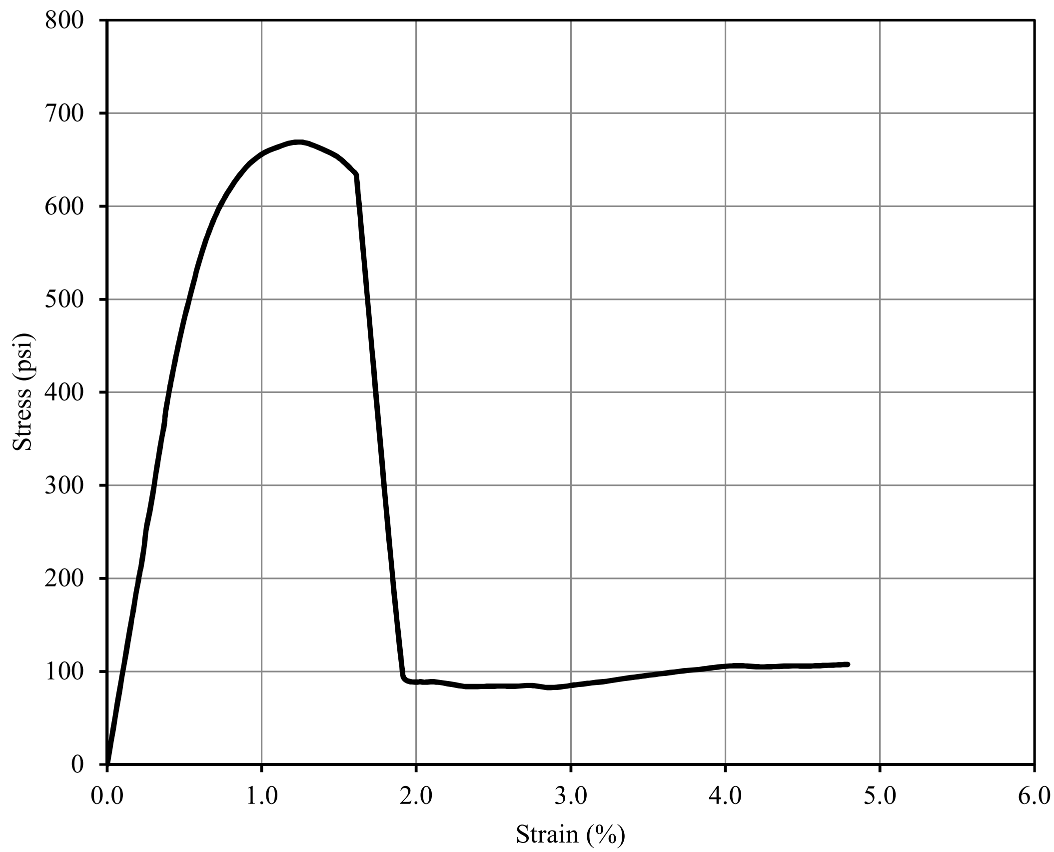
Test Result					
Peak deviator stress (w/ Height correction)	568	psi	Strain at failure, εf :	1.22	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	45(7) then 25(21)	°C(days)
I.D.:	D-4-B1	**Specimen Information**		
Test Date:	2018-03-17	Initial Height:	3.931	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	367.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



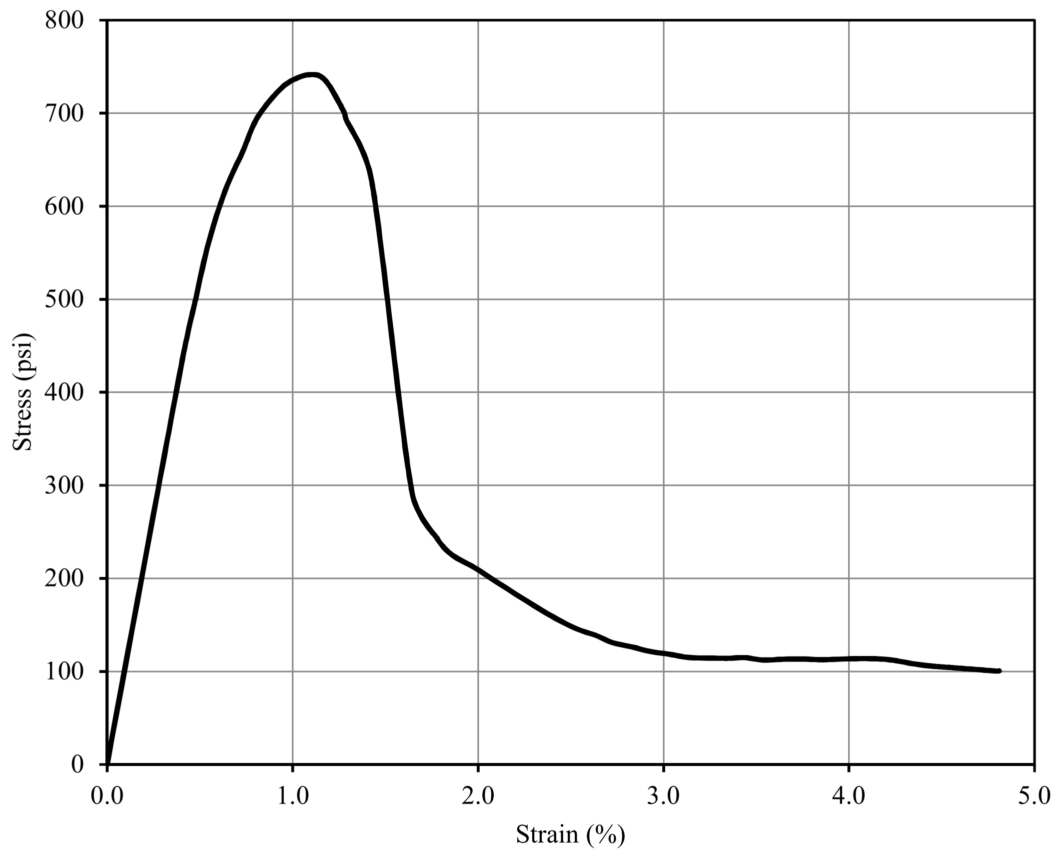
Test Result					
Peak deviator stress (w/ Height correction)	580	psi	Strain at failure, εf :	1.23	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(14) then 25(14)	°C(days)
I.D.:	D-4-C1	**Specimen Information**		
Test Date:	2018-03-17	Initial Height:	3.923	in
Strain Rate:	1 %/min	Initial Diameter:	2.041	in
Mixture Proportion		Initial Area:	3.272	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	366.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



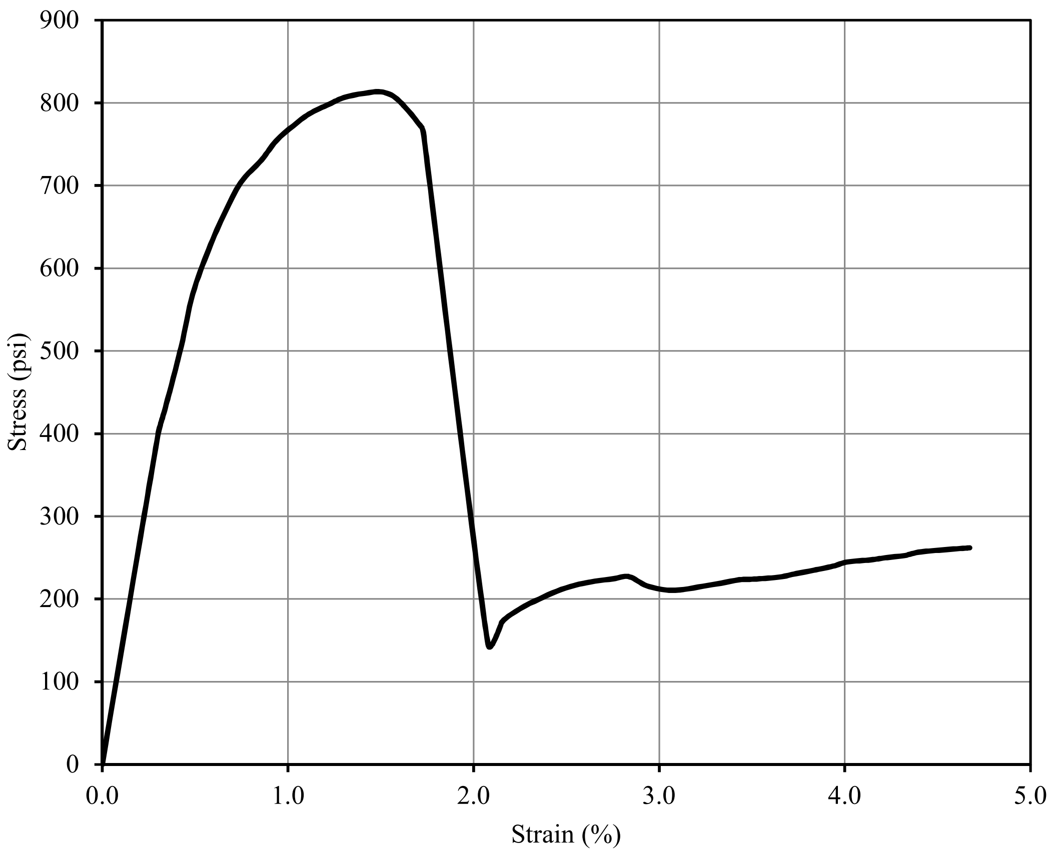
Test Result					
Peak deviator stress (w/ Height correction)	664	psi	Strain at failure, εf :	1.28	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(21) then 25(7)	°C(days)
I.D.:	D-4-D1	**Specimen Information**		
Test Date:	2018-03-17	Initial Height:	3.92	in
Strain Rate:	1 %/min	Initial Diameter:	2.046	in
Mixture Proportion		Initial Area:	3.288	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	367.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	109	pcf



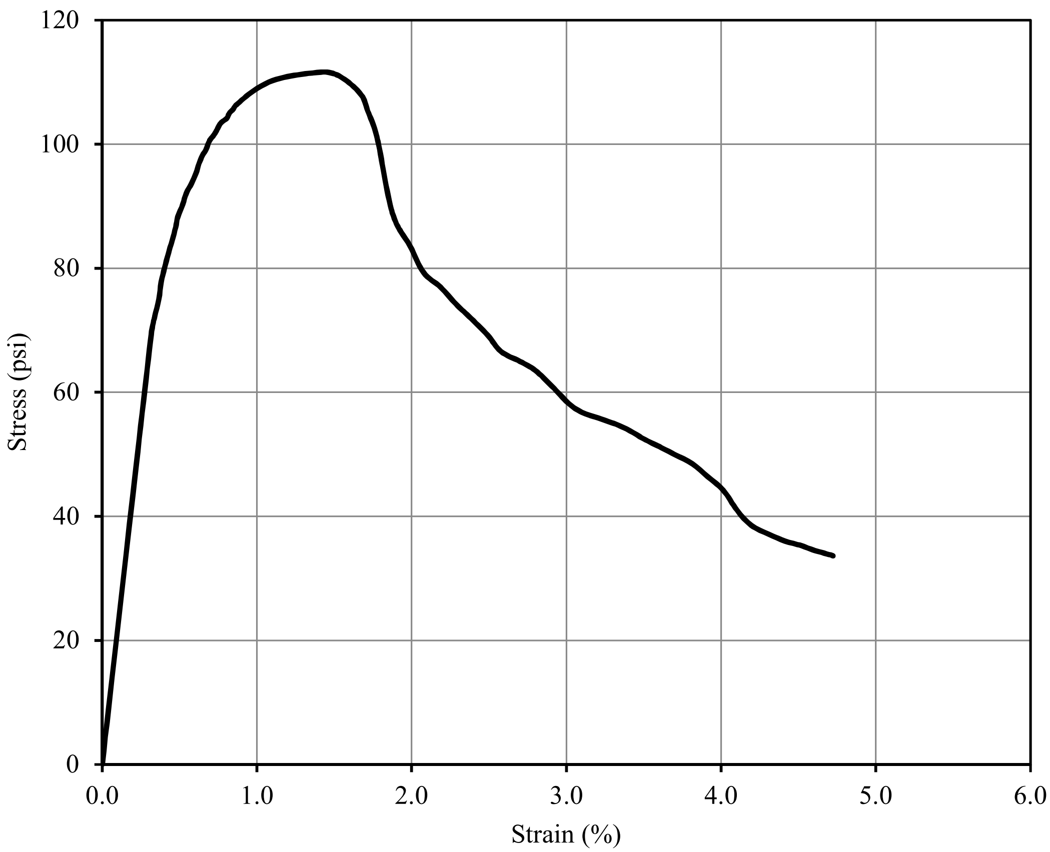
Test Result					
Peak deviator stress (w/ Height correction)	736	psi	Strain at failure, εf :	1.09	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	45(28)	°C(days)
I.D.:	D-4-E	**Specimen Information**		
Test Date:	2018-03-17	Initial Height:	3.926	in
Strain Rate:	1 %/min	Initial Diameter:	2.044	in
Mixture Proportion		Initial Area:	3.281	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	365.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	108	pcf



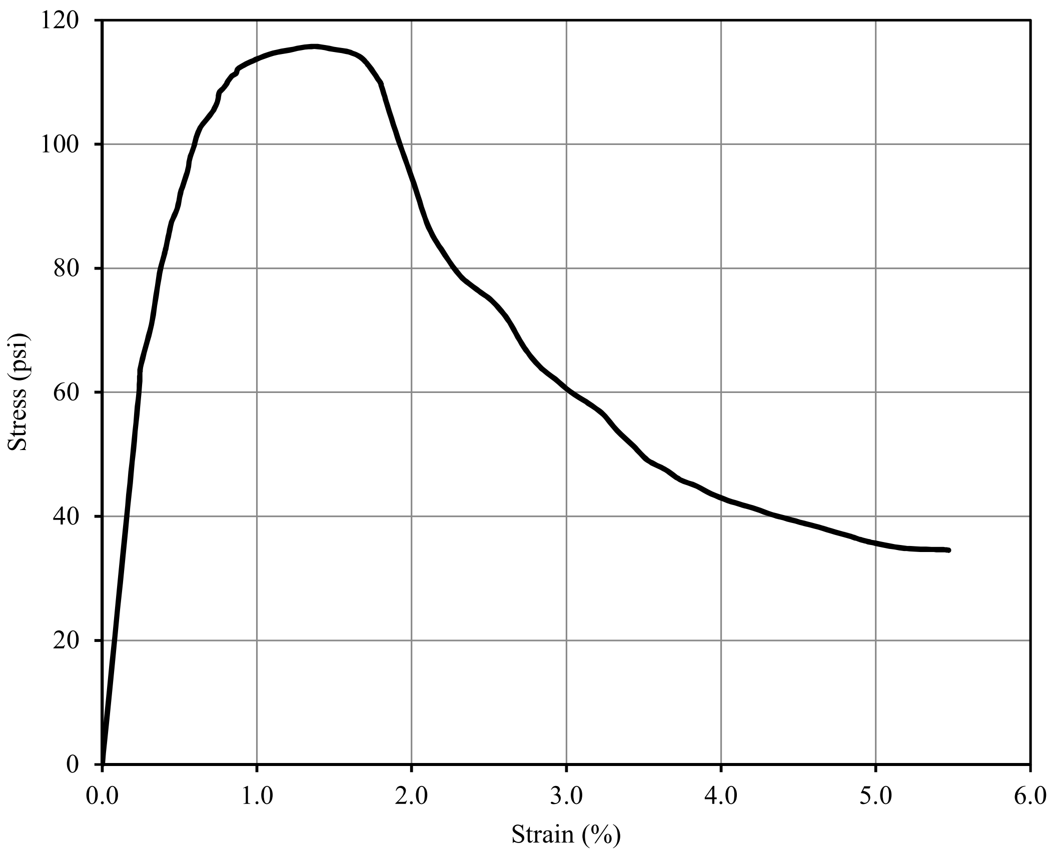
Test Result					
Peak deviator stress (w/ Height correction)	808	psi	Strain at failure, εf :	1.51	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	55	°C
I.D.:	S-1-H	**Specimen Information**		
Test Date:	2017-09-19	Initial Height:	3.67	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	317.4	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	101	pcf



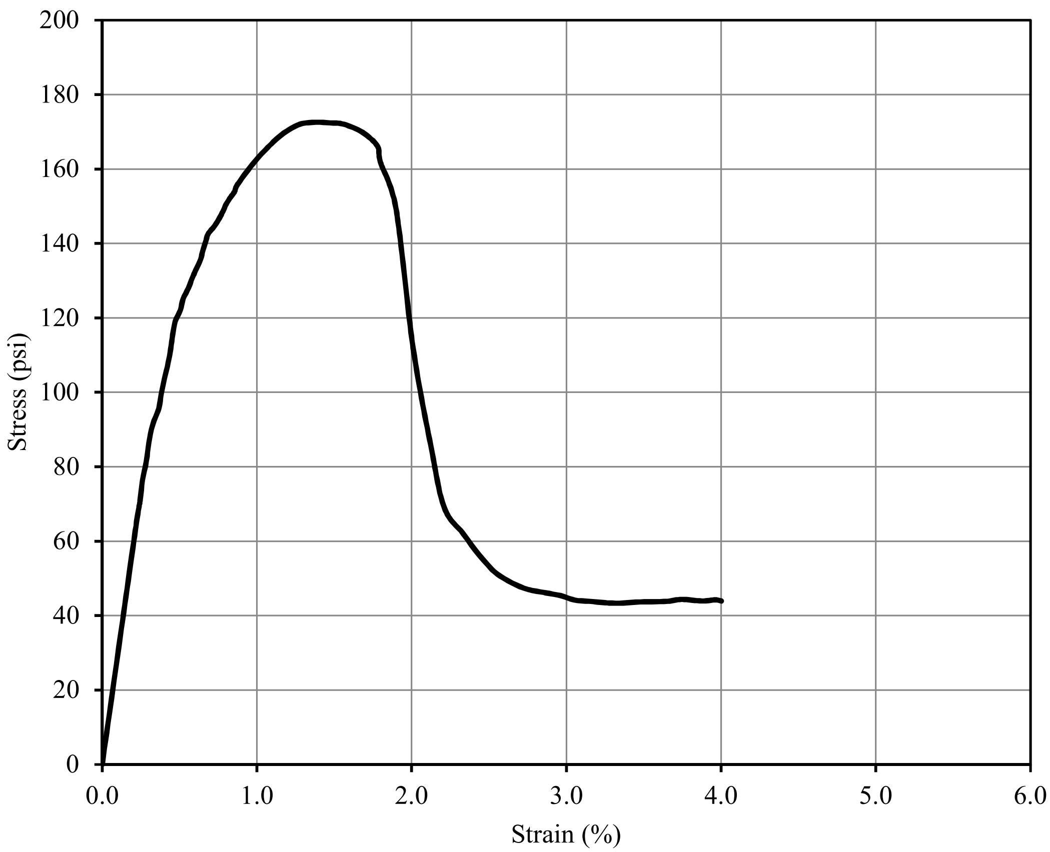
Test Result					
Peak deviator stress (w/ Height correction)	110	psi	Strain at failure, εf :	1.47	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-1-I	**Specimen Information**		
Test Date:	2017-09-19	Initial Height:	3.787	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	327.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	101	pcf



Test Result					
Peak deviator stress (w/ Height correction)	114	psi	Strain at failure, εf :	1.39	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-1-B	**Specimen Information**		
Test Date:	2017-09-23	Initial Height:	3.924	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	339.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	102	pcf

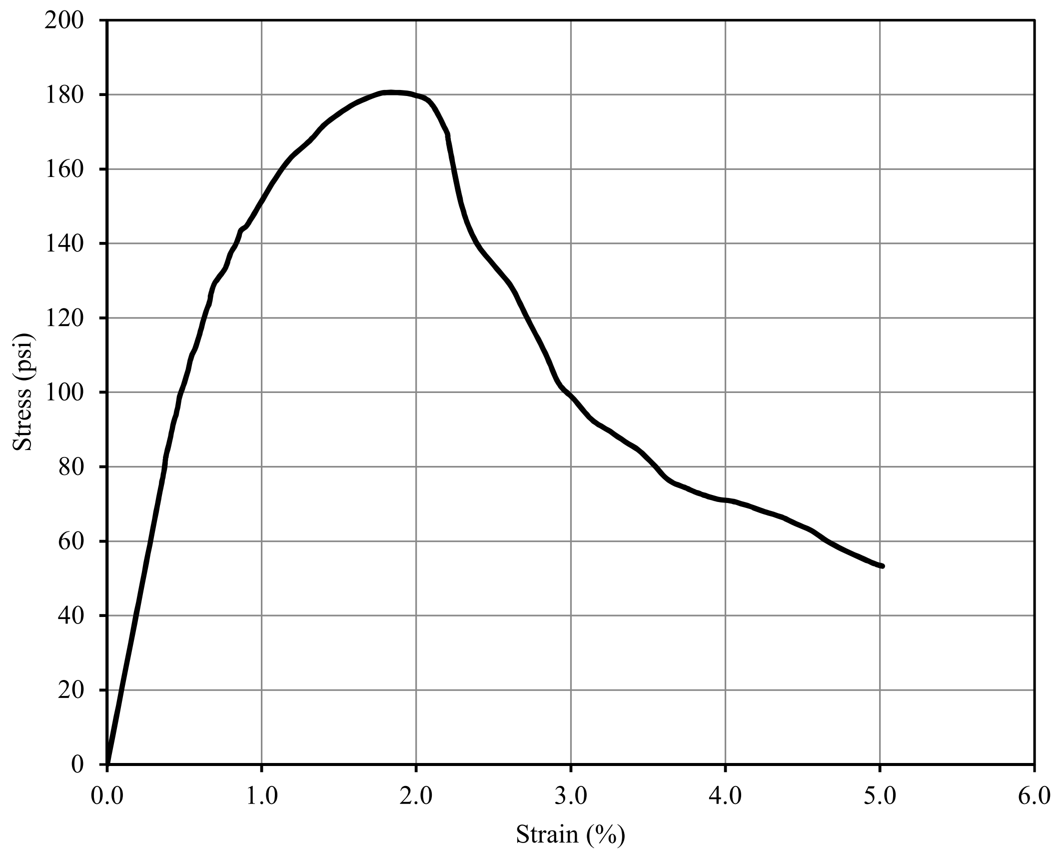


Test Result					
Peak deviator stress (w/ Height correction)	172	psi	Strain at failure, εf :	1.38	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

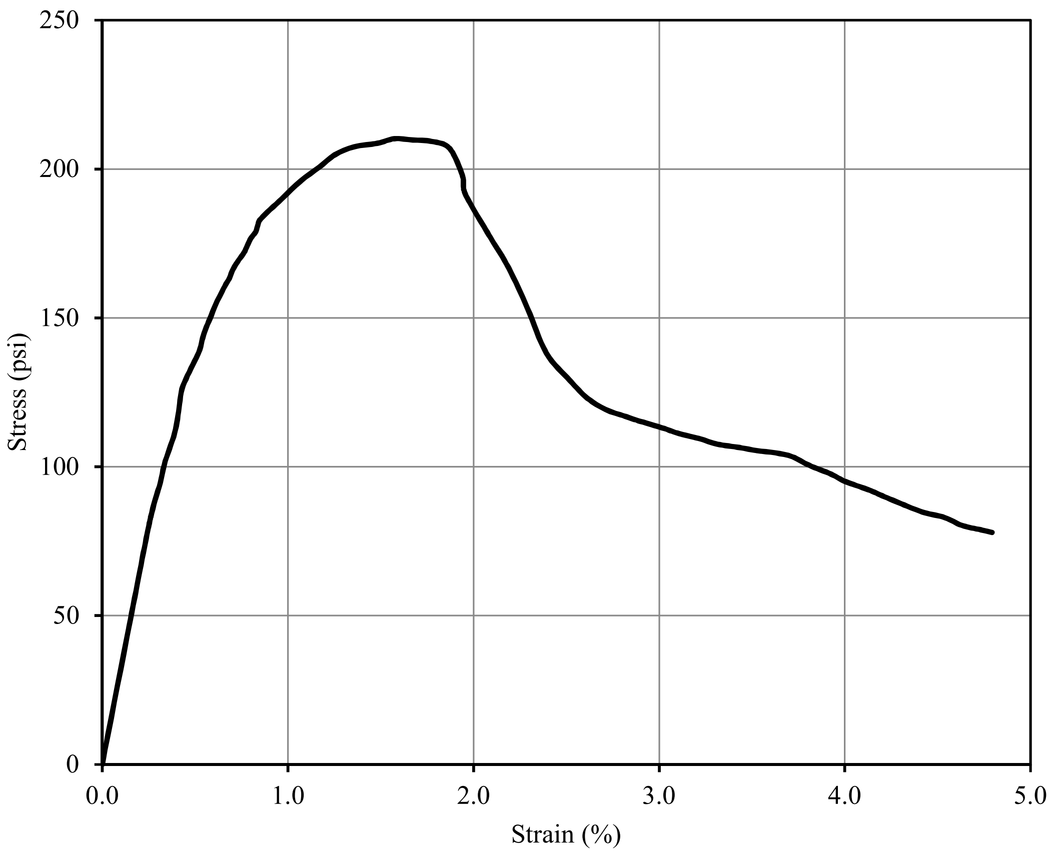
Test Information		Specimen Information		
I.D.:	S-1-G	Initial Height:	3.866	in
Test Date:	2017-09-23	Initial Diameter:	2.034	in
Strain Rate:	1 %/min	Initial Area:	3.249	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	333.2	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	101	pcf



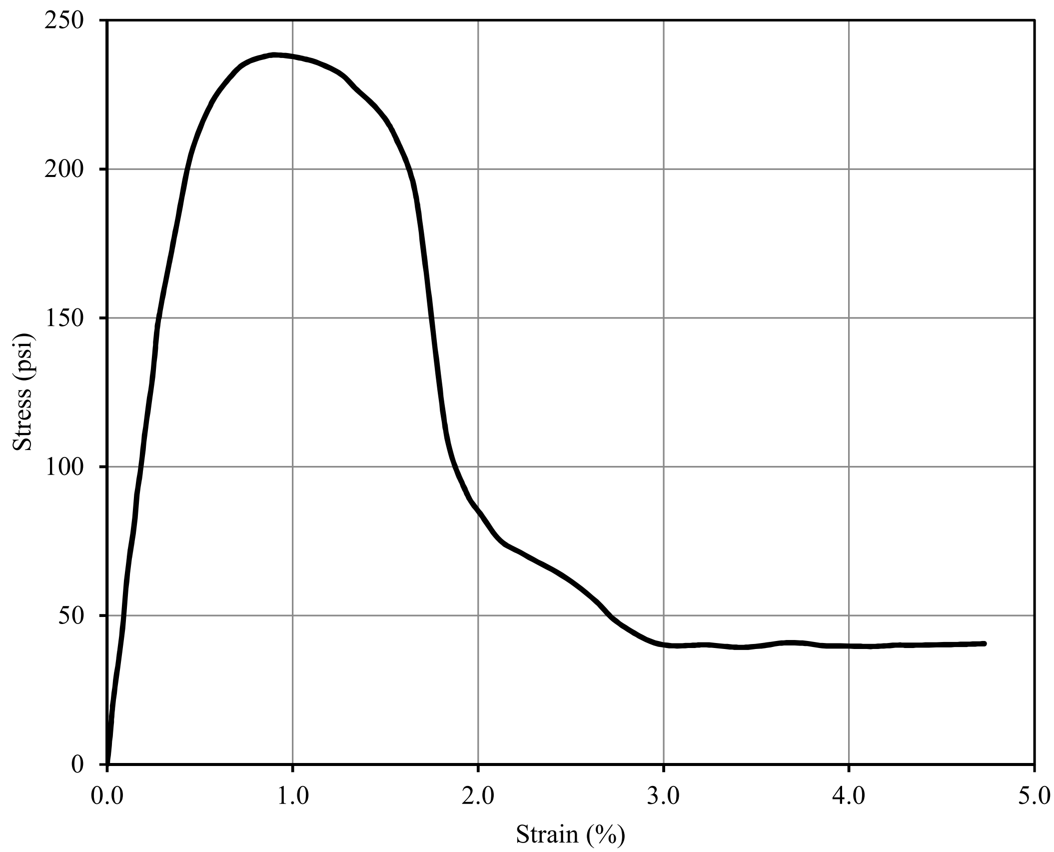
Test Result					
Peak deviator stress (w/ Height correction)	179	psi	Strain at failure, εf :	1.89	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-1-C	**Specimen Information**		
Test Date:	2017-09-30	Initial Height:	3.869	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	334.2	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	101	pcf



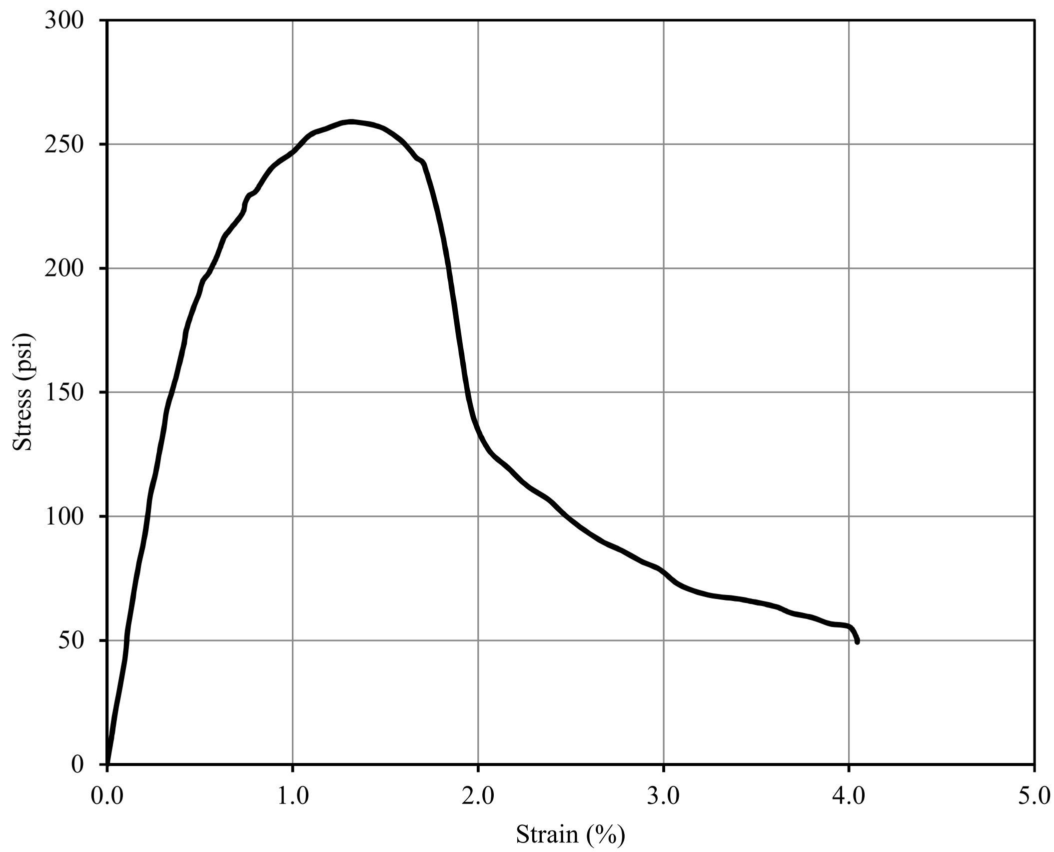
Test Result					
Peak deviator stress (w/ Height correction)	209	psi	Strain at failure, εf :	1.57	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-1-F	**Specimen Information**		
Test Date:	2017-09-30	Initial Height:	3.881	in
Strain Rate:	1 %/min	Initial Diameter:	2.031	in
Mixture Proportion		Initial Area:	3.240	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	338.4	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	103	pcf



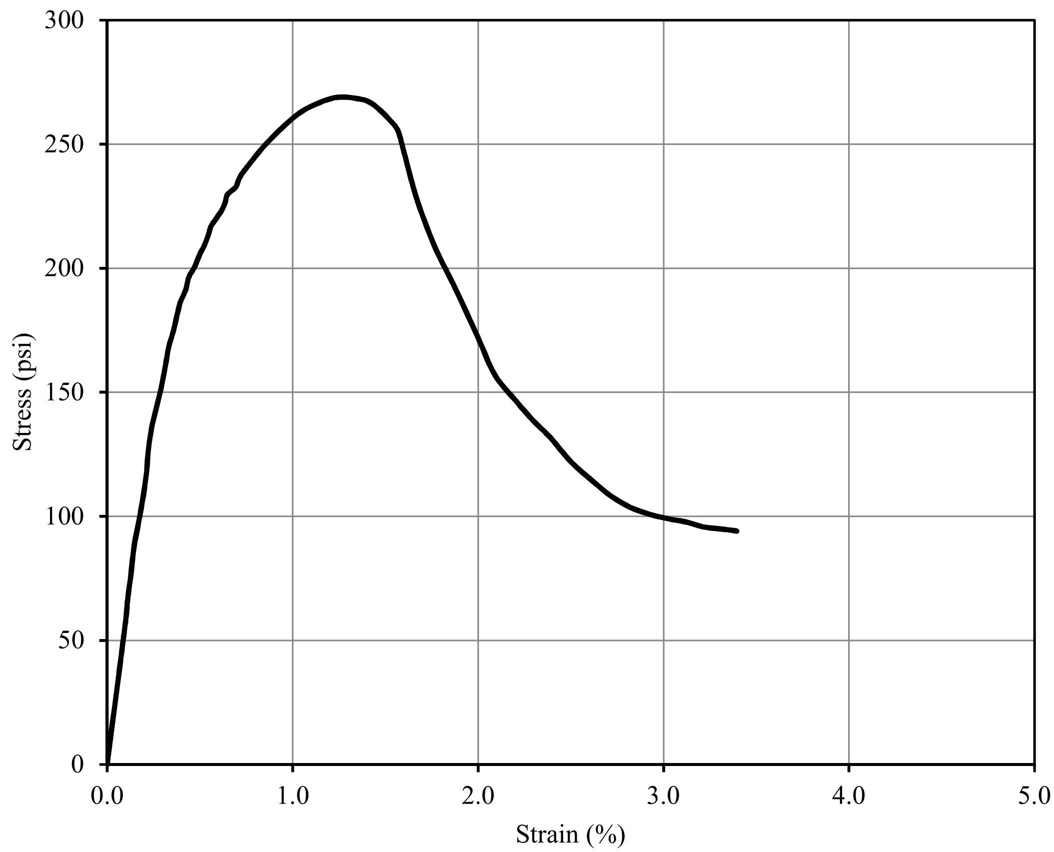
Test Result					
Peak deviator stress (w/ Height correction)	237	psi	Strain at failure, εf :	0.95	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-1-D	**Specimen Information**		
Test Date:	2017-10-14	Initial Height:	3.569	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	308.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	101	pcf



