Effect of Concentration of Sphagnum Peat Moss on Strength of Binder-Treated Soil

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Academic Abstract

Organic soils are formed as deceased plant and animal wildlife is deposited in wet environs and decomposes. These soils have loose structures, low undrained strengths, and high natural water contents, and require improvement before they can be used as foundation materials. Previous researchers have found that the deep mixing method effectively improves organic soils. This study presents a quantitative and reliable method for predicting the strength of one organic soil treated with deep mixing.

For this thesis, organic soils were manufactured from commercially available components. Soil-binder mixture specimens with different values of organic matter content, *OM*, binder content, water-to-binder ratio, and curing time were tested for unconfined compressive strength (UCS). Least-squares regression was used to fit a predictive equation, modified from the findings of previous researchers, to this data. The equation estimates the UCS of a deep-mixed organic soil specimen using its total water-to-binder ratio and mixture dry unit weight. Soil *OM* is incorporated into the equation as a threshold binder content, a_T, required to improve a soil with a given *OM*; the a_T term is used to calculate an effective total water-to-binder ratio.

This thesis reached several important conclusions. The modified equation was successfully fitted to the data, meaning that the UCS of some organic soil-binder mixtures may be predicted in the same manner as that of inorganic soil-binder mixtures. The fitting coefficients from the predictive equations indicated that for the soils and binder tested, specimens of organic soil-binder mixtures have a greater relative gain of UCS immediately after mixing compared to specimens of inorganic soil-binder mixtures. However, the inorganic mixtures generally have a greater relative gain of UCS during the curing period. The influence of curing temperature was found to be similar for organic and inorganic mixtures. For the organic soils and binder tested in this research, a_T may be expressed as a linear or power function of *OM*. For both functions, the value of a_T was negligible at values of *OM* below 45%, which reflects the chemistry of the organic matter in the peat moss. For projects involving deep mixing of organic soils, the predictive equation will be used most effectively by fitting it to the results of bench-scale testing and then checking it against the results of field-scale testing.

Effect of Concentration of Sphagnum Peat Moss on Strength of Binder-Treated Soil

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General Audience Abstract

Organic soils are formed continuously as matter from deceased organisms – mainly plants – is deposited in wet environs and decomposes. Organic soils are most commonly found in swamps, marshes, and coastal areas. These soils make poor foundation materials due to their low strengths.

Deep mixing, or soil mixing, involves introducing a binder like Portland cement or lime into soil and blending the soil and binder together to form columns or blocks. Upon mixing, cementitious reactions occur, and the soil-binder mixture gains strength as it cures. Deep mixing may be performed using either a dry binder, known as dry mixing, or a binder-water slurry, referred to as wet mixing. Deep mixing may be used to treat either inorganic or organic soils to depths of 30 meters or greater. Contractor experience has shown that deep mixing is one of the most effective methods of improving the strength of organic soils.

Lab-scale studies (by previous researchers) of wet mixing of inorganic soils have found that the strength of soil-binder mixtures can be expressed as a function of mixture curing time and curing temperature, as well as the quantity of binder used, or binder factor, and the consistency of the binder slurry. No corresponding expression has been generated for wet mixing of organic soils, although many studies on the subject have been performed by previous researchers. The goal of this research was to generate such an expression for one organic soil. The soil used was made of sphagnum peat moss, an organic material commonly found in nature, and an inorganic clay used by previous researchers in studies of deep mixing in inorganic soils. The binder used in this research was a Portland cement.

For this research, 43 unique soil-binder mixtures were manufactured. Each mixture involved a unique combination of soil organic matter content, binder factor, and binder slurry consistency. After a soil-binder mixture was made, it was divided, placed into cylindrical molds, and allowed to cure. The temperature of the curing environment of the mixture was monitored. Mixture compressive strength was assessed after 7, 14, and 28 days of curing using two cylindrically molded specimens of the mixture. Data on mixture strength was then evaluated to assess whether it could be expressed as a function of the variables tested.

This research determined that the strength of at least some organic soils improved with wet mixing can be expressed as a function of soil organic matter content, binder factor, binder slurry consistency, and mixture curing time and curing temperature. The function will likely prove useful to deep mixing contractors, who routinely perform lab-scale deep mixing trials on samples of the soils to be improved in the field. Assuming wet mixing is used, the results of the trials are used to select values of binder factor and binder slurry consistency for the project. The function generated from this research will allow deep mixing contractors to select these values more reliably during the lab-scale phase of their work.

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Notation

The following symbols are used in this thesis:

a = binder content

AC = soil ash content

a_T = threshold binder content

c_c = compression index

c_v = coefficient of consolidation

c_0, c_1, c_2, $c_{3,1}$, $c_{3,2}$, c_4 = final fitting coefficients for UCS predictive equation by Ju (2018)

c_α = secondary compression index

d_1, d_2, $d_{3,1}$, $d_{3,2}$, d_4 = preliminary fitting coefficients for UCS predictive equations by Ju (2018) and in current research

d_5, d_6 = preliminary fitting coefficients for a_T – OM relationships

e = void ratio

e_0, e_1, e_2, $e_{3,1}$, $e_{3,2}$, e_4 = final fitting coefficients for UCS predictive equation in current research

e_5, e_6 = final fitting coefficients for a_T – OM relationships

f_c = curing factor

G_B = G_s of solids of binder

G_s = specific gravity of solids (general)

$G_{s\text{-}I}$ = G_s of inorganic base component of soil

$G_{s\text{-}SPM}$ = G_s of SPM

H = von Post level of decomposition

k = coefficient of permeability

LL = liquid limit

n = number of samples tested

OM = soil organic matter content

p_{ATM} = standard atmospheric pressure, 14.7 psi

PI = plasticity index

R^2 = coefficient of determination

S = degree of saturation

s_u = undrained shear strength = ½ x UCS

T = curing temperature, °C

T_C = reading of curing temperature in specimen bath, °C

T_{NWS} = reading of ambient temperature from National Weather Service station in Blacksburg, °C

T_0 = reference curing temperature, 21.1 °C

t = curing time

t_o = reference curing time, 1 day

t^* = calendar days since start of curing

UCS_{PRED} = predicted UCS

UCS_t = UCS at a given t

UCS_{28} = UCS at t = 28 days

V_S = volume of solids

W = weight of soil (including water)

W_B = weight of binder

W_I = weight of inorganic base component in soil

$W_{OS,O}$ = weight of organic solids in soil organic matter

$W_{S,O}$ = weight of solids in soil organic matter (SPM in this research)

W_S = weight of soil solids

W_W = weight of water in soil

w = soil water content

$w{:}b$ = water-to-binder ratio of the slurry

$w_T{:}b$ = total-water-to-binder ratio of mixture

$w_T{:}b_E$ = total-water-to-effective-binder ratio of mixture

α = binder factor

$\alpha_{I\text{-}P}$ = binder factor in-place

$\alpha_{I\text{-}P\text{-}T}$ = threshold binder factor in-place

$\gamma_{D\text{-}MIX}$ = dry unit weight of mixture

$\gamma_{D\text{-}SOIL}$ = dry unit weight of soil

γ_M = moist unit weight of soil

$\gamma_{T\text{-}MIX}$ = total unit weight of mixture

γ_W = unit weight of water at reference temperature (21.1 °C)

σ'_p = preconsolidation pressure

σ'_v = vertical effective stress

The following abbreviations are used in this thesis:

CEC = cation exchange capacity

CSH = calcium silica hydrate

$C_3S = (CaO)_3 \cdot SiO_2$

DCDT = direct current LVDT

LOI = loss on ignition (test)

LVDT = linear variable differential transformer

NWS = National Weather Service

SPM = sphagnum peat moss

UCS = unconfined compressive strength (general)

USCS = Unified Soil Classification System

Chapter 1: Introduction

This thesis describes a laboratory research program to investigate treatment of organic soils by the deep mixing method. This method, also known as soil mixing, involves using industrial augers to mix binder into soft soils to increase their shear strength. Organic soils are formed by deposition and decomposition of deceased wildlife, primarily plants. The typically loose structures, low strengths, and high natural water contents of these soils make them poor foundation materials.

Previous studies have established that soil mixing can effectively improve organic soils. However, the influence of variables such as organic matter content (*OM*), mixture proportions, and curing time on the unconfined compressive strength (UCS) of the mixtures has not been quantified. This study assesses previous findings and new research and presents a procedure in which these variables are used to predict the UCS of mixtures of organic soils.

For the research in this thesis, several organic soils were fabricated from commercially available components. Soil-binder mixture specimens with different values of *OM*, binder content, total water-to-binder ratio, and curing time were tested for UCS. The resulting data were used to generate equations for predicting UCS from *OM*, total water-to-binder ratio, and mixture dry unit weight. These equations incorporate values of the minimum or threshold binder content, a_T, required to improve soils with a given *OM* value.

This study has several limitations. As mentioned, an artificial organic soil was used, since repeatability of test results was an important research goal at this basic level of investigation. Only one type of organic soil and one type of binder were investigated, and mixture curing temperature varied only due to atmospheric influence.

Chapter 2 of this thesis presents a literature review of previous research on organic soils and soil mixing. Chapter 3 provides an overview of the testing program conducted. Chapter 4 presents and discusses the results of the testing program. Chapter 5 summarizes findings from this research and describes some potential future research topics regarding the improvement of organic soils by deep mixing.

Chapter 2: Literature Review

Chapter 2 provides a review of literature relevant to this research. Section 2.1 reviews organic soils and their origins, properties, geotechnical significance, composition, and classification. Section 2.2 summarizes basic soil mixing principles. Section 2.3 reviews the chemistry of deep mixing of organic soils, the threshold binder concept, and findings from previous studies of deep mixing of organic soils.

2.1. Organic Soils

2.1.1. Origins, Properties, and Location

Organic matter consists of carbon-based compounds derived from living organisms (Pettit n.d.). While many soils contain at least some organic matter, the organic soils of greatest concern to geotechnical engineers are created as organic matter is deposited continuously and haphazardly in low-lying, continuously wet regions such as swamps, marshes, and coastal areas (Costello 2016, Soil Science Society of America n.d.). In soil science, organic soils like these are known as histosols (University of Idaho 2017). The organic matter in soils is primarily plant matter, although it may also include animal, bacterial, and fungal matter (Hwang et al. 2005, Huang et al. 2009).

Organic matter may decay under aerobic or anaerobic conditions. Aerobic decomposition, which is mainly driven by bacteria, occurs when the soil is partially submerged or saturated. Anaerobic decomposition only occurs when the soil is fully submerged and occurs as a series of fermentation and putrefaction reactions. Generally, aerobic decomposition occurs much more rapidly than anaerobic decomposition (Larsson 1996). Organic decay may be accelerated by high temperatures (International Peat Society n.d., Timoney et al. 2012).

The organic matter content, or *OM*, of a soil is defined per Equation 1 as:

$$OM = \frac{W_{OS,O}}{W_S} \tag{1}$$

where $W_{OS,O}$ represents the weight of organic solids in the soil and W_S represents the total weight of soil solids. Generally, soils with higher *OM* values will have higher Atterberg limits and lower values of specific gravity of solids, G_s, and will be more difficult to compact effectively (Huang et al. 2009). A value of *OM* of as low as 5% can cause mineral soils to behave like organic soils (Huang et al. 2009).

Organic soils may have a spongy, fibrous, or amorphous texture depending on the degree of decomposition of their component organic matter. An advanced degree of decomposition of soil organic matter may give these soils a distinct odor (ASTM D2487 2017). Organic soils are usually black, brown, or gray, but may change color upon exposure to air due to drying and/or oxidation (Jacobson et al. 2003, Sleep et al. 2009). They generally have loose, wet structures which make them weak in shear, and they are highly compressible, especially during secondary compression (Jacobson et al. 2003, Sleep et al. 2009, Farrell 2012, ASTM D3282 2015, ASTM D2488 2017). As soil *OM* increases, soil pH tends to decrease (Huang 2009).

The behavior of an organic soil is strongly influenced by the degree of decomposition of its component organic matter. While plant matter fibers can reinforce less-decomposed soils, the shear strength, s_u, of organic soil decreases as decomposition, or humification, progresses and the fibers disintegrate (Hwang et al. 2005, Huang et al. 2009). Table 1 shows typical ranges of moist unit weight γ_M, G_s, and water content w for organic soils.

Table 1. Common values of organic soil physical properties.

γ_M, pcf	55-100
G_s	1.2-2.7
w, %	100-1600

Sources: Hwang et al. (2005), Sleep et al. (2009).

While organic soils make poor foundation materials, they are increasingly encountered in geotechnical practice. Many remaining sites for development are situated on poor geotechnical materials such as organic soils (Hwang et al. 2005), and organic soil deposits are often located near commercial, transportation, and population centers. In the US, these areas include the Northeast Corridor, Florida, the Great Lakes region, the Mississippi delta, and the San Francisco Bay area (Natural Resources Conservation Service n.d., Lambrechts et al. 2003, Kolka et al. 2015, Idaho 2017). Organic soil deposits may extend to depths of 200 m (Maraveas 2018).

2.1.2. Classification

Literature review findings indicate that the most widely used classification systems for organic soils are the Radforth, von Post, ASTM D2487, and ASTM D4427 systems.

The Radforth classification system, which originated in Canada, defines peats as soils with *OM* values of at least 80%. It classifies peats into 17 types based on the presence of wood fibers and/or fragments. While the Radforth system was designed for engineering use, its peat types are defined qualitatively, and it applies only to highly organic soils (Hwang et al. 2005, Huang et al. 2009). Therefore, it has limited geotechnical utility.

The von Post classification system, which originated in Sweden, classifies peats based on seven parameters. These include sample depth, degree of humification (abbreviated as H), moisture content, fiber coarseness and content, and the presence of wood remains. The von Post H value can be assessed according to ASTM D5715 (2014). The specificity of the von Post system can make it more useful than the Radforth system for geotechnical applications (Hwang et al. 2005). Many organic soil mixing studies include the von Post H values of the tested soils. Nevertheless, the qualitative classifications in the von Post system allow for subjectivity (Andriesse 1988, Hwang et al. 2005), which limits its geotechnical utility.

ASTM D2487 (2017), also known as the unified soil classification system (USCS), describes organic soils in objective geotechnical terms and includes a repeatable test for whether a soil is organic. The test involves taking two samples of a soil, drying one, and assessing the liquid limit of each sample. If the liquid limit of the dried specimen is less than 75% of the liquid limit of the non-dried specimen, the soil is considered organic. Further geotechnical assessments, such as particle size distributions and Atterberg limits, are then performed to classify the organic soil in more detail.

ASTM D4427 (2017) provides information about the amount and nature of organic matter in a soil sample. Per ASTM D2974 (2014), the soil *OM* is assessed by oven-drying a sample, weighing it, then heating it to 440 °C to combust organic matter. The proportion of material remaining is known as the ash content (*AC*) of the soil. The *OM* of the soil is then calculated using Equation 2:

$$OM\ (\%) = 100\% - AC\ (\%) \tag{2}$$

This procedure is known as the loss on ignition, or LOI, test. ASTM D4427 also calls for assessments of other organic soil properties, including relative fiber content (ASTM D1997 2013), pH (ASTM D2976 2015), water absorbency (ASTM D2980 2017), and, where applicable, botanical composition.

For soils with little organic matter, the LOI test may overestimate *OM* by removing diffuse double layer water from clay minerals or hydroxide groups from aluminosilicate molecules (Huang et al. 2009). However, the LOI test remains the most common method for assessing soil

OM in geotechnical practice. Huang et al. (2009) compared *OM* values determined using the LOI test with *OM* values for the same soil determined using a dry combustion technique. They determined that for a soil with an *OM* of 15% or greater, the LOI test provides an *OM* value accurate to within a few percentage points of the dry combustion value.

2.1.3. Chemical Composition of Soil Organic Matter

Only about 5% of organic matter in soils is comprised of living organisms (Chikyala 2008). Of non-living soil organic matter, 20-40% belongs to categories of typical organic molecules, such as amino acids, lipids, waxes, and sugars (Chikyala 2008). These materials are considered non-humic substances (Tremblay et al. 2002). The remaining non-living organic materials are known as humic substances or humus substances and form during plant decomposition. These comprise 60-80% of non-living soil organic matter (Chikyala 2008).

Living organic material, such as plant or fungal matter, is usually removed from a site at the start of geotechnical construction per standard practice. Non-humic substances are usually decomposed rapidly by microbes. Thus, geotechnical discussions of soil organic matter mainly pertain to humus substances (Huang et al. 2009).

Humus substances generally have high molecular weights, are yellow-to-black in color, and have high values of cation exchange capacity (CEC) of 300-1400 meq/100 g (Weber and Michalczyk 1997, Hwang et al. 2005, Huang et al. 2009). They frequently complex with non-organic particles such as clay minerals or metal cations (Stevenson 1994, Kujala et al. 1996). Generally, humus substances are resistant to bacterial decomposition (Chikyala 2008). They also have a high buffering capacity (Kujala et al. 1996).

A literature review found that while experts agree that humus substances are difficult to describe, they disagree regarding why. Rice et al. (1999) note that humus substances generally seem to lack discrete structure. By contrast, Mayhew (2004) observes that nuclear magnetic resonance and spectrometer studies have shown that humus substances have relatively uniform molecular structures.

Although debate persists about the precise molecular structure of humus substances, several systems have been devised to subdivide them based on their chemical behavior (Chen and Wang 2006). A literature review found that humus substances are most commonly categorized into three types – fulvic acids, humic acids, and humins – based on chemical fractionation (Huang et al. 2009). Fulvic acids are soluble in both acids and bases, and decompose most quickly. Humic acids are only soluble in bases, and decompose at an intermediate rate. Humins are soluble in neither acids nor bases, and decompose most slowly (Chikyala 2008, Huang et al. 2009).

The chemical fractionation of humus substances allows for a repeatable, detailed description of soil organic matter. After an organic soil is dried, it is separated using hydrochloric acid and sodium hydroxide into fulvic acid, humic acid, and humin fractions. Further processing is then performed on the fulvic and humic acids to remove attached non-humic substances to the maximum possible extent. The processed fractions are then weighed and their proportions in the organic matter are compared. A detailed fractionation procedure based on the procedure described by Swift (1996) is included in Appendix A.

Several studies have been conducted on the fractionation of humus substances in organic soils. Bobet et al. (2011) examined soil from a swamp in Indiana, Kalisz et al. (2010) assessed soils in river valleys in northeast Poland, Valladares et al. (2007) studied soils in Brazil, and Zelazny and Carlisle (1974) examined soils in Florida. Some of their findings are summarized in Table 2. Since each study utilized a slightly different procedure for fractionation, the findings should be compared cautiously. Only Valladares et al. (2007) looked at the percentage of soil organic matter comprised of humus substances in the soils they studied. The studies reviewed did not describe the nature of the non-humus organic substances in the soils they tested. Within Table 2, *n* refers to the number of soils tested.

Current procedures for the fractionation of humus substances, such as the one in Appendix A, have several limitations. Not all further purify the humin isolated in the process of fractionation. Also, since the humus substances are not isolated prior to fractionation, inorganic matter – whether loose or attached – may be included in the fractionation results. Lastly, the strong acids and bases used in fractionation may dissolve some humus substances (Stevenson 1994). New procedures are being developed to improve the reliability of results of fractionations of humus substances in soil (ISO 19822 2018). The procedure described in Appendix A represents the current standard of care in soil science for fractionation of humus substances in soil.

Table 2. Fractionations of humus substances in organic soils from published literature.

Study	Parameter of Interest	*OM*, %	Fulvic Acid Content, %	Humic Acid Content, %	Humin Content, %	Humus *OM* as % Total *OM*
Bobet et al. (2011) *n* = 1*	Average	45.1	2.4	23.7	73.9	–
	Std. Dev.	4.6	–	–	–	–
Kalisz et al. (2010) *n* = 4	Average	60.4	4.6	2.7	92.7	–
	Std. Dev.	13.0	1.3	0.7	2.0	–
Valladares et al. (2007) *n* = 22	Average	–	7.3	38.4	54.3	91.4
	Std. Dev.	–	3.4	7.2	6.5	7.4
Zelazny and Carlisle (1974) *n* = 8	Average	87.4	15.8	13.4	70.9	–
	Std. Dev.	2.9	9.5	3.5	8.4	–

**OM* reading based on 27 samples; humus substance fractionation based on 1 sample

2.2. Soil Mixing

During geotechnical construction projects, weak and compressible organic soils usually require one of three remediation strategies: (1) removal and replacement, (2) bypassing the organic soils with deep foundations, or (3) improvement. Removal and replacement can be cost prohibitive for deep organic deposits. Deep foundations can also be more expensive than improvement, and lateral loading on deep foundations in organic soils can be problematic. Improvement techniques for organic soils include the following: (1) surcharging, which can be time-prohibitive, (2) preloading and surcharging with sand drains or prefabricated vertical drains, which can be ineffective in organic soils due to the potential for large secondary compression following the preload and surcharge program, (3) dynamic replacement, which works only for shallow organic soil deposits, (4) lightweight fills, which do not always meet project requirements for strength and stiffness, and (5) the deep mixing method, which has been shown to be effective in improving organic soils (Hwang et al. 2005, Mullins and Gunaratne 2015). Some basic principles of the deep mixing method, which is often referred to as soil mixing in this thesis, are reviewed here.

Soil mixing was developed in Sweden and Japan in the 1960s and has been used in the US since the 1980s (Hwang et al. 2005, Bruce 2014). It involves introducing a cementitious binder into soil and blending the soil and binder together to form round columns, rectangular barrettes (massive piers), long walls, or large mass stabilized blocks. Treatment can extend to depths of 30 meters or more (Timoney et al. 2012). The binder may be an ordinary Portland cement, a calcium-based additive such as lime, a pozzolan like blast-furnace slag, or a blend of these materials (Janz and Johansson 2002). Upon mixing, cementitious reactions occur, strengthening the binder-soil skeleton as it cures (Filz et al. 2005). Bruce et al. (2013) and Kitazume and Terashi (2013) present thorough descriptions of soil mixing.

Although soil mixing requires a specialty contractor and may cost more than other ground improvement methods, it has several advantages. For deep deposits of organic soil, it is less expensive than excavation and replacement, faster and more reliable than preloading, and able to treat soil to depths greater than dynamic replacement can. Soil mixing also has a lesser impact on adjacent infrastructure than techniques such as preloading (with or without drains) or dynamic replacement (Lambrechts et al. 2003).

Soil mixing may be performed using either a dry binder, referred to as dry mixing, or a binder-water slurry, referred to as wet mixing. While both methods are commonly used, wet-mixing produces mixtures that are more homogeneous, with fewer air pockets and more-uniformly hydrated binder particles (Hampton and Edil 1998, Hernandez-Martinez 2006, Souliman and Zapata 2011).

Filz et al. (2005) and other researchers found that the UCS of soil-binder mixtures can be described using a logarithmic function of curing time, t, and a power function of the total water-to-binder ratio of the mixture, $w_T{:}b$. Nevarez et al. (2018) combined these relationships into a single function which they fitted to soil-binder mixture UCS data. They found that the fit was more accurate when a power function of the dry unit weight of the mixture, $\gamma_{D\text{-}MIX}$, was also included in the fitting function. Values of $w_T{:}b$ and $\gamma_{D\text{-}MIX}$ are functions of two other mixture parameters – binder factor, α, and water-to-binder ratio of the slurry, $w{:}b$. The binder factor represents the weight of binder added per unit volume of soil, while the water-to-binder ratio of the slurry is computed using the weights of water and binder within the binder slurry. Equations 3 and 4 represent $w_T{:}b$ and $\gamma_{D\text{-}MIX}$ in terms of $w{:}b$, α, w, dry unit weight of the soil, $\gamma_{D\text{-}SOIL}$, specific gravity of the binder, G_B, and unit weight of water, γ_W:

$$w_T{:}b = \left(w \times \frac{\gamma_{D\text{-}SOIL}}{\alpha}\right) + w{:}b \tag{3}$$

$$\gamma_{D\text{-}MIX} = \frac{\gamma_{D\text{-}SOIL} + \alpha}{1 + \alpha \times \left(\frac{1 + G_B \times w{:}b}{G_B \times \gamma_W}\right)} \tag{4}$$

Nevarez et al. (2018) developed Equation 5a to predict the UCS of the cured soil-binder mixture:

$$\frac{UCS_{PRED}}{p_{ATM}} = \left(d_1 + d_2 \times \ln\left(\frac{t}{t_o}\right)\right) \times (w_T{:}b)^{d_3} \times \left(\frac{\gamma_{D\text{-}MIX}}{\gamma_W}\right)^{d_4} \tag{5a}$$

where coefficients d_1, d_2, d_3, and d_4 are soil- and binder-specific constants obtained from a regression fitting from all specimens of all batches (i.e. all $w_T{:}b$ and $\gamma_{D\text{-}MIX}$ values), p_{ATM} represents atmospheric pressure, and t_o represents a reference curing time of 1 day.

Equation 5a may be rewritten such that *e*-coefficients replace the *d*-coefficients by solving

$$e_0 = d_1 + d_2 \times \ln\left(\frac{28\text{ d}}{1\text{ d}}\right) \tag{5b}$$

$$e_1 = \frac{d_1}{e_0} \tag{5c}$$

$$e_2 = \frac{d_2}{e_0} \tag{5d}$$

$$e_3 = d_3 \tag{5e}$$

$$e_4 = d_4 \tag{5f}$$

Using substitution, Equation 5a becomes

$$\frac{UCS_{PRED}}{p_{ATM}} = e_0 \times \left(e_1 + e_2 \times ln\left(\frac{t}{t_o}\right)\right) \times (w_T{:}b_E)^{e_3} \times \left(\frac{\gamma_{D\text{-}MIX}}{\gamma_W}\right)^{e_4} \tag{5g}$$

Using the term f_c, defined as

$$f_c = \frac{UCS_t}{UCS_{28}} = e_1 + e_2 \times \ln\left(\frac{t}{t_o}\right) \tag{6a}$$

where UCS_{28} represents specimen UCS at t = 28 days, Equation 5g may be rewritten as

$$\frac{UCS_{PRED}}{p_{ATM}} = e_0 \times f_c \times (w_T{:}b)^{e_3} \times \left(\frac{\gamma_{D\text{-}MIX}}{\gamma_W}\right)^{e_4} \tag{6b}$$

Ju (2018) and others found that higher curing temperatures produced higher UCS values for specimens of mixtures of inorganic soils. Ju (2018) expressed this influence by modifying Equation 5g into Equation 7:

$$\frac{UCS_{PRED}}{p_{ATM}} = c_0 \times \left(c_1 + c_2 \times ln\left(\frac{t}{t_o}\right)\right) * (w_T{:}b)^{c_{3,1} + c_{3,2} \times \left(\frac{T - T_0}{T_0}\right)} * \left(\frac{\gamma_{D\text{-}MIX}}{\gamma_W}\right)^{c_4} \tag{7}$$

where T refers to specimen curing temperature, T_0 refers to a reference room temperature of 21.1 °C (70 °F), and c_0, c_1, c_2, $c_{3,1}$, $c_{3,2}$, and c_4 are soil- and binder-specific coefficients obtained by a least-squares regression fitting of UCS data which included independent variation of t, T, $w_T{:}b$, and $\gamma_{D\text{-}MIX}$.

Although bench-scale mixing UCS values provide a useful reference for developing mixture proportions for field usage, bench-scale UCS usually do not equal field UCS values (Filz et al. 2005, Bruce et al. 2013). Differences in mixing effort, confining stress, pore pressures, drainage path length, and curing temperature all contribute to this disparity (Ahnberg et al. 2001, Ahnberg et al. 2003). Proposed mixing programs should be verified by field column tests prior to the start of mixing (Ahnberg et al. 2003, Bruce et al. 2013).

2.3. Deep Mixing of Organic Soils

The deep mixing method has been successfully applied to organic soils on numerous major geotechnical construction projects. Examples in the US include the Hudson-Bergen Light Rail Transit System embankment improvement near New York City, the I-95/US-1 interchange reconstruction near Washington, DC, and the post-Hurricane Katrina LPV 111 levee reconstruction near New Orleans (Esrig et al. 2003, Lambrechts et al. 2003, Hwang et al. 2005, Burke et al. 2007, Cooling et al. 2012). The technique has also been used on organic soils in many international projects (Hoikkala et al. 1997, Schwarz and Raithel 2005, Pye et al. 2012, Wheeler et al. 2017).

This section reviews previous laboratory studies of deep mixing of organic soils. It presents important points regarding the chemistry of and binder requirements for the mixing of organic soils, and summarizes other trends observed in the literature.

2.3.1. Chemical and Physical Factors

It is established that more binder is required for mixing organic soils than for inorganic soils. *OM* values of only 2% to 5% may negatively influence the strength of treated soil (Kujala et al. 1996, Hwang et al. 2005, Harris et al. 2009, Kitazume and Terashi 2013).

Organic matter interferes with cementitious reactions and strength development in soil-binder mixtures through one or more of several mechanisms that may act simultaneously. Several of these mechanisms act at a molecular level during binder reactions. Organic matter may be adsorbed onto binder molecules as binder is added to the soil, inhibiting the reactivity of the binder (Young 1972, Banfill and Saunders 1986). As the binder dissolves, the high CEC of organic matter may result in calcium cations being drawn from the binder, leaving fewer calcium cations available for cementation (Bruce et al. 2013, Costello 2016). The high capacity of organic matter for water absorption may also limit the extent to which remaining binder may be hydrated (Tastan et al. 2011). As cementation reactions progress, organic matter may complex with silicate and aluminate compounds, which can inhibit these reactions (Young 1972, Hampton and Edil 1998). Organic molecules may also be adsorbed onto hydrating cement particles, which can impede hydration (Banfill and Saunders 1986).

The pH of an organic soil also influences strength development in soil-cement mixtures. MacLean and Sherwood (1961) measured the strength and pH of various organic soils treated with Portland cement. They noted that all soil-cement mixtures which showed significant strength gain after 7 days had a pH of 12 or greater, and that all mixtures with a pH of 12 or greater exhibited significant strength gain within 42 days. Tremblay et al. (2002) added concentrations of different organic substances to specimens of two inorganic fine-grained soils, then mixed the organic-treated soils with Portland cement. After 7 to 28 days of curing, the s_u of each soil-binder mixture specimen was measured, as was the pH of the pore water in the specimen. Tremblay et al. (2002) determined that the organic soils with the lowest pore water pH values also had the lowest s_u values, and that a minimum pore water pH of 9 was required for strength gain to occur. Wong et al. (2013b) evaluated the pH of mixtures of organic soil and Portland cement at various values of α. They noted that when the specimen pH exceeded 9, increasing α produced a significant increase in specimen UCS.

Even when cementitious reactions occur in organic soils, their products may differ from those occurring in inorganic soils. Montgomery et al. (1991) conducted an experiment in which the hydration products of cements, some of which were treated with an organic polymer, were studied using a scanning electron microscope and X-ray diffraction. They discovered that the primary reaction product of cement not treated with the polymer was tricalcium silicate (C_3S in cement chemistry notation). C_3S is a precursor to calcium silicate hydrate (CSH), which is the primary reaction product that gives strength to cement mixtures. By contrast, Montgomery et al. (1991) found that the primary reaction product in polymer-treated cement was ettringite, a compound recognized to be weaker than CSH (Chikyala 2008). Subsequently, Hampton and

Edil (1998) and Hernandez-Martinez and al-Tabbaa (2005) reported that ettringite, not CSH or its precursors, was the dominant short-term cementitious product in organic soil-binder mixtures. According to Chikyala (2008), ettringite forms more easily than CSH in organic soil-binder mixtures because the silicates necessary to form CSH polymerize less readily in organic soil-binder mixtures than in inorganic soil-binder mixtures.

Several physical factors also contribute to the lower strength of organic soil-binder mixtures relative to inorganic soil-binder mixtures. Compared to inorganic soils, organic soils generally have higher water contents and lower solids contents. Since coefficient e_3 in Equation 5g has a negative value, an organic soil-binder mixture will have a lower $w_T{:}b$ value – and, therefore, a lower UCS – than an inorganic soil-binder mixture, even if α is identical for the two mixtures. Organic soil-binder mixtures thus require a greater quantity of binder than inorganic soil-binder mixtures to achieve a given UCS (Janz and Johansson 2002). The relatively large voids within organic soils may also be more difficult to fill with cement hydration products than the smaller voids within inorganic soils.

The degree of decomposition of an organic soil also influences its strength. As organic matter decomposes, it becomes finer and more dispersed throughout soil. When organic matter is finer and better-dispersed within soil, it will interfere more with cementitious reactions. Thus, more-decomposed organic soils are more difficult to improve by mixing than less-decomposed organic soils (Pousette et al. 1999, Bruce et al. 2013, Costello 2016).

2.3.2. Threshold Binder Level

Previous studies of the improvement of organic soils by deep mixing have observed that if the quantity of binder added to an organic soil does not exceed a certain threshold, the resulting soil-binder mixture will exhibit a negligible gain in UCS after mixing. Mullins and Gunaratne (2015) expressed this threshold in terms of binder factor in-place, $\alpha_{I\text{-}P}$. While α represents the weight of binder added per unit volume of soil, $\alpha_{I\text{-}P}$ represents the weight of binder added per unit volume of mixture (soil and binder slurry). Mullins and Gunaratne (2015) used the term effective binder to refer to the binder that is added beyond the threshold value of $\alpha_{I\text{-}P}$, denoted as $\alpha_{I\text{-}P\text{-}T}$, and that is available to improve the strength of the organic soil-binder mixture. The presence of $\alpha_{I\text{-}P\text{-}T}$ reflects the mechanisms discussed in the previous section by which organic matter interferes with cementitious reactions.

While past studies have created reliable UCS prediction equations for deep-mixed inorganic soils (Nevarez et al. 2018, Ju 2018), these equations have not considered $\alpha_{I\text{-}P\text{-}T}$. Any equation for predicting the UCS of organic soil-binder mixtures must consider $\alpha_{I\text{-}P\text{-}T}$. It seems logical that the value of $\alpha_{I\text{-}P\text{-}T}$ for an organic soil is a function of its value of *OM*.

Mullins and Gunaratne (2015) confirmed through lab testing of different organic soils that the binder threshold was non-zero for these soils and varied with *OM*. Mullins and Gunaratne (2015) found that beyond $\alpha_{I\text{-}P\text{-}T}$, UCS increased as $\alpha_{I\text{-}P}$ increased. They used their $\alpha_{I\text{-}P\text{-}T}$ and *OM* data to generate a threshold curve to estimate $\alpha_{I\text{-}P\text{-}T}$ as a function of *OM* for a specific combination of organic soil and binder type. Their findings may be used to iteratively generate the weight and *w:b* of binder slurry required to attain a given UCS for a deep-mixed organic soil. Costello (2016) generated additional threshold curves for different combinations of organic soil and binder type.

2.3.3. Trends from Previous Studies

This section summarizes findings from previous bench-scale studies of improving organic soils by deep mixing.

No consensus exists regarding specimen preparation and testing procedures for studies of organic soil-binder mixing. Each previous study has included unique procedures for soil processing before mixing, the mixing apparatus and duration, specimen shape and size, specimen preparation, and specimen curing conditions. Previous studies have also used different definitions to describe the quantity of binder used in the test mixing of organic soils. These non-uniformities make it difficult to directly compare the results of previous studies on improving organic soils using deep mixing. However, some general trends may be observed regarding the impact of properties of organic soils on mixture UCS, the influence of different binders on mixture UCS, the effect of different curing conditions on mixture UCS, and the influence of deep mixing on other properties of organic soils.

2.3.3.1. Effects of Properties of Organic Soils on UCS of Organic Soil-Binder Mixtures

Almost all the studies reviewed utilized natural organic soils for mixing tests. Each organic soil has unique chemistry and behavior, which further complicates direct comparison of results of different studies. Furthermore, organic matter within a single soil is highly heterogeneous, even if the soil is sieved and processed prior to mixing. This also complicates the interpretation of results from any individual study. Of the studies reviewed, only Ling et al. (2013), Yeo et al. (2016), and Law et al. (2018) utilized artificial organic soils. Their soils all consisted of kaolin mixed with an organic compound such as humic acid.

Of the studies reviewed, 16 assessed the impact of soil *OM* on the UCS of organic soil-binder mixture specimens. Eight studies concluded that UCS generally decreased with increasing *OM* (Petry and Glazier 2003, Hayashi and Nishimoto 2005, Hwang et al. 2005, Hernandez-Martinez 2006, Tang et al. 2011, Tastan et al. 2011, Ling et al. 2013, Baker 2015). The other eight studies determined that UCS did not change uniformly with increasing *OM* (Hampton and Edil 1998, Ahnberg and Holm 1999, Andersson et al. 2000, Axelsson et al. 2002, Kazemian et al. 2012, Yeo et al. 2016, Law et al. 2018, Rahman et al. 2018a). The lack of consensus on this topic reflects that many factors apart from *OM* also affect the UCS of specimens of deep-mixed organic soils.

Numerous studies examined the impact of soil pH on the UCS of organic soil-binder mixtures. Most of these studies indicated that, for identically stabilized mixes, no clear relationship existed between soil pH and UCS (Andersson et al. 2000, Jacobson et al. 2003, Hayashi and Nishimoto 2005, Tastan et al. 2011). However, some studies suggested that as soil pH decreased, UCS also decreased (Ahnberg and Holm 1999, Cortellazzo and Cola 1999). Mullins and Gunaratne (2015) investigated whether increasing the pH of organic soils prior to mixing would improve the UCS of soil-binder mixture specimens. They concluded that altering soil pH had no significant impact on mixture strength.

Several studies used multiple soils to research the relationship between the degree of organic soil decomposition, as represented by von Post H, and mixture UCS (Huttunen and Kujala 1996, Hebib and Farrell 1999, Axelsson et al. 2002, Zulkifley et al. 2014b). These studies found that for identically stabilized mixtures, UCS decreased as H increased. Hernandez-Martinez (2006) reached the same conclusion based on a literature review.

2.3.3.2. Effects of Binder Used on UCS of Organic Soil-Binder Mixtures

Previous studies on improving organic soils using deep mixing have employed many binder materials. Binders used have included Portland cements, limes, blast-furnace slags, fly ashes, gypsum, magnesium oxide cement, diatomaceous earth, zeolite, and plastic polymers, as well as combinations of these materials. Generally, previous studies have found that for equal quantities of binder, cement and slag-cement blends are most effective for improving organic soils (Bruce et al. 2013, Costello 2016), while lime is less effective (Jacobson et al. 2003, Hwang et al. 2005, Hernandez-Martinez 2006, Kolay and Suraya 2007). Inert materials such as sand, silica, or kaolin have also been used in some mixtures to increase mixture density by filling void spaces and to provide solid materials on which a soil-binder skeleton may form (Axelsson et al. 2002, Wong et al. 2013a).

Hayashi and Nishimoto (2005) and Tastan et al. (2011) studied in detail the effect of binder chemistry on the UCS of organic soil-binder mixtures. Hayashi and Nishimoto (2005) tested various high-sulfur Japanese specialty cements. They plotted mixture specimen UCS versus the ratio within the binder of combined mass of sulfur trioxide and aluminum oxide to mass of calcium oxide. Hayashi and Nishimoto (2005) found that, at a given binder content, binders with higher values of this ratio produced mixture specimens with higher values of UCS after curing. Tastan et al. (2011) tested mixtures of organic soils and various fly ashes. They found that, at a given fly ash content, mixture UCS was closely related to the ratio within the fly ash of mass of calcium oxide to combined mass of silicon dioxide (silica) and aluminum oxide. Tastan et al. (2011) noted that mixture UCS was greatest when this ratio equaled 0.6 to 0.7. They also observed that the effect of this ratio was less clear for soils with higher *OM* values.

Ahnberg et al. (2003) compared the rate of strength gain of specimens of organic soil-binder mixtures when different binders were used. They utilized various blends of Portland cement, lime, slag, and fly ash to stabilize specimens of one organic soil. Ahnberg et al. (2003) found that specimens in which Portland cement was the predominant binder component attained a higher UCS more rapidly than those in which lime was the predominant binder component. Sing et al. (2009) reached a similar conclusion through a literature review of previous studies on deep mixing of organic soils. They noted that specimens mixed with Portland cement usually attained a higher UCS sooner than specimens mixed with slag or fly ash binders.

Bertero et al. (2012) performed a large bench-scale study on Mississippi delta peats to compare the performance of five different blended binders composed of cement and slag. They found that the peat was most successfully stabilized using a binder composed of 25% cement and 75% slag by weight. Costello (2016) performed a data review from previous studies of deep mixing of organic soils, including the work of Bertero et al. (2012). Costello (2016) concluded that sandy organic soils were best stabilized with pure cement binders, while clayey organic soils were best stabilized with blended cement-slag binders.

Hebib and Farrell (2003) examined how von Post H might influence the efficacy of binders in the deep mixing of organic soils. They used two soils, one with a low H value and another with a high H value. Hebib and Farrell (2003) found that while Portland cement binders were effective for both soils, only the low-H soil was improved using a slag or slag-gypsum binder.

In the studies reviewed, mixture specimen UCS generally increased with an increase in binder added. However, Humphrey (2001), Petry and Glazier (2003), Hernandez-Martinez and Al-Tabbaa (2004), and Shao et al. (2008) noted that when binder was added beyond a certain quantity, UCS leveled off or decreased. Humphrey hypothesized that when more binder was added, excess binder particles were binding to each other, rather than binding and stabilizing the soil. Leong and Eriktius (2014) speculated that, beyond a certain quantity of added binder, insufficient water would be available for binder hydration, causing a decrease in mixture UCS.

2.3.3.3. Effects of Curing Conditions on UCS of Organic Soil-Binder Mixtures

Previous studies investigated the influence of several variables related to curing conditions on the UCS of organic soil-binder mixtures. These included curing time, curing temperature, and the presence of a surcharge. Several variables related to the physical environment in which curing occurred were also examined, including curing medium, curing solution pH, and curing solution carbon dioxide concentration.

The studies reviewed reported that, generally, the UCS of specimens of organic soil-binder mixtures increased with curing time up to the standard 28 days allowed for cement curing. In some studies, specimens were cured for longer durations. Although most studies observed that specimen UCS continued to increase or plateaued beyond 28 days of curing, several studies reported modest decreases in specimen UCS beyond 28 days. These studies examined soils cured at higher temperatures (Hernandez-Martinez 2006) as well as some organic soils from Texas (Harris et al. 2009), the Czech Republic (Kanty et al. 2017), and Malaysia (Rahman et al. 2018a, Rahman et al. 2018b).

Rahman et al. (2018a) and Rahman et al. (2018b) identified two possible mechanisms that may, over extended curing times, cause a decrease in UCS for some specimens of organic soil-binder mixtures. Rahman et al. (2018a) examined specimens cured for either 28 or 56 days using

X-ray diffraction. They found that cementitious compounds present in the specimens cured for 28 days were absent in the specimens cured for 56 days. Rahman et al. (2018a) did not address the potential causes of the disappearances of the compounds. Rahman et al. (2018b) found that one of the mixtures for which specimens cured for 28 days were stronger than those cured for 56 days had a significant increase in bacterial population during this time. They suggested that once cementitious reactions in the soil-binder mixture had slowed after 28 days, bacteria had begun growing in the mixture again, consuming organic fibers, weakening the soil-binder matrix, and decreasing UCS. Harris et al. (2009) observed that the pH of some organic soil-binder mixtures decreased slightly between 28 and 56 days, which may also contribute to the decline in mixture UCS during this time.

Jacobson et al. (2003) and Hernandez-Martinez (2006) investigated the influence of curing temperature on the UCS of specimens of organic soil-binder mixtures. Hernandez-Martinez (2006) found that specimen UCS decreased as curing temperature increased, while Jacobson et al. (2003) observed the opposite trend. The difference between the observations most likely relates to the different *OM* values of the soils studied. Jacobson et al. (2003) used soils with *OM* values of 6% to 15%, while Hernandez-Martinez (2006) used soils with *OM* values of 30% to 94%. The difference between the response of lower *OM* and higher *OM* soil-binder mixtures to increasing curing temperature may relate to microbial activity. As mentioned in Section 2.1.1, bacterial activity is one of the primary causes of organic soil decomposition (Hampton and Edil 1998). In the higher-*OM* soils studied by Hernandez-Martinez (2006), higher curing temperatures may have increased microbial activity, which could have caused an increase in degree of decomposition and a decrease in UCS.

Several studies examined the influence of imposing a surcharge during curing on the UCS of organic soil-binder mixture specimens (Pousette et al. 1999, EuroSoilStab 2002, Hwang et al. 2005, Kalantari and Prasad 2014). All found that specimen UCS generally increased as curing surcharge increased. Kalantari and Prasad (2014) found that surcharged specimens were only stronger than non-surcharged specimens at higher binder dosages. No other source identified this phenomenon.

Pousette et al. (1999), Kalantari and Prasad (2014), and Abdel-Salam (2018) examined the influence of curing medium on the UCS of specimens of organic soil-binder mixtures which were otherwise identical. Pousette et al. (1999) cured specimens under water and exposed them to 0, 1, 2, 4, or 8 freeze-thaw cycles. They found that specimen strength decreased with an increasing number of freeze-thaw cycles. Kalantari and Prasad (2014) compared specimens left open to air during curing to specimens submerged under water during curing. They found that, for the same mixture, water-cured specimens had a lower UCS than air-cured specimens. Abdel-Salam (2018) cured specimens underwater using both clean and swampy water. They observed that, for the same mixture, specimens cured under clean water were approximately 10% stronger than those cured under swampy water.

Kazemian et al. (2011a) and Kazemian et al. (2011b) examined the influence of the pH of curing solution on the UCS of identical sets of specimens of organic soil-binder mixtures. They cured one set of specimens in acidic solutions with pH values of 3 to 5, and the other set of specimens in basic solutions with pH values of 10 to 12. Kazemian et al. (2011a) and Kazemian et al. (2011b) observed that the specimens cured in acidic media had UCS values substantially lower than those cured in basic media.

Hernandez-Martinez (2006) and Kazemian et al. (2011a) examined the effect of carbon dioxide concentration on the UCS of specimens of organic soil-binder mixtures. Hernandez-Martinez (2006) cured some specimens cured in an environment exposed to elevated carbon dioxide concentrations and other, identical specimens in an environment without elevated exposure to carbon dioxide. They noted no difference in UCS values for the two specimens. Kazemian et al. (2011a) mixed two identical sets of specimen batches using two binders – one pure cement, one a cement-slag blend – and cured one set in distilled water and the other set in carbonated water. Kazemian et al. (2011a) found that, for specimens mixed using the pure cement binder, the specimens cured in carbonated water consistently had slightly higher UCS values than the specimens cured in distilled water. By contrast, they found that, for specimens mixed using the cement-slag binder, the specimens cured in carbonated water consistently had slightly lower UCS values than the specimens cured in distilled water.

Hernandez-Martinez (2006) assessed the effects of the relative humidity of the curing environment on specimen UCS. They did not observe any trend between these parameters.

2.3.3.4. Effects of Deep Mixing on Other Properties of Organic Soils

Previous studies have addressed the impacts of deep mixing on several properties of organic soils apart from their UCS. These properties include permeability, k, preconsolidation pressure, σ'_p, coefficient of consolidation, c_v, and secondary compression index, c_α. The change in humus substance fractionation due to deep mixing and the potential for organic soil-binder mixtures to leach contaminants were also evaluated.

Previous studies which have evaluated the impact of deep mixing on the value of k in organic soils have reached different conclusions. Wong et al. (2008) determined that deep mixing had little impact on k in organic soils, Bobet et al. (2011) found that deep mixing increased k in organic soils by several orders of magnitude, and Wong et al. (2013a) concluded that deep mixing decreased k in organic soils by several orders of magnitude. These disparate findings likely reflect the widely varying nature of organic soils.

Multiple studies have examined the effect of deep mixing on the compression characteristics of organic soils. Bobet et al. (2011) experimented with a single organic soil and multiple values of binder content, a, where a is defined by Equation 8 as

$$a = \frac{W_B}{W_S} \tag{8}$$

where W_B is the weight of binder in the mixture and W_S is the weight of soil solids in the mixture, as defined in Equation 1. Bobet et al. (2011) determined that, as a increased, the value of σ'_p of the soil-binder mixture increased, as did the value of c_v of the mixture at a given value of effective vertical stress, σ'_v.

Bobet et al. (2011), Sobhan et al. (2012), and Sarsour (2014) investigated the effect of mixing on the value of c_α of an organic soil-binder mixture by looking at the change in the ratio of values of c_α to values of compression index, c_c, for the mixture. All three studies found that as a increased, the ratio $\frac{C_\alpha}{C_c}$ decreased from values of 0.05 and higher, which are typical of peats, to values of 0.03 to 0.04, which are typical of inorganic clays. Mixing even improved the ratio of $\frac{C_\alpha}{C_c}$ for some organic soils to values below 0.03, which are typical of granular soils.

Bobet et al. (2011) examined how the fractionation of humus substances in an organic soil changed as it was improved with deep mixing. Their procedure was similar to the one described in Appendix A. They found that as a increased, the proportions of fulvic acid and humic acid determined by the fractionation decreased, while the proportion of humin increased. Bobet et al. (2011) commented that these results suggested that three groups of humus substances each had different reactivity with the cement. Bobet et al. (2011) represented the only study of those reviewed here in which fractionation of humus substances was performed on the organic soil improved using deep mixing.

den Haan et al. (2000) and Leong and Eriktius (2014) evaluated the potential of organic soil-binder mixtures to leach chemical contaminants. den Haan et al. (2000) performed leaching tests of an unspecified nature on an organic soil mixed with a blended binder containing slag, Portland cement, and gypsum. They found that the mixture had significant potential to leach sulfate ions. Leong and Eriktius (2014) performed constant head tests to assess contaminant levels in water leached from peat specimens stabilized with fly ash. They determined that concentrations of arsenic, barium, cadmium, and lead in the leached water were all higher than those permissible per Singaporean drinking water standards (the study was conducted in Singapore).

Chapter 3: Specimen Testing

This chapter provides an overview of the materials tested and the tests conducted. Section 3.1 discusses the base soil used and its composition. Section 3.2 describes the testing program. Section 3.3 summarizes the specimen manufacturing and testing process. Section 3.4 reviews the data processing and equation fitting performed.

3.1. Base Soils

3.1.1. Inorganic Fraction

The inorganic fraction of the soils used in these experiments was identical to the soil used by Nevarez et al. (2018). The inorganic soil was fabricated from commercially available materials so it could be easily reproduced. The fabricated soil consists of 10% fine sand, 65% silica flour, 20% Tile 6 kaolin, and 5% bentonite. All of the soil passes the No. 40 sieve, 88% passes the No. 200 sieve, the liquid limit is 35, and the plasticity index (PI) is 22. According to ASTM D2487 (2017), the USCS symbol for the soil is CL, and the soil is classified as a lean clay.

3.1.2. Organic Fraction

Artificial organic soils were prepared for this study. Natural organic soils are highly heterogeneous, and the organic fraction can oxidize rapidly and experience microbial decomposition while in storage after sampling (Farrell 2012). These factors influenced the decision to use a commercially available organic source material to fabricate organic soils with different organic contents, instead of using naturally occurring organic soils. The objective was to reduce variability so that basic trends in treatability could be observed without the trends being masked by variability.

The organic source material used in this study was selected to have a value of *OM* greater than 50% and to contain all three humus substances. It was also selected to be relatively easy to mix and to produce organic soils with properties similar to those that are improved by the deep mixing method in practice. After evaluating a variety of potential organic source materials, sphagnum peat moss (SPM) was identified as the best organic source material to satisfy these objectives. SPM is one of the most common forms of vegetation found in bogs (Verry et al. 2011, Farrell 2012), which makes it a reasonable choice to fabricate organic soils similar to those encountered in practice. Appendix B summarizes the tests performed on organic materials considered for use in this research.

Larger particles may disproportionately and randomly influence the UCS behavior of bench-scale organic soil mixture specimens. To reduce variability, the SPM was shaken through a #4 sieve and then ground in a coffee grinder. Sieving of organic soils prior to testing has been performed in previous studies (Kalantari and Prasad 2014, Rahman et al. 2016). The effect of grinding on the particle size distribution of SPM is shown in Appendix C. The particle size plots show that grinding reduces the largest particle size to approximately 1 mm.

Table 3 lists the values of *OM* and G_s for the SPM. To create an organic soil with a target *OM*, the SPM was blended with the dry inorganic soil components. Determining the weights of SPM and inorganic soil to combine to achieve a target *OM* requires knowing the *OM* of the SPM. This value was initially determined by applying the LOI test (ASTM D2974 2014) to a sample of SPM taken directly from storage.

Later, when checking the *OM* values of the organic soils after they were wetted to their liquid limits and cured overnight, it was discovered that their measured *OM* values were larger than their target *OM* values, and that the difference increased as target *OM* value increased. To investigate this, the *OM* of SPM which had been wetted and cured overnight to replicate the sequence for the organic soil mixtures was also tested. The *OM* of the wetted, cured SPM was significantly higher than the *OM* of the stored, unwetted SPM, as shown in Table 3. The mechanism by which wetting and curing increased the *OM* of the SPM is not known. It is possible, however, that the wetting and curing caused organic matter in the SPM to become more separated from inorganic matter than would otherwise be the case. This could have resulted in greater combustion of organic matter in the SPM during the LOI test. Test results for *w* and *OM* for all soils used in this research, as well as the SPM, are presented in Appendix D.

The G_s of the SPM was determined using a gas pycnometer (ASTM D5550 2014). A conventional, water-based pycnometer test (ASTM D854 2014) could not be used because some components of the SPM float in water, possibly due to surface tension and/or air pockets and bubbles of gas trapped in the material. The G_s value of the SPM listed in Table 3 is comparable

Table 3. Properties of sphagnum peat moss.

OM (not wetted), %	*OM* (wetted), %	G_s
62.9	73.2	1.52

to those of many peats found in the field (Humphrey 2001, Duraisamy et al. 2007). The gas pycnometer test results for the SPM are presented in Appendix E.

Fractionation of the humus substances in the SPM was performed using the procedure outlined in Appendix A. The results are shown in Table 4 (and in Appendix A). Compared to the values listed in Table 2, the SPM contains less humic acid than most organic soils tested, but its proportions of fulvic acid and humin are similar to those of other organic soils tested.

Table 4. Proportions of humus substances within sphagnum peat moss.

Fulvic Acid Content, %	Humic Acid Content, %	Humin Content, %
4.8	1.3	93.9

3.1.3. Soil Properties

Nine soils – one inorganic and eight organic – were tested for treatability with binder. The soils were manufactured from inorganic base soil and SPM. Table 5 lists *OM* values, USCS classification symbols, G_s values, liquid limit and plasticity index values, fines contents, von Post H values, and pH values for the soils. The test results for Soil 0 are reproduced from Nevarez et al. (2018), except for *OM* and pH, which were measured as part of this research. Table 5 shows that not all properties were tested for all soils. While *OM* values were tested for all soils, USCS classifications, as well as values of liquid limit, plasticity index, fines content, von Post H, and pH, were only obtained for Soils 0, 10, 30, and 50. This decision was made because these soils were used in most of the batches mixed for this research. The liquid limit values for Soils 5, 15, 20, 25, and 40 were estimated by interpolation. These values were used only to establish the water content for wetting and curing the soils overnight before blending them with cement-water slurry. Test results for Atterberg limits are presented in Appendix F.

Table 5. Properties of soils tested.

Soil Designation	*OM*, %	USCS Symbol	G_s	LL	PI	Fines, %	Von Post H	pH
0	0.9	CL	2.66	35	22	88	*N/A*	7.2
5	8.3		2.51	48				
10	15.0	MH	2.38	60	3	88	*N/A*	5.2
15	22.6		2.26	84				
20	29.6		2.15	108				
25	33.4		2.05	132				
30	36.1	MH	1.96	156	*N/A*	79	*N/A*	4.6
40	48.9		1.80	211				
50	57.5	PT	1.67	265	*N/A*	63	H5	4.6

Values of G_s for all soils were calculated using the value of G_s measured for Soil 0, $G_{s\text{-}I}$, and the value of G_s measured for SPM, $G_{s\text{-}SPM}$, and the weights of Soil 0, W_I, and SPM solids, $W_{S,O}$, in the soil. Equation 9 shows the expression used:

$$G_s = \left(\frac{W_I}{G_{s\text{-}I}\times(W_I+W_{S,O})}+\frac{W_{SPM}}{G_{s\text{-}SPM}\times(W_I+W_{S,O})}\right)^{-1} \tag{9}$$

The soil designation numbers in Table 5 are based on their target values of *OM*. The portions of inorganic soil and SPM used for a target *OM* value were based on an *OM* value of zero for the inorganic portion described in Section 3.1.1 and the *OM* value for the stored, non-wetted SPM listed in Table 3. In the column labeled "*OM*" in Table 5, the measured values of *OM* are listed, as determined from LOI tests on soil specimens that had been wetted to their liquid limits and cured overnight. The measured *OM* values in Table 5 are larger than the target *OM* values, and the difference tends to increase as the target *OM* increases. This is apparently due to the effect of wetting and curing the SPM overnight prior to performing the *OM* tests, as discussed in Section 3.1.2. Table 5 also shows that Soil 0 exhibited an *OM* of 0.9%. As mentioned in Section 2.1.2, non-zero values of *OM* can be measured in LOI tests of soils with no organic matter due to the loss of diffuse double layer water in clay minerals and/or the removal of hydroxide groups from aluminosilicate particles (Huang et al. 2009).

Within the research, all soils containing SPM were referred to as organic soils. However, of only Soil 50 was classified as organic per ASTM D2487 (2017). Unless soils have a dark color and an organic odor, as Soil 50 does, ASTM D2487 (2017) defines a soil as organic if its liquid limit after oven-drying is less than 75% of its liquid limit without oven-drying, as discussed in Section 2.1.2. The values of this ratio were assessed for Soils 10 and 30 and were found to be 82% and 77%, respectively. Results of these tests are presented in Appendix F.

The fines content and particle size distribution for Soils 10, 30, and 50 were determined using ASTM D6913 (2017). The fines contents are listed in Table 5, and the particle size distributions are presented in Appendix C. While ASTM D6913 (2017) is typically not used for organic soils because organic particles often have high aspect ratios, a search revealed no suitable alternative test. The ASTM D6913 (2017) test results may be affected by the action of moving the soil back and forth over the # 200 mesh during washing, which could abrade organic soil particles. The organic soil particle size distributions do not include information on particles passing the #200 sieve. Although hydrometer testing was attempted per ASTM D7928 (2017), it was unsuccessful because the tendency of SPM to float meant that hydrometer readings differed considerably from sieve analysis readings on the same soil.

The von Post H of Soil 50 was determined using ASTM D5715 (2014). As mentioned in Table 5, Soil 50 has a von Post classification of H5, signifying moderate decomposition. This test result is presented in Appendix G.

The pH of Soils 0, 10, 30, and 50 was assessed using ASTM D4972 (2019), and the results are listed in Table 5. The soil was dried, immersed in deionized water, and allowed to sit for one hour with occasional stirring before the pH probe was inserted into the solution. ASTM 4972 (2019) allows several different ratios of solids to deionized water by weight to be used to assess soil pH. For these measurements, a ratio of 1 g solid to 5 g water was used.

Although ASTM D2976 (2015) is a pH test written specifically for organic soils, ASTM D4972 (2019) was used so that inorganic and organic soils could be compared using a common standard. To provide a point of direct comparison, the pH of Soil 50 was also determined using ASTM D2976 (2015), and a pH value of 4.9 was obtained. This is slightly higher than the value measured using ASTM D4972 (2019). Test results for soil pH are presented in Appendix H.

3.2. Testing Program

The lab-scale testing program involved mixing the nine soil types listed in Table 5 with cement-water slurry, casting several specimens from each mixture, curing the specimens for different times, and testing the UCS of the cured specimens. For each soil type, different *w:b* ratios of the slurry and different amounts of slurry were used. Table 6 summarizes the testing program. The batch numbers are of the form x-y, where x is the soil type from Table 5, and y is the chronological order in which different batches for that soil type were prepared. Table 6 provides values of *OM*, *w:b*, *a*, $\alpha_{I\text{-}P}$, and specimen curing times for each batch. Two sets of $\alpha_{I\text{-}P}$ values are provided for each batch: the first value listed is the design value, and the second value, which is in parentheses, represents the actual $\alpha_{I\text{-}P}$ value after adjusting for measured mixture proportions and bleed water that collected at the top of some specimens during curing.

Batches 0-1 through 0-5 were done to permit comparison with previous results on the same soil from Nevarez et al. (2018) and Ju (2018). The remaining batches in Table 6 were used to investigate the influence of *OM* from SPM on soil treatability with Portland Type I/II cement.

3.3. Specimen Preparation and Testing

The specimen preparation and testing procedures used in this study were nearly identical to those used by Nevarez et al. (2018), although some refinements were made. The procedures are described briefly here and are presented in detail in Appendix I. Mixing summaries for each batch are presented in Appendix J.

3.3.1. Base Soil Preparation

As discussed in Section 3.1.2, the SPM was passed through a #4 sieve and a coffee grinder to enhance uniformity before mixing with the inorganic soil materials. Similarly, only the sand passing the #40 sieve and retained on the #200 sieve was used in mixing. No processing was done for the silica, kaolin, or bentonite.

The required amounts of all the dry components of a base soil batch were computed, weighed, placed to a large bowl, and lightly mixed by hand using a large spoon. The soil was then loaded into a jar mill and tumbled for 10 minutes to thoroughly mix the components.

Table 6. Properties of cement-treated soil batches for UCS testing.

Batch	*OM*, %	*w:b*	*a*, %	$\alpha_{I\text{-}P}$, kg/m^3	Curing Times, d
0-1	0.9	1.0	10.9	125 (124.8)	10, 44
0-2	0.9	1.0	11.3	125 (128.9)	7, 16, 28
0-3	0.9	0.6	39.2	350 (350.8)	7, 15, 28
0-4	0.9	1.0	19.7	200 (199.4)	8, 14, 33
0-5	0.9	1.0	46.8	350 (347.9)	8, 14, 33
5-1	8.3	1.0	16.9	150 (152.4)	7, 15, 28
5-2	8.3	1.2	36.4	250 (254.1)	7, 15, 28
5-3	8.3	0.8	31.1	250 (252.9)	7, 15, 28
10-1	15.6	1.0	8.1	71 (71.1)	10, 20, 35
10-2	15.6	1.0	13.8	113 (114.4)	10, 21, 35
10-3	15.6	1.0	19.9	150 (154.5)	10, 21, 35
10-4	15.6	1.2	42.1	250 (253.2)	7, 14, 28
10-5	15.6	1.0	67.3	350 (352.5)	7, 14, 28
10-6	15.6	0.8	117.4	500 (503.3)	7, 14, 28
15-1	22.6	0.6	32.2	200 (203.7)	7, 15, 28
15-2	22.6	0.6	54.3	300 (304.5)	7, 15, 28
15-3	22.6	1.0	65.3	300 (303.8)	7, 15, 28
20-1	29.6	0.6	44.9	225 (229.2)	7, 15, 28
20-2	29.6	0.6	81.3	350 (354.3)	7, 15, 28
20-3	29.6	1.0	102.6	350 (354.4)	7, 15, 28
25-1	33.4	1.2	74.6	250 (253.5)	7, 14, 28
25-2	33.4	0.6	60.1	250 (254.8)	7, 14, 28
25-3	33.4	1.2	190.1	400 (409.1)	7, 14, 28
30-1	36.1	1.0	41.7	152 (157.4)	9, 16, 33
30-2	36.1	1.0	69.4	226 (230.3)	11, 16, 32
30-3	36.1	1.0	96.1	283 (286.1)	11, 16, 32
30-4	36.1	0.8	121.2	350 (354.8)	7, 14, 28
30-5	36.1	0.8	151.6	400 (404.8)	7, 15, 28
30-6	36.1	0.6	194.2	500 (505.4)	7, 15, 28
30-7	36.1	0.6	36.9	150 (153.3)	8, 14, 28
30-8	36.1	0.6	51.7	200 (203.1)	8, 14, 28
40-1	48.9	1.0	232.3	400 (410.0)	7, 14, 28
40-2	48.9	0.5	162.1	400 (404.3)	7, 14, 28
40-3	48.9	1.0	407.5	500 (519.7)	7, 14, 28
40-4	48.9	0.6	88.4	250 (254.4)	7, 14, 28
50-1	57.5	1.0	91.9	200 (207.9)	11, 14, 31
50-2	57.5	1.0	150.3	281 (295.4)	11, 14, 31
50-3	57.5	1.0	205.0	338 (356.9)	11, 14, 31
50-4	57.5	0.8	239.6	400 (413.3)	7, 14, 30
50-5	57.5	0.6	254.7	450 (459.9)	7, 14, 30
50-6	57.5	0.6	306.1	500 (510.5)	7, 14, 30
50-7	57.5	0.6	82.3	200 (206.3)	9, 15, 28
50-8	57.5	0.6	137.9	300 (308.3)	9, 15, 28

After tumbling, the soil was weighed and transferred to a kitchen mixing bowl. Enough water was then added so that the soil moisture content equaled its liquid limit. The dry soil and water were mixed for 5 minutes using a 12-quart kitchen mixer with a dough-hook attachment. The mixer was stopped several times so soil beyond the reach of the dough hook could be mixed manually. Once soil-water mixing was complete, the moist soil was transferred to a sealed container and stored overnight.

3.3.2. Base Soil Remixing, Binder Slurry Mixing, and Soil-Slurry Mixing

After the moist soil had cured for at least 12 hours (and usually for no more than 36 hours), it was re-weighed and placed in the mixing bowl. The binder slurry was then prepared using Portland Type I/II cement and tap water. Only cement passing the #200 sieve was used. More binder slurry than required was always prepared since slurry always stuck to the blender pitcher.

Once the binder was added to the water, they were mixed into slurry for 3 minutes using a 14-speed kitchen blender. As binder mixing occurred, the moist soil was remixed for 3 minutes using the kitchen mixer and dough-hook.

After slurry mixing and soil remixing were complete, the slurry was poured incrementally into the mixing bowl with the moist soil. Between each increment of slurry addition, the slurry and moist soil were briefly mixed to avoid splashing of slurry during mixing.

After the binder slurry had been added, the soil and slurry were mixed for 10 minutes using the kitchen mixer. Every 2½ minutes, the mixer was stopped so soil and slurry in hard-to-reach portions of the bowl and hook set-up could be blended manually into the rest of the mixture.

3.3.3. Specimen Molding and Curing

Specimens were molded from each batch within 30 minutes after mixing had been finished. Each specimen was molded using a plastic cylinder 2 inches in diameter and 4 inches tall. The specimen was molded in three lifts, each about one-third the height of the mold. After the placement of each lift, the mold was lifted vertically and tapped hard about 60 times on a lab counter to remove any air bubbles from the mixture. In very fluid mixtures, which were prone to splashing, the final half-inch of material was placed without tapping. Following the final lift, the top of the mold was leveled when necessary using a straight-edged spatula. Once the specimens were molded, they were weighed.

This study utilized a weight-based tolerance to assess the uniformity of molded specimens. The specimens were weighed and the range of their masses was determined. If the weight of any specimens fell outside of a 5-gram range, several grams of soil-cement was removed or added as necessary from these specimens until the weights of all specimens fell within a 5-gram range. Each specimen which had had its weight adjusted was then re-leveled with the straight-edged spatula and tapped several more times.

The efficacy of the weight-based tolerance was checked using values of mixture total unit weight, $\gamma_{T\text{-}MIX}$, for each batch, where $\gamma_{T\text{-}MIX}$ is the ratio of the weight of all material within the mixture to the volume of the mixture. The design value of $\gamma_{T\text{-}MIX}$ for each specimen was compared to the actual value of $\gamma_{T\text{-}MIX}$ of the specimen. The ratio of actual $\gamma_{T\text{-}MIX}$ to design $\gamma_{T\text{-}MIX}$ was generally 97-98%, indicating that using the weight-based tolerance resulted in specimens with very few voids and relatively uniform masses and volumes.

Once the specimens were weighed and found to be within tolerance, the molds were capped with tight-fitting plastic lids. Each mold was then sealed with 3 wraps (approximately 24 inches) of plastic electrical tape. The sealed specimens were submerged in sealed tubs of water for curing. Within the tubs, specimens were spaced to ensure that the heat of hydration could be dissipated. Temperature readings were taken periodically from each tub. During these readings, the spacing, seals, and submergence of the specimens were checked and corrected if necessary.

3.3.4. Specimen Preparation and UCS Testing

After a specimen had cured for its designated length of time, it was removed from the water bath and dried. Once the lid and the tape seal had been removed from the mold, the specimen and, if necessary, the interior of the lid were blotted dry with a paper towel. The change in mass of the paper towel before and after blotting was used to measure the quantity of bleed water from the specimen. The bottom of the mold was then removed using a power miter saw. A utility knife was used to remove any remaining portions of the bottom of the mold. The specimen was then carefully extracted from the cylinder by making a series of small cuts in the side of the mold with a utility knife.

Once the specimen was extracted, its bottom and top ends were ground flat and its weight, diameter, and height were measured. To account for dimensional variations, the specimen's diameter and height were each measured three times and the readings were averaged.

Specimen UCS was determined using guidance from ASTM D2166 (2016), ASTM D1632 (2017), and ASTM D1633 (2017). UCS tests were run at a strain rate of 1% per minute, with UCS defined as peak strength. Specimen compression was measured by end platen readings and a direct current linear variable differential transformer (DC LVDT, or DCDT). The UCS tests were stopped once the machine reported that the peak UCS had been reached.

3.4. Data Processing and Equation Fitting

3.4.1. Data Processing

When necessary, UCS data was corrected to remove the effects of specimen end-face compliance and slack in testing equipment. The data correction involved drawing a tangent line to the first, relatively linear portion of the stress-strain curve and determining its intersection with the x-axis; this x-value was designated the strain correction offset. Then, the uncorrected data was shifted to the left by the amount of the offset, which was most likely due to machine slack and end face compliance rather than actual material response. Figure 1 illustrates this process.

For all specimens, a right circular cylinder correction was applied during data reduction in accordance with ASTM D2166 (2016). This correction accounted for changes in specimen area during testing due to bulging.

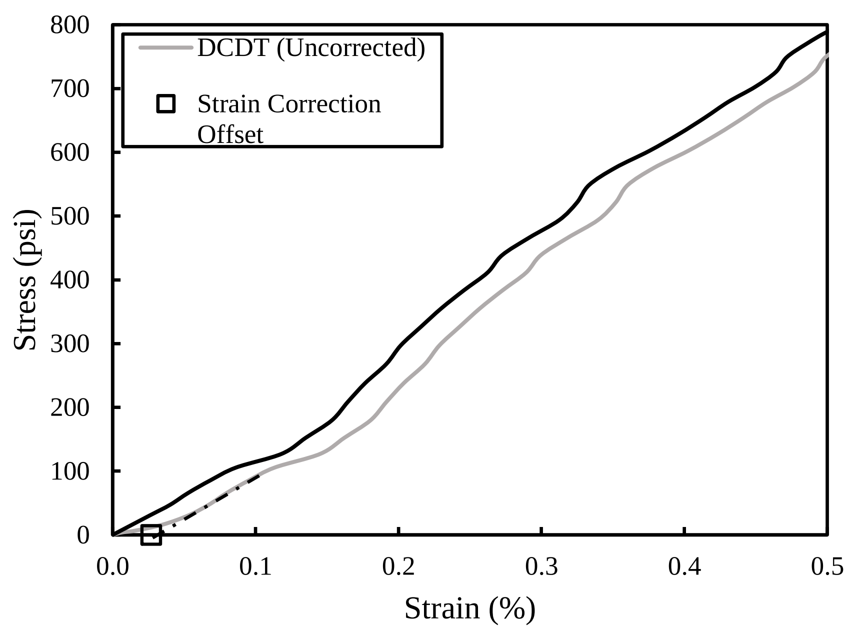

Figure 1. UCS test stress-strain diagram showing steps of data correction process.

Both end platen and DCDT displacement measurements were taken during testing for this study. The measurements are slightly different, as they measure distinct things. The end platen measurement is actually a calculation of the displacement of the bottom platen relative to the machine base using the thread pitch and rotation rate of the actuator rod for the bottom platen. The DCDT measures displacement of the bottom platen relative to the top crossbar of the testing machine. The DCDT measurements are not affected by possible errors in the end platen measurements, such as compression of the load cell or specimen cap. Therefore, only UCS values based on DCDT measurements are discussed in this study.

The average curing temperature for specimens in each batch was assessed in one of three ways, depending on the availability of readings of curing temperature for the batch. For the first three batches mixed, readings of curing temperature were not taken. Curing temperatures for these batches were therefore estimated using ambient temperature data from the National Weather Service (NWS) station in Blacksburg (National Weather Service n.d.). A trend function relating ambient and curing temperatures, further described below, was used to estimate curing temperatures for these three initial batches.

For the next 20 batches mixed, readings of curing temperature were taken periodically. For each of these batches, curing temperature versus time data were fitted to a trend line, from which average curing temperatures were estimated. To supplement these estimates, ambient temperature data from the NWS Blacksburg station were used. For each batch, the NWS temperature readings from the curing period were compared to the direct readings of the curing temperature of the batch, and these data were fitted to a trendline. The trendline was then used to generate a second set of average curing temperature estimates for the batch. Lastly, both sets of estimates were compared and used to generate final estimates of average curing temperatures for each batch. Primary importance was ascribed to the direct readings of curing temperature.

The data from the NWS and the curing temperature readings for all 20 of these batches was fitted to a master trendline which could be used to estimate batch curing temperature from NWS temperature over a wide range of ambient temperatures. This function was used to estimate batch curing temperatures for the first three batches mixed.

For the final 20 batches mixed, readings of curing temperature were taken almost every day. For each of these batches, curing temperature and time data were fitted to a trend line. For these batches, only these trend lines were used to establish curing temperatures. Complete curing temperature data for all batches is included in Appendix K.

3.4.2. Equation Fitting

After data on curing time, curing temperature, a, $w_T{:}b$, $\gamma_{D\text{-}MIX}$, OM, and UCS had been compiled for each specimen, an equation to predict specimen UCS was fitted to all data. The fitting was performed using a modified version of Equation 7. To account for the a_T concept, the $w_T{:}b$ term in Equation 7 was replaced by the $w_T{:}b_E$ term. The $w_T{:}b_E$ term represents the ratio of water to effective binder in the mixture, and may be calculated from $w_T{:}b$ using an expression originally described by Baker (2015):

$$w_T{:}b_E = w_T{:}b \times \frac{a}{a\text{-}a_T} \tag{10}$$

Substituting $w_T{:}b_E$ into Equation 7, and changing the notation of the coefficients from c to e, produces

$$\frac{UCS_{PRED}}{p_{ATM}} = e_0 \times \left(e_1 + e_2 \times ln\left(\frac{t}{t_o}\right)\right) \times (w_T{:}b_E)^{e_{3,1}+e_{3,2}\times\left(\frac{T\text{-}T_0}{T_0}\right)} \times \left(\frac{\gamma_{D\text{-}MIX}}{\gamma_W}\right)^{e_4} \tag{11a}$$

which may also be written as

$$\frac{UCS_{PRED}}{p_{ATM}} = e_0 \times f_c \times (w_T{:}b_E)^{e_{3,1}+e_{3,2}\times\left(\frac{T\text{-}T_0}{T_0}\right)} \times \left(\frac{\gamma_{D\text{-}MIX}}{\gamma_W}\right)^{e_4} \tag{11b}$$

A γ_W value of 998.0 kg/m^3 was used, which represents the unit weight of water at 21.1 °C, which is the same room temperature used to normalize curing temperature (Lide 2004).

The data were fitted to Equations 11a and 11b using a least-squares regression process described in detail by Nevarez et al. (2018). The process incorporated a genetic algorithm and used four significant digits to avoid overestimations of precision (ASTM D6026 2013). Fitting was performed using a modified form of Equation 5a which included the curing temperature term from Ju (2018). During the fitting process, the equation coefficients were constrained slightly to avoid unrealistic outcomes. Coefficients d_1 and d_2 were restricted to be non-negative, coefficient $d_{3,1}$ was restricted to be negative, and coefficients $d_{3,2}$ and d_4 were restricted to be non-negative. After the fitting, the coefficients were converted from d-notation to e-notation using Equations 5b through 5f ($e_{3,1}$ was set equal to $d_{3,1}$).

Chapter 4: UCS Test Results and Discussion

This chapter presents and discusses the results of the UCS tests that were performed as part of this research. The data sheets for individual UCS tests are included in Appendix L. These data sheets include specimen identification, dimensions, weights, stress-strain curves, and UCS values. In this chapter, UCS values are presented in plots that show the degree to which UCS predictive equations fit the measured UCS values. The predictive equations, described in Section 3.4.2, express UCS in terms of independent parameters, including curing time, t, curing temperature, T, total-water-to-binder ratio, $w_T{:}b$, dry unit weight of the mixture, $\gamma_{D\text{-}MIX}$, and organic matter content, OM, of the base soil.

The original concept in this research was that the threshold binder content a_T would be proportional to OM. After Virginia Tech researchers suggested this to University of South Florida researchers, Mullins and Costello (*pers. comm.* 2019) reassessed data from Mullins and Gunaratne (2015) and determined that the ratio of a_T to OM was approximately 0.67 for the organic soil and Portland cement binder used in their research. (Mullins and Gunaratne (2015) used a natural organic soil in their research. They tested different values of OM by adding sand in different quantities to the soil to decrease soil OM.)

In this thesis, four possible relationships between a_T and OM were investigated:

- The value of a_T is always zero. In this case, Equation 7 from Ju (2018) was used.
- The value of a_T is directly proportional to OM such that

$$a_T = d_5 \times OM \tag{12a}$$

- The value of a_T is a power function of OM, such that

$$a_T = d_5 \times OM^{\,d_6} \tag{12b}$$

- The value of a_T is a linear function of OM once OM exceeds a certain value, such that

$$a_T = \text{Maximum}\ \{0,\ d_6 \times (OM - d_5)\} \tag{12c}$$

Once a value of a_T had been calculated, the value of $w_T{:}b_E$ could be determined using

$$w_T{:}b_E = w_T{:}b \times \frac{a}{a\text{-}a_T}$$

and UCS could be predicted using

$$\frac{UCS_{PRED}}{p_{ATM}} = e_0 \times \left(e_1 + e_2 \times ln\left(\frac{t}{t_o}\right)\right) \times (w_T{:}b_E)^{e_{3,1}+e_{3,2}\times\left(\frac{T-T_0}{T_0}\right)} \times \left(\frac{\gamma_{D\text{-}MIX}}{\gamma_W}\right)^{e_4}$$

The coefficients d_5 and d_6 in Equations 12a through 12c were constrained to be non-negative. The values of the coefficients of the selected a_T equation and of coefficients d_1 through d_4 in Equation 5a (modified to include the temperature term) were determined simultaneously during the least-squares regression process.

Regressions were performed on four data sets: (1) the UCS tests conducted on binder-treated specimens of inorganic soils, (2) all UCS tests conducted in this research, (3) all UCS tests conducted on specimens of cement-treated organic soils, and (4) all UCS tests conducted on specimens of cement-treated organic soils with UCS values of less than 600 psi (i.e. excluding the eight test results from Batch 10-I-6). Data Sets 1, 2, 3, and 4 consisted of 42, 273, 231, and 223 UCS values, respectively.

After fittings had been completed, Equations 5b through 5f were used to convert coefficients d_1 through d_4 to coefficients e_0 through e_4. Coefficient $d_{3,1}$ was again set equal to $e_{3,1}$, and coefficients d_5 and d_6 were similarly set equal to coefficients e_5 and e_6, respectively.

The results of the fitting which included only inorganic specimens and the fittings which included all specimens are presented and discussed in Appendix M. This chapter presents and discusses the results of the analyses focused only on cement-treated organic soil batches. The results of these regressions are shown in Table 7 and in Figures 2 through 7. Comparisons with results from Ju (2018) are also included.

Table 7. Summary of fitting coefficients and R^2 values for predictive UCS equation for fittings including only specimens of cement-treated organic soils and for Ju (2018).

Data Set	Formulation for a_T	e_0	e_1	e_2	$e_{3,1}$	$e_{3,2}$	e_4	e_5	e_6	R^2
All organics	No a_T	109	0.235	0.230	-1.59	0.740	2.42	N/A	N/A	0.979
	Prop. a_T	109	0.235	0.230	-1.60	0.727	2.41	0.000	N/A	0.979
	Power a_T	108	0.242	0.227	-1.62	0.563	2.19	15.0	6.91	0.983
	Linear a_T	109	0.248	0.226	-1.62	0.522	2.21	0.459	2.68	0.983
All organics with UCS < 600 psi	No a_T	104	0.238	0.229	-1.55	0.711	2.35	N/A	N/A	0.962
	Prop. a_T	103	0.222	0.234	-1.54	0.722	2.34	0.000	N/A	0.962
	Power a_T	102	0.233	0.230	-1.56	0.531	2.13	37.2	8.53	0.973
	Linear a_T	102	0.231	0.231	-1.56	0.517	2.14	0.462	2.88	0.973
Ju (2018)	No a_T	94.1	0.168	0.250	-1.63	0.484	2.12	N/A	N/A	0.964

Table 7 reflects that the regressions on the cement-treated organic soils that treat a_T as being directly proportional to *OM* result in near-zero values of the constant of proportionality, d_5 (the values are only non-zero when more than three decimal places are considered). This is the same outcome as the case of setting a_T equal to zero. The minor differences for the other coefficients for these two cases arise from the genetic algorithm used to perform the regressions.

Table 7 also indicates that the organic soil regressions using a_T equal to zero, whether by assignment or from the regression, have values of $e_{3,2}$ that range from about 0.71 to 0.74, which is noticeably larger than the value of 0.48 reported by Ju (2018). By contrast, for the organic soil regressions in which a_T is represented by a power function or an offset linear function of *OM*, the values of $e_{3,2}$ range from about 0.52 to 0.56, which are noticeably closer to the $e_{3,2}$ value reported by Ju (2018). Similarly, the values of coefficient e_4, which represent the influence of $\gamma_{D\text{-}MIX}$, are closer to the value reported by Ju (2018) when a_T is represented by a power function or an offset linear function than when a_T is zero or nearly zero.

In addition to producing better agreement with the values of $e_{3,2}$ and e_4 from Ju (2018), the R^2 values for the regressions of the cement-treated organic soils are slightly higher when a_T is

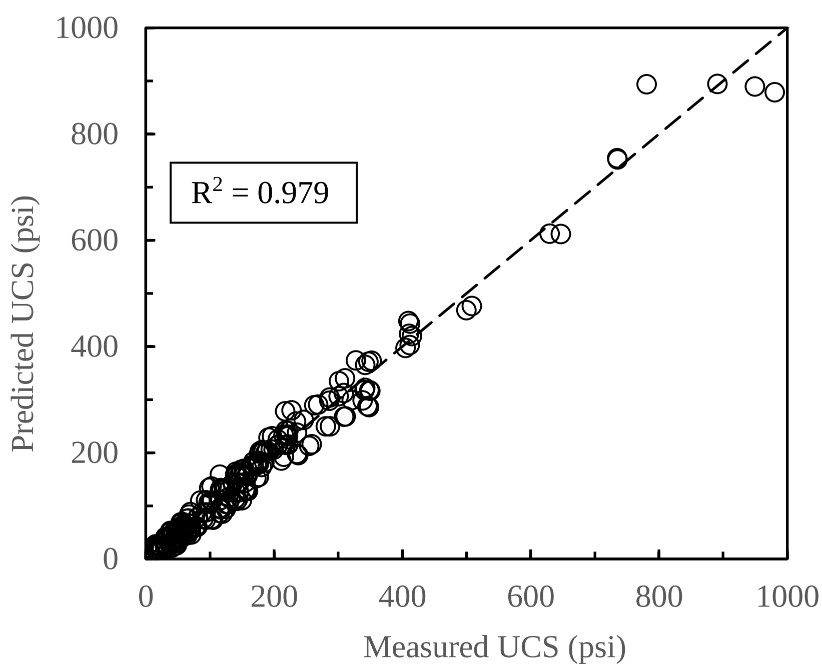

Figure 2. Plot of predicted versus measured UCS values for all organic specimens tested using a fitting with a_T = 0.

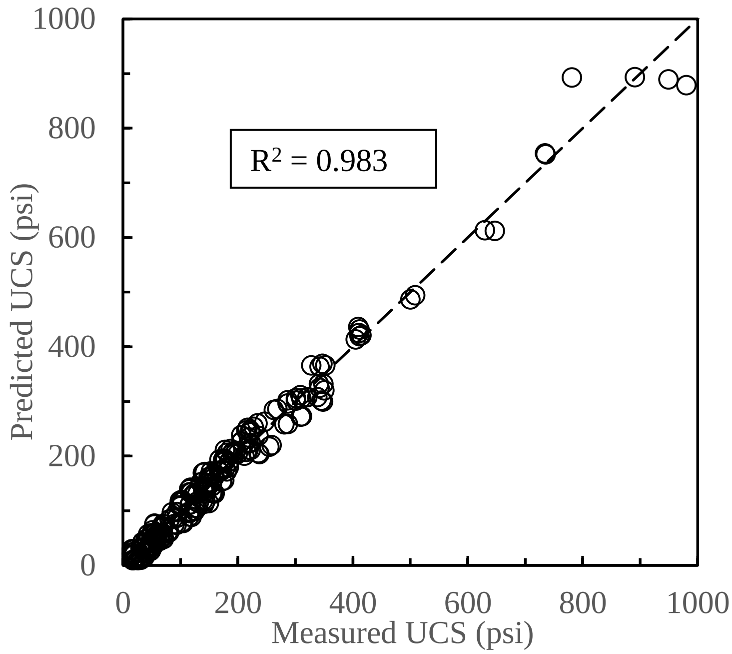

Figure 3. Plot of predicted versus measured UCS values for all organic specimens tested using a fitting with a_T as a power function of OM.

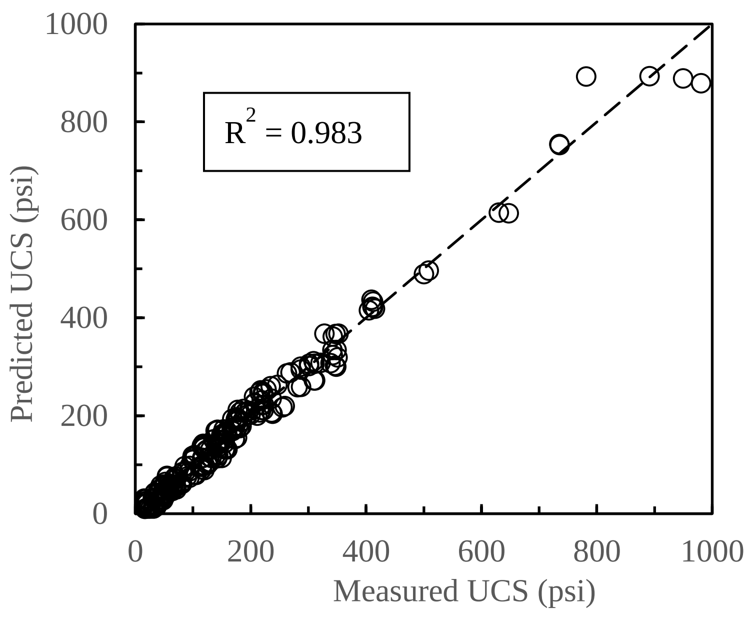

Figure 4. Plot of predicted versus measured UCS values for all organic specimens tested using a fitting with a_T as an offset linear function of OM.

represented by a power function or an offset linear function than when a_T is zero or nearly zero. This is shown in Figures 2 through 4 for the data from all the cement-treated organic soil batches. The fitting is slightly better when a_T is represented by a power function or an offset linear function than when a_T is zero. Most of the improvement can be observed in the mid-range of UCS values.

Figures 2 through 4 show that the most data scatter occurs at the highest UCS values. Regressions on the specimens of binder-treated organic soil with UCS less than 600 psi were performed to investigate whether the eight high-strength specimens significantly affected the regressions. The regression coefficients in Table 7 for the binder-treated organic soils with and without UCS values larger than 600 psi are very similar, which indicates that the high-strength specimens do not have a large impact on the regressions. Similar to Figures 2 through 4, Figures 5 through 7 show that the fittings are good and there is a slight improvement when a_T is represented by a power function or an offset linear function compared to when a_T is zero or when a_T is assumed to be directly proportional to *OM*.

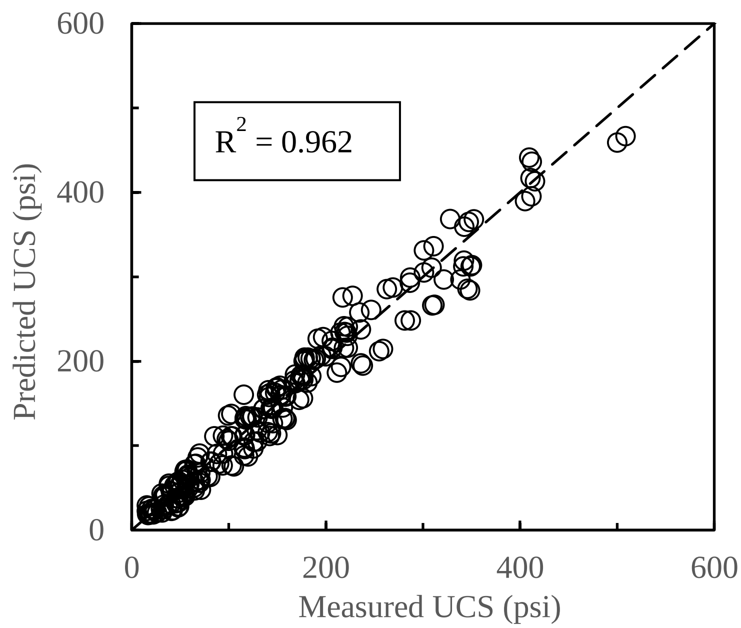

Figure 5. Plot of predicted versus measured UCS values for all organic specimens tested with UCS values less than 600 psi using a fitting with $a_T = 0$.

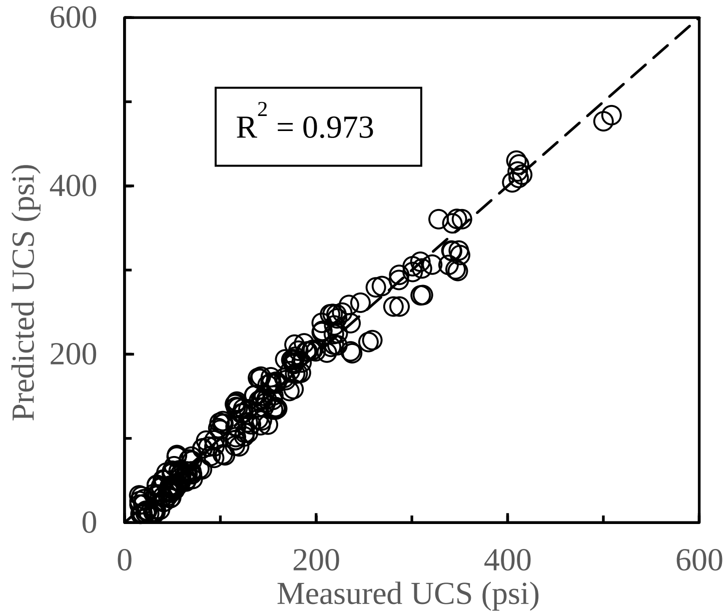

Figure 6. Plot of predicted versus measured UCS values for all organic specimens tested with UCS values less than 600 psi using a fitting with a_T as a power function of OM.

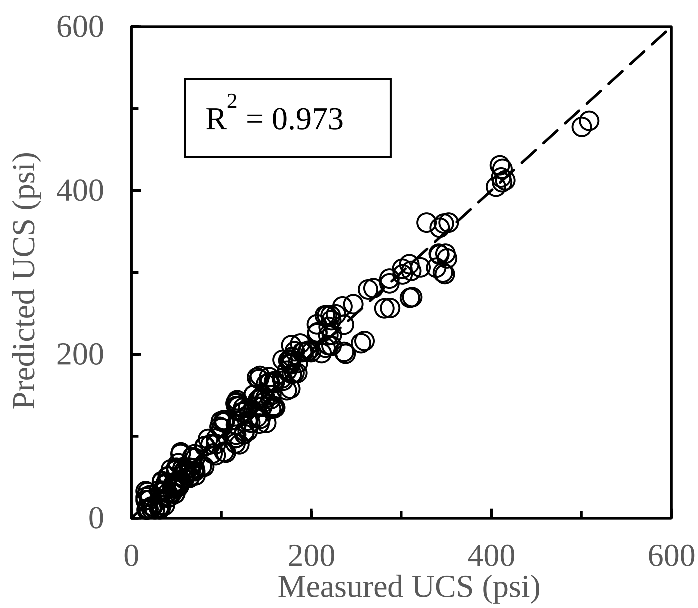

Figure 7. Plot of predicted versus measured UCS values for all organic specimens with UCS values less than 600 psi tested using a fitting with a_T as an offset linear function of OM.

The coefficient values, and the fitting quality, are very similar for the binder-treated organic soils with and without UCS values larger than 600 psi. However, for the power a_T function, exclusion of UCS values larger than 600 psi appear to have an effect on the e_5 and e_6 values. These values increase markedly when the 600 psi values are excluded. However, increasing both coefficient values simultaneously has counterbalancing effects, which can be seen by examining Equation 12b and recognizing that the value of *OM* is less than one. The similarity between the power function representations of a_T is shown graphically in Figure 8 for the binder-treated organic soils with and without UCS values larger than 600 psi.

Table 7 shows that the values of the e_5 and e_6 coefficients for the offset linear a_T function change little for the binder-treated organic soils regardless of whether specimens with UCS values larger than 600 psi are considered. This is shown graphically in Figure 9.

Figure 10 compares the power and offset linear representations of a_T as a function of *OM* for binder-treated organic soils with and without UCS values larger than 600 psi. The figure shows that for both functions and both sets of data, the regressions found substantially similar representations of a_T as a function of *OM* for binder-treated organic soils. In all cases, the threshold binder content, a_T, does not become significant until *OM* exceeds about 45%. This

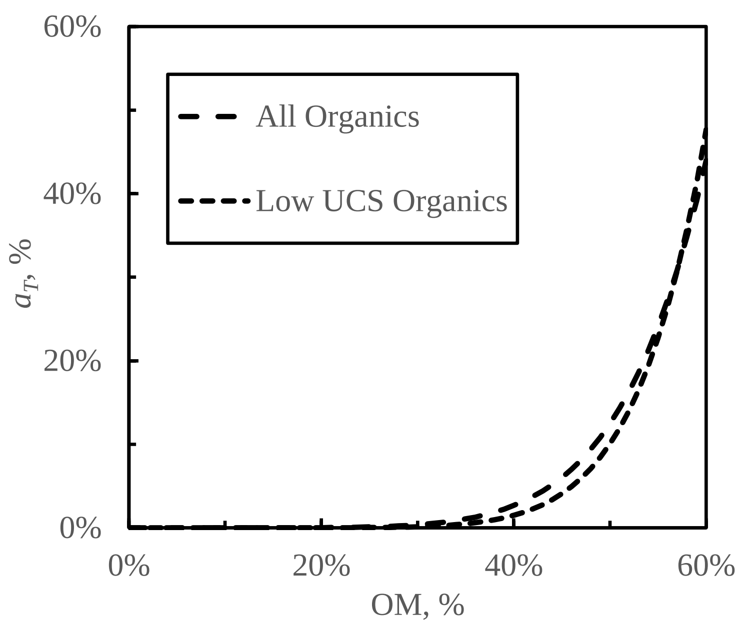

Figure 8. Comparison of power relationships between a_T and OM for fittings performed to all organic specimens and to all organic specimens with UCS below 600 psi.

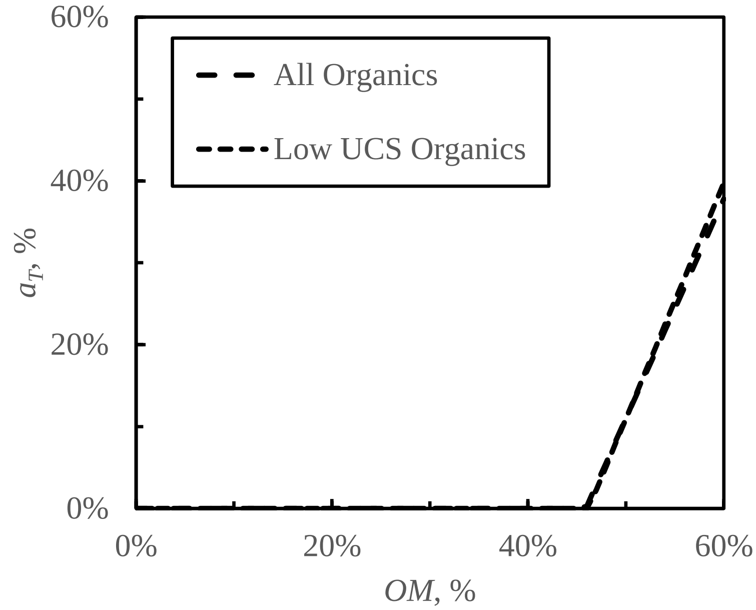

Figure 9. Comparison of offset linear relationships between a_T and OM for fittings performed to all organic specimens and to all organic specimens with UCS below 600 psi.

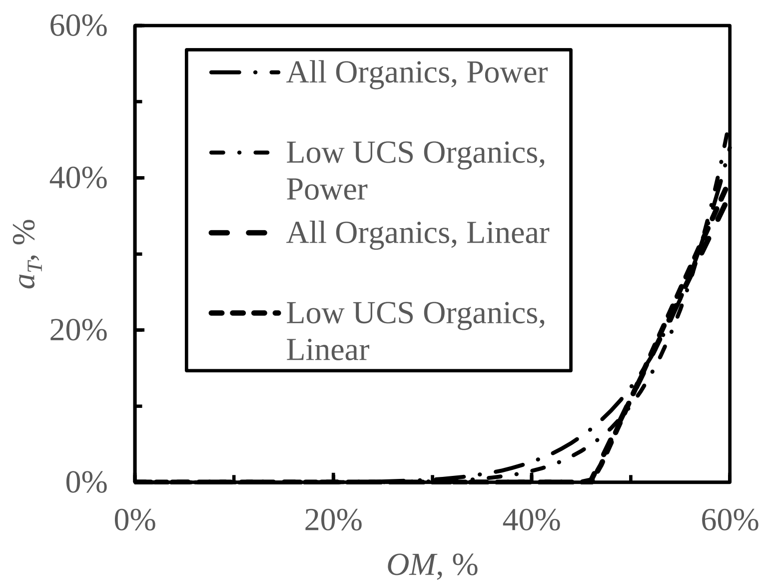

Figure 10. Comparison of power and offset linear relationships between a_T and OM for fittings performed to all organic specimens and to all organic specimens with UCS below 600 psi.

indicates that the presence of SPM does not affect the relationship between UCS and $w_T{:}b$ until the *OM* value in the soil exceeds about 45%. At higher *OM* values, the regressions indicate that $w_T{:}b$ should be increased to the $w_T{:}b_E$ value according to Equation 10. However, even at *OM* values less than 45%, the presence of SPM can impact the amount of binder necessary to reach a desired UCS because SPM can increase soil w and decrease $\gamma_{D\text{-}MIX}$.

Further investigation of different potential representations of a_T as a function of *OM* would be facilitated by the use of other organic source materials. Ideally, for these materials, a_T would be significantly larger than zero at lower *OM* values than encountered in this research for the SPM. The organic matter in the SPM used here contained a small amount of fulvic acid, very little humic acid, and a large portion of humin. Since humins are not soluble in strong acids or bases, they may not be chemically reactive with Portland cement. Organic source material with higher concentrations of fulvic acid and humic acid could produce significant a_T values at lower *OM* values than did the SPM.

Notably, the slope of the a_T versus *OM* plots in Figures 8 and 9 exceeds one when the *OM* value exceeds about 45%. For the offset linear representation of a_T versus *OM*, the slopes in Figure 9 are about 2.7 to 2.9. The strong impact of *OM* above 45% may be due to a combination of chemical and mechanical interference with cementation. An abundance of fibers from SPM in the soil may interfere with the ability of the Portland cement to form cementitious bonds between adjacent mineral soil particles. Chemical and mechanical interferences with cementation are listed and discussed in Chapter 2.

Based on the preceding discussion, it appears that power and offset linear a_T functions produce nearly the same outcomes, and they are better than setting a_T equal to zero or making a_T directly proportional to *OM*. This is because the power and offset linear a_T functions have the following advantages:

- They produce values of $e_{3,2}$ and e_4 that are in significantly better agreement with the values determined by Ju (2018).
- They produce slightly better fits, as indicated by slightly higher R^2 values.

- Although they have different forms, they produce similar relationships between a_T and *OM*, and these relationships can be understood in terms of chemical and mechanical interferences with cementation.

A final trend illustrated in Table 7 is that the values of the curing time coefficients e_1 and e_2 for the binder-treated organic soils are larger and slightly smaller, respectively, than the values determined by Ju (2018). This indicates that for the soils reviewed in these studies, the cement-treated organic soils gained a greater proportion of their strength shortly after mixing and gained a lesser proportion of their strength during the curing period. By contrast, the cement-treated inorganic soils gained a lesser proportion of their strength shortly after mixing and gained a greater proportion of their strength during the curing period.

Chapter 5: Conclusions and Recommendations

Chapter 5 summarizes the most important findings of this thesis and identifies opportunities for future research on the improvement of organic soils via deep mixing.

5.1. Conclusions

The most important conclusions of this thesis are:

1) Many previous researchers have discussed the threshold binder concept for deep mixing of organic soils. This concept refers to a minimum amount of binder below which no significant strength improvement occurs. This research successfully quantified this concept in terms of a threshold binder content, a_T.

2) The predicted UCS of organic soil-binder mixtures can be expressed as a function of curing time, t, curing temperature, T, total water-to-binder ratio of the mixture, $w_T{:}b$, and dry unit weight of the mixture, $\gamma_{D\text{-}MIX}$, using Equations 11a and 11b. The functional form of the fitting equation is modified from the one developed for inorganic soils by Nevarez et al. (2018) and Ju (2018) by using the ratio of water to effective binder in the mixture, $w_T{:}b_E$, instead of $w_T{:}b$. Effective binder refers to the binder beyond a_T that is available to produce a significant increase in the mixture strength.

3) The parameter $w_T{:}b_E$ works well in Equations 11a and 11b for organic soils as a replacement for $w_T{:}b$ for inorganic soils. As the $w_T{:}b$ of a binder-treated inorganic soil increases, and as the $w_T{:}b_E$ of a binder-treated organic soil increases, the UCS of the cured mixtures decrease. The value of $w_T{:}b_E$ is related to $w_T{:}b$ using the value of a_T. For the organic soils and Type I/II Portland cement tested in this study, the value of a_T can be expressed as a function of soil organic content, OM. This research found that either a power function or an offset linear function can be used to describe the relationship between the two parameters. The two functions result in fittings of similar R^2 values, indicating that they are almost identically accurate for predictions of the UCS of the organic soil-binder mixtures in this study.

4) The values of coefficient e_2 in Equation 11a determined from fittings to data was lower for organic specimens than for inorganic specimens. This indicates that for the soils and binder tested, specimens of organic soil-binder mixtures, compared to specimens of inorganic soil-binder mixtures, generally gain a greater proportion of their strength shortly after mixing and have a lesser relative gain of UCS during curing.

5) The values of coefficient $e_{3,2}$ in Equation 10a determined from fittings to organic soils were almost identical to the value of $e_{3,2}$ determined by Ju (2018) for fittings to inorganic soils. This suggests that curing temperature has a similar impact on the UCS of specimens of inorganic and organic soil-binder mixtures.

6) Fittings to all data showed that for the organic soils used in this research, the value of a_T was negligible at values of OM below 45%. Since the main humus substance in the SPM used in this study was humin, this suggests that out of the three humus substances, humin has the lowest impact on the UCS of organic soil-binder mixtures. However, the SPM still impacted the UCS of soils with values of OM below 45%. As soil SPM content increased, soil w and $w_T{:}b$ increased, and soil $\gamma_{D\text{-}MIX}$ decreased.

7) For projects involving deep mixing of organic soils, Equations 11a and 11b will be used most effectively if they are fitted to the results of bench-scale mixing tests of project soils and then checked against field-scale mixing tests for the same soils (Bertero et al. 2012, Cooling et al. 2012).

5.2. Recommendations

Several opportunities for future research on treatment of organic soils by deep mixing are apparent from this research. These include:

1) Appropriate means to describe organic soils and their treatability by the deep mixing method should be identified and/or developed. Continued collaboration between geotechnical engineers and soil scientists will help accomplish this.

2) Modern analytical tools of soil science, such as scanning electron microscopy, X-ray diffraction, nuclear magnetic resonance imaging, and X-ray absorption spectroscopy can be pursued to investigate organic soil-binder interactions.

3) The influence of soil properties and mixing factors on values of a_T for organic soils should be further investigated. Relevant soil properties would include parent vegetation type, von Post H, and humus substance fractionation. Relevant mixing factors would include binder type, t, T, $\gamma_{D\text{-}MIX}$, $\alpha_{I\text{-}P}$, and $w:b$.

4) Testing programs to evaluate a_T and generate equation fittings for the prediction of UCS of organic soil-binder mixtures should be performed on different types of organic soils.

5) While many binders have been used in previous studies on the deep mixing of organic soils, only Portland Type I/II cement was used in this research. Similar studies should be performed for other binders such as blast furnace slag, fly ash and gypsum. Slag is particularly promising due to its high resistance to chemical attack (ASTM C989 2018), and because many contractors have successfully used it in mixing organic soils. Different types of each binder could also be compared.

6) The literature review conducted for this thesis found that the impact of curing times longer than 28 days on the UCS of organic soil-binder mixtures is unclear. Extended curing times should be further investigated.

7) Nevarez et al. (2018) and Ju (2018) have laid out guidelines to select a binder slurry for deep mixing projects in inorganic soils based on both strength requirements and considerations of mixture consistency. Such guidelines ensure that mixtures are designed for efficient use of binder and for contractor workability. Similar consistency guidelines should be developed for deep mixing of organic soils.

8) A broader range of curing temperatures for specimens of organic soil-binder mixtures should be investigated to fully understand the impact of this parameter on mixture UCS.

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Appendix A: Laboratory Procedure and Results for Fractionation of Humus Substances

The objective of this procedure is to determine the proportions of the three humus substances (fulvic acid, humic acid, and humin) in different organic materials. The test is based on one created by Swift (1996) and modified by Professor Xunzhong Zhang of the Virginia Tech Department of Crop and Soil Environmental Sciences. If at any time stopping work is necessary, samples should be placed in a refrigerator at a temperature of 4-5 °C (39-41 °F) until the procedure can continue. The procedure below is outlined for testing three organic materials simultaneously. It is outlined in Section 2.1.3, and results are listed in Section 3.1.2, Table 3B.

Equipment

1. 40 5-mL syringes with large steel needles
2. 45 centrifuge tubes
3. 9 60-mL syringes
4. 9 0.2-μm syringe filters
5. Centrifuge tube labels
6. Centrifuge
7. Balance.
8. Deionized water
9. Gloves, goggles, and a lab coat
10. pH meter
11. 0.5 L 1 M HF
12. 0.5 L 6 M HCl
13. 0.5 L 1 M HCl
14. 0.5 L 0.1 M HCl/0.3 M HF
15. 0.5 L 1 M NaOH
16. 0.5 L 0.1 M NaOH
17. 0.5 L 0.1 M KOH
18. Solid KCl
19. Shaker table
20. Centrifuge tube rack
21. Storage refrigerator
22. Tank of N_2 gas with a hose and nozzle
23. XAD-8 resin
24. 2 2-mL volumetric measuring containers
25. Small tub
26. Dialysis tubing strips

Procedure

1. Obtain and label 3 50-mL centrifuge tubes for each material or soil of interest. For the current study, the labels used were FUL-1 to 3 (fulvic acid), HUM-1 to 3 (humic acid), and SPM-1 to 3 (SPM).
2. For each tube, remove the cap, mass the tube, and tare the balance.
3. Put 5 g, ± 0.01 g, of the relevant organic component into each tube.

4. Add deionized (DI) water to each centrifuge tube until the volume of its contents is 35 mL. Cap each tube and shake thoroughly.
5. Remove the cap from each tube and add more DI water to the tube until the volume of its contents is 40 mL. Recap the tube and shake thoroughly again.
6. Remove the cap and use the pH meter to measure the pH of the mixture in each tube.
7. Use a 5-mL syringe to add 1 M HCl to each tube in 1-mL increments. Shake the tube between increments to mix the compounds. Continue until the pH of the mixture in each tube is between 1 and 2.
8. Use a 5-mL syringe to fill each centrifuge to the 50 mL mark with 0.1 M HCl. Recap the tubes and shake thoroughly.
9. Check that the pH of the mixtures in the tubes remains between 1 and 2.
10. Put the centrifuge tubes in the shaker table and run it for 1 hour at 125 rpm and 21 °C.
11. Transfer the tubes to the centrifuge, and run at 1000 rpm for 20 minutes.
12. Use a 5-mL syringe to decant as much supernatant as possible from each centrifuge tube to a clean, new centrifuge tube. This represents Fulvic Acid Extract 1 (FA1). The label on the new tube will match that on the corresponding original tubes, except that it will also have an "FA1" added after the original label (for example, "HUM-1/FA1"). Refrigerate the FA1 tubes. Leave the residue in the original tubes.
13. Using a nozzle-fitted bottle, add DI water to each original centrifuge tube until it is full to a volume of is 35 mL. Cap the tube, shake thoroughly, and record pH.
14. Using a 5-mL syringe, add 1 M NaOH to each original tube in 1-mL increments until the pH is greater than 7 (keeping the pH as close to 7 as possible).
15. Using a 5-mL syringe, add 0.1 M NaOH to each original tube until its contents reach the 50 mL level. Use a tank of N_2 gas to blow N_2 gas over the top of the tube.
16. Put the original tubes on the shaker table for 4 hours at 125 rpm and 21 °C. Store the original tubes overnight.
17. Using a 5-mL syringe, decant the supernatant from each original tube into a corresponding new tube. Label the new tube with the label from the original tube plus the suffix "Extract A" (for example, "HUM-1 Extract A").
18. Using a 5-mL syringe, add 6 M HCl to each Extract A tube in 1-mL increments. Shake the tube between increments to mix the compounds. Continue until the pH of the mixture in each tube is equal to or just less than 1. Allow the Extract A tubes to sit overnight.

FA1 Extract

19. Retrieve nine 60-mL syringes (columns). Attach a 0.2-µm filter to the tip of each.
20. Using a 2-mL volumetric measuring container, add 0.75 cm^3 of XAD-8 to each column.
21. Label the columns to match the FA1 extract tubes. Set the columns up in a centrifuge tube rack over a small tub capable of holding at least 1 L of liquid.
22. Pour each FA1 extract through the corresponding column. Allow the extracts to flow through using gravity and/or the force of the syringe pumps. If a filter becomes clogged, remove it so that no material flows out and poke small holes through it using a steel syringe needle. Ensure that no XAD-8 passes the filters. The effluent from this step can be discarded.

23. Flush each column with 40 mL of DI water. The effluent from this step can be discarded.
24. Mass and label a new centrifuge tube for each column. Label the new tubes as FA1 – for example, “HUM-1/FA1”.
25. Place each tube under its corresponding column, use a 5-mL syringe to flush the column with 5 mL of 0.1 M NaOH, and re-flush the column with 10 mL of DI water, making sure all effluent is collected in the new tube. Discard the XAD-8.
26. Using a 5 mL syringe, add 6 M HCl in 1-mL increments to each new FA1 centrifuge tube until the pH of the contents of the tube is equal to or just less than 1.
27. Calculate the amount of 1 M HF which must be added to each new FA1 tube to create a 0.3 M HF solution inside the tube. Using a 5-mL syringe, add the appropriate quantity of 1 M HF to each new FA1 tube.

Extract A

28. Centrifuge the Extract A tubes at 3,000 rpm for 40 minutes.
29. Upon removing the Extract A tubes, use a 5 mL syringe to decant the Fulvic Acid Extract 2 (FA2) in each tube from the humic acid (HA) precipitate. Put the fulvic acid into tubes marked “FA2” – for instance, “HUM-1/FA2”. Leaving the HA in the Extract A tubes, relabel these tubes as “HA” – for instance, “HUM-1/HA”. Refrigerate the HA tubes.
30. Repeat steps 20-27 for the FA2 tubes.

HA Extract

31. For each HA tube, use a 5-mL syringe to add sufficient 0.1 M KOH to re-dissolve all the precipitated humic acid. Measure both the quantity of 0.1 M KOH added and the final volume of solution in the tube.
32. For each HA tube, calculate the weight of solid KCl which must be added to produce a 0.3 M concentration of K^+. Using a 2-mL volumetric measuring container, add the appropriate weight of KCl to the tube.
33. For each HA tube, use a 5-mL syringe to add 6 M HCl to the tube until its pH equals 1. Once this has been done for all HA tubes, let the tubes sit overnight in a refrigerator.
34. Centrifuge the HA tubes for 30 minutes at 3,000 rpm.
35. Using a 5-mL syringe, decant and discard the supernatant from the HA tubes.
36. Add 0.1 M HCl/0.3 M HF to each HA tube. For the tubes containing HA from the humic acid, where there was a large amount of HA, filling the tube to a volume of 45 mL was sufficient. For the tubes containing HA from the SPM, where there was a much lower amount of HA, filling the tube to a volume of 20 mL was sufficient.
37. Shake the HA tubes overnight on a shake table at a speed of 125 rpm and a temperature of 21 °C.
38. Centrifuge the HA tubes at 3,000 rpm for 30 minutes.
39. Decant the supernatant from each HA tube.
40. Using DI water, re-fill each HA tube to the volume to which it was filled during Step 36. Shake the tube thoroughly to mix the residue and DI water.
41. For each HA tube, tie off or clamp a strip of dialysis tubing at one end. Label each dialysis tube per its corresponding HA tube.

42. For each HA tube, fill a large container with DI water.
43. Using a funnel, empty each HA tube into a dialysis tubing strip. Rinse the HA tube and funnel with DI water to ensure that all solids from the HA tube are washed into the dialysis tubing strip. Clamp the other end of the tubing strip after it has been filled.
44. Immerse each dialysis tubing strip in one of the large containers of DI water. Leave out overnight. Change the DI water in the containers once during this time, preferably a few hours after immersion begins.

Freezing and Freeze-Drying

45. Label and weigh clean, new centrifuge tubes for the different extracts (caps on). Label the caps also. Transfer the extracts into the new tubes. Never fill them above 40 mL.
46. Cool the new tubes in a refrigerator at standard temperature, then freeze them overnight at -80 °C (-108 °F).
47. Remove the new tubes from the freezer five at a time. For safety purposes wear two pairs of disposable gloves when removing the new tubes and grasp the tubes by the cap. Any tubes with broken tubes or caps should be placed in a beaker within a refrigerator set to a temperature of 4.5 °C (40 °F) so the contents may thaw and be placed in new tubes.
48. For each group of five tubes, remove the cap of each tube. Put two sheets of dry tissue paper over the opening of each tube and seal them tightly to the tube with a rubber band. Place the five tissue-sealed tubes in a glass freeze-drying beaker.
49. Fit a rubber top to the beaker. Put one edge of the top over the lip of the beaker and then carefully pull the other edge over the lip an inch at a time. Insert a metal connecting pipe into the socket in the rubber top.
50. Connect the free end of the metal connecting pipe to one of the sockets on the freeze-drying machine. Wedge one side of the pipe into the socket and then shove the pipe inward until it is fully connected to the socket.
51. Begin the freeze-drying process by flipping the switch on the socket until the flat side of the switch faces the metal connecting tube. The beaker should be sucked in toward the socket as a vacuum is formed.
52. Repeat steps 48-51 for as many remaining groups of five tubes as are necessary. Once the green indicator light on the machine illuminates several minutes after a socket is switched on for one freeze-drying beaker, the socket may be switched on for the next beaker.
53. Freeze-dry the tissue-sealed tubes overnight. If there are more tubes than the freeze-drying machine can process at one, multiple batches of freeze-drying must be performed.
54. Once all ice has been removed from the tissue-sealed tubes, freeze-drying is complete. After completion, turn off the socket switches, and remove each metal tube and cap from each beaker. Remove the tissue paper and rubber band from each tube and immediately reattach the corresponding cap.
55. Weigh the full, capped tubes and compute the weights of their contents. Solve for the weight of fulvic acid, humic acid, and humin in each component material.

Results
Table A1 lists the results of tests for values of *w* for SPM.

Table A1. Results of w tests for SPM.

Test	Container Weight, g			W_W, g	W_S, g	*w*, %
	Empty	Full (wet)	Full (dry)			
1	11.84	18.53	16.62	4.78	1.91	39.96%
2	11.20	19.00	16.74	5.54	2.26	40.79%
3	11.10	18.88	16.64	5.54	2.24	40.43%
4	11.81	20.32	17.55	5.74	2.77	48.26%
5	11.20	19.95	17.09	5.89	2.86	48.56%
6	11.10	20.72	17.57	6.47	3.15	48.69%
Sum	68.25	117.40	102.21	33.96	15.19	44.73%

Table A2 lists the results of the fractionation of three samples of SPM. The percentages of material recovered are calculated by dividing the recovered W_S by the tested W_S. Since specimens were not dried before fractionation, the tested W_S was computed using the tested W_W and the test value of *w*.

Table A2 shows that the percentages of SPM material recovered often exceed 100%. There are two potential reasons this situation may arise. First, after drying has been completed, water may be absorbed from the atmosphere. Second, during fractionation, the SPM may form salts and/or conjugates with the chemicals added to it.

Table A2. Results of humus substance fractionation for specimens of SPM.

SPM Specimen	*W*, g	W_S, g	Recovered W_S, g	Weight, g, and (%) Rec. W_S			% Weight Recovered
				Fulvic Acid	Humic Acid	Humin	
1	5.00	3.46	3.68	0.19 (5.3%)	0.03 (0.8%)	3.45 (93.9%)	106.3%
2	5.01	3.46	3.80	0.16 (4.3%)	0.06 (1.6%)	3.57 (94.1%)	109.8%
3	5.01	3.46	3.80	0.18 (4.7%)	0.05 (1.4%)	3.56 (93.8%)	109.8%
Sum	15.02	10.38	11.27	0.54 (4.8%)	0.14 (1.3%)	10.59 (93.9%)	108.6%

Appendix B. Results of Search and *OM* Tests for Potential Humus Materials

This appendix describes the search process for humus materials suitable for use in testing. It also reviews the results of *OM* tests on compounds selected through the search process.

The search process involved searching the website of the Humic Products Trade Association, a trade group for manufacturers of commercially available fulvic and humic acid substances. (Humin is not commercially manufactured. Hence, a natural substance rich in humin – i.e., SPM – had to be used instead.) Substances were selected based on their listed concentrations of humic and/or fulvic acid and their values of *OM*, and only powdered substances were selected to ensure homogeneous mixing during research. After a thorough search of the websites of HPTA members, the following potentially suitable products were located (listed by manufacturer):

- Agrienergy Resources: Microhumic
- Bio-Gro: CHB Humic Fines
- Black Earth Humic: Activ80 XP
- Canadian Humalite International: CHI Powder
- Helena (subsidiary of Horizon Ag-Products): Hydra-Huma DG T&O
- Humic Growth Solutions: HumiK WSP
- Leonardite Products: Leonardite Fines
- Mesa Verde Humates (subsidiary of Bio Huma Netics): Micromate
- Minerals Technologies: Agro-Lig Ultra Fine Powder
- Soilbiotics: 4r Foliar Concentrate

The following additional products were also identified based on research into local sources:

- Lowe's (Christiansburg, VA): Premier Horticulture Sphagnum Peat Moss
- Seven Springs Farm (Check, VA): Ferti-Organics Fulvic Plus
- Walmart (Christiansburg, VA): Granular Humic Acid

The identified sources and suppliers were contacted regarding the availability of samples of the listed products. Suppliers who did not respond within one business week were removed from further consideration. Samples of the two locally available substances were either picked up directly or shipped to Virginia Tech. Through this process, the field of potential substances was narrowed to the following options:

- Black Earth Humic: Activ80 XP
- Canadian Humalite International: CHI Powder
- Humic Growth Solutions: HumiK WSP

- Leonardite Products: Leonardite Fines
- Lowe's (Brand – Premier Horticulture): Sphagnum Peat Moss
- Minerals Technologies: Agro-Lig Ultra Fine Powder
- Seven Springs Farm: Ferti-Organics Fulvic Plus
- Walmart (Brand – Earthworks Health LLC): Granular Humic Acid

The eight candidate substances identified were tested for *OM* using the procedure outlined in ASTM D2974 (2014). Table B1 (next page) lists the results of testing. (Fractionation of the SPM had been performed prior to the *OM* test.)

Table B1 shows that, of the organic substances tested, only SPM had the requisite *OM* value of greater than 50%. It was therefore decided that only SPM could be used in the testing program. This meant that the effect of different fractionations of humus substances on mixture UCS could not be assessed in this study.

As Appendix D shows, the *OM* of SPM changed significantly when it was wetted and re-dried. This suggests that the same phenomenon could occur with other humus substances tested during this program.

Table B1. Results of OM tests on potential humus materials for research.

Company	Material	Test	Container Weight, g			W_S, g	$W_{OS,O}$, g	*OM*, %
			Empty	Full (pre-bake)	Full (baked)			
Black Earth Humic	Activ80 XP	1	16.55	24.60	21.84	2.76	8.05	34.34%
		2	16.25	25.76	22.16	3.59	9.51	37.80%
		3	16.66	29.14	25.08	4.05	12.47	32.50%
		Sum	49.46	79.49	69.08	10.41	30.03	34.67%
Canadian Humalite Interna-tional	CHI Powder	1	16.16	29.10	25.38	3.72	12.94	28.77%
		2	17.75	32.64	28.23	4.41	14.89	29.63%
		3	17.98	30.96	26.66	4.31	12.99	33.18%
		Sum	51.89	92.71	80.26	12.44	40.81	30.49%
Humic Growth Solutions	HumiK WSP	1	16.72	25.39	23.20	2.19	8.67	25.27%
		2	19.66	31.60	28.59	3.01	11.93	25.18%
		3	15.10	26.28	23.52	2.76	11.18	24.72%
		Sum	51.49	83.27	75.31	7.96	31.78	25.04%
Leonardite Products	Leonardite Fines	1	15.03	25.67	22.36	3.31	10.64	31.15%
		2	18.38	26.93	23.95	2.99	8.55	34.91%
		3	16.29	29.53	25.03	4.50	13.24	34.00%
		Sum	49.70	82.14	71.33	10.80	32.43	33.31%
Lowe's (Premier Horti-culture)	Sphagnum Peat Moss	1	19.53	25.12	21.39	3.73	5.59	66.73%
		2	18.24	24.03	20.30	3.73	5.79	64.42%
		3	17.06	22.64	19.42	3.22	5.58	57.71%
		4	44.37	55.25	49.08	6.17	10.88	56.71%
		Sum	99.20	127.04	110.19	16.85	27.84	60.52%
Minerals Techno-logies	AgroLig Ultra-Fine	1	16.79	28.57	24.33	4.25	11.78	36.04%
		2	17.53	30.56	25.73	4.83	13.03	37.04%
		3	17.06	29.46	25.10	4.36	12.40	35.20%
		Sum	51.38	88.59	75.15	13.44	37.21	36.11%
Seven Springs Farm	Ferti-Organics Fulvic Plus	1	16.08	29.93	24.73	5.20	13.85	37.56%
		2	14.91	28.82	23.11	5.71	13.91	41.06%
		3	16.01	29.95	24.24	5.71	13.94	40.97%
		Sum	47.00	88.70	72.07	16.62	41.70	39.87%
Walmart (Earth-works Health LLC)	Granular Humic Acid	1	16.57	39.00	32.92	6.08	22.43	27.09%
		2	17.91	44.02	36.87	7.15	26.11	27.37%
		3	15.87	37.78	31.64	6.14	21.91	28.01%
		Sum	50.34	120.80	101.44	19.36	70.46	27.48%

Appendix C: Particle Size Distribution Plots for Base Soils and Sphagnum Peat Moss.

Table C1. Sieve and hydrometer results for inorganic soil. Reproduced from Nevarez et al. (2018).

Particle Size, mm	% Finer
0.4200	100.0
0.2970	96.3
0.1490	90.5
0.1050	89.3
0.0740	88.3
0.0286	71.9
0.0189	62.7
0.0115	50.7
0.0083	44.2
0.0060	40.6
0.0031	28.6
0.0013	20.3

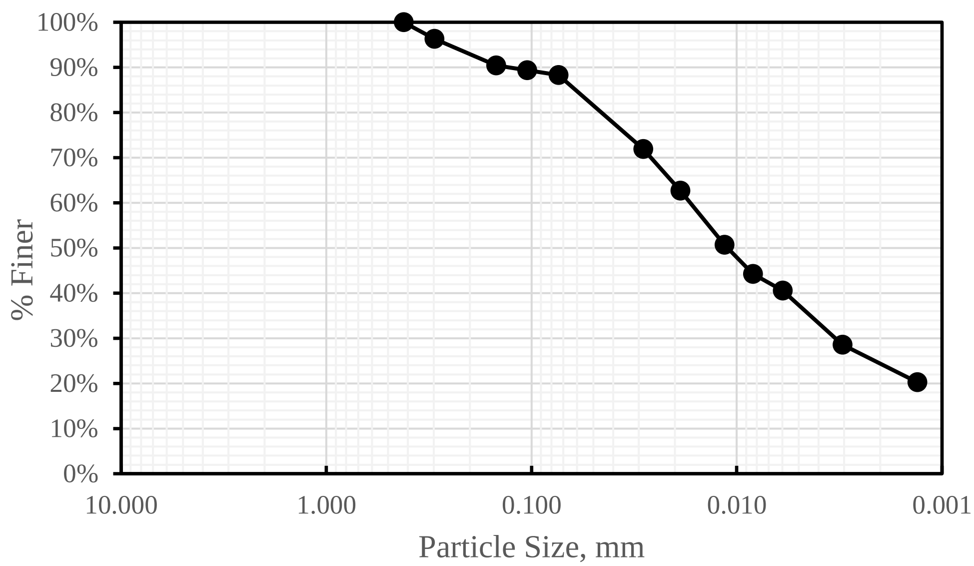

Figure C1. Plot of sieve and hydrometer results for inorganic soil. Reproduced from Nevarez et al. (2018).

Table C2. Sieve results for unground SPM.

Sieve Opening, mm	% Passing
4.750	100.0
2.000	91.6
1.180	85.1
0.850	82.0
0.600	78.2
0.425	73.5
0.300	68.8
0.250	64.9
0.212	62.3
0.150	57.6
0.106	54.4
0.075	50.7

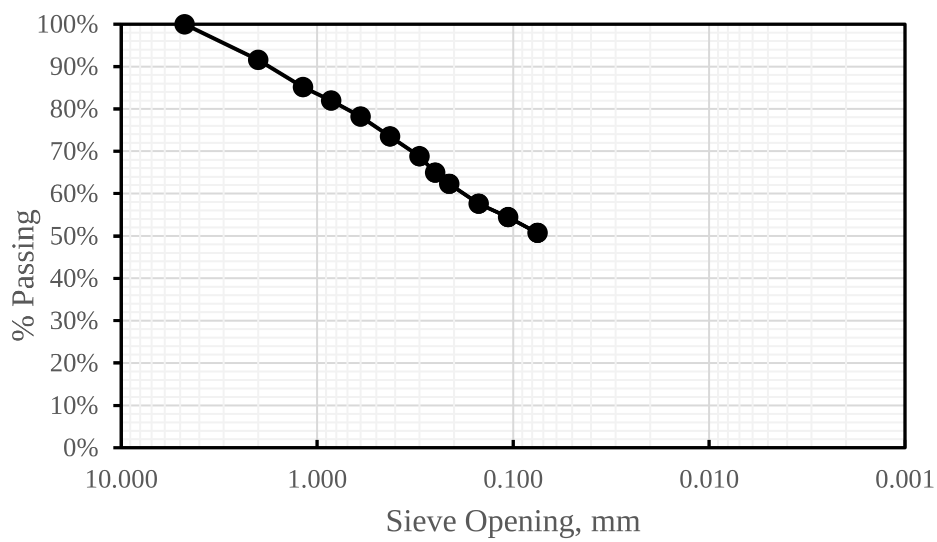

Figure C2. Plot of sieve results for unground SPM.

Table C3. Sieve results for ground SPM.

Sieve Opening, mm	% Passing
4.750	100.0
2.000	99.8
1.180	99.4
0.850	98.4
0.600	95.7
0.425	90.9
0.300	83.7
0.250	77.4
0.212	76.8
0.150	73.3
0.106	70.4
0.075	67.8

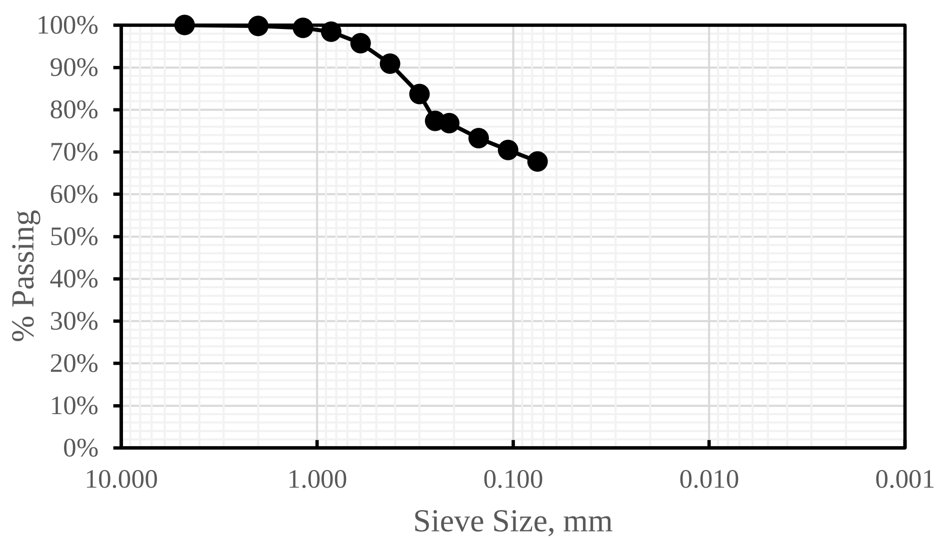

Figure C3. Plot of sieve results for ground SPM.

Table C4. Sieve results for Soil 10.

Sieve Opening, mm	% Passing
4.750	100.0
2.000	100.0
1.180	99.9
0.850	99.8
0.600	99.6
0.425	99.2
0.300	97.1
0.250	94.8
0.212	93.0
0.150	90.3
0.106	88.9
0.075	87.9

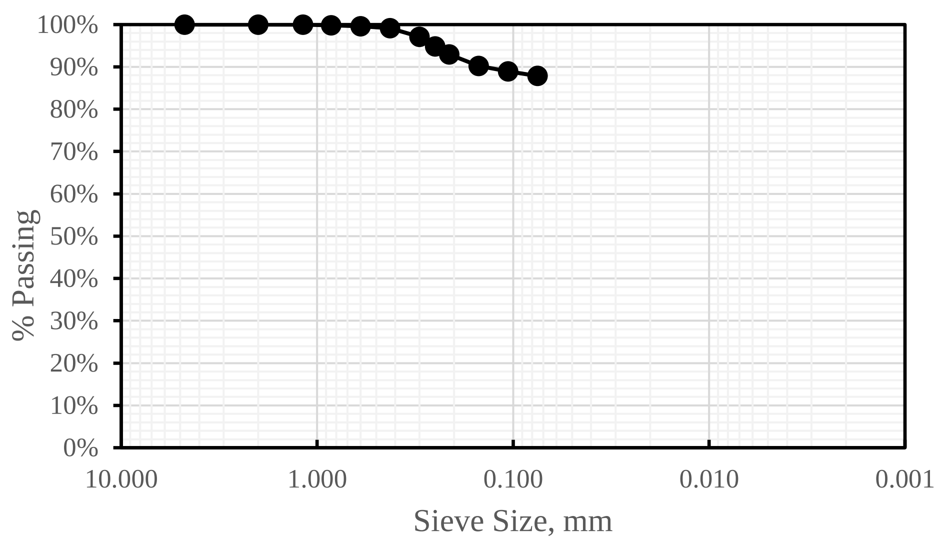

Figure C4. Plot of sieve results for Soil 10.

Table C5. Sieve results for Soil 30.

Sieve Opening, mm	% Passing
4.750	100.0
2.000	99.9
1.180	99.8
0.850	99.4
0.600	97.7
0.425	94.4
0.300	89.7
0.250	86.2
0.212	84.1
0.150	81.1
0.106	79.7
0.075	78.6

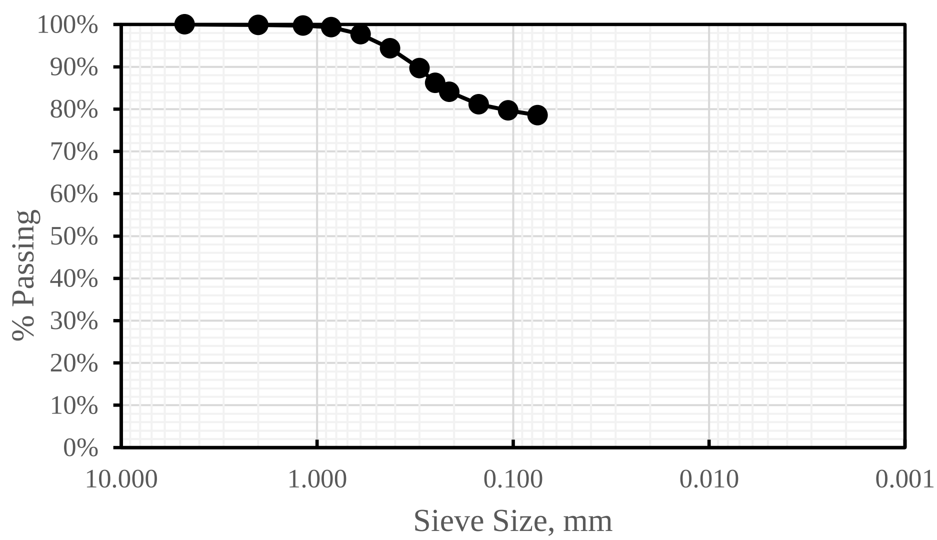

Figure C5. Plot of sieve results for Soil 30.

Table C6. Sieve results for Soil 50.

Sieve Opening, mm	% Passing
4.750	100.0
2.000	100.0
1.180	99.7
0.850	98.7
0.600	96.4
0.425	91.5
0.300	83.8
0.250	74.7
0.212	73.0
0.150	66.9
0.106	65.0
0.075	63.3

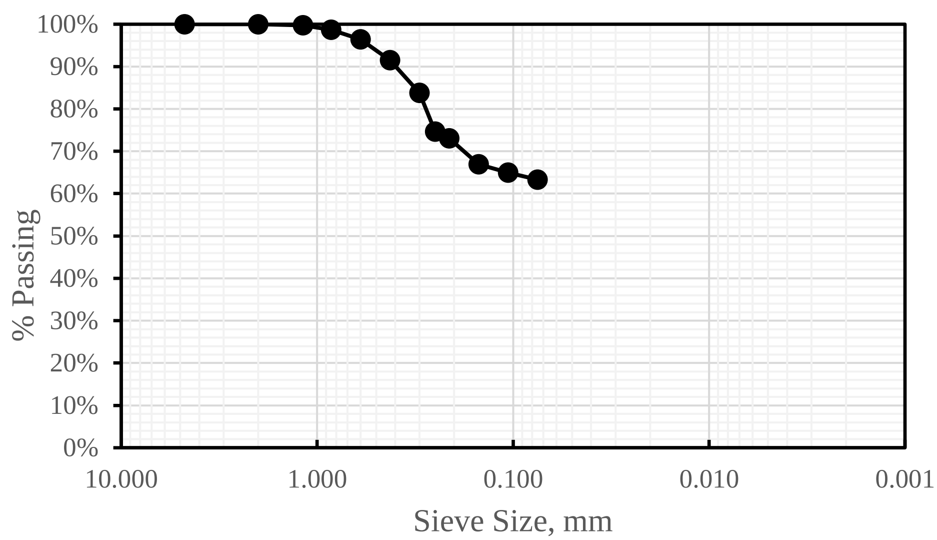

Figure C6. Plot of sieve results for Soil 50.

Appendix D. Results of *w* and *OM* Test for Soils

This appendix summarizes the results of *w* and *OM* tests performed on the organic soils tested, as well as the SPM. Tests of specimen *w* and *OM* were performed to verify that, for the soils used in testing, the actual values of these parameters were close to the design values. For Soils 5, 15, 20, 25, 30, and 40, samples of soil were taken from batches produced during mixing and testing and used to conduct *w* and *OM* tests. For Soils 0, 10, and 50, small quantities of soil were manufactured after mixing and testing and used to conduct *w* and *OM* tests.

Table D1 presents the results of the soil *w* tests. The table shows good agreement between design and actual values of soil *w*. This agreement is displayed visually in Figure D1.

Table D1. Results of soil w tests.

Soil	Design *w*, %	Sample	Container Weight, g			W_W, g	W_S, g	Actual *w*, %
			Empty	Full (wet)	Full (dry)			
0	35	1	40.37	52.49	49.20	3.29	8.83	37.3
		2	37.74	48.75	45.86	2.89	8.12	35.6
		3	40.74	51.72	48.76	2.96	8.02	36.9
		Sum	118.85	152.96	143.82	9.14	24.97	36.6
5	48	1	12.00	25.91	21.33	4.58	9.33	49.1
		2	11.85	21.94	18.70	3.24	6.85	47.3
		3	11.15	21.40	18.07	3.33	6.92	48.1
		Sum	35.00	69.25	58.10	11.15	23.10	48.3
10	60	1	39.05	50.29	45.99	4.30	6.94	62.0
		2	38.31	49.22	45.18	4.04	6.87	58.8
		3	40.27	48.97	45.72	3.25	5.45	59.6
		Sum	117.63	148.48	136.89	11.59	19.26	60.2
15	84	1	10.86	20.03	15.79	4.24	4.93	86.0
		2	10.90	20.07	15.82	4.25	4.92	86.4
		3	11.00	22.22	17.05	5.17	6.05	85.5
		Sum	32.76	62.32	48.66	13.66	15.90	85.9
20	108	1	12.01	23.48	17.28	6.20	5.27	117.6
		2	11.23	21.06	15.76	5.30	4.53	117.0
		3	11.12	22.00	16.22	5.78	5.10	113.3
		Sum	34.36	66.54	49.26	17.28	14.9	116.0
25	132	1	11.08	22.86	15.95	6.91	4.87	141.9
		2	10.93	20.30	14.77	5.53	3.84	144.0
		3	11.17	20.40	15.01	5.39	3.84	140.4
		Sum	33.18	63.56	45.73	17.83	12.55	142.1

Table D1 (continued). Results of soil w tests.

Soil	Design w, %	Sample	Container Weight, g			W_W, g	W_S, g	Actual w, %
			Empty	Full (wet)	Full (dry)			
30	156	1	39.36	50.78	43.85	6.93	4.49	154.3
		2	39.64	49.85	43.65	6.20	4.01	154.6
		3	41.62	51.90	45.67	6.23	4.05	153.8
		Sum	120.62	152.53	133.17	19.36	12.55	154.3
40	211	1	11.96	21.85	15.07	6.78	3.11	218.0
		2	10.94	21.90	14.54	7.36	3.60	204.4
		3	11.12	21.22	14.33	6.89	3.21	214.6
		4	11.84	23.62	15.76	7.86	3.92	200.5
		Sum	45.86	88.59	59.70	28.89	13.84	208.7
50	265	1	40.32	50.87	43.33	7.54	3.01	250.5
		2	37.8	49.82	41.17	8.65	3.37	256.7
		3	40.72	51.47	43.34	8.13	2.62	310.3
		Sum	118.84	152.16	127.84	24.32	9.00	270.2

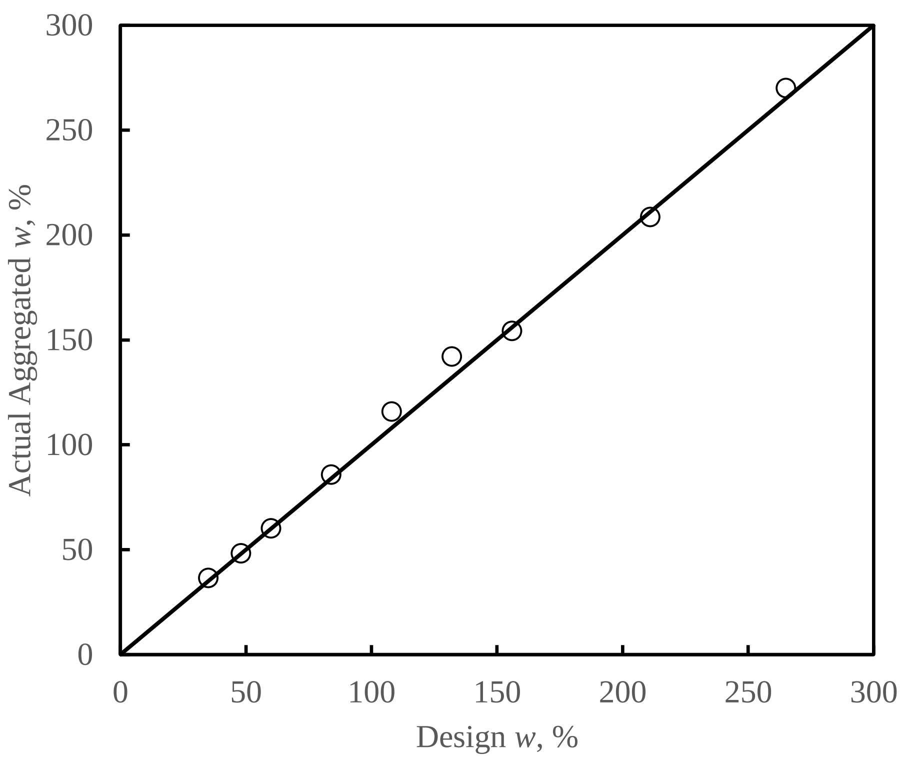

Figure D1. Plot of actual aggregated w values versus design w values.

Table D2 presents the results of the soil *OM* tests. Tests on unwetted and wetted SPM tests are also presented; the unwetted SPM tests are shown in full in Appendix B. Figure D2 plots the results of Table D2. It can be seen that, generally, the measured values of *OM* for the soils significantly exceed their design values of *OM*. This lends credence to the theory presented in Section 3.1.2 that the soil wetting and curing process caused organic matter in the SPM which had been bound to inorganic matter to separate and combust.

Table D2. Results of the soil OM tests.

Soil	Test	Container Weight, g			$W_{OS,O}$, g	W_S, g	*OM*, %
		Empty	Full (pre-baking)	Full (baked)			
0	1	44.03	65.85	65.65	0.20	21.82	0.9%
5	1	44.03	66.66	64.78	1.88	22.63	8.3%
10	1	44.86	63.84	60.99	2.85	18.98	15.0%
15	1	44.02	59.74	56.18	3.56	15.72	22.6%
20	1	43.99	58.72	54.36	4.36	14.73	29.6%
25	1	44.02	57.20	52.80	4.40	13.18	33.4%
30	1	44.00	56.46	51.96	4.50	12.46	36.1%
40	1	44.08	54.54	49.42	5.12	10.46	48.9%
50	1	44.88	53.84	48.69	5.15	8.96	57.5%
SPM (Unwetted)	Sum of 4	99.20	127.04	110.19	16.85	27.84	60.5%
SPM (Wetted)	1	43.17	51.15	45.34	5.81	7.98	72.8%
	2	44.10	51.88	46.16	5.72	7.78	73.5%
	Sum	87.27	103.03	91.50	11.53	15.76	73.2%

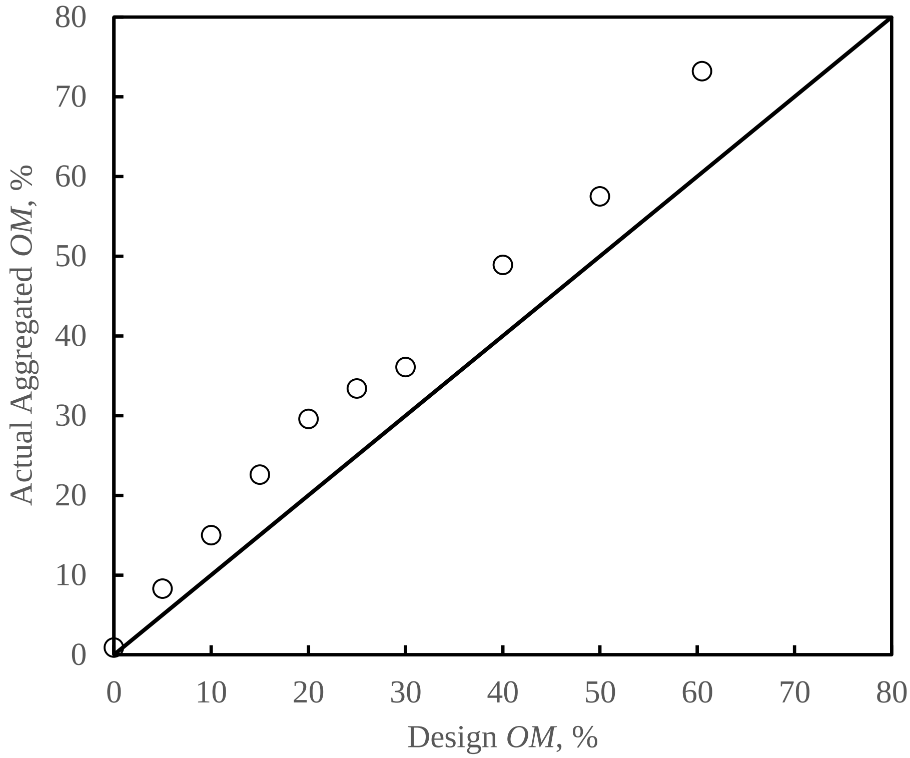

Figure D2. Plot of actual aggregated OM values versus design OM values.

Appendix E. Results of Gas Pycnometer Test for G_s of Sphagnum Peat Moss

This appendix presents the results of the G_s test conducted for SPM using a gas pycnometer. The test was performed using the procedure outlined in ASTM D5550 (2014). Table E1 summarizes the results of the test. Since the result was within the typical range of G_s values for organic soils, no additional tests were performed.

Table E1. Results of G_s test for SPM.

W_S, g	V_S, cm^3	Test T, °C	γ_W at T, g/cm^3	Gs
1.95	1.285	19	0.9984	1.52

Appendix F. Results of Atterberg Limit Tests on Soils and Soil Classification Results

This appendix presents the results of liquid and plastic limit tests performed on Soils 10, 30, and 50 per ASTM D4318 (2017). It also presents how these soils were classified using ASTM D2487 (2017), i.e. the USCS. Detailed information on the liquid and plastic limits of Soil 0, and its USCS classification, is available in Nevarez et al. (2018).

Tables F1 and F2 present liquid and plastic limit test data, respectively, for Soil 10. The trend function used to compute the liquid limit is included below Table F1.

Table F1. Liquid limit test data for Soil 10.

Test	Container Weight, g			W_W, g	W_S, g	w, %	Number (N) of Drops
	Empty	Full (wet)	Full (dry)				
1	11.96	30.98	24.08	6.90	12.12	57%	32
2	10.87	30.70	23.30	7.40	12.43	60%	24
3	11.90	34.11	25.87	8.24	13.97	59%	18
4	11.15	24.65	19.45	5.20	8.30	63%	21
5	12.02	23.52	19.22	4.30	7.20	60%	21
6	11.10	24.58	19.45	5.13	8.35	61%	28

Trend function: w (decimal) = -0.031 × N + 0.70, $R^2 = 0.111$

At $N = 25$, $w = 0.598$; so, LL (Soil 10) = 60%

Table F2. Plastic limit test data for Soil 10.

Test	Container Weight, g			W_W, g	W_S, g	PL, %
	Empty	Full (wet)	Full (dry)			
1	15.22	21.67	19.42	2.25	4.20	54%
2	15.46	22.22	19.69	2.53	4.23	60%
Sum	30.68	43.89	39.11	4.78	8.43	57%

As mentioned in Section 3.1.3, a soil is considered, per ASTM D2487 (2017), to be organic if the ratio of its liquid limit after oven-drying to its liquid limit without oven-drying is less than 0.75. Table F3 presents the results of liquid limit tests on samples of Soil 10 for which oven-dried SPM was used. (The inorganic components contain negligible water and were not dried.) As calculations below Table F3 show, Soil 10 does not classify as organic per ASTM D2487 (2017).

Table F3. Liquid limit test data for Soil 10 made with oven-dried SPM.

Test	Container Weight, g			W_W, g	W_S, g	w, %	Number (N) of Drops
	Empty	Full (wet)	Full (dry)				
1	10.86	29.41	23.16	6.25	12.30	51%	18
2	11.84	32.46	25.67	6.79	13.83	49%	23
3	11.16	36.68	28.30	8.38	17.14	49%	31
4	11.16	37.79	29.07	8.72	17.91	49%	24
5	11.84	48.05	35.90	12.15	24.06	50%	15
6	10.86	41.18	31.24	9.94	20.38	49%	34

Trend function: w (decimal) = -0.026 × N + 0.58, R^2 = 0.722

At N = 25, w = 0.492; so, LL (Soil 10, oven-dried SPM) = 49%

Ratio of liquid limit values = 49/60 = 81.7%

Soil 10 is not organic and has a liquid limit greater than 50. It has a plasticity index of 3, which means it is located below the A-line, and can be classified per ASTM D2487 (2017) as MH. Since less than 15% of particles in Soil 10 are retained on the # 200 sieve, it can be described per ASTM D2487 (2017) as an elastic silt.

Table F4 presents liquid limit test data for Soil 30. The plastic limit test was attempted for Soil 30, but could not be successfully completed, meaning that Soil 30 has a plasticity index of zero.

Table F4. Liquid limit test data for Soil 30.

Test	Container Weight, g			W_W, g	W_S, g	w, %	Number (N) of Drops
	Empty	Full (wet)	Full (dry)				
1	11.91	29.57	18.87	10.70	6.96	154%	37
2	10.76	28.16	17.73	10.43	6.97	150%	28
3	11.14	28.96	17.84	11.12	6.70	166%	18
4	11.53	24.38	16.64	7.74	5.11	151%	24
5	12.04	24.96	17.21	7.75	5.17	150%	33
6	11.11	27.12	17.4	9.72	6.29	155%	27

Trend function: w (decimal) = -0.18 × N + 2.12, R^2 = 0.534

At N = 25, w = 1.558; so, LL (Soil 30) = 156%

Table F5 presents the results of liquid limit tests on samples of Soil 30 for which oven-dried SPM was used. As the calculations below Table F5 show, Soil 30 does not classify as organic per ASTM D2487 (2017).

Table F5. Liquid limit test data for Soil 30 made with oven-dried SPM.

Test	Container Weight, g			W_W, g	W_S, g	*w*, %	Number (*N*) of Drops
	Empty	Full (wet)	Full (dry)				
1	12.05	28.62	19.52	9.10	7.47	122%	20
2	11.16	30.18	19.82	10.36	8.66	120%	23
3	11.11	30.16	19.78	10.38	8.67	120%	29
4	10.96	32.82	20.72	12.10	9.76	124%	15
5	10.9	35.72	22.36	13.36	11.46	117%	33
6	13.53	40.64	25.79	14.85	12.26	121%	24

Trend function: w (decimal) = $-0.084 \times N + 1.47$, $R^2 = 0.874$

At $N = 25$, $w = 1.197$; so, LL (Soil 30, oven-dried SPM) = 120%

Ratio of liquid limit values = 120/156 = 76.8%

Soil 30 is not organic and has a liquid limit greater than 50. It has a plasticity index of 0, which means it is located below the A-line, and can be classified per ASTM D2487 (2017) as MH. Since between 15% and 30% of particles in Soil 30 are retained on the # 200 sieve, and since the percentage of sand-sized particles in Soil 30 is greater than the percentage of gravel-sized particles in Soil 30, it can be described per ASTM D2487 (2017) as an elastic silt with sand.

Table F6 presents liquid limit test data for Soil 50. The plastic limit test was attempted for Soil 50, but could not be successfully completed, meaning that Soil 50 has a plasticity index of zero.

Table F6. Liquid limit test data for Soil 50.

Test	Container Weight, g			W_W, g	W_S, g	*w*, %	Number (*N*) of Drops
	Empty	Full (wet)	Full (dry)				
1	16.31	34.64	21.43	13.21	5.12	258%	38
2	34.36	51.84	39.06	12.78	4.70	272%	27
3	34.54	55.51	40.21	15.30	5.67	270%	19
4	11.19	26.86	15.62	11.24	4.43	254%	29
5	11.18	24.02	14.60	9.42	3.42	275%	19
6	10.98	23.82	14.67	9.15	3.69	248%	33

Trend function: w (decimal) = $-0.30 \times N + 3.61$, $R^2 = 0.589$

At $N = 25$, $w = 2.6454$; so, LL (Soil 50) = 265%

ASTM D2487 (2017) notes that a soil composed mainly of plant matter with a dark color and an organic scent is classified as peat, PT. Since Soil 50 meets all three of these criteria, it can be classified per ASTM D2487 (2017) as PT and described per the same standard as peat.

Appendix G. Results of von Post H Test for Soil 50

This appendix discusses the von Post H test conducted on Soil 50 per ASTM 5715 (2014). For the von Post H test, a 1-inch diameter sphere of the soil of interest is molded manually, then squeezed firmly. The consistency of the material remaining in the hand and the appearance of the extruded water is examined to determine a von Post H value.

Based on ASTM D5715 (2014), it was decided that a von Post classification of H5 was most appropriate for Soil 50. The extruded water was extremely turbid and contained some granular peat. The tissues of the parent plant – in this case, sphagnum peat moss – were tough to recognize, although still visible. While the texture of the remaining material was granular, not pasty as specified in ASTM D5715 (2014), H5 remained the most appropriate von Post classification for Soil 50.

Appendix H. Results of Soil pH Tests

Table H1 lists the results of all pH tests performed per ASTM D4972 (2019). For all tests, approximately 100 g (± 3 g) of deionized water was added to approximately 20 g (± 1 g) of dried material. The dried material was stirred thoroughly into the deionized water and allowed to sit for 1 hour, during which time periodic stirrings were performed. After 1 hour, a final stirring was performed and the pH of the mixture was measured using an Accumet AR-10 electronic pH meter. All mixtures had a temperature of approximately 21 °C (± 1 °C).

Table H1. Results of pH testing using ASTM D4972 (2019).

Soil or Material	pH
Soil 0	7.22
Soil 10	5.18
Soil 30	4.63
Soil 50	4.59
SPM	4.45

Table H2 lists the results of all pH tests performed per ASTM D2976 (2015). For all tests, approximately 50 g (± 2 g) of deionized water was added to approximately 3 g (± 0.1 g) of dried material. The dried material was stirred thoroughly into the deionized water and allowed to sit for 30 minutes, during which time periodic stirrings were performed. After 30 minutes, a final stirring was performed and the pH of the mixture was measured using an electronic pH meter. All mixtures had a temperature of 20-21 °C.

Table H2. Results of pH testing using ASTM D2976 (2015).

Soil or Material	pH
Soil 50	4.88
SPM	4.75

Tables H1 and H2 show that generally, the pH values determined using ASTM D2976 (2015) were slightly more basic than those determined using ASTM D4972 (2015). This may be attributed to the lower concentration of solid material in deionized water for the tests conducted using ASTM D2976 (2015).

Appendix I: Laboratory Procedure for Soil Mixture, Preparation, and Testing

This procedure for mixing, curing, and preparing organic soil-cement specimens is based on procedures developed by Hodges et al. (2008), Nevarez et al. (2018), and Ju (2018).

Equipment

- Respirator
- Latex gloves
- Laboratory goggles
- Plastic bags, airtight containers, and plastic wrap
- Electronic balance
- Hobart™ Legacy HL 120 Mixer (12-quart) with dough hook attachment
- Oster™ 14 speed blender (2 L)
- Hamilton Beach coffee grinder (Model 80393)
- U.S. Stoneware jar mill
- SPX Blue M electric oven (soil water content)
- Barnstead Thermolyne FB1400 muffle furnace (soil organic content)
- Perfect Prime TC41-Thermocouple 4-probe thermometer
- Mixing bowls
- Moisture tins
- Rubber spatula
- Large spoon
- 50 mm diameter, 100 mm tall (2" x 4") plastic molds with lids
- Drywall or straight-edge spatula
- Digital calipers
- Miter saw with stone cutting blade
- Unconfined compression testing apparatus
- Small utility knife
- Silver Sharpie
- Paint brush
- Water bottle
- Camera

Soil Components

- Tile 6 kaolin
- Bentonite
- Premium play sand
- Silica flour SMS-200
- Portland cement type I/II
- Sphagnum peat moss

Table I1. Sources of soil components and selected equipment.

Soil Component	Source	Location	Contact
Tile 6 Kaolin	Kentucky Tennessee Clay	Asheville, NC	highwaterclays.com
Gel Bentonite	H. C. Spinks	Gleason, TN	lhoist.com/us_en/spinks-clay
Premium Play Sand	Short Mountain Silica	Mooresburg, TN	shortmtnsilica.com
Silica Flour SMS-200			
Sphagnum Peat Moss (SPM)	Premier Horticulture, Inc.	Riviere-du-Loup, QC	www.pthorticulture.com
Type I/II Portland Cement	Quikrete	Atlanta, GA (HQ)	quikrete.com
2” x 4” test cylinder mold with lid	Paragon Products	Mt. Pleasant, IA	paragonproducts-ia.com
Soil oven (water content)	Blue M	East Troy, WI (HQ)	wisoven.com
Soil muffle furnace (organic content)	ThermoFisher Scientific	Waltham, MA (HQ)	thermofisher.com
15-oz. Coffee Grinder	Hamilton Beach	Glen Allen, VA (HQ)	hamiltonbeach.com
14-Speed Blender (2 L)	Oster	Boca Raton, FL (HQ)	oster.com
Legacy HL 120 Mixer (12-quart) with dough hook	Hobart Corporation	Troy, OH	hobartcorp.com
Jar Mill	U.S. Stoneware	East Palestine, OH	usstoneware.com
Sigma-1 Automated Load Test System	GeoTAC	Houston, TX	geotac.com

Dry Mixing and Wet Mixing of Base Soil

Dry mixing is performed first to ensure a thorough mixing of the solid soil components. Since inhaling silica dust and/or other dry soil components is a respiratory hazard, an appropriate half-face respirator with a filter approved for silica dust should be worn whenever dry mixing is performed. Dust generation during dry mixing can be minimized by slowly and carefully transferring each dry soil component using a spatula.

These instructions assume that dry and wet base soil mixing are performed consecutively, as is typical. If this cannot be done, dry soil should be stored in a sealed container between the end of dry mixing and the start of wet mixing. More wet soil should be prepared than will be needed for specimen preparation, since some will stick to the mixing bowl and curing container.

1. Put on the respirator, gloves, and goggles and prepare the dry soil components.
    a. Sieve the Premium play sand to obtain the desired gradation. This study used sand passing the #40 sieve and retained on the #200 sieve.
    b. Air-dry the sieved sand if needed and store it in a sealed container.
    c. Sieve the SPM to obtain the desired gradation. This study used SPM passing the #4 sieve.
    d. Run the SPM through the coffee grinder on a Fine-12 setting. The grinding cycle will last approximately 34 seconds.
    e. Store the sieved, ground SPM in a sealed container.
    f. Store the rest of the dry components in sealed containers away from moisture to prevent changes in moisture content between batches.
    g. Sieve the binder for 18-20 minutes to obtain the desired gradation. This study used binder passing the #200 sieve to meet the technical definition of cement.
2. Weigh the dry components.
    a. Select the amount of base soil to be prepared and determine the required amount of each component. The proportions by weight of the inorganic and organic fractions of each soil are listed in Table 4.
3. Place the dry components in a large bowl and mix them briefly with a spoon.
4. Transfer the contents of the bowl to the jar mill drum and seal the lid.
5. Place the drum on the motorized rollers.
6. Turn on the jar mill on speed setting 30 and allow it to rotate for 10 minutes. If the amount of soil to be prepared exceeds the capacity of the jar mill, several smaller batches should be prepared and combined.
7. Remove and open the jar mill drum. Transfer the dry base soil into the mixing bowl with a spatula. Use a paint brush to sweep any remaining dry soil out of the drum.
8. Determine the mass of soil in the bowl.
9. Determine the necessary weight of water to be added to the dry components to obtain the desired water content. For this study, a water content equal to the liquid limit of the soil being tested was used. Liquid limit values are listed in Table 4.
10. Using the water bottle and pipette, add the required amount of water to the mixing bowl.
    a. To improve mixing efficacy and avoid splashing, dig a small depression in the center of the dry soil and pour the water into it.
11. Use the rubber spatula to manually mix the dry soil and water (center-to-outside pattern), especially at the center of the bowl where the dough hook has limited reach. This enables thorough mixing and limits splashing during Step 12.

12. Set the Hobart mixer to speed setting "1". Use the mixer and dough hook attachment to mix the dry soil and water for 5 minutes. Every 1:15, turn the mixer off and use the rubber spatula to move soil sticking to the edges of the bowl and/or the dough hook into the center of the bowl. Minimize the time spent manually mixing the soil and do not include it in the 5-minute mixing time.
    b. The respirator may be removed after the mixing process is complete.
13. Transfer the wet soil to a massed sealable container using the spatula. Record the mass of the filled container.
    a. For accuracy, ensure that 3% or less of wet soil mass is lost during transfer.
14. Seal the container with cellophane and a lid. Store the container in a humid environment for 12-36 hours to allow the wet soil to fully hydrate.

Wet Soil Re-Mixing and Binder Slurry Mixing

Wet soil re-mixing and binder slurry mixing should be performed simultaneously to prevent moisture loss in the wet soil. Wear a respirator during this phase of mixing for protection from cement dust.

15. For each planned specimen, label a clean, dry molds with soil type, binder type, batch number, and specimen number. Remove the lid from each mold using a utility knife.
16. Determine the weight of water and weight of binder needed for the w:b ratio of the binder slurry. To account for slurry which will stick to the blender interior, prepare more slurry than will be used.
17. Using the water bottle, add the required mass of slurry water to the Oster kitchen blender.
18. Retrieve the wet soil container and remove the lid and cellophane from it.
    a. Remove approximately 10 g of soil from the container. Record its exact mass and place it in the soil oven. Dry the specimen for 24 hours and re-mass it to obtain the soil water content.
    b. Once the specimen has been dried, place it in an aluminum foil-covered crucible. Place the crucible in the muffle furnace for 24 hours and re-mass it to obtain the soil organic content.
19. Place the soil container on the balance and zero the balance.
20. Transfer the soil to the Hobart mixing bowl. Use the rubber spatula and/or straight-edge spatula as needed to scrape any remaining soil out of the container.
    a. Mass the empty container to obtain the actual weight of moist soil used.
21. Moisten the inside of the Hobart mixing bowl. Pat dry any visible water droplets with a paper towel.
22. Raise the bowl into mixing position and set the Hobart mixer to speed setting "Stir".
23. Add the required mass of dry binder to the Oster blender and cap the blender. As the dry binder is added, manually stir the slurry with a straight-edge spatula to avoid clogging the blender rotor during mixing. Set the blender to power setting "High".
24. Simultaneously press "Start" on the Hobart mixer and "Blend" on the Oster blender. Run both machines for 3 minutes.
    a. The respirator may be removed after binder slurry mixing has begun.

Soil-Binder Mixing

25. After 3 minutes has elapsed, turn off the blender and mixer. Remove the blender pitcher lid and mass the slurry-filled pitcher. Subtract the required weight of binder slurry to determine the mass of the pitcher at which to stop adding slurry.
26. Incrementally add the binder slurry to the wet soil in the mixing bowl to avoid splashing slurry in the bowl. After each increment of slurry has been added, run the Hobart mixer on speed setting "Stir" for 30-40 s to slightly mix the slurry into the wet soil. While the mixer is running, agitate the pitcher to prevent the binder from settling out of suspension before adding the next increment of slurry.
27. Once enough binder slurry has been added, record the weight of the binder-filled pitcher to determine the exact amount of binder slurry mixed with the wet soil. Set the Hobart mixer to speed setting "2". Mix the soil and slurry briefly by hand.
    a. Leftover slurry should be diluted and dumped into a trashcan.
28. Mix the wet soil and binder for 10 minutes using the Hobart mixer and dough hook. Every 2:30, stop the mixer and use a rubber spatula to scrape soil from the hook and/or the bottom/sides of the bowl back into the center of the bowl before resuming machine mixing. Minimize the time spent manually mixing the soil and do not include it in the 10-minute mixing time.
    b. While machine mixing takes place, disassemble the blender pitcher and scrub the components to keep the blender blade in working order. Then move the specimen molds over to the nearest adjacent counter space and remove their lids.
29. At the end of the 10-minute mixing time, record the actual time since the start of mixing.

Molding Specimens

30. **Immediately** following soil-binder mixing, begin molding. Use a rubber spatula to transfer the soil-binder mixture from the mixing bowl into a plastic mold. All molding must be completed within 30 minutes after soil-binder mixing.
31. Fill each mold in three lifts.
    a. After each lift, tap the mold on a hard surface 50-60 times to remove air bubbles. Mixtures with less binder slurry will require more tapping. Stop tapping either when water begins to separate from the mixture or when bubbles no longer break the mixture surface.
    b. If the soil-binder mixture is highly liquid, the third lift should fill the mold to approximately 0.5" from the top to prevent splashing of the mixture during molding. The remaining 0.5" of mixture can then be placed without tapping.
32. Screed the top of each specimen flush with the top of the mold using a straight-edge spatula. Cap the specimen by pressing on the sides of the lid until it locks in place.
    a. Do not press the center of the lid, which may damage the specimen.
33. Check that all specimen masses fall within a 5-gram range. If any fall outside this range, use a straight-edge spatula to remove and/or add material to these specimens as needed.
34. Once all molds are filled and capped, clean any excess mixture off them and dry them.
35. Seal each mold around the lip of the lid with approximately 24" of black Scotch 700 vinyl electrical tape or white Scotch 35 vinyl electrical tape.
36. Mass each molded specimen individually and discard any outside the designated mass tolerance. Each testing program should set its own tolerance based on the variability of

the soil being tested and the sensitivity of the soil-binder mixture to segregating. For this study, a tolerance of 5 g below maximum specimen mass was used.

Curing

37. Store the sealed specimens inside a water-filled 28-quart container stored in a humid room. The water level in the container should be kept high enough to fully submerge the samples.
    b. Specimens should be stored in the sealed cylinder molds under these controlled conditions for their specified curing period (7 to 28 days).
38. Every day, use the 4-probe thermometer to assess the temperature of the humid room and each tub. Submerge the probes for 15 seconds before taking readings.
    a. While temperature readings are being taken, the seals, spacing, and submergence of the specimens in the tub should be checked.
    b. Keep a 1-gallon bucket of water in the humid room at all times so that room-temperature water may be added to the tubs if needed.

Specimen Preparation

Specimens should be prepared for testing as close as possible to testing time.

39. After a specimen has reached its selected curing age, remove it from the tub, dry the mold, and remove the tape and cap.
    a. If bleed water has formed at the top of the specimen, mass a dry paper towel. Use the paper towel to absorb the bleed water, then record its mass again.
    b. If the specimen is too soft to be tested in unconfined compression, use a miniature vane shear test to assess its strength.
40. Use the miter saw to cut off the bottom of the mold.
    a. To cut the proper thickness off the bottom, line up the bottom edge of the mold with a point halfway between the middle and right edge of the blade.
    b. If additional material remains that is too thin for the miter saw to remove without cutting into the specimen, use the utility knife to remove this material.
41. Remove the specimen from the mold.
    a. If possible, push the specimen out without cutting into the mold.
    b. If the specimen cannot be pushed out, use the small utility knife to remove the top and bottom edges of the specimen mold, then push the specimen out.
    c. If the specimen still cannot be pushed out, use the utility knife to carefully cut downward along the side of the mold. Be careful to minimize cutting into the specimen; cutting downward diagonally instead of vertically helps achieve this.
    d. *DO NOT* remove specimens from their molds using standard stripping tools for concrete specimens. Soil mixing specimens are softer than standard concrete specimens and may be damaged if not extracted carefully.
42. If either face of the specimen is severely unlevel, use the miter saw to carefully trim it.
    a. Mark an arrow on the side of the specimen indicating the top.
43. Place the specimen in the grinder clamp. Align the bottom of the specimen with the grinder, then clamp the specimen into place.
    a. Do not attempt to scrape loose material off the specimen face when the grinder is not running. This may damage the specimen.

44. After turning on the attached vacuum, turn on the grinder. Grind the bottom of the specimen until it appears flat. Turn the grinder dial up in increments of 0.5. Use the lever on the grinder clamp to pass the bottom face of the specimen back and forth over the grinder 3-4 times at each grinder dial reading.
    a. A good indicator of whether the bottom of the specimen is flat is whether it has a homogeneous color and marking pattern.
45. Once the bottom is flat, turn off the grinder, flip the specimen, and repeat steps 40-42 for the top end.
46. Once both faces of the specimen have been ground, dust the specimen with a paint brush.
47. Use a digital caliper to measure and record the specimen's height. The three readings should be within 0.004" of each other per ASTM C39 (2018) and ASTM D1632 (2017). Otherwise, continue grinding until the 0.004" tolerance is met.
48. Once the height tolerance has been achieved, calculate the average height of the specimen. Then measure the specimen diameter at three locations. Record and average these measurements. Mark the top of the specimen with a T using a silver Sharpie.
49. Measure and record the specimen mass to the nearest tenth of a gram. All balances should be calibrated per ASTM D4753 (2015).
50. Record any unique features of the specimen such as voids, cracks, spots of color, etc.

Load Cell Adjustment

This portion of the procedure needs to be performed only *once* prior to the start of testing.

51. Disconnect the cable leading into the DCDT.
52. Loosen and remove the load cell bolt, taking care not to drop the load cell.
53. On the attached computer, go to "Setup", Sensors", "Name External Load Cell Channel 1", and "Check ID" to ensure that the appropriate 5-kip load cell is being used.
54. Input the load cell ID and click "Update from Database". Each load cell has a different calibration factor.
55. For excitation, select a 10-volt interval and "OK".
56. Go to "Sensors" and "Add". Under "Name", enter <u>DCDT</u>. Under "IP", enter <u>LP-179, Channel 3</u>. Click "Update from Database".

UCS Test

57. Place the specimen on the end platen of the GEOTAC apparatus and put a clear plastic cap atop the specimen. Center the specimen under the cap.
58. Raise the bottom platen by selecting the "Up" arrow (with line) and "Run". Select "Stop" when the cap is close enough to the load cell for alignment. Center the cap and specimen under the load cell.
59. Open the SIGMA1 UCS program. Select "Tare Loadcell" and "Yes" to zero the load.
60. Select "New Test" and enter the specimen batch number, specimen number, diameter, and height. Use a depth of 10'. Save the data file.
61. Select "Set Up", "Preferences", and "Perform Automatic Seating". Set a contact threshold of 5.0 lb. and select "OK". (This will save as a default.)
62. Select "Start Test". Continue checking the centering of the cap and specimen under the load cell until seating is complete. Once this happens, select "View Plot".

63. After the peak stress on the specimen has been recorded, per the SIGMA1 home screen, select “Stop Test” and “End Test”.
64. Remove the failed specimen from the apparatus and photograph it. Record its failure mode per ASTM C39 (2018), any voids present, and anything else noteworthy.
65. Discard the failed specimen and sweep the load frame clean.

Points on Proper Cleaning and Maintenance

A. All equipment should be cleaned after each use.
B. After using the jar mill, wipe the interior of the drum with moist paper towels to remove any remaining dry soil material. Then, use paper towels to dry the interior of the drum. Finally, use a paintbrush to sweep any paper towel fragments out of the drum.
C. Clean all excess slurry from the blender pitcher components (especially the blade) using warm-to-hot water and a scrub brush.
    a. After molding is completed, reassemble the pitcher, fill it with hot water, cap it, and run the blender for 5 minutes to ensure that all pitcher components are clean and in working order.
    b. After the warm-water cleaning, dump the water outside, clean the pitcher components again, and air-dry them.
D. After mixing each batch, clean all counter space used. Clean the Hobart mixer at the dough-hook attachment.

Appendix J. Batch Mixing Sheets for Laboratory Preparation of Soil Mixtures

The tables in Appendix J list complete mixing information for each batch. Each sheet includes the design and actual weights of all components used in the mixture, the design and actual values of key mixture parameters such as $\alpha_{I\text{-}P}$, $\gamma_{D\text{-}MIX}$, and $w_T{:}b$, and dimensions and weights for each specimen tested. The batches are listed in order of parent soil. For each soil, batches are listed chronologically.

A few measurements were inadvertently not recorded during mixing and testing and were estimated after the fact. The weights of specimens 5-1-B and 15-1-D were not recorded at the time of testing. The values of degree of saturation, S, and $\gamma_{D\text{-}MIX}$ of the other specimens in batches 5-1 and 15-1, as well as the dimensions of specimens 5-1-B and 15-1-D, were used to estimate the weights of these specimens.

The weights of specimens 20-2-D and 20-3-C were only recorded after testing, by which time they had become chipped. The weight of the whole portions of these specimens were recorded. These weights were used along with the dimensions of specimens 20-2-D and 20-3-C and the values of S and $\gamma_{D\text{-}MIX}$ of the other specimens in batches 20-2 and 20-3 to estimate the actual weights of these specimens.

The actual weight of binder slurry used in batch 40-1 was not recorded during testing. This weight was estimated based on the design weight of binder slurry for batch 40-1, as well as the typical difference between design and actual weights of binder slurry for other batches.

The mode of failure of each specimen during the UCS test was classified per ASTM C39 (2018). Many specimens did not have a clear mode of failure. This may be because ASTM C39 (2018) is intended for use with concrete specimens, which are generally stiffer than soil-binder mixture specimens and may therefore have more clearly defined modes of failure. Also, UCS tests in this research were stopped once peak strength had been reached. Had the tests been continued beyond peak UCS, specimen modes of failure may have become more apparent. Among specimens which did clearly display a mode of failure per ASTM C39 (2018), the most common mode was 4, which connotes a single diagonal plane of failure running through most or all of the length of the cylinder.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 0-1 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/28/18 (soil), 4/29/18 (soil-cement)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	0%
Specific Gravity of Solids, G_S	2.66
Soil Water Content, w	35%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1374.7
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1855.9

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	125
Weight of Binder, W_b (g)	334.6
Weight of Slurry Water, $W_{w,slurry}$ (g)	334.6
Weight of Slurry, W_{slurry} (g)	669.3
Weight of Soil, W_{soil} (g)	4148.4

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	0.0
Bleed Water from Batch,* (g)	0.0
Volume of Bleed Water (in^3)	0.0

As-Mixed Batch Properties

W_{slurry} (g)		610.0	
1) Comps. put into jar mill, g		2900.0	
2) Comps. removed from jar mill,g		2899.1	
3) Wet soil made, g	*QC only*		
4) Wet soil used, g		3785.4	
W_o (g)	0.0	W_s (g)	2802.9
$W_{s,o}$ (g)	0.0	$W_{w,soil}$ (g)	982.5
$W_{os,o}$ (g)	0.0	W_{soil} (g)	3785.4
$W_{w,o}$ (g)	0.0	Soil w (%)	35.1%
Mixture G_s		2.70	
$\gamma_{d,mix}$ (pcf)		79.4	
Mixture w, %		41.4%	
$\gamma_{t,mix}$ (kg/m^3)		1799.1	
Total Water-to-Binder Ratio, w_t:b		4.22	
Binder Content, a (%)		10.9%	
Binder Factor, α (kg/m^3)		149.48	
Binder Factor In-Place, α_{I-P} (kg/m^3)		124.8	
Volume Ratio, VR (%)		19.7%	
w_t:b	4.22	$\gamma_{d,mix}$ (pcf)	79.4
α_{I-P} (kg/m^3)	124.8		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	0.0	0.0	0.0
$W_{i,add}$, g	2900.0	2899.1	2802.9
$W_{w,add}$, g	N/A	1016.2	982.5
Σ		3915.3	

Soil OC (%)	0.0%
W_b (g)	305.0
$W_{w,slurry}$ (g)	305.0
$\gamma_{D,Soil}$, pcf	85.8
$\gamma_{D,Slurry}$, pcf	47.3

Checks — Based on actual mix prepared

α (kg/m^3)	149.48
a (kg/m^3)	10.9%
VR	19.7%
w_t:b	4.22

SAMPLE DATA:

Based on table below

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/29 4:30 PM	10.00	5/9 4:26 PM	2.041	3.980	--	--	377.8		169.59	1.71	1.9504	0.996	168.92	2	2.13E-04	1771.5	1.15	97.1%	1252.6
B	4/29 4:30 PM	10.04	5/9 5:32 PM	2.038	3.848	--	--	358.2		207.96	2.74	1.88813	0.991	206.10	4	2.06E-04	1741.4	1.19	94.1%	1231.3
C	4/29 4:30 PM	43.89	6/12 1:45 PM	2.035	3.842	--	--	359.6		274.69	1.63	1.88839	0.991	272.24	4	2.05E-04	1756.4	1.17	95.6%	1242.0
D	4/29 4:30 PM	43.99	6/12 4:17 PM	2.039	3.869	--	--	367.2		241.32	1.01	1.8975	0.992	239.34	2	2.07E-04	1773.7	1.15	97.3%	1254.1
E			Not tested																	
F			Not tested																	
G			Not tested																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1760.7			
																% Theoretical	97.9%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 0-2 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	6/6/18 (soil), 6/7/18 (soil-cement)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	0%
Specific Gravity of Solids, G_S	2.66
Soil Water Content, w	35%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1374.7
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1855.9

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	125
Weight of Binder, W_b (g)	334.6
Weight of Slurry Water, $W_{w,slurry}$ (g)	334.6
Weight of Slurry, W_{slurry} (g)	669.3
Weight of Soil, W_{soil} (g)	4148.4

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	0.0
Bleed Water from Batch,* (g)	0.0
Volume of Bleed Water (in^3)	0.0

As-Mixed Batch Properties

W_{slurry} (g)		646.4
1) Comps. put into jar mill, g		2900.0
2) Comps. removed from jar mill,g		2900
3) Wet soil made, g	*QC only*	
4) Wet soil used, g		3861.4

W_o (g)	0.0	W_s (g)	2859.8
$W_{s,o}$ (g)	0.0	$W_{w,soil}$ (g)	1001.6
$W_{os,o}$ (g)	0.0	W_{soil} (g)	3861.4
$W_{w,o}$ (g)	0.0	Soil w (%)	35.0%

Mixture G_s	2.70
$\gamma_{d,mix}$ (pcf)	79.2
Mixture w, %	41.6%
$\gamma_{t,mix}$ (kg/m^3)	1797.6
Total Water-to-Binder Ratio, w_t:b	4.10
Binder Content, a (%)	11.3%
Binder Factor, α (kg/m^3)	155.31
Binder Factor In-Place, α_{I-P} (kg/m^3)	128.9
Volume Ratio, VR (%)	20.5%

w_t:b	4.10	$\gamma_{d,mix}$ (pcf)	79.2
α_{I-P} (kg/m^3)	128.9		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	0.0	0.0	0.0
$W_{i,add}$, g	2900.0	2900.0	2859.8
$W_{w,add}$, g	N/A	1015.7	1001.6
Σ		3915.7	

Soil OC (%)	0.0%
W_b (g)	323.2
$W_{w,slurry}$ (g)	323.2
$\gamma_{D,Soil}$, pcf	85.8
$\gamma_{D,Slurry}$, pcf	47.3

Based on actual mix prepared

Checks	
α (kg/m^3)	155.31
a (kg/m^3)	11.3%
VR	20.5%
w_t:b	4.10

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	6/7 4:30 PM	7.19	6/14 8:59 PM	2.037	3.950	--	--	375.4	0.0	99.26	0.90	1.93917	0.995	98.78	4	2.11E-04	1780.1	1.15	98.2%	1256.9
B	6/7 4:30 PM	7.27	6/14 11:02 PM	2.040	3.760	--	--	353.7	0.0	205.57	2.08	1.84281	0.987	202.98	4	2.01E-04	1756.1	1.18	95.7%	1240.0
C	6/7 4:30 PM	7.31	6/14 11:49 PM	2.033	3.890	--	--	366.2	0.0	115.64	1.08	1.91361	0.993	114.84	4	2.07E-04	1770.3	1.16	97.2%	1250.0
D	6/7 4:30 PM	16.17	6/23 8:35 PM	2.031	3.877	--	--	365.0	0.0	281.02	1.72	1.90863	0.993	278.97	4	2.06E-04	1772.8	1.15	97.4%	1251.8
E	6/7 4:30 PM	16.20	6/23 9:20 PM	2.027	3.821	--	--	359.8	0.0	243.36	1.05	1.88472	0.991	241.12	3	2.02E-04	1780.5	1.15	98.2%	1257.2
F	6/7 4:30 PM	16.22	6/23 9:48 PM	2.036	3.804	--	--	361.2	0.0	134.91	0.57	1.86864	0.989	133.49	4	2.03E-04	1780.3	1.15	98.2%	1257.1
G	6/7 4:30 PM	16.29	6/23 11:29 PM	2.033	3.950	--	--	372.5	0	300.8	1.93	1.94309	0.995	299.4	4	2.10E-04	1772.7	1.15	97.4%	1251.7
H	6/7 4:30 PM	28.27	7/5 10:56 PM	2.033	3.903	--	--	368.2	0	307.7	1.12	1.91963	0.994	305.7	2	2.08E-04	1773.1	1.15	97.5%	1252.0
I	6/7 4:30 PM	28.30	7/5 11:35 PM	2.038	3.962	--	--	375.0	0	316.6	1.15	1.94435	0.996	315.2	4	2.12E-04	1771.1	1.16	97.2%	1250.6
J	6/7 4:30 PM	28.31	7/6 12:01 AM	2.034	3.987	--	--	377.2	0	341.0	1.42	1.96032	0.997	339.9	4	2.12E-04	1777.4	1.15	97.9%	1255.0
																Average	1773.4			
																% Theoretical	98.7%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 0-3 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	6/8/18 (soil), 6/9/18 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	0%
Specific Gravity of Solids, G_S	2.66
Soil Water Content, w	35%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1374.7
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1855.9

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	350
Weight of Binder, W_b (g)	937.0
Weight of Slurry Water, $W_{w,slurry}$ (g)	562.2
Weight of Slurry, W_{slurry} (g)	1499.1
Weight of Soil, W_{soil} (g)	3369.7

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	0.0
Bleed Water from Batch,* (g)	0.0
Volume of Bleed Water (in^3)	0.0

As-Mixed Batch Properties

W_{slurry} (g)			1487.7	
1) Comps. put into jar mill, g			2400.0	
2) Comps. removed from jar mill,g			2400	
3) Wet soil made, g		QC only		
4) Wet soil used, g			3271.2	
W_o (g)	0.0		W_s (g)	2370.0
$W_{s,o}$ (g)	0.0		$W_{w,soil}$ (g)	901.2
$W_{os,o}$ (g)	0.0		W_{soil} (g)	3271.2
$W_{w,o}$ (g)	0.0		Soil w (%)	38.0%
Mixture G_s			2.78	
$\gamma_{d,mix}$ (pcf)			77.7	
Mixture w, %			44.2%	
$\gamma_{t,mix}$ (kg/m^3)			1795.3	
Total Water-to-Binder Ratio, w_t:b			1.57	
Binder Content, a (%)			39.2%	
Binder Factor, α (kg/m^3)			517.77	
Binder Factor In-Place, α_{I-P} (kg/m^3)			350.8	
Volume Ratio, VR (%)			47.6%	
w_t:b		1.57		
α_{I-P} (kg/m^3)		350.8		

	Components Mass 1	Mass 2	Wet soil Mass 4
W_o, g	0.0	0.0	0.0
$W_{i,add}$, g	2400.0	2400.0	2370.0
$W_{w,add}$, g	N/A	912.6	901.2
Σ		3312.6	

Soil OC (%)	0.0%
W_b (g)	929.8
$W_{w,slurry}$ (g)	557.9
$\gamma_{D,Soil}$, pcf	82.4
$\gamma_{D,Slurry}$, pcf	67.9

Based on actual mix prepared

Checks	
α (kg/m^3)	517.75
a (kg/m^3)	39.2%
VR	47.6%
w_t:b	1.57

$\gamma_{d,mix}$ (pcf) 77.7 — Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	6/9 7:00 PM	7.15	6/16 10:41 PM	2.038	3.897	--	--	371.0	0.0	631.08	1.09	1.91174	0.993	626.62	3	2.08E-04	1780.5	1.25	98.5%	1234.6
B	6/9 7:00 PM	7.19	6/16 11:31 PM	2.030	3.845	--	--	363.0	0.0	723.82	1.67	1.89437	0.992	717.70	4	2.04E-04	1780.5	1.25	98.5%	1234.6
C	6/9 7:00 PM	7.23	6/17 12:32 AM	2.043	3.856	--	--	366.5	0.0	688.29	1.62	1.88727	0.991	682.08	4	2.07E-04	1769.5	1.26	97.4%	1226.9
D	6/9 7:00 PM	15.06	6/24 8:26 PM	2.041	3.900	--	--	372.3	0.0	882.27	1.25	1.91096	0.993	875.99	3	2.09E-04	1781.2	1.25	98.6%	1235.1
E	6/9 7:00 PM	15.09	6/24 9:02 PM	2.034	3.898	--	--	369.1	0.0	946.81	1.47	1.91629	0.993	940.47	2	2.08E-04	1777.6	1.25	98.2%	1232.6
F	6/9 7:00 PM	15.11	6/24 9:41 PM	2.035	3.854	--	--	366.6	0.0	935.09	1.44	1.89358	0.991	927.13	2	2.05E-04	1784.1	1.24	98.9%	1237.1
G	6/9 7:00 PM	15.15	6/24 10:35 PM	2.037	3.912	--	--	374.3	0.0	885.1	1.29	1.92034	0.994	879.5	4	2.09E-04	1791.0	1.24	99.6%	1241.8
H	6/9 7:00 PM	28.16	7/7 10:55 PM	2.038	3.938	--	--	374.3	0.0	1066.4	1.24	1.93223	0.995	1060.6	2	2.10E-04	1778.6	1.25	98.3%	1233.3
I	6/9 7:00 PM	28.18	7/7 11:22 PM	2.037	3.999	--	--	385.0	0.0	978.0	0.77	1.96322	0.997	975.1	2	2.13E-04	1803.5	1.22	100.8%	1250.5
J	6/9 7:00 PM	28.20	7/7 11:54 PM	2.041	3.948	--	--	379.5	0.0	1029.5	1.03	1.93439	0.995	1024.0	2	2.12E-04	1793.4	1.23	99.8%	1243.5
																Average	1784.0			
																% Theoretical	99.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 0-4 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	7/21/18 (soil), 7/23/18 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	0%
Specific Gravity of Solids, G_S	2.66
Soil Water Content, w	35%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1374.7
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1855.9

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)	
Soil Mixing Time (min.)		5
Soil/Binder Mixing Time (min.)		10
Blender Type/Model		Oster 14-Speed
Slurry Blending Time (min.)		3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	200
Weight of Binder, W_b (g)	535.4
Weight of Slurry Water, $W_{w,slurry}$ (g)	535.4
Weight of Slurry, W_{slurry} (g)	1070.8
Weight of Soil, W_{soil} (g)	3656.5

Batch As-Cured Properties:

# Specimens Tested	8
Bleed Water from Specimens, g	0.5
Bleed Water from Batch,* (g)	0.8
Volume of Bleed Water (in^3)	0.0

As-Mixed Batch Properties

W_{slurry} (g)		1012.2
1) Comps. put into jar mill, g		2600.4
2) Comps. removed from jar mill,g		2600.4
3) Wet soil made, g	*QC only*	
4) Wet soil used, g		3469

W_o (g)	0.0	W_s (g)	2567.0
$W_{s,o}$ (g)	0.0	$W_{w,soil}$ (g)	902.0
		W_{soil} (g)	3469.0
$W_{w,o}$ (g)	0.0	Soil w (%)	35.1%

Mixture G_s	2.73
$\gamma_{d,mix}$ (pcf)	75.6
Mixture w, %	45.8%
$\gamma_{t,mix}$ (kg/m^3)	1764.9
Total Water-to-Binder Ratio, w_t:b	2.78
Binder Content, a (%)	19.7%
Binder Factor, α (kg/m^3)	270.52
Binder Factor In-Place, α_{I-P} (kg/m^3)	199.3
Volume Ratio, VR (%)	35.7%
w_t:b	2.78
α_{I-P} (kg/m^3)	199.4

$\gamma_{d,mix}$ (pcf) 75.6

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	0.0	0.0	0.0
$W_{i,add}$, g	2600.4	2600.4	2567.0
$W_{w,add}$, g	N/A	913.7	902.0
Σ		3514.1	

W_b (g)	506.1
$W_{w,slurry}$ (g)	506.1
$\gamma_{D,Soil}$, pcf	85.7
$\gamma_{D,Slurry}$, pcf	47.3

Based on actual mix prepared

Checks	
α (kg/m^3)	270.52
a (kg/m^3)	19.7%
VR	35.7%
w_t:b	2.78

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	7/23 3:00 PM	8.12	7/31 5:57 PM	2.037	3.945	--	--	367.1	0.0	137.7	0.62	1.937	0.995	136.96	3	2.11E-04	1742.6	1.28	97.7%	1195.0
B	7/23 3:00 PM	8.16	7/31 6:44 PM	2.044	3.798	--	--	352.2	0.0	163.9	1.25	1.858	0.989	162.07	4	2.04E-04	1724.2	1.30	95.9%	1182.4
C	7/23 3:00 PM	8.18	7/31 7:22 PM	2.035	3.884	--	--	359.4	0.0	164.1	0.54	1.909	0.993	162.93	4	2.07E-04	1736.0	1.29	97.1%	1190.5
E	7/23 3:00 PM	14.18	8/6 7:20 PM	2.034	3.824	--	--	353.1	0.0	262.0	1.47	1.880	0.990	259.45	4	2.04E-04	1734.6	1.29	96.9%	1189.5
F	7/23 3:00 PM	14.21	8/6 7:57 PM	2.030	3.797	--	--	352.8	0.0	278.1	1.02	1.870	0.990	275.18	4	2.01E-04	1751.6	1.27	98.6%	1201.2
G	7/23 3:00 PM	14.32	8/6 10:35 PM	2.027	3.863	--	--	352.3	0.0	268.9	1.24	1.906	0.992	266.91	3	2.04E-04	1723.9	1.30	95.9%	1182.3
H	7/23 3:00 PM	33.28	8/25 9:39 PM	2.038	3.837	--	--	355.1	0.5	322.9	0.78	1.883	0.991	319.9	4	2.05E-04	1731.2	1.29	96.6%	1187.3
I	7/23 3:00 PM	33.30	8/25 10:17 PM	2.036	3.926	--	--	361.4	0.0	264.0	0.55	1.928	0.994	262.5	4	2.09E-04	1725.5	1.30	96.0%	1183.3
J	7/23 3:00 PM	33.32	8/25 10:46 PM	2.041	3.929	--	--	366.2	0.0	330.9	0.69	1.925	0.994	329.0	4	2.11E-04	1738.9	1.28	97.4%	1192.5
D			Broke																	
																Average	1734.3			
																% Theoretical	98.3%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 0-5 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	7/22/18 (soil), 7/23/18 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	0%
Specific Gravity of Solids, G_S	2.66
Soil Water Content, w	35%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1374.7
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1855.9

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	350
Weight of Binder, W_b (g)	937.0
Weight of Slurry Water, $W_{w,slurry}$ (g)	937.0
Weight of Slurry, W_{slurry} (g)	1873.9
Weight of Soil, W_{soil} (g)	2672.7

Batch As-Cured Properties:

# Specimens Tested	9
Bleed Water from Specimens, g	0.0
Bleed Water from Batch,* (g)	0.0
Volume of Bleed Water (in^3)	0.0

As-Mixed Batch Properties

W_{slurry} (g)		1752.1
1) Comps. put into jar mill, g		1899.7
2) Comps. removed from jar mill,g		1899.7
3) Wet soil made, g	QC only	
4) Wet soil used, g		2526.6

W_o (g)	0.0	W_s (g)	1871.5
$W_{s,o}$ (g)	0.0	$W_{w,soil}$ (g)	655.1
$W_{os,o}$ (g)	0.0	W_{soil} (g)	2526.6
$W_{w,o}$ (g)	0.0	Soil w (%)	35.0%

Mixture G_s	2.80
$\gamma_{d,mix}$ (pcf)	68.1
Mixture w, %	55.7%
$\gamma_{t,mix}$ (kg/m^3)	1699.2
Total Water-to-Binder Ratio, w_t:b	1.75
Binder Content, a (%)	46.8%
Binder Factor, α (kg/m^3)	643.47
Binder Factor In-Place, α_{I-P} (kg/m^3)	347.9
Volume Ratio, VR (%)	84.9%

w_t:b	1.75	$\gamma_{d,mix}$ (pcf)	68.1
α_{I-P} (kg/m^3)	347.9		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	0.0	0.0	0.0
$W_{i,add}$, g	1899.7	1899.7	1871.5
$W_{w,add}$, g	N/A	665.0	655.1
Σ		2564.7	

Soil OC (%)	0.0%		
W_b (g)	876.1		
$W_{w,slurry}$ (g)	876.1		
$\gamma_{D,Soil}$, pcf	85.8		
$\gamma_{D,Slurry}$, pcf	47.3		

Based on actual mix prepared

Checks	
α (kg/m^3)	643.45
a (kg/m^3)	46.8%
VR	84.9%
w_t:b	1.75

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	7/23 5:30 PM	8.10	7/31 7:54 PM	2.033	3.951	--	--	360.2	0.0	452.1	1.25	1.943	0.995	450.1	2	2.10E-04	1713.5	1.54	101.4%	1100.3
B	7/23 5:30 PM	8.15	7/31 9:02 PM	2.038	3.994	--	--	363.0	0.0	441.0	1.16	1.960	0.997	439.6	4	2.13E-04	1700.9	1.56	100.2%	1092.2
C	7/23 5:30 PM	8.17	7/31 9:33 PM	2.043	3.944	--	--	358.6	0.0	457.0	1.07	1.930	0.994	454.4	4	2.12E-04	1692.3	1.57	99.3%	1086.7
E	7/23 5:30 PM	14.29	8/7 12:25 AM	2.034	3.981	--	--	363.9	0.0	565.8	1.09	1.957	0.997	563.8	4	2.12E-04	1716.8	1.53	101.7%	1102.4
F	7/23 5:30 PM	14.31	8/7 12:56 AM	2.043	3.973	--	--	362.2	0.0	545.8	1.23	1.945	0.996	543.4	4	2.13E-04	1697.6	1.56	99.8%	1090.1
G	7/23 5:30 PM	14.33	8/7 1:26 AM	2.039	3.975	--	--	360.7	0.0	571.0	1.33	1.949	0.996	568.6	2	2.13E-04	1695.5	1.57	99.6%	1088.7
H	7/23 5:30 PM	33.24	8/25 11:21 PM	2.038	3.977	--	--	363.7	0.0	724.5	1.17	1.952	0.996	721.7	3	2.13E-04	1711.4	1.54	101.2%	1098.9
I	7/23 5:30 PM	33.26	8/25 11:50 PM	2.037	3.989	--	--	365.3	0.0	711.3	1.08	1.958	0.997	708.9	3 & 4	2.13E-04	1714.2	1.54	101.4%	1100.7
J	7/23 5:30 PM	33.28	8/26 12:17 AM	2.041	3.999	--	--	365.8	0.0	726.9	1.07	1.959	0.997	724.5	4	2.14E-04	1705.6	1.55	100.6%	1095.3
D			Broke																	
																Average	1705.3			
																% Theoretical	100.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 5-1 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	6/1/19 (soil), 6/1/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	5%
Specific Gravity of Solids, G_S	2.51
Soil Water Content, w	48%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1136.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1681.5

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	150
Weight of Binder, W_b (g)	247.1
Weight of Slurry Water, $W_{w,slurry}$ (g)	247.1
Weight of Slurry, W_{slurry} (g)	494.2
Weight of Soil, W_{soil} (g)	2221.5

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	1.6
Bleed Water from Batch,* (g)	2.2
Volume of Bleed Water (in^3)	0.1

As-Mixed Batch Properties

W_{slurry} (g)		496.7	
1) Comps. put into jar mill, g		1556.0	
2) Comps. removed from jar mill,g		1555	
3) Wet soil made, g	*QC only*	2207.1	
4) Wet soil used, g		2187.2	
W_o (g)	170.6	W_s (g)	1472.5
$W_{s,o}$ (g)	117.1	$W_{w,soil}$ (g)	714.7
		W_{soil} (g)	2187.2
$W_{w,o}$ (g)	53.5	Soil w (%)	48.5%
Mixture G_s		2.59	
$\gamma_{d,mix}$ (pcf)		65.8	
Mixture w, %		56.0%	
$\gamma_{t,mix}$ (kg/m^3)		1644.7	
Total Water-to-Binder Ratio, w_t:b		3.88	
Binder Content, a (%)		16.9%	
Binder Factor, α (kg/m^3)		190.46	
Binder Factor In-Place, α_{I-P} (kg/m^3)		152.2	
Volume Ratio, VR (%)		25.1%	
w_t:b	3.87	$\gamma_{d,mix}$ (pcf)	65.9
α_{I-P} (kg/m^3)	152.4		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	173.9	173.8	170.6
$W_{i,add}$, g	1382.1	1381.2	1355.5
$W_{w,add}$, g	N/A	673.7	661.2
Σ		2228.7	
W_b (g)		248.4	
$W_{w,slurry}$ (g)		248.4	
$\gamma_{D,Soil}$, pcf		70.5	
$\gamma_{D,Slurry}$, pcf		47.3	

Checks (Based on actual mix prepared)

α (kg/m^3)	190.45
a (kg/m^3)	16.9%
VR	25.1%
w_t:b	3.88

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	6/1 9:35 PM	6.68	6/8 1:48 PM	2.038	3.921	--	--	339.6	0.1	125.02	2.20	1.92409	0.994	124.26	N/A	2.10E-04	1620.1	1.48	97.5%	1038.8
B	6/1 9:35 PM	6.70	6/8 2:17 PM	2.043	3.948		--	343.0	0.1	122.80	1.71	1.93217	0.995	122.13	N/A	2.12E-04	1616.8	1.49	97.2%	1036.7
C	6/1 9:35 PM	14.85	6/16 5:55 PM	2.046	3.929	--	--	341.0	0.3	150.38	2.19	1.92019	0.994	149.42	N/A	2.12E-04	1611.0	1.50	96.6%	1033.0
D	6/1 9:35 PM	14.86	6/16 6:15 PM	2.043	3.788	--	--	329.4	0.4	154.48	1.91	1.85399	0.988	152.68	4	2.03E-04	1618.9	1.49	97.4%	1038.0
E	6/1 9:35 PM	27.66	6/29 1:29 PM	2.043	3.884	--	--	338.7	0.3	179.63	1.57	1.90155	0.992	178.22	4	2.09E-04	1623.5	1.48	97.8%	1041.0
F	6/1 9:35 PM	27.68	6/29 1:53 PM	2.050	3.910	--	--	340.6	0.4	178.57	1.66	1.90746	0.993	177.24	N/A	2.12E-04	1610.2	1.50	96.5%	1032.5
G			Not tested																	
																Average	1616.7			
																% Theoretical	98.3%			

Based on table below

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

5-I-1-B mass estimated

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LAB MIXING DATA: ORGANIC MIXING BATCH 5-2 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	6/1/19 (soil), 6/1/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	5%
Specific Gravity of Solids, G_S	2.51
Soil Water Content, w	48%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1136.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1681.5

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	1.2
Binder Factor In-Place, α_{I-P} (kg/m^3)	250
Weight of Binder, W_b (g)	411.9
Weight of Slurry Water, $W_{w,slurry}$ (g)	494.2
Weight of Slurry, W_{slurry} (g)	906.1
Weight of Soil, W_{soil} (g)	1717.0

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	1.6
Bleed Water from Batch,* (g)	2.1
Volume of Bleed Water (in^3)	0.1

As-Mixed Batch Properties

W_{slurry} (g)		907.1
1) Comps. put into jar mill, g		1202.7
2) Comps. removed from jar mill,g		1200.5
3) Wet soil made, g	QC only	1688.6
4) Wet soil used, g		1676.6

W_o (g)	131.1	W_s (g)	1132.2
$W_{s,o}$ (g)	90.0	$W_{w,soil}$ (g)	544.4
		W_{soil} (g)	1676.6
$W_{w,o}$ (g)	41.1	Soil w (%)	48.1%

Mixture G_s	2.65
$\gamma_{d,mix}$ (pcf)	59.4
Mixture w, %	67.3%
$\gamma_{t,mix}$ (kg/m^3)	1590.4
Total Water-to-Binder Ratio, w_t:b	2.52
Binder Content, a (%)	36.4%
Binder Factor, α (kg/m^3)	413.34
Binder Factor In-Place, α_{I-P} (kg/m^3)	253.8
Volume Ratio, VR (%)	62.9%
w_t:b	2.52
α_{I-P} (kg/m^3)	254.1
$\gamma_{d,mix}$ (pcf)	59.4

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	134.4	134.2	131.1
$W_{i,add}$, g	1068.3	1066.3	1042.2
$W_{w,add}$, g	N/A	515.0	503.3
Σ		1715.5	

W_b (g)	412.3
$W_{w,slurry}$ (g)	494.8
$\gamma_{D,Soil}$, pcf	70.9
$\gamma_{D,Slurry}$, pcf	41.1

Checks (Based on actual mix prepared)

α (kg/m^3)	413.33
a (kg/m^3)	36.4%
VR	62.9%
w_t:b	2.52

SAMPLE DATA:

Based on table below

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	6/1 10:45 PM	6.66	6/8 2:39 PM	2.042	3.827	--	--	326.6	0.2	183.29	1.20	1.87442	0.990	181.45	N/A	2.05E-04	1590.7	1.79	100.0%	950.9
B	6/1 10:45 PM	6.68	6/8 3:07 PM	2.045	3.879	--	--	331.2	0.1	191.29	1.43	1.89669	0.992	189.70	4	2.09E-04	1585.7	1.79	99.5%	947.9
C	6/1 10:45 PM	14.83	6/16 6:38 PM	2.042	3.979	--	--	340.2	0.1	247.55	1.07	1.94843	0.996	246.53	N/A	2.14E-04	1593.3	1.78	100.3%	952.4
D	6/1 10:45 PM	14.84	6/16 7:01 PM	2.043	3.777	--	--	321.7	0.6	237.37	1.04	1.8489	0.988	234.50	N/A	2.03E-04	1585.4	1.79	99.5%	947.7
E	6/1 10:45 PM	27.65	6/29 2:20 PM	2.044	3.896	--	--	334.0	0.1	311.25	0.90	1.90635	0.993	308.92	N/A	2.09E-04	1594.6	1.78	100.4%	953.2
F	6/1 10:45 PM	27.67	6/29 2:45 PM	2.050	3.948	--	--	337.8	0.5	302.66	0.90	1.926	0.994	300.87	N/A	2.14E-04	1581.8	1.80	99.2%	945.6
G			Not tested																	
																Average	1588.6			
																% Theoretical	99.9%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 5-3 SPREADSHEET

General Information	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	6/1/19 (soil), 6/1/19 (soil-cement mixing)

Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F), γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:	
Soil Type	Artificial
Organic Content, OC	5%
Specific Gravity of Solids, G_S	2.51
Soil Water Content, w	48%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	1136.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1681.5

Mixing Machinery & Time	
Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:	
Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	0.8
Binder Factor In-Place, α_{I-P} (kg/m^3)	250
Weight of Binder, W_b (g)	411.9
Weight of Slurry Water, $W_{w,slurry}$ (g)	329.5
Weight of Slurry, W_{slurry} (g)	741.3
Weight of Soil, W_{soil} (g)	1994.6

Batch As-Cured Properties:	
# Specimens Tested	6
Bleed Water from Specimens, g	1.1
Bleed Water from Batch,* (g)	1.5
Volume of Bleed Water (in^3)	0.1

As-Mixed Batch Properties			
W_{slurry} (g)	742.4		
1) Comps. put into jar mill, g	1397.0		
2) Comps. removed from jar mill,g	1396.4		
3) Wet soil made, g *QC only*	1979.4		
4) Wet soil used, g	1966.0		
W_o (g)	153.5	W_s (g)	1325.7
$W_{s,o}$ (g)	105.4	$W_{w,soil}$ (g)	640.3
		W_{soil} (g)	1966.0
$W_{w,o}$ (g)	48.2	Soil w (%)	48.3%
Mixture G_s	2.64		
$\gamma_{d,mix}$ (pcf)	66.5		
Mixture w, %	55.8%		
$\gamma_{t,mix}$ (kg/m^3)	1658.9		
Total Water-to-Binder Ratio, w_t:b	2.35		
Binder Content, a (%)	31.1%		
Binder Factor, α (kg/m^3)	352.27		
Binder Factor In-Place, α_{I-P} (kg/m^3)	252.6		
Volume Ratio, VR (%)	39.4%		
w_t:b	2.35	$\gamma_{d,mix}$ (pcf)	66.5
α_{I-P} (kg/m^3)	252.9		

	Components: Mass 1	Mass 2	Wet soil: Mass 4
W_o, g	156.1	156.0	153.5
$W_{i,add}$, g	1240.9	1240.4	1220.4
$W_{w,add}$, g	N/A	601.8	592.1
Σ		1998.2	
W_b (g)		412.4	
$W_{w,slurry}$ (g)		330.0	
$\gamma_{D,Soil}$, pcf		70.7	
$\gamma_{D,Slurry}$, pcf		55.8	

Based on actual mix prepared	Checks	
	α (kg/m^3)	352.26
	a (kg/m^3)	31.1%
	VR	39.4%
	w_t:b	2.35

SAMPLE DATA:

Based on table below

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	6/1 11:55 PM	6.65	6/8 3:29 PM	2.047	3.912	--	--	344.8	0.0	270.89	1.23	1.91109	0.993	268.96	4	2.11E-04	1634.3	1.51	97.5%	1048.9
B	6/1 11:55 PM	6.67	6/8 3:54 PM	2.052	3.347	--	--	295.7	0.2	270.72	1.38	1.63109	0.970	262.73	N/A	1.81E-04	1630.2	1.52	97.1%	1046.2
C	6/1 11:55 PM	14.81	6/16 7:20 PM	2.047	4.000	--	--	353.4	0.2	353.73	1.01	1.95422	0.996	352.43	N/A	2.16E-04	1638.8	1.50	98.0%	1051.8
D	6/1 11:55 PM	14.82	6/16 7:40 PM	2.046	3.993	--	--	352.5	0.1	329.22	0.92	1.9519	0.996	327.95	4	2.15E-04	1639.0	1.50	98.0%	1051.9
E	6/1 11:55 PM	27.65	6/29 3:26 PM	2.044	4.002	--	--	354.1	0.2	410.81	0.79	1.95821	0.997	409.43	4	2.15E-04	1646.2	1.49	98.7%	1056.5
F	6/1 11:55 PM	27.67	6/29 3:53 PM	2.046	3.901	--	--	344.2	0.4	415.22	0.95	1.90693	0.993	412.13	N/A	2.10E-04	1638.3	1.50	97.9%	1051.4
G			Not tested																	

Average	1637.8
% Theoretical	98.7%

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 10-1 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	11/26/18 (soil), 11/27/18 (mix)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	10%
Specific Gravity of Solids, G_S	2.38
Soil Water Content, w	60%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	978.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1565.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	71
Weight of Binder, W_b (g)	175.4
Weight of Slurry Water, $W_{w,slurry}$ (g)	175.4
Weight of Slurry, W_{slurry} (g)	350.9
Weight of Soil, W_{soil} (g)	3505.2

Batch As-Cured Properties:

# Specimens Tested	4
Bleed Water from Specimens, g	0.8
Bleed Water from Batch,* (g)	2.4
Volume of Bleed Water (in^3)	0.1

As-Mixed Batch Properties

W_{slurry} (g)		350.5
1) Comps. put into jar mill, g		2351.6
2) Comps. removed from jar mill,g		2351.5
3) Wet soil made, g	*QC only*	3491.5
4) Wet soil used, g		3489.8

W_o (g)	504.1	W_s (g)	2171.5
$W_{s,o}$ (g)	339.2	$W_{w,soil}$ (g)	1318.3
		W_{soil} (g)	3489.8
$W_{w,o}$ (g)	164.9	Soil w (%)	60.7%

Mixture G_s	2.42
$\gamma_{d,mix}$ (pcf)	59.4
Mixture w, %	63.6%
$\gamma_{t,mix}$ (kg/m^3)	1556.9
Total Water-to-Binder Ratio, w_t:b	8.52
Binder Content, a (%)	8.1%
Binder Factor, α (kg/m^3)	78.40
Binder Factor In-Place, α_{I-P} (kg/m^3)	71.0
Volume Ratio, VR (%)	10.4%

w_t:b	8.51	$\gamma_{d,mix}$ (pcf)	59.45
α_{I-P} (kg/m^3)	71.1		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	507.6	507.6	504.1
$W_{i,add}$, g	1845.0	1844.9	1832.3
$W_{w,add}$, g	N/A	1161.4	1153.4
Σ		3513.9	

W_b (g)	175.3
$W_{w,slurry}$ (g)	175.3
$\gamma_{D,Soil}$, pcf	60.6
$\gamma_{D,Slurry}$, pcf	47.3

Based on actual mix prepared

Checks	
α (kg/m^3)	78.40
a (kg/m^3)	8.1%
VR	10.4%
w_t:b	8.52

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	11/27 11:30 PM	9.49	12/7 11:21 AM	2.030	3.752	--	--	296.8	0.0	40.84	4.96	1.85	0.988	40.35	4	1.99E-04	1492.2	1.65	93.3%	911.9
B	11/27 11:30 PM	9.71	12/7 4:30 PM	2.030	3.867	--	--	308.2	0.0	45.99	6.45	1.91	0.992	45.64	4	2.05E-04	1503.0	1.63	94.4%	918.5
C	11/27 11:30 PM	19.93	12/17 9:46 PM	2.034	3.892	--	--	309.4	0.3	46.01	5.22	1.91	0.993	45.69	4	2.07E-04	1493.6	1.65	93.5%	912.7
D	11/27 11:30 PM	19.97	12/17 10:53 PM	2.026	3.806	--	--	298.7	0.0	48.09	5.23	1.88	0.990	47.62	4	2.01E-04	1486.2	1.66	92.7%	908.2
E	11/27 11:30 PM	34.67	1/1 3:30 PM	2.031	3.905	--	--	311.6	0.3	49.41	4.96	1.92	0.994	49.10	4	2.07E-04	1502.6	1.63	94.4%	918.2
F	11/27 11:30 PM	34.73	1/1 5:05 PM	2.037	3.882	--	--	310.5	0.2	47.80	5.45	1.91	0.992	47.44	4	2.07E-04	1497.3	1.64	93.8%	915.0
G			Not tested																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1495.8			
																% Theoretical	96.1%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 10-2 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	11/26/18 (soil), 11/28/18 (mix)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) — γ_w	998.0	kg/m^3
γ_w	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	10%
Specific Gravity of Solids, G_S	2.38
Soil Water Content, w	60%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	978.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1565.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	113
Weight of Binder, W_b (g)	279.2
Weight of Slurry Water, $W_{w,slurry}$ (g)	279.2
Weight of Slurry, W_{slurry} (g)	558.5
Weight of Soil, W_{soil} (g)	3290.8

Batch As-Cured Properties:

# Specimens Tested	4
Bleed Water from Specimens, g	2.0
Bleed Water from Batch,* (g)	6.0
Volume of Bleed Water (in^3)	0.4

As-Mixed Batch Properties

W_{slurry} (g)		564.5
1) Comps. put into jar mill, g		2208.3
2) Comps. removed from jar mill,g		2205.5
3) Wet soil made, g	QC only	3281.0
4) Wet soil used, g		3278.7

W_o (g)	473.5	W_s (g)	2039.5
$W_{s,o}$ (g)	318.6	$W_{w,soil}$ (g)	1239.2
		W_{soil} (g)	3278.7
$W_{w,o}$ (g)	154.9	Soil w (%)	60.8%

Mixture G_s	2.45
$\gamma_{d,mix}$ (pcf)	58.6
Mixture w, %	65.5%
$\gamma_{t,mix}$ (kg/m^3)	1554.0
Total Water-to-Binder Ratio, w_t:b	5.39
Binder Content, a (%)	13.8%
Binder Factor, α (kg/m^3)	134.38
Binder Factor In-Place, α_{I-P} (kg/m^3)	114.1
Volume Ratio, VR (%)	17.7%

w_t:b	5.37	$\gamma_{d,mix}$ (pcf)	58.8
α_{I-P} (kg/m^3)	114.4		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	476.5	475.9	473.5
$W_{i,add}$, g	1731.8	1729.6	1720.8
$W_{w,add}$, g	N/A	1089.9	1084.4
Σ		3295.4	

W_b (g)	282.3
$W_{w,slurry}$ (g)	282.3
$\gamma_{D,Soil}$, pcf	60.6
$\gamma_{D,Slurry}$, pcf	47.3

Checks (Based on actual mix prepared)

α (kg/m^3)	134.37
a (kg/m^3)	13.8%
VR	17.7%
w_t:b	5.39

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	11/28 2:45 AM	9.60	12/7 5:16 PM	2.037	3.932	--	--	313.3	0	81.42	3.96	1.931	0.994	80.97	4	2.10E-04	1492.4	1.72	93.7%	901.6
B	11/28 2:45 AM	9.83	12/7 10:34 PM	2.038	3.839	--	--	306.6	0	79.02	3.95	1.884	0.991	78.29	N/A	2.05E-04	1494.3	1.71	93.9%	902.7
D	11/28 2:45 AM	20.50	12/18 2:46 PM	2.030	3.907	--	--	311.6	0.4	90.57	3.46	1.924	0.994	90.02	4	2.07E-04	1503.9	1.69	94.9%	908.5
E	11/28 2:45 AM	20.54	12/18 3:40 PM	2.035	3.899	--	--	308.5	0.2	94.31	3.93	1.916	0.993	93.68	4	2.08E-04	1485.0	1.73	93.0%	897.1
F	11/28 2:45 AM	34.65	1/1 6:14 PM	2.033	3.897	--	--	313.4	0.6	94.59	3.64	1.917	0.993	93.96	4	2.07E-04	1511.7	1.68	95.7%	913.2
G	11/28 2:45 AM	34.71	1/1 7:54 PM	2.035	3.881	--	--	311.8	0.8	88.50	3.41	1.907	0.993	87.84	N/A	2.07E-04	1507.9	1.69	95.3%	910.9
C			Broke																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1499.2			
																% Theoretical	96.5%			

*Weight of bleed w ater for the batch w as determined based on the average w eight of bleed w ater per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 10-3 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	11/26/18 (soil), 11/28/18 (mix)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	10%
Specific Gravity of Solids, G_S	2.38
Soil Water Content, w	60%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	978.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1565.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	150
Weight of Binder, W_b (g)	370.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	370.7
Weight of Slurry, W_{slurry} (g)	741.3
Weight of Soil, W_{soil} (g)	3101.9

Batch As-Cured Properties:

# Specimens Tested	4
Bleed Water from Specimens, g	3.0
Bleed Water from Batch,* (g)	9.0
Volume of Bleed Water (in^3)	0.6

As-Mixed Batch Properties

W_{slurry} (g)		765.3
1) Comps. put into jar mill, g		2081.2
2) Comps. removed from jar mill,g		2078.2
3) Wet soil made, g	*QC only*	3092.4
4) Wet soil used, g		3090.0

W_o (g)	446.3	W_s (g)	1921.6
$W_{s,o}$ (g)	300.3	$W_{w,soil}$ (g)	1168.4
		W_{soil} (g)	3090.0
$W_{w,o}$ (g)	145.9	Soil w (%)	60.8%

Mixture G_s	2.48
$\gamma_{d,mix}$ (pcf)	57.9
Mixture w, %	67.3%
$\gamma_{t,mix}$ (kg/m^3)	1551.4
Total Water-to-Binder Ratio, w_t:b	4.05
Binder Content, a (%)	19.9%
Binder Factor, α (kg/m^3)	193.28
Binder Factor In-Place, α_{I-P} (kg/m^3)	154.0
Volume Ratio, VR (%)	25.5%
w_t:b	4.03
α_{I-P} (kg/m^3)	154.5
$\gamma_{d,mix}$ (pcf)	58.1

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	449.2	448.6	446.3
$W_{i,add}$, g	1632.0	1629.6	1621.3
$W_{w,add}$, g	N/A	1027.7	1022.4
Σ		3105.9	

W_b (g)	382.7
$W_{w,slurry}$ (g)	382.7
$\gamma_{D,Soil}$, pcf	60.6
$\gamma_{D,Slurry}$, pcf	47.3

Checks (Based on actual mix prepared)

α (kg/m^3)	193.27
a (kg/m^3)	19.9%
VR	25.5%
w_t:b	4.05

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	11/28 5:00 AM	9.77	12/7 11:32 PM	2.028	3.852	--	--	304.8	0.0	117.00	3.73	1.899	0.992	116.06	4	2.04E-04	1494.9	1.771	94.3%	893.5
B	11/28 5:00 AM	9.81	12/8 12:21 AM	2.033	3.865	--	--	306.6	0.0	116.36	3.82	1.901	0.992	115.44	4	2.06E-04	1490.7	1.779	93.9%	891.0
C	11/28 5:00 AM	20.51	12/18 5:15 PM	2.038	3.881	--	--	306.0	0.6	133.17	3.90	1.904	0.992	132.15	4	2.07E-04	1475.1	1.808	92.4%	881.6
D	11/28 5:00 AM	20.55	12/18 6:09 PM	2.035	3.836	--	--	304.4	0.6	129.97	3.21	1.885	0.991	128.77	4	2.05E-04	1488.3	1.783	93.6%	889.5
E	11/28 5:00 AM	34.73	1/1 10:34 PM	2.038	3.921	--	--	312.7	0.8	124.86	2.61	1.924	0.994	124.10	N/A	2.10E-04	1491.4	1.777	94.0%	891.4
F	11/28 5:00 AM	34.79	1/1 11:54 PM	2.036	3.890	--	--	308.6	1.0	130.51	3.10	1.910	0.993	129.57	4	2.08E-04	1487.1	1.785	93.5%	888.8
G																				
H																				
I																				
J																				

Based on table below

Average	1487.9
% Theoretical	95.9%

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 10-4 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/16/19 (soil), 4/17/19 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	10%
Specific Gravity of Solids, G_S	2.38
Soil Water Content, w	60%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	978.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1565.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	1.2
Binder Factor In-Place, α_{I-P} (kg/m^3)	250
Weight of Binder, W_b (g)	463.3
Weight of Slurry Water, $W_{w,slurry}$ (g)	556.0
Weight of Slurry, W_{slurry} (g)	1019.3
Weight of Soil, W_{soil} (g)	1798.1

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	0.8
Bleed Water from Batch,* (g)	1.2
Volume of Bleed Water (in^3)	0.1

As-Mixed Batch Properties

W_{slurry} (g)		1035.3
1) Comps. put into jar mill, g		1199.2
2) Comps. removed from jar mill,g		1197.9
3) Wet soil made, g	*QC only*	1790.4
4) Wet soil used, g		1790.1

W_o (g)	252.3	W_s (g)	1118.4
$W_{s,o}$ (g)	177.8	$W_{w,soil}$ (g)	671.7
		W_{soil} (g)	1790.1
$W_{w,o}$ (g)	74.5	Soil w (%)	60.1%

Mixture G_s	2.57
$\gamma_{d,mix}$ (pcf)	53.3
Mixture w, %	77.8%
$\gamma_{t,mix}$ (kg/m^3)	1519.4
Total Water-to-Binder Ratio, w_t:b	2.63
Binder Content, a (%)	42.1%
Binder Factor, α (kg/m^3)	411.37
Binder Factor In-Place, α_{I-P} (kg/m^3)	253.1
Volume Ratio, VR (%)	62.6%

w_t:b	2.62		$\gamma_{d,mix}$ (pcf)	53.4
α_{I-P} (kg/m^3)	253.2			

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	253.6	253.3	252.3
$W_{i,add}$, g	945.6	944.6	940.6
$W_{w,add}$, g	N/A	599.8	597.3
Σ		1797.7	

W_b (g)	470.6
$W_{w,slurry}$ (g)	564.7
$\gamma_{D,Soil}$, pcf	61.0
$\gamma_{D,Slurry}$, pcf	41.1

Based on actual mix prepared

Checks	
α (kg/m^3)	411.36
a (kg/m^3)	42.1%
VR	62.6%
w_t:b	2.63

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/17 2:12 AM	6.75	4/23 8:09 PM	2.043	3.957	--	--	312.8	0.1	169.38	2.60	1.937	0.995	168.52	4	2.12E-04	1472.1	2.09	95.4%	827.9
B	4/17 2:12 AM	6.82	4/23 9:50 PM	2.045	3.983	--	--	317.4	0.1	167.77	2.39	1.947	0.996	167.06	4	2.14E-04	1480.1	2.08	96.2%	832.4
C	4/17 2:12 AM	13.79	4/30 9:05 PM	2.047	3.672	--	--	293.8	0.1	198.50	1.61	1.794	0.984	195.23	N/A	1.98E-04	1483.9	2.07	96.5%	834.5
D	4/17 2:12 AM	13.81	4/30 9:45 PM	2.048	3.974	--	--	317.8	0.1	200.61	1.78	1.941	0.995	199.67	N/A	2.14E-04	1481.7	2.07	96.3%	833.3
E	4/17 2:12 AM	27.82	5/14 9:49 PM	2.050	3.821	--	--	304.6	0.3	221.50	1.37	1.864	0.989	219.08	N/A	2.07E-04	1474.0	2.09	95.6%	829.0
F	4/17 2:12 AM	27.84	5/14 10:25 PM	2.050	3.958	--	--	317.4	0.1	237.43	1.35	1.931	0.994	236.11	N/A	2.14E-04	1482.1	2.07	96.4%	833.5
G			Not tested																	
H			Not tested																	
																	Average 1479.0			
																	% Theoretical 97.3%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 10-5 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/16/19 (soil), 4/17/19 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	10%
Specific Gravity of Solids, G_S	2.38
Soil Water Content, w	60%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	978.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1565.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	350
Weight of Binder, W_b (g)	648.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	648.7
Weight of Slurry, W_{slurry} (g)	1297.3
Weight of Soil, W_{soil} (g)	1560.5

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	1.3
Bleed Water from Batch,* (g)	2.0
Volume of Bleed Water (in^3)	0.1

As-Mixed Batch Properties

W_{slurry} (g)		1304.4
1) Comps. put into jar mill, g		1040.7
2) Comps. removed from jar mill,g		1039
3) Wet soil made, g	*QC only*	1552.4
4) Wet soil used, g		1550.5

W_o (g)	218.6	W_s (g)	968.5
$W_{s,o}$ (g)	154.0	$W_{w,soil}$ (g)	582.0
		W_{soil} (g)	1550.5
$W_{w,o}$ (g)	64.5	Soil w (%)	60.1%

Mixture G_s	2.64
$\gamma_{d,mix}$ (pcf)	54.6
Mixture w, %	76.2%
$\gamma_{t,mix}$ (kg/m^3)	1541.5
Total Water-to-Binder Ratio, w_t:b	1.89
Binder Content, a (%)	67.3%
Binder Factor, α (kg/m^3)	658.15
Binder Factor In-Place, α_{I-P} (kg/m^3)	352.2
Volume Ratio, VR (%)	86.9%

w_t:b	1.89	$\gamma_{d,mix}$ (pcf)	54.7
α_{I-P} (kg/m^3)	352.5		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	220.2	219.8	218.6
$W_{i,add}$, g	820.5	819.2	814.4
$W_{w,add}$, g	N/A	520.5	517.5
Σ		1559.5	

W_b (g)	652.2
$W_{w,slurry}$ (g)	652.2
$\gamma_{D,Soil}$, pcf	61.0
$\gamma_{D,Slurry}$, pcf	47.3

Based on actual mix prepared

Checks	
α (kg/m^3)	658.13
a (kg/m^3)	67.3%
VR	86.9%
w_t:b	1.89

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/17 3:38 AM	6.80	4/23 10:44 PM	2.047	3.891	--	--	314.5	0.1	288.94	1.20	1.901	0.992	286.64	4	2.10E-04	1498.2	2.10	95.8%	850.5
B	4/17 3:38 AM	7.19	4/24 8:14 AM	2.050	3.963	--	--	321.4	0.1	288.31	1.17	1.933	0.995	286.76	N/A	2.14E-04	1499.2	2.10	95.9%	851.0
C	4/17 3:38 AM	13.78	4/30 10:22 PM	2.050	3.625	--	--	295.1	0.1	348.88	0.97	1.769	0.981	342.42	N/A	1.96E-04	1505.4	2.08	96.5%	854.6
D	4/17 3:38 AM	14.28	5/1 10:25 AM	2.053	3.998	--	--	327.2	0.1	348.65	0.83	1.947	0.996	347.18	N/A	2.17E-04	1508.8	2.08	96.8%	856.5
E	4/17 3:38 AM	27.81	5/14 11:06 PM	2.050	3.830	--	--	314.1	0.5	415.14	0.87	1.868	0.989	410.76	N/A	2.07E-04	1515.7	2.06	97.5%	860.4
F	4/17 3:38 AM	27.83	5/14 11:40 PM	2.047	3.772	--	--	307.0	0.4	420.55	1.09	1.843	0.987	415.26	N/A	2.03E-04	1509.3	2.07	96.9%	856.8
G			Not tested																	
H			Not tested																	
																	Average: 1506.1			
																	% Theoretical: 97.7%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 10-6 SPREADSHEET

General Information		
Organization	Virginia Tech	
Location	Blacksburg, VA	
Conducted By	M. Bennett, G. Filz	
Date	4/16/19 (soil), 4/17/19 (soil-cement mixing)	
Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m³
	62.30	pcf
Soil Properties:		
Soil Type	Artificial	
Organic Content, OC	10%	
Specific Gravity of Solids, G_S	2.38	
Soil Water Content, w	60%	
Degree of Saturation, S	1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m³)	978.2	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m³)	1565.2	

Mixing Machinery & Time	
Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3
Batch Design Properties:	
Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.8
Binder Factor In-Place, α_{I-P} (kg/m³)	500
Weight of Binder, W_b (g)	926.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	741.3
Weight of Slurry, W_{slurry} (g)	1668.0
Weight of Soil, W_{soil} (g)	1276.8
Batch As-Cured Properties:	
# Specimens Tested	8
Bleed Water from Specimens, g	3.6
Bleed Water from Batch,* (g)	4.1
Volume of Bleed Water (in³)	0.2

As-Mixed Batch Properties				
W_{slurry} (g)		1675.9		
1) Comps. put into jar mill, g		851.5		
2) Comps. removed from jar mill,g		850.4		
3) Wet soil made, g	*QC only*	1270.5		
4) Wet soil used, g		1269.6		
W_o (g)	178.9	W_s (g)	793.0	
$W_{s,o}$ (g)	126.1	$W_{w,soil}$ (g)	476.6	
		W_{soil} (g)	1269.6	
$W_{w,o}$ (g)	52.8	Soil w (%)	60.1%	
Mixture G_s		2.74		
$\gamma_{d,mix}$ (pcf)		58.1		
Mixture w, %		70.8%		
$\gamma_{t,mix}$ (kg/m³)		1588.7		
Total Water-to-Binder Ratio, w_t:b		1.31		
Binder Content, a (%)		117.4%		
Binder Factor, α (kg/m³)		1147.45		
Binder Factor In-Place, α_{I-P} (kg/m³)		502.2		
Volume Ratio, VR (%)		128.5%		
w_t:b	1.31		$\gamma_{d,mix}$ (pcf)	58.2
α_{I-P} (kg/m³)	503.3			

	Components		Wet soil
	Mass 1	Mass 2	Mass 4
W_o, g	180.1	179.9	178.9
$W_{i,add}$, g	671.4	670.5	667.0
$W_{w,add}$, g	N/A	426.0	423.7
Σ		1276.4	
	W_b (g)	931.1	
	$W_{w,slurry}$ (g)	744.8	
	$\gamma_{D,Soil}$, pcf	61.0	
	$\gamma_{D,Slurry}$, pcf	55.8	
		Checks	
Based on actual mix prepared		α (kg/m³)	1147.41
		a (kg/m³)	117.4%
		VR	128.5%
		w_t:b	1.31
		Based on table below	

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m³)	$\gamma_{t,mix}$ (kg/m³)	e	S	$\gamma_{d,mix}$ (kg/m³)
A	4/17 5:40 AM	7.13	4/24 8:49 AM	2.039	3.958	--	--	332.8	0.1	632.92	0.94	1.941	0.995	629.95	4	2.12E-04	1571.8	1.97	98.4%	920.0
B	4/17 5:40 AM	7.18	4/24 9:52 AM	2.036	3.860	--	--	323.2	0.0	652.77	0.83	1.896	0.992	647.34	N/A	2.06E-04	1569.3	1.98	98.2%	918.6
C	4/17 5:40 AM	14.22	5/1 11:01 AM	2.047	3.633	--	--	308.8	0.0	749.13	0.66	1.775	0.982	735.66	2	1.96E-04	1576.4	1.97	98.8%	922.7
D	4/17 5:40 AM	14.25	5/1 11:38 AM	2.046	3.731	--	--	317.2	0.4	745.40	0.87	1.824	0.986	734.88	4	2.01E-04	1578.0	1.96	99.0%	923.6
E	4/17 5:40 AM	28.41	5/15 3:25 PM	2.053	3.706	--	--	315.9	1.3	995.91	0.87	1.805	0.984	980.36	4	2.01E-04	1570.9	1.98	98.3%	919.5
F	4/17 5:40 AM	28.43	5/15 3:52 PM	2.046	3.760	--	--	320.5	0.4	791.47	0.59	1.838	0.987	781.19	N/A	2.03E-04	1582.2	1.95	99.4%	926.1
G	4/17 5:40 AM	28.70	5/15 10:30 PM	2.048	3.715	--	--	317.0	0.6	904.54	0.86	1.814	0.985	891.10	N/A	2.00E-04	1581.2	1.96	99.3%	925.5
H	4/17 5:40 AM	28.72	5/15 11:01 PM	2.051	3.605	--	--	307.8	0.8	968.38	0.86	1.758	0.981	949.62	N/A	1.95E-04	1577.6	1.96	98.9%	923.4
																Average	1575.9			
																% Theoretical	99.2%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 15-1 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/31/19 (soil), 6/1/19 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	15%
Specific Gravity of Solids, G_S	2.26
Soil Water Content, w	84%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	778.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1431.8

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	200
Weight of Binder, W_b (g)	329.5
Weight of Slurry Water, $W_{w,slurry}$ (g)	197.7
Weight of Slurry, W_{slurry} (g)	527.2
Weight of Soil, W_{soil} (g)	1925.1

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	2.8
Bleed Water from Batch,* (g)	3.8
Volume of Bleed Water (in^3)	0.2

As-Mixed Batch Properties

W_{slurry} (g)		533.2	
1) Comps. put into jar mill, g		1160.5	
2) Comps. removed from jar mill,g		1158.9	
3) Wet soil made, g	*QC only*	1918.2	
4) Wet soil used, g		1906.4	
W_o (g)	358.9	W_s (g)	1033.0
$W_{s,o}$ (g)	246.3	$W_{w,soil}$ (g)	873.4
		W_{soil} (g)	1906.4
$W_{w,o}$ (g)	112.6	Soil w (%)	84.6%
Mixture G_s		2.43	
$\gamma_{d,mix}$ (pcf)		52.0	
Mixture w, %		78.6%	
$\gamma_{t,mix}$ (kg/m^3)		1487.9	
Total Water-to-Binder Ratio, w_t:b		3.22	
Binder Content, a (%)		32.3%	
Binder Factor, α (kg/m^3)		249.96	
Binder Factor In-Place, α_{I-P} (kg/m^3)		203.3	
Volume Ratio, VR (%)		23.0%	
w_t:b	3.21	$\gamma_{d,mix}$ (pcf)	52.1
α_{I-P} (kg/m^3)	203.7		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	363.6	363.1	358.9
$W_{i,add}$, g	797.0	795.9	786.7
$W_{w,add}$, g	N/A	769.8	760.9
Σ		1928.8	
W_b (g)		333.3	
$W_{w,slurry}$ (g)		200.0	
$\gamma_{D,Soil}$, pcf		48.4	
$\gamma_{D,Slurry}$, pcf		67.9	

Checks (Based on actual mix prepared)

α (kg/m^3)	249.95
a (kg/m^3)	32.3%
VR	23.0%
w_t:b	3.22

SAMPLE DATA:

Based on table below

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	6/1 12:33 AM	6.92	6/7 10:42 PM	2.041	3.986	--	--	310.3	0.2	126.13	2.74	1.9531	0.996	125.65	4	2.14E-04	1452.5	1.98	96.4%	813.4
B	6/1 12:33 AM	6.94	6/7 11:01 PM	2.040	3.982		--	309.9	0.3	129.57	2.86	1.95225	0.996	129.08	N/A	2.13E-04	1453.4	1.98	96.5%	813.9
C	6/1 12:33 AM	14.87	6/15 9:29 PM	2.042	3.883	--	--	303.0	0.4	159.10	2.48	1.9017	0.992	157.85	4	2.08E-04	1454.6	1.97	96.6%	814.6
D	6/1 12:33 AM	14.89	6/15 9:50 PM	2.048	3.843	--	--	301.5	1.0	156.85	2.69	1.87646	0.990	155.30	4	2.07E-04	1453.3	1.98	96.5%	813.9
E	6/1 12:33 AM	27.59	6/28 2:45 PM	2.040	3.992	--	--	311.5	0.4	177.15	2.39	1.95643	0.997	176.53	N/A	2.14E-04	1456.6	1.97	96.8%	815.7
F	6/1 12:33 AM	27.61	6/28 3:08 PM	2.050	3.974	--	--	311.2	0.5	173.30	2.40	1.93868	0.995	172.45	N/A	2.15E-04	1447.7	1.99	95.9%	810.7
G			Not tested			--	--													
																Average	1453.0			
																% Theoretical	97.7%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

15-I-1-D mass estimated

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LAB MIXING DATA: ORGANIC MIXING BATCH 15-2 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/31/19 (soil), 6/1/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m³
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	15%
Specific Gravity of Solids, G_S	2.26
Soil Water Content, w	84%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m³)	778.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m³)	1431.8

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m³)	300
Weight of Binder, W_b (g)	494.2
Weight of Slurry Water, $W_{w,slurry}$ (g)	296.5
Weight of Slurry, W_{slurry} (g)	790.8
Weight of Soil, W_{soil} (g)	1708.2

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	1.9
Bleed Water from Batch,* (g)	2.6
Volume of Bleed Water (in³)	0.2

As-Mixed Batch Properties

W_{slurry} (g)		796.2
1) Comps. put into jar mill, g		1029.9
2) Comps. removed from jar mill,g		1028.4
3) Wet soil made, g	*QC only*	1700.5
4) Wet soil used, g		1688.4

W_o (g)	318.6	W_s (g)	917.0
$W_{s,o}$ (g)	218.7	$W_{w,soil}$ (g)	771.4
		W_{soil} (g)	1688.4
$W_{w,o}$ (g)	99.9	Soil w (%)	84.1%

Mixture G_s	2.51
$\gamma_{d,mix}$ (pcf)	53.9
Mixture w, %	75.6%
$\gamma_{t,mix}$ (kg/m³)	1517.7
Total Water-to-Binder Ratio, w_t:b	2.15
Binder Content, a (%)	54.3%
Binder Factor, α (kg/m³)	421.88
Binder Factor In-Place, α_{I-P} (kg/m³)	304.0
Volume Ratio, VR (%)	38.8%
w_t:b	2.14
α_{I-P} (kg/m³)	304.5
$\gamma_{d,mix}$ (pcf)	54.0

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	322.7	322.2	318.6
$W_{i,add}$, g	707.2	706.2	698.3
$W_{w,add}$, g	N/A	679.0	671.4
Σ		1707.4	

W_b (g)	497.6
$W_{w,slurry}$ (g)	298.6
$\gamma_{D,Soil}$, pcf	48.5
$\gamma_{D,Slurry}$, pcf	67.9

Checks (Based on actual mix prepared)

α (kg/m³)	421.87
a (kg/m³)	54.3%
VR	38.8%
w_t:b	2.15

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m³)	$\gamma_{t,mix}$ (kg/m³)	e	S	$\gamma_{d,mix}$ (kg/m³)
A	6/1 1:45 AM	6.90	6/7 11:23 PM	2.046	3.879	--	--	308.8	0.2	257.13	1.91	1.896	0.992	254.99	N/A	2.09E-04	1478.0	1.98	96.1%	841.5
B	6/1 1:45 AM	6.92	6/7 11:43 PM	2.045	3.987	--	--	318.9	0.2	259.92	1.65	1.949	0.996	258.87	N/A	2.15E-04	1485.7	1.96	96.8%	845.9
C	6/1 1:45 AM	14.86	6/15 10:17 PM	2.047	3.765	--	--	300.2	0.3	315.81	1.61	1.839	0.987	311.75	N/A	2.03E-04	1478.4	1.98	96.1%	841.7
D	6/1 1:45 AM	14.87	6/15 10:37 PM	2.051	3.997	--	--	319.5	0.4	310.69	1.53	1.949	0.996	309.43	4	2.16E-04	1476.9	1.98	95.9%	840.9
E	6/1 1:45 AM	27.57	6/28 3:27 PM	2.050	3.996	--	--	322.0	0.4	343.48	1.28	1.950	0.996	342.09	4	2.16E-04	1490.0	1.95	97.2%	848.4
F	6/1 1:45 AM	27.59	6/28 3:51 PM	2.051	3.950	--	--	316.3	0.5	352.62	1.40	1.926	0.994	350.54	N/A	2.14E-04	1479.5	1.97	96.2%	842.4
G			Not tested			--	--													
																Average	1481.4			
																% Theoretical	97.6%			

Based on table below

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 15-3 SPREADSHEET

General Information		
Organization	Virginia Tech	
Location	Blacksburg, VA	
Conducted By	M. Bennett, G. Filz	
Date	5/31/19 (soil), 6/1/19 (soil-cement mixing)	
Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F), γ_w	998.0	kg/m^3
	62.30	pcf
Soil Properties:		
Soil Type	Artificial	
Organic Content, OC	15%	
Specific Gravity of Solids, G_S	2.26	
Soil Water Content, w	84%	
Degree of Saturation, S	1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	778.2	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1431.8	

Mixing Machinery & Time		
Mixer Type & Model	Hobart (Dough Hook)	
Soil Mixing Time (min.)		5
Soil/Binder Mixing Time (min.)		10
Blender Type/Model		Oster 14-Speed
Slurry Blending Time (min.)		3
Batch Design Properties:		
Number of Specimens, N		5
Water-to-Binder Ratio of Slurry, w:b		1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)		300
Weight of Binder, W_b (g)		494.2
Weight of Slurry Water, $W_{w,slurry}$ (g)		494.2
Weight of Slurry, W_{slurry} (g)		988.4
Weight of Soil, W_{soil} (g)		1424.6
Batch As-Cured Properties:		
# Specimens Tested		6
Bleed Water from Specimens, g		3.2
Bleed Water from Batch,* (g)		4.3
Volume of Bleed Water (in^3)		0.3

As-Mixed Batch Properties				
W_{slurry} (g)			994.8	
1) Comps. put into jar mill, g			859.0	
2) Comps. removed from jar mill, g			857	
3) Wet soil made, g		*QC only*	1420.8	
4) Wet soil used, g			1407.6	
W_o (g)	264.8		W_s (g)	762.2
$W_{s,o}$ (g)	181.7		$W_{w,soil}$ (g)	645.4
			W_{soil} (g)	1407.6
$W_{w,o}$ (g)	83.1		Soil w (%)	84.7%
Mixture G_s			2.54	
$\gamma_{d,mix}$ (pcf)			47.9	
Mixture w, %			90.7%	
$\gamma_{t,mix}$ (kg/m^3)			1463.7	
Total Water-to-Binder Ratio, w_t:b			2.30	
Binder Content, a (%)			65.3%	
Binder Factor, α (kg/m^3)			505.15	
Binder Factor In-Place, α_{I-P} (kg/m^3)			303.1	
Volume Ratio, VR (%)			66.7%	
w_t:b	2.29		$\gamma_{d,mix}$ (pcf)	48.0
α_{I-P} (kg/m^3)	303.8			

Components	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	269.1	268.5	264.8
$W_{i,add}$, g	589.9	588.5	580.4
$W_{w,add}$, g	N/A	570.2	562.4
Σ		1427.2	
	W_b (g)	497.4	
	$W_{w,slurry}$ (g)	497.4	
	$\gamma_{D,Soil}$, pcf	48.3	
	$\gamma_{D,Slurry}$, pcf	47.3	

Based on actual mix prepared	Checks	
	α (kg/m^3)	505.13
	a (kg/m^3)	65.3%
	VR	66.7%
	w_t:b	2.30

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	6/1 2:58 AM	6.88	6/8 12:06 AM	2.043	3.792	--	--	292.1	0.7	147.63	2.00	1.85609	0.988	145.93	N/A	2.04E-04	1433.9	2.38	97.1%	751.8
B	6/1 2:58 AM	6.90	6/8 12:29 AM	2.043	3.809	--	--	293.6	0.6	157.21	1.88	1.86427	0.989	155.50	N/A	2.05E-04	1435.0	2.37	97.2%	752.4
C	6/1 2:58 AM	14.83	6/15 10:57 PM	2.047	3.684	--	--	285.0	0.4	188.01	1.59	1.79956	0.984	184.99	4	1.99E-04	1434.6	2.38	97.2%	752.2
D	6/1 2:58 AM	14.85	6/15 11:15 PM	2.048	3.827	--	--	296.4	0.9	178.70	1.78	1.86865	0.989	176.82	4	2.07E-04	1434.7	2.37	97.2%	752.2
E	6/1 2:58 AM	27.55	6/28 4:09 PM	2.049	3.972	--	--	308.2	0.2	219.65	1.45	1.93851	0.995	218.57	N/A	2.15E-04	1435.8	2.37	97.3%	752.8
F	6/1 2:58 AM	27.57	6/28 4:38 PM	2.047	3.763	--	--	291.8	0.4	225.60	1.28	1.83788	0.987	222.68	N/A	2.03E-04	1437.4	2.37	97.4%	753.6
G			Not tested																	
																Average	1435.3			
																% Theoretical	98.1%			

Based on table below

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 20-1 SPREADSHEET

General Information		
Organization	Virginia Tech	
Location	Blacksburg, VA	
Conducted By	M. Bennett, G. Filz	
Date	5/30/19 (soil), 5/30/19 (soil-cement mixing)	
Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf
Soil Properties:		
Soil Type	Artificial	
Organic Content, OC	20%	
Specific Gravity of Solids, G_S	2.15	
Soil Water Content, w	108%	
Degree of Saturation, S	1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	645.9	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1343.4	

Mixing Machinery & Time		
Mixer Type & Model	Hobart (Dough Hook)	
Soil Mixing Time (min.)		5
Soil/Binder Mixing Time (min.)		10
Blender Type/Model	Oster 14-Speed	
Slurry Blending Time (min.)		3
Batch Design Properties:		
Number of Specimens, N		5
Water-to-Binder Ratio of Slurry, w:b		0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)		225
Weight of Binder, W_b (g)		370.7
Weight of Slurry Water, $W_{w,slurry}$ (g)		222.4
Weight of Slurry, W_{slurry} (g)		593.1
Weight of Soil, W_{soil} (g)		1755.4
Batch As-Cured Properties:		
# Specimens Tested		6
Bleed Water from Specimens, g		1.9
Bleed Water from Batch,* (g)		2.5
Volume of Bleed Water (in^3)		0.2

As-Mixed Batch Properties				
W_{slurry} (g)			597.1	
1) Comps. put into jar mill, g			966.9	
2) Comps. removed from jar mill,g			966.5	
3) Wet soil made, g		*QC only*	1746.1	
4) Wet soil used, g			1728.6	
W_o (g)	384.9		W_s (g)	830.9
$W_{s,o}$ (g)	264.2		$W_{w,soil}$ (g)	897.7
			W_{soil} (g)	1728.6
$W_{w,o}$ (g)	120.7		Soil w (%)	108.1%
Mixture G_s			2.38	
$\gamma_{d,mix}$ (pcf)			46.1	
Mixture w, %			93.2%	
$\gamma_{t,mix}$ (kg/m^3)			1426.9	
Total Water-to-Binder Ratio, w_t:b			3.01	
Binder Content, a (%)			44.9%	
Binder Factor, α (kg/m^3)			290.01	
Binder Factor In-Place, α_{I-P} (kg/m^3)			229.0	
Volume Ratio, VR (%)			26.7%	
w_t:b	3.00		$\gamma_{d,mix}$ (pcf)	46.2
α_{I-P} (kg/m^3)	229.3			

	Components Mass 1	Mass 2	Wet soil Mass 4
W_o, g	391.1	390.9	384.9
$W_{i,add}$, g	575.8	575.6	566.7
$W_{w,add}$, g	N/A	789.2	777.0
Σ		1755.7	
W_b (g)		373.2	
$W_{w,slurry}$ (g)		223.9	
$\gamma_{D,Soil}$, pcf		40.3	
$\gamma_{D,Slurry}$, pcf		67.9	

Based on actual mix prepared	Checks	
	α (kg/m^3)	290.00
	a (kg/m^3)	44.9%
	VR	26.7%
	w_t:b	3.01

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/30 10:31 PM	6.79	6/6 5:21 PM	2.041	3.994	--	--	298.5	0.3	115.99	2.21	1.957	0.997	115.59	4	2.14E-04	1394.1	2.30	96.7%	721.7
B	5/30 10:31 PM	6.80	6/6 5:45 PM	2.045	3.950	--	--	294.7	0.2	120.47	2.69	1.932	0.995	119.82	4	2.13E-04	1386.6	2.32	96.0%	717.9
C	5/30 10:31 PM	14.81	6/14 6:01 PM	2.040	3.979	--	--	296.8	0.2	142.77	1.99	1.950	0.996	142.20	N/A	2.13E-04	1392.6	2.30	96.6%	721.0
D	5/30 10:31 PM	14.83	6/14 6:23 PM	2.040	3.971	--	--	297.4	0.3	150.53	2.41	1.946	0.996	149.88	4	2.13E-04	1398.4	2.29	97.1%	723.9
E	5/30 10:31 PM	27.76	6/27 4:48 PM	2.049	3.872	--	--	290.8	0.5	161.01	2.08	1.890	0.991	159.59	4	2.09E-04	1389.8	2.31	96.3%	719.5
F	5/30 10:31 PM	27.78	6/27 5:14 PM	2.045	3.983	--	--	299.9	0.4	158.68	2.18	1.948	0.996	158.02	N/A	2.14E-04	1399.5	2.28	97.2%	724.5
G			Not tested																	
																Average	1393.5			
																% Theoretical	97.7%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 20-2 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/30/19 (soil), 5/30/19 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	20%
Specific Gravity of Solids, G_S	2.15
Soil Water Content, w	108%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	645.9
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1343.4

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	350
Weight of Binder, W_b (g)	576.6
Weight of Slurry Water, $W_{w,slurry}$ (g)	346.0
Weight of Slurry, W_{slurry} (g)	922.5
Weight of Soil, W_{soil} (g)	1501.1

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	2.0
Bleed Water from Batch,* (g)	2.6
Volume of Bleed Water (in^3)	0.2

As-Mixed Batch Properties

W_{slurry} (g)		923.8	
1) Comps. put into jar mill, g		826.7	
2) Comps. removed from jar mill,g		825.6	
3) Wet soil made, g	*QC only*	1492.3	
4) Wet soil used, g		1478.5	
W_o (g)	329.0	W_s (g)	710.3
$W_{s,o}$ (g)	225.8	$W_{w,soil}$ (g)	768.2
		W_{soil} (g)	1478.5
$W_{w,o}$ (g)	103.2	Soil w (%)	108.2%
Mixture G_s		2.51	
$\gamma_{d,mix}$ (pcf)		49.3	
Mixture w, %		86.6%	
$\gamma_{t,mix}$ (kg/m^3)		1472.3	
Total Water-to-Binder Ratio, w_t:b		1.93	
Binder Content, a (%)		81.3%	
Binder Factor, α (kg/m^3)		524.50	
Binder Factor In-Place, α_{I-P} (kg/m^3)		353.9	
Volume Ratio, VR (%)		48.2%	
w_t:b	1.93	$\gamma_{d,mix}$ (pcf)	49.3
α_{I-P} (kg/m^3)	354.4		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	334.4	334.0	329.0
$W_{i,add}$, g	492.4	491.7	484.5
$W_{w,add}$, g	N/A	675.0	665.0
Σ		1500.7	
W_b (g)		577.4	
$W_{w,slurry}$ (g)		346.4	
$\gamma_{D,Soil}$, pcf		40.3	
$\gamma_{D,Slurry}$, pcf		67.9	

Based on actual mix prepared	Checks	
	α (kg/m^3)	524.48
	a (kg/m^3)	81.3%
	VR	48.2%
	w_t:b	1.93

SAMPLE DATA:

Based on table below

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/30 11:45 PM	6.77	6/6 6:12 PM	2.050	3.916	--	--	298.9	0.5	239.60	1.51	1.911	0.993	237.88	N/A	2.12E-04	1411.5	2.31	94.1%	756.6
B	5/30 11:45 PM	6.79	6/6 6:35 PM	2.043	3.899	--	--	296.9	0.3	237.80	1.54	1.909	0.993	236.06	N/A	2.09E-04	1418.0	2.29	94.7%	760.1
C	5/30 11:45 PM	14.79	6/14 6:44 PM	2.048	3.958	--	--	302.5	0.1	288.95	1.22	1.933	0.995	287.39	N/A	2.14E-04	1415.7	2.30	94.5%	758.8
D	5/30 11:45 PM	14.80	6/14 7:02 PM	2.047	3.871	--	--	295.4	0.6	283.56	1.47	1.891	0.991	281.09	N/A	2.09E-04	1414.9	2.30	94.4%	758.4
E	5/30 11:45 PM	27.76	6/27 5:53 PM	2.047	3.885	--	--	298.9	0.3	323.92	1.20	1.898	0.992	321.28	N/A	2.10E-04	1426.7	2.27	95.5%	764.7
F	5/30 11:45 PM	27.77	6/27 6:14 PM	2.048	3.988	--	--	306.9	0.2	339.90	1.02	1.948	0.996	338.48	4	2.15E-04	1425.9	2.27	95.5%	764.3
G			Not tested																	
																Average	1418.8			
																% Theoretical	96.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

* 20-2-D mass estimated

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 20-3 SPREADSHEET

General Information		
Organization	Virginia Tech	
Location	Blacksburg, VA	
Conducted By	M. Bennett, G. Filz	
Date	5/30/19 (soil), 5/31/19 (soil-cement mixing)	
Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 20 °C (68 °F) γ_w	998.0	kg/m^3
	62.30	pcf
Soil Properties:		
Soil Type	Artificial	
Organic Content, OC	20%	
Specific Gravity of Solids, G_S	2.15	
Soil Water Content, w	108%	
Degree of Saturation, S	1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	645.9	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1343.4	

Mixing Machinery & Time		
Mixer Type & Model	Hobart (Dough Hook)	
Soil Mixing Time (min.)		5
Soil/Binder Mixing Time (min.)		10
Blender Type/Model		Oster 14-Speed
Slurry Blending Time (min.)		3
Batch Design Properties:		
Number of Specimens, N		5
Water-to-Binder Ratio of Slurry, w:b		1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)		350
Weight of Binder, W_b (g)		576.6
Weight of Slurry Water, $W_{w,slurry}$ (g)		576.6
Weight of Slurry, W_{slurry} (g)		1153.2
Weight of Soil, W_{soil} (g)		1190.6
Batch As-Cured Properties:		
# Specimens Tested		6
Bleed Water from Specimens, g		6.3
Bleed Water from Batch,* (g)		8.3
Volume of Bleed Water (in^3)		0.5

As-Mixed Batch Properties					
W_{slurry} (g)			1154.8		
1) Comps. put into jar mill, g			655.9		
2) Comps. removed from jar mill,g			654.7		
3) Wet soil made, g		*QC only*	1184.2		
4) Wet soil used, g			1171.5		
	W_o (g)	260.7	W_s (g)	562.7	
	$W_{s,o}$ (g)	178.9	$W_{w,soil}$ (g)	608.8	
			W_{soil} (g)	1171.5	
	$W_{w,o}$ (g)	81.8	Soil w (%)	108.2%	
Mixture G_s			2.56		
$\gamma_{d,mix}$ (pcf)			43.5		
Mixture w, %			104.0%		
$\gamma_{t,mix}$ (kg/m^3)			1423.2		
Total Water-to-Binder Ratio, w_t:b			2.05		
Binder Content, a (%)			102.6%		
Binder Factor, α (kg/m^3)			661.94		
Binder Factor In-Place, α_{I-P} (kg/m^3)			353.3		
Volume Ratio, VR (%)			87.4%		
w_t:b		2.04		$\gamma_{d,mix}$ (pcf)	43.8
α_{I-P} (kg/m^3)		355.1		`	

	Components Mass 1	Mass 2	Wet soil Mass 4
W_o, g	265.3	264.8	260.7
$W_{i,add}$, g	390.6	389.9	383.8
$W_{w,add}$, g	N/A	535.4	527.0
Σ		1190.1	
W_b (g)		577.4	
$W_{w,slurry}$ (g)		577.4	
$\gamma_{D,Soil}$, pcf		40.3	
$\gamma_{D,Slurry}$, pcf		47.3	

Based on actual mix prepared	Checks	
	α (kg/m^3)	661.92
	a (kg/m^3)	102.6%
	VR	87.4%
	w_t:b	2.05

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/31 12:53 AM	6.75	6/6 6:55 PM	2.043	3.598	--	--	271.8	1.0	138.11	1.74	1.761	0.981	135.47	N/A	1.93E-04	1406.8	2.71	98.4%	689.4
B	5/31 12:53 AM	6.77	6/6 7:15 PM	2.041	3.751	--	--	283.2	0.5	137.64	1.28	1.838	0.987	135.85	N/A	2.01E-04	1408.3	2.70	98.6%	690.2
C	5/31 12:53 AM	14.77	6/14 7:24 PM	2.038	3.675	--	--	278.1	1.4	170.82	1.50	1.804	0.984	168.14	N/A	1.96E-04	1415.9	2.68	99.3%	693.9
D	5/31 12:53 AM	14.79	6/14 7:47 PM	2.041	3.729	--	--	282.3	1.2	176.68	1.47	1.827	0.986	174.24	N/A	2.00E-04	1411.9	2.69	98.9%	692.0
E	5/31 12:53 AM	27.74	6/27 6:36 PM	2.045	3.733	--	--	283.6	0.9	209.09	1.33	1.825	0.986	206.16	N/A	2.01E-04	1411.1	2.70	98.8%	691.6
F	5/31 12:53 AM	27.76	6/27 7:03 PM	2.046	3.846	--	--	293.3	1.3	208.73	1.15	1.879	0.990	206.72	N/A	2.07E-04	1414.9	2.69	99.2%	693.5
G			Not tested																	
																Average	1411.5			
																% Theoretical	99.2%			

Based on table below

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

*20-3-C mass estimated

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LAB MIXING DATA: ORGANIC MIXING BATCH 25-1 SPREADSHEET

General Information

Organization	Virginia Tech		
Location	Blacksburg, VA		
Conducted By	M. Bennett, G. Filz		
Date	5/28/19 (soil), 5/29/19 (soil-cement mixing)		

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	25%
Specific Gravity of Solids, G_S	2.05
Soil Water Content, w	132%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	552.0
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1280.7

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)	
Soil Mixing Time (min.)		5
Soil/Binder Mixing Time (min.)		10
Blender Type/Model		Oster 14-Speed
Slurry Blending Time (min.)		3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	1.2
Binder Factor In-Place, α_{I-P} (kg/m^3)	250
Weight of Binder, W_b (g)	411.9
Weight of Slurry Water, $W_{w,slurry}$ (g)	494.2
Weight of Slurry, W_{slurry} (g)	906.1
Weight of Soil, W_{soil} (g)	1307.8

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	1.2
Bleed Water from Batch,* (g)	1.6
Volume of Bleed Water (in^3)	0.1

As-Mixed Batch Properties

W_{slurry} (g)		908.2
1) Comps. put into jar mill, g		666.5
2) Comps. removed from jar mill,g		666.1
3) Wet soil made, g	*QC only*	1299.4
4) Wet soil used, g		1283.6

W_o (g)	320.3	W_s (g)	553.1
$W_{s,o}$ (g)	219.8	$W_{w,soil}$ (g)	730.5
		W_{soil} (g)	1283.6
$W_{w,o}$ (g)	100.5	Soil w (%)	132.1%

Mixture G_s	2.41
$\gamma_{d,mix}$ (pcf)	37.0
Mixture w, %	126.9%
$\gamma_{t,mix}$ (kg/m^3)	1344.6
Total Water-to-Binder Ratio, w_t:b	2.97
Binder Content, a (%)	74.6%
Binder Factor, α (kg/m^3)	411.86
Binder Factor In-Place, α_{I-P} (kg/m^3)	253.3
Volume Ratio, VR (%)	62.6%

w_t:b	2.97	$\gamma_{d,mix}$ (pcf)	37.0
α_{I-P} (kg/m^3)	253.5		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	326.6	326.4	320.3
$W_{i,add}$, g	339.8	339.6	333.3
$W_{w,add}$, g	N/A	642.0	630.0
Σ		1308	

W_b (g)	412.8
$W_{w,slurry}$ (g)	495.4
$\gamma_{D,Soil}$, pcf	34.4
$\gamma_{D,Slurry}$, pcf	41.1

Based on actual mix prepared

Checks	
α (kg/m^3)	411.84
a (kg/m^3)	74.6%
VR	62.6%
w_t:b	2.97

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/29 1:11 AM	6.60	6/4 3:28 PM	2.038	3.855	--	--	272.5	0.4	59.04	3.45	1.892	0.991	58.53	N/A	2.06E-04	1322.2	3.13	97.8%	582.7
B	5/29 1:11 AM	6.62	6/4 3:59 PM	2.035	3.885	--	--	276.6	0.0	59.94	2.84	1.909	0.993	59.50	N/A	2.07E-04	1335.3	3.09	99.1%	588.5
C	5/29 1:11 AM	13.88	6/11 10:24 PM	2.030	3.893	--	--	276.1	0.1	67.71	2.93	1.918	0.993	67.27	N/A	2.06E-04	1337.6	3.08	99.3%	589.5
D	5/29 1:11 AM	13.90	6/11 10:51 PM	2.043	3.828	--	--	272.7	0.3	71.45	2.86	1.874	0.990	70.73	N/A	2.06E-04	1326.6	3.11	98.2%	584.6
E	5/29 1:11 AM	27.67	6/25 5:10 PM	2.042	3.983	--	--	284.3	0.2	81.55	2.50	1.951	0.996	81.23	N/A	2.14E-04	1330.0	3.10	98.6%	586.1
F	5/29 1:11 AM	27.68	6/25 5:34 PM	2.041	3.982	--	--	284.4	0.2	82.18	2.43	1.951	0.996	81.86	N/A	2.14E-04	1331.7	3.10	98.7%	586.9
G			Not tested																	
																Average	1330.6			
																% Theoretical	99.0%			

Based on table below

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 25-2 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/28/19 (soil), 5/29/19 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	25%
Specific Gravity of Solids, G_S	2.05
Soil Water Content, w	132%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	552.0
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1280.7

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	250
Weight of Binder, W_b (g)	411.9
Weight of Slurry Water, $W_{w,slurry}$ (g)	247.1
Weight of Slurry, W_{slurry} (g)	659.0
Weight of Soil, W_{soil} (g)	1625.0

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	3.9
Bleed Water from Batch,* (g)	5.2
Volume of Bleed Water (in^3)	0.3

As-Mixed Batch Properties

W_{slurry} (g)		663.8
1) Comps. put into jar mill, g		827.8
2) Comps. removed from jar mill, g		826.4
3) Wet soil made, g	*QC only*	1617.9
4) Wet soil used, g		1603.3

W_o (g)	399.8	W_s (g)	690.4
$W_{s,o}$ (g)	274.4	$W_{w,soil}$ (g)	912.9
		W_{soil} (g)	1603.3
$W_{w,o}$ (g)	125.4	Soil w (%)	132.2%

Mixture G_s	2.36
$\gamma_{d,mix}$ (pcf)	42.2
Mixture w, %	105.1%
$\gamma_{t,mix}$ (kg/m^3)	1387.7
Total Water-to-Binder Ratio, w_t:b	2.80
Binder Content, a (%)	60.1%
Binder Factor, α (kg/m^3)	331.31
Binder Factor In-Place, α_{I-P} (kg/m^3)	254.0
Volume Ratio, VR (%)	30.5%

w_t:b	2.79	$\gamma_{d,mix}$ (pcf)	42.4
α_{I-P} (kg/m^3)	254.8		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	405.7	405.0	399.8
$W_{i,add}$, g	422.2	421.5	416.0
$W_{w,add}$, g	N/A	797.8	787.5
Σ		1624.3	

W_b (g)	414.9
$W_{w,slurry}$ (g)	248.9
$\gamma_{D,Soil}$, pcf	34.4
$\gamma_{D,Slurry}$, pcf	67.9

Checks (Based on actual mix prepared)

α (kg/m^3)	331.30
a (kg/m^3)	60.1%
VR	30.5%
w_t:b	2.80

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/29 2:24 AM	6.59	6/4 4:34 PM	2.045	3.765	--	--	269.6	0.5	106.41	3.14	1.841	0.987	105.06	N/A	2.03E-04	1330.8	2.63	94.3%	648.8
B	5/29 2:24 AM	6.61	6/4 5:02 PM	2.042	3.780	--	--	271.5	0.6	104.06	2.33	1.851	0.988	102.82	4	2.03E-04	1337.9	2.61	95.0%	652.3
C	5/29 2:24 AM	13.87	6/11 11:12 PM	2.045	3.799	--	--	273.6	0.6	117.65	2.98	1.858	0.989	116.31	N/A	2.04E-04	1337.9	2.61	95.0%	652.3
D	5/29 2:24 AM	13.88	6/11 11:37 PM	2.042	3.710	--	--	267.0	0.7	127.19	2.19	1.817	0.985	125.33	N/A	1.99E-04	1341.4	2.60	95.4%	654.0
E	5/29 2:24 AM	27.65	6/25 5:58 PM	2.040	3.630	--	--	261.8	0.8	142.51	2.19	1.779	0.982	139.99	4	1.94E-04	1346.1	2.59	95.8%	656.3
F	5/29 2:24 AM	27.67	6/25 6:26 PM	2.049	3.818	--	--	276.0	0.7	145.10	1.79	1.863	0.989	143.51	N/A	2.06E-04	1337.4	2.61	95.0%	652.0
G			Not tested																	
																Average	1338.6			
																% Theoretical	96.5%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 25-3 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/28/19 (soil), 5/29/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	25%
Specific Gravity of Solids, G_S	2.05
Soil Water Content, w	132%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	552.0
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1280.7

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	5
Water-to-Binder Ratio of Slurry, w:b	1.2
Binder Factor In-Place, α_{I-P} (kg/m^3)	400
Weight of Binder, W_b (g)	659.0
Weight of Slurry Water, $W_{w,slurry}$ (g)	790.8
Weight of Slurry, W_{slurry} (g)	1449.7
Weight of Soil, W_{soil} (g)	826.6

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	15.2
Bleed Water from Batch,* (g)	20.3
Volume of Bleed Water (in^3)	1.2

As-Mixed Batch Properties

W_{slurry} (g)			1454.6		
1) Comps. put into jar mill, g			421.2		
2) Comps. removed from jar mill,g			420.1		
3) Wet soil made, g		QC only	820.7		
4) Wet soil used, g			807.8		
	W_o (g)	201.3	W_s (g)	347.7	
	$W_{s,o}$ (g)	138.2	$W_{w,soil}$ (g)	460.1	
			W_{soil} (g)	807.8	
	$W_{w,o}$ (g)	63.2	Soil w (%)	132.3%	
Mixture G_s			2.66		
$\gamma_{d,mix}$ (pcf)			38.5		
Mixture w, %			124.2%		
$\gamma_{t,mix}$ (kg/m^3)			1382.6		
Total Water-to-Binder Ratio, w_t:b			1.90		
Binder Content, a (%)			190.1%		
Binder Factor, α (kg/m^3)			1047.88		
Binder Factor In-Place, α_{I-P} (kg/m^3)			404.1		
Volume Ratio, VR (%)			159.3%		
	w_t:b	1.87		$\gamma_{d,mix}$ (pcf)	39.0
	α_{I-P} (kg/m^3)	409.1			

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	206.4	205.9	201.3
$W_{i,add}$, g	214.8	214.2	209.5
$W_{w,add}$, g	N/A	405.8	396.9
Σ		825.9	

W_b (g)	661.2
$W_{w,slurry}$ (g)	793.4
$\gamma_{D,Soil}$, pcf	34.4
$\gamma_{D,Slurry}$, pcf	41.1

Based on actual mix prepared

Checks	
α (kg/m^3)	1047.85
a (kg/m^3)	190.1%
VR	159.3%
w_t:b	1.90

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/29 3:34 AM	6.58	6/4 5:33 PM	2.044	3.703	--	--	276.2	2.5	147.59	0.96	1.812	0.985	145.37	N/A	1.99E-04	1387.6	3.29	100.5%	618.8
B	5/29 3:34 AM	6.60	6/4 5:59 PM	2.043	3.681	--	--	274.5	2.6	142.30	0.99	1.802	0.984	140.04	N/A	1.98E-04	1388.2	3.29	100.5%	619.1
C	5/29 3:34 AM	13.85	6/12 12:01 AM	2.041	3.586	--	--	265.8	3.9	144.45	0.86	1.757	0.981	141.64	N/A	1.92E-04	1382.9	3.30	100.0%	616.7
D	5/29 3:34 AM	13.87	6/12 12:23 AM	2.043	3.612	--	--	269.7	2.7	155.77	0.84	1.768	0.981	152.88	N/A	1.94E-04	1390.5	3.28	100.7%	620.1
E	5/29 3:34 AM	27.64	6/25 6:54 PM	2.041	3.743	--	--	281.1	2.0	218.48	0.82	1.834	0.987	215.57	N/A	2.01E-04	1400.8	3.25	101.7%	624.7
F	5/29 3:34 AM	27.66	6/25 7:18 PM	2.046	3.687	--	--	273.9	1.5	214.72	0.84	1.802	0.984	211.32	N/A	1.99E-04	1379.2	3.31	99.7%	615.1
G			Not tested																	
																Average	1388.2			
																% Theoretical	100.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 30-1 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	12/1/18 (soil), 12/2/18 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	30%
Specific Gravity of Solids, G_S	1.96
Soil Water Content, w	156%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	152
Weight of Binder, W_b (g)	375.6
Weight of Slurry Water, $W_{w,slurry}$ (g)	375.6
Weight of Slurry, W_{slurry} (g)	751.2
Weight of Soil, W_{soil} (g)	2437.6

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	7.5
Bleed Water from Batch,* (g)	15.0
Volume of Bleed Water (in^3)	0.9

As-Mixed Batch Properties

W_{slurry} (g)		773.6	
1) Comps. put into jar mill, g		1158.2	
2) Comps. removed from jar mill,g		1155.7	
3) Wet soil made, g	*QC only*	2417.2	
4) Wet soil used, g		2412.6	

W_o (g)	652.2	W_s (g)	927.9
$W_{s,o}$ (g)	438.9	$W_{w,soil}$ (g)	1484.7
		W_{soil} (g)	2412.6
$W_{w,o}$ (g)	213.3	Soil w (%)	160.0%

Mixture G_s	2.21
$\gamma_{d,mix}$ (pcf)	33.2
Mixture w, %	142.4%
$\gamma_{t,mix}$ (kg/m^3)	1288.5
Total Water-to-Binder Ratio, w_t:b	4.84
Binder Content, a (%)	41.7%
Binder Factor, α (kg/m^3)	197.14
Binder Factor In-Place, α_{I-P} (kg/m^3)	156.4
Volume Ratio, VR (%)	26.0%

w_t:b	4.80	$\gamma_{d,mix}$ (pcf)	33.4
α_{I-P} (kg/m^3)	157.4		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	661.9	660.5	652.2
$W_{i,add}$, g	496.3	495.2	489.0
$W_{w,add}$, g	N/A	1287.6	1271.4
Σ		2443.3	

W_b (g)	386.8
$W_{w,slurry}$ (g)	386.8
$\gamma_{D,Soil}$, pcf	29.5
$\gamma_{D,Slurry}$, pcf	47.3

Based on actual mix prepared

Checks	
α (kg/m^3)	197.13
a (kg/m^3)	41.7%
VR	26.0%
w_t:b	4.84

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	12/2 7:00 PM	8.75	12/11 1:06 PM	2.023	3.858	--	--	251.6	1.0	15.92	7.25	1.90717	0.993	15.80	4	2.03E-04	1238.1	3.31	94.9%	510.8
B	12/2 7:00 PM	8.82	12/11 2:34 PM	2.009	3.733	--	--	242.6	1.2	19.93	9.50	1.85827	0.989	19.70	4	1.94E-04	1251.5	3.26	96.2%	516.4
C	12/2 7:00 PM	16.07	12/18 8:45 PM	1.972	3.537	--	--	229.1	1.1	20.87	8.45	1.79336	0.983	20.52	4	1.77E-04	1294.3	3.12	100.6%	534.1
D	12/2 7:00 PM	16.12	12/18 9:46 PM	2.025	3.881	--	--	254.5	1.3	15.80	5.72	1.91669	0.993	15.69	4	2.05E-04	1242.4	3.29	95.3%	512.6
E	12/2 7:00 PM	32.79	1/4 1:59 PM	2.013	3.833	--	--	253.1	1.2	17.87	7.97	1.90369	0.992	17.73	4	2.00E-04	1265.8	3.21	97.7%	522.3
F	12/2 7:00 PM	32.88	1/4 4:02 PM	1.999	3.655	--	--	241.9	1.7	15.83	6.97	1.82814	0.986	15.61	4	1.88E-04	1286.5	3.15	99.8%	530.8
G			Not tested																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1263.1			
																% Theoretical	98.0%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 30-2 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	12/1/18 (soil), 12/3/18 (mix)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	30%
Specific Gravity of Solids, G_S	1.96
Soil Water Content, w	156%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	226
Weight of Binder, W_b (g)	558.5
Weight of Slurry Water, $W_{w,slurry}$ (g)	558.5
Weight of Slurry, W_{slurry} (g)	1116.9
Weight of Soil, W_{soil} (g)	2139.7

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	7.7
Bleed Water from Batch,* (g)	15.4
Volume of Bleed Water (in^3)	0.9

As-Mixed Batch Properties

W_{slurry} (g)		1135.0
1) Comps. put into jar mill, g		1016.6
2) Comps. removed from jar mill,g		1014.2
3) Wet soil made, g	*QC only*	2135.7
4) Wet soil used, g		2127.1

W_o (g)	574.8	W_s (g)	817.7
$W_{s,o}$ (g)	386.8	$W_{w,soil}$ (g)	1309.4
		W_{soil} (g)	2127.1
$W_{w,o}$ (g)	188.0	Soil w (%)	160.1%

Mixture G_s	2.32
$\gamma_{d,mix}$ (pcf)	34.9
Mixture w, %	135.5%
$\gamma_{t,mix}$ (kg/m^3)	1315.7
Total Water-to-Binder Ratio, w_t:b	3.31
Binder Content, a (%)	69.4%
Binder Factor, α (kg/m^3)	328.02
Binder Factor In-Place, α_{I-P} (kg/m^3)	228.9
Volume Ratio, VR (%)	43.3%

w_t:b	3.28	$\gamma_{d,mix}$ (pcf)	35.1
α_{I-P} (kg/m^3)	230.3		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	581.0	579.6	574.8
$W_{i,add}$, g	435.6	434.6	430.9
$W_{w,add}$, g	N/A	1130.8	1121.4
Σ		2145.0	

W_b (g)	567.5
$W_{w,slurry}$ (g)	567.5
$\gamma_{D,Soil}$, pcf	29.5
$\gamma_{D,Slurry}$, pcf	47.3

Checks (Based on actual mix prepared)

α (kg/m^3)	328.01
a (kg/m^3)	69.4%
VR	43.3%
w_t:b	3.31

SAMPLE DATA:

Based on table below

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	12/3 12:30 PM	11.45	12/14 11:25 PM	2.026	3.777	--	--	245.5	0.7	34.27	3.65	1.865	0.989	33.90	4	1.99E-04	1230.6	3.43	91.6%	522.6
B	12/3 12:30 PM	11.52	12/15 12:59 AM	2.025	3.694	--	--	238.2	1.5	34.32	4.19	1.824	0.986	33.84	4	1.95E-04	1222.0	3.46	90.8%	518.9
C	12/3 12:30 PM	15.49	12/19 12:11 AM	2.019	3.925	--	--	258.6	0.9	40.33	4.00	1.944	0.996	40.15	4	2.06E-04	1255.9	3.34	94.1%	533.3
D	12/3 12:30 PM	16.08	12/19 2:31 PM	2.031	3.753	--	--	247.7	1.5	41.94	3.68	1.847	0.988	41.43	4	1.99E-04	1242.9	3.38	92.8%	527.8
F	12/3 12:30 PM	32.19	1/4 5:10 PM	2.031	3.769	--	--	250.1	1.6	50.74	3.32	1.856	0.988	50.15	4	2.00E-04	1249.9	3.36	93.5%	530.8
H	12/3 12:30 PM	32.25	1/4 6:30 PM	2.025	3.776	--	--	249.0	1.5	50.24	3.16	1.865	0.989	49.70	4	1.99E-04	1249.5	3.36	93.5%	530.6
E			Broke																	
G			Broke																	
I			Not tested																	
J			Not tested																	
																Average	1241.8			
																% Theoretical	94.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 30-3 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	12/1/18 (soil), 12/3/18 (mix)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	30%
Specific Gravity of Solids, G_S	1.96
Soil Water Content, w	156%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	283
Weight of Binder, W_b (g)	699.3
Weight of Slurry Water, $W_{w,slurry}$ (g)	699.3
Weight of Slurry, W_{slurry} (g)	1398.6
Weight of Soil, W_{soil} (g)	1910.3

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	8.8
Bleed Water from Batch,* (g)	17.6
Volume of Bleed Water (in^3)	1.1

As-Mixed Batch Properties

W_{slurry} (g)		1406.0	
1) Comps. put into jar mill, g		907.7	
2) Comps. removed from jar mill,g		905.7	
3) Wet soil made, g	*QC only*	1904.9	
4) Wet soil used, g		1901.9	
W_o (g)	514.4	W_s (g)	731.7
$W_{s,o}$ (g)	346.1	$W_{w,soil}$ (g)	1170.2
		W_{soil} (g)	1901.9
$W_{w,o}$ (g)	168.2	Soil w (%)	159.9%
Mixture G_s		2.41	
$\gamma_{d,mix}$ (pcf)		36.2	
Mixture w, %		130.6%	
$\gamma_{t,mix}$ (kg/m^3)		1336.6	
Total Water-to-Binder Ratio, w_t:b		2.66	
Binder Content, a (%)		96.1%	
Binder Factor, α (kg/m^3)		454.53	
Binder Factor In-Place, α_{I-P} (kg/m^3)		284.1	
Volume Ratio, VR (%)		60.0%	
w_t:b	2.64	$\gamma_{D\text{-}MIX}$, pcf	36.5
α_{I-P} (kg/m^3)	286.1		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	518.8	517.7	514.4
$W_{i,add}$, g	388.9	388.0	385.6
$W_{w,add}$, g	N/A	1008.4	1002.0
Σ		1914.1	
W_b (g)		703.0	
$W_{w,slurry}$ (g)		703.0	
$\gamma_{D,Soil}$, pcf		29.5	
$\gamma_{D,Slurry}$, pcf		47.3	

Based on actual mix prepared

Checks	
α (kg/m^3)	454.52
a (kg/m^3)	96.1%
VR	60.0%
w_t:b	2.66

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d',mix}$ (kg/m^3)
A	12/3 4:00 PM	11.43	12/15 2:20 AM	2.031	3.774	--	--	233.6	1.3	44.45	1.46	1.858	0.989	43.94	4	2.00E-04	1165.8	3.75	83.8%	505.6
C	12/3 4:00 PM	11.48	12/15 3:36 AM	2.034	3.784	--	--	233.1	1.2	50.03	1.56	1.861	0.989	49.48	4	2.01E-04	1157.2	3.78	83.0%	501.9
D	12/3 4:00 PM	15.41	12/19 1:53 AM	2.036	3.760	--	--	228.8	1.8	50.63	1.85	1.847	0.988	50.01	4	2.01E-04	1140.7	3.85	81.5%	494.8
E	12/3 4:00 PM	15.98	12/19 3:28 PM	2.033	3.768	--	--	236.7	1.0	52.66	1.64	1.853	0.988	52.04	4	2.00E-04	1181.1	3.69	85.2%	512.3
F	12/3 4:00 PM	32.15	1/4 7:36 PM	2.032	3.774	--	--	235.5	1.4	55.24	1.72	1.857	0.989	54.61	4	2.00E-04	1174.7	3.71	84.6%	509.5
G	12/3 4:00 PM	32.18	1/4 8:19 PM	2.030	3.713	--	--	233.7	2.1	55.73	1.86	1.829	0.986	54.97	4	1.97E-04	1187.1	3.66	85.8%	514.9
B			Broke																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1167.8			
																% Theoretical	87.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 30-4 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/18/19 (soil), 4/19/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F), γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	30%
Specific Gravity of Solids, G_S	1.96
Soil Water Content, w	156%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.8
Binder Factor In-Place, α_{I-P} (kg/m^3)	350
Weight of Binder, W_b (g)	648.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	518.9
Weight of Slurry, W_{slurry} (g)	1167.6
Weight of Soil, W_{soil} (g)	1390.8

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	6.5
Bleed Water from Batch,* (g)	9.8
Volume of Bleed Water (in^3)	0.6

As-Mixed Batch Properties

W_{slurry} (g)		1176.0
1) Comps. put into jar mill, g		652.1
2) Comps. removed from jar mill,g		651
3) Wet soil made, g	*QC only*	1384.0
4) Wet soil used, g		1381.3

W_o (g)	364.8	W_s (g)	539.0
$W_{s,o}$ (g)	257.1	$W_{w,soil}$ (g)	842.3
		W_{soil} (g)	1381.3
$W_{w,o}$ (g)	107.7	Soil w (%)	156.3%

Mixture G_s	2.47
$\gamma_{d,mix}$ (pcf)	40.2
Mixture w, %	114.5%
$\gamma_{t,mix}$ (kg/m^3)	1381.4
Total Water-to-Binder Ratio, w_t:b	2.09
Binder Content, a (%)	121.2%
Binder Factor, α (kg/m^3)	583.57
Binder Factor In-Place, α_{I-P} (kg/m^3)	352.9
Volume Ratio, VR (%)	65.3%
w_t:b	2.07
α_{I-P} (kg/m^3)	354.8

$\gamma_{d,mix}$ (pcf): 40.4

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	367.8	367.2	364.8
$W_{i,add}$, g	284.3	283.8	282.0
$W_{w,add}$, g	N/A	739.4	734.6
Σ		1390.4	

W_b (g)	653.3
$W_{w,slurry}$ (g)	522.7
$\gamma_{D,Soil}$, pcf	30.1
$\gamma_{D,Slurry}$, pcf	55.8

Based on actual mix prepared

Checks	
α (kg/m^3)	583.55
a (kg/m^3)	121.2%
VR	65.3%
w_t:b	2.09

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/19 10:02 AM	6.98	4/26 9:36 AM	2.042	3.768	--	--	261.0	1.2	103.73	1.72	1.845	0.988	102.45	4	2.02E-04	1290.3	3.10	91.3%	601.6
B	4/19 10:02 AM	7.01	4/26 10:14 AM	2.042	3.971	--	--	275.1	0.8	103.97	1.73	1.944	0.996	103.51	4	2.13E-04	1290.5	3.10	91.3%	601.7
C	4/19 10:02 AM	14.25	5/3 4:04 PM	2.048	3.370	--	--	233.8	0.8	119.84	1.58	1.645	0.972	116.44	N/A	1.82E-04	1284.9	3.12	90.8%	599.1
D	4/19 10:02 AM	14.30	5/3 5:12 PM	2.042	3.377	--	--	234.3	1.2	120.73	1.47	1.654	0.972	117.38	N/A	1.81E-04	1293.3	3.09	91.6%	603.0
E	4/19 10:02 AM	28.49	5/17 9:41 PM	2.045	3.616	--	--	254.6	1.4	142.02	1.17	1.768	0.981	139.39	4	1.95E-04	1307.7	3.05	92.9%	609.7
F	4/19 10:02 AM	28.50	5/17 10:06 PM	2.041	3.650	--	--	257.2	1.1	145.09	1.26	1.788	0.983	142.63	N/A	1.96E-04	1313.9	3.03	93.5%	612.6
G			Not tested																	
H			Not tested																	
																Average	1296.8			
																% Theoretical	93.9%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 30-5 SPREADSHEET

General Information		
Organization	Virginia Tech	
Location	Blacksburg, VA	
Conducted By	M. Bennett, G. Filz	
Date	4/18/19 (soil), 4/19/19 (soil-cement mixing)	
Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F), γ_w	998.0	kg/m^3
	62.30	pcf
Soil Properties:		
Soil Type	Artificial	
Organic Content, OC	30%	
Specific Gravity of Solids, G_S	1.96	
Soil Water Content, w	156%	
Degree of Saturation, S	1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1	

Mixing Machinery & Time	
Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3
Batch Design Properties:	
Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.8
Binder Factor In-Place, α_{I-P} (kg/m^3)	400
Weight of Binder, W_b (g)	741.3
Weight of Slurry Water, $W_{w,slurry}$ (g)	593.1
Weight of Slurry, W_{slurry} (g)	1334.4
Weight of Soil, W_{soil} (g)	1262.8
Batch As-Cured Properties:	
# Specimens Tested	6
Bleed Water from Specimens, g	9.1
Bleed Water from Batch,* (g)	13.7
Volume of Bleed Water (in^3)	0.8

As-Mixed Batch Properties		
W_{slurry} (g)		1335.3
1) Comps. put into jar mill, g		592.1
2) Comps. removed from jar mill,g		591.5
3) Wet soil made, g	*QC only*	1256.6
4) Wet soil used, g		1253.2

W_o (g)	331.1	W_s (g)	489.2
$W_{s,o}$ (g)	233.4	$W_{w,soil}$ (g)	764.0
		W_{soil} (g)	1253.2
$W_{w,o}$ (g)	97.8	Soil w (%)	156.2%

Mixture G_s	2.54
$\gamma_{d,mix}$ (pcf)	41.6
Mixture w, %	110.3%
$\gamma_{t,mix}$ (kg/m^3)	1402.0
Total Water-to-Binder Ratio, w_t:b	1.83
Binder Content, a (%)	151.6%
Binder Factor, α (kg/m^3)	730.41
Binder Factor In-Place, α_{I-P} (kg/m^3)	401.8
Volume Ratio, VR (%)	81.8%
w_t:b	1.81
α_{I-P} (kg/m^3)	404.8
$\gamma_{d,mix}$ (pcf)	41.9

Components	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	334.0	333.7	331.1
$W_{i,add}$, g	258.1	257.8	255.9
$W_{w,add}$, g	N/A	671.3	666.2
Σ		1262.8	

W_b (g)	741.8
$W_{w,slurry}$ (g)	593.5
$\gamma_{D,Soil}$, pcf	30.1
$\gamma_{D,Slurry}$, pcf	55.8

Based on actual mix prepared

Checks	
α (kg/m^3)	730.39
a (kg/m^3)	151.6%
VR	81.8%
w_t:b	1.83

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/19 11:15 AM	6.98	4/26 10:53 AM	2.046	3.748	--	--	275.3	1.5	160.32	1.66	1.832	0.987	158.16	4	2.02E-04	1363.3	2.91	96.3%	648.4
B	4/19 11:15 AM	7.26	4/26 5:23 PM	2.051	3.405	--	--	249.6	1.2	163.80	1.46	1.660	0.973	159.34	N/A	1.84E-04	1354.1	2.93	95.4%	644.0
D	4/19 11:15 AM	15.47	5/4 10:30 PM	2.042	3.613	--	--	266.7	1.8	191.13	1.37	1.770	0.982	187.61	N/A	1.94E-04	1375.8	2.87	97.5%	654.3
E	4/19 11:15 AM	15.49	5/4 11:02 PM	2.045	3.763	--	--	277.4	1.4	179.97	0.97	1.840	0.987	177.67	N/A	2.02E-04	1370.1	2.89	96.9%	651.6
F	4/19 11:15 AM	28.48	5/17 10:40 PM	2.044	3.572	--	--	265.0	1.6	225.89	1.14	1.748	0.980	221.33	4	1.92E-04	1380.0	2.86	97.9%	656.3
G	4/19 11:15 AM	28.49	5/17 11:06 PM	2.046	3.700	--	--	275.2	1.6	218.24	1.19	1.808	0.985	214.89	4	1.99E-04	1380.0	2.86	97.9%	656.3
C			Broke			--	--													
H																				
																Average	1370.5			
																% Theoretical	97.8%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 30-6 SPREADSHEET

General Information	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/18/19 (soil), 4/19/19 (soil-cement mixing)

Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:	
Soil Type	Artificial
Organic Content, OC	30%
Specific Gravity of Solids, G_S	1.96
Soil Water Content, w	156%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1

Mixing Machinery & Time	
Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:	
Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	500
Weight of Binder, W_b (g)	926.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	556.0
Weight of Slurry, W_{slurry} (g)	1482.7
Weight of Soil, W_{soil} (g)	1235.8

Batch As-Cured Properties:	
# Specimens Tested	6
Bleed Water from Specimens, g	6.4
Bleed Water from Batch,* (g)	9.6
Volume of Bleed Water (in^3)	0.6

As-Mixed Batch Properties			
W_{slurry} (g)			1485.8
1) Comps. put into jar mill, g			579.5
2) Comps. removed from jar mill,g			578.5
3) Wet soil made, g		*QC only*	1228.8
4) Wet soil used, g			1225.5

W_o (g)	323.7	W_s (g)	478.2
$W_{s,o}$ (g)	228.1	$W_{w,soil}$ (g)	747.3
		W_{soil} (g)	1225.5
$W_{w,o}$ (g)	95.6	Soil w (%)	156.3%

Mixture G_s	2.61
$\gamma_{d,mix}$ (pcf)	47.6
Mixture w, %	92.7%
$\gamma_{t,mix}$ (kg/m^3)	1467.9
Total Water-to-Binder Ratio, w_t:b	1.40
Binder Content, a (%)	194.2%
Binder Factor, α (kg/m^3)	934.89
Binder Factor In-Place, α_{I-P} (kg/m^3)	502.8
Volume Ratio, VR (%)	85.9%

w_t:b	1.39	$\gamma_{d,mix}$ (pcf)	47.8
α_{I-P} (kg/m^3)	505.4		

	Components Mass 1	Mass 2	Wet soil Mass 4
W_o, g	326.9	326.3	323.7
$W_{i,add}$, g	252.6	252.2	250.1
$W_{w,add}$, g	N/A	657.1	651.7
Σ		1235.6	

W_b (g)	928.6
$W_{w,slurry}$ (g)	557.2
$\gamma_{D,Soil}$, pcf	30.1
$\gamma_{D,Slurry}$, pcf	67.9

Based on actual mix prepared	Checks	
	α (kg/m^3)	934.86
	a (kg/m^3)	194.2%
	VR	85.9%
	w_t:b	1.40

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/19 12:41 PM	7.23	4/26 6:05 PM	2.044	3.653	--	--	276.9	0.8	347.27	1.10	1.787	0.983	341.37	N/A	1.96E-04	1409.6	2.56	94.5%	731.4
B	4/19 12:41 PM	7.25	4/26 6:47 PM	2.047	3.700	--	--	281.2	1.2	354.48	1.20	1.807	0.985	349.01	N/A	2.00E-04	1408.9	2.56	94.4%	731.0
C	4/19 12:41 PM	15.46	5/4 11:39 PM	2.049	3.781	--	--	290.1	1.1	416.99	0.97	1.845	0.988	411.83	4	2.04E-04	1419.4	2.54	95.4%	736.5
D	4/19 12:41 PM	15.48	5/5 12:15 AM	2.048	3.744	--	--	285.2	1.0	410.63	0.97	1.828	0.986	404.98	N/A	2.02E-04	1410.6	2.56	94.6%	731.9
E	4/19 12:41 PM	28.46	5/17 11:36 PM	2.047	3.743	--	--	287.8	1.3	507.09	0.87	1.829	0.986	500.15	N/A	2.02E-04	1426.0	2.52	96.0%	739.9
F	4/19 12:41 PM	28.47	5/18 12:03 AM	2.042	3.718	--	--	286.6	1.0	516.15	0.92	1.820	0.986	508.74	4	2.00E-04	1436.0	2.50	97.0%	745.1
G			Not tested																	
H			Not tested																	
																Average	1418.4			
																% Theoretical	96.6%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 30-7 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/19/19 (soil), 5/20/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	30%
Specific Gravity of Solids, G_S	1.96
Soil Water Content, w	156%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	150
Weight of Binder, W_b (g)	278.0
Weight of Slurry Water, $W_{w,slurry}$ (g)	166.8
Weight of Slurry, W_{slurry} (g)	444.8
Weight of Soil, W_{soil} (g)	1971.8

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	3.6
Bleed Water from Batch,* (g)	5.4
Volume of Bleed Water (in^3)	0.3

As-Mixed Batch Properties

W_{slurry} (g)		449.5
1) Comps. put into jar mill, g		924.3
2) Comps. removed from jar mill,g		922.8
3) Wet soil made, g	*QC only*	1962.0
4) Wet soil used, g		1949

W_o (g)	514.8	W_s (g)	760.6
$W_{s,o}$ (g)	362.8	$W_{w,soil}$ (g)	1188.4
		W_{soil} (g)	1949.0
$W_{w,o}$ (g)	152.0	Soil w (%)	156.3%

Mixture G_s	2.18
$\gamma_{d,mix}$ (pcf)	35.4
Mixture w, %	130.3%
$\gamma_{t,mix}$ (kg/m^3)	1304.9
Total Water-to-Binder Ratio, w_t:b	4.83
Binder Content, a (%)	36.9%
Binder Factor, α (kg/m^3)	177.85
Binder Factor In-Place, α_{I-P} (kg/m^3)	152.9
Volume Ratio, VR (%)	16.3%

w_t:b	4.81	$\gamma_{d,mix}$ (pcf)	35.5
α_{I-P} (kg/m^3)	153.3		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	521.4	520.6	514.8
$W_{i,add}$, g	402.9	402.2	397.8
$W_{w,add}$, g	N/A	1048.0	1036.4
Σ		1970.8	

W_b (g)	280.9
$W_{w,slurry}$ (g)	168.6
$\gamma_{D,Soil}$, pcf	30.1
$\gamma_{D,Slurry}$, pcf	67.9

Based on actual mix prepared

Checks	
α (kg/m^3)	177.84
a (kg/m^3)	36.9%
VR	16.3%
w_t:b	4.83

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/20 5:06 PM	8.21	5/28 10:08 PM	2.043	3.551	--	--	237.4	0.5	41.67	4.55	1.739	0.979	40.80	4	1.91E-04	1244.8	3.03	93.9%	540.5
B	5/20 5:06 PM	8.23	5/28 10:37 PM	2.029	3.633	--	--	243.8	0.5	43.11	4.83	1.791	0.983	42.39	4	1.92E-04	1266.9	2.96	96.1%	550.1
C	5/20 5:06 PM	14.15	6/3 8:42 PM	2.036	3.517	--	--	234.7	0.3	49.03	4.65	1.727	0.978	47.96	4	1.88E-04	1250.5	3.01	94.4%	543.0
D	5/20 5:06 PM	14.17	6/3 9:11 PM	2.031	3.947	--	--	265.8	0.6	49.19	4.65	1.943	0.995	48.97	4	2.10E-04	1268.5	2.95	96.3%	550.8
E	5/20 5:06 PM	27.90	6/17 2:35 PM	2.031	3.759	--	--	253.3	1.1	49.08	4.07	1.851	0.988	48.50	N/A	2.00E-04	1269.4	2.95	96.3%	551.2
F	5/20 5:06 PM	27.91	6/17 3:03 PM	2.028	3.946	--	--	265.9	0.6	47.65	3.86	1.946	0.996	47.44	N/A	2.09E-04	1272.9	2.94	96.7%	552.7
G			Not tested																	
H			Not tested																	
																Average	1262.2			
																% Theoretical	96.7%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 30-8 SPREADSHEET

General Information

Organization	Virginia Tech	
Location	Blacksburg, VA	
Conducted By	M. Bennett, G. Filz	
Date	5/19/19 (soil), 5/20/19 (soil-cement mixing)	

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial	
Organic Content, OC	30%	
Specific Gravity of Solids, G_S	1.96	
Soil Water Content, w	156%	
Degree of Saturation, S	1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	482.1	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1234.1	

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)	
Soil Mixing Time (min.)		5
Soil/Binder Mixing Time (min.)		10
Blender Type/Model		Oster 14-Speed
Slurry Blending Time (min.)		3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	200
Weight of Binder, W_b (g)	370.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	222.4
Weight of Slurry, W_{slurry} (g)	593.1
Weight of Soil, W_{soil} (g)	1866.6

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	3.1
Bleed Water from Batch,* (g)	4.7
Volume of Bleed Water (in^3)	0.3

As-Mixed Batch Properties

W_{slurry} (g)		595.2
1) Comps. put into jar mill, g		875.1
2) Comps. removed from jar mill,g		873.2
3) Wet soil made, g	*QC only*	1856.9
4) Wet soil used, g		1843.2

W_o (g)	486.7	W_s (g)	719.1
$W_{s,o}$ (g)	343.0	$W_{w,soil}$ (g)	1124.1
		W_{soil} (g)	1843.2
$W_{w,o}$ (g)	143.7	Soil w (%)	156.3%

Mixture G_s	2.25
$\gamma_{d,mix}$ (pcf)	37.1
Mixture w, %	123.5%
$\gamma_{t,mix}$ (kg/m^3)	1328.1
Total Water-to-Binder Ratio, w_t:b	3.62
Binder Content, a (%)	51.7%
Binder Factor, α (kg/m^3)	248.99
Binder Factor In-Place, α_{I-P} (kg/m^3)	202.6
Volume Ratio, VR (%)	22.9%

w_t:b	3.61	$\gamma_{d,mix}$ (pcf)	37.2
α_{I-P} (kg/m^3)	203.1		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	493.6	492.5	486.7
$W_{i,add}$, g	381.5	380.7	376.1
$W_{w,add}$, g	N/A	992.2	980.4
Σ		1865.4	

W_b (g)	372.0
$W_{w,slurry}$ (g)	223.2
$\gamma_{D,Soil}$, pcf	30.0
$\gamma_{D,Slurry}$, pcf	67.9

Based on actual mix prepared

Checks	
α (kg/m^3)	248.99
a (kg/m^3)	51.7%
VR	22.9%
w_t:b	3.62

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/20 6:44 PM	8.18	5/28 11:08 PM	2.034	3.730	--	--	254.4	0.2	54.79	3.44	1.834	0.987	54.06	N/A	1.99E-04	1281.0	2.92	95.2%	573.2
B	5/20 6:44 PM	8.20	5/28 11:38 PM	2.039	3.622	--	--	247.5	0.5	56.24	3.33	1.776	0.982	55.23	4	1.94E-04	1277.5	2.93	94.9%	571.6
C	5/20 6:44 PM	14.13	6/3 9:49 PM	2.041	3.675	--	--	250.7	0.4	66.13	3.46	1.800	0.984	65.07	4	1.97E-04	1272.1	2.94	94.4%	569.2
D	5/20 6:44 PM	14.16	6/3 10:33 PM	2.035	3.857	--	--	264.0	0.4	71.99	3.84	1.895	0.992	71.39	4	2.06E-04	1283.9	2.91	95.5%	574.5
F	5/20 6:44 PM	27.87	6/17 3:31 PM	2.042	3.923	--	--	269.7	0.6	70.47	3.13	1.921	0.994	70.03	4	2.11E-04	1281.1	2.92	95.2%	573.3
G	5/20 6:44 PM	27.88	6/17 3:55 PM	2.040	3.763	--	--	258.7	1.0	65.76	3.36	1.845	0.988	64.95	N/A	2.02E-04	1283.5	2.91	95.5%	574.3
E			Broke																	
H			Not tested																	
																Average	1279.9			
																% Theoretical	96.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 40-1 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/20/19 (soil), 5/22/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	40%
Specific Gravity of Solids, G_S	1.80
Soil Water Content, w	211%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	374.4
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1164.4

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	400
Weight of Binder, W_b (g)	741.3
Weight of Slurry Water, $W_{w,slurry}$ (g)	741.3
Weight of Slurry, W_{slurry} (g)	1482.7
Weight of Soil, W_{soil} (g)	1018.4

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	19.7
Bleed Water from Batch,* (g)	29.6
Volume of Bleed Water (in^3)	1.8

As-Mixed Batch Properties

W_{slurry} (g)		1484.7	Estimated
1) Comps. put into jar mill, g		422.9	
2) Comps. removed from jar mill, g		421.2	
3) Wet soil made, g	QC only	1014.4	
4) Wet soil used, g		1000.3	

W_o (g)	296.1	W_s (g)	319.6
$W_{s,o}$ (g)	203.2	$W_{w,soil}$ (g)	680.7
		W_{soil} (g)	1000.3
$W_{w,o}$ (g)	92.9	Soil w (%)	213.0%

Mixture G_s	2.57
$\gamma_{d,mix}$ (pcf)	36.0
Mixture w, %	134.0%
$\gamma_{t,mix}$ (kg/m^3)	1350.5
Total Water-to-Binder Ratio, w_t:b	1.92
Binder Content, a (%)	232.3%
Binder Factor, α (kg/m^3)	863.18
Binder Factor In-Place, α_{I-P} (kg/m^3)	403.4
Volume Ratio, VR (%)	114.0%

w_t:b	1.88	$\gamma_{d,mix}$ (pcf)	36.6
α_{I-P} (kg/m^3)	410.0		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	303.6	302.4	296.1
$W_{i,add}$, g	119.3	118.8	116.3
$W_{w,add}$, g	N/A	600.4	587.9
Σ		1021.6	

W_b (g)	742.4
$W_{w,slurry}$ (g)	742.4
$\gamma_{D,Soil}$, pcf	23.2
$\gamma_{D,Slurry}$, pcf	47.3

Based on actual mix prepared

Checks	
α (kg/m^3)	863.15
a (kg/m^3)	232.3%
VR	114.0%
w_t:b	1.92

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/22 7:54 PM	7.06	5/29 9:19 PM	2.041	3.782	--	--	273.6	3.6	101.25	1.32	1.853	0.988	100.05	N/A	2.03E-04	1349.4	3.45	99.9%	576.6
B	5/22 7:54 PM	7.08	5/29 9:47 PM	2.035	3.710	--	--	268.8	2.4	99.38	1.45	1.823	0.986	97.97	4	1.98E-04	1359.1	3.42	100.8%	580.8
C	5/22 7:54 PM	13.88	6/5 5:00 PM	2.044	3.648	--	--	265.0	3.6	120.52	1.37	1.785	0.983	118.45	N/A	1.96E-04	1350.4	3.44	100.0%	577.1
D	5/22 7:54 PM	13.90	6/5 5:24 PM	2.041	3.695	--	--	268.3	3.3	118.12	1.41	1.810	0.985	116.32	N/A	1.98E-04	1353.8	3.43	100.3%	578.5
E	5/22 7:54 PM	27.67	6/19 12:04 PM	2.045	3.564	--	--	260.5	3.8	161.75	1.11	1.743	0.979	158.42	N/A	1.92E-04	1358.4	3.42	100.8%	580.5
F	5/22 7:54 PM	27.69	6/19 12:29 PM	2.040	3.549	--	--	259.0	3.0	156.92	1.04	1.740	0.979	153.65	N/A	1.90E-04	1363.0	3.40	101.2%	582.4
G			Not tested																	
H			Not tested																	
																Average	1355.7			
																% Theoretical	100.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 40-2 SPREADSHEET

General Information			
Organization	Virginia Tech		
Location	Blacksburg, VA		
Conducted By	M. Bennett, G. Filz		
Date	5/21/19 (soil), 5/22/19 (soil-cement mixing)		
Binder Properties:			
Binder Type	Portland Cement (Type I/II)		
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf
Soil Properties:			
Soil Type		Artificial	
Organic Content, OC		40%	
Specific Gravity of Solids, G_S		1.80	
Soil Water Content, w		211%	
Degree of Saturation, S		1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)		374.4	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)		1164.4	

Mixing Machinery & Time	
Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3
Batch Design Properties:	
Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.5
Binder Factor In-Place, α_{I-P} (kg/m^3)	400
Weight of Binder, W_b (g)	741.3
Weight of Slurry Water, $W_{w,slurry}$ (g)	370.7
Weight of Slurry, W_{slurry} (g)	1112.0
Weight of Soil, W_{soil} (g)	1450.9
Batch As-Cured Properties:	
# Specimens Tested	6
Bleed Water from Specimens, g	2.6
Bleed Water from Batch,* (g)	3.9
Volume of Bleed Water (in^3)	0.2

As-Mixed Batch Properties

W_{slurry} (g)			1113.7		
1) Comps. put into jar mill, g			602.3		
2) Comps. removed from jar mill,g			600.8		
3) Wet soil made, g		*QC only*	1447.6		
4) Wet soil used, g			1433.3		
	W_o (g)	424.5		W_s (g)	458.2
	$W_{s,o}$ (g)	291.4		$W_{w,soil}$ (g)	975.1
				W_{soil} (g)	1433.3
	$W_{w,o}$ (g)	133.2		Soil w (%)	212.8%
Mixture G_s			2.45		
$\gamma_{d,mix}$ (pcf)			40.7		
Mixture w, %			112.1%		
$\gamma_{t,mix}$ (kg/m^3)			1383.9		
Total Water-to-Binder Ratio, w_t:b			1.81		
Binder Content, a (%)			162.1%		
Binder Factor, α (kg/m^3)			602.57		
Binder Factor In-Place, α_{I-P} (kg/m^3)			403.4		
Volume Ratio, VR (%)			49.4%		
	w_t:b	1.81		$\gamma_{d,mix}$ (pcf)	40.8
	α_{I-P} (kg/m^3)	404.3			

	Components		Wet soil
	Mass 1	Mass 2	Mass 4
W_o, g	432.4	431.3	424.5
$W_{i,add}$, g	169.9	169.5	166.8
$W_{w,add}$, g	N/A	855.5	842.0
Σ		1456.3	
	W_b (g)	742.5	
	$W_{w,slurry}$ (g)	371.2	
	$\gamma_{D,Soil}$, pcf	23.2	
	$\gamma_{D,Slurry}$, pcf	76.2	
		Checks	
Based on actual mix prepared		α (kg/m^3)	602.55
		a (kg/m^3)	162.1%
		VR	49.4%
		w_t:b	1.81
		Based on table below	

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/22 9:54 PM	7.01	5/29 10:13 PM	2.044	3.575	--	--	235.8	0.1	119.29	1.28	1.749	0.980	116.89	N/A	1.92E-04	1226.6	3.23	85.1%	578.2
B	5/22 9:54 PM	7.03	5/29 10:39 PM	2.048	3.735	--	--	246.7	0.2	117.75	1.29	1.824	0.986	116.08	4	2.02E-04	1223.7	3.24	84.8%	576.8
C	5/22 9:54 PM	13.83	6/5 5:52 PM	2.038	3.763		--	250.2	0.6	145.99	1.12	1.847	0.988	144.20	N/A	2.01E-04	1244.3	3.17	86.7%	586.5
D	5/22 9:54 PM	13.85	6/5 6:16 PM	2.048	3.817	--	--	257.0	0.6	144.60	1.00	1.864	0.989	143.03	4	2.06E-04	1247.2	3.16	87.0%	587.9
E	5/22 9:54 PM	27.63	6/19 12:55 PM	2.044	3.835		--	258.7	0.2	182.80	1.09	1.876	0.990	180.98	N/A	2.06E-04	1254.0	3.13	87.6%	591.1
F	5/22 9:54 PM	27.64	6/19 1:16 PM	2.045	3.803	--	--	258.5	0.9	174.94	0.96	1.860	0.989	172.98	N/A	2.05E-04	1262.9	3.11	88.4%	595.3
G			Not tested																	
H			Not tested																	
																Average	1243.1			
																% Theoretical	89.8%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 40-3 SPREADSHEET

General Information		
Organization	Virginia Tech	
Location	Blacksburg, VA	
Conducted By	M. Bennett, G. Filz	
Date	5/21/19 (soil), 5/22/19 (soil-cement mixing)	
Binder Properties:		
Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf
Soil Properties:		
Soil Type	Artificial	
Organic Content, OC	40%	
Specific Gravity of Solids, G_S	1.80	
Soil Water Content, w	211%	
Degree of Saturation, S	1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	374.4	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1164.4	

Mixing Machinery & Time	
Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3
Batch Design Properties:	
Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	500
Weight of Binder, W_b (g)	926.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	926.7
Weight of Slurry, W_{slurry} (g)	1853.3
Weight of Soil, W_{soil} (g)	733.6
Batch As-Cured Properties:	
# Specimens Tested	6
Bleed Water from Specimens, g	50.5
Bleed Water from Batch,* (g)	75.8
Volume of Bleed Water (in^3)	4.6

As-Mixed Batch Properties					
W_{slurry} (g)			1855.2		
1) Comps. put into jar mill, g			304.7		
2) Comps. removed from jar mill,g			303.3		
3) Wet soil made, g		*QC only*	750.0		
4) Wet soil used, g			736		
W_o (g)	210.9		W_s (g)	227.6	
$W_{s,o}$ (g)	144.8		$W_{w,soil}$ (g)	508.4	
			W_{soil} (g)	736.0	
$W_{w,o}$ (g)	66.2		Soil w (%)	223.3%	
Mixture G_s			2.74		
$\gamma_{d,mix}$ (pcf)			38.8		
Mixture w, %			124.3%		
$\gamma_{t,mix}$ (kg/m^3)			1392.6		
Total Water-to-Binder Ratio, w_t:b			1.55		
Binder Content, a (%)			407.5%		
Binder Factor, α (kg/m^3)			1458.20		
Binder Factor In-Place, α_{I-P} (kg/m^3)			498.5		
Volume Ratio, VR (%)			192.5%		
w_t:b	1.47			$\gamma_{d,mix}$ (pcf)	40.4
α_{I-P} (kg/m^3)	519.7				

Components	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	218.7	217.7	210.9
$W_{i,add}$, g	85.9	85.5	82.8
$W_{w,add}$, g	N/A	456.4	442.2
Σ		759.6	
W_b (g)		927.6	
$W_{w,slurry}$ (g)		927.6	
$\gamma_{D,Soil}$, pcf		22.3	
$\gamma_{D,Slurry}$, pcf		47.3	

Based on actual mix prepared	Checks	
	α (kg/m^3)	1458.16
	a (kg/m^3)	407.5%
	VR	192.5%
	w_t:b	1.55

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/22 11:20 PM	6.99	5/29 11:10 PM	2.043	3.469	--	--	258.2	9.3	180.02	0.74	1.698	0.976	175.67	N/A	1.86E-04	1385.4	3.43	99.3%	617.7
B	5/22 11:20 PM	7.01	5/29 11:36 PM	2.047	3.501	--	--	257.8	9.2	180.90	0.71	1.710	0.977	176.70	N/A	1.89E-04	1365.1	3.50	97.5%	608.6
C	5/22 11:20 PM	13.83	6/5 7:12 PM	2.043	3.578	--	--	265.2	8.0	210.23	0.67	1.752	0.980	206.05	N/A	1.92E-04	1380.2	3.45	98.8%	615.3
D	5/22 11:20 PM	13.84	6/5 7:36 PM	2.039	3.605	--	--	269.1	8.5	226.26	0.58	1.768	0.981	222.06	N/A	1.93E-04	1394.6	3.41	100.2%	621.8
E	5/22 11:20 PM	27.60	6/19 1:45 PM	2.043	3.350	--	--	255.8	8.1	356.13	0.76	1.640	0.971	345.87	N/A	1.80E-04	1421.9	3.32	102.7%	633.9
F	5/22 11:20 PM	27.64	6/19 2:45 PM	2.047	3.556	--	--	271.9	7.4	355.81	0.68	1.737	0.979	348.32	N/A	1.92E-04	1417.4	3.33	102.3%	631.9
G			Not tested																	
H			Not tested																	
																Average	1394.1			
																% Theoretical	100.1%			

Based on table below

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 40-4 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/21/19 (soil), 5/23/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	40%
Specific Gravity of Solids, G_S	1.80
Soil Water Content, w	211%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	374.4
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1164.4

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	250
Weight of Binder, W_b (g)	463.3
Weight of Slurry Water, $W_{w,slurry}$ (g)	278.0
Weight of Slurry, W_{slurry} (g)	741.3
Weight of Soil, W_{soil} (g)	1662.0

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	4.4
Bleed Water from Batch,* (g)	6.6
Volume of Bleed Water (in^3)	0.4

As-Mixed Batch Properties

W_{slurry} (g)			743.6
1) Comps. put into jar mill, g			689.9
2) Comps. removed from jar mill,g			688.5
3) Wet soil made, g		*QC only*	1652.9
4) Wet soil used, g			1636.9

W_o (g)	487.1	W_s (g)	525.7
$W_{s,o}$ (g)	334.3	$W_{w,soil}$ (g)	1111.2
		W_{soil} (g)	1636.9
$W_{w,o}$ (g)	152.8	Soil w (%)	211.4%

Mixture G_s	2.25
$\gamma_{d,mix}$ (pcf)	33.7
Mixture w, %	140.3%
$\gamma_{t,mix}$ (kg/m^3)	1298.4
Total Water-to-Binder Ratio, w_t:b	2.99
Binder Content, a (%)	88.4%
Binder Factor, α (kg/m^3)	330.52
Binder Factor In-Place, α_{I-P} (kg/m^3)	253.5
Volume Ratio, VR (%)	30.4%
w_t:b	2.98
α_{I-P} (kg/m^3)	254.4
$\gamma_{d,mix}$ (pcf)	33.8

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	495.3	494.3	487.1
$W_{i,add}$, g	194.6	194.2	191.4
$W_{w,add}$, g	N/A	972.6	958.4
Σ		1661.1	

W_b (g)	464.8
$W_{w,slurry}$ (g)	278.9
$\gamma_{D,Soil}$, pcf	23.3
$\gamma_{D,Slurry}$, pcf	67.9

Based on actual mix prepared

Checks	
α (kg/m^3)	330.51
a (kg/m^3)	88.4%
VR	30.4%
w_t:b	2.99

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
B	5/23 12:53 AM	6.97	5/30 12:09 AM	2.043	3.859	--	--	258.5	0.6	53.20	2.72	1.889	0.991	52.73	4	2.07E-04	1247.3	3.33	94.9%	519.0
C	5/23 12:53 AM	6.99	5/30 12:33 AM	2.042	3.736	--	--	250.6	1.1	51.51	2.86	1.830	0.986	50.81	4	2.00E-04	1250.1	3.32	95.2%	520.1
D	5/23 12:53 AM	13.80	6/5 7:58 PM	2.040	3.499	--	--	234.7	0.7	59.77	1.94	1.715	0.977	58.41	N/A	1.87E-04	1252.7	3.31	95.4%	521.2
E	5/23 12:53 AM	13.81	6/5 8:21 PM	2.035	3.878	--	--	260.8	0.7	64.81	2.12	1.905	0.992	64.31	4	2.07E-04	1261.5	3.28	96.3%	524.9
F	5/23 12:53 AM	27.59	6/19 3:07 PM	2.042	3.975	--	--	267.2	0.5	71.12	2.25	1.947	0.996	70.82	4	2.13E-04	1252.9	3.31	95.4%	521.3
G	5/23 12:53 AM	27.61	6/19 3:35 PM	2.041	3.759	--	--	252.8	0.8	70.15	1.49	1.842	0.987	69.27	N/A	2.02E-04	1254.4	3.31	95.6%	521.9
A			Broke																	
H			Not tested																	
																Average	1253.2			
																% Theoretical	96.5%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB DATA: ORGANIC BATCH 50-1 MIXING SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	12/5/18 (soil), 12/5/18 (mix)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	50%
Specific Gravity of Solids, G_S	1.67
Soil Water Content, w	265%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	307.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1121.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	200
Weight of Binder, W_b (g)	494.2
Weight of Slurry Water, $W_{w,slurry}$ (g)	494.2
Weight of Slurry, W_{slurry} (g)	988.4
Weight of Soil, W_{soil} (g)	2039.1

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	37.0
Bleed Water from Batch,* (g)	74.0
Volume of Bleed Water (in^3)	4.5

As-Mixed Batch Properties

W_{slurry} (g)	996.9	
1) Comps. put into jar mill, g	759.2	
2) Comps. removed from jar mill,g	757.0	
3) Wet soil made, g	2031.6	*QC only*
4) Wet soil used, g	2028.0	

W_o (g)	640.8	W_s (g)	542.1
$W_{s,o}$ (g)	431.2	$W_{w,soil}$ (g)	1485.9
		W_{soil} (g)	2028.0
$W_{w,o}$ (g)	209.6	Soil w (%)	274.1%

Mixture G_s	2.15
$\gamma_{d,mix}$ (pcf)	26.3
Mixture w, %	190.7%
$\gamma_{t,mix}$ (kg/m^3)	1223.5
Total Water-to-Binder Ratio, w_t:b	3.98
Binder Content, a (%)	91.9%
Binder Factor, α (kg/m^3)	274.75
Binder Factor In-Place, α_{I-P} (kg/m^3)	201.6
Volume Ratio, VR (%)	36.3%

w_t:b	3.83	$\gamma_{d,mix}$ (pcf)	27.1
α_{I-P} (kg/m^3)	207.9		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	647.2	645.3	640.8
$W_{i,add}$, g	112.0	111.7	110.9
$W_{w,add}$, g	N/A	1285.2	1276.3
Σ		2042.2	

W_b (g)	498.5
$W_{w,slurry}$ (g)	498.5
$\gamma_{D,Soil}$, pcf	18.7
$\gamma_{D,Slurry}$, pcf	47.3

Checks (Based on actual mix prepared)

α (kg/m^3)	274.74
a (kg/m^3)	91.9%
VR	36.3%
w_t:b	3.98

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	12/5 7:30 PM	11.11	12/16 10:01 PM	2.016	3.577	--	--	223.2	6.6	17.07	4.07	1.774	0.982	16.77	4	1.87E-04	1193.3	4.24	96.9%	410.5
C	12/5 7:30 PM	11.17	12/16 11:28 PM	2.019	3.756	--	--	236.9	7.4	18.28	4.08	1.860	0.989	18.07	4	1.97E-04	1202.0	4.20	97.8%	413.5
D	12/5 7:30 PM	13.89	12/19 4:58 PM	2.017	3.761	--	--	236.6	6.7	19.10	4.20	1.864	0.989	18.89	4	1.97E-04	1201.0	4.21	97.7%	413.2
E	12/5 7:30 PM	13.95	12/19 6:12 PM	2.021	3.633	--	--	227.5	4.7	22.66	4.07	1.797	0.984	22.29	4	1.91E-04	1191.3	4.25	96.7%	409.8
F	12/5 7:30 PM	30.83	1/5 3:23 PM	2.018	3.617	--	--	230.4	5.5	23.00	3.72	1.792	0.983	22.62	4	1.90E-04	1215.8	4.14	99.2%	418.2
G	12/5 7:30 PM	30.88	1/5 4:40 PM	2.012	3.648	--	--	231.8	6.1	24.35	3.77	1.813	0.985	23.98	4	1.90E-04	1219.7	4.13	99.6%	419.6
B			Broke																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1203.9			
																% Theoretical	98.4%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 50-2 SPREADSHEET

General Information			
Organization	Virginia Tech		
Location	Blacksburg, VA		
Conducted By	M. Bennett, G. Filz		
Date	12/5/18 (soil), 12/5/18 (mix)		
Binder Properties:			
Binder Type	Portland Cement (Type I/II)		
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf
Soil Properties:			
Soil Type		Artificial	
Organic Content, OC		50%	
Specific Gravity of Solids, G_S		1.67	
Soil Water Content, w		265%	
Degree of Saturation, S		1	
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)		307.2	
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)		1121.2	

Mixing Machinery & Time		
Mixer Type & Model	Hobart (Dough Hook)	
Soil Mixing Time (min.)		5
Soil/Binder Mixing Time (min.)		10
Blender Type/Model		Oster 14-Speed
Slurry Blending Time (min.)		3
Batch Design Properties:		
Number of Specimens, N		10
Water-to-Binder Ratio of Slurry, w:b		1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)		281
Weight of Binder, W_b (g)		694.4
Weight of Slurry Water, $W_{w,slurry}$ (g)		694.4
Weight of Slurry, W_{slurry} (g)		1388.8
Weight of Soil, W_{soil} (g)		1742.9
Batch As-Cured Properties:		
# Specimens Tested		6
Bleed Water from Specimens, g		57.5
Bleed Water from Batch,* (g)		115.0
Volume of Bleed Water (in^3)		7.0

As-Mixed Batch Properties					
W_{slurry} (g)				1389.6	
1) Comps. put into jar mill, g				649.0	
2) Comps. removed from jar mill,g				646.6	
3) Wet soil made, g			*QC only*	1736.6	
4) Wet soil used, g				1732.4	
	W_o (g)	546.6		W_s (g)	462.4
	$W_{s,o}$ (g)	367.8		$W_{w,soil}$ (g)	1270.0
				W_{soil} (g)	1732.4
	$W_{w,o}$ (g)	178.8		Soil w (%)	274.7%
Mixture G_s				2.33	
$\gamma_{d,mix}$ (pcf)				29.3	
Mixture w, %				169.8%	
$\gamma_{t,mix}$ (kg/m^3)				1265.3	
Total Water-to-Binder Ratio, w_t:b				2.83	
Binder Content, a (%)				150.3%	
Binder Factor, α (kg/m^3)				448.25	
Binder Factor In-Place, α_{I-P} (kg/m^3)				281.6	
Volume Ratio, VR (%)				59.2%	
	w_t:b		2.66	$\gamma_{d,mix}$ (pcf)	30.7
	α_{I-P} (kg/m^3)		295.4		

	Components		Wet soil
	Mass 1	Mass 2	Mass 4
W_o, g	553.3	551.3	546.6
$W_{i,add}$, g	95.7	95.3	94.5
$W_{w,add}$, g	N/A	1100.5	1091.2
Σ		1747.1	
	W_b (g)	694.8	
	$W_{w,slurry}$ (g)	694.8	
	$\gamma_{D,Soil}$, pcf	18.6	
	$\gamma_{D,Slurry}$, pcf	47.3	

Based on actual mix prepared	Checks	
	α (kg/m^3)	448.23
	a (kg/m^3)	150.3%
	VR	59.2%
	w_t:b	2.83

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	12/5 4:30 PM	11.34	12/17 12:36 AM	2.033	3.688	--	--	241.4	11.0	35.01	2.47	1.814	0.985	34.49	4	1.96E-04	1230.1	4.09	96.5%	456.0
B	12/5 4:30 PM	11.38	12/17 1:41 AM	2.031	3.696	--	--	241.4	9.9	32.77	2.48	1.820	0.986	32.30	4	1.96E-04	1230.5	4.09	96.6%	456.1
C	12/5 4:30 PM	14.12	12/19 7:23 PM	2.031	3.754	--	--	245.6	9.9	31.08	2.07	1.849	0.988	30.71	4	1.99E-04	1232.7	4.08	96.8%	456.9
D	12/5 4:30 PM	14.19	12/19 8:58 PM	2.029	3.787	--	--	245.6	8.6	34.93	2.46	1.867	0.989	34.56	4	2.01E-04	1224.4	4.12	96.0%	453.8
E	12/5 4:30 PM	31.05	1/5 5:39 PM	2.028	3.529	--	--	230.1	8.8	39.08	2.24	1.740	0.979	38.27	4	1.87E-04	1231.4	4.09	96.7%	456.4
F	12/5 4:30 PM	31.09	1/5 6:36 PM	2.022	3.705	--	--	244.6	9.3	38.68	2.06	1.833	0.987	38.16	4	1.95E-04	1254.9	3.99	99.0%	465.1
G			Not tested																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1234.0			
																% Theoretical	97.5%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC BATCH 50-3 MIXING SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	12/5/18 (soil), 12/6/18 (mix)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F), γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	50%
Specific Gravity of Solids, G_S	1.67
Soil Water Content, w	265%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	307.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1121.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	10
Water-to-Binder Ratio of Slurry, w:b	1.0
Binder Factor In-Place, α_{I-P} (kg/m^3)	338
Weight of Binder, W_b (g)	835.2
Weight of Slurry Water, $W_{w,slurry}$ (g)	835.2
Weight of Slurry, W_{slurry} (g)	1670.5
Weight of Soil, W_{soil} (g)	1534.4

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	62.7
Bleed Water from Batch,* (g)	125.4
Volume of Bleed Water (in^3)	7.7

As-Mixed Batch Properties

W_{slurry} (g)		1672.1
1) Comps. put into jar mill, g		571.4
2) Comps. removed from jar mill,g		569.6
3) Wet soil made, g	QC only	1526.7
4) Wet soil used, g		1525.6

W_o (g)	482.1	W_s (g)	407.9
$W_{s,o}$ (g)	324.4	$W_{w,soil}$ (g)	1117.7
		W_{soil} (g)	1525.6
$W_{w,o}$ (g)	157.7	Soil w (%)	274.1%

Mixture G_s	2.44
$\gamma_{d,mix}$ (pcf)	31.5
Mixture w, %	157.1%
$\gamma_{t,mix}$ (kg/m^3)	1295.4
Total Water-to-Binder Ratio, w_t:b	2.34
Binder Content, a (%)	205.0%
Binder Factor, α (kg/m^3)	612.61
Binder Factor In-Place, α_{I-P} (kg/m^3)	338.7
Volume Ratio, VR (%)	80.9%

w_t:b	2.19	$\gamma_{d,mix}$ (pcf)	33.1
α_{I-P} (kg/m^3)	356.9		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	487.1	485.6	482.1
$W_{i,add}$, g	84.3	84.0	83.4
$W_{w\text{-}add}$, g	N/A	967.0	960.1
Σ		1536.6	

W_b (g)	836.1
$W_{w,slurry}$ (g)	836.1
$\gamma_{D,Soil}$, pcf	18.7
$\gamma_{D,Slurry}$, pcf	47.3

Based on actual mix prepared

Checks	
α (kg/m^3)	612.59
a (kg/m^3)	205.0%
VR	80.9%
w_t:b	2.34

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	12/6 12:30 AM	11.49	12/17 12:12 PM	2.029	3.662	--	--	238.3	10.8	60.15	2.44	1.805	0.984	59.21	4	1.94E-04	1228.4	4.10	93.6%	477.8
C	12/6 12:30 AM	11.56	12/17 2:01 PM	2.038	3.674	--	--	244.0	11.1	58.24	1.65	1.802	0.984	57.32	N/A	1.96E-04	1242.1	4.04	94.9%	483.2
D	12/6 12:30 AM	13.96	12/19 11:36 PM	2.036	3.665	--	--	247.8	10.7	57.41	1.34	1.800	0.984	56.49	N/A	1.96E-04	1267.0	3.94	97.2%	492.9
E	12/6 12:30 AM	14.01	12/20 12:42 AM	2.037	3.637	--	--	248.6	10.8	58.09	1.64	1.786	0.983	57.10	4	1.94E-04	1280.3	3.89	98.5%	498.0
F	12/6 12:30 AM	30.88	1/5 9:31 PM	2.032	3.618	--	--	250.0	9.7	71.24	1.69	1.781	0.982	69.99	4	1.92E-04	1300.6	3.81	100.5%	506.0
G	12/6 12:30 AM	30.92	1/5 10:30 PM	2.030	3.704	--	--	250.2	9.6	68.78	1.37	1.824	0.986	67.81	N/A	1.96E-04	1273.7	3.92	97.9%	495.5
B			Broke																	
H			Not tested																	
I			Not tested																	
J			Not tested																	
																Average	1265.4			
																% Theoretical	97.7%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 50-4 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/20/19 (soil), 4/21/19 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m³
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	50%
Specific Gravity of Solids, G_S	1.67
Soil Water Content, w	265%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m³)	307.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m³)	1121.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.8
Binder Factor In-Place, α_{I-P} (kg/m³)	400
Weight of Binder, W_b (g)	741.3
Weight of Slurry Water, $W_{w,slurry}$ (g)	593.1
Weight of Slurry, W_{slurry} (g)	1334.4
Weight of Soil, W_{soil} (g)	1147.3

Batch As-Cured Properties:

# Specimens Tested	7
Bleed Water from Specimens, g	36.1
Bleed Water from Batch,* (g)	46.4
Volume of Bleed Water (in³)	2.8

As-Mixed Batch Properties

W_{slurry} (g)		1337.0
1) Comps. put into jar mill, g		419.2
2) Comps. removed from jar mill,g		417.6
3) Wet soil made, g	*QC only*	1137.2
4) Wet soil used, g		1134.5

W_o (g)	349.7	W_s (g)	310.0
$W_{s,o}$ (g)	246.4	$W_{w,soil}$ (g)	824.5
		W_{soil} (g)	1134.5
$W_{w,o}$ (g)	103.3	Soil w (%)	265.9%

Mixture G_s	2.50
$\gamma_{d,mix}$ (pcf)	35.6
Mixture w, %	134.8%
$\gamma_{t,mix}$ (kg/m³)	1340.3
Total Water-to-Binder Ratio, w_t:b	1.91
Binder Content, a (%)	239.6%
Binder Factor, α (kg/m³)	733.85
Binder Factor In-Place, α_{I-P} (kg/m³)	402.8
Volume Ratio, VR (%)	82.2%

w_t:b	1.85	$\gamma_{d,mix}$ (pcf)	36.6
α_{I-P} (kg/m³)	413.3		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	354.7	353.3	349.7
$W_{i,add}$, g	64.5	64.3	63.6
$W_{w,add}$, g	N/A	728.7	721.2
Σ		1146.3	

W_b (g)	742.8
$W_{w,slurry}$ (g)	594.2
$\gamma_{D,Soil}$, pcf	19.1
$\gamma_{D,Slurry}$, pcf	55.8

Based on actual mix prepared

Checks	
α (kg/m³)	733.83
a (kg/m³)	239.6%
VR	82.2%
w_t:b	1.91

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m³)	$\gamma_{t,mix}$ (kg/m³)	e	S	$\gamma_{d,mix}$ (kg/m³)
A	4/21 10:56 PM	6.93	4/28 9:15 PM	2.039	3.670	--	--	261.0	5.7	95.53	1.84	1.800	0.984	94.00	4	1.96E-04	1328.7	3.40	98.9%	566.0
B	4/21 10:56 PM	6.96	4/28 9:56 PM	2.038	3.523	--	--	249.3	5.6	87.10	1.73	1.729	0.978	85.21	4	1.88E-04	1324.1	3.42	98.4%	564.1
C	4/21 10:56 PM	14.00	5/5 10:53 PM	2.037	3.673	--	--	262.3	4.6	104.36	1.55	1.803	0.984	102.72	4	1.96E-04	1337.2	3.38	99.7%	569.6
D	4/21 10:56 PM	14.02	5/5 11:27 PM	2.039	3.591	--	--	255.3	5.8	101.27	1.61	1.761	0.981	99.33	4	1.92E-04	1328.2	3.41	98.8%	565.8
E	4/21 10:56 PM	28.91	5/20 8:51 PM	2.038	3.518	--	--	250.6	6.1	118.10	1.61	1.726	0.978	115.51	N/A	1.88E-04	1333.0	3.39	99.3%	567.8
G	4/21 10:56 PM	29.92	5/21 8:59 PM	2.038	3.579	--	--	257.6	3.7	143.54	1.20	1.756	0.981	140.74	N/A	1.91E-04	1346.8	3.35	100.6%	573.7
H	4/21 10:56 PM	30.01	5/21 11:08 PM	2.043	3.576	--	--	259.3	4.6	158.00	1.12	1.750	0.980	154.85	N/A	1.92E-04	1349.3	3.34	100.9%	574.8
F			Broke																	
																Average	1335.3			
																% Theoretical	99.6%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

CHANGE ONLY BLACK TEXT. RED IS CALCULATED

LAB MIXING DATA: ORGANIC MIXING BATCH 50-5 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/20/19 (soil), 4/22/19 (soil-cement mixing)

Binder Properties:

Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m^3
		62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	50%
Specific Gravity of Solids, G_S	1.67
Soil Water Content, w	265%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	307.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1121.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	450
Weight of Binder, W_b (g)	834.0
Weight of Slurry Water, $W_{w,slurry}$ (g)	500.4
Weight of Slurry, W_{slurry} (g)	1334.4
Weight of Soil, W_{soil} (g)	1218.3

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	14.9
Bleed Water from Batch,* (g)	22.4
Volume of Bleed Water (in^3)	1.4

As-Mixed Batch Properties

W_{slurry} (g)		1341.8	
1) Comps. put into jar mill, g		445.2	
2) Comps. removed from jar mill,g		443.4	
3) Wet soil made, g	*QC only*	1208.2	
4) Wet soil used, g		1204.8	
W_o (g)	371.4	W_s (g)	329.2
$W_{s,o}$ (g)	261.7	$W_{w,soil}$ (g)	875.6
		W_{soil} (g)	1204.8
$W_{w,o}$ (g)	109.7	Soil w (%)	265.9%
Mixture G_s		2.52	
$\gamma_{d,mix}$ (pcf)		39.5	
Mixture w, %		118.1%	
$\gamma_{t,mix}$ (kg/m^3)		1379.6	
Total Water-to-Binder Ratio, w_t:b		1.64	
Binder Content, a (%)		254.7%	
Binder Factor, α (kg/m^3)		780.19	
Binder Factor In-Place, α_{I-P} (kg/m^3)		454.3	
Volume Ratio, VR (%)		71.7%	
w_t:b	1.62	$\gamma_{d,mix}$ (pcf)	40.0
α_{I-P} (kg/m^3)	459.9		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	376.7	375.2	371.4
$W_{i,add}$, g	68.5	68.2	67.5
$W_{w,add}$, g	N/A	773.8	765.9
Σ		1217.2	

W_b (g)	838.6
$W_{w,slurry}$ (g)	503.2
$\gamma_{D,Soil}$, pcf	19.1
$\gamma_{D,Slurry}$, pcf	67.9

Checks (Based on actual mix prepared)

α (kg/m^3)	780.17
a (kg/m^3)	254.7%
VR	71.7%
w_t:b	1.64

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/22 12:43 AM	6.91	4/28 10:35 PM	2.049	3.737	--	--	269.0	2.9	149.82	1.19	1.824	0.986	147.72	N/A	2.02E-04	1332.5	3.12	95.5%	611.1
B	4/22 12:43 AM	7.42	4/29 10:53 AM	2.044	3.427	--	--	246.6	2.2	152.58	1.30	1.676	0.974	148.63	N/A	1.84E-04	1337.8	3.10	96.0%	613.5
C	4/22 12:43 AM	13.97	5/6 12:01 AM	2.045	3.492	--	--	252.8	2.4	182.49	0.97	1.707	0.977	178.22	N/A	1.88E-04	1344.5	3.08	96.6%	616.6
D	4/22 12:43 AM	14.46	5/6 11:45 AM	2.045	3.588	--	--	259.2	2.1	187.95	1.12	1.754	0.980	184.26	N/A	1.93E-04	1342.3	3.09	96.4%	615.6
E	4/22 12:43 AM	29.97	5/22 12:00 AM	2.044	3.609	--	--	261.6	2.6	222.86	1.03	1.766	0.981	218.68	N/A	1.94E-04	1348.6	3.07	97.0%	618.5
F	4/22 12:43 AM	30.00	5/22 12:39 AM	2.046	3.702	--	--	268.5	2.7	225.86	0.90	1.810	0.985	222.43	N/A	1.99E-04	1346.6	3.07	96.8%	617.5
G			Not tested																	
H			Not tested																	
																Average	1342.0			
																% Theoretical	97.3%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 50-6 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	4/20/19 (soil), 4/22/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	50%
Specific Gravity of Solids, G_S	1.67
Soil Water Content, w	265%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	307.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1121.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	500
Weight of Binder, W_b (g)	926.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	556.0
Weight of Slurry, W_{slurry} (g)	1482.7
Weight of Soil, W_{soil} (g)	1122.8

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	17.2
Bleed Water from Batch,* (g)	25.8
Volume of Bleed Water (in^3)	1.6

As-Mixed Batch Properties

W_{slurry} (g)		1484.8	
1) Comps. put into jar mill, g		410.2	
2) Comps. removed from jar mill,g		408.1	
3) Wet soil made, g	QC only	1113.6	
4) Wet soil used, g		1110.2	
W_o (g)	341.9	W_s (g)	303.1
$W_{s,o}$ (g)	241.0	$W_{w,soil}$ (g)	807.1
		W_{soil} (g)	1110.2
$W_{w,o}$ (g)	101.0	Soil w (%)	266.2%
Mixture G_s		2.59	
$\gamma_{d,mix}$ (pcf)		41.7	
Mixture w, %		110.8%	
$\gamma_{t,mix}$ (kg/m^3)		1407.4	
Total Water-to-Binder Ratio, w_t:b		1.47	
Binder Content, a (%)		306.1%	
Binder Factor, α (kg/m^3)		936.81	
Binder Factor In-Place, α_{I-P} (kg/m^3)		503.3	
Volume Ratio, VR (%)		86.1%	
w_t:b	1.44	$\gamma_{d,mix}$ (pcf)	42.3
α_{I-P} (kg/m^3)	510.5		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	347.1	345.3	341.9
$W_{i,add}$, g	63.1	62.8	62.2
$W_{w,add}$, g	N/A	713.1	706.1
Σ		1121.2	

W_b (g)	928.0
$W_{w,slurry}$ (g)	556.8
$\gamma_{D,Soil}$, pcf	19.1
$\gamma_{D,Slurry}$, pcf	67.9

Based on actual mix prepared

Checks	
α (kg/m^3)	936.78
a (kg/m^3)	306.1%
VR	86.1%
w_t:b	1.47

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	4/22 2:19 AM	7.38	4/29 11:30 AM	2.049	3.712	--	--	274.6	2.3	194.47	1.18	1.812	0.985	191.54	N/A	2.01E-04	1369.5	2.97	96.4%	649.7
B	4/22 2:19 AM	7.41	4/29 12:15 PM	2.047	3.708	--	--	274.7	2.7	200.15	0.98	1.812	0.985	197.14	N/A	2.00E-04	1374.0	2.96	96.8%	651.9
C	4/22 2:19 AM	14.42	5/6 12:23 PM	2.047	3.662	--	--	272.2	3.0	231.28	0.91	1.789	0.983	227.38	N/A	1.97E-04	1378.3	2.95	97.2%	653.9
D	4/22 2:19 AM	14.44	5/6 12:54 PM	2.051	3.738	--	--	278.2	3.6	220.47	0.82	1.822	0.986	217.33	N/A	2.02E-04	1374.3	2.96	96.8%	652.0
E	4/22 2:19 AM	29.98	5/22 1:46 AM	2.049	3.742	--	--	280.0	2.7	305.32	0.91	1.826	0.986	301.08	N/A	2.02E-04	1385.3	2.93	97.9%	657.2
F	4/22 2:19 AM	29.99	5/22 2:11 AM	2.047	3.643	--	--	273.9	2.9	316.35	1.00	1.780	0.982	310.78	N/A	1.96E-04	1394.0	2.90	98.7%	661.4
G			Not tested																	
H			Not tested																	
																Average	1379.2			
																% Theoretical	98.0%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 50-7 SPREADSHEET

General Information

Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/19/19 (soil), 5/20/19 (soil-cement mixing)

Binder Properties:

Binder Type	Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b	3.15	
Water Temp.: 21.1 °C (70 °F) γ_w	998.0	kg/m^3
	62.30	pcf

Soil Properties:

Soil Type	Artificial
Organic Content, OC	50%
Specific Gravity of Solids, G_S	1.67
Soil Water Content, w	265%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m^3)	307.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m^3)	1121.2

Mixing Machinery & Time

Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:

Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m^3)	200
Weight of Binder, W_b (g)	370.7
Weight of Slurry Water, $W_{w,slurry}$ (g)	222.4
Weight of Slurry, W_{slurry} (g)	593.1
Weight of Soil, W_{soil} (g)	1695.9

Batch As-Cured Properties:

# Specimens Tested	6
Bleed Water from Specimens, g	10.8
Bleed Water from Batch,* (g)	16.2
Volume of Bleed Water (in^3)	1.0

As-Mixed Batch Properties

W_{slurry} (g)		599.7
1) Comps. put into jar mill, g		619.6
2) Comps. removed from jar mill,g		616.7
3) Wet soil made, g	*QC only*	1685.2
4) Wet soil used, g		1668.3

W_o (g)	514.0	W_s (g)	455.7
$W_{s,o}$ (g)	362.2	$W_{w,soil}$ (g)	1212.6
		W_{soil} (g)	1668.3
$W_{w,o}$ (g)	151.8	Soil w (%)	266.1%

Mixture G_s	2.12
$\gamma_{d,mix}$ (pcf)	28.3
Mixture w, %	173.1%
$\gamma_{t,mix}$ (kg/m^3)	1237.2
Total Water-to-Binder Ratio, w_t:b	3.84
Binder Content, a (%)	82.3%
Binder Factor, α (kg/m^3)	251.81
Binder Factor In-Place, α_{I-P} (kg/m^3)	204.5
Volume Ratio, VR (%)	23.1%

w_t:b	3.79	$\gamma_{d,mix}$ (pcf)	28.5
α_{I-P} (kg/m^3)	206.3		

Components

	Mass 1	Mass 2	Wet soil Mass 4
W_o, g	524.2	521.7	514.0
$W_{i,add}$, g	95.3	94.9	93.4
$W_{w,add}$, g	N/A	1076.8	1060.8
Σ		1693.4	

W_b (g)	374.8
$W_{w,slurry}$ (g)	224.9
$\gamma_{D,Soil}$, pcf	19.1
$\gamma_{D,Slurry}$, pcf	67.9

Based on actual mix prepared

Checks	
α (kg/m^3)	251.80
a (kg/m^3)	82.3%
VR	23.1%
w_t:b	3.84

Based on table below

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m^3)	$\gamma_{t,mix}$ (kg/m^3)	e	S	$\gamma_{d,mix}$ (kg/m^3)
A	5/20 1:16 AM	8.80	5/28 8:34 PM	2.036	3.676	--	--	234.3	1.6	26.42	3.78	1.806	0.984	26.01	4	1.96E-04	1194.7	3.83	95.7%	437.5
B	5/20 1:16 AM	8.82	5/28 8:57 PM	2.041	3.418	--	--	220.7	1.9	32.32	4.45	1.675	0.974	31.48	4	1.83E-04	1204.3	3.80	96.6%	441.0
C	5/20 1:16 AM	14.69	6/3 5:45 PM	2.027	3.359	--	--	214.8	1.7	33.56	4.94	1.657	0.973	32.64	4	1.78E-04	1209.3	3.78	97.1%	442.8
D	5/20 1:16 AM	14.72	6/3 6:30 PM	2.027	3.621	--	--	231.4	2.4	30.74	2.93	1.786	0.983	30.22	4	1.91E-04	1208.5	3.78	97.1%	442.5
E	5/20 1:16 AM	28.49	6/17 1:03 PM	2.029	3.618	--	--	235.0	1.8	37.80	4.63	1.783	0.983	37.14	N/A	1.92E-04	1225.5	3.71	98.8%	448.8
F	5/20 1:16 AM	28.51	6/17 1:28 PM	2.023	3.700	--	--	239.3	1.4	33.50	3.98	1.829	0.986	33.04	N/A	1.95E-04	1228.2	3.70	99.1%	449.8
G			Not tested																	
H			Not tested																	
																Average	1211.7			
																% Theoretical	97.9%			

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

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LAB MIXING DATA: ORGANIC MIXING BATCH 50-8 SPREADSHEET

General Information	
Organization	Virginia Tech
Location	Blacksburg, VA
Conducted By	M. Bennett, G. Filz
Date	5/19/19 (soil), 5/20/19 (soil mixing)

Binder Properties:			
Binder Type		Portland Cement (Type I/II)	
Specific Gravity of Solids, G_b		3.15	
Water Temp.: 21.1 °C (70 °F)	γ_w	998.0	kg/m³
		62.30	pcf

Soil Properties:	
Soil Type	Artificial
Organic Content, OC	50%
Specific Gravity of Solids, G_S	1.67
Soil Water Content, w	265%
Degree of Saturation, S	1
Dry Unit Weight, $\gamma_{d,soil}$ (kg/m³)	307.2
Total Unit Weight, $\gamma_{t,soil}$ (kg/m³)	1121.2

Mixing Machinery & Time	
Mixer Type & Model	Hobart (Dough Hook)
Soil Mixing Time (min.)	5
Soil/Binder Mixing Time (min.)	10
Blender Type/Model	Oster 14-Speed
Slurry Blending Time (min.)	3

Batch Design Properties:	
Number of Specimens, N	6
Water-to-Binder Ratio of Slurry, w:b	0.6
Binder Factor In-Place, α_{I-P} (kg/m³)	300
Weight of Binder, W_b (g)	556.0
Weight of Slurry Water, $W_{w,slurry}$ (g)	333.6
Weight of Slurry, W_{slurry} (g)	889.6
Weight of Soil, W_{soil} (g)	1504.9

Batch As-Cured Properties:	
# Specimens Tested	6
Bleed Water from Specimens, g	15.6
Bleed Water from Batch,* (g)	23.4
Volume of Bleed Water (in³)	1.4

As-Mixed Batch Properties				
W_{slurry} (g)		893.7		
1) Comps. put into jar mill, g		549.9		
2) Comps. removed from jar mill,g		548.2		
3) Wet soil made, g	*QC only*	1496.6		
4) Wet soil used, g		1481.3		
W_o (g)	456.8		W_s (g)	405.1
$W_{s,o}$ (g)	321.9		$W_{w,soil}$ (g)	1076.2
			W_{soil} (g)	1481.3
$W_{w,o}$ (g)	134.9		Soil w (%)	265.7%
Mixture G_s		2.30		
$\gamma_{d,mix}$ (pcf)		32.8		
Mixture w, %		146.5%		
$\gamma_{t,mix}$ (kg/m³)		1294.3		
Total Water-to-Binder Ratio, w_t:b		2.53		
Binder Content, a (%)		137.9%		
Binder Factor, α (kg/m³)		422.68		
Binder Factor In-Place, α_{I-P} (kg/m³)		304.4		
Volume Ratio, VR (%)		38.9%		
w_t:b	2.48		$\gamma_{d,mix}$ (pcf)	33.2
α_{I-P} (kg/m³)	308.3			

	Components		Wet soil
	Mass 1	Mass 2	Mass 4
W_o, g	465.2	463.8	456.8
$W_{i,add}$, g	84.7	84.4	83.2
$W_{w,add}$, g	N/A	955.8	941.4
Σ		1504	
W_b (g)		558.6	
$W_{w,slurry}$ (g)		335.1	
$\gamma_{D,Soil}$, pcf		19.1	
$\gamma_{D,Slurry}$, pcf		67.9	

Based on actual mix prepared	Checks	
	α (kg/m³)	422.67
	a (kg/m³)	137.9%
	VR	38.9%
	w_t:b	2.53

SAMPLE DATA:

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 Mass Post-Curing (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)	ASTM C39 Failure Type	Volume (m³)	$\gamma_{t,mix}$ (kg/m³)	e	S	$\gamma_{d,mix}$ (kg/m³)
A	5/20 2:43 AM	8.78	5/28 9:24 PM	2.040	3.579	--	--	240.6	2.5	47.78	3.26	1.754	0.980	46.84	4	1.92E-04	1255.2	3.50	96.1%	509.3
B	5/20 2:43 AM	8.79	5/28 9:46 PM	2.035	3.657	--	--	246.5	3.2	49.15	2.64	1.797	0.984	48.36	4	1.95E-04	1265.0	3.46	97.1%	513.3
C	5/20 2:43 AM	14.68	6/3 7:06 PM	2.038	3.598	--	--	241.6	2.6	58.88	3.04	1.765	0.981	57.78	N/A	1.92E-04	1256.1	3.49	96.2%	509.7
D	5/20 2:43 AM	14.71	6/3 7:44 PM	2.036	3.598	--	--	240.9	2.4	59.92	2.34	1.767	0.981	58.80	4	1.92E-04	1255.3	3.50	96.1%	509.3
E	5/20 2:43 AM	28.46	6/17 1:52 PM	2.039	3.650	--	--	246.9	2.4	65.77	2.61	1.790	0.983	64.66	4	1.95E-04	1264.2	3.47	97.0%	512.9
F	5/20 2:43 AM	28.48	6/17 2:14 PM	2.037	3.627	--	--	245.4	2.5	67.22	1.90	1.780	0.982	66.04	4	1.94E-04	1267.0	3.46	97.3%	514.1
G			Not tested																	
H			Not tested																	
																Average	1260.5			
																% Theoretical	97.4%			

Based on table below

*Weight of bleed water for the batch was determined based on the average weight of bleed water per sample and the actual volume of the mix.