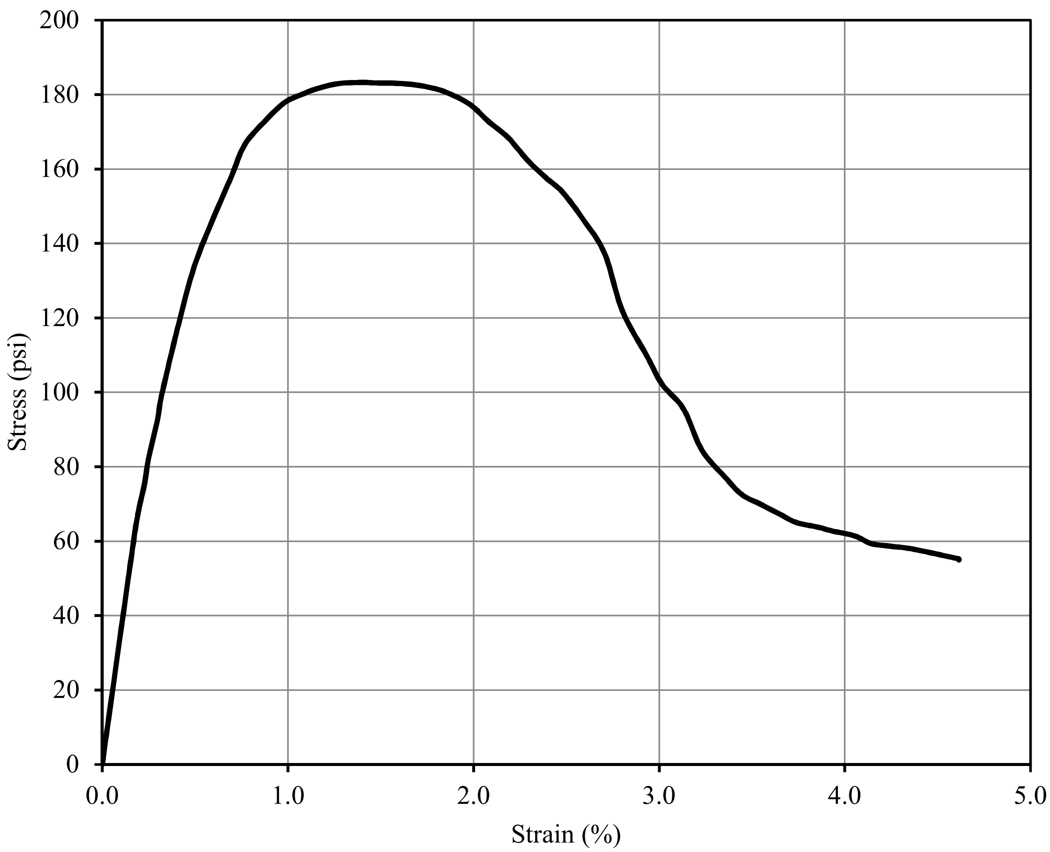
Test Result					
Peak deviator stress (w/ Height correction)	254	psi	Strain at failure, εf :	1.29	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-1-E	**Specimen Information**		
Test Date:	2017-10-14	Initial Height:	3.634	in
Strain Rate:	1 %/min	Initial Diameter:	2.031	in
Mixture Proportion		Initial Area:	3.240	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	314.5	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	102	pcf



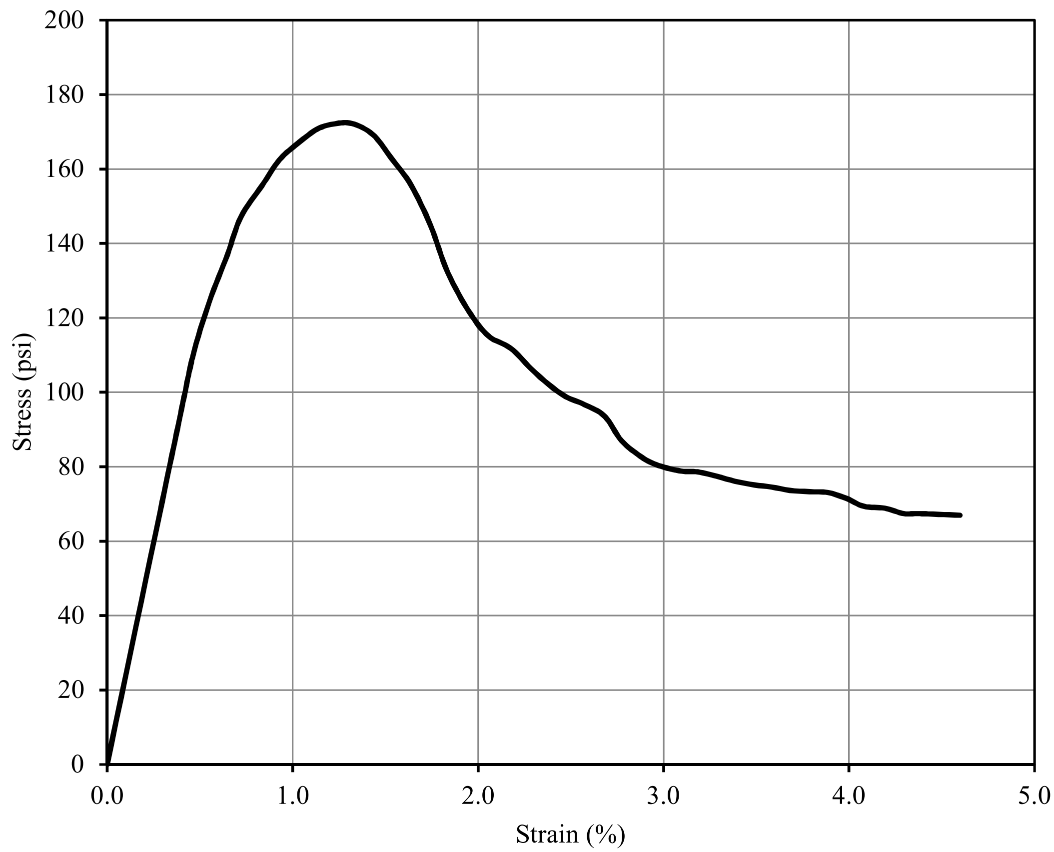
Test Result					
Peak deviator stress (w/ Height correction)	264	psi	Strain at failure, εf :	1.24	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-2-A	**Specimen Information**		
Test Date:	2018-02-14	Initial Height:	3.864	in
Strain Rate:	1 %/min	Initial Diameter:	2.028	in
Mixture Proportion		Initial Area:	3.230	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	338.2	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	103	pcf



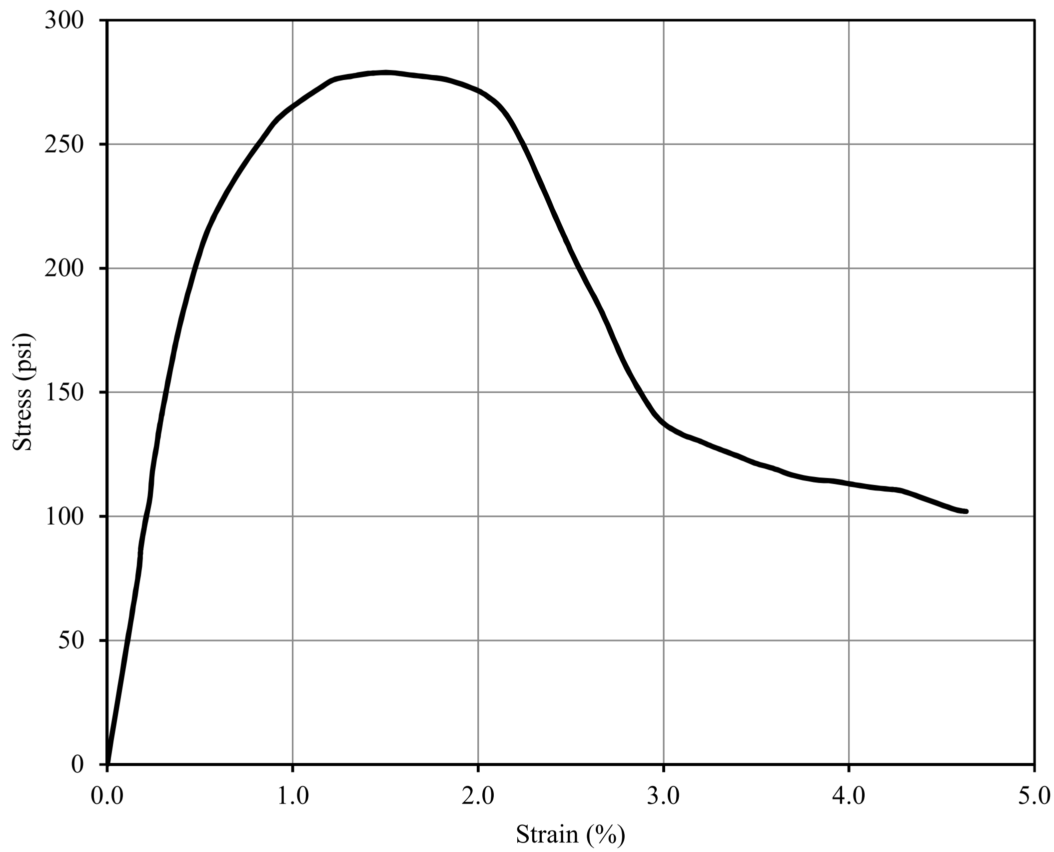
Test Result					
Peak deviator stress (w/ Height correction)	182	psi	Strain at failure, εf :	1.40	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-2-H	**Specimen Information**		
Test Date:	2018-02-14	Initial Height:	3.82	in
Strain Rate:	1 %/min	Initial Diameter:	2.03	in
Mixture Proportion		Initial Area:	3.237	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	334.2	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



Test Result					
Peak deviator stress (w/ Height correction)	171	psi	Strain at failure, εf :	1.32	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-2-B	**Specimen Information**		
Test Date:	2018-02-18	Initial Height:	3.699	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	323.4	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf

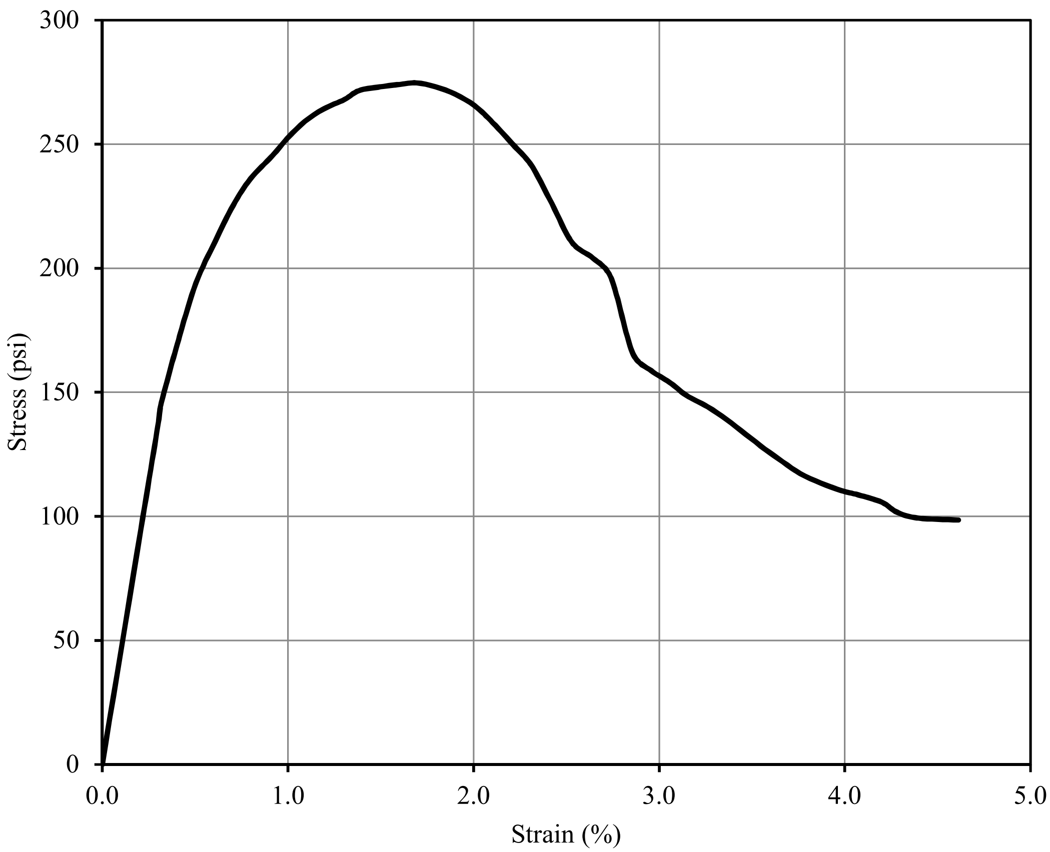


Test Result					
Peak deviator stress (w/ Height correction)	275	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

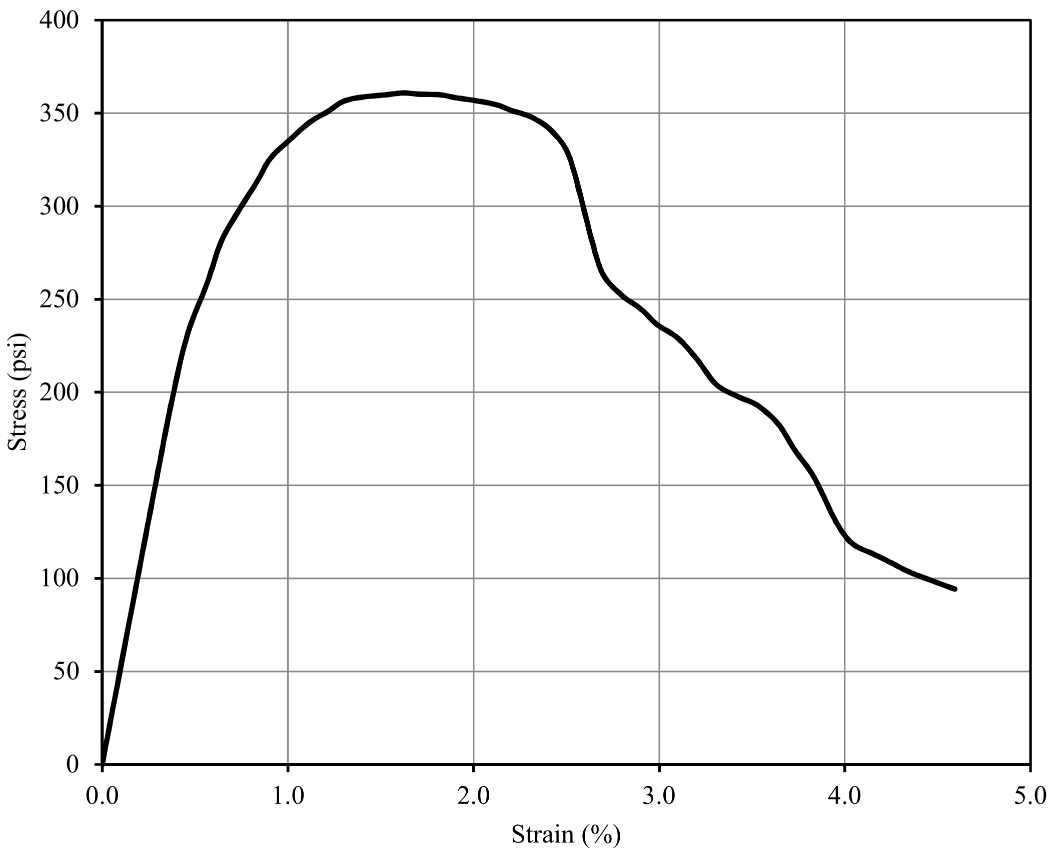
		Specimen Information		
I.D.:	S-2-G	Initial Height:	3.916	in
Test Date:	2018-02-18	Initial Diameter:	2.030	in
Strain Rate:	1 %/min	Initial Area:	3.237	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	342.2	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



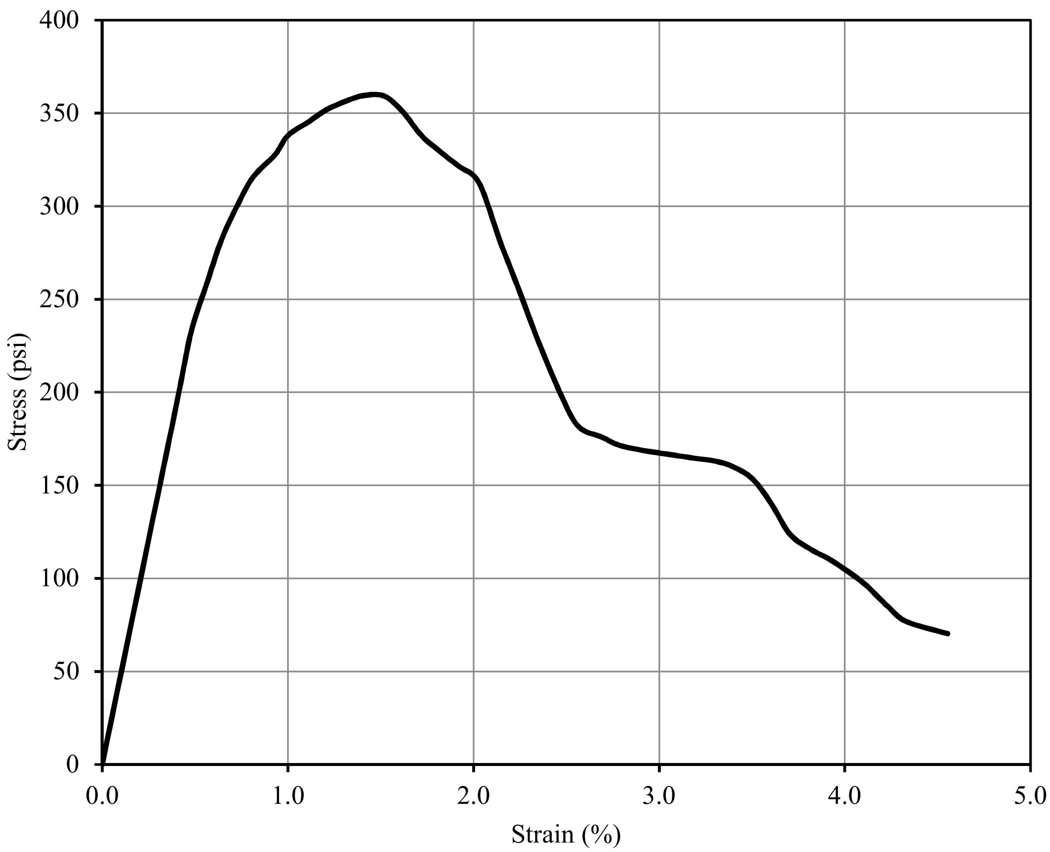
Test Result					
Peak deviator stress (w/ Height correction)	273	psi	Strain at failure, εf :	1.69	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.2	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
		Specimen Information		
I.D.:	S-2-C	Initial Height:	3.868	in
Test Date:	2018-02-25	Initial Diameter:	2.032	in
Strain Rate:	1 %/min	Initial Area:	3.243	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	338.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



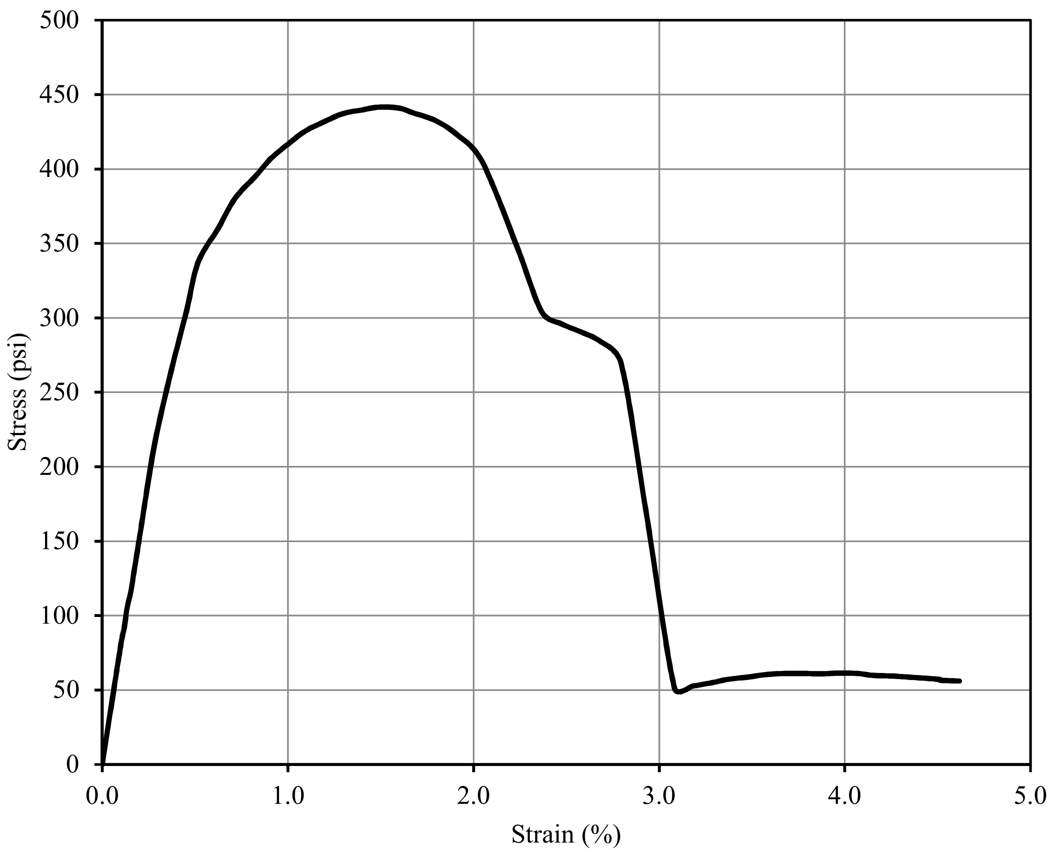
Test Result					
Peak deviator stress (w/ Height correction)	358	psi	Strain at failure, εf :	1.62	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.2	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-2-F	**Specimen Information**		
Test Date:	2018-02-25	Initial Height:	3.751	in
Strain Rate:	1 %/min	Initial Diameter:	2.027	in
Mixture Proportion		Initial Area:	3.227	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	327.7	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



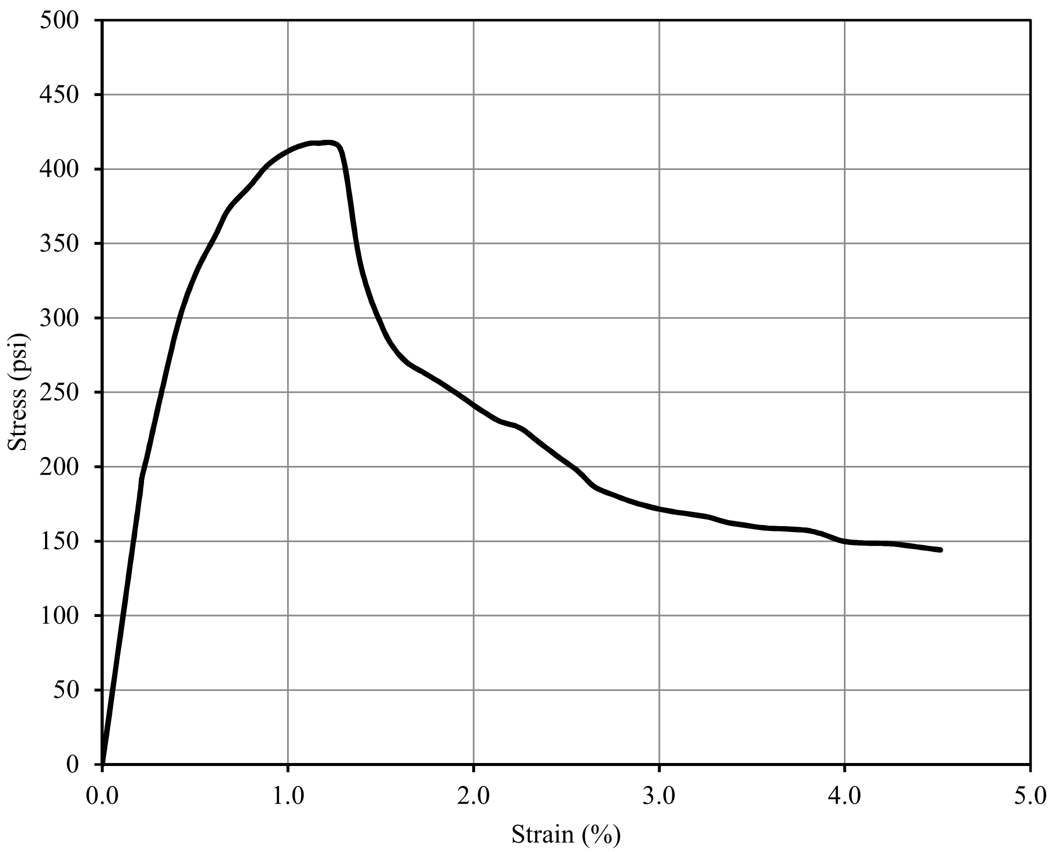
Test Result					
Peak deviator stress (w/ Height correction)	355	psi	Strain at failure, εf :	1.41	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-2-D	**Specimen Information**		
Test Date:	2018-03-11	Initial Height:	3.736	in
Strain Rate:	1 %/min	Initial Diameter:	2.031	in
Mixture Proportion		Initial Area:	3.240	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	326.4	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



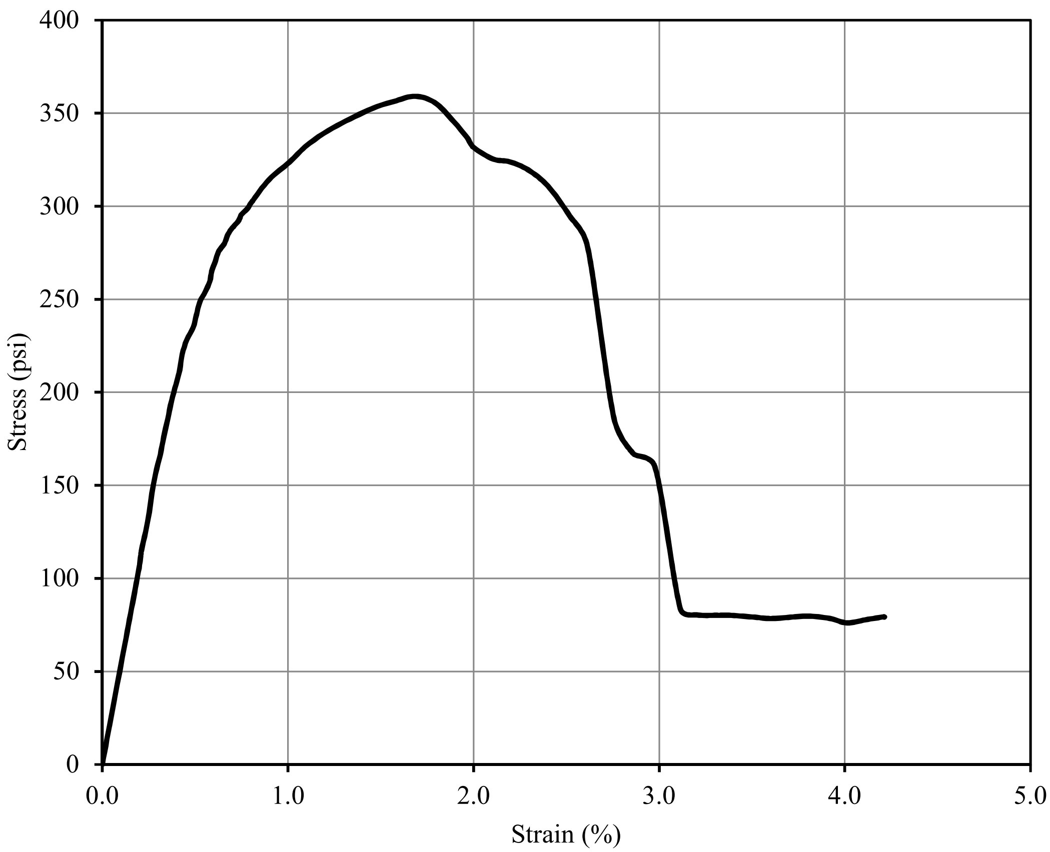
Test Result					
Peak deviator stress (w/ Height correction)	436	psi	Strain at failure, εf :	1.49	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-2-E	**Specimen Information**		
Test Date:	2018-03-11	Initial Height:	3.803	in
Strain Rate:	1 %/min	Initial Diameter:	2.031	in
Mixture Proportion		Initial Area:	3.240	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	332.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



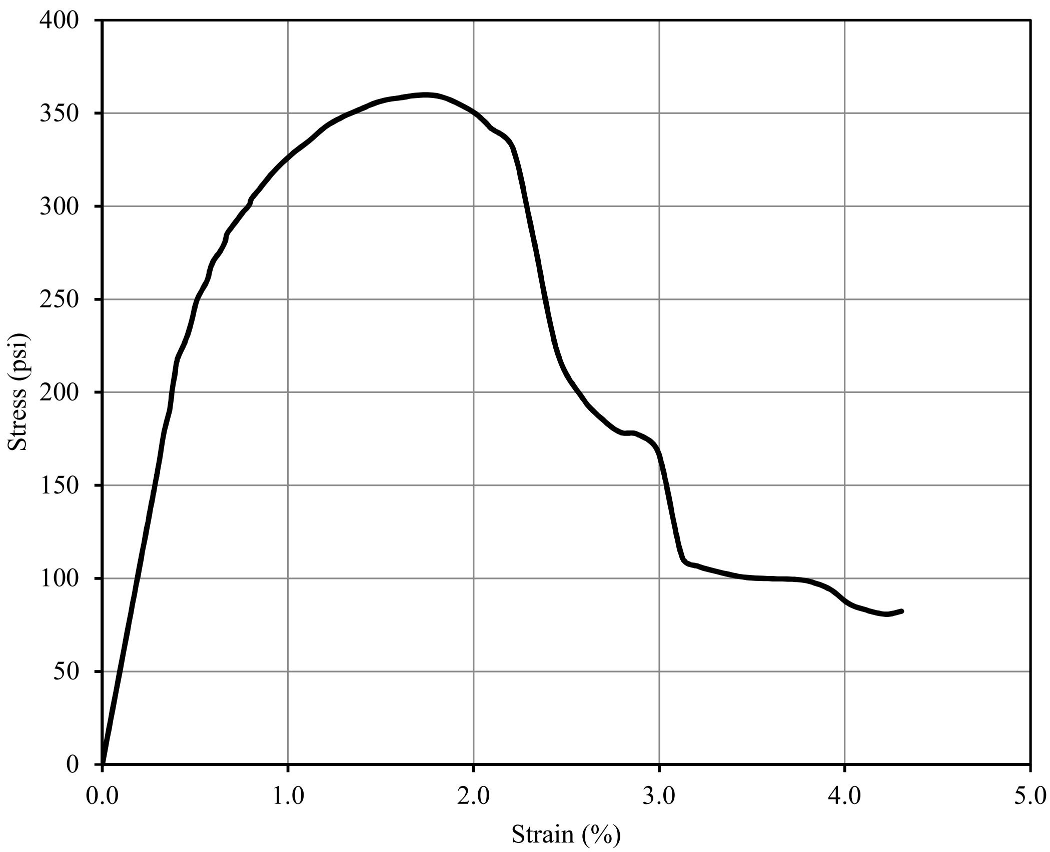
Test Result					
Peak deviator stress (w/ Height correction)	413	psi	Strain at failure, εf :	1.16	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-3-A	**Specimen Information**		
Test Date:	2017-10-02	Initial Height:	3.889	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	341.5	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



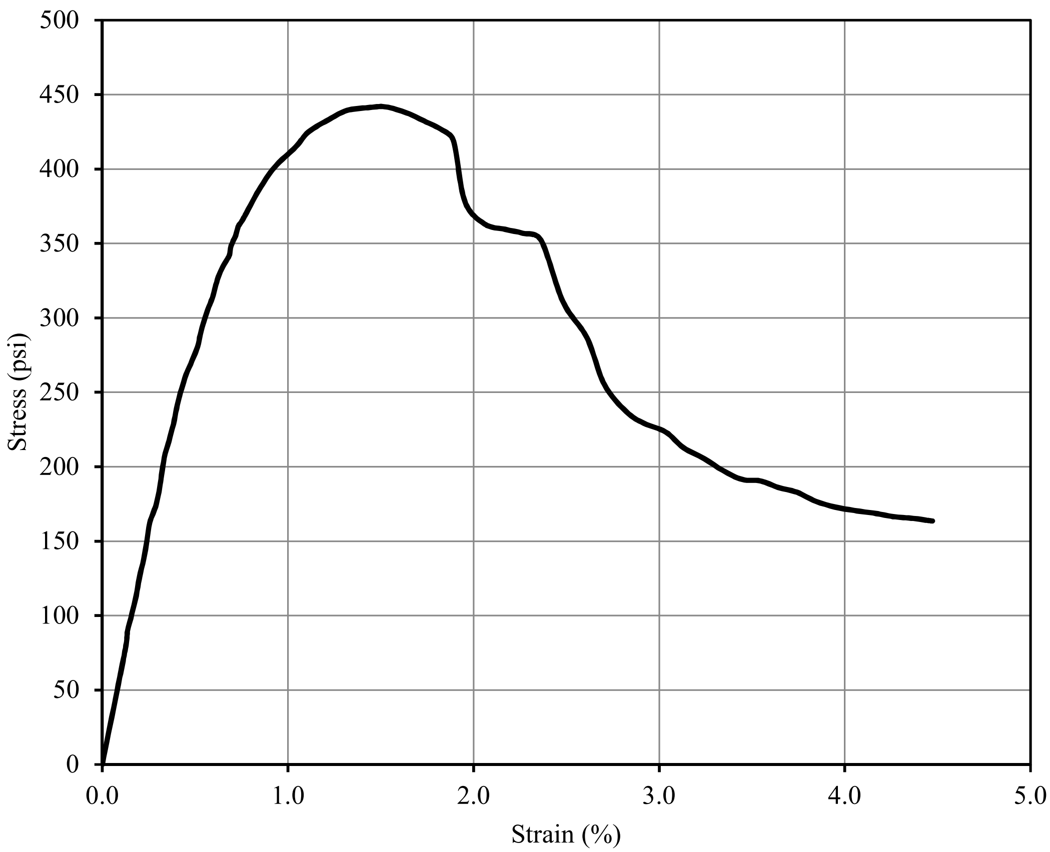
Test Result					
Peak deviator stress (w/ Height correction)	357	psi	Strain at failure, εf :	1.69	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-3-H	**Specimen Information**		
Test Date:	2017-10-02	Initial Height:	3.911	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	343.8	g
(w:c)$_{slurry}$:	0.6	Unit Weight:	103	pcf