Appendix K. Batch Curing Temperature Data

This appendix includes a batch curing temperature data sheet for each of the 43 batches mixed.

The influence of curing temperature, T, on the UCS of organic soil-binder mixtures became a point of interest during this research. To better define this influence, direct readings of values of batch curing temperature, T_C, were commenced, first periodically and then regularly. Values of the average value of ambient temperature during curing (as measured at the Blacksburg station of the National Weather Service), denoted as T_{NWS}, were also obtained. All temperatures were measured in degrees Celsius.

The value of curing time, t, used to perform the equation fitting represented the exact time elapsed during curing. However, T was estimated using the number of calendar days elapsed since the start of curing. This slightly different value of curing time was denoted as t^*. Relevant values of t and t^* are both presented in this appendix.

As discussed in Section 3.4.1, T was estimated for the specimens in each batch using one of three methods. The estimation method was chosen based on the availability of T_C readings for the batch. For batches mixed later in the research, T_C was measured almost daily, and so it was exclusively used to estimate T. For batches mixed earlier in the research, T_C was measured periodically, and so both T_C and T_{NWS} were used to estimate T. For a handful of batches mixed at the beginning of research, no readings of T_C were taken, and only T_{NWS} could be used to estimate T. The T_C-only method was used to estimate T for 20 batches, the $T_C - T_{NWS}$ method was used for 20 batches, and the T_{NWS}-only method was used for 3 batches. The method used for each batch is denoted at the top of each data sheet.

The presentation of data for each batch depends on the method used to estimate T. Each method is reviewed in detail below.

T_C-Only Method: Values of T_C and t^* were tabulated for the period of curing. Using this data, a linear trend function for T_C versus t^* was formulated for the batch. For each specimen, the function was used to estimate T from t^*. To account for fluctuations in T over time, T was estimated using the midpoint of the curing period of the specimen. For example, the T of a specimen cured for 14 days would be estimated by evaluating the trend function at $t^* = 7$ days. Each estimate was compared to the data and, when deemed appropriate, modified on the basis of engineering judgment.

For this method, batch T_C values were not measured for the final day specimens were tested.

T_C-T_{NWS} Method: Values of T_C, T_{NWS}, and t^* were tabulated for each day on which T_C was measured during the period of curing. Using the process described for the T_C-only method, estimates of T based on T_C readings were generated for the specimens in the batch.

Next, a linear trend function which evaluated T_C versus T_{NWS} was generated for the batch. This trend function was evaluated using a complete set of T_{NWS} data for the curing period to estimate T

on each day of curing. For each specimen, estimated T values were averaged over the curing period to generate a second estimate of T. For example, the T of a specimen cured for 14 days would be estimated by averaging the daily estimates of T from $t^* = 0$ days to $t^* = 14$ days.

Finally, for each specimen, the estimate of T based on the T_C versus t^* trend function was compared with the estimate of T based on the T_C versus T_{NWS} trend function. These estimates were used to generate a final estimate of T for each specimen. To minimize potential errors, the final estimate was generated using not a strict equation but a careful consideration of the estimate values, the data on which they were based, and engineering judgment. As stated in Section 3.4.1, the measured values of T_C and the estimates based upon them were generally given more consideration because they were viewed as a better representation of actual temperatures than the measured values of T_{NWS} and the estimates based upon them.

T_{NWS}-Only Method: To estimate T solely from T_{NWS}, T_C versus T_{NWS} data was gathered from batches for which the T_C-T_{NWS} method had been used. T_{NWS} data was then obtained for the periods of curing for the batches of interest. Based on the range of T_{NWS} data for these periods of curing, the set of T_C versus T_{NWS} data was pared so similar values of T_{NWS} would be compared between the two sets. All points in the T_C versus T_{NWS} data set which had values of T_{NWS} less than 6 °C (43 °F) were removed. Data for this function is included at the end of the appendix.

A linear trend function was then fitted to the combined set of T_C versus T_{NWS} data. Usually, values of T_{NWS} had been compared to multiple values of T_C, since multiple batches were always curing simultaneously. All of these pairs of data were used during the fitting process. The data used to generate this function is included at the end of this appendix.

For each batch, the combined T_C versus T_{NWS} trend function was used with the relevant T_{NWS} data to estimate T on each day of curing. For each specimen in the batch, the estimated T values were averaged over the curing period to generate a final estimate of T.

Many of the linear trend functions used in estimating T for each batch had low values of R^2. The trend functions were ultimately still used, since they were being supplemented with both engineering judgment and checks with the full set of data. All values of R^2 for the trend functions are included in the data sheets, along with the expressions for the functions.

T_C was measured using a four-probe thermometer, the readings from which were averaged. During the testing program, some of the probes failed and could not be immediately replaced. As a result, some T_C values listed are based on readings from only 2 or 3 probes.

Data Sheet: Curing – Batch 0-1

Method of Estimating T	T_{NWS}-Only
Curing Start	4/29/18
Curing End	6/12/18
Values of t Tested (d)	10, 44

t, d	t^*, d	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
10	10	22.07	22.00
44	44	23.13	23.00

Combined Trend Function for T_C versus T_{NWS}: $T_C = 0.28 \times T_{NWS} + 17.77$ ($R^2 = 0.416$)

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
4/29/18	0	8.89	20.26
4/30/18	1	10.56	20.73
5/1/18	2	13.89	21.66
5/2/18	3	16.67	22.44
5/3/18	4	18.89	23.06
5/4/18	5	20.00	23.37
5/5/18	6	18.33	22.91
5/6/18	7	15.56	22.13
5/7/18	8	14.44	21.82
5/8/18	9	15.56	22.13
5/9/18	10	16.11	22.28
5/10/18	11	18.33	22.91
5/11/18	12	19.44	23.22
5/12/18	13	21.67	23.84
5/13/18	14	21.67	23.84
5/14/18	15	21.67	23.84
5/15/18	16	21.67	23.84
5/16/18	17	18.33	22.91
5/17/18	18	21.11	23.68
5/18/18	19	17.78	22.75
5/19/18	20	20.00	23.37
5/20/18	21	21.67	23.84
5/21/18	22	20.56	23.53

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
5/22/18	23	21.11	23.68
5/23/18	24	20.00	23.37
5/24/18	25	20.00	23.37
5/25/18	26	21.11	23.68
5/26/18	27	18.89	23.06
5/27/18	28	21.67	23.84
5/28/18	29	20.00	23.37
5/29/18	30	20.56	23.53
5/30/18	31	22.22	23.99
5/31/18	32	22.22	23.99
6/1/18	33	21.67	23.84
6/2/18	34	21.11	23.68
6/3/18	35	21.67	23.84
6/4/18	36	18.89	23.06
6/5/18	37	18.89	23.06
6/6/18	38	17.78	22.75
6/7/18	39	18.33	22.91
6/8/18	40	21.67	23.84
6/9/18	41	22.78	24.15
6/10/18	42	21.67	23.84
6/11/18	43	18.89	23.06
6/12/18	44	16.67	22.44

Data Sheet: Curing – Batch 0-2

Method of Estimating T	T_{NWS}-Only
Curing Start	6/7/18
Curing End	7/5/18
Values of t Tested (d)	7, 16, 28

t, d	t^*, d	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	23.49	23.50
16	16	23.82	23.80
28	28	23.97	24.00

Combined Trend Function for T_C versus T_{NWS}: $T_C = 0.28 \times T_{NWS} + 17.77$ ($R^2 = 0.416$)

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
6/7/18	0	18.33	22.91
6/8/18	1	21.67	23.84
6/9/18	2	22.78	24.15
6/10/18	3	21.67	23.84
6/11/18	4	18.89	23.06
6/12/18	5	16.67	22.44
6/13/18	6	21.67	23.84
6/14/18	7	21.67	23.84
6/15/18	8	19.44	23.22
6/16/18	9	20.56	23.53
6/17/18	10	23.33	24.31
6/18/18	11	24.44	24.62
6/19/18	12	25.56	24.93
6/20/18	13	23.89	24.46
6/21/18	14	22.78	24.15

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
6/22/18	15	21.67	23.84
6/23/18	16	22.22	23.99
6/24/18	17	23.33	24.31
6/25/18	18	20.00	23.37
6/26/18	19	18.33	22.91
6/27/18	20	21.11	23.68
6/28/18	21	22.78	24.15
6/29/18	22	22.22	23.99
6/30/18	23	23.33	24.31
7/1/18	24	23.89	24.46
7/2/18	25	24.44	24.62
7/3/18	26	25.00	24.77
7/4/18	27	25.56	24.93
7/5/18	28	25.00	24.77

Data Sheet: Curing – Batch 0-3

Method of Estimating T	T_{NWS}-Only
Curing Start	6/9/18
Curing End	7/7/18
Values of t Tested (d)	7, 15, 28

t, d	t*, d	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	23.49	23.50
15	15	23.88	23.90
28	28	24.01	24.00

Combined Trend Function for T_C versus T_{NWS}: $T_C = 0.28 \times T_{NWS} + 17.77$ ($R^2 = 0.416$)

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
6/9/18	0	22.78	24.15
6/10/18	1	21.67	23.84
6/11/18	2	18.89	23.06
6/12/18	3	16.67	22.44
6/13/18	4	21.67	23.84
6/14/18	5	21.67	23.84
6/15/18	6	19.44	23.22
6/16/18	7	20.56	23.53
6/17/18	8	23.33	24.31
6/18/18	9	24.44	24.62
6/19/18	10	25.56	24.93
6/20/18	11	23.89	24.46
6/21/18	12	22.78	24.15
6/22/18	13	21.67	23.84
6/23/18	14	22.22	23.99

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
6/24/18	15	23.33	24.31
6/25/18	16	20.00	23.37
6/26/18	17	18.33	22.91
6/27/18	18	21.11	23.68
6/28/18	19	22.78	24.15
6/29/18	20	22.22	23.99
6/30/18	21	23.33	24.31
7/1/18	22	23.89	24.46
7/2/18	23	24.44	24.62
7/3/18	24	25.00	24.77
7/4/18	25	25.56	24.93
7/5/18	26	25.00	24.77
7/6/18	27	23.89	24.46
7/7/18	28	19.44	23.22

<u>Data Sheet: Curing – Batch 0-4</u>

Method of Estimating T	T_C-T_{NWS}
Curing Start	7/23/18
Curing End	8/25/18
Values of t Tested (d)	8, 14, 33

t, d	t*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
8	8	25.83	25.53	26.00
14	14	25.75	25.58	25.50
33	33	25.51	25.53	25.00

Trend Function for T_C versus t*: $T_C = -\ 0.026 \times t^* + 25.93$ ($R^2 = 0.517$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.14 \times T_{NWS} + 22.55$ ($R^2 = 0.309$)

Date	t*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
7/25/18	2	26.0	26.1	26.1	26.0	26.05	21.67
7/26/18	3	25.7	26.0	26.0	25.9	25.90	22.22
7/31/18	8	25.5	25.5	25.6	25.4	25.50	21.67
8/4/18	12	25.2	25.2	25.2	25.1	25.18	22.78
8/5/18	13	25.6	25.6	25.6	25.5	25.58	23.33
8/6/18	14	25.7	25.7	25.8	25.8	25.75	23.33
8/10/18	18	25.8	25.8	25.8	25.7	25.78	21.67
8/20/18	28	25.5	25.5	25.3	25.6	25.48	21.67
8/25/18	33	24.8	24.9	24.9	24.8	24.85	18.33

Data Sheet: Curing – Batch 0-4

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
7/23/18	0	20.00	25.31
7/24/18	1	22.78	25.69
7/25/18	2	21.67	25.53
7/26/18	3	22.22	25.61
7/27/18	4	22.22	25.61
7/28/18	5	21.11	25.46
7/29/18	6	20.56	25.38
7/30/18	7	22.78	25.69
7/31/18	8	21.67	25.53
8/1/18	9	22.78	25.69
8/2/18	10	21.67	25.53
8/3/18	11	21.11	25.46
8/4/18	12	22.78	25.69
8/5/18	13	23.33	25.76
8/6/18	14	23.33	25.76
8/7/18	15	22.78	25.69
8/8/18	16	23.33	25.76
8/9/18	17	23.33	25.76
8/10/18	18	21.67	25.53
8/11/18	19	23.33	25.76
8/12/18	20	21.67	25.53
8/13/18	21	21.11	25.46
8/14/18	22	20.56	25.38
8/15/18	23	21.11	25.46
8/16/18	24	23.33	25.76
8/17/18	25	24.44	25.92
8/18/18	26	21.11	25.46
8/19/18	27	22.78	25.69
8/20/18	28	21.67	25.53
8/21/18	29	22.78	25.69
8/22/18	30	19.44	25.23
8/23/18	31	17.22	24.92
8/24/18	32	16.67	24.85
8/25/18	33	18.33	25.08

Data Sheet: Curing – Batch 0-5

Method of Estimating T	T_C-T_{NWS}
Curing Start	7/23/18
Curing End	8/25/18
Values of t Tested (d)	8, 14, 33

t, d	t*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
8	8	26.02	25.73	26.00
14	15	25.93	25.78	25.80
33	33	25.71	25.73	25.70

Trend Function for T_C versus t^*: $T_C = -\, 0.024 \times t^* + 26.11$ ($R^2 = 0.513$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.13 \times T_{NWS} + 22.84$ ($R^2 = 0.312$)

Date	t*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
7/25/18	2	26.0	26.4	26.4	26.2	26.25	21.67
7/26/18	3	26.0	26.2	26.3	26.1	26.15	22.22
7/31/18	8	25.6	25.7	25.7	25.5	25.63	21.67
8/4/18	12	25.5	25.4	25.4	25.4	25.43	22.78
8/5/18	13	25.8	25.8	25.8	25.8	25.80	23.33
8/6/18	14	25.8	25.9	25.9	25.9	25.88	23.33
8/10/18	18	25.9	25.9	25.9	25.8	25.88	21.67
8/20/18	28	25.7	25.8	25.7	25.8	25.75	21.67
8/25/18	33	25.1	25.1	25.1	25.0	25.08	18.33

Data Sheet: Curing – Batch 0-5

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
7/23/18	0	20.00	25.51
7/24/18	1	22.78	25.88
7/25/18	2	21.67	25.73
7/26/18	3	22.22	25.81
7/27/18	4	22.22	25.81
7/28/18	5	21.11	25.66
7/29/18	6	20.56	25.58
7/30/18	7	22.78	25.88
7/31/18	8	21.67	25.73
8/1/18	9	22.78	25.88
8/2/18	10	21.67	25.73
8/3/18	11	21.11	25.66
8/4/18	12	22.78	25.88
8/5/18	13	23.33	25.95
8/6/18	14	23.33	25.95
8/7/18	15	22.78	25.88
8/8/18	16	23.33	25.95
8/9/18	17	23.33	25.95
8/10/18	18	21.67	25.73
8/11/18	19	23.33	25.95
8/12/18	20	21.67	25.73
8/13/18	21	21.11	25.66
8/14/18	22	20.56	25.58
8/15/18	23	21.11	25.66
8/16/18	24	23.33	25.95
8/17/18	25	24.44	26.10
8/18/18	26	21.11	25.66
8/19/18	27	22.78	25.88
8/20/18	28	21.67	25.73
8/21/18	29	22.78	25.88
8/22/18	30	19.44	25.44
8/23/18	31	17.22	25.14
8/24/18	32	16.67	25.07
8/25/18	33	18.33	25.29

Data Sheet: Curing – Batch 5-1

Method of Estimating T	T_C-Only
Curing Start	6/1/19
Curing End	6/29/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	20.29	20.50
15	15	20.54	20.50
28	28	20.93	20.90

Trend Function for T_C versus t^*: $T_C = 0.061 \times t^* + 20.08$ ($R^2 = 0.520$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
6/1/19	0	20.9	21.4	21.2	21.17
6/3/19	2	20.1	20.7	20.4	20.40
6/4/19	3	20.3	20.8	20.6	20.57
6/5/19	4	20.2	20.8	20.6	20.53
6/6/19	5	20.0	20.6	20.3	20.30
6/7/19	6	20.1	20.7	20.6	20.47
6/9/19	8	20.2	20.8	20.7	20.57
6/10/19	9	20.1	20.6	20.5	20.40
6/11/19	10	20.3	20.8	20.6	20.57
6/12/19	11	20.3	20.8	20.6	20.57
6/13/19	12	20.1	20.5	20.4	20.33
6/14/19	13	20.0	–	20.6	20.30
6/15/19	14	19.5	–	20.2	19.85
6/16/19	15	20.2	–	20.8	20.50
6/17/19	16	20.1	–	20.8	20.45
6/18/19	17	20.5	–	21.1	20.80
6/19/19	18	21.3	–	21.8	21.55
6/20/19	19	21.3	–	21.1	21.20
6/21/19	20	22.6	–	21.2	21.90
6/22/19	21	21.3	–	20.3	20.80
6/23/19	22	22.8	–	21.1	21.95
6/24/19	23	22.2	–	21.0	21.60
6/25/19	24	22.6	–	21.4	22.00
6/26/19	25	22.7	–	21.2	21.95
6/27/19	26	22.4	–	21.8	22.10
6/28/19	27	22.3	–	21.4	21.85

Data Sheet: Curing – Batch 5-2

Method of Estimating T	T_C-Only
Curing Start	6/1/19
Curing End	6/29/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	18.62	18.90
15	15	18.96	18.90
28	28	19.51	19.50

Trend Function for T_C versus t^*: $T_C = 0.085 \times t^* + 18.32$ ($R^2 = 0.651$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
6/3/19	2	18.8	19.1	19.1	19.00
6/4/19	3	18.9	19.3	19.1	19.10
6/5/19	4	18.6	19.3	19.1	19.00
6/6/19	5	18.8	19.5	19.2	19.17
6/7/19	6	18.5	19.2	19.0	18.90
6/9/19	8	18.6	19.2	19.1	18.97
6/10/19	9	18.5	19.1	19.0	18.87
6/11/19	10	18.8	19.3	19.1	19.07
6/12/19	11	18.9	19.4	19.1	19.13
6/13/19	12	18.6	19.1	18.9	18.87
6/14/19	13	18.7	–	19.4	19.05
6/15/19	14	18.0	–	18.8	18.40
6/16/19	15	19.0	–	19.6	19.30
6/17/19	16	18.7	–	19.3	19.00
6/18/19	17	20.8	–	19.8	20.30
6/19/19	18	18.7	–	19.2	18.95
6/20/19	19	20.2	–	19.4	19.80
6/21/19	20	21.2	–	19.7	20.45
6/22/19	21	20.3	–	19.1	19.70
6/23/19	22	21.7	–	19.9	20.80
6/24/19	23	21.4	–	19.5	20.45
6/25/19	24	21.5	–	19.8	20.65
6/26/19	25	21.8	–	19.6	20.70
6/27/19	26	22.2	–	20.1	21.15
6/28/19	27	21.9	–	19.6	20.75

<u>Data Sheet: Curing – Batch 5-3</u>

Method of Estimating T	T_C-Only
Curing Start	6/1/19
Curing End	6/29/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	18.62	18.90
15	15	18.96	18.90
28	28	19.51	19.50

Trend Function for T_C versus t^*: $T_C = 0.085 \times t^* + 18.32$ ($R^2 = 0.651$)

Note: Batches 5-2 and 5-3 were cured simultaneously in the same container – hence their identical sets of T_C data.

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
6/3/19	2	18.8	19.1	19.1	19.00
6/4/19	3	18.9	19.3	19.1	19.10
6/5/19	4	18.6	19.3	19.1	19.00
6/6/19	5	18.8	19.5	19.2	19.17
6/7/19	6	18.5	19.2	19.0	18.90
6/9/19	8	18.6	19.2	19.1	18.97
6/10/19	9	18.5	19.1	19.0	18.87
6/11/19	10	18.8	19.3	19.1	19.07
6/12/19	11	18.9	19.4	19.1	19.13
6/13/19	12	18.6	19.1	18.9	18.87
6/14/19	13	18.7	–	19.4	19.05
6/15/19	14	18.0	–	18.8	18.40
6/16/19	15	19.0	–	19.6	19.30
6/17/19	16	18.7	–	19.3	19.00
6/18/19	17	20.8	–	19.8	20.30
6/19/19	18	18.7	–	19.2	18.95
6/20/19	19	20.2	–	19.4	19.80
6/21/19	20	21.2	–	19.7	20.45
6/22/19	21	20.3	–	19.1	19.70
6/23/19	22	21.7	–	19.9	20.80
6/24/19	23	21.4	–	19.5	20.45
6/25/19	24	21.5	–	19.8	20.65
6/26/19	25	21.8	–	19.6	20.70
6/27/19	26	22.2	–	20.1	21.15
6/28/19	27	21.9	–	19.6	20.75

Data Sheet: Curing – Batch 10-1

Method of Estimating T	T_C-T_{NWS}
Curing Start	11/27/18
Curing End	1/1/19
Values of t Tested (d)	10, 20, 35

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
10	10	19.84	20.15	20.00
20	20	19.95	20.14	20.00
35	35	20.10	20.15	20.10

Trend Function for T_C versus t^*: $T_C = 0.021 \times t^* + 19.74$ ($R^2 = 0.287$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.0077 \times T_{NWS} + 20.13$ ($R^2 = 0.016$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	13	20.2	20.4	20.1	20.1	20.20	-0.56
12/11/18	14	20.2	20.3	20.3	20.3	20.28	-3.33
12/14/18	17	20.3	20.3	20.4	20.0	20.25	2.22
12/16/18	19	19.9	19.8	19.9	19.8	19.85	6.67
12/17/18	20	20.0	20.0	19.9	19.9	19.95	6.67
12/18/18	21	20.0	20.1	20.0	20.0	20.03	2.22
12/19/18	22	20.0	20.1	20.0	20.0	20.03	3.33
1/1/19	35	20.7	20.7	20.7	20.7	20.70	10.00

Data Sheet: Curing – Batch 10-1

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
11/27/18	0	-3.89	20.10
11/28/18	1	-6.11	20.09
11/29/18	2	0.56	20.14
11/30/18	3	6.67	20.18
12/1/18	4	5.56	20.18
12/2/18	5	10.00	20.21
12/3/18	6	7.78	20.19
12/4/18	7	0.56	20.14
12/5/18	8	-0.56	20.13
12/6/18	9	-0.56	20.13
12/7/18	10	-1.11	20.12
12/8/18	11	-2.22	20.12
12/9/18	12	-3.89	20.10
12/10/18	13	-0.56	20.13
12/11/18	14	-3.33	20.11
12/12/18	15	-2.22	20.12
12/13/18	16	1.67	20.15
12/14/18	17	2.22	20.15
12/15/18	18	4.44	20.17
12/16/18	19	6.67	20.18
12/17/18	20	6.67	20.18
12/18/18	21	2.22	20.15
12/19/18	22	3.33	20.16
12/20/18	23	2.78	20.15
12/21/18	24	6.67	20.18
12/22/18	25	-0.56	20.13
12/23/18	26	1.11	20.14
12/24/18	27	1.11	20.14
12/25/18	28	1.11	20.14
12/26/18	29	0.56	20.14
12/27/18	30	-1.11	20.12
12/28/18	31	5.56	20.18
12/29/18	32	6.11	20.18
12/30/18	33	7.22	20.19
12/31/18	34	8.89	20.20
1/1/19	35	10.00	20.21

Data Sheet: Curing – Batch 10-2

Method of Estimating T	T_C-T_{NWS}
Curing Start	11/28/18
Curing End	1/1/19
Values of t Tested (d)	10, 21, 35

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
10	9	19.90	20.15	20.00
21	20	19.93	20.15	20.00
35	34	19.97	20.15	20.10

Trend Function for T_C versus t^*: $T_C = 0.0053 \times t^* + 19.88$ ($R^2 = 0.015$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.017 \times T_{NWS} + 20.04$ ($R^2 = 0.059$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	12	20.3	20.2	20.2	20.1	20.20	-0.56
12/11/18	13	20.3	20.3	20.3	20.3	20.30	-3.33
12/14/18	16	20.1	20.1	20.2	20.1	20.13	2.22
12/16/18	18	19.7	19.6	19.7	19.6	19.65	6.67
12/17/18	19	19.7	19.7	19.8	19.7	19.73	6.67
12/18/18	20	19.7	19.7	19.7	19.7	19.70	2.22
12/19/18	21	19.8	19.8	19.8	19.8	19.80	3.33
1/1/19	34	20.4	20.4	20.4	20.3	20.38	10.00

Data Sheet: Curing – Batch 10-2

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
11/28/18	0	-6.11	20.09
11/29/18	1	0.56	20.14
11/30/18	2	6.67	20.18
12/1/18	3	5.56	20.18
12/2/18	4	10.00	20.21
12/3/18	5	7.78	20.19
12/4/18	6	0.56	20.14
12/5/18	7	-0.56	20.13
12/6/18	8	-0.56	20.13
12/7/18	9	-1.11	20.12
12/8/18	10	-2.22	20.12
12/9/18	11	-3.89	20.10
12/10/18	12	-0.56	20.13
12/11/18	13	-3.33	20.11
12/12/18	14	-2.22	20.12
12/13/18	15	1.67	20.15
12/14/18	16	2.22	20.15
12/15/18	17	4.44	20.17
12/16/18	18	6.67	20.18
12/17/18	19	6.67	20.18
12/18/18	20	2.22	20.15
12/19/18	21	3.33	20.16
12/20/18	22	2.78	20.15
12/21/18	23	6.67	20.18
12/22/18	24	-0.56	20.13
12/23/18	25	1.11	20.14
12/24/18	26	1.11	20.14
12/25/18	27	1.11	20.14
12/26/18	28	0.56	20.14
12/27/18	29	-1.11	20.12
12/28/18	30	5.56	20.18
12/29/18	31	6.11	20.18
12/30/18	32	7.22	20.19
12/31/18	33	8.89	20.20
1/1/19	34	10.00	20.21

Data Sheet: Curing – Batch 10-3

Method of Estimating T	T_C-T_{NWS}
Curing Start	11/28/18
Curing End	1/1/19
Values of t Tested (d)	10, 21, 35

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
10	9	20.02	19.93	20.00
21	20	19.97	19.95	20.00
35	34	19.91	19.92	20.00

Trend Function for T_C versus t^*: $T_C = -0.0084 \times t^* + 20.06$ ($R^2 = 0.066$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.029 \times T_{NWS} + 20.00$ ($R^2 = 0.314$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	12	20.3	20.3	20.2	20.1	20.23	-0.56
12/11/18	13	20.2	20.2	20.1	20.1	20.15	-3.33
12/14/18	16	19.9	20.0	20.0	20.0	19.98	2.22
12/16/18	18	19.7	19.7	19.7	19.7	19.70	6.67
12/17/18	19	19.7	19.7	19.6	19.5	19.63	6.67
12/18/18	20	19.8	19.8	19.7	19.6	19.73	2.22
12/19/18	21	19.8	19.8	19.8	19.7	19.78	3.33
1/1/19	34	20.0	20.0	20.0	20.0	20.00	10.00

Data Sheet: Curing – Batch 10-3

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
11/28/18	0	-6.11	20.17
11/29/18	1	0.56	19.98
11/30/18	2	6.67	19.80
12/1/18	3	5.56	19.83
12/2/18	4	10.00	19.71
12/3/18	5	7.78	19.77
12/4/18	6	0.56	19.98
12/5/18	7	-0.56	20.01
12/6/18	8	-0.56	20.01
12/7/18	9	-1.11	20.03
12/8/18	10	-2.22	20.06
12/9/18	11	-3.89	20.11
12/10/18	12	-0.56	20.01
12/11/18	13	-3.33	20.09
12/12/18	14	-2.22	20.06
12/13/18	15	1.67	19.95
12/14/18	16	2.22	19.93
12/15/18	17	4.44	19.87
12/16/18	18	6.67	19.80
12/17/18	19	6.67	19.80
12/18/18	20	2.22	19.93
12/19/18	21	3.33	19.90
12/20/18	22	2.78	19.92
12/21/18	23	6.67	19.80
12/22/18	24	-0.56	20.01
12/23/18	25	1.11	19.96
12/24/18	26	1.11	19.96
12/25/18	27	1.11	19.96
12/26/18	28	0.56	19.98
12/27/18	29	-1.11	20.03
12/28/18	30	5.56	19.83
12/29/18	31	6.11	19.82
12/30/18	32	7.22	19.79
12/31/18	33	8.89	19.74
1/1/19	34	10.00	19.71

Data Sheet: Curing – Batch 10-4

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/17/19
Curing End	5/14/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	6	28.18	22.37	26.00
14	13	26.94	22.67	24.00
28	27	24.44	23.06	23.00

Trend Function for T_C versus t^*: $T_C = -0.36 \times t^* + 29.26$ ($R^2 = 0.832$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.26 \times T_{NWS} + 18.69$ ($R^2 = 0.199$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	11	25.9	25.9	25.9	25.8	25.88	16.11
4/29/19	12	25.5	25.5	25.7	25.7	25.60	13.33
4/30/19	13	25.4	25.5	25.5	25.6	25.50	18.89
5/1/19	14	25.1	25.1	25.2	25.2	25.15	21.11
5/3/19	16	22.3	22.3	22.4	22.3	22.33	20.00
5/4/19	17	22.2	22.3	22.3	22.2	22.25	20.00
5/5/19	18	21.6	21.5	21.4	21.5	21.50	16.67
5/6/19	19	21.6	21.7	21.7	21.7	21.68	16.11
5/14/19	27	20.3	20.2	20.3	20.3	20.28	9.44
5/15/19	28	19.9	19.9	20.0	20.1	19.98	11.67

Data Sheet: Curing – Batch 10-4

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
4/17/19	0	15.00	22.66
4/18/19	1	17.78	23.40
4/19/19	2	17.22	23.25
4/20/19	3	8.89	21.04
4/21/19	4	9.44	21.19
4/22/19	5	12.22	21.92
4/23/19	6	16.67	23.10
4/24/19	7	19.44	23.84
4/25/19	8	18.33	23.54
4/26/19	9	13.33	22.22
4/27/19	10	13.89	22.37
4/28/19	11	16.11	22.95
4/29/19	12	13.33	22.22
4/30/19	13	18.89	23.69
5/1/19	14	21.11	24.28
5/2/19	15	20.56	24.13
5/3/19	16	20.00	23.98
5/4/19	17	20.00	23.98
5/5/19	18	16.67	23.10
5/6/19	19	16.11	22.95
5/7/19	20	16.67	23.10
5/8/19	21	19.44	23.84
5/9/19	22	20.56	24.13
5/10/19	23	21.67	24.43
5/11/19	24	18.33	23.54
5/12/19	25	18.33	23.54
5/13/19	26	13.33	22.22
5/14/19	27	9.44	21.19

Data Sheet: Curing – Batch 10-5

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/17/19
Curing End	5/14/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	6	28.28	22.10	26.00
14	13	26.95	22.42	24.00
28	27	24.29	22.83	23.00

Trend Function for T_C versus t^*: $T_C = -0.38 \times t^* + 29.41$ ($R^2 = 0.825$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.28 \times T_{NWS} + 18.22$ ($R^2 = 0.194$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	11	25.8	25.8	25.9	25.8	25.83	16.11
4/29/19	12	25.5	25.6	25.7	25.8	25.65	13.33
4/30/19	13	25.2	25.3	25.4	25.4	25.33	18.89
5/1/19	14	25.1	25.1	25.1	25.1	25.10	21.11
5/3/19	16	22.0	22.0	22.1	22.1	22.05	20.00
5/4/19	17	22.0	22.0	22.0	21.9	21.98	20.00
5/5/19	18	21.2	21.2	21.2	21.2	21.20	16.67
5/6/19	19	21.0	21.2	21.2	21.3	21.18	16.11
5/14/19	27	19.9	20.0	19.2	20.0	19.78	9.44
5/15/19	28	19.7	19.6	19.7	19.8	19.70	11.67

Data Sheet: Curing – Batch 10-5

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
4/17/19	0	15.00	22.41
4/18/19	1	17.78	23.18
4/19/19	2	17.22	23.03
4/20/19	3	8.89	20.70
4/21/19	4	9.44	20.86
4/22/19	5	12.22	21.63
4/23/19	6	16.67	22.87
4/24/19	7	19.44	23.65
4/25/19	8	18.33	23.34
4/26/19	9	13.33	21.94
4/27/19	10	13.89	22.10
4/28/19	11	16.11	22.72
4/29/19	12	13.33	21.94
4/30/19	13	18.89	23.49
5/1/19	14	21.11	24.11
5/2/19	15	20.56	23.96
5/3/19	16	20.00	23.80
5/4/19	17	20.00	23.80
5/5/19	18	16.67	22.87
5/6/19	19	16.11	22.72
5/7/19	20	16.67	22.87
5/8/19	21	19.44	23.65
5/9/19	22	20.56	23.96
5/10/19	23	21.67	24.27
5/11/19	24	18.33	23.34
5/12/19	25	18.33	23.34
5/13/19	26	13.33	21.94
5/14/19	27	9.44	20.86

Data Sheet: Curing – Batch 10-6

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/17/19
Curing End	5/15/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	26.08	21.76	25.00
14	14	25.10	21.95	24.00
28	28	23.13	22.15	23.00

Trend Function for T_C versus t^*: $T_C = -0.88 \times t^* + 27.07$ ($R^2 = 0.845$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.22 \times T_{NWS} + 18.55$ ($R^2 = 0.225$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	11	24.2	24.2	25.0	24.3	24.43	16.11
4/29/19	12	23.8	23.9	24.4	24.5	24.15	13.33
4/30/19	13	23.7	23.9	23.9	24.1	23.90	18.89
5/1/19	14	23.9	23.9	23.9	23.9	23.90	21.11
5/3/19	16	21.6	21.6	21.8	21.7	21.68	20.00
5/4/19	17	21.8	21.8	21.8	21.7	21.78	20.00
5/5/19	18	21.0	21.0	21.0	21.0	21.00	16.67
5/6/19	19	20.8	20.9	21.0	21.1	20.95	16.11
5/14/19	27	19.8	19.8	19.8	20.0	19.85	9.44
5/15/19	28	19.8	19.8	19.8	20.0	19.85	11.67

Data Sheet: Curing – Batch 10-6

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
4/17/19	0	15.00	21.85
4/18/19	1	17.78	22.47
4/19/19	2	17.22	22.34
4/20/19	3	8.89	20.51
4/21/19	4	9.44	20.63
4/22/19	5	12.22	21.24
4/23/19	6	16.67	22.22
4/24/19	7	19.44	22.83
4/25/19	8	18.33	22.59
4/26/19	9	13.33	21.49
4/27/19	10	13.89	21.61
4/28/19	11	16.11	22.10
4/29/19	12	13.33	21.49
4/30/19	13	18.89	22.71
5/1/19	14	21.11	23.20
5/2/19	15	20.56	23.08
5/3/19	16	20.00	22.96
5/4/19	17	20.00	22.96
5/5/19	18	16.67	22.22
5/6/19	19	16.11	22.10
5/7/19	20	16.67	22.22
5/8/19	21	19.44	22.83
5/9/19	22	20.56	23.08
5/10/19	23	21.67	23.32
5/11/19	24	18.33	22.59
5/12/19	25	18.33	22.59
5/13/19	26	13.33	21.49
5/14/19	27	9.44	20.63
5/15/19	28	11.67	21.12

Data Sheet: Curing – Batch 15-1

Method of Estimating T	T_C-Only
Curing Start	6/1/19
Curing End	6/28/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	6	20.78	21.00
15	14	20.96	21.00
28	27	21.27	21.30

Trend Function for T_C versus t^*: $T_C = 0.046 \times t^* + 20.64$ ($R^2 = 0.412$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
6/1/19	0	21.3	21.9	21.8	21.67
6/3/19	2	20.4	21.2	20.9	20.83
6/4/19	3	20.7	21.4	21.1	21.07
6/5/19	4	20.7	21.3	21.1	21.03
6/6/19	5	20.4	21.0	20.8	20.73
6/7/19	6	20.5	21.0	20.9	20.80
6/9/19	8	20.7	21.3	21.1	21.03
6/10/19	9	20.5	21.1	20.9	20.83
6/11/19	10	20.7	21.3	21.1	21.03
6/12/19	11	20.8	21.3	21.1	21.07
6/13/19	12	20.5	21.1	20.8	20.80
6/14/19	13	20.6	–	21.1	20.85
6/15/19	14	20.1	–	20.7	20.40
6/16/19	15	20.6	–	21.3	20.95
6/17/19	16	20.6	–	21.3	20.95
6/18/19	17	20.9	–	21.5	21.20
6/19/19	18	21.5	–	21.8	21.65
6/20/19	19	21.1	–	21.3	21.20
6/21/19	20	22.6	–	21.7	22.15
6/22/19	21	21.3	–	20.8	21.05
6/23/19	22	22.9	–	21.6	22.25
6/24/19	23	22.2	–	21.4	21.80
6/25/19	24	22.6	–	21.8	22.20
6/26/19	25	22.7	–	21.7	22.20
6/27/19	26	22.3	–	22.2	22.25

Data Sheet: Curing – Batch 15-2

Method of Estimating T	T_C-Only
Curing Start	6/1/19
Curing End	6/28/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	6	20.78	21.00
15	14	20.96	21.00
28	27	21.27	21.30

Trend Function for T_C versus t^*: $T_C = 0.046 \times t^* + 20.64$ ($R^2 = 0.412$)

Note: Batches 15-1 and 15-2 were cured simultaneously in the same container – hence their identical sets of T_C data.

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
6/1/19	0	21.3	21.9	21.8	21.67
6/3/19	2	20.4	21.2	20.9	20.83
6/4/19	3	20.7	21.4	21.1	21.07
6/5/19	4	20.7	21.3	21.1	21.03
6/6/19	5	20.4	21.0	20.8	20.73
6/7/19	6	20.5	21.0	20.9	20.80
6/9/19	8	20.7	21.3	21.1	21.03
6/10/19	9	20.5	21.1	20.9	20.83
6/11/19	10	20.7	21.3	21.1	21.03
6/12/19	11	20.8	21.3	21.1	21.07
6/13/19	12	20.5	21.1	20.8	20.80
6/14/19	13	20.6	–	21.1	20.85
6/15/19	14	20.1	–	20.7	20.40
6/16/19	15	20.6	–	21.3	20.95
6/17/19	16	20.6	–	21.3	20.95
6/18/19	17	20.9	–	21.5	21.20
6/19/19	18	21.5	–	21.8	21.65
6/20/19	19	21.1	–	21.3	21.20
6/21/19	20	22.6	–	21.7	22.15
6/22/19	21	21.3	–	20.8	21.05
6/23/19	22	22.9	–	21.6	22.25
6/24/19	23	22.2	–	21.4	21.80
6/25/19	24	22.6	–	21.8	22.20
6/26/19	25	22.7	–	21.7	22.20
6/27/19	26	22.3	–	22.2	22.25

Data Sheet: Curing – Batch 15-3

Method of Estimating T	T_C-Only
Curing Start	6/1/19
Curing End	6/28/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	20.30	20.50
15	14	20.51	20.50
28	27	20.90	20.90

Trend Function for T_C versus t^*: $T_C = 0.060 \times t^* + 20.09$ ($R^2 = 0.484$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
6/1/19	0	20.9	21.4	21.2	21.17
6/3/19	2	20.1	20.7	20.4	20.40
6/4/19	3	20.3	20.8	20.6	20.57
6/5/19	4	20.2	20.8	20.6	20.53
6/6/19	5	20.0	20.6	20.3	20.30
6/7/19	6	20.1	20.7	20.6	20.47
6/9/19	8	20.2	20.8	20.7	20.57
6/10/19	9	20.1	20.6	20.5	20.40
6/11/19	10	20.3	20.8	20.6	20.57
6/12/19	11	20.3	20.8	20.6	20.57
6/13/19	12	20.1	20.5	20.4	20.33
6/14/19	13	20.0	–	20.6	20.30
6/15/19	14	19.5	–	20.2	19.85
6/16/19	15	20.2	–	20.8	20.50
6/17/19	16	20.1	–	20.8	20.45
6/18/19	17	20.5	–	21.1	20.80
6/19/19	18	21.3	–	21.8	21.55
6/20/19	19	21.3	–	21.1	21.20
6/21/19	20	22.6	–	21.2	21.90
6/22/19	21	21.3	–	20.3	20.80
6/23/19	22	22.8	–	21.1	21.95
6/24/19	23	22.2	–	21.0	21.60
6/25/19	24	22.6	–	21.4	22.00
6/26/19	25	22.7	–	21.2	21.95
6/27/19	26	22.4	–	21.8	22.10

Data Sheet: Curing – Batch 20-1

Method of Estimating T	T_C-Only
Curing Start	5/30/19
Curing End	6/27/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	21.14	21.30
15	15	21.26	21.30
28	28	21.46	21.50

Trend Function for T_C versus t^*: $T_C = 0.030 \times t^* + 21.04$ ($R^2 = 0.290$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/31/19	1	21.3	22.0	21.8	21.70
6/1/19	2	21.1	21.8	21.6	21.50
6/3/19	4	20.6	21.3	21.2	21.03
6/4/19	5	21.1	21.6	21.4	21.37
6/5/19	6	21.0	21.6	21.5	21.37
6/6/19	7	20.8	21.4	21.2	21.13
6/7/19	8	20.7	21.2	21.1	21.00
6/9/19	10	21.0	21.5	21.4	21.30
6/10/19	11	20.8	21.4	21.3	21.17
6/11/19	12	21.1	21.6	21.5	21.40
6/12/19	13	21.2	21.7	21.4	21.43
6/13/19	14	21.1	21.4	21.1	21.20
6/14/19	15	20.8	–	21.5	21.15
6/15/19	16	20.5	–	21.0	20.75
6/16/19	17	21.1	–	21.5	21.30
6/17/19	18	21.2	–	21.6	21.40
6/18/19	19	21.3	–	21.9	21.60
6/19/19	20	21.5	–	21.9	21.70
6/20/19	21	21.1	–	21.7	21.40
6/21/19	22	22.6	–	21.8	22.20
6/22/19	23	21.0	–	21.0	21.00
6/23/19	24	22.9	–	21.8	22.35
6/24/19	25	22.0	–	21.8	21.90
6/25/19	26	22.3	–	22.5	22.40
6/26/19	27	22.4	–	22.1	22.25

<u>Data Sheet: Curing – Batch 20-2</u>

Method of Estimating T	T_C-Only
Curing Start	5/30/19
Curing End	6/27/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	21.15	21.30
15	15	21.28	21.30
28	28	21.48	21.50

Trend Function for T_C versus t^*: $T_C = 0.031 \times t^* + 21.05$ ($R^2 = 0.223$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/31/19	1	21.5	22.2	22.1	21.93
6/1/19	2	21.2	22.0	21.7	21.63
6/3/19	4	20.7	21.4	21.2	21.10
6/4/19	5	21.1	21.6	21.4	21.37
6/5/19	6	21.1	21.5	21.4	21.33
6/6/19	7	20.7	21.2	21.0	20.97
6/7/19	8	20.7	21.2	21.0	20.97
6/9/19	10	21.0	21.5	21.3	21.27
6/10/19	11	20.7	21.4	21.1	21.07
6/11/19	12	21.1	21.6	21.4	21.37
6/12/19	13	21.2	21.6	21.4	21.40
6/13/19	14	20.8	21.2	21.1	21.03
6/14/19	15	20.6	–	21.4	21.00
6/15/19	16	20.4	–	21.0	20.70
6/16/19	17	20.9	–	21.5	21.20
6/17/19	18	21.0	–	21.6	21.30
6/18/19	19	22.2	–	21.9	22.05
6/19/19	20	22.6	–	22.1	22.35
6/20/19	21	21.3	–	21.6	21.45
6/21/19	22	22.7	–	21.7	22.20
6/22/19	23	21.2	–	20.8	21.00
6/23/19	24	22.8	–	21.7	22.25
6/24/19	25	22.1	–	21.6	21.85
6/25/19	26	22.5	–	22.2	22.35
6/26/19	27	22.6	–	22.0	22.30

Data Sheet: Curing – Batch 20-3

Method of Estimating T	T_C-Only
Curing Start	5/31/19
Curing End	6/27/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	6	21.17	21.30
15	14	21.29	21.30
28	27	21.49	21.50

Trend Function for T_C versus t^*: $T_C = 0.031 \times t^* + 21.08$ ($R^2 = 0.223$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/31/19	0	21.5	22.2	22.1	21.93
6/1/19	1	21.2	22.0	21.7	21.63
6/3/19	3	20.7	21.4	21.2	21.10
6/4/19	4	21.1	21.6	21.4	21.37
6/5/19	5	21.1	21.5	21.4	21.33
6/6/19	6	20.7	21.2	21.0	20.97
6/7/19	7	20.7	21.2	21.0	20.97
6/9/19	9	21.0	21.5	21.3	21.27
6/10/19	10	20.7	21.4	21.1	21.07
6/11/19	11	21.1	21.6	21.4	21.37
6/12/19	12	21.2	21.6	21.4	21.40
6/13/19	13	20.8	21.2	21.1	21.03
6/14/19	14	20.6	–	21.4	21.00
6/15/19	15	20.4	–	21.0	20.70
6/16/19	16	20.9	–	21.5	21.20
6/17/19	17	21.0	–	21.6	21.30
6/18/19	18	22.2	–	21.9	22.05
6/19/19	19	22.6	–	22.1	22.35
6/20/19	20	21.3	–	21.6	21.45
6/21/19	21	22.7	–	21.7	22.20
6/22/19	22	21.2	–	20.8	21.00
6/23/19	23	22.8	–	21.7	22.25
6/24/19	24	22.1	–	21.6	21.85
6/25/19	25	22.5	–	22.2	22.35
6/26/19	26	22.6	–	22.0	22.30

Data Sheet: Curing – Batch 25-1

Method of Estimating T	T_C-Only
Curing Start	5/29/19
Curing End	6/25/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	6	20.97	21.10
14	13	21.03	21.10
28	27	21.16	21.20

Trend Function for T_C versus t^*: $T_C = 0.018 \times t^* + 20.91$ ($R^2 = 0.153$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/29/19	0	20.7	21.2	21.4	21.10
5/30/19	1	21.2	21.7	21.4	21.43
5/31/19	2	21.0	21.7	21.6	21.43
6/1/19	3	20.7	21.3	21.2	21.07
6/3/19	5	20.3	21.1	20.8	20.73
6/4/19	6	20.8	21.3	21.0	21.03
6/5/19	7	20.9	21.3	21.2	21.13
6/6/19	8	20.8	21.2	21.0	21.00
6/7/19	9	20.4	20.9	20.8	20.70
6/9/19	11	20.7	21.2	21.0	20.97
6/10/19	12	20.5	21.2	21.0	20.90
6/11/19	13	20.8	21.4	21.2	21.13
6/12/19	14	20.8	21.3	21.1	21.07
6/13/19	15	20.7	21.0	20.7	20.80
6/14/19	16	20.7	–	21.3	21.00
6/15/19	17	20.2	–	20.8	20.50
6/16/19	18	20.8	–	21.3	21.05
6/17/19	19	20.8	–	21.4	21.10
6/18/19	20	20.9	–	21.5	21.20
6/19/19	21	21.2	–	21.8	21.50
6/20/19	22	21.0	–	21.7	21.35
6/21/19	23	22.1	–	21.6	21.85
6/22/19	24	20.9	–	21.1	21.00
6/23/19	25	22.8	–	21.6	22.20
6/24/19	26	21.9	–	21.6	21.75

Data Sheet: Curing – Batch 25-2

Method of Estimating T	T_C-Only
Curing Start	5/29/19
Curing End	6/25/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	6	20.97	21.10
14	13	21.03	21.10
28	27	21.16	21.20

Trend Function for T_C versus t^*: $T_C = 0.018 \times t^* + 20.91$ ($R^2 = 0.153$)

Note: Batches 25-1 and 25-2 were cured simultaneously in the same container – hence their identical sets of T_C data.

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/29/19	0	20.7	21.2	21.4	21.10
5/30/19	1	21.2	21.7	21.4	21.43
5/31/19	2	21.0	21.7	21.6	21.43
6/1/19	3	20.7	21.3	21.2	21.07
6/3/19	5	20.3	21.1	20.8	20.73
6/4/19	6	20.8	21.3	21.0	21.03
6/5/19	7	20.9	21.3	21.2	21.13
6/6/19	8	20.8	21.2	21.0	21.00
6/7/19	9	20.4	20.9	20.8	20.70
6/9/19	11	20.7	21.2	21.0	20.97
6/10/19	12	20.5	21.2	21.0	20.90
6/11/19	13	20.8	21.4	21.2	21.13
6/12/19	14	20.8	21.3	21.1	21.07
6/13/19	15	20.7	21.0	20.7	20.80
6/14/19	16	20.7	–	21.3	21.00
6/15/19	17	20.2	–	20.8	20.50
6/16/19	18	20.8	–	21.3	21.05
6/17/19	19	20.8	–	21.4	21.10
6/18/19	20	20.9	–	21.5	21.20
6/19/19	21	21.2	–	21.8	21.50
6/20/19	22	21.0	–	21.7	21.35
6/21/19	23	22.1	–	21.6	21.85
6/22/19	24	20.9	–	21.1	21.00
6/23/19	25	22.8	–	21.6	22.20
6/24/19	26	21.9	–	21.6	21.75

Data Sheet: Curing – Batch 25-3

Method of Estimating T	T_C-Only
Curing Start	5/29/19
Curing End	6/25/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	6	21.23	21.40
14	14	21.29	21.40
28	27	21.40	21.40

Trend Function for T_C versus t^*: $T_C = 0.016 \times t^* + 21.18$ ($R^2 = 0.124$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/29/19	0	20.7	21.5	21.2	21.13
5/30/19	1	21.3	21.8	21.6	21.57
5/31/19	2	21.3	22.0	21.8	21.70
6/1/19	3	21.1	21.8	21.6	21.50
6/3/19	5	20.6	21.3	21.2	21.03
6/4/19	6	21.1	21.6	21.4	21.37
6/5/19	7	21.0	21.6	21.5	21.37
6/6/19	8	20.8	21.4	21.2	21.13
6/7/19	9	20.7	21.2	21.1	21.00
6/9/19	11	21.0	21.5	21.4	21.30
6/10/19	12	20.8	21.4	21.3	21.17
6/11/19	13	21.1	21.6	21.5	21.40
6/12/19	14	21.2	21.7	21.4	21.43
6/13/19	15	21.1	21.4	21.1	21.20
6/14/19	16	20.8	–	21.5	21.15
6/15/19	17	20.5	–	21.0	20.75
6/16/19	18	21.1	–	21.5	21.30
6/17/19	19	21.2	–	21.6	21.40
6/18/19	20	21.3	–	21.9	21.60
6/19/19	21	21.5	–	21.9	21.70
6/20/19	22	21.1	–	21.7	21.40
6/21/19	23	22.6	–	21.8	22.20
6/22/19	24	21.0	–	21.0	21.00
6/23/19	25	22.9	–	21.8	22.35
6/24/19	26	22.0	–	21.8	21.90

Data Sheet: Curing – Batch 30-1

Method of Estimating T	T_C-T_{NWS}
Curing Start	12/2/18
Curing End	1/4/19
Values of t Tested (d)	9, 16, 33

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
9	9	19.93	19.88	20.00
16	16	19.89	19.84	19.90
33	33	19.79	19.79	19.80

Trend Function for T_C versus t^*: $T_C = -0.012 \times t^* + 19.98$ ($R^2 = 0.166$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.045 \times T_{NWS} + 19.91$ ($R^2 = 0.350$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	8	20.2	20.2	20.1	20.3	20.20	-0.56
12/11/18	9	20.2	20.2	20.2	20.2	20.20	-3.33
12/14/18	12	19.9	20.0	20.0	19.9	19.95	2.22
12/16/18	14	19.6	19.5	19.4	19.4	19.48	6.67
12/17/18	15	19.6	19.6	19.6	19.6	19.60	6.67
12/18/18	16	19.6	19.5	19.5	19.4	19.50	2.22
12/19/18	17	19.6	19.6	19.6	19.5	19.58	3.33
1/1/19	30	19.8	19.8	19.7	19.8	19.78	10.00
1/2/19	31	19.9	19.9	20.0	19.9	19.93	3.89
1/3/19	32	19.5	19.6	19.6	19.6	19.58	3.89
1/4/19	33	19.5	19.6	19.5	19.5	19.53	2.78

<u>Data Sheet: Curing – Batch 30-1</u>

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
12/2/18	0	10.00	19.46
12/3/18	1	7.78	19.56
12/4/18	2	0.56	19.88
12/5/18	3	-0.56	19.93
12/6/18	4	-0.56	19.93
12/7/18	5	-1.11	19.96
12/8/18	6	-2.22	20.01
12/9/18	7	-3.89	20.08
12/10/18	8	-0.56	19.93
12/11/18	9	-3.33	20.06
12/12/18	10	-2.22	20.01
12/13/18	11	1.67	19.83
12/14/18	12	2.22	19.81
12/15/18	13	4.44	19.71
12/16/18	14	6.67	19.61
12/17/18	15	6.67	19.61
12/18/18	16	2.22	19.81
12/19/18	17	3.33	19.76
12/20/18	18	2.78	19.78
12/21/18	19	6.67	19.61
12/22/18	20	-0.56	19.93
12/23/18	21	1.11	19.86
12/24/18	22	1.11	19.86
12/25/18	23	1.11	19.86
12/26/18	24	0.56	19.88
12/27/18	25	-1.11	19.96
12/28/18	26	5.56	19.66
12/29/18	27	6.11	19.63
12/30/18	28	7.22	19.58
12/31/18	29	8.89	19.51
1/1/19	30	10.00	19.46
1/2/19	31	3.89	19.73
1/3/19	32	3.89	19.73
1/4/19	33	2.78	19.78

Data Sheet: Curing – Batch 30-2

Method of Estimating T	T_C-T_{NWS}
Curing Start	12/3/18
Curing End	1/4/19
Values of t Tested (d)	11, 16, 32

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
11	11	19.98	20.11	20.00
16	16	20.00	20.09	20.00
32	32	20.05	20.08	20.00

Trend Function for T_C versus t^*: $T_C = 0.0066 \times t^* + 19.95$ ($R^2 = 0.096$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.0094 \times T_{NWS} + 20.10$ ($R^2 = 0.026$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	7	20.2	20.1	20.1	20.2	20.15	-0.56
12/11/18	8	20.3	20.4	20.3	20.4	20.35	-3.33
12/14/18	11	20.0	20.0	20.0	20.0	20.00	2.22
12/16/18	13	19.9	19.8	19.8	19.7	19.80	6.67
12/17/18	14	19.9	19.9	20.0	19.8	19.90	6.67
12/18/18	15	20.0	19.9	19.8	19.8	19.88	2.22
12/19/18	16	19.9	19.9	19.9	19.8	19.88	3.33
1/1/19	29	20.4	20.4	20.3	20.3	20.35	10.00
1/2/19	30	20.3	20.4	20.3	20.3	20.33	3.89
1/3/19	31	20.1	20.2	20.3	20.2	20.20	3.89
1/4/19	32	19.9	20.0	20.0	20.0	19.98	2.78

Data Sheet: Curing – Batch 30-2

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
12/3/18	0	7.78	20.03
12/4/18	1	0.56	20.10
12/5/18	2	-0.56	20.11
12/6/18	3	-0.56	20.11
12/7/18	4	-1.11	20.12
12/8/18	5	-2.22	20.13
12/9/18	6	-3.89	20.14
12/10/18	7	-0.56	20.11
12/11/18	8	-3.33	20.14
12/12/18	9	-2.22	20.13
12/13/18	10	1.67	20.09
12/14/18	11	2.22	20.08
12/15/18	12	4.44	20.06
12/16/18	13	6.67	20.04
12/17/18	14	6.67	20.04
12/18/18	15	2.22	20.08
12/19/18	16	3.33	20.07
12/20/18	17	2.78	20.08
12/21/18	18	6.67	20.04
12/22/18	19	-0.56	20.11
12/23/18	20	1.11	20.09
12/24/18	21	1.11	20.09
12/25/18	22	1.11	20.09
12/26/18	23	0.56	20.10
12/27/18	24	-1.11	20.12
12/28/18	25	5.56	20.05
12/29/18	26	6.11	20.05
12/30/18	27	7.22	20.04
12/31/18	28	8.89	20.02
1/1/19	29	10.00	20.01
1/2/19	30	3.89	20.07
1/3/19	31	3.89	20.07
1/4/19	32	2.78	20.08

Data Sheet: Curing – Batch 30-3

Method of Estimating T	T_C-T_{NWS}
Curing Start	12/3/18
Curing End	1/4/19
Values of t Tested (d)	11, 16, 32

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
11	12	20.15	20.25	20.20
16	16	20.16	20.24	20.10
32	32	20.21	20.23	20.10

Trend Function for T_C versus t^*: $T_C = 0.0062 \times t^* + 20.11$ ($R^2 = 0.073$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.0053 \times T_{NWS} + 20.25$ ($R^2 = 0.007$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	7	20.2	20.3	20.3	20.2	20.25	-0.56
12/11/18	8	20.6	20.5	20.4	20.6	20.53	-3.33
12/14/18	11	20.1	20.1	20.1	20.1	20.10	2.22
12/16/18	13	19.9	19.9	19.9	19.9	19.90	6.67
12/17/18	14	20.1	20.2	20.2	20.2	20.18	6.67
12/18/18	15	20.1	20.1	20.1	20.0	20.08	2.22
12/19/18	16	20.1	20.1	20.1	20.0	20.08	3.33
1/1/19	29	20.7	20.6	20.5	20.4	20.55	10.00
1/2/19	30	20.6	20.5	20.6	20.6	20.58	3.89
1/3/19	31	20.2	20.1	20.1	20.2	20.15	3.89
1/4/19	32	20.1	20.1	20.2	20.2	20.15	2.78

Data Sheet: Curing – Batch 30-3

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
12/3/18	0	7.78	20.21
12/4/18	1	0.56	20.25
12/5/18	2	-0.56	20.25
12/6/18	3	-0.56	20.25
12/7/18	4	-1.11	20.25
12/8/18	5	-2.22	20.26
12/9/18	6	-3.89	20.27
12/10/18	7	-0.56	20.25
12/11/18	8	-3.33	20.27
12/12/18	9	-2.22	20.26
12/13/18	10	1.67	20.24
12/14/18	11	2.22	20.24
12/15/18	12	4.44	20.22
12/16/18	13	6.67	20.21
12/17/18	14	6.67	20.21
12/18/18	15	2.22	20.24
12/19/18	16	3.33	20.23
12/20/18	17	2.78	20.23
12/21/18	18	6.67	20.21
12/22/18	19	-0.56	20.25
12/23/18	20	1.11	20.24
12/24/18	21	1.11	20.24
12/25/18	22	1.11	20.24
12/26/18	23	0.56	20.25
12/27/18	24	-1.11	20.25
12/28/18	25	5.56	20.22
12/29/18	26	6.11	20.22
12/30/18	27	7.22	20.21
12/31/18	28	8.89	20.20
1/1/19	29	10.00	20.20
1/2/19	30	3.89	20.23
1/3/19	31	3.89	20.23
1/4/19	32	2.78	20.23

Data Sheet: Curing – Batch 30-4

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/19/19
Curing End	5/17/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	25.62	21.54	24.50
14	14	24.63	21.81	23.50
28	28	22.66	21.89	22.50

Trend Function for T_C versus t^*: $T_C = -0.28 \times t^* + 26.60$ ($R^2 = 0.832$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.18 \times T_{NWS} + 19.00$ ($R^2 = 0.101$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	9	24.7	24.6	24.9	25.1	24.83	16.11
4/29/19	10	24.5	24.3	24.7	24.7	24.55	13.33
4/30/19	11	24.1	24.2	24.3	24.5	24.28	18.89
5/1/19	12	23.6	23.7	24.0	23.9	23.80	21.11
5/3/19	14	21.5	21.6	21.7	21.7	21.63	20.00
5/4/19	15	21.5	21.5	21.6	21.5	21.53	20.00
5/5/19	16	20.9	20.8	20.9	20.9	20.88	16.67
5/6/19	17	20.6	20.8	21.0	20.9	20.83	16.11
5/14/19	25	19.6	19.6	19.6	19.8	19.65	9.44
5/15/19	26	19.5	19.4	19.6	19.6	19.53	11.67
5/17/19	28	19.5	19.6	19.7	19.7	19.63	18.89

Data Sheet: Curing – Batch 30-4

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
4/19/19	0	17.22	22.03
4/20/19	1	8.89	20.57
4/21/19	2	9.44	20.66
4/22/19	3	12.22	21.15
4/23/19	4	16.67	21.94
4/24/19	5	19.44	22.43
4/25/19	6	18.33	22.23
4/26/19	7	13.33	21.35
4/27/19	8	13.89	21.45
4/28/19	9	16.11	21.84
4/29/19	10	13.33	21.35
4/30/19	11	18.89	22.33
5/1/19	12	21.11	22.72
5/2/19	13	20.56	22.62
5/3/19	14	20.00	22.52
5/4/19	15	20.00	22.52
5/5/19	16	16.67	21.94
5/6/19	17	16.11	21.84
5/7/19	18	16.67	21.94
5/8/19	19	19.44	22.43
5/9/19	20	20.56	22.62
5/10/19	21	21.67	22.82
5/11/19	22	18.33	22.23
5/12/19	23	18.33	22.23
5/13/19	24	13.33	21.35
5/14/19	25	9.44	20.66
5/15/19	26	11.67	21.05
5/16/19	27	14.44	21.54
5/17/19	28	18.89	22.33

<u>Data Sheet: Curing – Batch 30-5</u>

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/19/19
Curing End	5/17/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	25.06	21.75	24.00
15	15	24.14	22.01	23.00
28	28	22.66	22.03	22.50

Trend Function for T_C versus t^*: $T_C = -0.23 \times t^* + 25.85$ ($R^2 = 0.823$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.15 \times T_{NWS} + 19.64$ ($R^2 = 0.101$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	9	24.2	24.4	24.6	24.5	24.43	16.11
4/29/19	10	24.3	23.8	24.2	24.1	24.10	13.33
4/30/19	11	23.9	23.8	23.9	24.0	23.90	18.89
5/1/19	12	23.7	23.7	23.7	24.2	23.83	21.11
5/3/19	14	21.6	21.7	21.8	21.8	21.73	20.00
5/4/19	15	21.7	21.8	22.0	21.8	21.83	20.00
5/5/19	16	21.1	21.2	21.2	21.2	21.18	16.67
5/6/19	17	20.9	21.1	21.2	21.2	21.10	16.11
5/14/19	25	20.2	20.3	20.4	20.4	20.33	9.44
5/15/19	26	20.0	20.1	20.1	20.2	20.10	11.67
5/17/19	28	20.1	20.1	20.2	20.2	20.15	18.89

Data Sheet: Curing – Batch 30-5

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
4/19/19	0	17.22	22.15
4/20/19	1	8.89	20.94
4/21/19	2	9.44	21.02
4/22/19	3	12.22	21.42
4/23/19	4	16.67	22.07
4/24/19	5	19.44	22.48
4/25/19	6	18.33	22.32
4/26/19	7	13.33	21.59
4/27/19	8	13.89	21.67
4/28/19	9	16.11	21.99
4/29/19	10	13.33	21.59
4/30/19	11	18.89	22.40
5/1/19	12	21.11	22.72
5/2/19	13	20.56	22.64
5/3/19	14	20.00	22.56
5/4/19	15	20.00	22.56
5/5/19	16	16.67	22.07
5/6/19	17	16.11	21.99
5/7/19	18	16.67	22.07
5/8/19	19	19.44	22.48
5/9/19	20	20.56	22.64
5/10/19	21	21.67	22.80
5/11/19	22	18.33	22.32
5/12/19	23	18.33	22.32
5/13/19	24	13.33	21.59
5/14/19	25	9.44	21.02
5/15/19	26	11.67	21.34
5/16/19	27	14.44	21.75
5/17/19	28	18.89	22.40

Data Sheet: Curing – Batch 30-6

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/19/19
Curing End	5/17/19
Values of t Tested (d)	7, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	25.01	21.85	24.00
15	15	24.15	22.14	23.50
28	28	22.76	22.16	23.00

Trend Function for T_C versus t^*: $T_C = -0.21 \times t^* + 25.75$ ($R^2 = 0.810$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.16 \times T_{NWS} + 19.51$ ($R^2 = 0.144$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	9	23.5	23.6	24.0	24.0	23.78	16.11
4/29/19	10	23.8	24.0	24.3	24.4	24.13	13.33
4/30/19	11	24.3	24.1	24.1	24.3	24.20	18.89
5/1/19	12	24.2	24.1	24.5	24.0	24.20	21.11
5/3/19	14	21.9	22.0	22.1	22.0	22.00	20.00
5/4/19	15	21.9	22.0	22.1	22.0	22.00	20.00
5/5/19	16	21.3	21.3	21.5	21.5	21.40	16.67
5/6/19	17	21.1	21.2	21.3	21.3	21.23	16.11
5/14/19	25	20.4	20.4	20.5	20.5	20.45	9.44
5/15/19	26	20.3	20.3	20.4	20.6	20.40	11.67
5/17/19	28	20.3	20.3	20.4	20.4	20.35	18.89

Data Sheet: Curing – Batch 30-6

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
4/19/19	0	17.22	22.30
4/20/19	1	8.89	20.95
4/21/19	2	9.44	21.04
4/22/19	3	12.22	21.49
4/23/19	4	16.67	22.21
4/24/19	5	19.44	22.66
4/25/19	6	18.33	22.48
4/26/19	7	13.33	21.67
4/27/19	8	13.89	21.76
4/28/19	9	16.11	22.12
4/29/19	10	13.33	21.67
4/30/19	11	18.89	22.57
5/1/19	12	21.11	22.93
5/2/19	13	20.56	22.84
5/3/19	14	20.00	22.75
5/4/19	15	20.00	22.75
5/5/19	16	16.67	22.21
5/6/19	17	16.11	22.12
5/7/19	18	16.67	22.21
5/8/19	19	19.44	22.66
5/9/19	20	20.56	22.84
5/10/19	21	21.67	23.02
5/11/19	22	18.33	22.48
5/12/19	23	18.33	22.48
5/13/19	24	13.33	21.67
5/14/19	25	9.44	21.04
5/15/19	26	11.67	21.40
5/16/19	27	14.44	21.85
5/17/19	28	18.89	22.57

Data Sheet: Curing – Batch 30-7

Method of Estimating T	T_C-Only
Curing Start	5/20/19
Curing End	6/17/19
Values of t Tested (d)	8, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
8	8	21.09	21.10
14	14	21.06	21.10
28	28	21.00	21.00

Trend Function for T_C versus t^*: $T_C = -0.0096 \times t^* + 21.13$ ($R^2 = 0.042$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/21/19	1	21.0	21.3	21.2	21.17
5/22/19	2	21.0	21.2	21.1	21.10
5/28/19	8	20.0	20.2	20.2	20.13
5/29/19	9	20.4	20.8	20.7	20.63
5/30/19	10	21.3	21.8	21.7	21.60
5/31/19	11	21.0	21.8	21.7	21.50
6/1/19	12	20.9	21.5	21.3	21.23
6/3/19	14	20.5	21.1	20.9	20.83
6/4/19	15	21.1	21.4	21.2	21.23
6/5/19	16	20.9	21.2	21.3	21.13
6/6/19	17	21.0	21.3	21.0	21.10
6/7/19	18	20.5	21.0	20.8	20.77
6/9/19	20	20.7	21.2	21.0	20.97
6/10/19	21	20.6	21.2	21.0	20.93
6/11/19	22	20.9	21.5	21.2	21.20
6/12/19	23	21.0	21.4	21.2	21.20
6/13/19	24	20.6	21.0	20.8	20.80
6/14/19	25	20.4	–	20.7	20.55
6/15/19	26	20.1	–	20.7	20.40
6/16/19	27	20.8	–	21.3	21.05

<u>Data Sheet: Curing – Batch 30-8</u>

Method of Estimating T	T_C-Only
Curing Start	5/20/19
Curing End	6/17/19
Values of t Tested (d)	8, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
8	8	21.09	21.10
14	14	21.06	21.10
28	28	21.00	21.00

Trend Function for T_C versus t^*: $T_C = -0.0096 \times t^* + 21.13$ ($R^2 = 0.042$)

Note: Batches 30-7 and 30-8 were cured simultaneously in the same container – hence their identical sets of T_C data.

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/21/19	1	21.0	21.3	21.2	21.17
5/22/19	2	21.0	21.2	21.1	21.10
5/28/19	8	20.0	20.2	20.2	20.13
5/29/19	9	20.4	20.8	20.7	20.63
5/30/19	10	21.3	21.8	21.7	21.60
5/31/19	11	21.0	21.8	21.7	21.50
6/1/19	12	20.9	21.5	21.3	21.23
6/3/19	14	20.5	21.1	20.9	20.83
6/4/19	15	21.1	21.4	21.2	21.23
6/5/19	16	20.9	21.2	21.3	21.13
6/6/19	17	21.0	21.3	21.0	21.10
6/7/19	18	20.5	21.0	20.8	20.77
6/9/19	20	20.7	21.2	21.0	20.97
6/10/19	21	20.6	21.2	21.0	20.93
6/11/19	22	20.9	21.5	21.2	21.20
6/12/19	23	21.0	21.4	21.2	21.20
6/13/19	24	20.6	21.0	20.8	20.80
6/14/19	25	20.4	–	20.7	20.55
6/15/19	26	20.1	–	20.7	20.40
6/16/19	27	20.8	–	21.3	21.05

Data Sheet: Curing – Batch 40-1

Method of Estimating T	T_C-Only
Curing Start	5/22/19
Curing End	6/19/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	20.48	20.00
14	14	20.50	20.30
28	28	20.55	20.50

Trend Function for T_C versus t^*: $T_C = 0.0066 \times t^* + 20.46$ ($R^2 = 0.022$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/22/19	0	20.7	21.0	20.7	20.80
5/28/19	6	19.6	19.9	19.9	19.80
5/29/19	7	19.7	20.1	20.2	20.00
5/30/19	8	20.7	21.3	21.0	21.00
5/31/19	9	20.4	21.1	21.0	20.83
6/1/19	10	20.1	20.8	20.5	20.47
6/3/19	12	19.9	20.6	20.3	20.27
6/4/19	13	20.7	21.1	20.7	20.83
6/5/19	14	20.4	21.0	20.8	20.73
6/6/19	15	20.5	20.9	20.6	20.67
6/7/19	16	20.0	20.6	20.4	20.33
6/9/19	18	20.3	20.9	20.7	20.63
6/10/19	19	20.2	20.7	20.5	20.47
6/11/19	20	20.5	21.0	20.9	20.80
6/12/19	21	20.6	21.1	21.1	20.93
6/13/19	22	20.2	20.6	20.3	20.37
6/14/19	23	20.3	–	20.8	20.55
6/15/19	24	19.7	–	20.3	20.00
6/16/19	25	20.3	–	20.9	20.60
6/17/19	26	20.4	–	21.1	20.75
6/18/19	27	20.7	–	21.2	20.95

<u>Data Sheet: Curing – Batch 40-2</u>

Method of Estimating T	T_C-Only
Curing Start	5/22/19
Curing End	6/19/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	20.48	20.00
14	14	20.50	20.30
28	28	20.55	20.50

Trend Function for T_C versus t^*: $T_C = 0.0066 \times t^* + 20.46$ ($R^2 = 0.022$)

Note: Batches 40-1 and 40-2 were cured simultaneously in the same container – hence their identical sets of T_C data.

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/22/19	0	20.7	21.0	20.7	20.80
5/28/19	6	19.6	19.9	19.9	19.80
5/29/19	7	19.7	20.1	20.2	20.00
5/30/19	8	20.7	21.3	21.0	21.00
5/31/19	9	20.4	21.1	21.0	20.83
6/1/19	10	20.1	20.8	20.5	20.47
6/3/19	12	19.9	20.6	20.3	20.27
6/4/19	13	20.7	21.1	20.7	20.83
6/5/19	14	20.4	21.0	20.8	20.73
6/6/19	15	20.5	20.9	20.6	20.67
6/7/19	16	20.0	20.6	20.4	20.33
6/9/19	18	20.3	20.9	20.7	20.63
6/10/19	19	20.2	20.7	20.5	20.47
6/11/19	20	20.5	21.0	20.9	20.80
6/12/19	21	20.6	21.1	21.1	20.93
6/13/19	22	20.2	20.6	20.3	20.37
6/14/19	23	20.3	–	20.8	20.55
6/15/19	24	19.7	–	20.3	20.00
6/16/19	25	20.3	–	20.9	20.60
6/17/19	26	20.4	–	21.1	20.75
6/18/19	27	20.7	–	21.2	20.95

Data Sheet: Curing – Batch 40-3

Method of Estimating T	T_C-Only
Curing Start	5/22/19
Curing End	6/19/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	20.37	20.40
14	14	20.40	20.40
28	28	20.43	20.40

Trend Function for T_C versus t^*: $T_C = 20.44$ ($R^2 = 0.000$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/28/19	6	19.4	19.6	19.8	19.60
5/29/19	7	19.8	20.3	20.4	20.17
5/30/19	8	20.6	21.3	21.0	20.97
5/31/19	9	20.6	21.3	21.1	21.00
6/1/19	10	20.1	20.9	20.6	20.53
6/3/19	12	19.8	20.6	20.3	20.23
6/4/19	13	20.5	21.0	20.7	20.73
6/5/19	14	20.2	20.9	20.7	20.60
6/6/19	15	20.2	20.8	20.4	20.47
6/7/19	16	19.9	20.5	20.3	20.23
6/9/19	18	20.2	20.7	20.5	20.47
6/10/19	19	20.0	20.7	20.5	20.40
6/11/19	20	20.2	20.8	20.6	20.53
6/12/19	21	20.4	20.9	20.6	20.63
6/13/19	22	20.1	20.5	20.2	20.27
6/14/19	23	20.1	–	20.7	20.40
6/15/19	24	19.6	–	20.2	19.90
6/16/19	25	20.2	–	20.8	20.50
6/17/19	26	20.2	–	20.7	20.45
6/18/19	27	20.3	–	20.9	20.60

Data Sheet: Curing – Batch 40-4

Method of Estimating T	T_C-Only
Curing Start	5/23/19
Curing End	6/19/19
Values of t Tested (d)	7, 14, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
7	7	20.44	20.40
14	13	20.44	20.40
28	27	20.44	20.40

Trend Function for T_C versus t^*: $T_C = 20.44$ ($R^2 = 0.000$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/28/19	5	19.4	19.6	19.8	19.60
5/29/19	6	19.8	20.3	20.4	20.17
5/30/19	7	20.6	21.3	21.0	20.97
5/31/19	8	20.6	21.3	21.1	21.00
6/1/19	9	20.1	20.9	20.6	20.53
6/3/19	11	19.8	20.6	20.3	20.23
6/4/19	12	20.5	21.0	20.7	20.73
6/5/19	13	20.2	20.9	20.7	20.60
6/6/19	14	20.2	20.8	20.4	20.47
6/7/19	15	19.9	20.5	20.3	20.23
6/9/19	17	20.2	20.7	20.5	20.47
6/10/19	18	20.0	20.7	20.5	20.40
6/11/19	19	20.2	20.8	20.6	20.53
6/12/19	20	20.4	20.9	20.6	20.63
6/13/19	21	20.1	20.5	20.2	20.27
6/14/19	22	20.1	–	20.7	20.40
6/15/19	23	19.6	–	20.2	19.90
6/16/19	24	20.2	–	20.8	20.50
6/17/19	25	20.2	–	20.7	20.45
6/18/19	26	20.3	–	20.9	20.60

Data Sheet: Curing – Batch 50-1

Method of Estimating T	T_C-T_{NWS}
Curing Start	12/5/18
Curing End	1/5/19
Values of t Tested (d)	11, 14, 31

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
11	11	20.14	20.22	20.20
14	14	20.15	20.21	20.10
31	31	20.18	20.20	20.20

Trend Function for T_C versus t^*: $T_C = 0.004 \times t^* + 20.12$ ($R^2 = 0.030$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.0091 \times T_{NWS} + 20.22$ ($R^2 = 0.019$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	5	20.2	20.3	20.3	20.2	20.25	-0.56
12/11/18	6	20.4	20.5	20.5	20.5	20.48	-3.33
12/14/18	9	20.2	20.3	20.3	20.3	20.28	2.22
12/16/18	11	19.9	19.8	19.8	19.8	19.83	6.67
12/17/18	12	20.1	20.2	20.2	20.2	20.18	6.67
12/18/18	13	19.9	19.9	19.8	19.9	19.88	2.22
12/19/18	14	20.0	20.0	19.9	19.9	19.95	3.33
1/1/19	27	20.5	20.6	20.5	20.4	20.50	10.00
1/2/19	28	20.5	20.5	20.5	20.5	20.50	3.89
1/3/19	29	20.2	20.2	20.2	20.2	20.20	3.89
1/4/19	30	20.1	20.2	20.2	20.3	20.20	2.78
1/5/19	31	20.0	20.1	20.1	20.0	20.05	5.56

Data Sheet: Curing – Batch 50-1

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
12/5/18	0	-0.56	20.23
12/6/18	1	-0.56	20.23
12/7/18	2	-1.11	20.23
12/8/18	3	-2.22	20.24
12/9/18	4	-3.89	20.26
12/10/18	5	-0.56	20.23
12/11/18	6	-3.33	20.25
12/12/18	7	-2.22	20.24
12/13/18	8	1.67	20.21
12/14/18	9	2.22	20.20
12/15/18	10	4.44	20.18
12/16/18	11	6.67	20.16
12/17/18	12	6.67	20.16
12/18/18	13	2.22	20.20
12/19/18	14	3.33	20.19
12/20/18	15	2.78	20.20
12/21/18	16	6.67	20.16
12/22/18	17	-0.56	20.23
12/23/18	18	1.11	20.21
12/24/18	19	1.11	20.21
12/25/18	20	1.11	20.21
12/26/18	21	0.56	20.22
12/27/18	22	-1.11	20.23
12/28/18	23	5.56	20.17
12/29/18	24	6.11	20.17
12/30/18	25	7.22	20.16
12/31/18	26	8.89	20.14
1/1/19	27	10.00	20.13
1/2/19	28	3.89	20.19
1/3/19	29	3.89	20.19
1/4/19	30	2.78	20.20
1/5/19	31	5.56	20.17

Data Sheet: Curing – Batch 50-2

Method of Estimating T	T_C-T_{NWS}
Curing Start	12/5/18
Curing End	1/5/19
Values of t Tested (d)	11, 14, 31

t, d	t*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
11	12	20.02	20.22	20.20
14	14	20.03	20.21	20.00
31	31	20.05	20.20	20.10

Trend Function for T_C versus t*: $T_C = 0.0032 \times t^* + 20.00$ ($R^2 = 0.017$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.0091 \times T_{NWS} + 20.22$ ($R^2 = 0.019$)

Date	t*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	5	20.2	20.2	20.1	20.2	20.18	-0.56
12/11/18	6	20.4	20.4	20.4	20.3	20.38	-3.33
12/14/18	9	20.0	20.1	20.1	20.1	20.08	2.22
12/16/18	11	19.6	19.6	19.5	19.5	19.55	6.67
12/17/18	12	20.0	20.1	20.1	20.0	20.05	6.67
12/18/18	13	19.9	19.9	19.8	19.8	19.85	2.22
12/19/18	14	19.9	19.9	19.9	19.9	19.90	3.33
1/1/19	27	20.5	20.5	20.5	20.4	20.48	10.00
1/2/19	28	20.2	20.3	20.4	20.2	20.28	3.89
1/3/19	29	20.1	20.1	20.1	20.1	20.10	3.89
1/4/19	30	20.0	20.1	20.1	20.1	20.08	2.78
1/5/19	31	19.8	19.8	19.9	19.9	19.85	5.56

Data Sheet: Curing – Batch 50-2

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
12/5/18	0	-0.56	20.23
12/6/18	1	-0.56	20.23
12/7/18	2	-1.11	20.23
12/8/18	3	-2.22	20.24
12/9/18	4	-3.89	20.26
12/10/18	5	-0.56	20.23
12/11/18	6	-3.33	20.25
12/12/18	7	-2.22	20.24
12/13/18	8	1.67	20.21
12/14/18	9	2.22	20.20
12/15/18	10	4.44	20.18
12/16/18	11	6.67	20.16
12/17/18	12	6.67	20.16
12/18/18	13	2.22	20.20
12/19/18	14	3.33	20.19
12/20/18	15	2.78	20.20
12/21/18	16	6.67	20.16
12/22/18	17	-0.56	20.23
12/23/18	18	1.11	20.21
12/24/18	19	1.11	20.21
12/25/18	20	1.11	20.21
12/26/18	21	0.56	20.22
12/27/18	22	-1.11	20.23
12/28/18	23	5.56	20.17
12/29/18	24	6.11	20.17
12/30/18	25	7.22	20.16
12/31/18	26	8.89	20.14
1/1/19	27	10.00	20.13
1/2/19	28	3.89	20.19
1/3/19	29	3.89	20.19
1/4/19	30	2.78	20.20
1/5/19	31	5.56	20.17

Data Sheet: Curing – Batch 50-3

Method of Estimating T	T_C-T_{NWS}
Curing Start	12/6/18
Curing End	1/5/19
Values of t Tested (d)	11, 14, 30

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
11	11	19.84	19.87	20.00
14	14	19.84	19.86	19.80
30	30	19.81	19.83	19.80

Trend Function for T_C versus t^*: $T_C = -0.003 \times t^* + 19.86$ ($R^2 = 0.014$)

Trend Function for T_C versus T_{NWS}: $T_C = -0.020 \times T_{NWS} + 19.88$ ($R^2 = 0.079$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
12/10/18	4	20.0	20.1	20.1	20.0	20.05	-0.56
12/11/18	5	20.1	20.1	20.1	20.2	20.13	-3.33
12/14/18	8	19.9	19.9	19.9	19.9	19.90	2.22
12/16/18	10	19.5	19.4	19.4	19.4	19.43	6.67
12/17/18	11	19.8	19.8	19.8	19.7	19.78	6.67
12/18/18	12	19.7	19.7	19.6	19.6	19.65	2.22
12/19/18	13	19.6	19.6	19.5	19.6	19.58	3.33
1/1/19	26	20.2	20.2	20.1	20.1	20.15	10.00
1/2/19	27	20.0	20.0	20.1	20.1	20.05	3.89
1/3/19	28	19.7	19.8	19.8	19.8	19.78	3.89
1/4/19	29	19.8	19.7	19.8	19.7	19.75	2.78
1/5/19	30	19.4	19.4	19.5	19.5	19.45	5.56

Data Sheet: Curing – Batch 50-3

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
12/6/18	0	-0.56	19.89
12/7/18	1	-1.11	19.90
12/8/18	2	-2.22	19.93
12/9/18	3	-3.89	19.96
12/10/18	4	-0.56	19.89
12/11/18	5	-3.33	19.95
12/12/18	6	-2.22	19.93
12/13/18	7	1.67	19.85
12/14/18	8	2.22	19.83
12/15/18	9	4.44	19.79
12/16/18	10	6.67	19.74
12/17/18	11	6.67	19.74
12/18/18	12	2.22	19.83
12/19/18	13	3.33	19.81
12/20/18	14	2.78	19.82
12/21/18	15	6.67	19.74
12/22/18	16	-0.56	19.89
12/23/18	17	1.11	19.86
12/24/18	18	1.11	19.86
12/25/18	19	1.11	19.86
12/26/18	20	0.56	19.87
12/27/18	21	-1.11	19.90
12/28/18	22	5.56	19.77
12/29/18	23	6.11	19.76
12/30/18	24	7.22	19.73
12/31/18	25	8.89	19.70
1/1/19	26	10.00	19.68
1/2/19	27	3.89	19.80
1/3/19	28	3.89	19.80
1/4/19	29	2.78	19.82
1/5/19	30	5.56	19.77

Data Sheet: Curing – Batch 50-4

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/21/19
Curing End	5/21/19
Values of t Tested (d)	11, 14, 30

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
11	11	24.02	21.73	24.00
14	14	23.74	21.87	23.00
30	30	22.24	21.92	22.00

Trend Function for T_C versus t^*: $T_C = -0.19 \times t^* + 25.05$ ($R^2 = 0.730$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.14 \times T_{NWS} + 19.47$ ($R^2 = 0.088$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	7	24.0	24.1	24.2	24.4	24.18	16.11
4/29/19	8	24.0	24.3	24.5	24.6	24.35	13.33
4/30/19	9	24.3	24.2	24.5	24.6	24.40	18.89
5/1/19	10	24.1	24.1	24.2	24.2	24.15	21.11
5/3/19	12	21.8	21.9	22.0	21.9	21.90	20.00
5/4/19	13	21.9	22.0	22.0	22.0	21.98	20.00
5/5/19	14	21.2	21.3	21.4	21.4	21.33	16.67
5/6/19	15	21.0	21.2	21.2	21.3	21.18	16.11
5/14/19	23	19.6	19.5	19.3	19.5	19.48	9.44
5/15/19	24	20.1	20.3	20.4	20.3	20.28	11.67
5/17/19	26	20.3	20.2	20.3	20.3	20.28	18.89
5/18/19	27	20.7	20.7	20.8	20.8	20.75	21.11
5/21/19	30	20.6	20.2	20.9	20.8	20.63	17.22

Data Sheet: Curing – Batch 50-4

Date	t*, d	T_{NWS}, °C	Est. T_C, °C
4/21/19	0	9.44	20.83
4/22/19	1	12.22	21.23
4/23/19	2	16.67	21.87
4/24/19	3	19.44	22.27
4/25/19	4	18.33	22.11
4/26/19	5	13.33	21.39
4/27/19	6	13.89	21.47
4/28/19	7	16.11	21.79
4/29/19	8	13.33	21.39
4/30/19	9	18.89	22.19
5/1/19	10	21.11	22.51
5/2/19	11	20.56	22.43
5/3/19	12	20.00	22.35
5/4/19	13	20.00	22.35
5/5/19	14	16.67	21.87
5/6/19	15	16.11	21.79
5/7/19	16	16.67	21.87
5/8/19	17	19.44	22.27
5/9/19	18	20.56	22.43
5/10/19	19	21.67	22.59
5/11/19	20	18.33	22.11
5/12/19	21	18.33	22.11
5/13/19	22	13.33	21.39
5/14/19	23	9.44	20.83
5/15/19	24	11.67	21.15
5/16/19	25	14.44	21.55
5/17/19	26	18.89	22.19
5/18/19	27	21.11	22.51
5/19/19	28	21.11	22.51
5/20/19	29	20.56	22.43
5/21/19	30	17.22	21.95

Data Sheet: Curing – Batch 50-5

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/22/19
Curing End	5/22/19
Values of t Tested (d)	7, 14, 30

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	24.08	21.58	24.00
14	14	23.41	21.76	23.00
30	30	21.89	21.78	21.90

Trend Function for T_C versus t^*: $T_C = -0.19 \times t^* + 24.74$ ($R^2 = 0.766$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.11 \times T_{NWS} + 19.96$ ($R^2 = 0.048$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	6	23.7	23.8	24.5	24.3	24.08	16.11
4/29/19	7	24.2	24.1	24.2	24.4	24.23	13.33
4/30/19	8	24.2	23.9	24.1	24.5	24.18	18.89
5/1/19	9	24.0	24.1	24.1	23.9	24.03	21.11
5/3/19	11	21.5	21.7	21.8	21.7	21.68	20.00
5/4/19	12	21.6	21.7	21.8	21.8	21.73	20.00
5/5/19	13	21.1	21.1	21.2	21.2	21.15	16.67
5/6/19	14	20.8	20.9	21.1	21.1	20.98	16.11
5/14/19	22	20.0	20.0	20.0	20.2	20.05	9.44
5/15/19	23	19.8	19.9	20.0	20.0	19.93	11.67
5/17/19	25	19.9	19.9	20.0	20.0	19.95	18.89
5/18/19	26	20.3	20.4	20.5	20.5	20.43	21.11
5/21/19	29	20.0	20.2	20.4	20.4	20.25	17.22

Data Sheet: Curing – Batch 50-5

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
4/22/19	0	12.22	21.24
4/23/19	1	16.67	21.71
4/24/19	2	19.44	22.00
4/25/19	3	18.33	21.88
4/26/19	4	13.33	21.36
4/27/19	5	13.89	21.42
4/28/19	6	16.11	21.65
4/29/19	7	13.33	21.36
4/30/19	8	18.89	21.94
5/1/19	9	21.11	22.18
5/2/19	10	20.56	22.12
5/3/19	11	20.00	22.06
5/4/19	12	20.00	22.06
5/5/19	13	16.67	21.71
5/6/19	14	16.11	21.65
5/7/19	15	16.67	21.71
5/8/19	16	19.44	22.00
5/9/19	17	20.56	22.12
5/10/19	18	21.67	22.24
5/11/19	19	18.33	21.88
5/12/19	20	18.33	21.88
5/13/19	21	13.33	21.36
5/14/19	22	9.44	20.95
5/15/19	23	11.67	21.18
5/16/19	24	14.44	21.48
5/17/19	25	18.89	21.94
5/18/19	26	21.11	22.18
5/19/19	27	21.11	22.18
5/20/19	28	20.56	22.12
5/21/19	29	17.22	21.77
5/22/19	30	17.22	21.77

Data Sheet: Curing – Batch 50-6

Method of Estimating T	T_C-T_{NWS}
Curing Start	4/22/19
Curing End	5/22/19
Values of t Tested (d)	7, 14, 30

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (T_{NWS} trend)	Est. T, °C (Final)
7	7	24.46	21.46	24.00
14	14	23.65	21.64	23.00
30	30	21.81	21.67	21.80

Trend Function for T_C versus t^*: $T_C = -0.23 \times t^* + 25.27$ ($R^2 = 0.747$)

Trend Function for T_C versus T_{NWS}: $T_C = 0.11 \times T_{NWS} + 19.76$ ($R^2 = 0.035$)

Date	t^*, d	Probe 1 T_C, °C	Probe 2 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C	T_{NWS}, °C
4/28/19	6	24.5	24.6	25.1	24.9	24.78	16.11
4/29/19	7	25.0	24.7	25.1	24.7	24.88	13.33
4/30/19	8	24.5	24.7	24.8	24.6	24.65	18.89
5/1/19	9	23.9	23.9	24.1	24.0	23.98	21.11
5/3/19	11	21.3	21.4	21.6	21.5	21.45	20.00
5/4/19	12	21.3	21.4	21.6	21.5	21.45	20.00
5/5/19	13	20.9	20.8	21.0	21.0	20.93	16.67
5/6/19	14	20.5	20.6	20.8	20.7	20.65	16.11
5/14/19	22	19.5	19.4	19.5	19.6	19.50	9.44
5/15/19	23	19.3	19.3	19.5	19.5	19.40	11.67
5/17/19	25	19.5	19.6	19.6	19.6	19.58	18.89
5/18/19	26	19.9	19.9	20.0	20.1	19.98	21.11
5/21/19	29	19.8	20.0	20.0	20.1	19.98	17.22

Data Sheet: Curing – Batch 50-6

Date	t^*, d	T_{NWS}, °C	Est. T_C, °C
4/22/19	0	12.22	21.11
4/23/19	1	16.67	21.60
4/24/19	2	19.44	21.90
4/25/19	3	18.33	21.78
4/26/19	4	13.33	21.23
4/27/19	5	13.89	21.29
4/28/19	6	16.11	21.53
4/29/19	7	13.33	21.23
4/30/19	8	18.89	21.84
5/1/19	9	21.11	22.09
5/2/19	10	20.56	22.02
5/3/19	11	20.00	21.96
5/4/19	12	20.00	21.96
5/5/19	13	16.67	21.60
5/6/19	14	16.11	21.53
5/7/19	15	16.67	21.60
5/8/19	16	19.44	21.90
5/9/19	17	20.56	22.02
5/10/19	18	21.67	22.15
5/11/19	19	18.33	21.78
5/12/19	20	18.33	21.78
5/13/19	21	13.33	21.23
5/14/19	22	9.44	20.80
5/15/19	23	11.67	21.04
5/16/19	24	14.44	21.35
5/17/19	25	18.89	21.84
5/18/19	26	21.11	22.09
5/19/19	27	21.11	22.09
5/20/19	28	20.56	22.02
5/21/19	29	17.22	21.66
5/22/19	30	17.22	21.66

Data Sheet: Curing – Batch 50-7

Method of Estimating T	T_C-Only
Curing Start	5/20/19
Curing End	6/17/19
Values of t Tested (d)	9, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
9	8	21.27	21.30
15	14	21.25	21.30
28	28	21.23	21.20

Trend Function for T_C versus t^*: $T_C = -0.0037 \times t^* + 21.28$ ($R^2 = 0.009$)

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/21/19	1	21.3	21.3	21.3	21.30
5/22/19	2	21.1	21.3	21.1	21.17
5/28/19	8	20.4	20.6	20.7	20.57
5/29/19	9	20.9	21.0	21.0	20.97
5/30/19	10	21.2	21.8	21.5	21.50
5/31/19	11	21.2	21.8	21.7	21.57
6/1/19	12	21.2	21.7	21.6	21.50
6/3/19	14	20.8	21.4	21.2	21.13
6/4/19	15	21.5	21.8	21.6	21.63
6/5/19	16	21.3	21.8	21.5	21.53
6/6/19	17	21.1	21.5	21.2	21.27
6/7/19	18	20.8	21.3	21.0	21.03
6/9/19	20	20.9	21.5	21.3	21.23
6/10/19	21	20.9	21.4	21.2	21.17
6/11/19	22	21.2	21.6	21.4	21.40
6/12/19	23	21.3	21.6	21.5	21.47
6/13/19	24	21.0	21.3	21.0	21.10
6/14/19	25	20.8	20.9	21.0	20.90
6/15/19	26	20.4	--	20.9	20.65
6/16/19	27	21.1	--	21.6	21.35

Data Sheet: Curing – Batch 50-8

Method of Estimating T	T_C-Only
Curing Start	5/20/19
Curing End	6/17/19
Values of t Tested (d)	9, 15, 28

t, d	t^*, d	Est. T, °C (T_C trend)	Est. T, °C (Final)
9	8	21.27	21.30
15	14	21.25	21.30
28	28	21.23	21.20

Trend Function for T_C versus t^*: $T_C = -0.0037 \times t^* + 21.28$ ($R^2 = 0.009$)

Note: Batches 50-7 and 50-8 were cured simultaneously in the same container – hence their identical sets of T_C data.

Date	t^*, d	Probe 1 T_C, °C	Probe 3 T_C, °C	Probe 4 T_C, °C	Average T_C, °C
5/21/19	1	21.3	21.3	21.3	21.30
5/22/19	2	21.1	21.3	21.1	21.17
5/28/19	8	20.4	20.6	20.7	20.57
5/29/19	9	20.9	21.0	21.0	20.97
5/30/19	10	21.2	21.8	21.5	21.50
5/31/19	11	21.2	21.8	21.7	21.57
6/1/19	12	21.2	21.7	21.6	21.50
6/3/19	14	20.8	21.4	21.2	21.13
6/4/19	15	21.5	21.8	21.6	21.63
6/5/19	16	21.3	21.8	21.5	21.53
6/6/19	17	21.1	21.5	21.2	21.27
6/7/19	18	20.8	21.3	21.0	21.03
6/9/19	20	20.9	21.5	21.3	21.23
6/10/19	21	20.9	21.4	21.2	21.17
6/11/19	22	21.2	21.6	21.4	21.40
6/12/19	23	21.3	21.6	21.5	21.47
6/13/19	24	21.0	21.3	21.0	21.10
6/14/19	25	20.8	20.9	21.0	20.90
6/15/19	26	20.4	––	20.9	20.65
6/16/19	27	21.1	––	21.6	21.35

Data Sheet: Combined Trend Function for T_C versus T_{NWS}

This sheet shows the data used to generate the combined trend function used to estimate T_C values for batches 0-1, 0-2, and 0-3. All pairs of T_C and T_{NWS} data were gathered. Then, since the lowest T_{NWS} value for batches 0-1, 0-2, and 0-3 was 8.89 °C (48 °F), data pairs with T_{NWS} values less than 6.11 °C (43 °F) were excluded from the trend function fitting. This meant that the range of T_{NWS} values used to generate the trend function provided a good match to the range of T_{NWS} values for which the trend function was used. Points not used to generate the trend function are *italicized* in the table.

Batch	T_{NWS}, °C	T_C, °C
0-I-4	21.67	26.05
	22.22	25.90
	21.67	25.50
	22.78	25.18
	23.33	25.58
	23.33	25.75
	21.67	25.78
	21.67	25.48
	18.33	24.85
0-I-5	21.67	26.25
	22.22	26.15
	21.67	25.63
	22.78	25.43
	23.33	25.80
	23.33	25.88
	21.67	25.88
	21.67	25.75
	18.33	25.08
10-I-1	*-0.56*	*20.20*
	-3.33	*20.28*
	2.22	*20.25*
	6.67	19.85
	6.67	19.95
	2.22	*20.03*
	3.33	*20.03*
	10.00	20.70

Batch	T_{NWS}, °C	T_C, °C
10-I-2	*-0.56*	*20.20*
	-3.33	*20.30*
	2.22	*20.13*
	6.67	19.65
	6.67	19.73
	2.22	*19.70*
	3.33	*19.80*
	10.00	20.38
10-I-3	*-0.56*	*20.23*
	-3.33	*20.15*
	2.22	*19.98*
	6.67	19.70
	6.67	19.63
	2.22	*19.73*
	3.33	*19.78*
	10.00	20.00
10-I-4	16.11	25.88
	13.33	25.60
	18.89	25.50
	21.11	25.15
	20.00	22.33
	20.00	22.25
	16.67	21.50
	16.11	21.68
	9.44	20.28
	11.67	19.98

Data Sheet: Combined Trend Function for T_C versus T_{NWS}

Batch	T_{NWS}, °C	T_C, °C
10-I-5	16.11	25.83
	13.33	25.65
	18.89	25.33
	21.11	25.10
	20.00	22.05
	20.00	21.98
	16.67	21.20
	16.11	21.18
	9.44	19.78
	11.67	19.70
10-I-6	16.11	24.43
	13.33	24.15
	18.89	23.90
	21.11	23.90
	20.00	21.68
	20.00	21.78
	16.67	21.00
	16.11	20.95
	9.44	19.85
	11.67	19.85
30-I-1	*-0.56*	*20.20*
	-3.33	*20.20*
	2.22	*19.95*
	6.67	19.48
	6.67	19.60
	2.22	*19.50*
	3.33	*19.58*
	10.00	19.78
	3.89	*19.93*
	3.89	*19.58*
	2.78	*19.53*

Batch	T_{NWS}, °C	T_C, °C
30-I-2	*-0.56*	*20.15*
	-3.33	*20.35*
	2.22	*20.00*
	6.67	19.80
	6.67	19.90
	2.22	*19.88*
	3.33	*19.88*
	10.00	20.35
	3.89	*20.33*
	3.89	*20.20*
	2.78	*19.98*
30-I-3	*-0.56*	*20.25*
	-3.33	*20.53*
	2.22	*20.10*
	6.67	19.90
	6.67	20.18
	2.22	*20.08*
	3.33	*20.08*
	10.00	20.55
	3.89	*20.58*
	3.89	*20.15*
	2.78	*20.15*
30-I-4	16.11	24.83
	13.33	24.55
	18.89	24.28
	21.11	23.80
	20.00	21.63
	20.00	21.53
	16.67	20.88
	16.11	20.83
	9.44	19.65
	11.67	19.53
	18.89	19.63

Data Sheet: Combined Trend Function for T_C versus T_{NWS}

Batch	T_{NWS}, °C	T_C, °C
30-I-5	16.11	24.43
	13.33	24.10
	18.89	23.90
	21.11	23.83
	20.00	21.73
	20.00	21.83
	16.67	21.18
	16.11	21.10
	9.44	20.33
	11.67	20.10
	18.89	20.15
30-I-6	16.11	23.78
	13.33	24.13
	18.89	24.20
	21.11	24.20
	20.00	22.00
	20.00	22.00
	16.67	21.40
	16.11	21.23
	9.44	20.45
	11.67	20.40
	18.89	20.35
50-I-1	*-0.56*	*20.25*
	-3.33	*20.48*
	2.22	*20.28*
	6.67	19.83
	6.67	20.18
	2.22	*19.88*
	3.33	*19.95*
	10.00	20.50
	3.89	*20.50*
	3.89	*20.20*
	2.78	*20.20*
	5.56	*20.05*

Batch	T_{NWS}, °C	T_C, °C
50-I-2	*-0.56*	*20.18*
	-3.33	*20.38*
	2.22	*20.08*
	6.67	19.55
	6.67	20.05
	2.22	*19.85*
	3.33	*19.90*
	10.00	20.48
	3.89	*20.28*
	3.89	*20.10*
	2.78	*20.08*
	5.56	*19.85*
50-I-3	*-0.56*	*20.05*
	-3.33	*20.13*
	2.22	*19.90*
	6.67	19.43
	6.67	19.78
	2.22	*19.65*
	3.33	*19.58*
	10.00	20.15
	3.89	*20.05*
	3.89	*19.78*
	2.78	*19.75*
	5.56	*19.45*
50-I-4	16.11	24.18
	13.33	24.35
	18.89	24.40
	21.11	24.15
	20.00	21.90
	20.00	21.98
	16.67	21.33
	16.11	21.18
	9.44	19.48
	11.67	20.28
	18.89	20.28
	21.11	20.75
	17.22	20.63

Data Sheet: Combined Trend Function for T_C versus T_{NWS}

Batch	T_{NWS}, °C	T_C, °C
50-I-5	16.11	24.08
	13.33	24.23
	18.89	24.18
	21.11	24.03
	20.00	21.68
	20.00	21.73
	16.67	21.15
	16.11	20.98
	9.44	20.05
	11.67	19.93
	18.89	19.95
	21.11	20.43
	17.22	20.25
50-I-6	16.11	24.78
	13.33	24.88
	18.89	24.65
	21.11	23.98
	20.00	21.45
	20.00	21.45
	16.67	20.93
	16.11	20.65
	9.44	19.50
	11.67	19.40
	18.89	19.58
	21.11	19.98
	17.22	19.98

Equation for Combined T_C-T_{NWS} Trend Function: $T_C = 0.28 \times T_{NWS} + 17.77$ ($R^2 = 0.416$)

Appendix L: Unconfined Compressive Strength Test Data Sheets and Results

This appendix includes a UCS test data sheet for each of the 273 specimens tested. Each sheet lists information on the batch in which the specimen was mixed, including the date on which specimen molding was completed, $\alpha_{I\text{-}P}$, *w:b*, and soil *OM*. Each sheet also lists information specific to the specimen, including length of curing period, testing date, diameter, height, weight, quantity of bleed water, UCS, strain at failure, and, where applicable, fracture type per ASTM C39 (2018). A stress-strain diagram for the UCS test is also included.

The values of peak UCS listed for each specimen have been corrected to account for differences in the heights of specimens. This correction accounts for the minor disparity between the peak UCS values listed and those shown on the stress-strain plots.

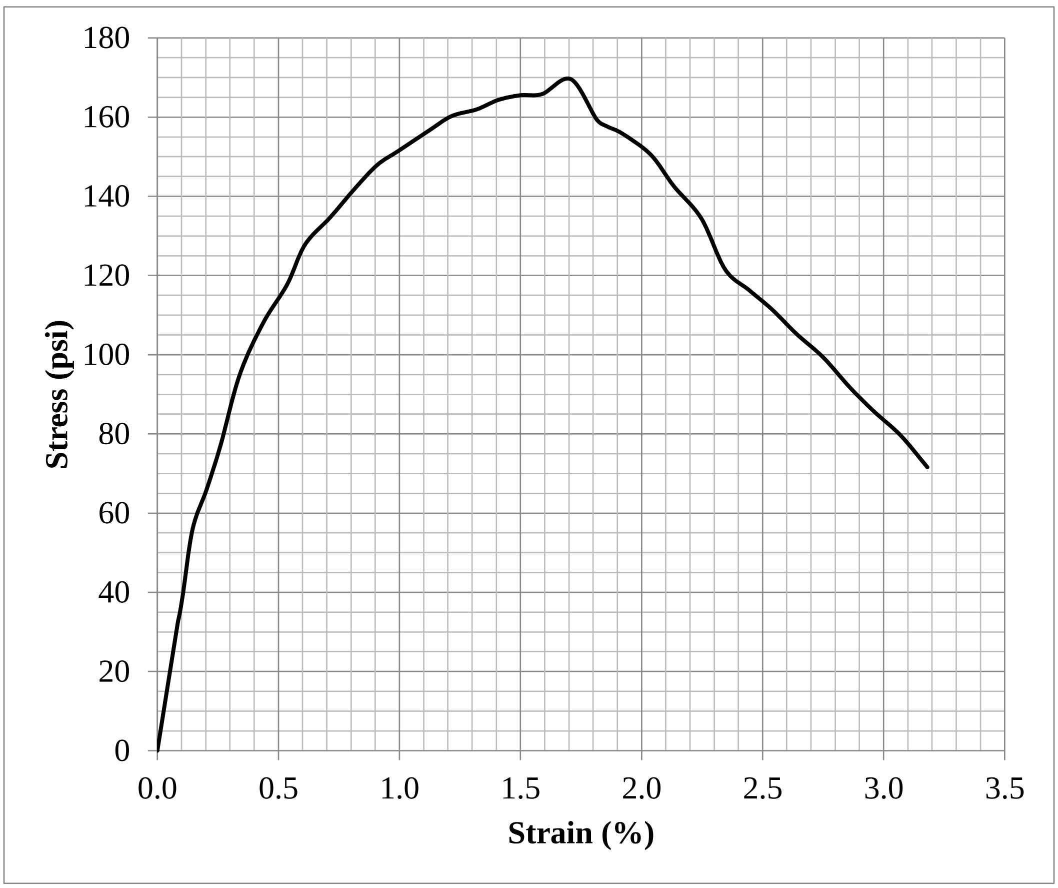
The values in the data sheets have been drawn from data shown in Appendix J. If Appendix J and this appendix list different values of the same parameter for any test, those in Appendix J should be regarded as definitive.

During testing, every effort was made to use only specimens taller than 3.5”. Occasionally, this was unavoidable due to bleed water, chipping during extraction, or a scarcity of available duplicate specimens. All specimens used were at least 3.3” tall.

Data Sheet: Specimen UCS Test

Specimen ID	0-1-A
Molding Date	4/29/18
Curing Period (d)	10
α_{I-P} (kg/m^3)	125 (124.8)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

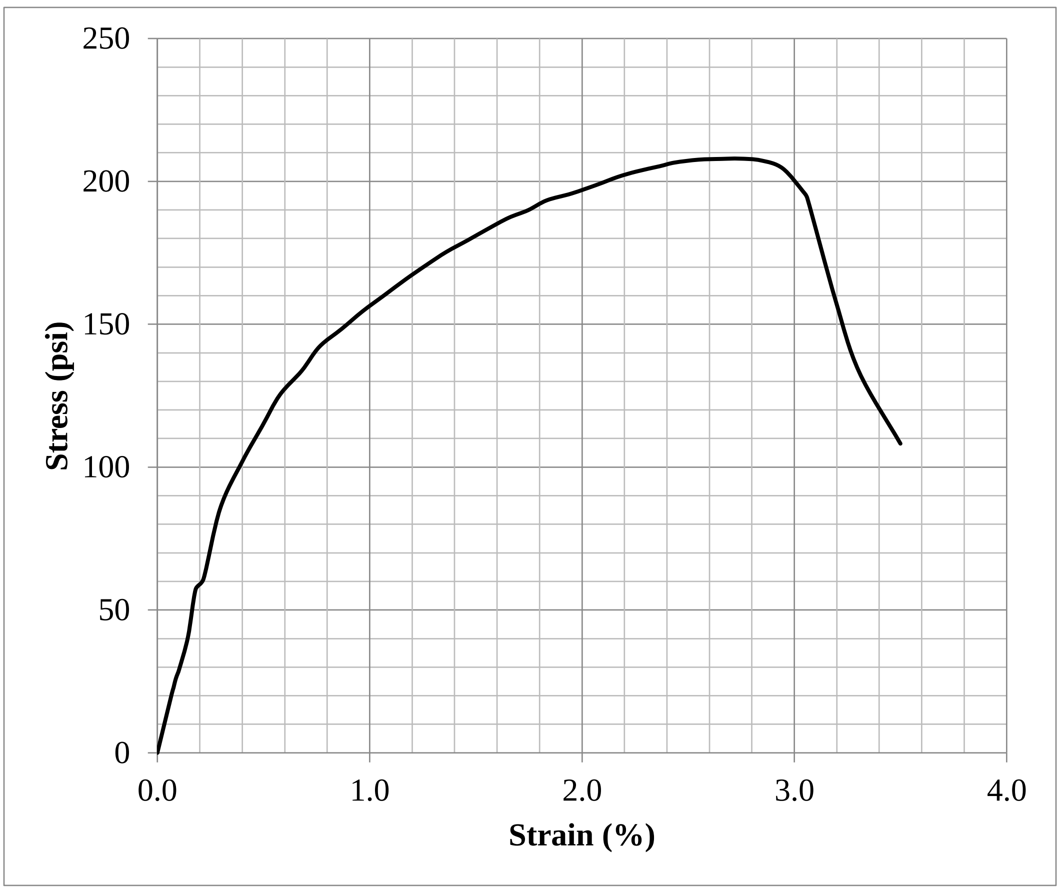
Testing Date	5/9/18
Diameter (in.)	2.041
Height (in.)	3.980
Weight (g)	377.8
Corrected Peak UCS (psi)	168.9
Corrected Failure Strain (%)	1.71
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-1-B
Molding Date	4/29/18
Curing Period (d)	10
$\alpha_{I\text{-}P}$ (kg/m^3)	125 (124.8)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

Testing Date	5/9/18
Diameter (in.)	2.038
Height (in.)	3.848
Weight (g)	358.2
Corrected Peak UCS (psi)	206.1
Corrected Failure Strain (%)	2.74
ASTM C39 Fracture Type	4

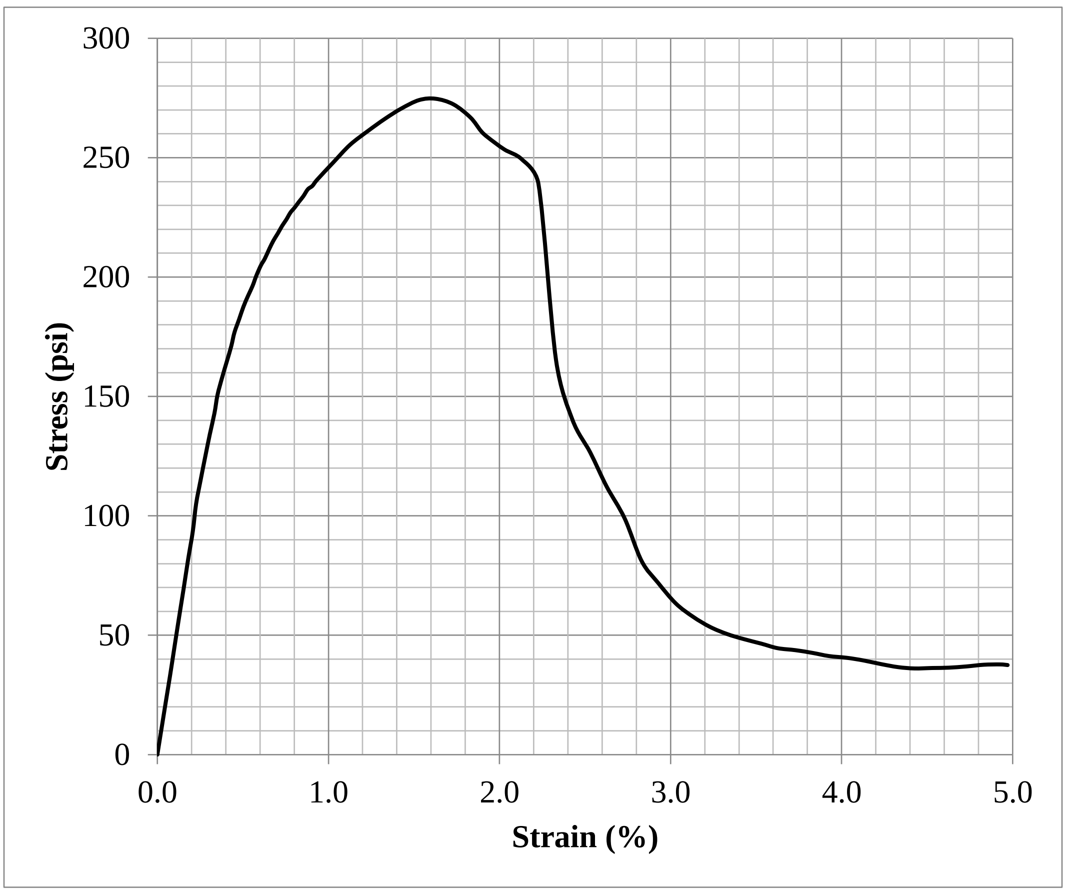


<u>Data Sheet: Specimen UCS Test</u>

Specimen ID	0-1-C
Molding Date	4/29/18
Curing Period (d)	44
$\alpha_{I\text{-}P}$ (kg/m^3)	125 (124.8)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

Testing Date	6/12/18
Diameter (in.)	2.035
Height (in.)	3.842
Weight (g)	359.6
Corrected Peak UCS (psi)	272.2
Corrected Failure Strain (%)	1.63
ASTM C39 Fracture Type	4

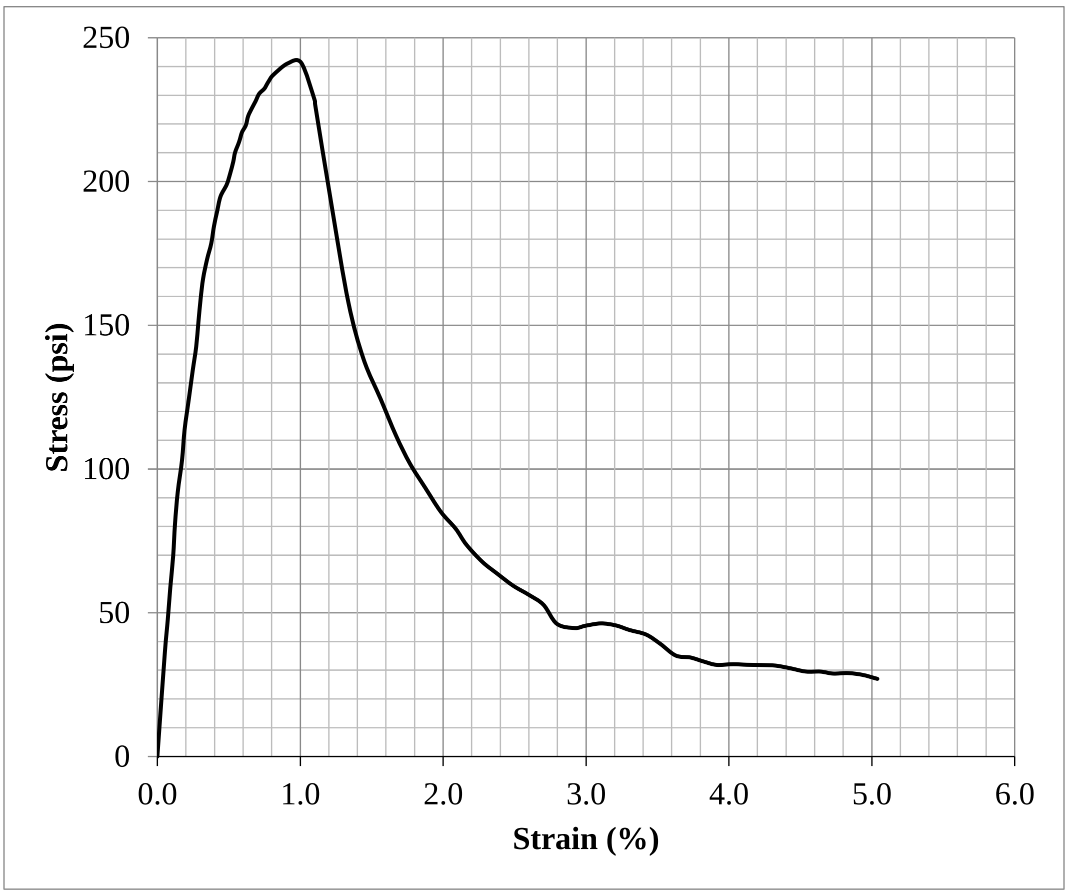
Note: Data shown is from end platen readings. DCDT was not operational during this test.



Data Sheet: Specimen UCS Test

Specimen ID	0-1-D
Molding Date	4/29/18
Curing Period (d)	44
α_{I-P} (kg/m^3)	125 (124.8)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

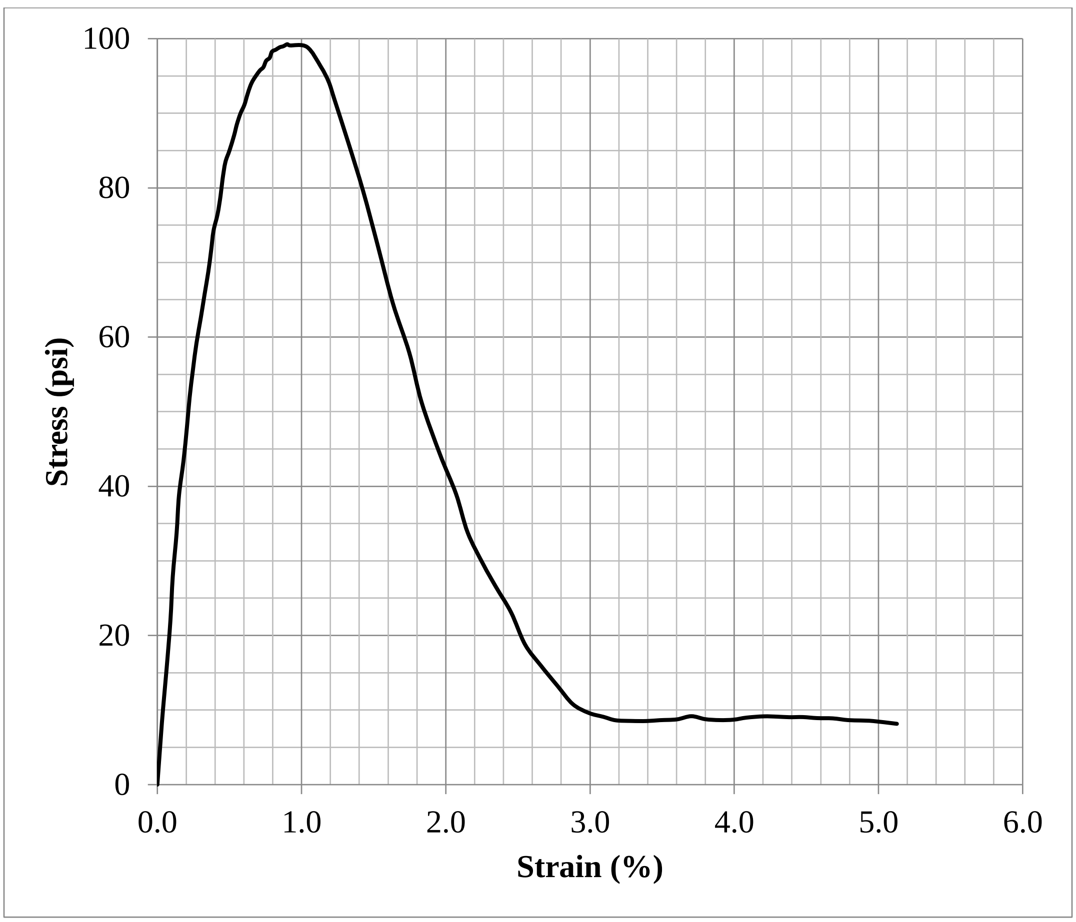
Testing Date	6/12/18
Diameter (in.)	2.039
Height (in.)	3.869
Weight (g)	367.2
Corrected Peak UCS (psi)	239.3
Corrected Failure Strain (%)	1.01
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-2-A
Molding Date	6/7/18
Curing Period (d)	7
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

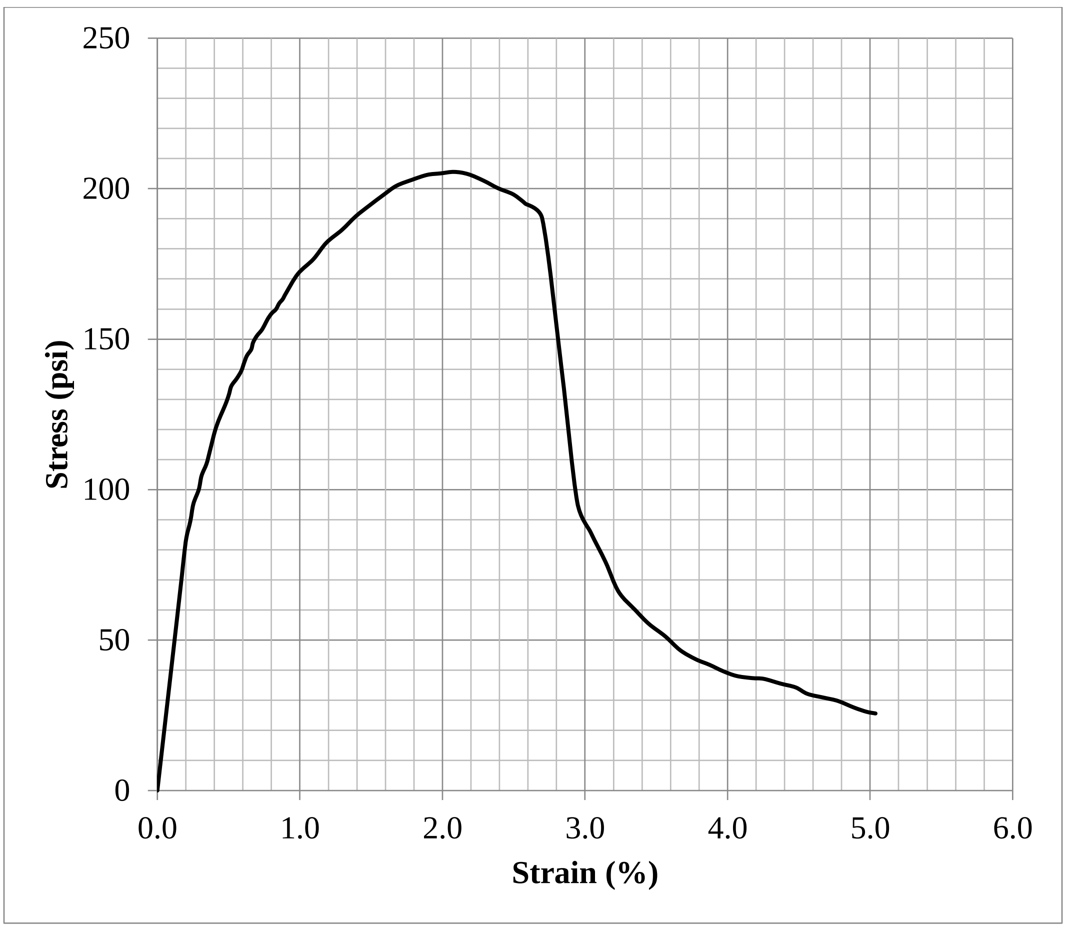
Testing Date	6/14/18
Diameter (in.)	2.037
Height (in.)	3.950
Weight (g)	375.4
Corrected Peak UCS (psi)	98.8
Corrected Failure Strain (%)	0.90
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-2-B
Molding Date	6/7/18
Curing Period (d)	7
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

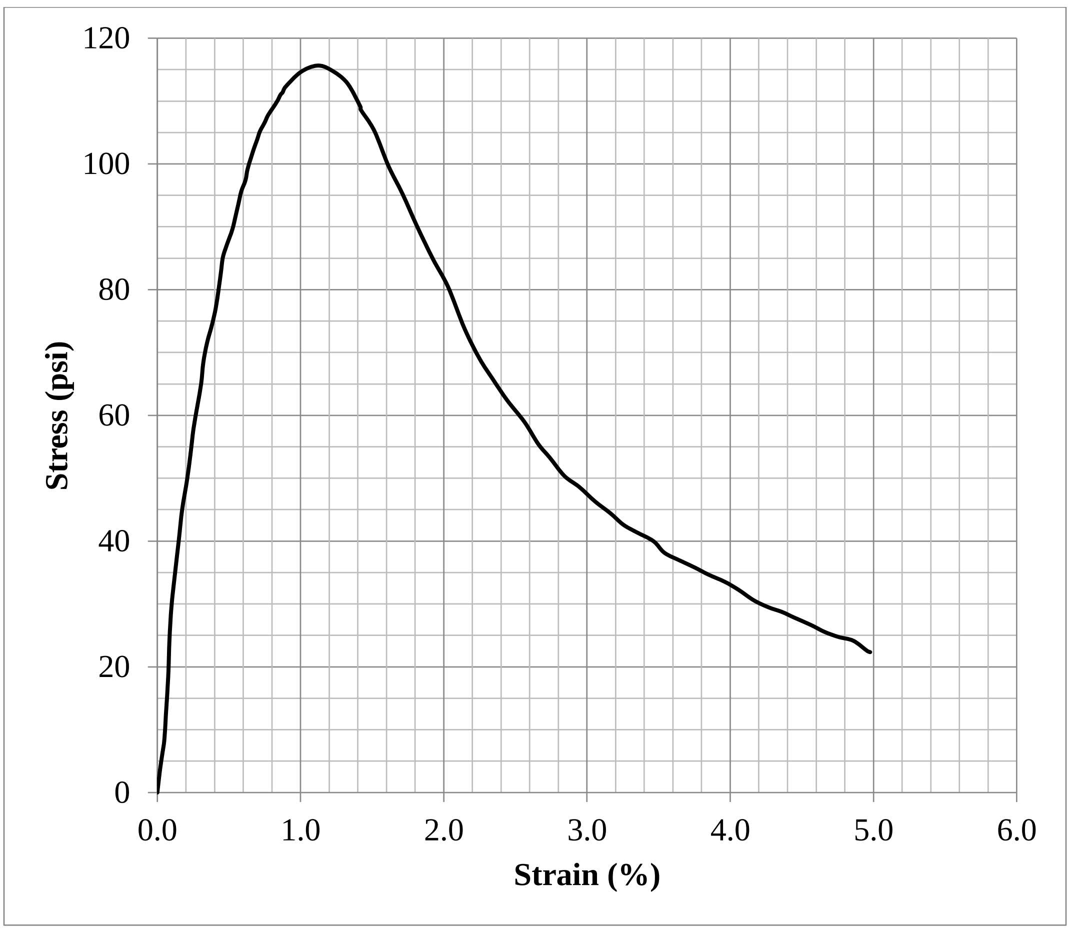
Testing Date	6/14/18
Diameter (in.)	2.040
Height (in.)	3.760
Weight (g)	353.7
Corrected Peak UCS (psi)	203.0
Corrected Failure Strain (%)	2.08
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-2-C
Molding Date	6/7/18
Curing Period (d)	7
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

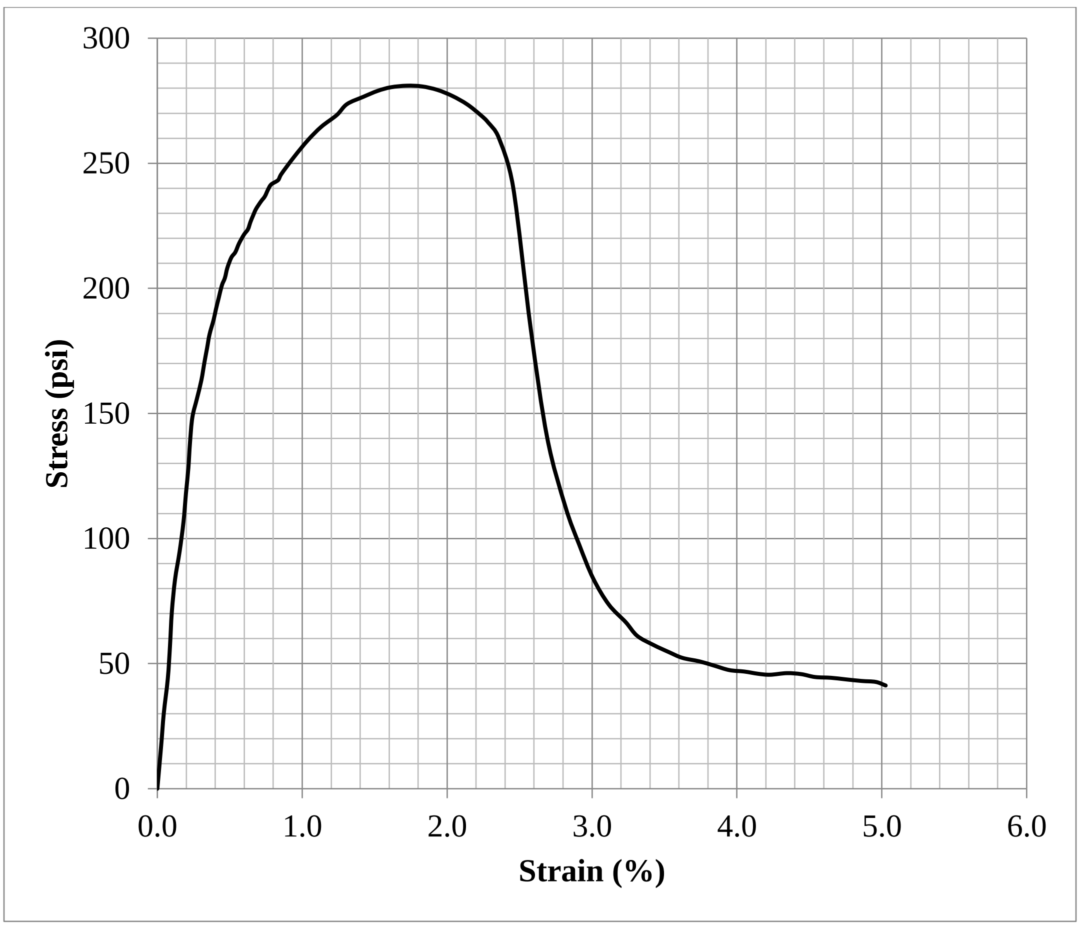
Testing Date	6/14/18
Diameter (in.)	2.033
Height (in.)	3.890
Weight (g)	366.2
Corrected Peak UCS (psi)	114.8
Corrected Failure Strain (%)	1.08
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-2-D
Molding Date	6/7/18
Curing Period (d)	16
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

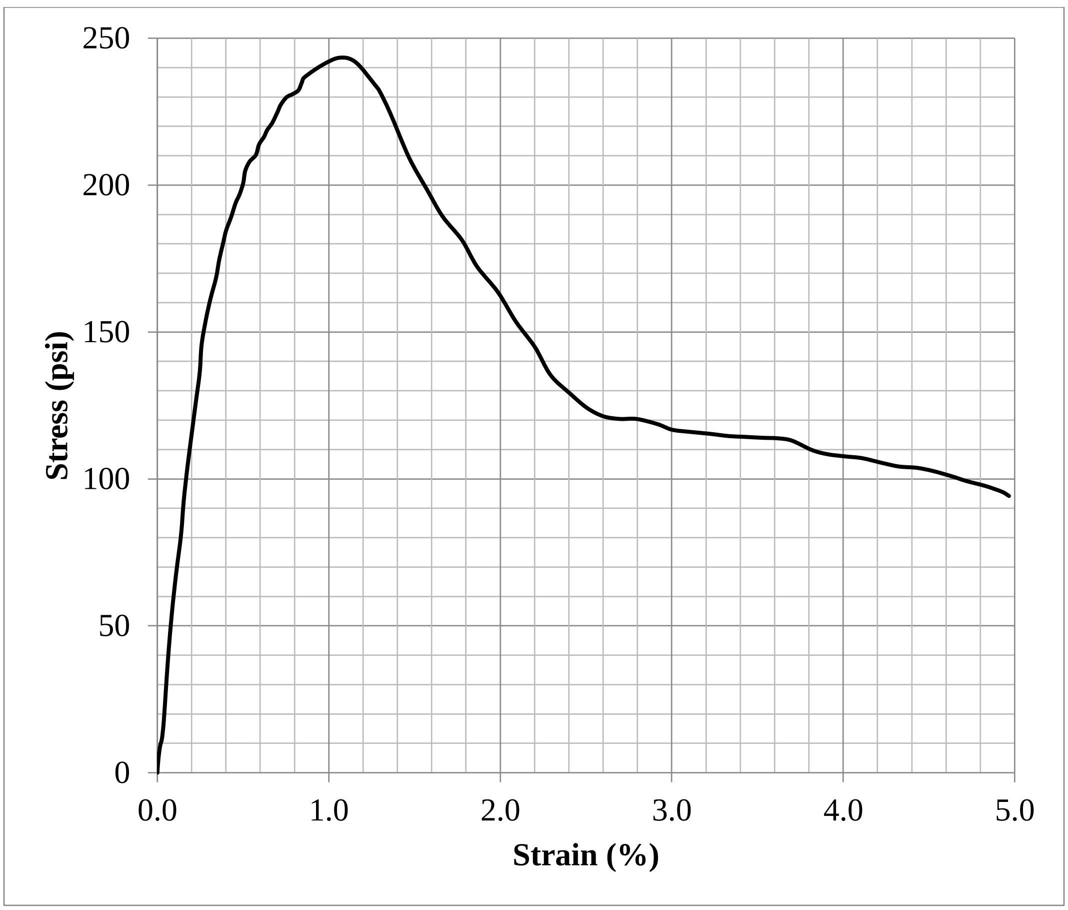
Testing Date	6/23/18
Diameter (in.)	2.031
Height (in.)	3.877
Weight (g)	365.0
Corrected Peak UCS (psi)	279.0
Corrected Failure Strain (%)	1.72
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-2-E
Molding Date	6/7/18
Curing Period (d)	16
$\alpha_{I\text{-}P}$ (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

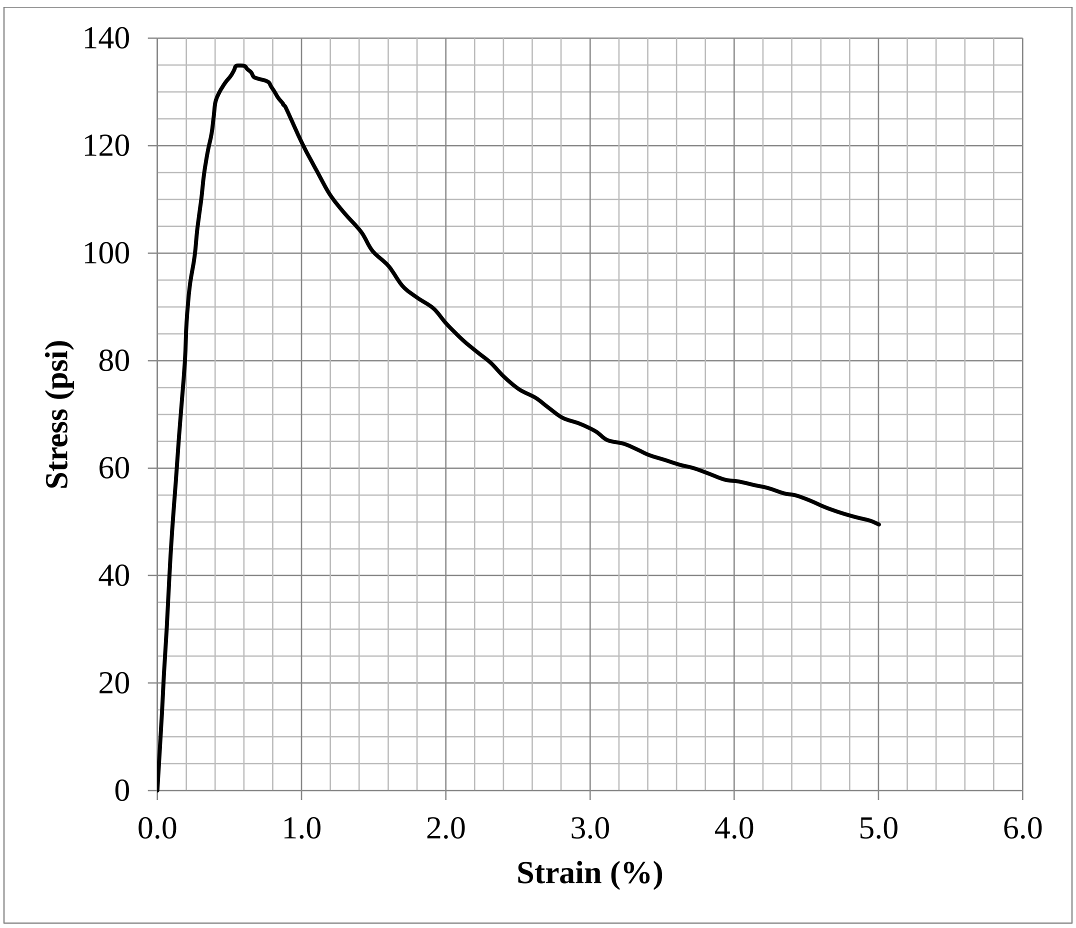
Testing Date	6/23/18
Diameter (in.)	2.027
Height (in.)	3.821
Weight (g)	359.8
Corrected Peak UCS (psi)	241.1
Corrected Failure Strain (%)	1.05
ASTM C39 Fracture Type	3



Data Sheet: Specimen UCS Test

Specimen ID	0-2-F
Molding Date	6/7/18
Curing Period (d)	16
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

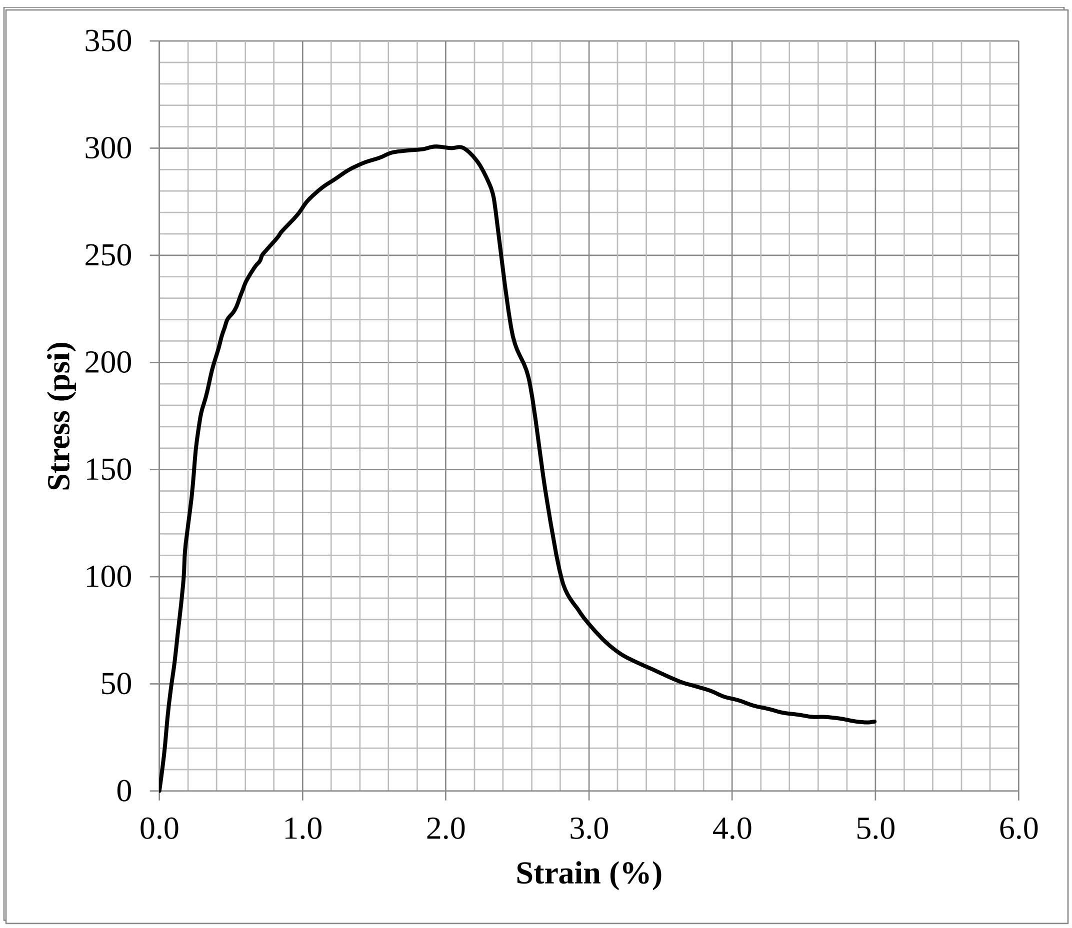
Testing Date	6/23/18
Diameter (in.)	2.036
Height (in.)	3.804
Weight (g)	361.2
Corrected Peak UCS (psi)	133.5
Corrected Failure Strain (%)	0.57
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-2-G
Molding Date	6/7/18
Curing Period (d)	16
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

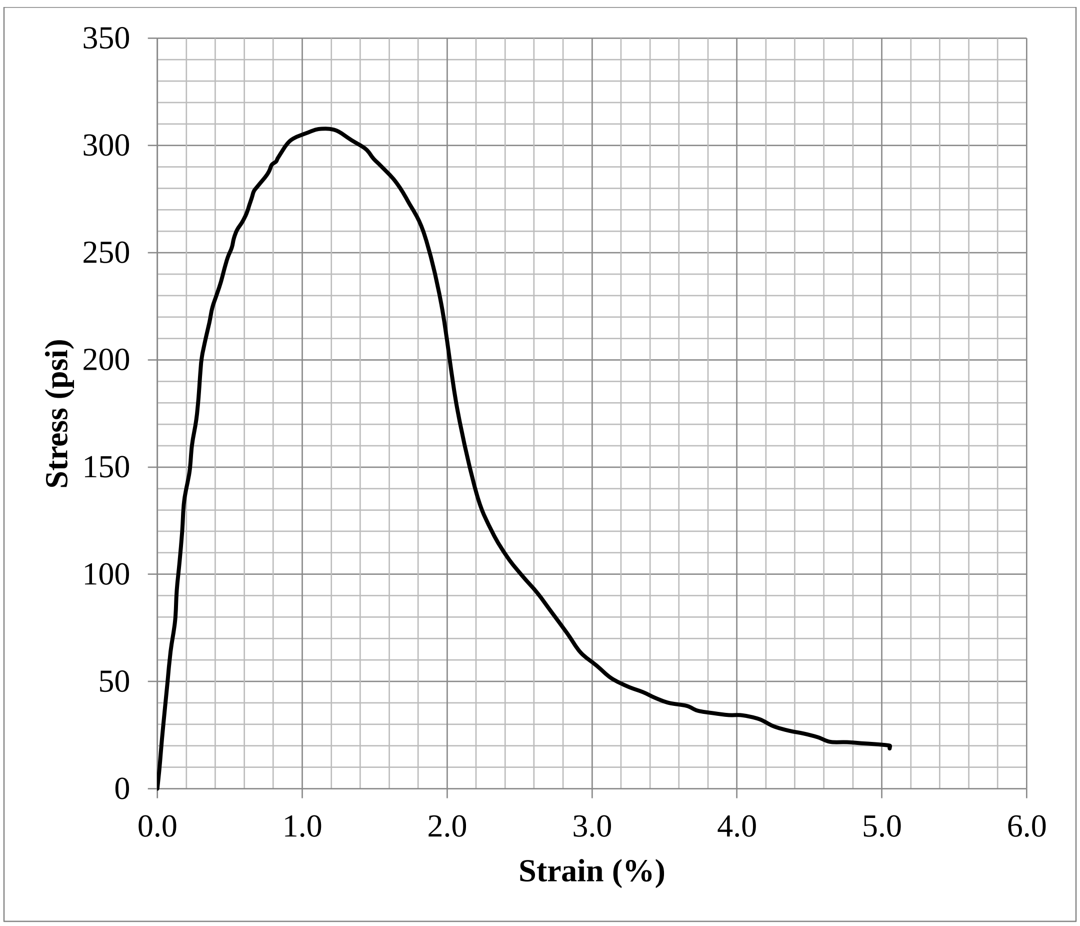
Testing Date	6/23/18
Diameter (in.)	2.033
Height (in.)	3.950
Weight (g)	372.5
Corrected Peak UCS (psi)	299.4
Corrected Failure Strain (%)	1.93
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-2-H
Molding Date	6/7/18
Curing Period (d)	28
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

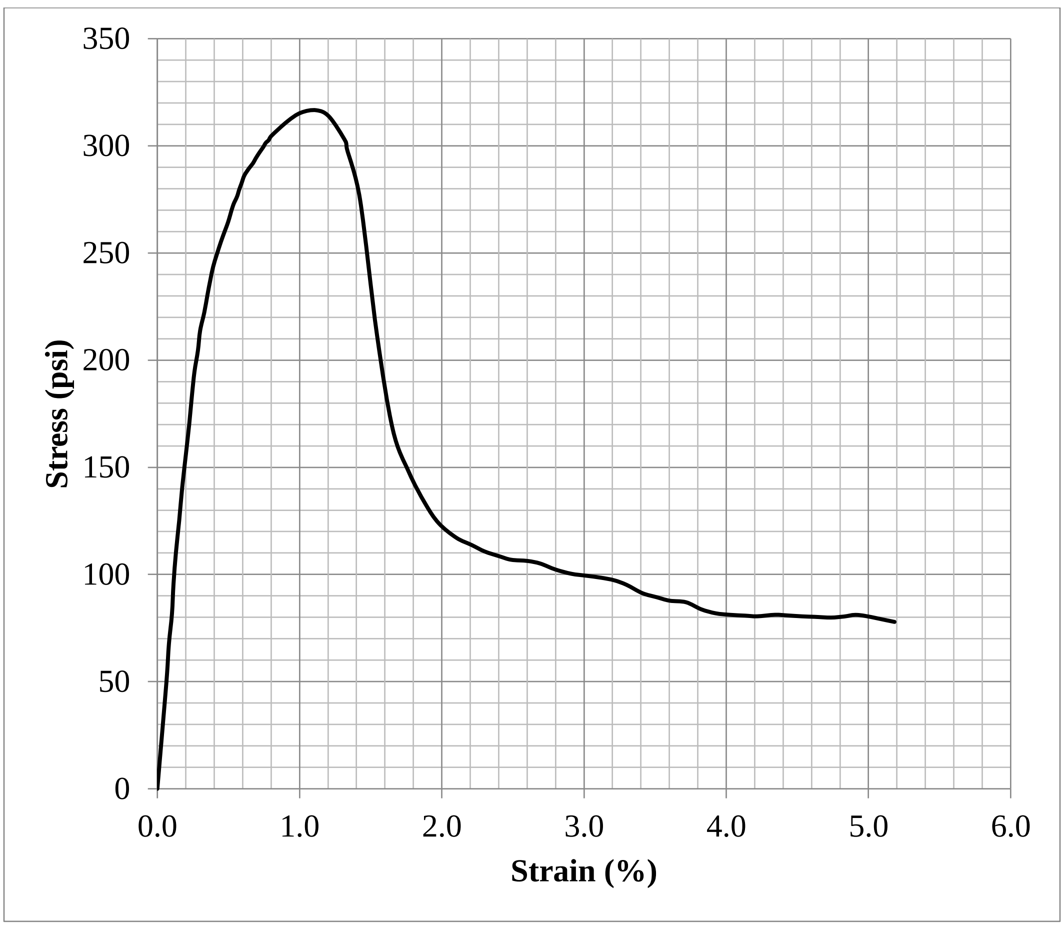
Testing Date	7/5/18
Diameter (in.)	2.033
Height (in.)	3.903
Weight (g)	368.2
Corrected Peak UCS (psi)	305.7
Corrected Failure Strain (%)	1.12
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-2-I
Molding Date	6/7/18
Curing Period (d)	28
α_{I-P} (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

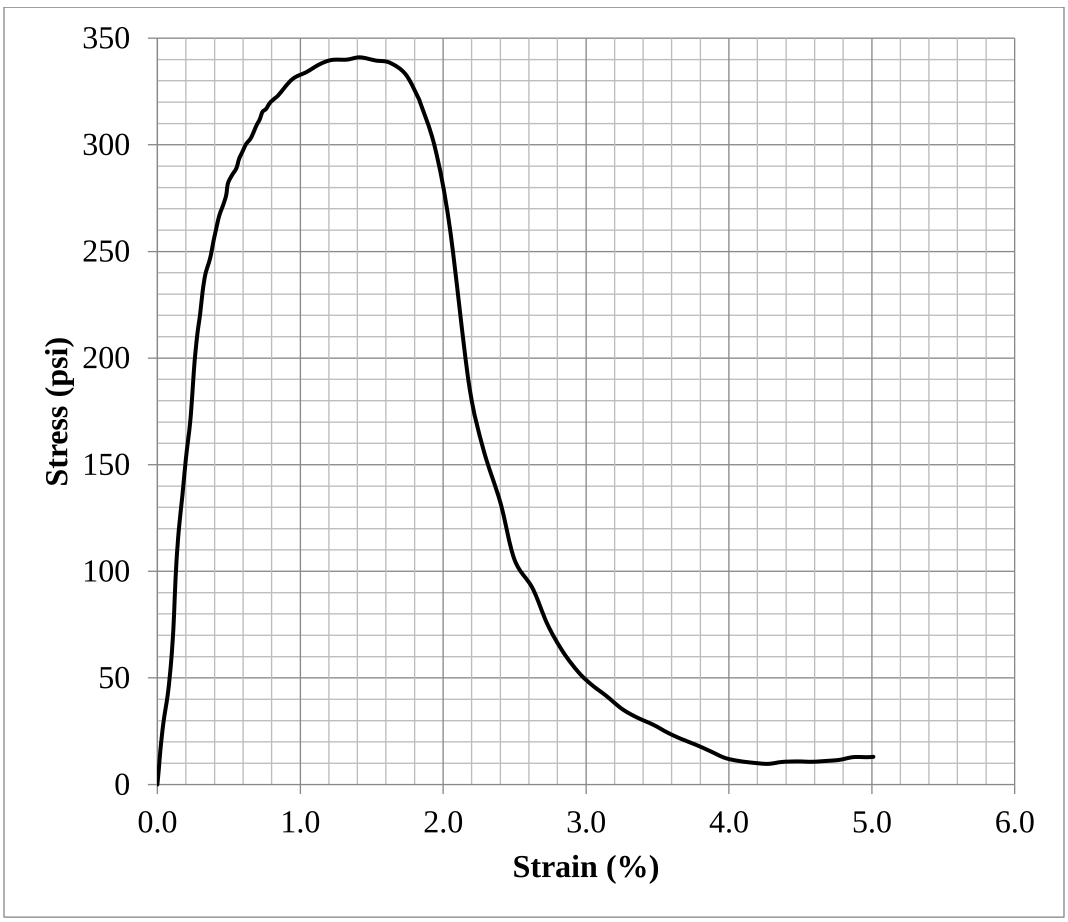
Testing Date	7/5/18
Diameter (in.)	2.038
Height (in.)	3.962
Weight (g)	375.0
Corrected Peak UCS (psi)	315.2
Corrected Failure Strain (%)	1.15
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-2-J
Molding Date	6/7/18
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	125 (128.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

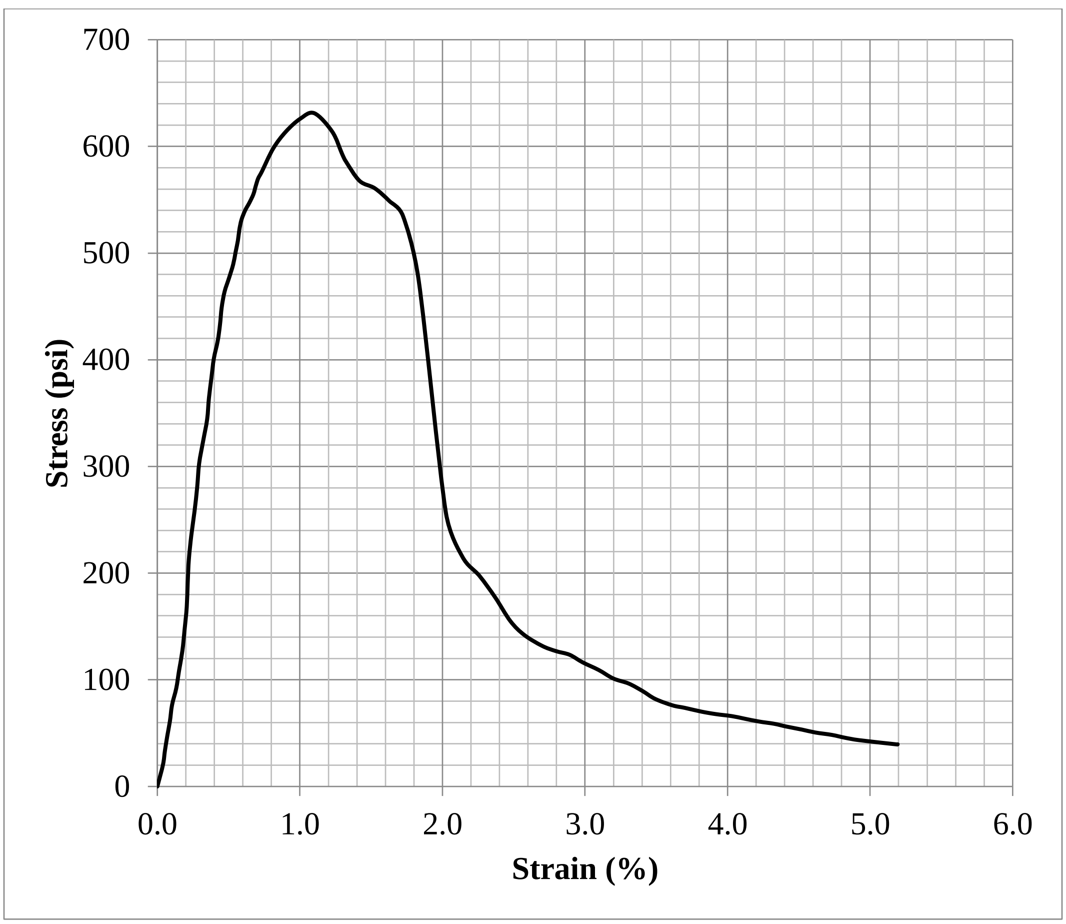
Testing Date	7/6/18
Diameter (in.)	2.034
Height (in.)	3.987
Weight (g)	377.2
Corrected Peak UCS (psi)	339.9
Corrected Failure Strain (%)	1.42
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-3-A
Molding Date	6/9/18
Curing Period (d)	7
α_{I-P} (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

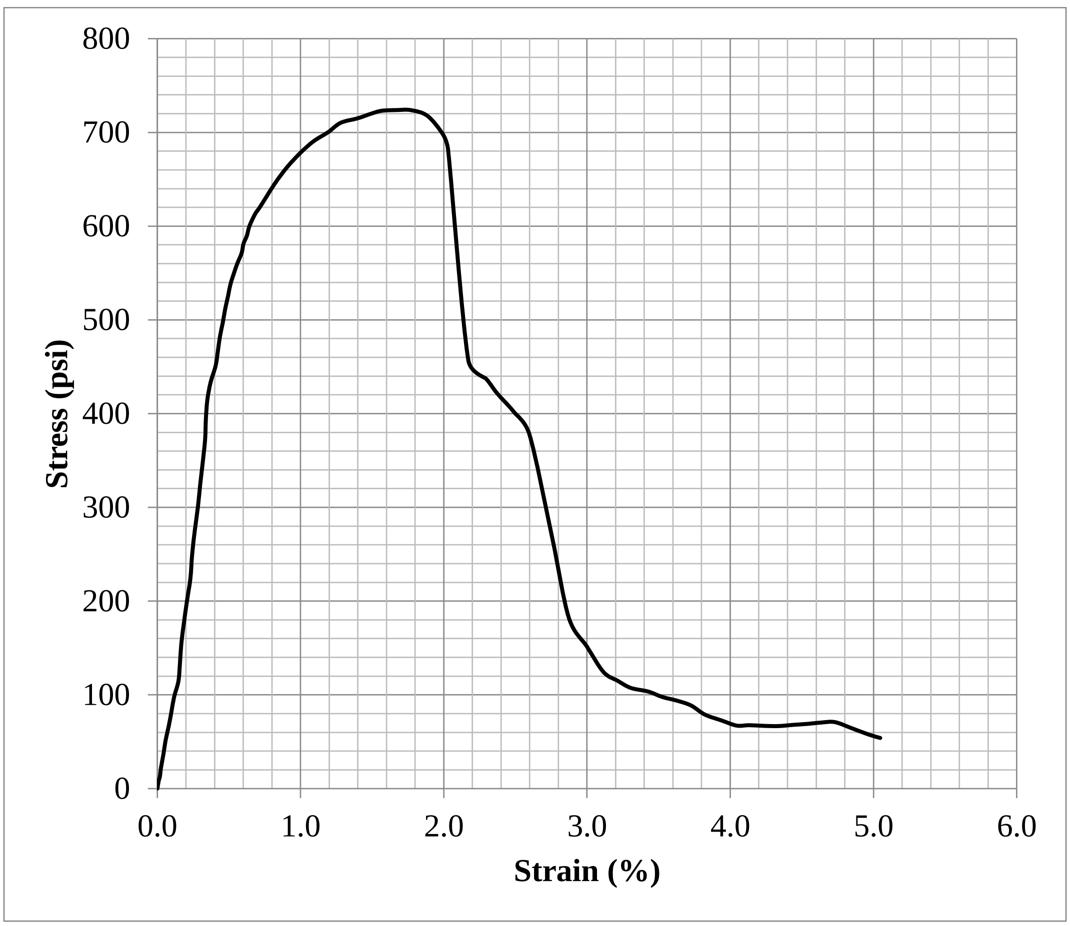
Testing Date	6/16/18
Diameter (in.)	2.038
Height (in.)	3.897
Weight (g)	371.0
Corrected Peak UCS (psi)	626.6
Corrected Failure Strain (%)	1.09
ASTM C39 Fracture Type	3



Data Sheet: Specimen UCS Test

Specimen ID	0-3-B
Molding Date	6/9/18
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

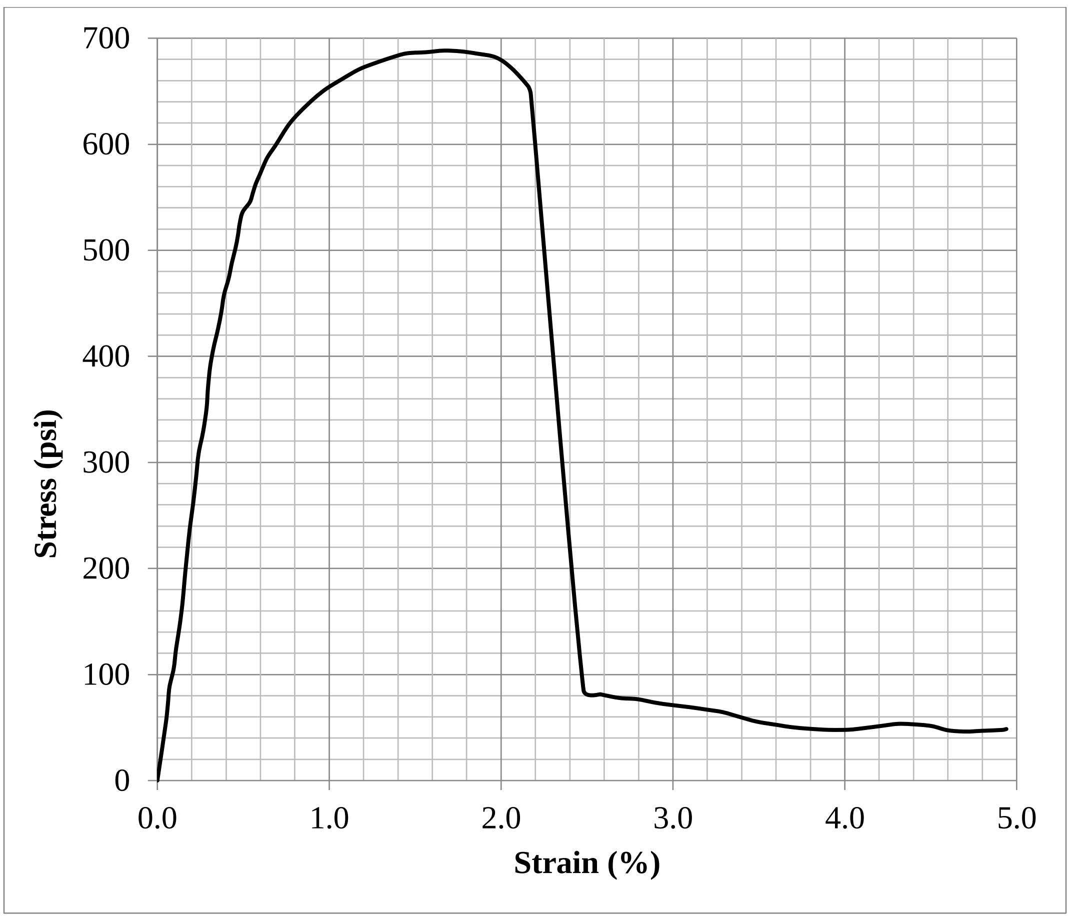
Testing Date	6/16/18
Diameter (in.)	2.030
Height (in.)	3.845
Weight (g)	363.0
Corrected Peak UCS (psi)	717.7
Corrected Failure Strain (%)	1.67
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-3-C
Molding Date	6/9/18
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

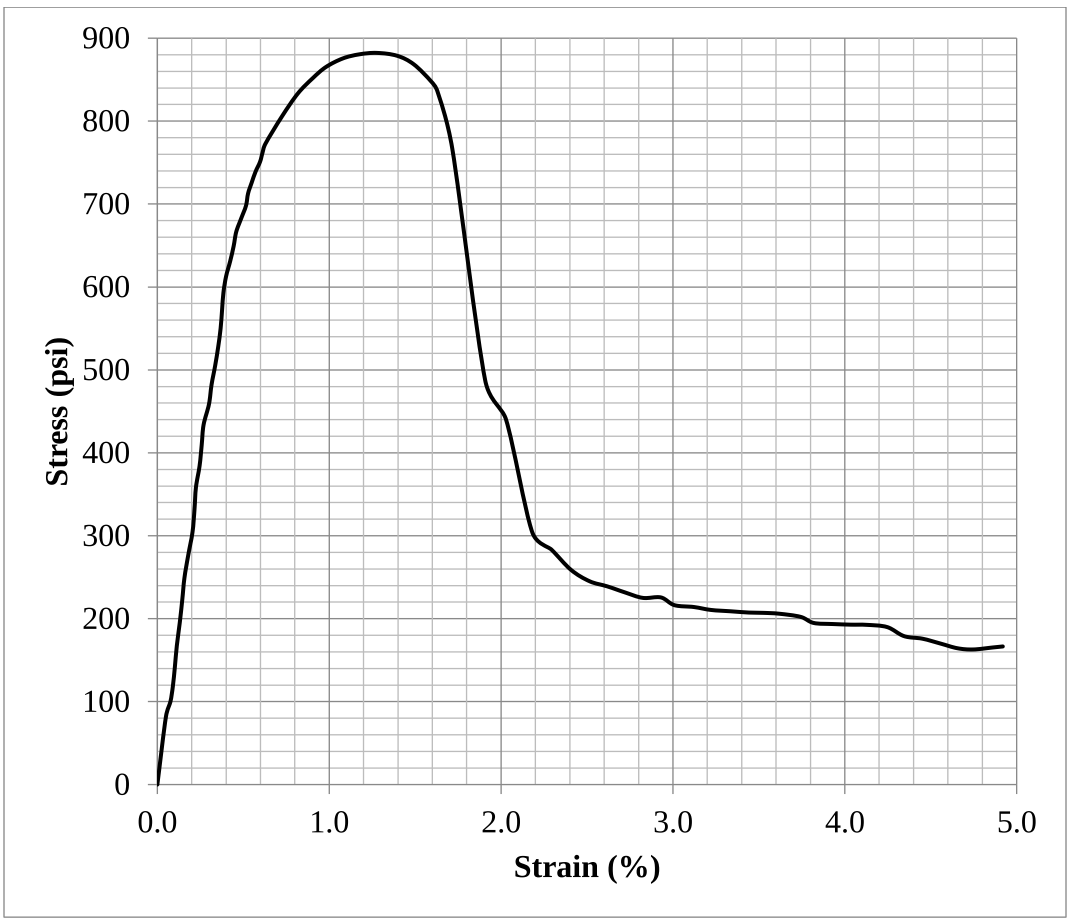
Testing Date	6/17/18
Diameter (in.)	2.043
Height (in.)	3.856
Weight (g)	366.5
Corrected Peak UCS (psi)	682.1
Corrected Failure Strain (%)	1.62
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-3-D
Molding Date	6/9/18
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

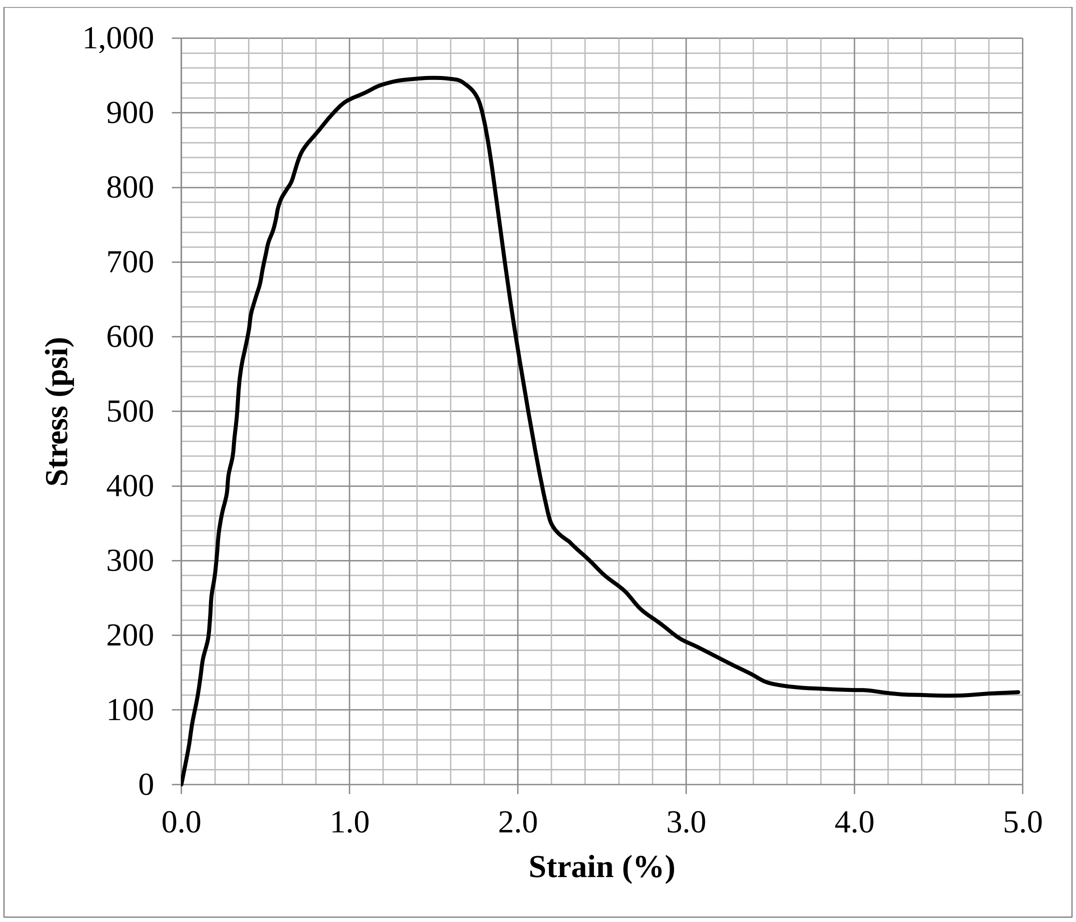
Testing Date	6/24/18
Diameter (in.)	2.041
Height (in.)	3.900
Weight (g)	372.3
Corrected Peak UCS (psi)	876.0
Corrected Failure Strain (%)	1.25
ASTM C39 Fracture Type	3



Data Sheet: Specimen UCS Test

Specimen ID	0-3-E
Molding Date	6/9/18
Curing Period (d)	15
α_{I-P} (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

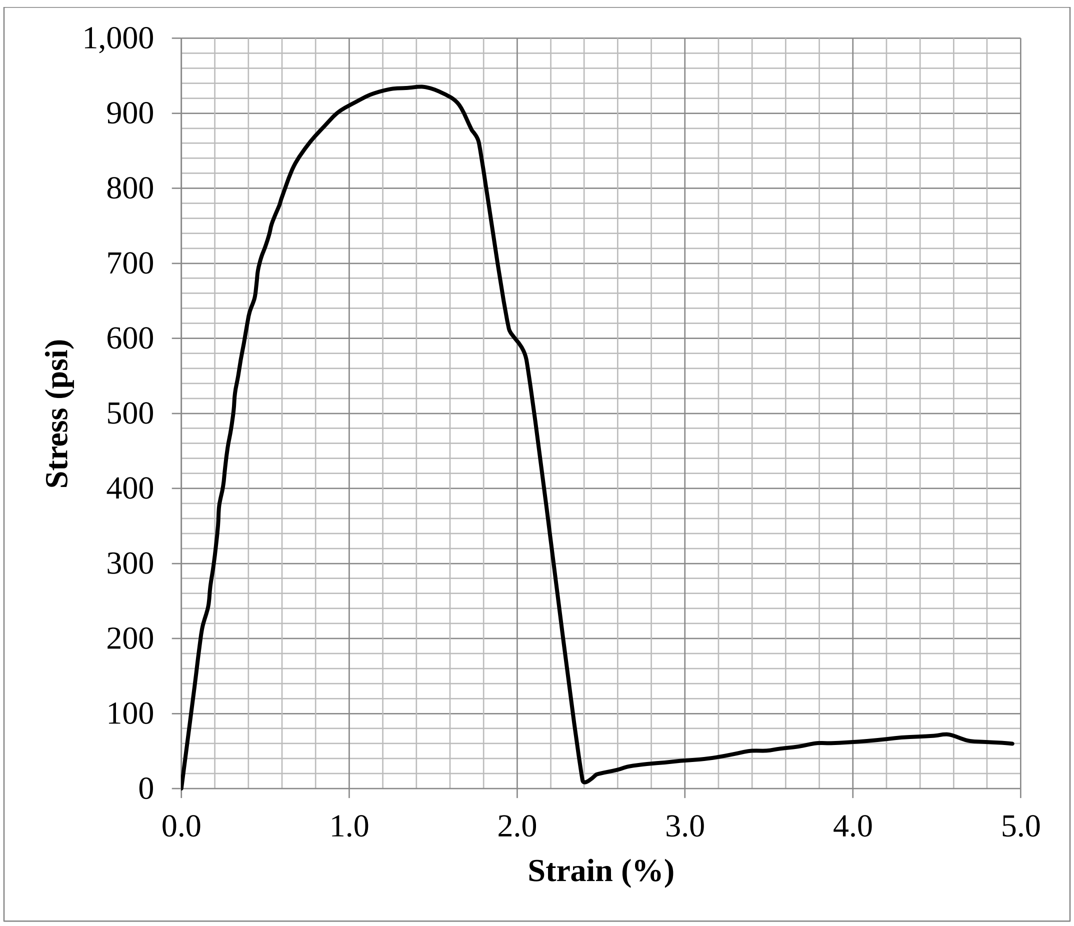
Testing Date	6/24/18
Diameter (in.)	2.034
Height (in.)	3.898
Weight (g)	369.1
Corrected Peak UCS (psi)	940.5
Corrected Failure Strain (%)	1.47
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-3-F
Molding Date	6/9/18
Curing Period (d)	15
α_{I-P} (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

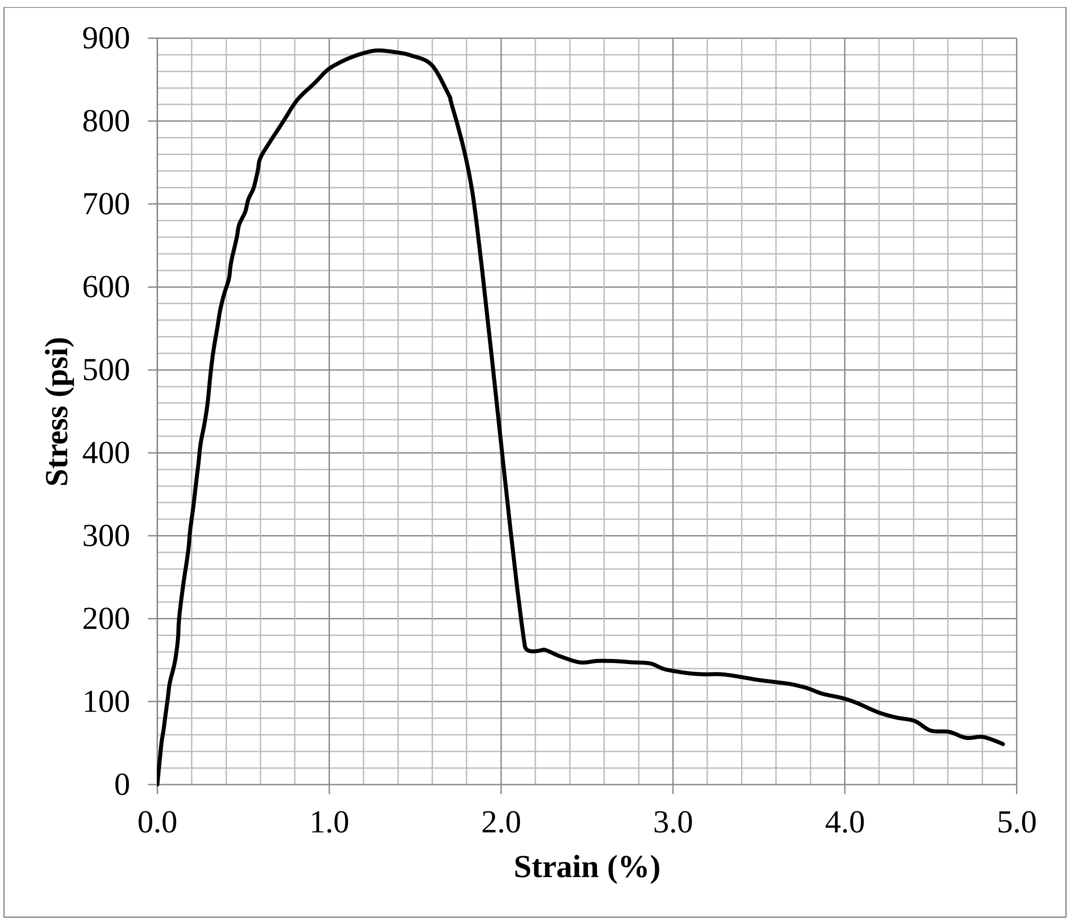
Testing Date	6/24/18
Diameter (in.)	2.035
Height (in.)	3.854
Weight (g)	366.6
Corrected Peak UCS (psi)	927.1
Corrected Failure Strain (%)	1.44
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-3-G
Molding Date	6/9/18
Curing Period (d)	15
α_{I-P} (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

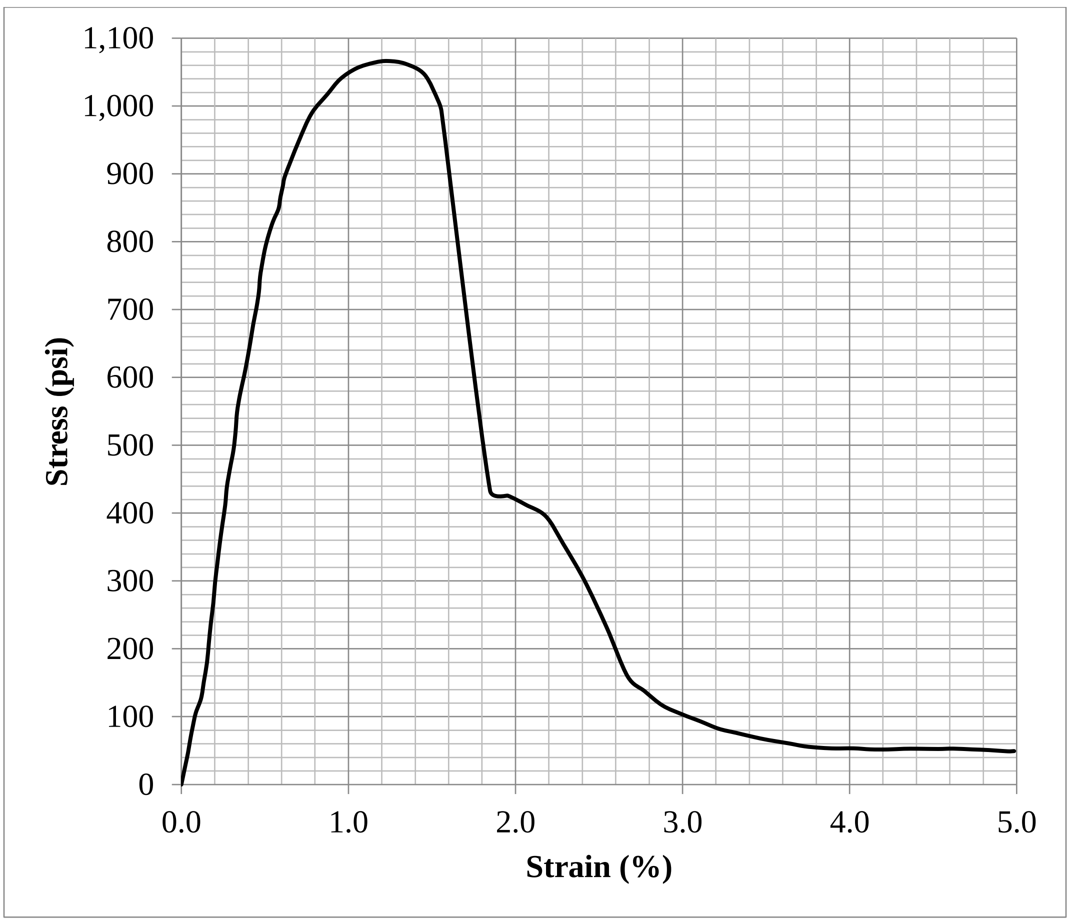
Testing Date	6/24/18
Diameter (in.)	2.037
Height (in.)	3.912
Weight (g)	374.3
Corrected Peak UCS (psi)	879.5
Corrected Failure Strain (%)	1.29
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-3-H
Molding Date	6/9/18
Curing Period (d)	28
α_{I-P} (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

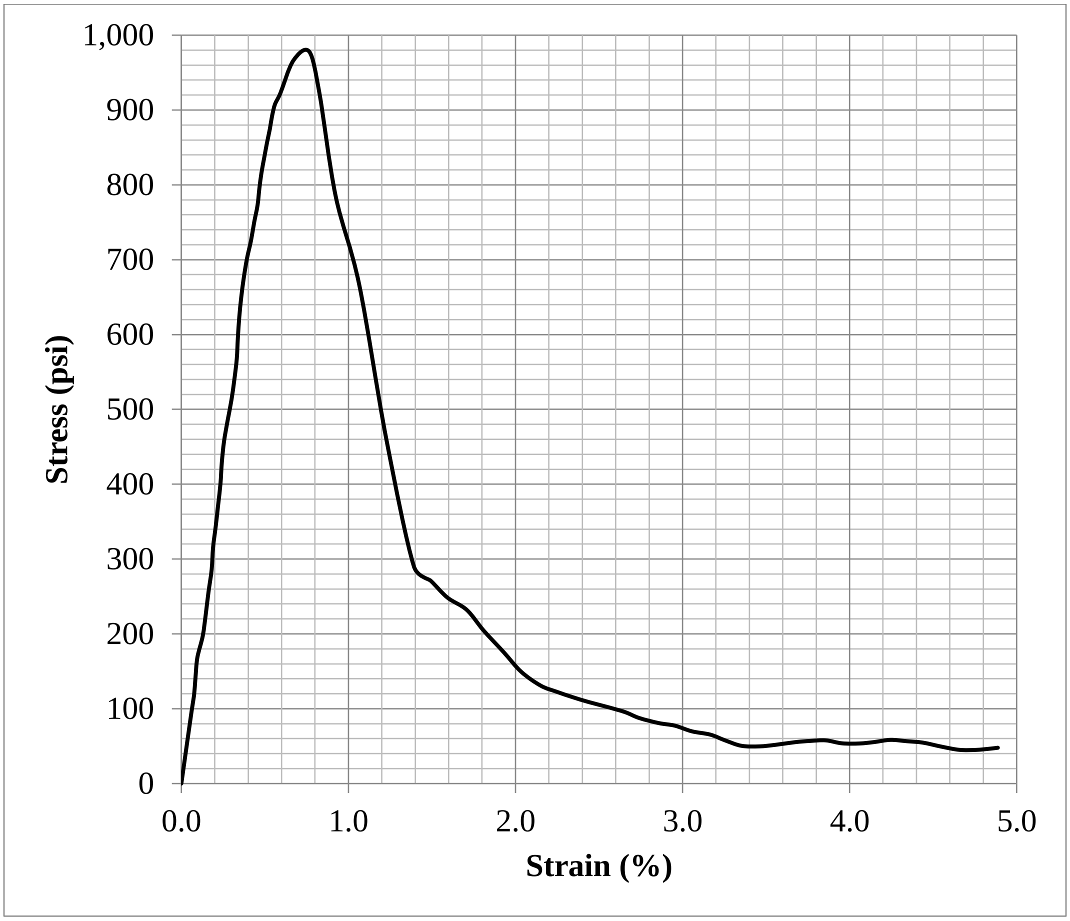
Testing Date	7/7/18
Diameter (in.)	2.038
Height (in.)	3.938
Weight (g)	374.3
Corrected Peak UCS (psi)	1060.6
Corrected Failure Strain (%)	1.24
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-3-I
Molding Date	6/9/18
Curing Period (d)	28
α_{I-P} (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

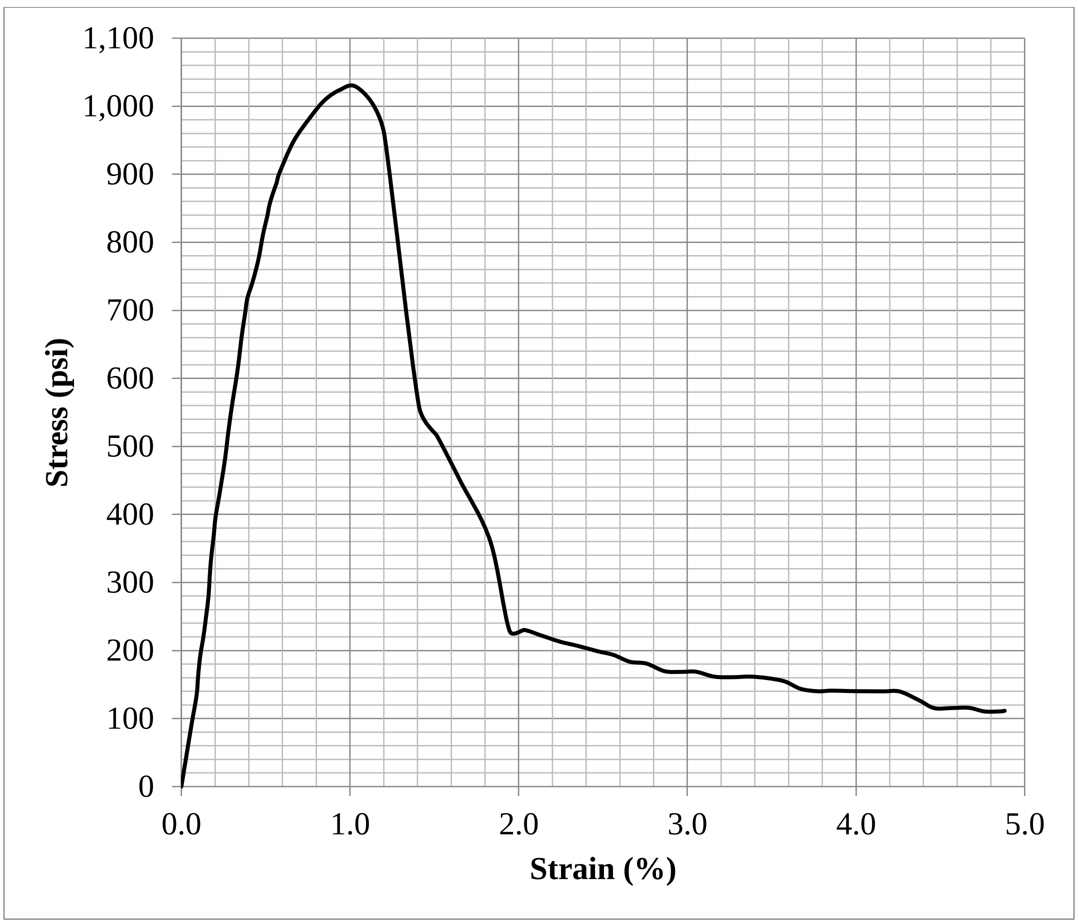
Testing Date	7/7/18
Diameter (in.)	2.037
Height (in.)	3.999
Weight (g)	385.0
Corrected Peak UCS (psi)	975.1
Corrected Failure Strain (%)	0.77
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-3-J
Molding Date	6/9/18
Curing Period (d)	28
α_{I-P} (kg/m^3)	350 (350.8)
w:b	0.6
Soil OM (%)	0.9
Bleed Water (g)	0

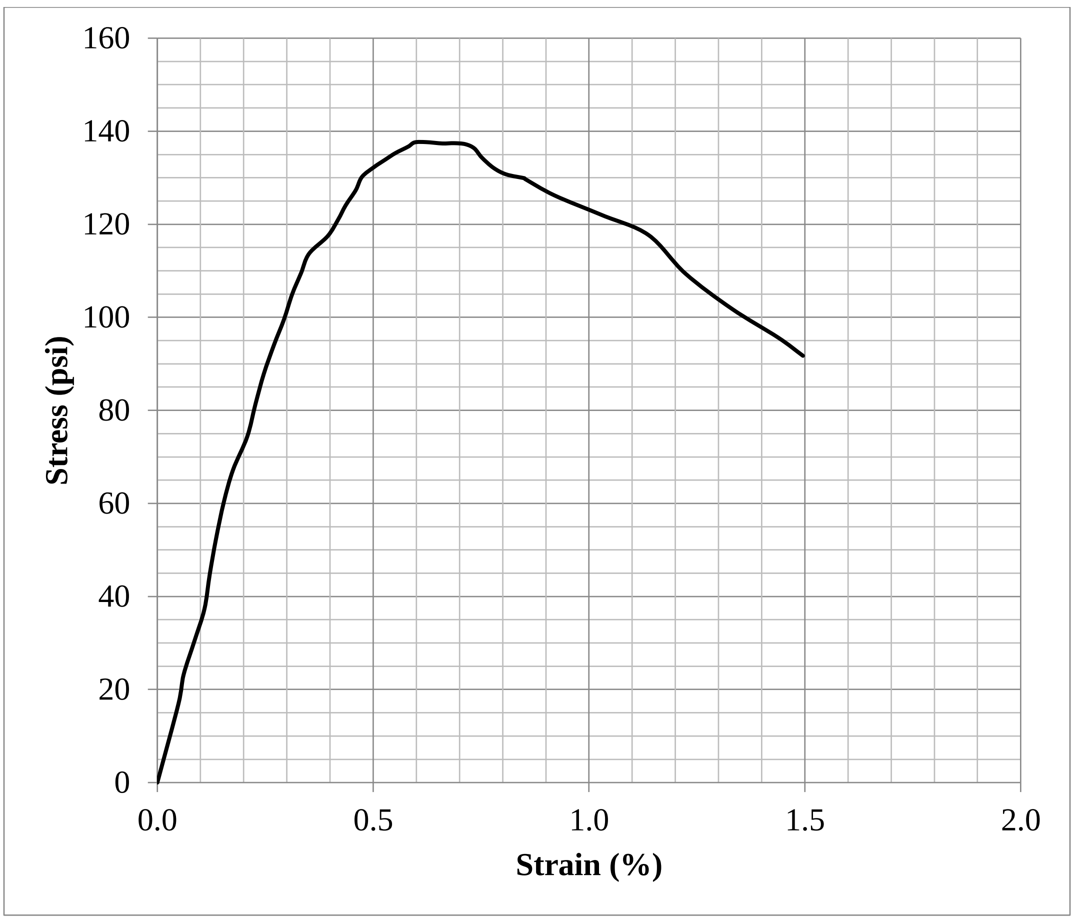
Testing Date	7/7/18
Diameter (in.)	2.041
Height (in.)	3.948
Weight (g)	379.5
Corrected Peak UCS (psi)	1024.0
Corrected Failure Strain (%)	1.03
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-4-A
Molding Date	7/23/18
Curing Period (d)	8
α_{I-P} (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

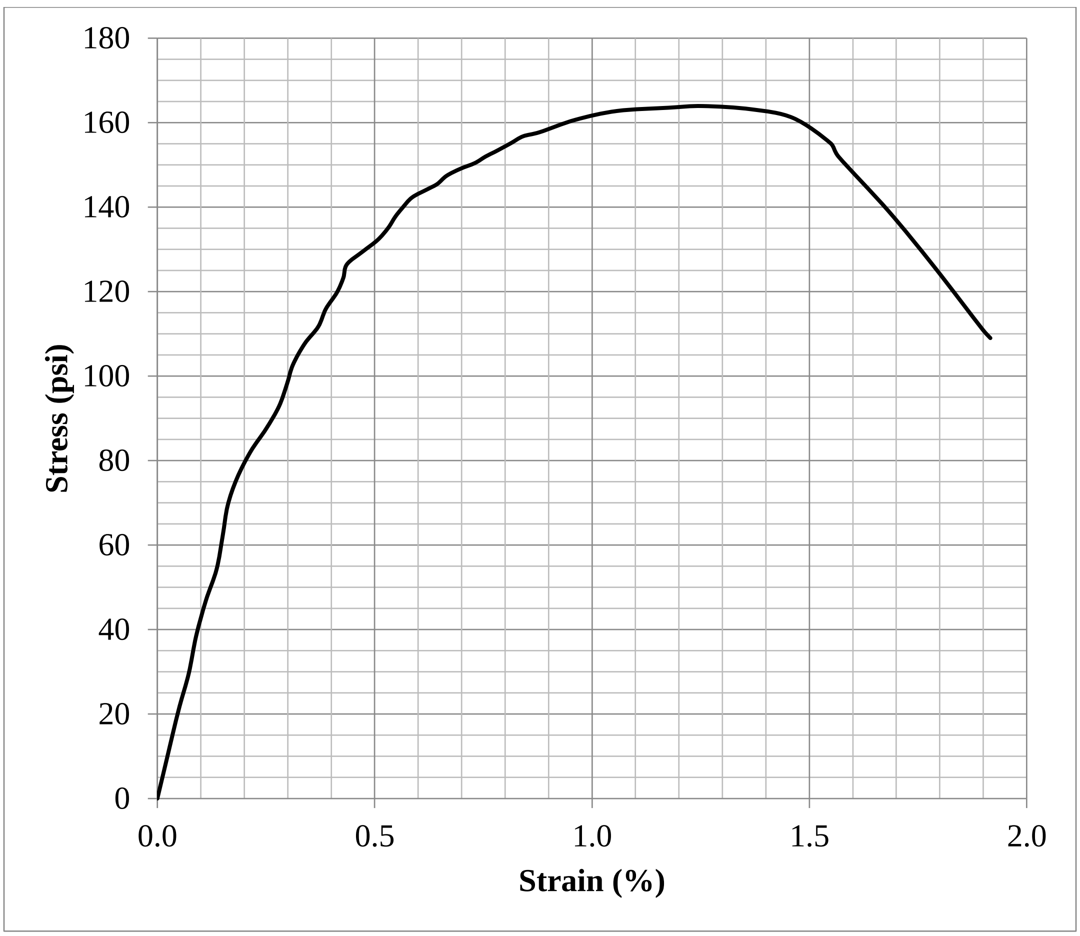
Testing Date	7/31/18
Diameter (in.)	2.037
Height (in.)	3.945
Weight (g)	367.1
Corrected Peak UCS (psi)	137.0
Corrected Failure Strain (%)	0.62
ASTM C39 Fracture Type	3



Data Sheet: Specimen UCS Test

Specimen ID	0-4-B
Molding Date	7/23/18
Curing Period (d)	8
α_{I-P} (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

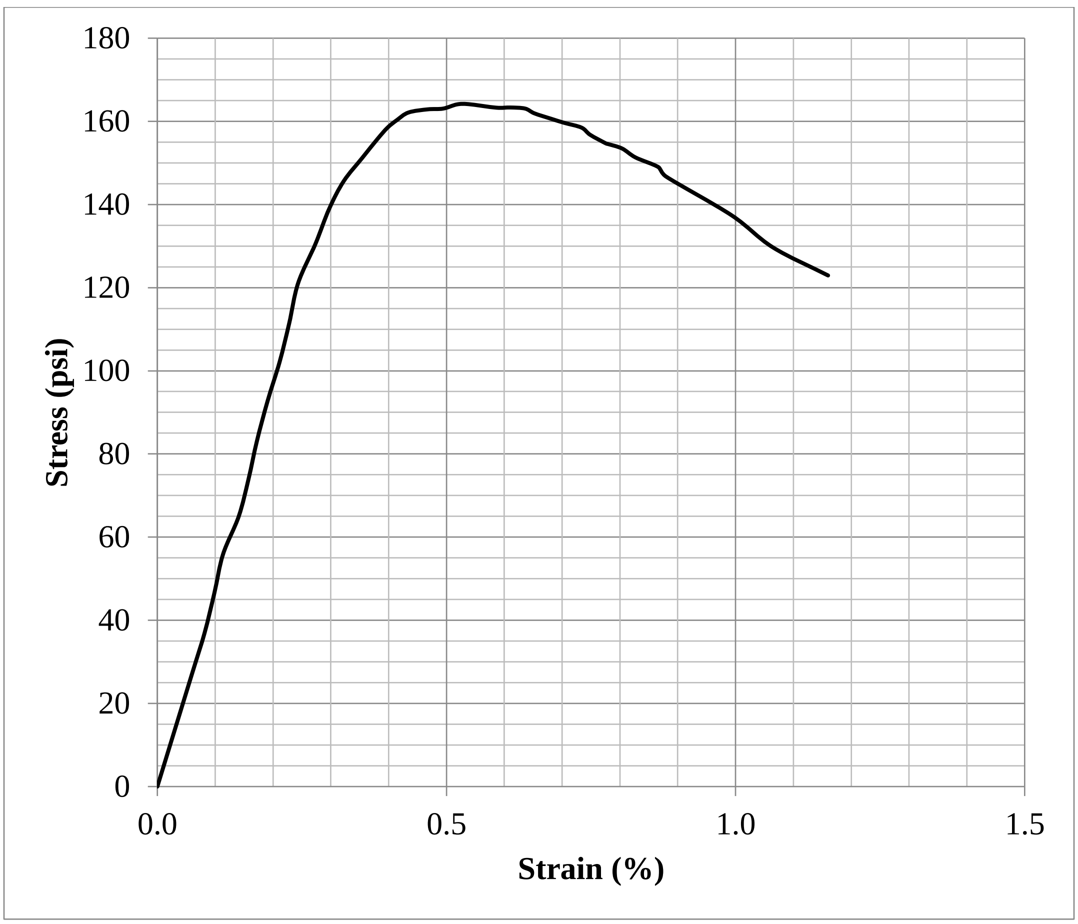
Testing Date	7/31/18
Diameter (in.)	2.044
Height (in.)	3.798
Weight (g)	352.2
Corrected Peak UCS (psi)	162.1
Corrected Failure Strain (%)	1.25
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-4-C
Molding Date	7/23/18
Curing Period (d)	8
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

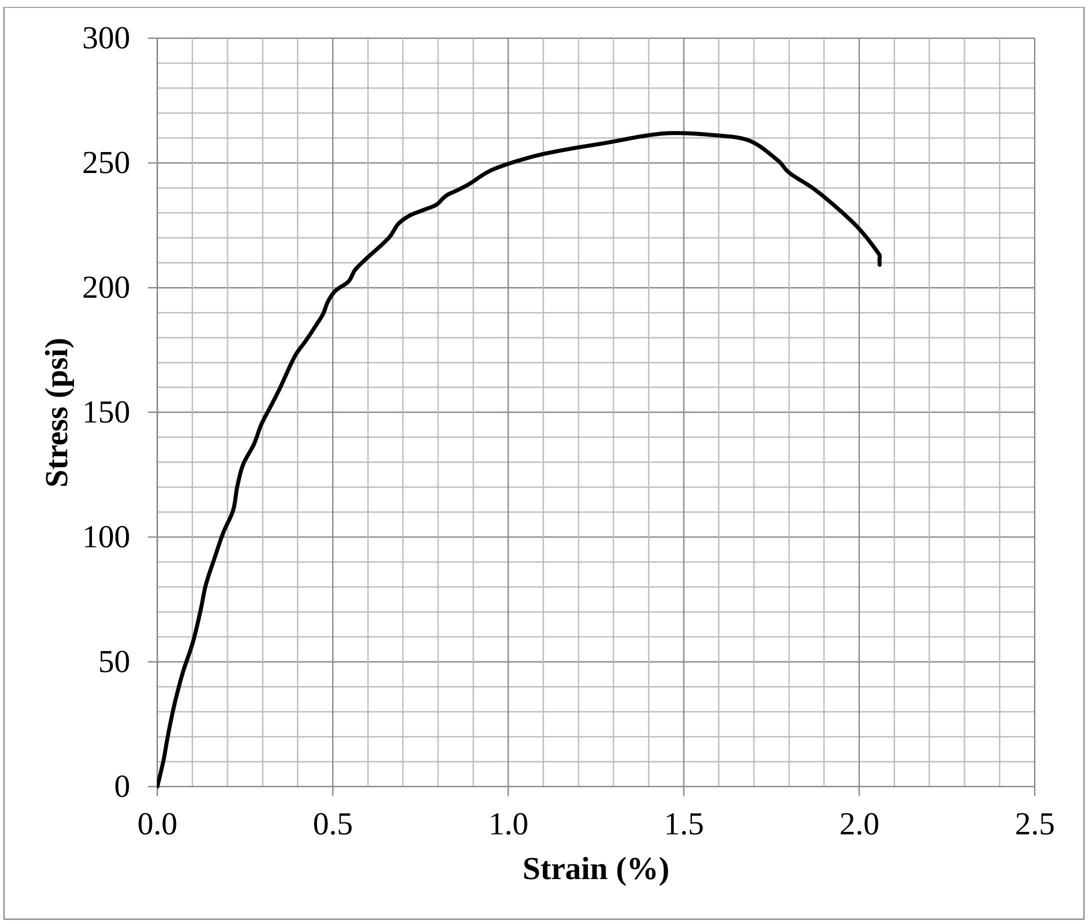
Testing Date	7/31/18
Diameter (in.)	2.035
Height (in.)	3.884
Weight (g)	359.4
Corrected Peak UCS (psi)	162.9
Corrected Failure Strain (%)	0.54
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-4-E
Molding Date	7/23/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

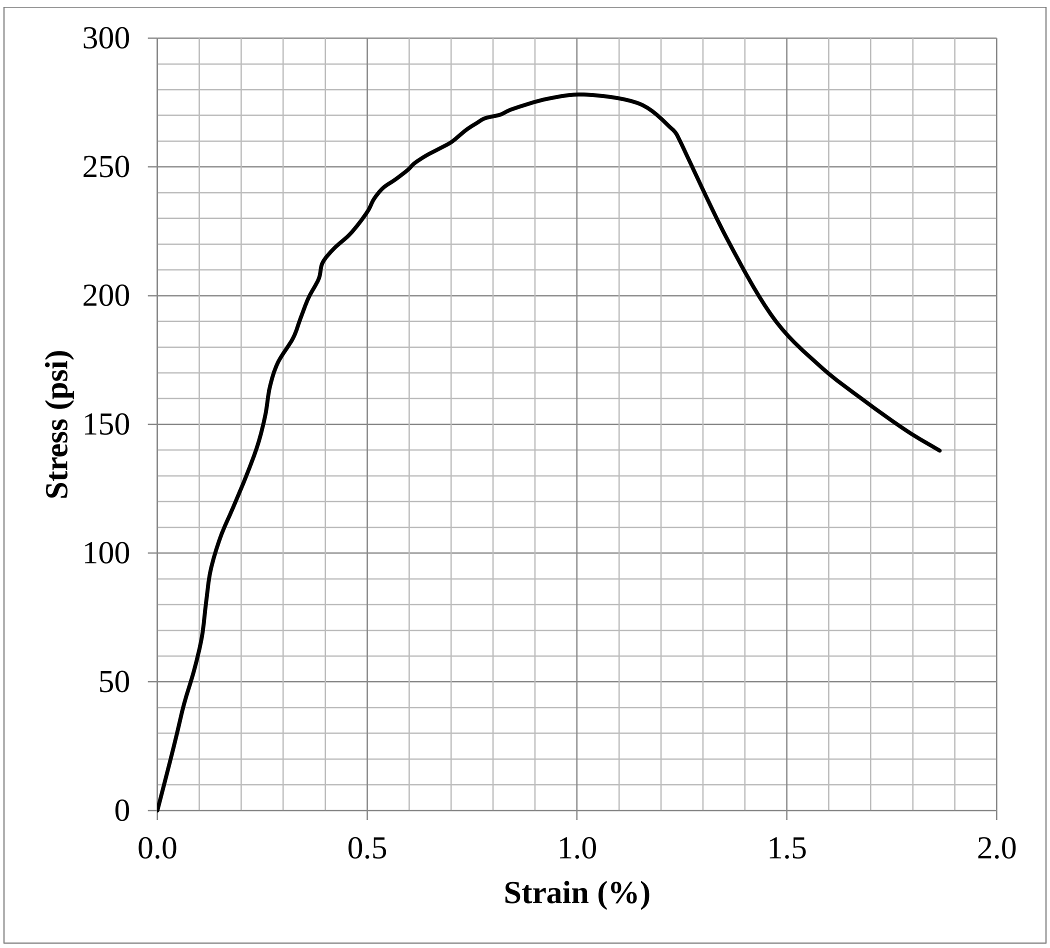
Testing Date	8/6/18
Diameter (in.)	2.034
Height (in.)	3.824
Weight (g)	353.1
Corrected Peak UCS (psi)	259.5
Corrected Failure Strain (%)	1.47
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-4-F
Molding Date	7/23/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

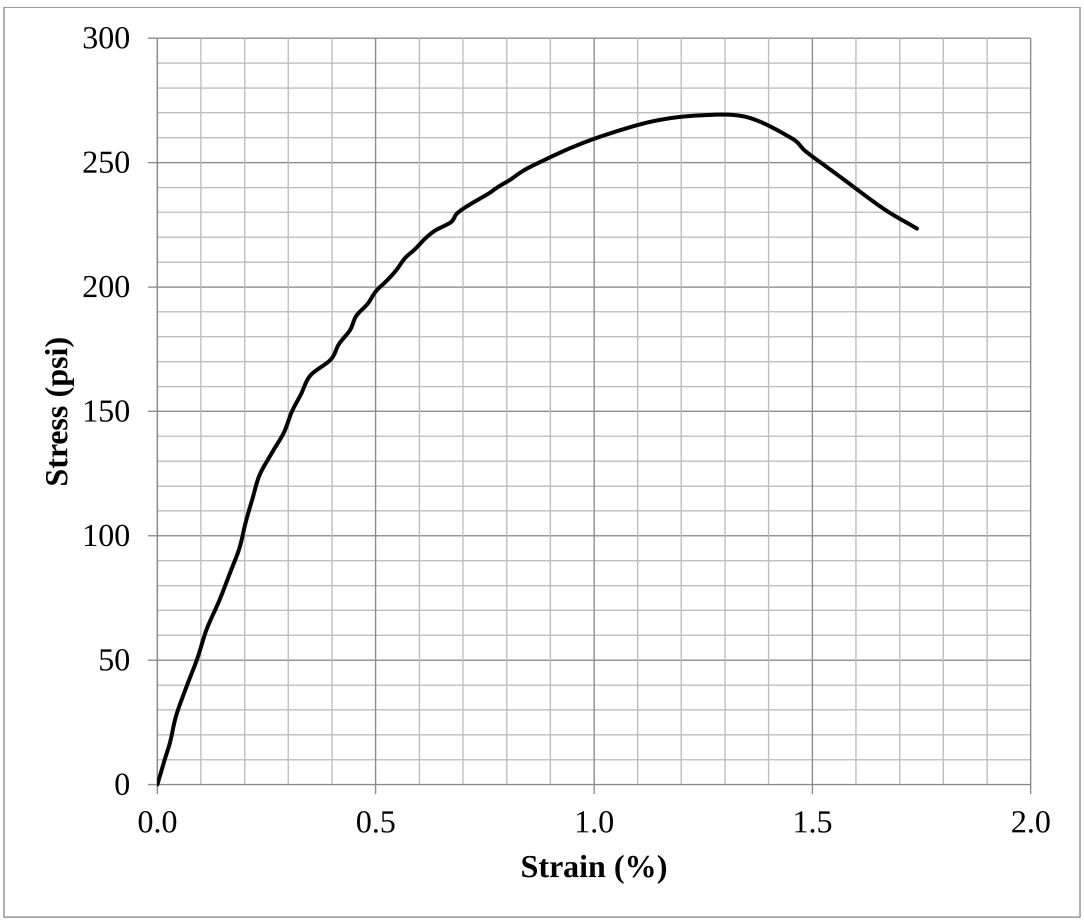
Testing Date	8/6/18
Diameter (in.)	2.030
Height (in.)	3.797
Weight (g)	352.8
Corrected Peak UCS (psi)	275.2
Corrected Failure Strain (%)	1.02
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-4-G
Molding Date	7/23/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

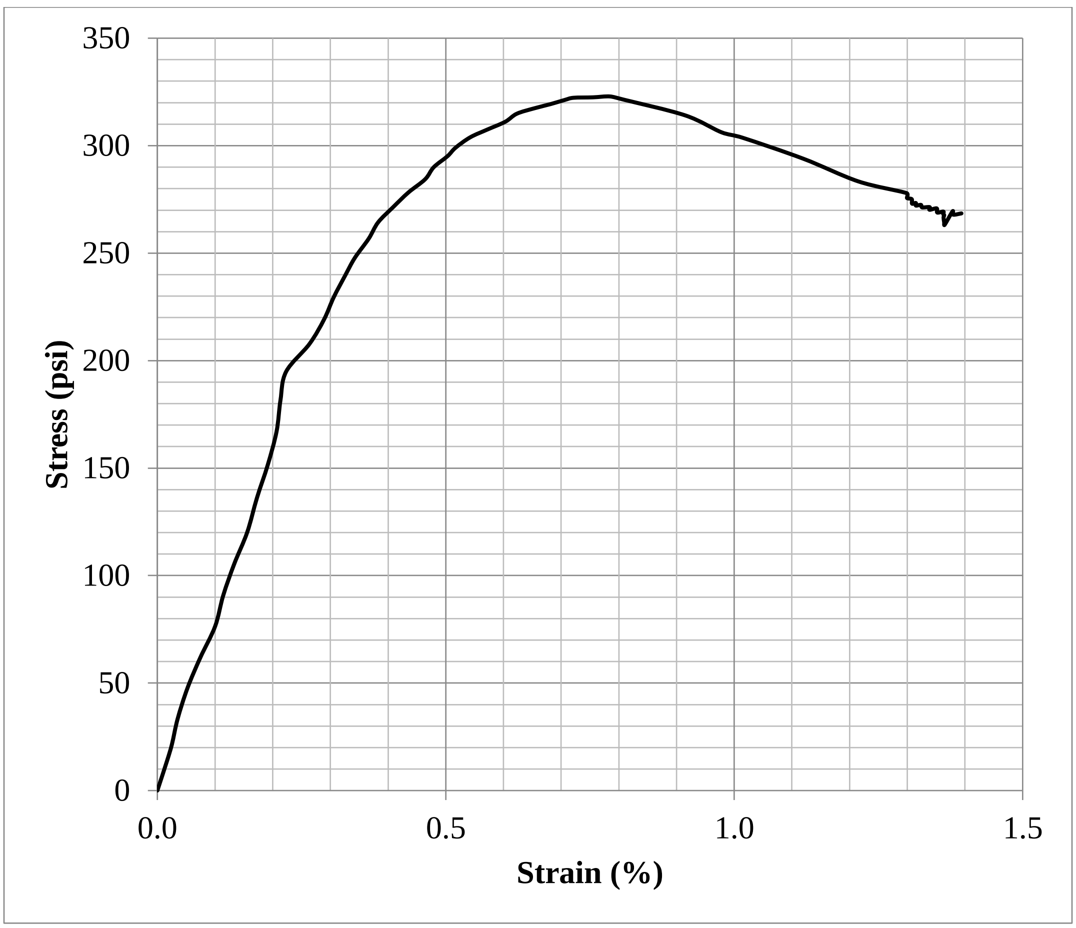
Testing Date	8/6/18
Diameter (in.)	2.027
Height (in.)	3.863
Weight (g)	352.3
Corrected Peak UCS (psi)	266.9
Corrected Failure Strain (%)	1.24
ASTM C39 Fracture Type	3



Data Sheet: Specimen UCS Test

Specimen ID	0-4-H
Molding Date	7/23/18
Curing Period (d)	33
α_{I-P} (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0.5

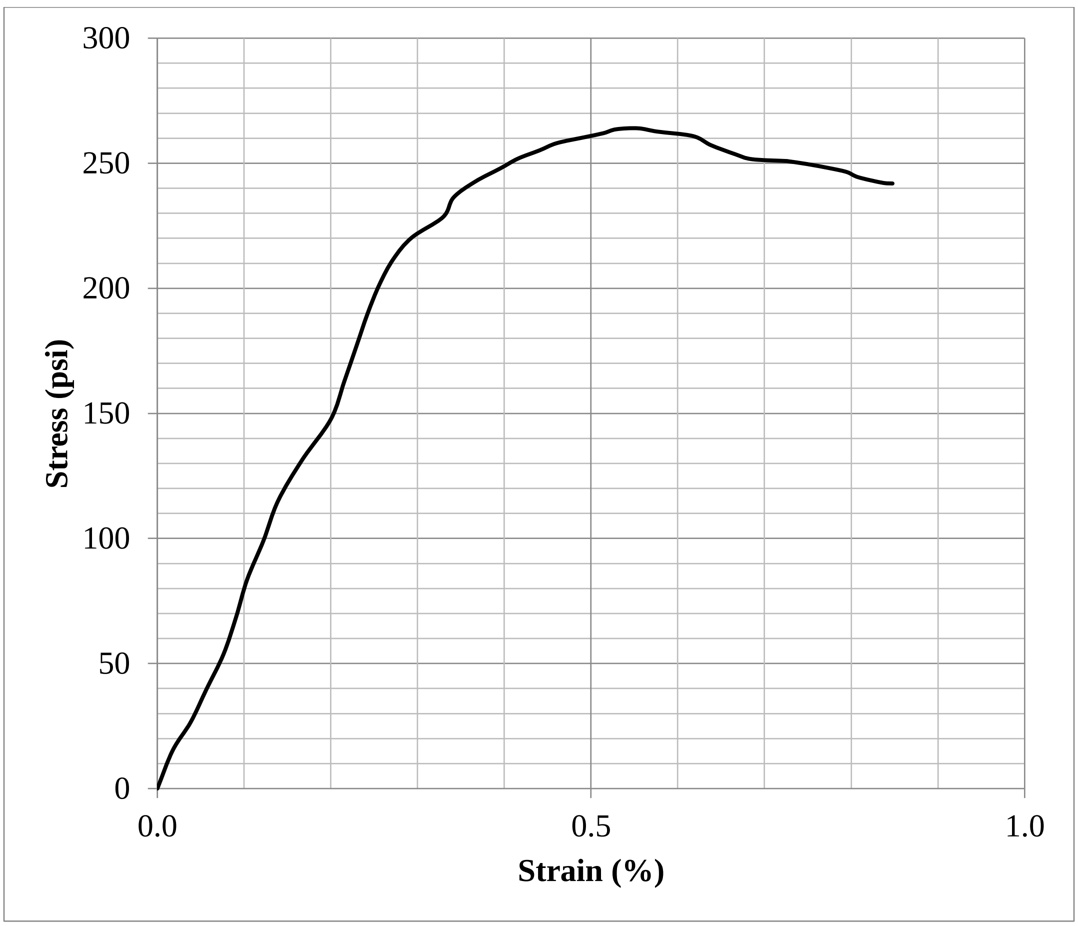
Testing Date	8/25/18
Diameter (in.)	2.038
Height (in.)	3.837
Weight (g)	355.1
Corrected Peak UCS (psi)	319.9
Corrected Failure Strain (%)	0.78
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-4-I
Molding Date	7/23/18
Curing Period (d)	33
α_{I-P} (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

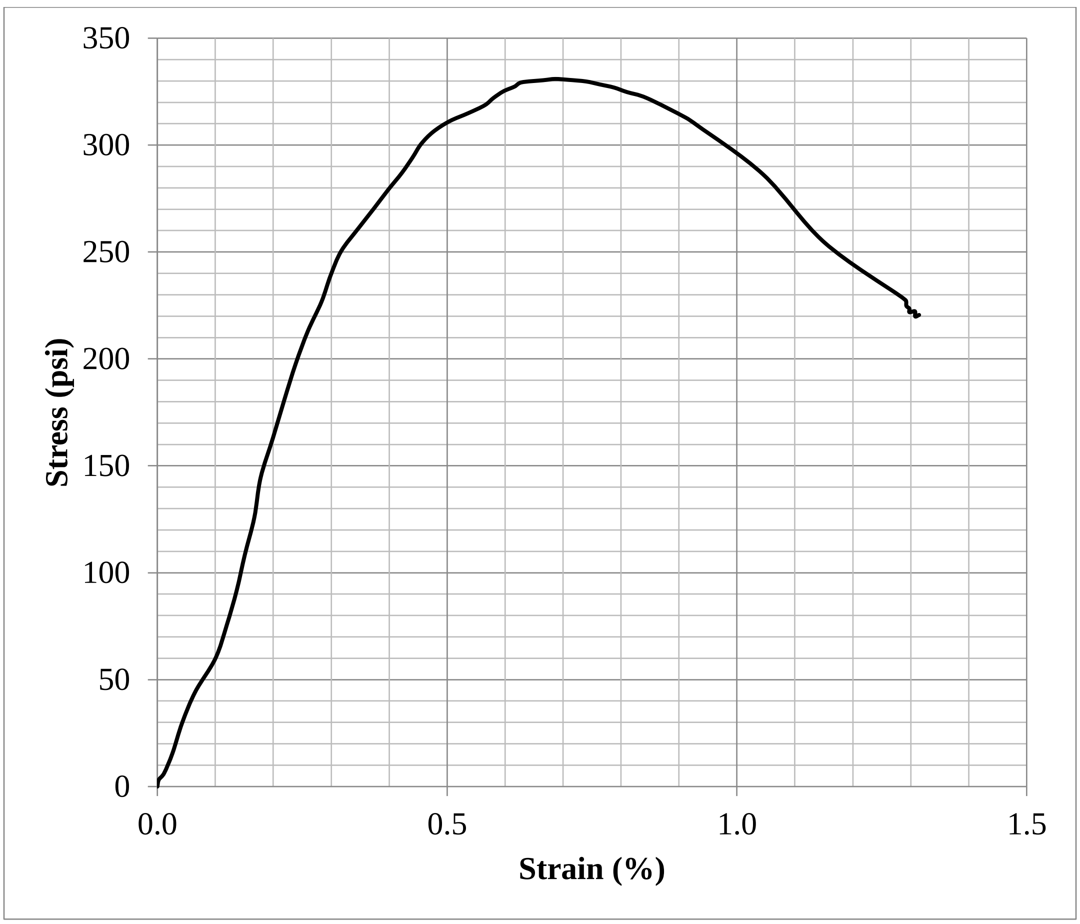
Testing Date	8/25/18
Diameter (in.)	2.036
Height (in.)	3.926
Weight (g)	361.4
Corrected Peak UCS (psi)	262.5
Corrected Failure Strain (%)	0.55
ASTM C39 Fracture Type	4



<u>**Data Sheet: Specimen UCS Test**</u>

Specimen ID	0-4-J
Molding Date	7/23/18
Curing Period (d)	33
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (199.4)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

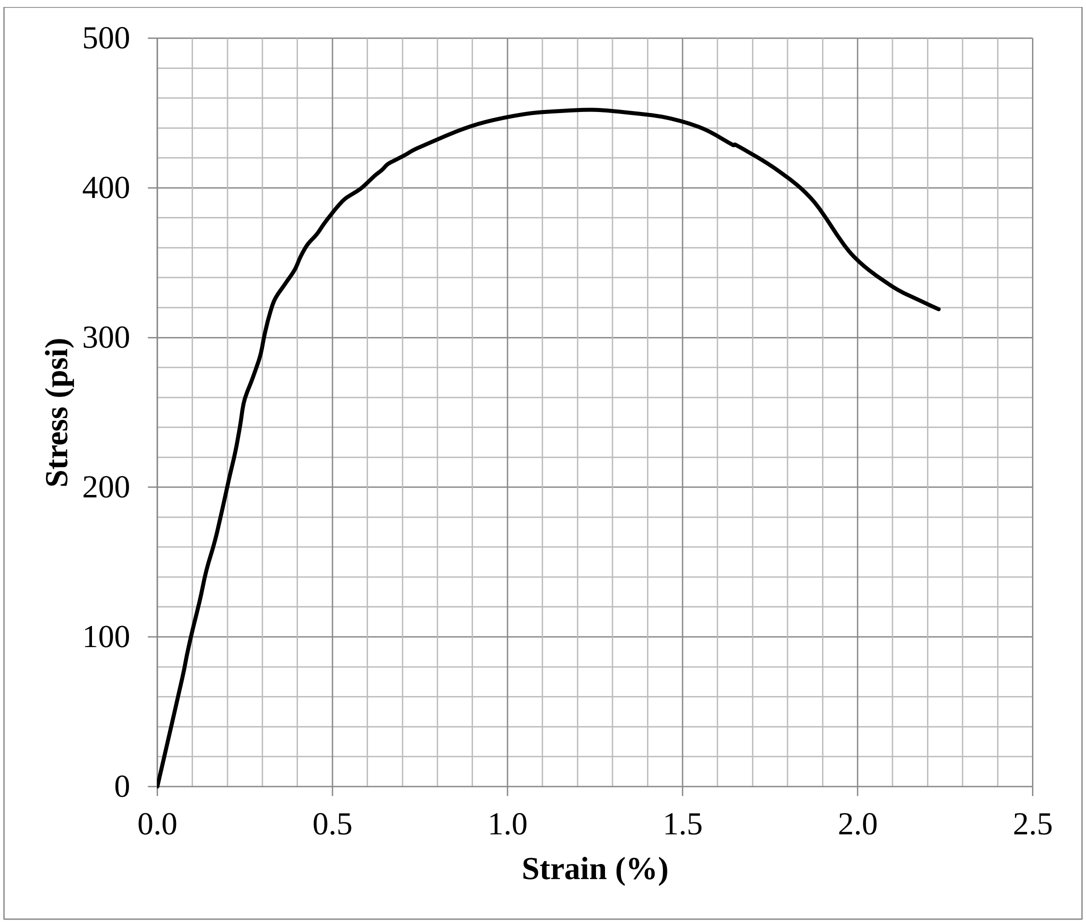
Testing Date	8/25/18
Diameter (in.)	2.041
Height (in.)	3.929
Weight (g)	366.2
Corrected Peak UCS (psi)	329.0
Corrected Failure Strain (%)	0.69
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-5-A
Molding Date	7/23/18
Curing Period (d)	8
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

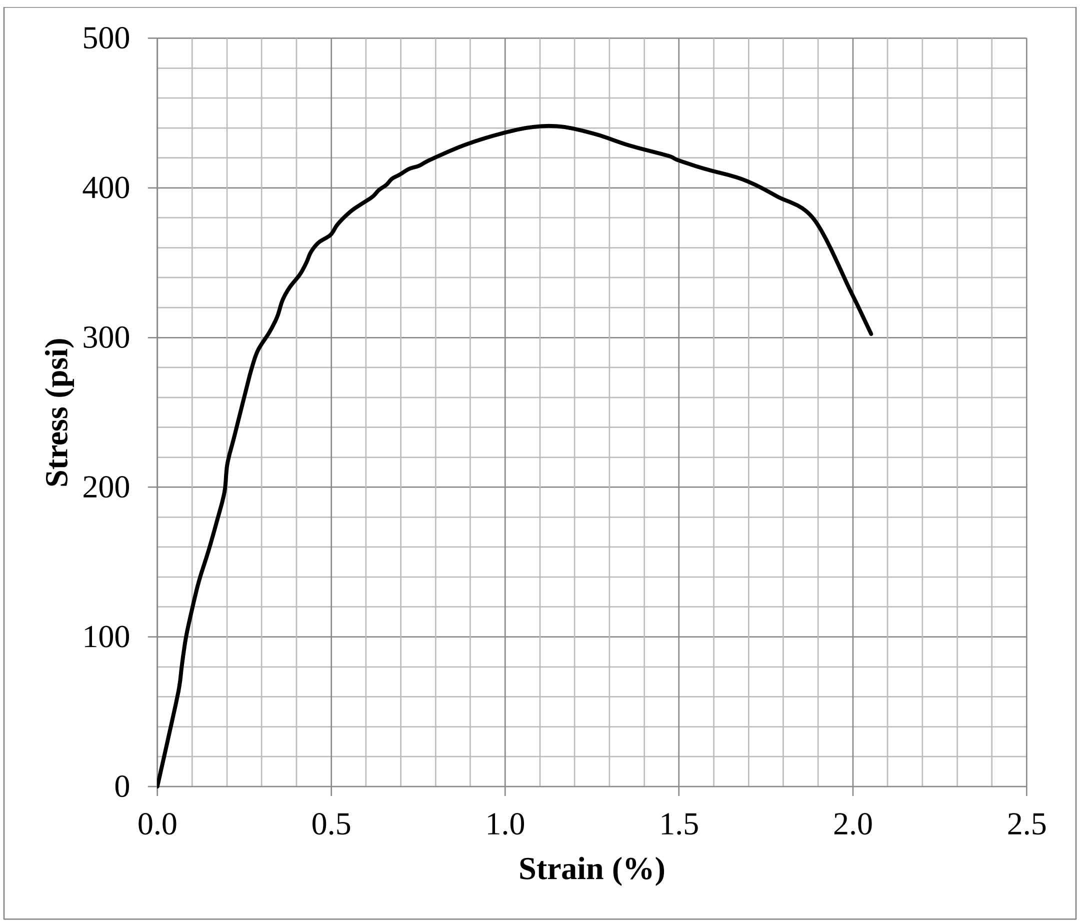
Testing Date	7/31/18
Diameter (in.)	2.033
Height (in.)	3.951
Weight (g)	360.2
Corrected Peak UCS (psi)	450.1
Corrected Failure Strain (%)	1.25
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-5-B
Molding Date	7/23/18
Curing Period (d)	8
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

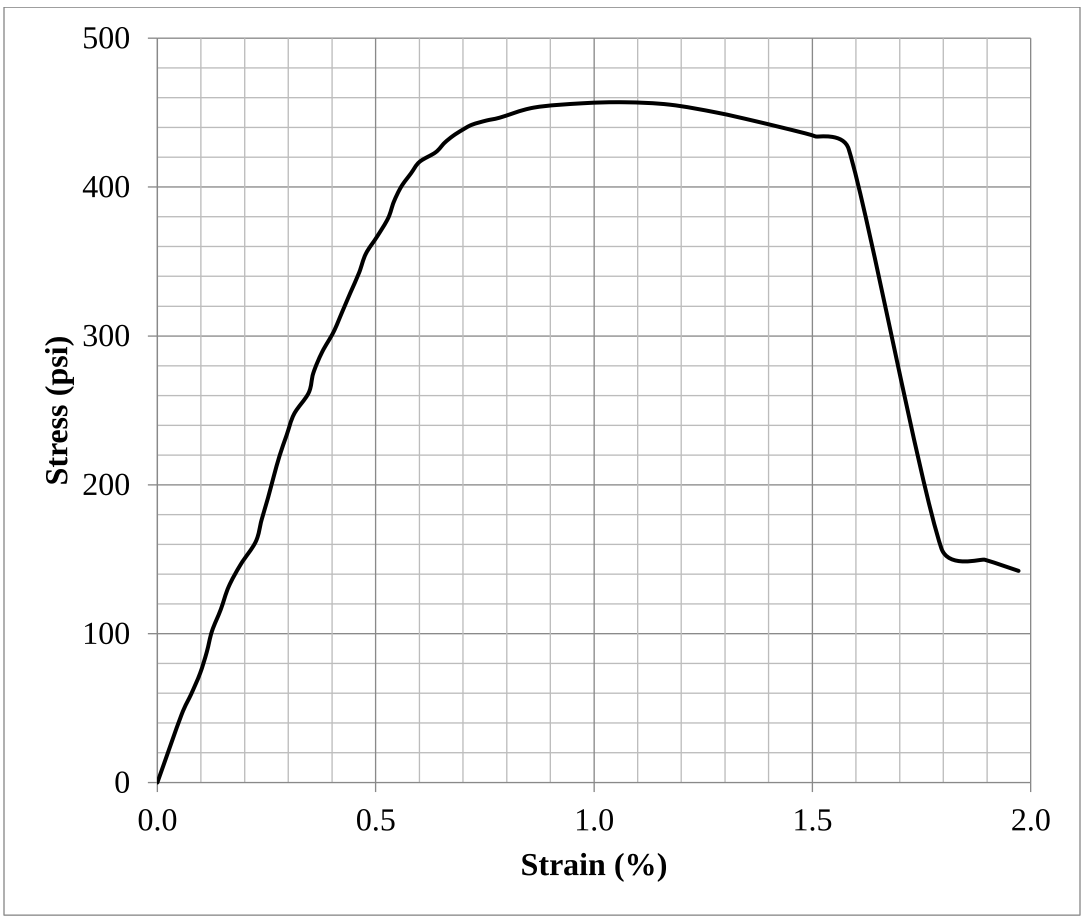
Testing Date	7/31/18
Diameter (in.)	2.038
Height (in.)	3.994
Weight (g)	363.0
Corrected Peak UCS (psi)	439.6
Corrected Failure Strain (%)	1.16
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-5-C
Molding Date	7/23/18
Curing Period (d)	8
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

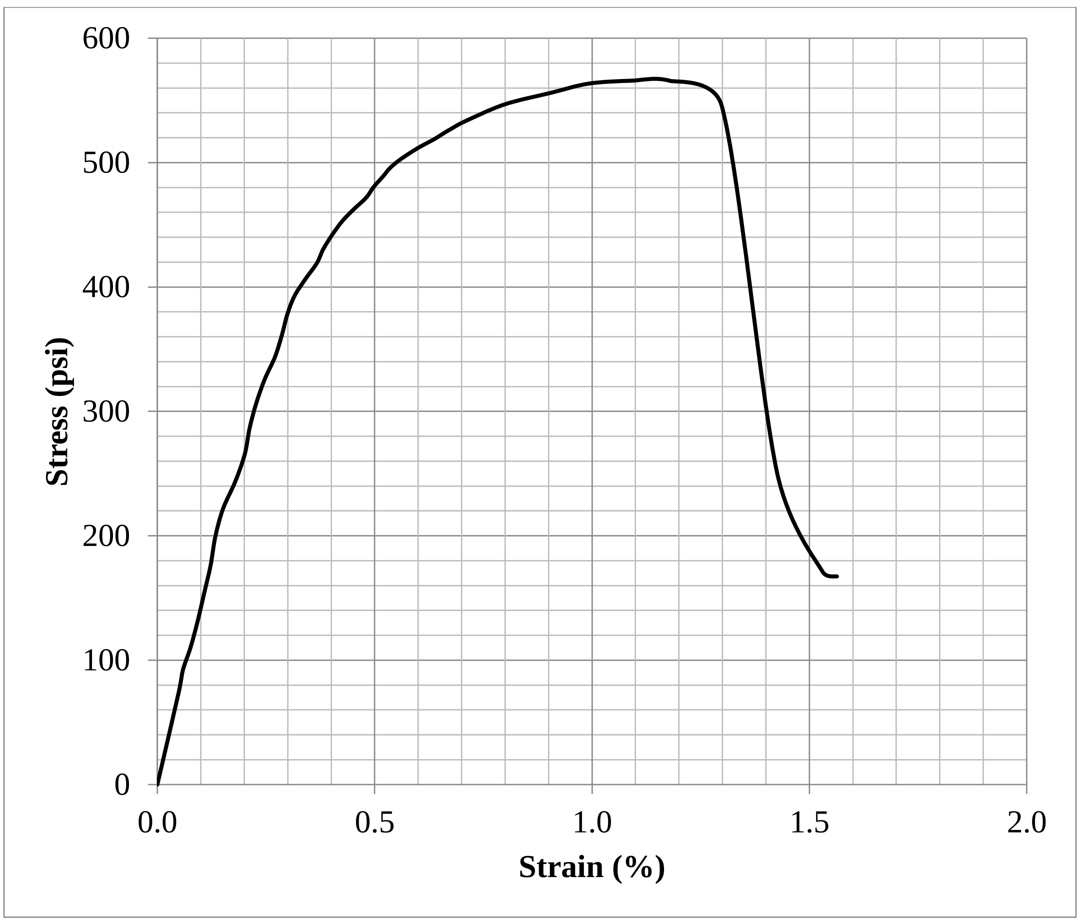
Testing Date	7/31/18
Diameter (in.)	2.043
Height (in.)	3.944
Weight (g)	358.6
Corrected Peak UCS (psi)	454.4
Corrected Failure Strain (%)	1.07
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-5-E
Molding Date	7/23/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

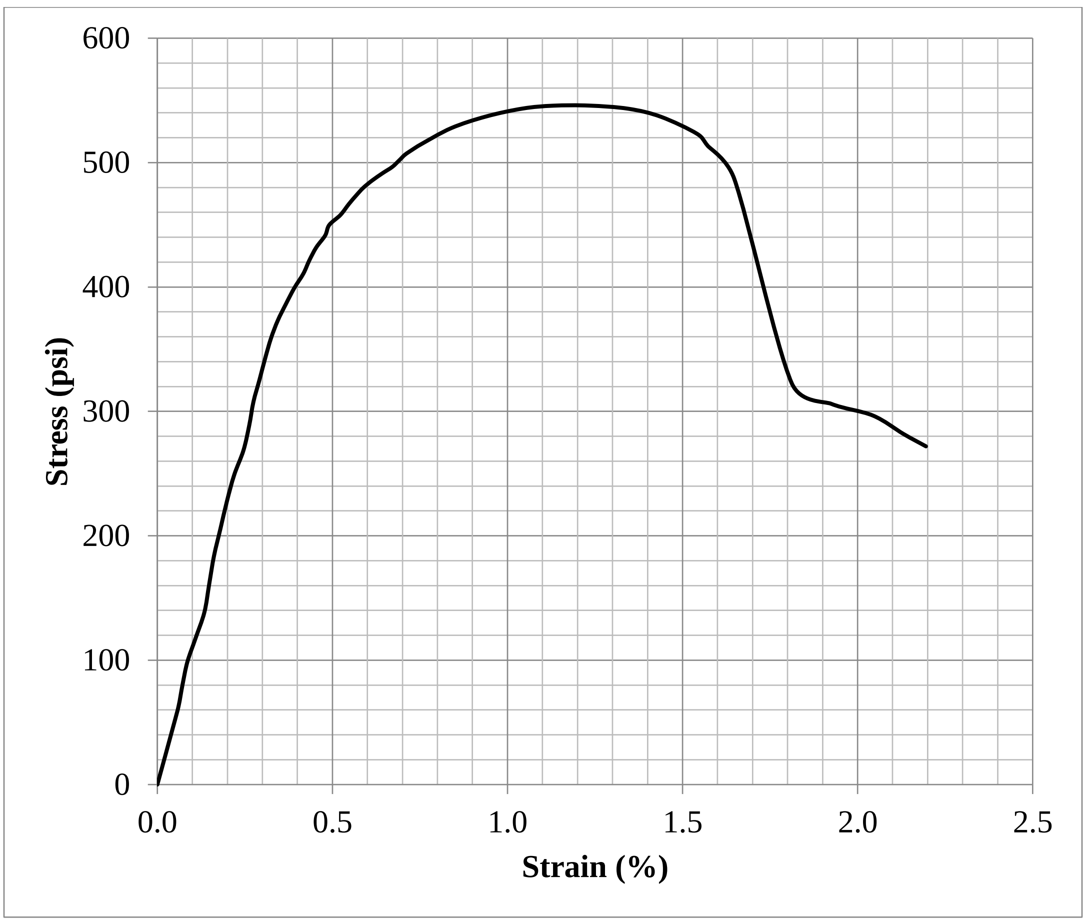
Testing Date	8/7/18
Diameter (in.)	2.034
Height (in.)	3.981
Weight (g)	363.9
Corrected Peak UCS (psi)	563.8
Corrected Failure Strain (%)	1.09
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	0-5-F
Molding Date	7/23/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

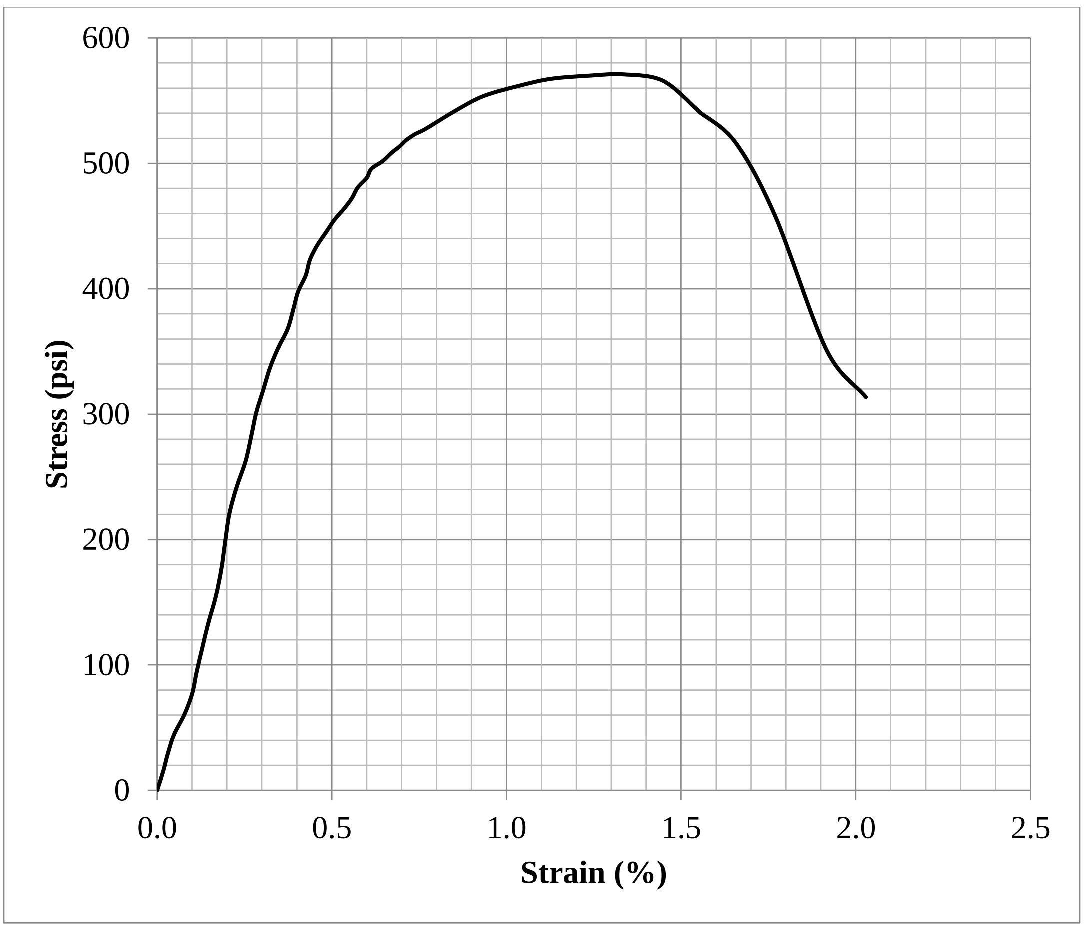
Testing Date	8/7/18
Diameter (in.)	2.043
Height (in.)	3.973
Weight (g)	362.2
Corrected Peak UCS (psi)	543.4
Corrected Failure Strain (%)	1.23
ASTM C39 Fracture Type	4



<u>Data Sheet: Specimen UCS Test</u>

Specimen ID	0-5-G
Molding Date	7/23/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

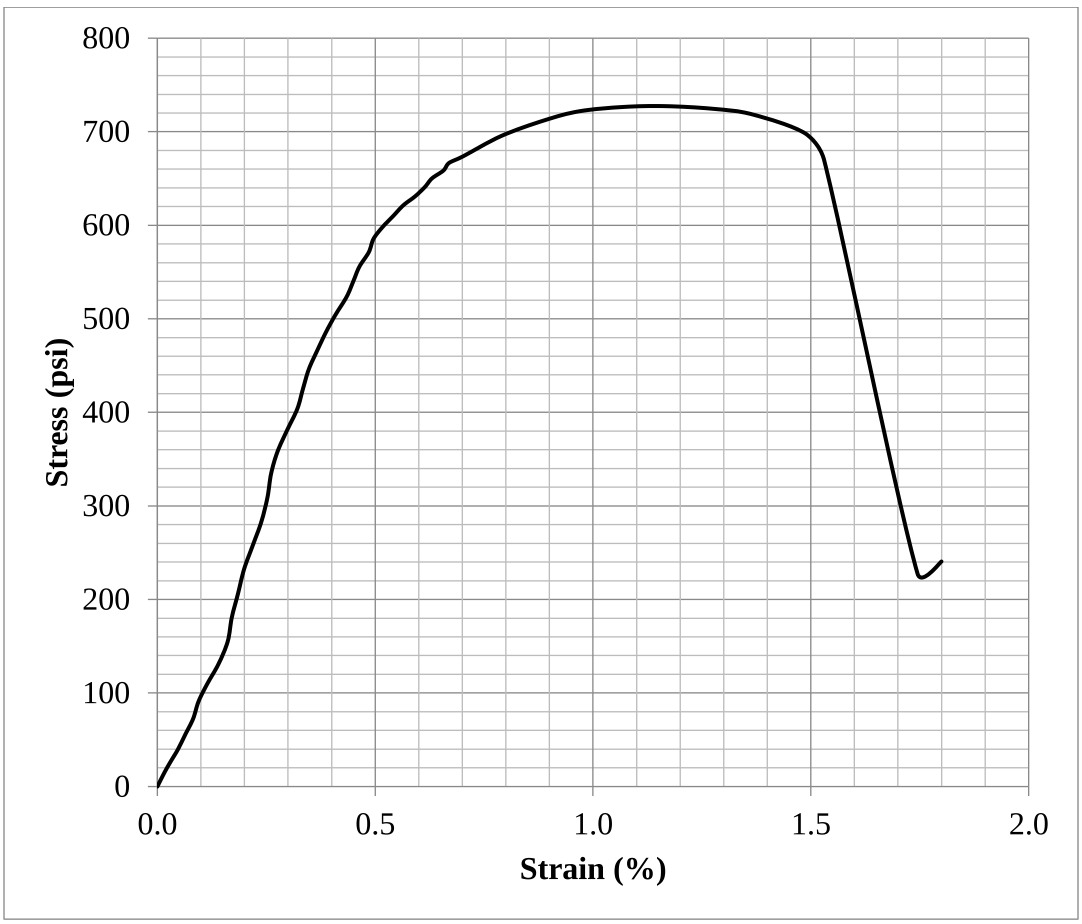
Testing Date	8/7/18
Diameter (in.)	2.039
Height (in.)	3.975
Weight (g)	360.7
Corrected Peak UCS (psi)	568.6
Corrected Failure Strain (%)	1.33
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	0-5-H
Molding Date	7/23/18
Curing Period (d)	33
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

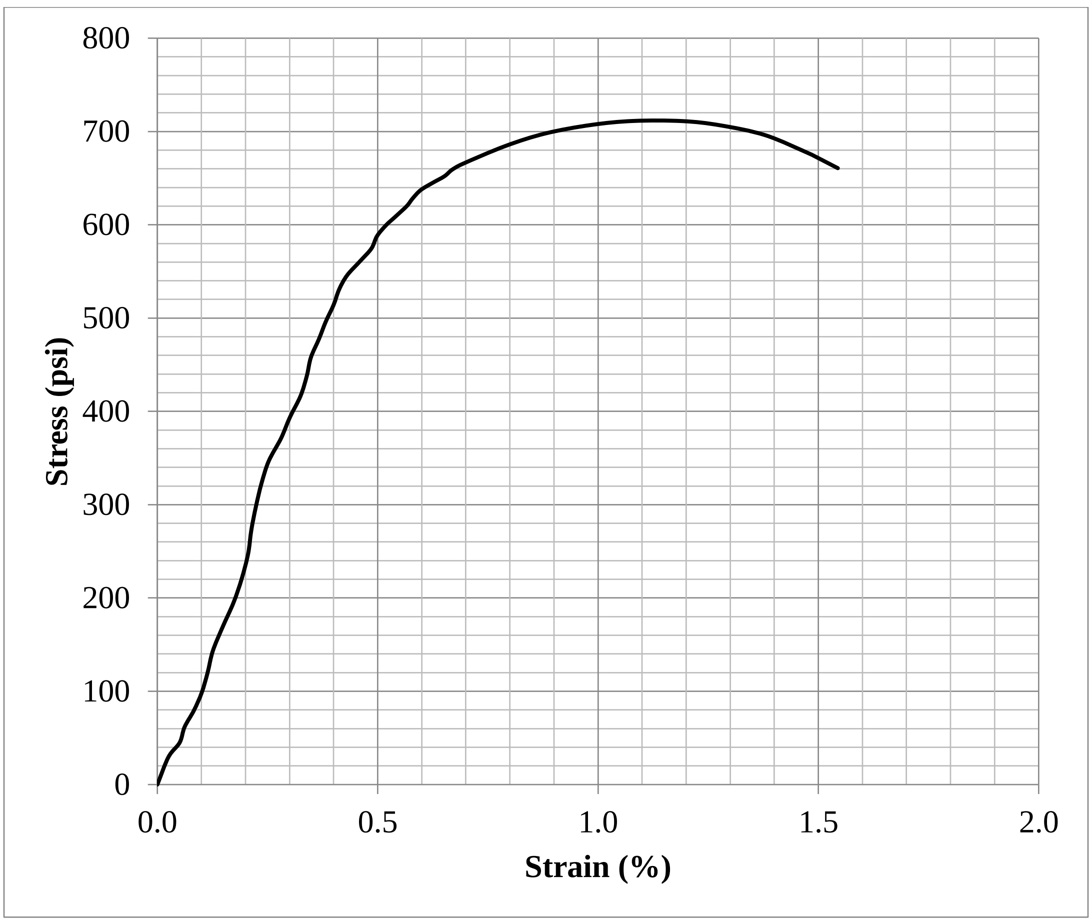
Testing Date	8/25/18
Diameter (in.)	2.038
Height (in.)	3.977
Weight (g)	363.7
Corrected Peak UCS (psi)	721.7
Corrected Failure Strain (%)	1.17
ASTM C39 Fracture Type	3



Data Sheet: Specimen UCS Test

Specimen ID	0-5-I
Molding Date	7/23/18
Curing Period (d)	33
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

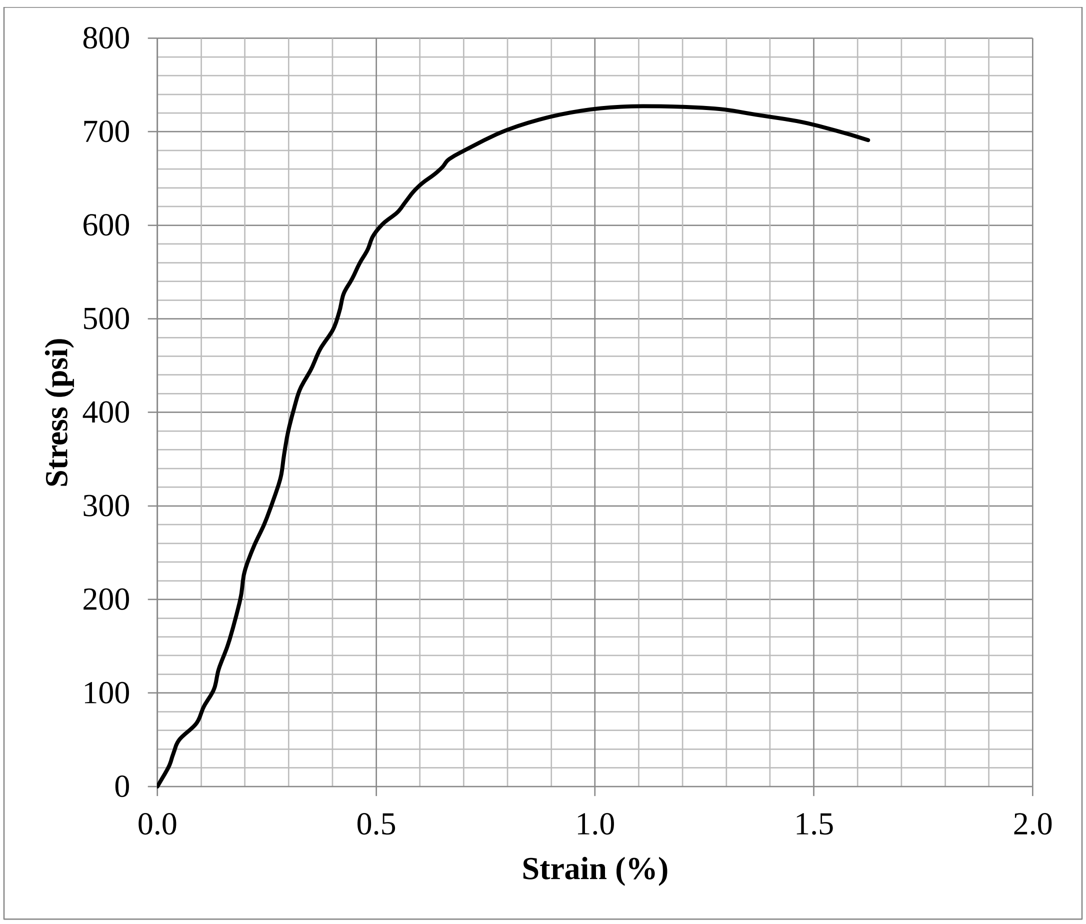
Testing Date	8/25/18
Diameter (in.)	2.037
Height (in.)	3.989
Weight (g)	365.3
Corrected Peak UCS (psi)	708.9
Corrected Failure Strain (%)	1.08
ASTM C39 Fracture Type	¾



Data Sheet: Specimen UCS Test

Specimen ID	0-5-J
Molding Date	7/23/18
Curing Period (d)	33
α_{I-P} (kg/m^3)	350 (347.9)
w:b	1.0
Soil OM (%)	0.9
Bleed Water (g)	0

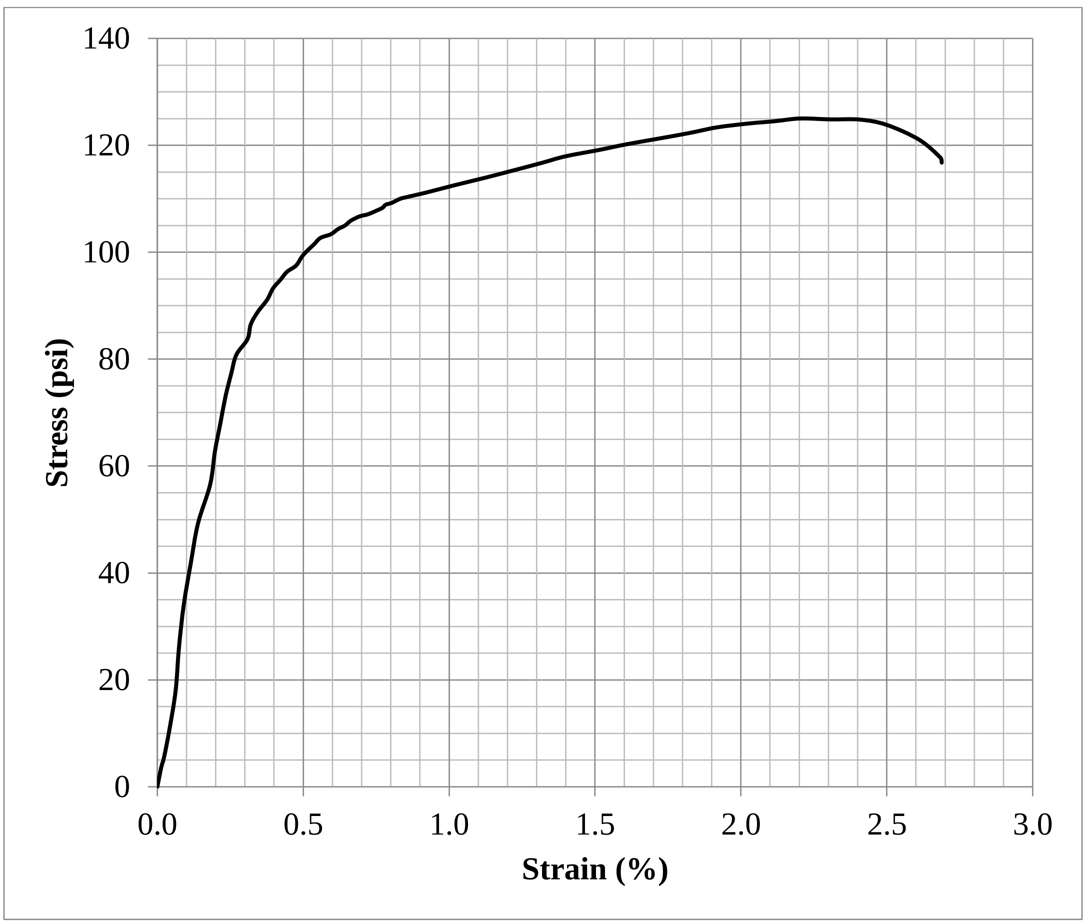
Testing Date	8/26/18
Diameter (in.)	2.041
Height (in.)	3.999
Weight (g)	365.8
Corrected Peak UCS (psi)	724.5
Corrected Failure Strain (%)	1.07
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	5-1-A
Molding Date	6/1/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	150 (152.4)
w:b	1.0
Soil OM (%)	8.3
Bleed Water (g)	0.1

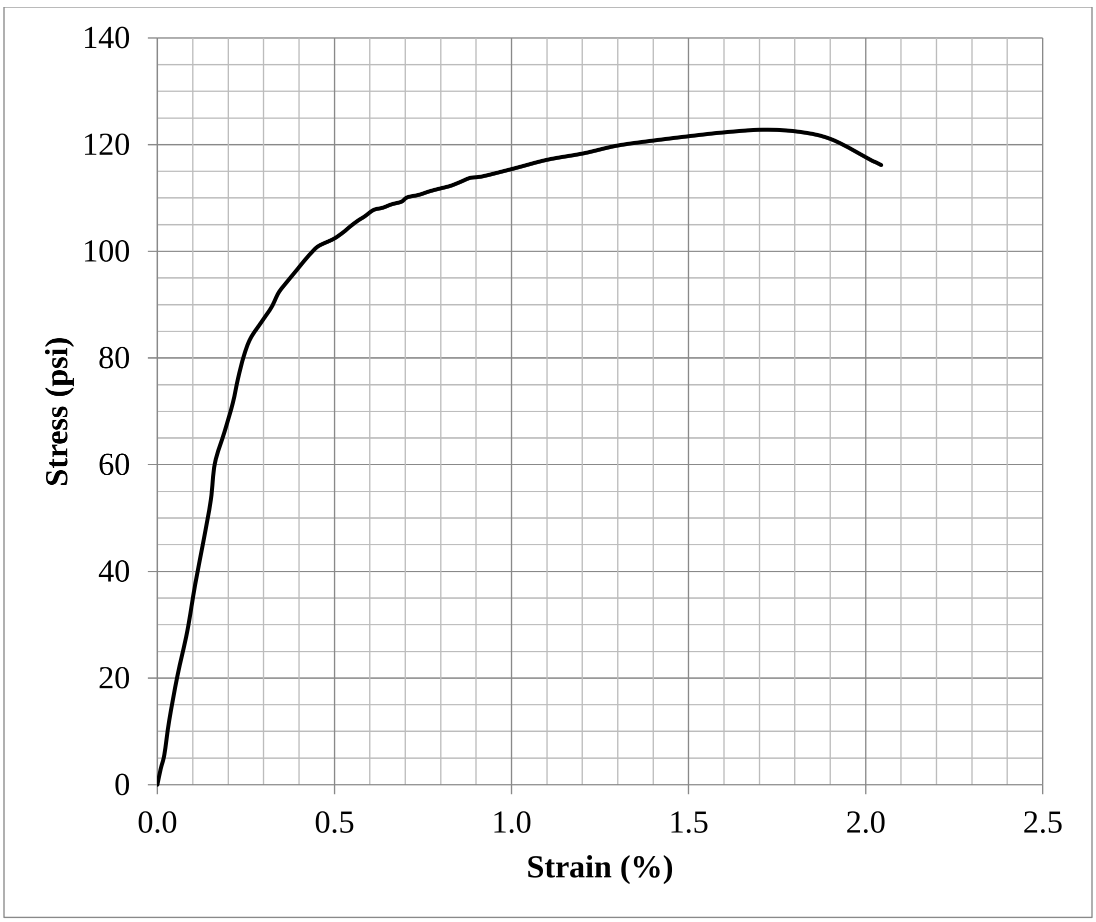
Testing Date	6/8/19
Diameter (in.)	2.038
Height (in.)	3.921
Weight (g)	339.6
Corrected Peak UCS (psi)	124.3
Corrected Failure Strain (%)	2.20
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-1-B
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	150 (152.4)
w:b	1.0
Soil OM (%)	8.3
Bleed Water (g)	0.1

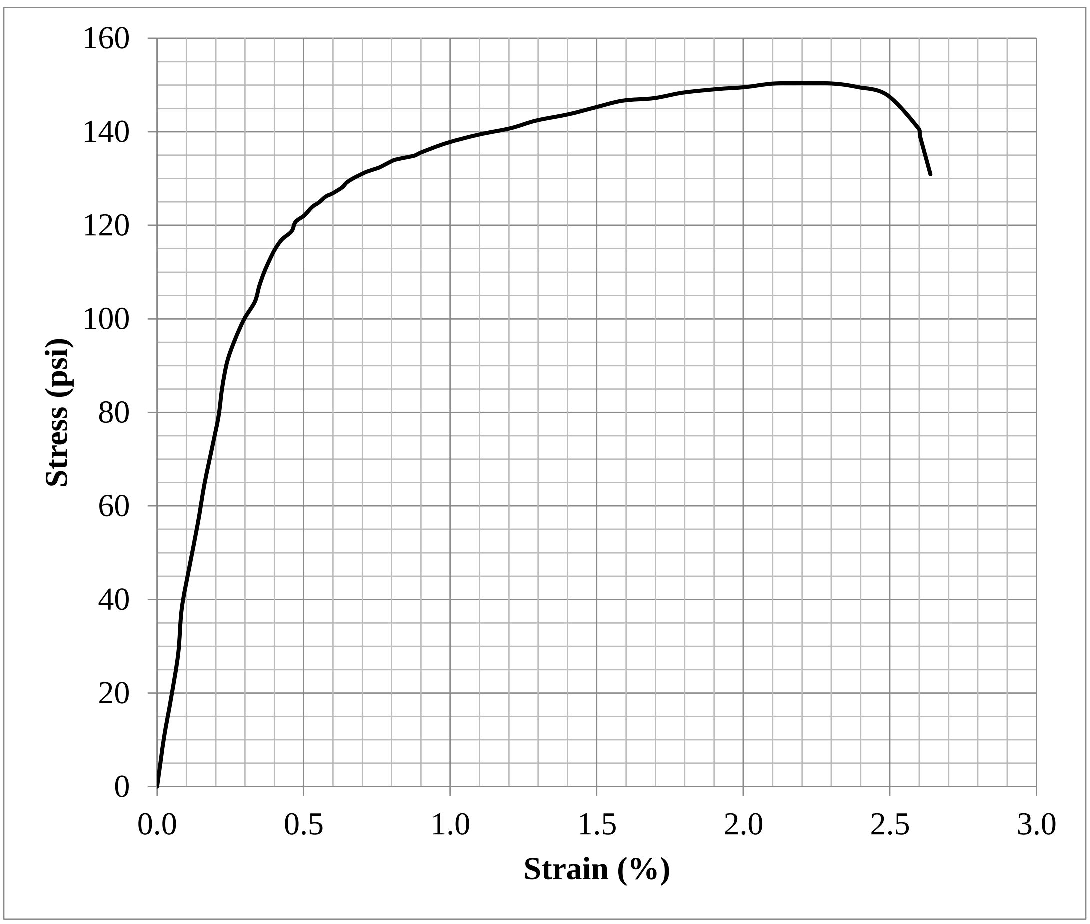
Testing Date	6/8/19
Diameter (in.)	2.043
Height (in.)	3.948
Weight (g)	343.0 (*est.*)
Corrected Peak UCS (psi)	122.1
Corrected Failure Strain (%)	1.71
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-1-C
Molding Date	6/1/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	150 (152.4)
w:b	1.0
Soil OM (%)	8.3
Bleed Water (g)	0.3

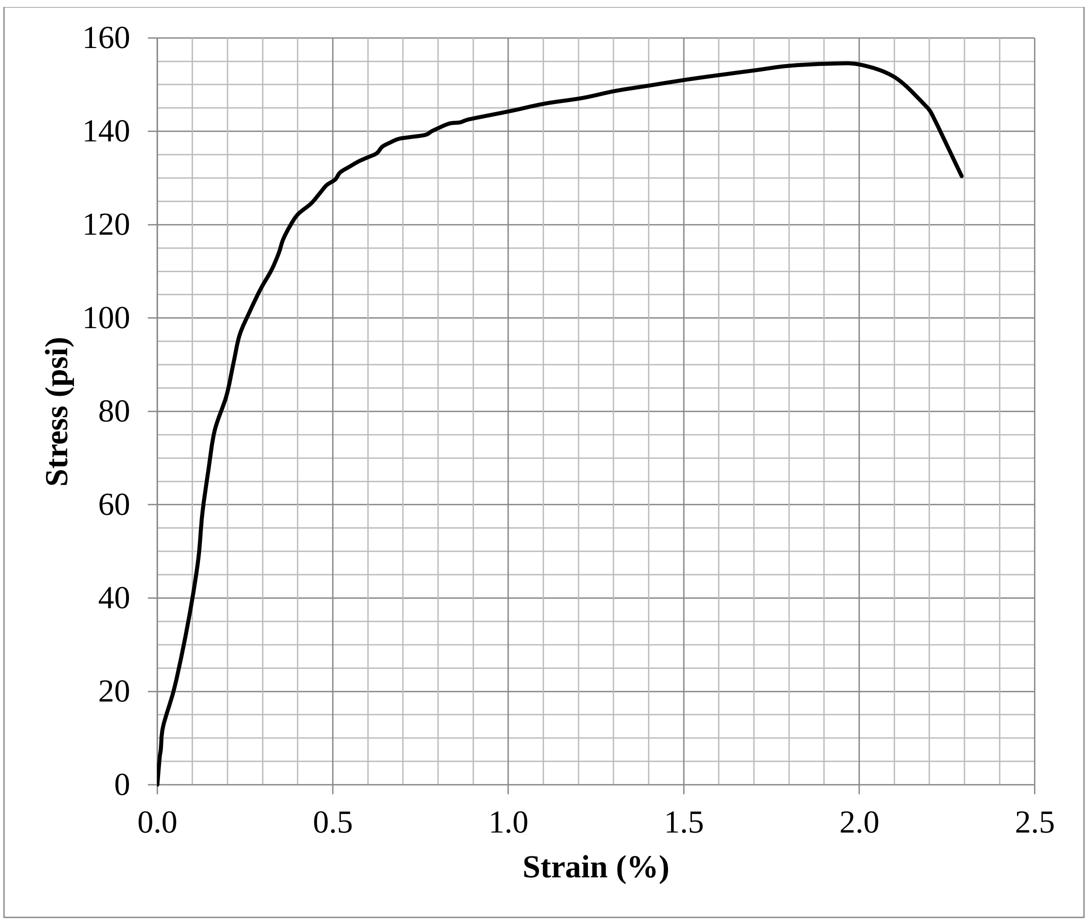
Testing Date	6/16/19
Diameter (in.)	2.046
Height (in.)	3.929
Weight (g)	341.0
Corrected Peak UCS (psi)	149.4
Corrected Failure Strain (%)	2.19
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-1-D
Molding Date	6/1/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	150 (152.4)
w:b	1.0
Soil OM (%)	8.3
Bleed Water (g)	0.4

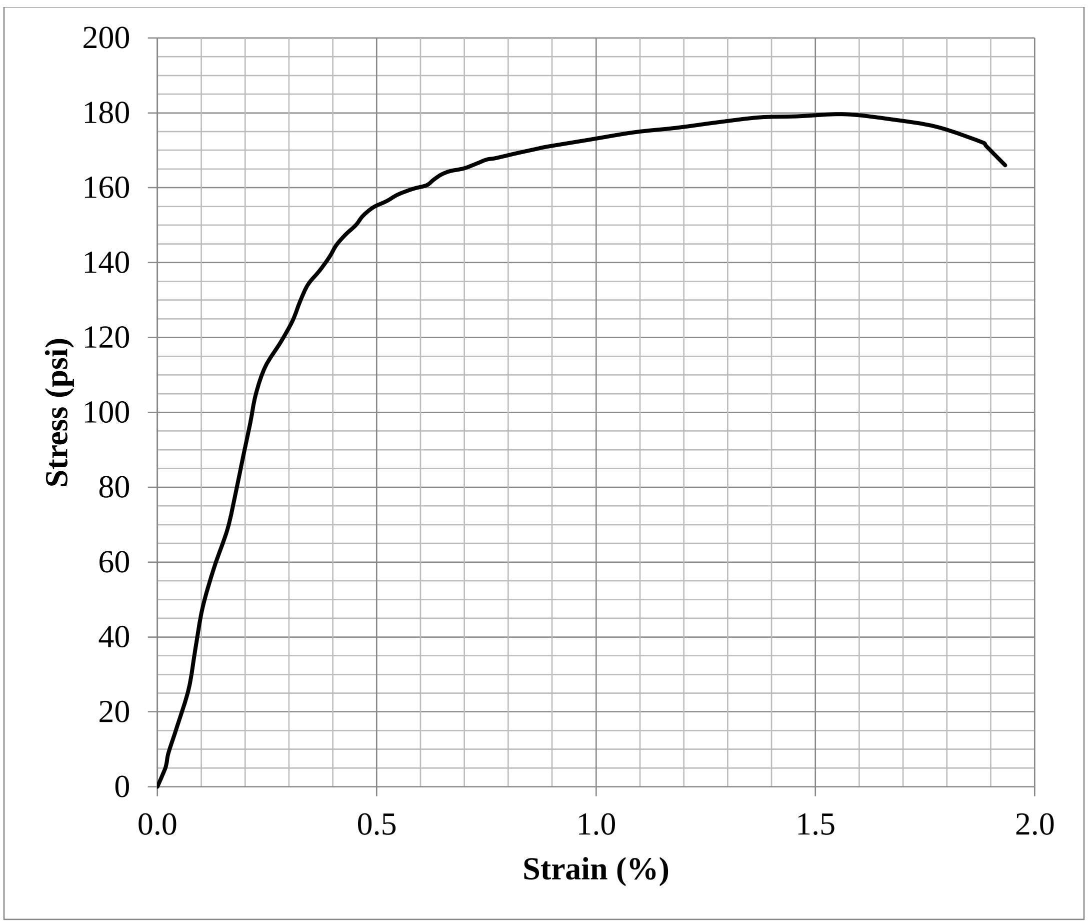
Testing Date	6/16/19
Diameter (in.)	2.043
Height (in.)	3.788
Weight (g)	329.4
Corrected Peak UCS (psi)	152.7
Corrected Failure Strain (%)	1.91
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	5-1-E
Molding Date	6/1/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	150 (152.4)
w:b	1.0
Soil OM (%)	8.3
Bleed Water (g)	0.3

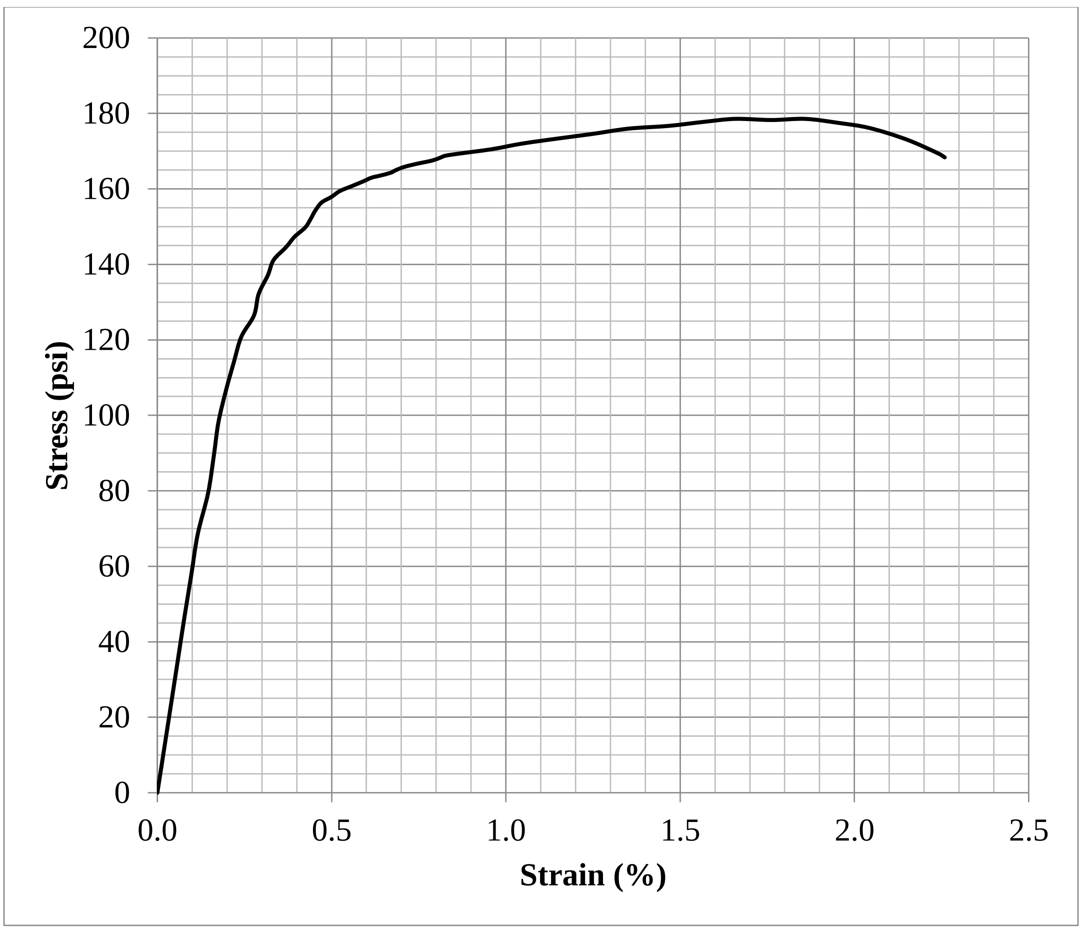
Testing Date	6/29/19
Diameter (in.)	2.043
Height (in.)	3.884
Weight (g)	338.7
Corrected Peak UCS (psi)	178.2
Corrected Failure Strain (%)	1.57
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	5-1-F
Molding Date	6/1/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	150 (152.4)
w:b	1.0
Soil OM (%)	8.3
Bleed Water (g)	0.4

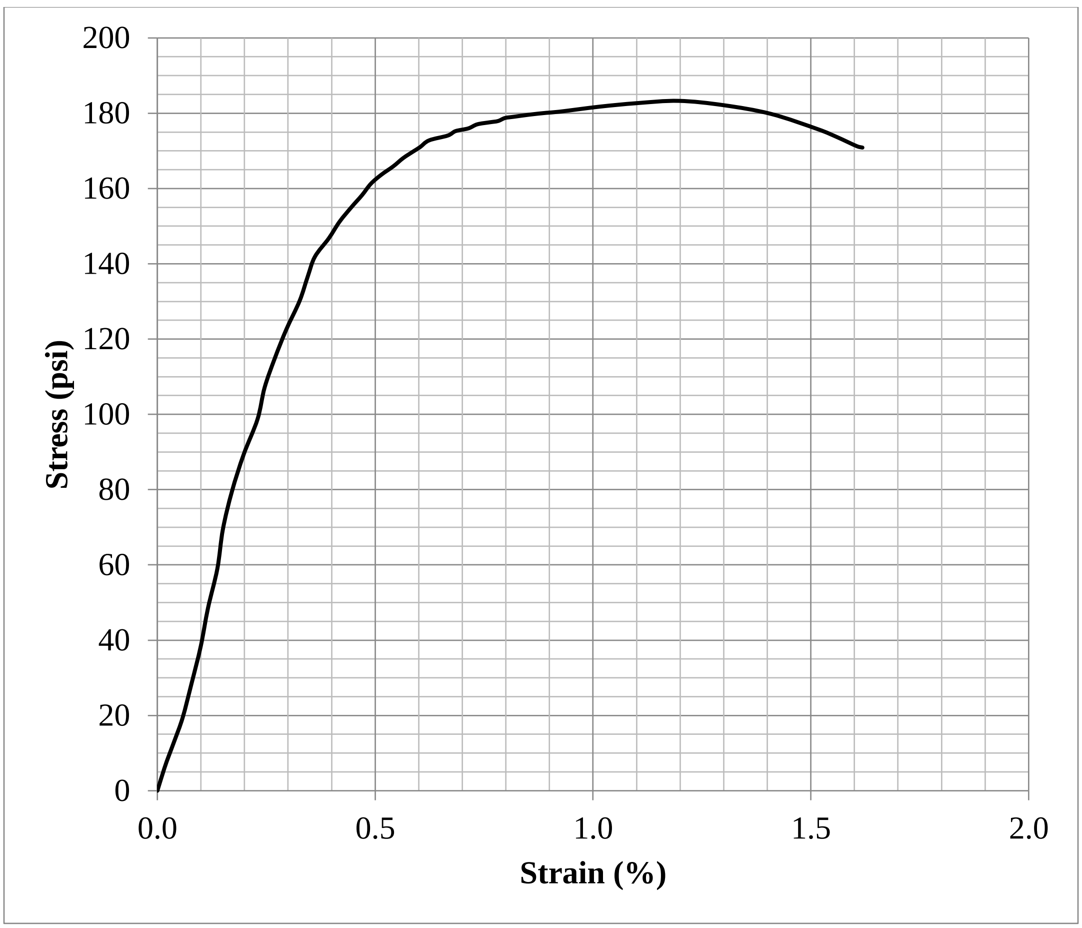
Testing Date	6/29/19
Diameter (in.)	2.050
Height (in.)	3.910
Weight (g)	340.6
Corrected Peak UCS (psi)	177.2
Corrected Failure Strain (%)	1.66
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-2-A
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (254.1)
w:b	1.2
Soil OM (%)	8.3
Bleed Water (g)	0.2

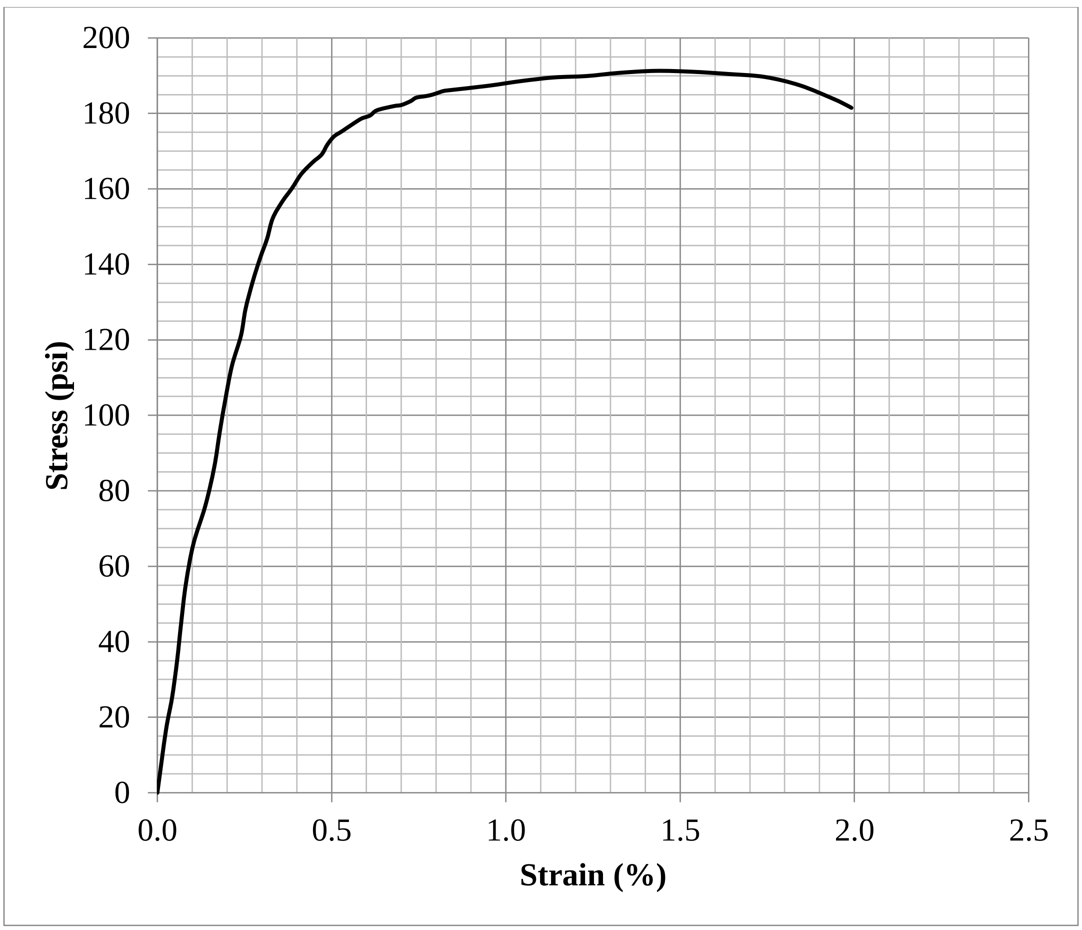
Testing Date	6/8/19
Diameter (in.)	2.042
Height (in.)	3.827
Weight (g)	326.6
Corrected Peak UCS (psi)	181.4
Corrected Failure Strain (%)	1.20
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-2-B
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (254.1)
w:b	1.2
Soil OM (%)	8.3
Bleed Water (g)	0.1

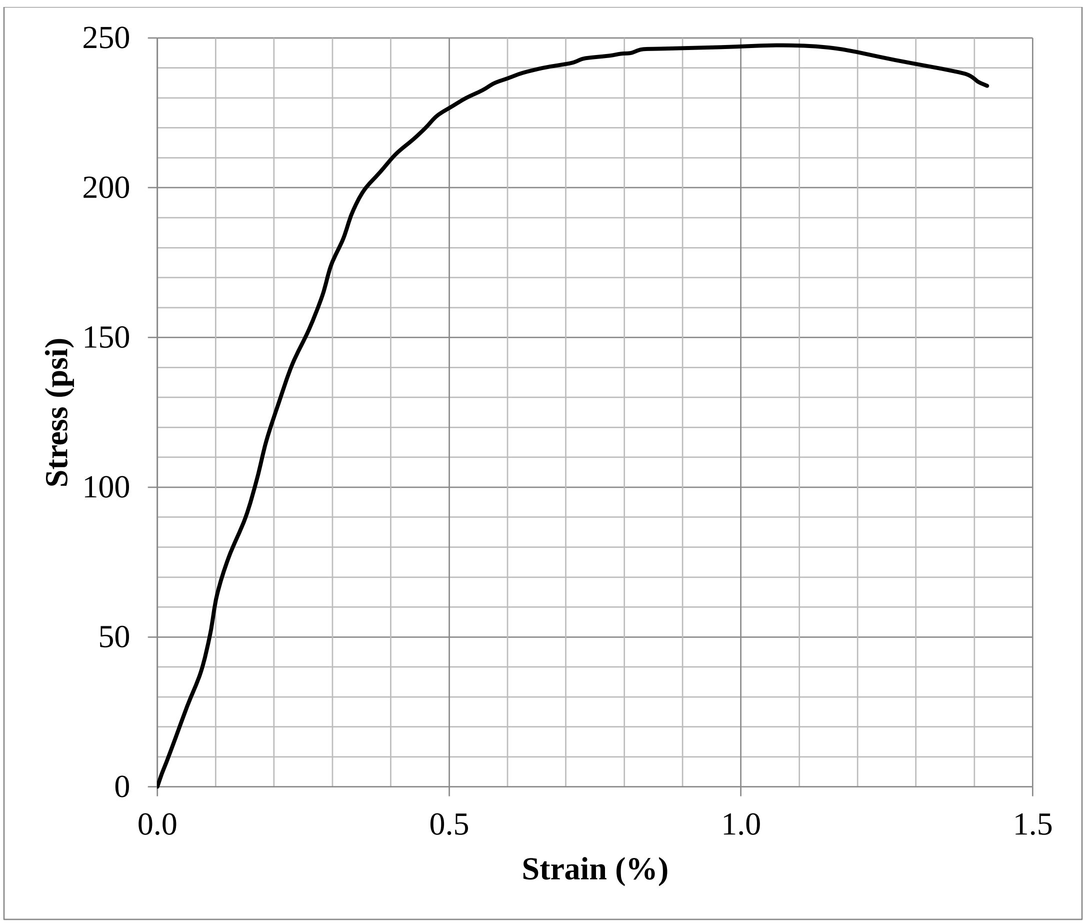
Testing Date	6/8/19
Diameter (in.)	2.045
Height (in.)	3.879
Weight (g)	331.2
Corrected Peak UCS (psi)	189.7
Corrected Failure Strain (%)	1.43
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	5-2-C
Molding Date	6/1/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	250 (254.1)
w:b	1.2
Soil OM (%)	8.3
Bleed Water (g)	0.1

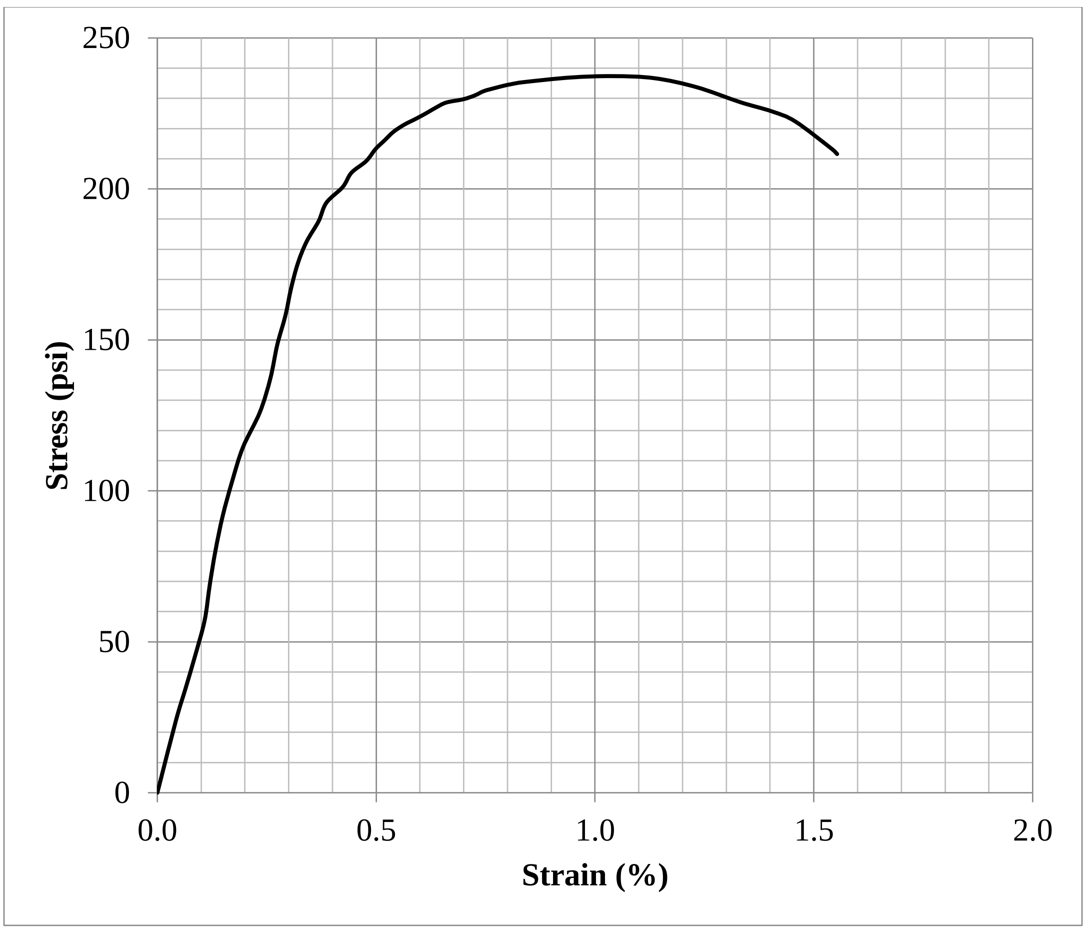
Testing Date	6/16/19
Diameter (in.)	2.042
Height (in.)	3.979
Weight (g)	340.2
Corrected Peak UCS (psi)	246.5
Corrected Failure Strain (%)	1.07
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-2-D
Molding Date	6/1/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (254.1)
w:b	1.2
Soil OM (%)	8.3
Bleed Water (g)	0.6

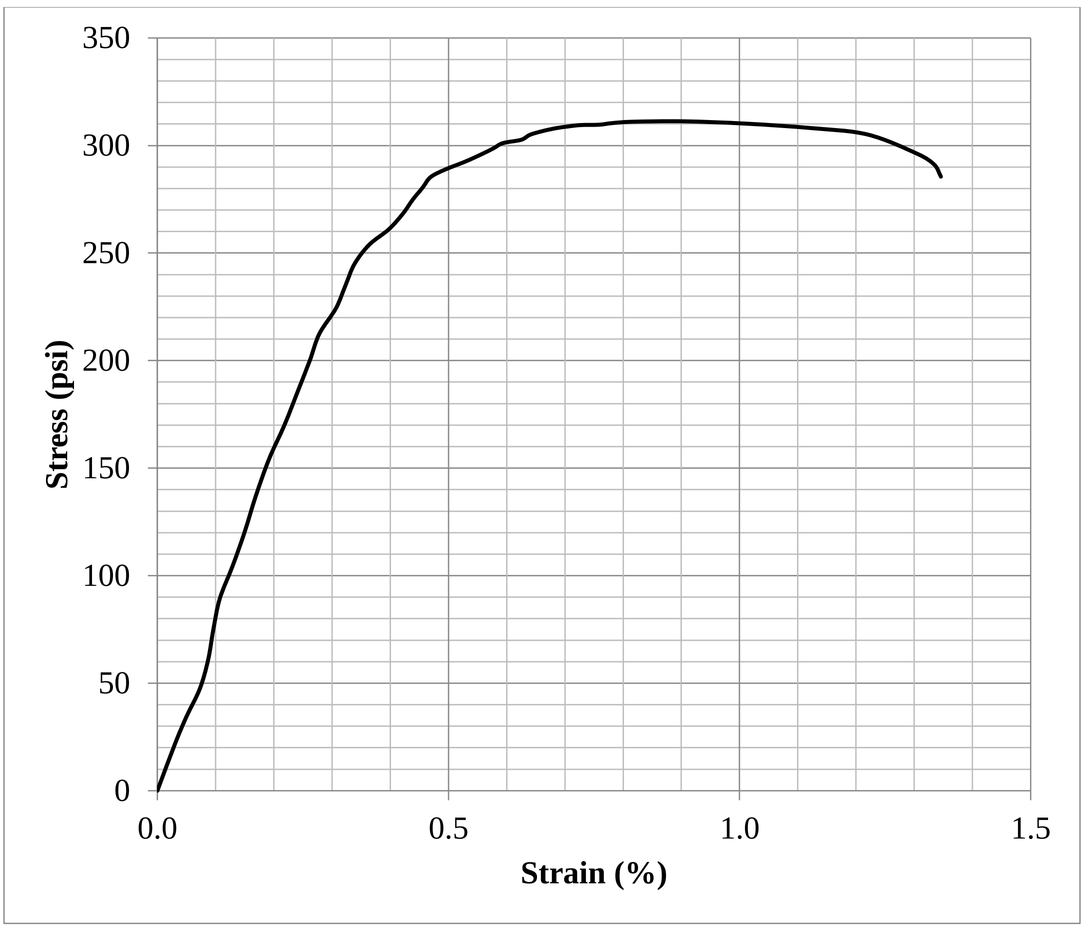
Testing Date	6/16/19
Diameter (in.)	2.043
Height (in.)	3.777
Weight (g)	321.7
Corrected Peak UCS (psi)	234.5
Corrected Failure Strain (%)	1.04
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-2-E
Molding Date	6/1/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (254.1)
w:b	1.2
Soil OM (%)	8.3
Bleed Water (g)	0.1

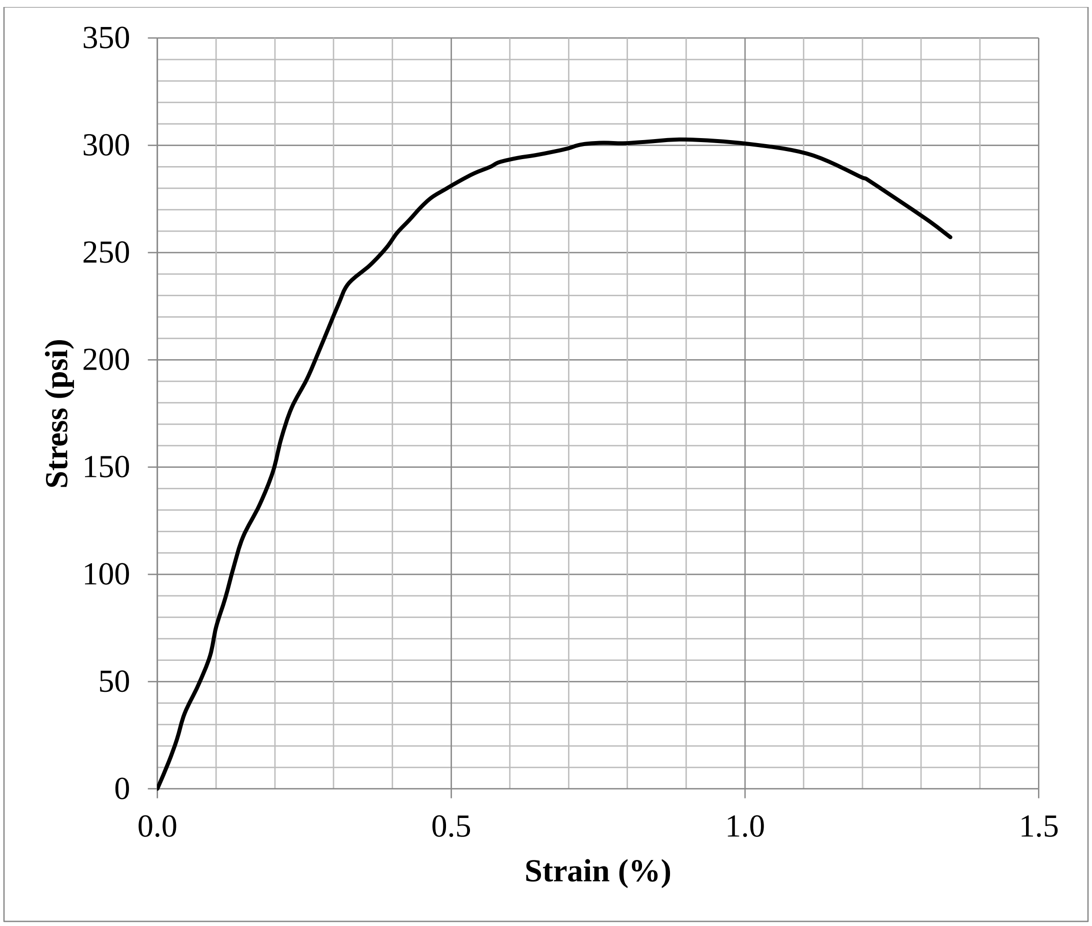
Testing Date	6/29/19
Diameter (in.)	2.044
Height (in.)	3.896
Weight (g)	334.0
Corrected Peak UCS (psi)	308.9
Corrected Failure Strain (%)	0.90
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-2-F
Molding Date	6/1/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (254.1)
w:b	1.2
Soil OM (%)	8.3
Bleed Water (g)	0.5

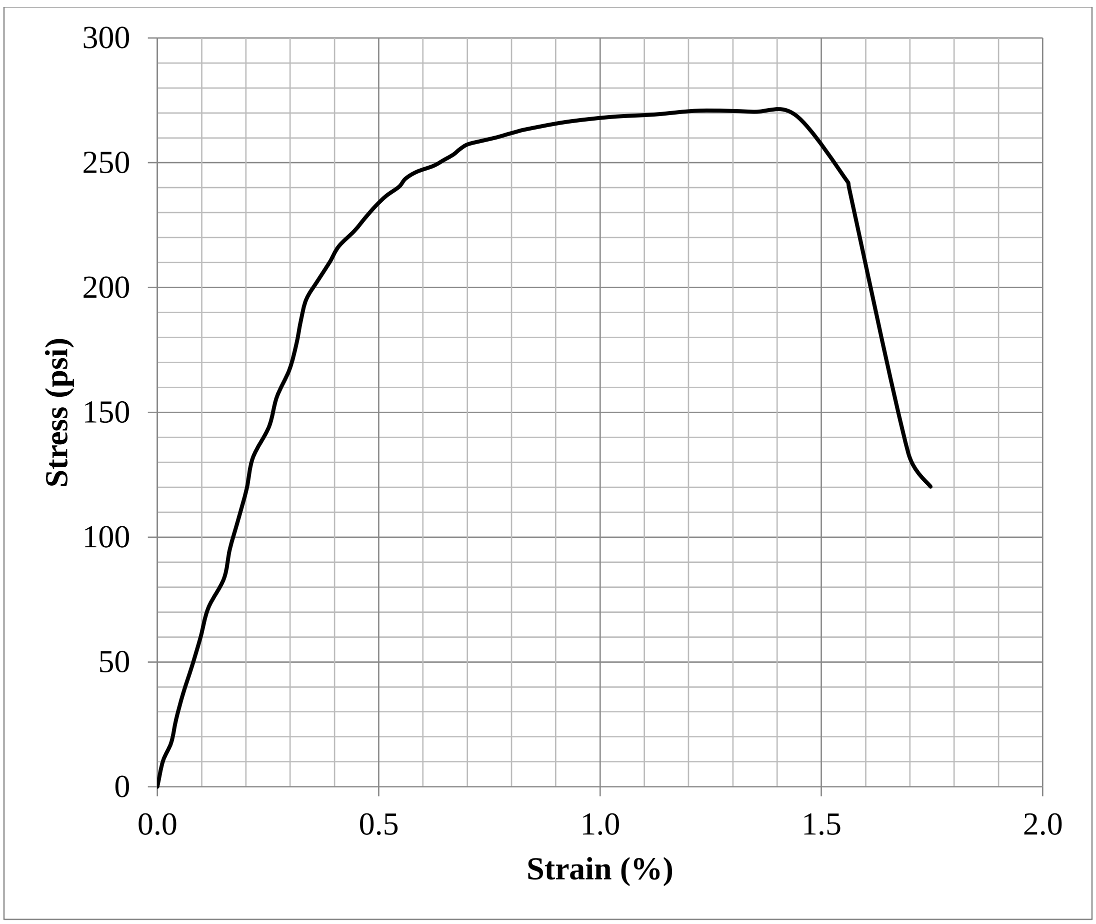
Testing Date	6/29/19
Diameter (in.)	2.050
Height (in.)	3.948
Weight (g)	337.8
Corrected Peak UCS (psi)	300.9
Corrected Failure Strain (%)	0.90
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-3-A
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (252.9)
w:b	0.8
Soil OM (%)	8.3
Bleed Water (g)	0

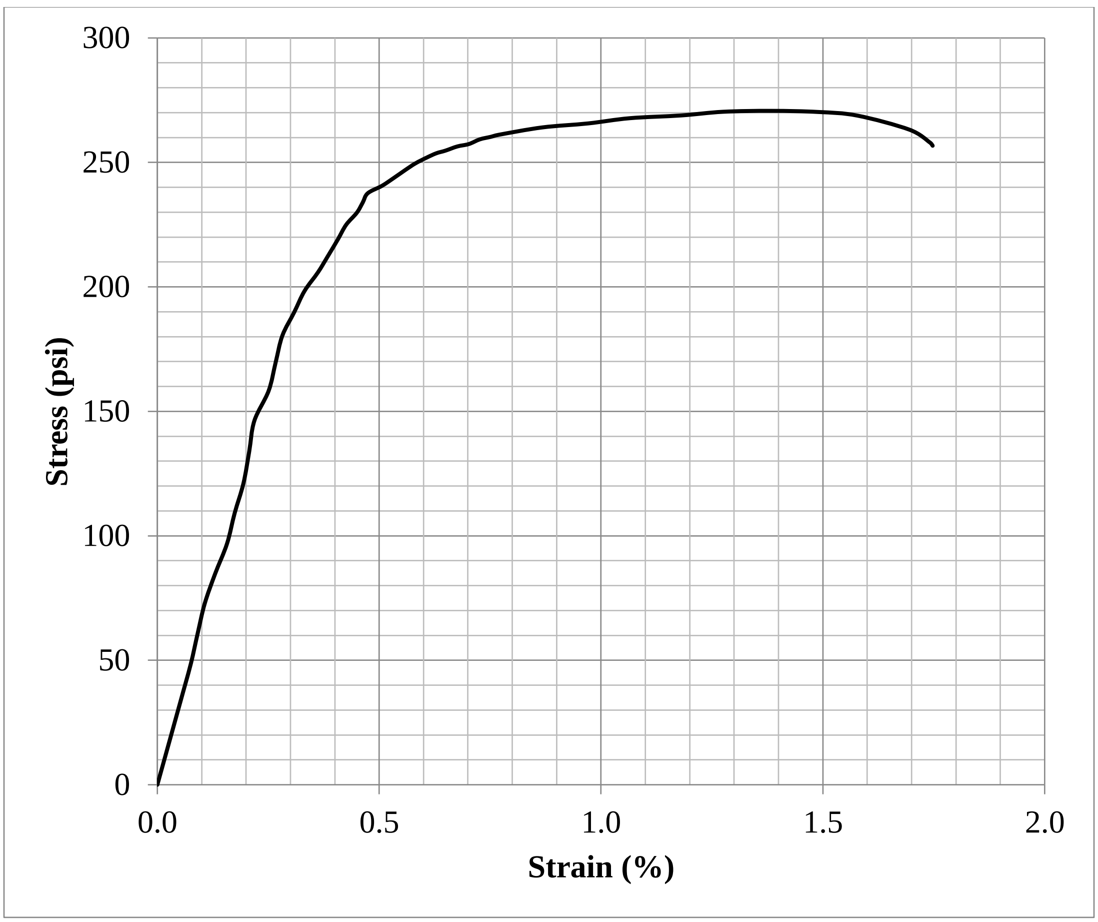
Testing Date	6/8/19
Diameter (in.)	2.047
Height (in.)	3.912
Weight (g)	344.8
Corrected Peak UCS (psi)	269.0
Corrected Failure Strain (%)	1.23
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	5-3-B
Molding Date	6/1/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (252.9)
w:b	0.8
Soil OM (%)	8.3
Bleed Water (g)	0.2

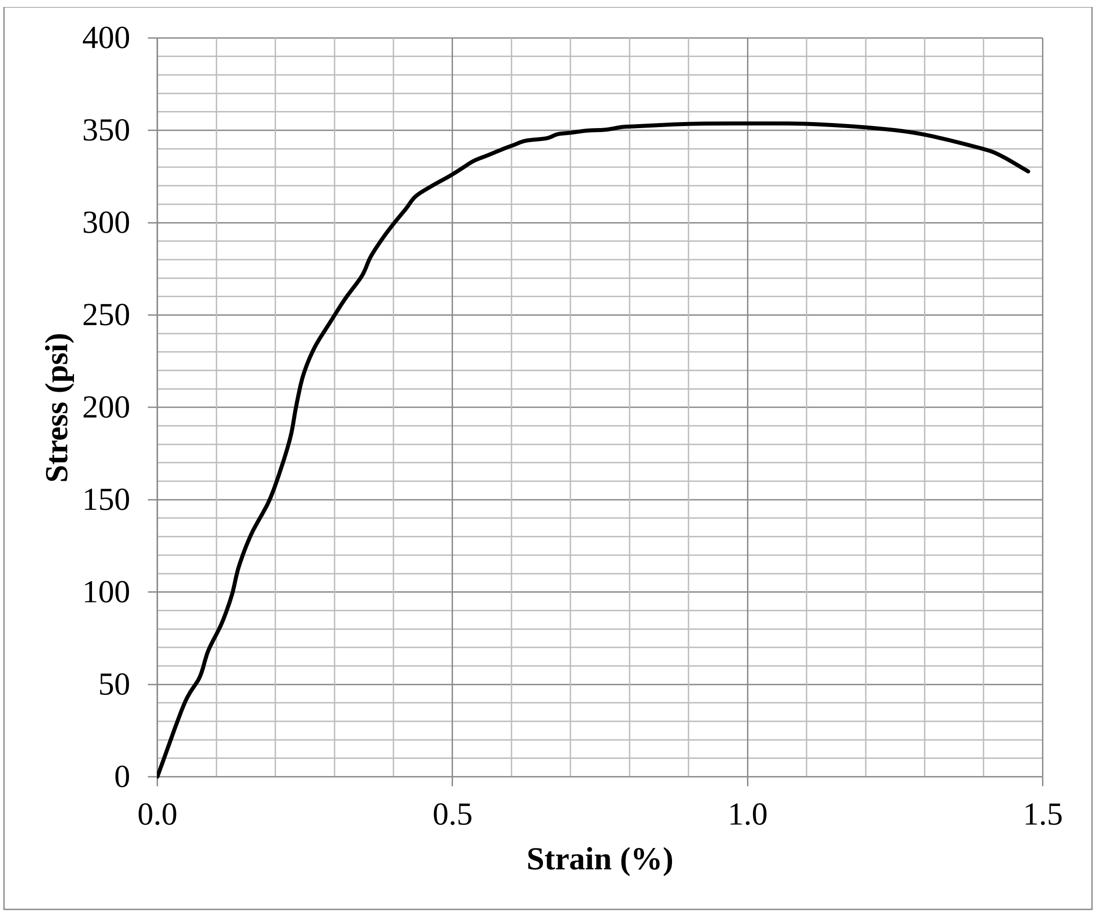
Testing Date	6/8/19
Diameter (in.)	2.052
Height (in.)	3.347
Weight (g)	295.7
Corrected Peak UCS (psi)	262.7
Corrected Failure Strain (%)	1.38
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-3-C
Molding Date	6/1/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (252.9)
w:b	0.8
Soil OM (%)	8.3
Bleed Water (g)	0.2

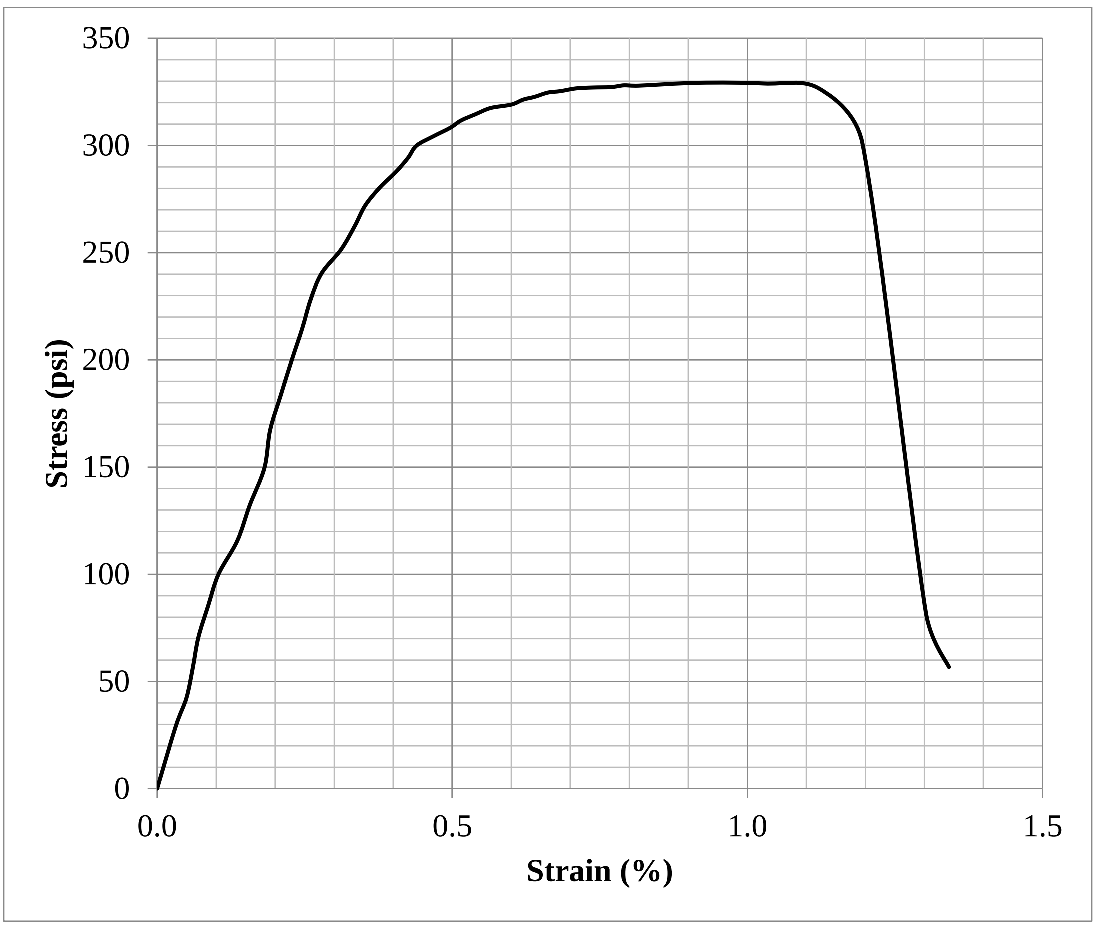
Testing Date	6/16/19
Diameter (in.)	2.047
Height (in.)	4.000
Weight (g)	353.4
Corrected Peak UCS (psi)	352.4
Corrected Failure Strain (%)	1.01
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	5-3-D
Molding Date	6/1/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	250 (252.9)
w:b	0.8
Soil OM (%)	8.3
Bleed Water (g)	0.1

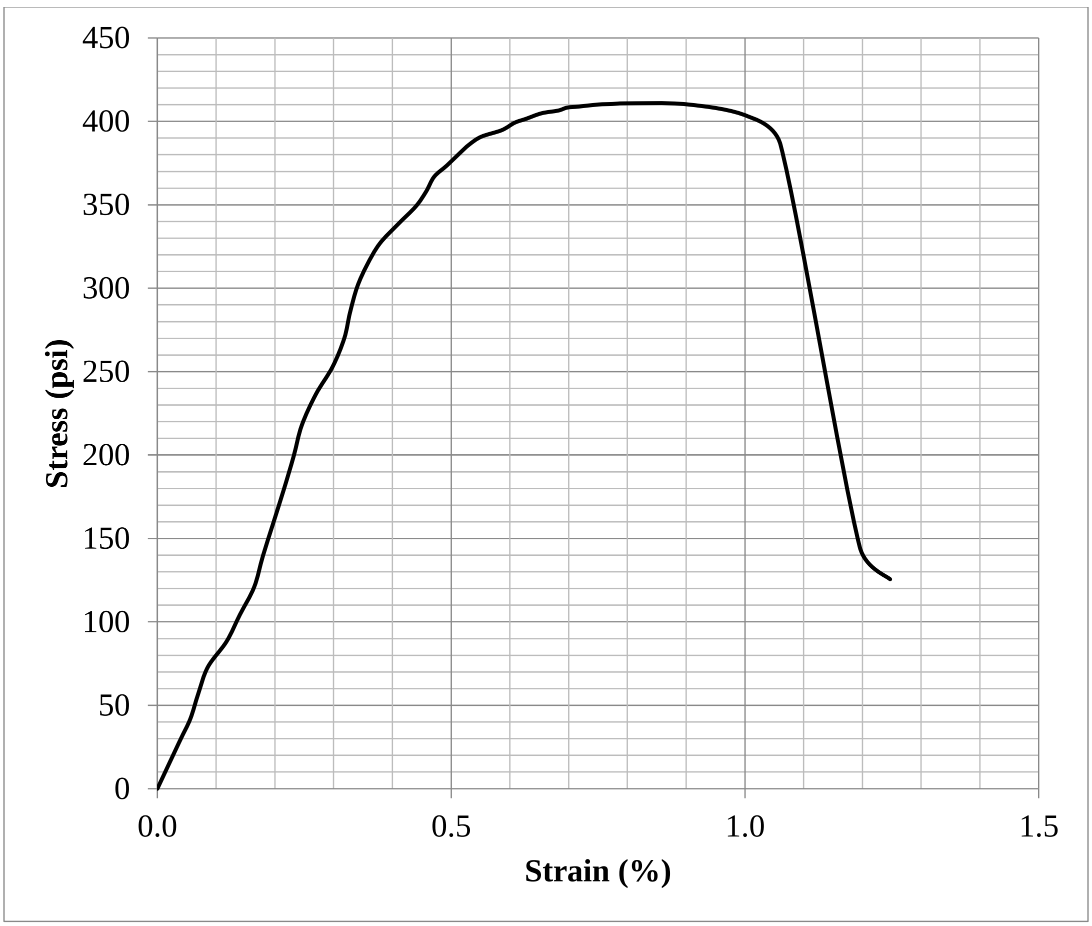
Testing Date	6/16/19
Diameter (in.)	2.046
Height (in.)	3.993
Weight (g)	352.5
Corrected Peak UCS (psi)	328.0
Corrected Failure Strain (%)	0.92
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	5-3-E
Molding Date	6/1/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (252.9)
w:b	0.8
Soil OM (%)	8.3
Bleed Water (g)	0.2

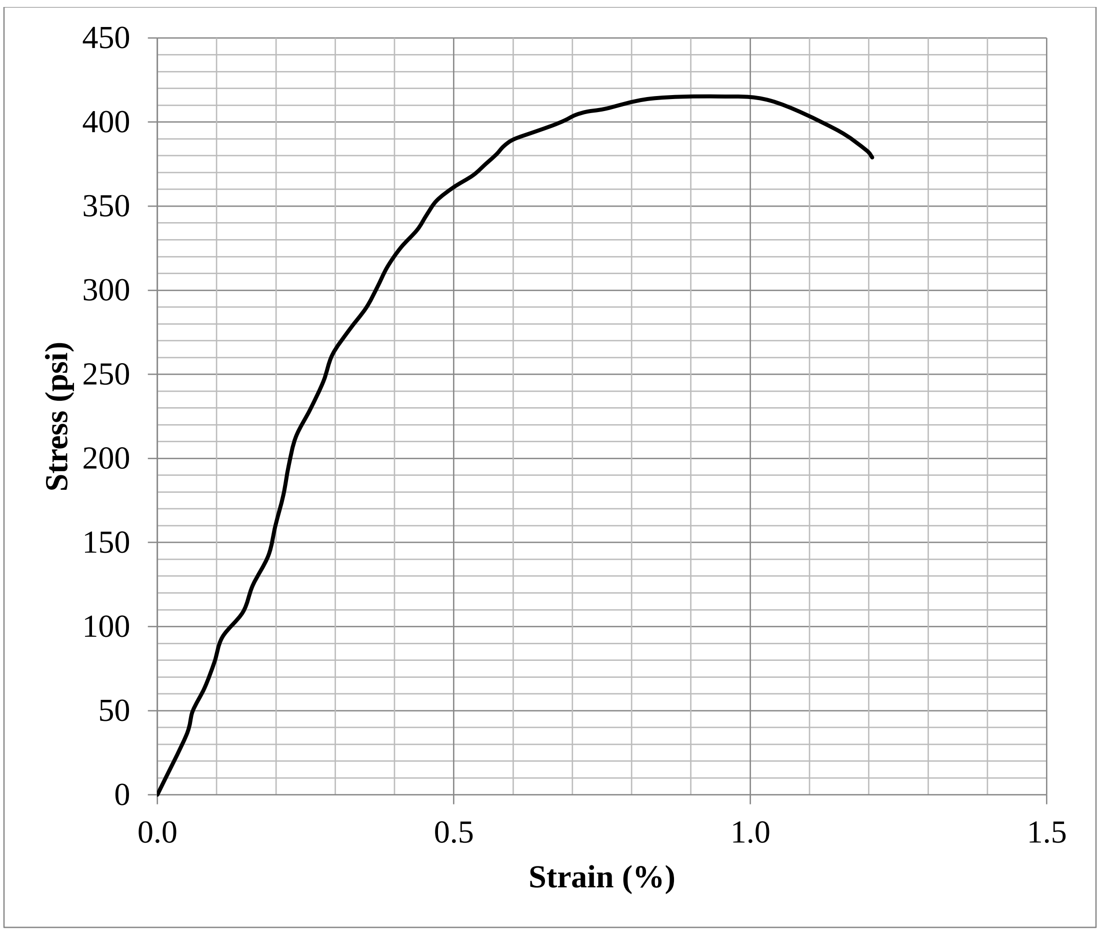
Testing Date	6/29/19
Diameter (in.)	2.044
Height (in.)	4.002
Weight (g)	354.1
Corrected Peak UCS (psi)	409.4
Corrected Failure Strain (%)	0.79
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	5-3-F
Molding Date	6/1/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (252.9)
w:b	0.8
Soil OM (%)	8.3
Bleed Water (g)	0.4

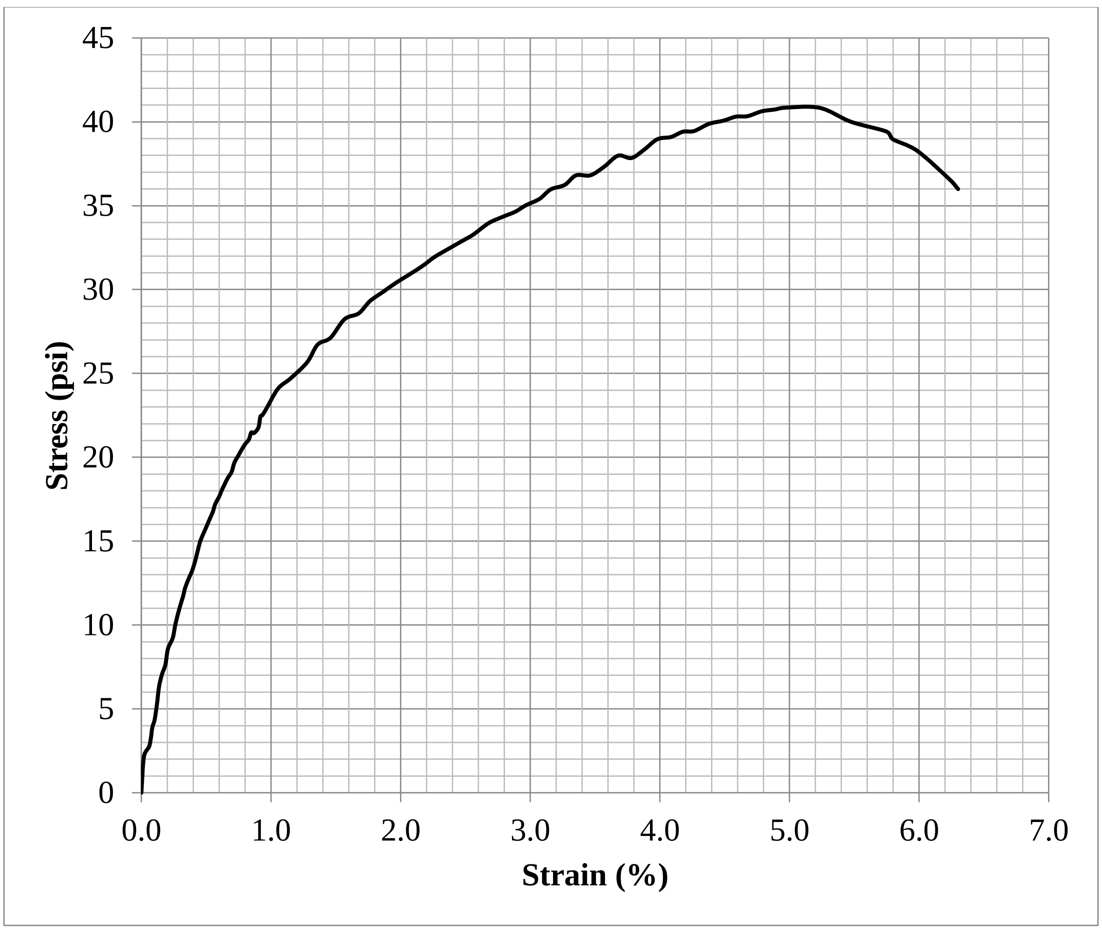
Testing Date	6/29/19
Diameter (in.)	2.046
Height (in.)	3.901
Weight (g)	344.2
Corrected Peak UCS (psi)	412.1
Corrected Failure Strain (%)	0.95
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-1-A
Molding Date	11/27/18
Curing Period (d)	9
α_{I-P} (kg/m^3)	71 (71.1)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0

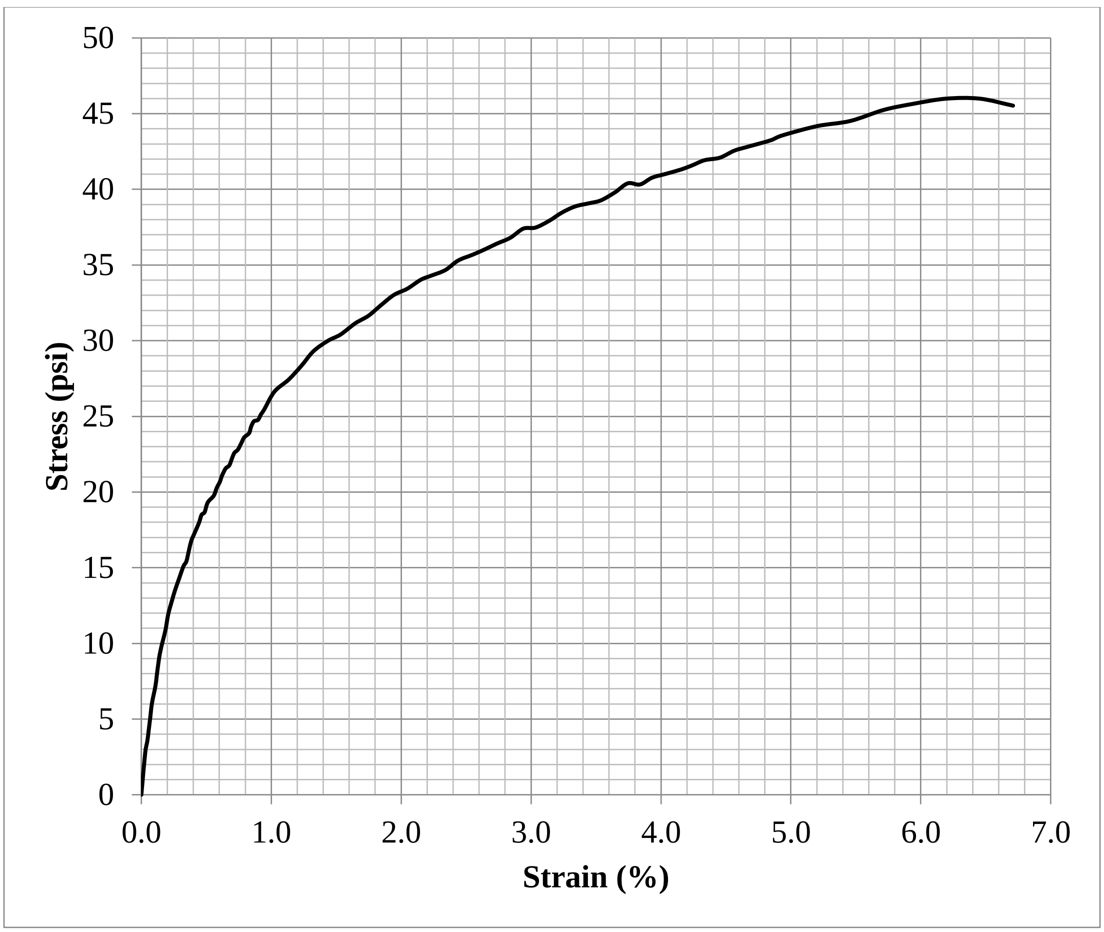
Testing Date	12/7/18
Diameter (in.)	2.030
Height (in.)	3.752
Weight (g)	296.8
Corrected Peak UCS (psi)	40.4
Corrected Failure Strain (%)	4.96
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-1-B
Molding Date	11/27/18
Curing Period (d)	10
α_{I-P} (kg/m^3)	71 (71.1)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0

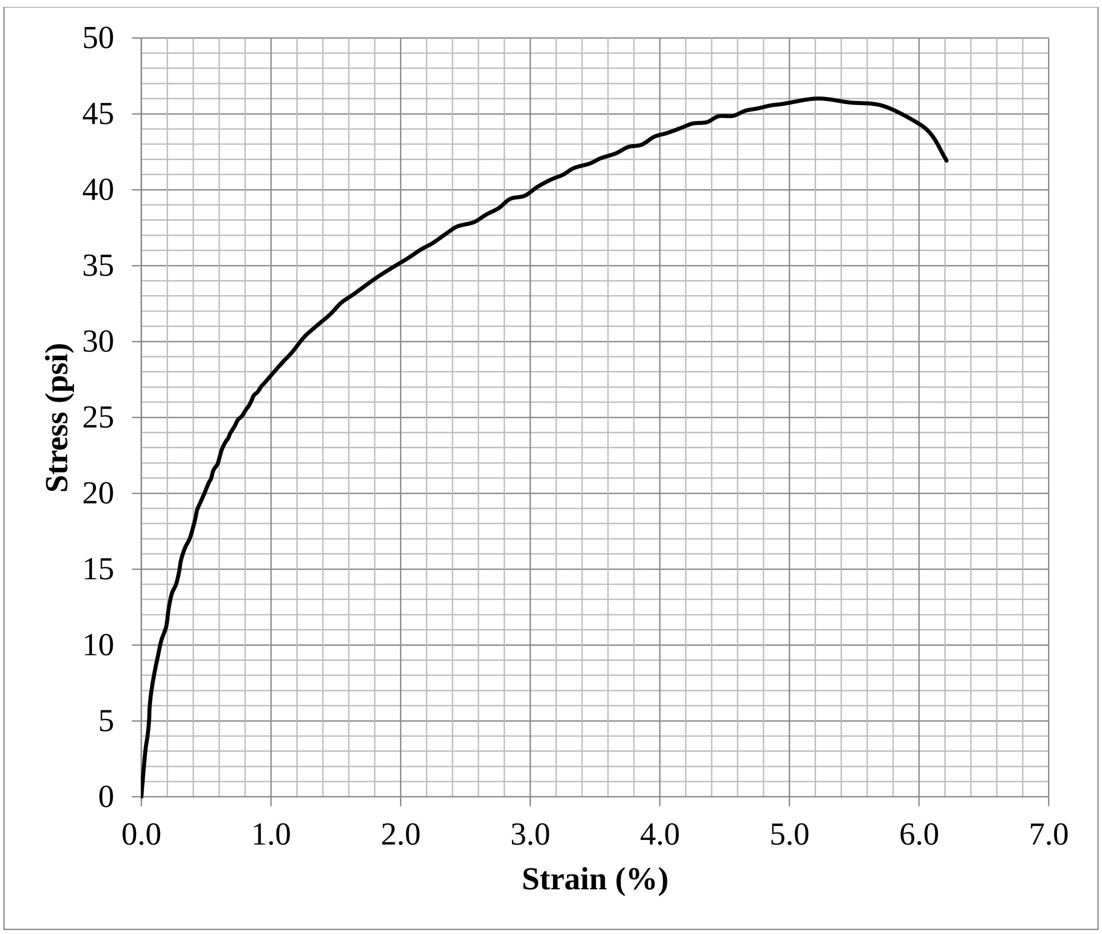
Testing Date	12/7/18
Diameter (in.)	2.030
Height (in.)	3.867
Weight (g)	308.2
Corrected Peak UCS (psi)	45.6
Corrected Failure Strain (%)	6.45
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-1-C
Molding Date	11/27/18
Curing Period (d)	20
α_{I-P} (kg/m^3)	71 (71.1)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.3

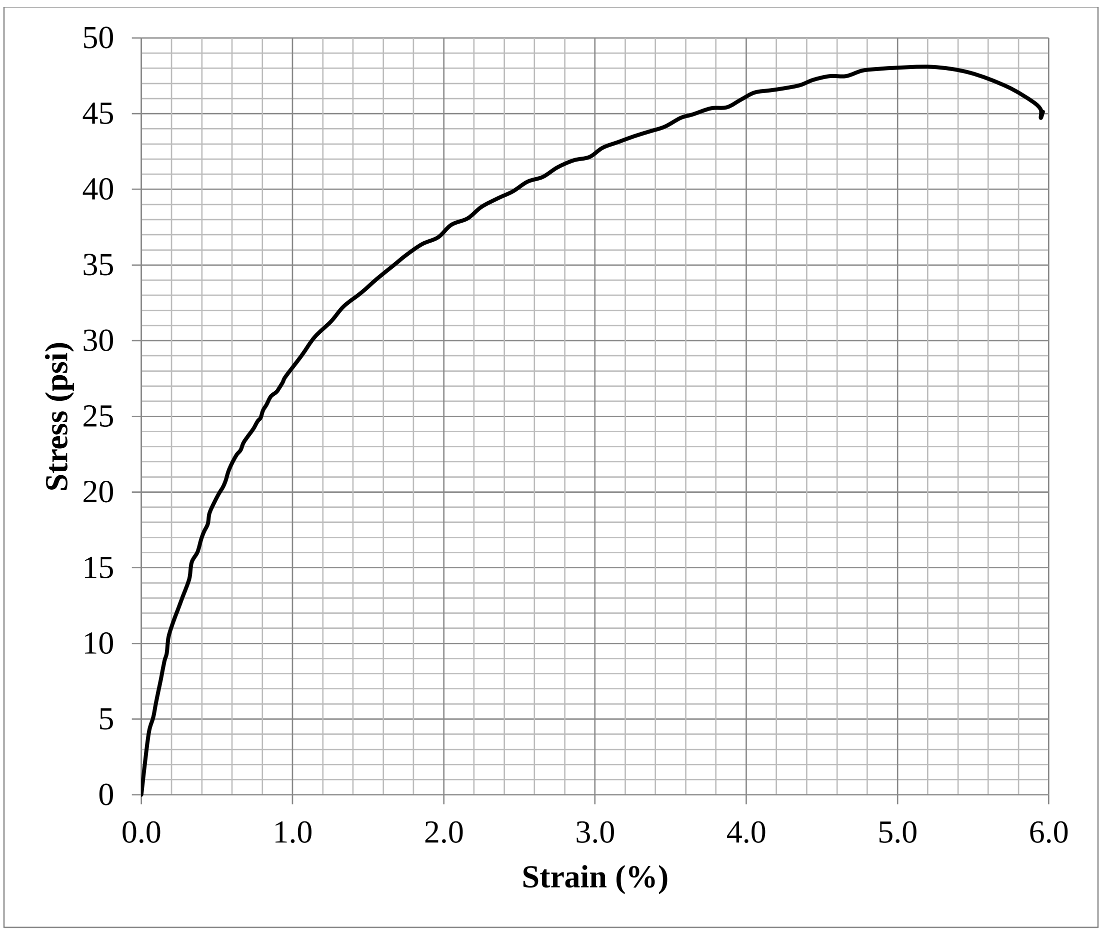
Testing Date	12/17/18
Diameter (in.)	2.034
Height (in.)	3.892
Weight (g)	309.4
Corrected Peak UCS (psi)	45.7
Corrected Failure Strain (%)	5.22
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-1-D
Molding Date	11/27/18
Curing Period (d)	20
α_{I-P} (kg/m^3)	71 (71.1)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0

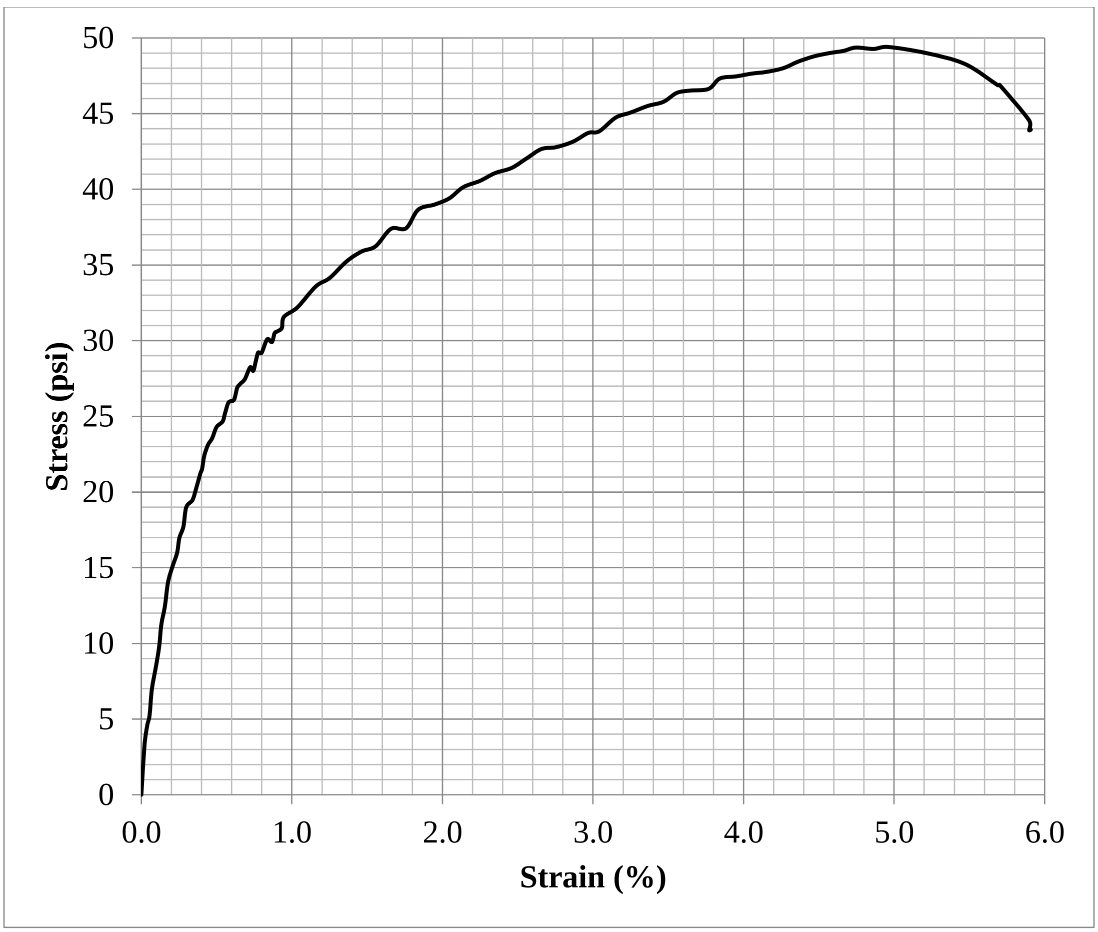
Testing Date	12/17/18
Diameter (in.)	2.026
Height (in.)	3.806
Weight (g)	298.7
Corrected Peak UCS (psi)	47.6
Corrected Failure Strain (%)	5.23
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-1-E
Molding Date	11/27/18
Curing Period (d)	35
α_{I-P} (kg/m^3)	71 (71.1)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.3