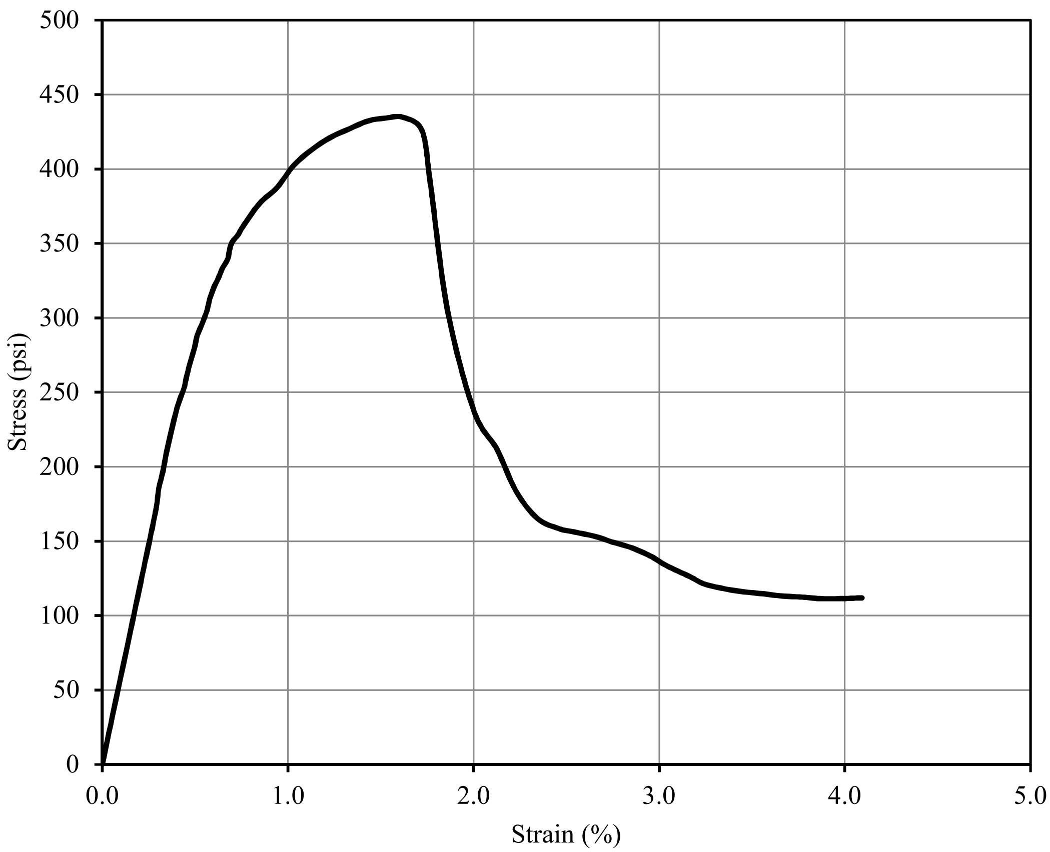
Test Result					
Peak deviator stress (w/ Height correction)	358	psi	Strain at failure, εf :	1.70	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-3-B	**Specimen Information**		
Test Date:	2017-10-06	Initial Height:	3.755	in
Strain Rate:	1 %/min	Initial Diameter:	2.035	in
Mixture Proportion		Initial Area:	3.253	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	329.1	g
$(w{:}c)_{slurry}$:	0.6	Unit Weight:	103	pcf



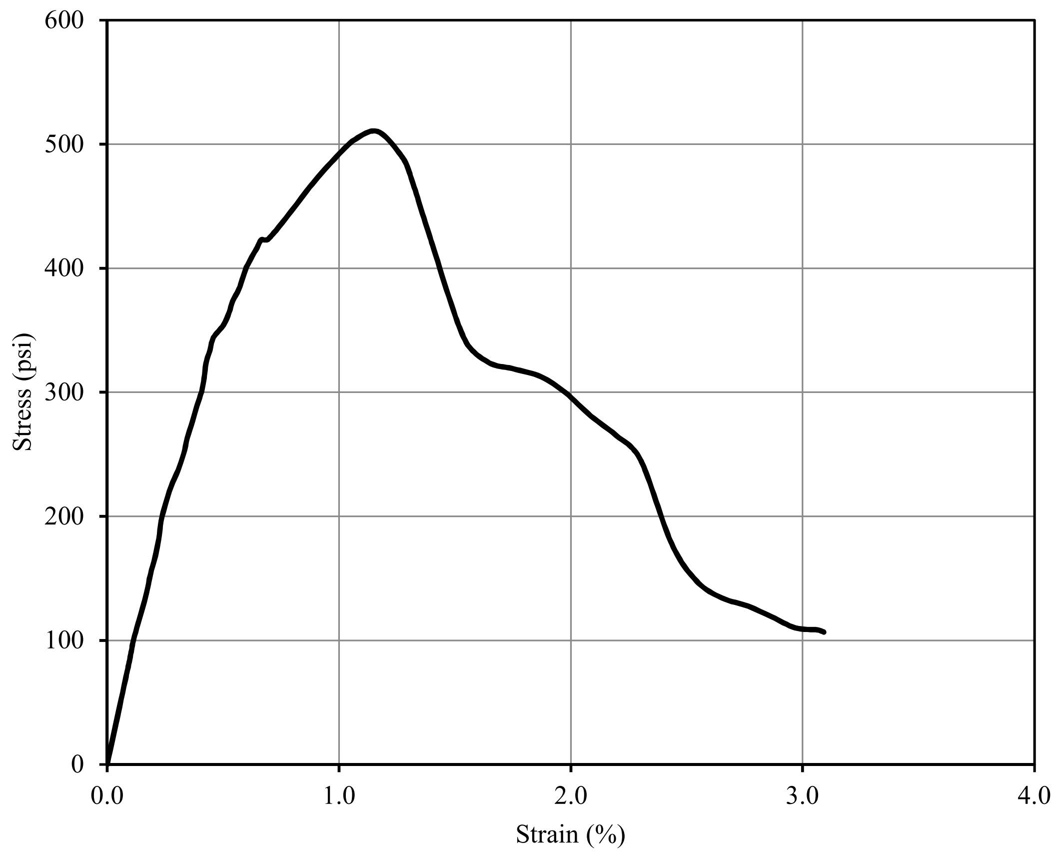
Test Result					
Peak deviator stress (w/ Height correction)	436	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-3-G	**Specimen Information**		
Test Date:	2017-10-06	Initial Height:	3.646	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	320.5	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



Test Result					
Peak deviator stress (w/ Height correction)	428	psi	Strain at failure, εf :	1.62	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-3-I	**Specimen Information**		
Test Date:	2017-10-13	Initial Height:	3.735	in
Strain Rate:	1 %/min	Initial Diameter:	2.031	in
Mixture Proportion		Initial Area:	3.240	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	328.4	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf

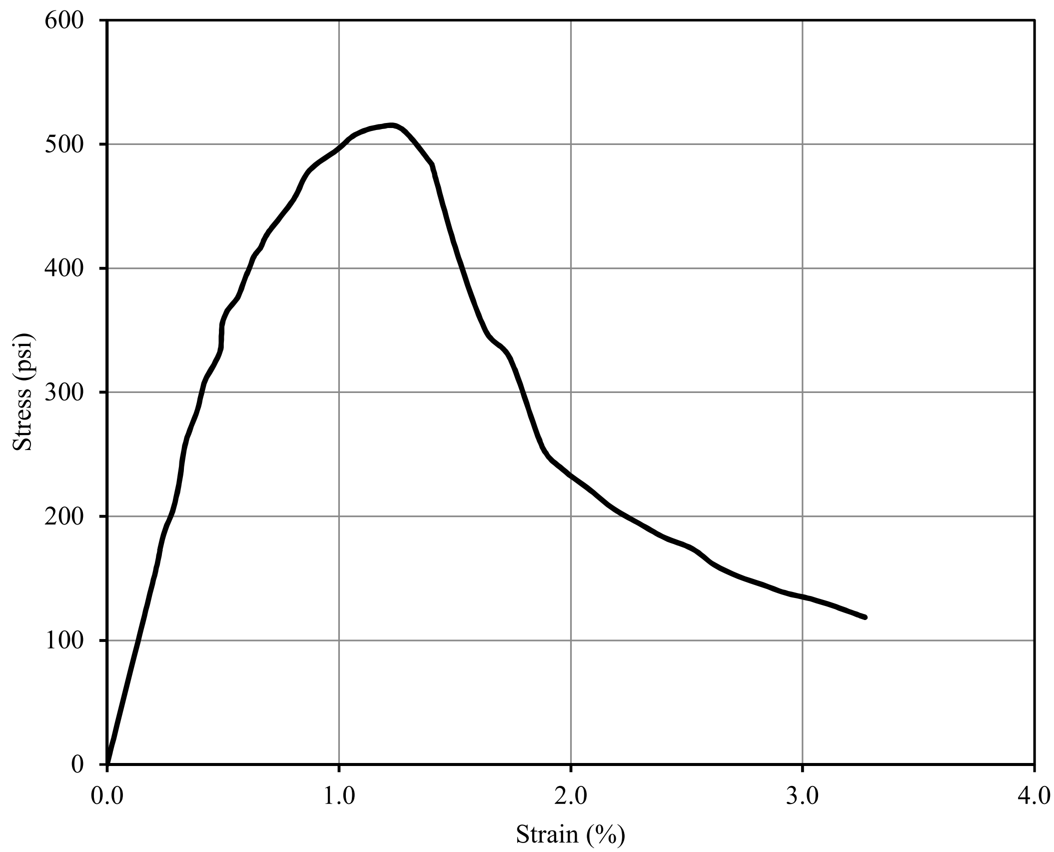


Test Result					
Peak deviator stress (w/ Height correction)	504	psi	Strain at failure, εf :	1.17	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

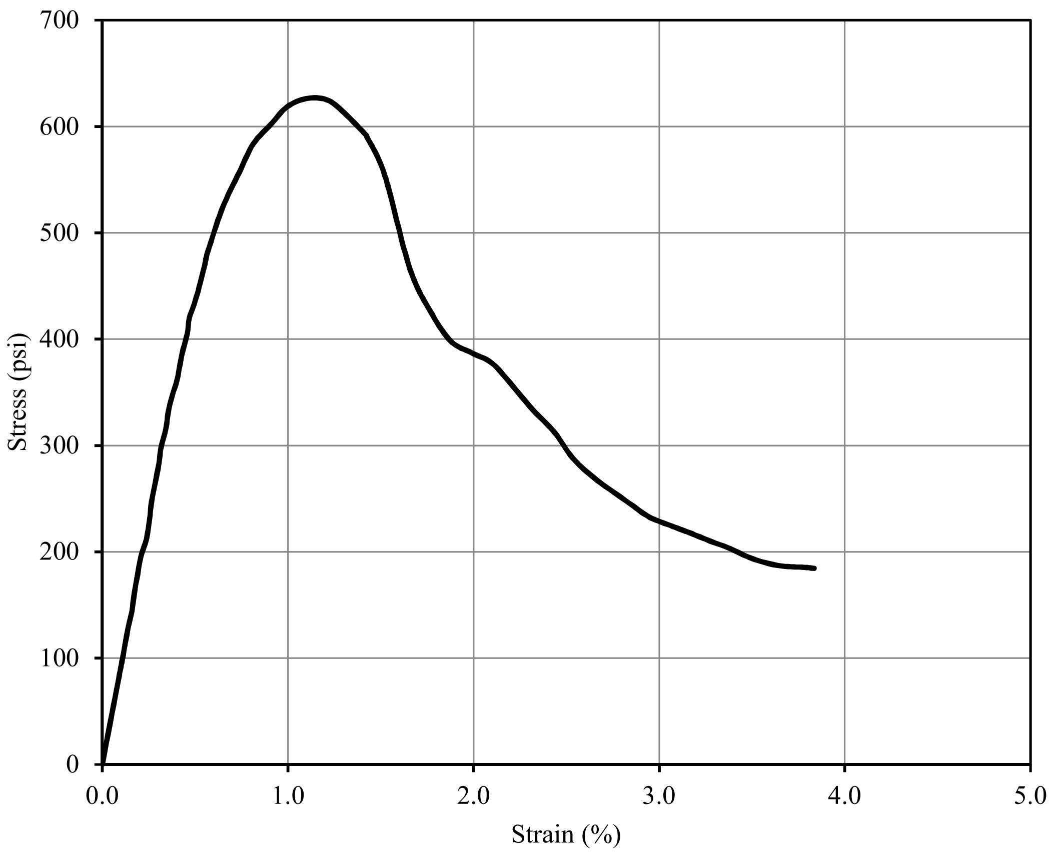
Test Information		Specimen Information		
I.D.:	S-3-F	Initial Height:	3.792	in
Test Date:	2017-10-13	Initial Diameter:	2.035	in
Strain Rate:	1 %/min	Initial Area:	3.253	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	333.6	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



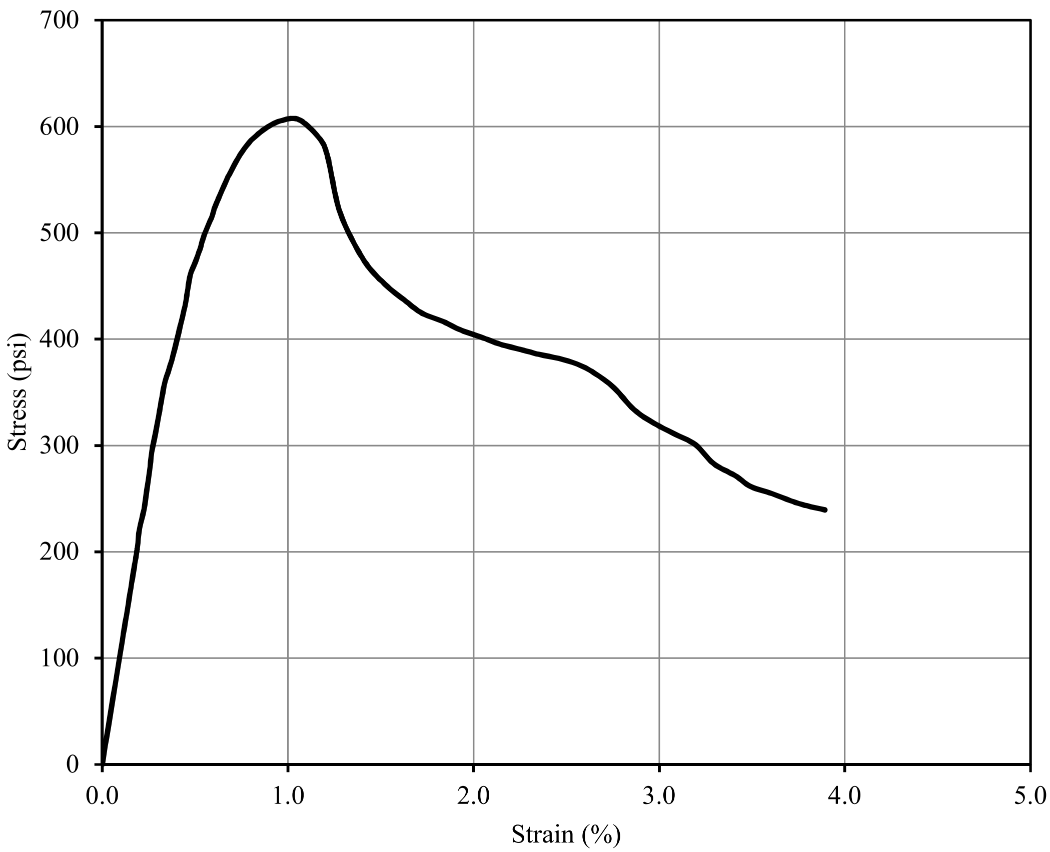
Test Result					
Peak deviator stress (w/ Height correction)	508	psi	Strain at failure, εf :	1.17	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-3-D	**Specimen Information**		
Test Date:	2017-10-27	Initial Height:	3.646	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	320.2	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



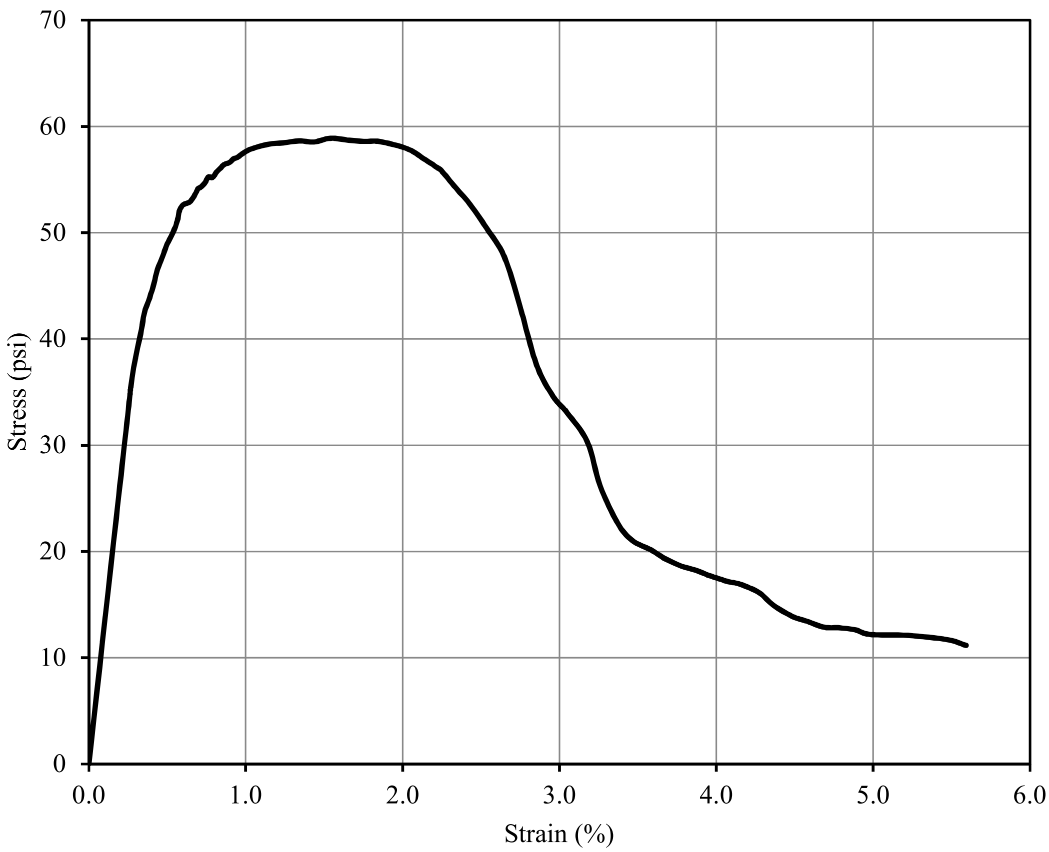
Test Result					
Peak deviator stress (w/ Height correction)	616	psi	Strain at failure, εf :	1.10	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-3-E	**Specimen Information**		
Test Date:	2017-10-27	Initial Height:	3.721	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	327.8	g
$(w:c)_{slurry}$:	0.6	Unit Weight:	103	pcf



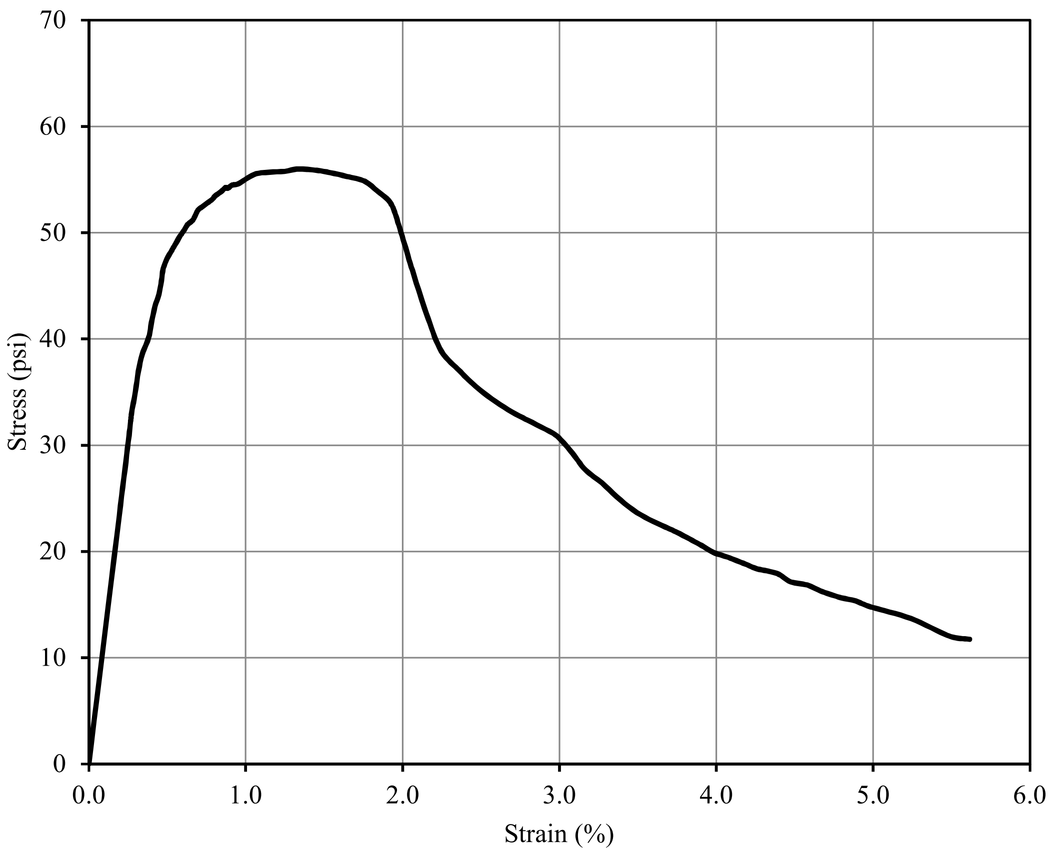
Test Result					
Peak deviator stress (w/ Height correction)	598	psi	Strain at failure, εf :	1.07	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-A	**Specimen Information**		
Test Date:	2017-09-17	Initial Height:	3.876	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	327.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



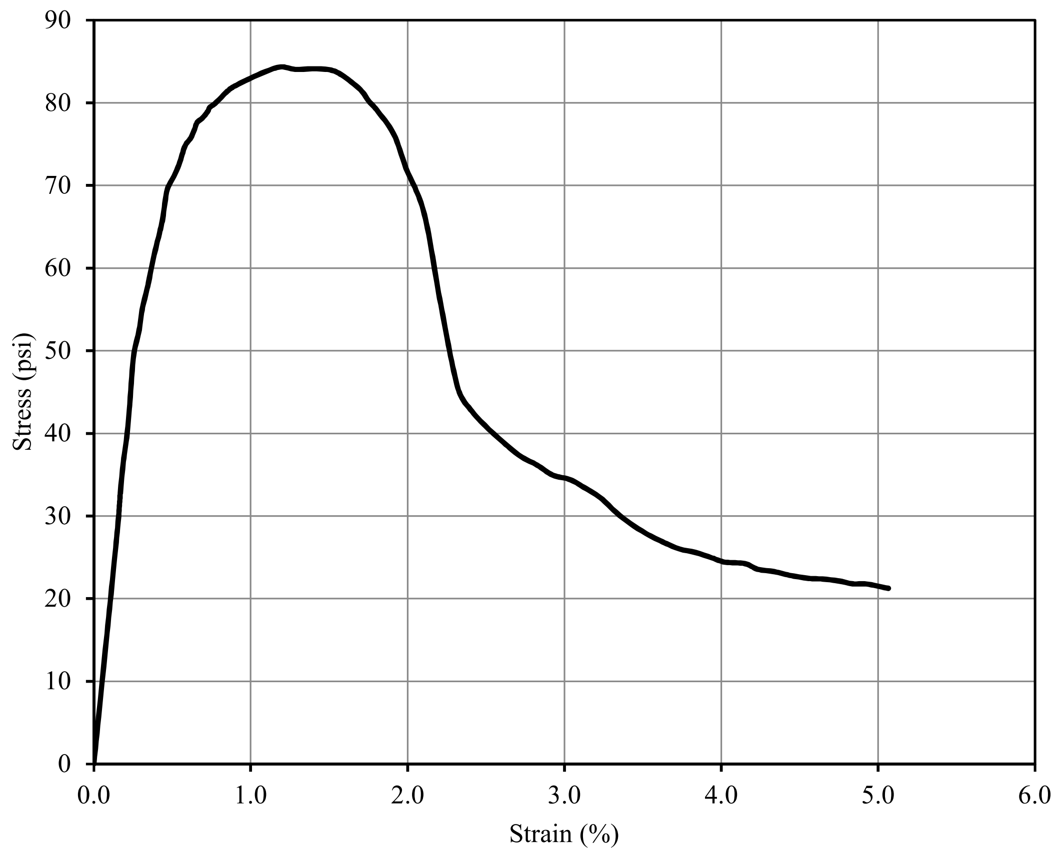
Test Result					
Peak deviator stress (w/ Height correction)	58	psi	Strain at failure, εf :	1.54	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-H	**Specimen Information**		
Test Date:	2017-09-17	Initial Height:	3.926	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	330.8	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	99	pcf



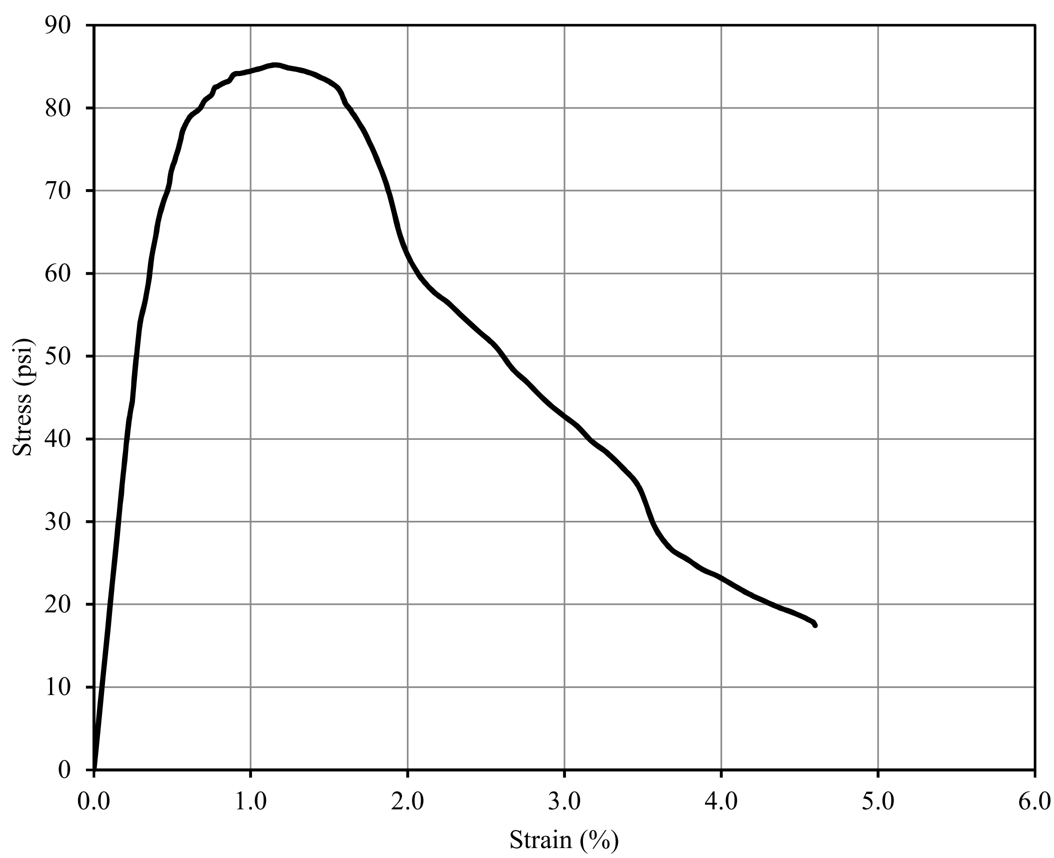
Test Result					
Peak deviator stress (w/ Height correction)	56	psi	Strain at failure, εf :	1.34	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-B	**Specimen Information**		
Test Date:	2017-09-21	Initial Height:	3.915	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	330.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



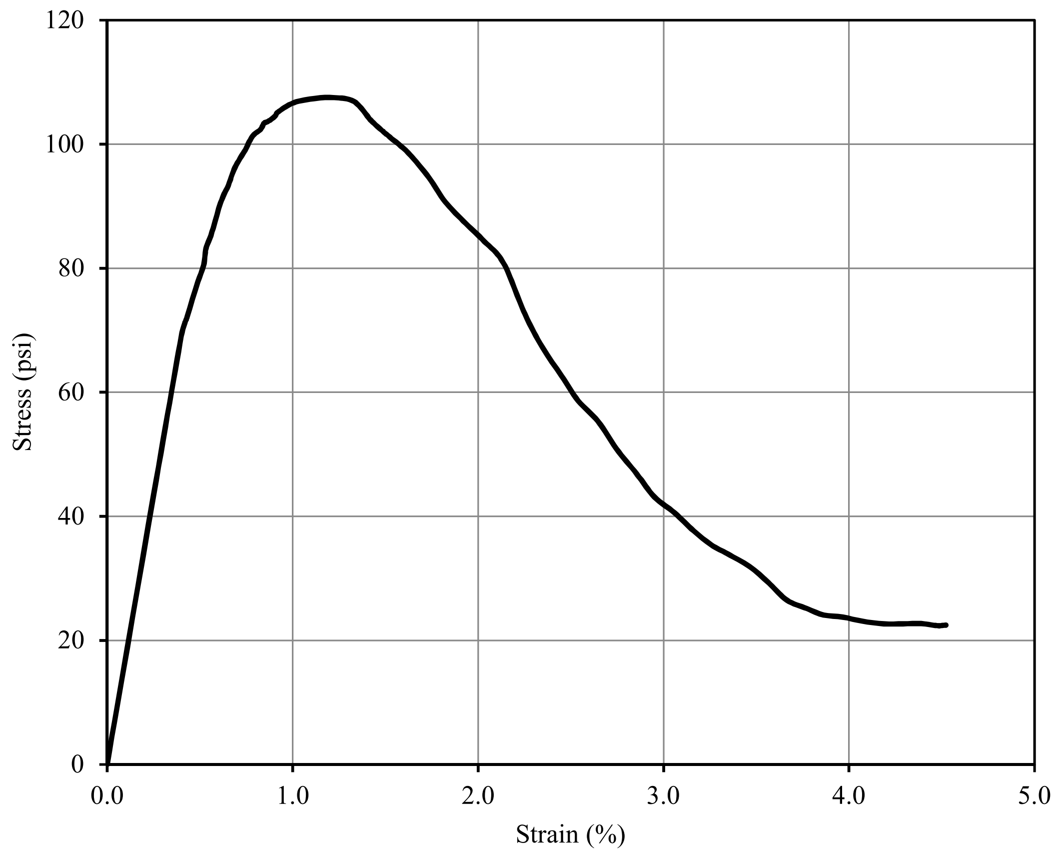
Test Result					
Peak deviator stress (w/ Height correction)	84	psi	Strain at failure, εf :	1.19	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-G	**Specimen Information**		
Test Date:	2017-09-21	Initial Height:	3.928	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	332.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