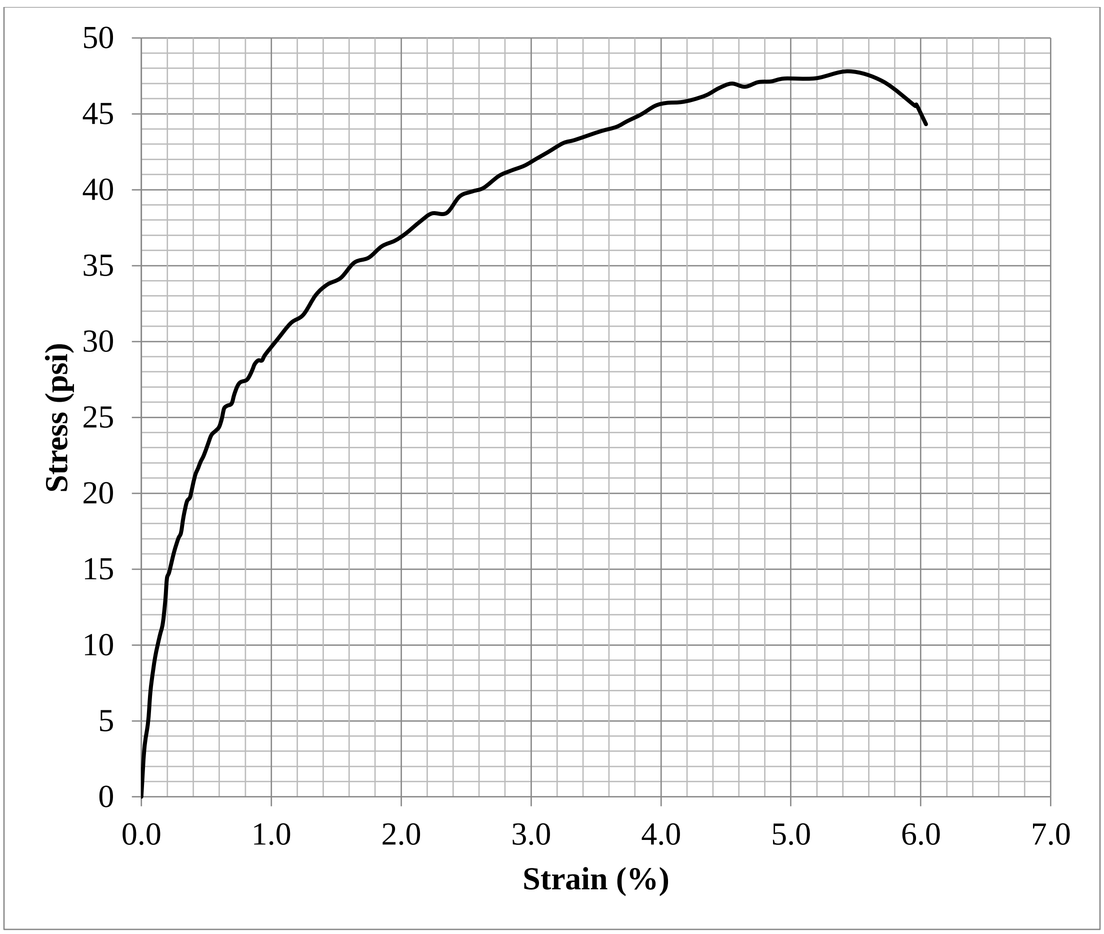
Testing Date	1/1/19
Diameter (in.)	2.031
Height (in.)	3.905
Weight (g)	311.6
Corrected Peak UCS (psi)	49.1
Corrected Failure Strain (%)	4.96
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-1-F
Molding Date	11/27/18
Curing Period (d)	35
α_{I-P} (kg/m^3)	71 (71.1)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.2

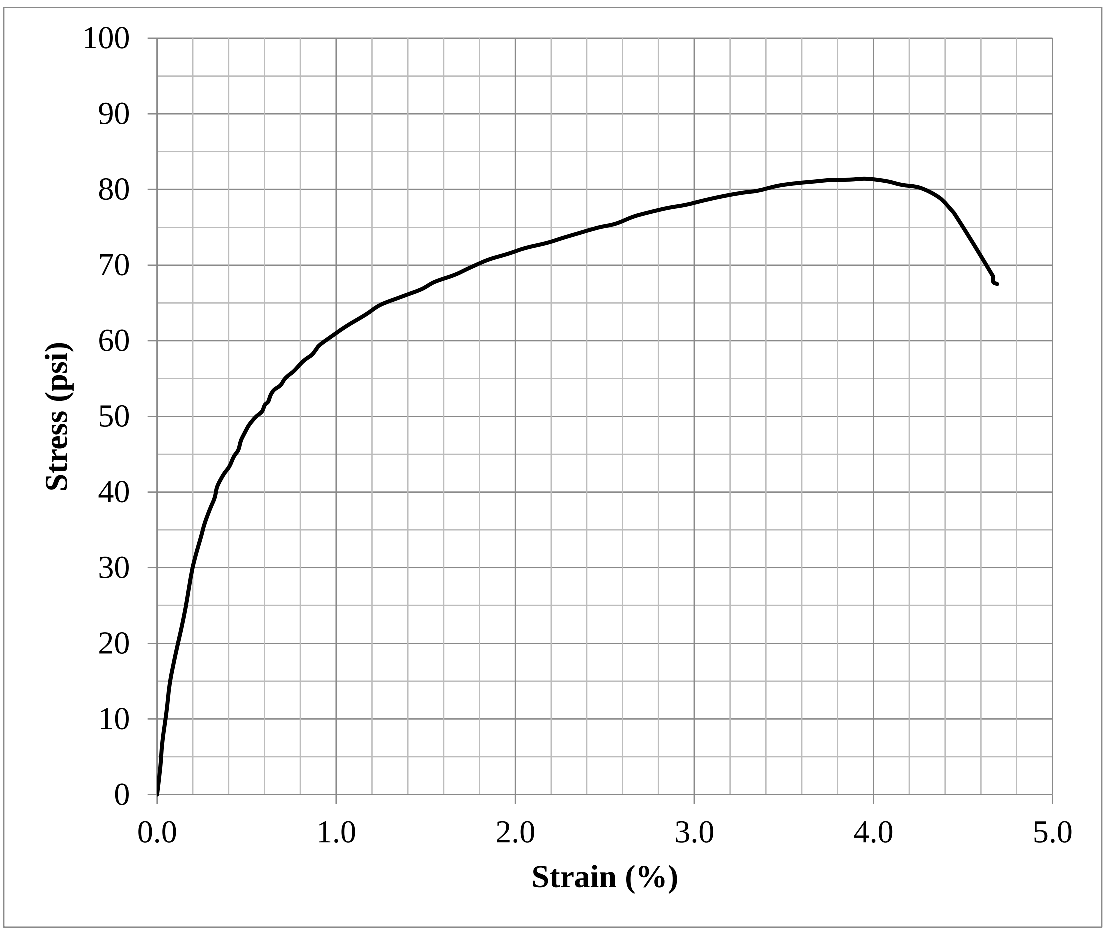
Testing Date	1/1/19
Diameter (in.)	2.037
Height (in.)	3.882
Weight (g)	310.5
Corrected Peak UCS (psi)	47.4
Corrected Failure Strain (%)	5.45
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-2-A
Molding Date	11/28/18
Curing Period (d)	10
α_{I-P} (kg/m^3)	113 (114.4)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0

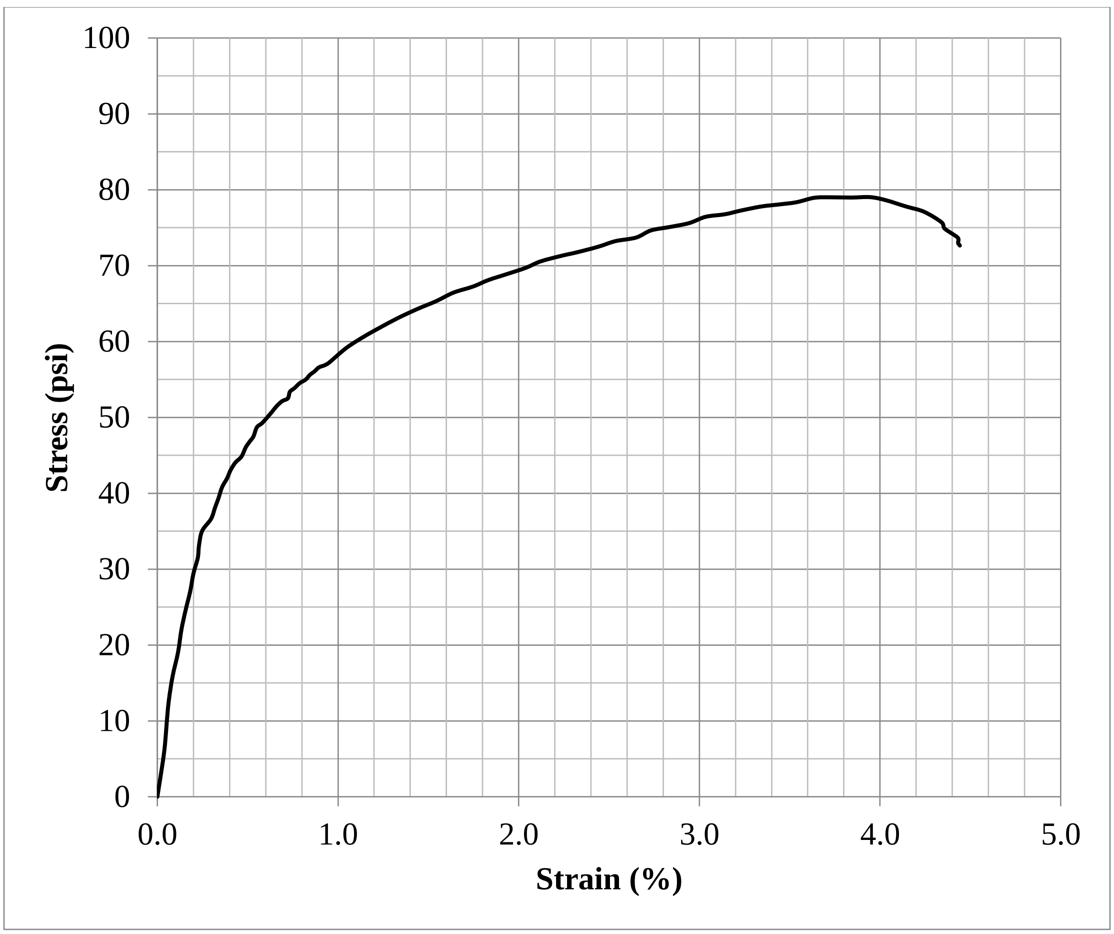
Testing Date	12/7/18
Diameter (in.)	2.037
Height (in.)	3.932
Weight (g)	313.3
Corrected Peak UCS (psi)	81.0
Corrected Failure Strain (%)	3.96
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-2-B
Molding Date	11/28/18
Curing Period (d)	10
α_{I-P} (kg/m^3)	113 (114.4)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0

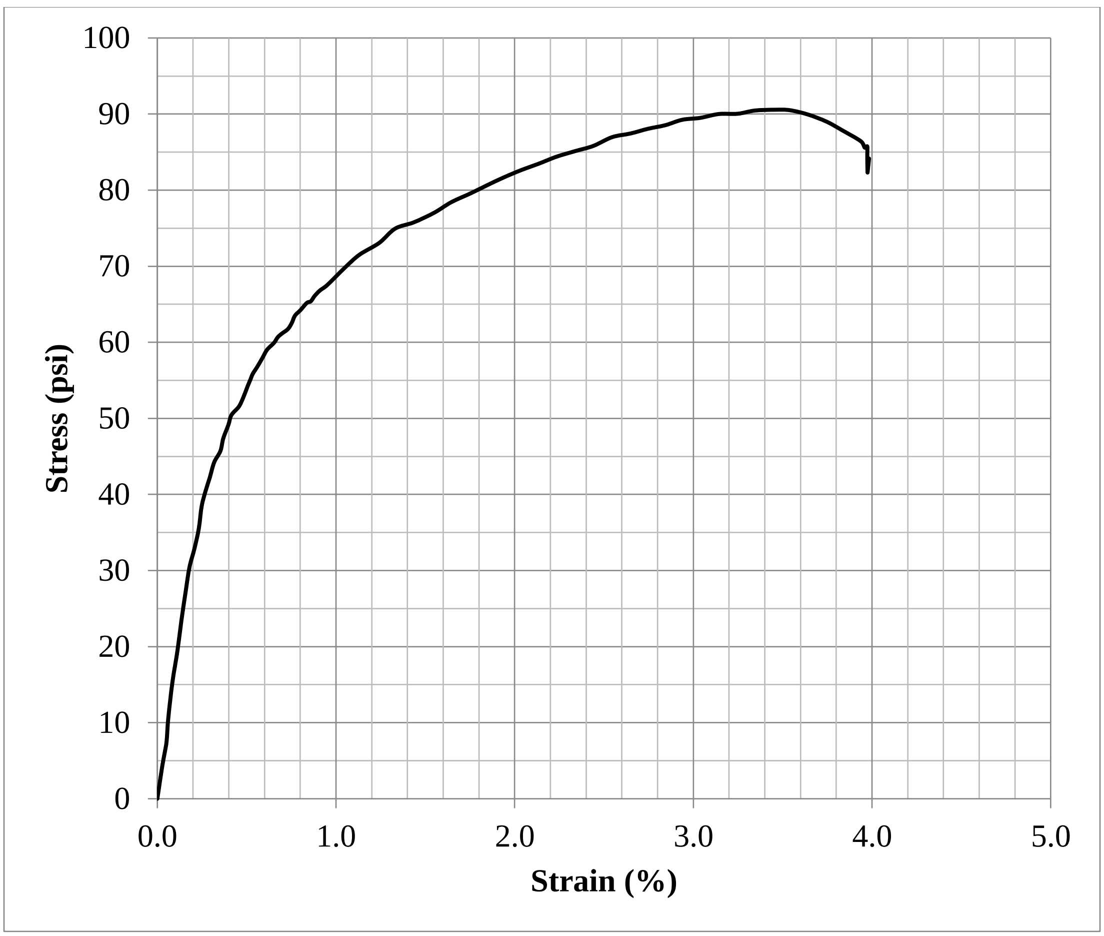
Testing Date	12/7/18
Diameter (in.)	2.038
Height (in.)	3.839
Weight (g)	306.6
Corrected Peak UCS (psi)	78.3
Corrected Failure Strain (%)	3.95
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-2-D
Molding Date	11/28/18
Curing Period (d)	20
α_{I-P} (kg/m^3)	113 (114.4)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.4

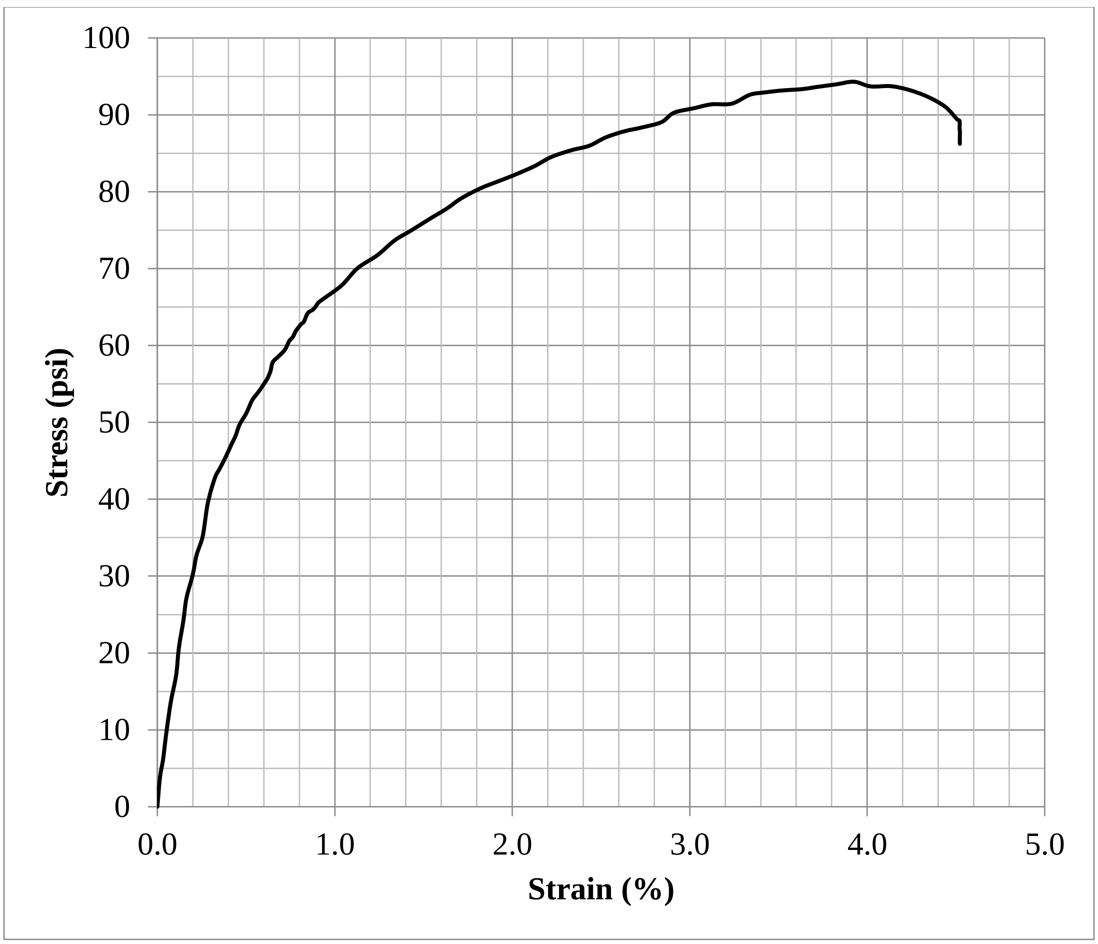
Testing Date	12/18/18
Diameter (in.)	2.030
Height (in.)	3.907
Weight (g)	311.6
Corrected Peak UCS (psi)	90.0
Corrected Failure Strain (%)	3.46
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-2-E
Molding Date	11/28/18
Curing Period (d)	20
α_{I-P} (kg/m^3)	113 (114.4)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.2

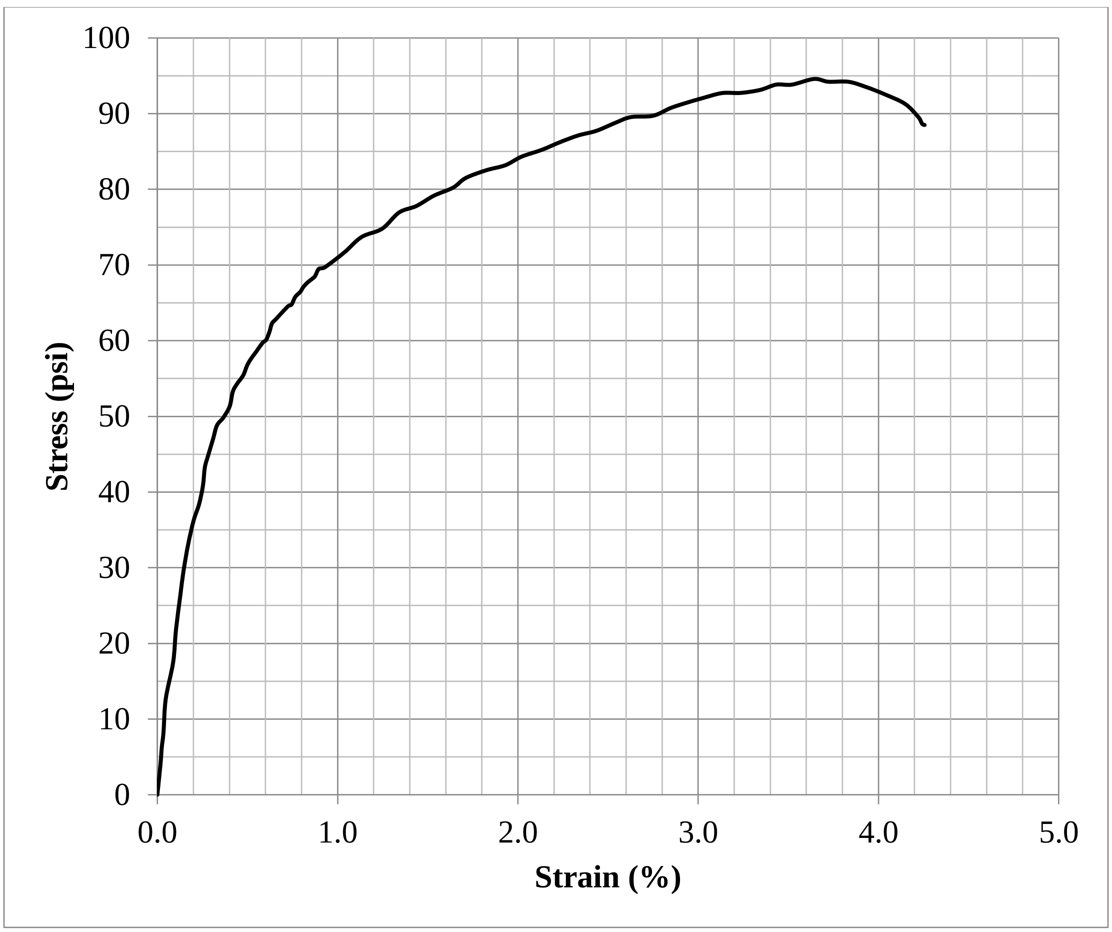
Testing Date	12/18/18
Diameter (in.)	2.035
Height (in.)	3.899
Weight (g)	308.5
Corrected Peak UCS (psi)	93.7
Corrected Failure Strain (%)	3.93
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-2-F
Molding Date	11/28/18
Curing Period (d)	35
$\alpha_{I\text{-}P}$ (kg/m^3)	113 (114.4)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.6

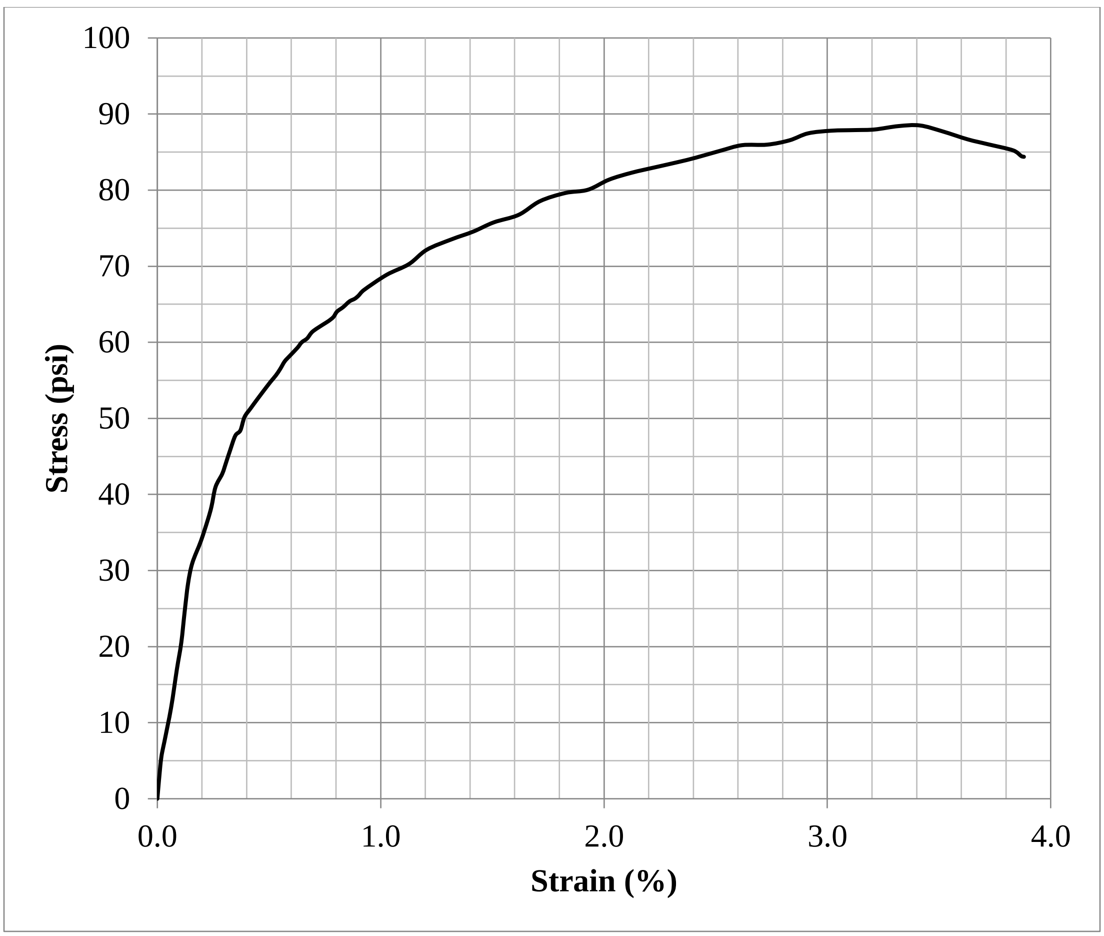
Testing Date	1/1/19
Diameter (in.)	2.033
Height (in.)	3.897
Weight (g)	313.4
Corrected Peak UCS (psi)	94.0
Corrected Failure Strain (%)	3.64
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-2-G
Molding Date	11/28/18
Curing Period (d)	35
α_{I-P} (kg/m^3)	113 (114.4)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.8

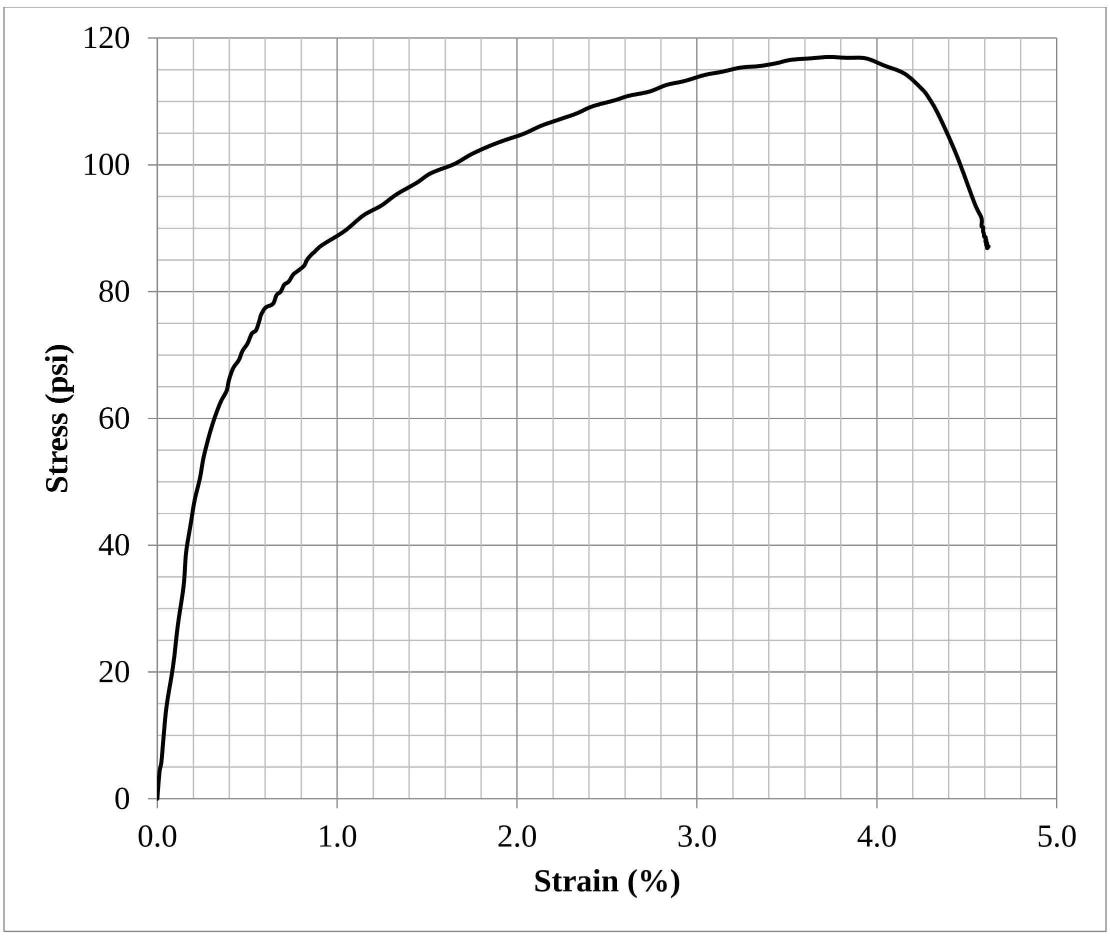
Testing Date	1/1/19
Diameter (in.)	2.035
Height (in.)	3.881
Weight (g)	311.8
Corrected Peak UCS (psi)	87.8
Corrected Failure Strain (%)	3.41
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-3-A
Molding Date	11/28/18
Curing Period (d)	10
α_{I-P} (kg/m^3)	150 (154.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0

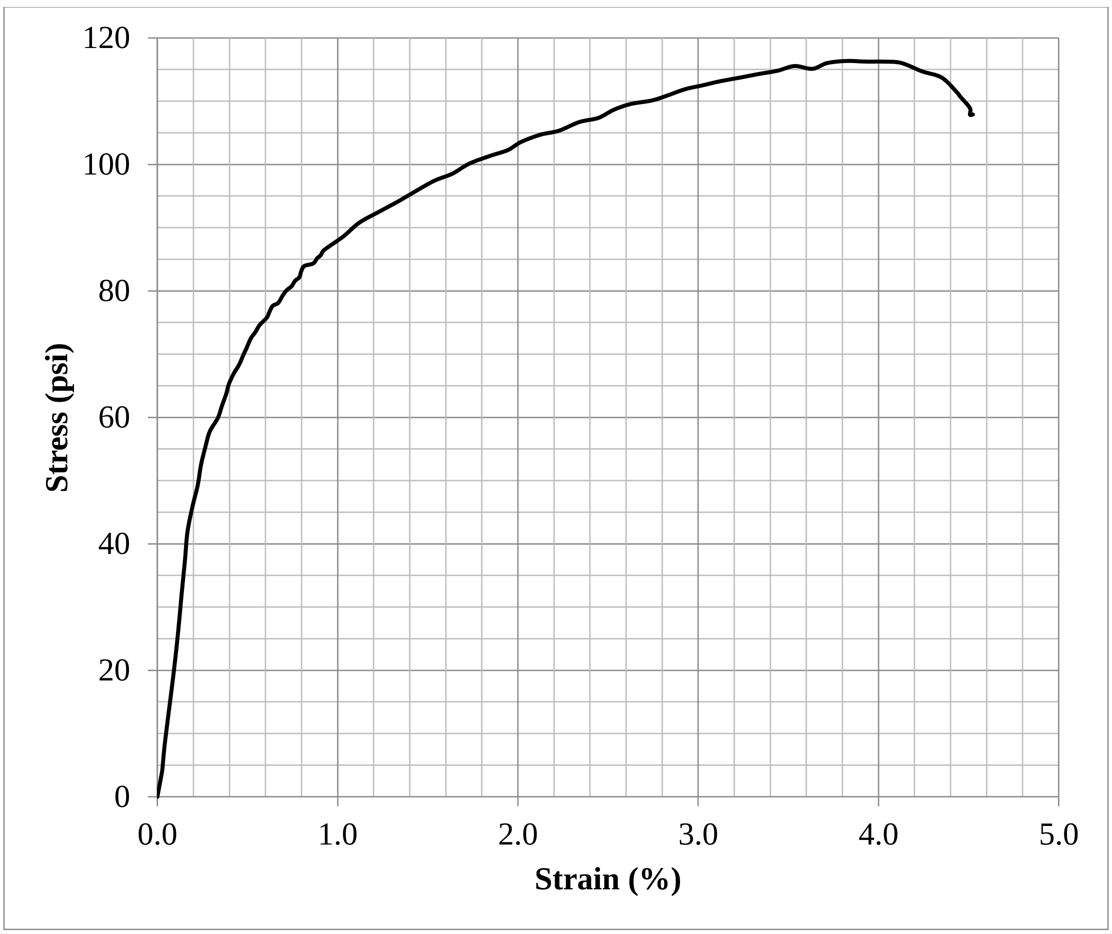
Testing Date	12/7/18
Diameter (in.)	2.028
Height (in.)	3.852
Weight (g)	304.8
Corrected Peak UCS (psi)	116.1
Corrected Failure Strain (%)	3.73
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-3-B
Molding Date	11/28/18
Curing Period (d)	10
α_{I-P} (kg/m^3)	150 (154.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0

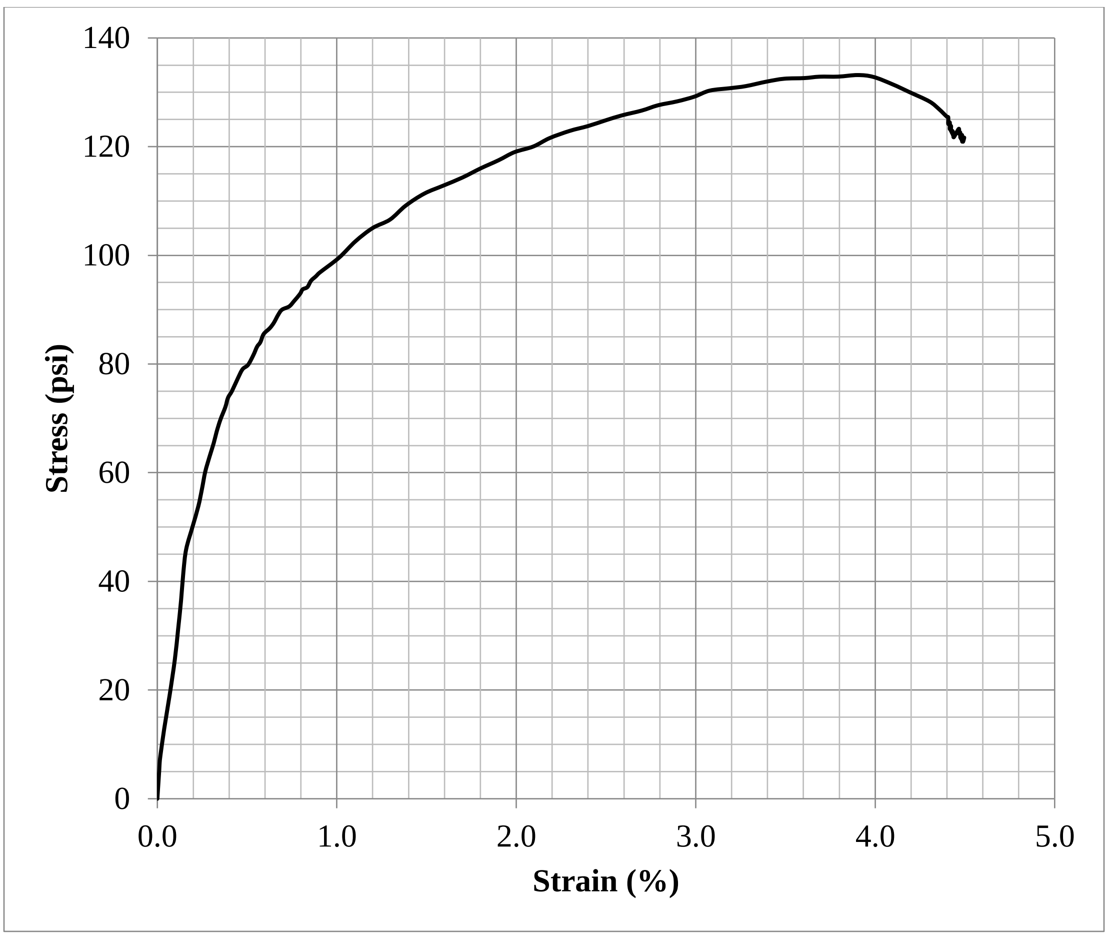
Testing Date	12/8/18
Diameter (in.)	2.033
Height (in.)	3.865
Weight (g)	306.6
Corrected Peak UCS (psi)	115.4
Corrected Failure Strain (%)	3.82
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-3-C
Molding Date	11/28/18
Curing Period (d)	21
α_{I-P} (kg/m^3)	150 (154.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.6

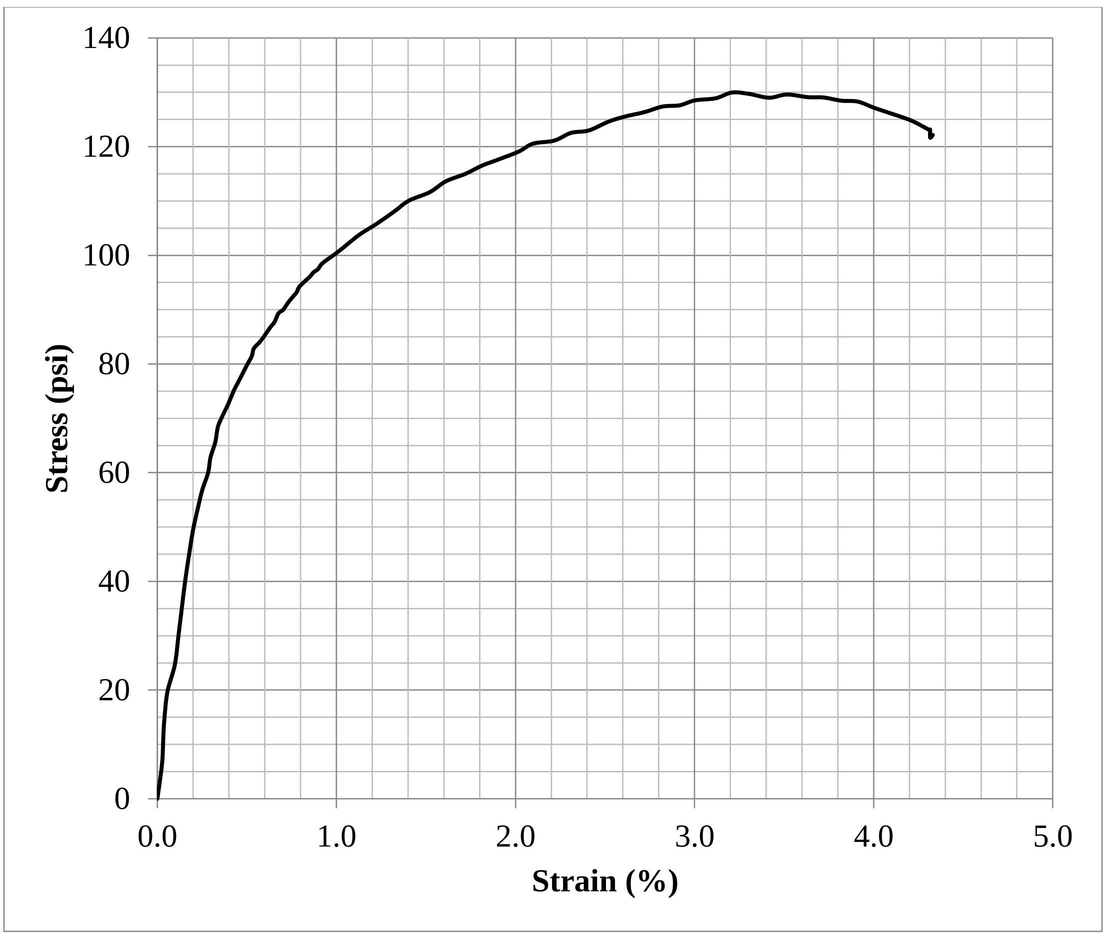
Testing Date	12/18/18
Diameter (in.)	2.038
Height (in.)	3.881
Weight (g)	306.0
Corrected Peak UCS (psi)	132.2
Corrected Failure Strain (%)	3.90
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-3-D
Molding Date	11/28/18
Curing Period (d)	21
α_{I-P} (kg/m^3)	150 (154.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.6

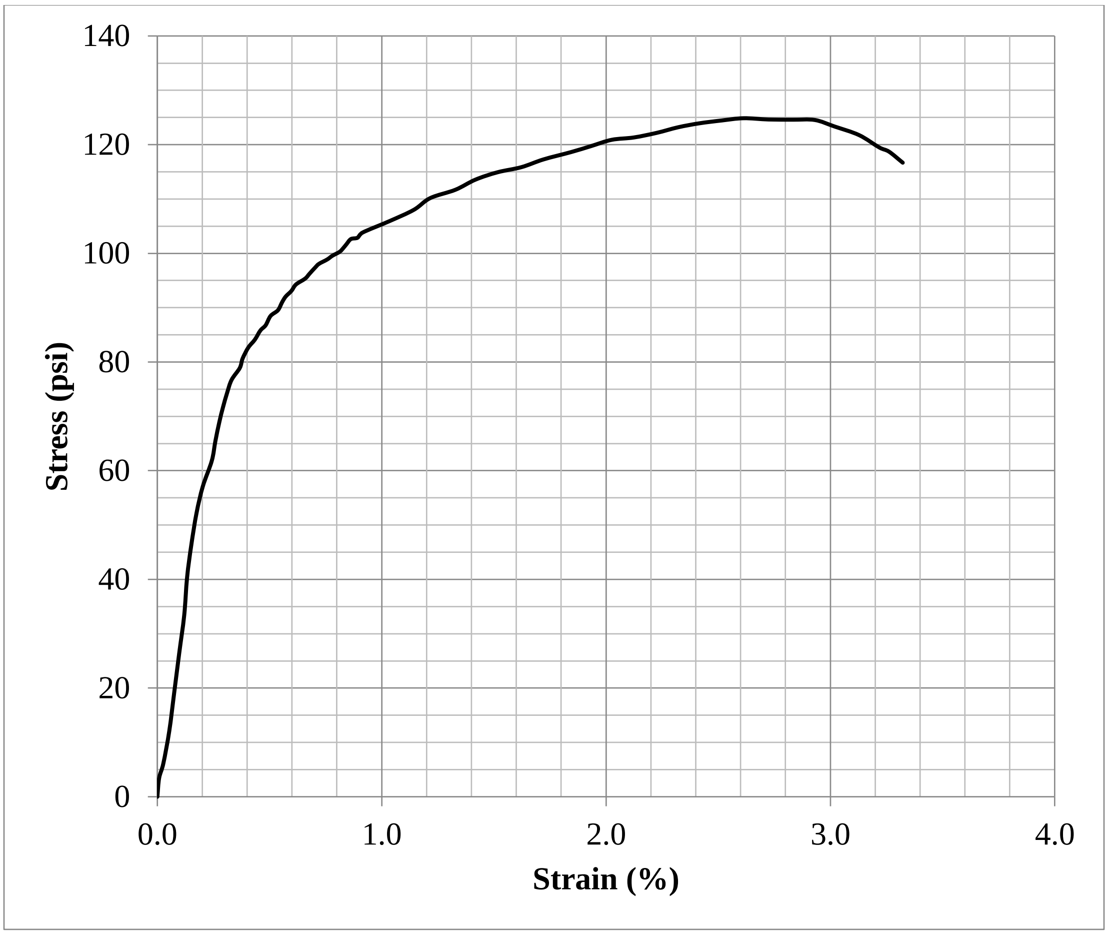
Testing Date	12/18/18
Diameter (in.)	2.035
Height (in.)	3.836
Weight (g)	304.4
Corrected Peak UCS (psi)	128.8
Corrected Failure Strain (%)	3.21
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-3-E
Molding Date	11/28/18
Curing Period (d)	35
α_{I-P} (kg/m^3)	150 (154.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.8

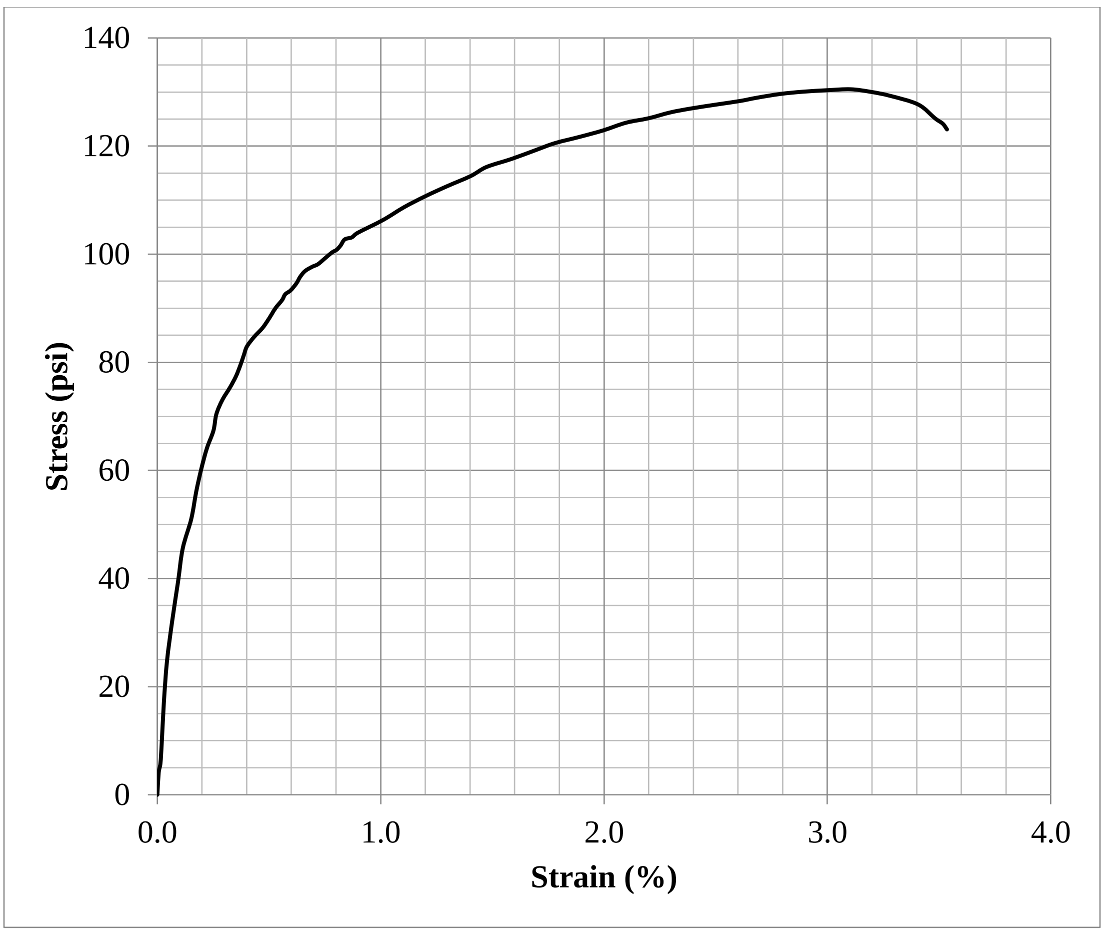
Testing Date	1/1/19
Diameter (in.)	2.038
Height (in.)	3.921
Weight (g)	312.7
Corrected Peak UCS (psi)	124.1
Corrected Failure Strain (%)	2.61
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-3-F
Molding Date	11/28/18
Curing Period (d)	35
α_{I-P} (kg/m^3)	150 (154.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	1.0

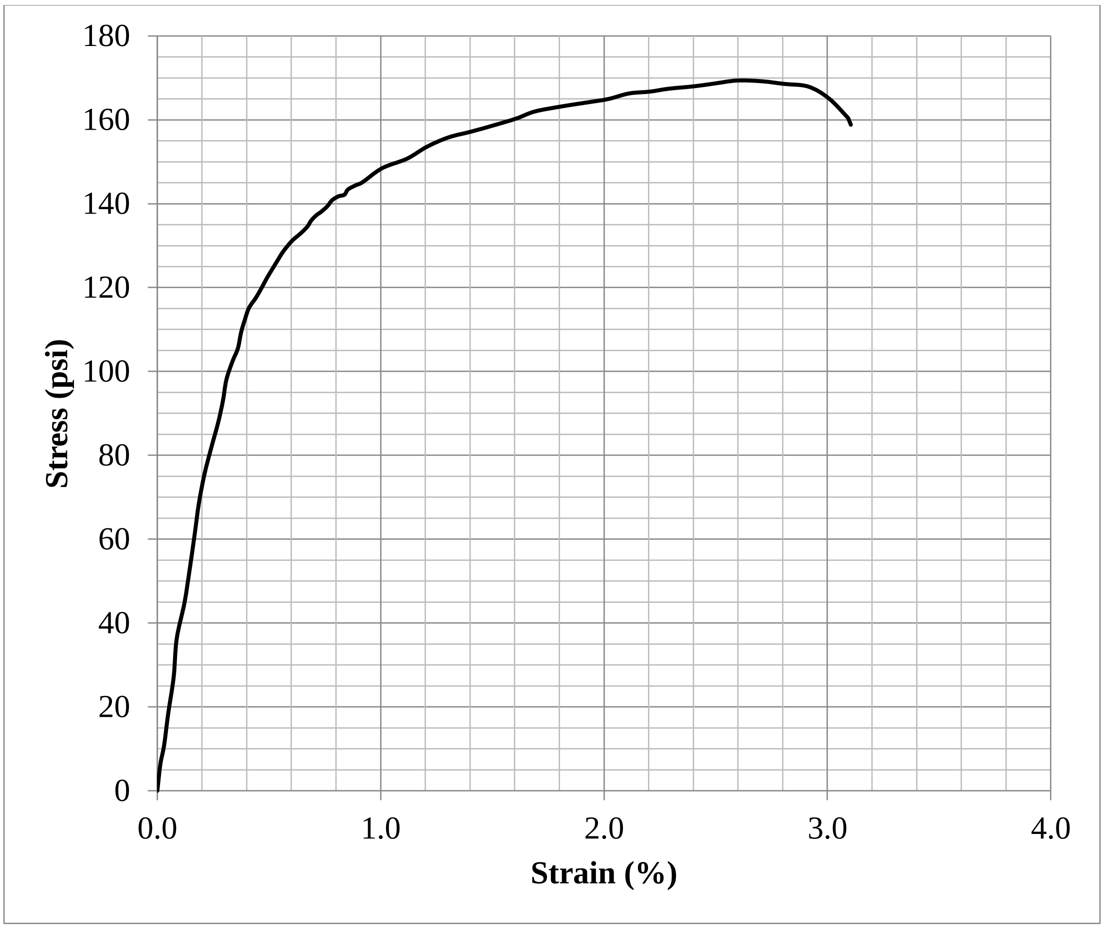
Testing Date	1/1/19
Diameter (in.)	2.036
Height (in.)	3.890
Weight (g)	308.6
Corrected Peak UCS (psi)	129.6
Corrected Failure Strain (%)	3.10
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-4-A
Molding Date	4/17/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (253.2)
w:b	1.2
Soil OM (%)	15.0
Bleed Water (g)	0.1

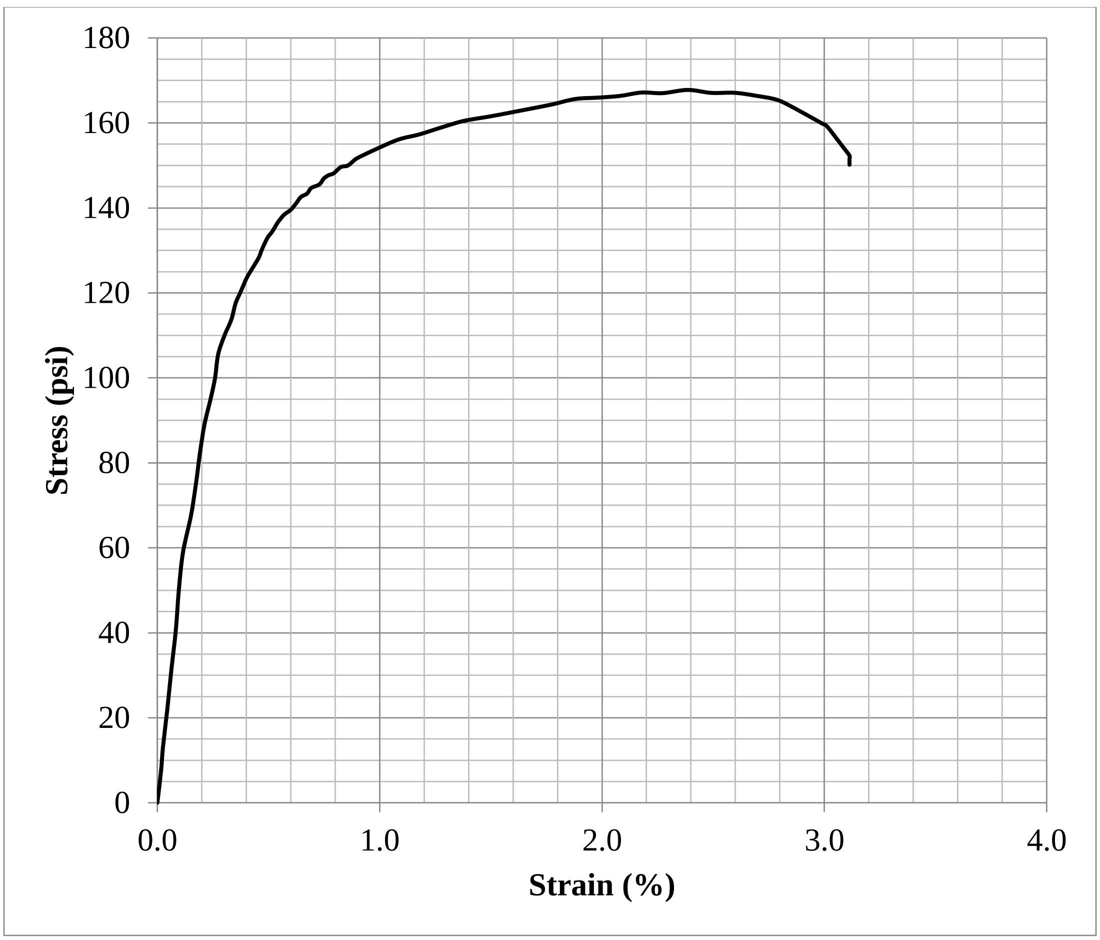
Testing Date	4/23/19
Diameter (in.)	2.043
Height (in.)	3.957
Weight (g)	312.8
Corrected Peak UCS (psi)	168.5
Corrected Failure Strain (%)	2.60
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-4-B
Molding Date	4/17/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (253.2)
w:b	1.2
Soil OM (%)	15.0
Bleed Water (g)	0.1

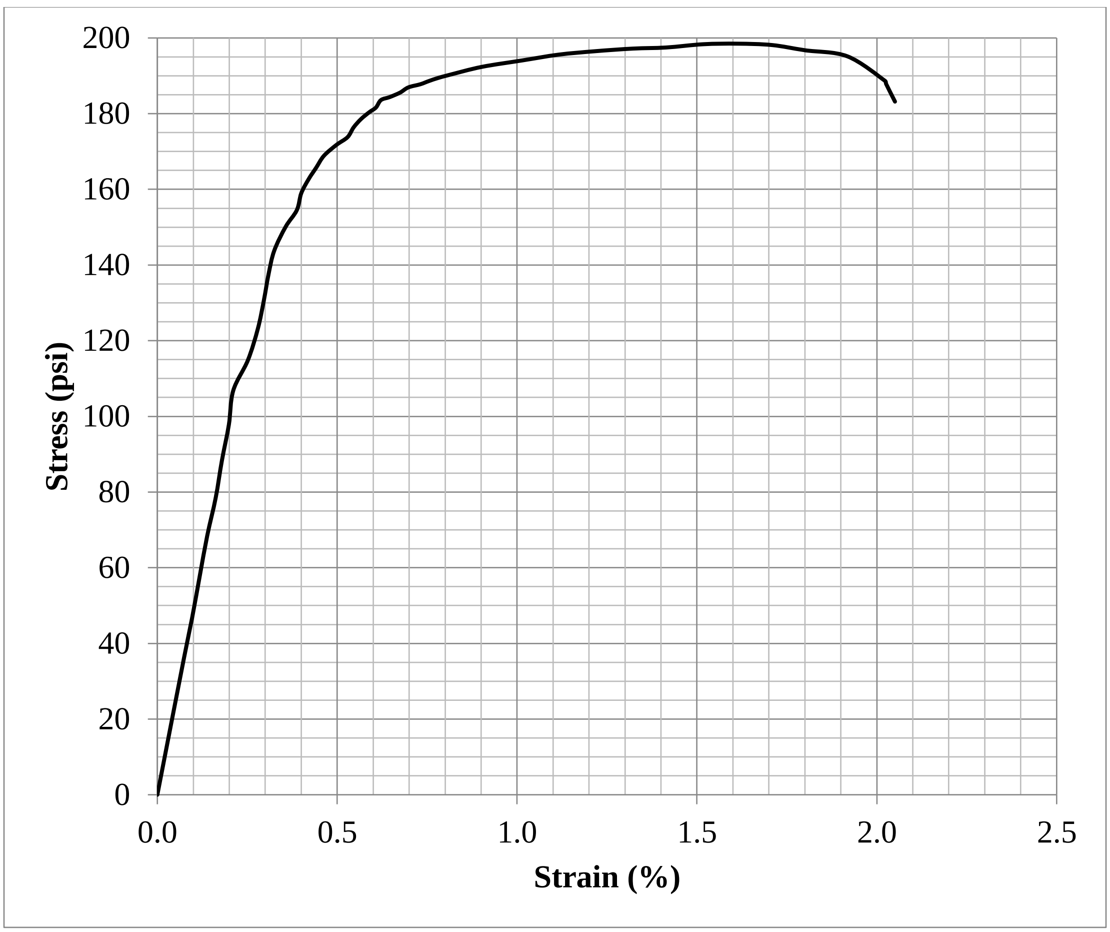
Testing Date	4/23/19
Diameter (in.)	2.045
Height (in.)	3.983
Weight (g)	317.4
Corrected Peak UCS (psi)	167.1
Corrected Failure Strain (%)	2.39
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-4-C
Molding Date	4/17/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (253.2)
w:b	1.2
Soil OM (%)	15.0
Bleed Water (g)	0.1

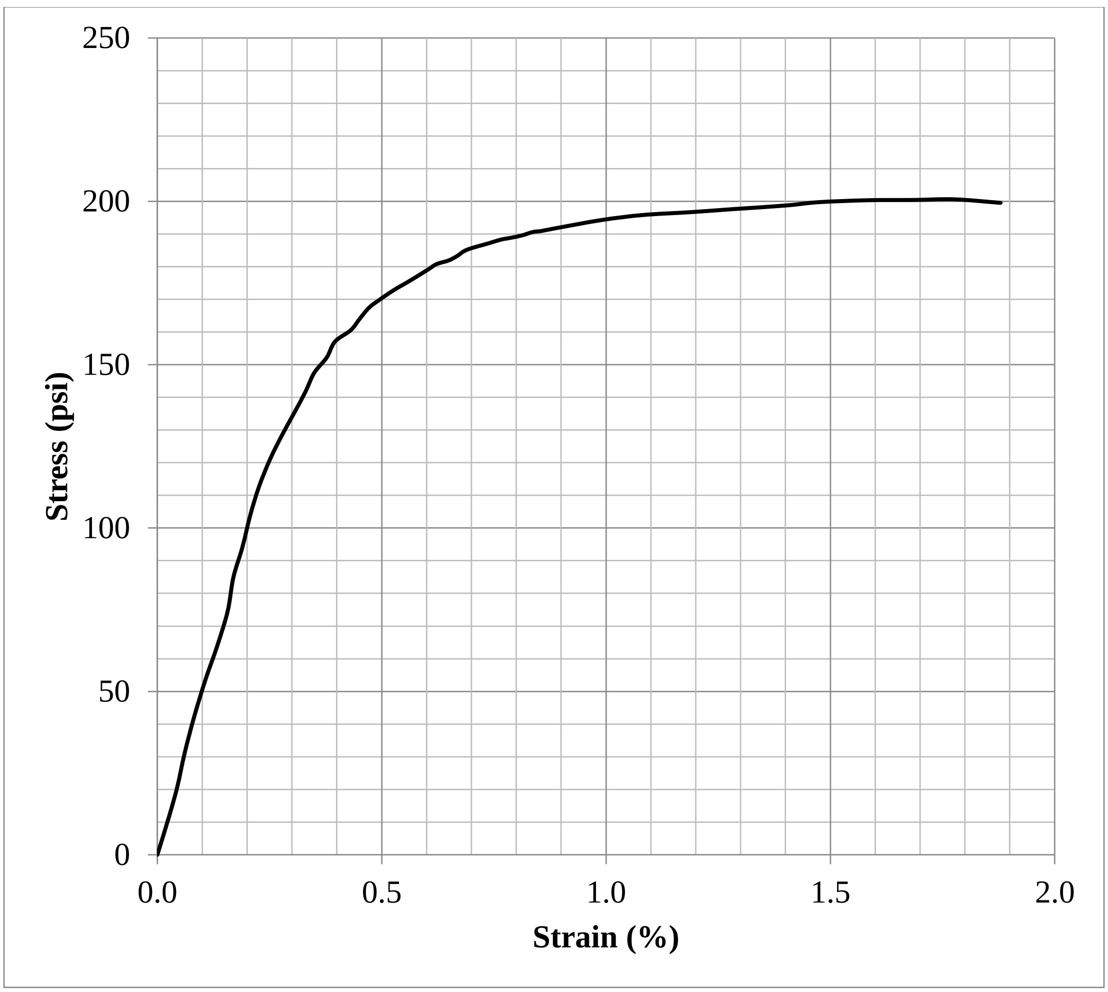
Testing Date	4/30/19
Diameter (in.)	2.047
Height (in.)	3.672
Weight (g)	293.8
Corrected Peak UCS (psi)	195.2
Corrected Failure Strain (%)	1.61
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-4-D
Molding Date	4/17/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (253.2)
w:b	1.2
Soil OM (%)	15.0
Bleed Water (g)	0.1

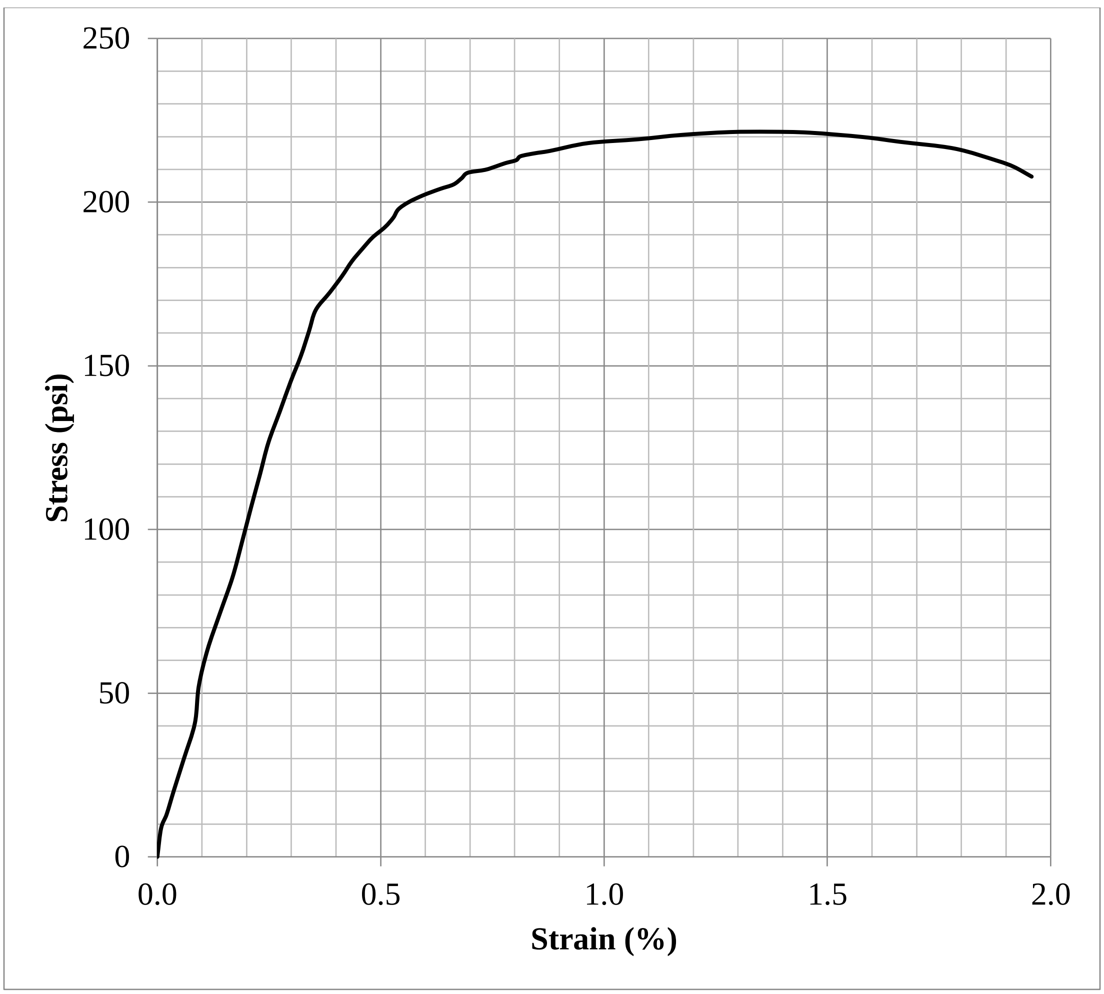
Testing Date	4/30/19
Diameter (in.)	2.048
Height (in.)	3.974
Weight (g)	317.8
Corrected Peak UCS (psi)	199.7
Corrected Failure Strain (%)	1.78
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-4-E
Molding Date	4/17/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (253.2)
w:b	1.2
Soil OM (%)	15.0
Bleed Water (g)	0.3

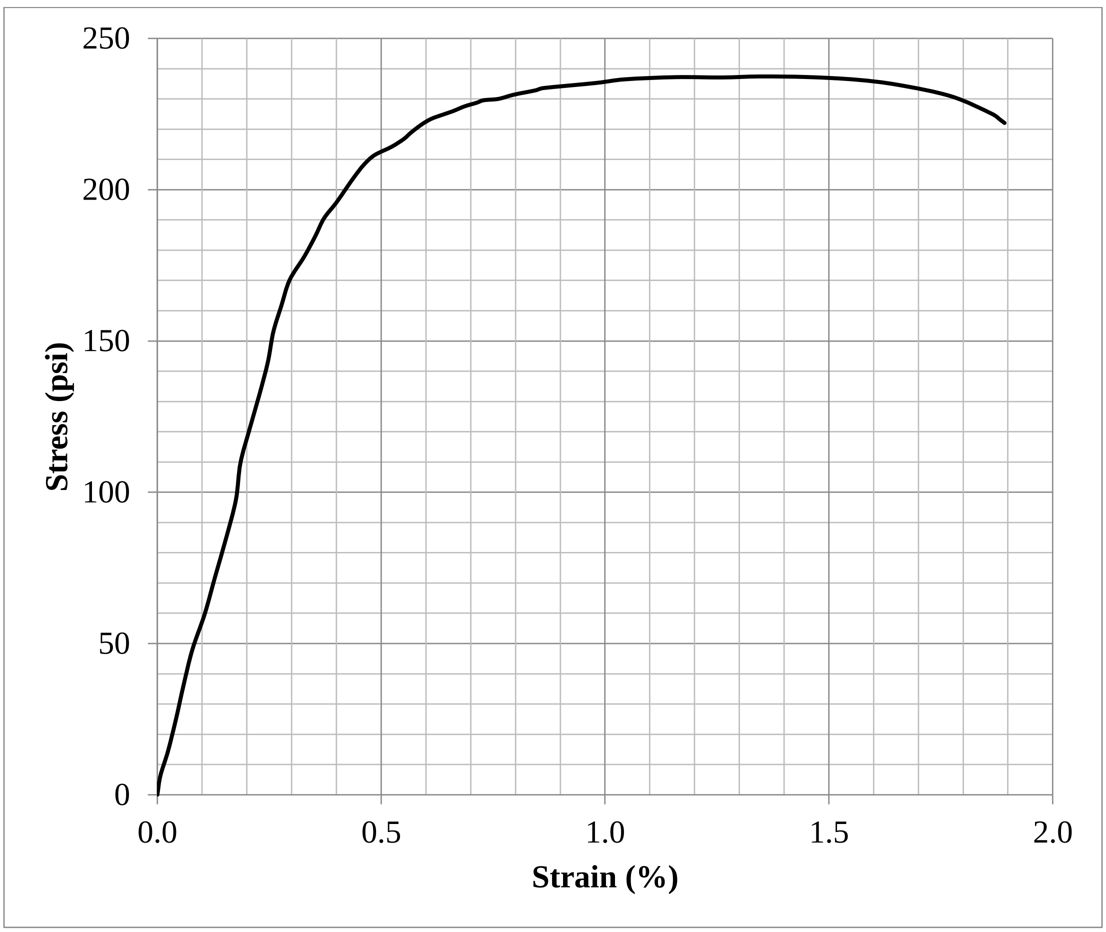
Testing Date	5/14/19
Diameter (in.)	2.050
Height (in.)	3.821
Weight (g)	304.6
Corrected Peak UCS (psi)	219.1
Corrected Failure Strain (%)	1.37
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-4-F
Molding Date	4/17/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (253.2)
w:b	1.2
Soil OM (%)	15.0
Bleed Water (g)	0.1

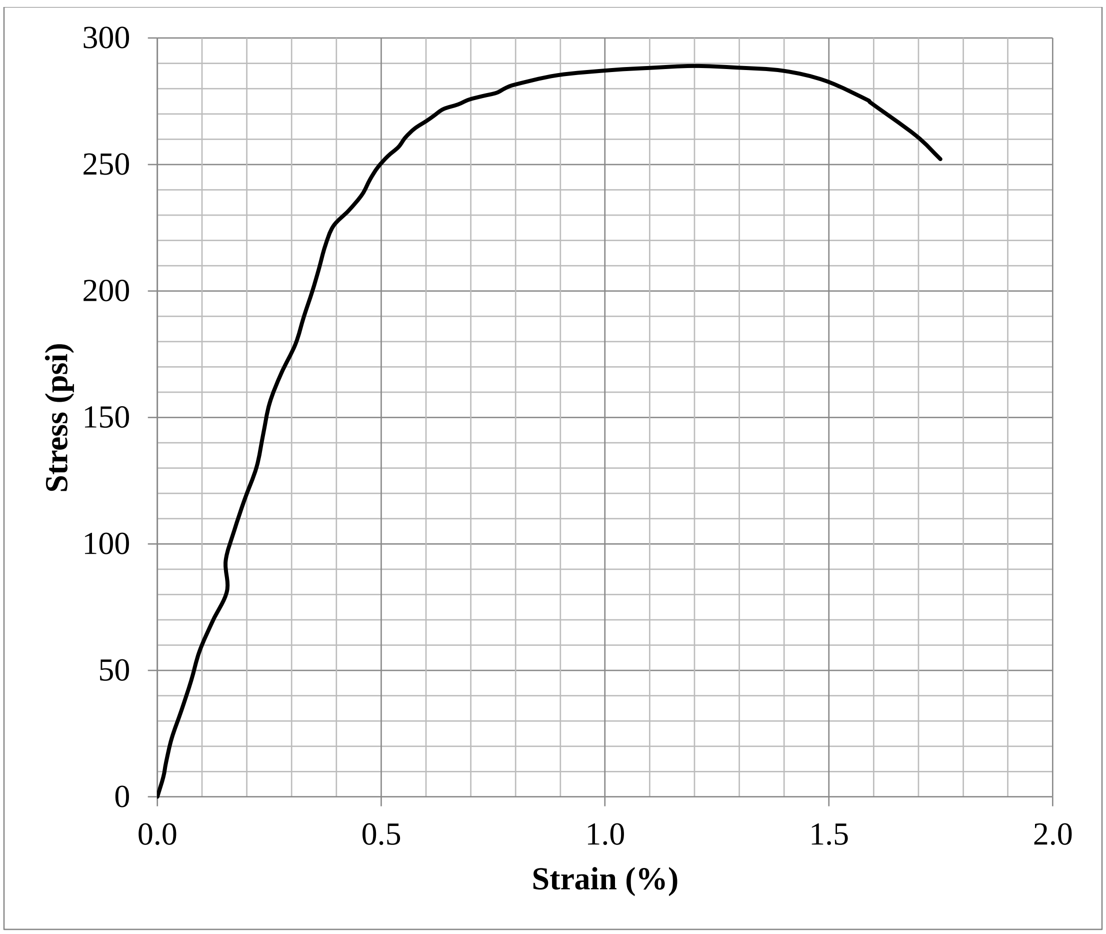
Testing Date	5/14/19
Diameter (in.)	2.050
Height (in.)	3.958
Weight (g)	317.4
Corrected Peak UCS (psi)	236.1
Corrected Failure Strain (%)	1.35
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-5-A
Molding Date	4/17/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (352.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.1

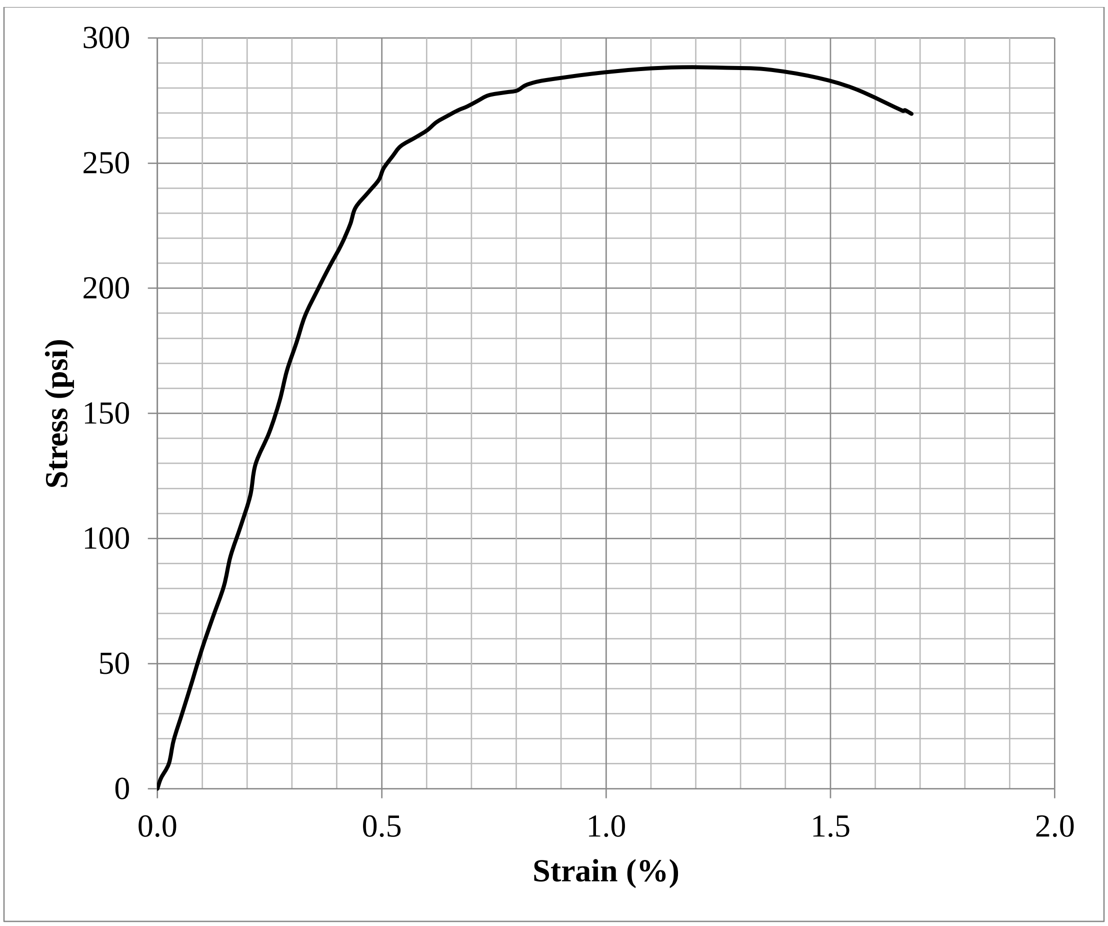
Testing Date	4/23/19
Diameter (in.)	2.047
Height (in.)	3.891
Weight (g)	314.5
Corrected Peak UCS (psi)	286.6
Corrected Failure Strain (%)	1.20
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-5-B
Molding Date	4/17/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	350 (352.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.1

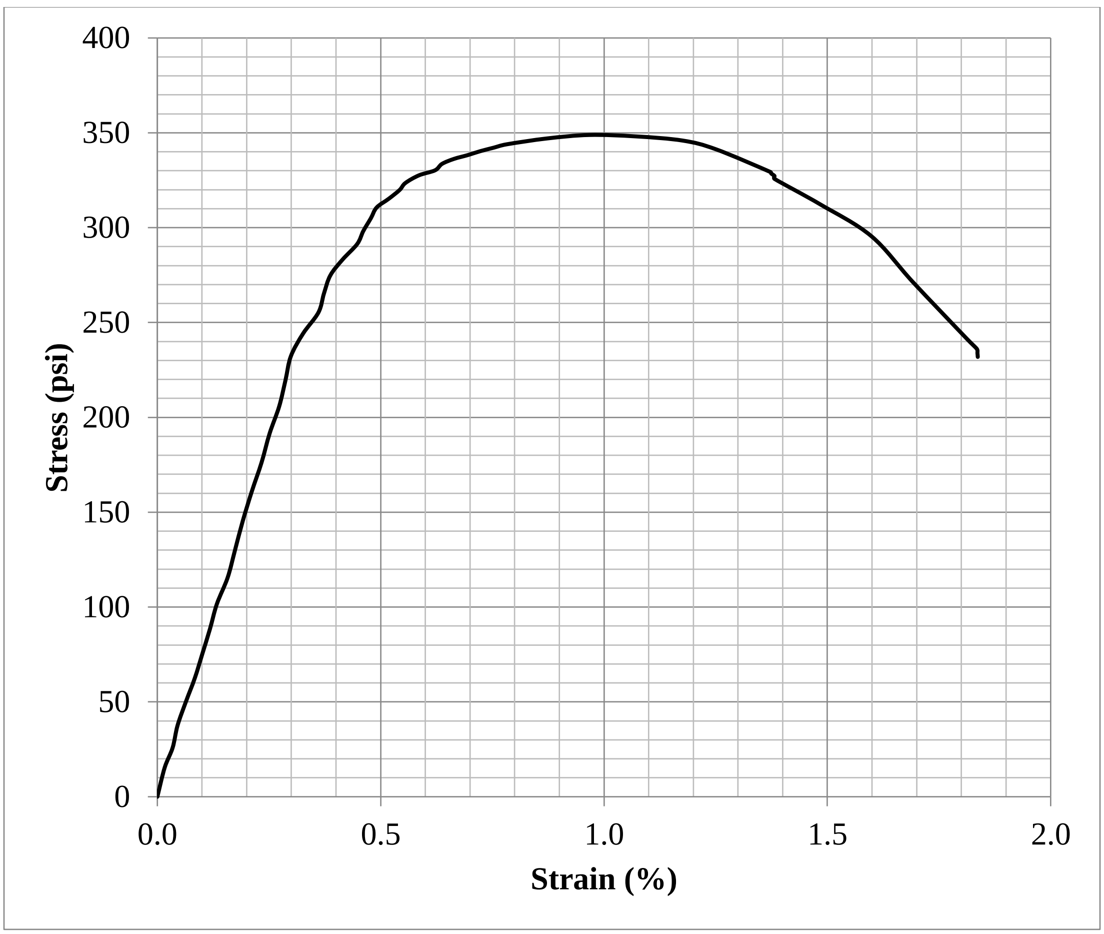
Testing Date	4/24/19
Diameter (in.)	2.050
Height (in.)	3.963
Weight (g)	321.4
Corrected Peak UCS (psi)	286.8
Corrected Failure Strain (%)	1.17
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-5-C
Molding Date	4/17/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	350 (352.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.1

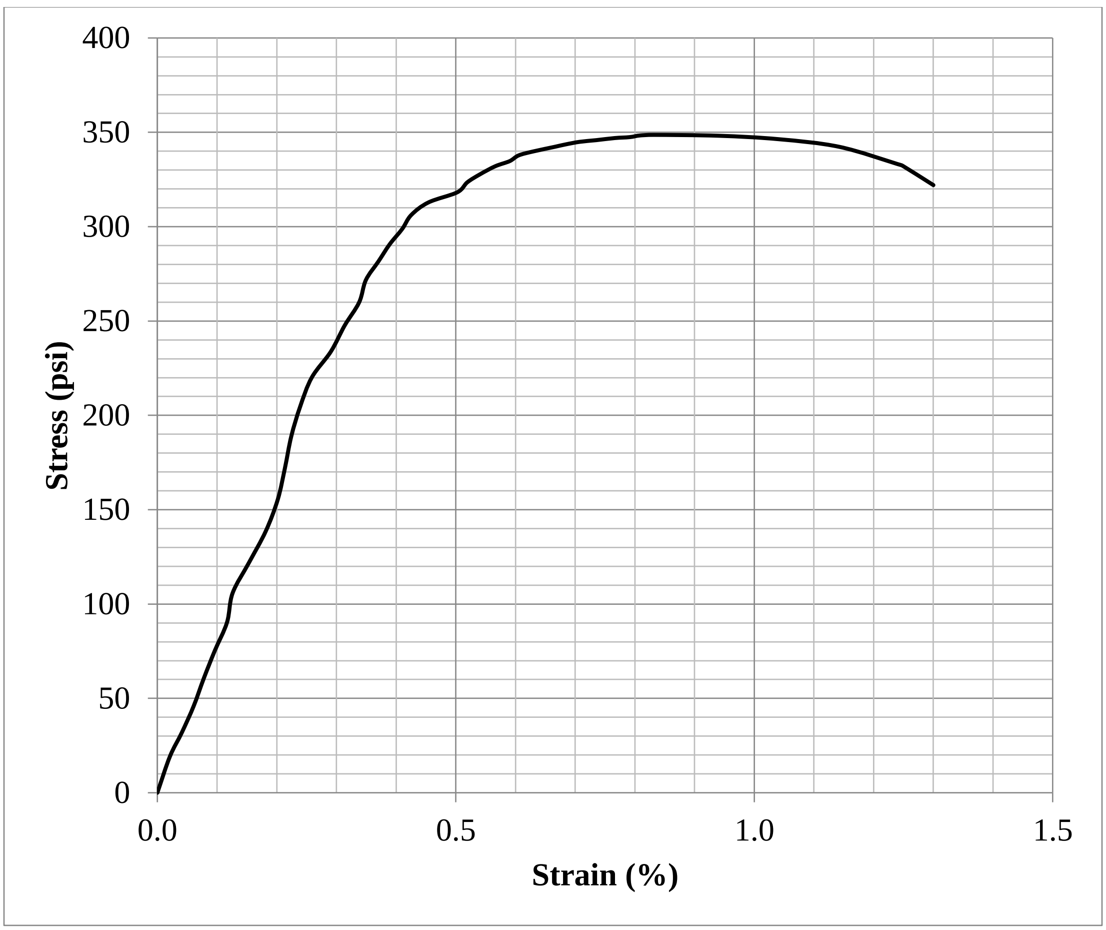
Testing Date	4/30/19
Diameter (in.)	2.050
Height (in.)	3.625
Weight (g)	295.1
Corrected Peak UCS (psi)	342.4
Corrected Failure Strain (%)	0.97
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-5-D
Molding Date	4/17/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (352.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.1

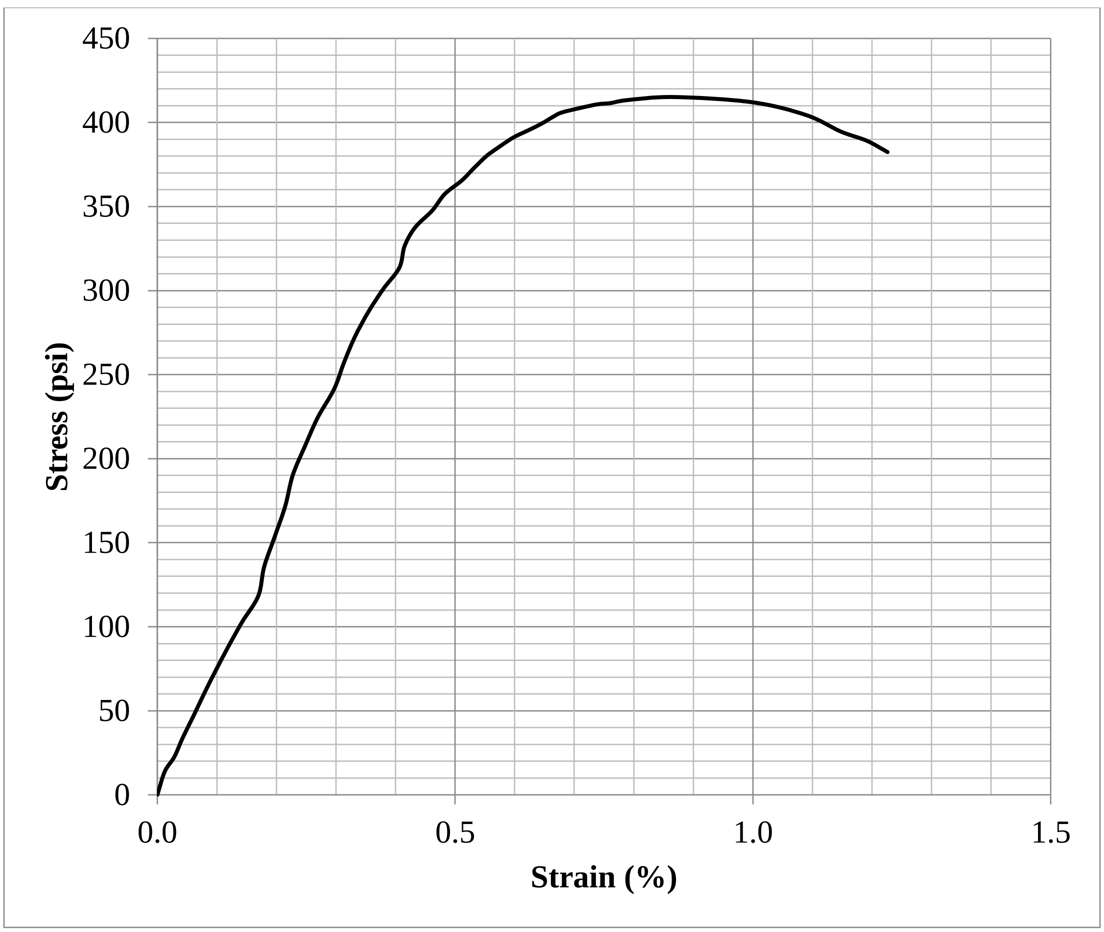
Testing Date	5/1/19
Diameter (in.)	2.053
Height (in.)	3.998
Weight (g)	327.2
Corrected Peak UCS (psi)	347.2
Corrected Failure Strain (%)	0.83
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-5-E
Molding Date	4/17/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	350 (352.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.5

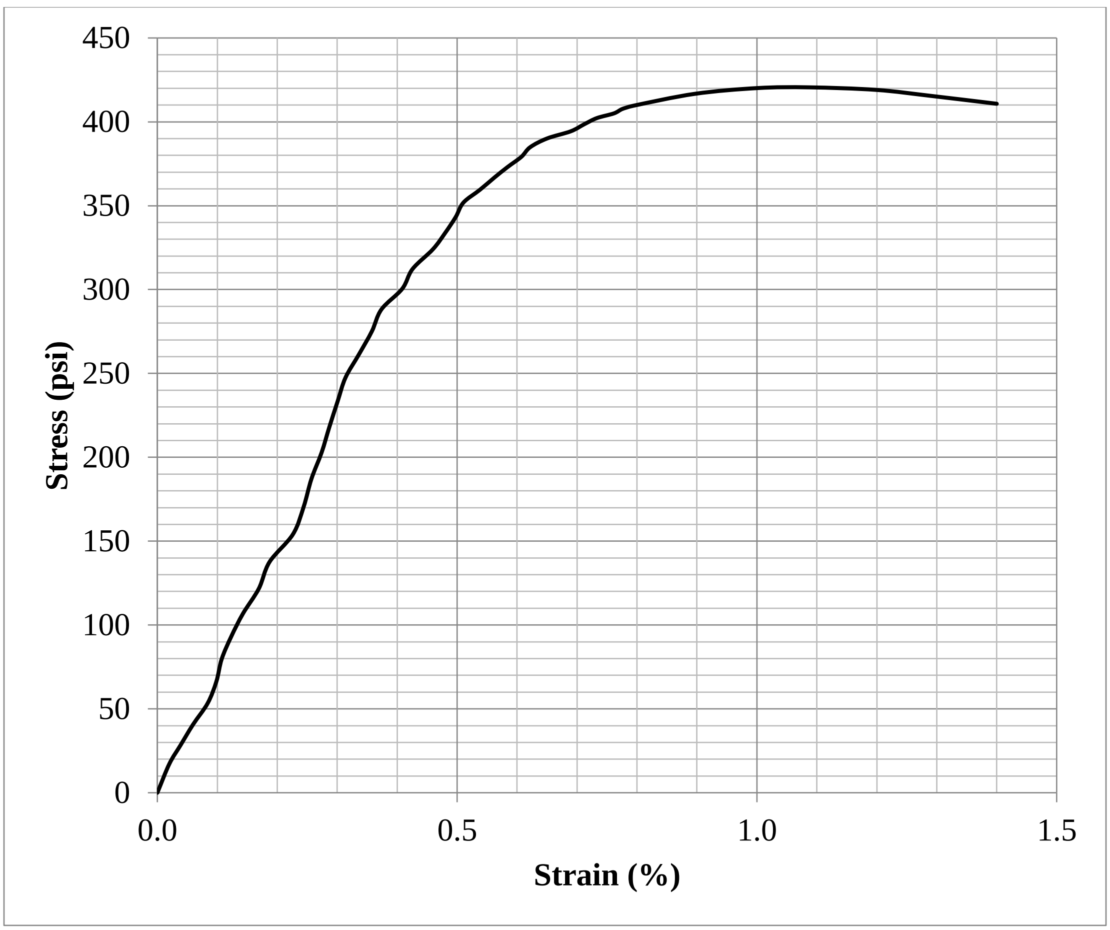
Testing Date	5/14/19
Diameter (in.)	2.050
Height (in.)	3.830
Weight (g)	314.1
Corrected Peak UCS (psi)	410.8
Corrected Failure Strain (%)	0.87
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-5-F
Molding Date	4/17/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	350 (352.5)
w:b	1.0
Soil OM (%)	15.0
Bleed Water (g)	0.4

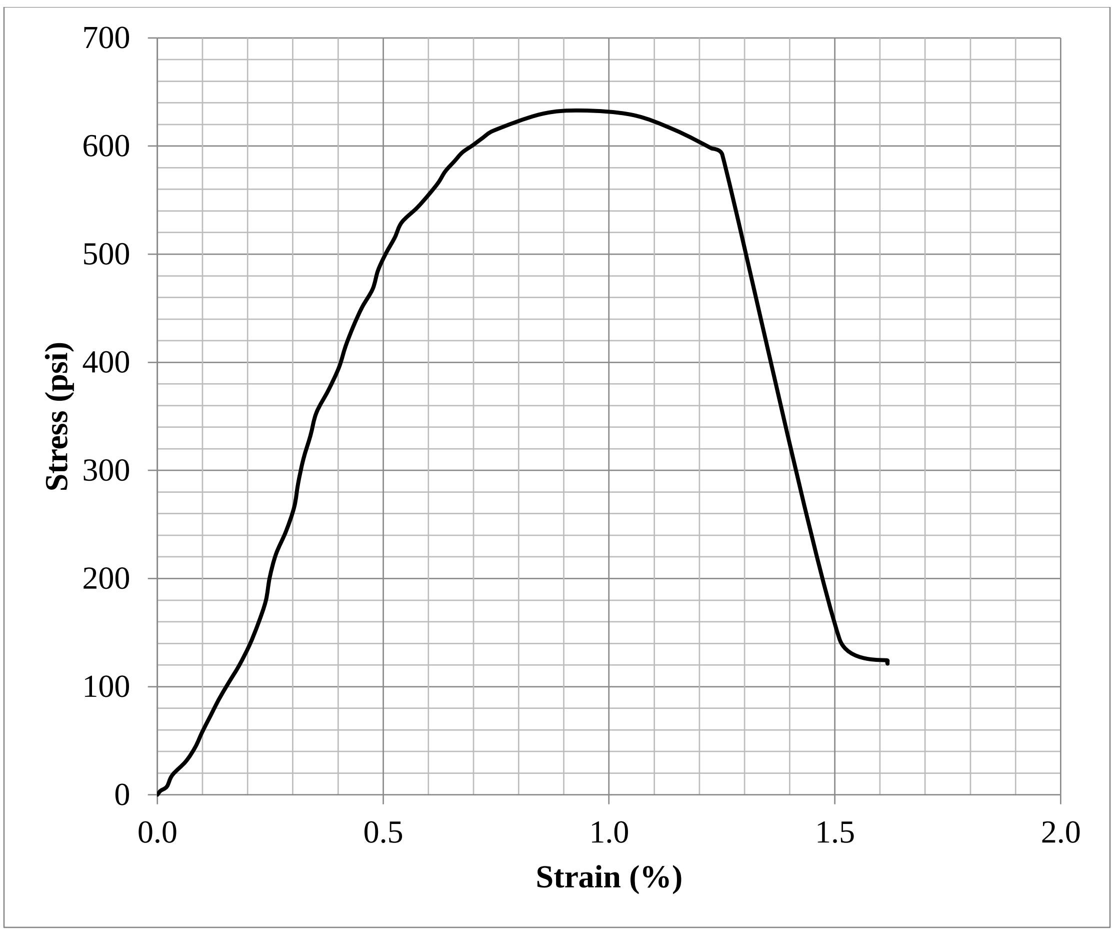
Testing Date	5/14/19
Diameter (in.)	2.047
Height (in.)	3.772
Weight (g)	307.0
Corrected Peak UCS (psi)	415.3
Corrected Failure Strain (%)	1.09
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-6-A
Molding Date	4/17/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	0.1

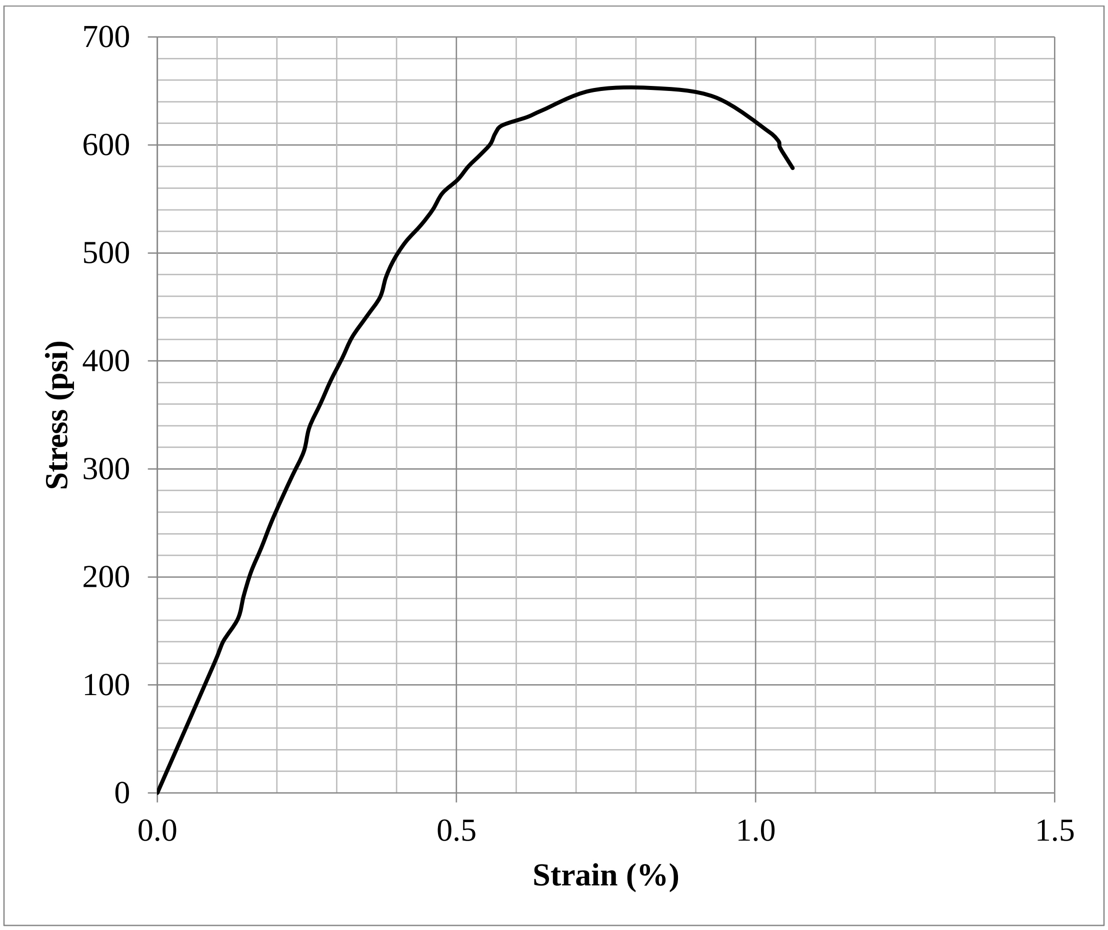
Testing Date	4/24/19
Diameter (in.)	2.039
Height (in.)	3.958
Weight (g)	332.8
Corrected Peak UCS (psi)	630.0
Corrected Failure Strain (%)	0.94
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-6-B
Molding Date	4/17/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	0

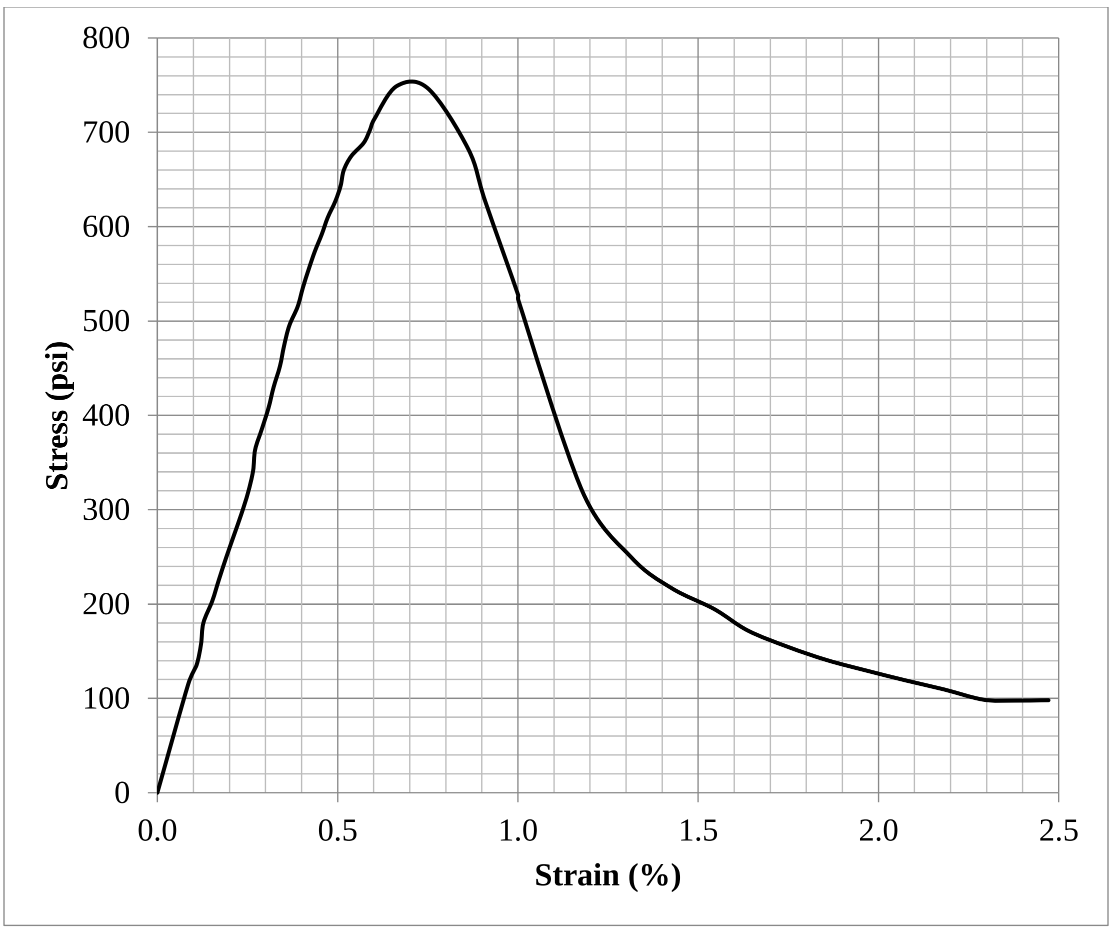
Testing Date	4/24/19
Diameter (in.)	2.036
Height (in.)	3.860
Weight (g)	323.2
Corrected Peak UCS (psi)	647.3
Corrected Failure Strain (%)	0.83
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-6-C
Molding Date	4/17/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	0

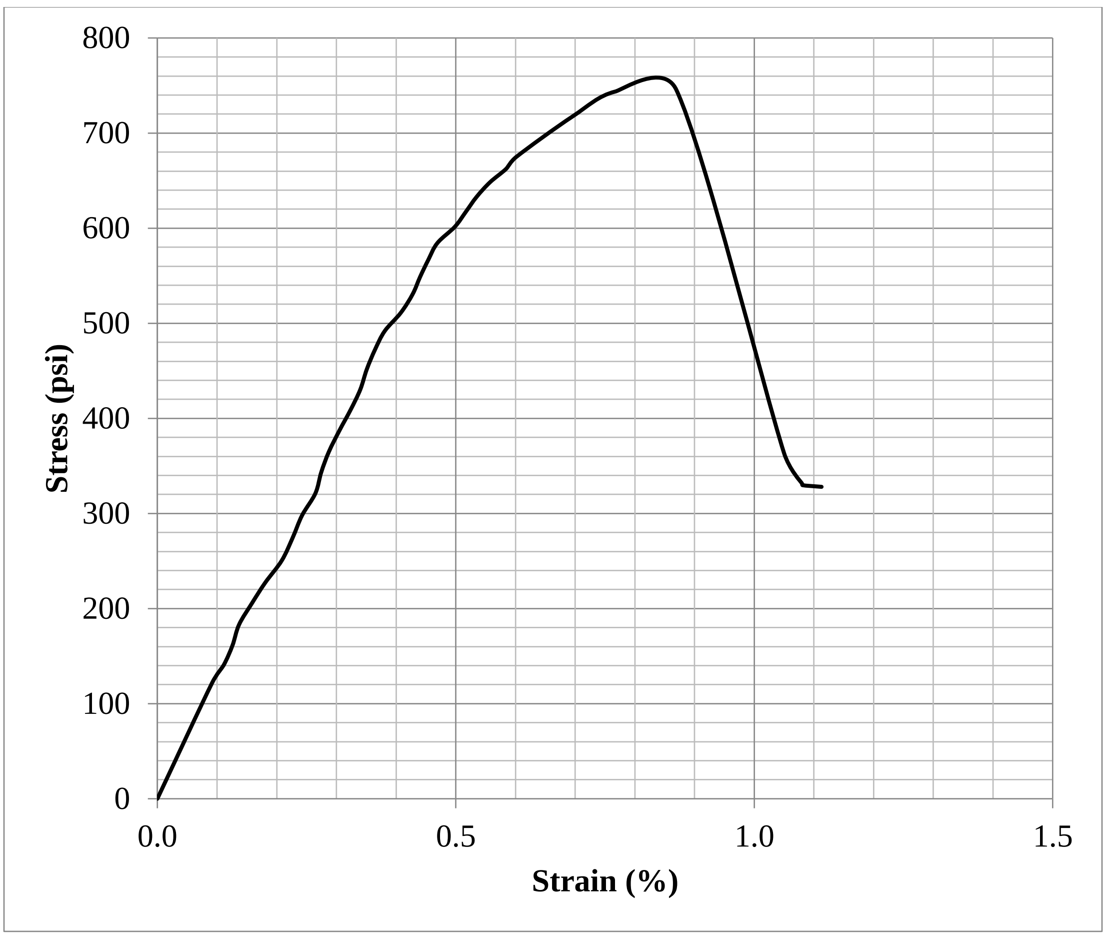
Testing Date	5/1/19
Diameter (in.)	2.047
Height (in.)	3.633
Weight (g)	308.8
Corrected Peak UCS (psi)	735.7
Corrected Failure Strain (%)	0.66
ASTM C39 Fracture Type	2



Data Sheet: Specimen UCS Test

Specimen ID	10-6-D
Molding Date	4/17/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	0.4

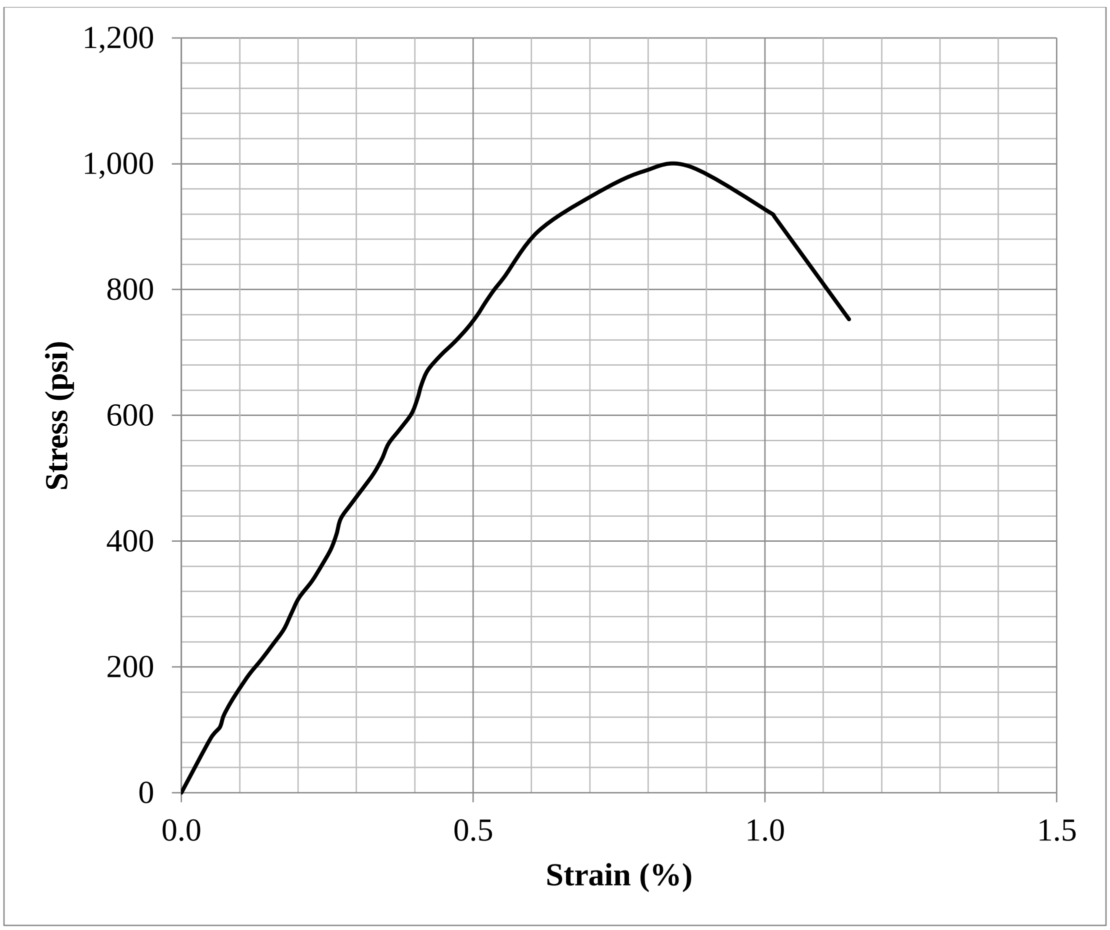
Testing Date	5/1/19
Diameter (in.)	2.046
Height (in.)	3.731
Weight (g)	317.2
Corrected Peak UCS (psi)	734.9
Corrected Failure Strain (%)	0.87
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-6-E
Molding Date	4/17/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	1.3

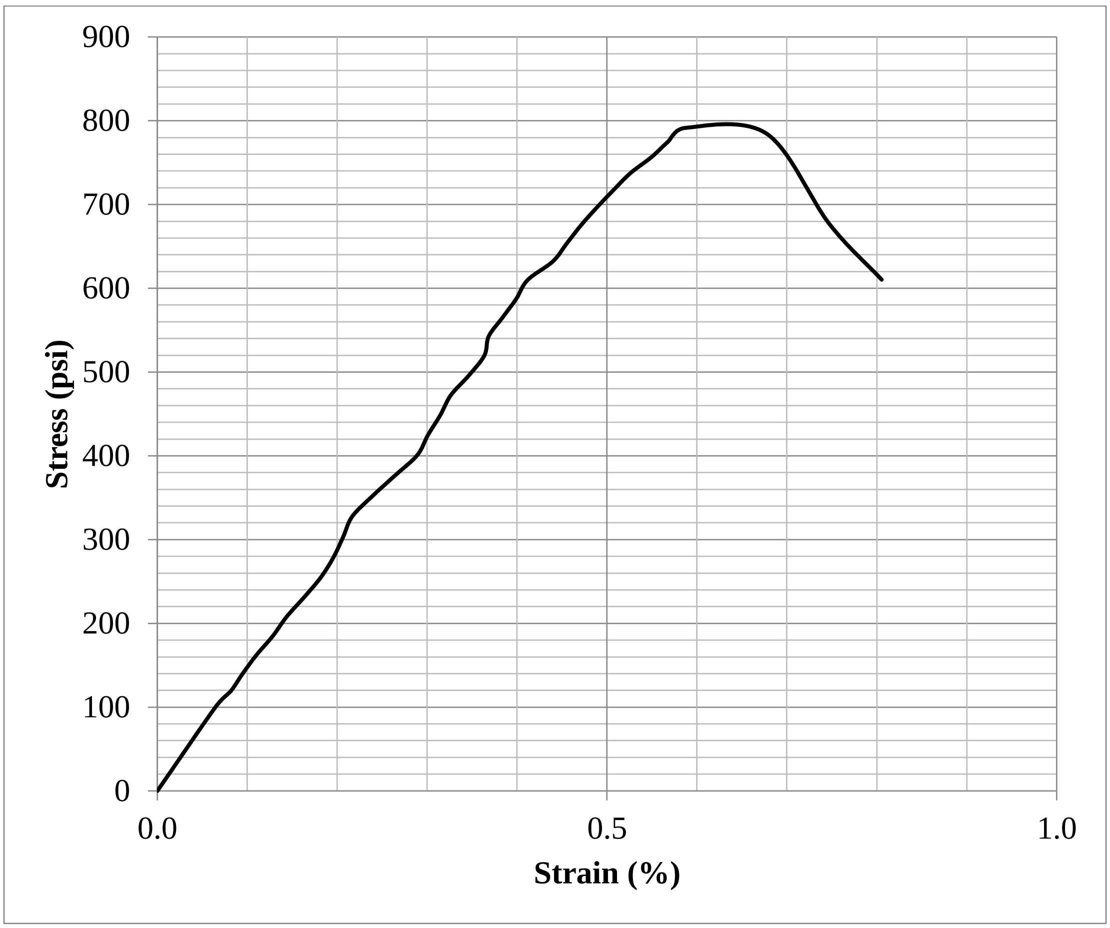
Testing Date	5/15/19
Diameter (in.)	2.053
Height (in.)	3.706
Weight (g)	315.9
Corrected Peak UCS (psi)	980.4
Corrected Failure Strain (%)	0.87
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	10-6-F
Molding Date	4/17/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	0.4

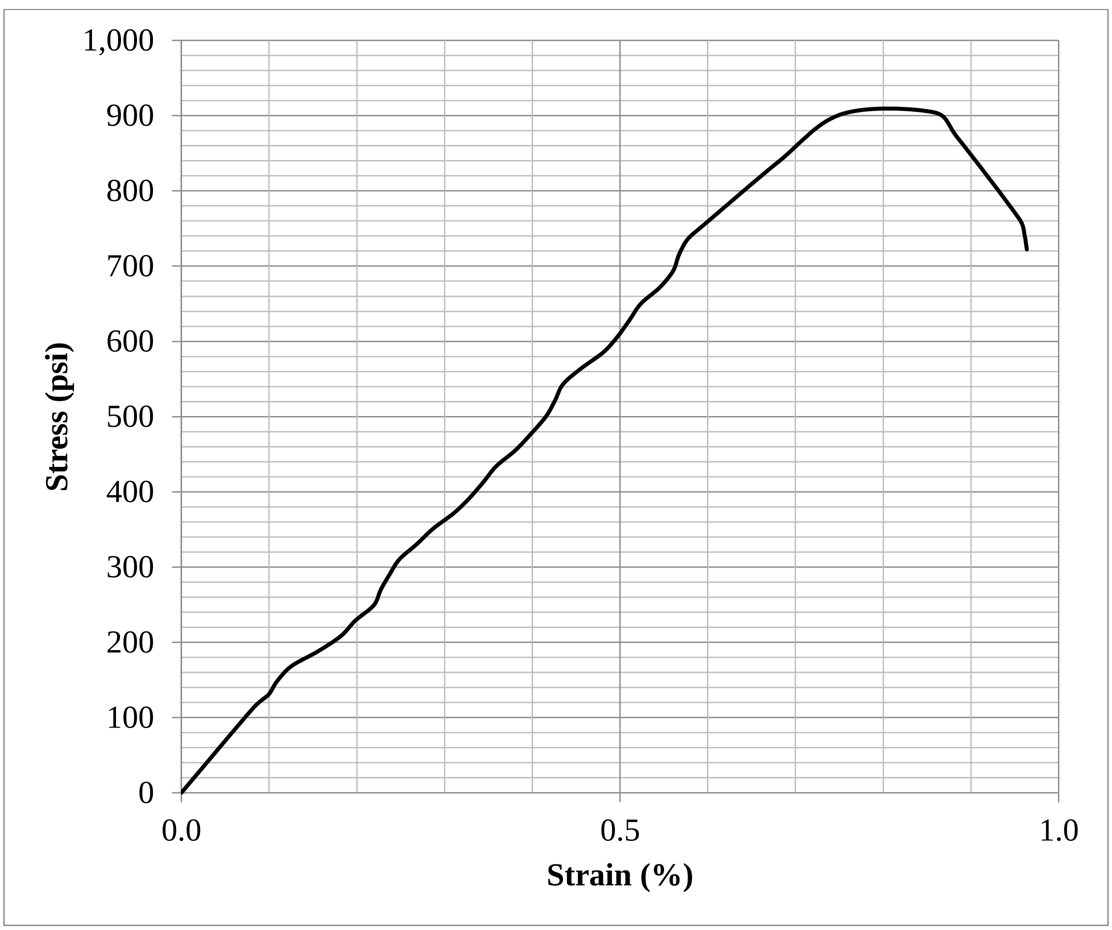
Testing Date	5/15/19
Diameter (in.)	2.046
Height (in.)	3.760
Weight (g)	320.5
Corrected Peak UCS (psi)	781.2
Corrected Failure Strain (%)	0.59
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-6-G
Molding Date	4/17/19
Curing Period (d)	29
$\alpha_{I\text{-}P}$ (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	0.6

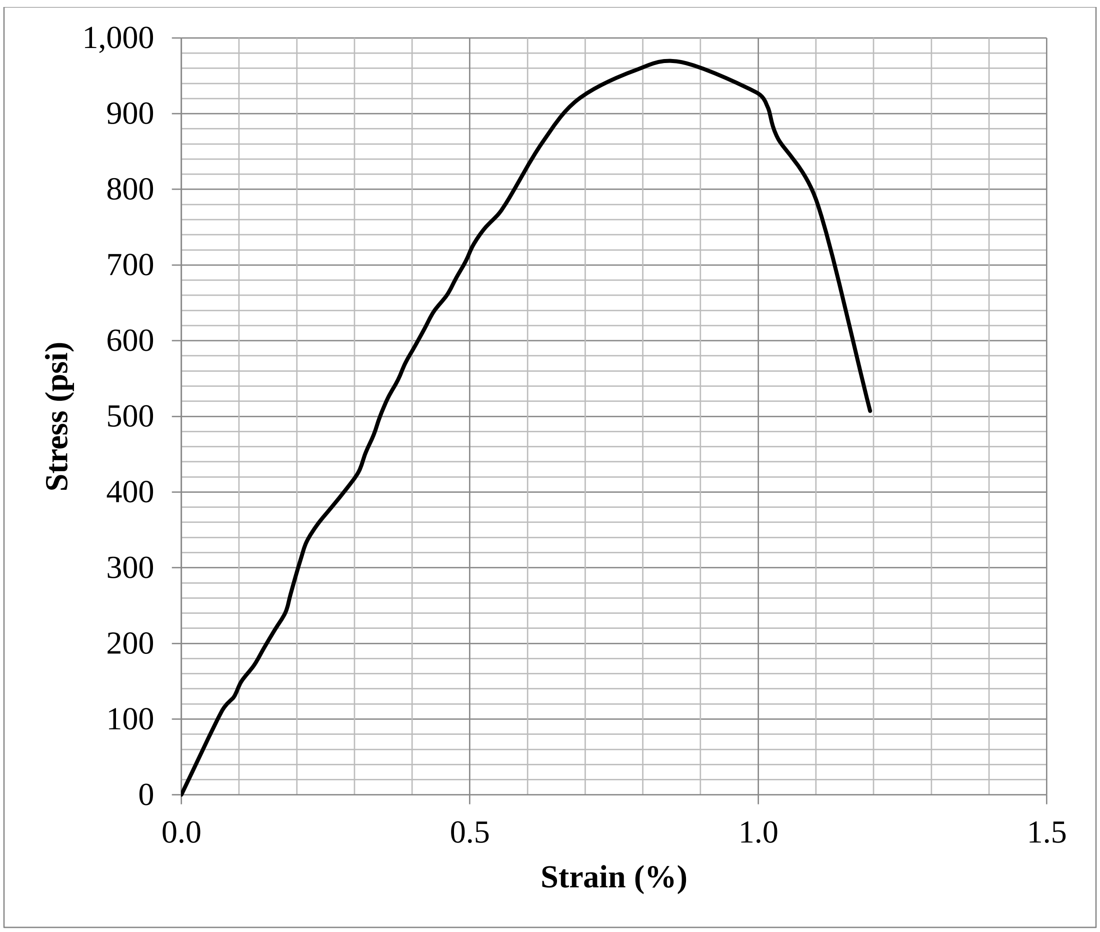
Testing Date	5/15/19
Diameter (in.)	2.048
Height (in.)	3.715
Weight (g)	317.0
Corrected Peak UCS (psi)	891.1
Corrected Failure Strain (%)	0.86
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	10-6-H
Molding Date	4/17/19
Curing Period (d)	29
$\alpha_{I\text{-}P}$ (kg/m^3)	500 (503.3)
w:b	0.8
Soil OM (%)	15.0
Bleed Water (g)	0.8

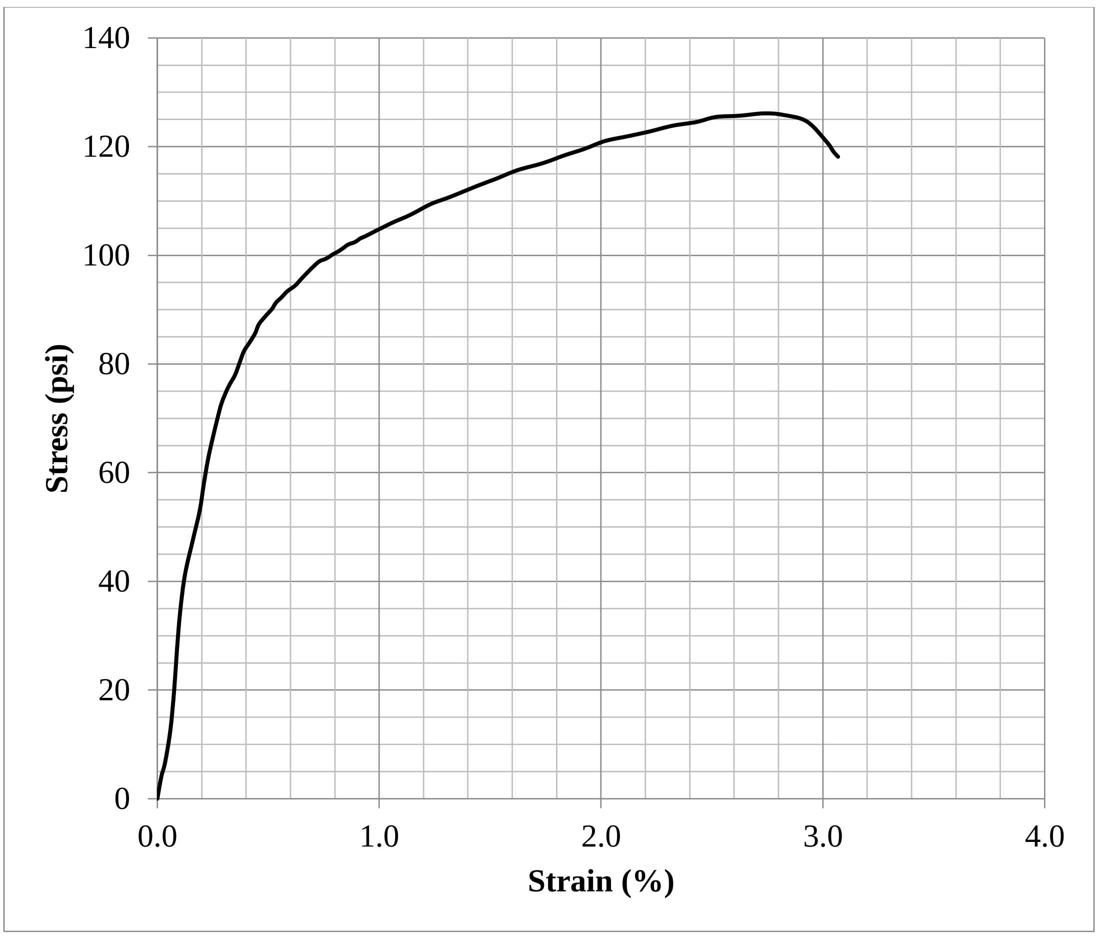
Testing Date	5/15/19
Diameter (in.)	2.051
Height (in.)	3.605
Weight (g)	307.8
Corrected Peak UCS (psi)	949.6
Corrected Failure Strain (%)	0.86
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-1-A
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	200 (203.7)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.2

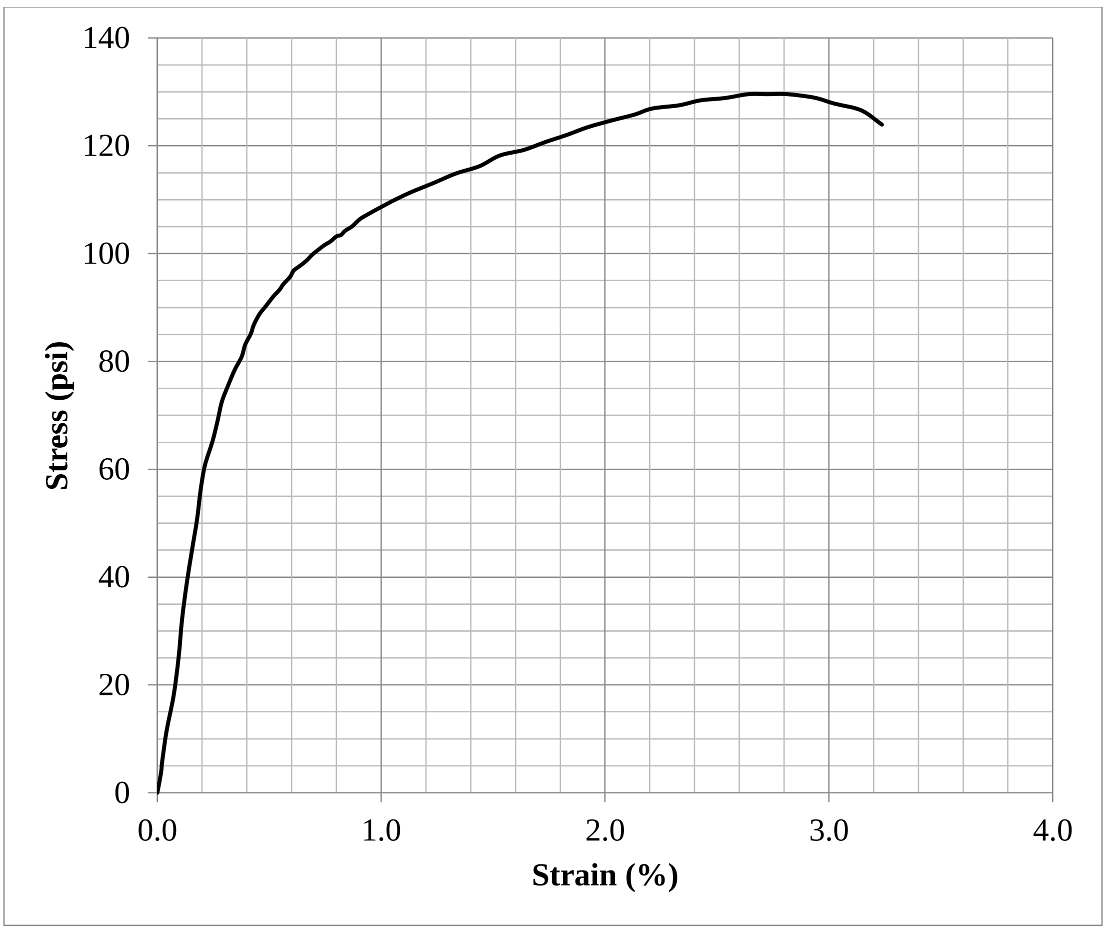
Testing Date	6/7/19
Diameter (in.)	2.041
Height (in.)	3.986
Weight (g)	310.3
Corrected Peak UCS (psi)	125.6
Corrected Failure Strain (%)	2.74
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	15-1-B
Molding Date	6/1/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (203.7)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.3

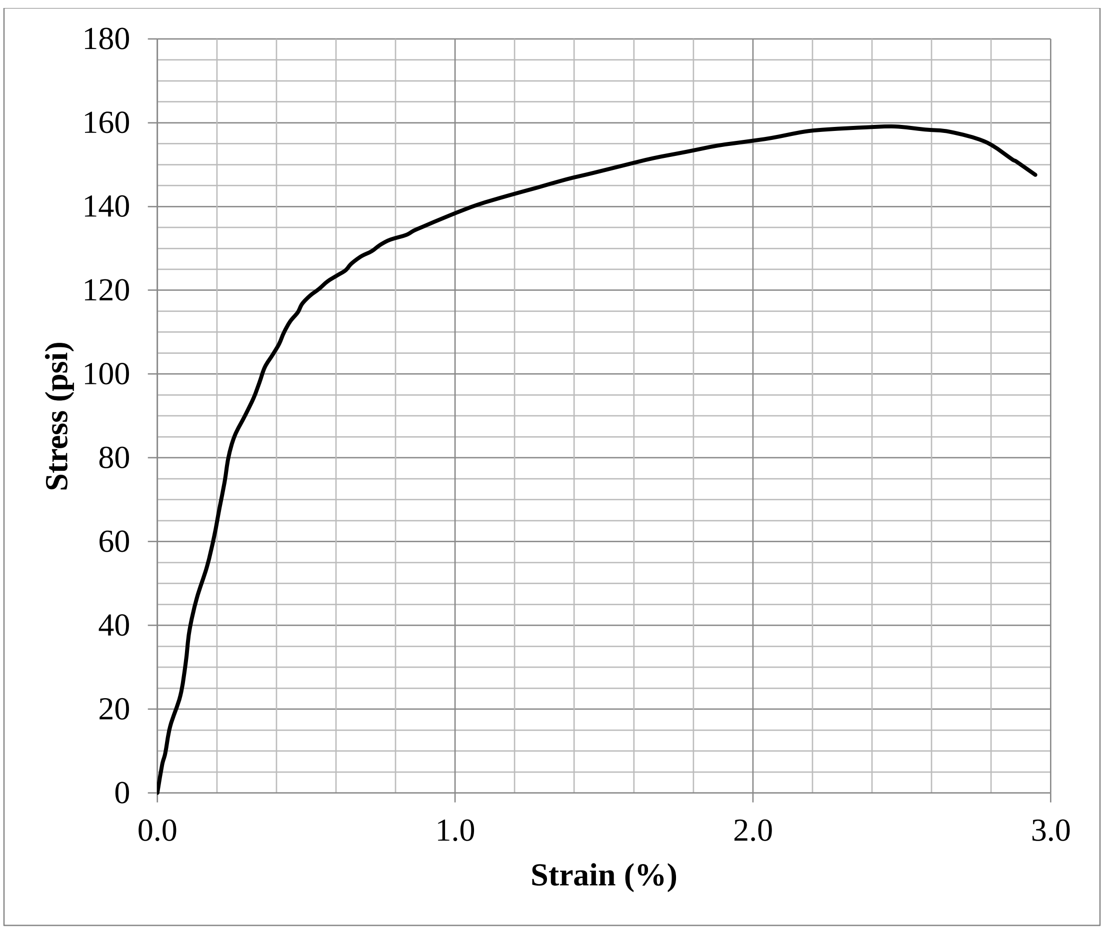
Testing Date	6/7/19
Diameter (in.)	2.040
Height (in.)	3.982
Weight (g)	309.9
Corrected Peak UCS (psi)	129.1
Corrected Failure Strain (%)	2.86
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-1-C
Molding Date	6/1/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (203.7)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.4

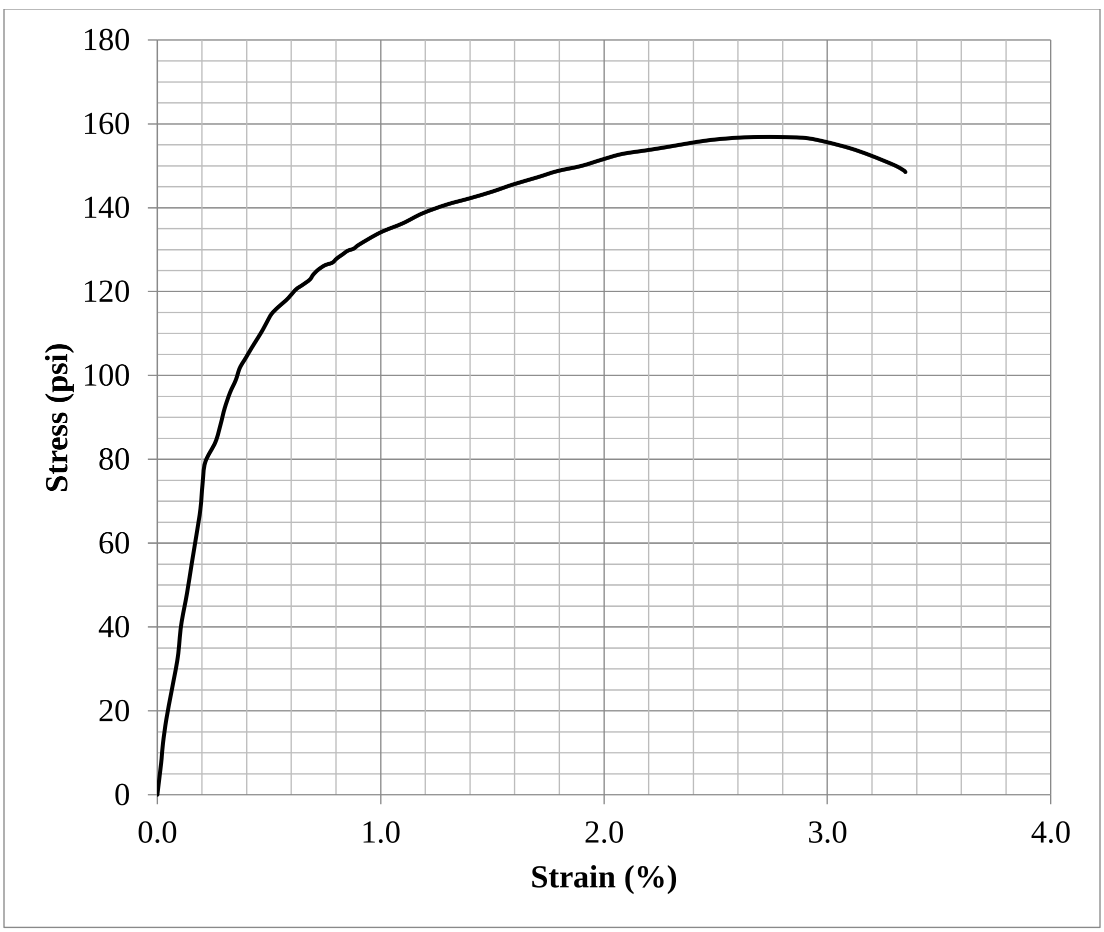
Testing Date	6/15/19
Diameter (in.)	2.042
Height (in.)	3.883
Weight (g)	303.0
Corrected Peak UCS (psi)	157.8
Corrected Failure Strain (%)	2.48
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	15-1-D
Molding Date	6/1/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	200 (203.7)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	1.0

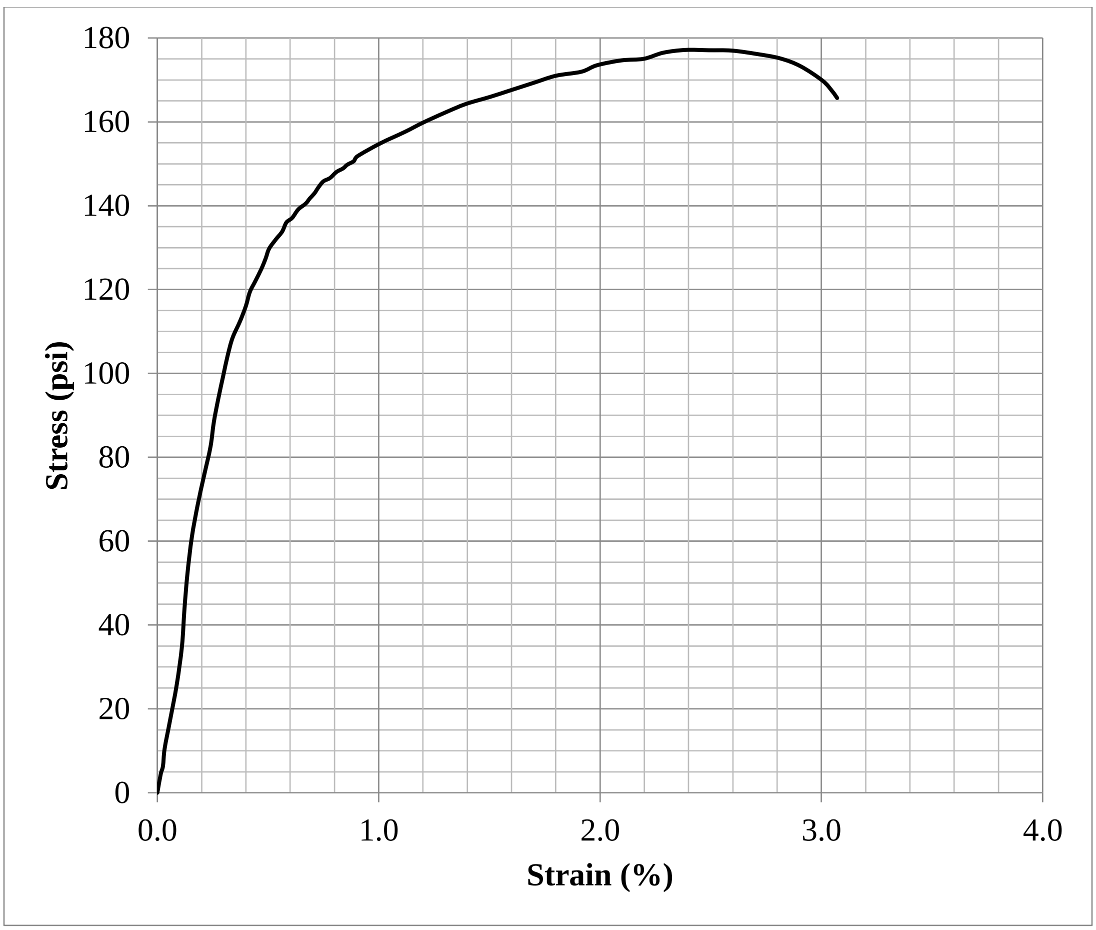
Testing Date	6/15/19
Diameter (in.)	2.048
Height (in.)	3.843
Weight (g)	301.5 (*Est.*)
Corrected Peak UCS (psi)	155.3
Corrected Failure Strain (%)	2.69
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	15-1-E
Molding Date	6/1/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (203.7)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.4

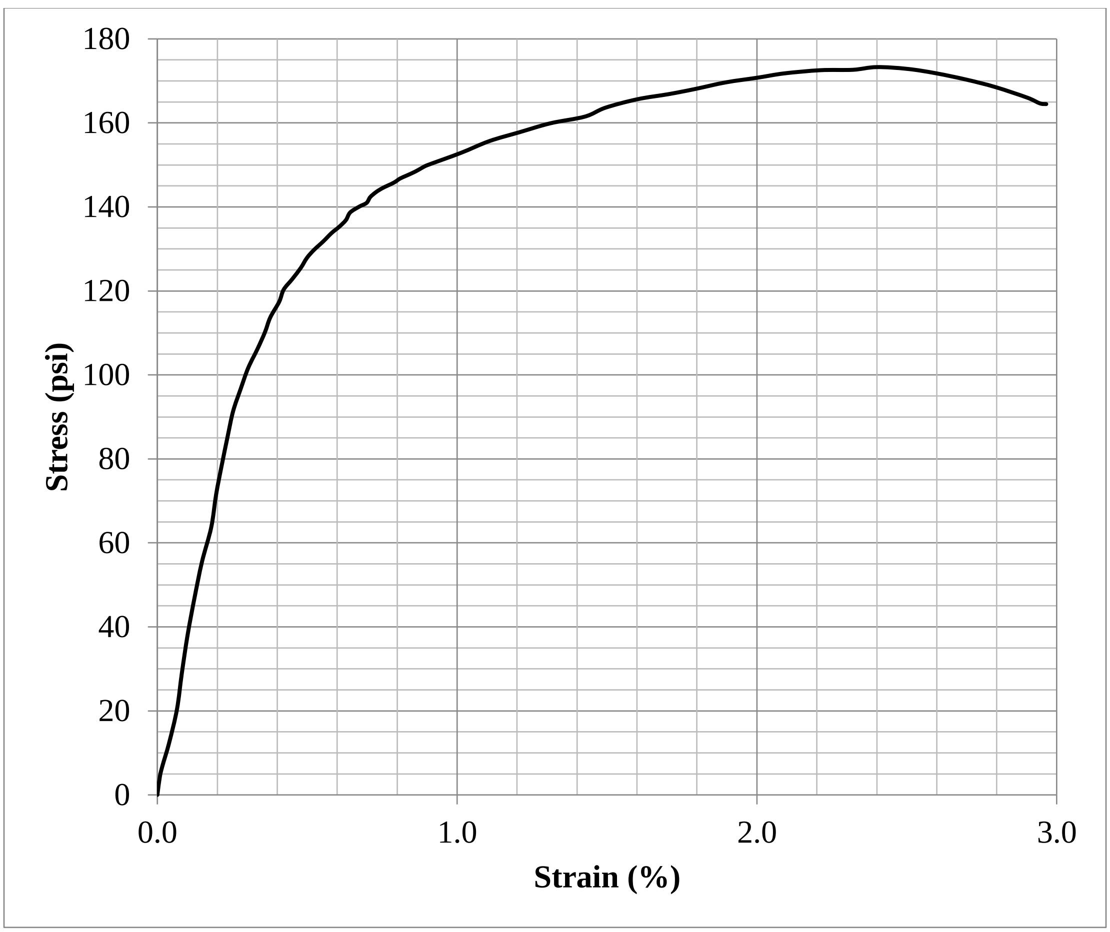
Testing Date	6/28/19
Diameter (in.)	2.040
Height (in.)	3.992
Weight (g)	311.5
Corrected Peak UCS (psi)	176.5
Corrected Failure Strain (%)	2.39
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-1-F
Molding Date	6/1/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	200 (203.7)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.5

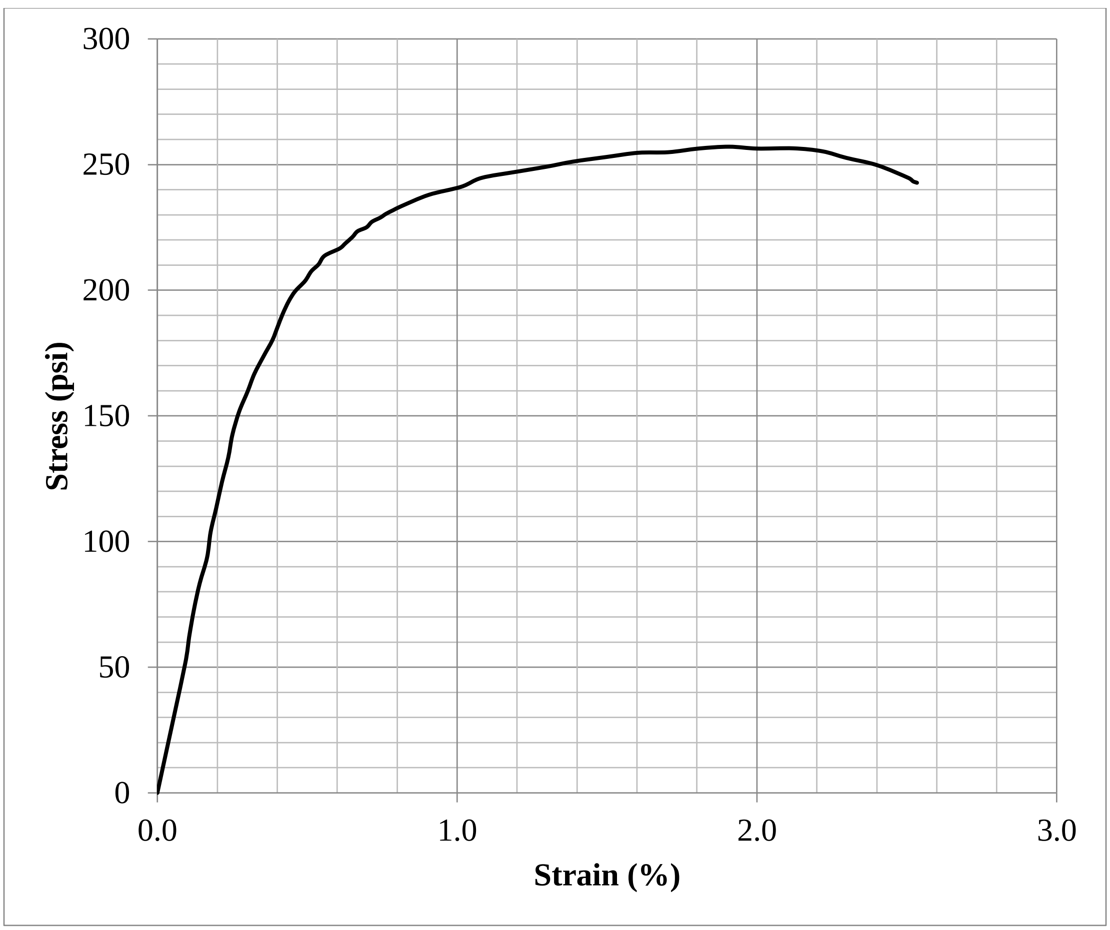
Testing Date	6/28/19
Diameter (in.)	2.050
Height (in.)	3.974
Weight (g)	311.2
Corrected Peak UCS (psi)	172.4
Corrected Failure Strain (%)	2.40
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-2-A
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	300 (304.5)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.2

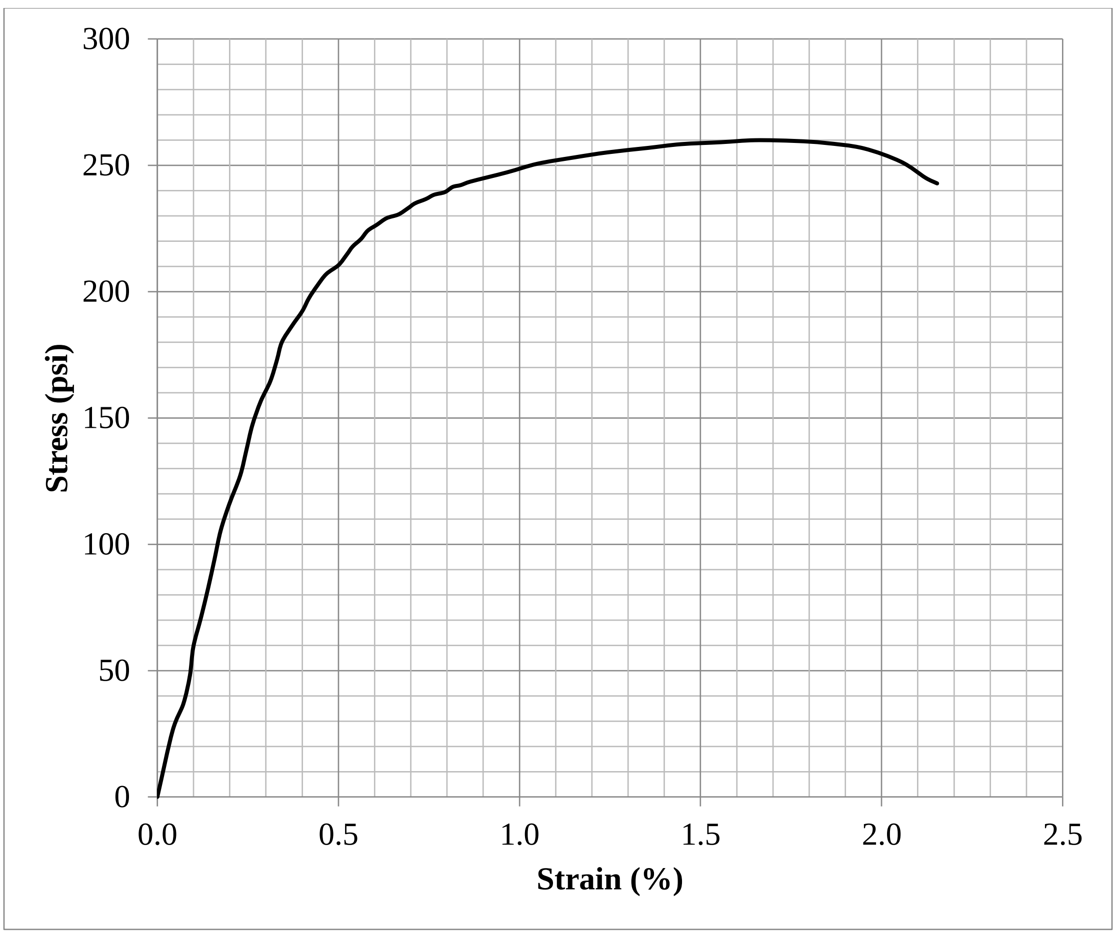
Testing Date	6/7/19
Diameter (in.)	2.046
Height (in.)	3.879
Weight (g)	308.8
Corrected Peak UCS (psi)	255.0
Corrected Failure Strain (%)	1.91
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-2-B
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	300 (304.5)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.2

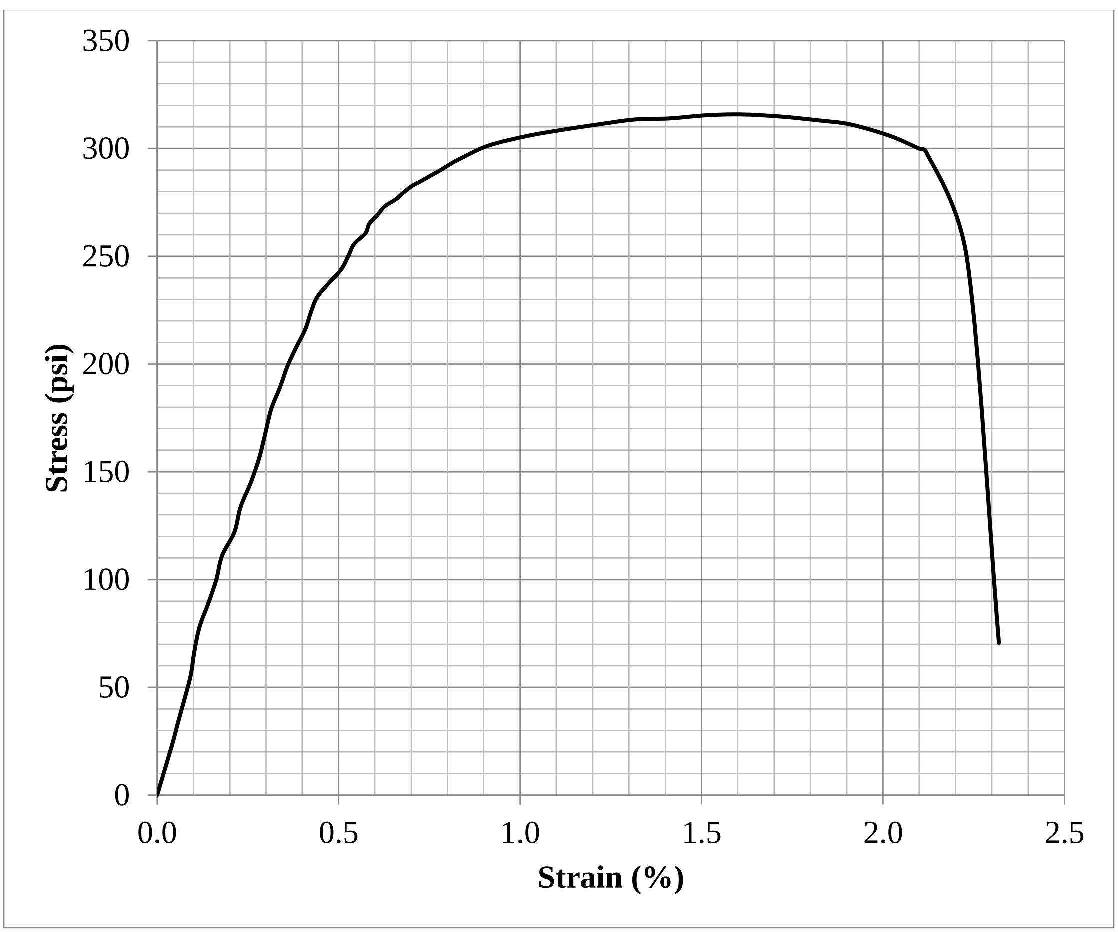
Testing Date	6/7/19
Diameter (in.)	2.045
Height (in.)	3.987
Weight (g)	318.9
Corrected Peak UCS (psi)	258.9
Corrected Failure Strain (%)	1.65
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-2-C
Molding Date	6/1/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (304.5)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.3

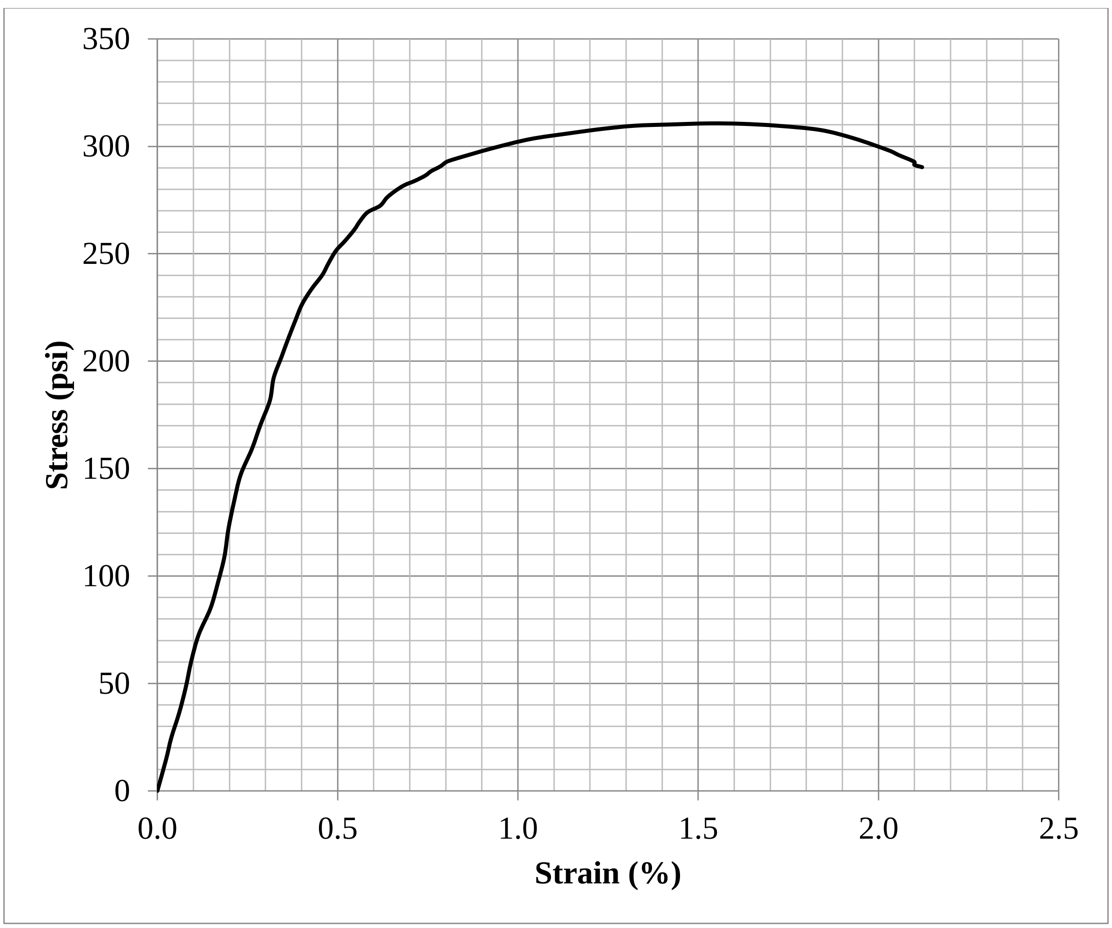
Testing Date	6/15/19
Diameter (in.)	2.047
Height (in.)	3.765
Weight (g)	300.2
Corrected Peak UCS (psi)	311.8
Corrected Failure Strain (%)	1.61
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-2-D
Molding Date	6/1/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	300 (304.5)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.4

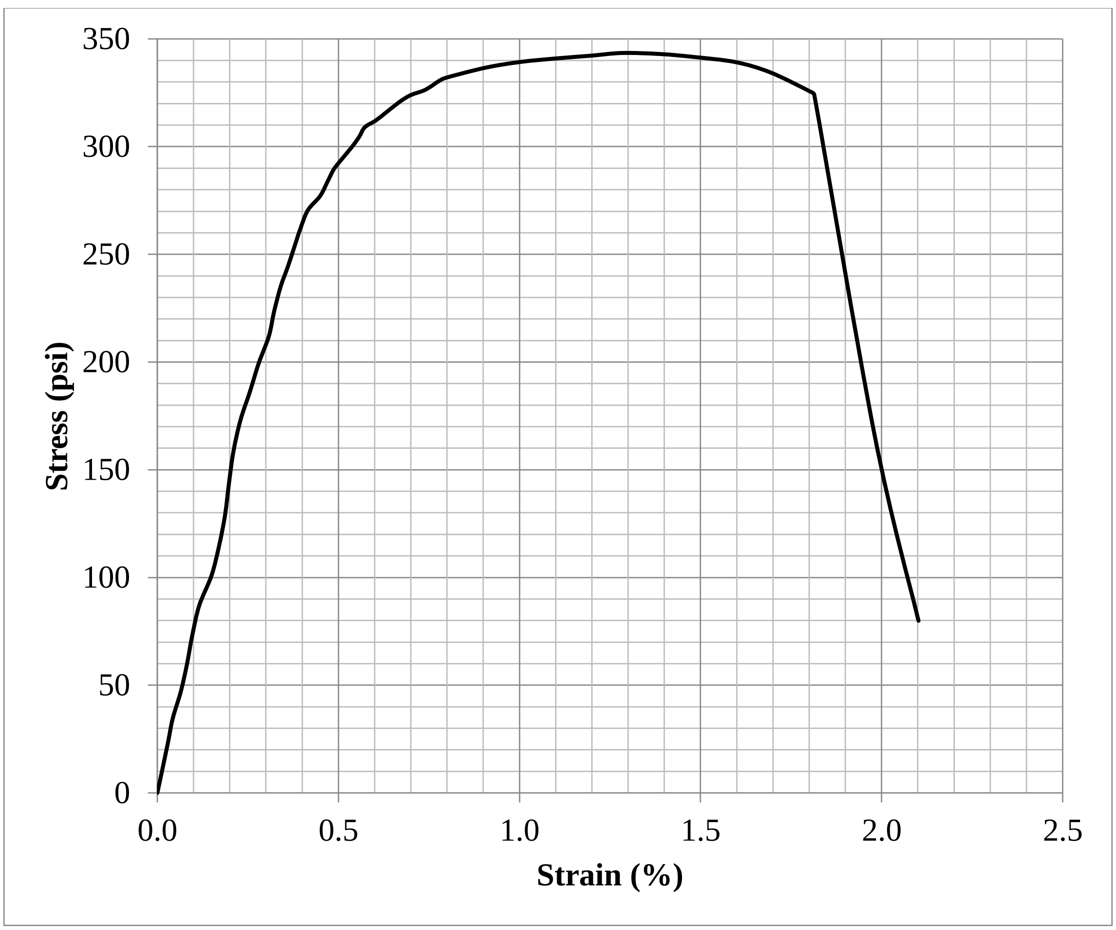
Testing Date	6/15/19
Diameter (in.)	2.051
Height (in.)	3.997
Weight (g)	319.5
Corrected Peak UCS (psi)	309.4
Corrected Failure Strain (%)	1.53
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	15-2-E
Molding Date	6/1/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	300 (304.5)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.4

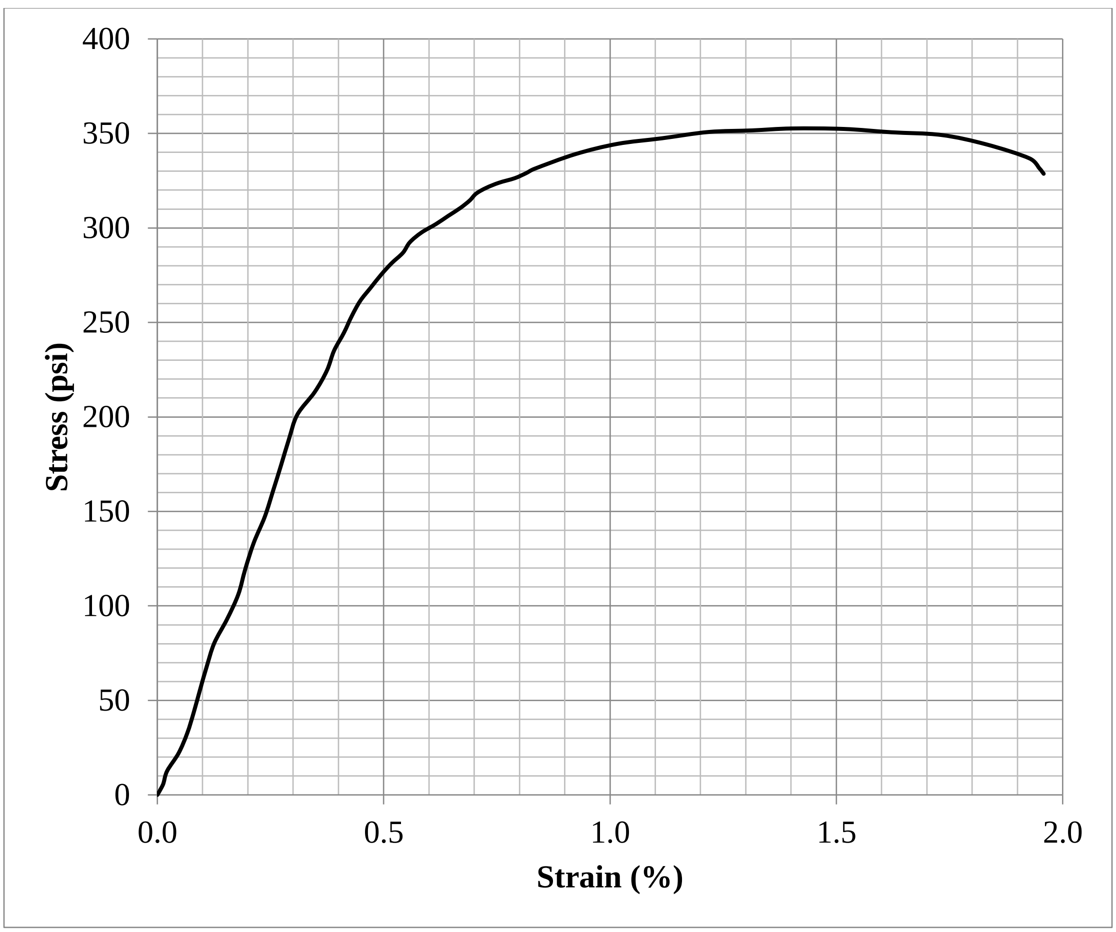
Testing Date	6/28/19
Diameter (in.)	2.050
Height (in.)	3.996
Weight (g)	322.0
Corrected Peak UCS (psi)	342.1
Corrected Failure Strain (%)	1.28
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	15-2-F
Molding Date	6/1/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (304.5)
w:b	0.6
Soil OM (%)	22.6
Bleed Water (g)	0.5

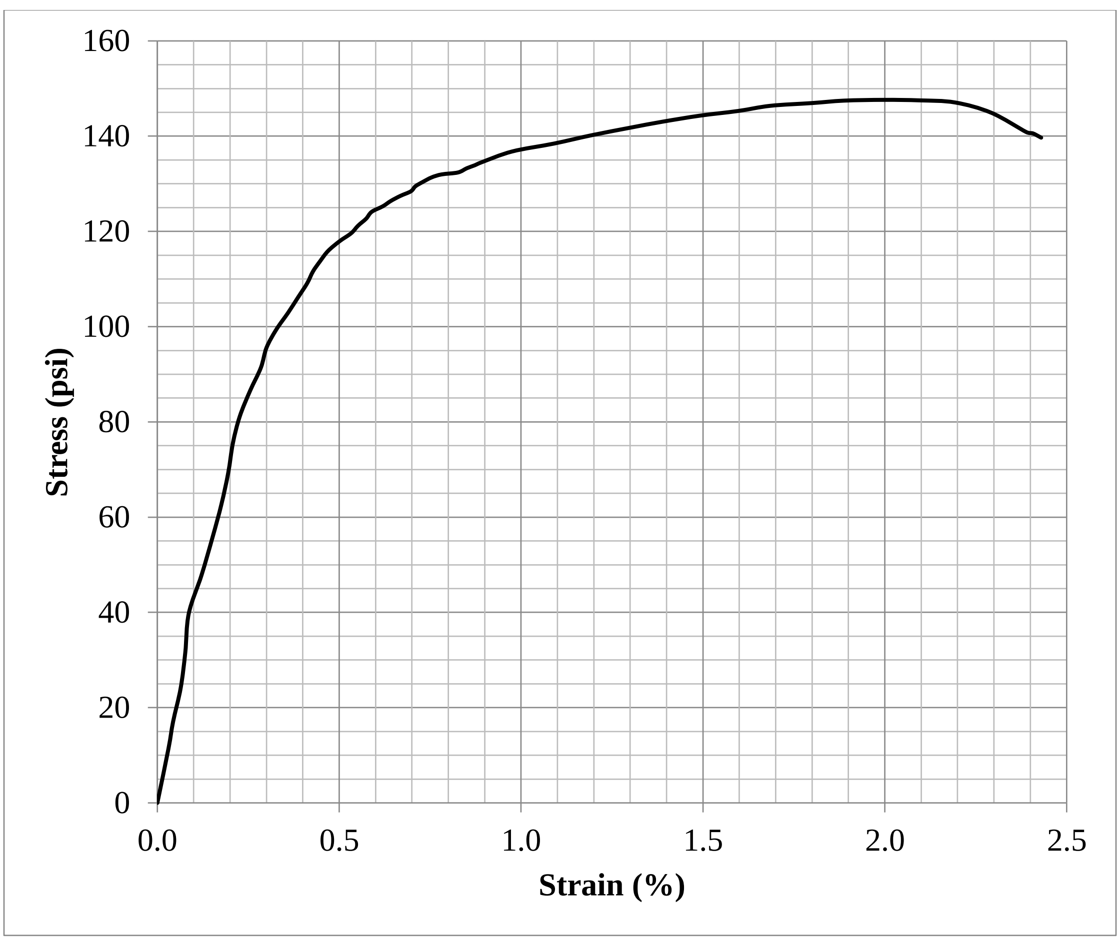
Testing Date	6/28/19
Diameter (in.)	2.051
Height (in.)	3.950
Weight (g)	316.3
Corrected Peak UCS (psi)	350.5
Corrected Failure Strain (%)	1.40
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-3-A
Molding Date	6/1/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	300 (303.8)
w:b	1.0
Soil OM (%)	22.6
Bleed Water (g)	0.7

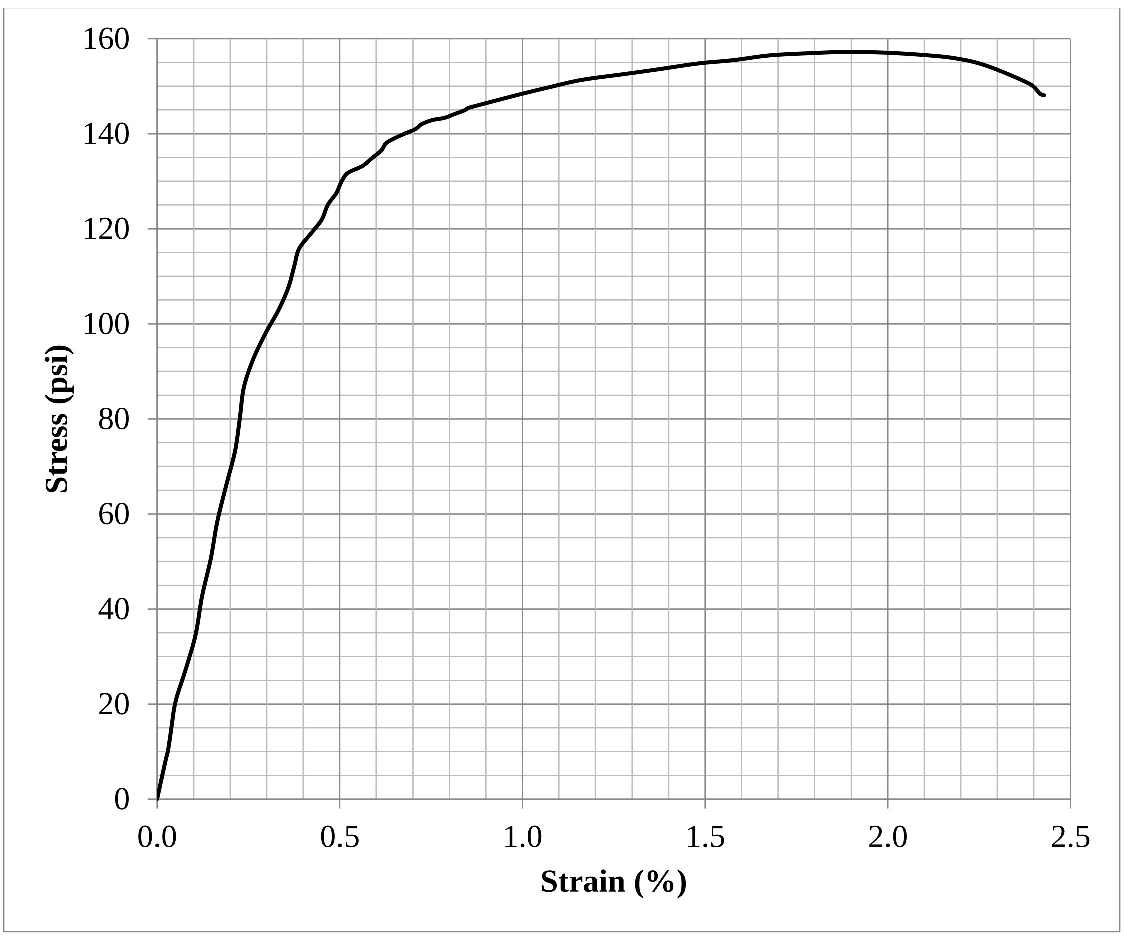
Testing Date	6/8/19
Diameter (in.)	2.043
Height (in.)	3.792
Weight (g)	292.1
Corrected Peak UCS (psi)	145.9
Corrected Failure Strain (%)	2.00
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-3-B
Molding Date	6/1/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (303.8)
w:b	1.0
Soil OM (%)	22.6
Bleed Water (g)	0.6

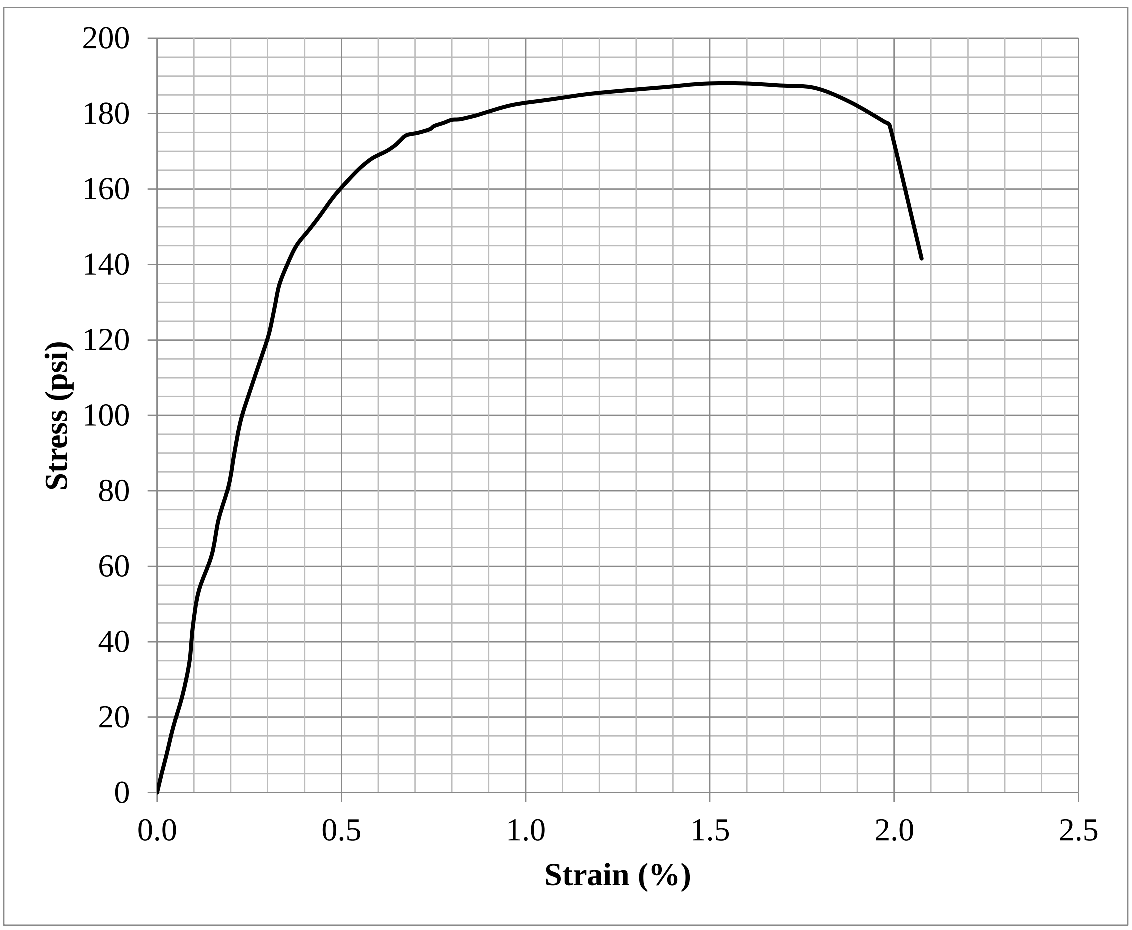
Testing Date	6/8/19
Diameter (in.)	2.043
Height (in.)	3.809
Weight (g)	293.6
Corrected Peak UCS (psi)	155.5
Corrected Failure Strain (%)	1.88
ASTM C39 Fracture Type	N/A



<u>Data Sheet: Specimen UCS Test</u>

Specimen ID	15-3-C
Molding Date	6/1/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (303.8)
w:b	1.0
Soil OM (%)	22.6
Bleed Water (g)	0.4

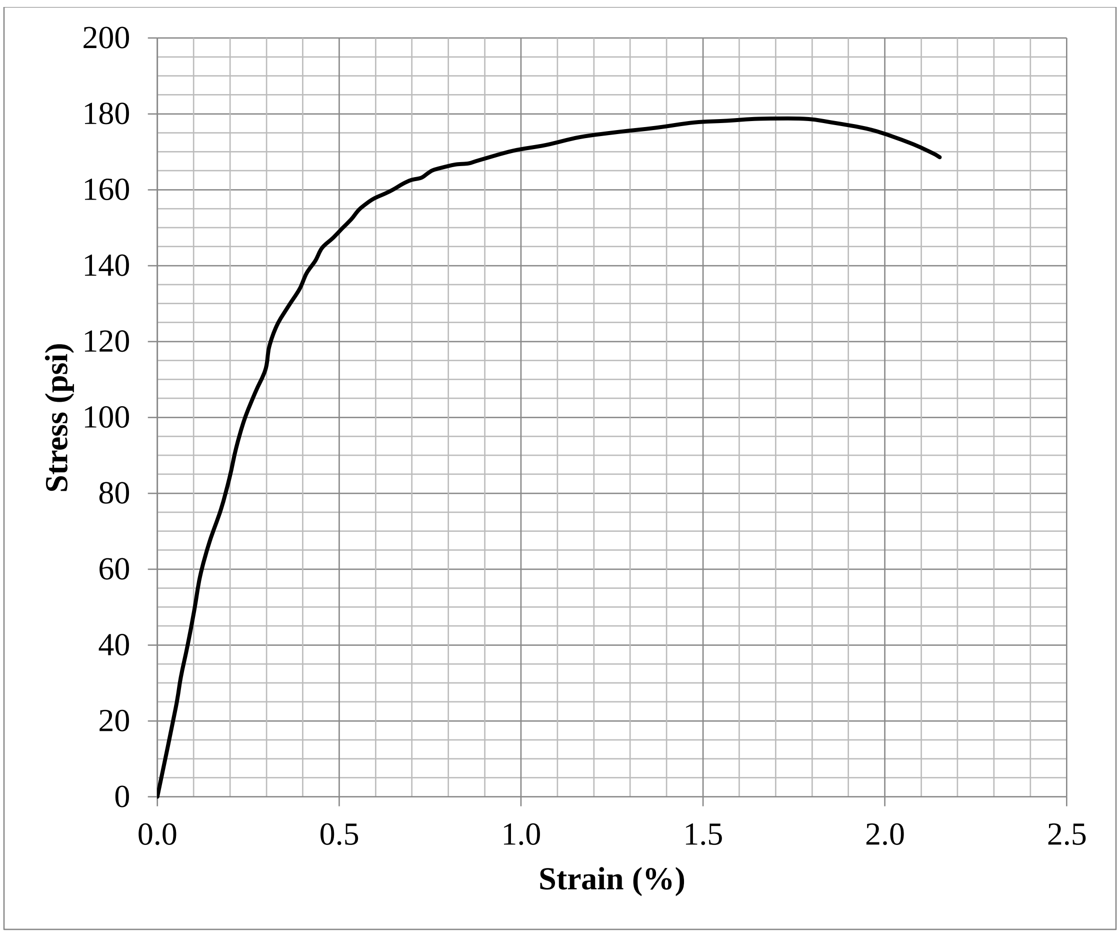
Testing Date	6/15/19
Diameter (in.)	2.047
Height (in.)	3.684
Weight (g)	285.0
Corrected Peak UCS (psi)	185.0
Corrected Failure Strain (%)	1.59
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	15-3-D
Molding Date	6/1/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (303.8)
w:b	1.0
Soil OM (%)	22.6
Bleed Water (g)	0.9

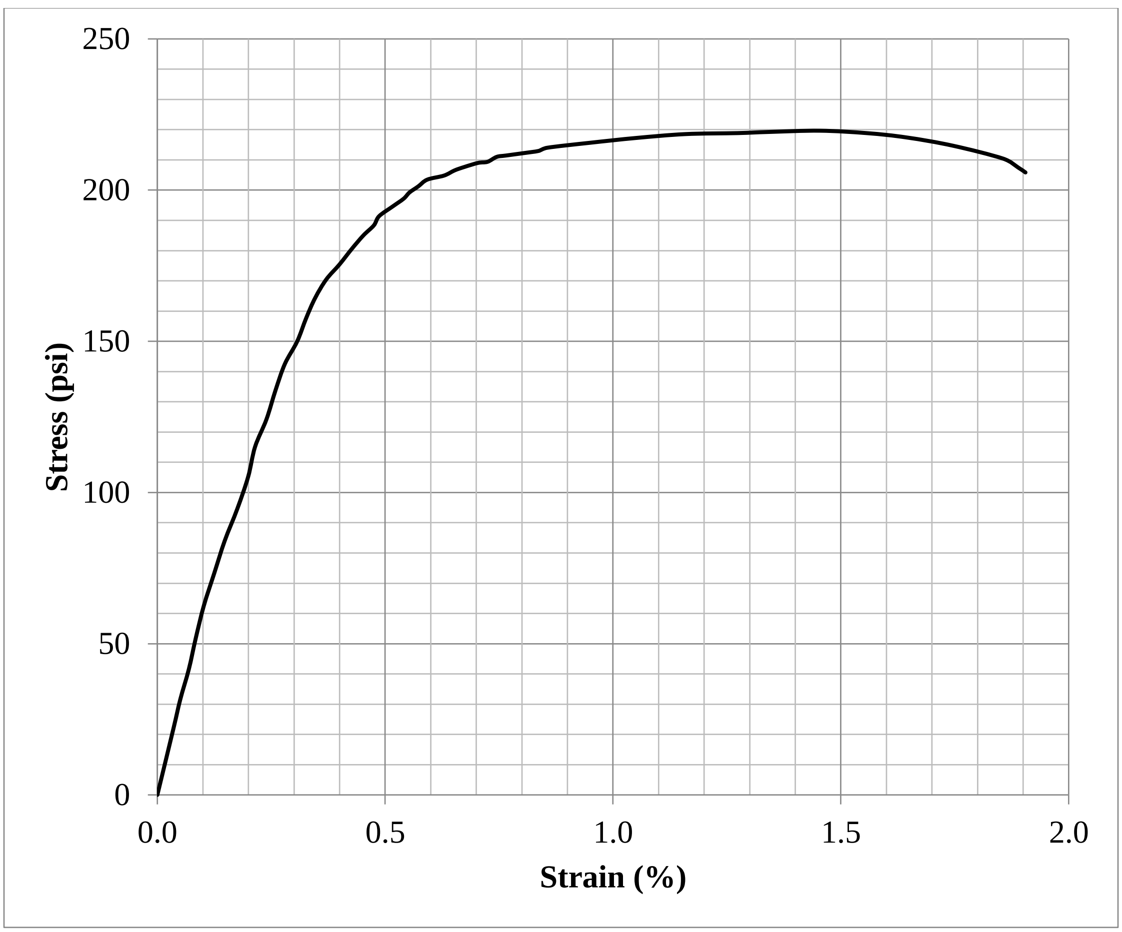
Testing Date	6/15/19
Diameter (in.)	2.048
Height (in.)	3.827
Weight (g)	296.4
Corrected Peak UCS (psi)	176.8
Corrected Failure Strain (%)	1.78
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	15-3-E
Molding Date	6/1/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (303.8)
w:b	1.0
Soil OM (%)	22.6
Bleed Water (g)	0.2

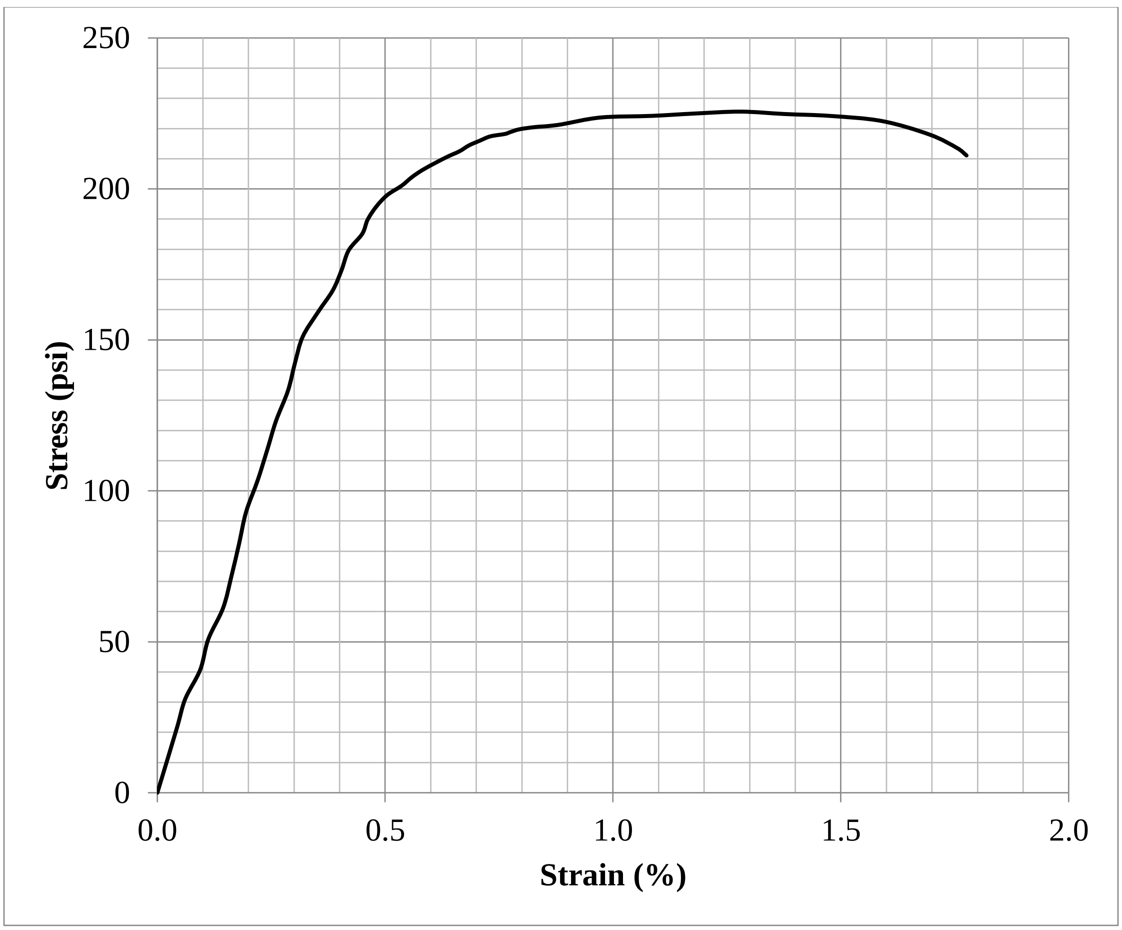
Testing Date	6/28/19
Diameter (in.)	2.049
Height (in.)	3.972
Weight (g)	308.2
Corrected Peak UCS (psi)	218.6
Corrected Failure Strain (%)	1.45
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	15-3-F
Molding Date	6/1/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (303.8)
w:b	1.0
Soil OM (%)	22.6
Bleed Water (g)	0.4

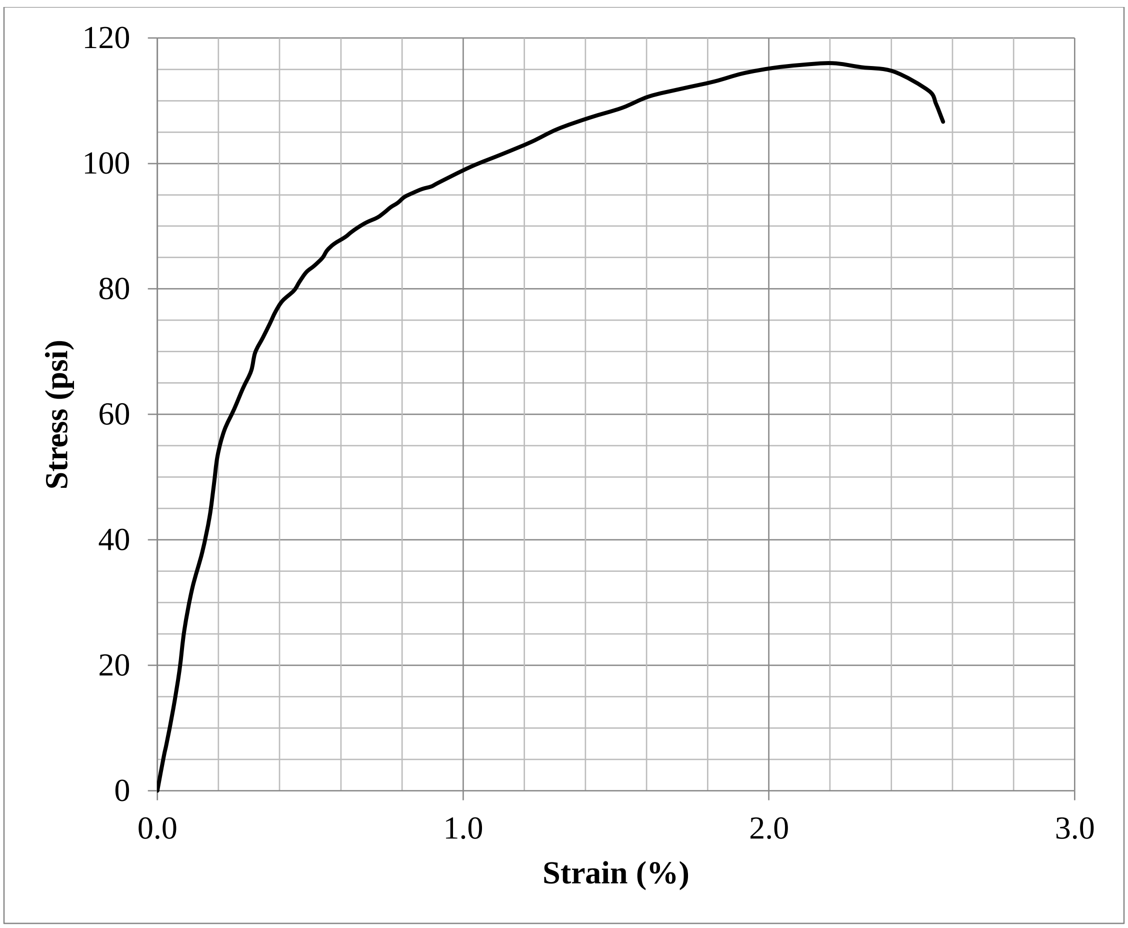
Testing Date	6/28/19
Diameter (in.)	2.047
Height (in.)	3.763
Weight (g)	291.8
Corrected Peak UCS (psi)	222.7
Corrected Failure Strain (%)	1.28
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-1-A
Molding Date	5/30/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	225 (229.3)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.3

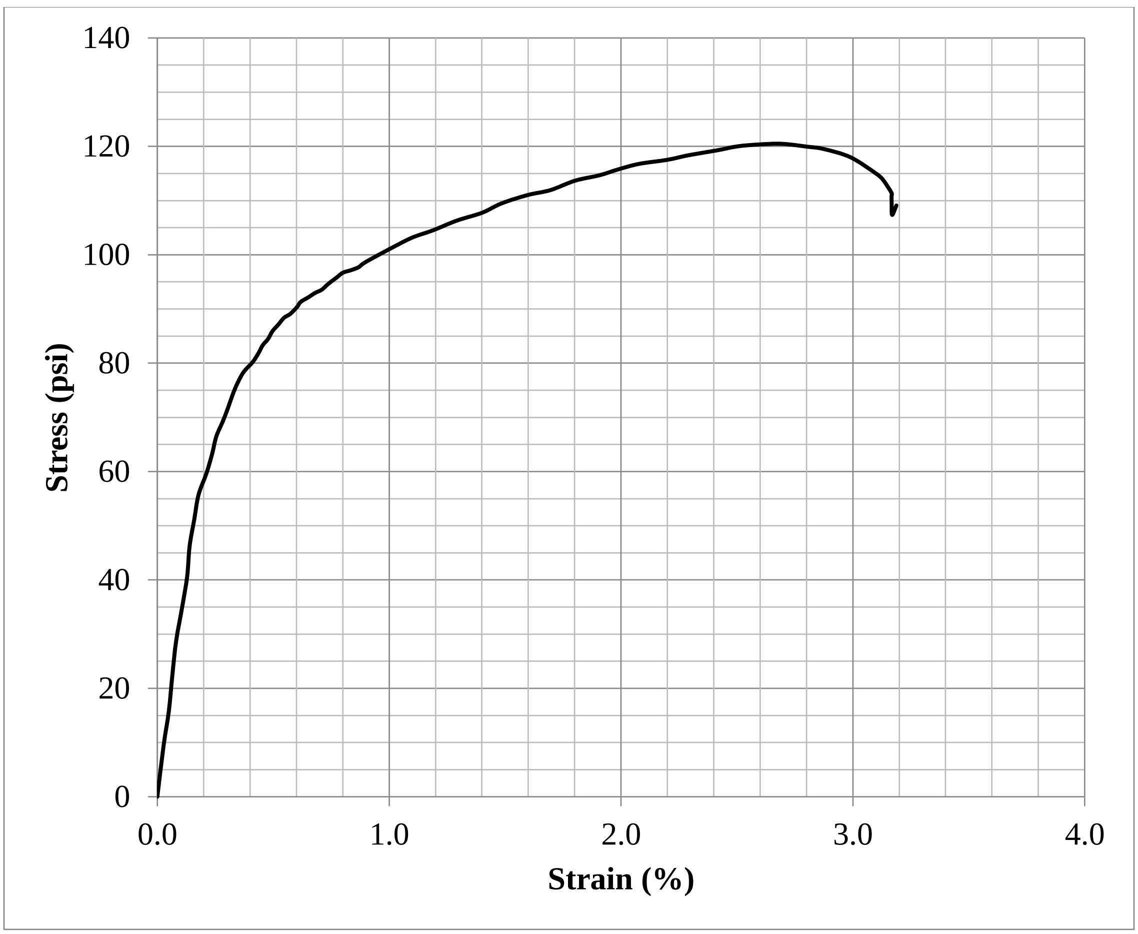
Testing Date	6/6/19
Diameter (in.)	2.041
Height (in.)	3.994
Weight (g)	298.5
Corrected Peak UCS (psi)	115.6
Corrected Failure Strain (%)	2.21
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	20-1-B
Molding Date	5/30/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	225 (229.3)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.2

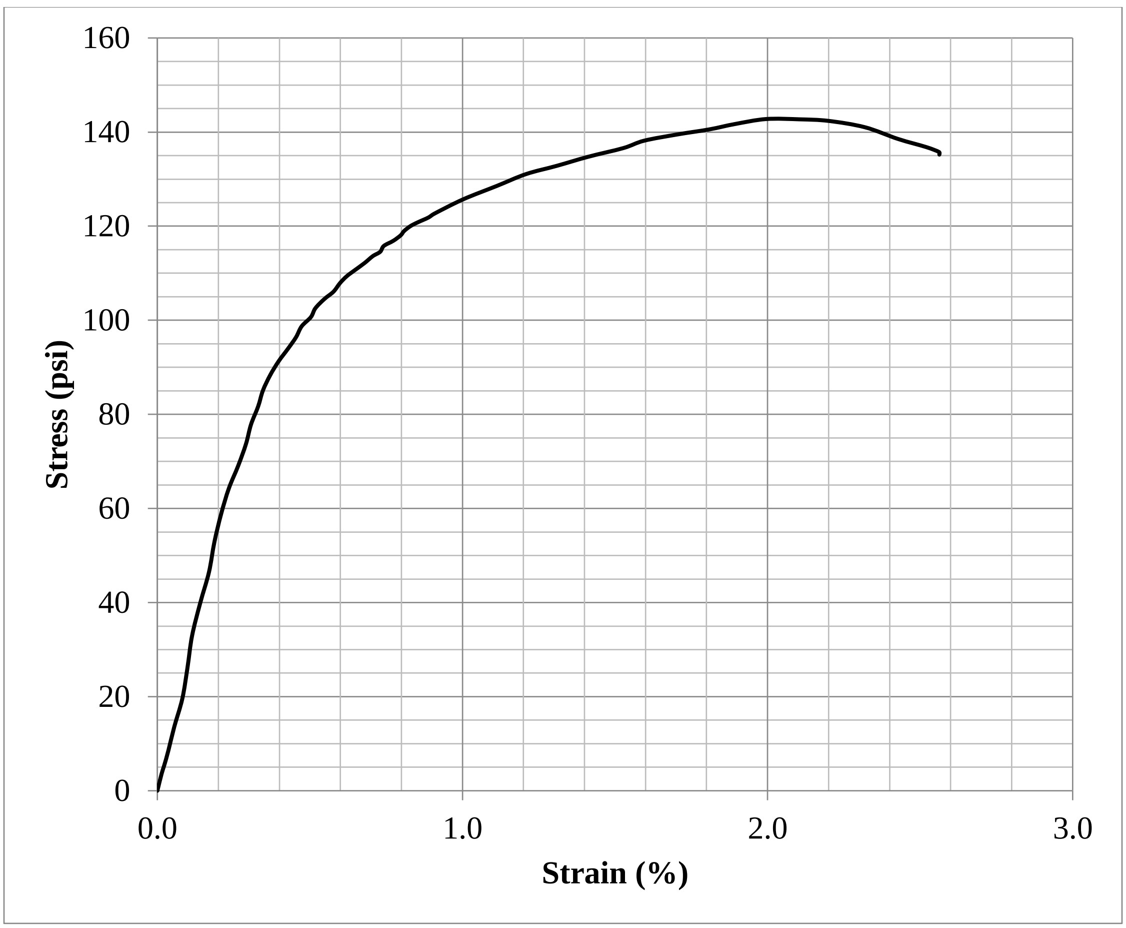
Testing Date	6/6/19
Diameter (in.)	2.045
Height (in.)	3.950
Weight (g)	294.7
Corrected Peak UCS (psi)	119.8
Corrected Failure Strain (%)	2.69
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	20-1-C
Molding Date	5/30/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	225 (229.3)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.2

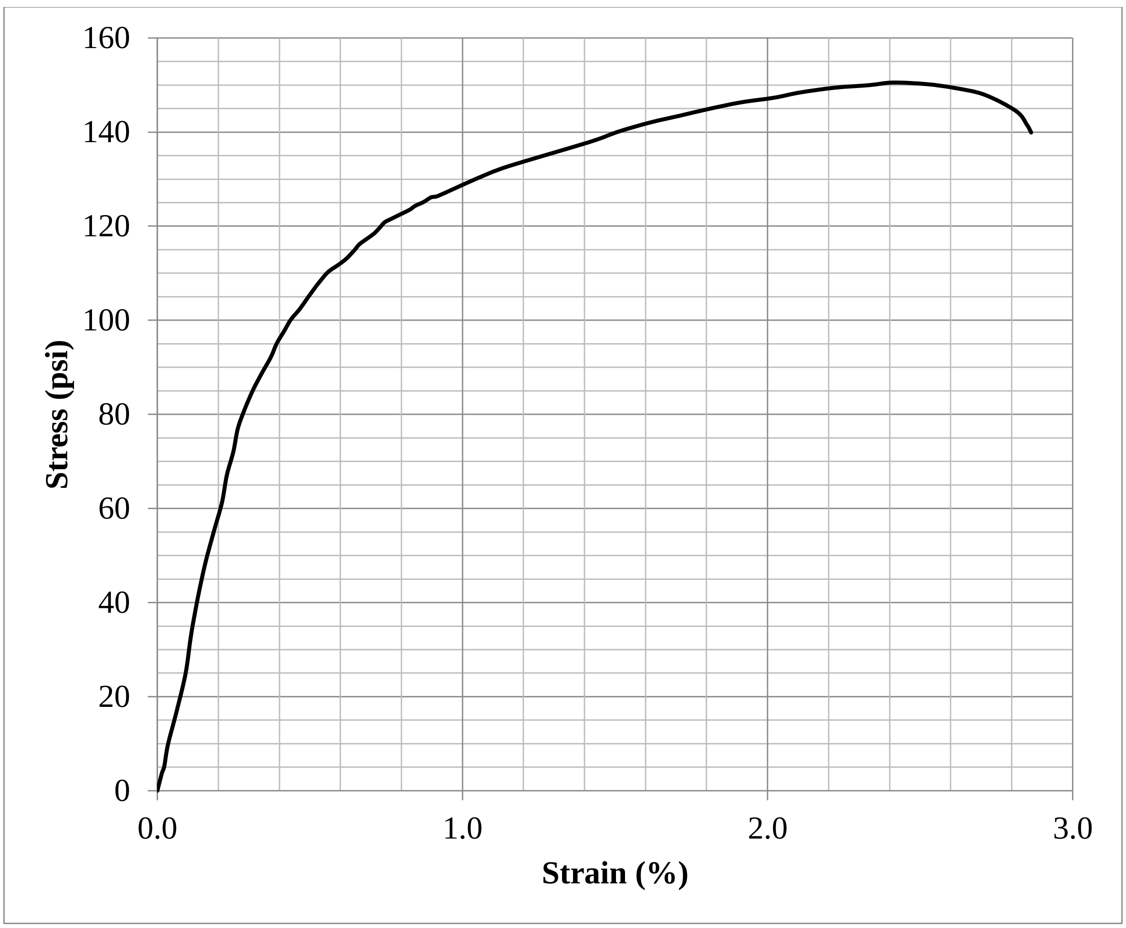
Testing Date	6/14/19
Diameter (in.)	2.040
Height (in.)	3.979
Weight (g)	296.8
Corrected Peak UCS (psi)	142.2
Corrected Failure Strain (%)	1.99
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-1-D
Molding Date	5/30/19
Curing Period (d)	15
$\alpha_{I\text{-}P}$ (kg/m^3)	225 (229.3)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.3

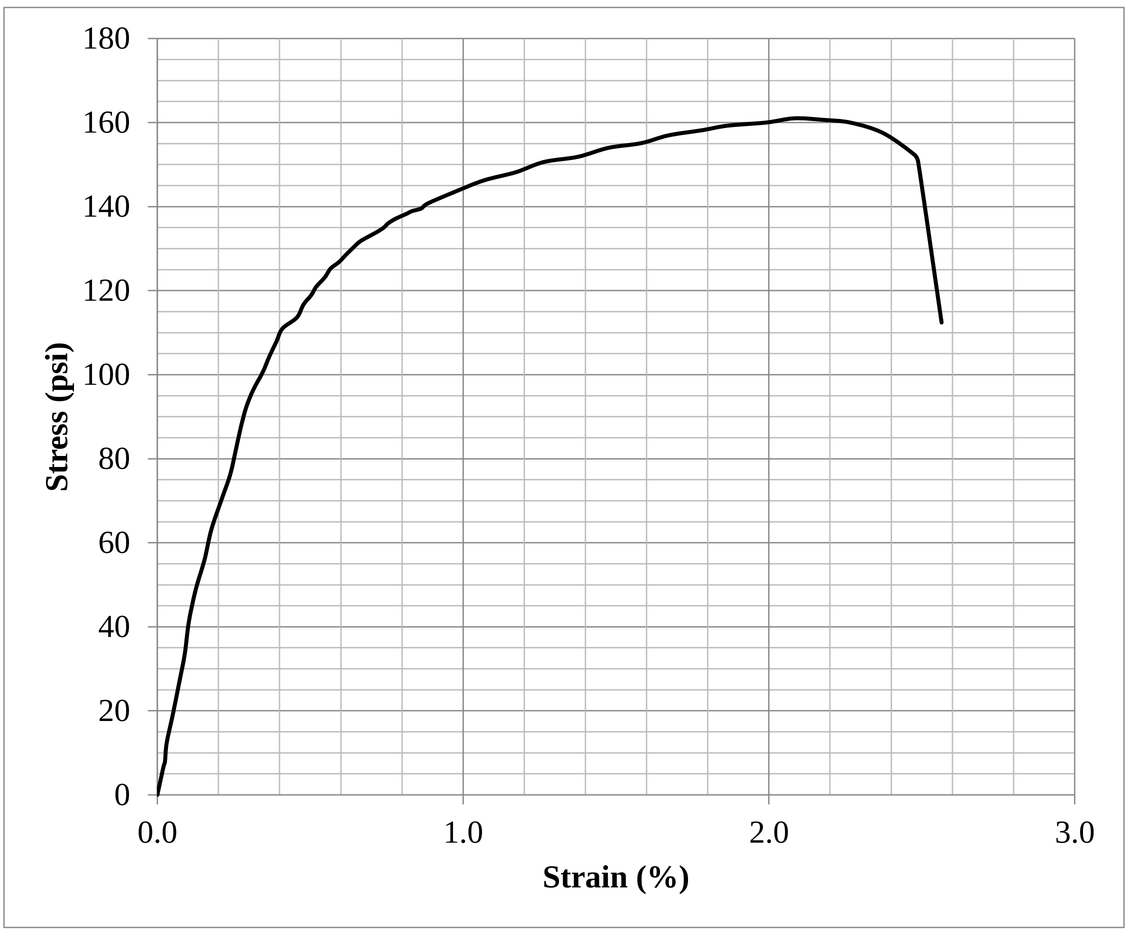
Testing Date	6/14/19
Diameter (in.)	2.040
Height (in.)	3.971
Weight (g)	297.4
Corrected Peak UCS (psi)	149.9
Corrected Failure Strain (%)	2.41
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	20-1-E
Molding Date	5/30/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	225 (229.3)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.5

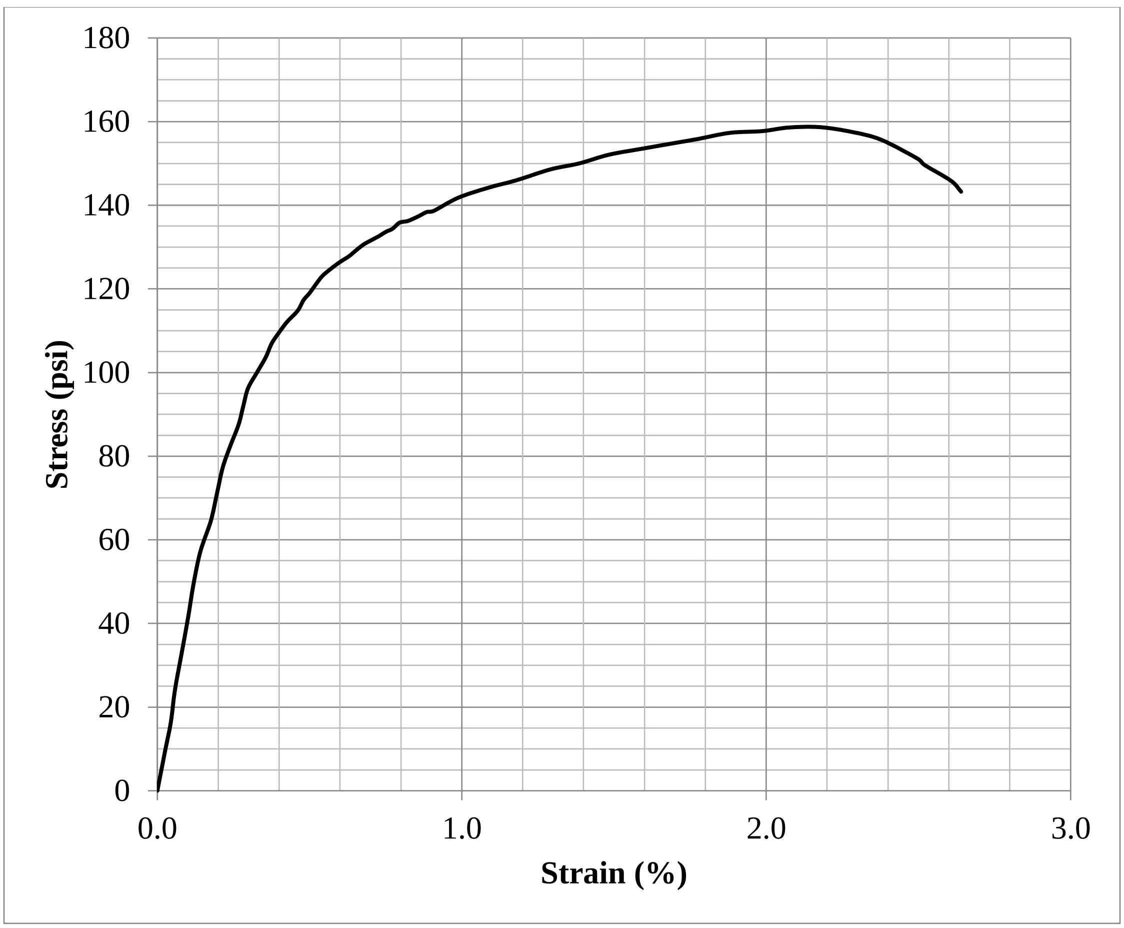
Testing Date	6/27/19
Diameter (in.)	2.049
Height (in.)	3.872
Weight (g)	290.8
Corrected Peak UCS (psi)	159.6
Corrected Failure Strain (%)	2.08
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	20-1-F
Molding Date	5/30/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	225 (229.3)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.4

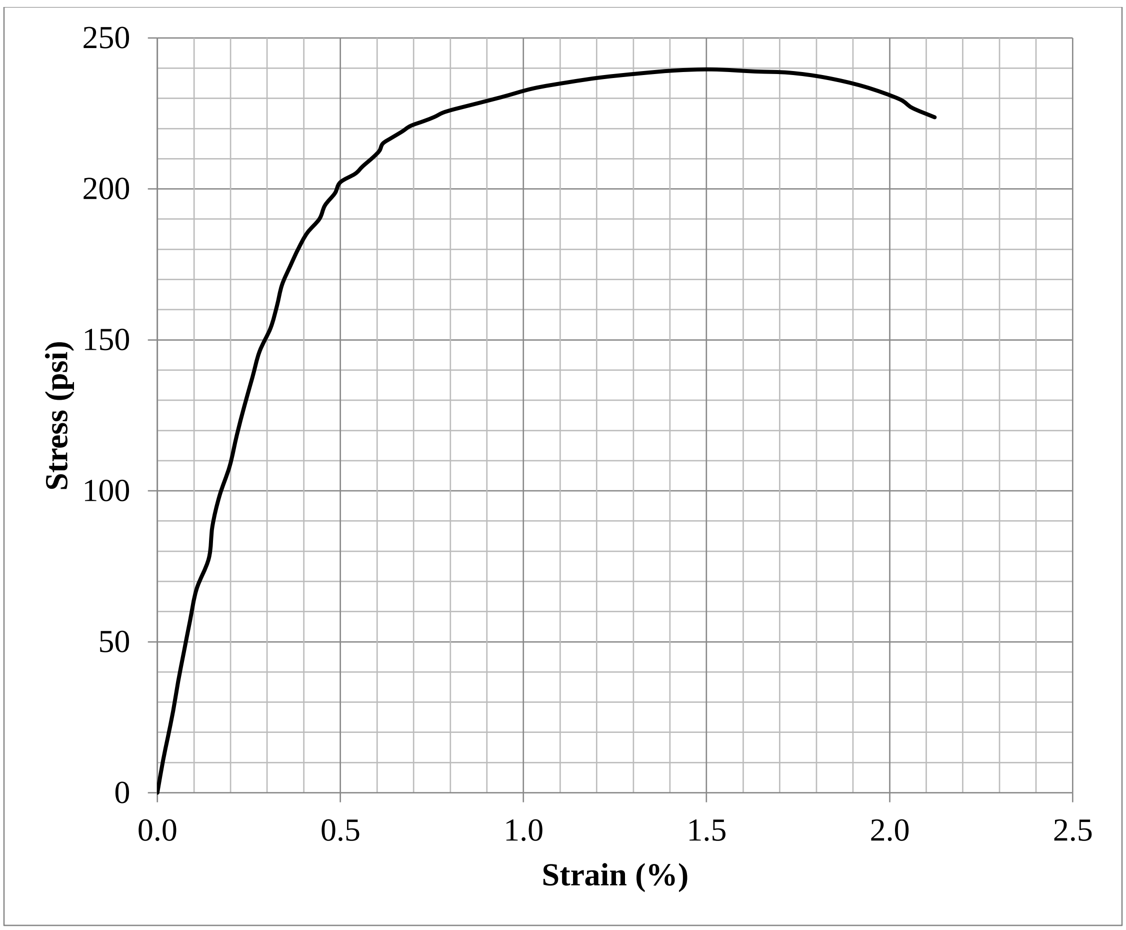
Testing Date	6/27/19
Diameter (in.)	2.045
Height (in.)	3.983
Weight (g)	299.9
Corrected Peak UCS (psi)	158.0
Corrected Failure Strain (%)	2.18
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-2-A
Molding Date	5/30/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	350 (354.4)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.5

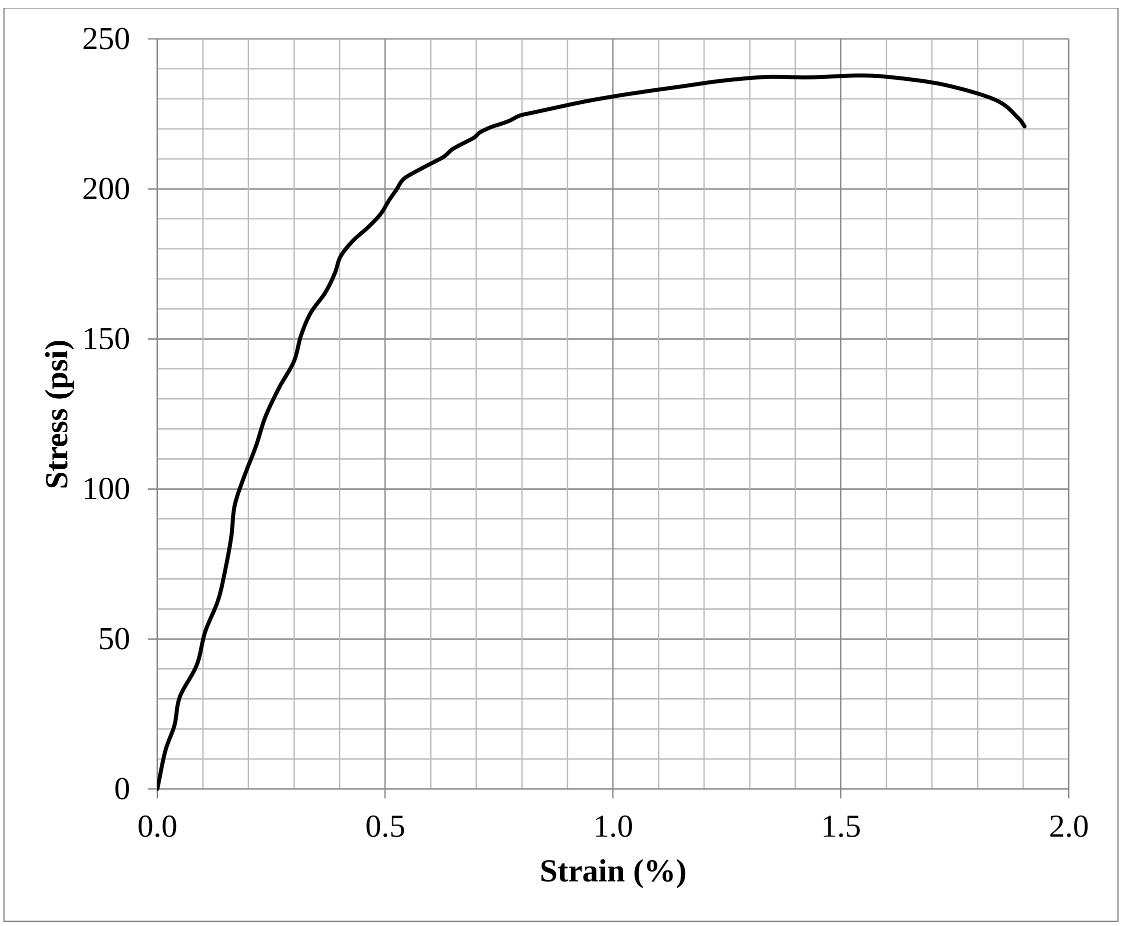
Testing Date	6/6/19
Diameter (in.)	2.050
Height (in.)	3.916
Weight (g)	298.9
Corrected Peak UCS (psi)	237.9
Corrected Failure Strain (%)	1.51
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-2-B
Molding Date	5/30/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	350 (354.4)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.3

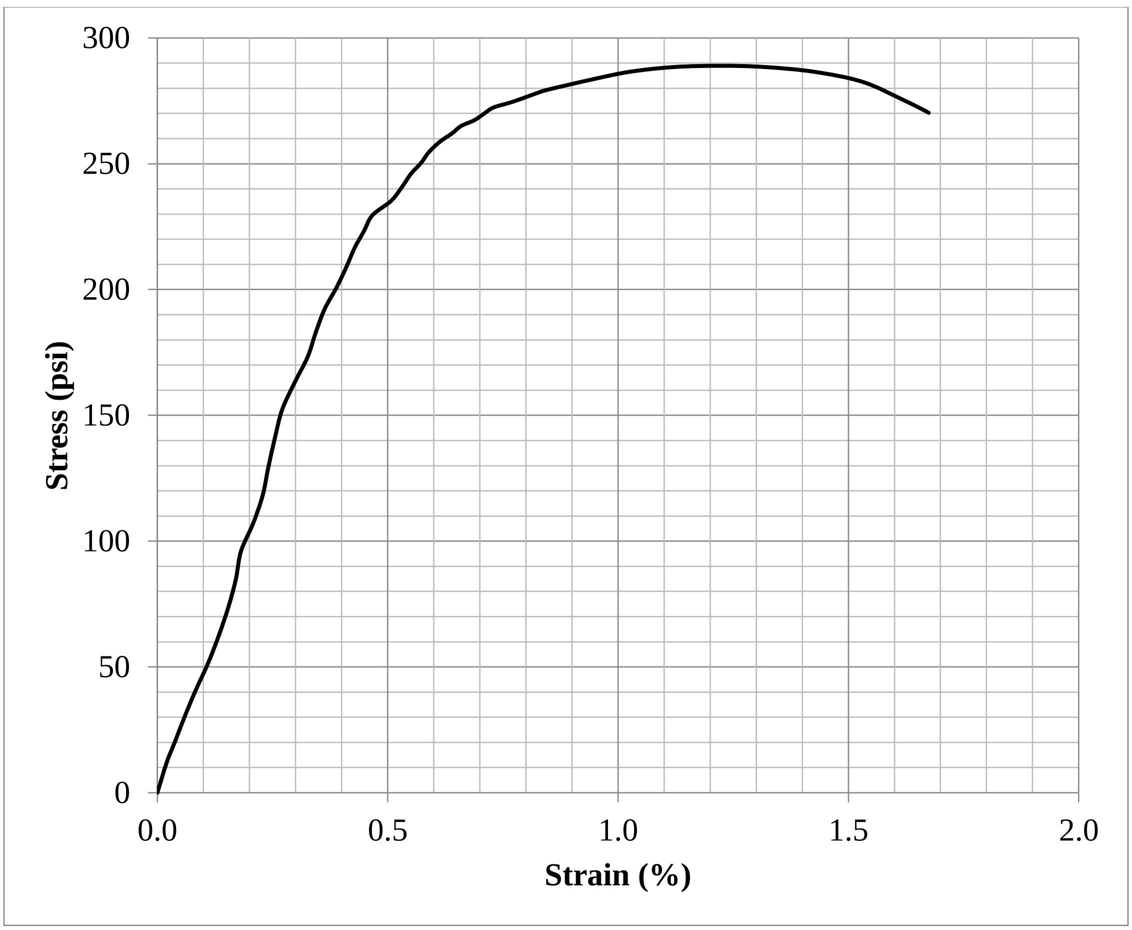
Testing Date	6/6/19
Diameter (in.)	2.043
Height (in.)	3.899
Weight (g)	296.9
Corrected Peak UCS (psi)	236.1
Corrected Failure Strain (%)	1.54
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-2-C
Molding Date	5/30/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	350 (354.4)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.1

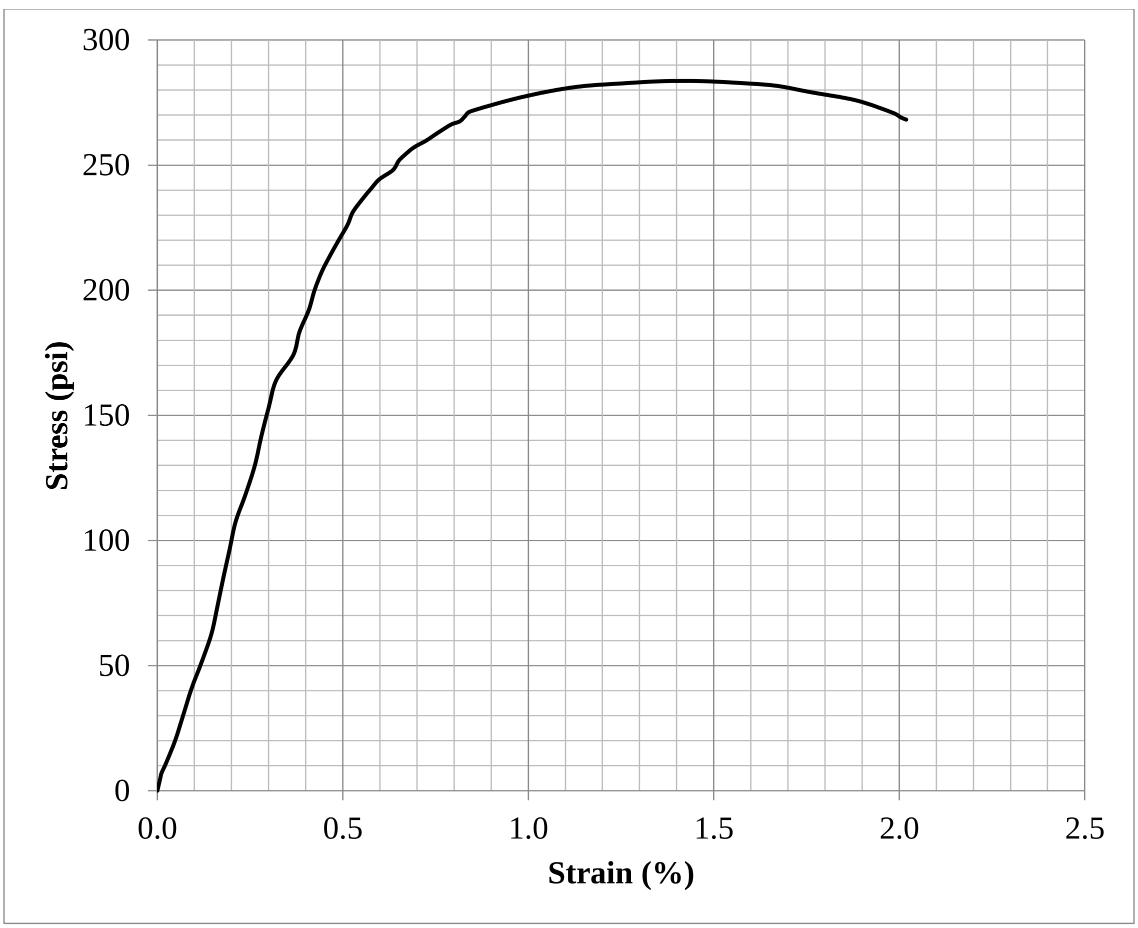
Testing Date	6/14/19
Diameter (in.)	2.048
Height (in.)	3.958
Weight (g)	302.5
Corrected Peak UCS (psi)	287.4
Corrected Failure Strain (%)	1.22
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-2-D
Molding Date	5/30/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	350 (354.4)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.6

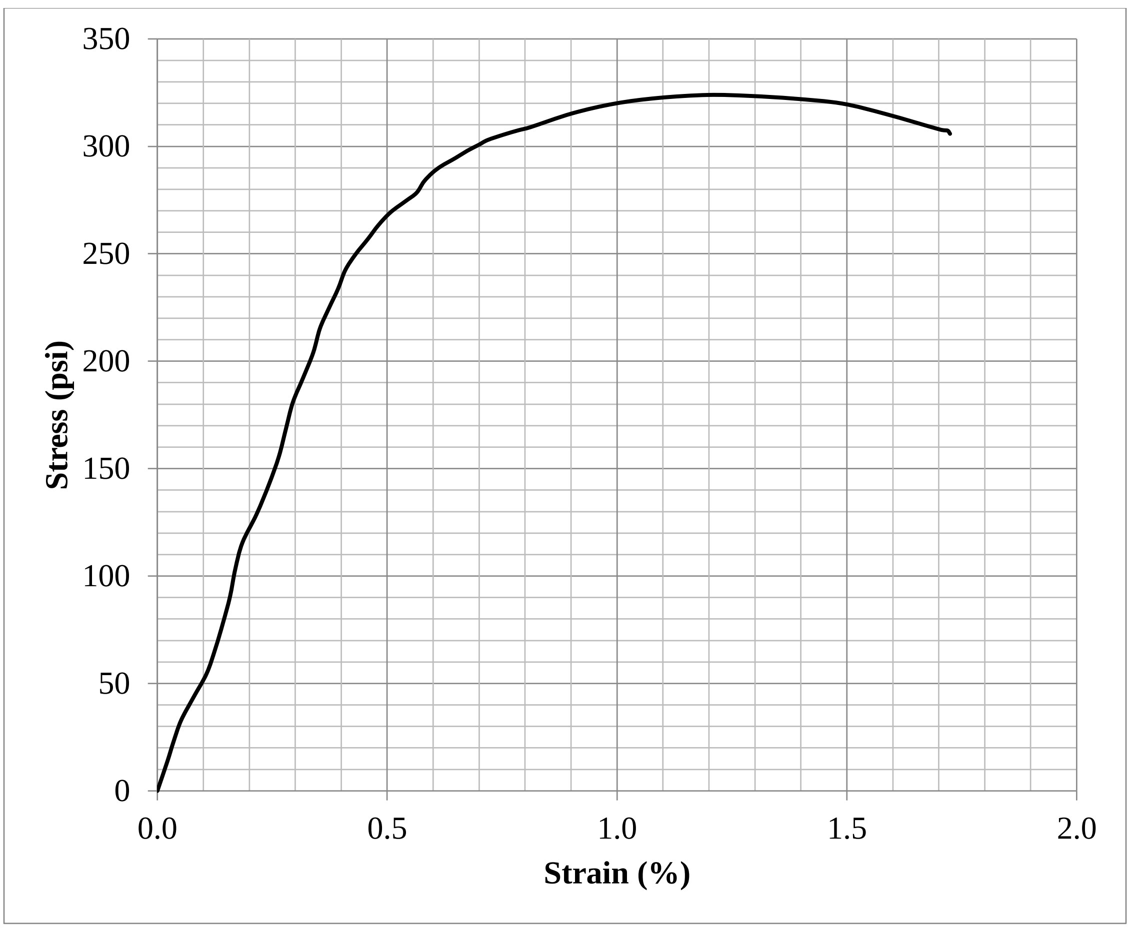
Testing Date	6/14/19
Diameter (in.)	2.047
Height (in.)	3.871
Weight (g)	295.4 (*Est.*)
Corrected Peak UCS (psi)	281.1
Corrected Failure Strain (%)	1.47
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-2-E
Molding Date	5/30/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (354.4)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.3

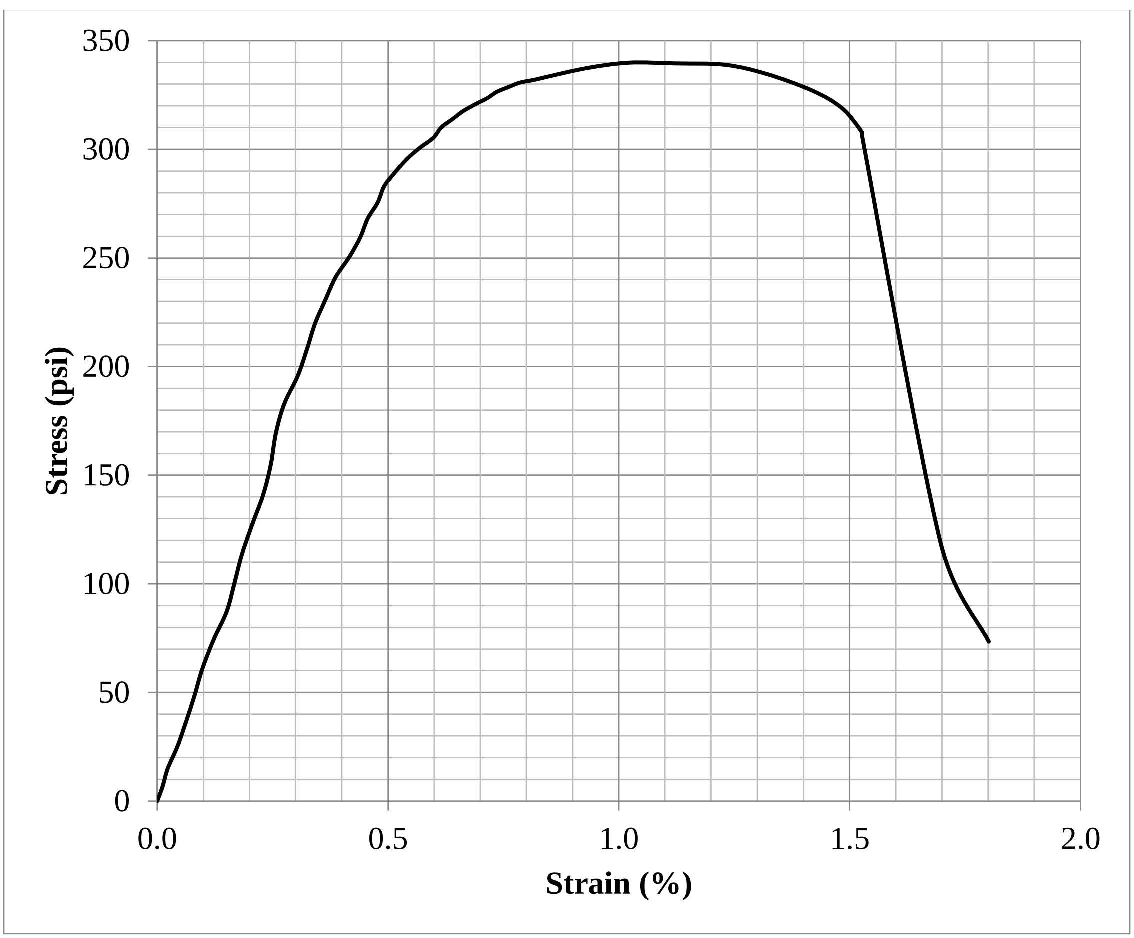
Testing Date	6/27/19
Diameter (in.)	2.047
Height (in.)	3.885
Weight (g)	298.9
Corrected Peak UCS (psi)	321.3
Corrected Failure Strain (%)	1.20
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-2-F
Molding Date	5/30/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	350 (354.4)
w:b	0.6
Soil OM (%)	29.6
Bleed Water (g)	0.2

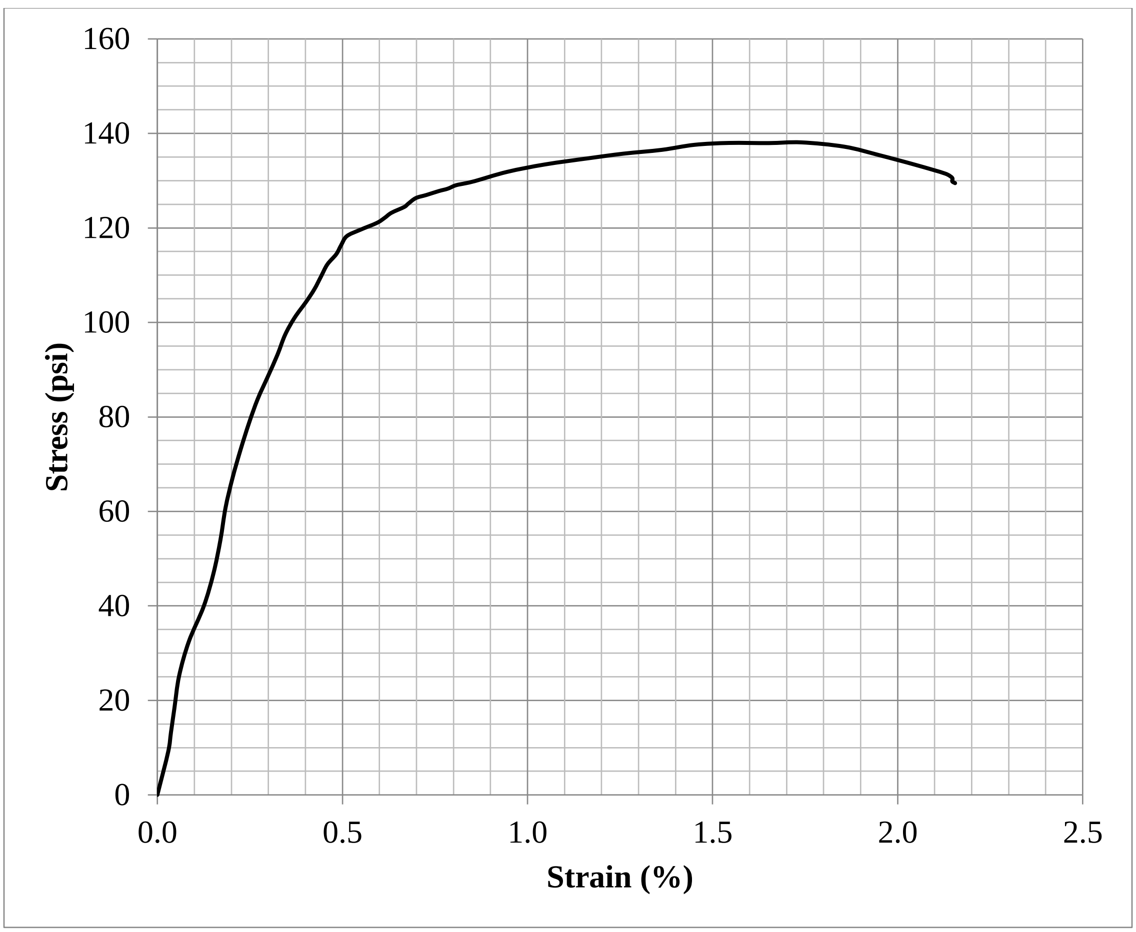
Testing Date	6/27/19
Diameter (in.)	2.048
Height (in.)	3.988
Weight (g)	306.9
Corrected Peak UCS (psi)	338.5
Corrected Failure Strain (%)	1.02
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	20-3-A
Molding Date	5/31/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	350 (355.1)
w:b	1.0
Soil OM (%)	29.6
Bleed Water (g)	1.0

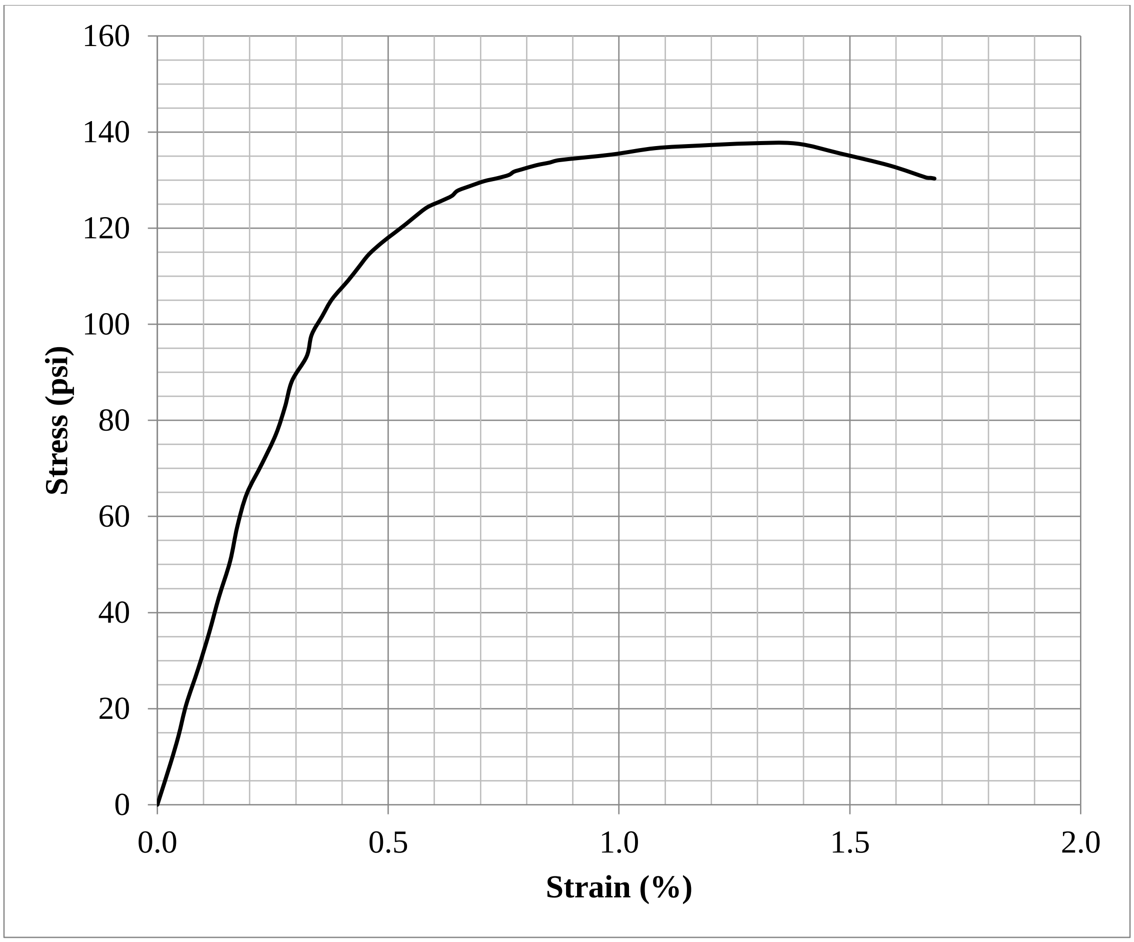
Testing Date	6/6/19
Diameter (in.)	2.043
Height (in.)	3.598
Weight (g)	271.8
Corrected Peak UCS (psi)	135.5
Corrected Failure Strain (%)	1.74
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-3-B
Molding Date	5/31/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (355.1)
w:b	1.0
Soil OM (%)	29.6
Bleed Water (g)	0.5

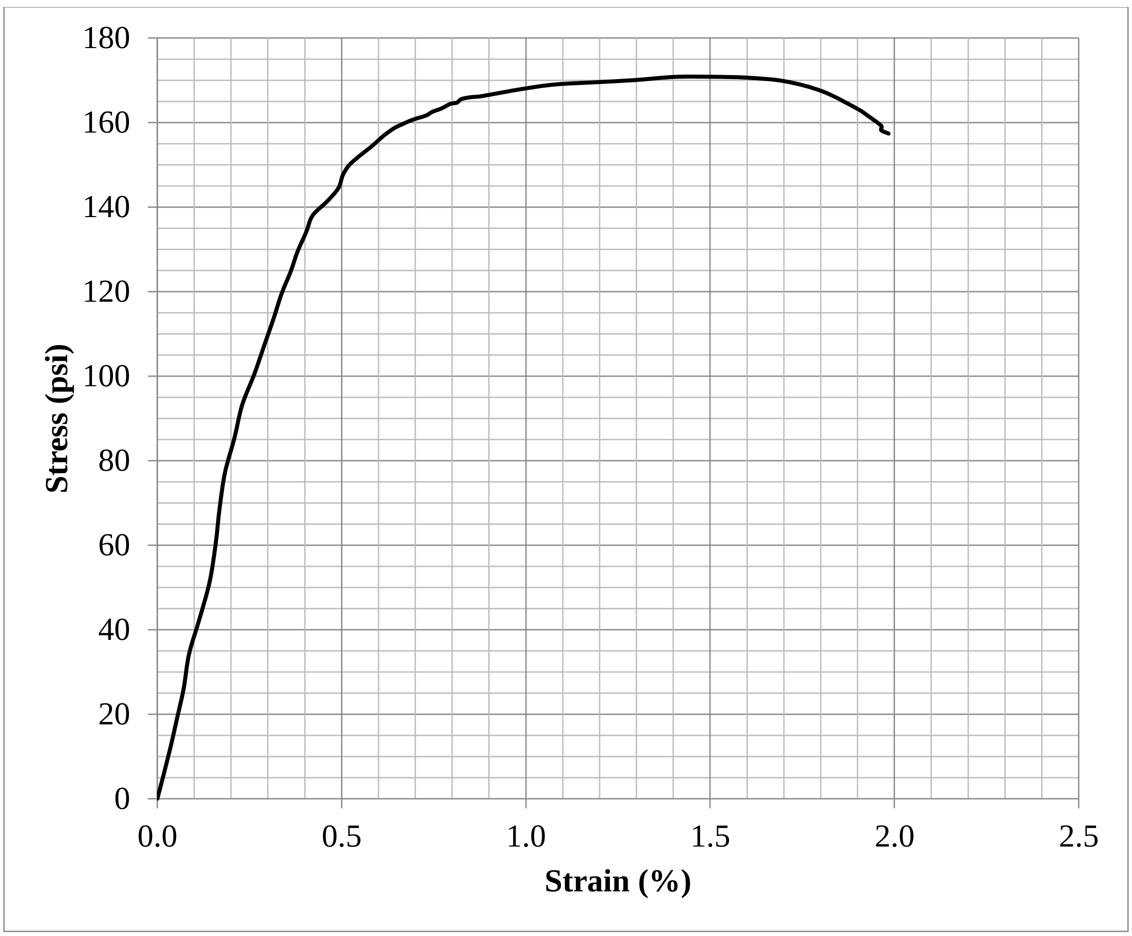
Testing Date	6/6/19
Diameter (in.)	2.041
Height (in.)	3.751
Weight (g)	283.2
Corrected Peak UCS (psi)	135.8
Corrected Failure Strain (%)	1.28
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-3-C
Molding Date	5/31/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	350 (355.1)
w:b	1.0
Soil OM (%)	29.6
Bleed Water (g)	1.4

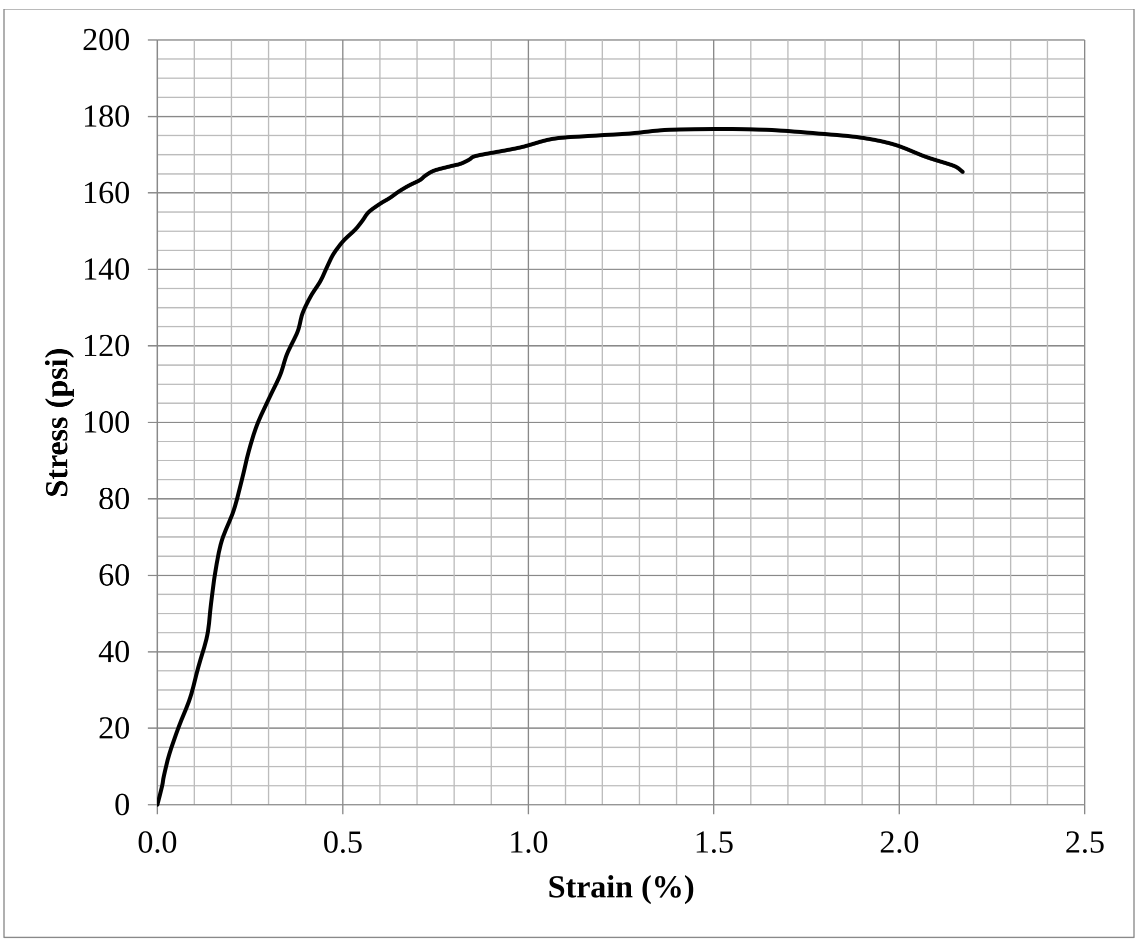
Testing Date	6/14/19
Diameter (in.)	2.038
Height (in.)	3.675
Weight (g)	278.1 (*Est.*)
Corrected Peak UCS (psi)	168.1
Corrected Failure Strain (%)	1.50
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-3-D
Molding Date	5/31/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	350 (355.1)
w:b	1.0
Soil OM (%)	29.6
Bleed Water (g)	1.2

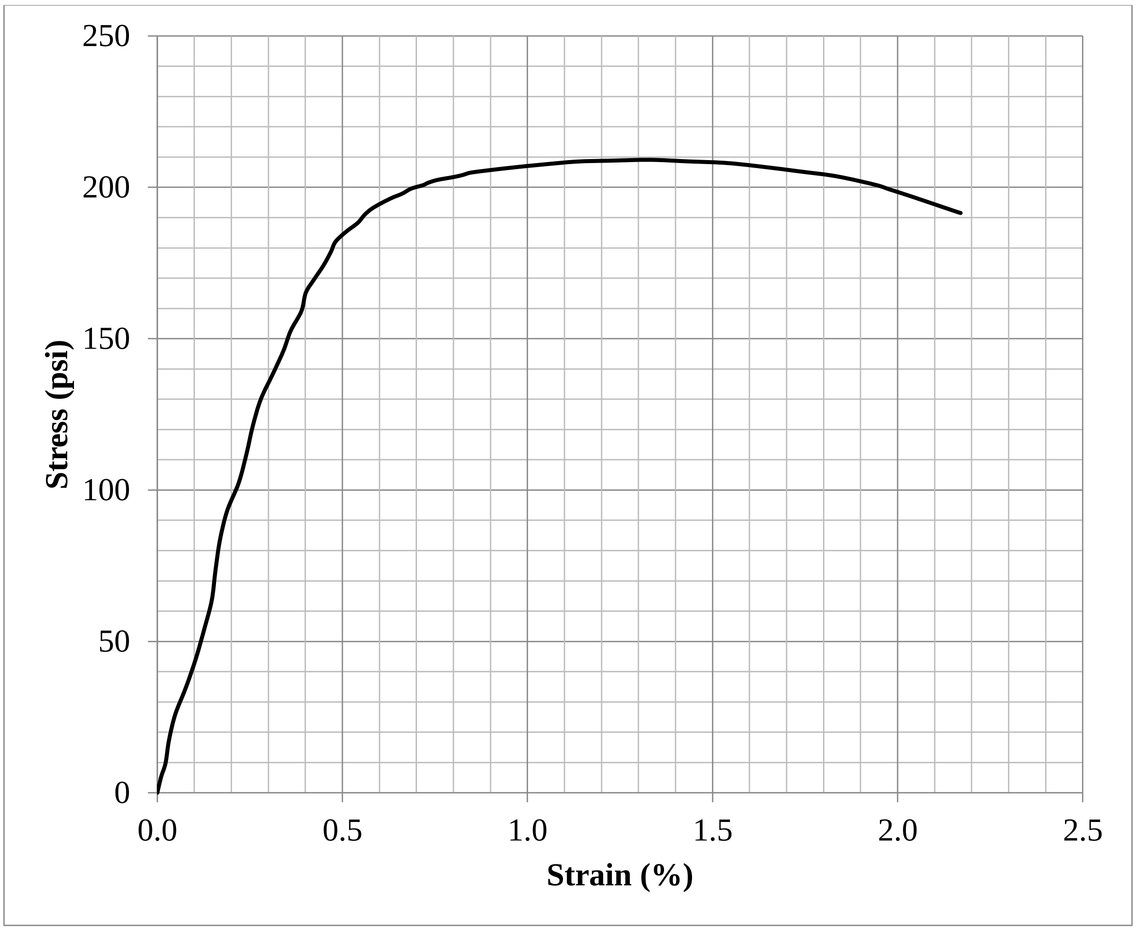
Testing Date	6/14/19
Diameter (in.)	2.041
Height (in.)	3.729
Weight (g)	282.3
Corrected Peak UCS (psi)	174.2
Corrected Failure Strain (%)	1.47
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-3-E
Molding Date	5/31/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (355.1)
w:b	1.0
Soil OM (%)	29.6
Bleed Water (g)	0.9

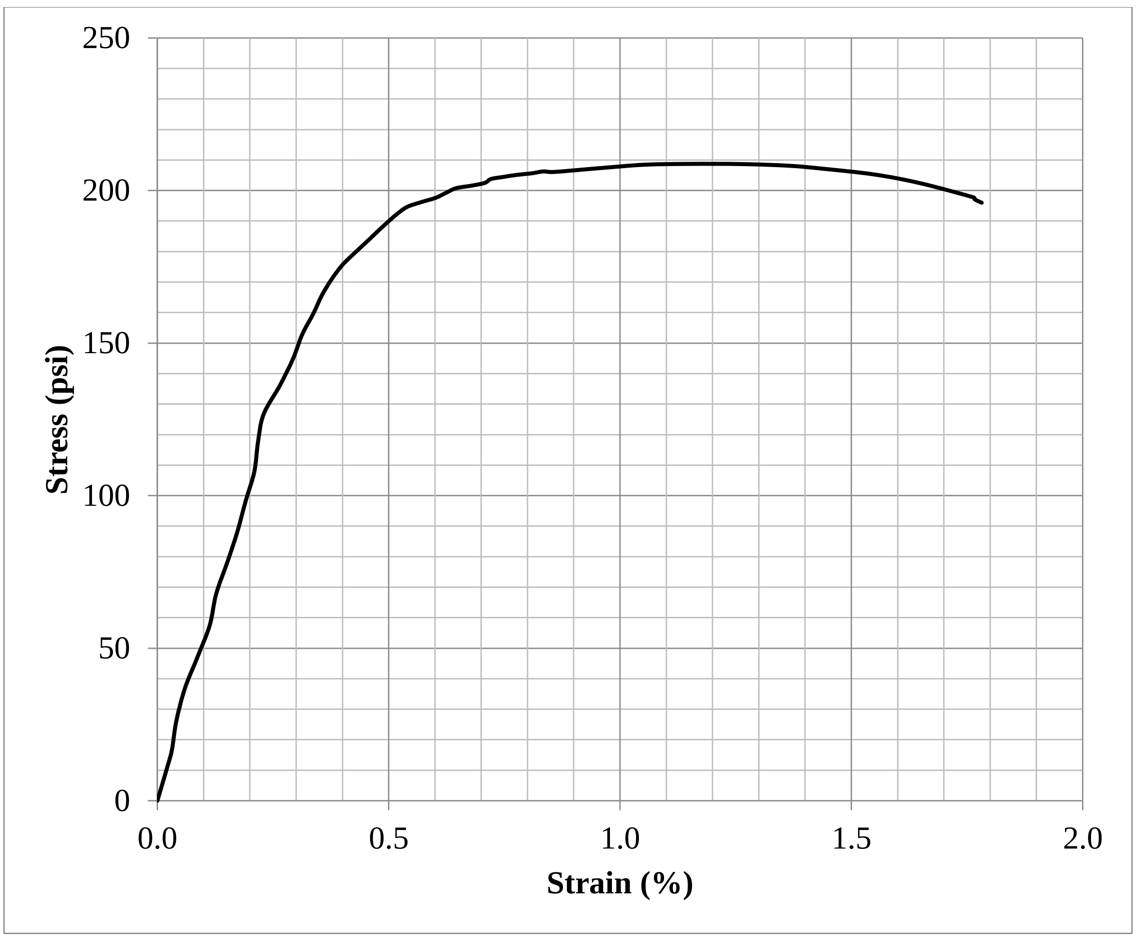
Testing Date	6/27/19
Diameter (in.)	2.045
Height (in.)	3.733
Weight (g)	283.6
Corrected Peak UCS (psi)	206.2
Corrected Failure Strain (%)	1.33
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	20-3-F
Molding Date	5/31/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (355.1)
w:b	1.0
Soil OM (%)	29.6
Bleed Water (g)	1.3

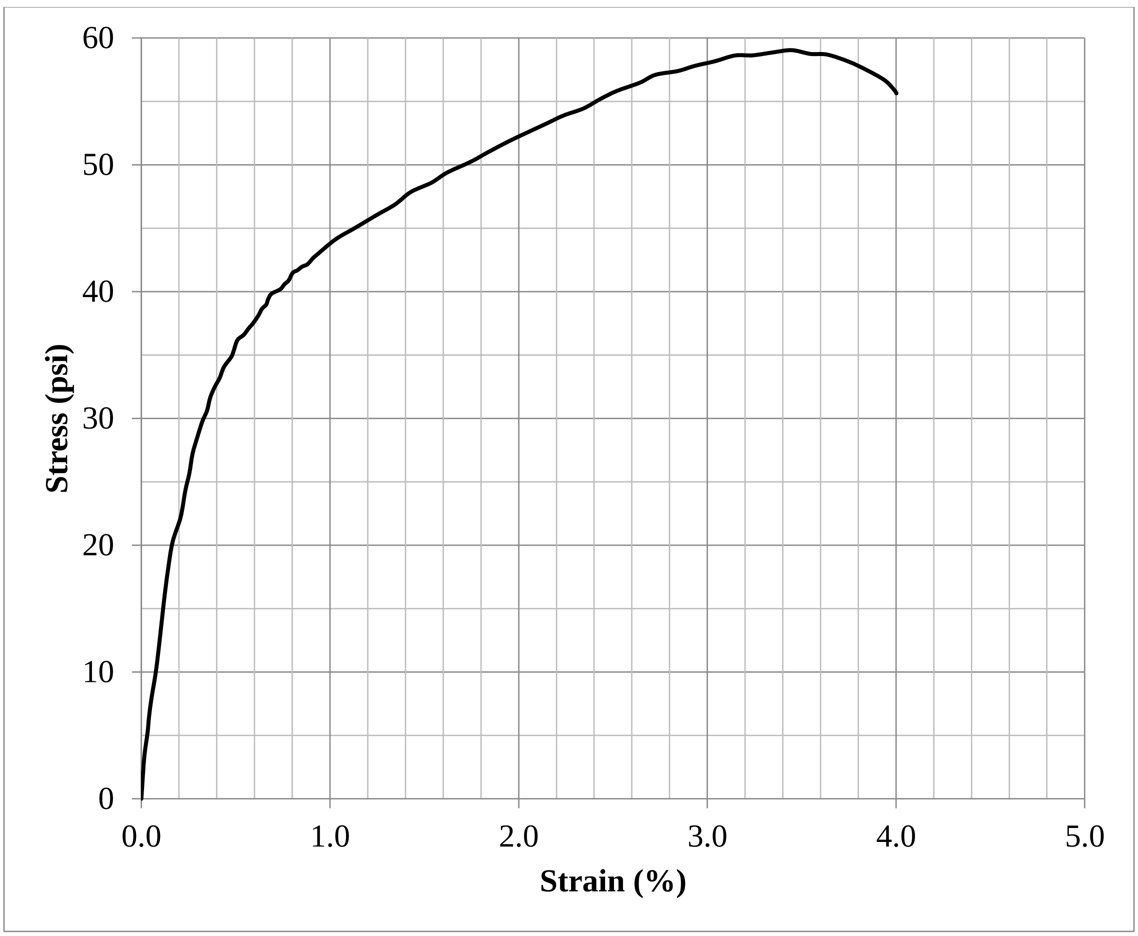
Testing Date	6/27/19
Diameter (in.)	2.046
Height (in.)	3.846
Weight (g)	293.3
Corrected Peak UCS (psi)	206.7
Corrected Failure Strain (%)	1.15
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-1-A
Molding Date	5/29/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (253.5)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	0.4

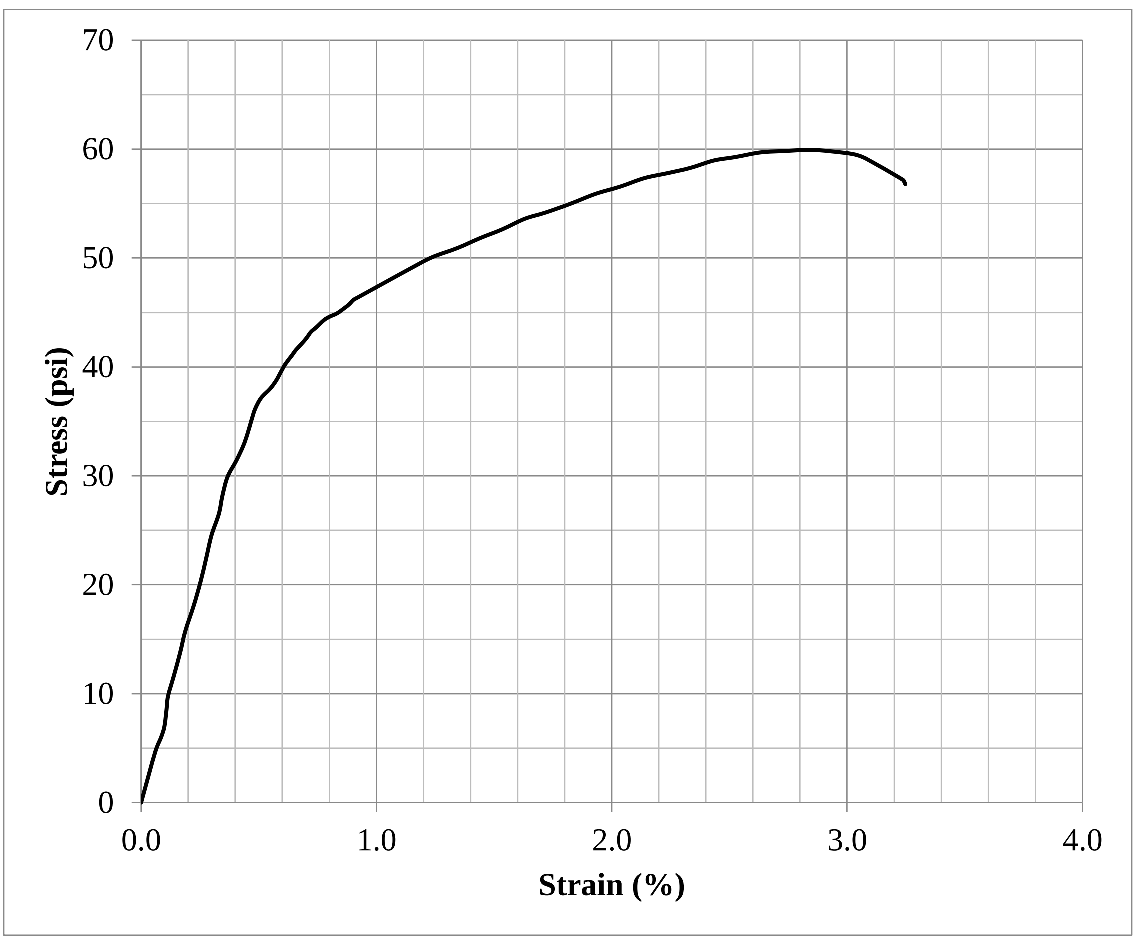
Testing Date	6/4/19
Diameter (in.)	2.038
Height (in.)	3.855
Weight (g)	272.5
Corrected Peak UCS (psi)	58.5
Corrected Failure Strain (%)	3.45
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-1-B
Molding Date	5/29/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (253.5)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	0

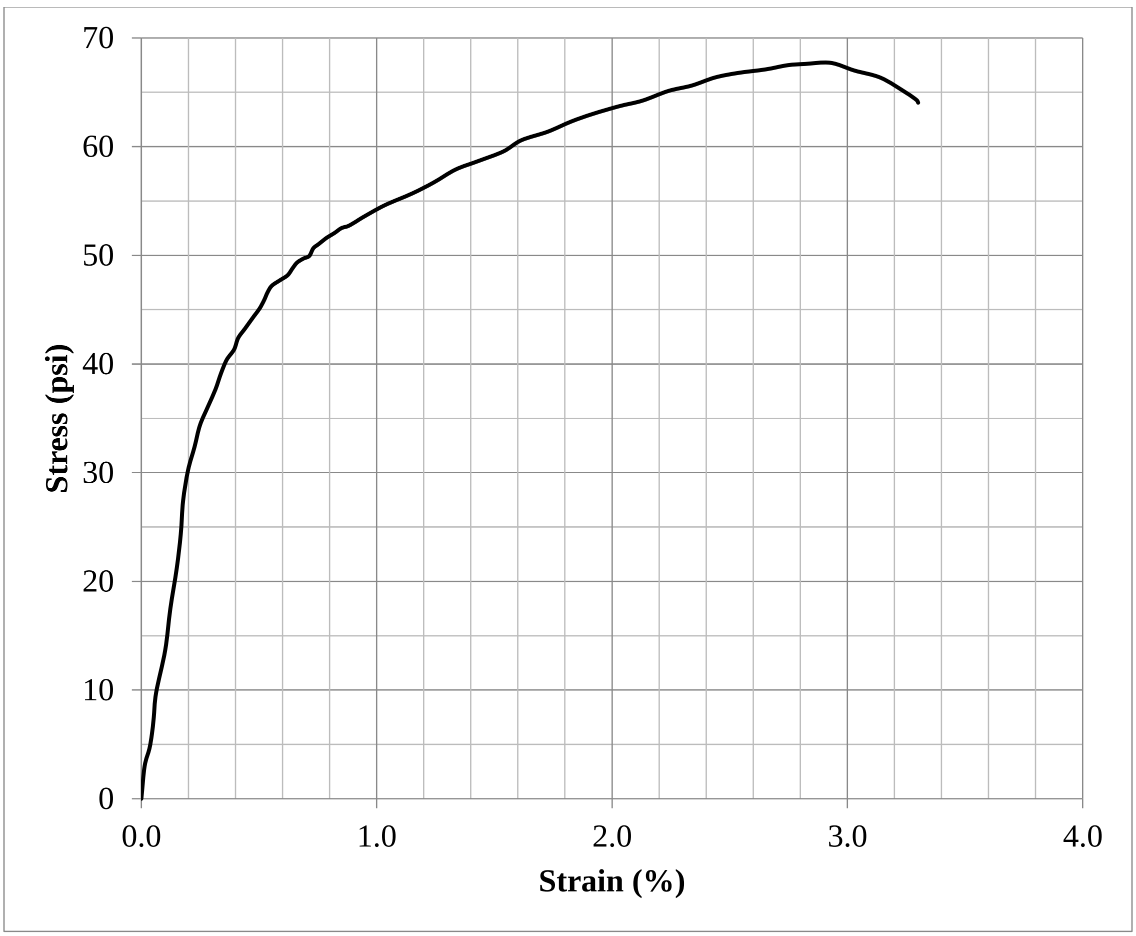
Testing Date	6/4/19
Diameter (in.)	2.035
Height (in.)	3.885
Weight (g)	276.6
Corrected Peak UCS (psi)	59.5
Corrected Failure Strain (%)	2.84
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-1-C
Molding Date	5/29/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	250 (253.5)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	0.1

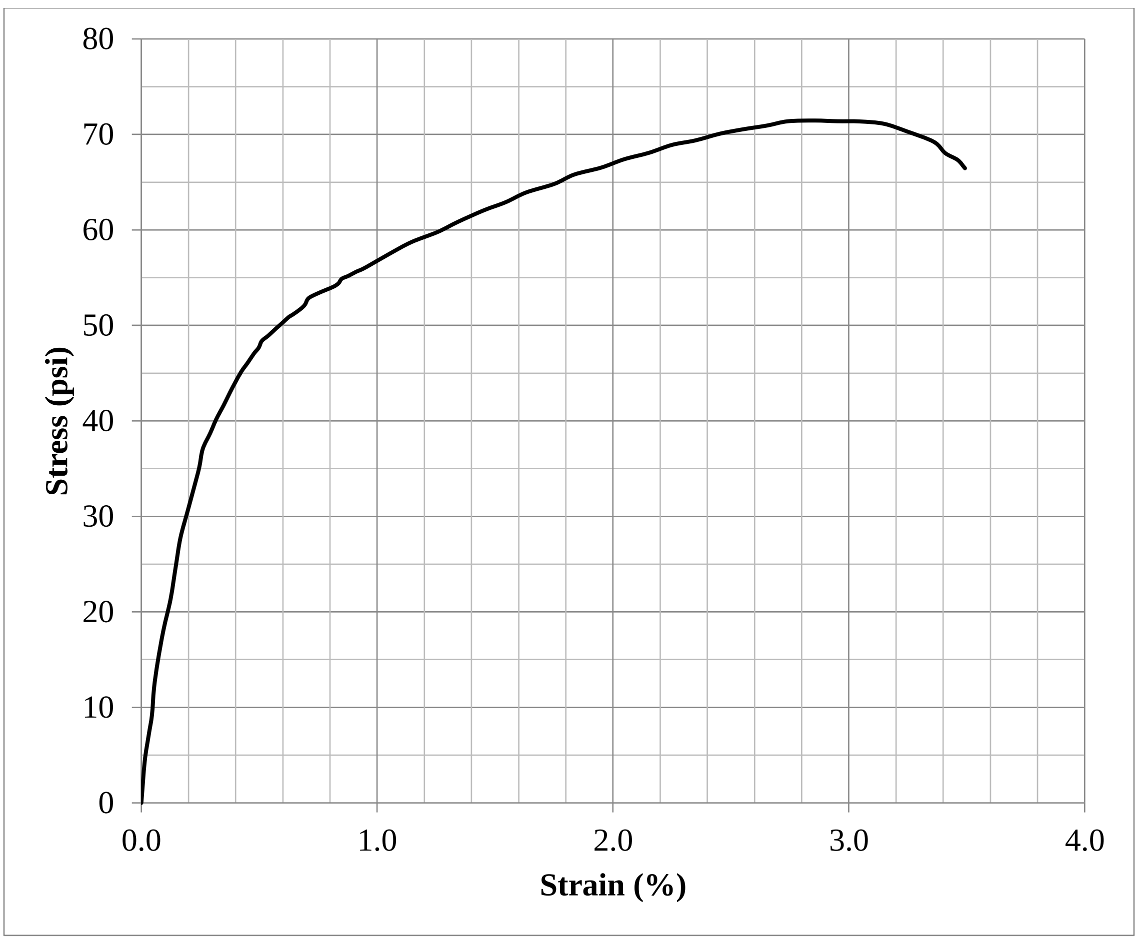
Testing Date	6/11/19
Diameter (in.)	2.030
Height (in.)	3.893
Weight (g)	276.1
Corrected Peak UCS (psi)	67.3
Corrected Failure Strain (%)	2.93
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-1-D
Molding Date	5/29/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	250 (253.5)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	0.3

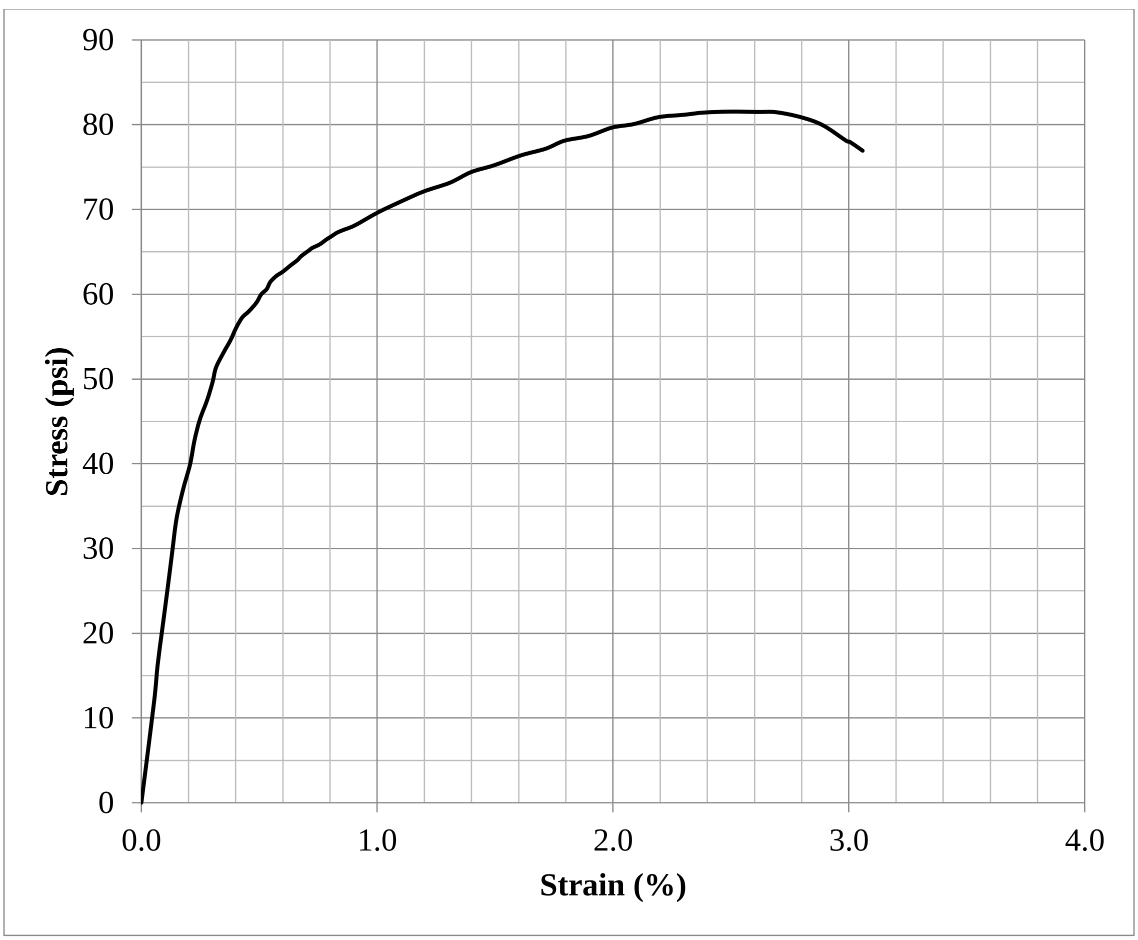
Testing Date	6/11/19
Diameter (in.)	2.043
Height (in.)	3.828
Weight (g)	272.7
Corrected Peak UCS (psi)	70.7
Corrected Failure Strain (%)	2.86
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-1-E
Molding Date	5/29/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (253.5)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	0.2

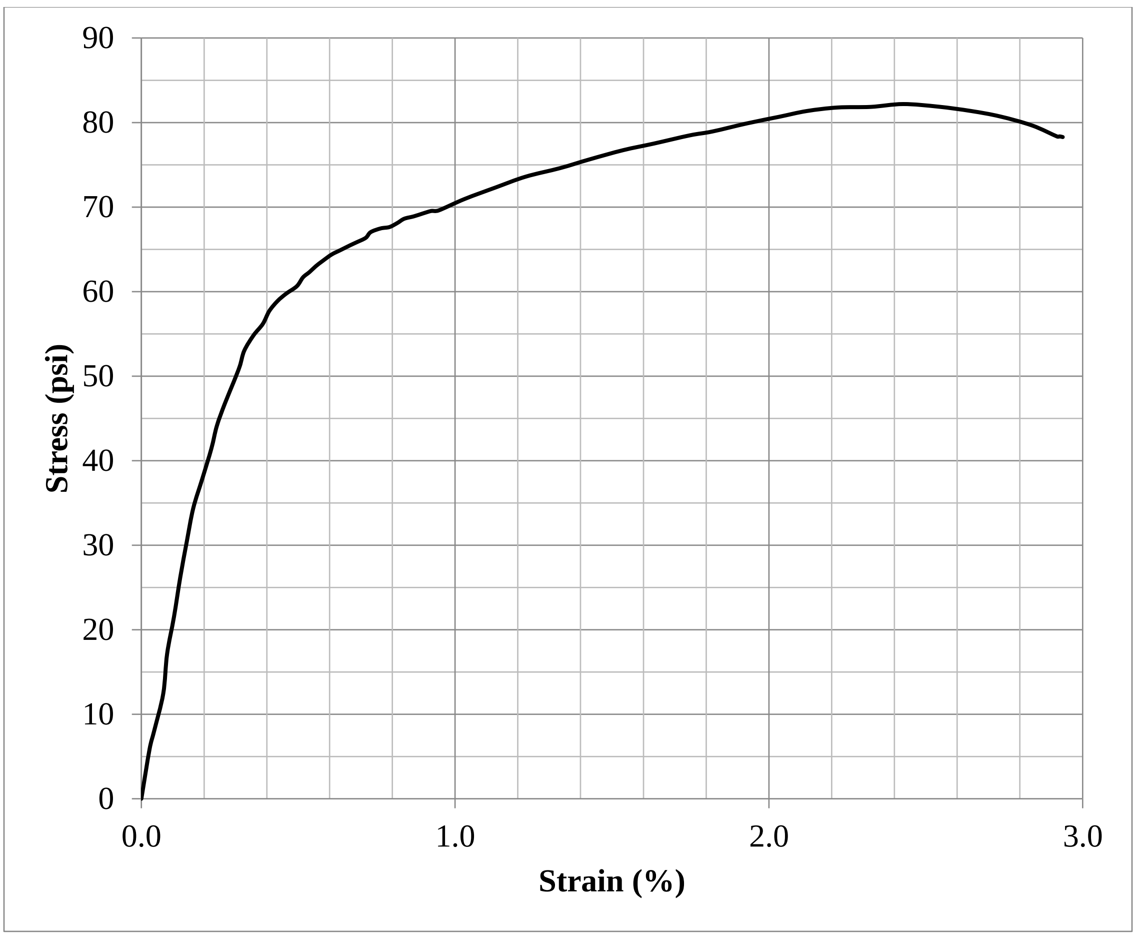
Testing Date	6/25/19
Diameter (in.)	2.042
Height (in.)	3.983
Weight (g)	284.3
Corrected Peak UCS (psi)	81.2
Corrected Failure Strain (%)	2.50
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-1-F
Molding Date	5/29/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (253.5)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	0.2

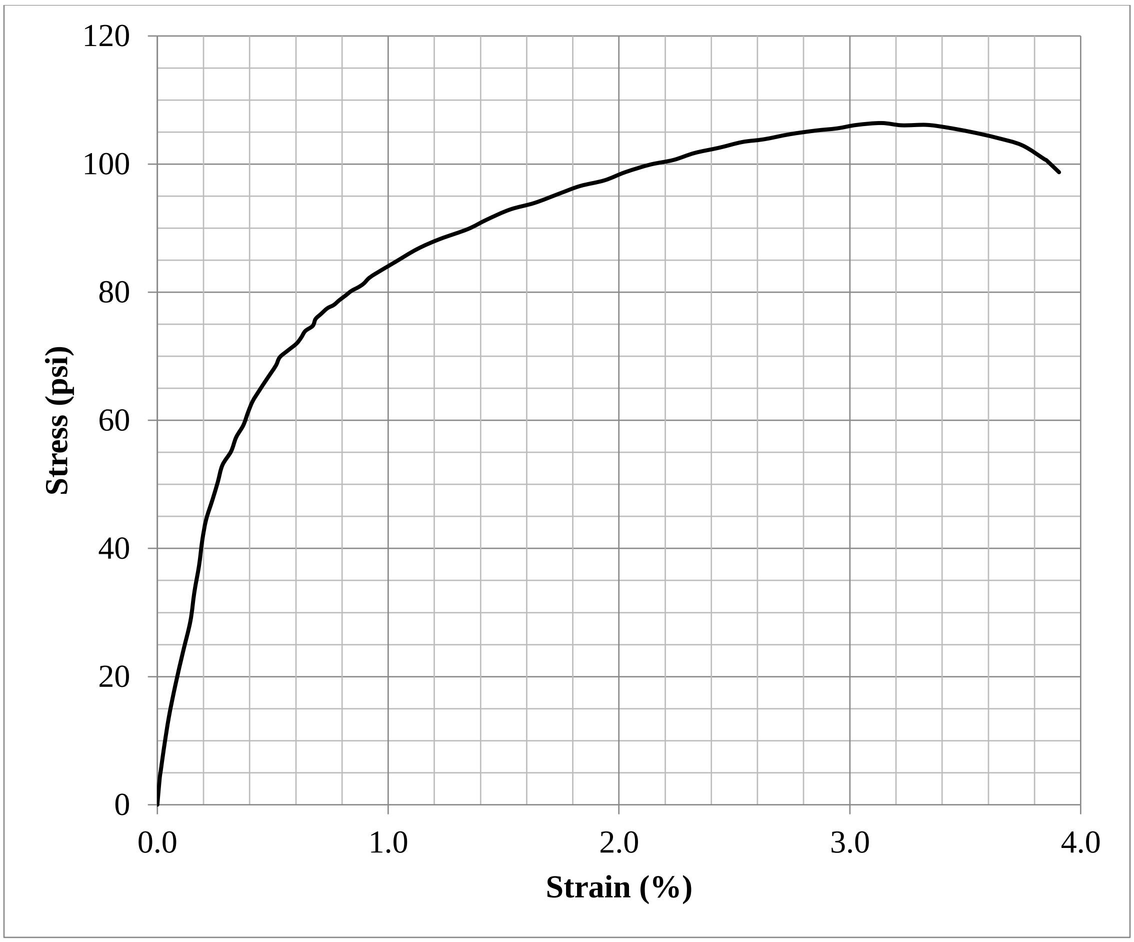
Testing Date	6/25/19
Diameter (in.)	2.041
Height (in.)	3.982
Weight (g)	284.4
Corrected Peak UCS (psi)	81.9
Corrected Failure Strain (%)	2.43
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-2-A
Molding Date	5/29/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (254.8)
w:b	0.6
Soil OM (%)	33.4
Bleed Water (g)	0.5

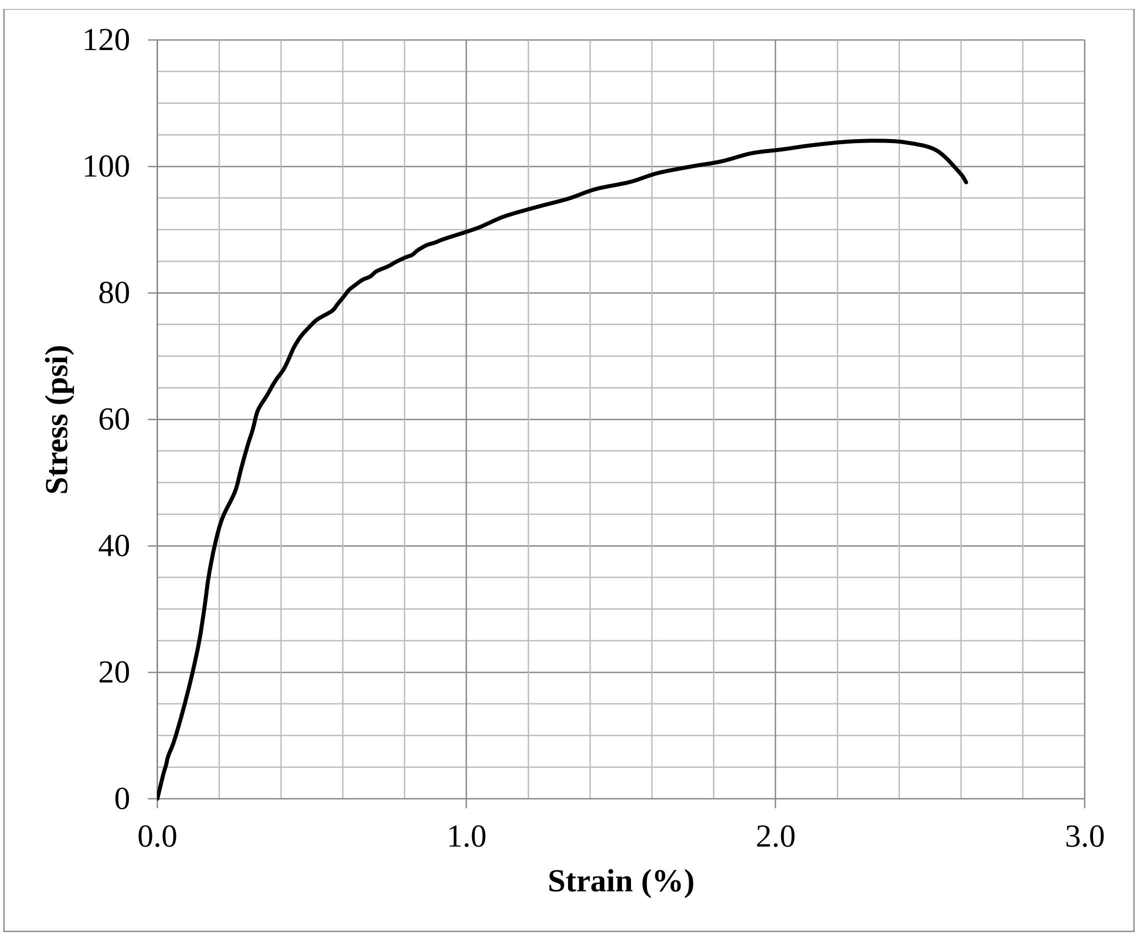
Testing Date	6/4/19
Diameter (in.)	2.045
Height (in.)	3.765
Weight (g)	269.6
Corrected Peak UCS (psi)	105.1
Corrected Failure Strain (%)	3.14
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-2-B
Molding Date	5/29/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (254.8)
w:b	0.6
Soil OM (%)	33.4
Bleed Water (g)	0.6

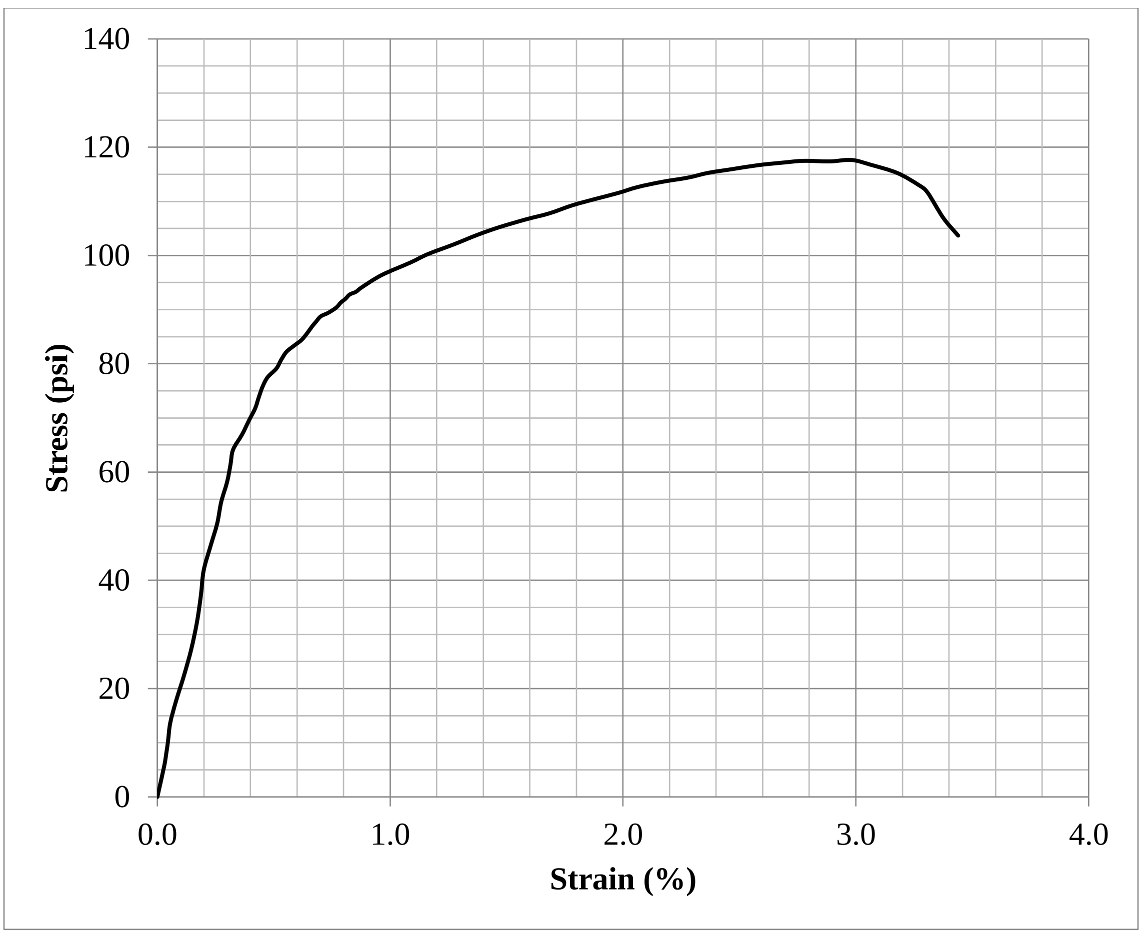
Testing Date	6/4/19
Diameter (in.)	2.042
Height (in.)	3.780
Weight (g)	271.5
Corrected Peak UCS (psi)	102.8
Corrected Failure Strain (%)	2.33
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	25-2-C
Molding Date	5/29/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	250 (254.8)
w:b	0.6
Soil OM (%)	33.4
Bleed Water (g)	0.6

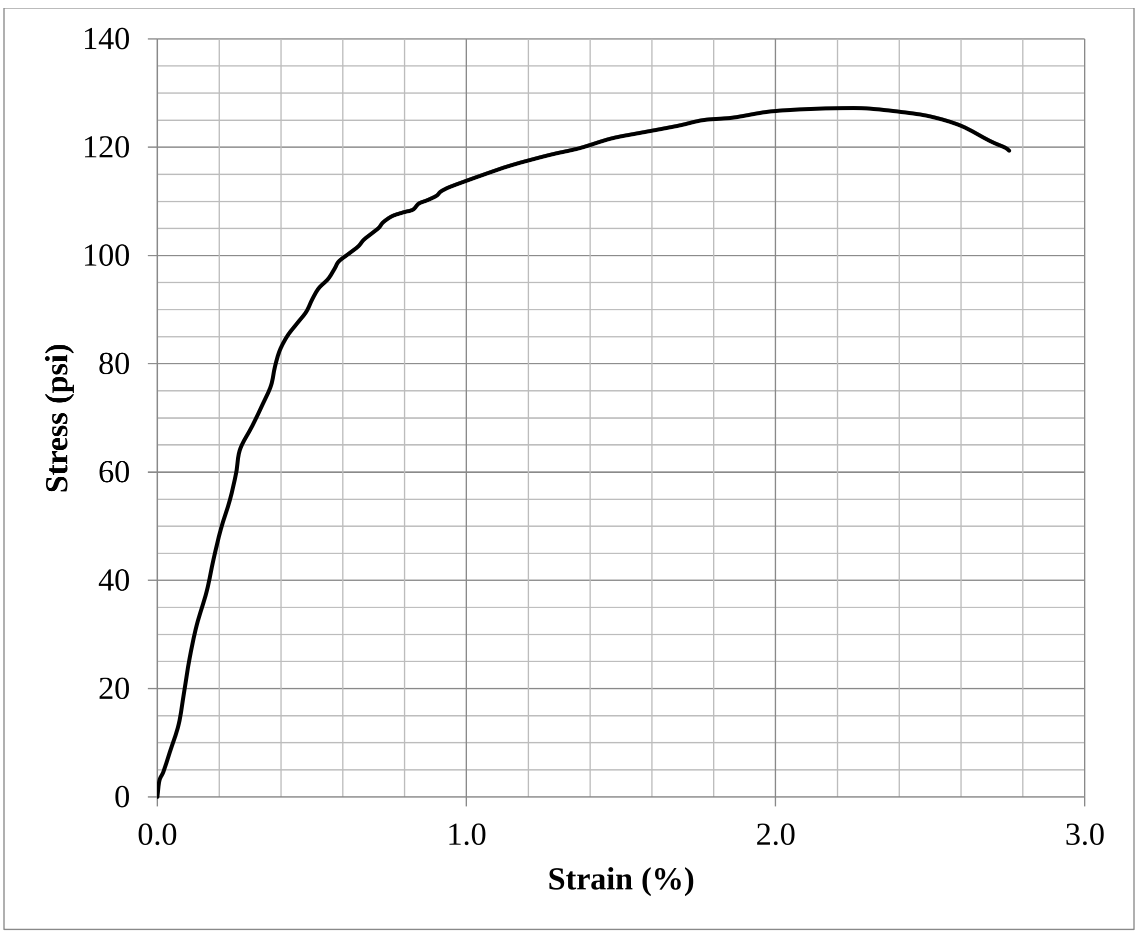
Testing Date	6/11/19
Diameter (in.)	2.045
Height (in.)	3.799
Weight (g)	273.6
Corrected Peak UCS (psi)	116.3
Corrected Failure Strain (%)	2.98
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-2-D
Molding Date	5/29/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (254.8)
w:b	0.6
Soil OM (%)	33.4
Bleed Water (g)	0.7

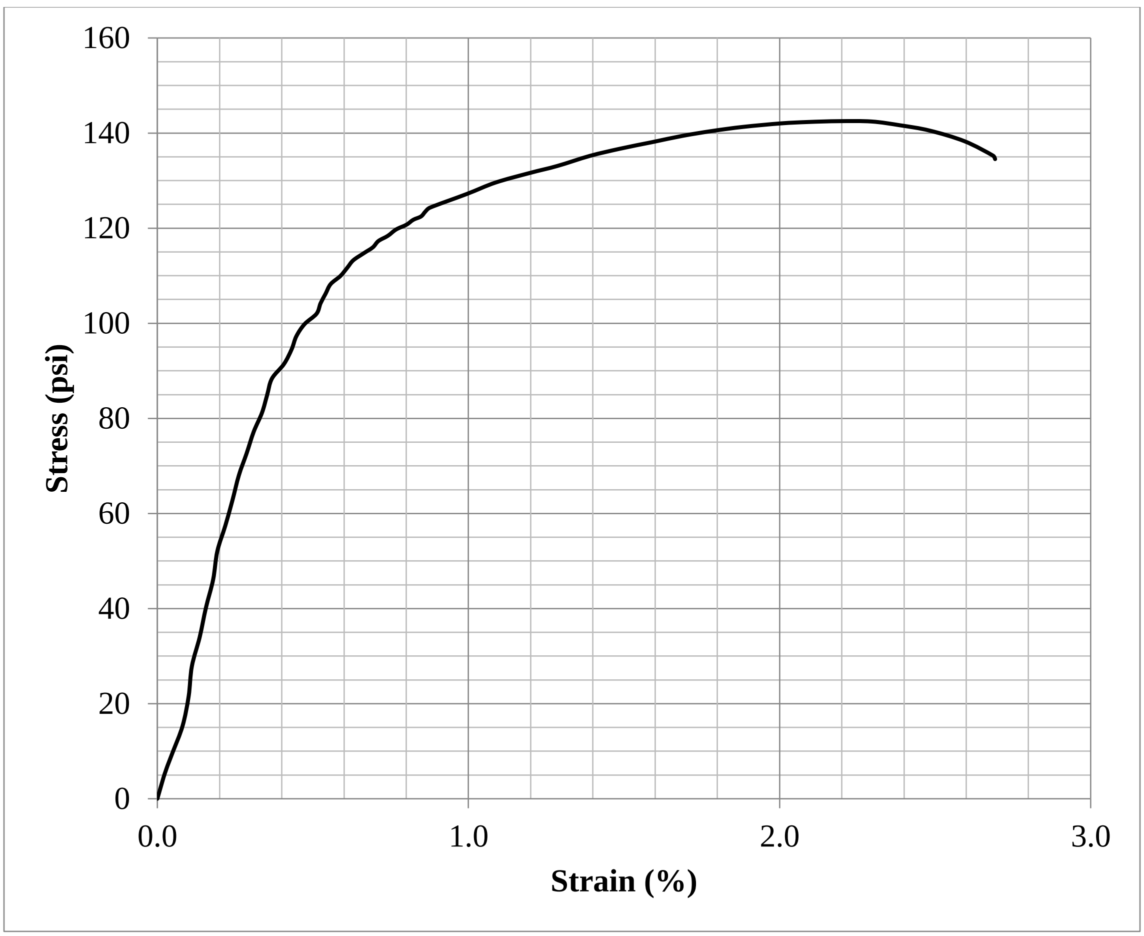
Testing Date	6/11/19
Diameter (in.)	2.042
Height (in.)	3.710
Weight (g)	267.0
Corrected Peak UCS (psi)	125.3
Corrected Failure Strain (%)	2.19
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-2-E
Molding Date	5/29/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (254.8)
w:b	0.6
Soil OM (%)	33.4
Bleed Water (g)	0.8

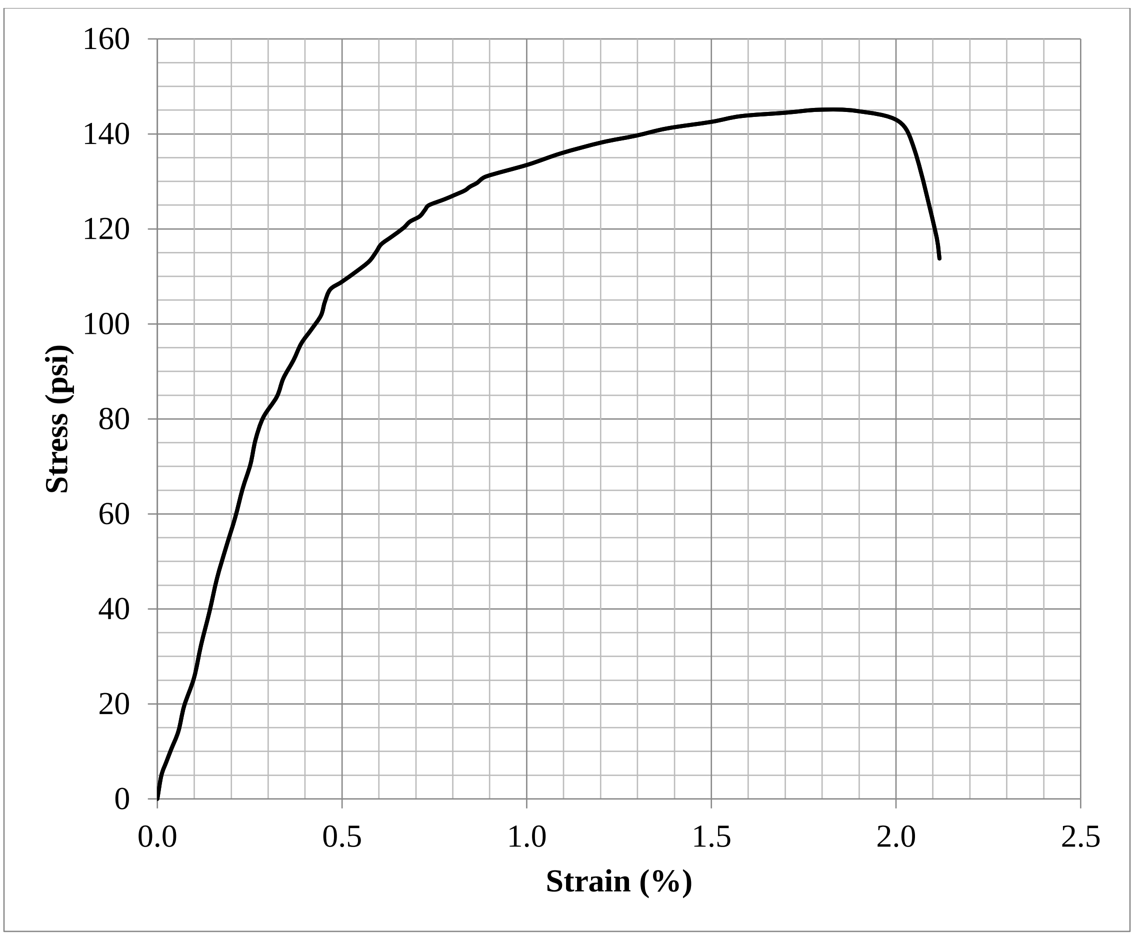
Testing Date	6/25/19
Diameter (in.)	2.040
Height (in.)	3.630
Weight (g)	261.8
Corrected Peak UCS (psi)	140.0
Corrected Failure Strain (%)	2.19
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	25-2-F
Molding Date	5/29/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (254.8)
w:b	0.6
Soil OM (%)	33.4
Bleed Water (g)	0.7

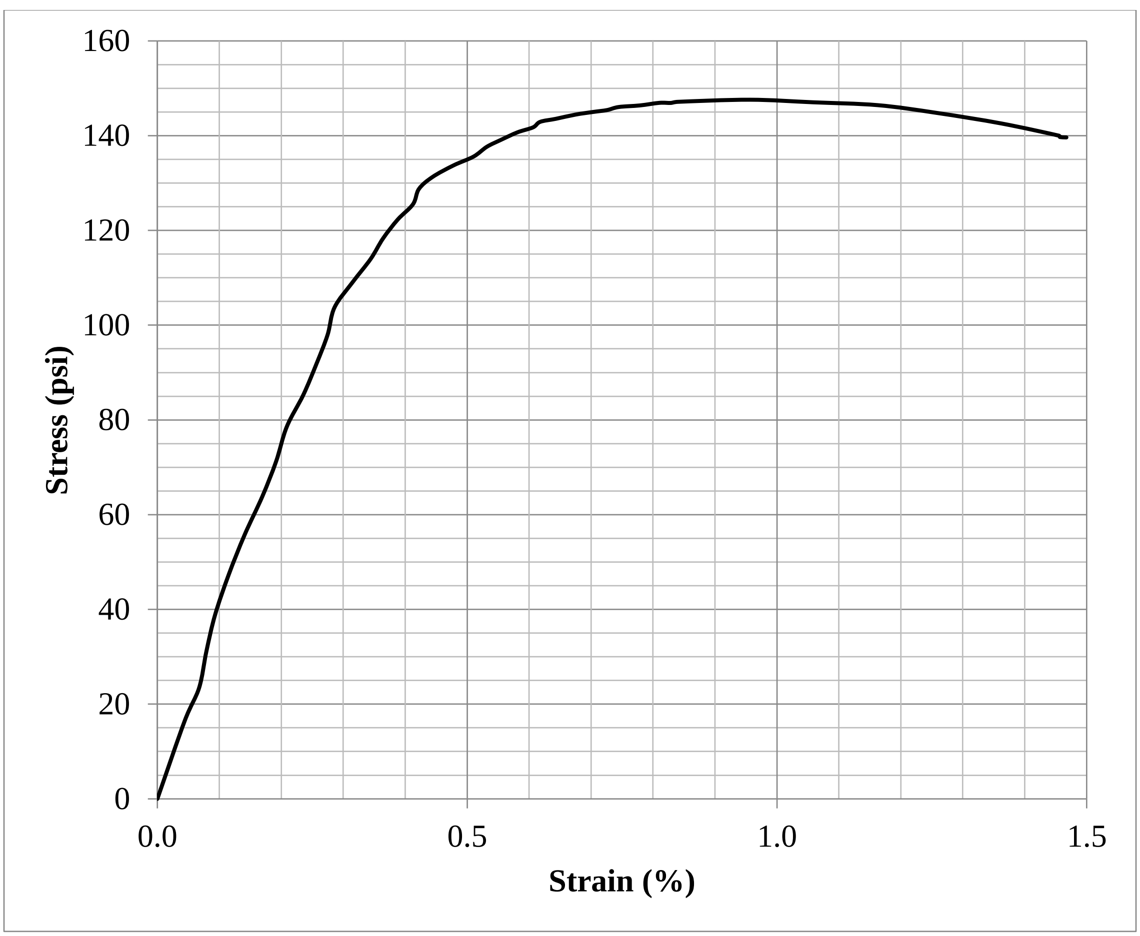
Testing Date	6/25/19
Diameter (in.)	2.049
Height (in.)	3.818
Weight (g)	276.0
Corrected Peak UCS (psi)	143.5
Corrected Failure Strain (%)	1.79
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-3-A
Molding Date	5/29/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (409.1)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	2.5

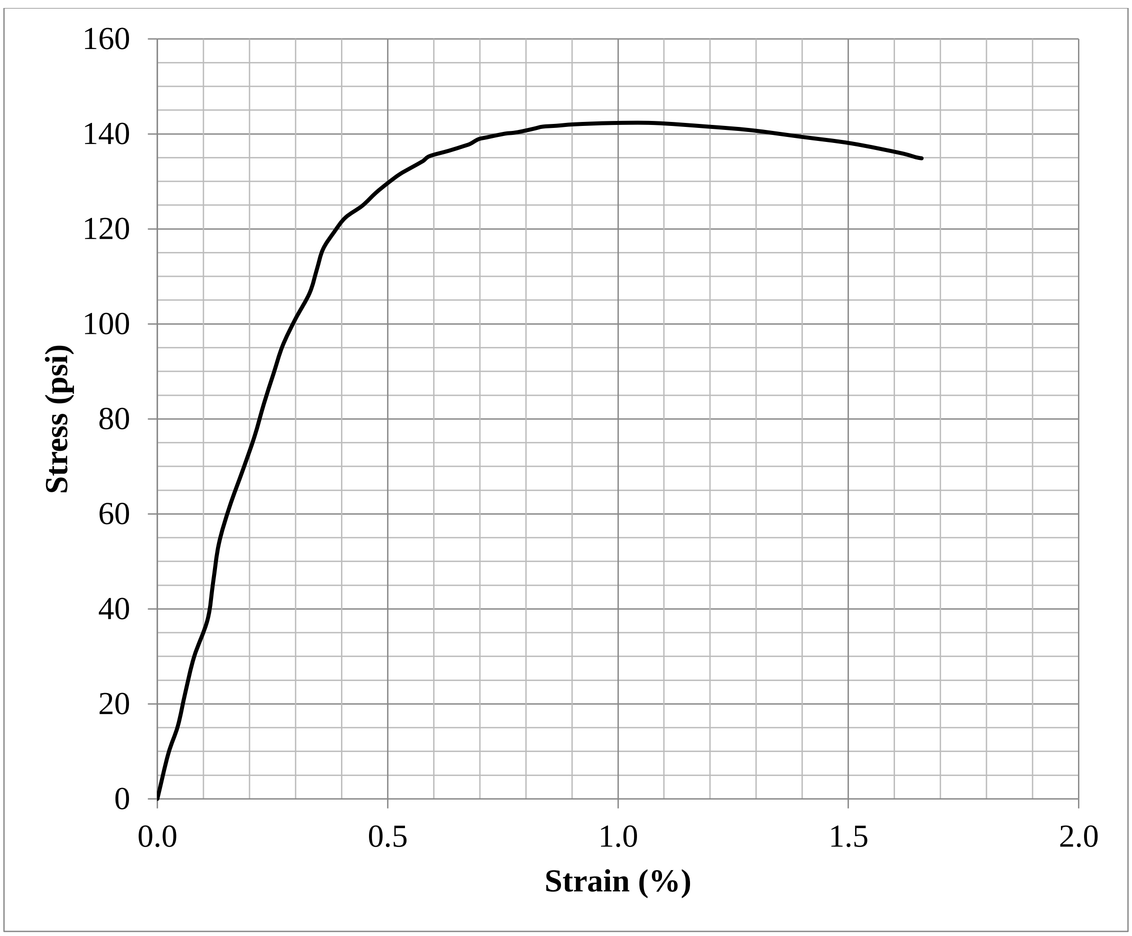
Testing Date	6/4/19
Diameter (in.)	2.044
Height (in.)	3.703
Weight (g)	276.2
Corrected Peak UCS (psi)	145.4
Corrected Failure Strain (%)	0.96
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-3-B
Molding Date	5/29/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (409.1)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	2.6

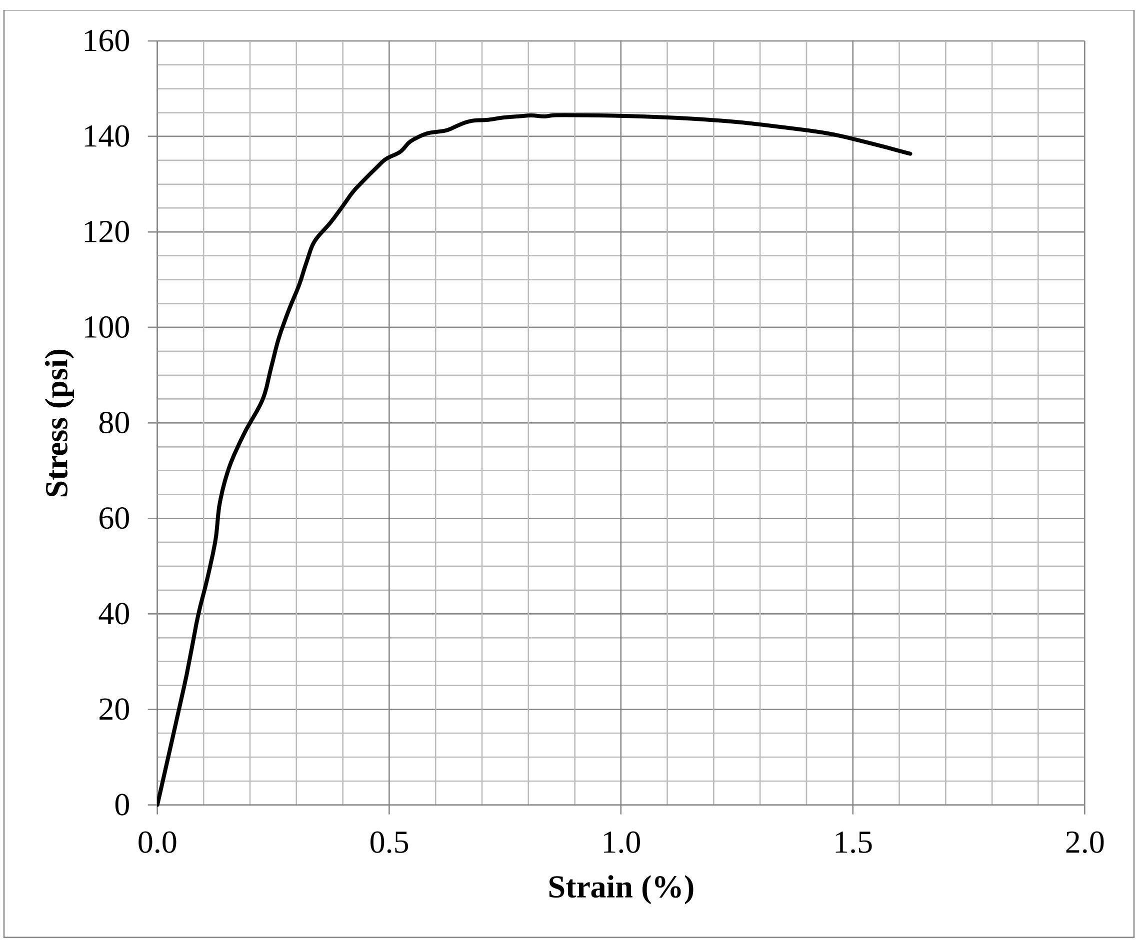
Testing Date	6/4/19
Diameter (in.)	2.043
Height (in.)	3.681
Weight (g)	274.5
Corrected Peak UCS (psi)	140.0
Corrected Failure Strain (%)	0.99
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-3-C
Molding Date	5/29/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (409.1)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	3.9

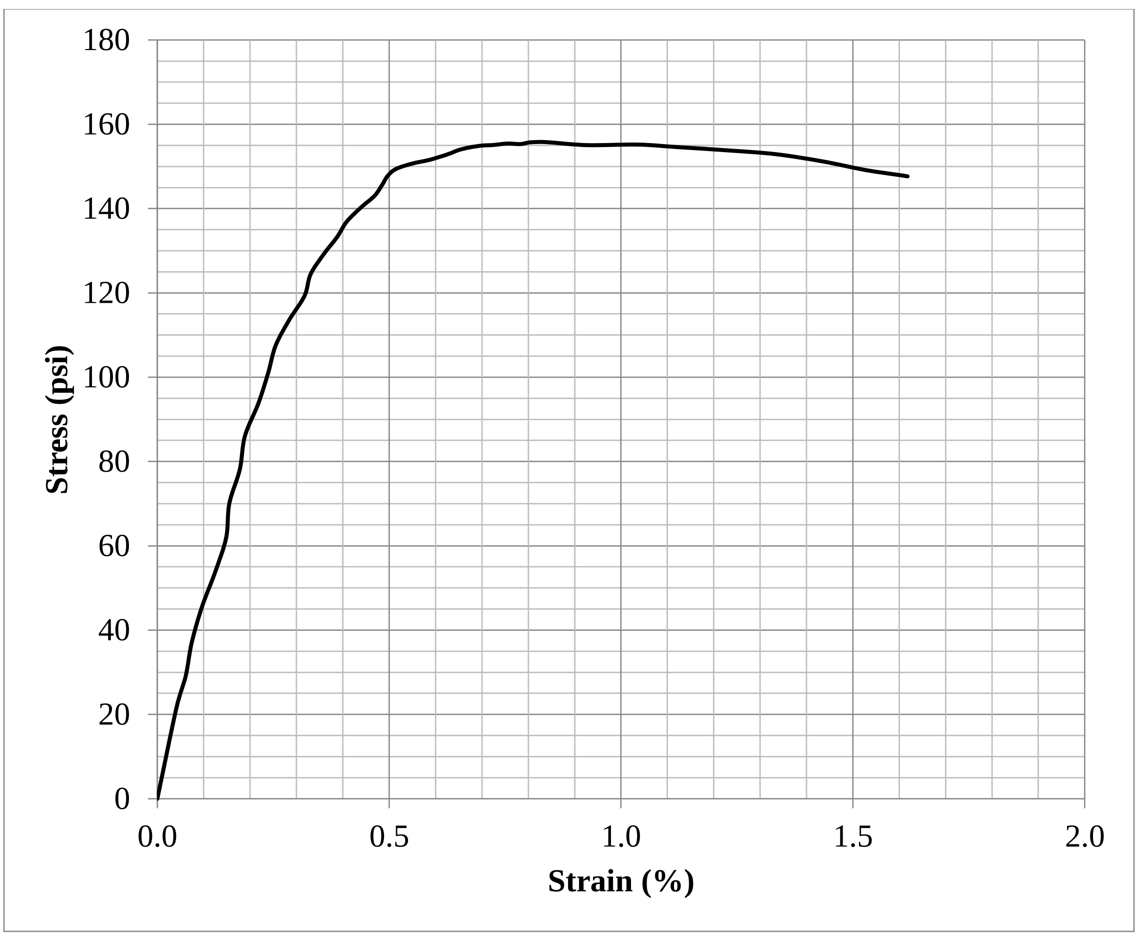
Testing Date	6/12/19
Diameter (in.)	2.041
Height (in.)	3.586
Weight (g)	265.8
Corrected Peak UCS (psi)	141.6
Corrected Failure Strain (%)	0.86
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-3-D
Molding Date	5/29/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	400 (409.1)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	2.7

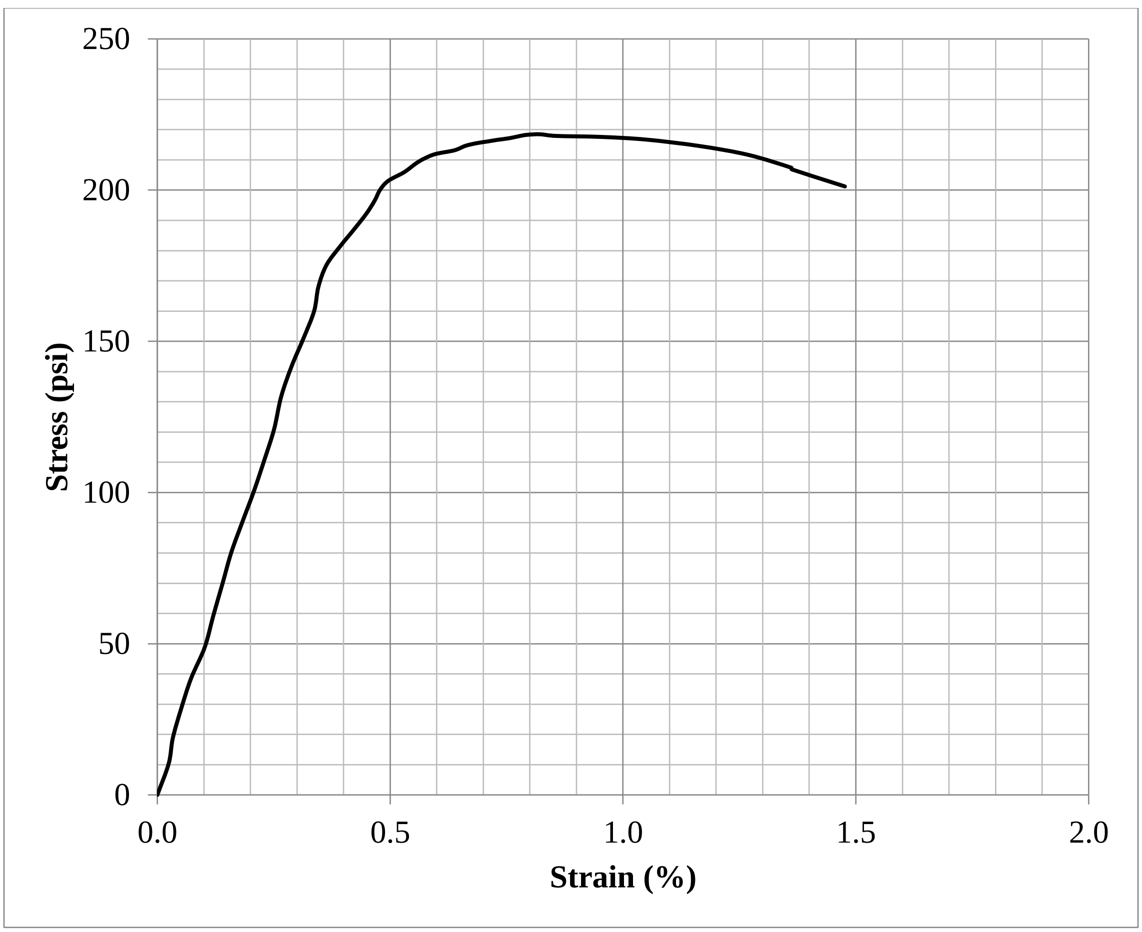
Testing Date	6/12/19
Diameter (in.)	2.043
Height (in.)	3.612
Weight (g)	269.7
Corrected Peak UCS (psi)	152.9
Corrected Failure Strain (%)	0.84
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-3-E
Molding Date	5/29/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	400 (409.1)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	2.0

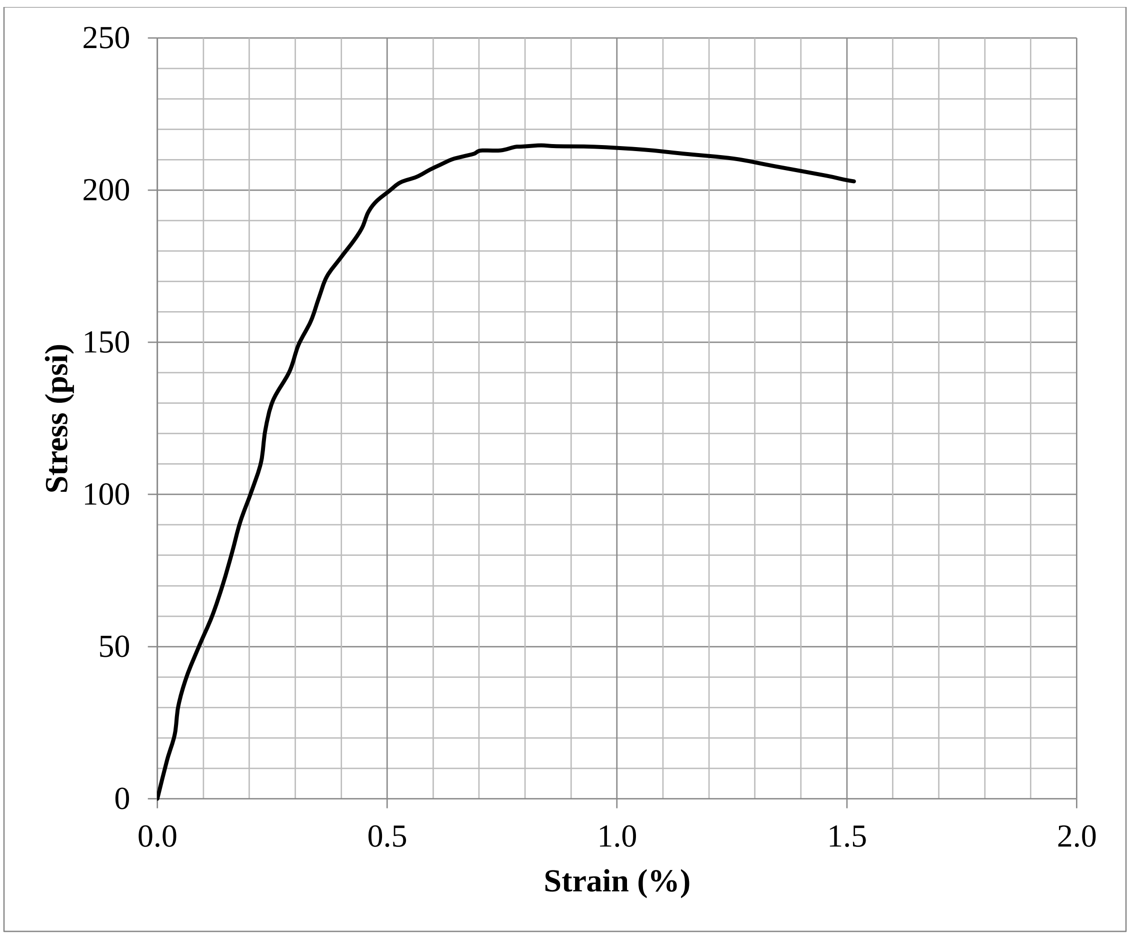
Testing Date	6/25/19
Diameter (in.)	2.041
Height (in.)	3.743
Weight (g)	281.1
Corrected Peak UCS (psi)	215.6
Corrected Failure Strain (%)	0.82
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	25-3-F
Molding Date	5/29/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (409.1)
w:b	1.2
Soil OM (%)	33.4
Bleed Water (g)	1.5

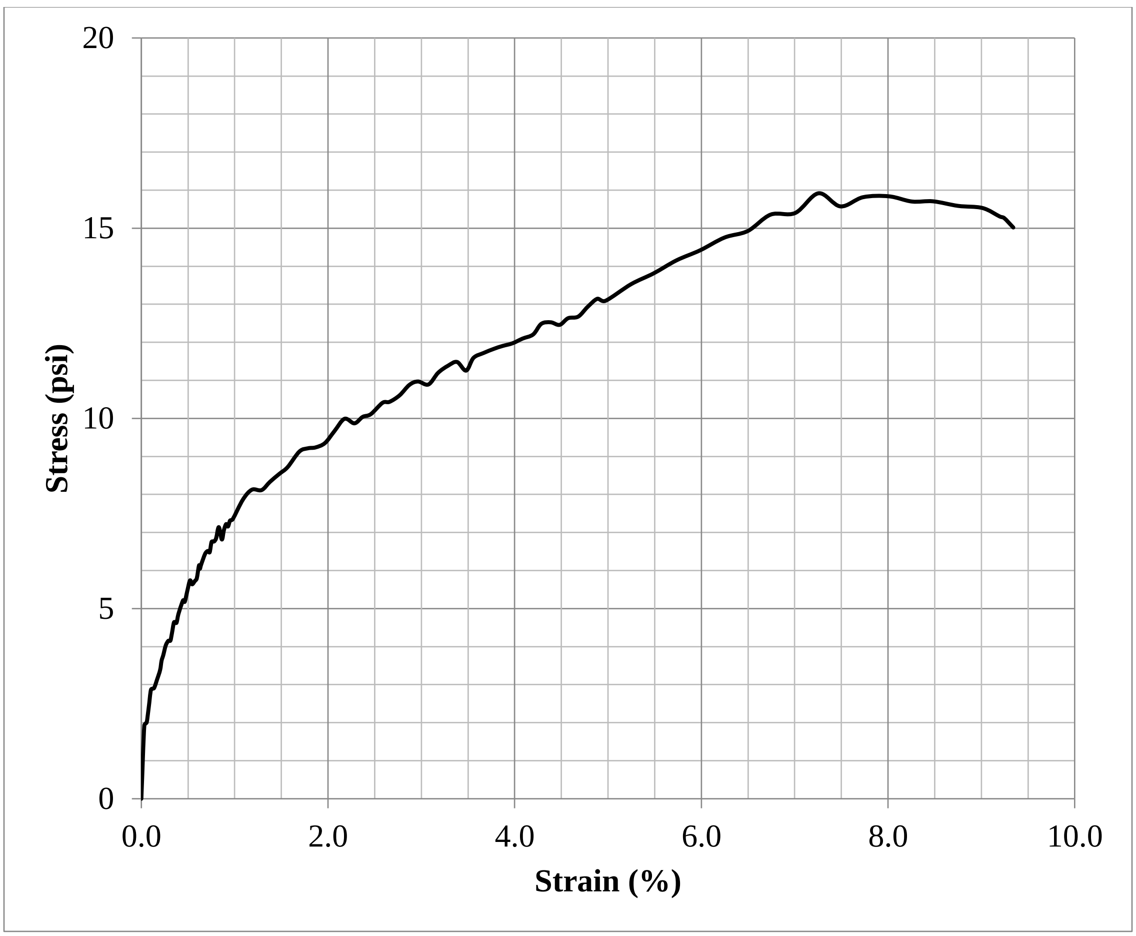
Testing Date	6/25/19
Diameter (in.)	2.046
Height (in.)	3.687
Weight (g)	273.9
Corrected Peak UCS (psi)	211.3
Corrected Failure Strain (%)	0.84
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-1-A
Molding Date	12/2/18
Curing Period (d)	9
α_{I-P} (kg/m^3)	152 (157.4)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.0

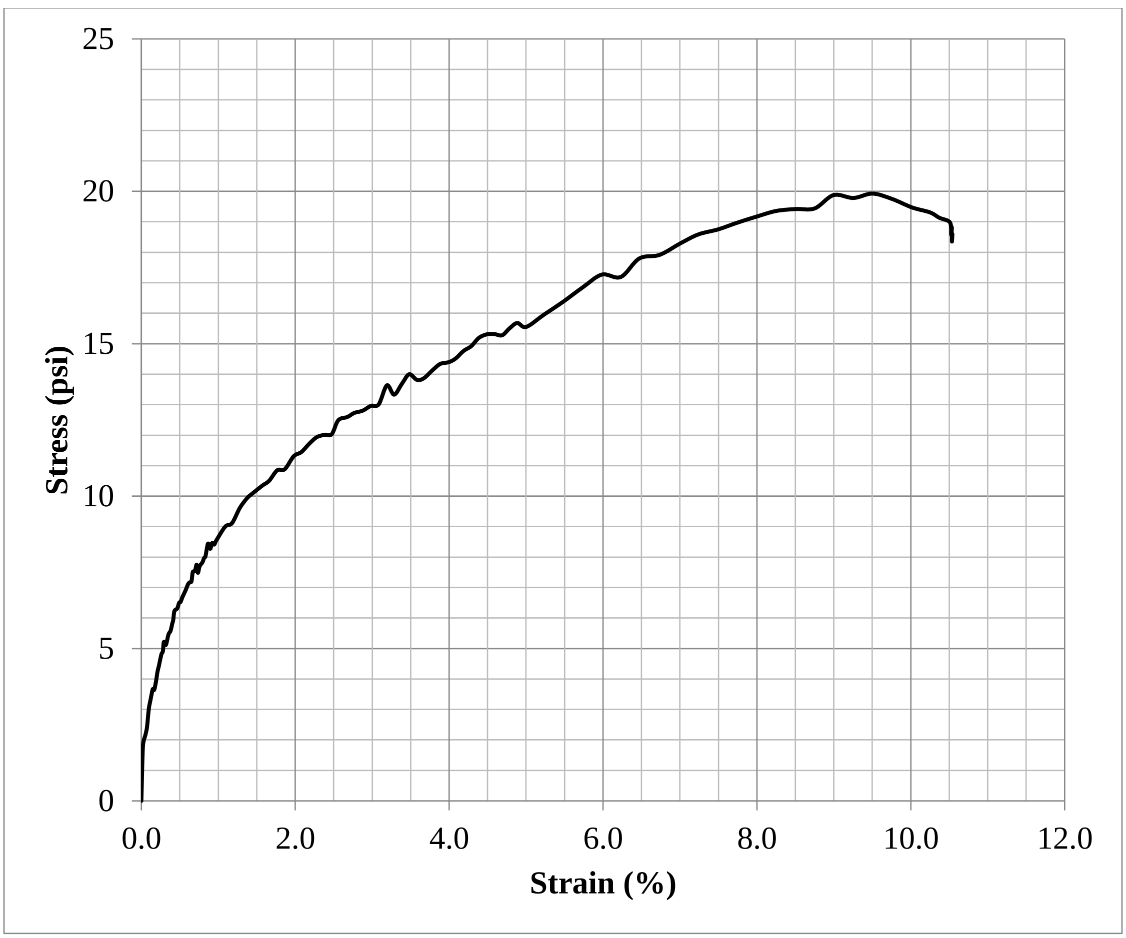
Testing Date	12/11/18
Diameter (in.)	2.023
Height (in.)	3.858
Weight (g)	251.6
Corrected Peak UCS (psi)	15.8
Corrected Failure Strain (%)	7.25
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-1-B
Molding Date	12/2/18
Curing Period (d)	9
$\alpha_{I\text{-}P}$ (kg/m^3)	152 (157.4)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.2

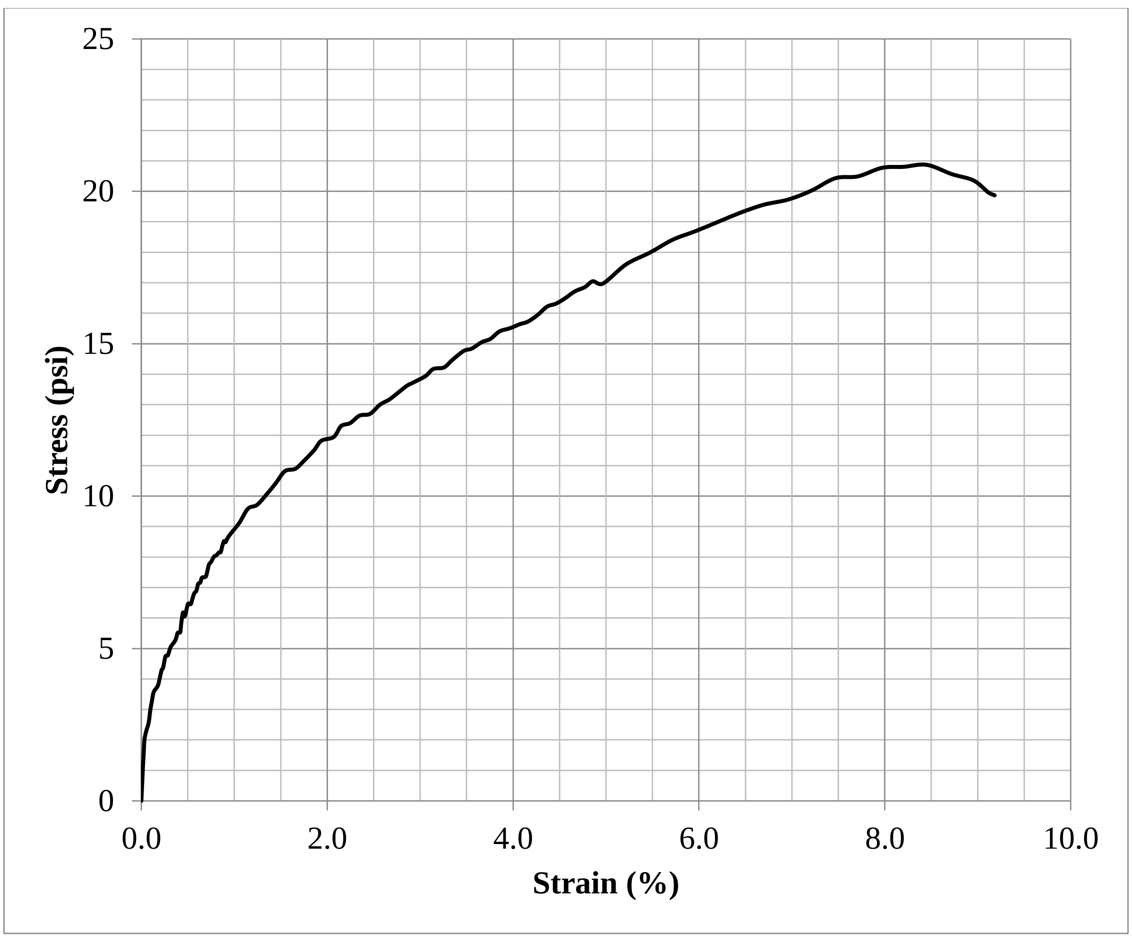
Testing Date	12/11/18
Diameter (in.)	2.009
Height (in.)	3.733
Weight (g)	242.6
Corrected Peak UCS (psi)	19.7
Corrected Failure Strain (%)	9.50
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-1-C
Molding Date	12/2/18
Curing Period (d)	16
$\alpha_{I\text{-}P}$ (kg/m^3)	152 (157.4)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.1

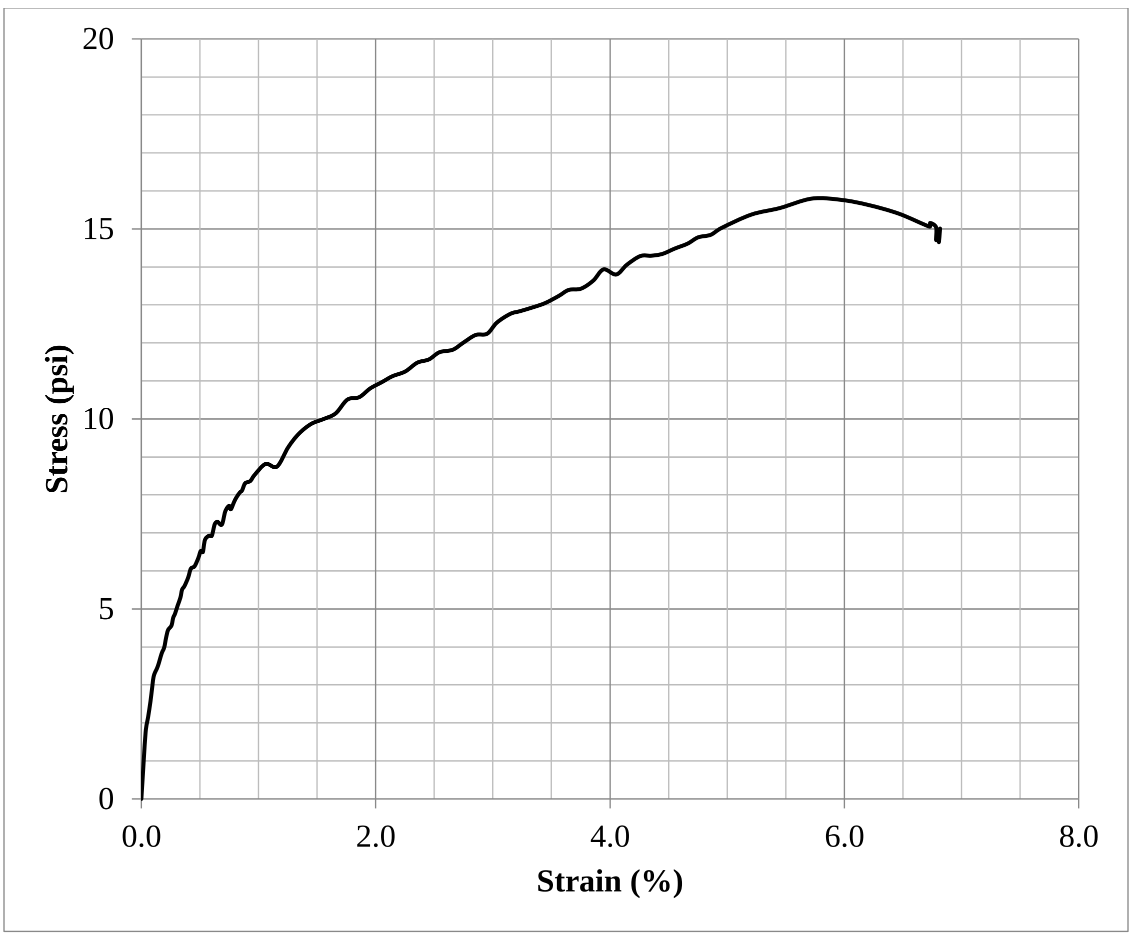
Testing Date	12/18/18
Diameter (in.)	1.972
Height (in.)	3.537
Weight (g)	229.1
Corrected Peak UCS (psi)	20.5
Corrected Failure Strain (%)	8.45
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-1-D
Molding Date	12/2/18
Curing Period (d)	16
α_{I-P} (kg/m^3)	152 (157.4)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.3

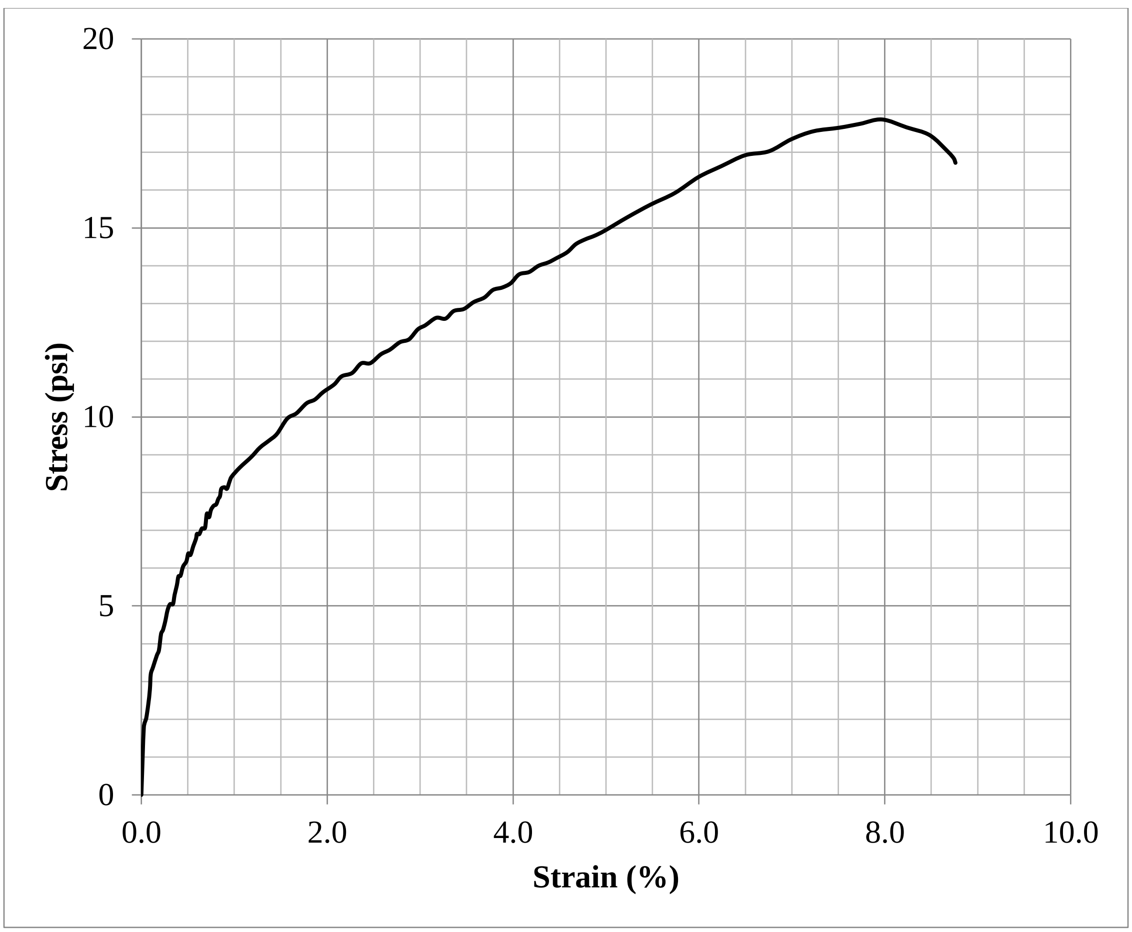
Testing Date	12/18/18
Diameter (in.)	2.025
Height (in.)	3.881
Weight (g)	254.5
Corrected Peak UCS (psi)	15.69
Corrected Failure Strain (%)	5.72
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-1-E
Molding Date	12/2/18
Curing Period (d)	33
$\alpha_{I\text{-}P}$ (kg/m^3)	152 (157.4)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.2

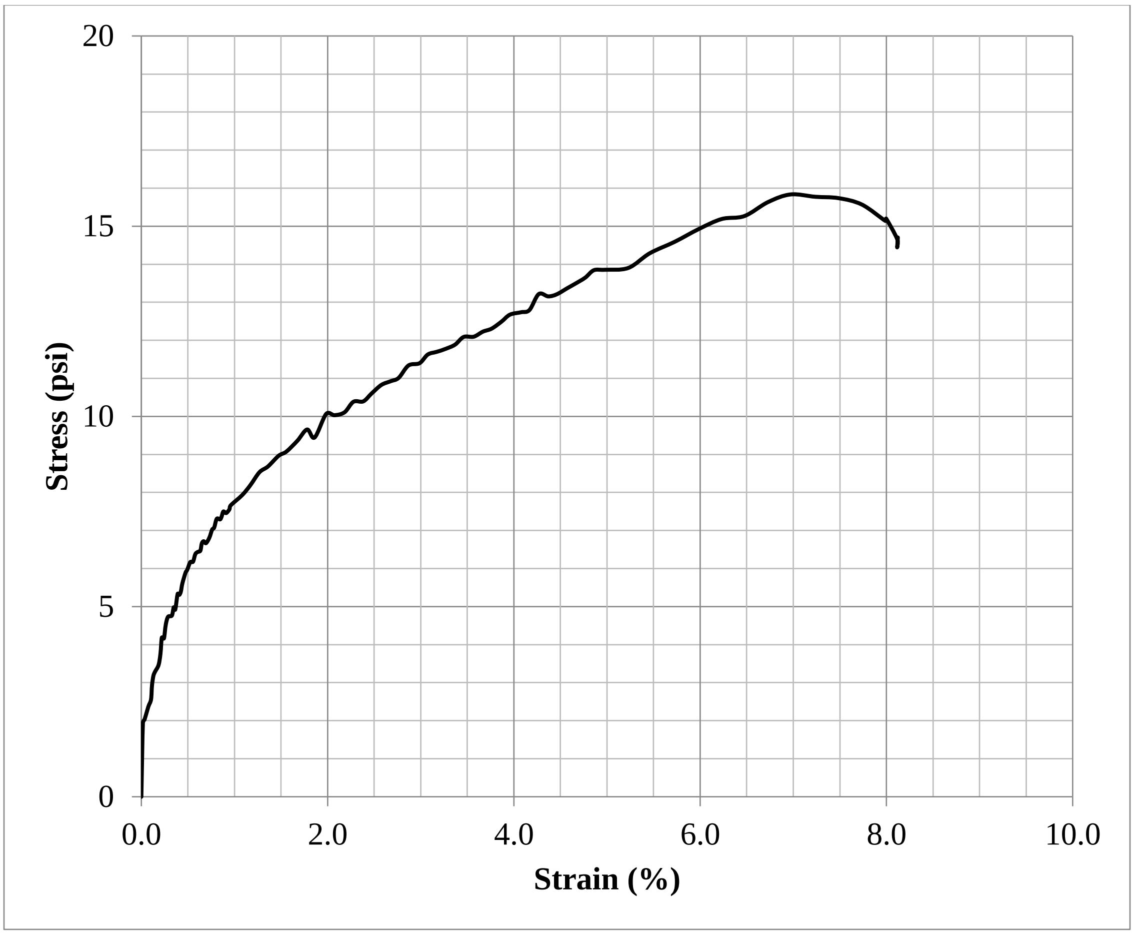
Testing Date	1/4/19
Diameter (in.)	2.013
Height (in.)	3.833
Weight (g)	253.1
Corrected Peak UCS (psi)	17.7
Corrected Failure Strain (%)	7.97
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-1-F
Molding Date	12/2/18
Curing Period (d)	33
α_{I-P} (kg/m^3)	152 (157.4)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.7

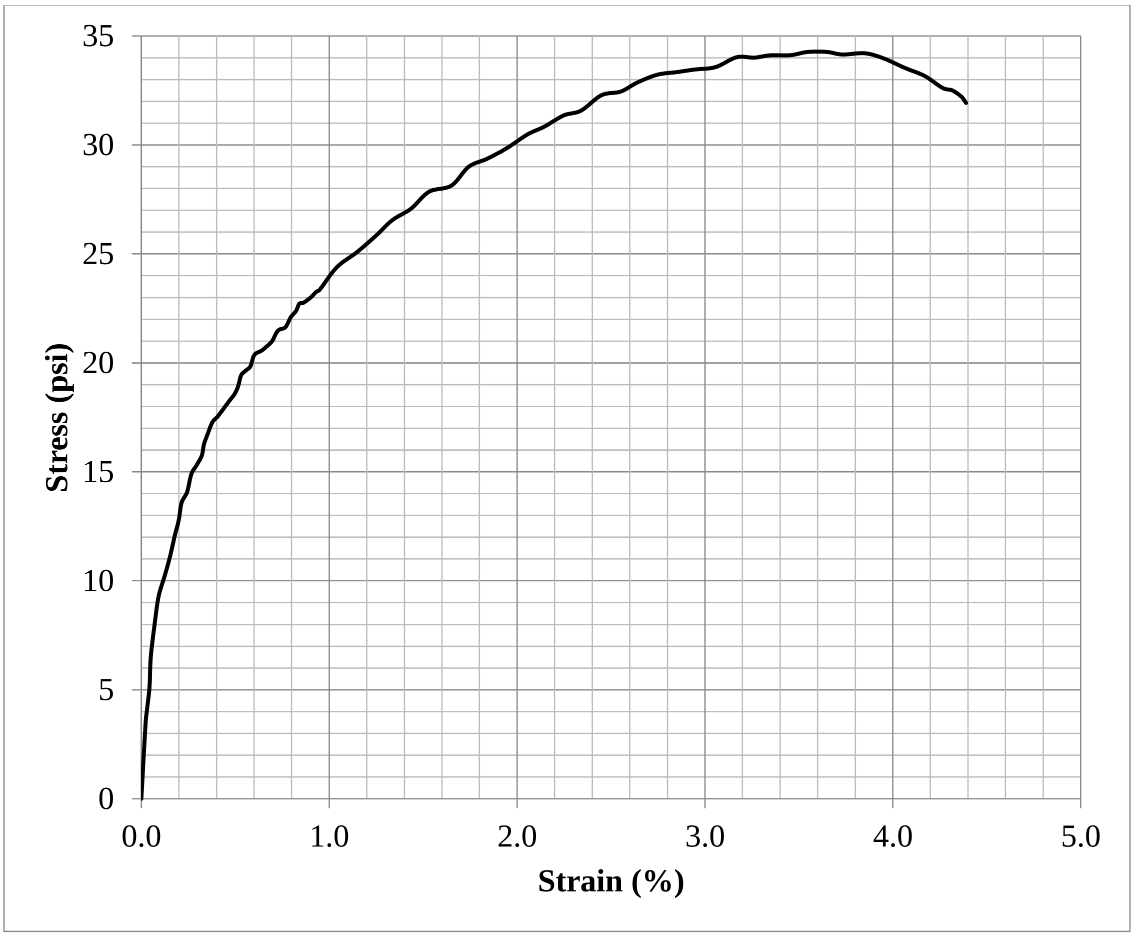
Testing Date	1/4/19
Diameter (in.)	1.999
Height (in.)	3.655
Weight (g)	241.9
Corrected Peak UCS (psi)	15.6
Corrected Failure Strain (%)	6.97
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-2-A
Molding Date	12/3/18
Curing Period (d)	11
α_{I-P} (kg/m^3)	226 (230.3)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	0.7