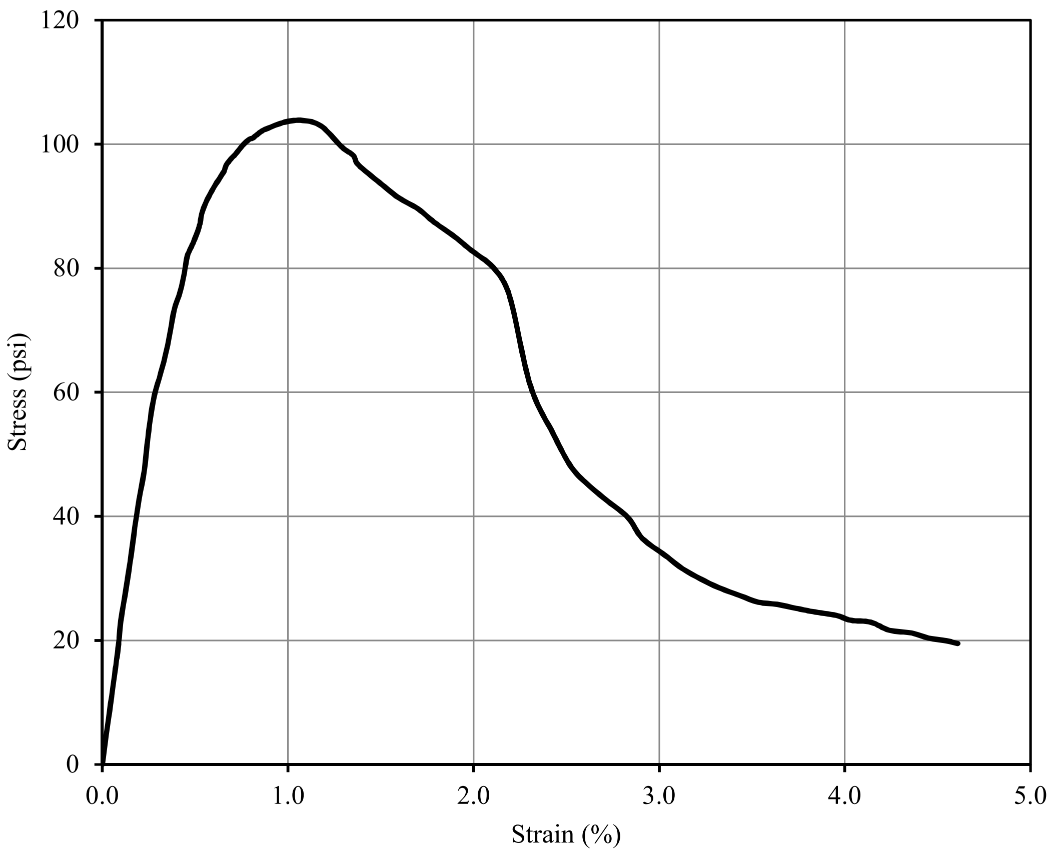
Test Result					
Peak deviator stress (w/ Height correction)	85	psi	Strain at failure, εf :	1.16	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-C	**Specimen Information**		
Test Date:	2017-09-28	Initial Height:	3.904	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	329.8	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	99	pcf



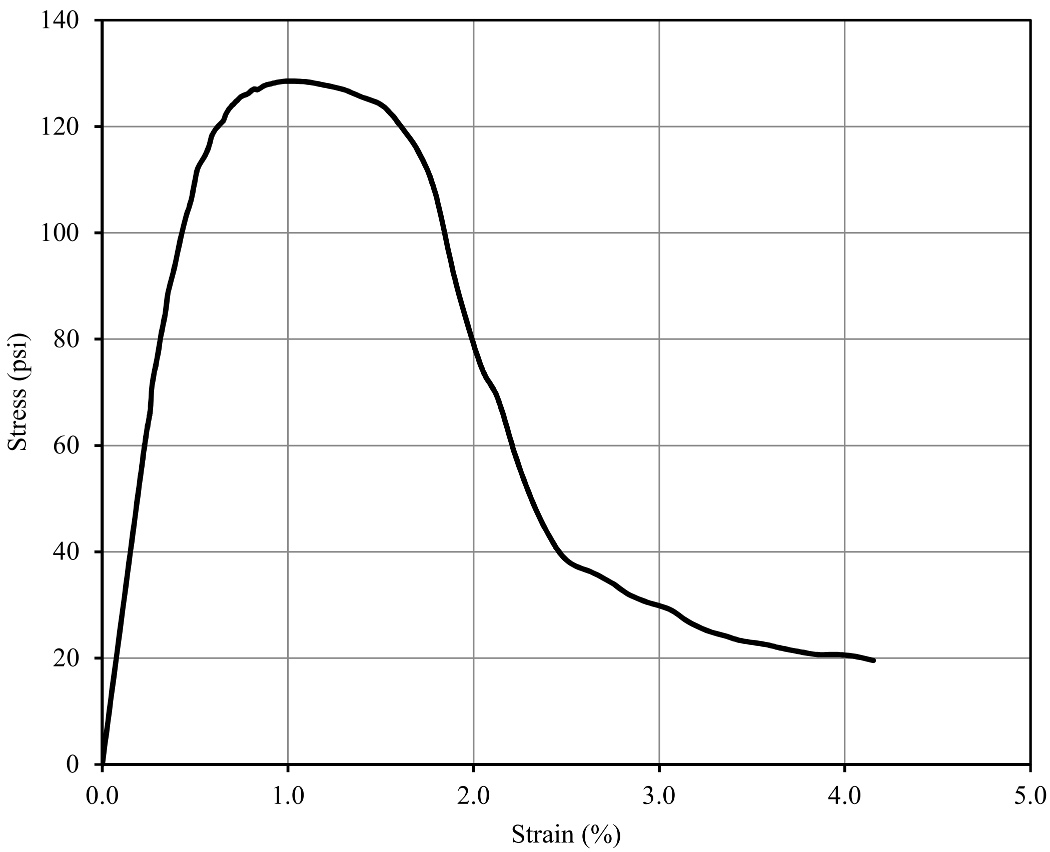
Test Result					
Peak deviator stress (w/ Height correction)	107	psi	Strain at failure, εf :	1.22	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-F	**Specimen Information**		
Test Date:	2017-09-28	Initial Height:	3.905	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	329.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



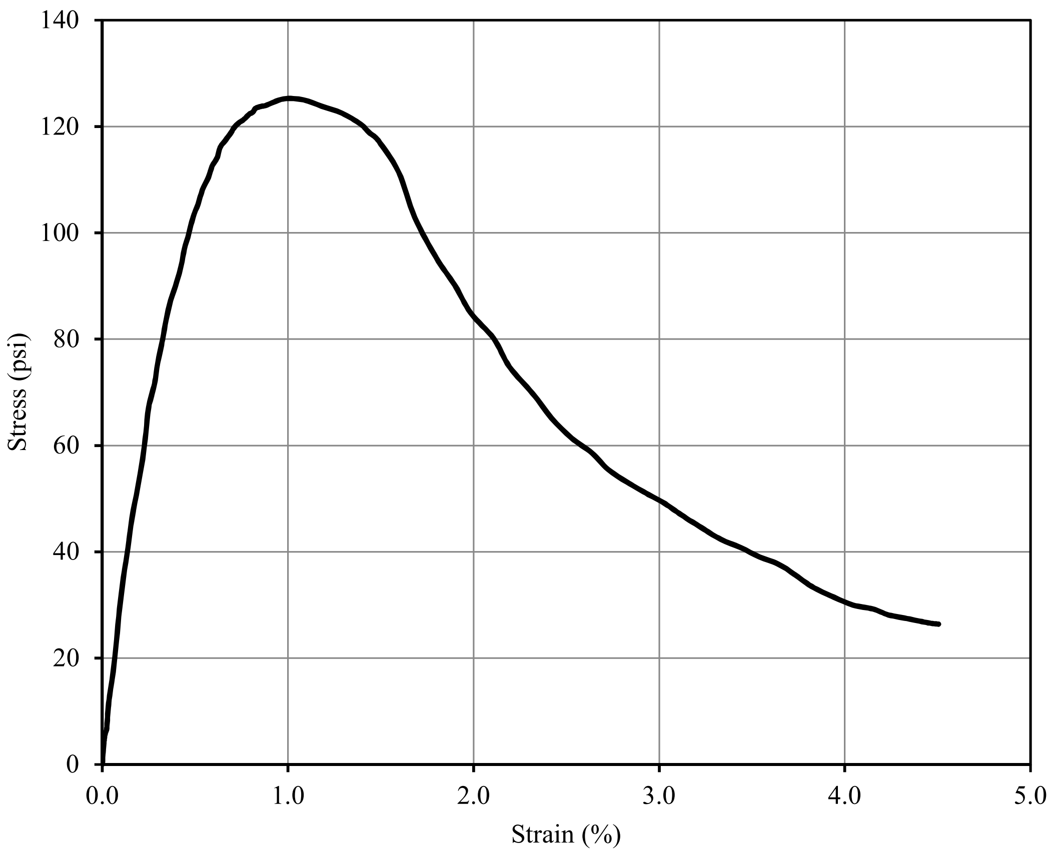
Test Result					
Peak deviator stress (w/ Height correction)	103	psi	Strain at failure, εf :	1.08	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-D	**Specimen Information**		
Test Date:	2017-10-12	Initial Height:	3.891	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	329.0	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



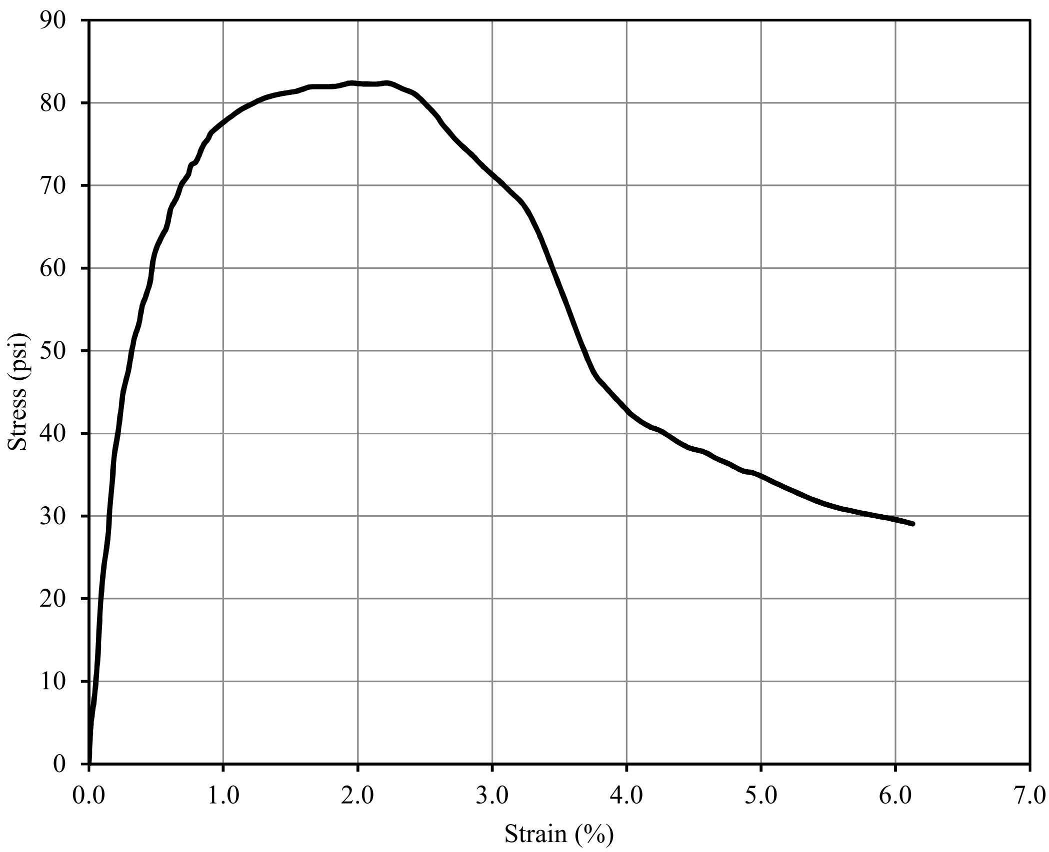
Test Result					
Peak deviator stress (w/ Height correction)	128	psi	Strain at failure, εf :	0.98	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-4-E	**Specimen Information**		
Test Date:	2017-10-12	Initial Height:	3.651	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	307.9	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	99	pcf



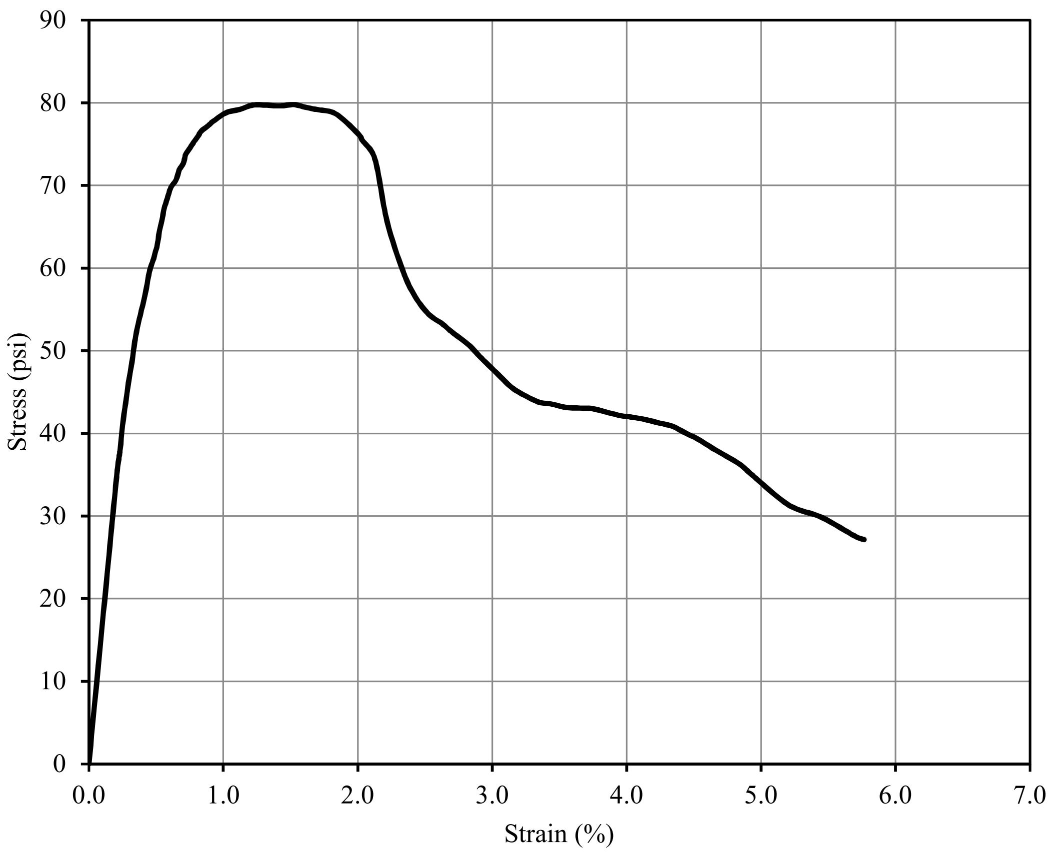
Test Result					
Peak deviator stress (w/ Height correction)	123	psi	Strain at failure, εf :	0.98	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.8	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-5-A	**Specimen Information**		
Test Date:	2017-09-17	Initial Height:	3.878	in
Strain Rate:	1 %/min	Initial Diameter:	2.03	in
Mixture Proportion		Initial Area:	3.237	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	324.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



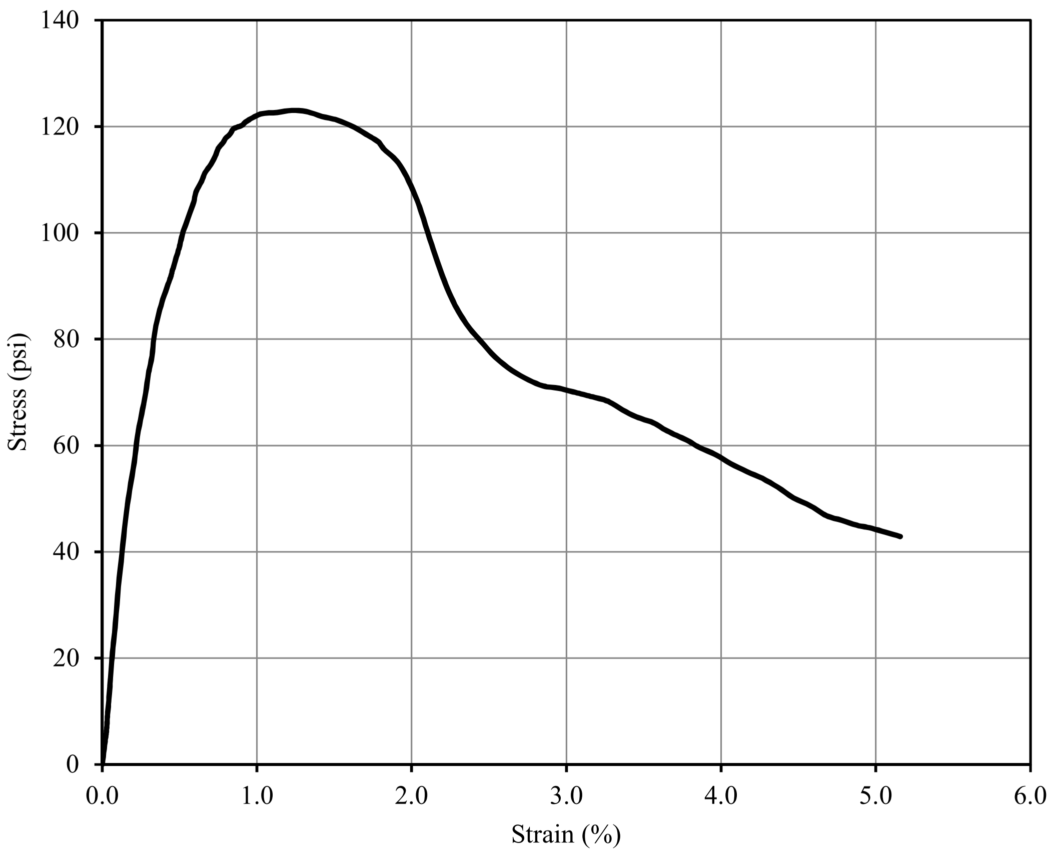
Test Result					
Peak deviator stress (w/ Height correction)	82	psi	Strain at failure, εf :	1.94	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.8	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-5-H	**Specimen Information**		
Test Date:	2017-09-17	Initial Height:	3.677	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	308.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



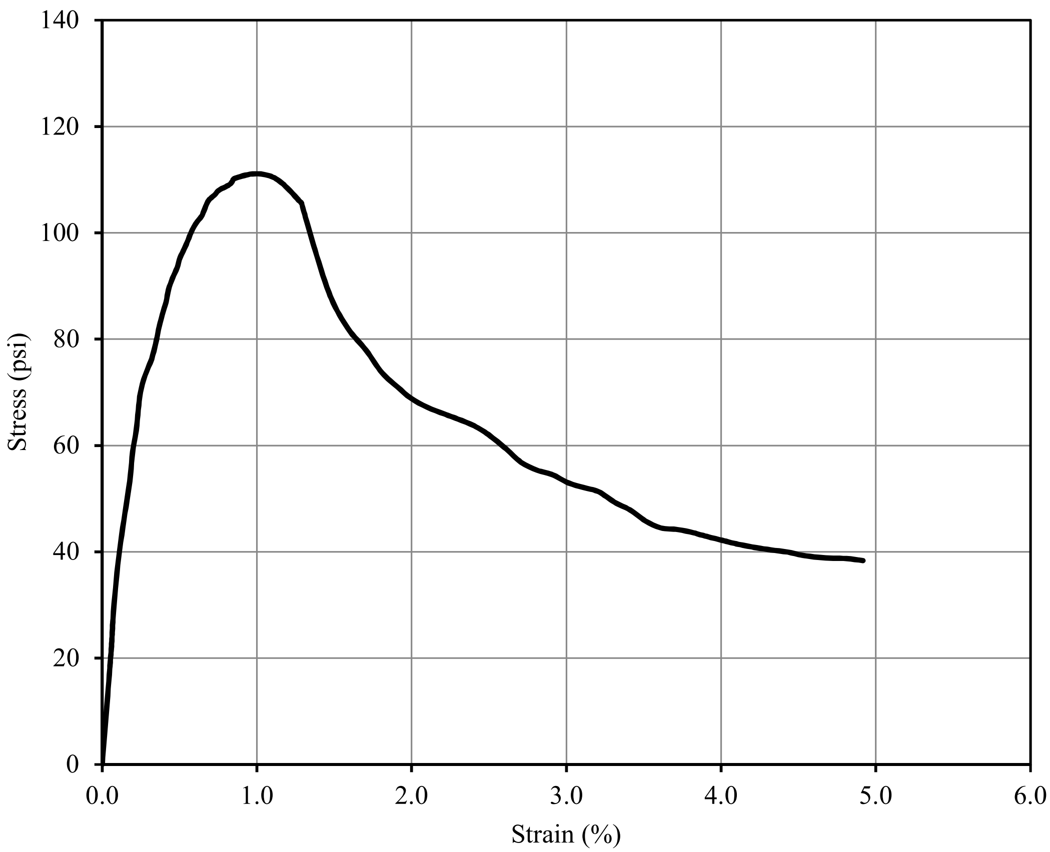
Test Result					
Peak deviator stress (w/ Height correction)	79	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.8	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-5-B	**Specimen Information**		
Test Date:	2017-09-21	Initial Height:	3.674	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	308.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



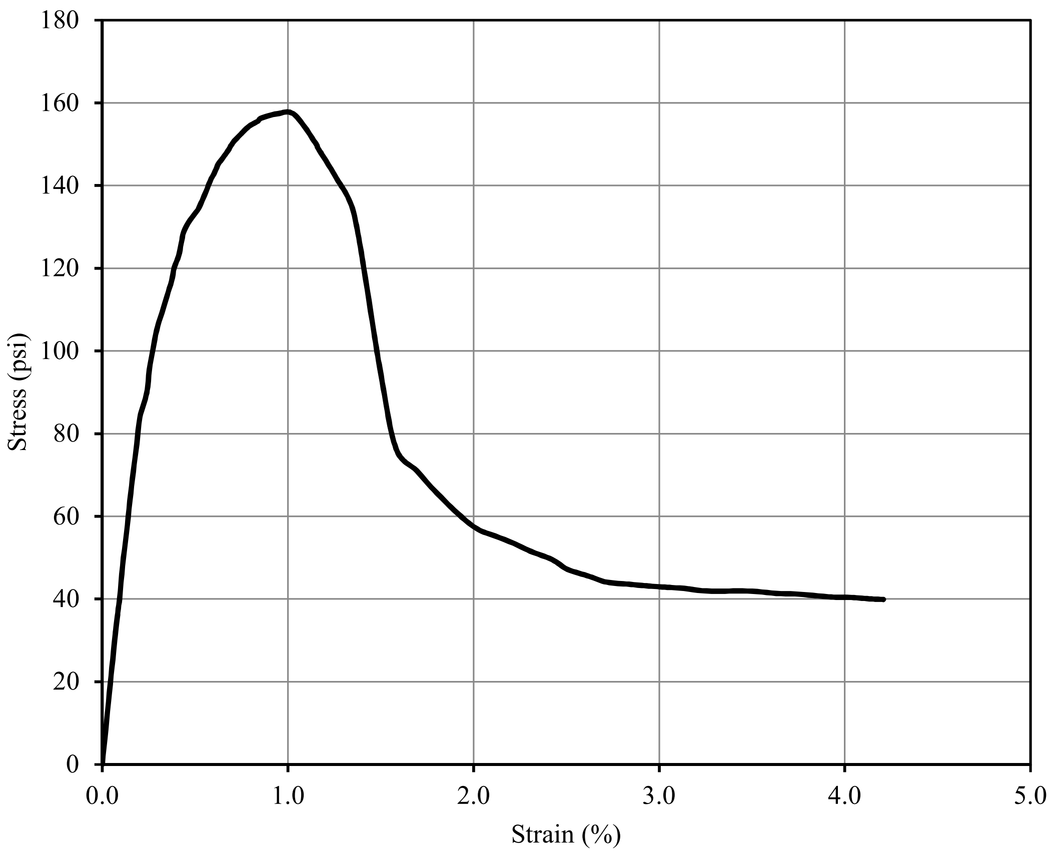
Test Result					
Peak deviator stress (w/ Height correction)	121	psi	Strain at failure, εf :	1.22	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.8	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-5-G	**Specimen Information**		
Test Date:	2017-09-21	Initial Height:	3.807	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	319.7	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	98	pcf



Test Result					
Peak deviator stress (w/ Height correction)	110	psi	Strain at failure, εf :	0.97	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-5-C	**Specimen Information**		
Test Date:	2017-09-28	Initial Height:	3.81	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	320.7	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf

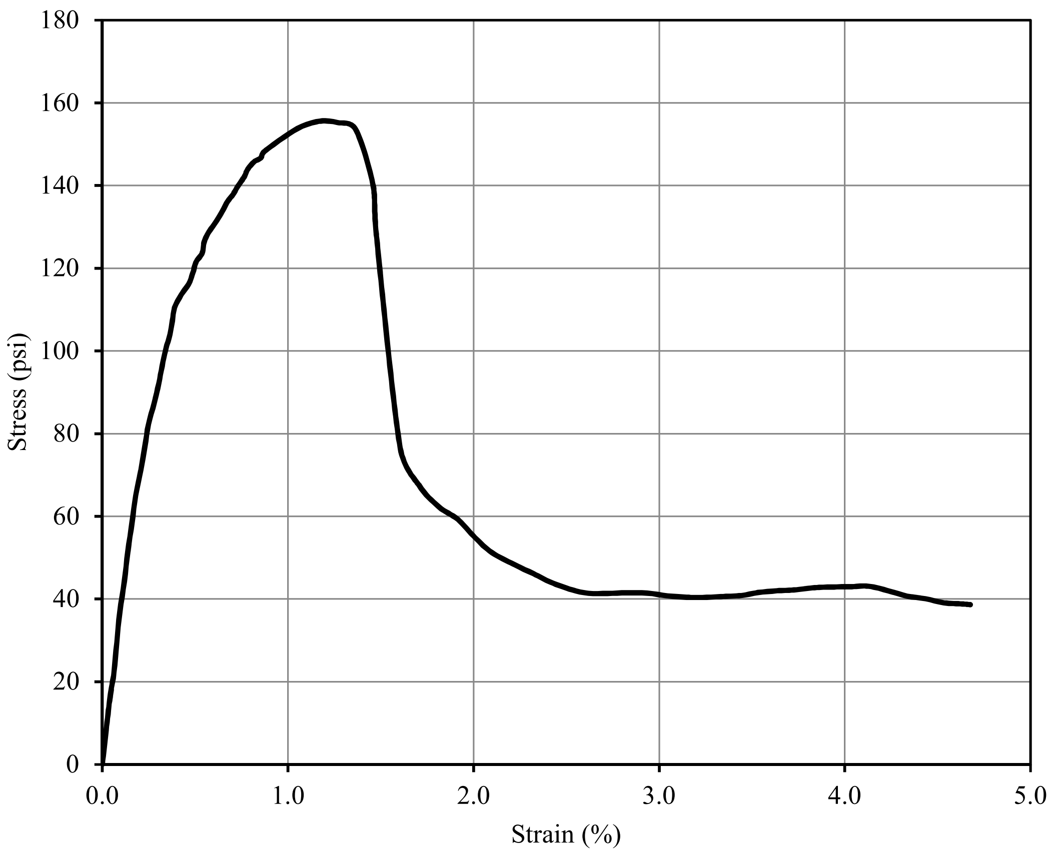


Test Result					
Peak deviator stress (w/ Height correction)	156	psi	Strain at failure, εf :	0.94	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

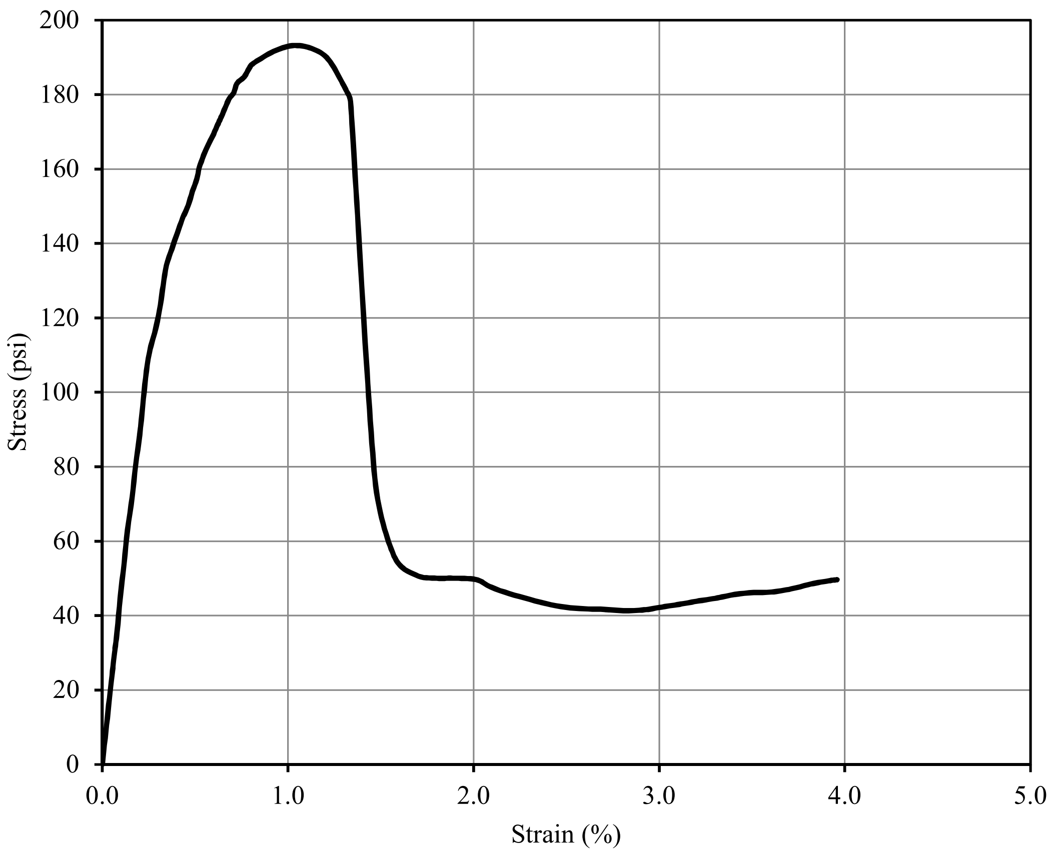
Test Information		Specimen Information		
I.D.:	S-5-F	Initial Height:	3.852	in
Test Date:	2017-09-28	Initial Diameter:	2.036	in
Strain Rate:	1 %/min	Initial Area:	3.256	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	324.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



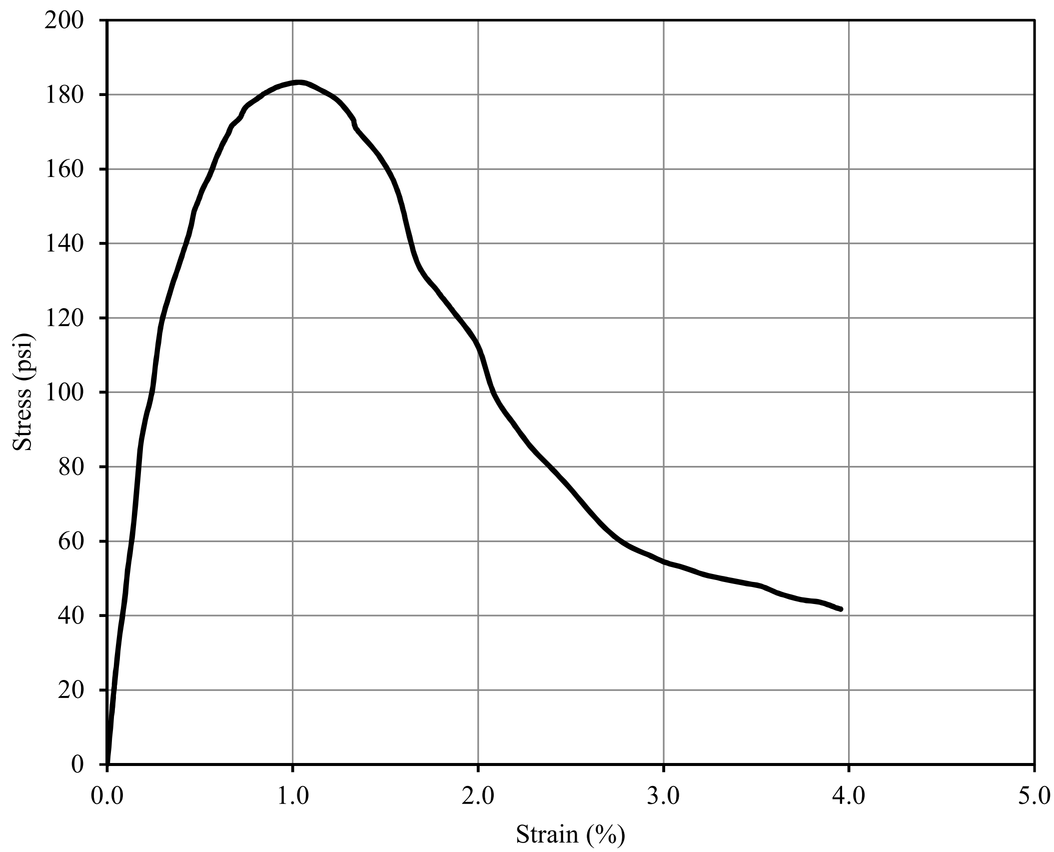
Test Result					
Peak deviator stress (w/ Height correction)	154	psi	Strain at failure, εf :	1.18	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-5-D	**Specimen Information**		
Test Date:	2017-10-12	Initial Height:	3.831	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	322.2	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



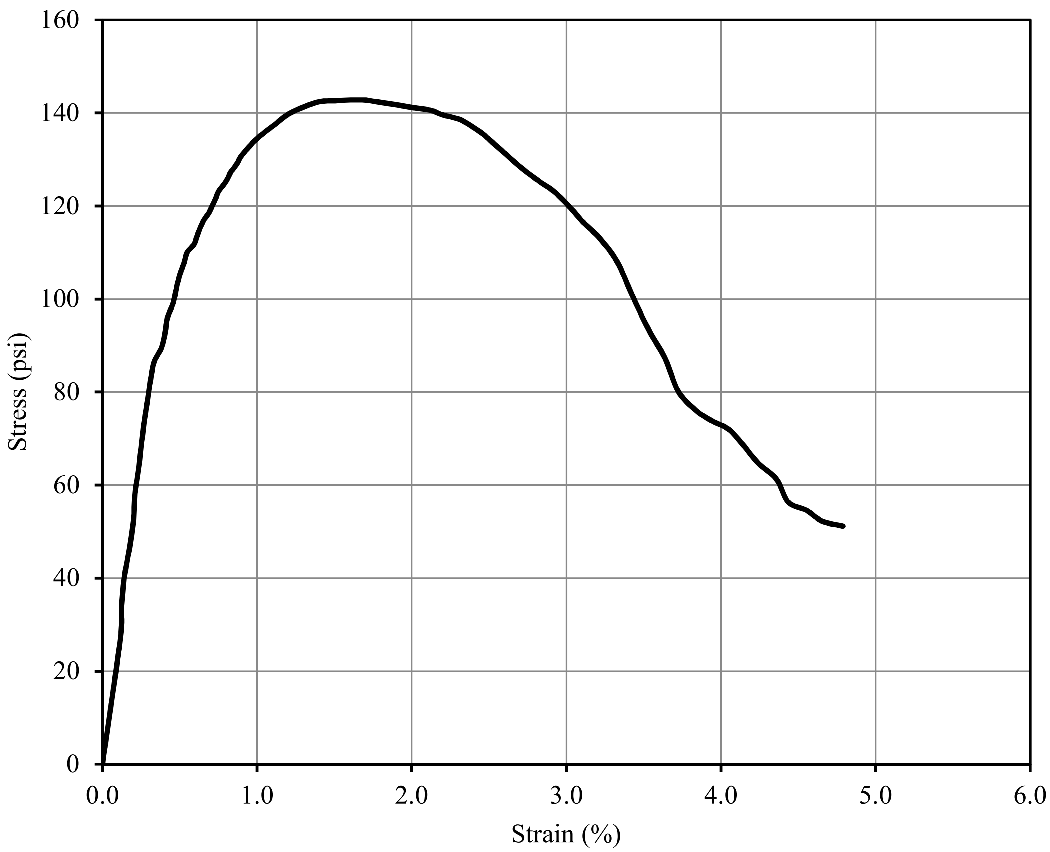
Test Result					
Peak deviator stress (w/ Height correction)	191	psi	Strain at failure, εf :	1.02	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-5-E	**Specimen Information**		
Test Date:	2017-10-12	Initial Height:	3.831	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	321.9	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



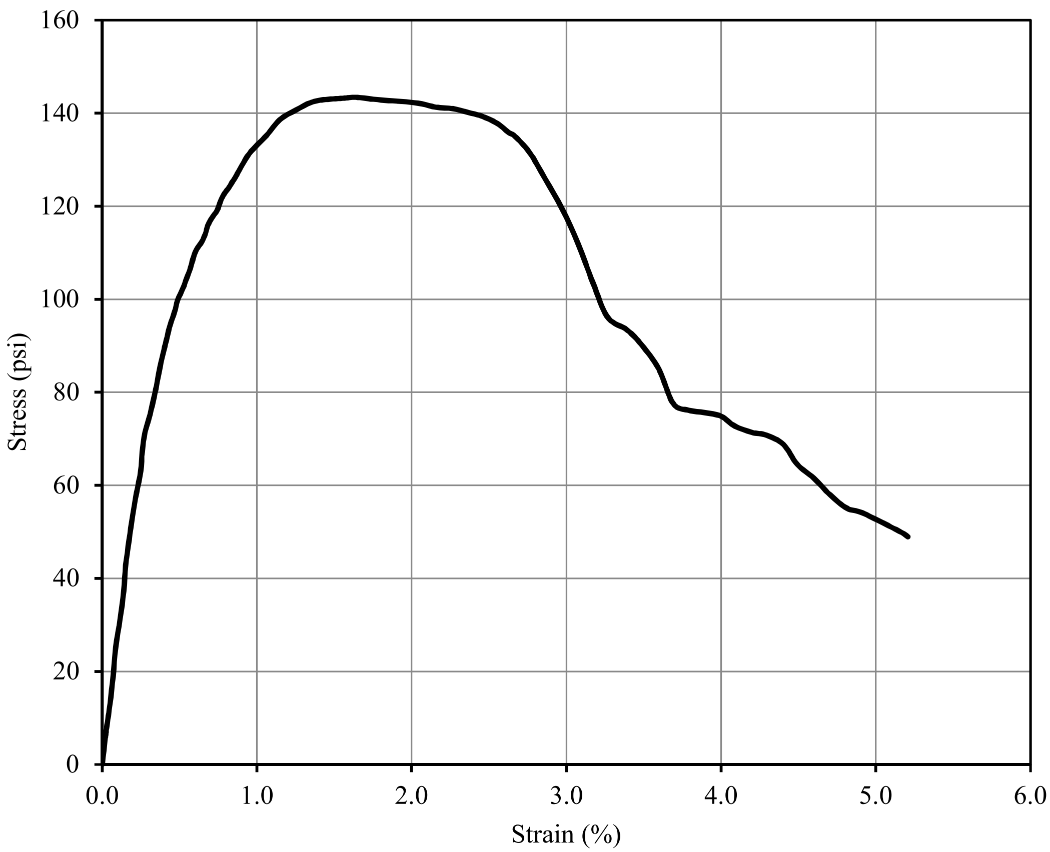
Test Result					
Peak deviator stress (w/ Height correction)	182	psi	Strain at failure, εf :	1.05	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-6-H	**Specimen Information**		
Test Date:	2017-10-06	Initial Height:	3.546	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	296.9	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	98	pcf



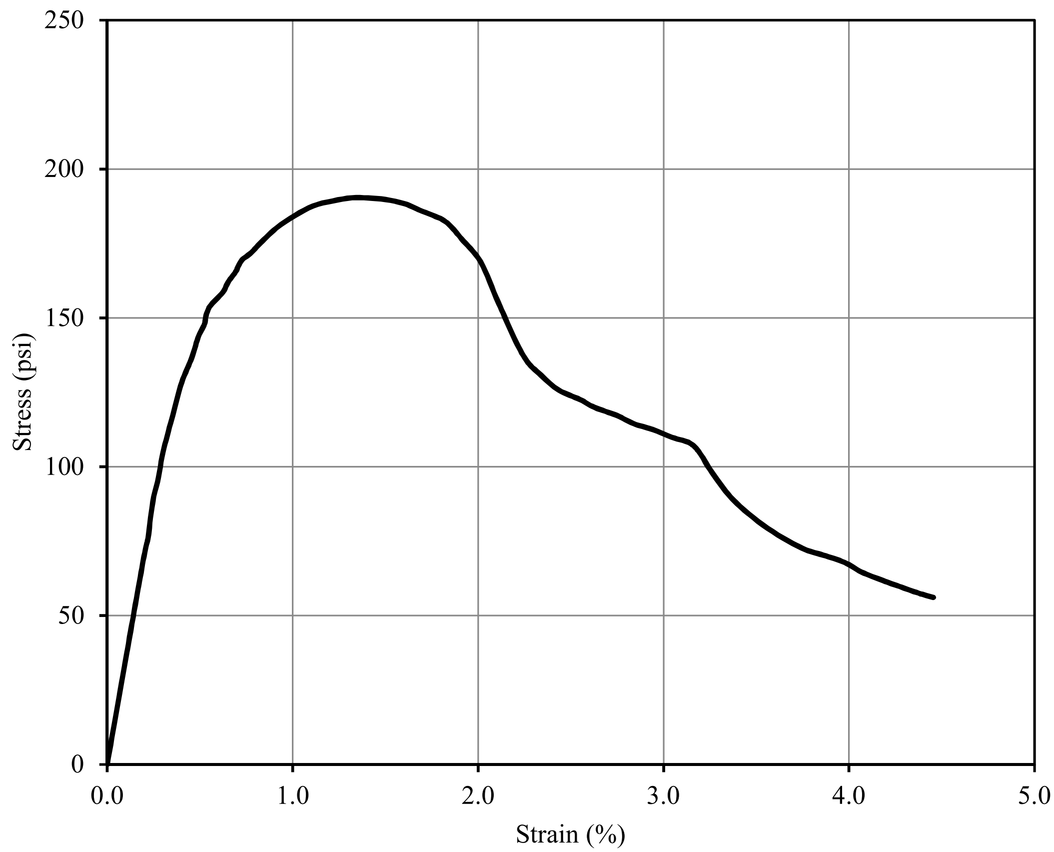
Test Result					
Peak deviator stress (w/ Height correction)	140	psi	Strain at failure, εf :	1.61	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-6-I	**Specimen Information**		
Test Date:	2017-10-06	Initial Height:	3.629	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	304.5	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



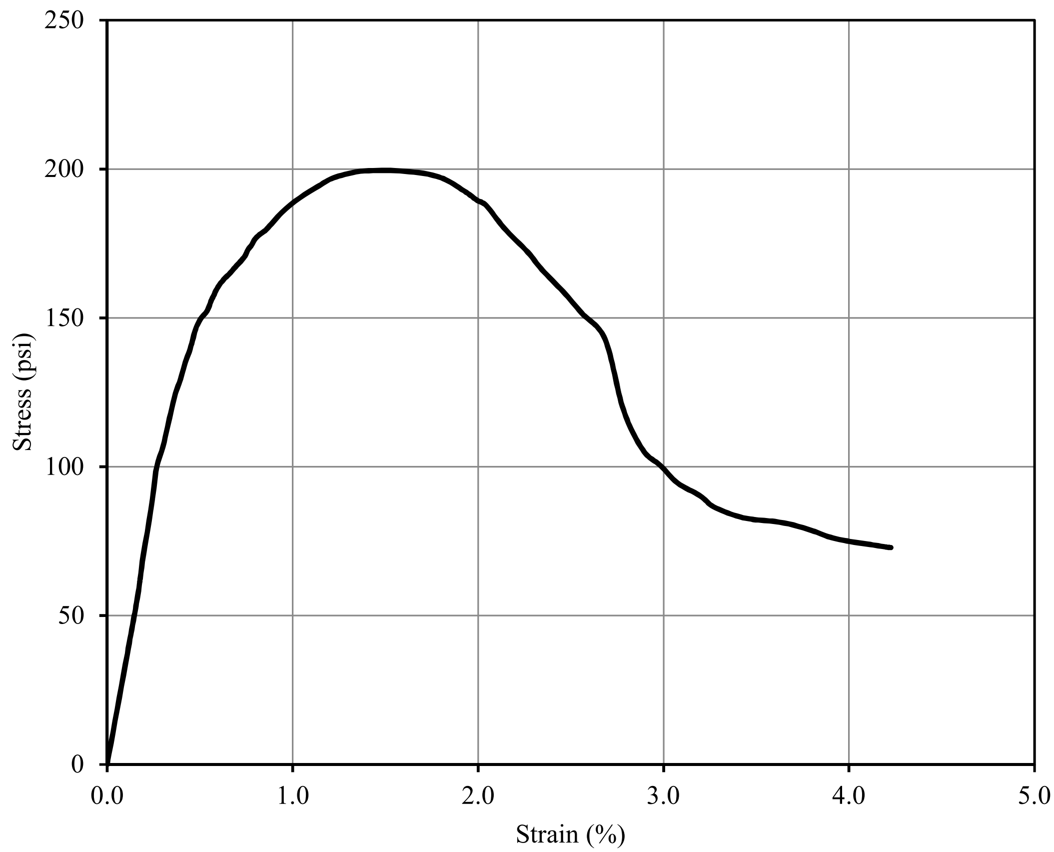
Test Result					
Peak deviator stress (w/ Height correction)	141	psi	Strain at failure, εf :	1.64	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-6-B	**Specimen Information**		
Test Date:	2017-10-10	Initial Height:	3.856	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	323.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



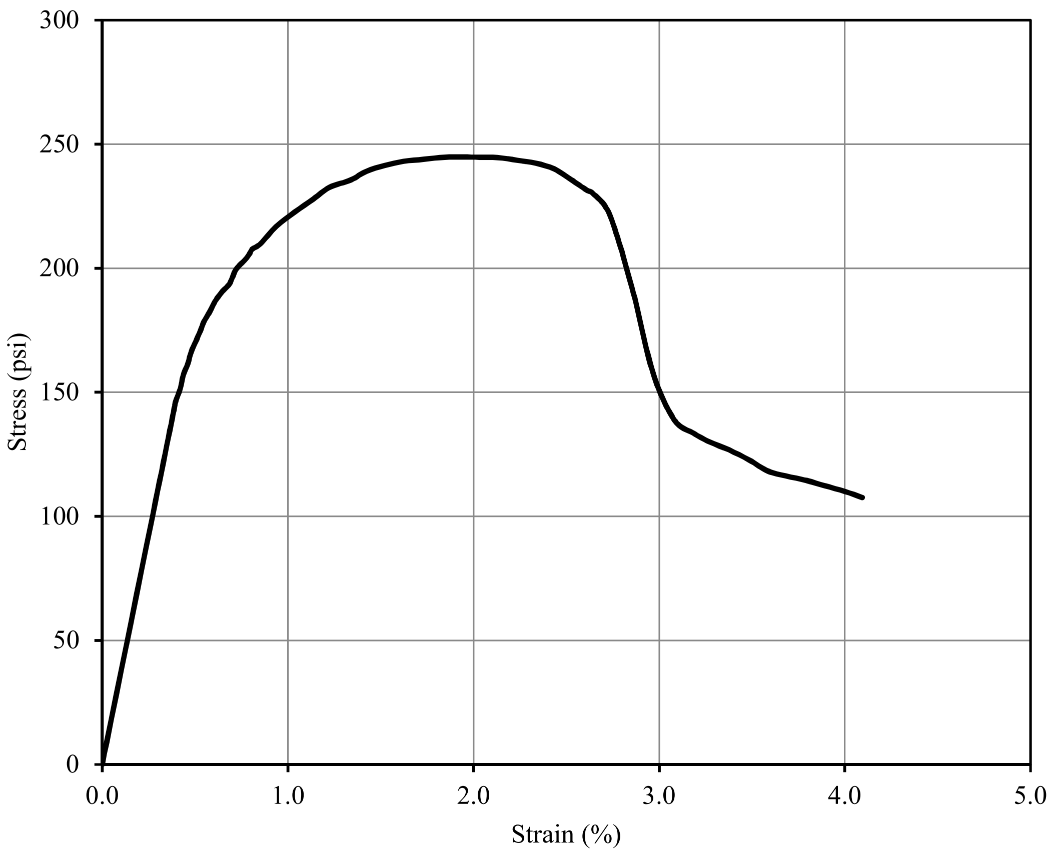
Test Result					
Peak deviator stress (w/ Height correction)	189	psi	Strain at failure, εf :	1.32	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-6-G	**Specimen Information**		
Test Date:	2017-10-10	Initial Height:	3.84	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	321.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



Test Result					
Peak deviator stress (w/ Height correction)	198	psi	Strain at failure, εf :	1.53	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-6-C	**Specimen Information**		
Test Date:	2017-10-17	Initial Height:	3.803	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	318.0	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	98	pcf

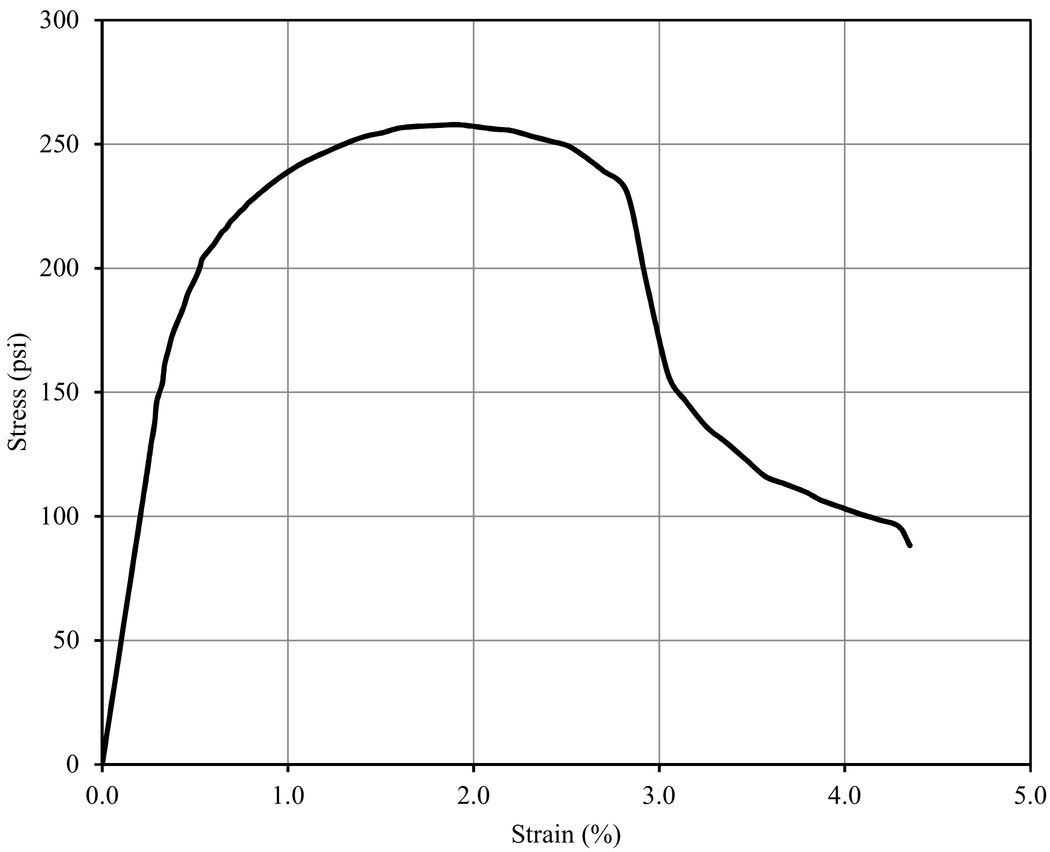


Test Result					
Peak deviator stress (w/ Height correction)	242	psi	Strain at failure, εf :	1.95	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

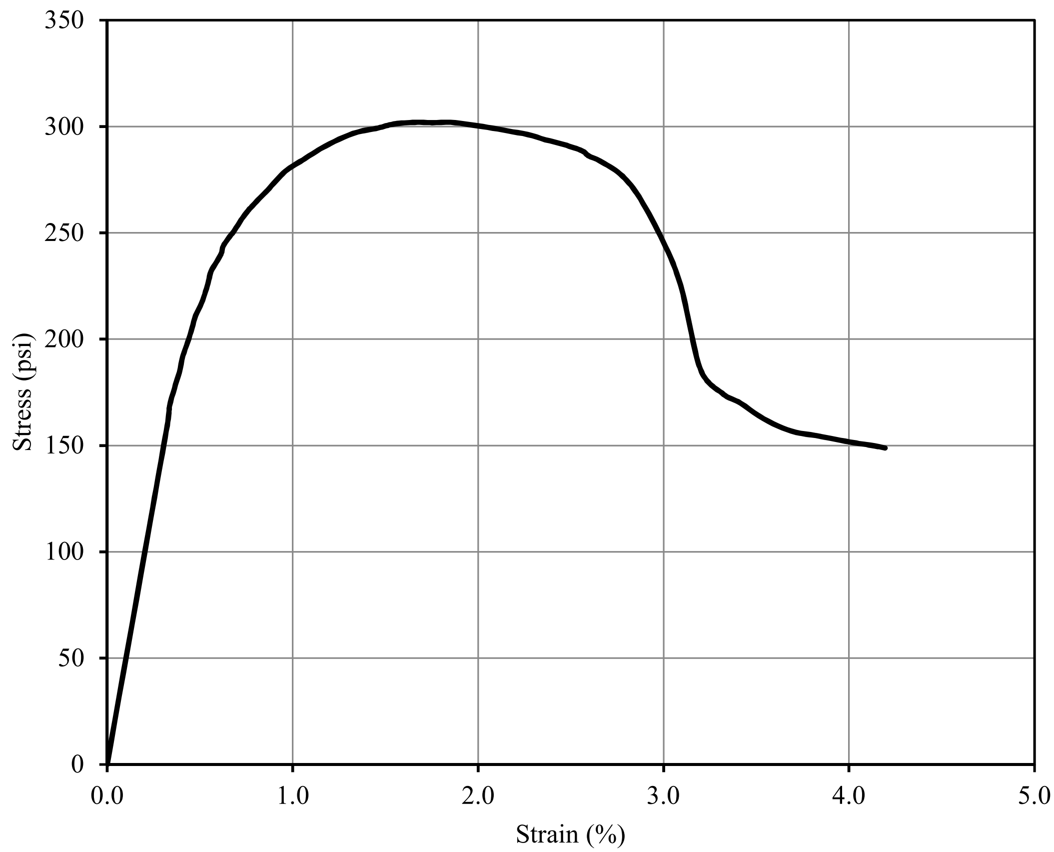
Test Information		Specimen Information		
I.D.:	S-6-F	Initial Height:	3.607	in
Test Date:	2017-10-17	Initial Diameter:	2.032	in
Strain Rate:	1 %/min	Initial Area:	3.243	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	301.9	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



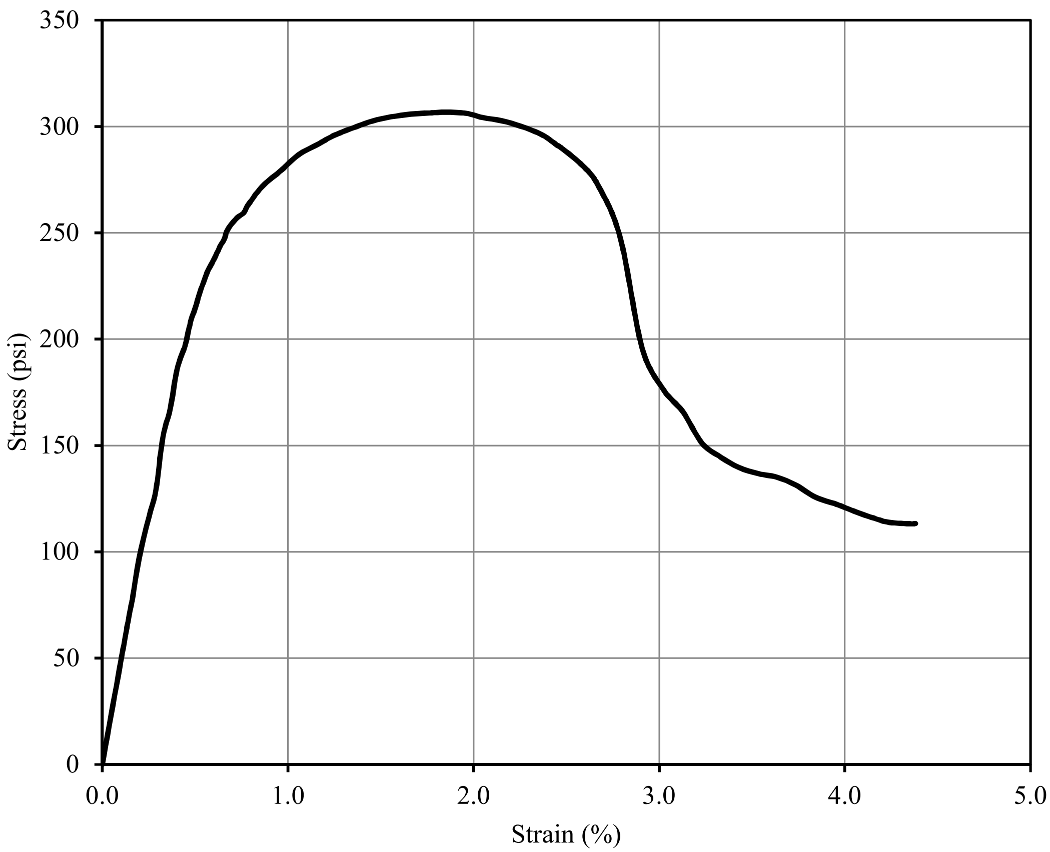
Test Result					
Peak deviator stress (w/ Height correction)	253	psi	Strain at failure, εf :	1.91	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-6-D	**Specimen Information**		
Test Date:	2017-10-31	Initial Height:	3.713	in
Strain Rate:	1 %/min	Initial Diameter:	2.029	in
Mixture Proportion		Initial Area:	3.233	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	310.8	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	99	pcf



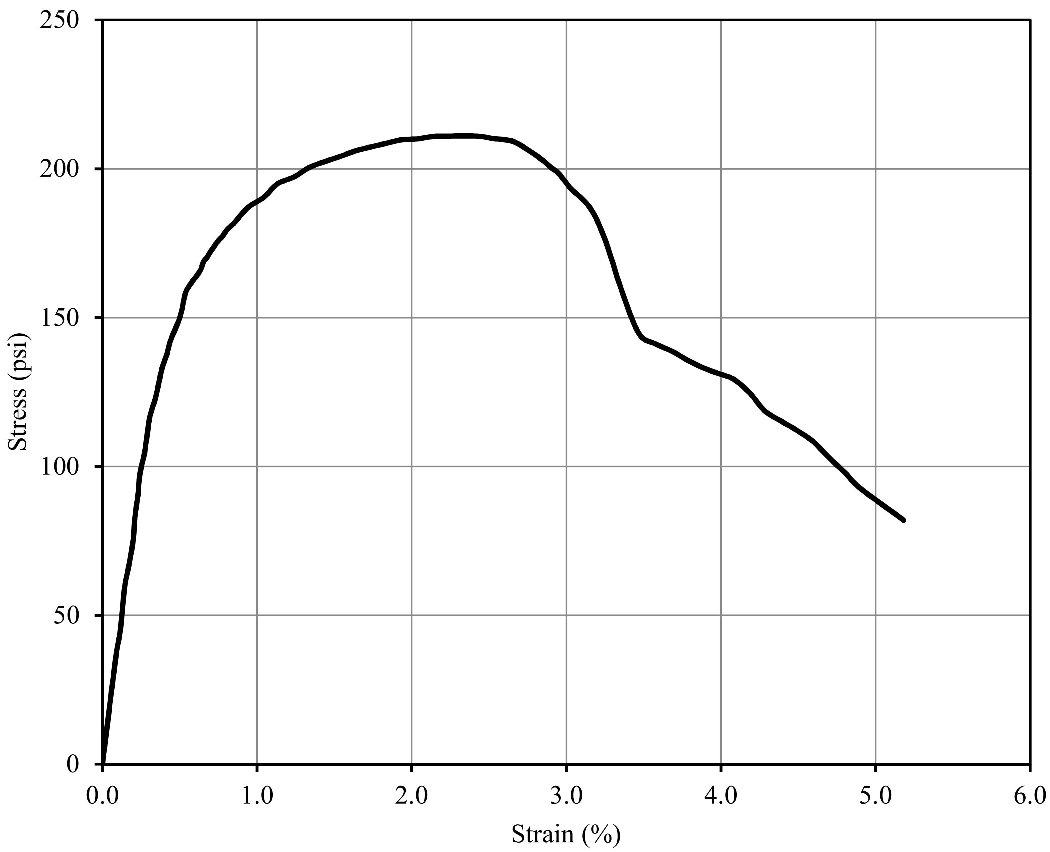
Test Result					
Peak deviator stress (w/ Height correction)	298	psi	Strain at failure, εf :	1.85	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-6-E	**Specimen Information**		
Test Date:	2017-10-31	Initial Height:	3.748	in
Strain Rate:	1 %/min	Initial Diameter:	2.030	in
Mixture Proportion		Initial Area:	3.237	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	313.6	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



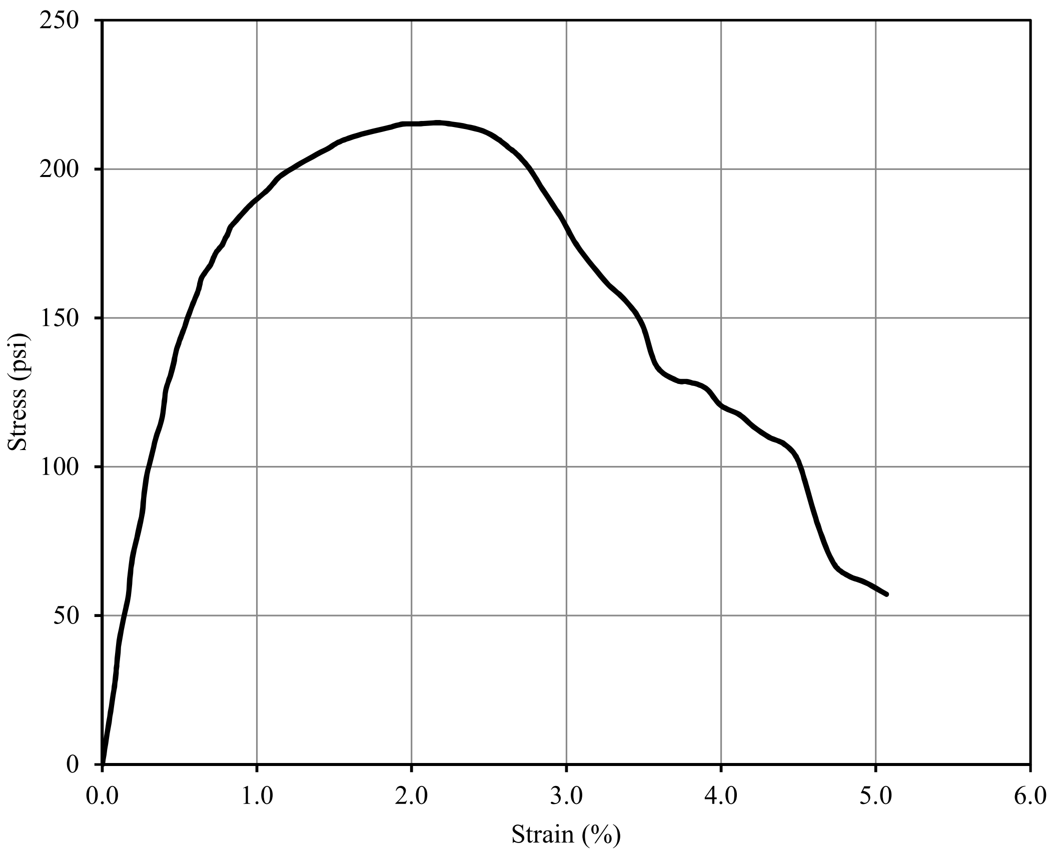
Test Result					
Peak deviator stress (w/ Height correction)	303	psi	Strain at failure, εf :	1.85	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-7-A	**Specimen Information**		
Test Date:	2017-09-29	Initial Height:	3.872	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	320.0	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	97	pcf



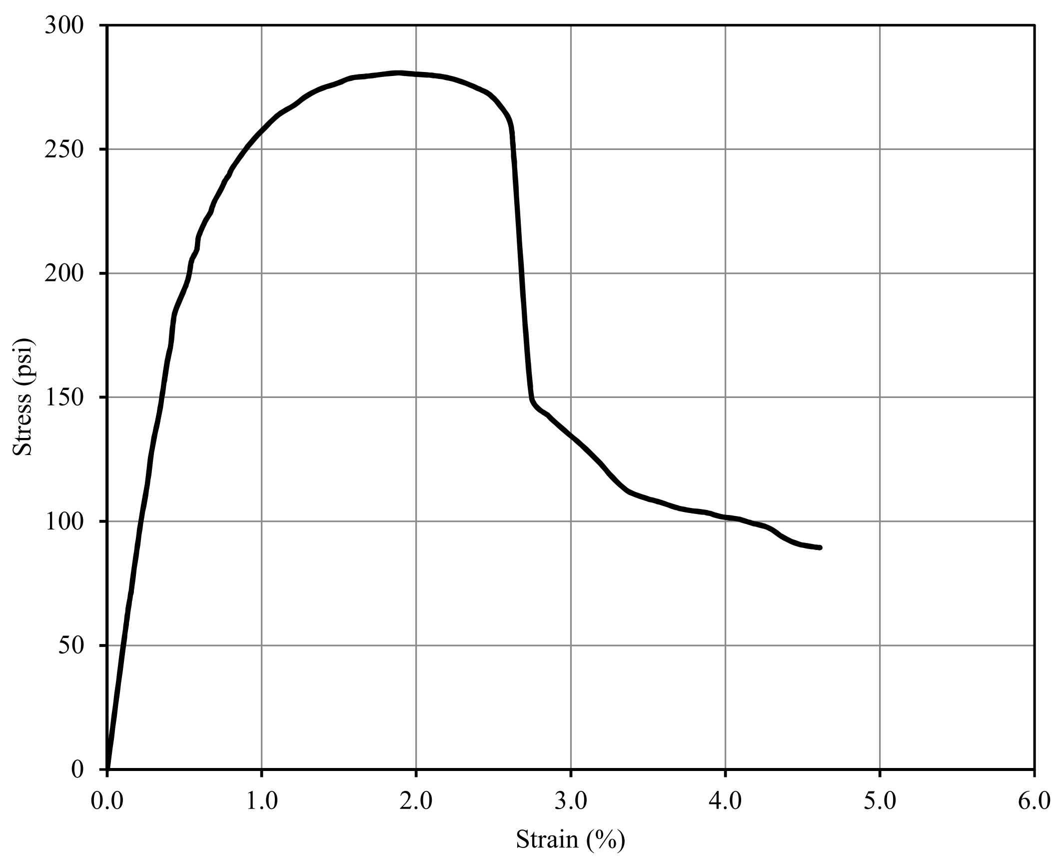
Test Result					
Peak deviator stress (w/ Height correction)	209	psi	Strain at failure, εf :	2.33	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-7-H	**Specimen Information**		
Test Date:	2017-09-29	Initial Height:	3.894	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	323.4	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	97	pcf