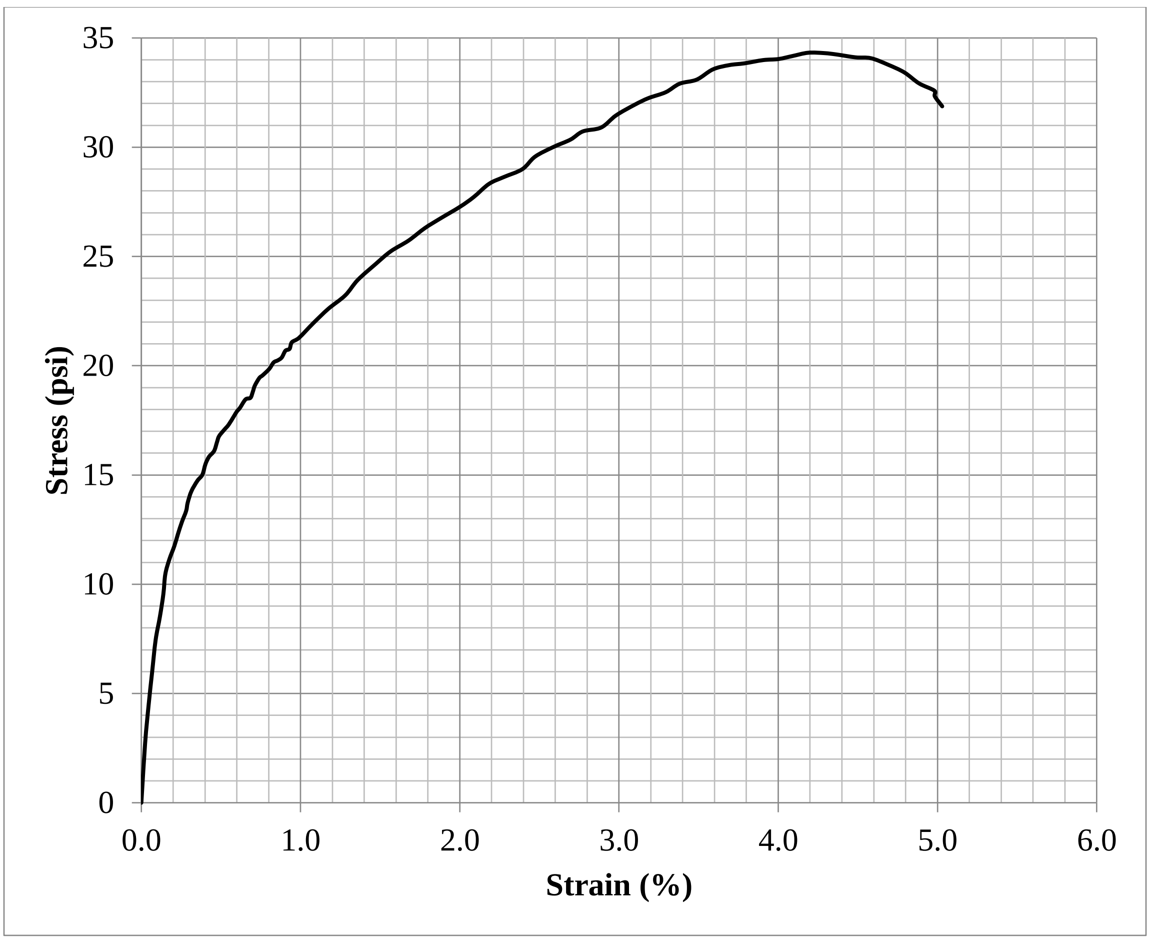
Testing Date	12/14/18
Diameter (in.)	2.026
Height (in.)	3.777
Weight (g)	245.5
Corrected Peak UCS (psi)	33.9
Corrected Failure Strain (%)	3.65
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-2-B
Molding Date	12/3/18
Curing Period (d)	12
$\alpha_{I\text{-}P}$ (kg/m^3)	226 (230.3)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.5

Testing Date	12/15/18
Diameter (in.)	2.025
Height (in.)	3.694
Weight (g)	238.2
Corrected Peak UCS (psi)	33.8
Corrected Failure Strain (%)	4.19
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-2-C
Molding Date	12/3/18
Curing Period (d)	15
α_{I-P} (kg/m^3)	226 (230.3)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	0.9

Testing Date	12/19/18
Diameter (in.)	2.019
Height (in.)	3.925
Weight (g)	258.6
Corrected Peak UCS (psi)	40.2
Corrected Failure Strain (%)	4.00
ASTM C39 Fracture Type	4

Data Sheet: Specimen UCS Test

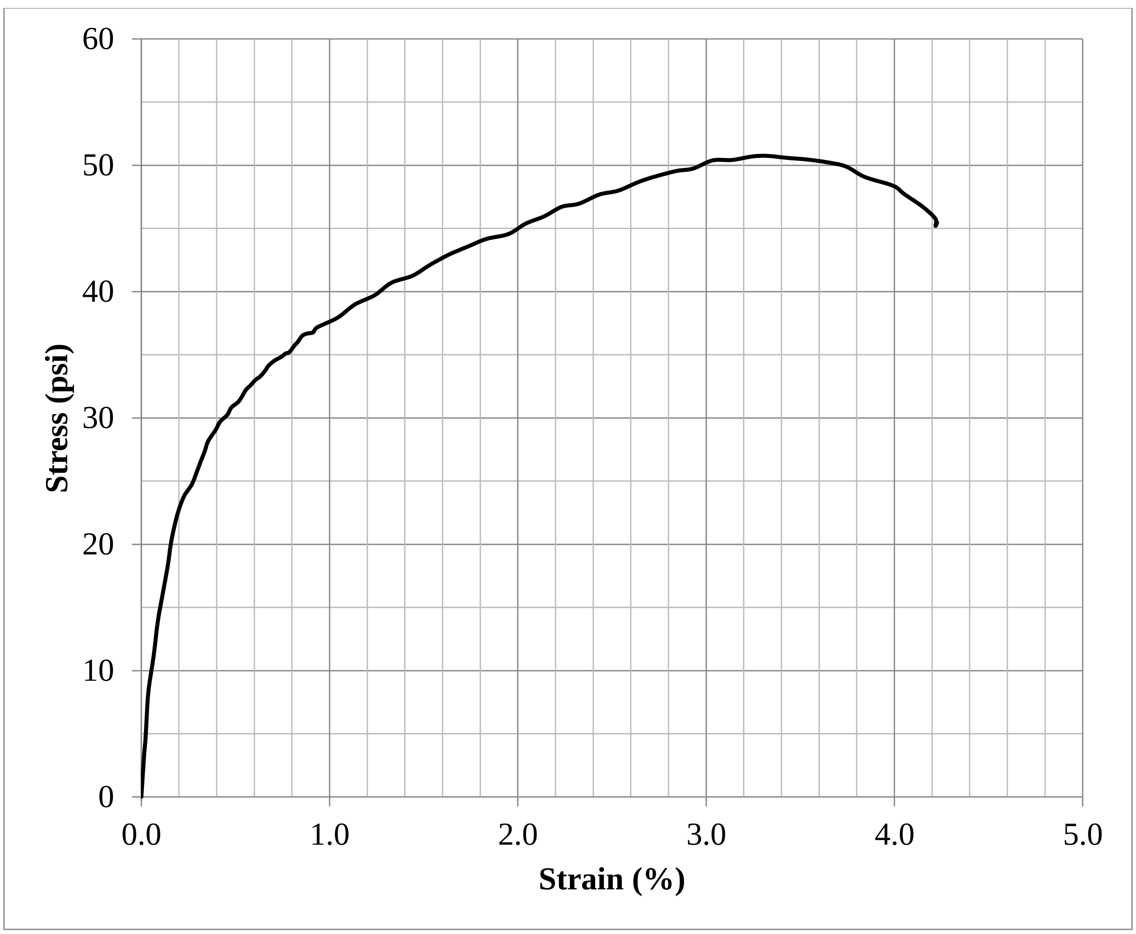
Specimen ID	30-2-D
Molding Date	12/3/18
Curing Period (d)	16
α_{I-P} (kg/m^3)	226 (230.3)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.5

Testing Date	12/19/18
Diameter (in.)	2.031
Height (in.)	3.753
Weight (g)	247.7
Corrected Peak UCS (psi)	41.4
Corrected Failure Strain (%)	3.68
ASTM C39 Fracture Type	4

Data Sheet: Specimen UCS Test

Specimen ID	30-2-F
Molding Date	12/3/18
Curing Period (d)	32
$\alpha_{I\text{-}P}$ (kg/m^3)	226 (230.3)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.6

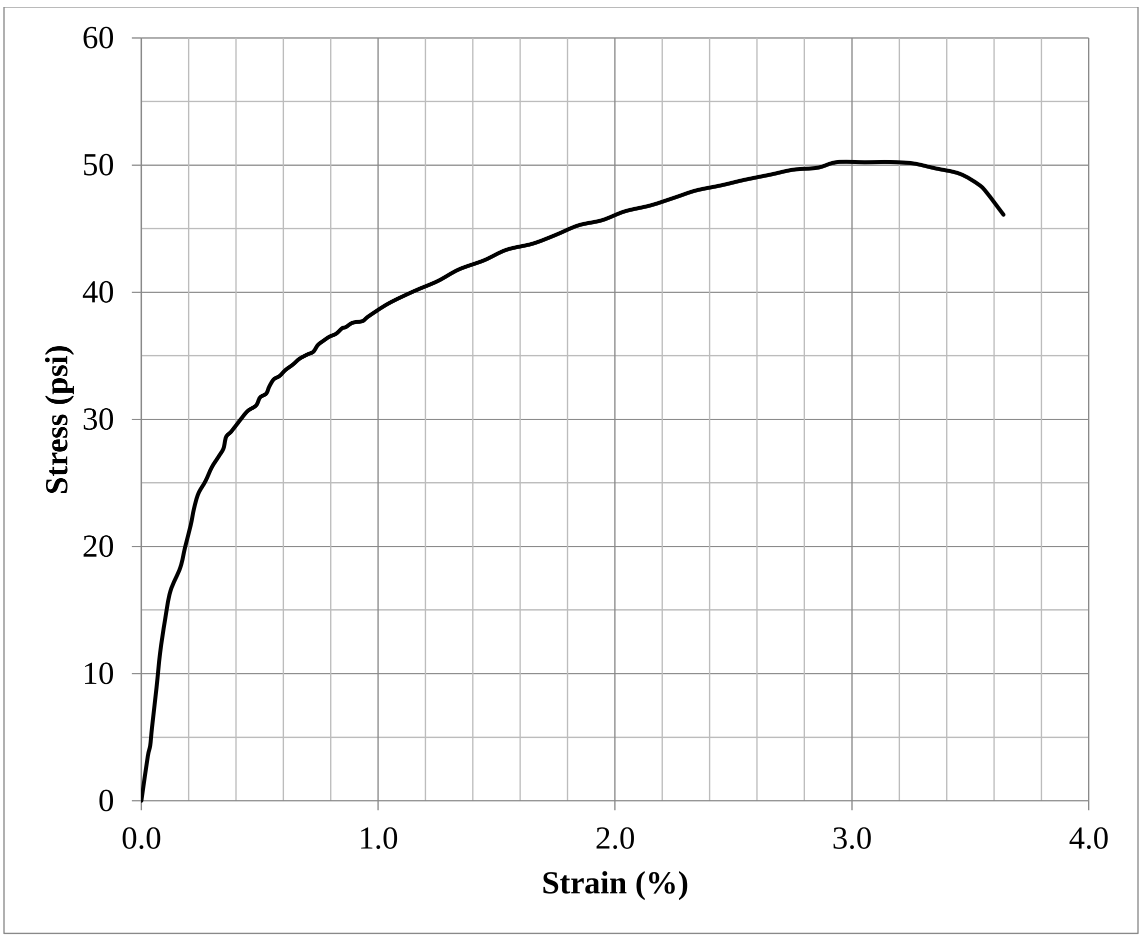
Testing Date	1/4/19
Diameter (in.)	2.031
Height (in.)	3.769
Weight (g)	250.1
Corrected Peak UCS (psi)	50.2
Corrected Failure Strain (%)	3.32
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-2-H
Molding Date	12/3/18
Curing Period (d)	32
α_{I-P} (kg/m^3)	226 (230.3)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.5

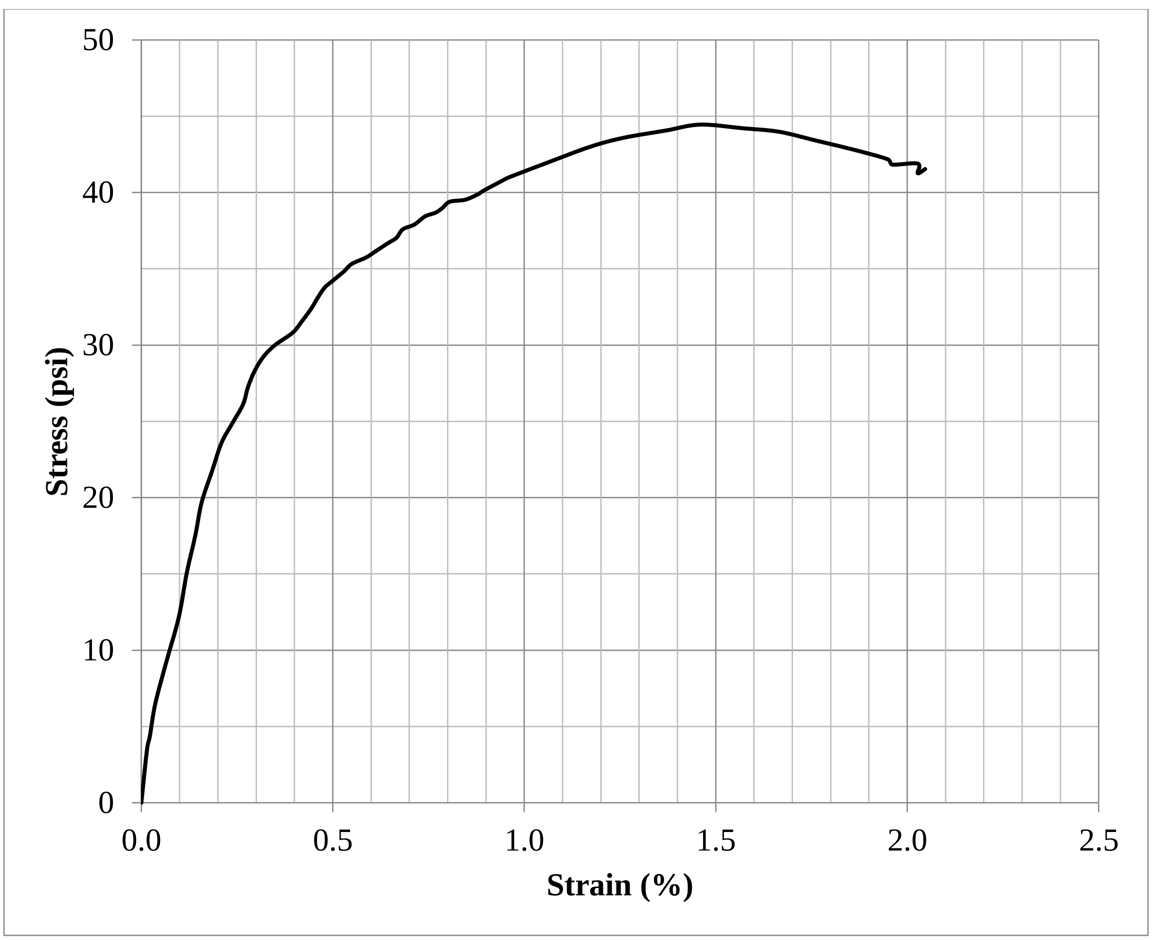
Testing Date	1/4/19
Diameter (in.)	2.025
Height (in.)	3.776
Weight (g)	249.0
Corrected Peak UCS (psi)	49.7
Corrected Failure Strain (%)	3.16
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-3-A
Molding Date	12/3/18
Curing Period (d)	11
$\alpha_{I\text{-}P}$ (kg/m^3)	283 (286.1)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.3

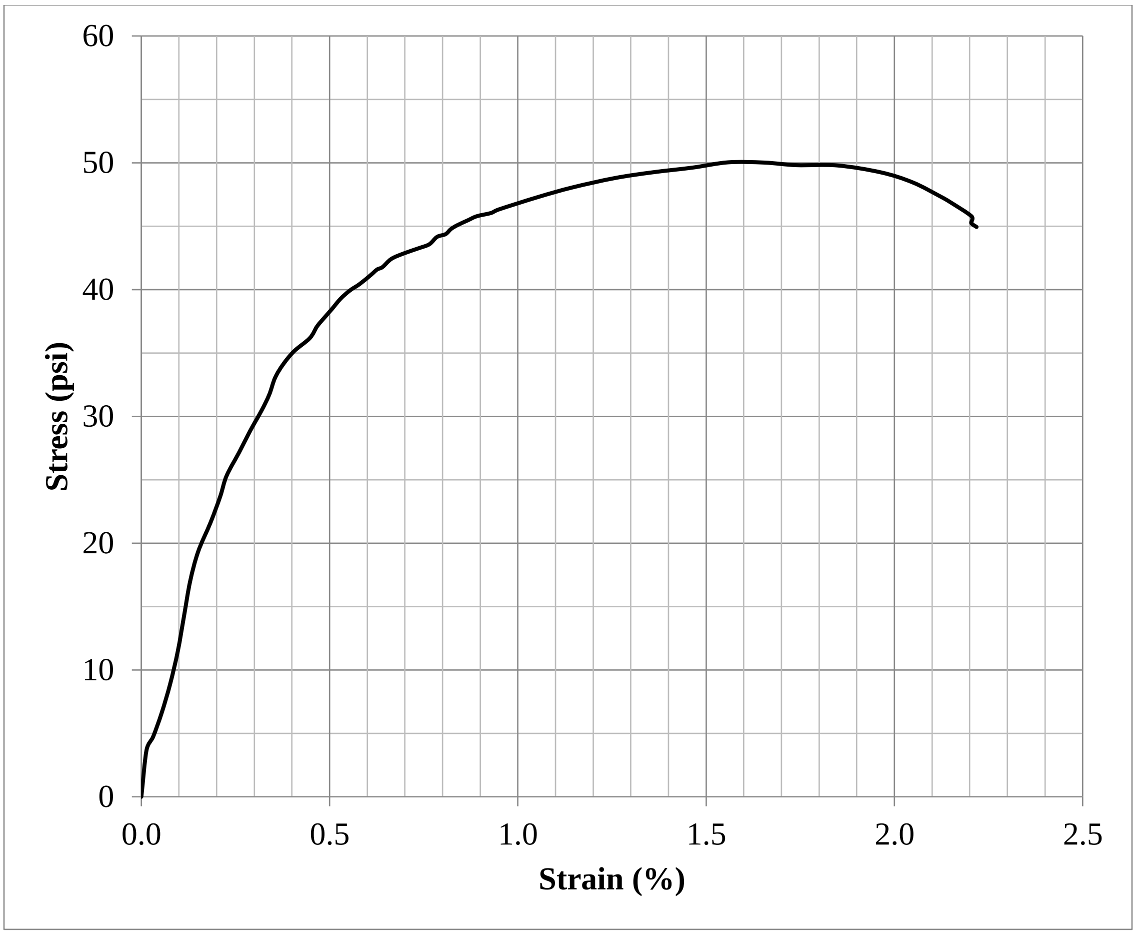
Testing Date	12/15/18
Diameter (in.)	2.031
Height (in.)	3.774
Weight (g)	233.6
Corrected Peak UCS (psi)	43.9
Corrected Failure Strain (%)	1.46
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-3-C
Molding Date	12/3/18
Curing Period (d)	11
α_{I-P} (kg/m^3)	283 (286.1)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.2

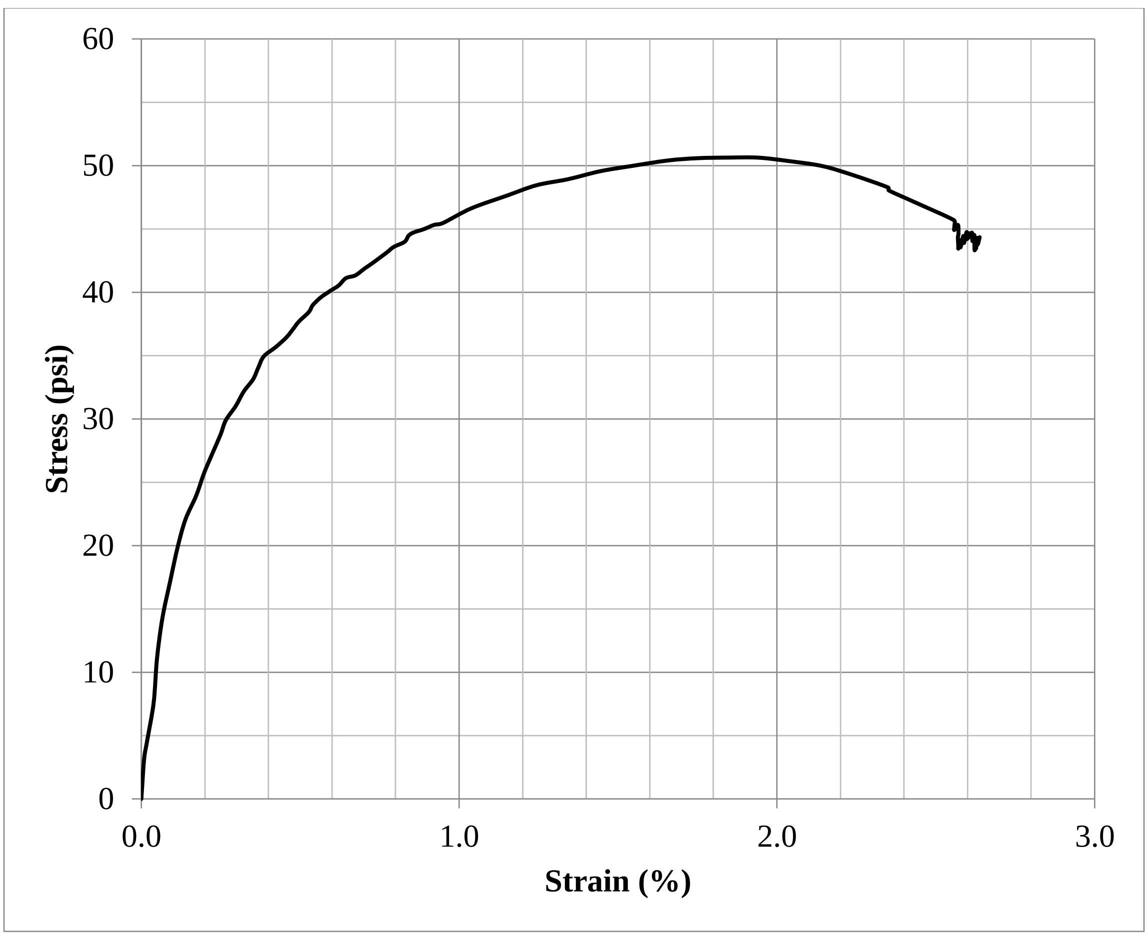
Testing Date	12/15/18
Diameter (in.)	2.034
Height (in.)	3.784
Weight (g)	233.1
Corrected Peak UCS (psi)	49.5
Corrected Failure Strain (%)	1.56
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-3-D
Molding Date	12/3/18
Curing Period (d)	15
α_{I-P} (kg/m^3)	283 (286.1)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.8

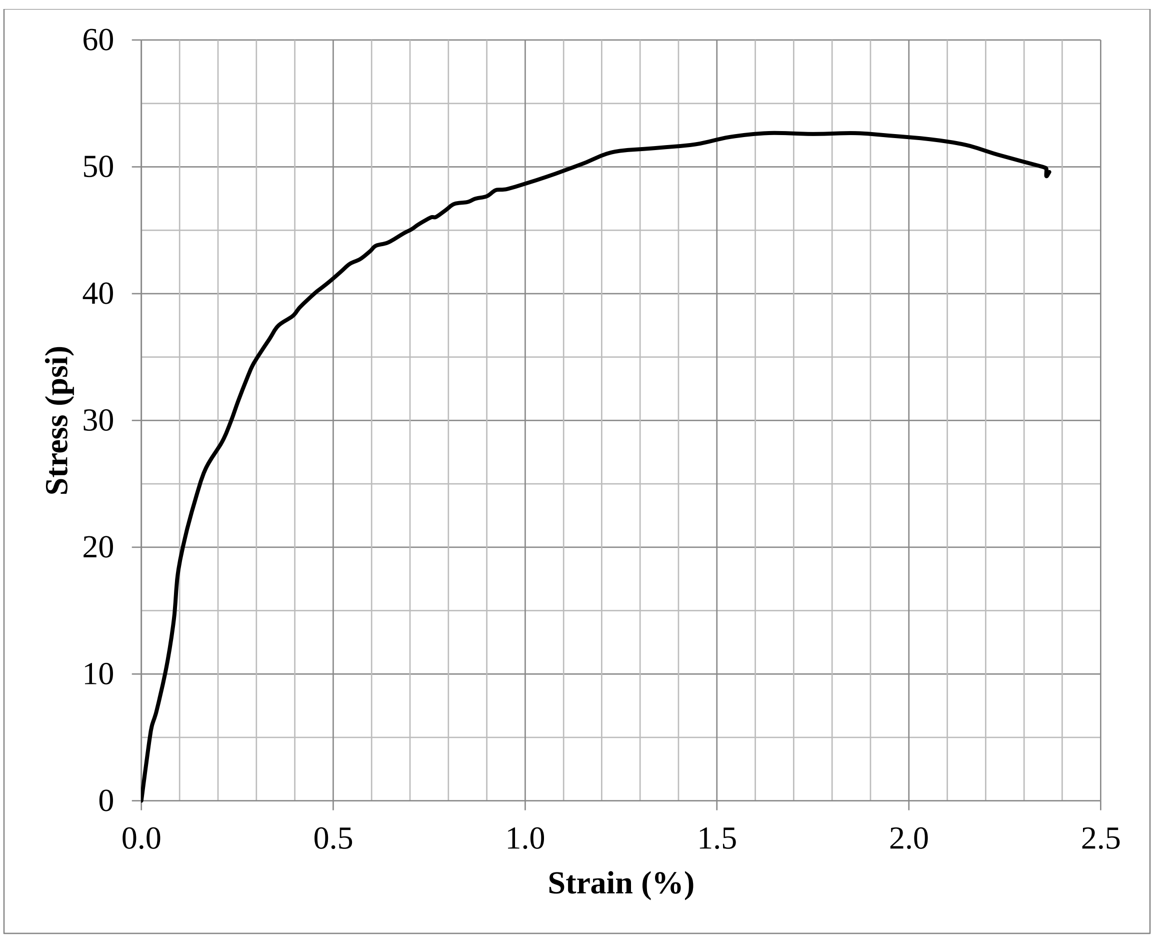
Testing Date	12/19/18
Diameter (in.)	2.036
Height (in.)	3.760
Weight (g)	228.8
Corrected Peak UCS (psi)	50.0
Corrected Failure Strain (%)	1.85
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-3-E
Molding Date	12/3/18
Curing Period (d)	16
α_{I-P} (kg/m^3)	283 (286.1)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.0

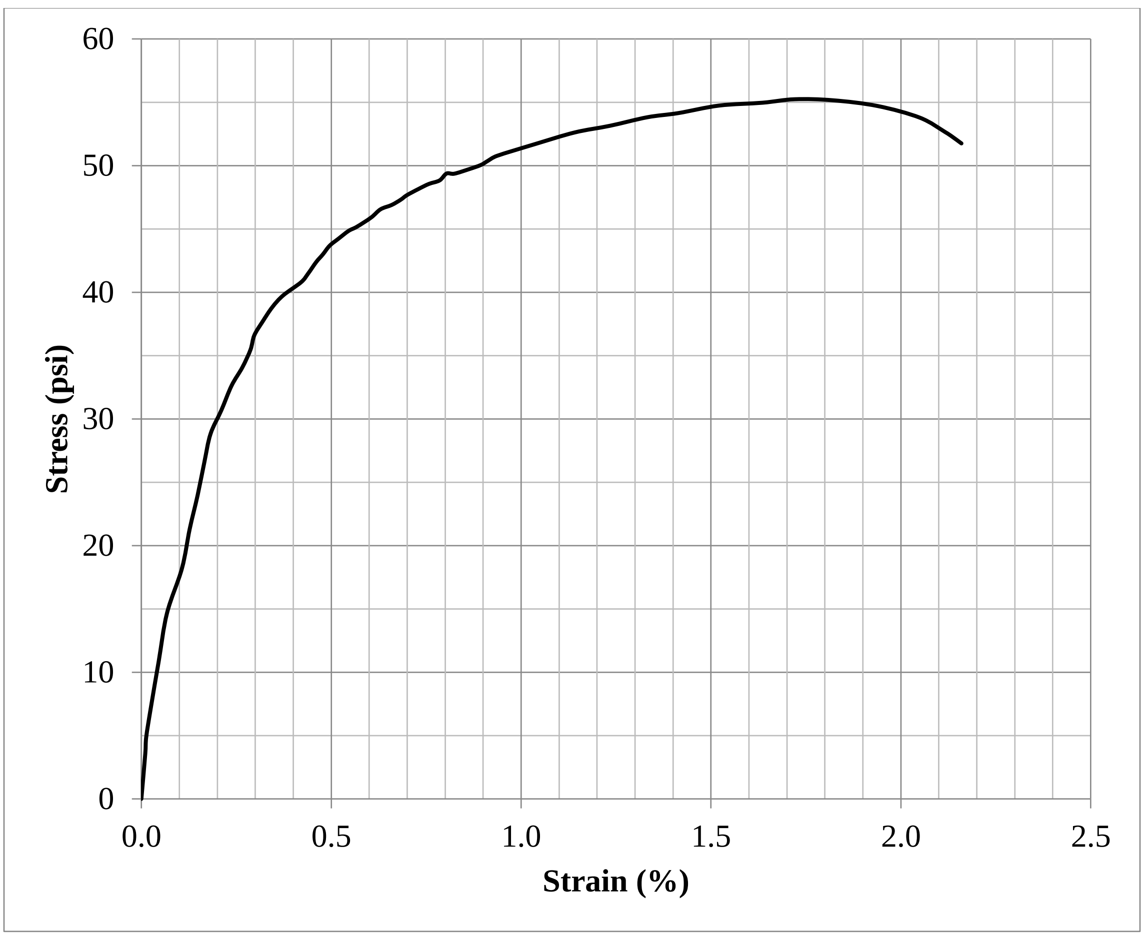
Testing Date	12/19/18
Diameter (in.)	2.033
Height (in.)	3.768
Weight (g)	236.7
Corrected Peak UCS (psi)	52.0
Corrected Failure Strain (%)	1.64
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-3-F
Molding Date	12/3/18
Curing Period (d)	32
α_{I-P} (kg/m^3)	283 (286.1)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	1.4

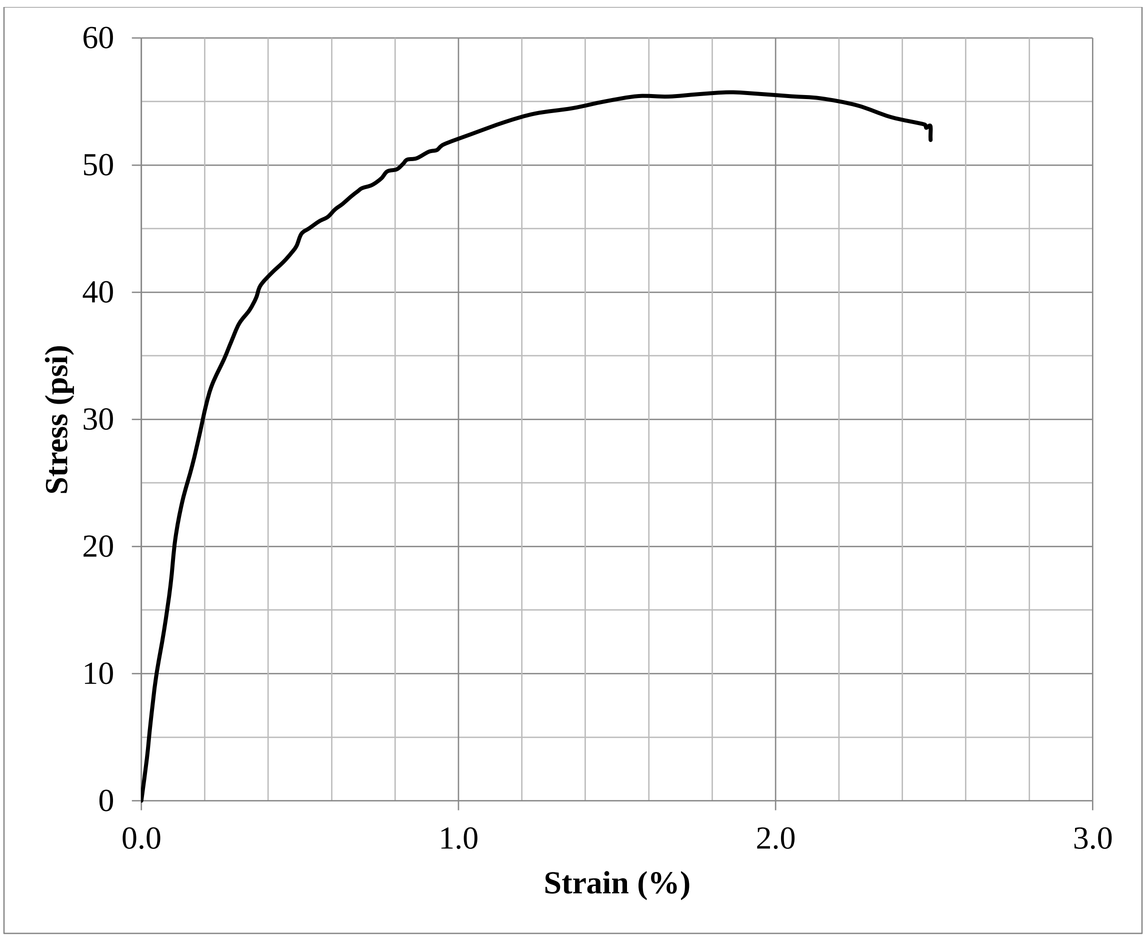
Testing Date	1/4/19
Diameter (in.)	2.032
Height (in.)	3.774
Weight (g)	235.5
Corrected Peak UCS (psi)	54.6
Corrected Failure Strain (%)	1.72
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-3-G
Molding Date	12/3/18
Curing Period (d)	32
$\alpha_{I\text{-}P}$ (kg/m^3)	283 (286.1)
w:b	1.0
Soil OM (%)	36.1
Bleed Water (g)	2.1

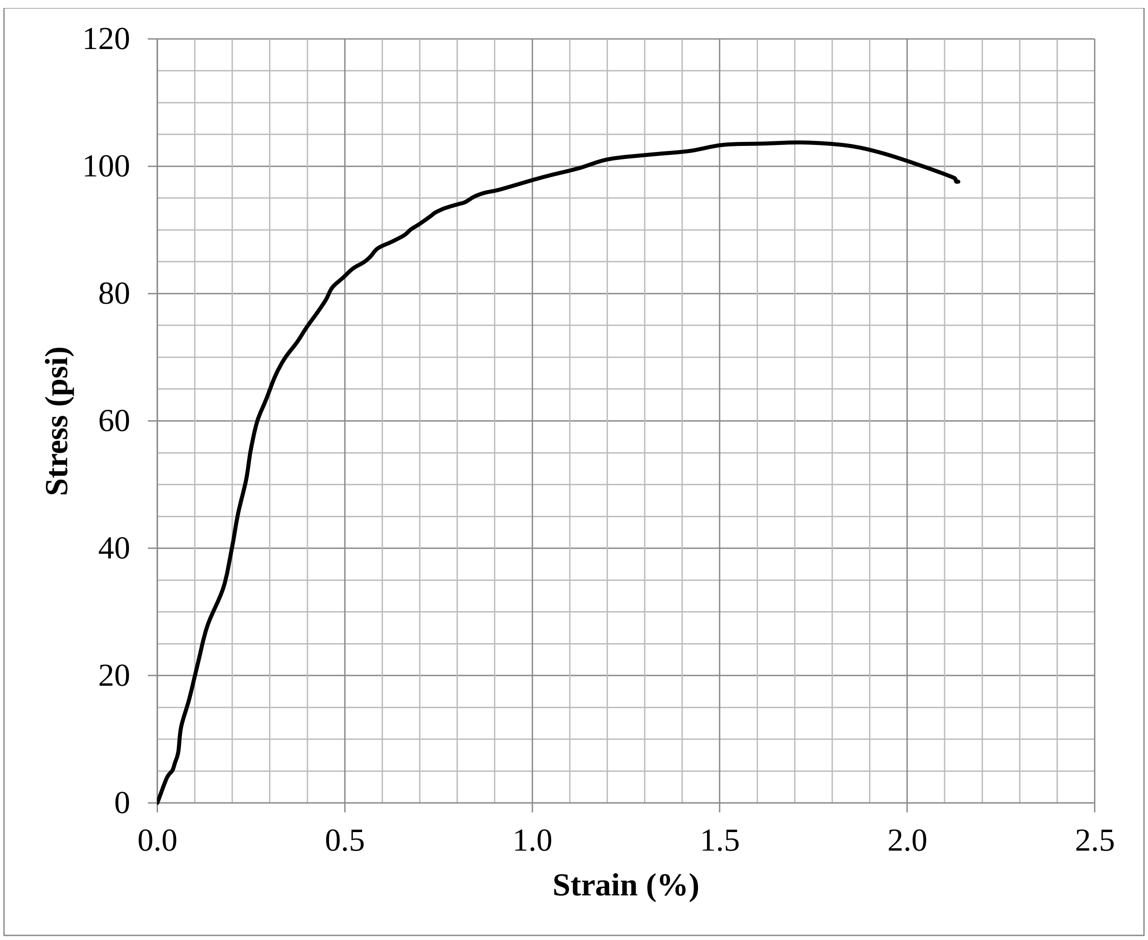
Testing Date	1/4/19
Diameter (in.)	2.030
Height (in.)	3.713
Weight (g)	233.7
Corrected Peak UCS (psi)	55.0
Corrected Failure Strain (%)	1.86
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-4-A
Molding Date	4/19/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	350 (354.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.2

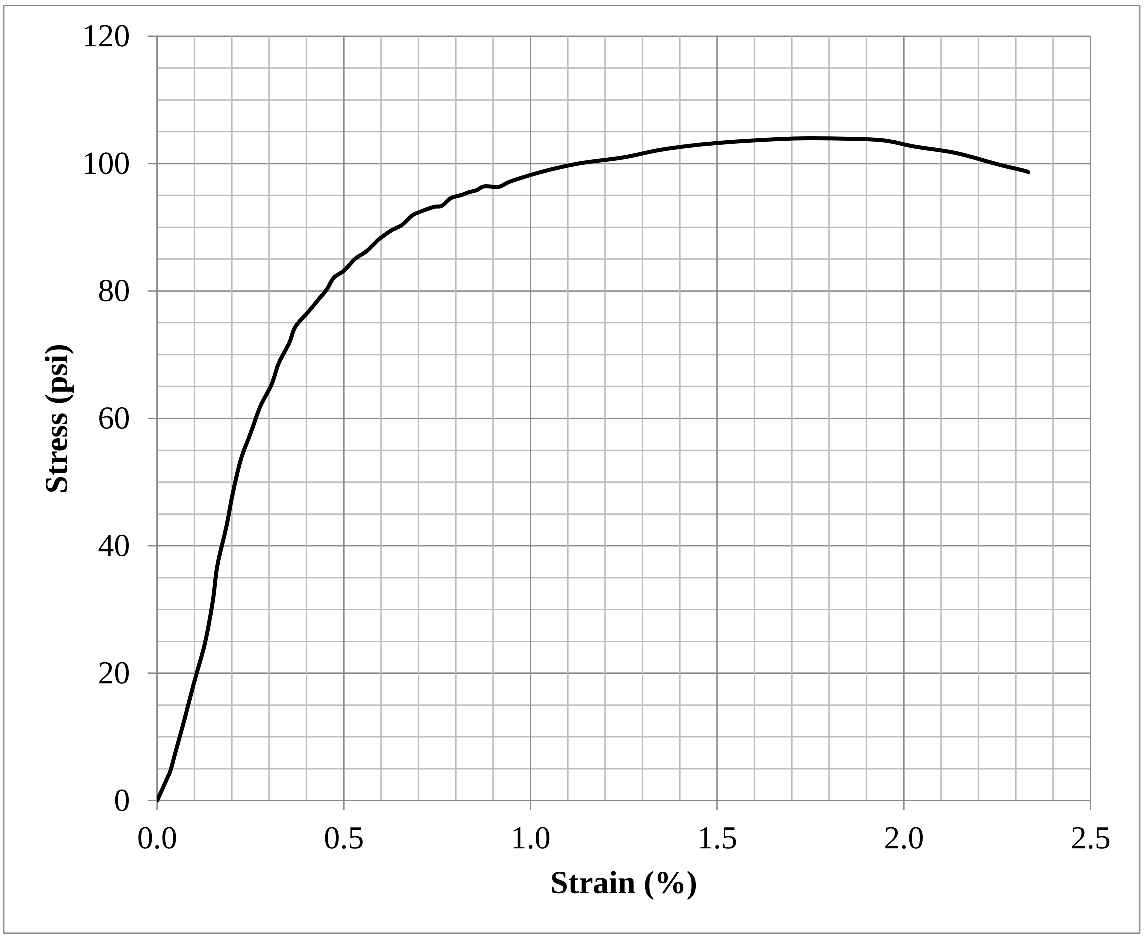
Testing Date	4/26/19
Diameter (in.)	2.042
Height (in.)	3.768
Weight (g)	261.0
Corrected Peak UCS (psi)	102.4
Corrected Failure Strain (%)	1.72
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-4-B
Molding Date	4/19/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	350 (354.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	0.8

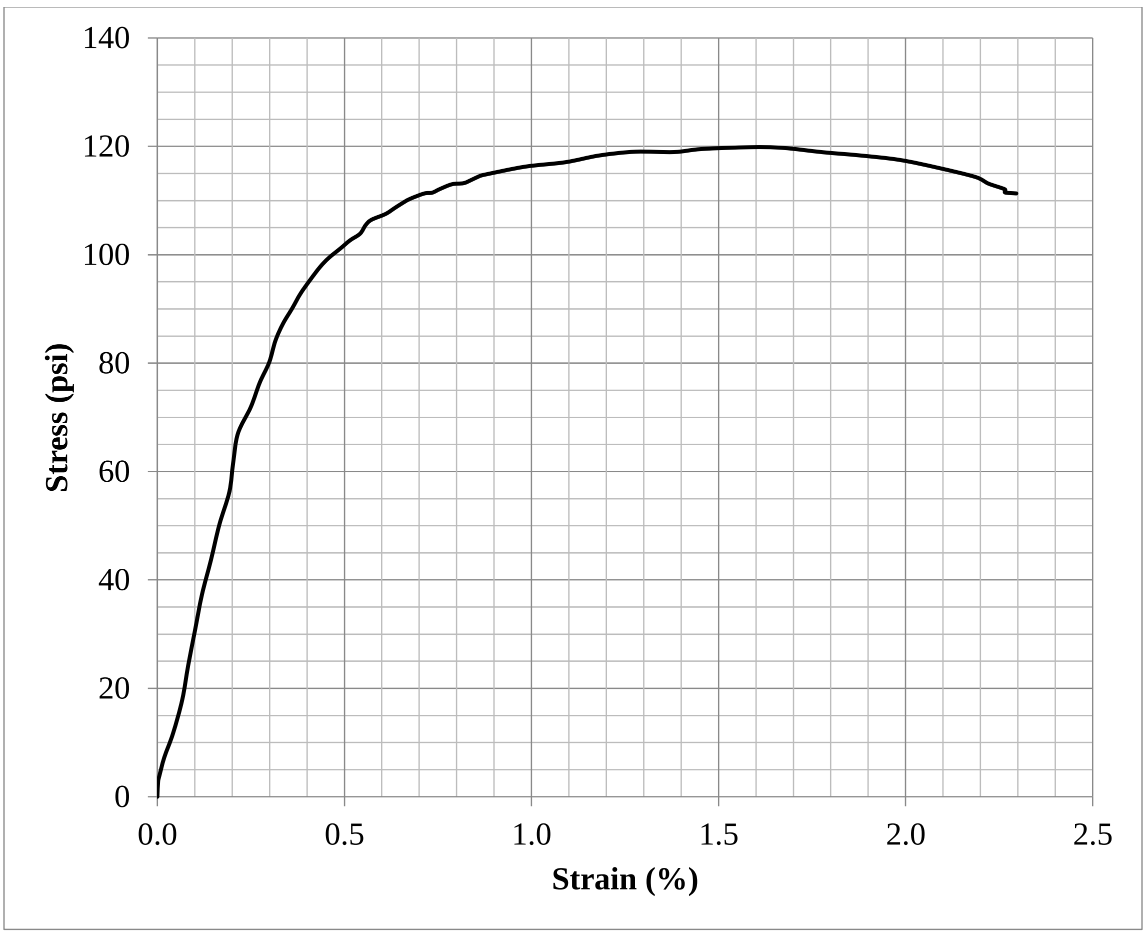
Testing Date	4/26/19
Diameter (in.)	2.042
Height (in.)	3.971
Weight (g)	275.1
Corrected Peak UCS (psi)	103.5
Corrected Failure Strain (%)	1.73
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-4-C
Molding Date	4/19/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	350 (354.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	0.8

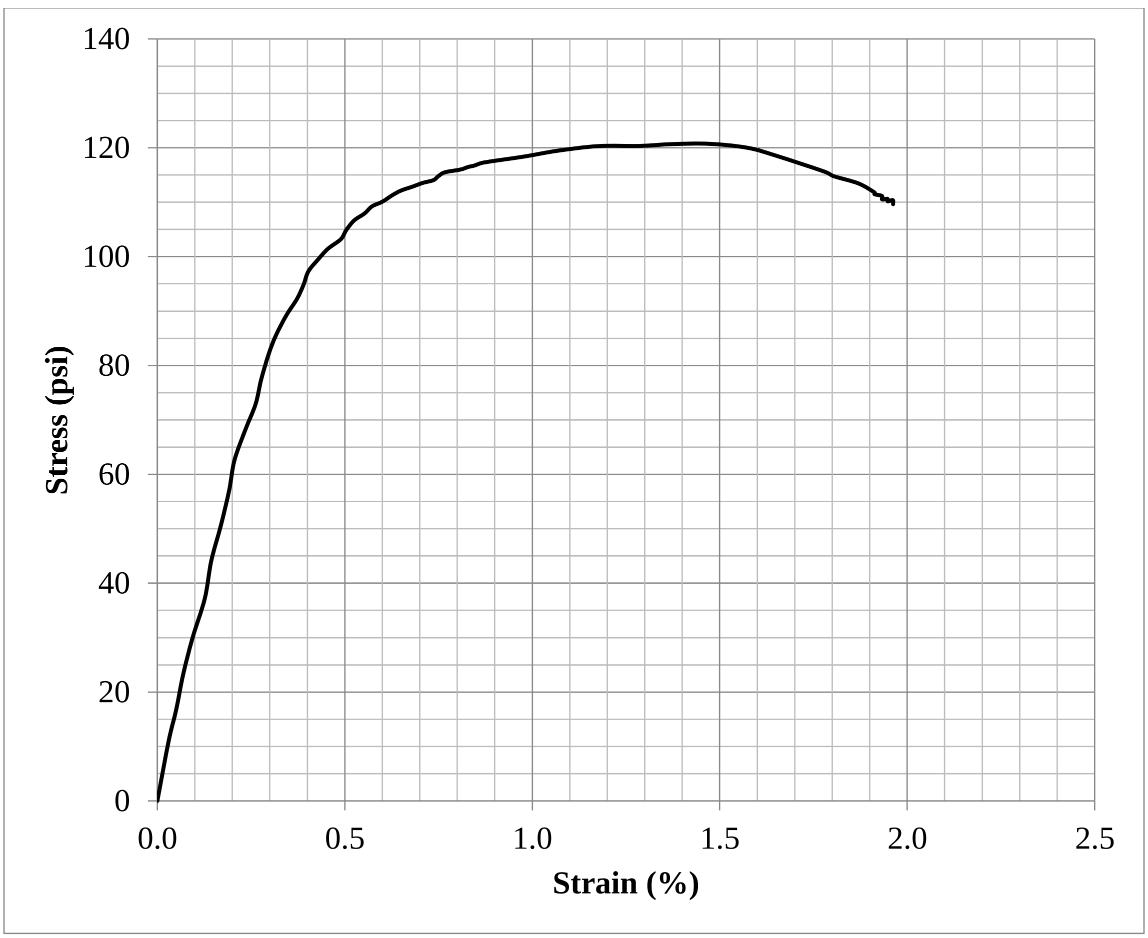
Testing Date	5/3/19
Diameter (in.)	2.048
Height (in.)	3.370
Weight (g)	233.8
Corrected Peak UCS (psi)	116.4
Corrected Failure Strain (%)	1.58
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-4-D
Molding Date	4/19/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (354.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.2

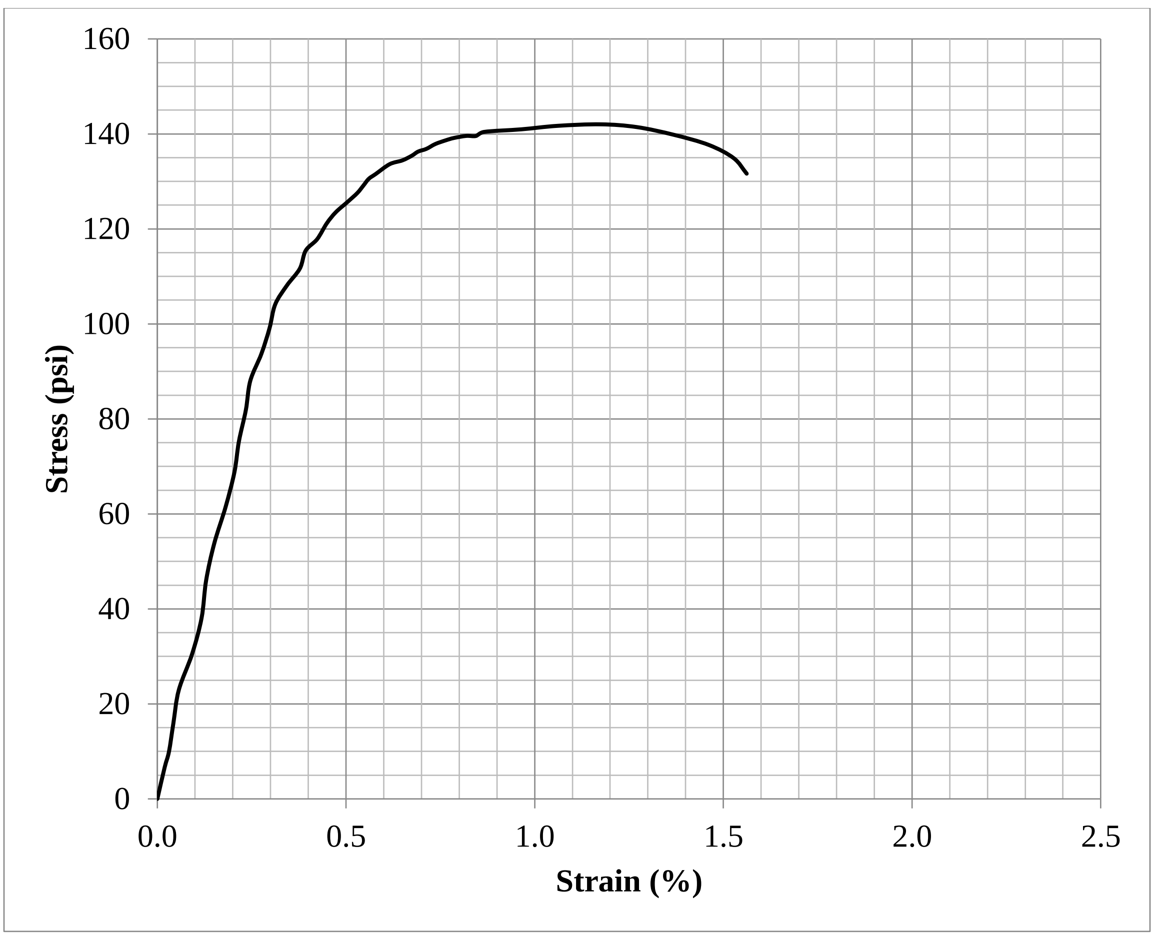
Testing Date	5/3/19
Diameter (in.)	2.042
Height (in.)	3.377
Weight (g)	234.3
Corrected Peak UCS (psi)	117.4
Corrected Failure Strain (%)	1.47
ASTM C39 Fracture Type	N/A



<u>Data Sheet: Specimen UCS Test</u>

Specimen ID	30-4-E
Molding Date	4/19/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	350 (354.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.4

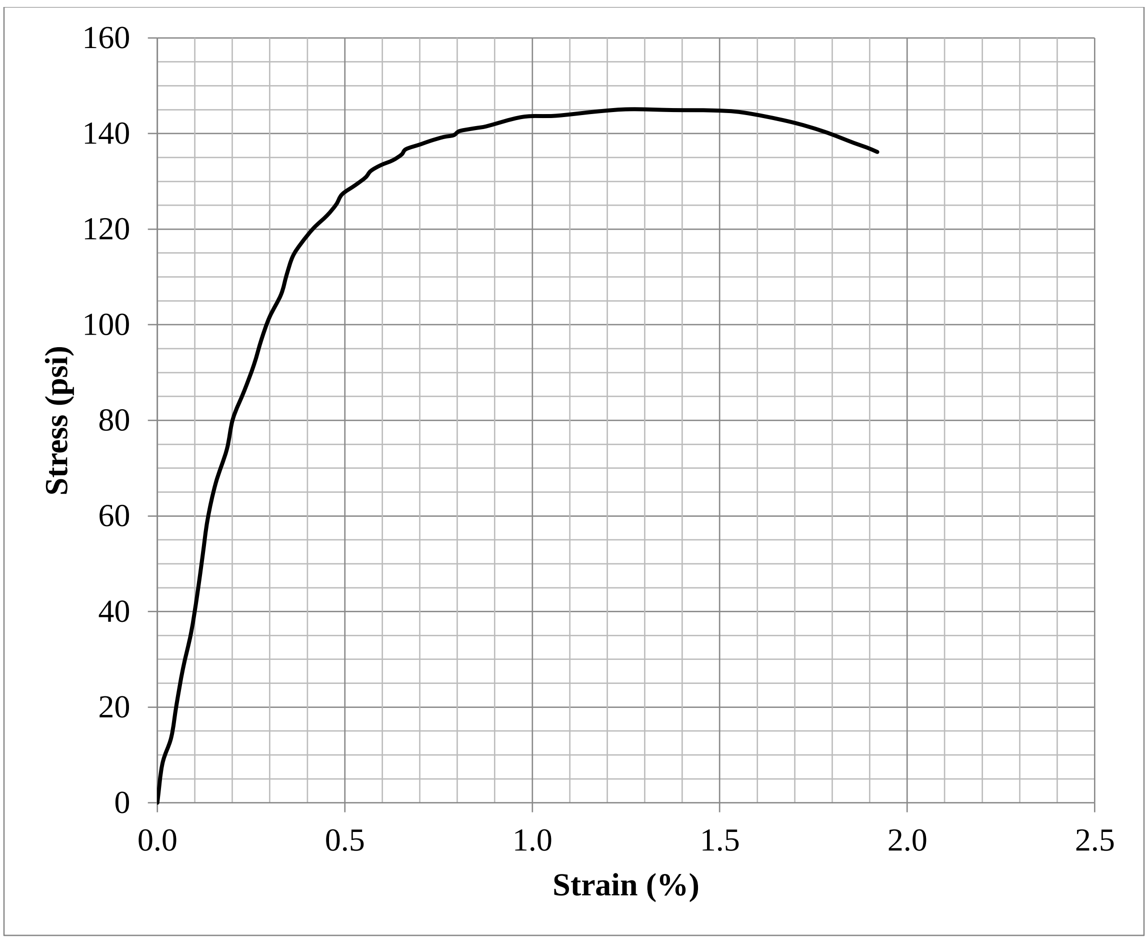
Testing Date	5/17/19
Diameter (in.)	2.045
Height (in.)	3.616
Weight (g)	254.6
Corrected Peak UCS (psi)	139.4
Corrected Failure Strain (%)	1.17
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-4-F
Molding Date	4/19/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	350 (354.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.1

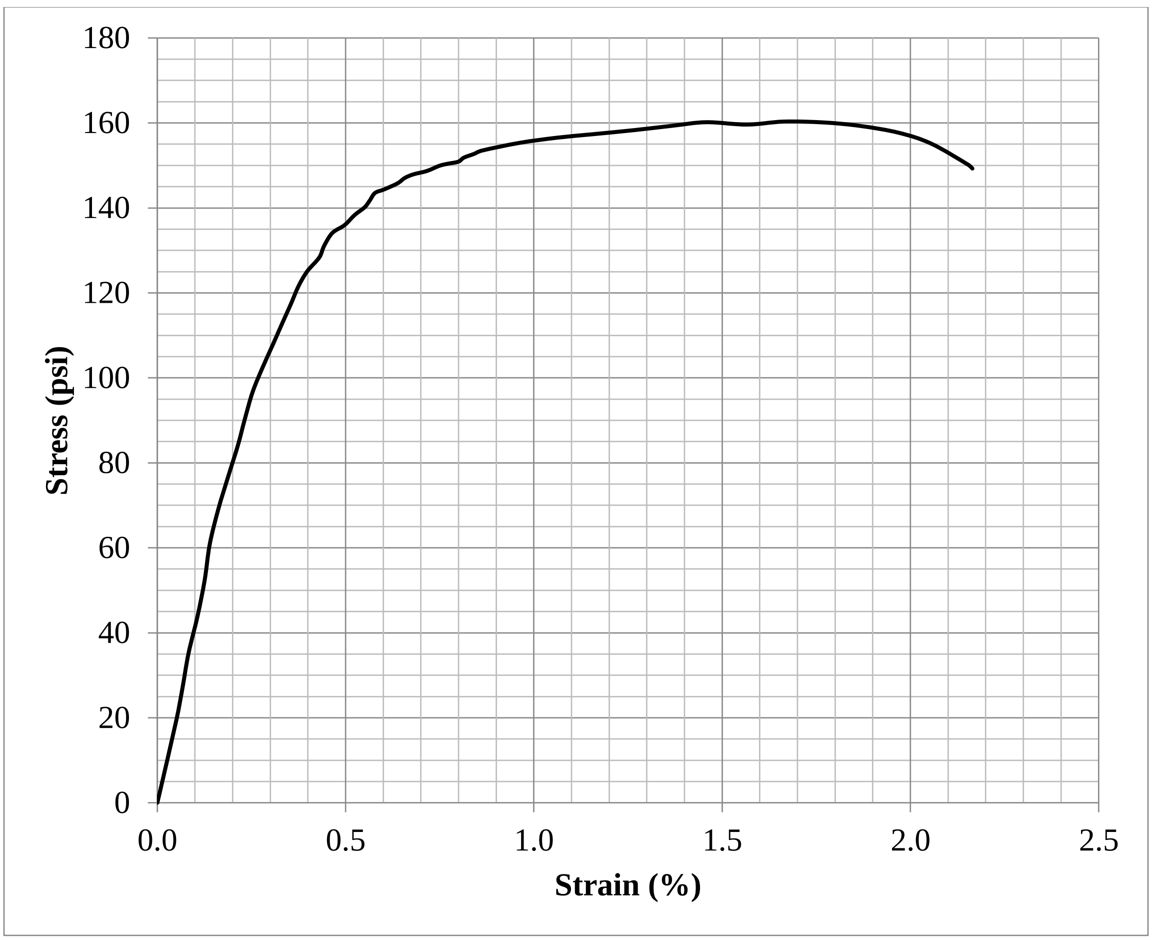
Testing Date	5/17/19
Diameter (in.)	2.041
Height (in.)	3.650
Weight (g)	257.2
Corrected Peak UCS (psi)	142.6
Corrected Failure Strain (%)	1.26
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-5-A
Molding Date	4/19/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (404.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.5

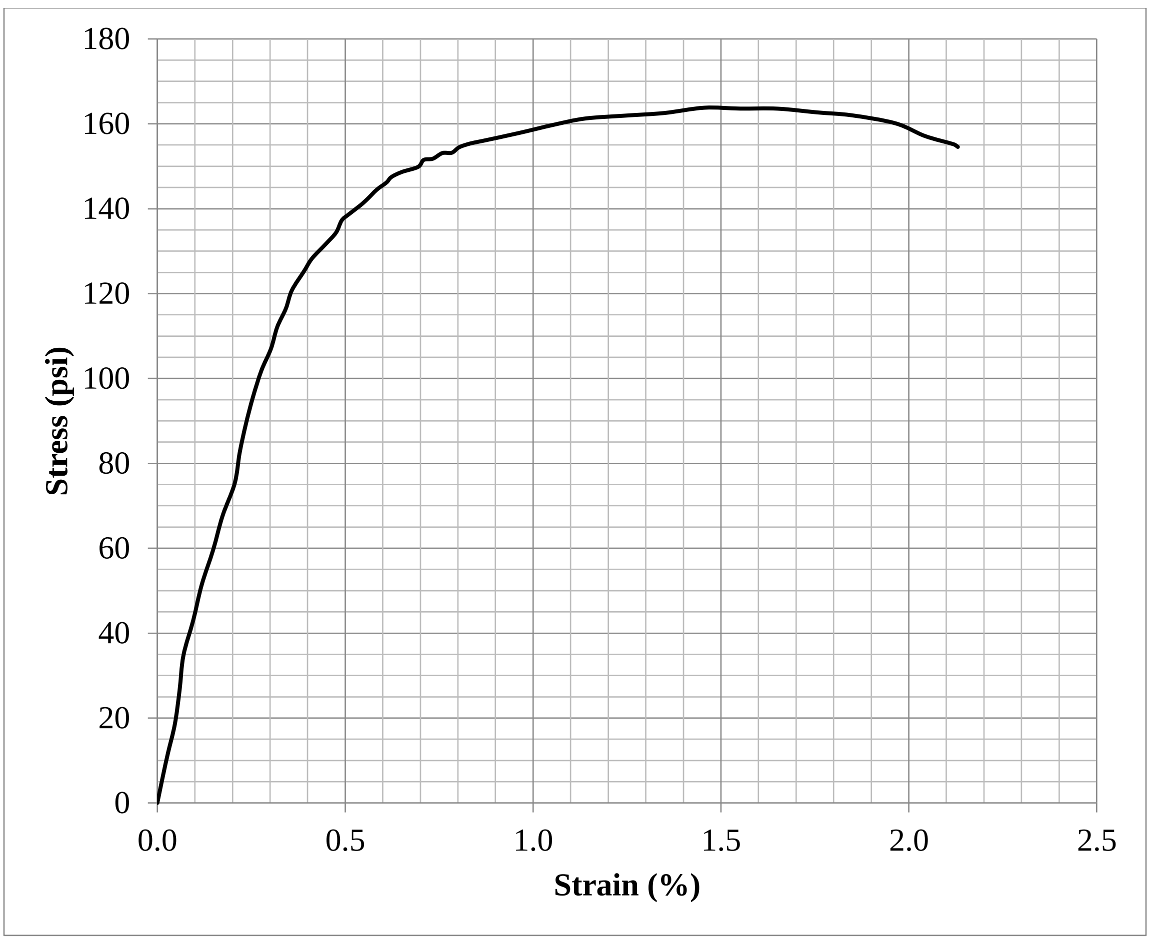
Testing Date	4/26/19
Diameter (in.)	2.046
Height (in.)	3.748
Weight (g)	275.3
Corrected Peak UCS (psi)	158.2
Corrected Failure Strain (%)	1.66
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-5-B
Molding Date	4/19/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (404.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.2

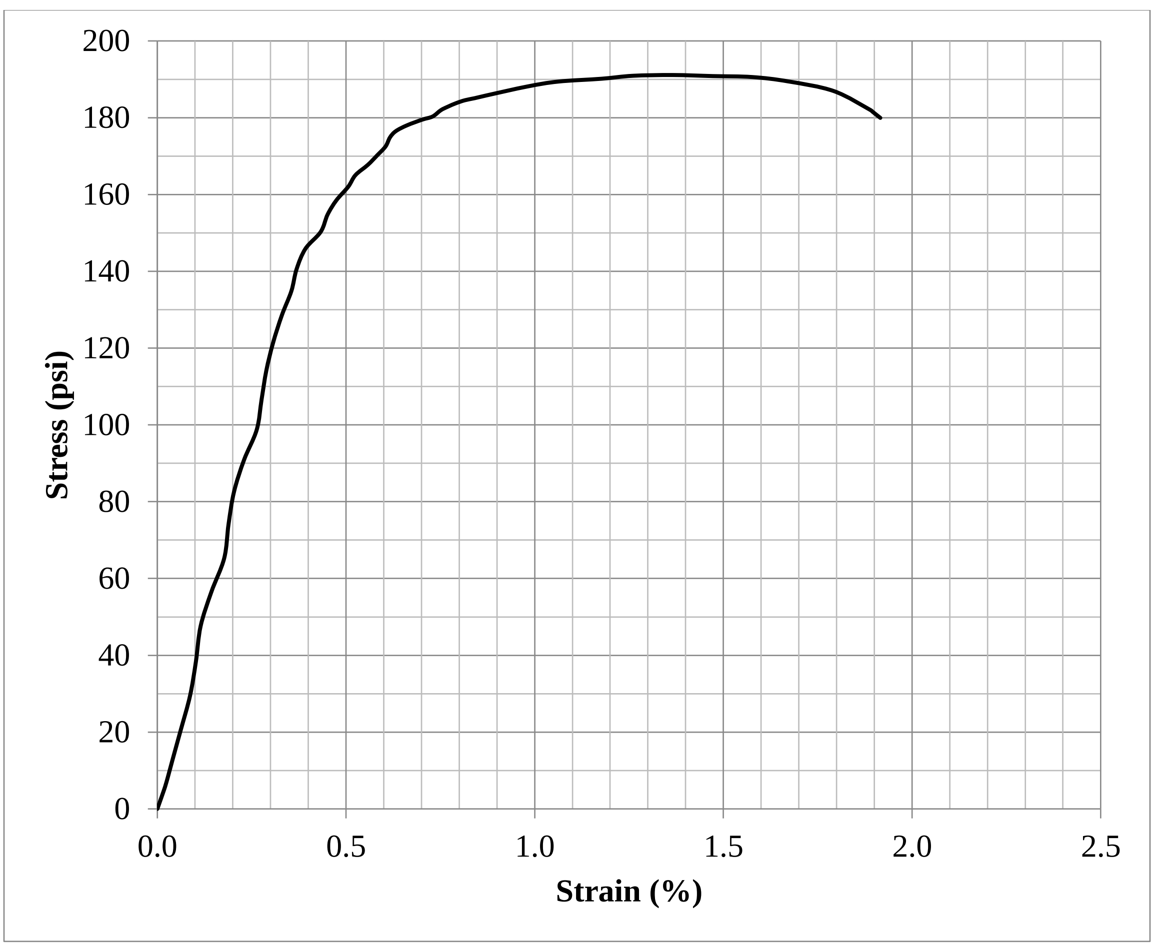
Testing Date	4/26/19
Diameter (in.)	2.051
Height (in.)	3.405
Weight (g)	249.6
Corrected Peak UCS (psi)	159.3
Corrected Failure Strain (%)	1.46
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-5-D
Molding Date	4/19/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	400 (404.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.8

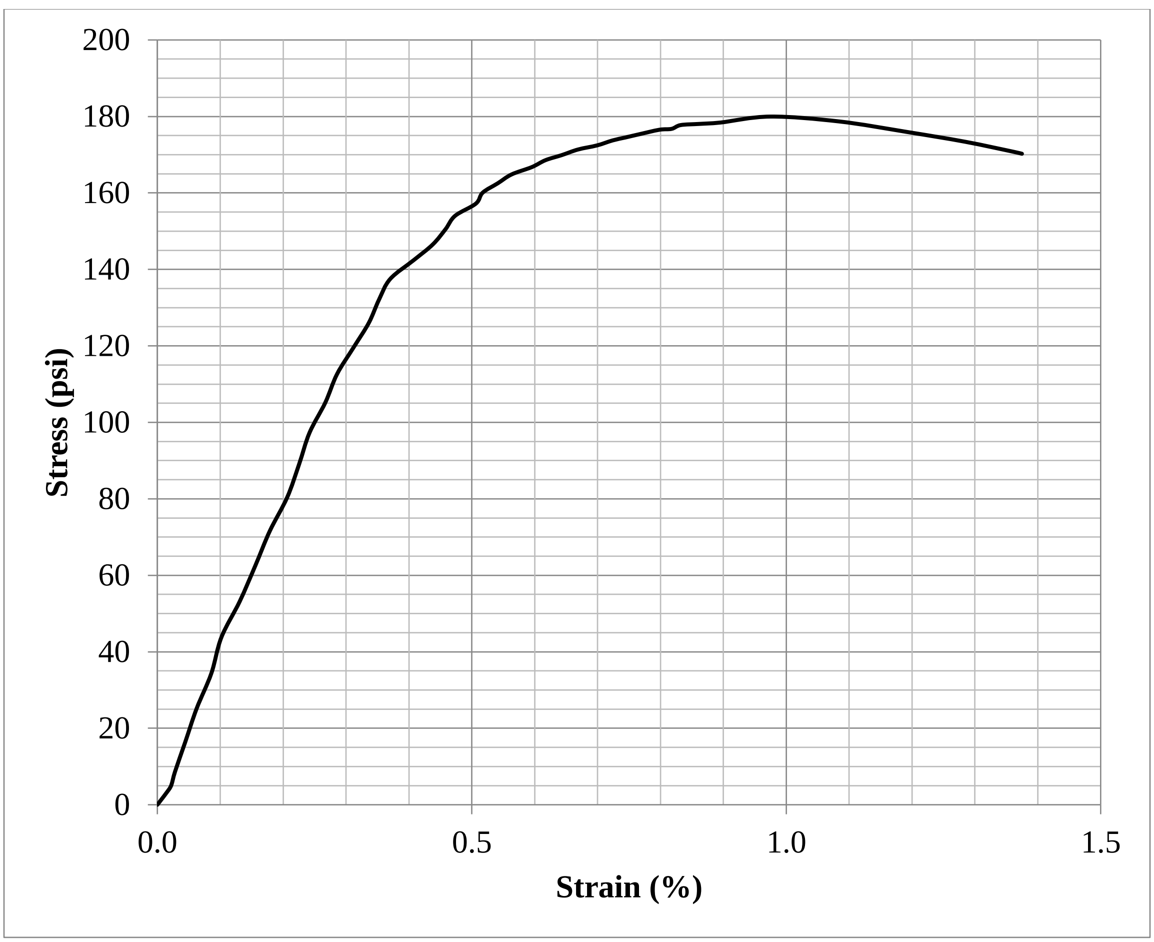
Testing Date	5/4/19
Diameter (in.)	2.042
Height (in.)	3.613
Weight (g)	266.7
Corrected Peak UCS (psi)	187.6
Corrected Failure Strain (%)	1.37
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-5-E
Molding Date	4/19/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	400 (404.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.4

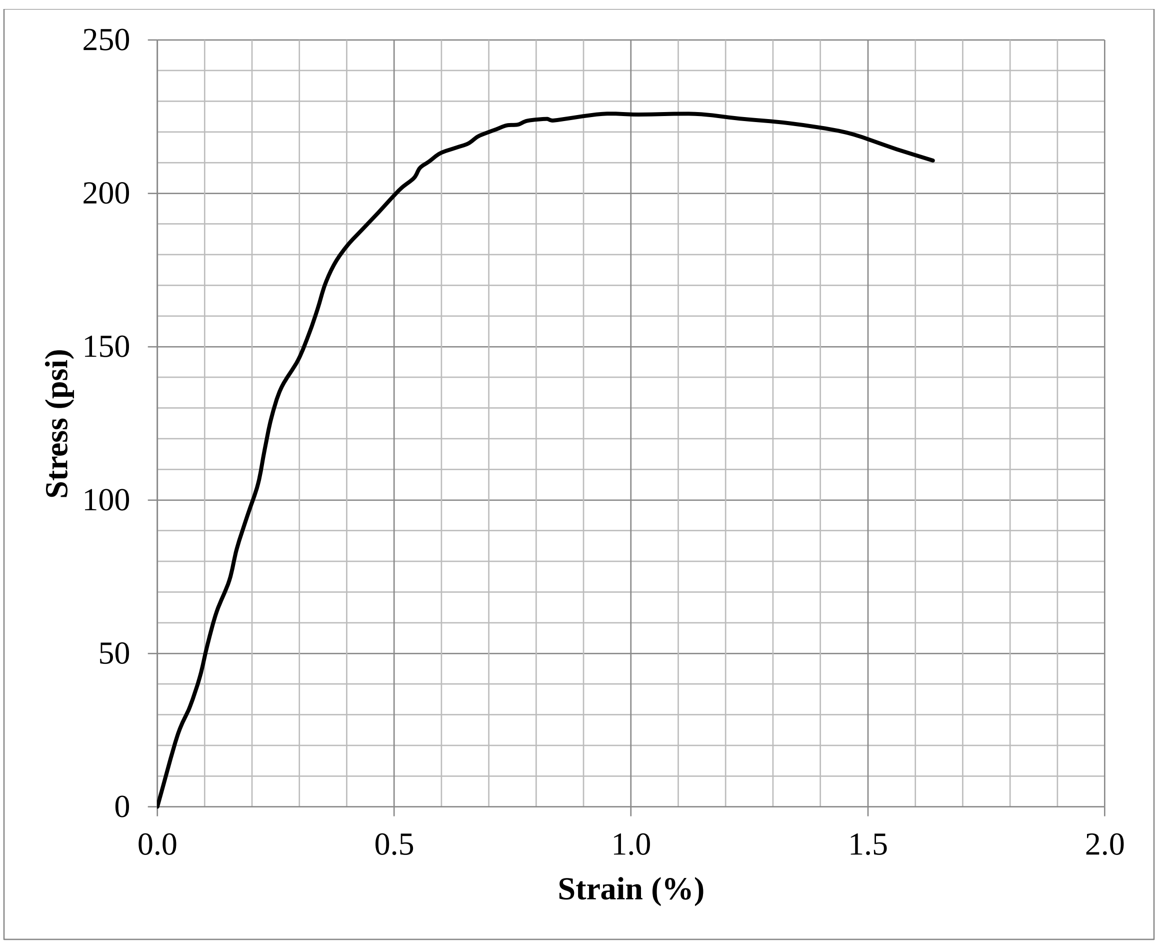
Testing Date	5/4/19
Diameter (in.)	2.045
Height (in.)	3.763
Weight (g)	277.4
Corrected Peak UCS (psi)	177.7
Corrected Failure Strain (%)	0.97
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-5-F
Molding Date	4/19/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	400 (404.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.6

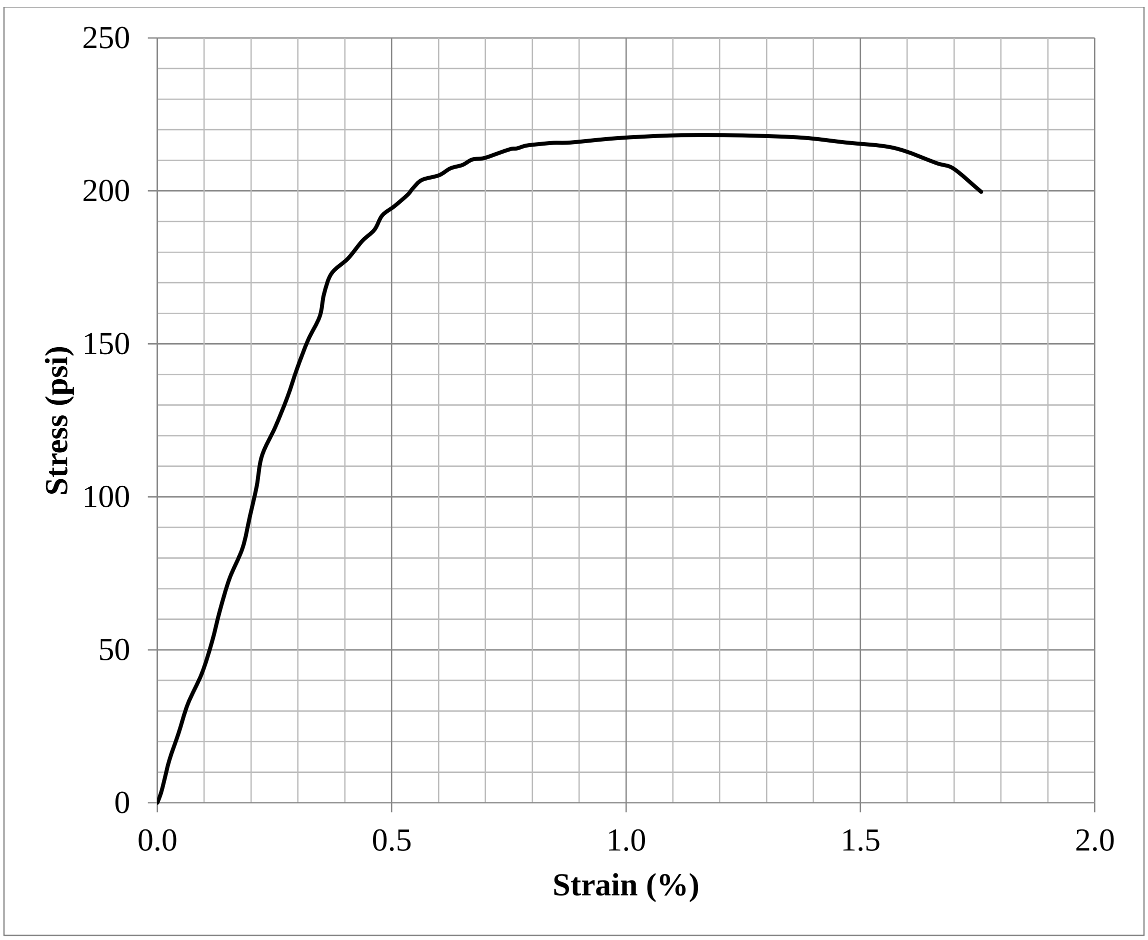
Testing Date	5/17/19
Diameter (in.)	2.044
Height (in.)	3.572
Weight (g)	265.0
Corrected Peak UCS (psi)	221.3
Corrected Failure Strain (%)	1.14
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-5-G
Molding Date	4/19/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (404.8)
w:b	0.8
Soil OM (%)	36.1
Bleed Water (g)	1.6

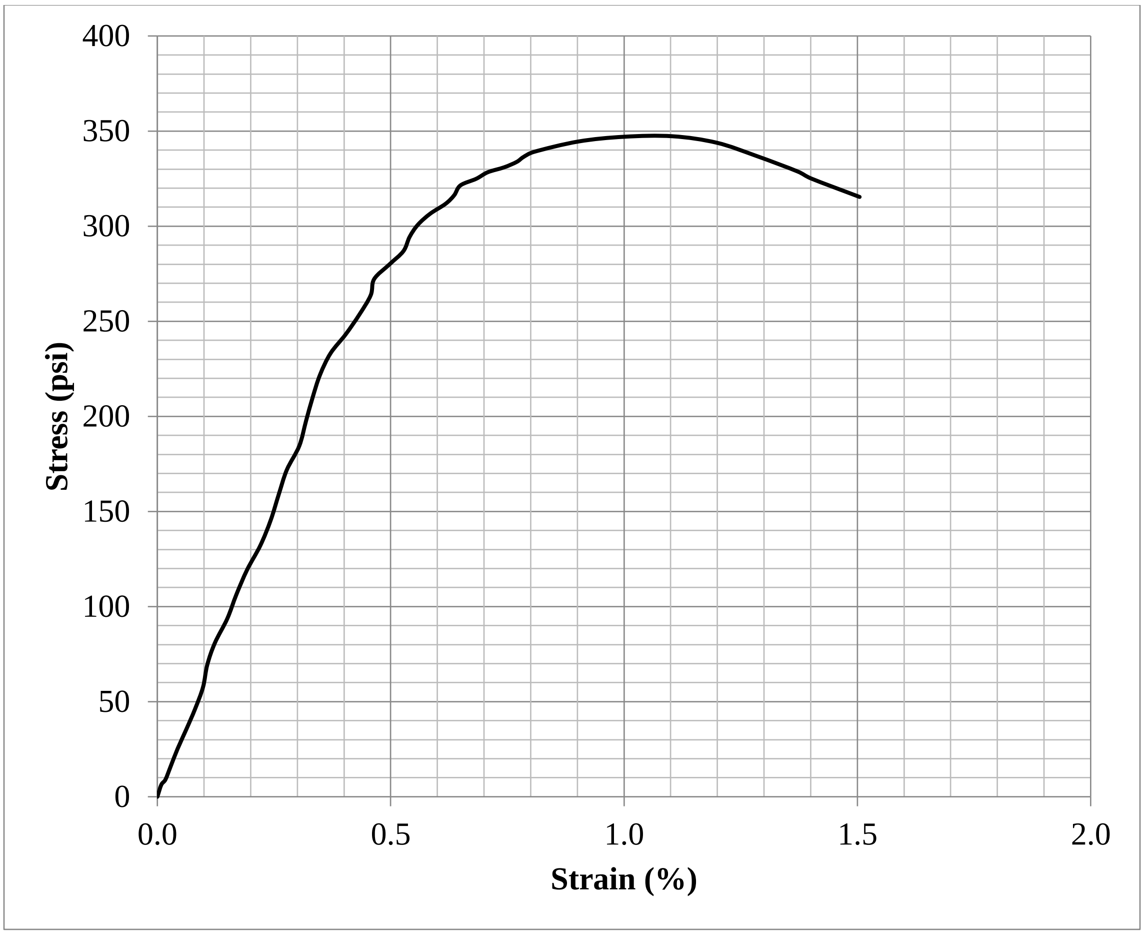
Testing Date	5/17/19
Diameter (in.)	2.046
Height (in.)	3.700
Weight (g)	275.2
Corrected Peak UCS (psi)	214.9
Corrected Failure Strain (%)	1.19
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-6-A
Molding Date	4/19/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	500 (505.4)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.8

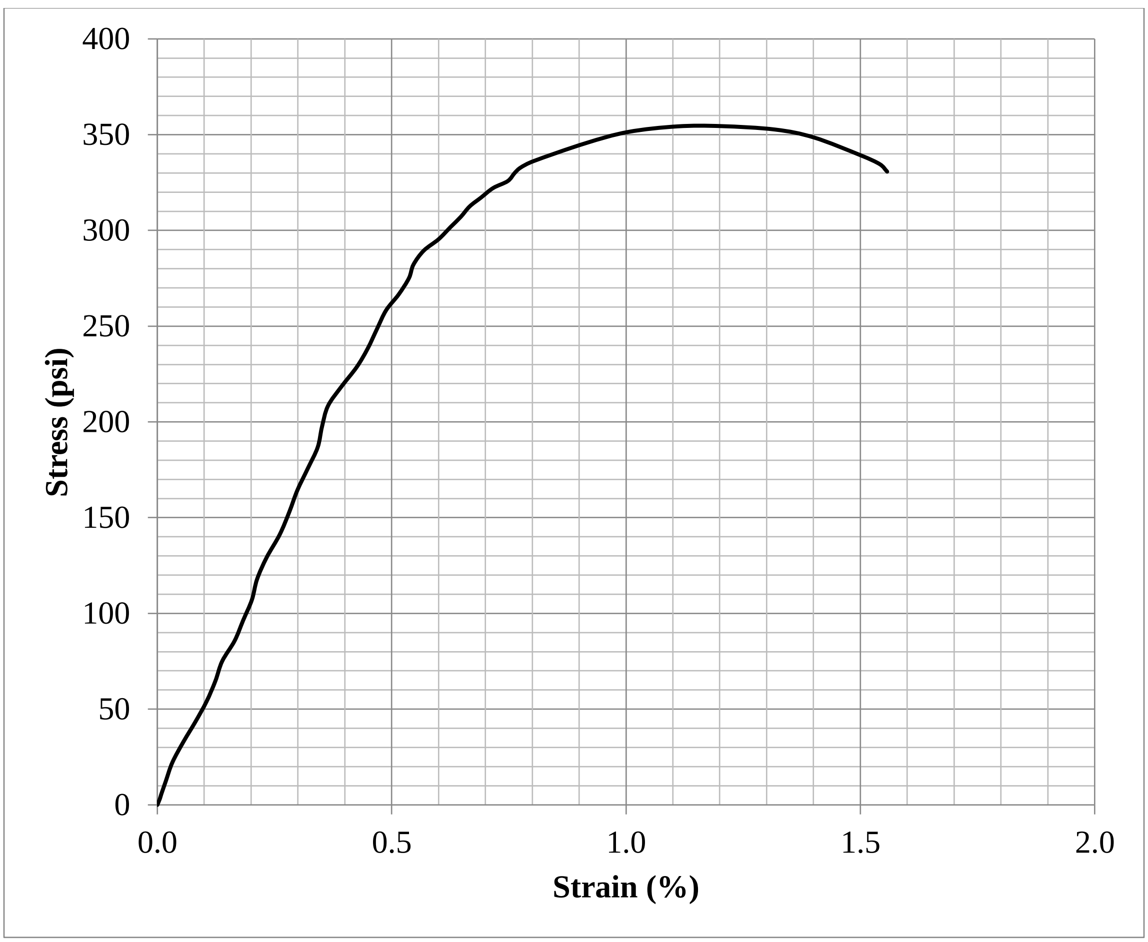
Testing Date	4/26/19
Diameter (in.)	2.044
Height (in.)	3.653
Weight (g)	276.9
Corrected Peak UCS (psi)	341.4
Corrected Failure Strain (%)	1.10
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-6-B
Molding Date	4/19/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	500 (505.4)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	1.2

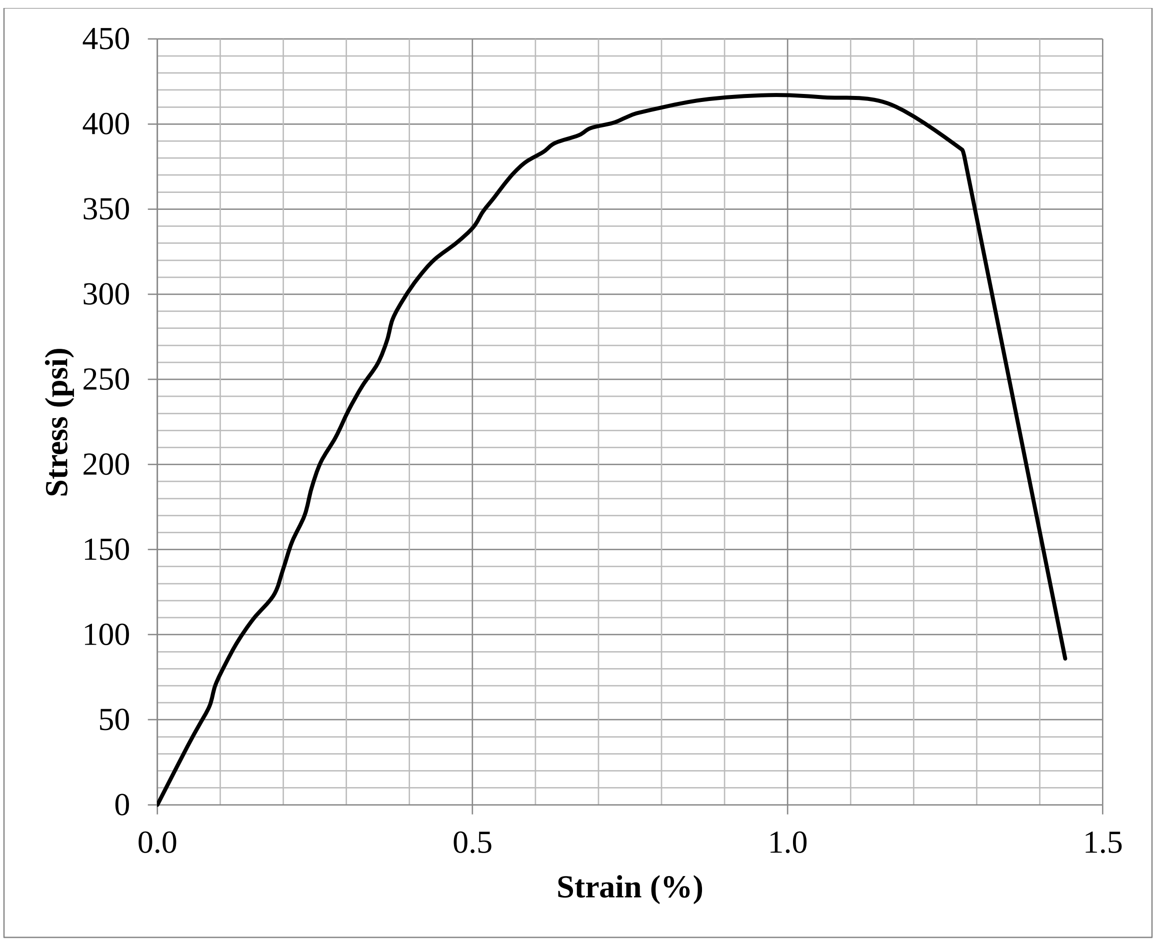
Testing Date	4/26/19
Diameter (in.)	2.047
Height (in.)	3.700
Weight (g)	281.2
Corrected Peak UCS (psi)	349.0
Corrected Failure Strain (%)	1.20
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-6-C
Molding Date	4/19/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	500 (505.4)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	1.1

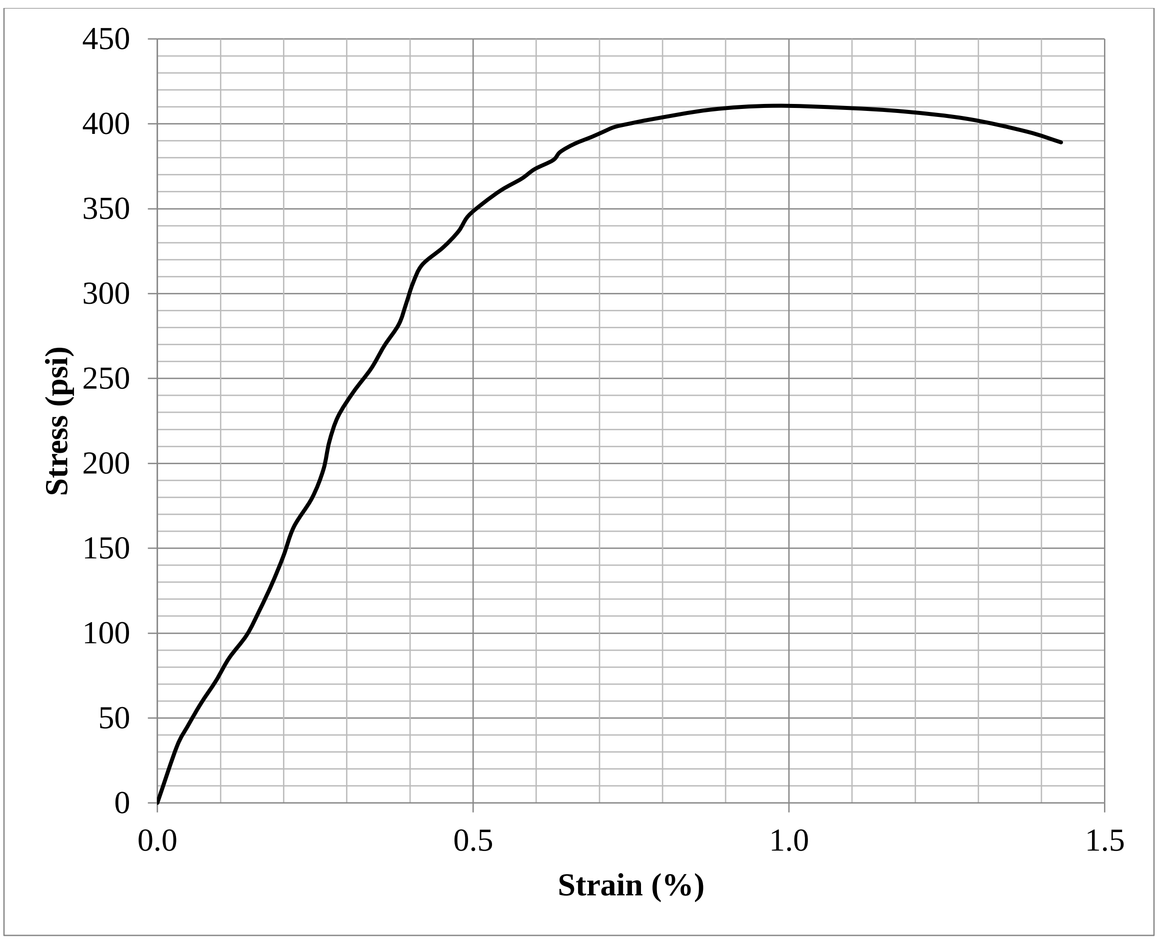
Testing Date	5/4/19
Diameter (in.)	2.049
Height (in.)	3.781
Weight (g)	290.1
Corrected Peak UCS (psi)	411.8
Corrected Failure Strain (%)	0.97
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-6-D
Molding Date	4/19/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	500 (505.4)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	1.0

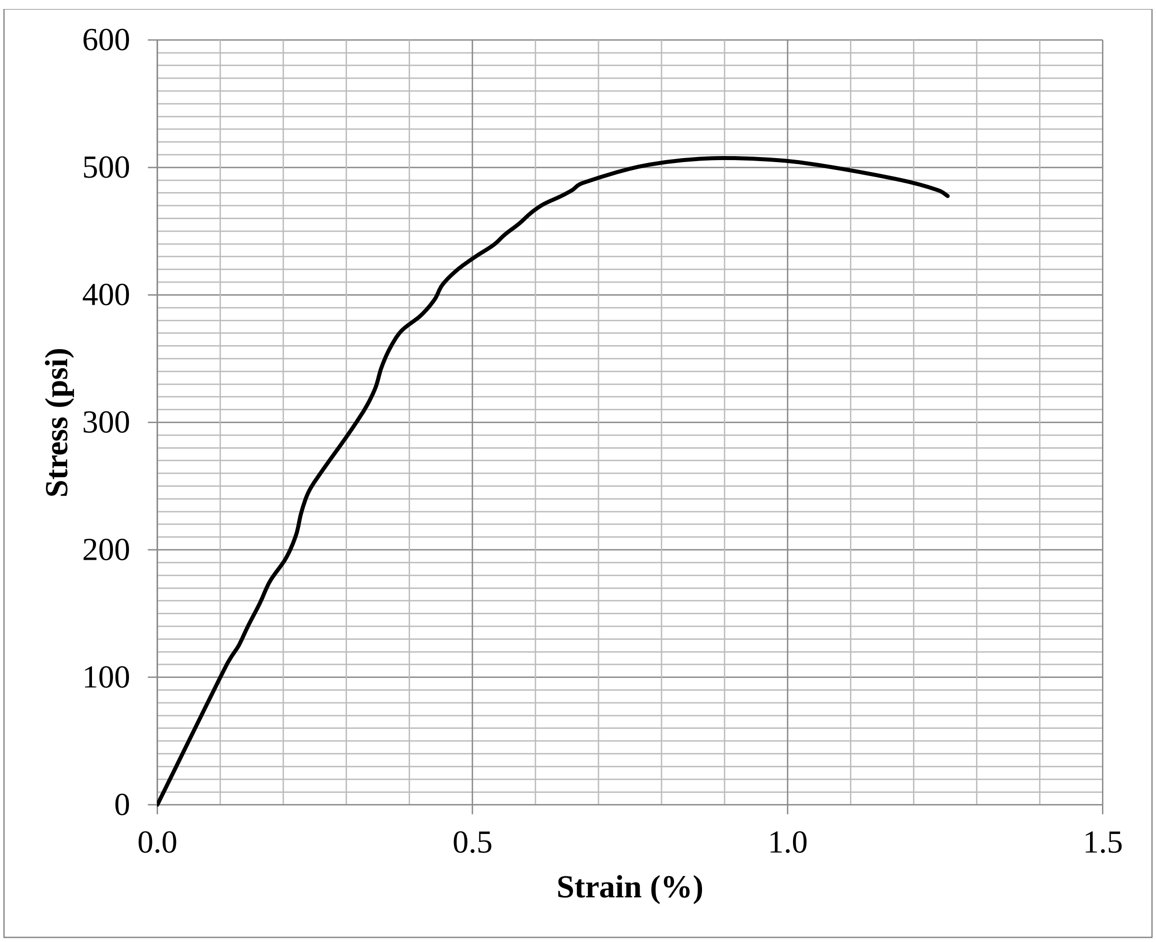
Testing Date	5/5/19
Diameter (in.)	2.048
Height (in.)	3.744
Weight (g)	285.2
Corrected Peak UCS (psi)	405.0
Corrected Failure Strain (%)	0.97
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-6-E
Molding Date	4/19/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	500 (505.4)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	1.3

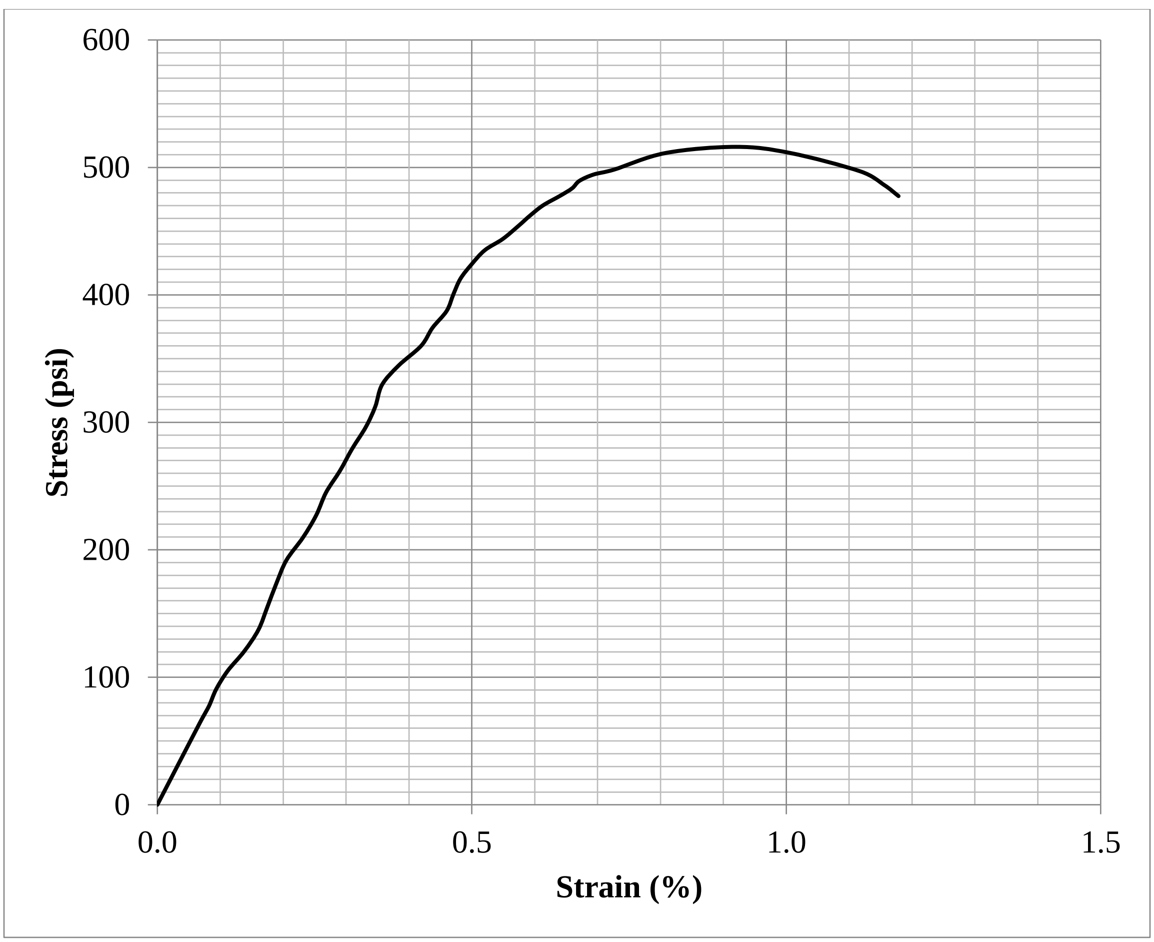
Testing Date	5/17/19
Diameter (in.)	2.047
Height (in.)	3.743
Weight (g)	287.8
Corrected Peak UCS (psi)	500.2
Corrected Failure Strain (%)	0.87
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-6-F
Molding Date	4/19/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	500 (505.4)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	1.0

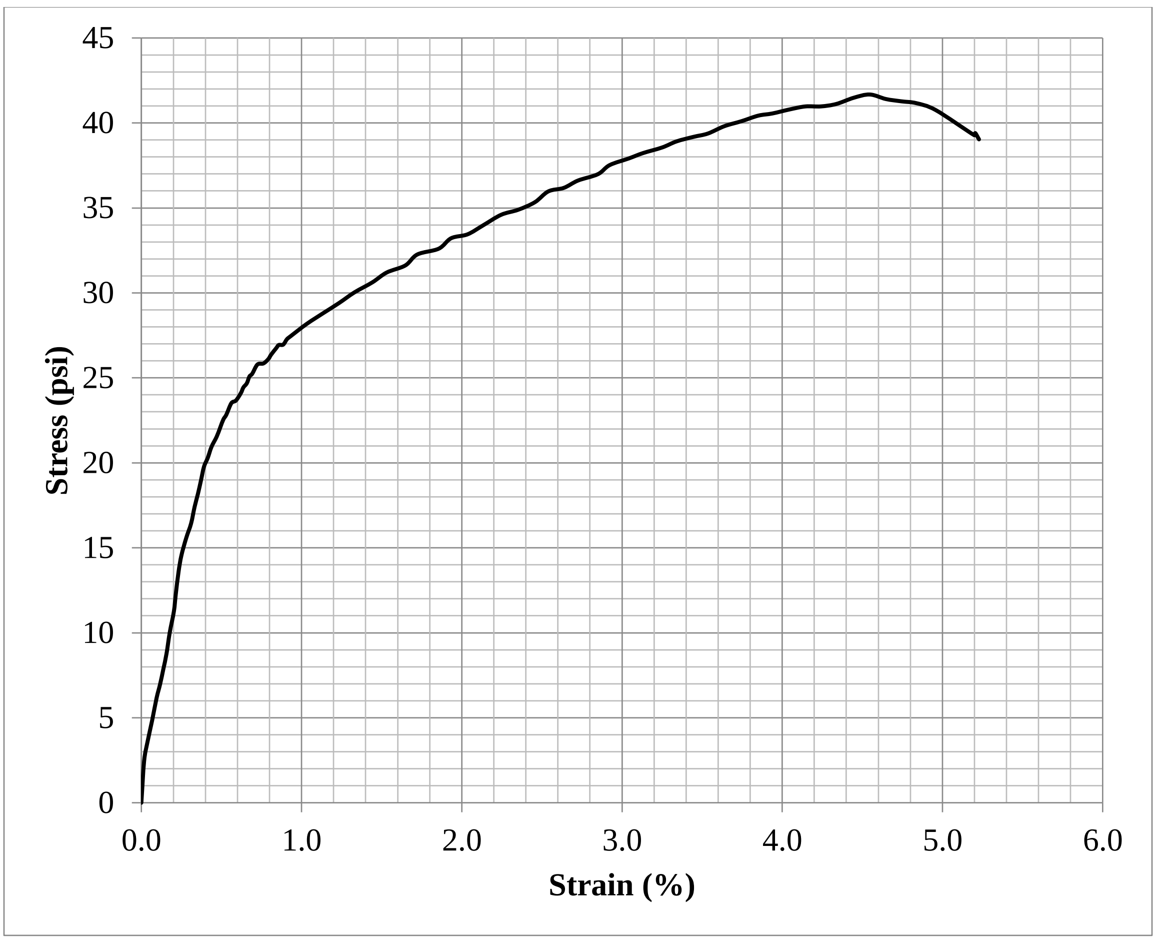
Testing Date	5/18/19
Diameter (in.)	2.042
Height (in.)	3.718
Weight (g)	286.6
Corrected Peak UCS (psi)	508.7
Corrected Failure Strain (%)	0.92
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-7-A
Molding Date	5/20/19
Curing Period (d)	8
α_{I-P} (kg/m^3)	150 (153.3)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.5

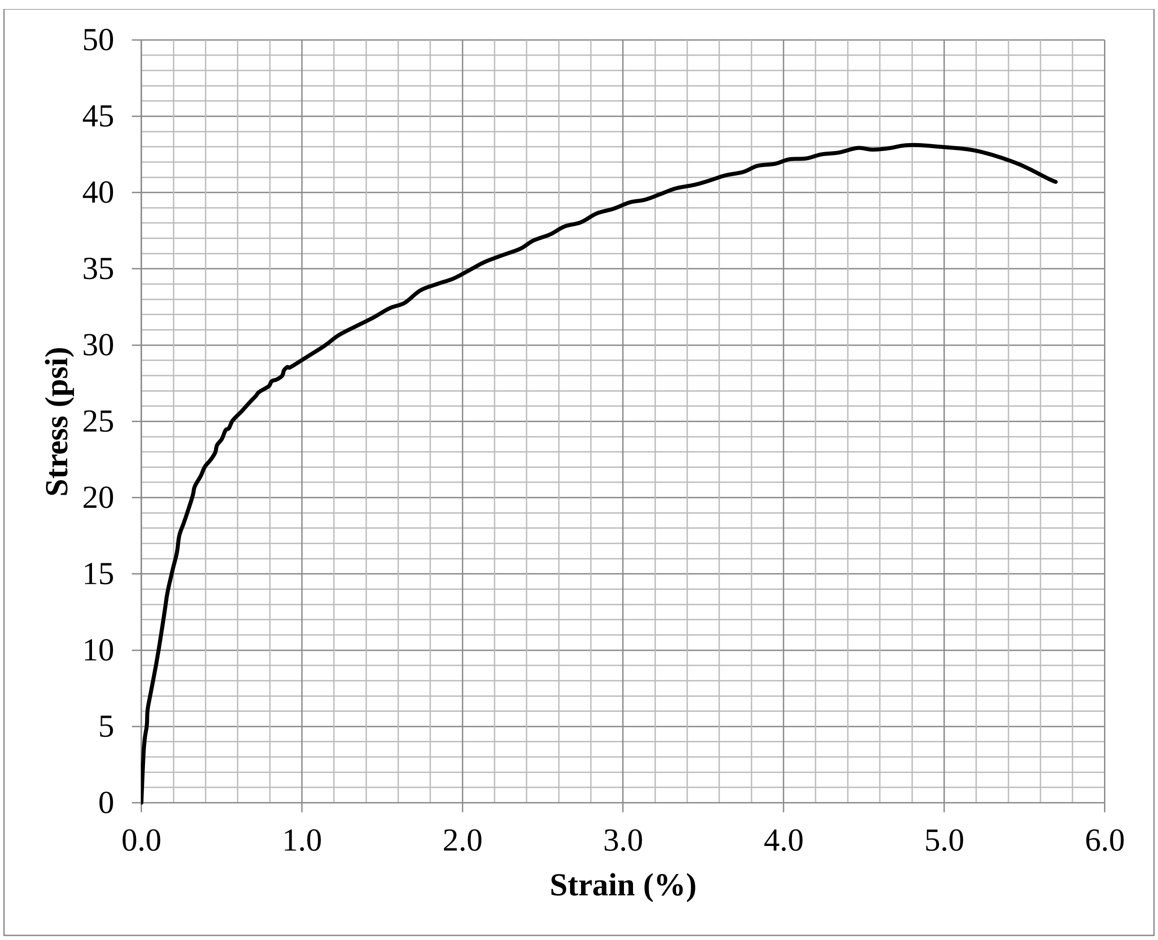
Testing Date	5/28/19
Diameter (in.)	2.043
Height (in.)	3.551
Weight (g)	237.4
Corrected Peak UCS (psi)	40.8
Corrected Failure Strain (%)	4.55
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-7-B
Molding Date	5/20/19
Curing Period (d)	8
α_{I-P} (kg/m^3)	150 (153.3)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.5

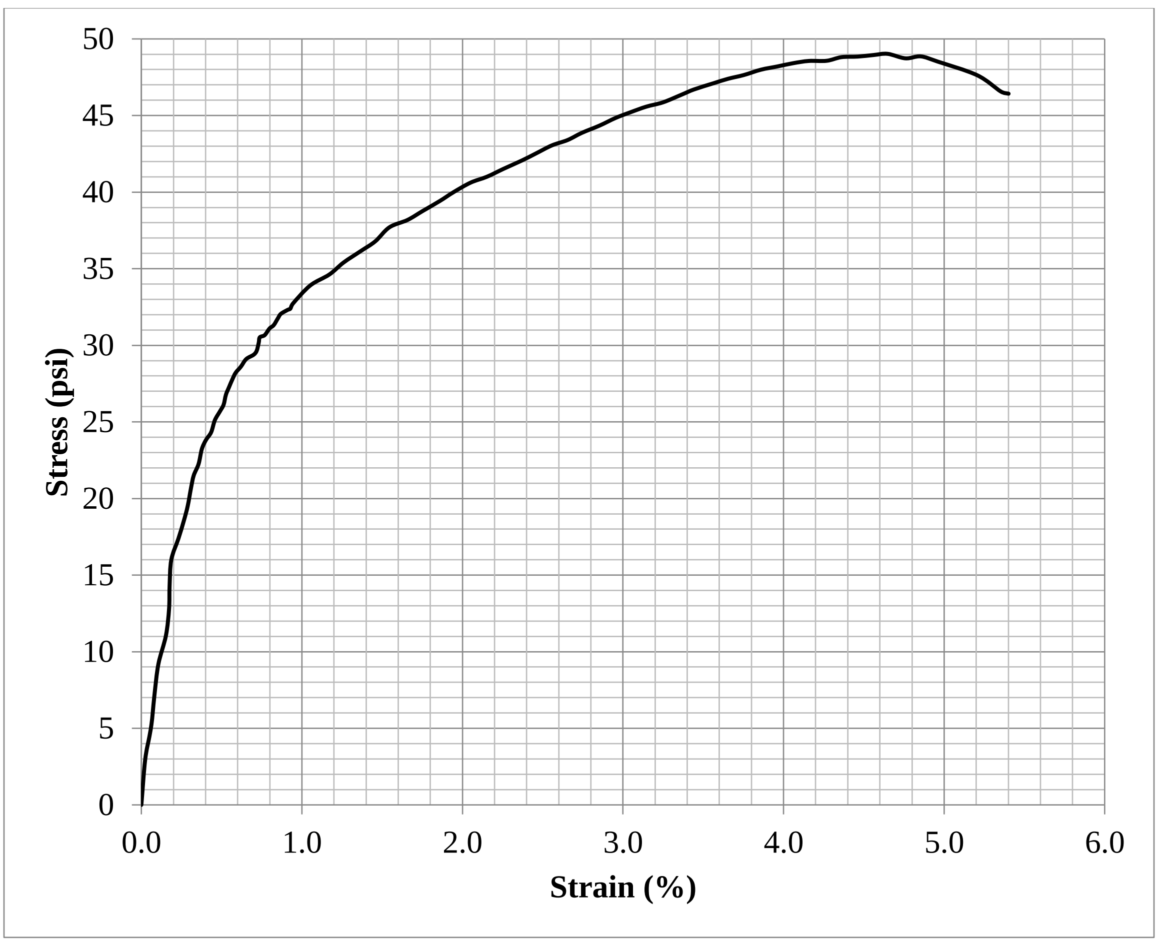
Testing Date	5/28/19
Diameter (in.)	2.029
Height (in.)	3.633
Weight (g)	243.8
Corrected Peak UCS (psi)	42.4
Corrected Failure Strain (%)	4.83
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-7-C
Molding Date	5/20/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	150 (153.3)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.3

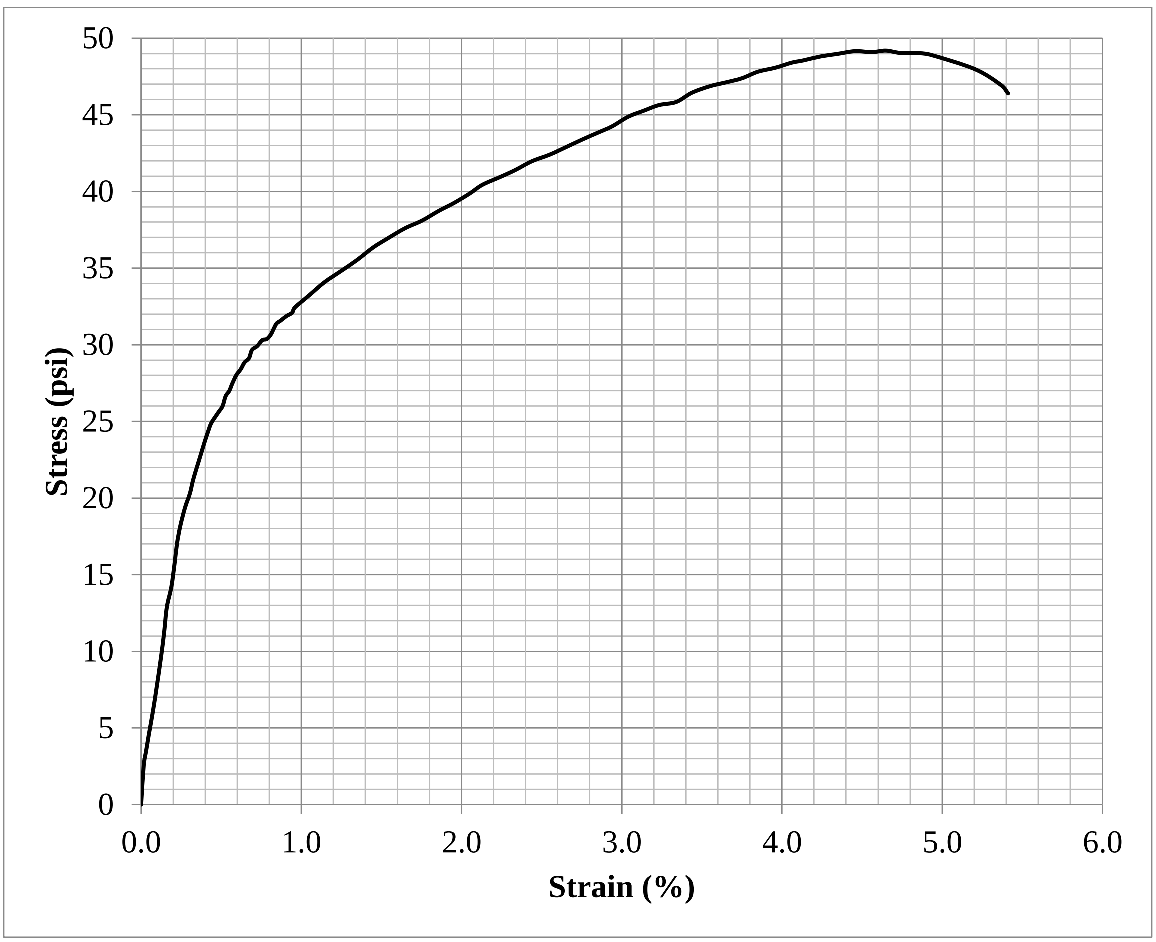
Testing Date	6/3/19
Diameter (in.)	2.036
Height (in.)	3.517
Weight (g)	234.7
Corrected Peak UCS (psi)	48.0
Corrected Failure Strain (%)	4.65
ASTM C39 Fracture Type	4



<u>Data Sheet: Specimen UCS Test</u>

Specimen ID	30-7-D
Molding Date	5/20/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	150 (153.3)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.6

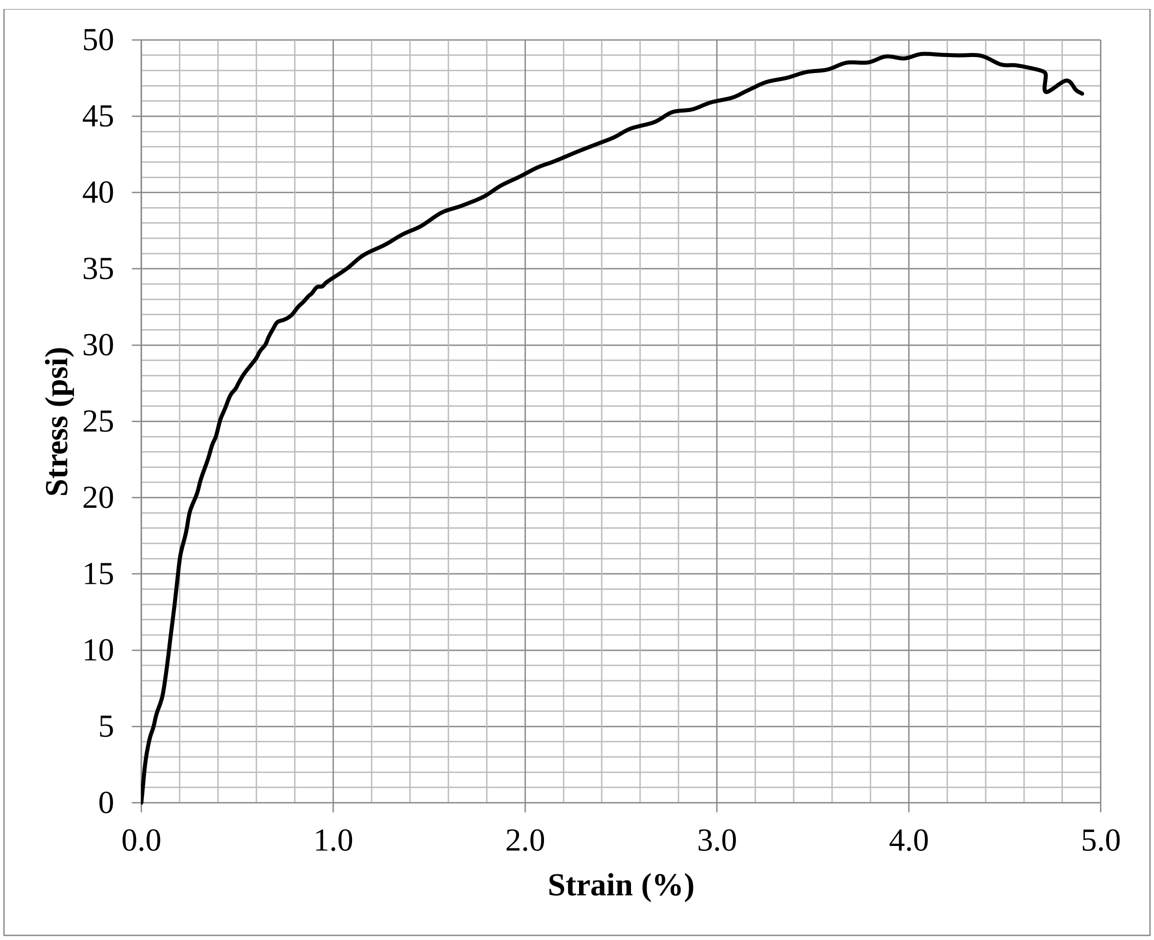
Testing Date	6/3/19
Diameter (in.)	2.031
Height (in.)	3.947
Weight (g)	265.8
Corrected Peak UCS (psi)	49.0
Corrected Failure Strain (%)	4.65
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-7-E
Molding Date	5/20/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	150 (153.3)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	1.1

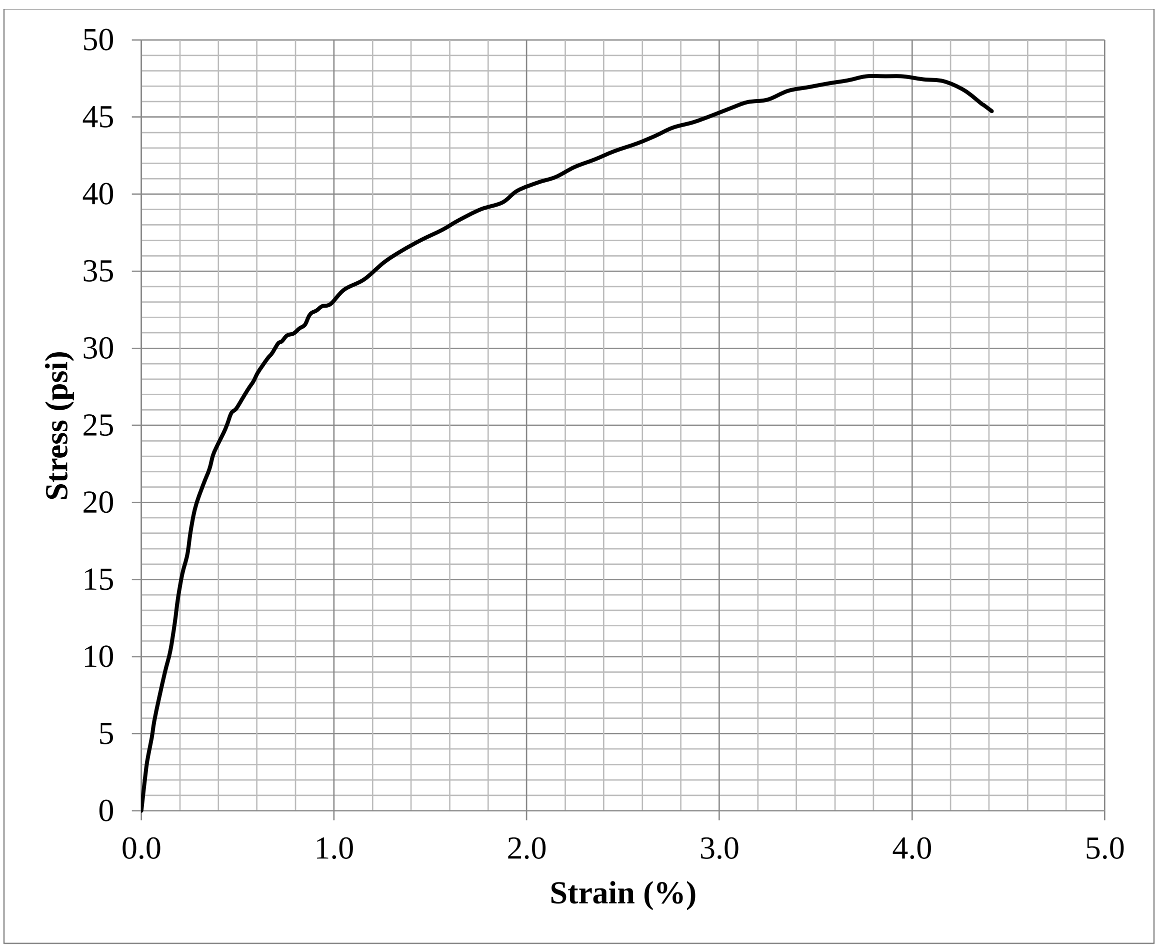
Testing Date	6/17/19
Diameter (in.)	2.031
Height (in.)	3.759
Weight (g)	253.3
Corrected Peak UCS (psi)	48.5
Corrected Failure Strain (%)	4.07
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-7-F
Molding Date	5/20/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	150 (153.3)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.6

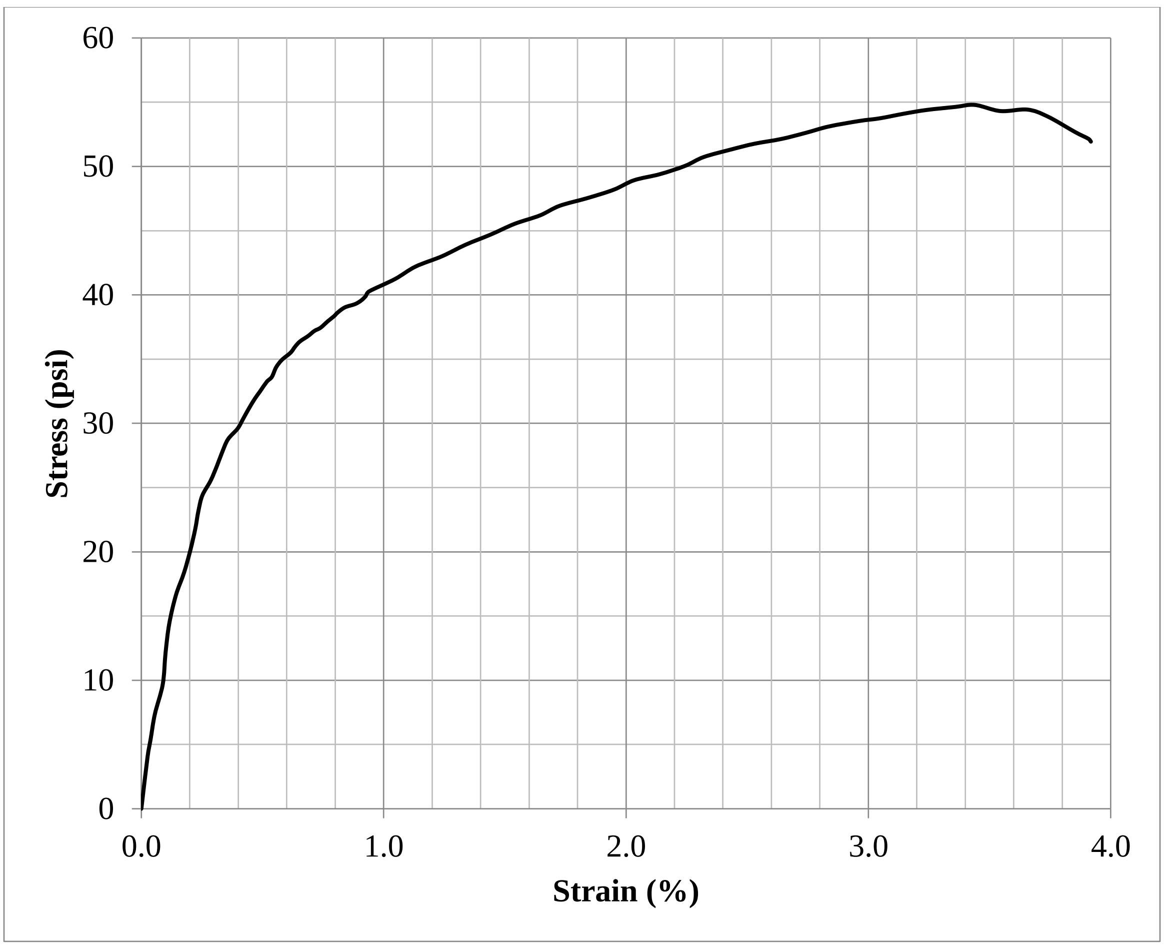
Testing Date	6/17/19
Diameter (in.)	2.028
Height (in.)	3.946
Weight (g)	265.9
Corrected Peak UCS (psi)	47.4
Corrected Failure Strain (%)	3.86
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-8-A
Molding Date	5/20/19
Curing Period (d)	8
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (203.1)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.2

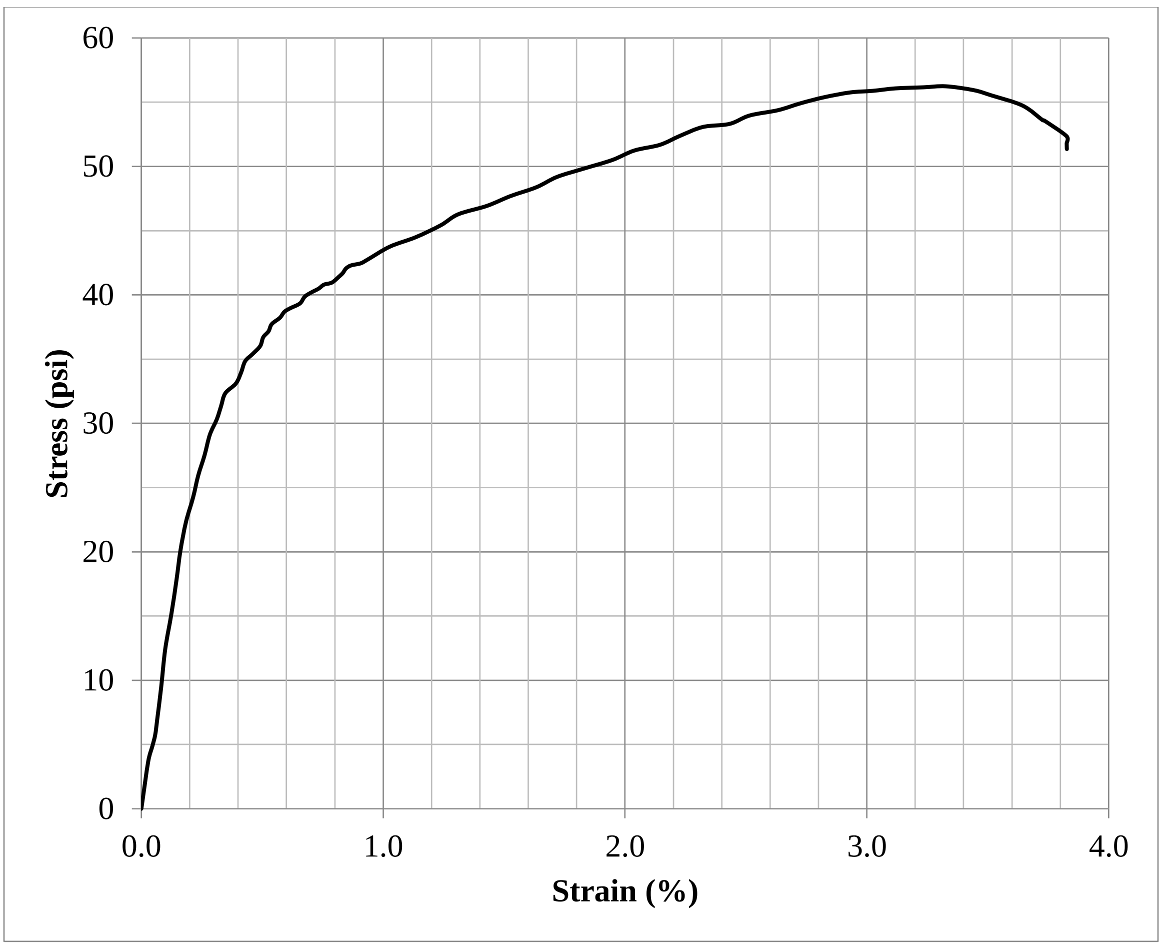
Testing Date	5/28/19
Diameter (in.)	2.034
Height (in.)	3.730
Weight (g)	254.4
Corrected Peak UCS (psi)	54.1
Corrected Failure Strain (%)	3.44
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	30-8-B
Molding Date	5/20/19
Curing Period (d)	8
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (203.1)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.5

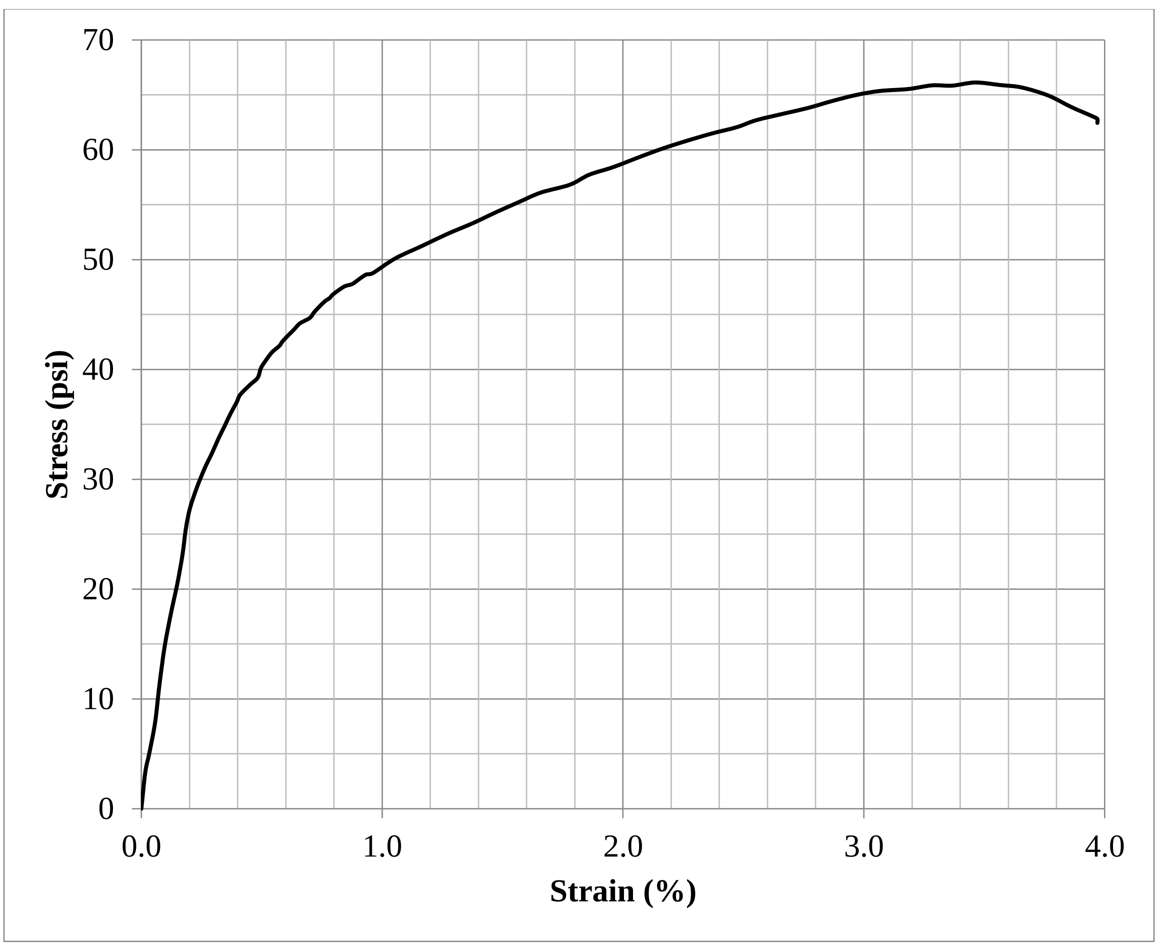
Testing Date	5/28/19
Diameter (in.)	2.039
Height (in.)	3.622
Weight (g)	247.5
Corrected Peak UCS (psi)	55.2
Corrected Failure Strain (%)	3.33
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-8-C
Molding Date	5/20/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (203.1)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.4

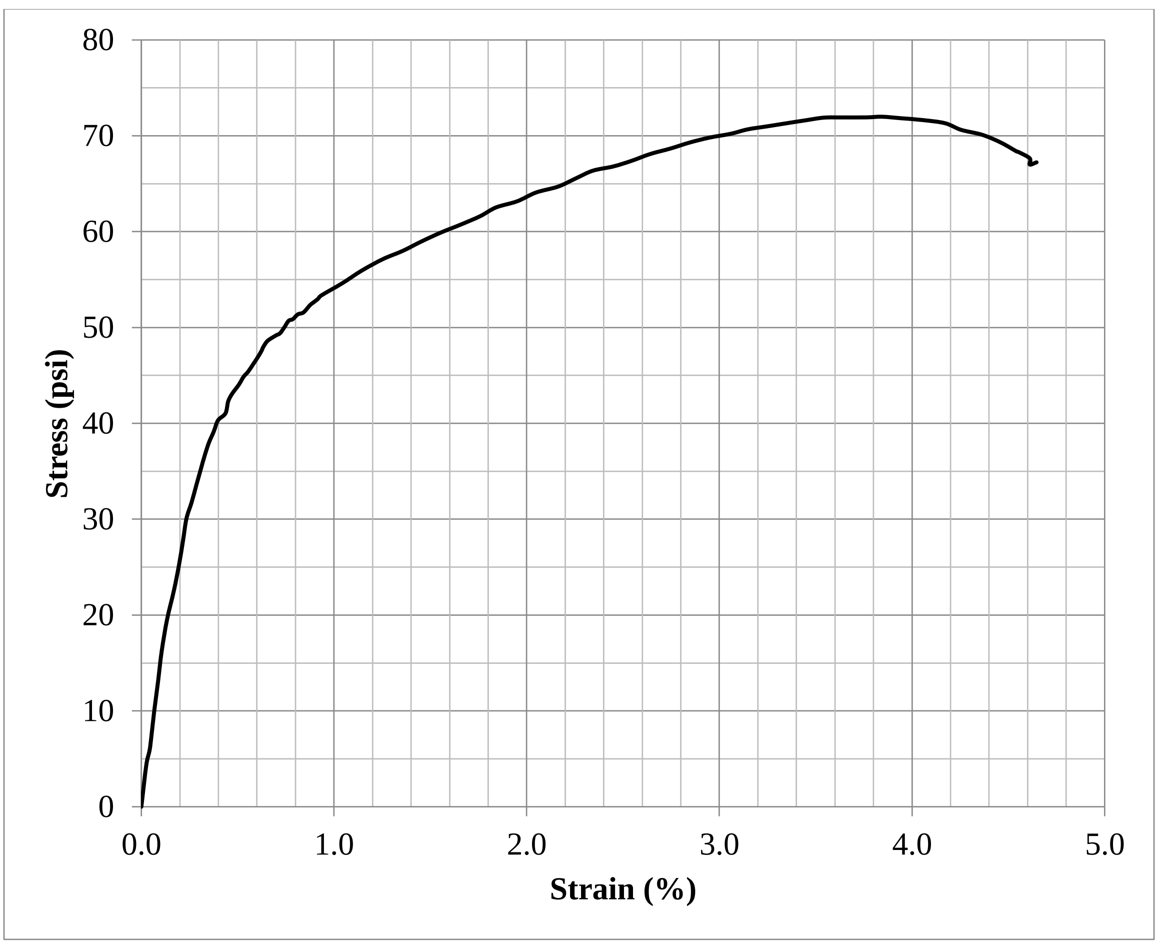
Testing Date	6/3/19
Diameter (in.)	2.041
Height (in.)	3.675
Weight (g)	250.7
Corrected Peak UCS (psi)	65.1
Corrected Failure Strain (%)	3.46
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-8-D
Molding Date	5/20/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	200 (203.1)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.4

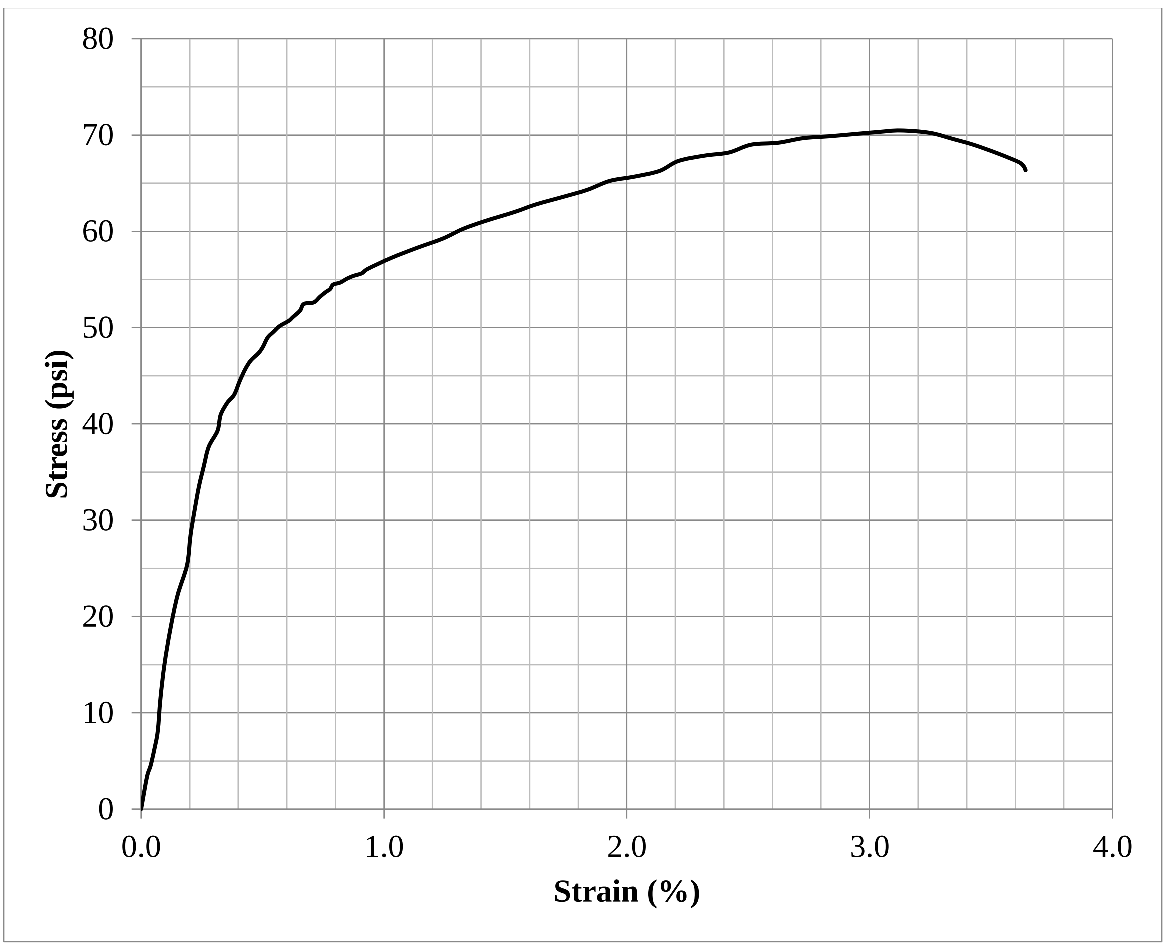
Testing Date	6/3/19
Diameter (in.)	2.035
Height (in.)	3.857
Weight (g)	264.0
Corrected Peak UCS (psi)	71.4
Corrected Failure Strain (%)	3.84
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-8-F
Molding Date	5/20/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	200 (203.1)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	0.6

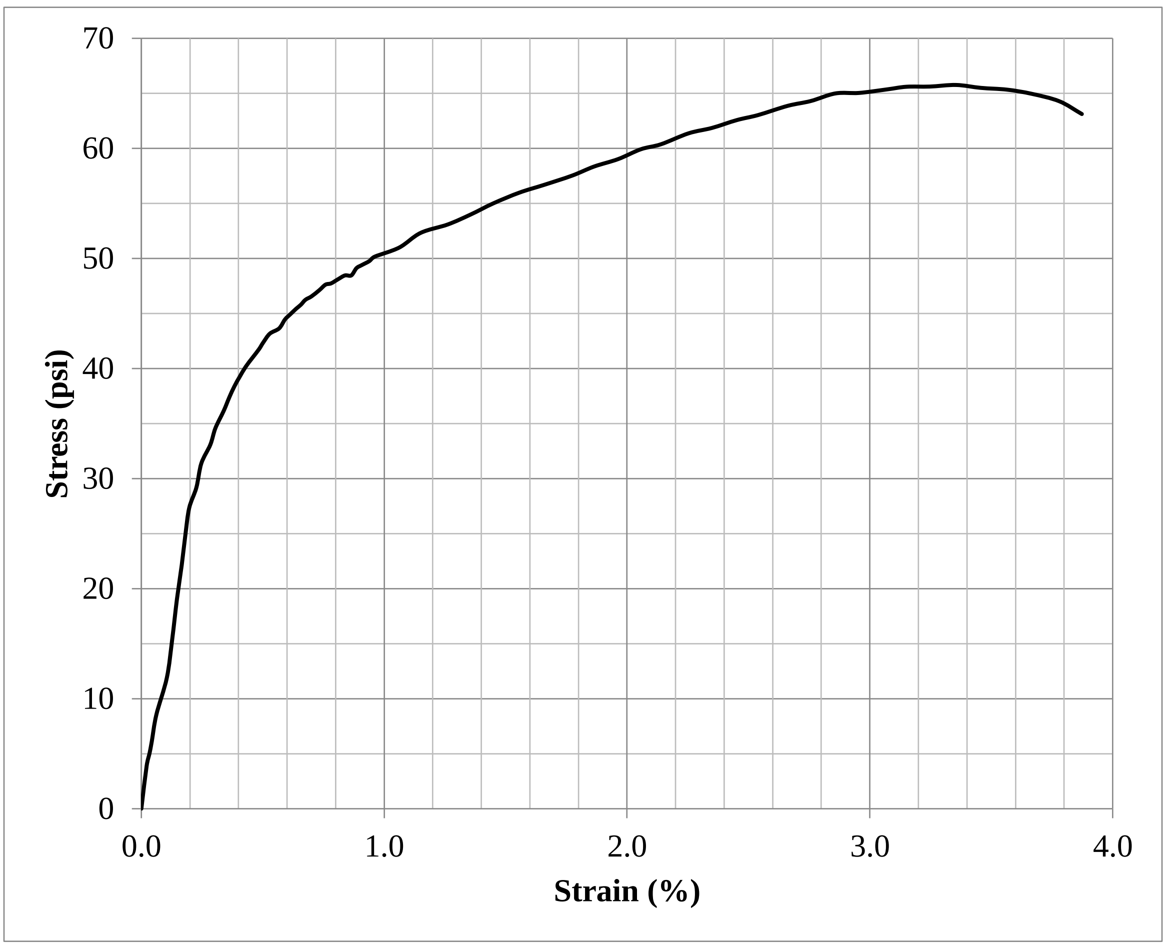
Testing Date	6/17/19
Diameter (in.)	2.042
Height (in.)	3.923
Weight (g)	269.7
Corrected Peak UCS (psi)	70.0
Corrected Failure Strain (%)	3.13
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	30-8-G
Molding Date	5/20/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	200 (203.1)
w:b	0.6
Soil OM (%)	36.1
Bleed Water (g)	1.0

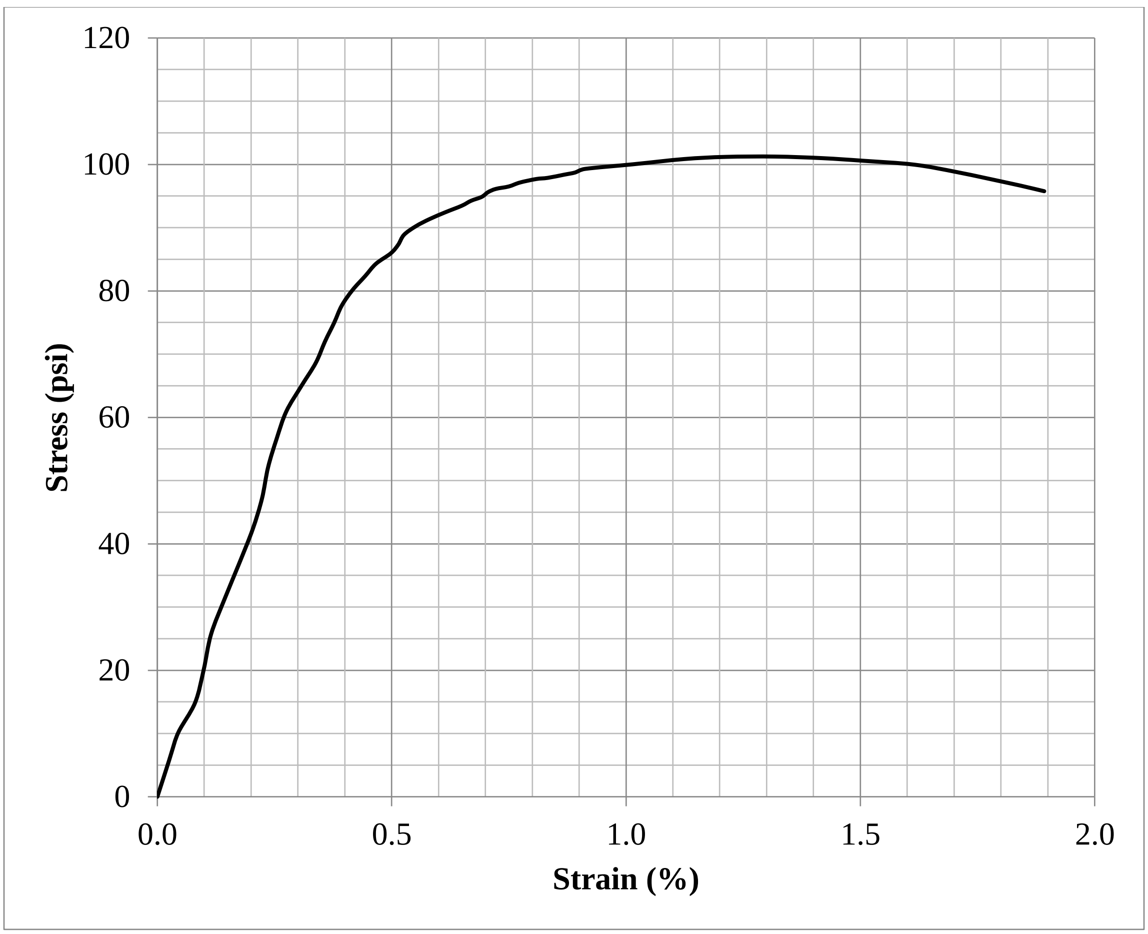
Testing Date	6/17/19
Diameter (in.)	2.040
Height (in.)	3.763
Weight (g)	258.7
Corrected Peak UCS (psi)	65.0
Corrected Failure Strain (%)	3.36
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-1-A
Molding Date	5/22/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (410.0)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	3.6

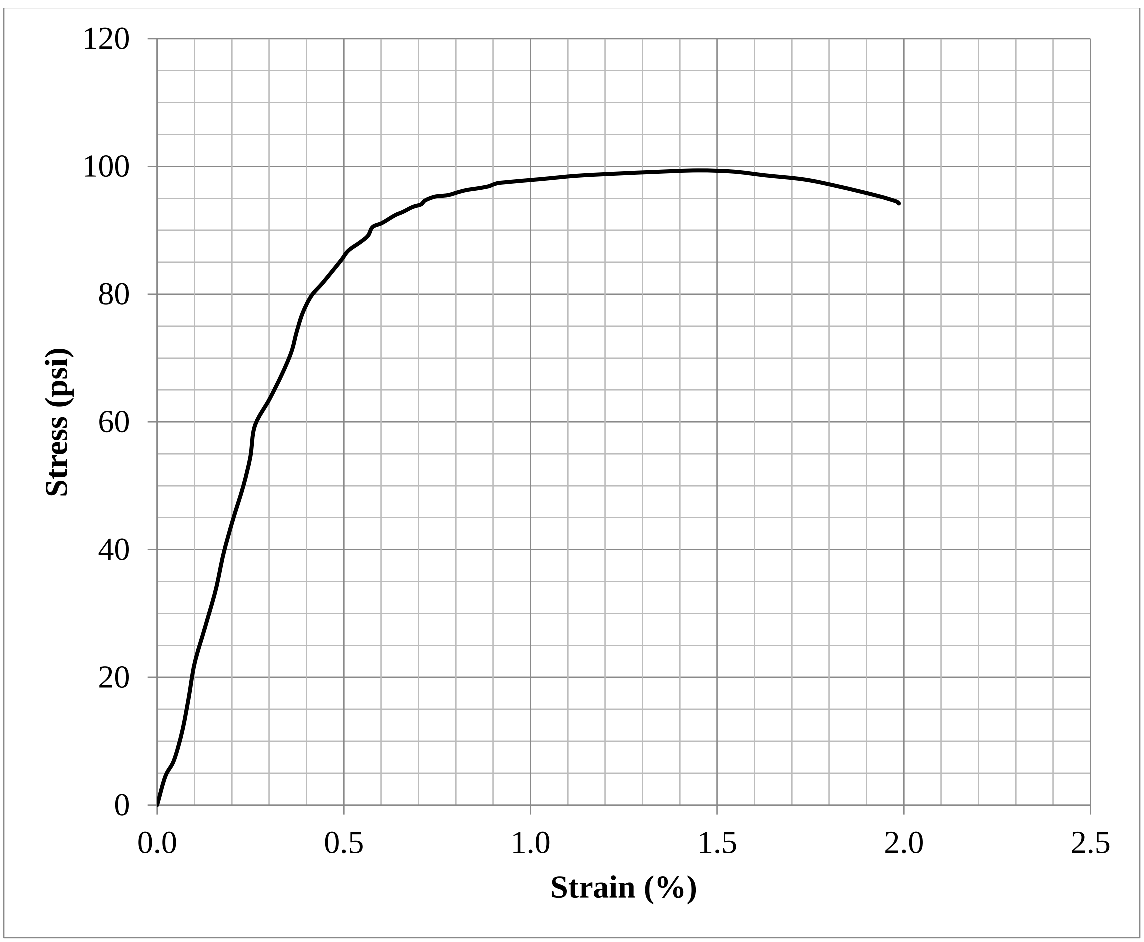
Testing Date	5/29/19
Diameter (in.)	2.041
Height (in.)	3.782
Weight (g)	273.6
Corrected Peak UCS (psi)	100.0
Corrected Failure Strain (%)	1.32
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-1-B
Molding Date	5/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (410.0)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	2.4

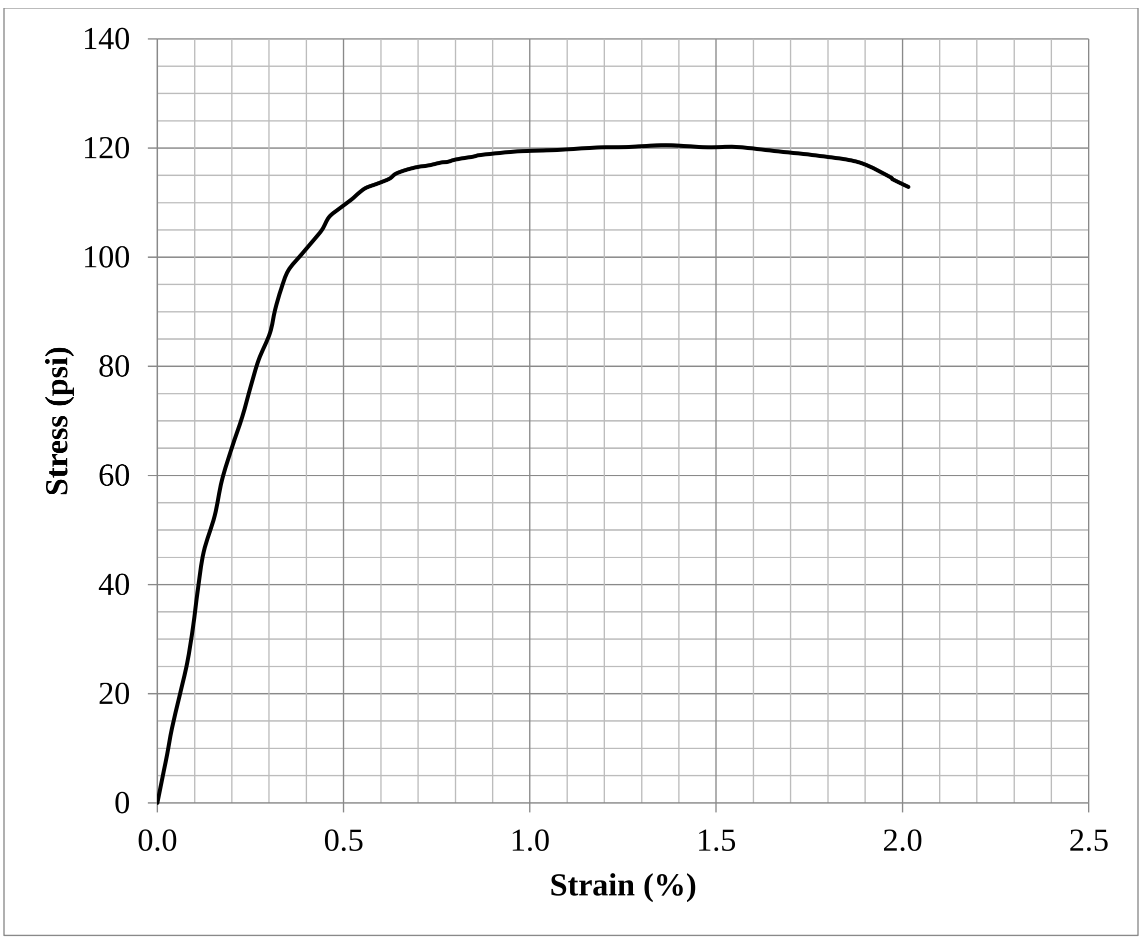
Testing Date	5/29/19
Diameter (in.)	2.035
Height (in.)	3.710
Weight (g)	268.8
Corrected Peak UCS (psi)	98.0
Corrected Failure Strain (%)	1.45
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	40-1-C
Molding Date	5/22/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (410.0)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	3.6

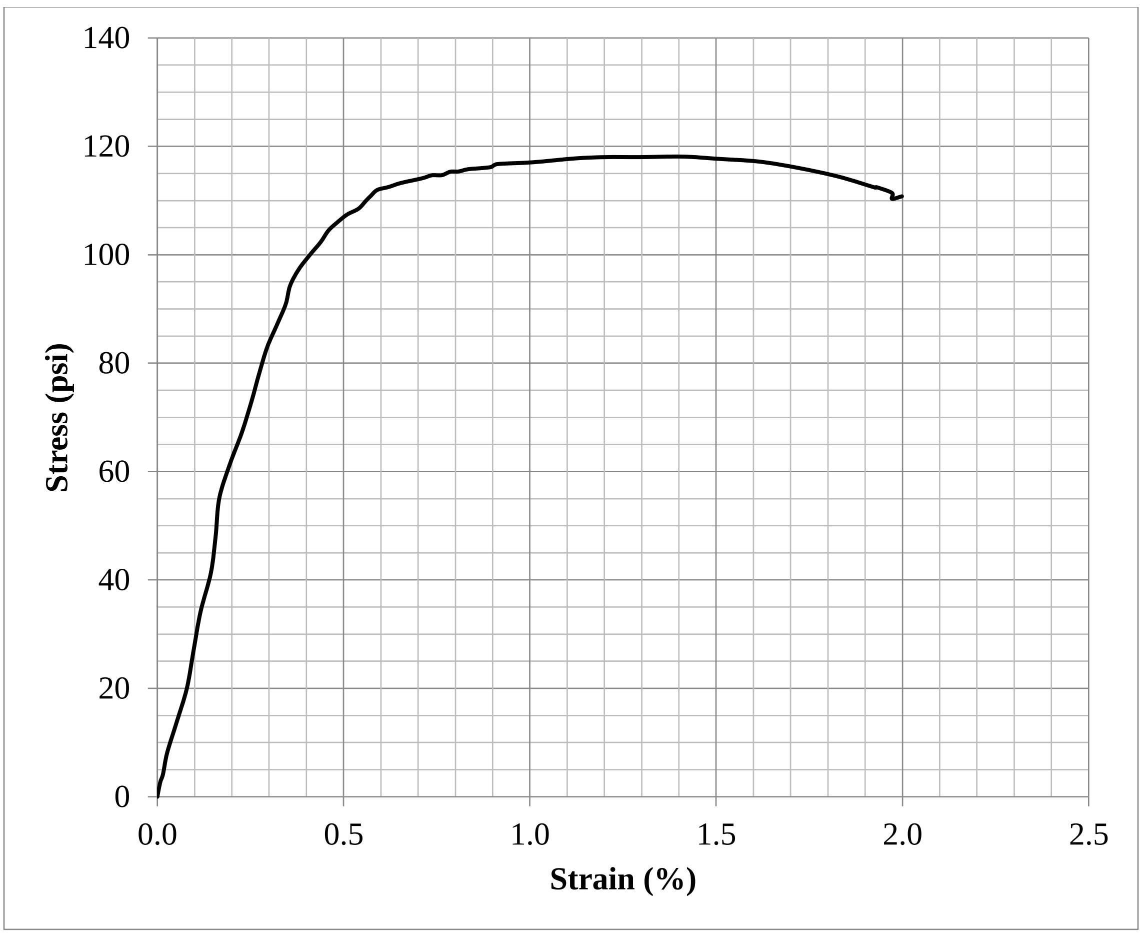
Testing Date	6/5/19
Diameter (in.)	2.044
Height (in.)	3.648
Weight (g)	265.0
Corrected Peak UCS (psi)	118.4
Corrected Failure Strain (%)	1.37
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-1-D
Molding Date	5/22/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	400 (410.0)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	3.3

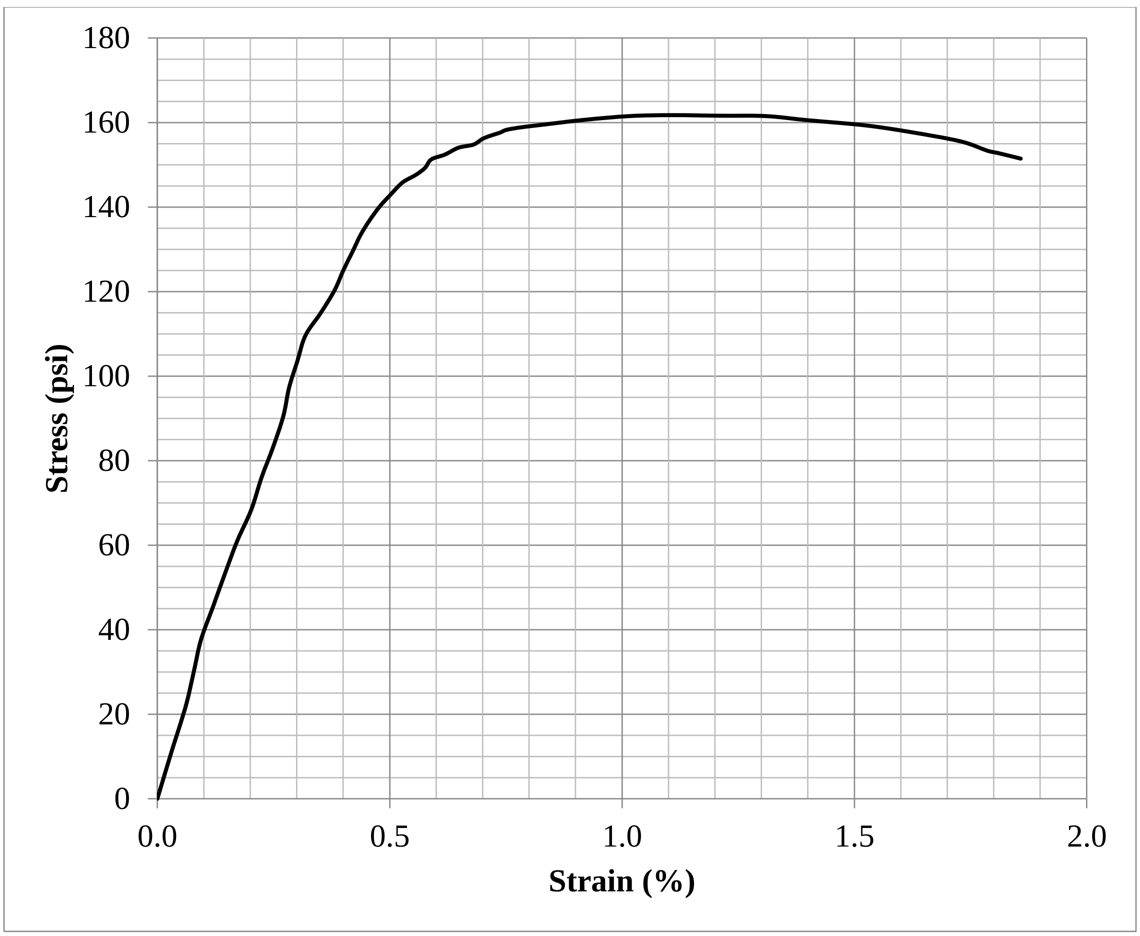
Testing Date	6/5/19
Diameter (in.)	2.041
Height (in.)	3.695
Weight (g)	268.3
Corrected Peak UCS (psi)	116.3
Corrected Failure Strain (%)	1.41
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-1-E
Molding Date	5/22/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	400 (410.0)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	3.8

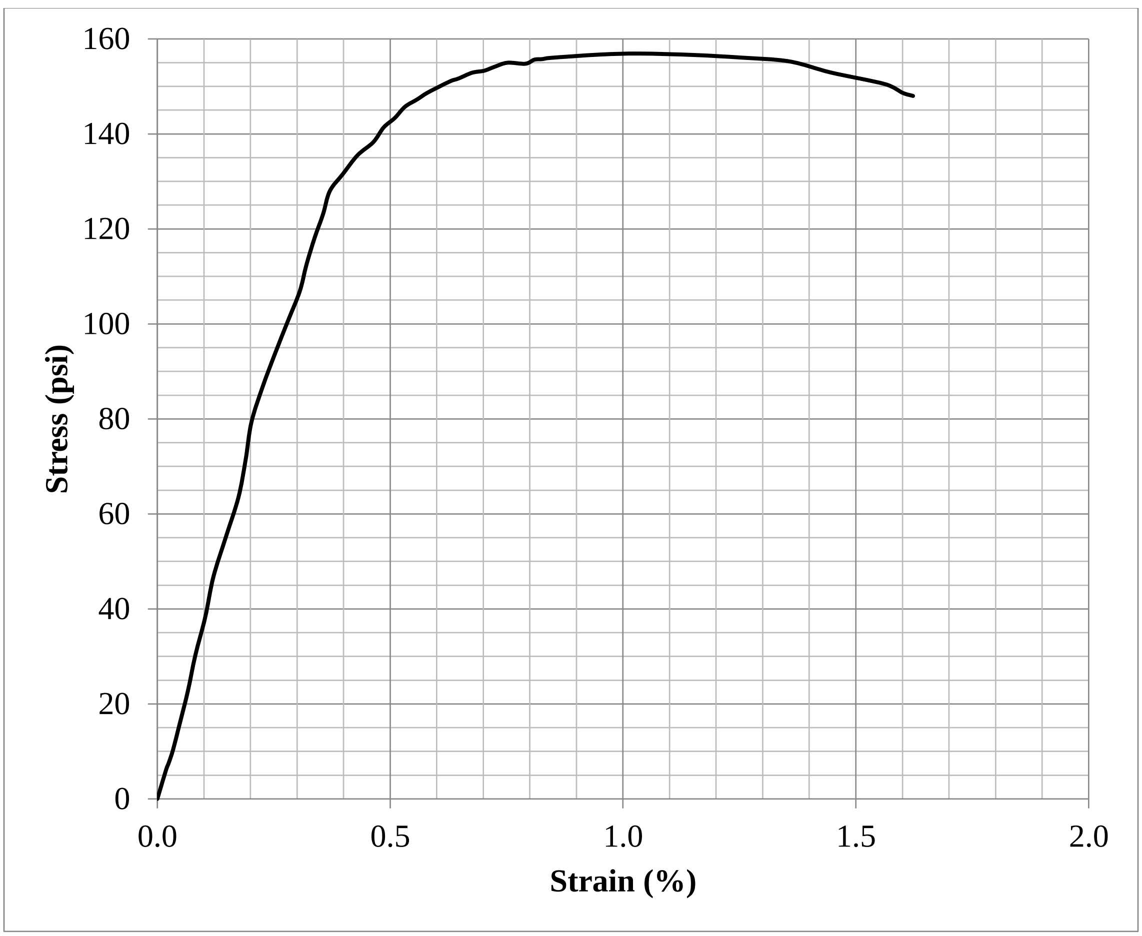
Testing Date	6/19/19
Diameter (in.)	2.045
Height (in.)	3.564
Weight (g)	260.5
Corrected Peak UCS (psi)	158.4
Corrected Failure Strain (%)	1.11
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-1-F
Molding Date	5/22/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (410.0)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	3.0