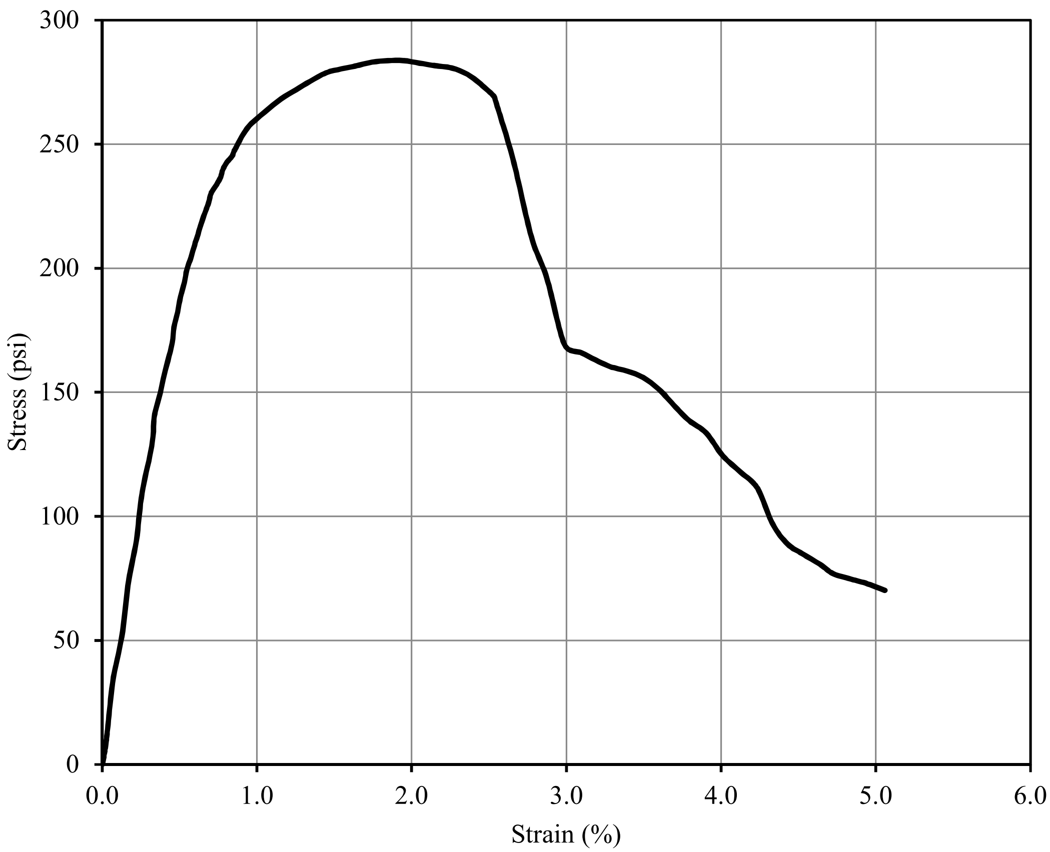
Test Result					
Peak deviator stress (w/ Height correction)	214	psi	Strain at failure, εf :	2.17	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-7-B	**Specimen Information**		
Test Date:	2017-10-03	Initial Height:	3.854	in
Strain Rate:	1 %/min	Initial Diameter:	2.037	in
Mixture Proportion		Initial Area:	3.259	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	320.1	g
$(w{:}c)_{slurry}$:	1.0	Unit Weight:	97	pcf



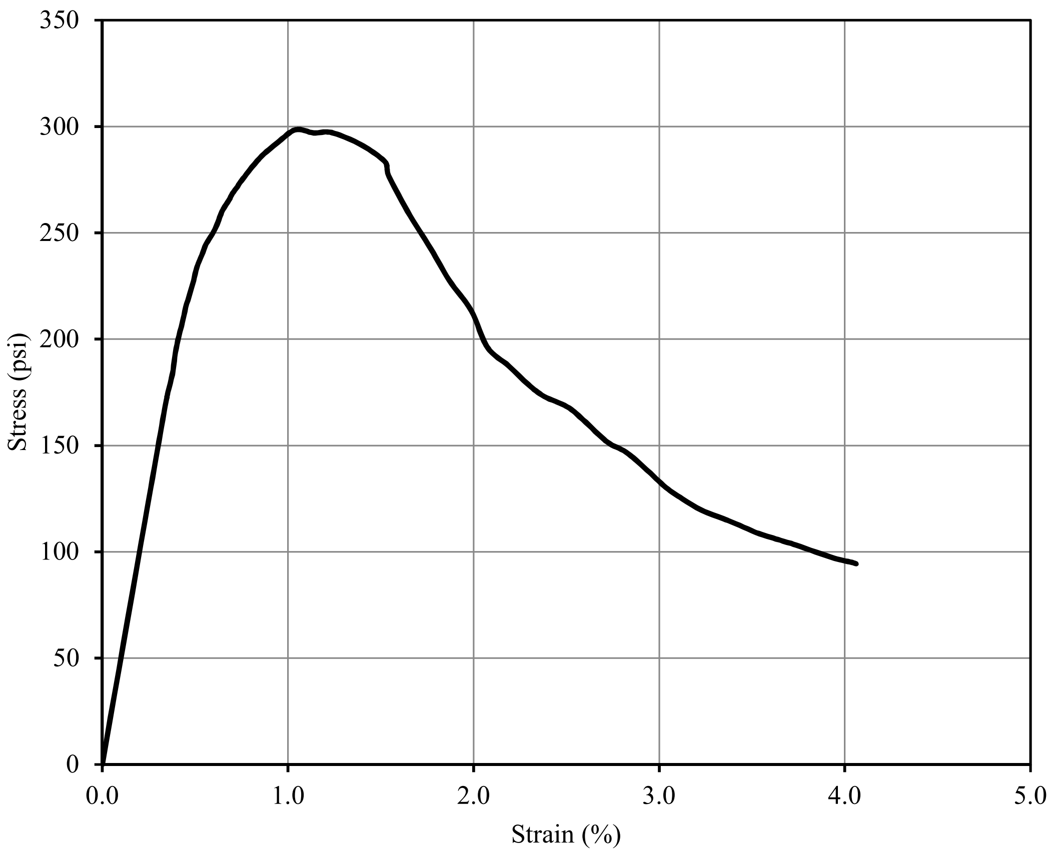
Test Result					
Peak deviator stress (w/ Height correction)	278	psi	Strain at failure, εf :	1.88	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
		Specimen Information		
I.D.:	S-7-G	Initial Height:	3.899	in
Test Date:	2017-10-03	Initial Diameter:	2.036	in
Strain Rate:	1 %/min	Initial Area:	3.256	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	324.1	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	97	pcf



Test Result					
Peak deviator stress (w/ Height correction)	282	psi	Strain at failure, εf :	1.95	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-7-C	**Specimen Information**		
Test Date:	2017-10-10	Initial Height:	3.665	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	304.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	97	pcf

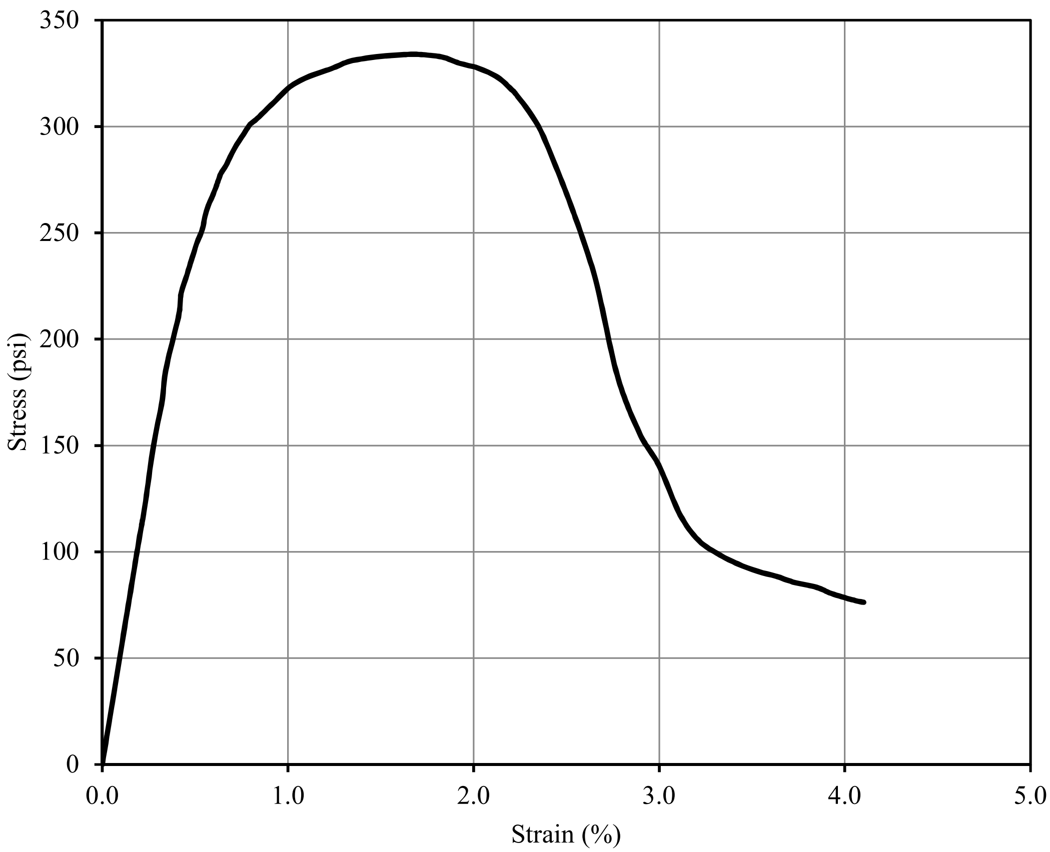


Test Result					
Peak deviator stress (w/ Height correction)	294	psi	Strain at failure, εf :	1.04	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

Test Information		Specimen Information		
I.D.:	S-7-F	Initial Height:	3.901	in
Test Date:	2017-10-10	Initial Diameter:	2.037	in
Strain Rate:	1 %/min	Initial Area:	3.259	in

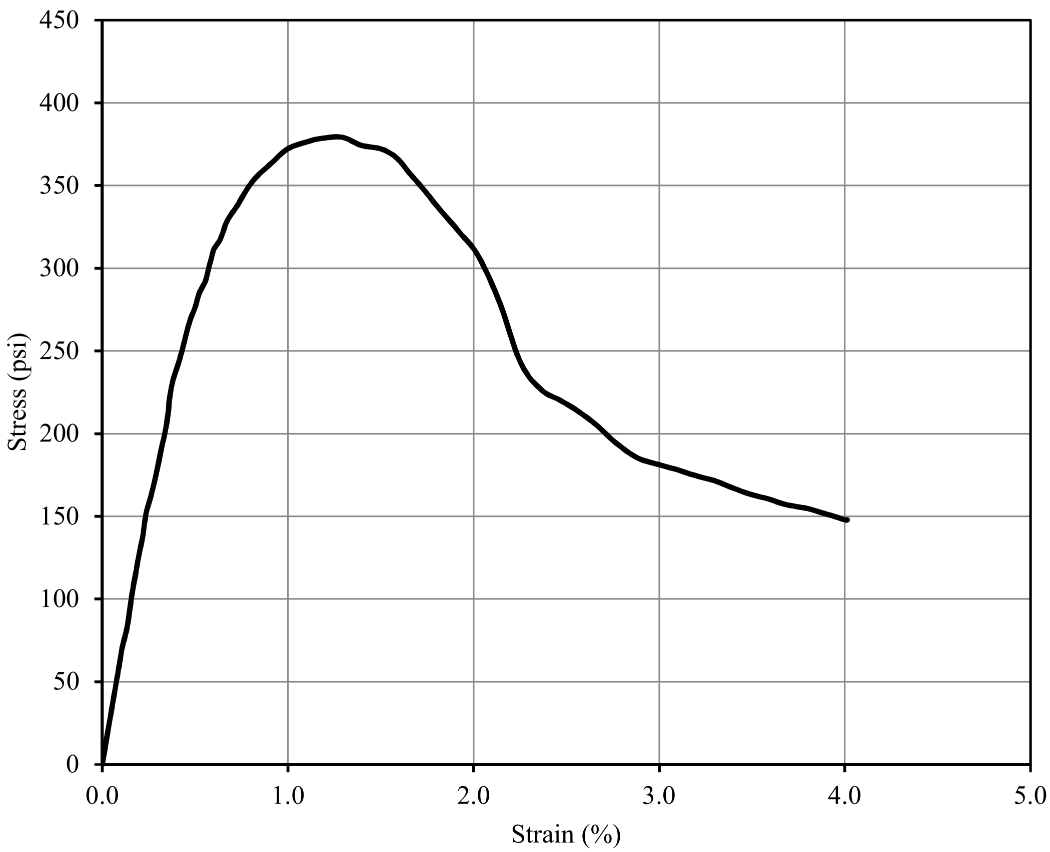
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	325.3	g
(w:c)$_{slurry}$:	1.0	Unit Weight:	97	pcf



Test Result					
Peak deviator stress (w/ Height correction)	332	psi	Strain at failure, εf :	1.70	%

Test Information	
Type of Test:	UCS Test
Tested by:	Hwanik Ju
I.D.:	S-7-J
Test Date:	2017-10-24
Strain Rate:	1 %/min
Mixture Proportion	
$\alpha_{in\text{-}place}$ (kg/m^3):	350
$(w{:}c)_{slurry}$:	1.0

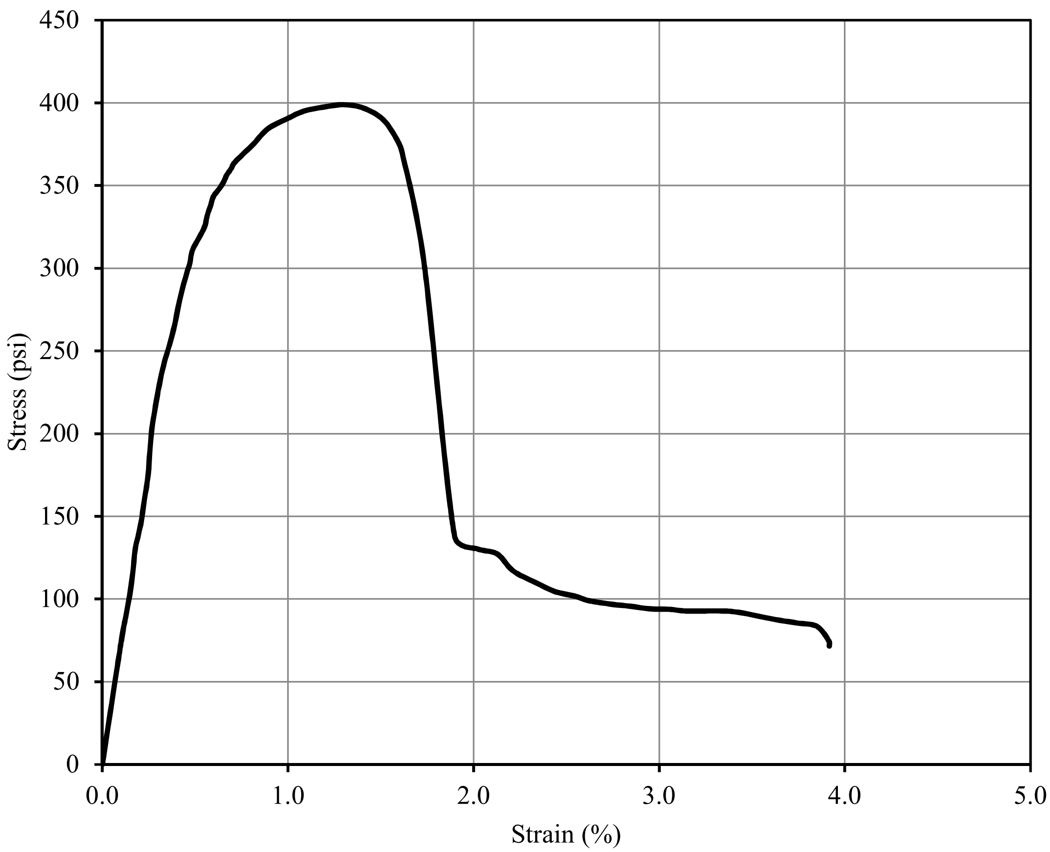
Curing Condition		
Curing Period	28.0	days
Curing temperature	21.1	°C
Specimen Information		
Initial Height:	3.715	in
Initial Diameter:	2.036	in
Initial Area:	3.256	in
Weight:	308.8	g
Unit Weight:	97	pcf



Test Result					
Peak deviator stress (w/ Height correction)	374	psi	Strain at failure, εf :	1.29	%

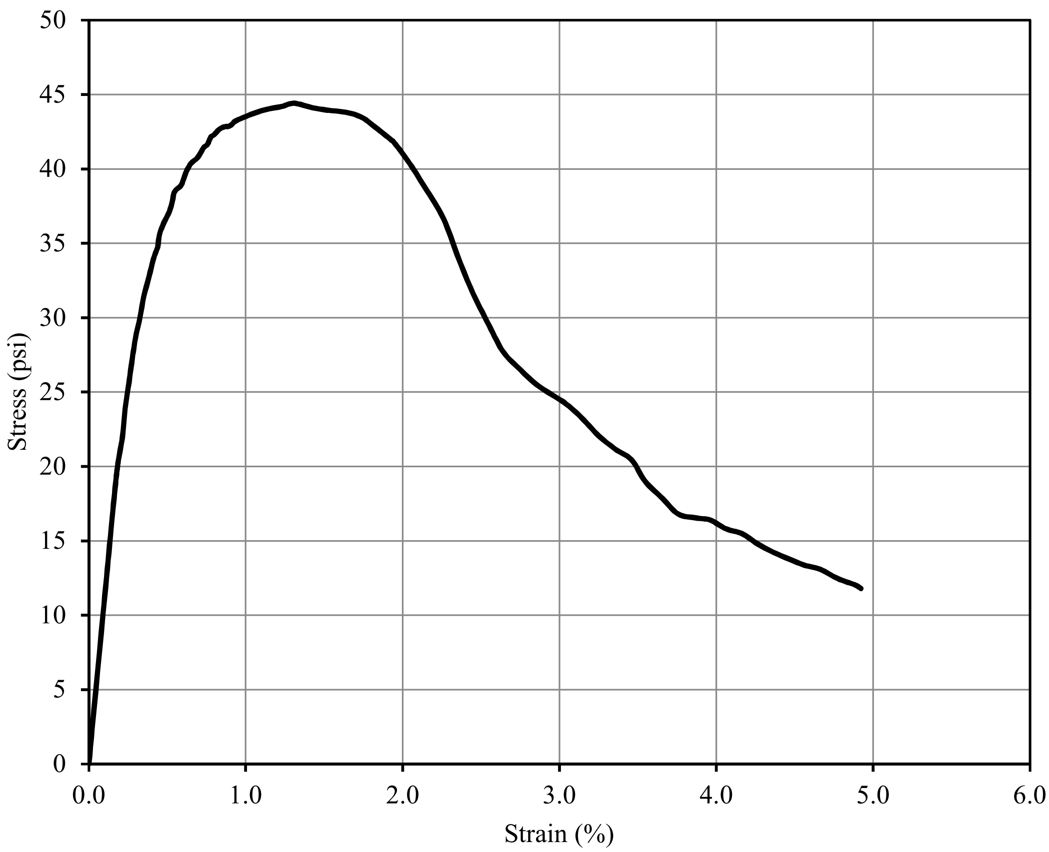
Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

Test Information		Specimen Information		
I.D.:	S-7-E	Initial Height:	3.939	in
Test Date:	2017-10-24	Initial Diameter:	2.033	in
Strain Rate:	1 %/min	Initial Area:	3.246	in
Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	350	Weight:	328.3	g
$(w:c)_{slurry}$:	1.0	Unit Weight:	98	pcf



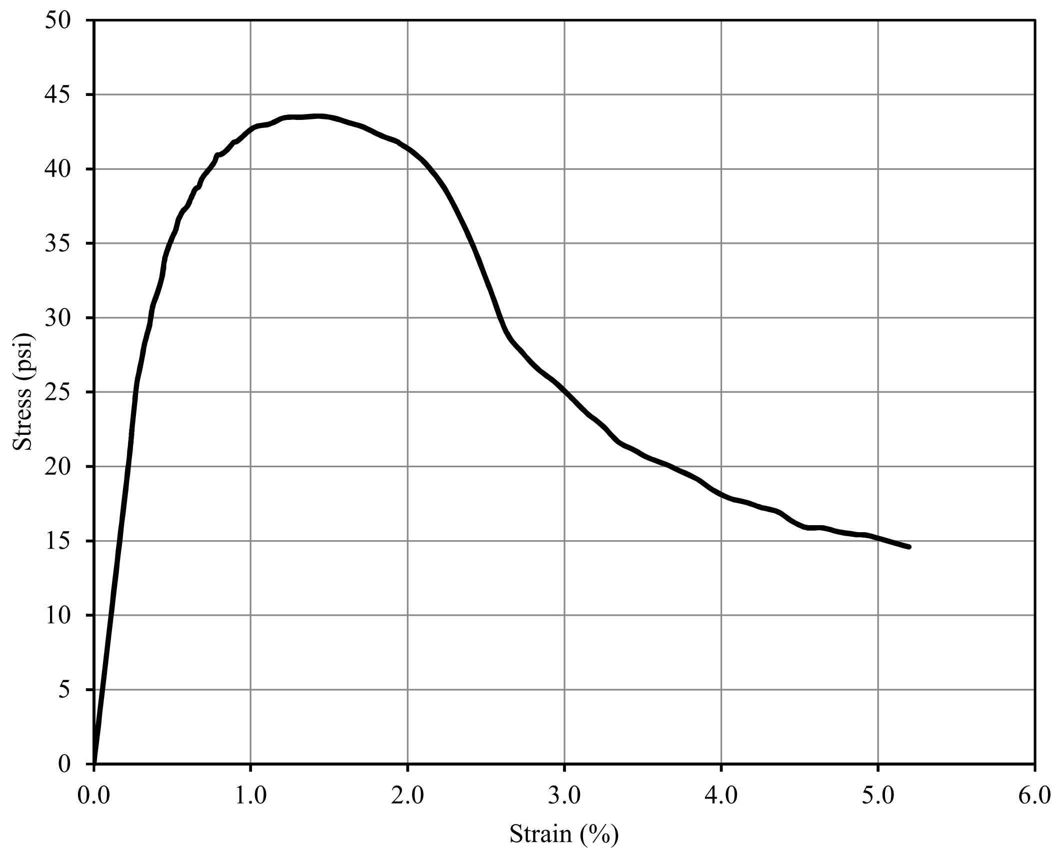
Test Result					
Peak deviator stress (w/ Height correction)	397	psi	Strain at failure, εf :	1.30	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-8-H	**Specimen Information**		
Test Date:	2017-09-19	Initial Height:	3.645	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	299.6	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	96	pcf



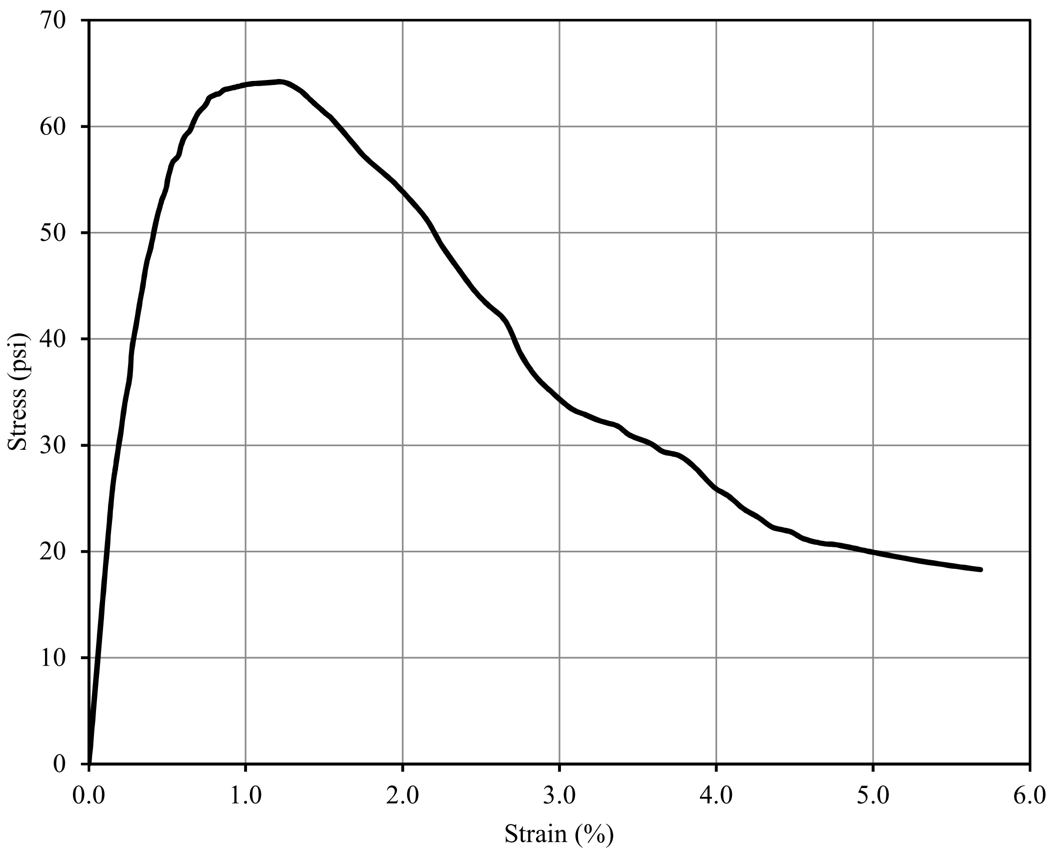
Test Result					
Peak deviator stress (w/ Height correction)	44	psi	Strain at failure, εf :	1.31	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-8-I	**Specimen Information**		
Test Date:	2017-09-19	Initial Height:	3.713	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	306.2	g
(w:c)$_{slurry}$:	1.4	Unit Weight:	97	pcf



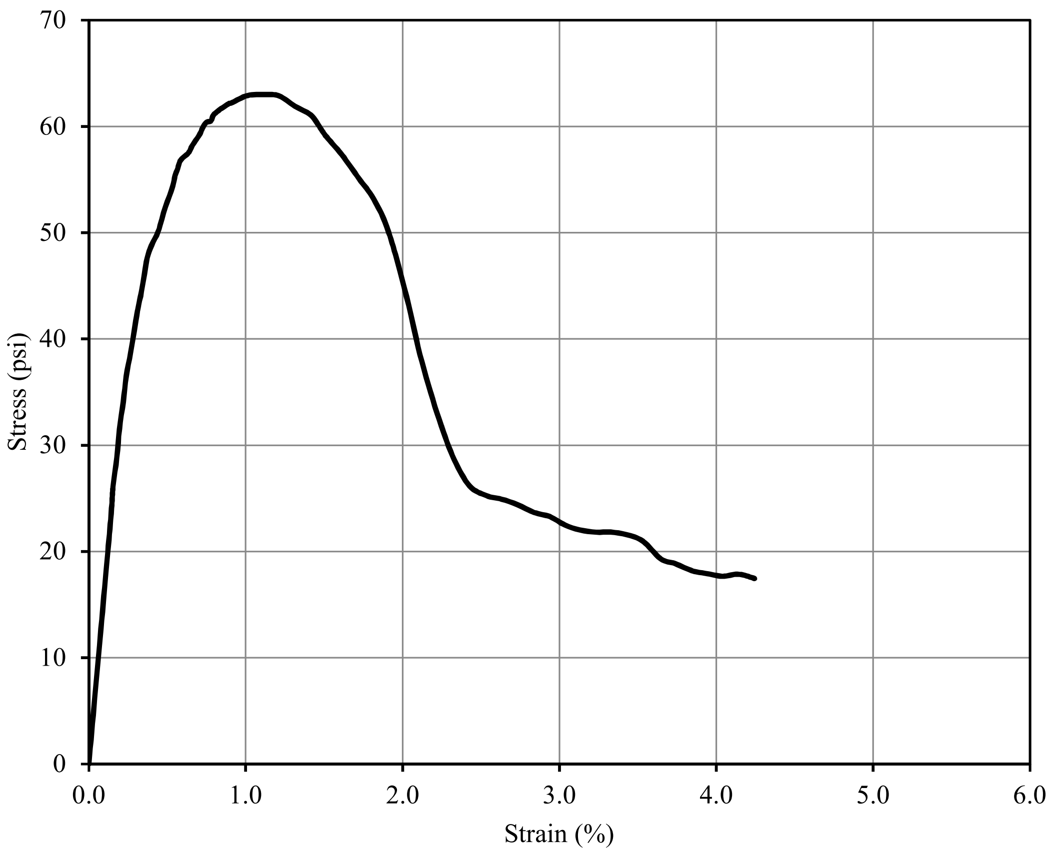
Test Result					
Peak deviator stress (w/ Height correction)	43	psi	Strain at failure, εf :	1.43	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-8-B	**Specimen Information**		
Test Date:	2017-09-23	Initial Height:	3.89	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	322.2	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



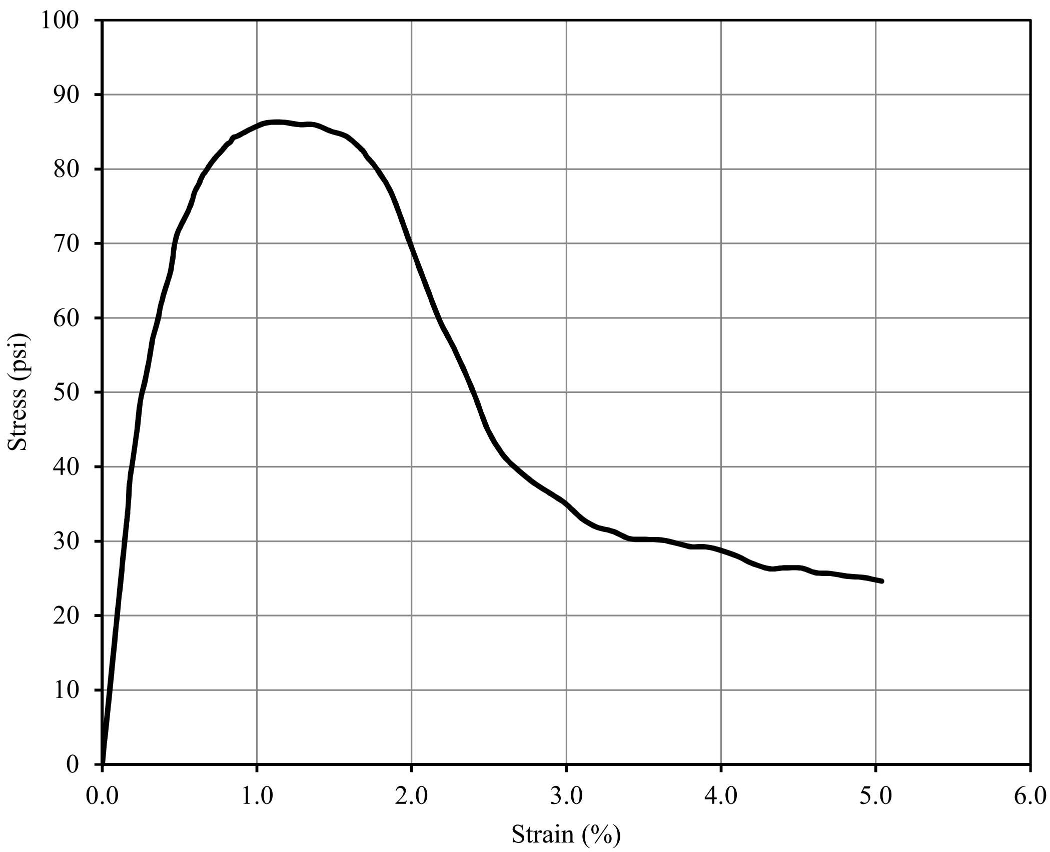
Test Result					
Peak deviator stress (w/ Height correction)	64	psi	Strain at failure, εf :	1.24	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-8-G	**Specimen Information**		
Test Date:	2017-09-23	Initial Height:	3.738	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	309.0	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



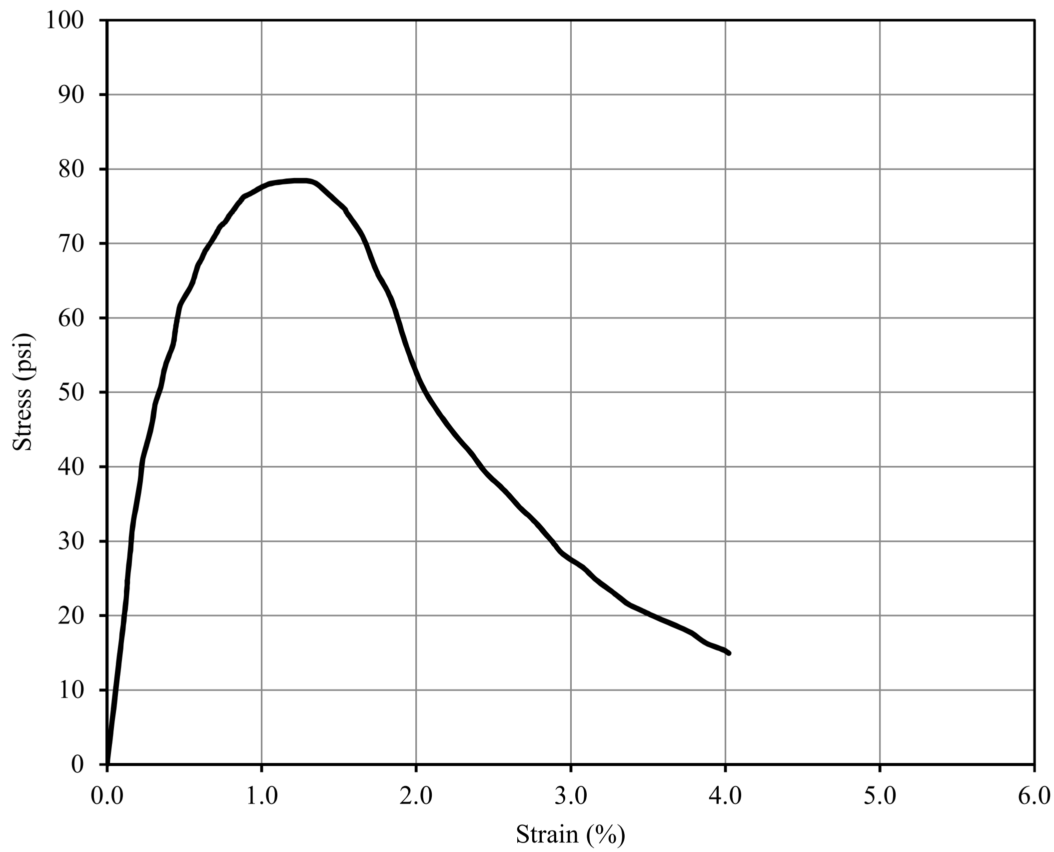
Test Result					
Peak deviator stress (w/ Height correction)	62	psi	Strain at failure, εf :	1.12	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-8-C	**Specimen Information**		
Test Date:	2017-09-30	Initial Height:	3.871	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	320.0	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



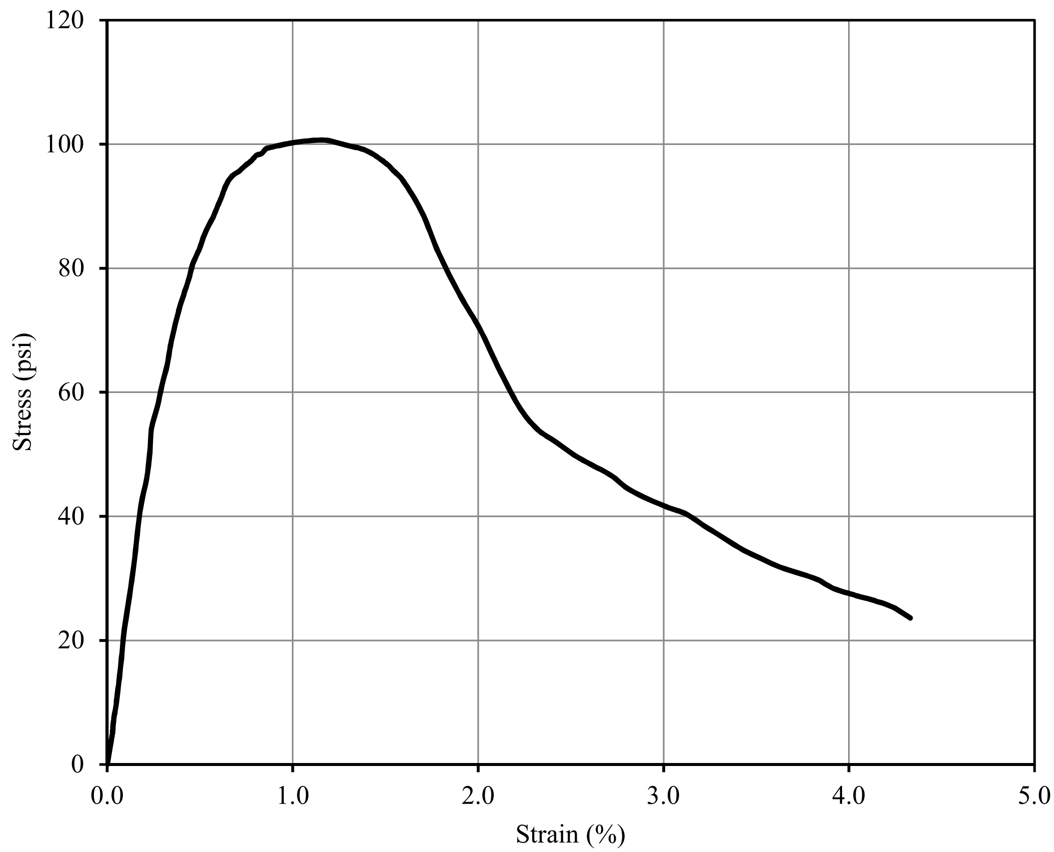
Test Result					
Peak deviator stress (w/ Height correction)	86	psi	Strain at failure, εf :	1.17	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	13.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-8-J	**Specimen Information**		
Test Date:	2017-09-30	Initial Height:	3.871	in
Strain Rate:	1 %/min	Initial Diameter:	2.032	in
Mixture Proportion		Initial Area:	3.243	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	319.8	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



Test Result					
Peak deviator stress (w/ Height correction)	78	psi	Strain at failure, εf :	1.24	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-8-D	**Specimen Information**		
Test Date:	2017-10-14	Initial Height:	3.681	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	303.9	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf

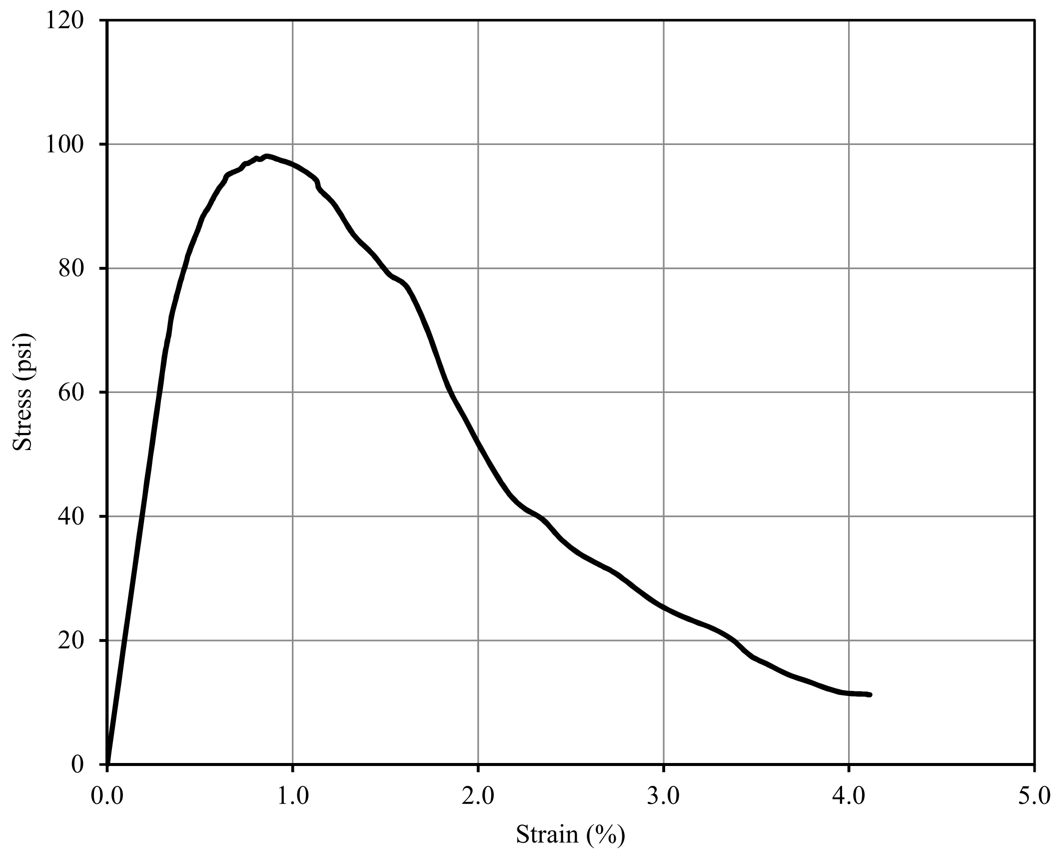


Test Result					
Peak deviator stress (w/ Height correction)	99	psi	Strain at failure, εf :	1.18	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

Test Information		Specimen Information		
I.D.:	S-8-E	Initial Height:	3.861	in
Test Date:	2017-10-14	Initial Diameter:	2.033	in
Strain Rate:	1 %/min	Initial Area:	3.246	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	125	Weight:	319.4	g
(w:c)$_{slurry}$:	1.4	Unit Weight:	97	pcf

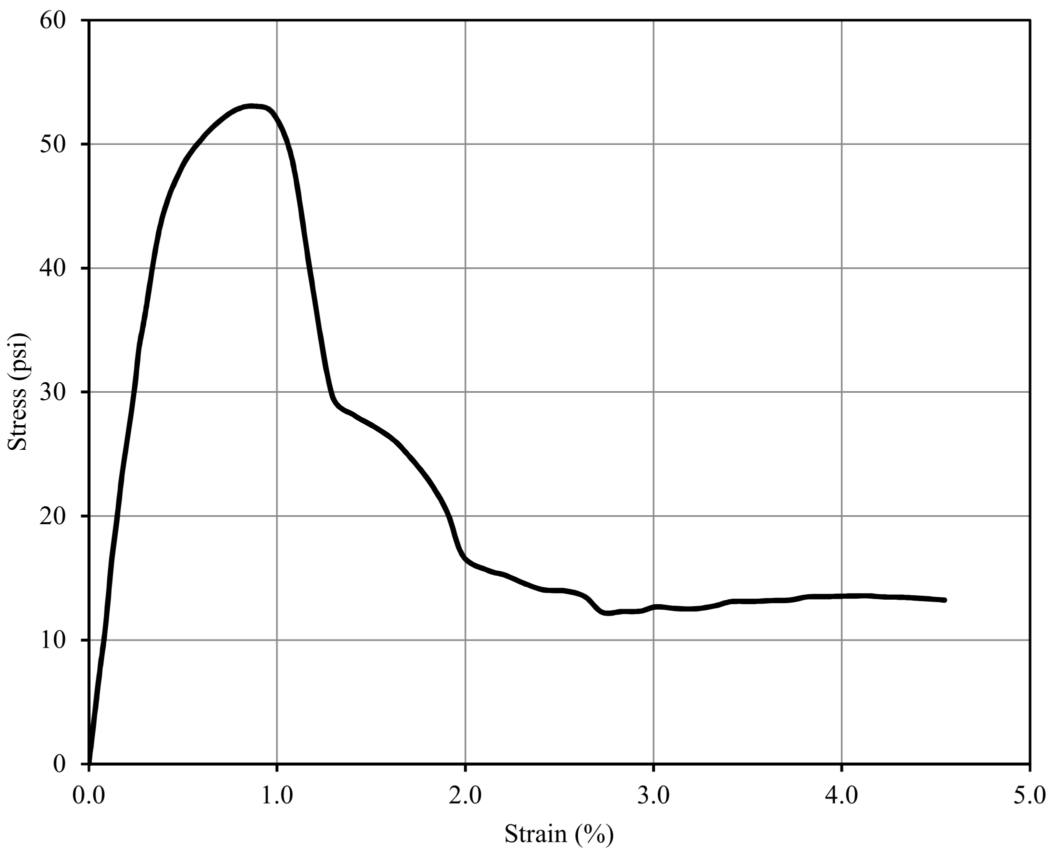


Test Result					
Peak deviator stress (w/ Height correction)	97	psi	Strain at failure, εf :	0.86	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

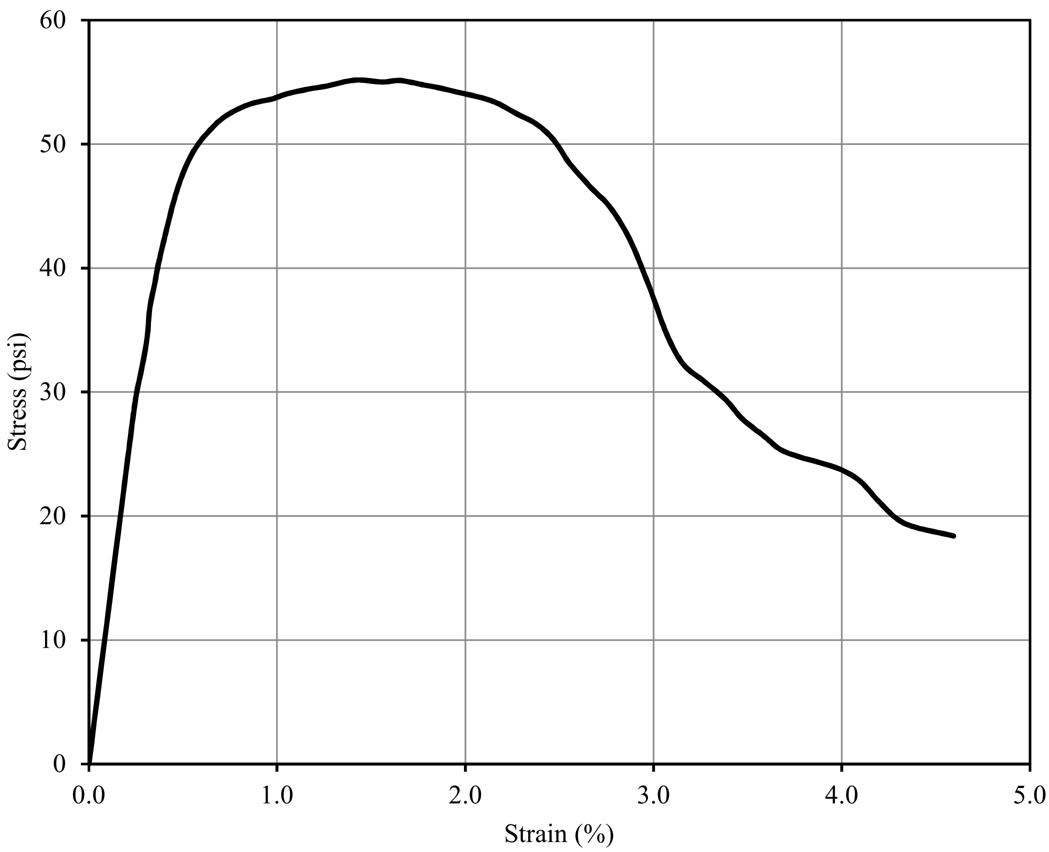
Test Information		Specimen Information		
I.D.:	S-9-A	Initial Height:	3.65	in
Test Date:	2018-02-14	Initial Diameter:	2.03	in
Strain Rate:	1 %/min	Initial Area:	3.237	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	299.4	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



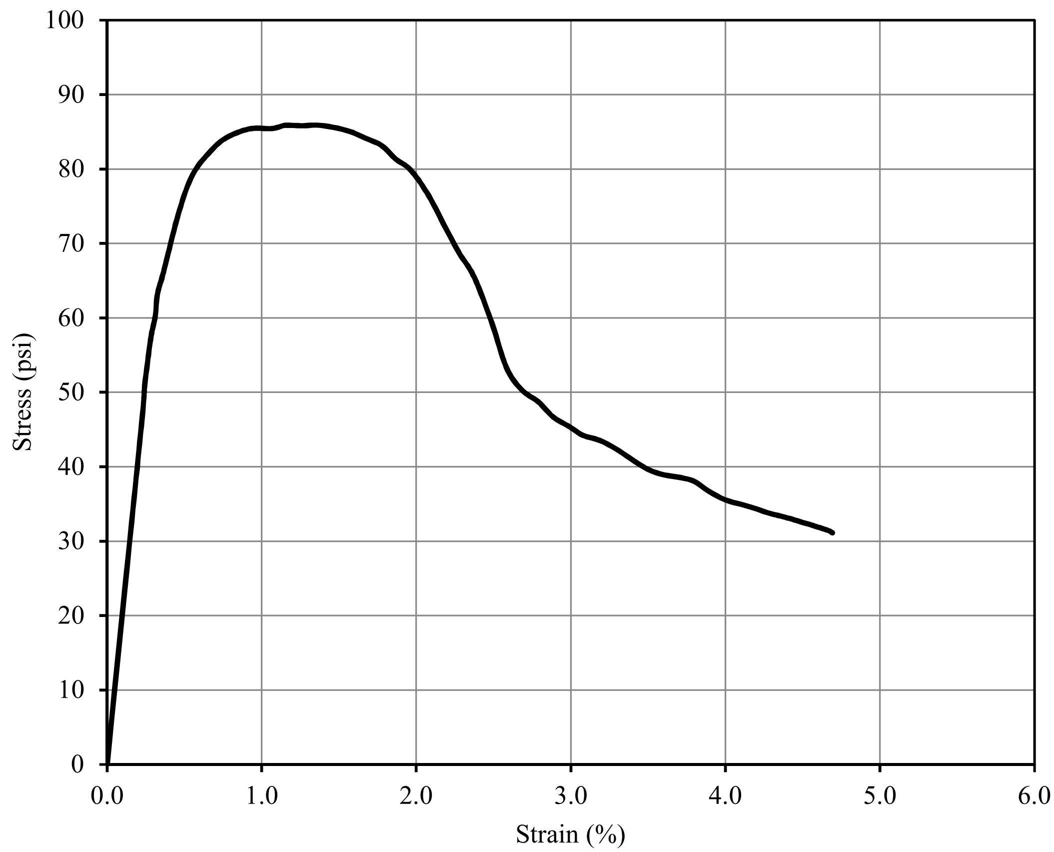
Test Result					
Peak deviator stress (w/ Height correction)	52	psi	Strain at failure, εf :	0.88	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-9-H	**Specimen Information**		
Test Date:	2018-02-14	Initial Height:	3.89	in
Strain Rate:	1 %/min	Initial Diameter:	2.034	in
Mixture Proportion		Initial Area:	3.249	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	319.7	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	96	pcf



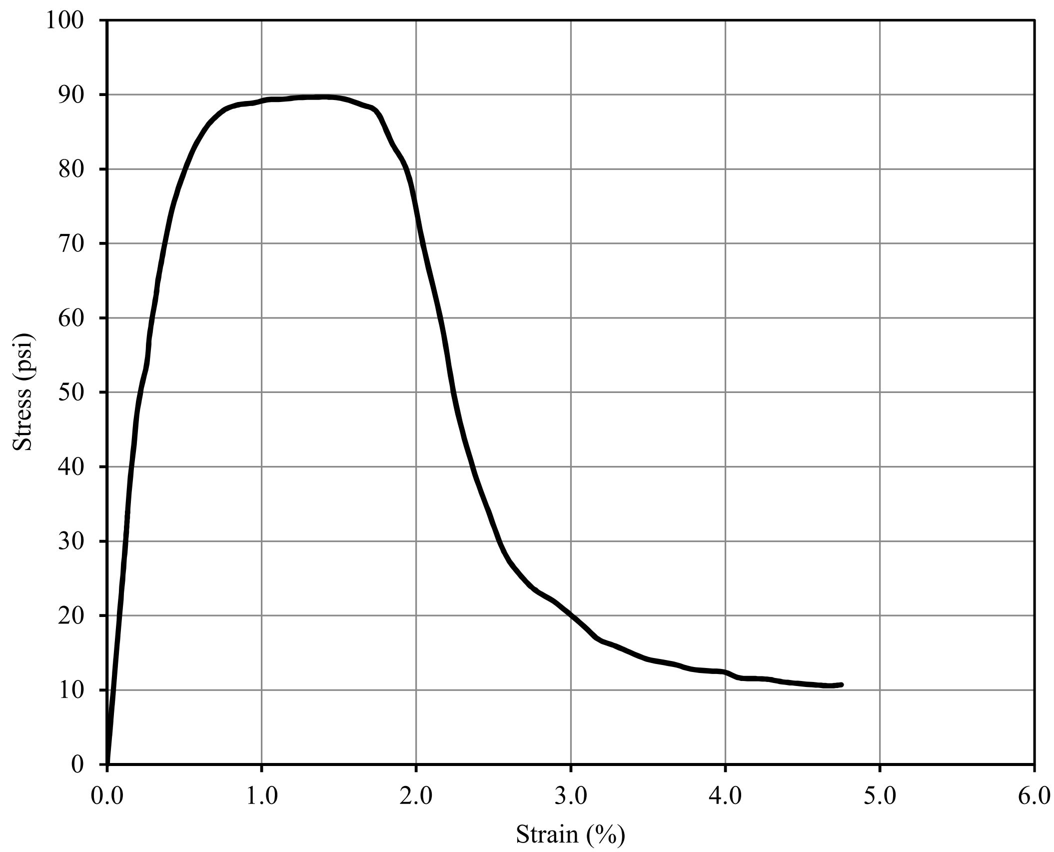
Test Result					
Peak deviator stress (w/ Height correction)	55	psi	Strain at failure, εf :	1.45	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-9-B	**Specimen Information**		
Test Date:	2018-02-18	Initial Height:	3.873	in
Strain Rate:	1 %/min	Initial Diameter:	2.031	in
Mixture Proportion		Initial Area:	3.240	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	318.4	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



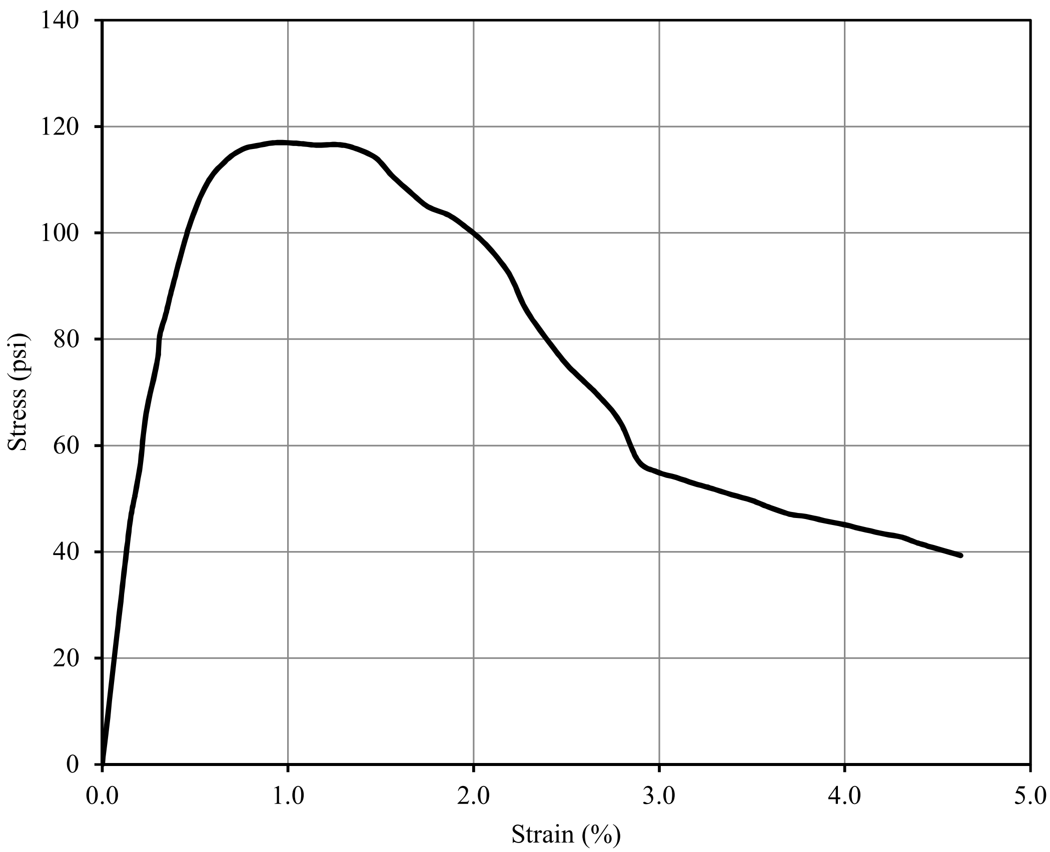
Test Result					
Peak deviator stress (w/ Height correction)	85	psi	Strain at failure, εf :	1.36	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	6.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-9-G	**Specimen Information**		
Test Date:	2018-02-18	Initial Height:	3.919	in
Strain Rate:	1 %/min	Initial Diameter:	2.030	in
Mixture Proportion		Initial Area:	3.237	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	321.9	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



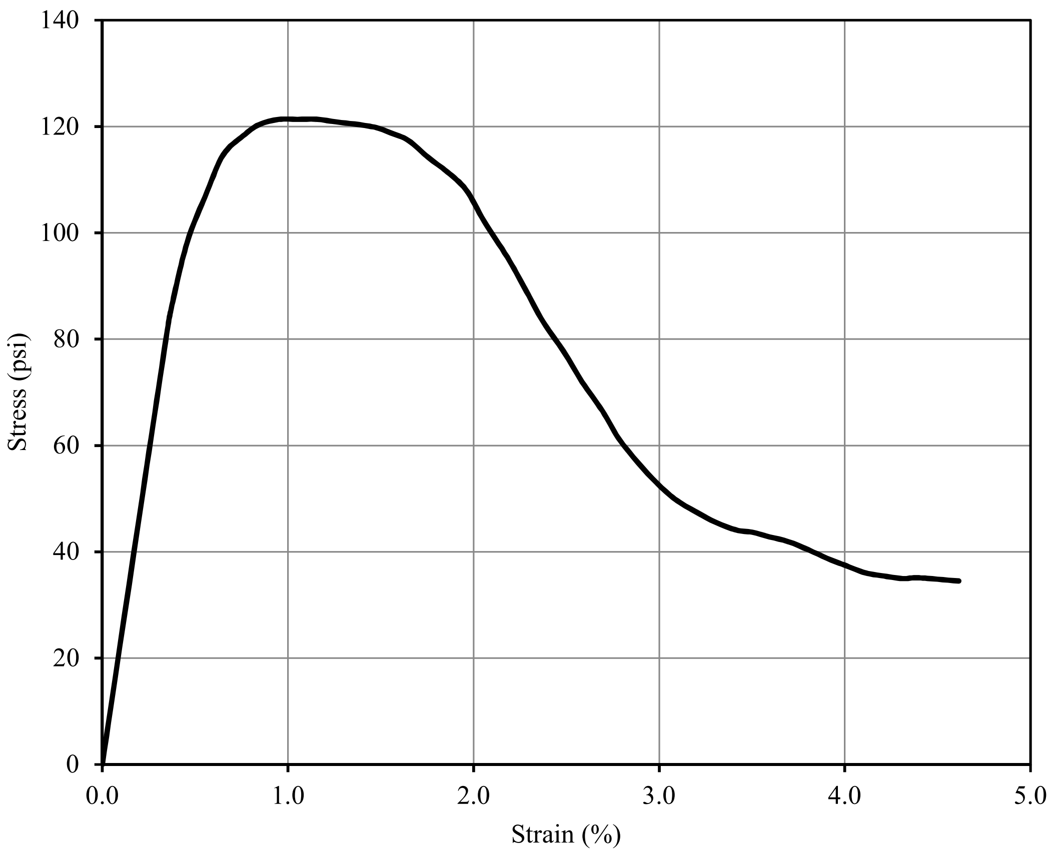
Test Result					
Peak deviator stress (w/ Height correction)	89	psi	Strain at failure, εf :	1.43	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-9-C	**Specimen Information**		
Test Date:	2018-02-25	Initial Height:	3.896	in
Strain Rate:	1 %/min	Initial Diameter:	2.029	in
Mixture Proportion		Initial Area:	3.233	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	320.4	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	97	pcf



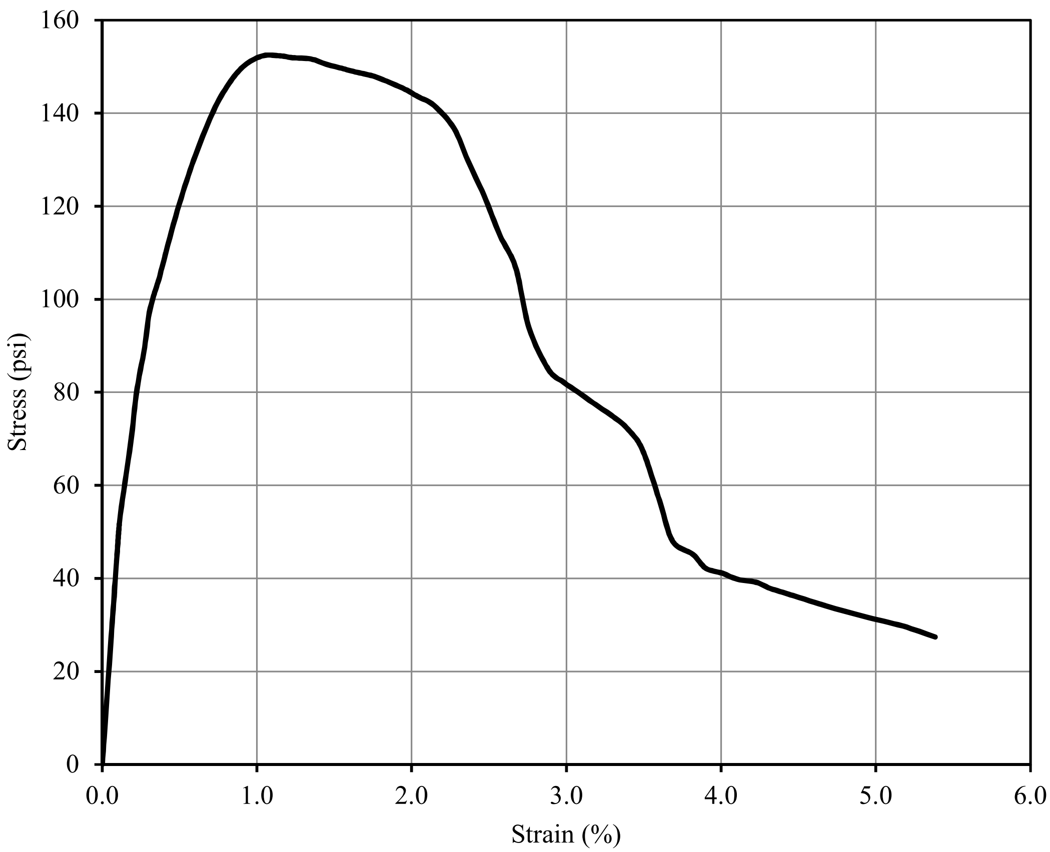
Test Result					
Peak deviator stress (w/ Height correction)	116	psi	Strain at failure, εf :	0.94	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.1	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-9-F	**Specimen Information**		
Test Date:	2018-02-25	Initial Height:	3.86	in
Strain Rate:	1 %/min	Initial Diameter:	2.03	in
Mixture Proportion		Initial Area:	3.237	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	317.2	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



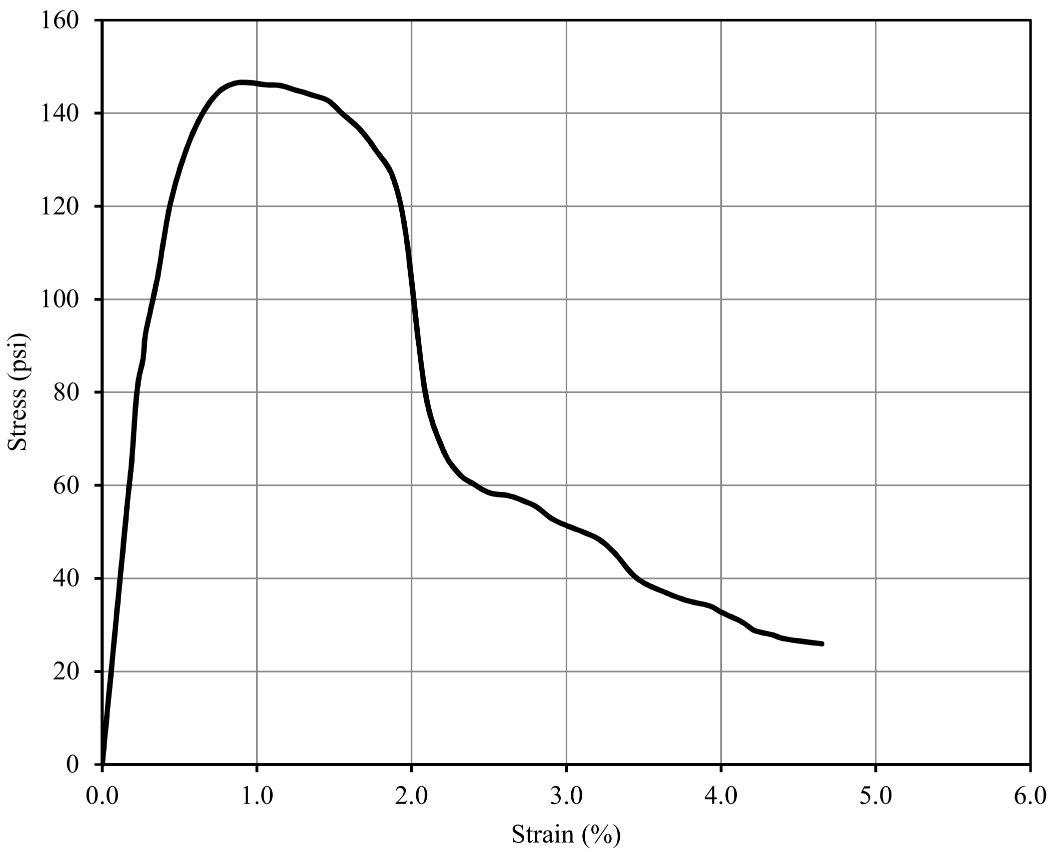
Test Result					
Peak deviator stress (w/ Height correction)	120	psi	Strain at failure, εf :	1.15	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-9-D	**Specimen Information**		
Test Date:	2018-03-11	Initial Height:	3.9	in
Strain Rate:	1 %/min	Initial Diameter:	2.031	in
Mixture Proportion		Initial Area:	3.240	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	320.4	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



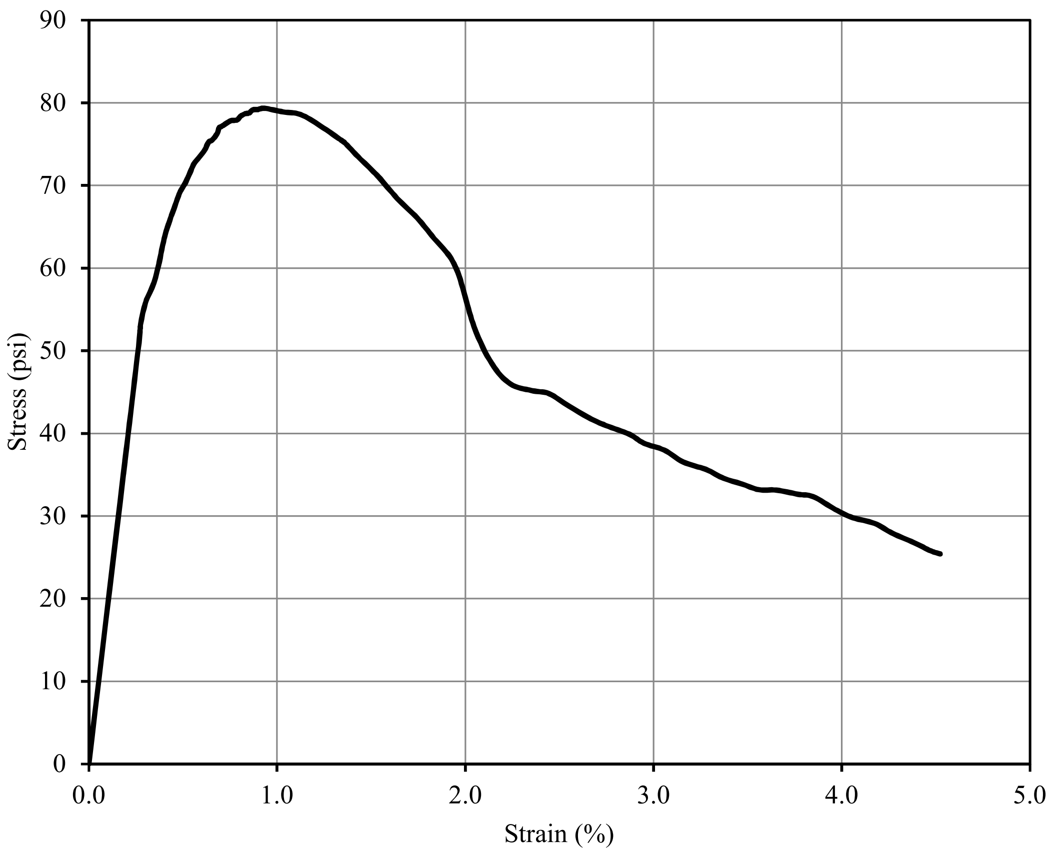
Test Result					
Peak deviator stress (w/ Height correction)	151	psi	Strain at failure, εf :	1.04	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	28.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-9-E	**Specimen Information**		
Test Date:	2018-03-11	Initial Height:	3.917	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	200	Weight:	322.2	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	97	pcf



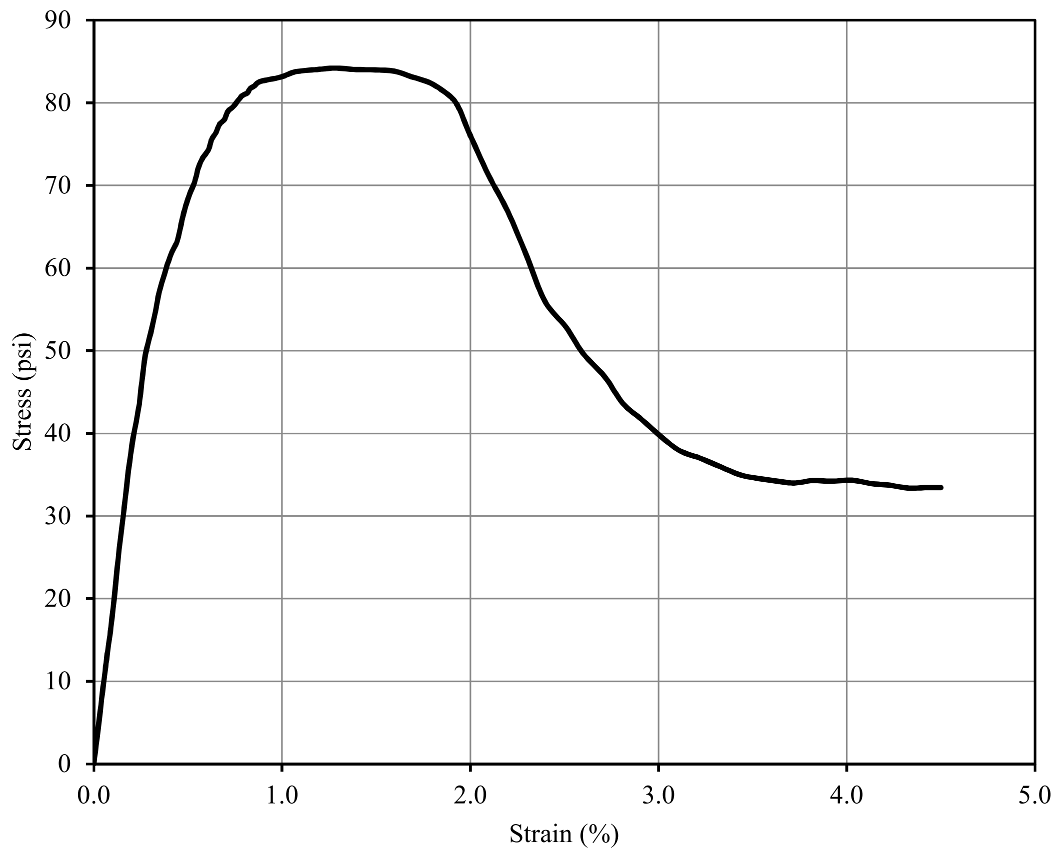
Test Result					
Peak deviator stress (w/ Height correction)	146	psi	Strain at failure, εf :	0.96	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	2.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-10-A	**Specimen Information**		
Test Date:	2017-10-07	Initial Height:	3.862	in
Strain Rate:	1 %/min	Initial Diameter:	2.033	in
Mixture Proportion		Initial Area:	3.246	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	310.0	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	94	pcf



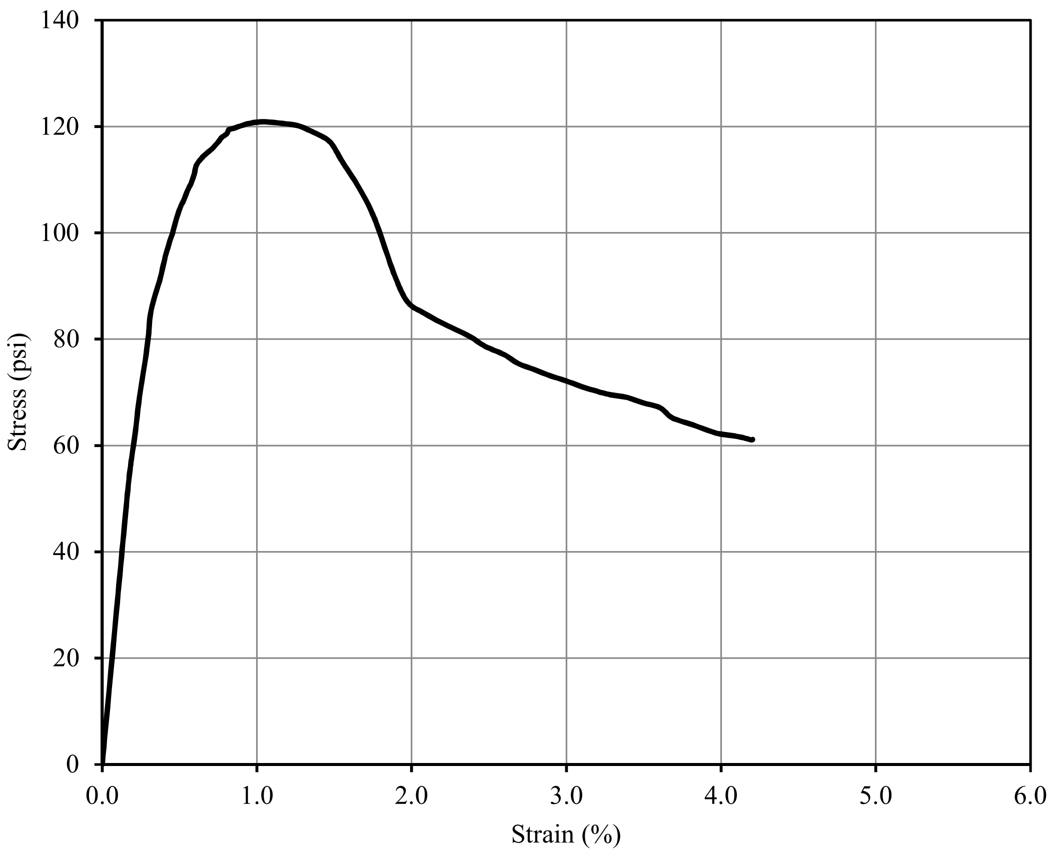
Test Result					
Peak deviator stress (w/ Height correction)	79	psi	Strain at failure, εf :	0.93	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	3.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-10-H	**Specimen Information**		
Test Date:	2017-10-07	Initial Height:	3.75	in
Strain Rate:	1 %/min	Initial Diameter:	2.037	in
Mixture Proportion		Initial Area:	3.259	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	301.9	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	94	pcf



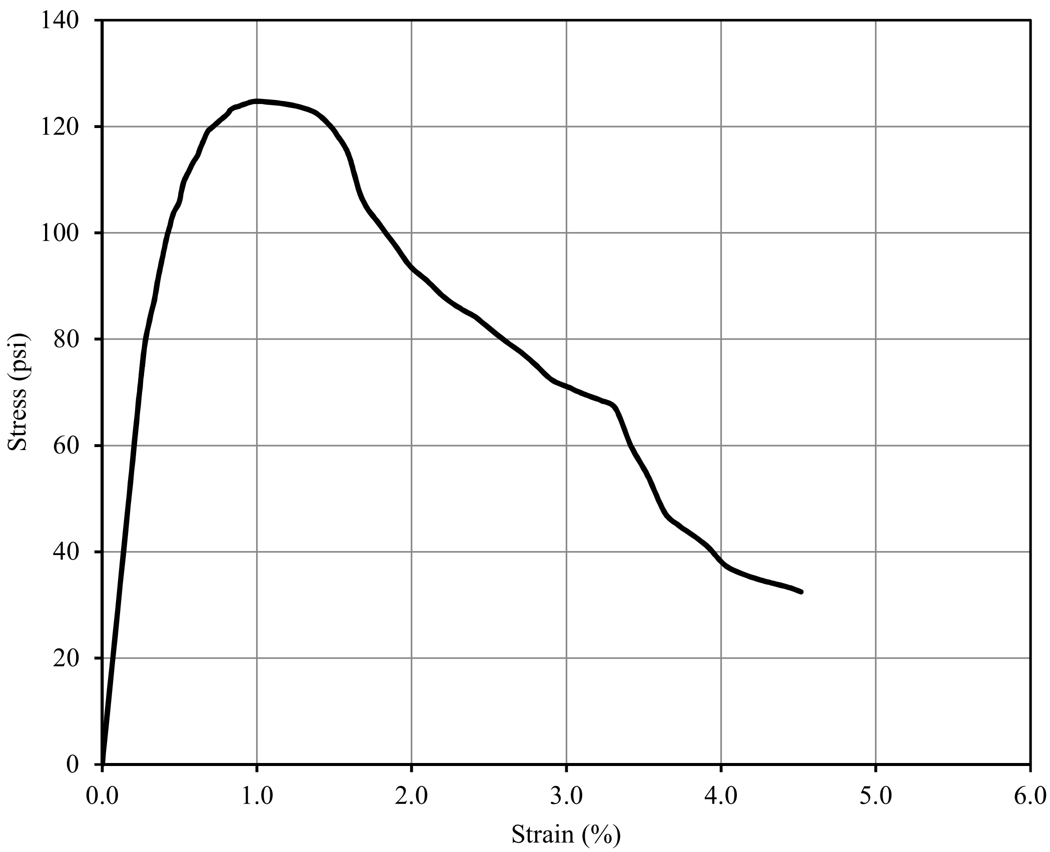
Test Result					
Peak deviator stress (w/ Height correction)	83	psi	Strain at failure, εf :	1.28	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-10-B	**Specimen Information**		
Test Date:	2017-10-11	Initial Height:	3.599	in
Strain Rate:	1 %/min	Initial Diameter:	2.038	in
Mixture Proportion		Initial Area:	3.262	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	289.5	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	94	pcf



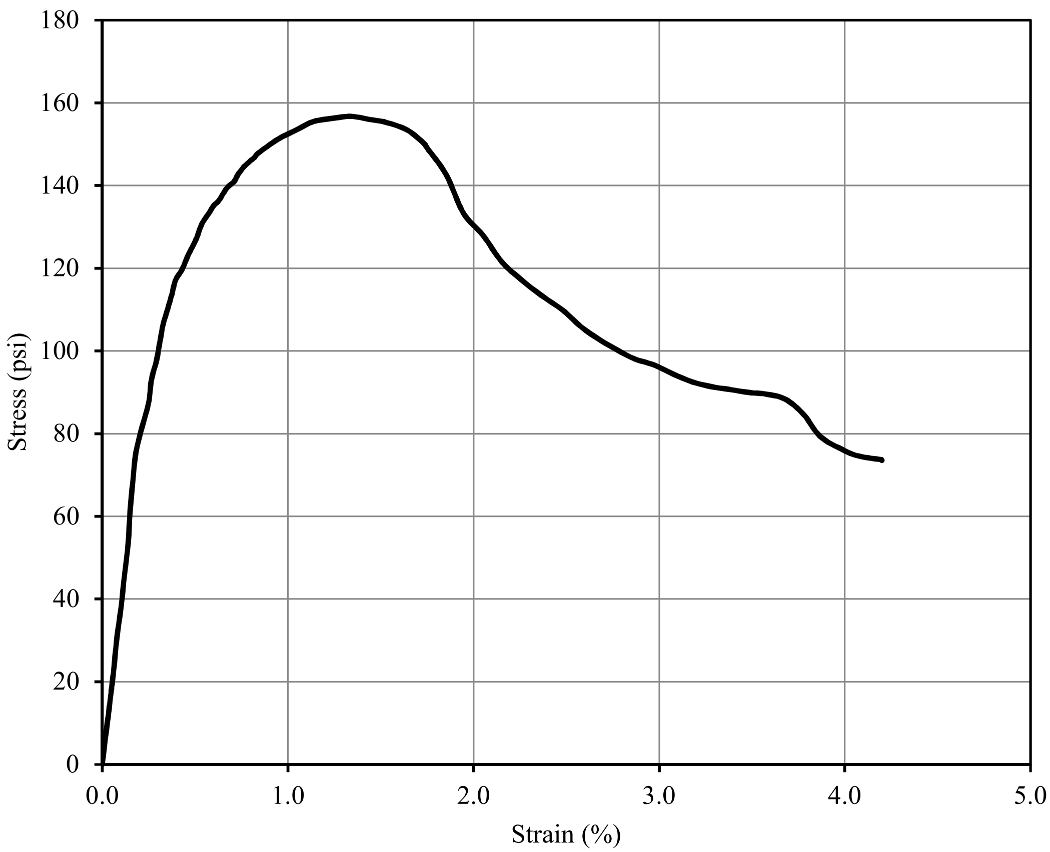
Test Result					
Peak deviator stress (w/ Height correction)	119	psi	Strain at failure, εf :	1.05	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	7.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-10-G	**Specimen Information**		
Test Date:	2017-10-11	Initial Height:	3.818	in
Strain Rate:	1 %/min	Initial Diameter:	2.036	in
Mixture Proportion		Initial Area:	3.256	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	307.3	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	94	pcf



Test Result					
Peak deviator stress (w/ Height correction)	123	psi	Strain at failure, εf :	0.98	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-10-C	**Specimen Information**		
Test Date:	2017-10-18	Initial Height:	3.722	in
Strain Rate:	1 %/min	Initial Diameter:	2.035	in
Mixture Proportion		Initial Area:	3.253	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	298.6	g
$(w{:}c)_{slurry}$:	1.4	Unit Weight:	94	pcf

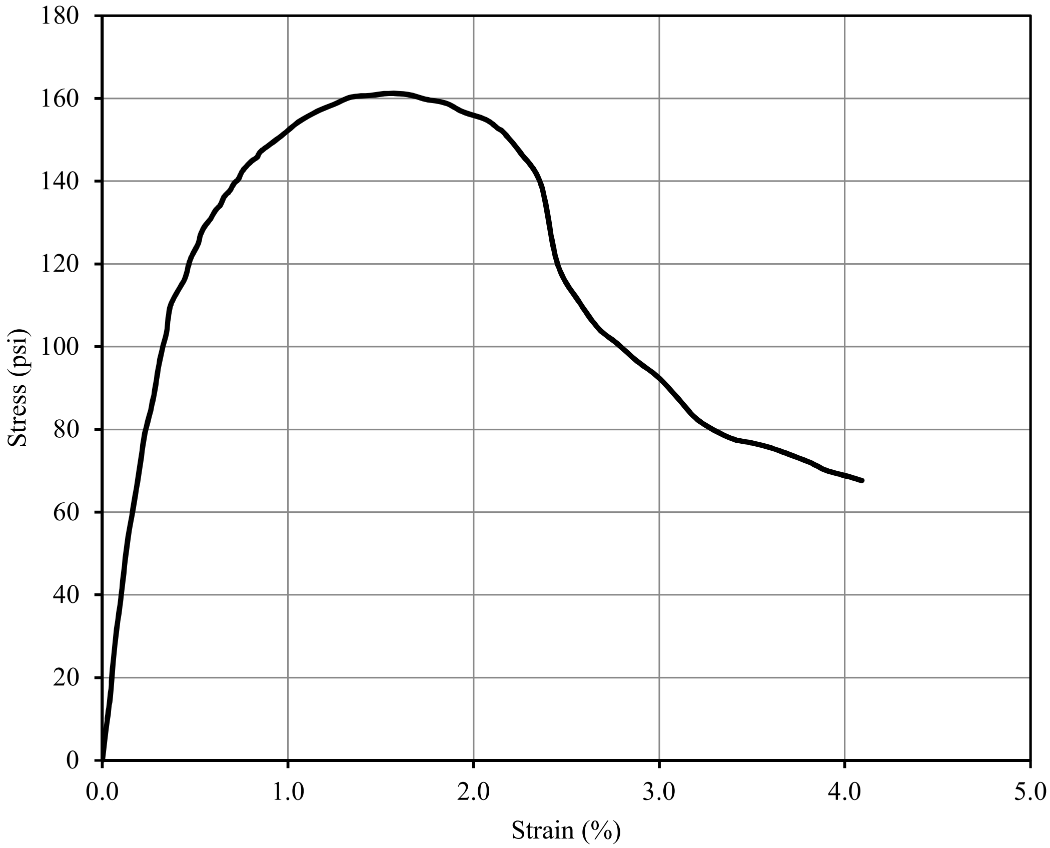


Test Result					
Peak deviator stress (w/ Height correction)	155	psi	Strain at failure, εf :	1.34	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	14.0	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

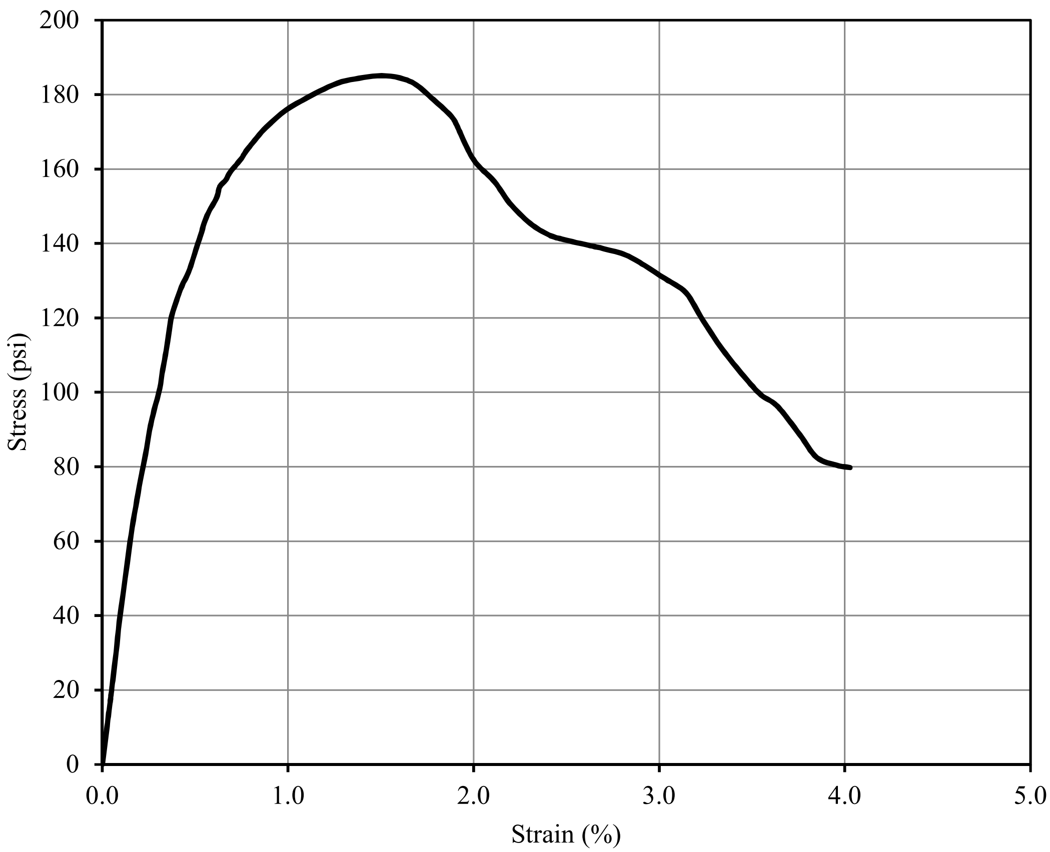
Test Information		Specimen Information		
I.D.:	S-10-F	Initial Height:	3.852	in
Test Date:	2017-10-18	Initial Diameter:	2.037	in
Strain Rate:	1 %/min	Initial Area:	3.259	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	309.0	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	94	pcf



Test Result					
Peak deviator stress (w/ Height correction)	160	psi	Strain at failure, εf :	1.54	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C
I.D.:	S-10-D	**Specimen Information**		
Test Date:	2017-11-01	Initial Height:	3.669	in
Strain Rate:	1 %/min	Initial Diameter:	2.035	in
Mixture Proportion		Initial Area:	3.253	in
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	293.9	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	94	pcf

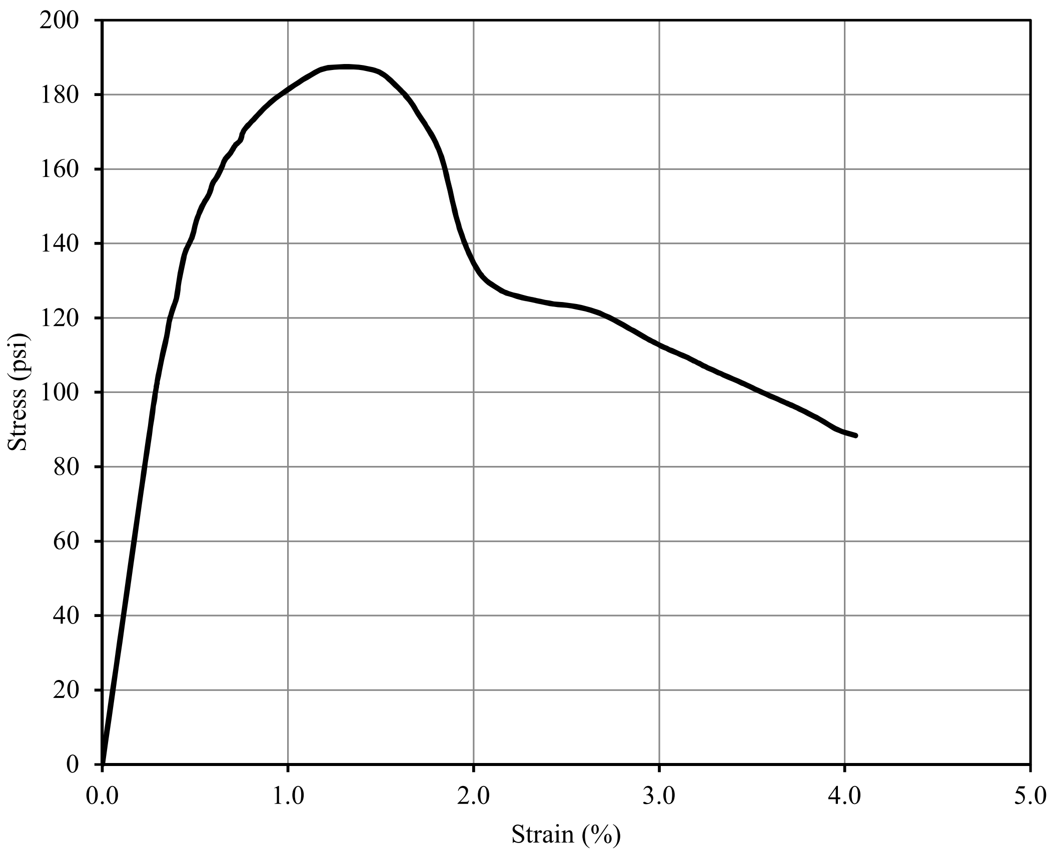


Test Result					
Peak deviator stress (w/ Height correction)	182	psi	Strain at failure, εf :	1.48	%

Test Information		Curing Condition		
Type of Test:	UCS Test	Curing Period	27.9	days
Tested by:	Hwanik Ju	Curing temperature	21.1	°C

Test Information		Specimen Information		
I.D.:	S-10-E	Initial Height:	3.709	in
Test Date:	2017-11-01	Initial Diameter:	2.032	in
Strain Rate:	1 %/min	Initial Area:	3.243	in

Mixture Proportion				
$\alpha_{in\text{-}place}$ (kg/m^3):	275	Weight:	297.5	g
$(w:c)_{slurry}$:	1.4	Unit Weight:	94	pcf



Test Result					
Peak deviator stress (w/ Height correction)	185	psi	Strain at failure, εf :	1.30	%

Appendix C: Evaluation of alternative prediction equations for unconfined compressive strength (UCS) and consistency (s_u)

The alternative equations for the prediction of UCS without temperature variation for lean clay (CL) and fat clay (CH) are listed. The best-fit coefficient values (d_1, d_2, d_3, and d_4) are provided below each equation, along with the coefficient of determination (R^2). The UCS data set collected by Nevárez-Garibaldi et al. (2018) is used for the lean clay, and the UCS data set obtained from batches S-1 to S-10 is used for the fat clay. To find the best equation for the prediction of UCS while minimizing the number of coefficients, the natural logarithmic function of the curing time, $d_1 + d_2 \, ln\left(\frac{t}{t_0}\right)$, is combined with a power/exponential function of the total-water-to-cement ratio ($w_t{:}c$) and a power/exponential function of the dry unit weight of the mixture normalized by the weight of the water ($\gamma_{d,mix};\gamma_w$). These parameters have been verified to affect the strength of binder-treated soil.

The first equation (Equation 2-1 / C-1) proposed by Nevárez-Garibaldi et al. (2018) produces the highest R^2 values for both lean and fat clays, and the second equation (C-2) also provides very high R^2 values which are very close to R^2 values for the first equation. Because the R^2 values are so similar, a different data set might have resulted in higher R^2 values for the second equation. For this research, the first equation was selected as the best equation to predict the strength of binder-treated soil for the curing times, mixture proportions, and clay plasticities that were investigated.

C-1 $$\frac{UCS_{pred}}{p_a} = \left[d_1 + d_2 \ln\left(\frac{t}{t_0}\right)\right] * [w_t : c]^{d_3} * \left[\gamma_{d,mix} : \gamma_w\right]^{d_4}$$

	R^2	d_1	d_2	d_3	d_4
CL (Base soil 1)	0.984	21.9	25.6	-1.58	1.45
CH (Base soil 2)	0.987	25.3	21.5	-1.49	2.44

C-2 $$\frac{UCS_{pred}}{p_a} = \left[d_1 + d_2 \ln\left(\frac{t}{t_0}\right)\right] * [w_t : c]^{d_3} * [d_4]^{(\gamma_{d,mix};\gamma_w)}$$

	R^2	d_1	d_2	d_3	d_4
CL (Base soil 1)	0.984	6.43	7.55	-1.59	3.45
CH (Base soil 2)	0.986	1.82	1.54	-1.49	13.9

C-3 $$\frac{UCS_{pred}}{p_a} = \left[d_1 + d_2 \ln\left(\frac{t}{t_0}\right)\right] * [d_3]^{(w_t : c)} * \left[\gamma_{d,mix} : \gamma_w\right]^{d_4}$$

	R^2	d_1	d_2	d_3	d_4
CL (Base soil 1)	0.971	29.6	34.4	0.501	1.63
CH (Base soil 2)	0.970	27.3	23.6	0.575	2.66

C-4 $$\frac{UCS_{pred}}{p_a} = \left[d_1 + d_2 \ln\left(\frac{t}{t_0}\right)\right] * [d_3]^{(w_t : c)} * [d_4]^{(\gamma_{d,mix};\gamma_w)}$$

	R^2	d_1	d_2	d_3	d_4
CL (Base soil 1)	0.971	7.53	8.78	0.501	3.98
CH (Base soil 2)	0.969	1.53	1.32	0.577	17.8

The equations considered for the prediction of consistency right after mixing, which is represented by the undrained shear strength (s_u), for lean clay (CL) and fat clay (CH) are listed. The best-fit coefficient values (e_1, e_2, e_3, and e_4) are provided below each equation, along with the coefficient of determination (R^2) values. The s_u data set collected by Nevárez-Garibaldi et al. (2018) is used for the lean clay, and the s_u data set obtained from batches C-0 to C-10 is used for the fat clay. To find the best equation for the prediction of s_u with the minimum number of coefficients, two of four potentially useful parameters are used in power or exponential forms and combined with a linear function of the curing time, $e_1 + e_2\left(\frac{t}{t_{0m}}\right)$. The four parameters selected for investigation of their ability to correlate with s_u are the water content of the mixture (w_{mix}), the total-water-to-soil-solids ratio ($w_t{:}s$), the total-water-to-cement ratio ($w_t{:}c$), and the cement factor (α). These parameters can be used to characterize the relative amounts of water, soil, and cement.

Although the first equation (Equation 4-11 / C-5) produces the highest R^2 values for both lean and fat clays, the second, fourth, and sixth equations (C-6, C-8, and C-10, respectively) also provide very high R^2 values that are close to R^2 values from the first equation. Therefore, with a different data set, any of these four equations might have turned out be the best equation. For this research, the first equation was selected as the best equation to predict the consistency of binder-treated soil right after mixing for the curing times, mixture proportions, and clay plasticities that were investigated.

C-5

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : s]^{e_3} * [e_4]^{(w_t : c)}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.989	1.84E-03	2.01E-03	-3.82	0.818
CH (Base soil 2)	0.978	9.98E-03	6.21E-03	-3.61	0.883

C-6

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : s]^{e_3} * [w_t : c]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.982	1.70E-03	1.88E-03	-3.91	-0.567
CH (Base soil 2)	0.974	1.07E-02	6.70E-03	-3.64	-0.432

C-7

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : s]^{e_3} * [w_{mix}]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.969	3.39E-04	3.72E-04	-1.24	-3.33
CH (Base soil 2)	0.967	3.68E-03	2.32E-03	-2.10	-1.95

C-8

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : s]^{e_3} * [\alpha]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.982	2.82E-05	3.10E-05	-4.48	0.567
CH (Base soil 2)	0.974	5.47E-04	3.42E-04	-4.07	0.432

C-9

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : c]^{e_3} * [w_{mix}]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.961	1.68E-04	1.85E-04	0.212	-4.87
CH (Base soil 2)	0.943	8.94E-04	5.67E-04	0.553	-4.62

C-10

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : c]^{e_3} * [\alpha]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.982	2.56E+09	2.82E+09	-4.44	-3.87
CH (Base soil 2)	0.974	6.84E+08	4.26E+08	-4.05	-3.62

C-11

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [\alpha]^{e_3} * [w_{mix}]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.962	6.94E-04	7.65E-04	-0.182	-4.64
CH (Base soil 2)	0.950	2.47E-02	1.56E-02	-0.439	-4.06

C-12

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:s)} * [e_4]^{(w_t:c)}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.974	8.32E-01	9.10E-01	0.0010	0.825
CH (Base soil 2)	0.960	4.62E-01	2.90E-01	0.0211	0.895

C-13

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:s)} * [e_4]^{(w_{mix})}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.956	9.94E-01	1.10E+00	0.109	0.0006
CH (Base soil 2)	0.958	4.95E-01	3.13E-01	0.102	0.0662

C-14

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:s)} * [e_4]^{(\alpha)}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.948	5.48E-01	6.06E-01	0.0003	1.002
CH (Base soil 2)	0.949	3.07E-01	1.94E-01	0.0139	1.001

C-15

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:c)} * [e_4]^{(w_{mix})}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.940	1.10E+00	1.21E+00	1.06	0.00002
CH (Base soil 2)	0.909	4.91E-01	3.15E-01	1.16	0.00159

C-16

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:c)} * [e_4]^{(\alpha)}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.732	9.73E-01	1.04E+00	0.453	0.993
CH (Base soil 2)	0.582	2.59E-01	1.61E-01	0.650	0.994

C-17

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(\alpha)} * [e_4]^{(w_{mix})}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.959	1.23E+00	1.36E+00	0.999	0.00004
CH (Base soil 2)	0.965	7.93E-01	5.02E-01	0.998	0.00340

C-18

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:s)} * [w_t:c]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.966	8.85E-01	9.71E-01	0.0008	-0.536
CH (Base soil 2)	0.956	5.02E-01	3.17E-01	0.0206	-0.381

C-19

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:s)} * [w_{mix}]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.965	2.13E-03	2.35E-03	0.122	-3.42
CH (Base soil 2)	0.960	3.72E-02	2.35E-02	0.101	-1.93

C-20

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:s)} * [\alpha]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.963	4.61E-02	5.06E-02	0.0003	0.526
CH (Base soil 2)	0.954	5.76E-02	3.64E-02	0.0140	0.370

C-21

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:c)} * [w_{mix}]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.954	1.73E-04	1.91E-04	1.06	-4.87
CH (Base soil 2)	0.914	1.02E-03	6.54E-04	1.16	-4.57

C-22

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(w_t:c)} * [\alpha]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.930	1.11E+07	1.20E+07	0.293	-3.06
CH (Base soil 2)	0.894	1.75E+06	1.06E+06	0.418	-2.86

C-23

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [e_3]^{(\alpha)} * [w_{mix}]^{e_4}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.971	3.40E-04	3.75E-04	0.999	-4.54
CH (Base soil 2)	0.971	3.53E-03	2.22E-03	0.998	-4.02

C-24

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : s]^{e_3} * [e_4]^{(w_{mix})}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.961	1.22E-01	1.35E-01	-1.30	0.0007
CH (Base soil 2)	0.964	5.09E-02	3.21E-02	-2.09	0.0643

C-25

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : s]^{e_3} * [e_4]^{(\alpha)}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.966	3.37E-04	3.72E-04	-4.64	1.00
CH (Base soil 2)	0.753	8.11E-03	5.24E-03	-2.03	1.00

C-26

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : c]^{e_3} * [e_4]^{(w_{mix})}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.947	1.08E+00	1.19E+00	0.197	0.00002
CH (Base soil 2)	0.937	4.58E-01	2.91E-01	0.537	0.00150

C-27

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [w_t : c]^{e_3} * [e_4]^{(\alpha)}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.885	3.26E+00	3.26E+00	-2.90	0.991
CH (Base soil 2)	0.750	1.44E+00	8.93E-01	-2.22	0.992

C-28

$$\frac{s_{u,pred}}{p_a} = \left[e_1 + e_2\left(\frac{t}{t_{mo}}\right)\right] * [\alpha]^{e_3} * [e_4]^{(w_{mix})}$$

	R^2	e_1	e_2	e_3	e_4
CL (Base soil 1)	0.950	2.83E+00	3.13E+00	-0.174	0.00003
CH (Base soil 2)	0.944	5.55E+00	3.52E+00	-0.429	0.00325