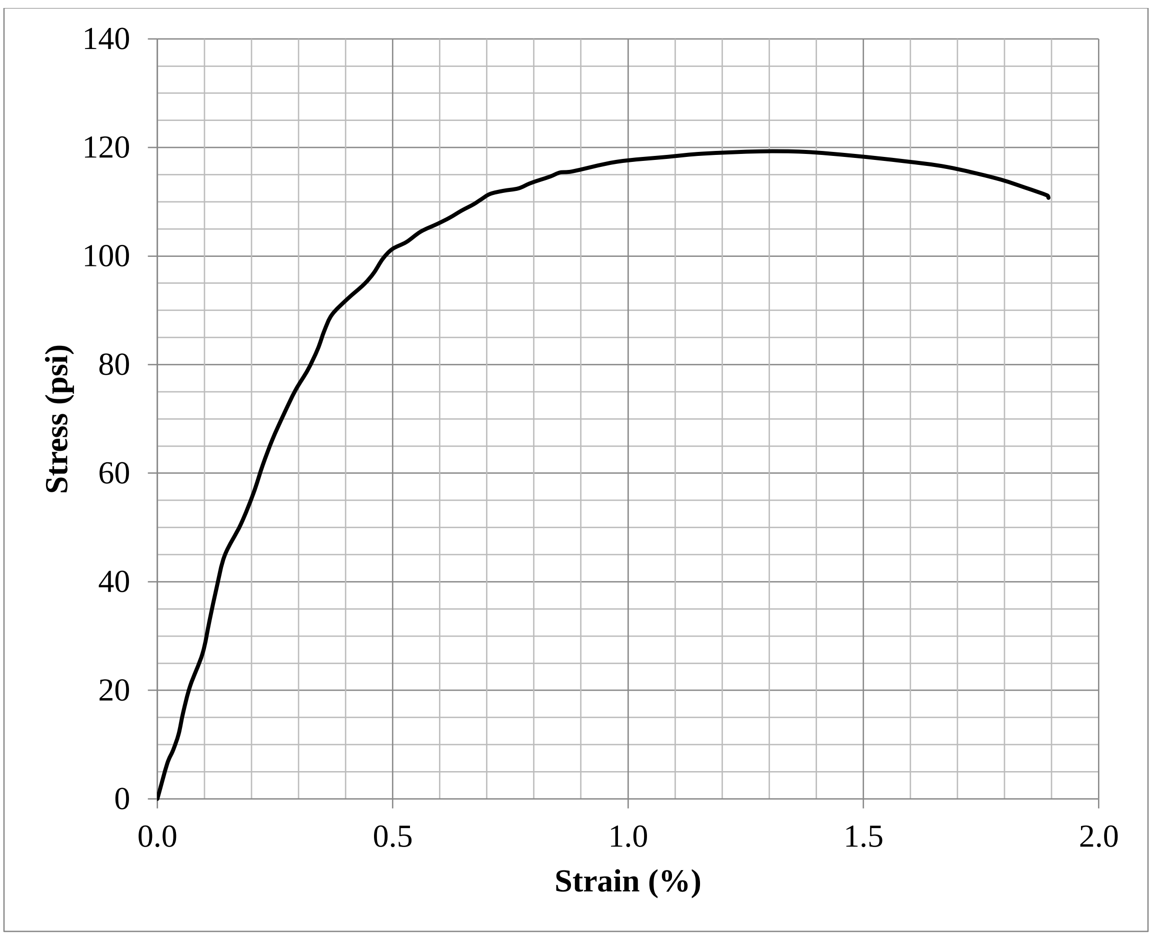
Testing Date	6/19/19
Diameter (in.)	2.040
Height (in.)	3.549
Weight (g)	259.0
Corrected Peak UCS (psi)	153.6
Corrected Failure Strain (%)	1.04
ASTM C39 Fracture Type	N/A



<u>Data Sheet: Specimen UCS Test</u>

Specimen ID	40-2-A
Molding Date	5/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (404.3)
w:b	0.5
Soil OM (%)	48.9
Bleed Water (g)	0.1

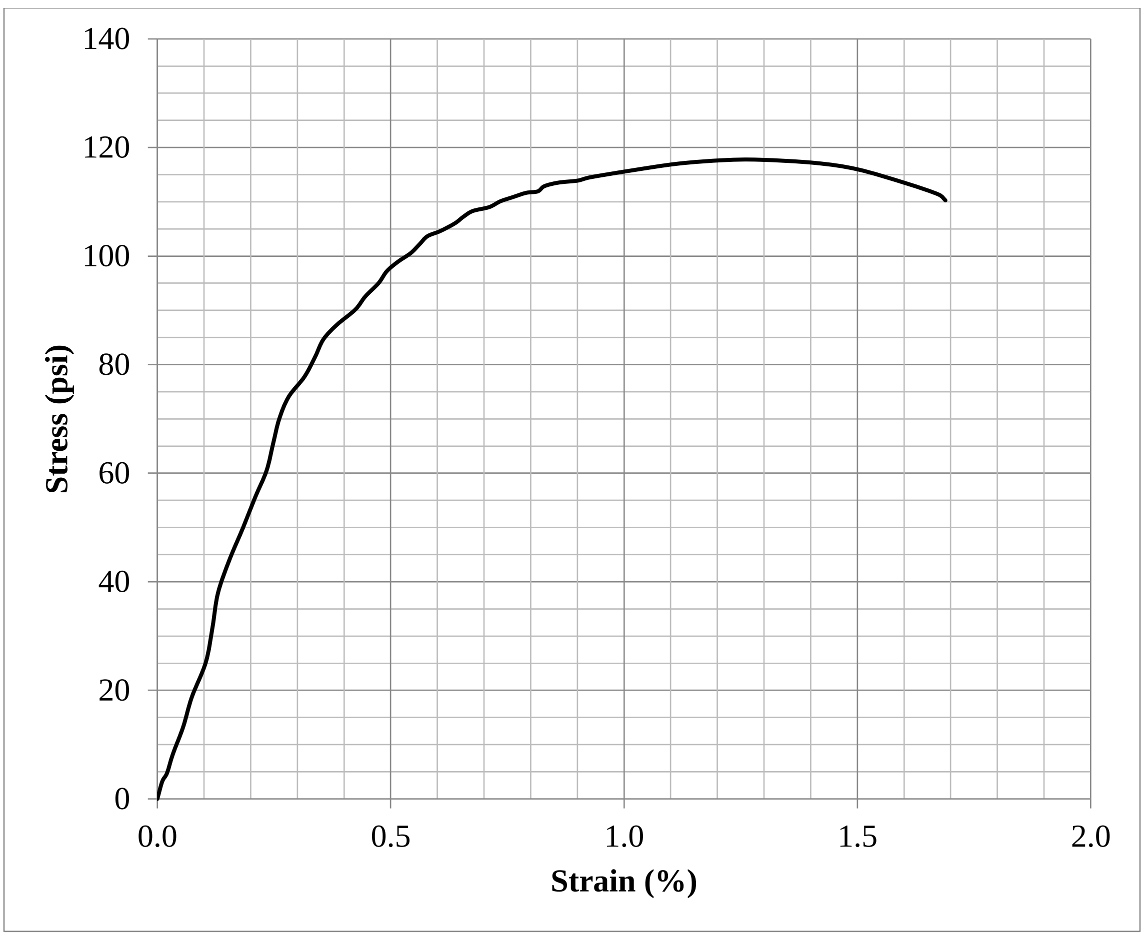
Testing Date	5/29/19
Diameter (in.)	2.044
Height (in.)	3.575
Weight (g)	235.8
Corrected Peak UCS (psi)	116.9
Corrected Failure Strain (%)	1.28
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-2-B
Molding Date	5/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (404.3)
w:b	0.5
Soil OM (%)	48.9
Bleed Water (g)	0.2

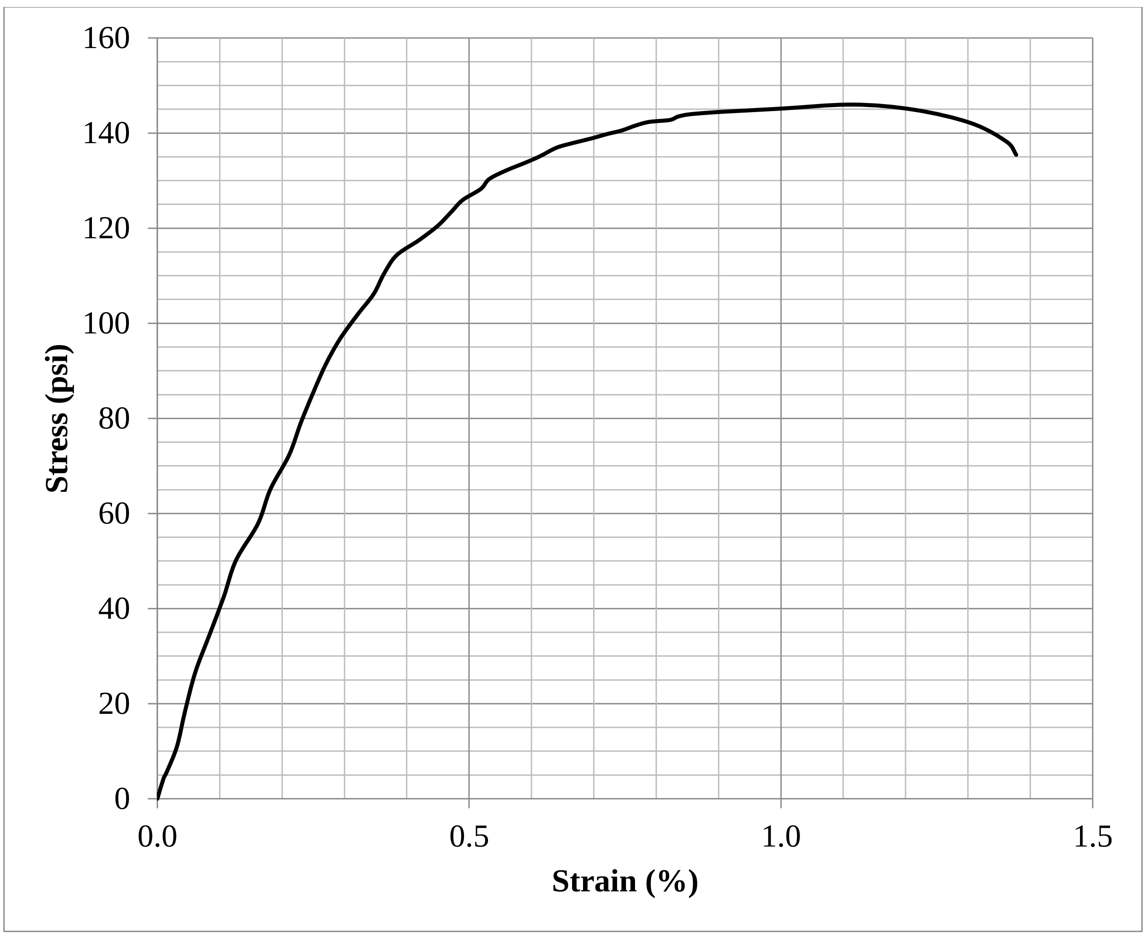
Testing Date	5/29/19
Diameter (in.)	2.048
Height (in.)	3.735
Weight (g)	246.7
Corrected Peak UCS (psi)	116.1
Corrected Failure Strain (%)	1.29
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	40-2-C
Molding Date	5/22/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	400 (404.3)
w:b	0.5
Soil OM (%)	48.9
Bleed Water (g)	0.6

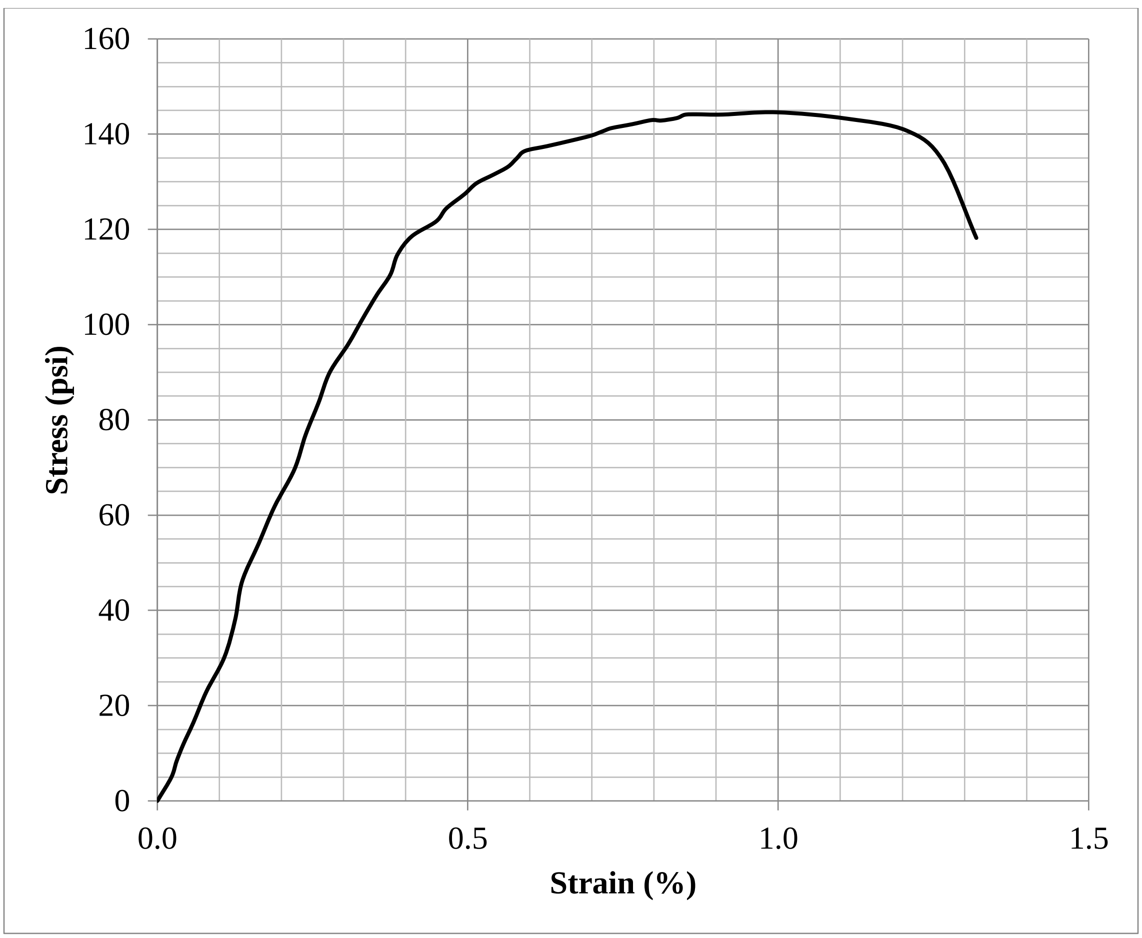
Testing Date	6/5/19
Diameter (in.)	2.038
Height (in.)	3.763
Weight (g)	250.2
Corrected Peak UCS (psi)	144.2
Corrected Failure Strain (%)	1.12
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-2-D
Molding Date	5/22/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (404.3)
w:b	0.5
Soil OM (%)	48.9
Bleed Water (g)	0.6

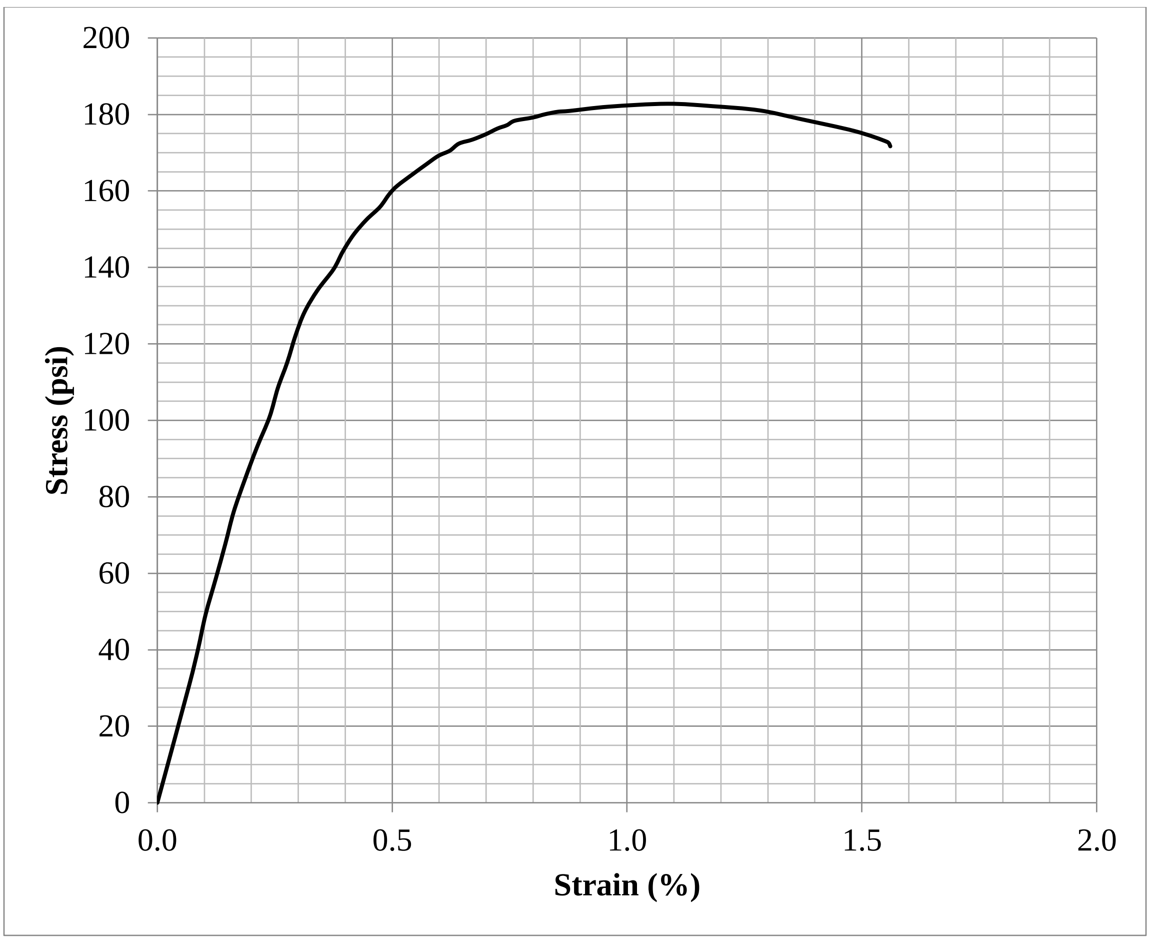
Testing Date	6/5/19
Diameter (in.)	2.048
Height (in.)	3.817
Weight (g)	257.0
Corrected Peak UCS (psi)	143.0
Corrected Failure Strain (%)	1.00
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	40-2-E
Molding Date	5/22/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	400 (404.3)
w:b	0.5
Soil OM (%)	48.9
Bleed Water (g)	0.2

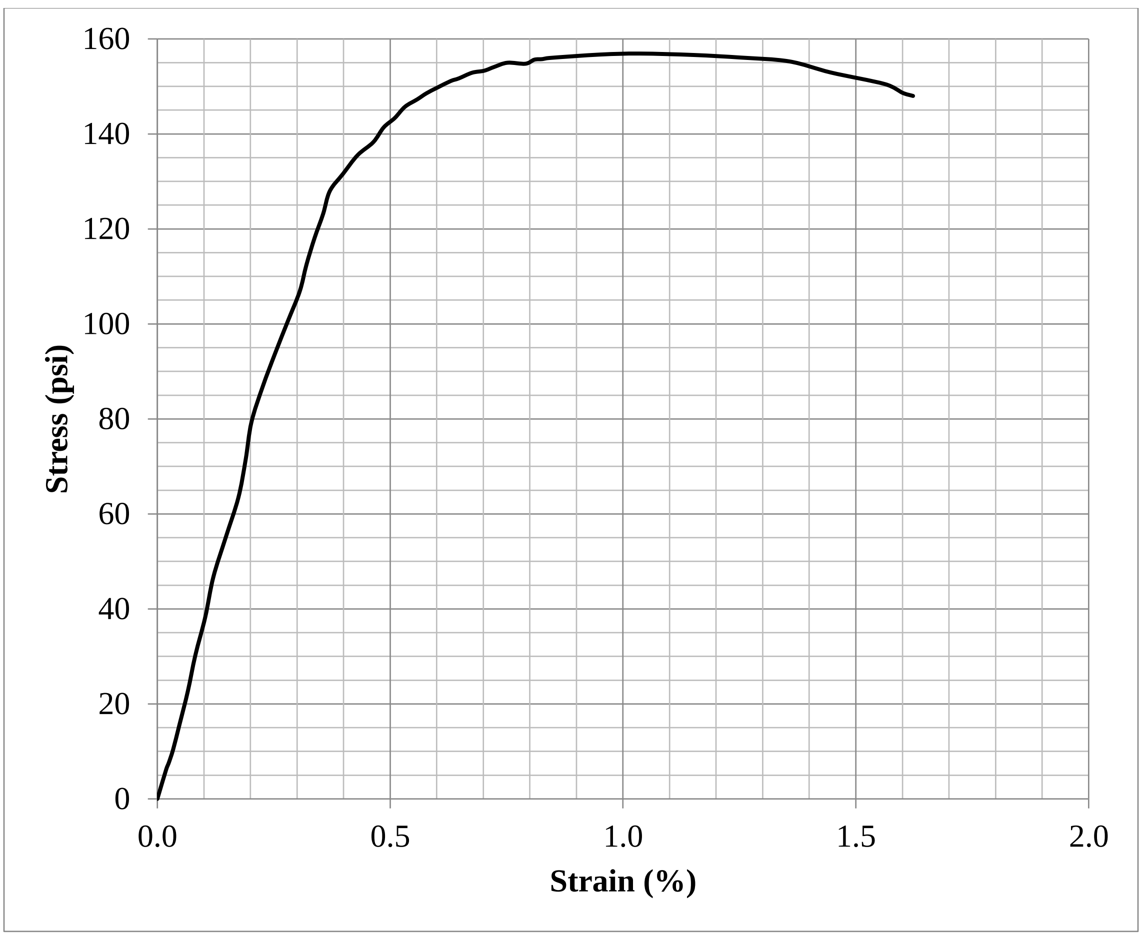
Testing Date	6/19/19
Diameter (in.)	2.044
Height (in.)	3.835
Weight (g)	258.7
Corrected Peak UCS (psi)	181.0
Corrected Failure Strain (%)	1.09
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-2-F
Molding Date	5/22/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (404.3)
w:b	0.5
Soil OM (%)	48.9
Bleed Water (g)	0.9

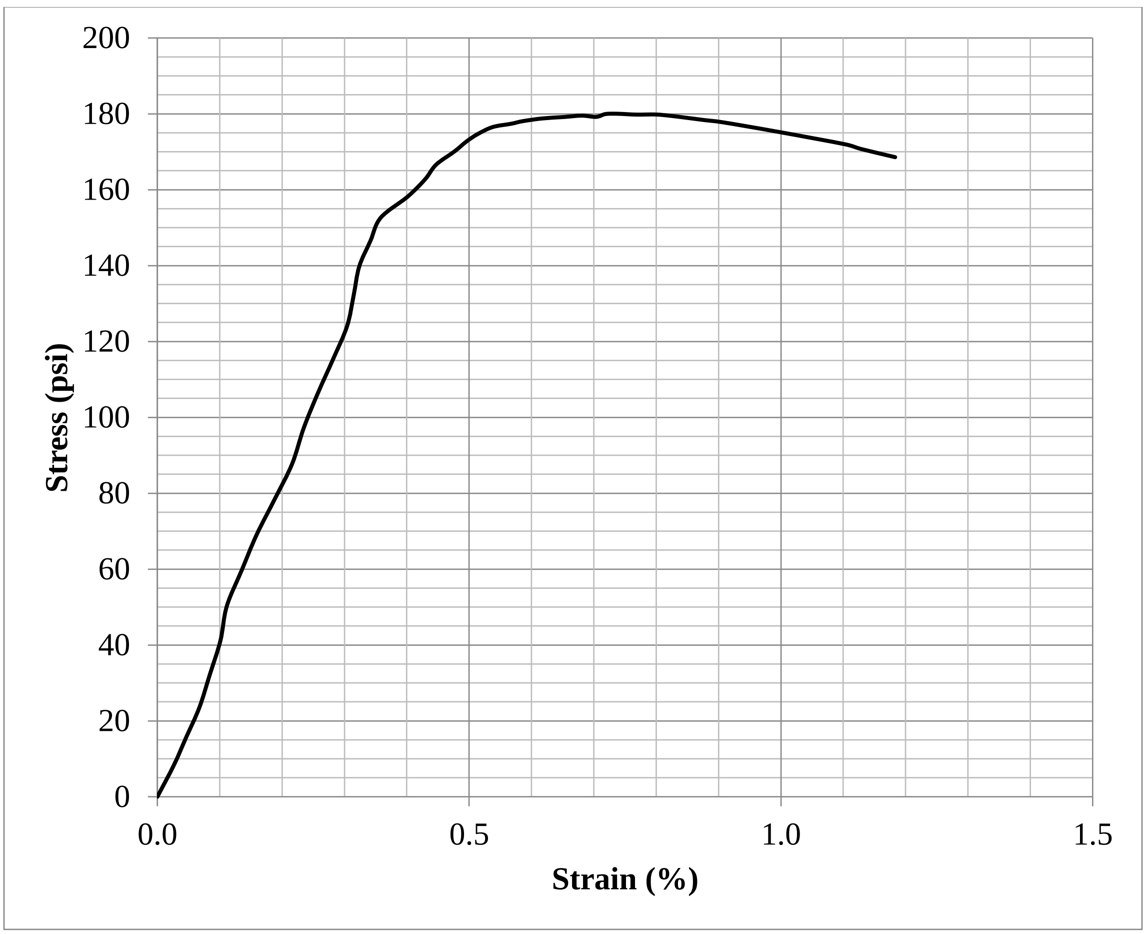
Testing Date	6/19/19
Diameter (in.)	2.045
Height (in.)	3.803
Weight (g)	258.5
Corrected Peak UCS (psi)	173.0
Corrected Failure Strain (%)	0.96
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-3-A
Molding Date	5/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	500 (519.7)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	9.3

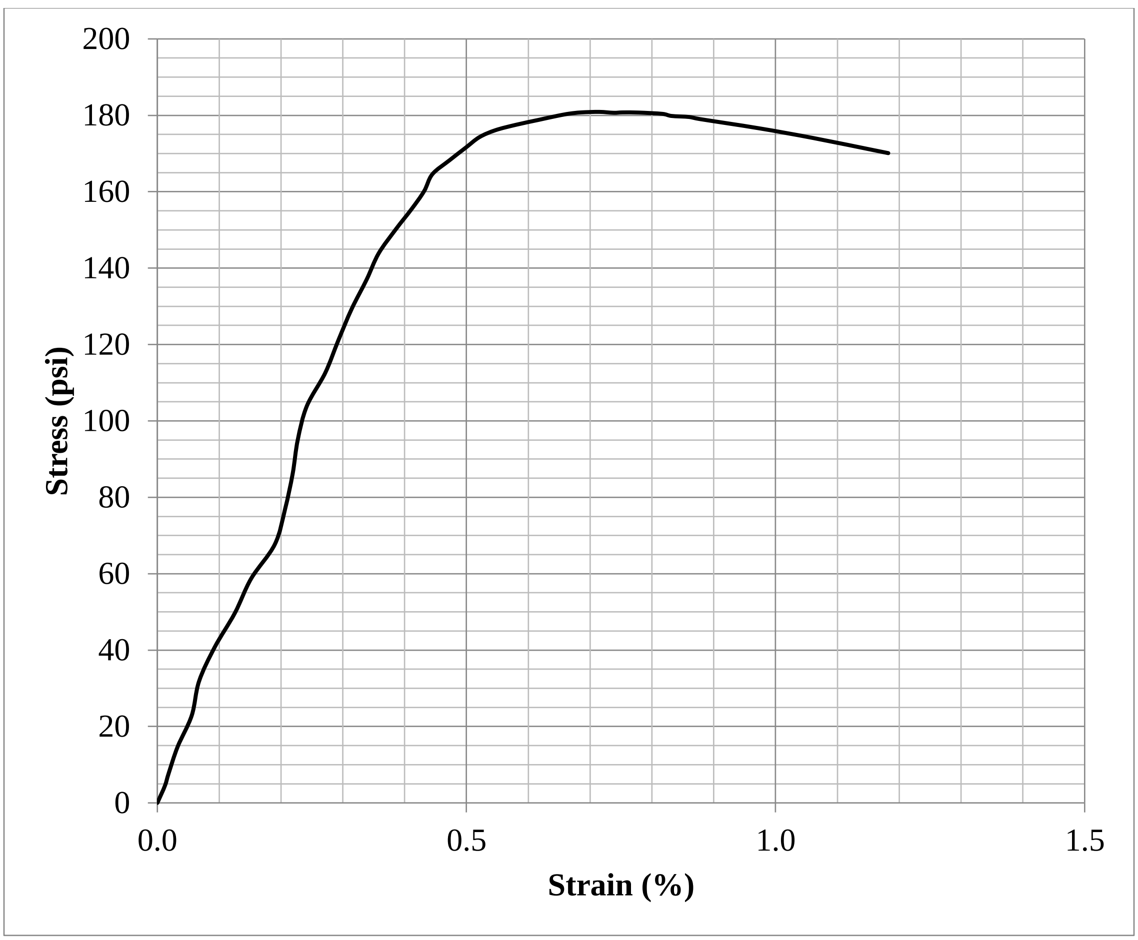
Testing Date	5/29/19
Diameter (in.)	2.043
Height (in.)	3.469
Weight (g)	258.2
Corrected Peak UCS (psi)	175.7
Corrected Failure Strain (%)	0.74
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-3-B
Molding Date	5/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	500 (519.7)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	9.2

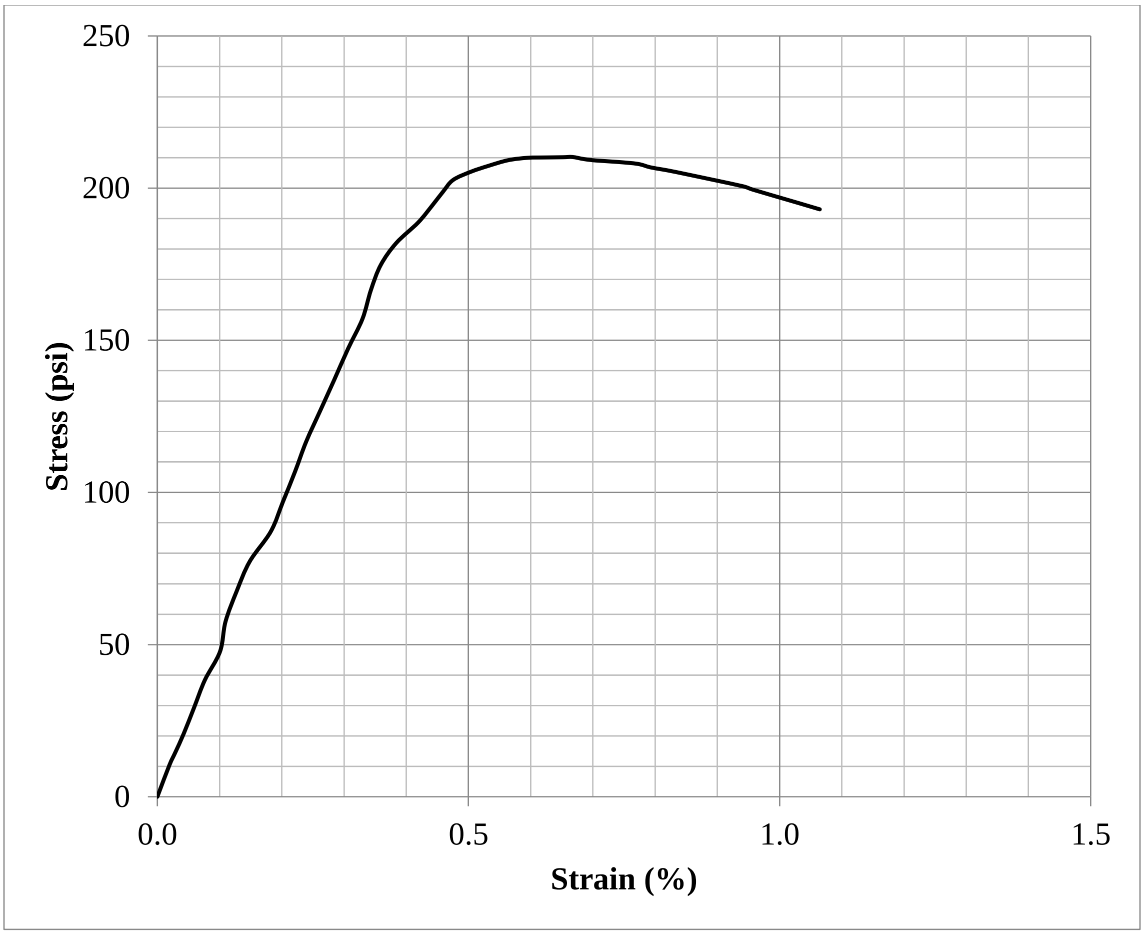
Testing Date	5/29/19
Diameter (in.)	2.047
Height (in.)	3.501
Weight (g)	257.8
Corrected Peak UCS (psi)	176.7
Corrected Failure Strain (%)	0.71
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-3-C
Molding Date	5/22/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	500 (519.7)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	8.0

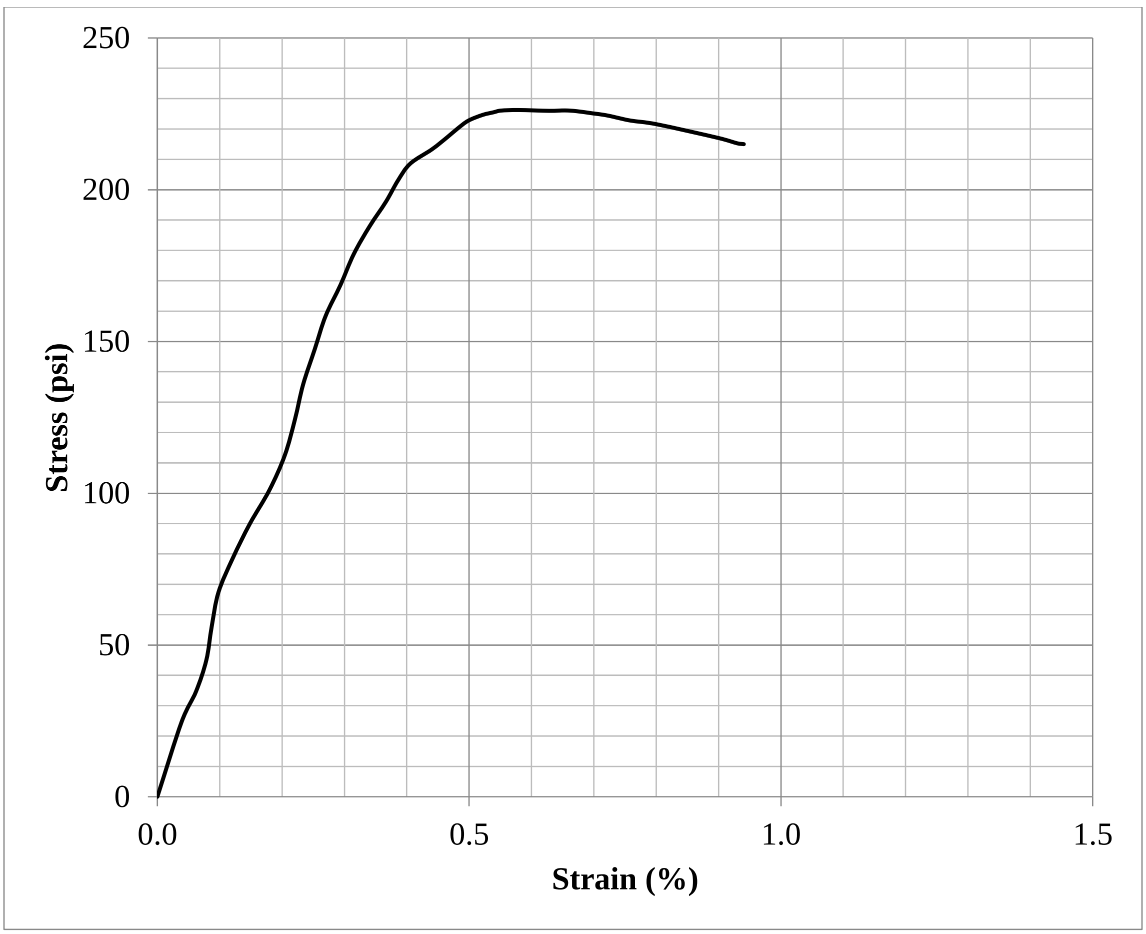
Testing Date	6/5/19
Diameter (in.)	2.043
Height (in.)	3.578
Weight (g)	265.2
Corrected Peak UCS (psi)	206.0
Corrected Failure Strain (%)	0.67
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-3-D
Molding Date	5/22/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	500 (519.7)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	8.5

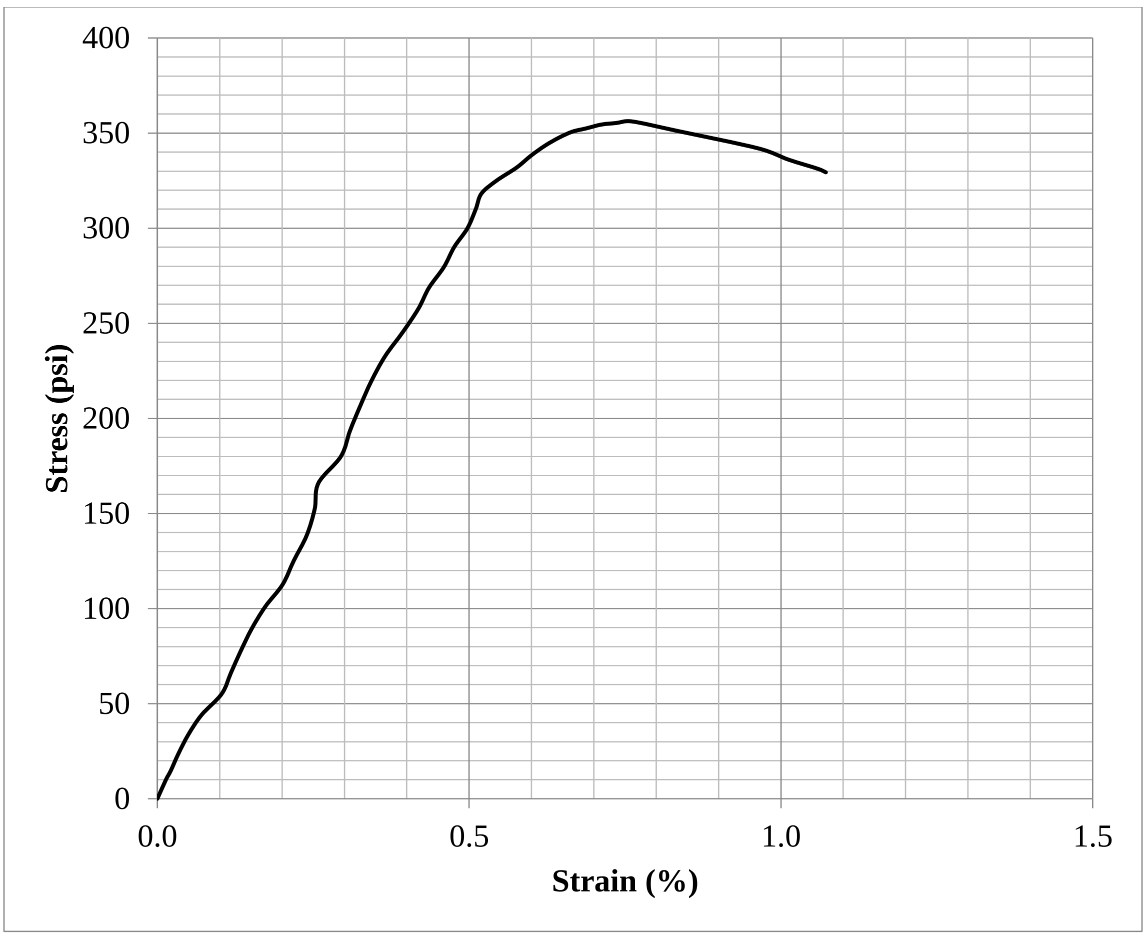
Testing Date	6/5/19
Diameter (in.)	2.039
Height (in.)	3.605
Weight (g)	269.1
Corrected Peak UCS (psi)	222.1
Corrected Failure Strain (%)	0.58
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-3-E
Molding Date	5/22/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	500 (519.7)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	8.1

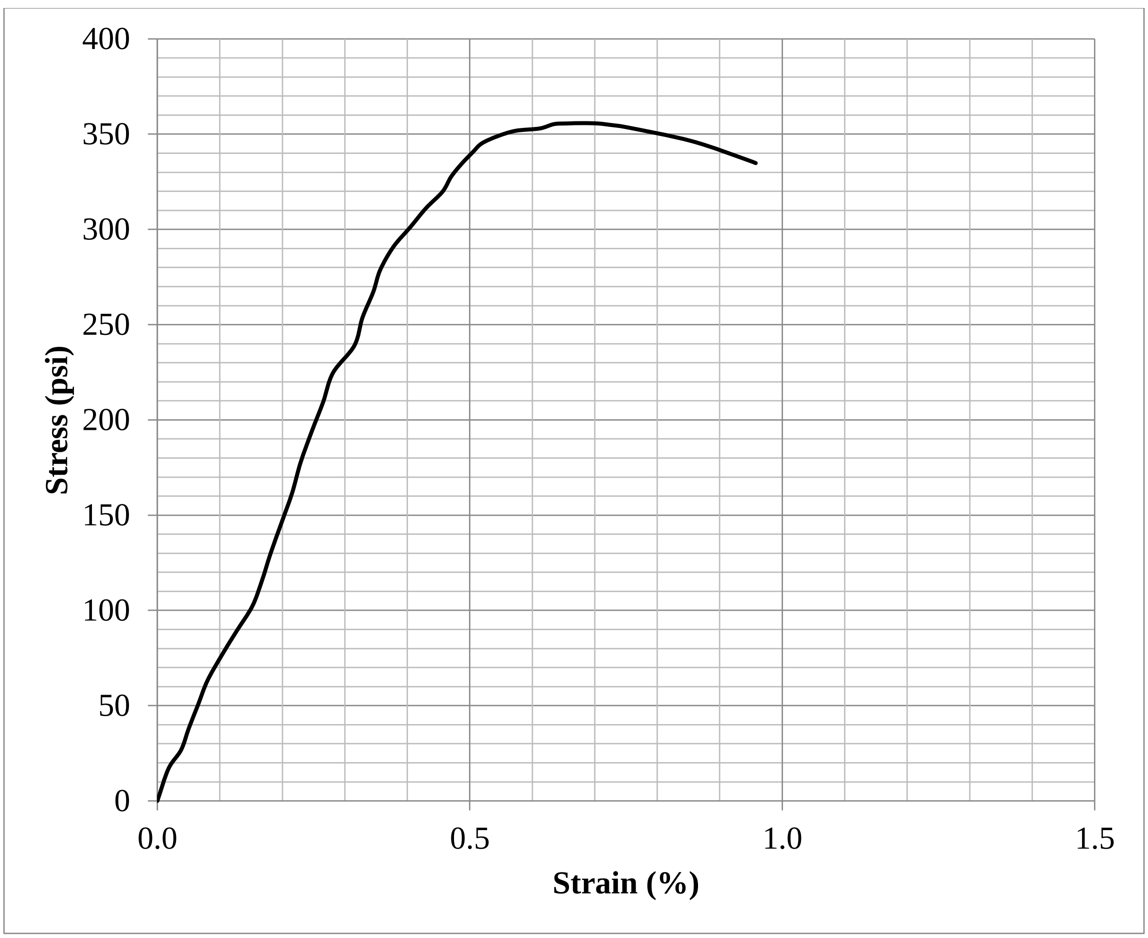
Testing Date	6/19/19
Diameter (in.)	2.043
Height (in.)	3.350
Weight (g)	255.8
Corrected Peak UCS (psi)	345.9
Corrected Failure Strain (%)	0.76
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-3-F
Molding Date	5/22/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	500 (519.7)
w:b	1.0
Soil OM (%)	48.9
Bleed Water (g)	7.4

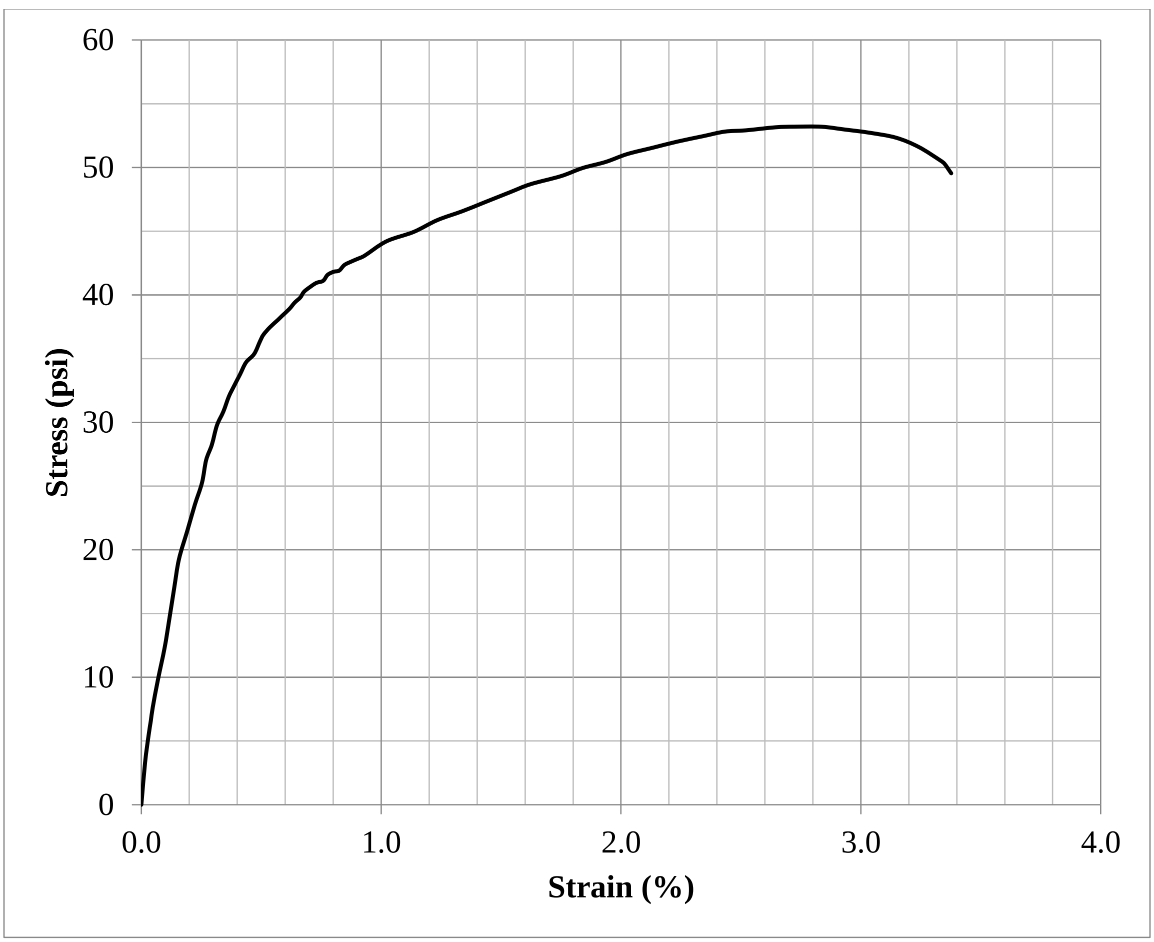
Testing Date	6/19/19
Diameter (in.)	2.047
Height (in.)	3.556
Weight (g)	271.9
Corrected Peak UCS (psi)	348.3
Corrected Failure Strain (%)	0.68
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-4-B
Molding Date	5/23/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	250 (254.4)
w:b	0.6
Soil OM (%)	48.9
Bleed Water (g)	0.6

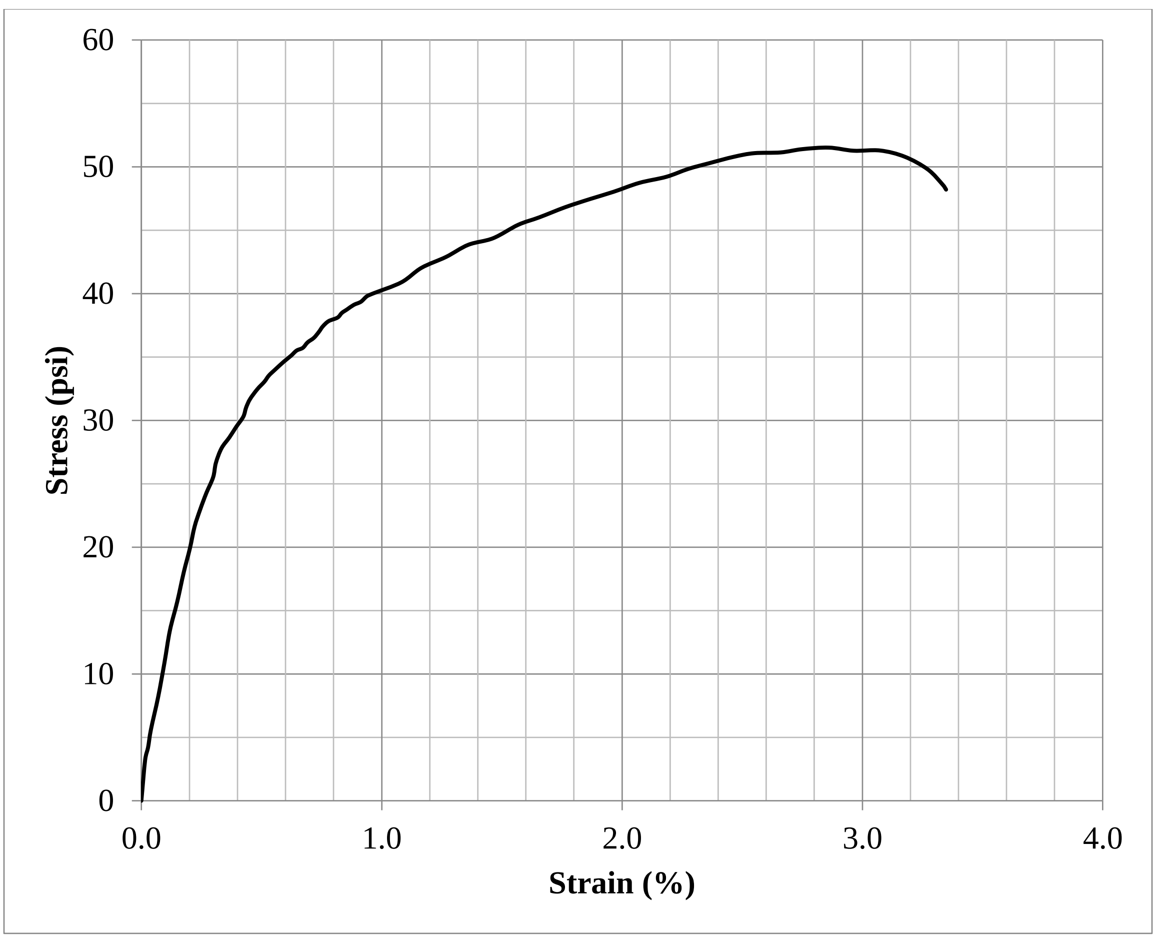
Testing Date	5/30/19
Diameter (in.)	2.043
Height (in.)	3.859
Weight (g)	258.5
Corrected Peak UCS (psi)	52.7
Corrected Failure Strain (%)	2.72
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	40-4-C
Molding Date	5/23/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	250 (254.4)
w:b	0.6
Soil OM (%)	48.9
Bleed Water (g)	1.1

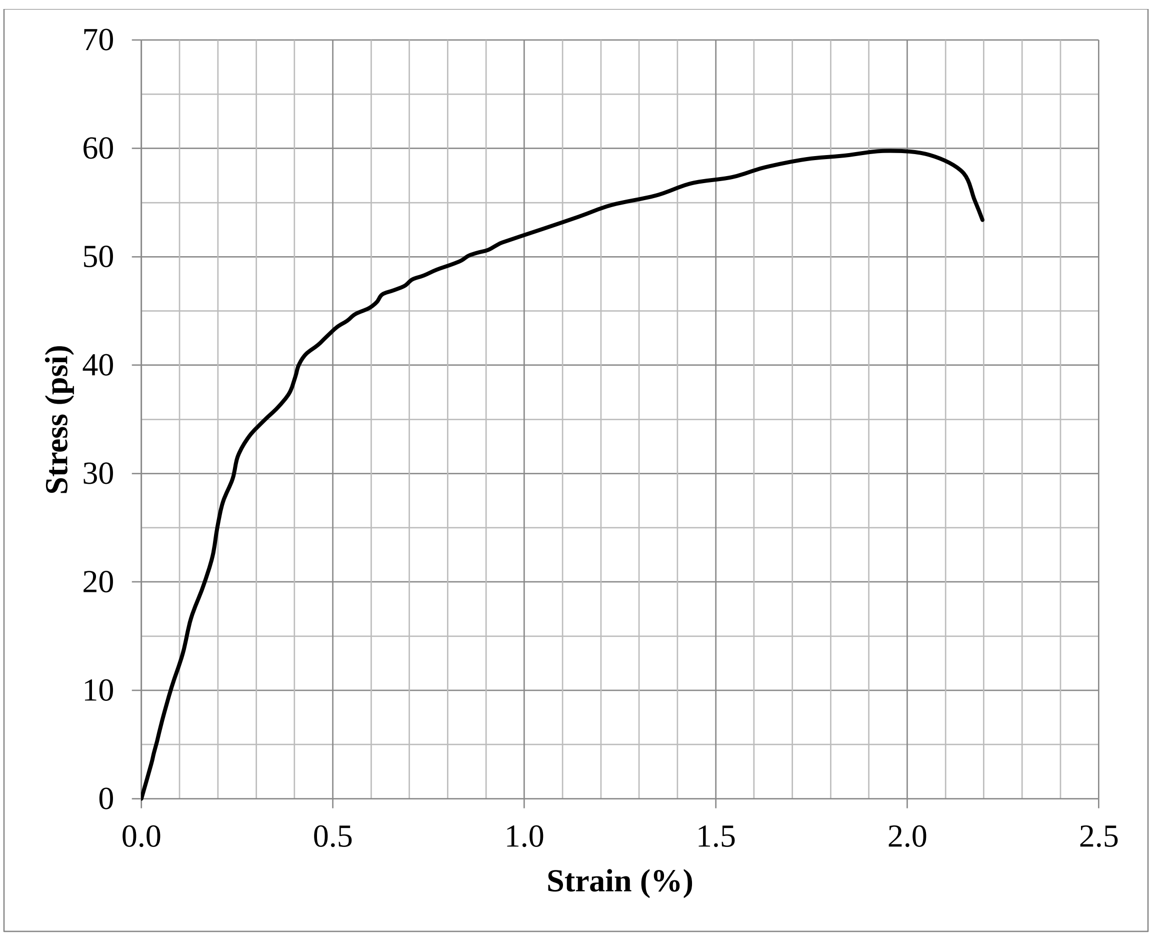
Testing Date	5/30/19
Diameter (in.)	2.042
Height (in.)	3.736
Weight (g)	250.6
Corrected Peak UCS (psi)	50.8
Corrected Failure Strain (%)	2.86
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	40-4-D
Molding Date	5/23/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	250 (254.4)
w:b	0.6
Soil OM (%)	48.9
Bleed Water (g)	0.7

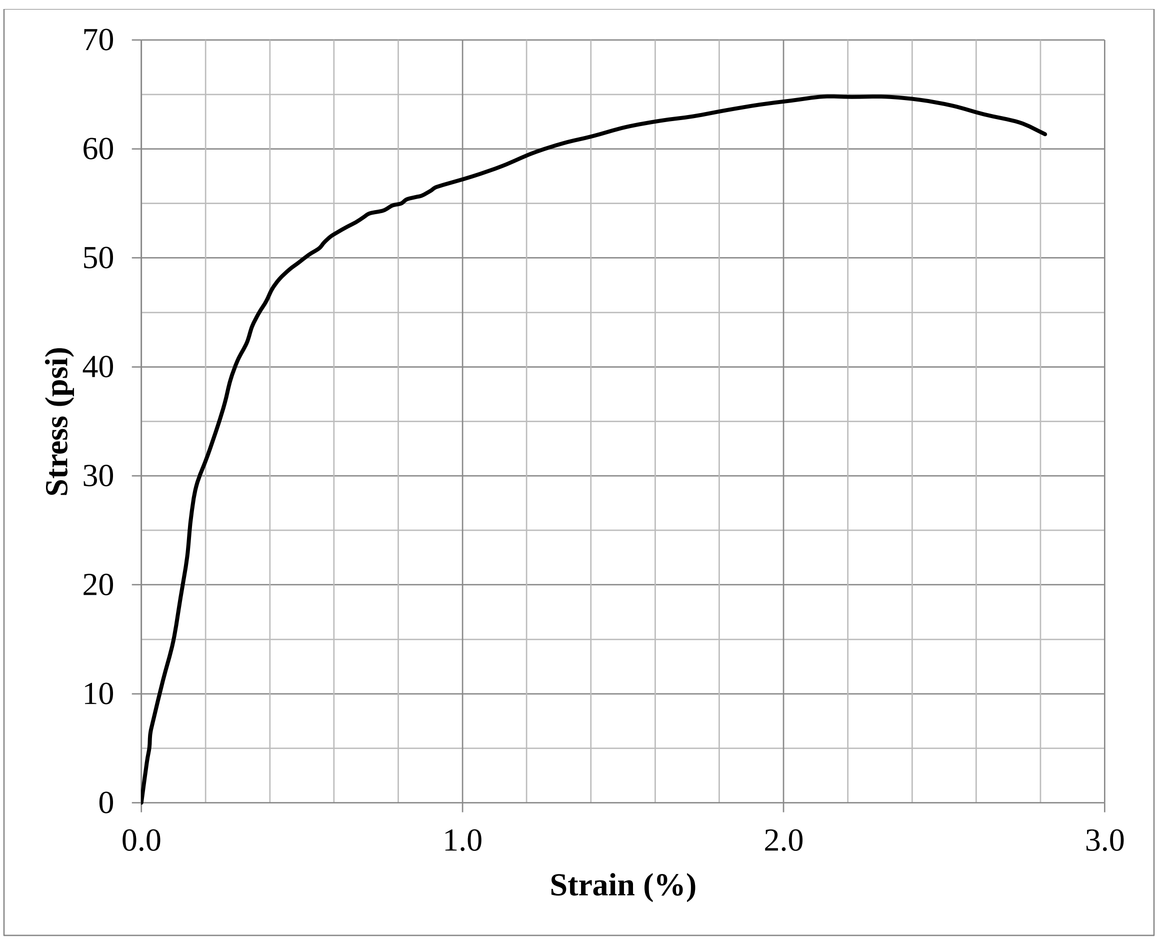
Testing Date	6/5/19
Diameter (in.)	2.040
Height (in.)	3.499
Weight (g)	234.7
Corrected Peak UCS (psi)	58.4
Corrected Failure Strain (%)	1.94
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	40-4-E
Molding Date	5/23/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	250 (254.4)
w:b	0.6
Soil OM (%)	48.9
Bleed Water (g)	0.7

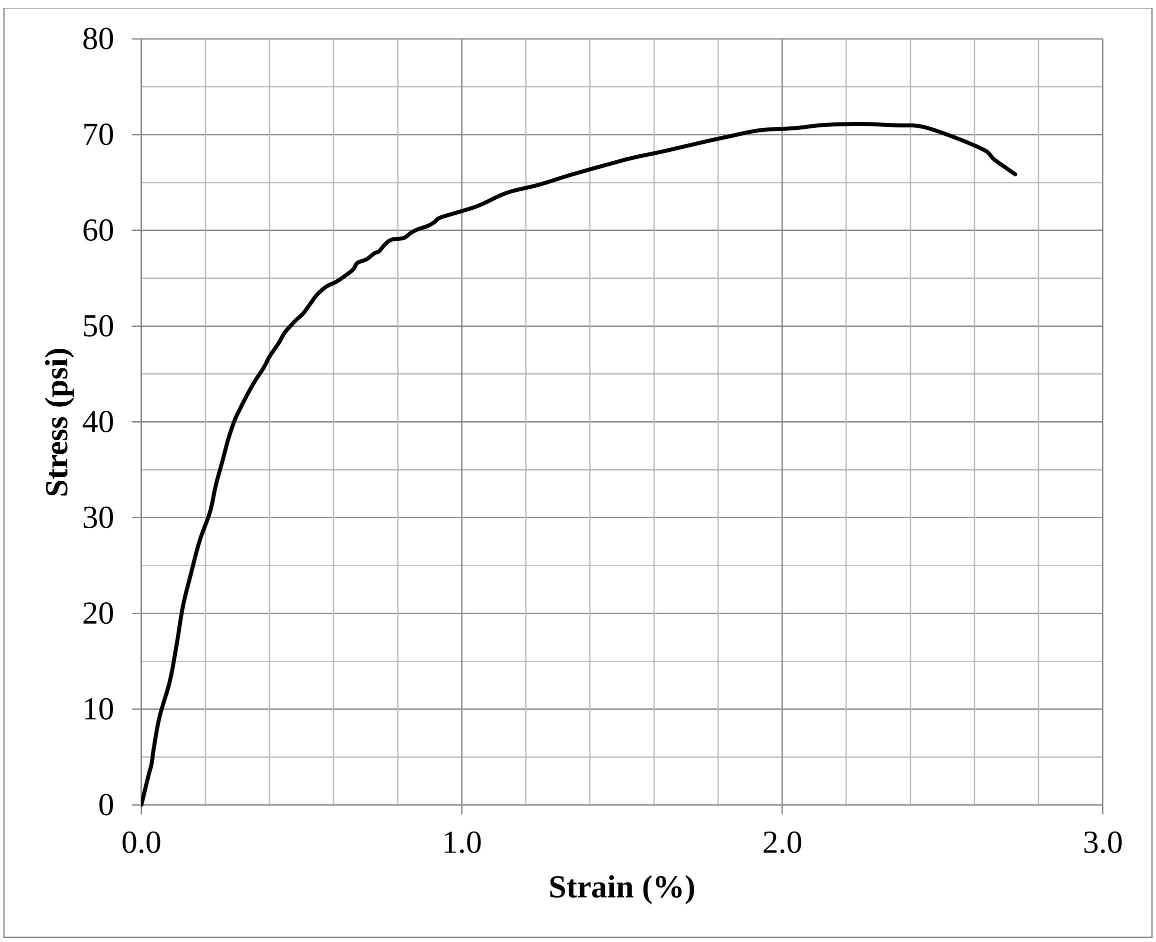
Testing Date	6/5/19
Diameter (in.)	2.035
Height (in.)	3.878
Weight (g)	260.8
Corrected Peak UCS (psi)	64.3
Corrected Failure Strain (%)	2.12
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	40-4-F
Molding Date	5/23/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (254.4)
w:b	0.6
Soil OM (%)	48.9
Bleed Water (g)	0.5

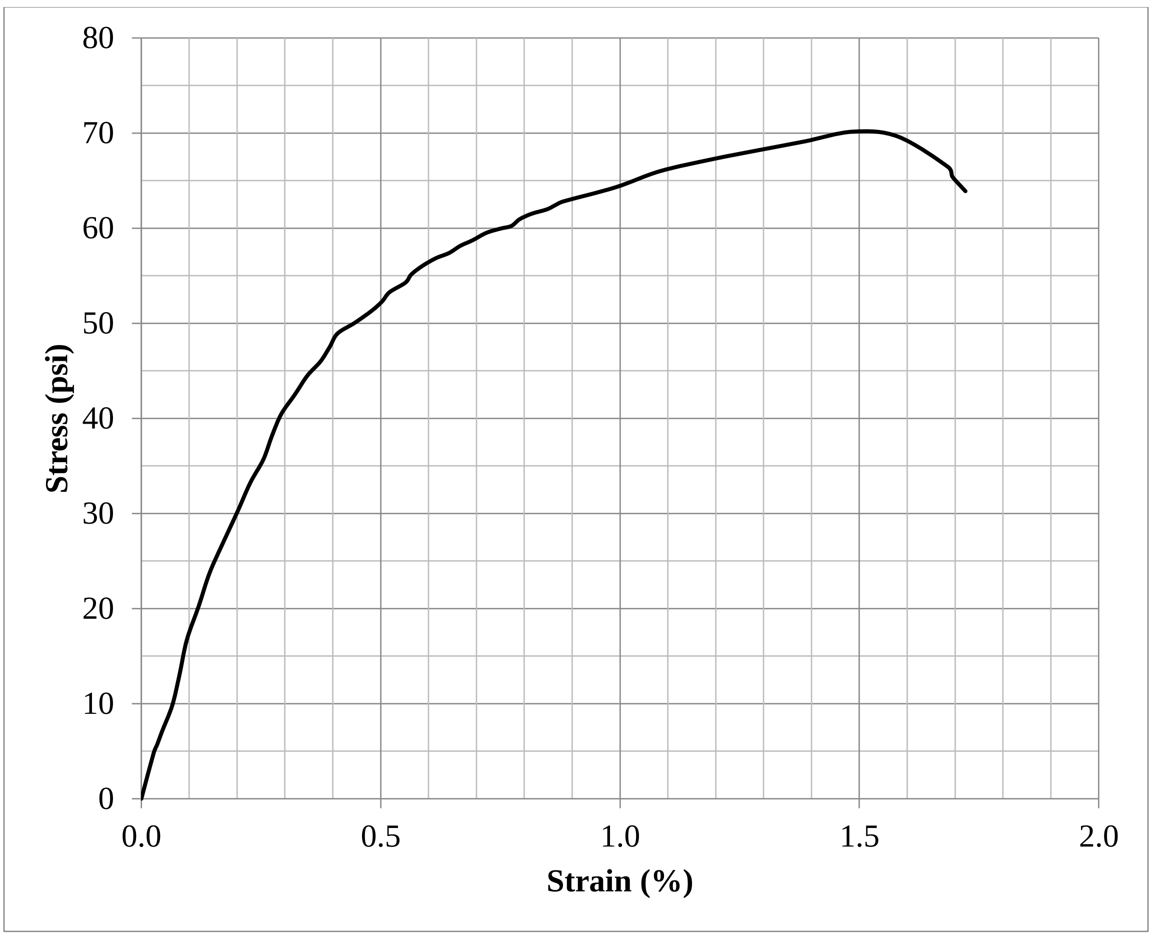
Testing Date	6/19/19
Diameter (in.)	2.042
Height (in.)	3.975
Weight (g)	267.1
Corrected Peak UCS (psi)	70.8
Corrected Failure Strain (%)	2.25
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	40-4-G
Molding Date	5/23/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	250 (254.4)
w:b	0.6
Soil OM (%)	48.9
Bleed Water (g)	0.8

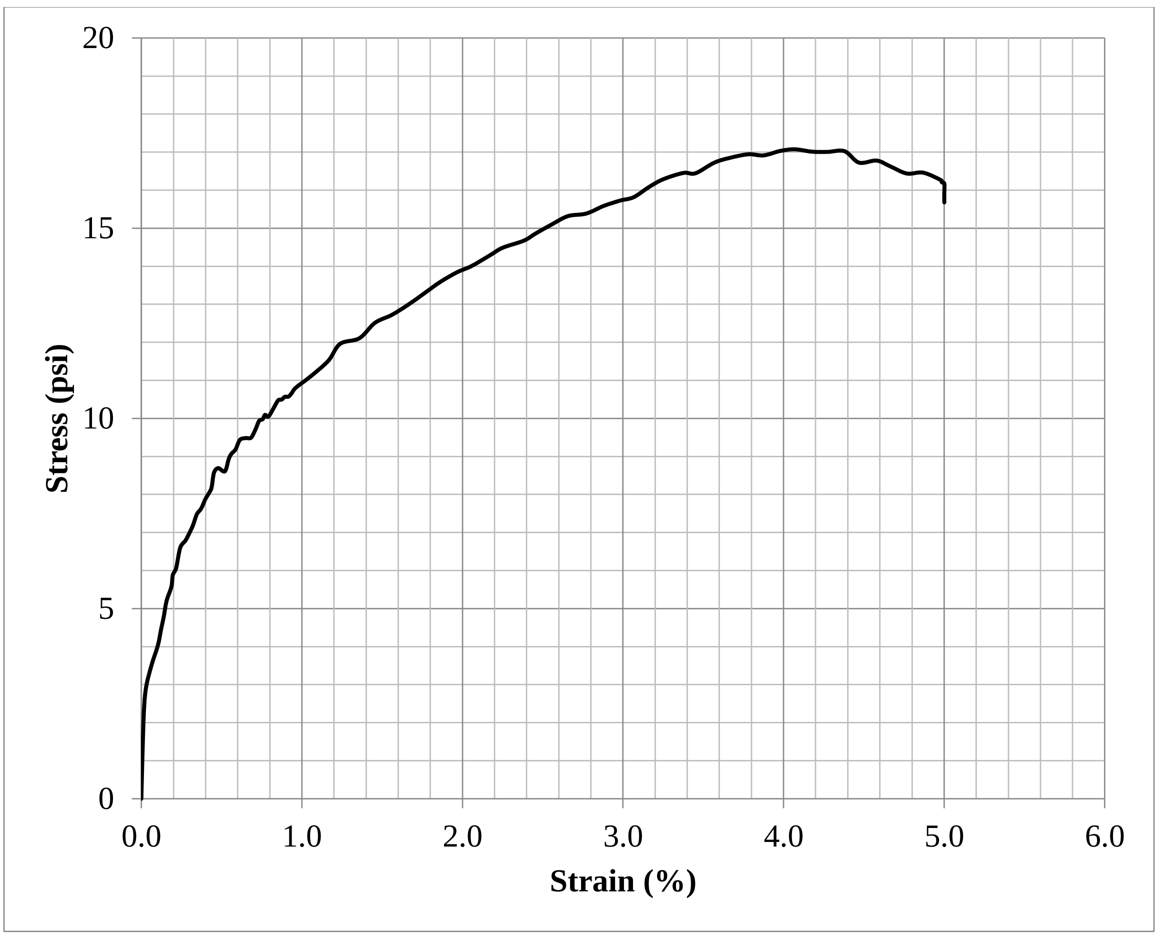
Testing Date	6/19/19
Diameter (in.)	2.041
Height (in.)	3.759
Weight (g)	252.8
Corrected Peak UCS (psi)	69.3
Corrected Failure Strain (%)	1.49
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-1-A
Molding Date	12/5/18
Curing Period (d)	11
α_{I-P} (kg/m^3)	200 (207.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	6.6

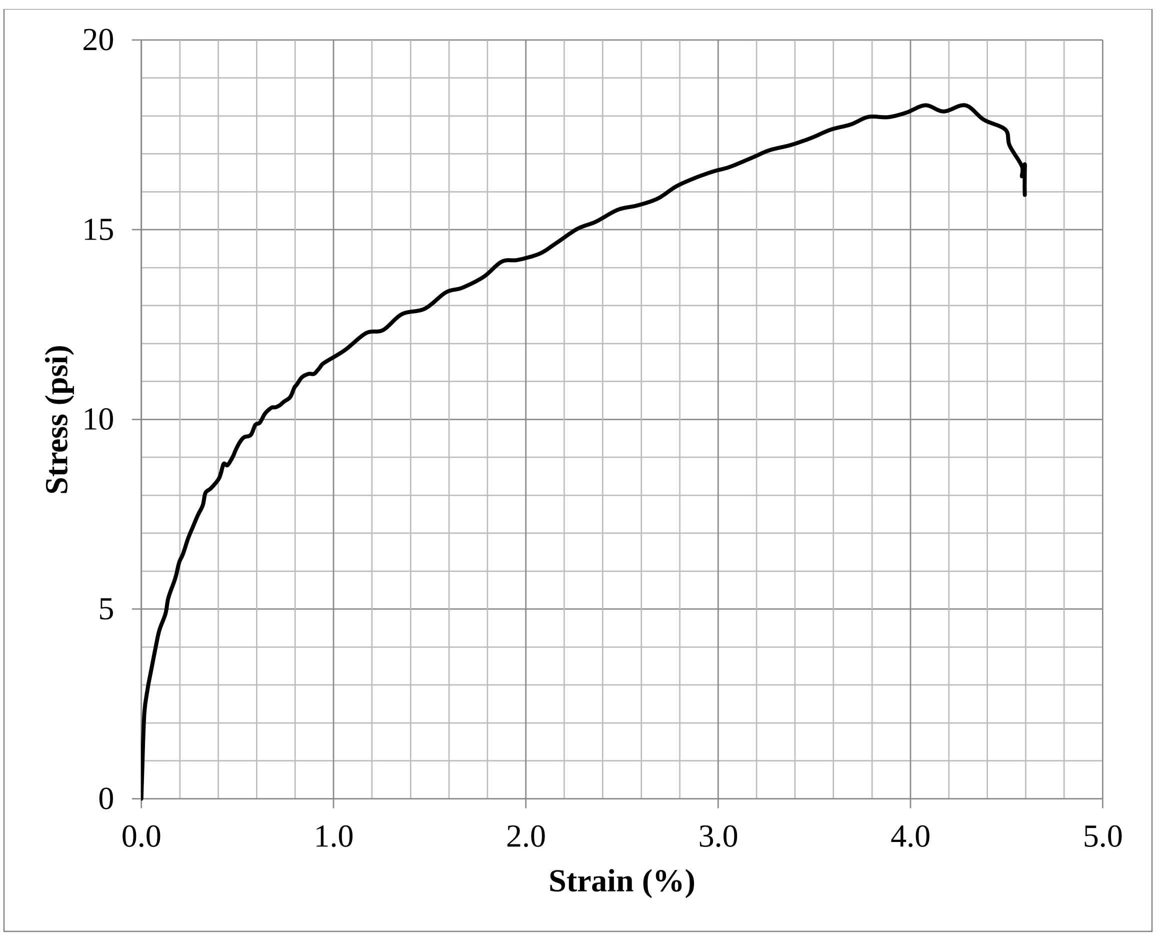
Testing Date	12/16/18
Diameter (in.)	2.016
Height (in.)	3.577
Weight (g)	223.2
Corrected Peak UCS (psi)	16.8
Corrected Failure Strain (%)	4.07
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-1-C
Molding Date	12/5/18
Curing Period (d)	11
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (207.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	7.4

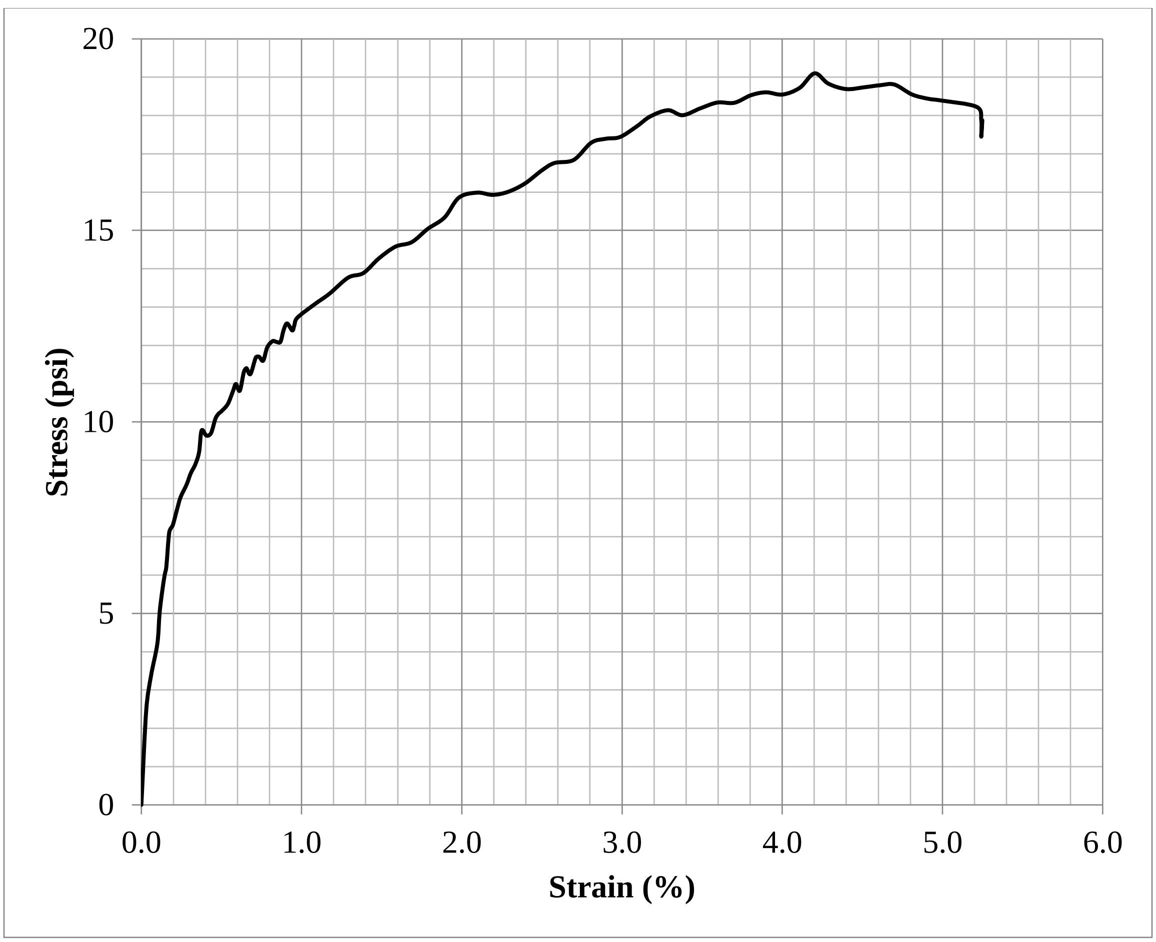
Testing Date	12/16/18
Diameter (in.)	2.019
Height (in.)	3.756
Weight (g)	236.9
Corrected Peak UCS (psi)	18.1
Corrected Failure Strain (%)	4.08
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-1-D
Molding Date	12/5/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	200 (207.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	6.7

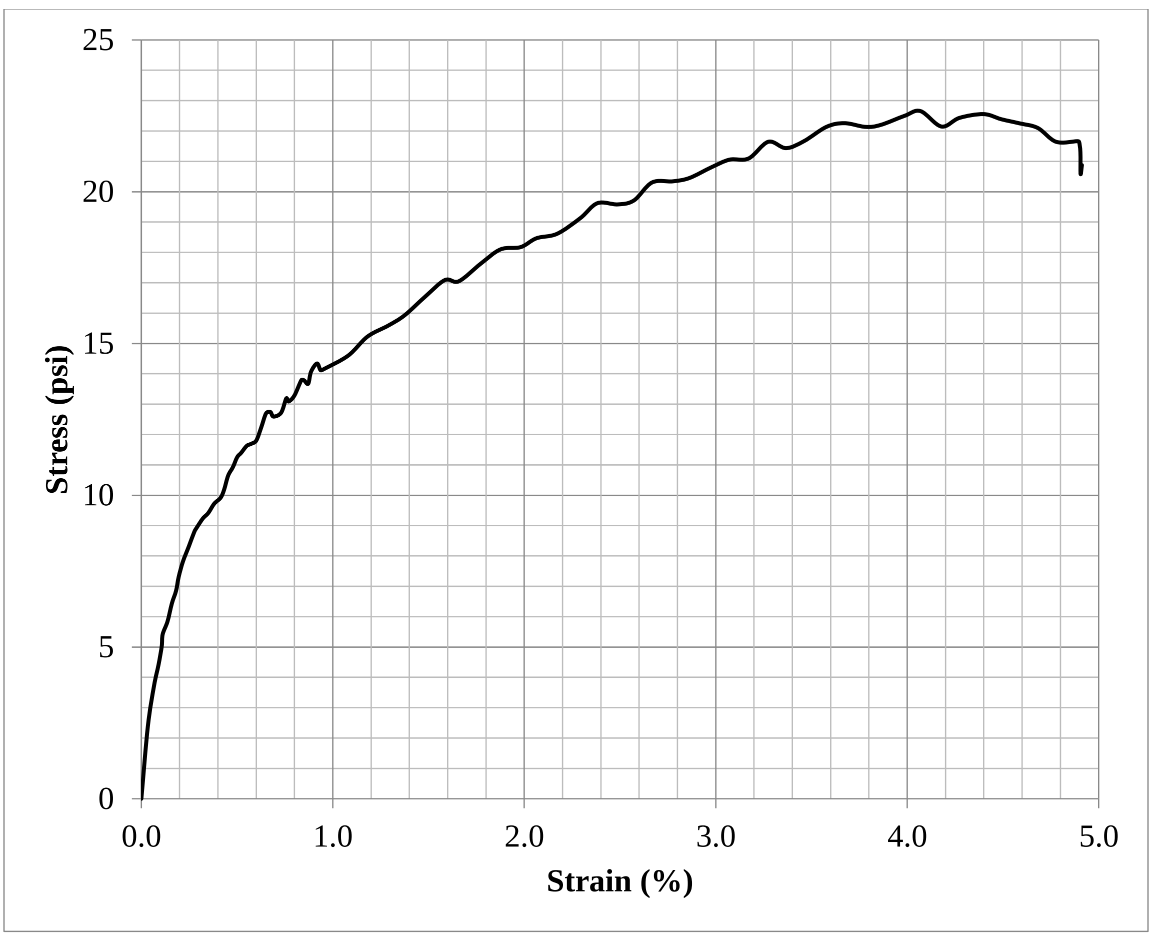
Testing Date	12/19/18
Diameter (in.)	2.017
Height (in.)	3.761
Weight (g)	236.6
Corrected Peak UCS (psi)	18.9
Corrected Failure Strain (%)	4.20
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-1-E
Molding Date	12/5/18
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (207.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	4.7

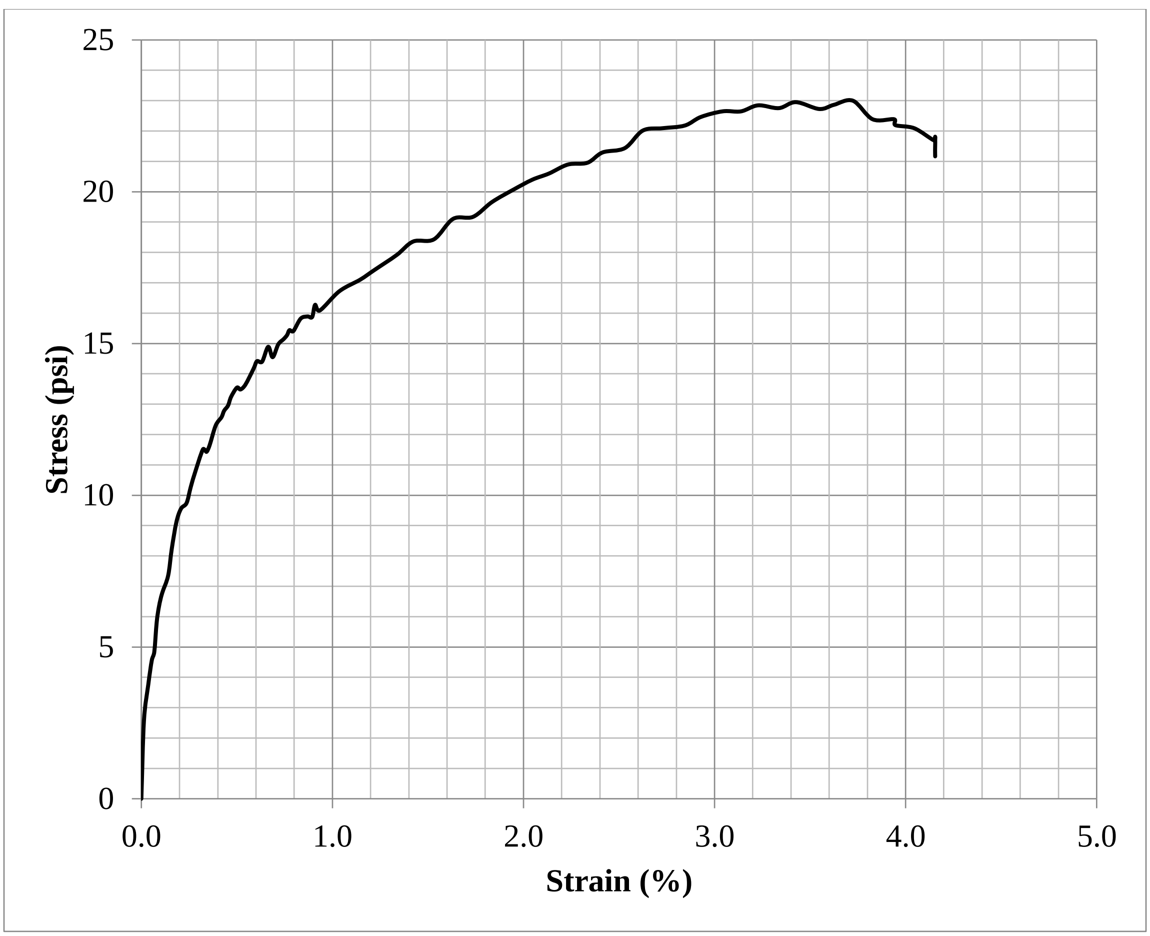
Testing Date	12/19/18
Diameter (in.)	2.021
Height (in.)	3.633
Weight (g)	227.5
Corrected Peak UCS (psi)	22.3
Corrected Failure Strain (%)	4.07
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-1-F
Molding Date	12/5/18
Curing Period (d)	31
α_{I-P} (kg/m^3)	200 (207.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	5.5

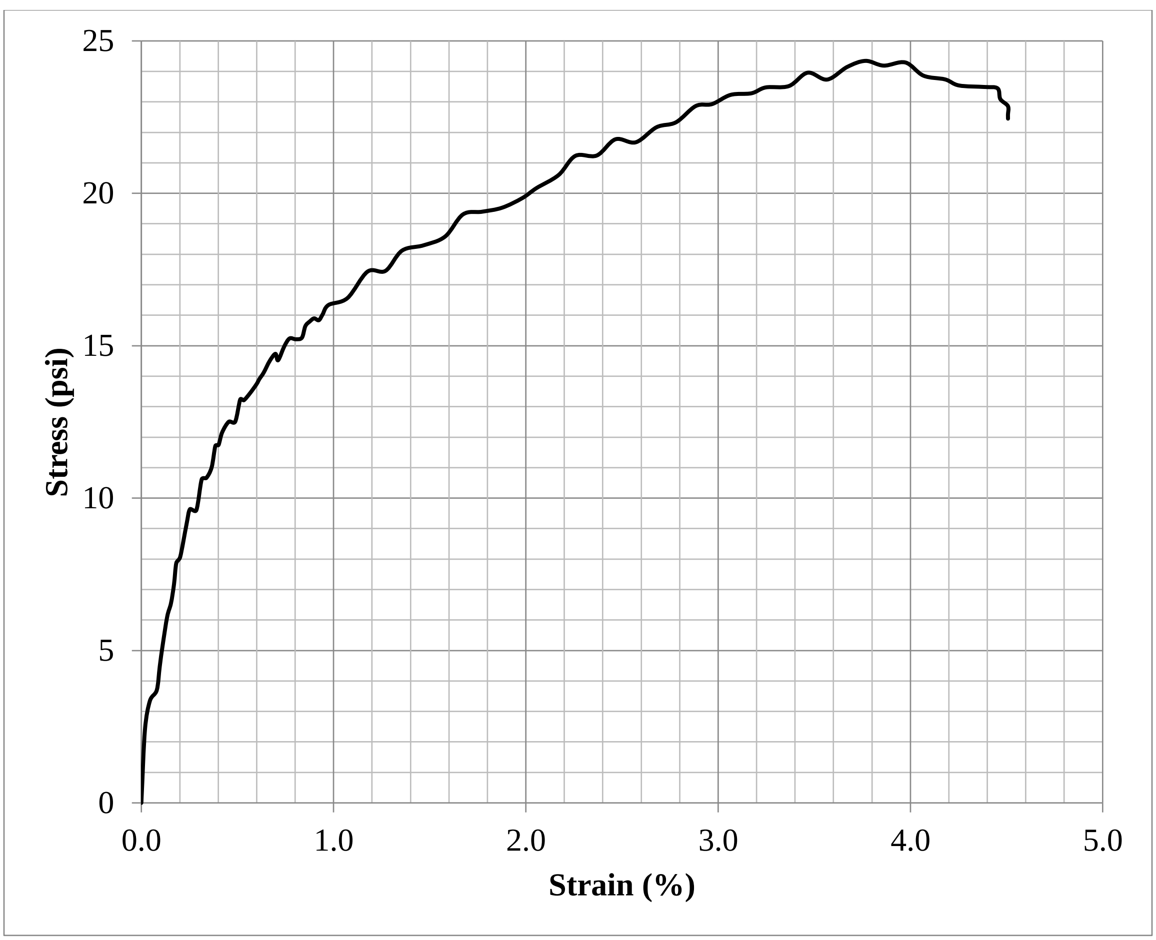
Testing Date	1/5/19
Diameter (in.)	2.018
Height (in.)	3.617
Weight (g)	230.4
Corrected Peak UCS (psi)	22.6
Corrected Failure Strain (%)	3.72
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-1-G
Molding Date	12/5/18
Curing Period (d)	31
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (207.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	6.1

Testing Date	1/5/19
Diameter (in.)	2.012
Height (in.)	3.648
Weight (g)	231.8
Corrected Peak UCS (psi)	24.0
Corrected Failure Strain (%)	3.77
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

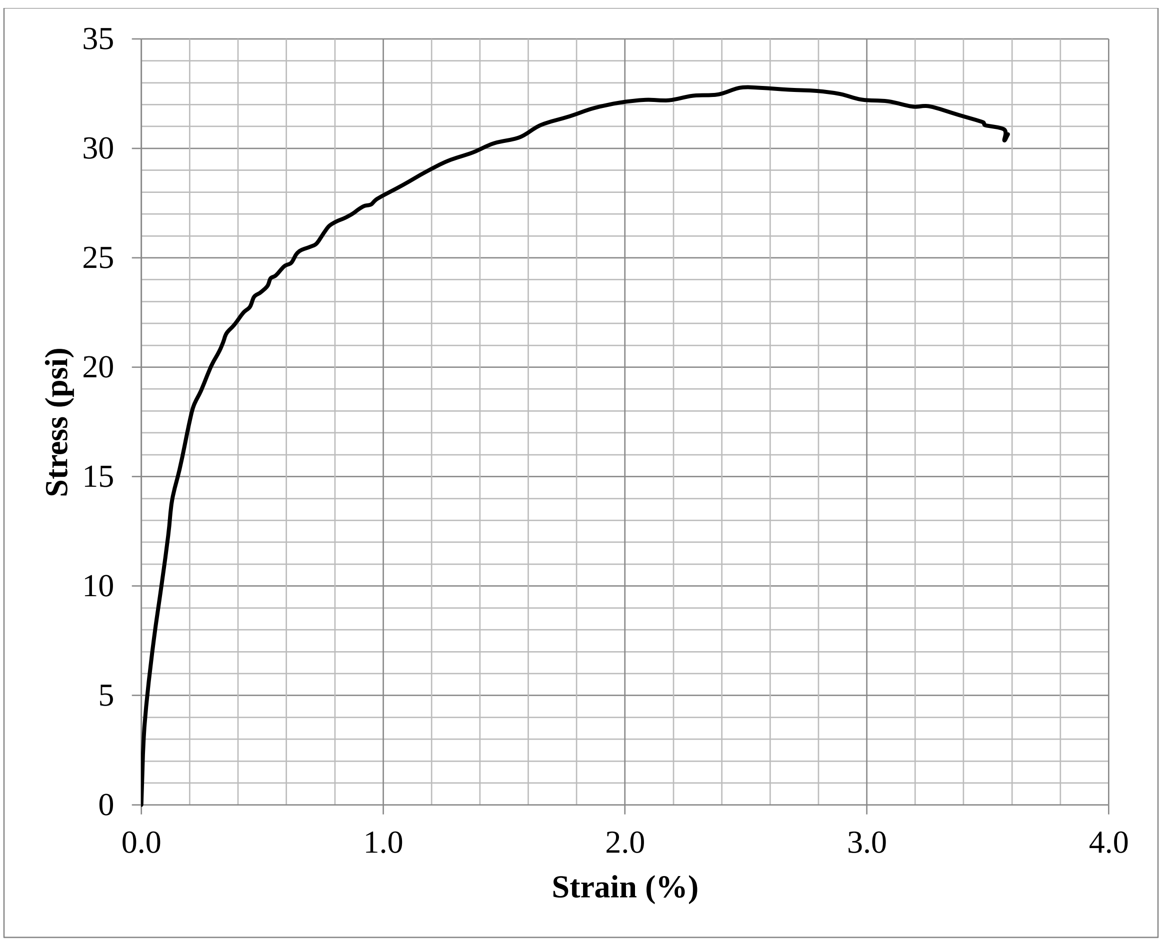
Specimen ID	50-2-A
Molding Date	12/5/18
Curing Period (d)	11
α_{I-P} (kg/m^3)	281 (295.4)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	11.0

Testing Date	12/17/18
Diameter (in.)	2.033
Height (in.)	3.688
Weight (g)	241.4
Corrected Peak UCS (psi)	34.5
Corrected Failure Strain (%)	2.47
ASTM C39 Fracture Type	4

Data Sheet: Specimen UCS Test

Specimen ID	50-2-B
Molding Date	12/5/18
Curing Period (d)	11
α_{I-P} (kg/m^3)	281 (295.4)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	9.9

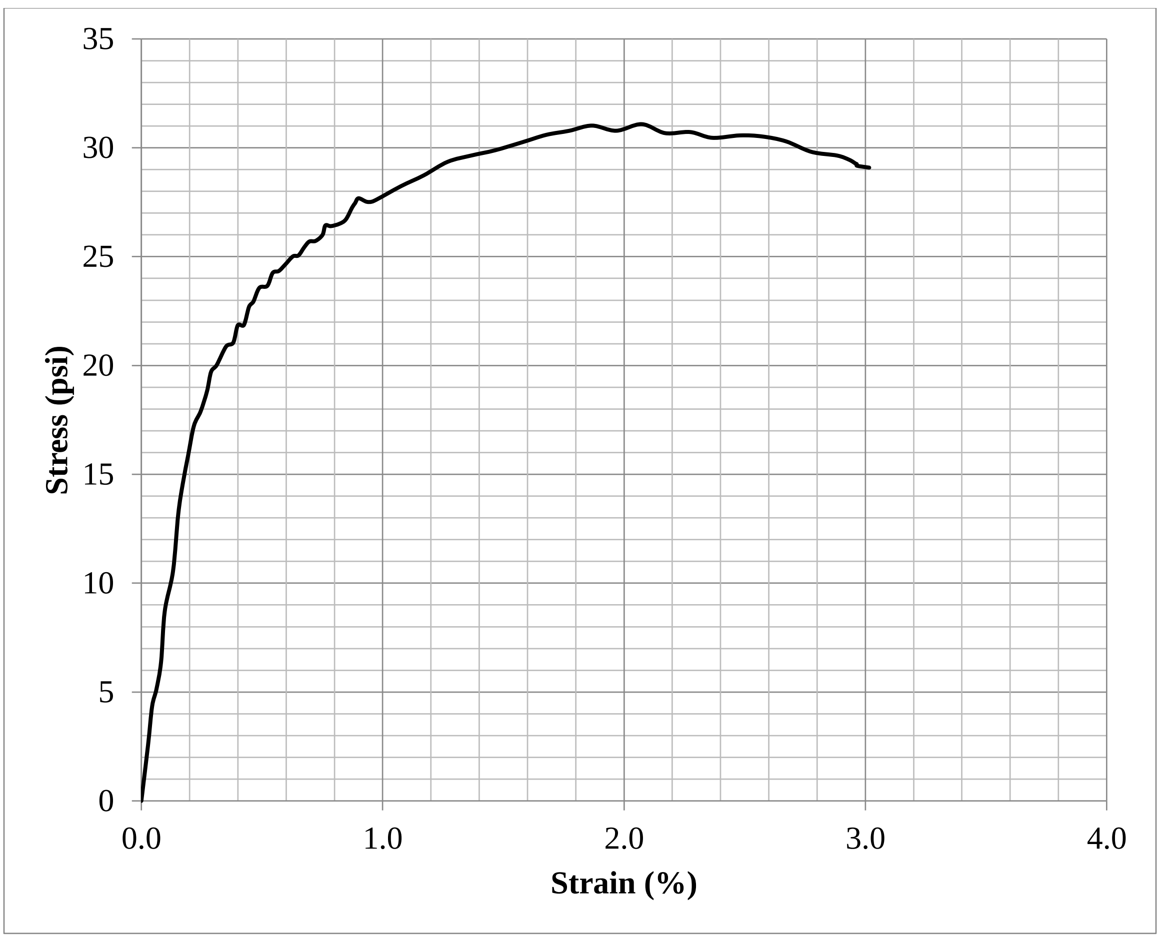
Testing Date	12/17/18
Diameter (in.)	2.031
Height (in.)	3.696
Weight (g)	241.4
Corrected Peak UCS (psi)	32.3
Corrected Failure Strain (%)	2.48
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-2-C
Molding Date	12/5/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	281 (295.4)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	9.9

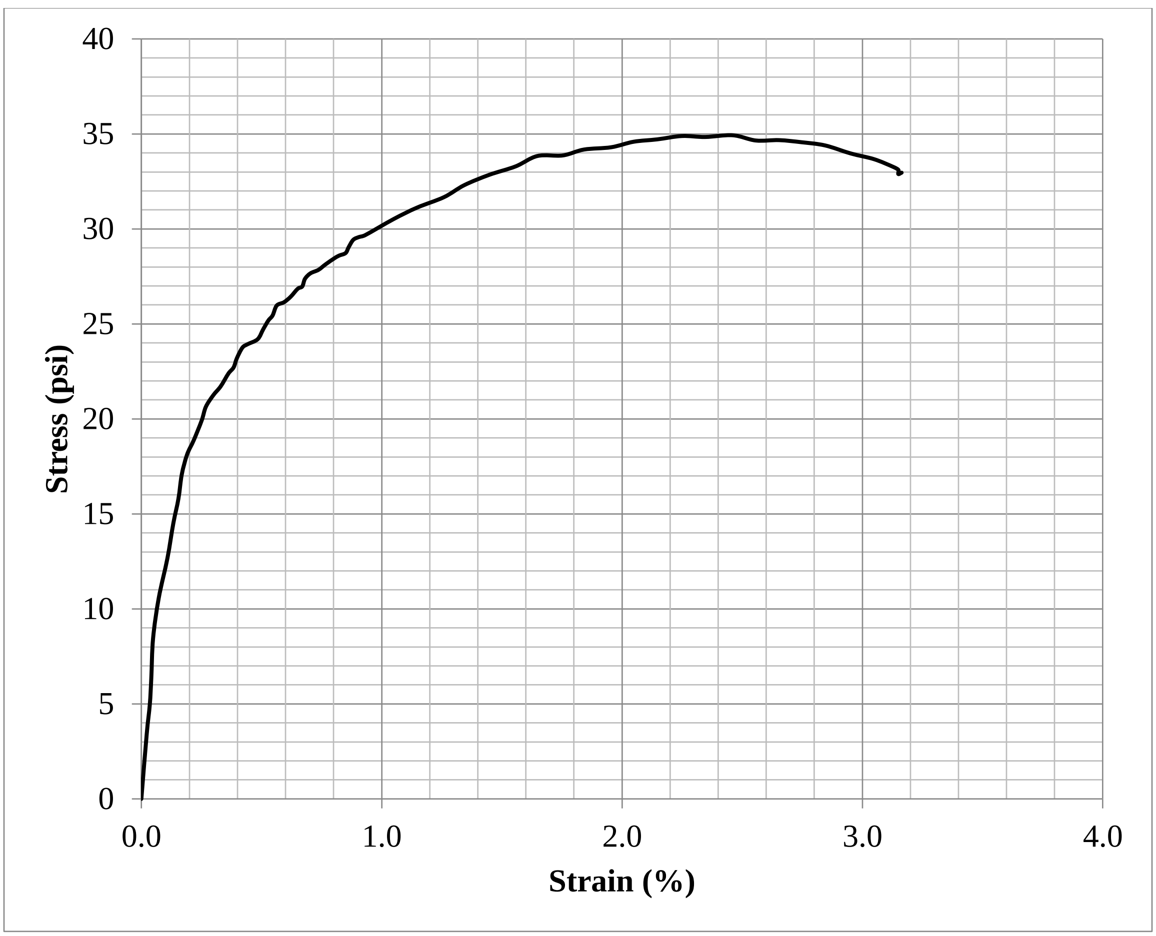
Testing Date	12/19/18
Diameter (in.)	2.031
Height (in.)	3.754
Weight (g)	245.6
Corrected Peak UCS (psi)	30.7
Corrected Failure Strain (%)	2.07
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-2-D
Molding Date	12/5/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	281 (295.4)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	8.6

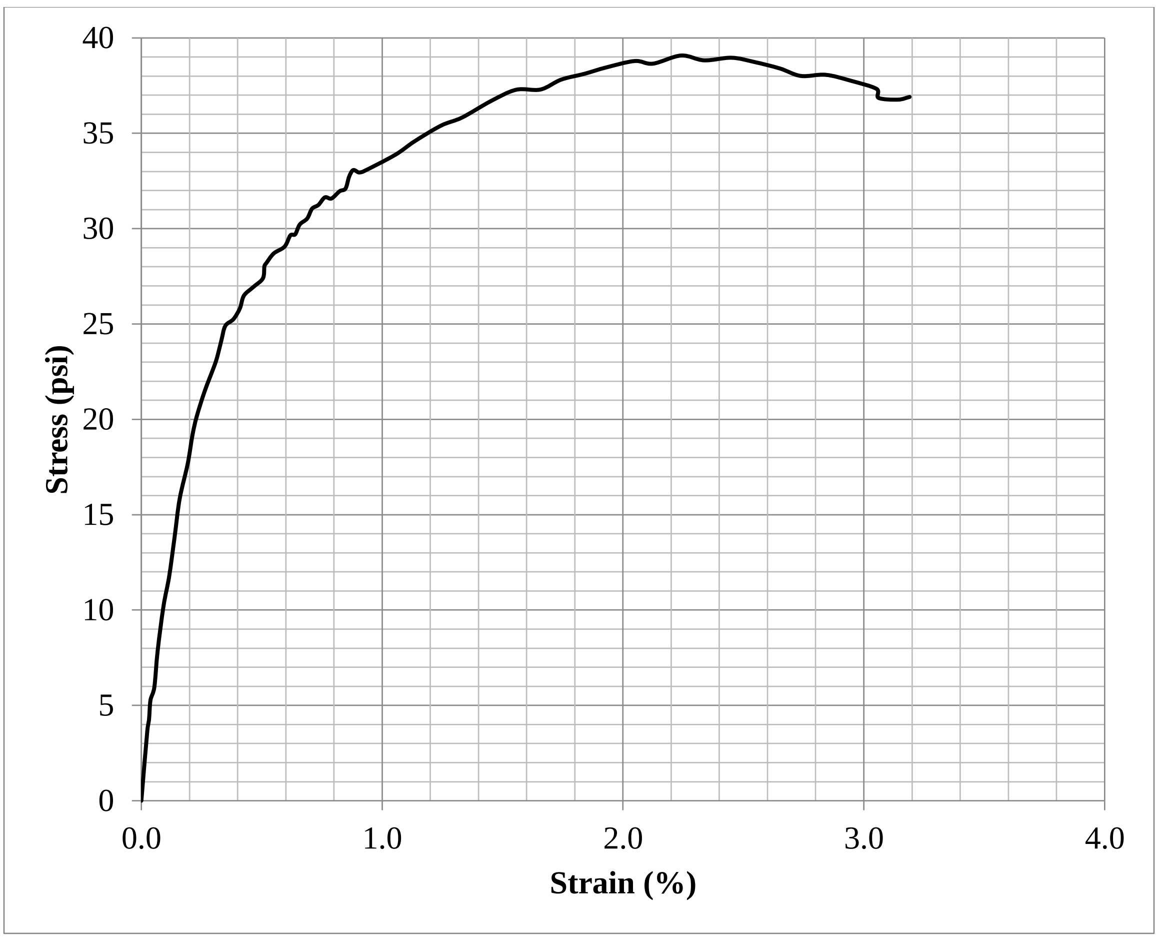
Testing Date	12/19/18
Diameter (in.)	2.029
Height (in.)	3.787
Weight (g)	245.6
Corrected Peak UCS (psi)	34.6
Corrected Failure Strain (%)	2.46
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-2-E
Molding Date	12/5/18
Curing Period (d)	31
α_{I-P} (kg/m^3)	281 (295.4)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	8.8

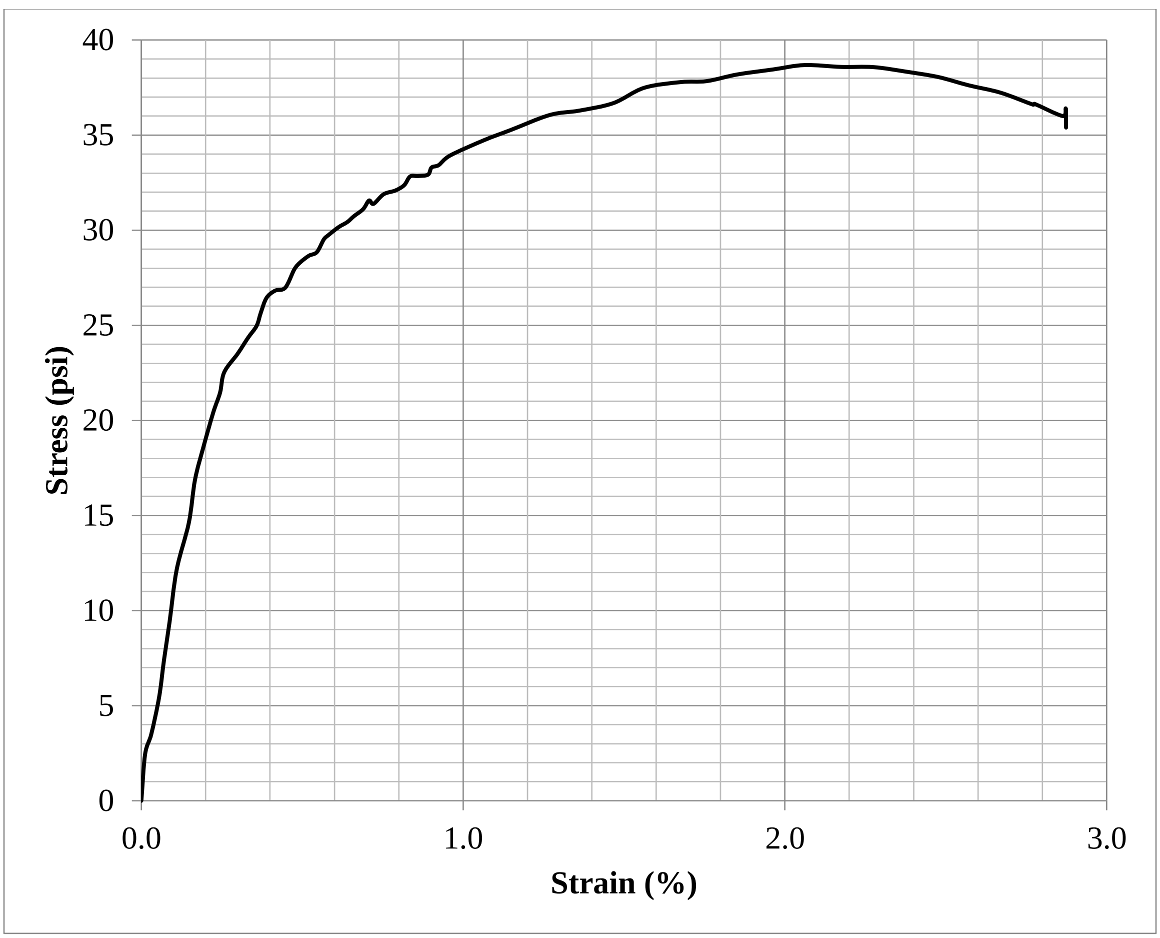
Testing Date	1/5/19
Diameter (in.)	2.028
Height (in.)	3.529
Weight (g)	230.1
Corrected Peak UCS (psi)	38.3
Corrected Failure Strain (%)	2.24
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-2-F
Molding Date	12/5/18
Curing Period (d)	31
$\alpha_{I\text{-}P}$ (kg/m^3)	281 (295.4)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	9.3

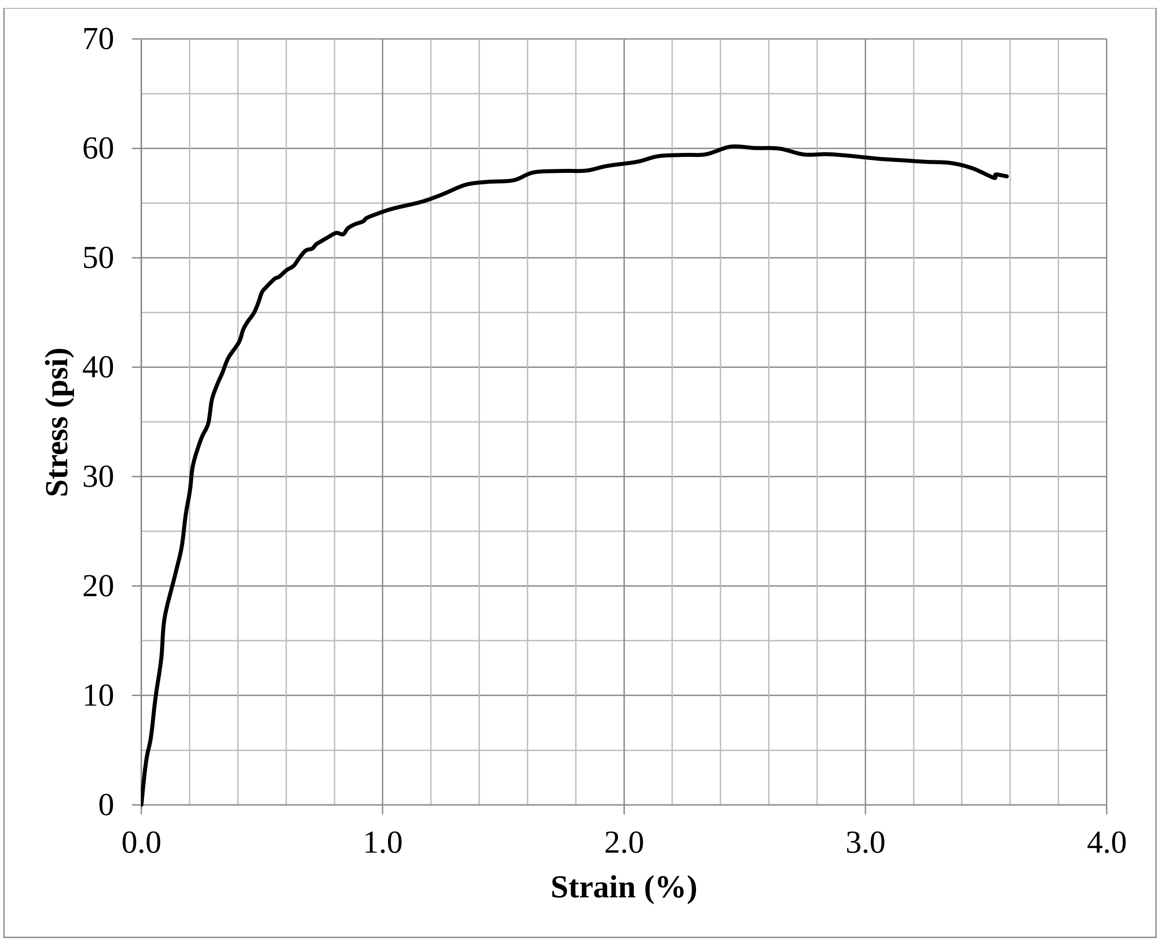
Testing Date	1/5/19
Diameter (in.)	2.022
Height (in.)	3.705
Weight (g)	244.6
Corrected Peak UCS (psi)	38.2
Corrected Failure Strain (%)	2.06
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-3-A
Molding Date	12/6/18
Curing Period (d)	11
$\alpha_{I\text{-}P}$ (kg/m^3)	338 (356.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	10.8

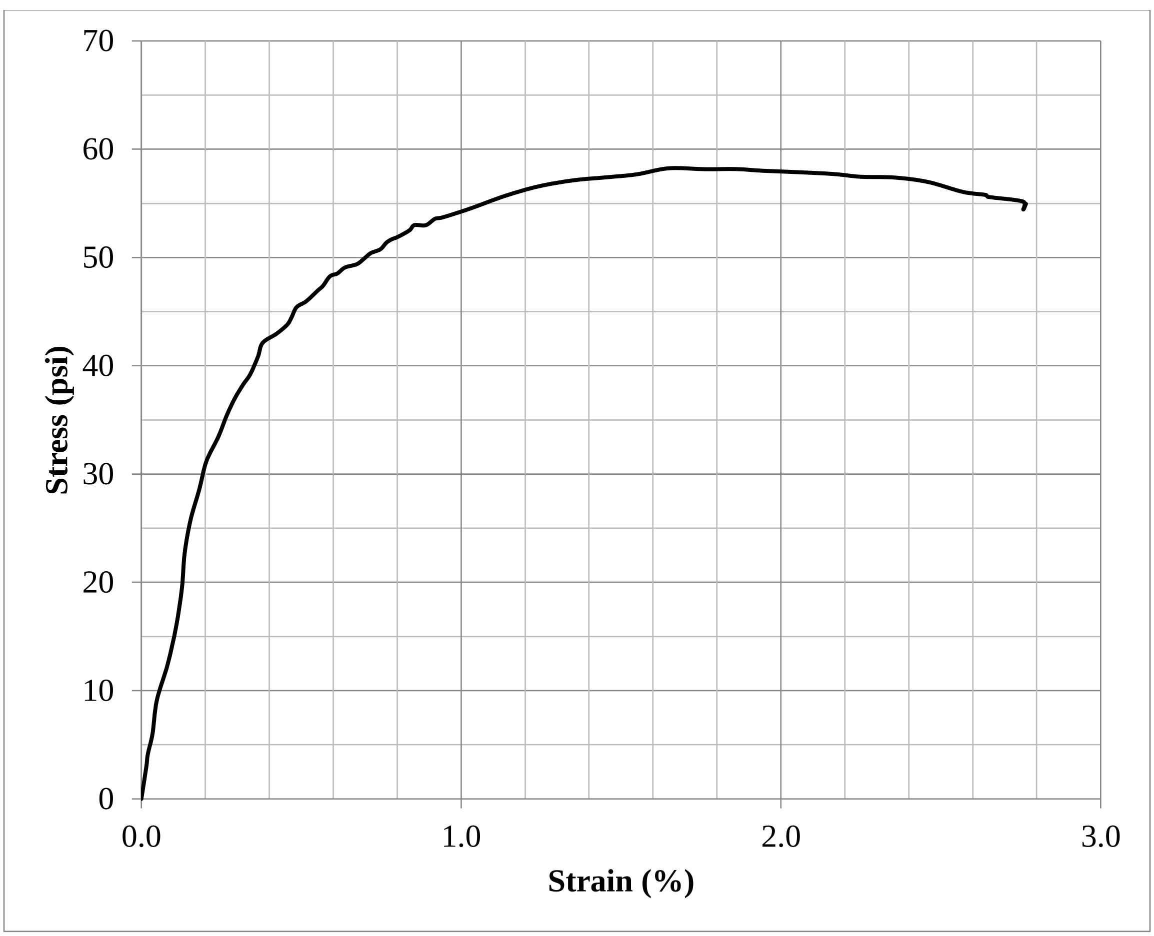
Testing Date	12/17/18
Diameter (in.)	2.029
Height (in.)	3.662
Weight (g)	238.3
Corrected Peak UCS (psi)	59.2
Corrected Failure Strain (%)	2.44
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-3-C
Molding Date	12/6/18
Curing Period (d)	12
α_{I-P} (kg/m^3)	338 (356.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	11.1

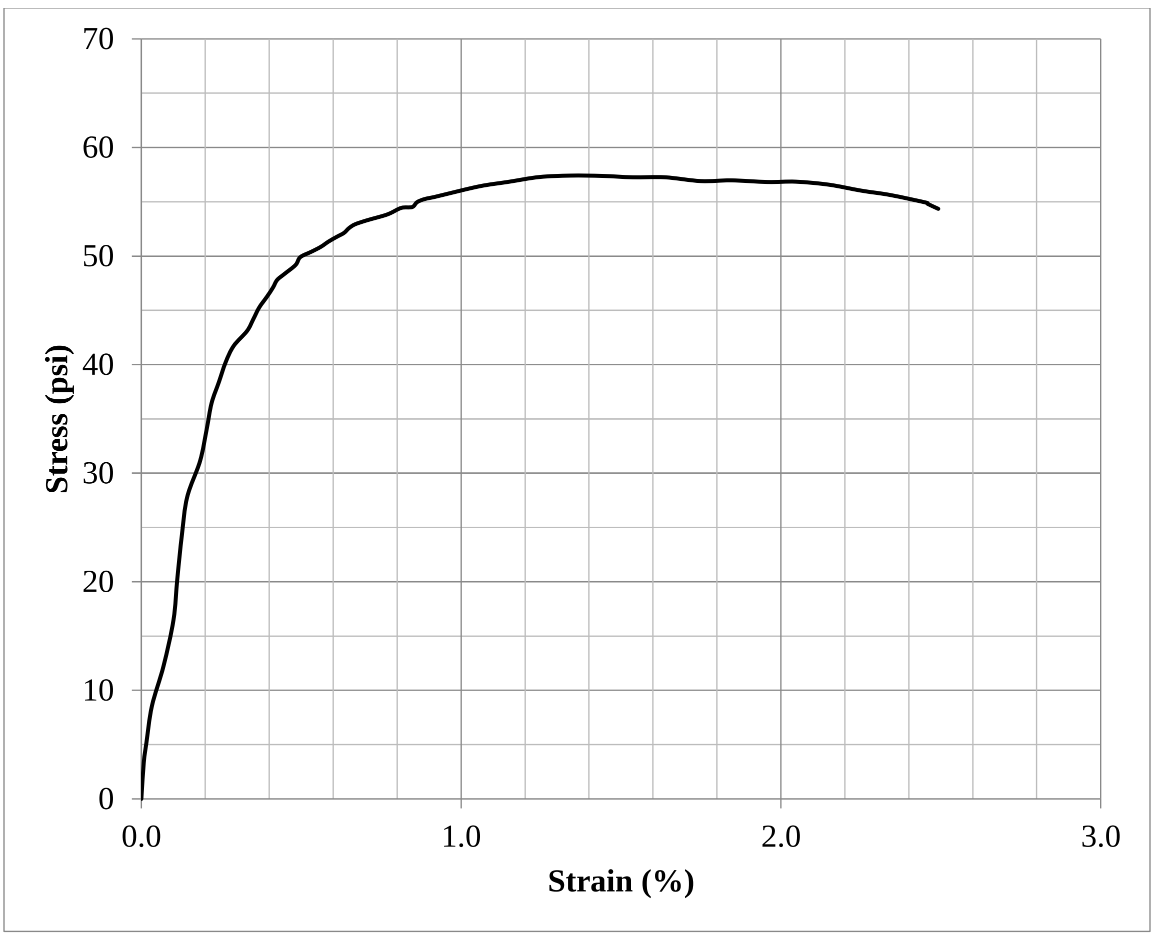
Testing Date	12/17/18
Diameter (in.)	2.038
Height (in.)	3.674
Weight (g)	244.0
Corrected Peak UCS (psi)	57.3
Corrected Failure Strain (%)	1.65
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-3-D
Molding Date	12/6/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	338 (356.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	10.7

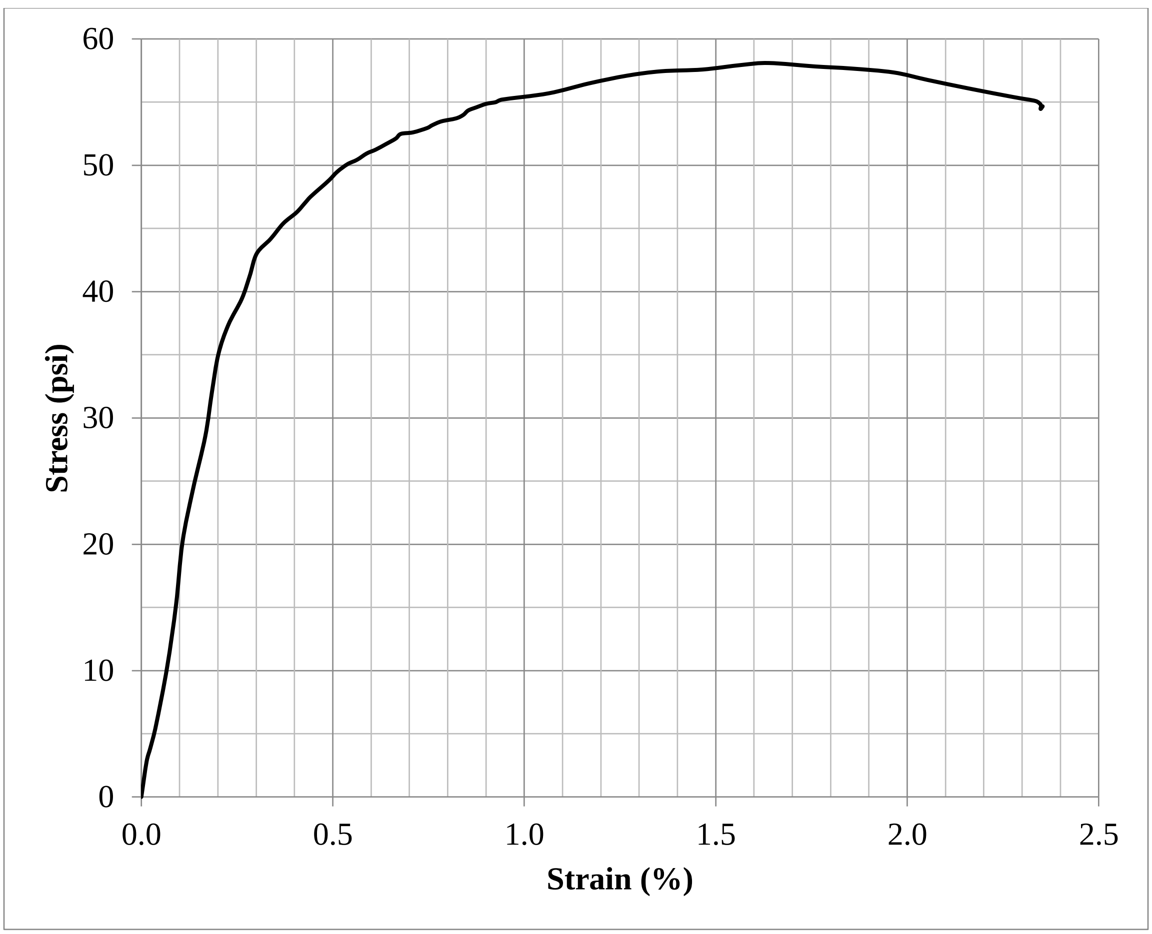
Testing Date	12/19/18
Diameter (in.)	2.036
Height (in.)	3.665
Weight (g)	247.8
Corrected Peak UCS (psi)	56.5
Corrected Failure Strain (%)	1.34
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-3-E
Molding Date	12/6/18
Curing Period (d)	14
α_{I-P} (kg/m^3)	338 (356.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	10.8

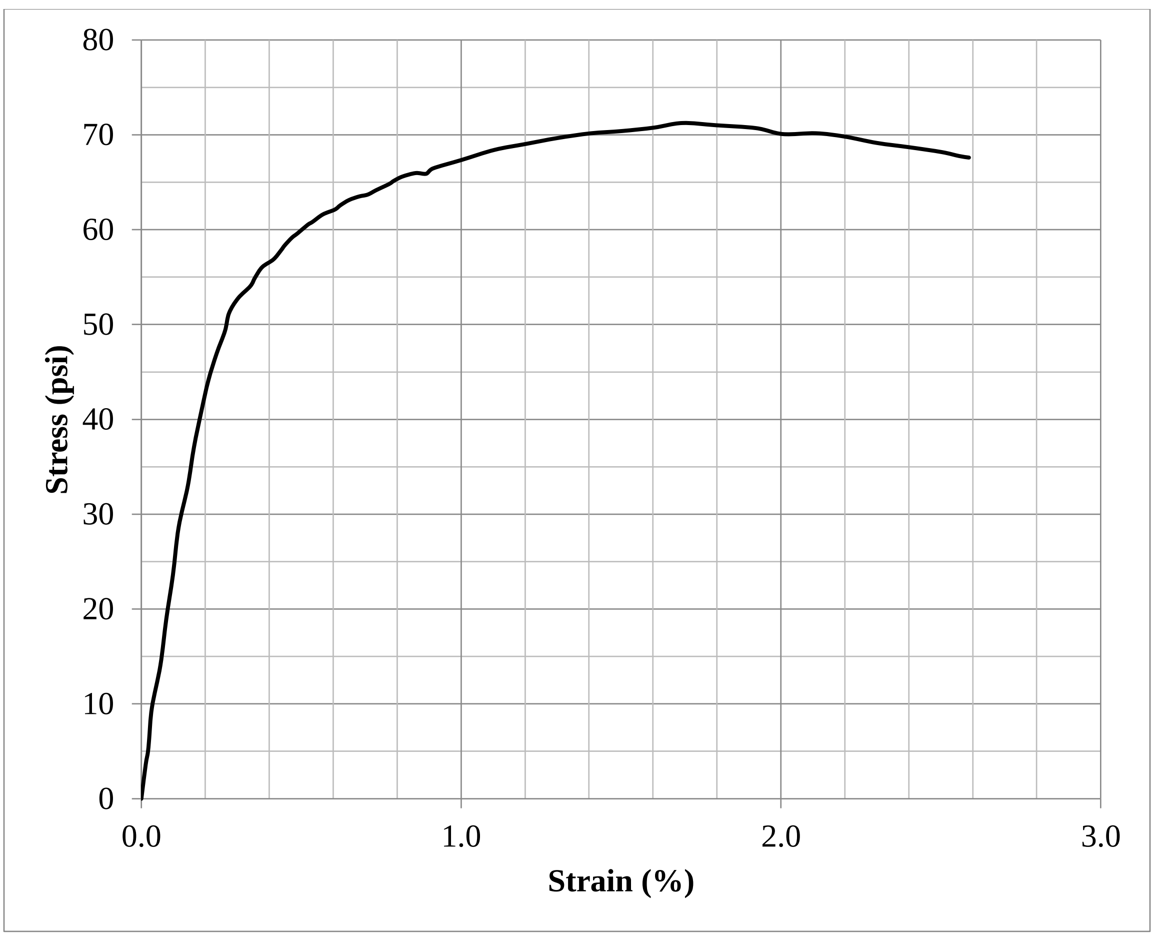
Testing Date	12/20/18
Diameter (in.)	2.037
Height (in.)	3.637
Weight (g)	248.6
Corrected Peak UCS (psi)	57.1
Corrected Failure Strain (%)	1.64
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-3-E
Molding Date	12/6/18
Curing Period (d)	31
α_{I-P} (kg/m^3)	338 (356.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	9.7

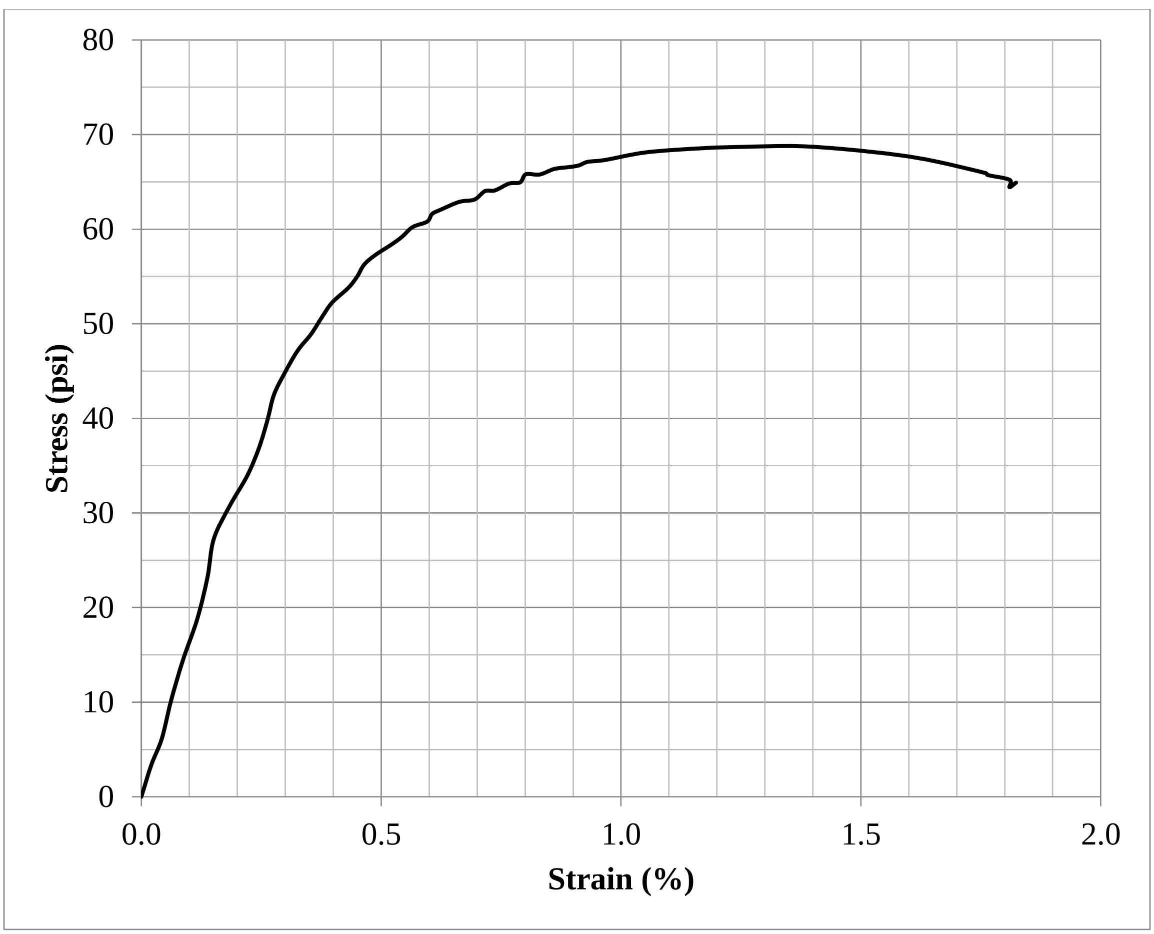
Testing Date	1/5/19
Diameter (in.)	2.032
Height (in.)	3.618
Weight (g)	250.0
Corrected Peak UCS (psi)	70.0
Corrected Failure Strain (%)	1.69
ASTM C39 Fracture Type	4



<u>Data Sheet: Specimen UCS Test</u>

Specimen ID	50-3-G
Molding Date	12/6/18
Curing Period (d)	31
α_{I-P} (kg/m^3)	338 (356.9)
w:b	1.0
Soil OM (%)	57.5
Bleed Water (g)	9.6

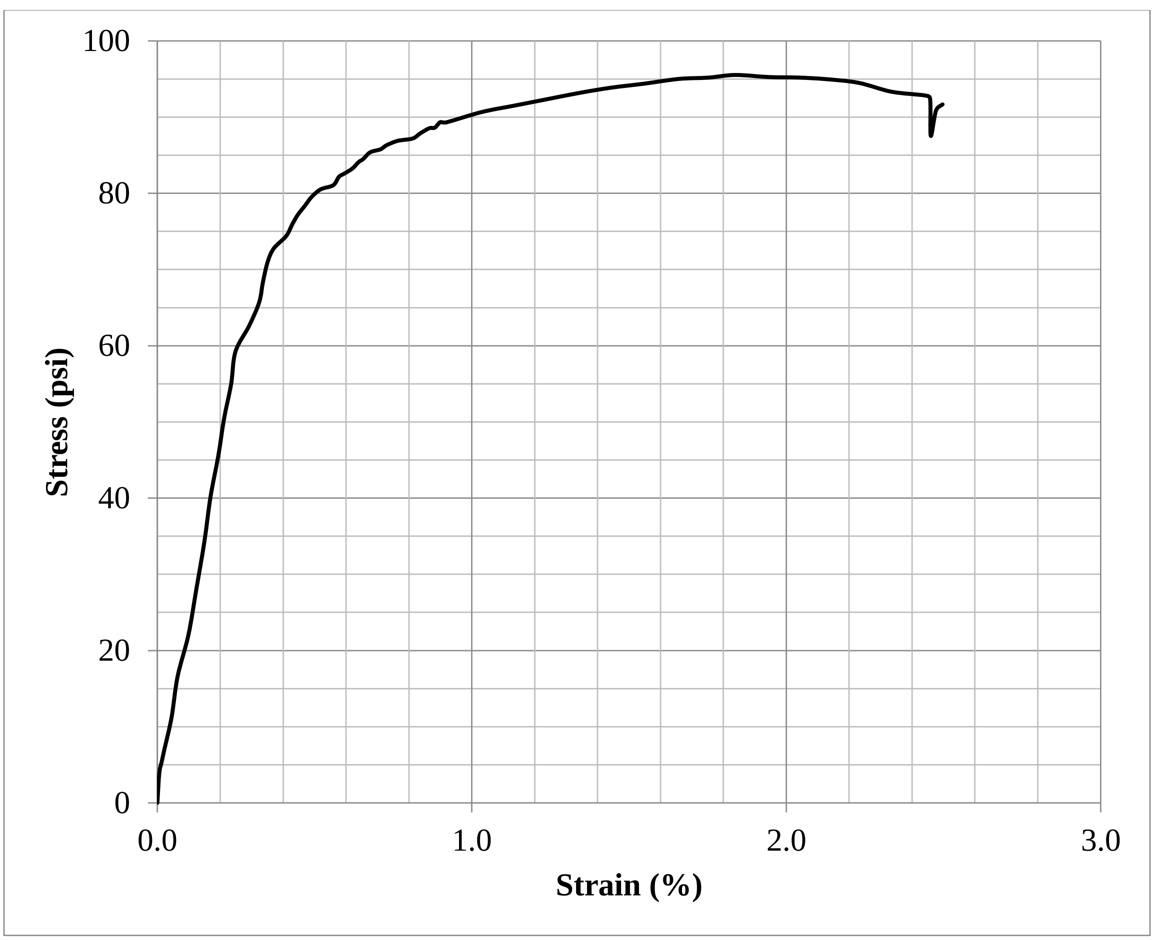
Testing Date	1/5/19
Diameter (in.)	2.030
Height (in.)	3.704
Weight (g)	250.2
Corrected Peak UCS (psi)	67.8
Corrected Failure Strain (%)	1.37
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-4-A
Molding Date	4/21/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (413.3)
w:b	0.8
Soil OM (%)	57.5
Bleed Water (g)	5.7

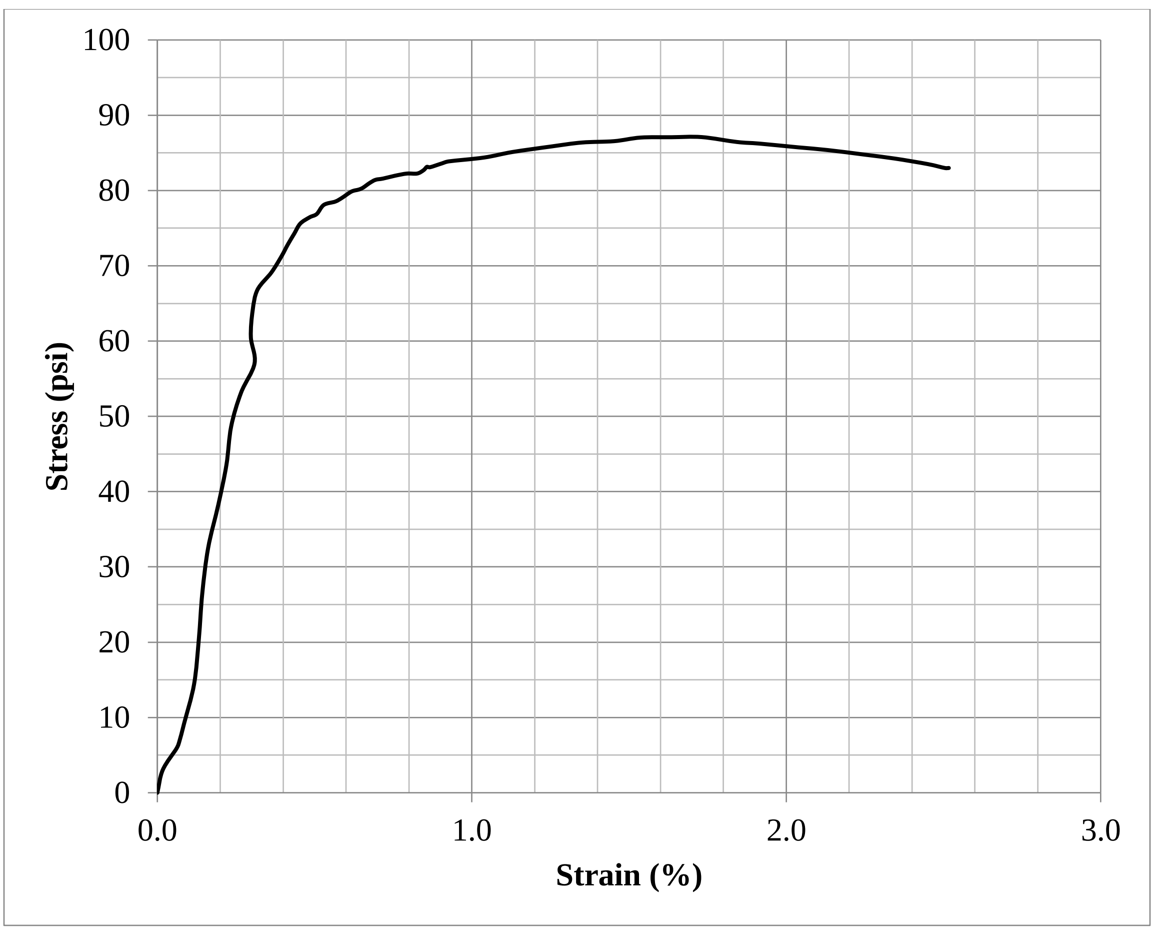
Testing Date	4/28/19
Diameter (in.)	2.039
Height (in.)	3.670
Weight (g)	261.0
Corrected Peak UCS (psi)	94.0
Corrected Failure Strain (%)	1.84
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-4-B
Molding Date	4/21/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	400 (413.3)
w:b	0.8
Soil OM (%)	57.5
Bleed Water (g)	5.6

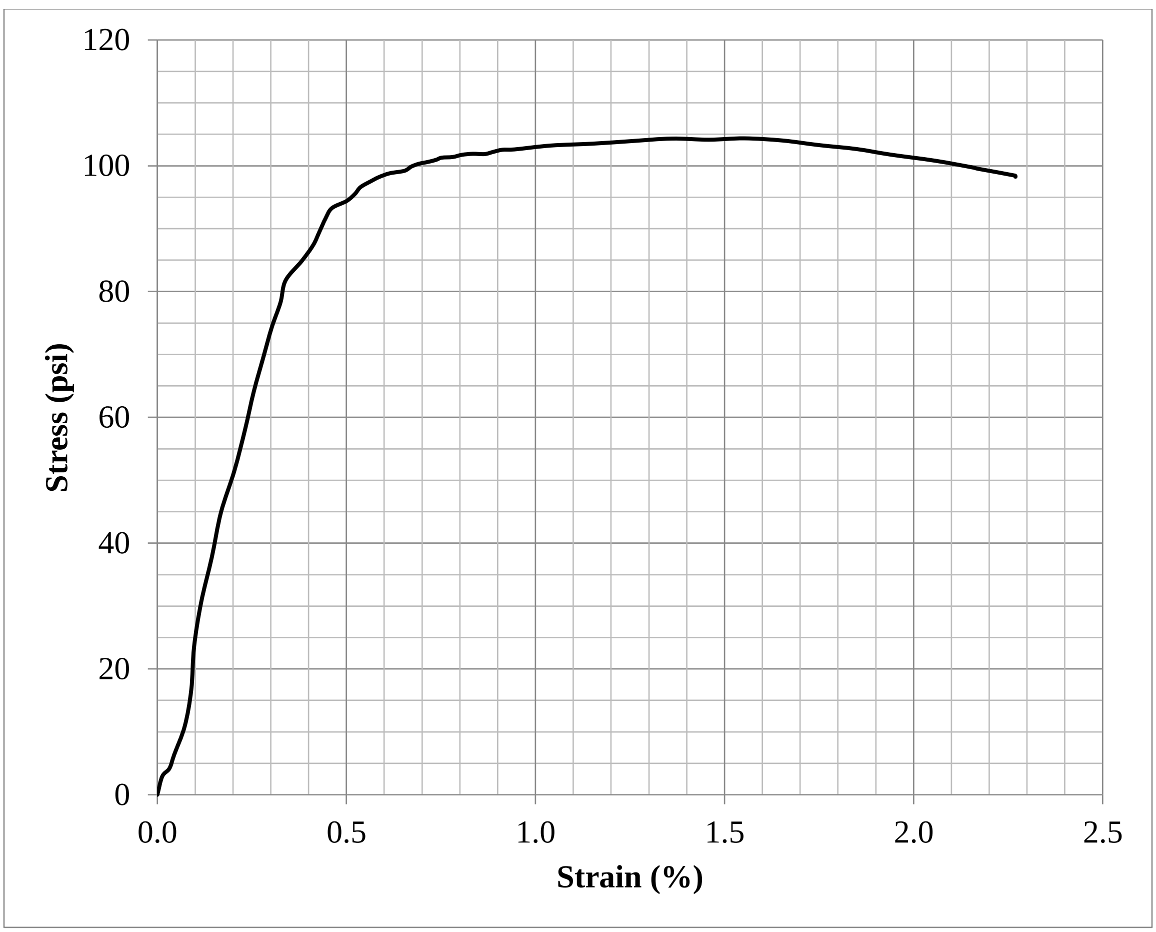
Testing Date	4/28/19
Diameter (in.)	2.038
Height (in.)	3.523
Weight (g)	249.3
Corrected Peak UCS (psi)	85.2
Corrected Failure Strain (%)	1.73
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-4-C
Molding Date	4/21/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	400 (413.3)
w:b	0.8
Soil OM (%)	57.5
Bleed Water (g)	4.6

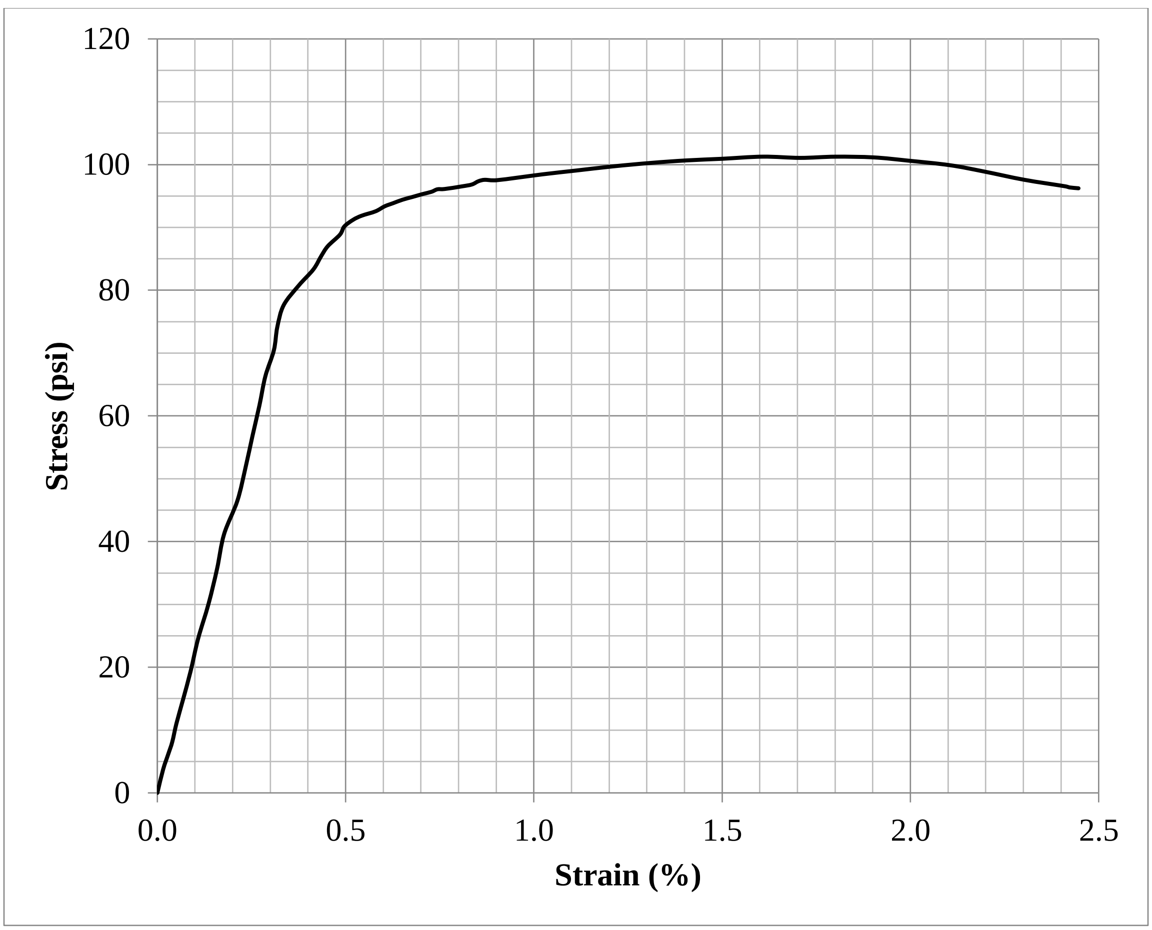
Testing Date	5/5/19
Diameter (in.)	2.037
Height (in.)	3.673
Weight (g)	262.3
Corrected Peak UCS (psi)	102.7
Corrected Failure Strain (%)	1.55
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-4-D
Molding Date	4/21/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	400 (413.3)
w:b	0.8
Soil OM (%)	57.5
Bleed Water (g)	5.8

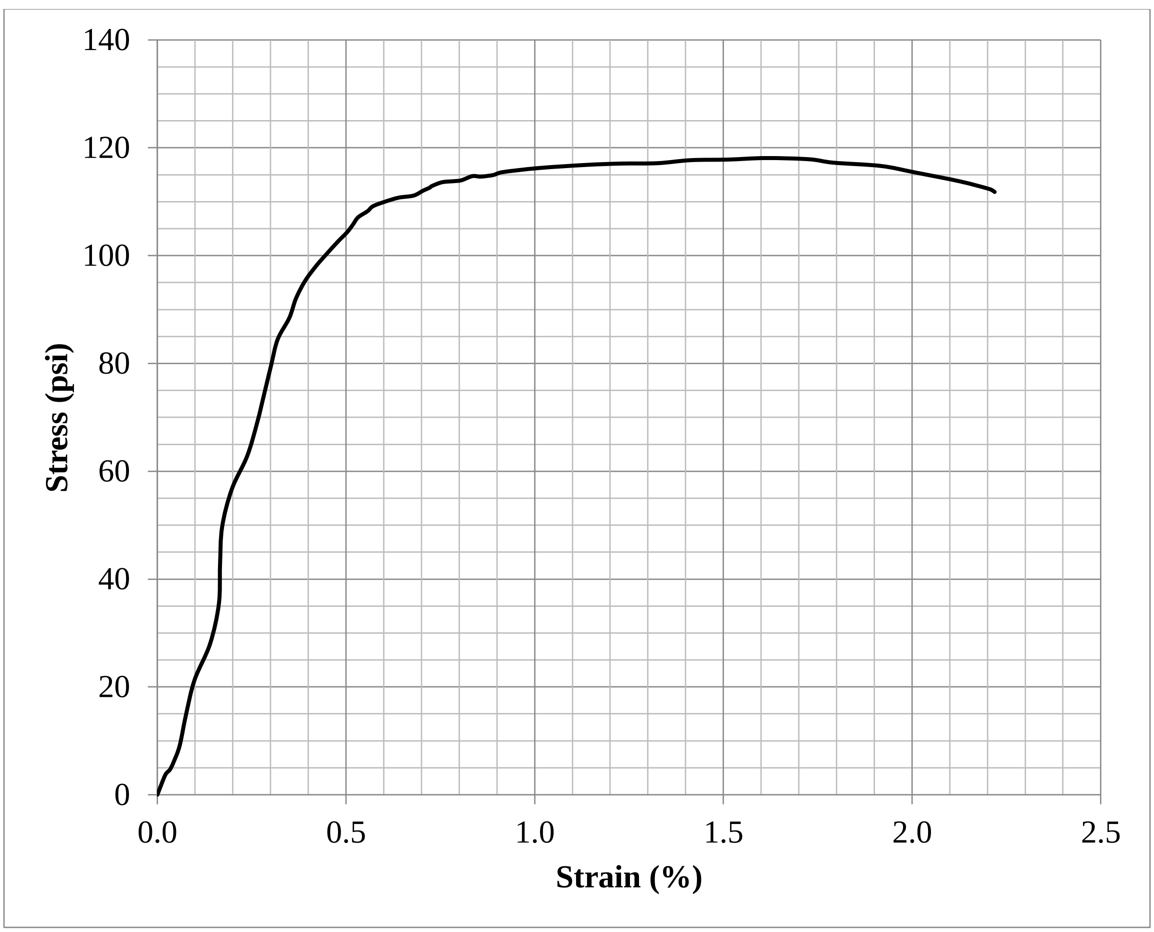
Testing Date	5/5/19
Diameter (in.)	2.039
Height (in.)	3.591
Weight (g)	255.3
Corrected Peak UCS (psi)	99.3
Corrected Failure Strain (%)	1.61
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-4-E
Molding Date	4/21/19
Curing Period (d)	29
α_{I-P} (kg/m^3)	400 (413.3)
w:b	0.8
Soil OM (%)	57.5
Bleed Water (g)	6.1

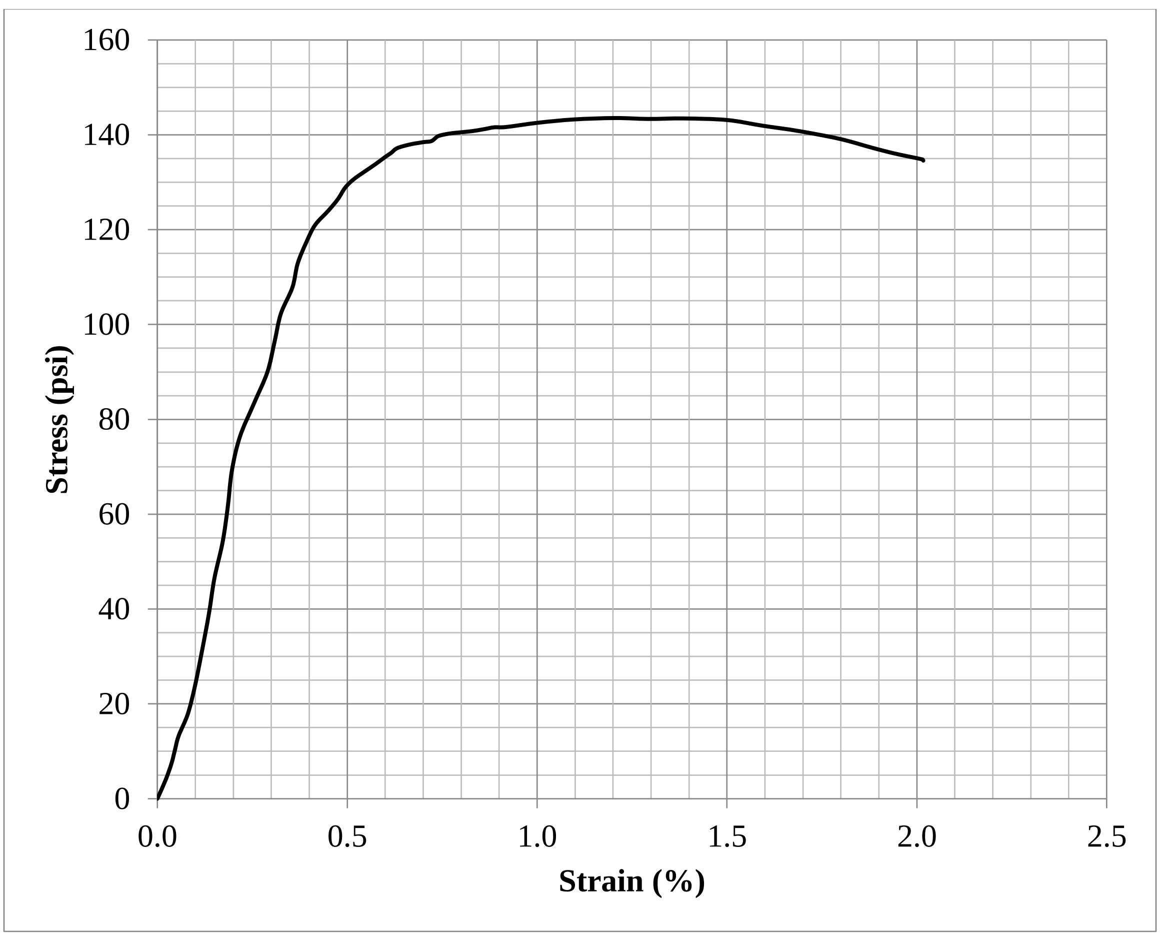
Testing Date	5/20/19
Diameter (in.)	2.038
Height (in.)	3.518
Weight (g)	250.6
Corrected Peak UCS (psi)	115.5
Corrected Failure Strain (%)	1.61
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-4-G
Molding Date	4/21/19
Curing Period (d)	30
α_{I-P} (kg/m^3)	400 (413.3)
w:b	0.8
Soil OM (%)	57.5
Bleed Water (g)	3.7

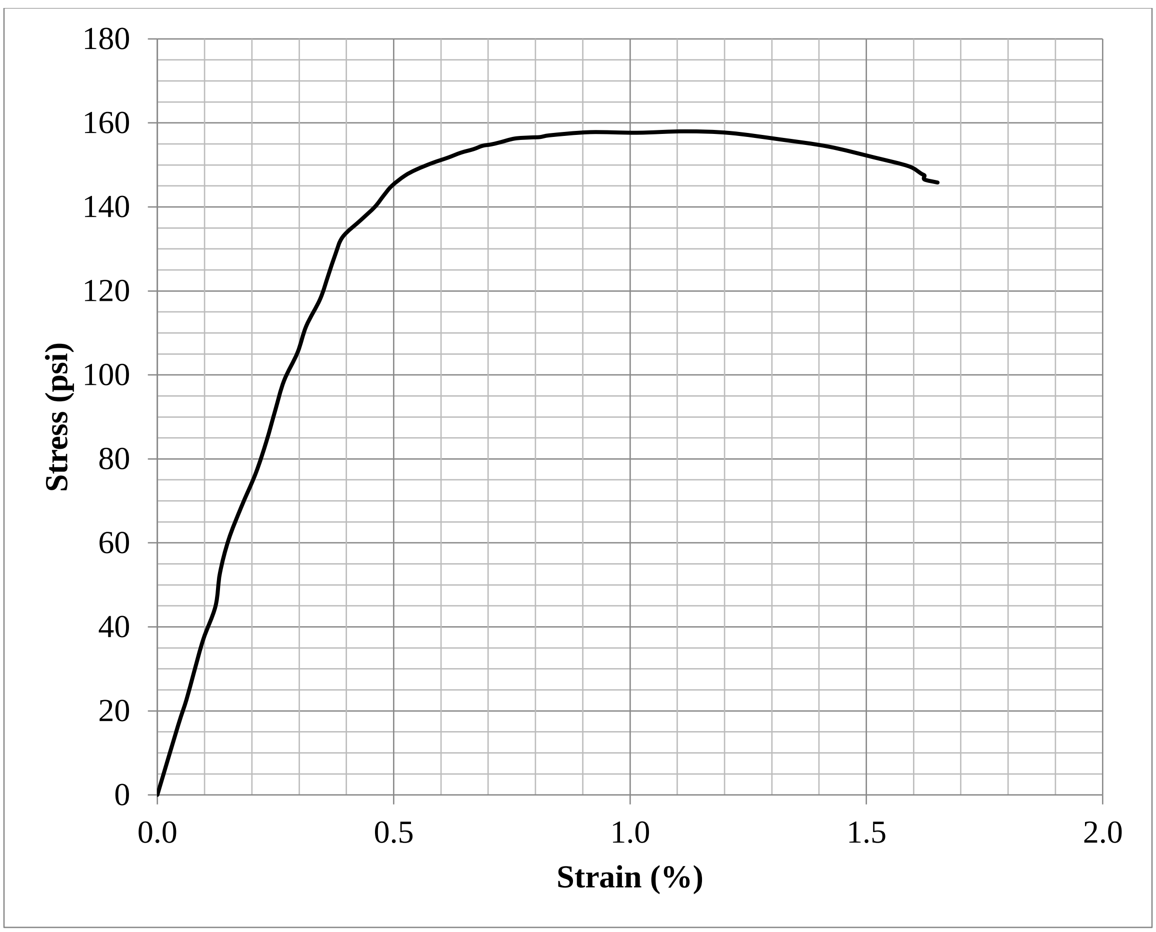
Testing Date	5/21/19
Diameter (in.)	2.038
Height (in.)	3.579
Weight (g)	257.6
Corrected Peak UCS (psi)	140.7
Corrected Failure Strain (%)	1.20
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-4-H
Molding Date	4/21/19
Curing Period (d)	30
α_{I-P} (kg/m^3)	400 (413.3)
w:b	0.8
Soil OM (%)	57.5
Bleed Water (g)	4.6

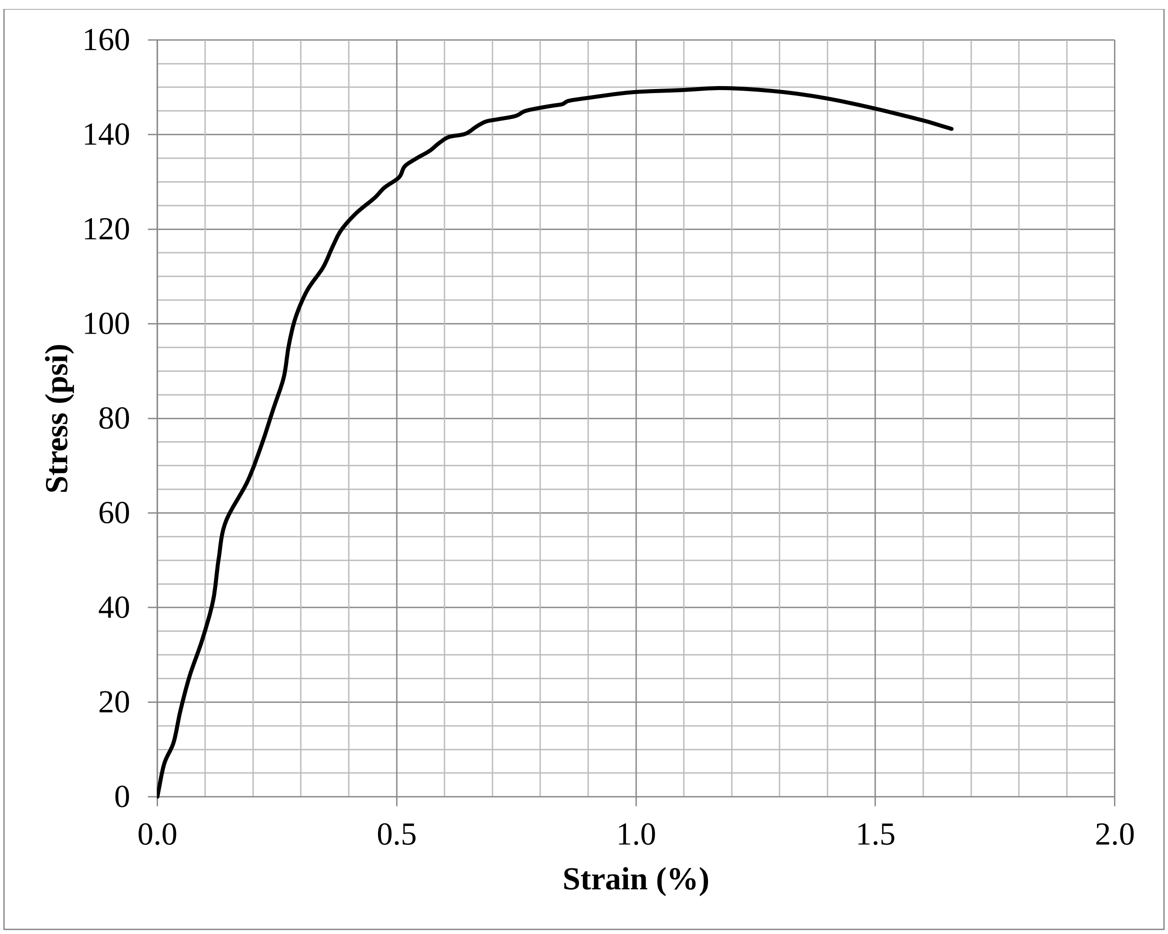
Testing Date	5/21/19
Diameter (in.)	2.043
Height (in.)	3.576
Weight (g)	259.3
Corrected Peak UCS (psi)	154.8
Corrected Failure Strain (%)	1.12
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-5-A
Molding Date	4/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	450 (459.9)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.9

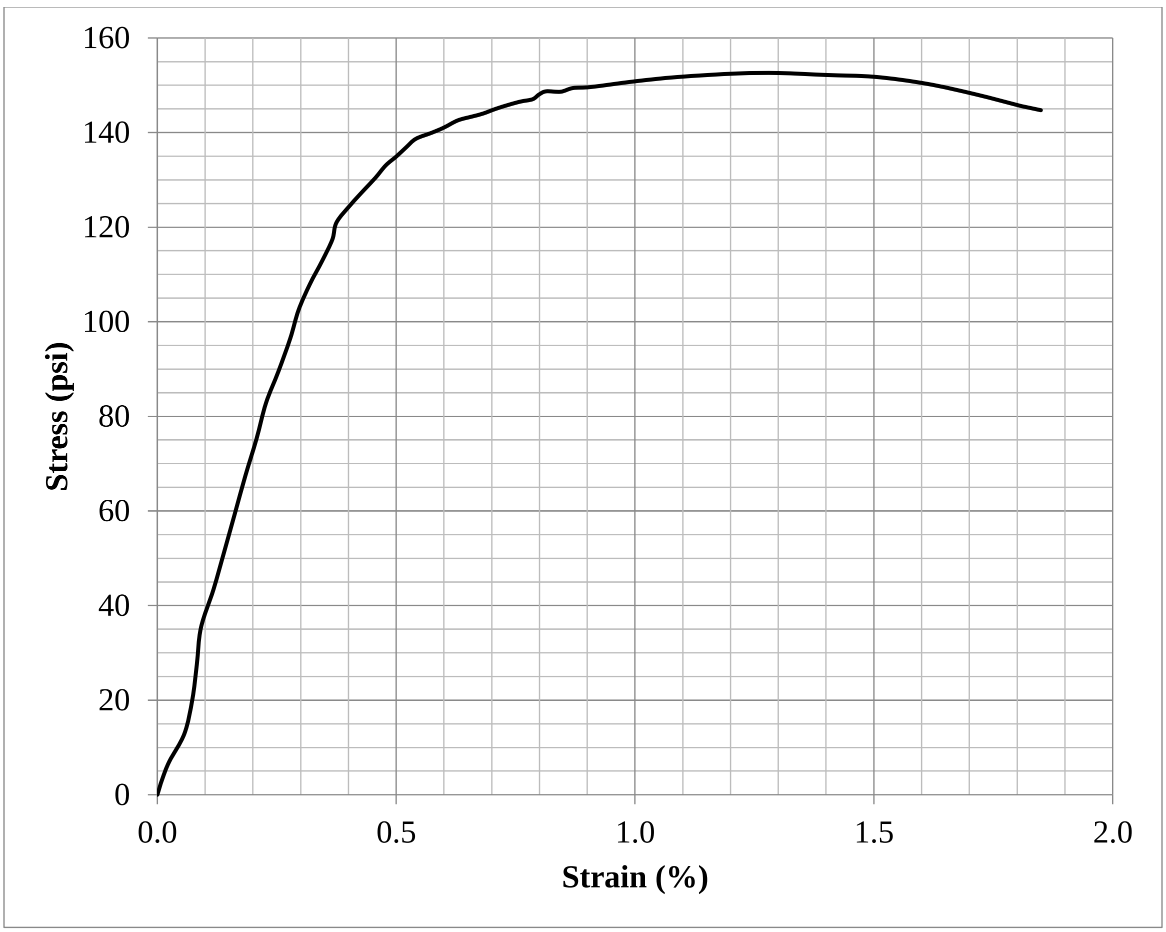
Testing Date	4/28/19
Diameter (in.)	2.049
Height (in.)	3.737
Weight (g)	269.0
Corrected Peak UCS (psi)	147.7
Corrected Failure Strain (%)	1.19
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-5-B
Molding Date	4/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	450 (459.9)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.2

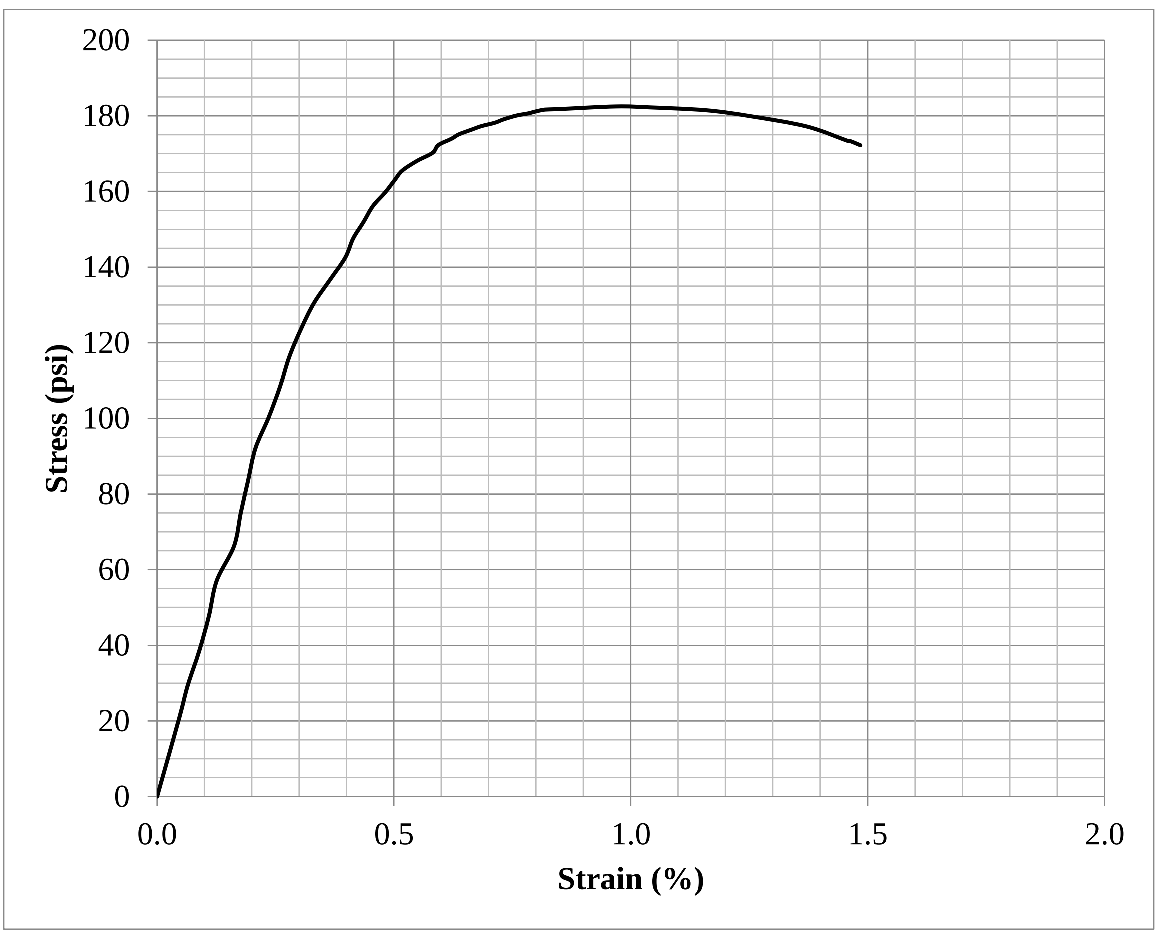
Testing Date	4/29/19
Diameter (in.)	2.044
Height (in.)	3.427
Weight (g)	246.6
Corrected Peak UCS (psi)	148.6
Corrected Failure Strain (%)	1.30
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-5-C
Molding Date	4/22/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	450 (459.9)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.4

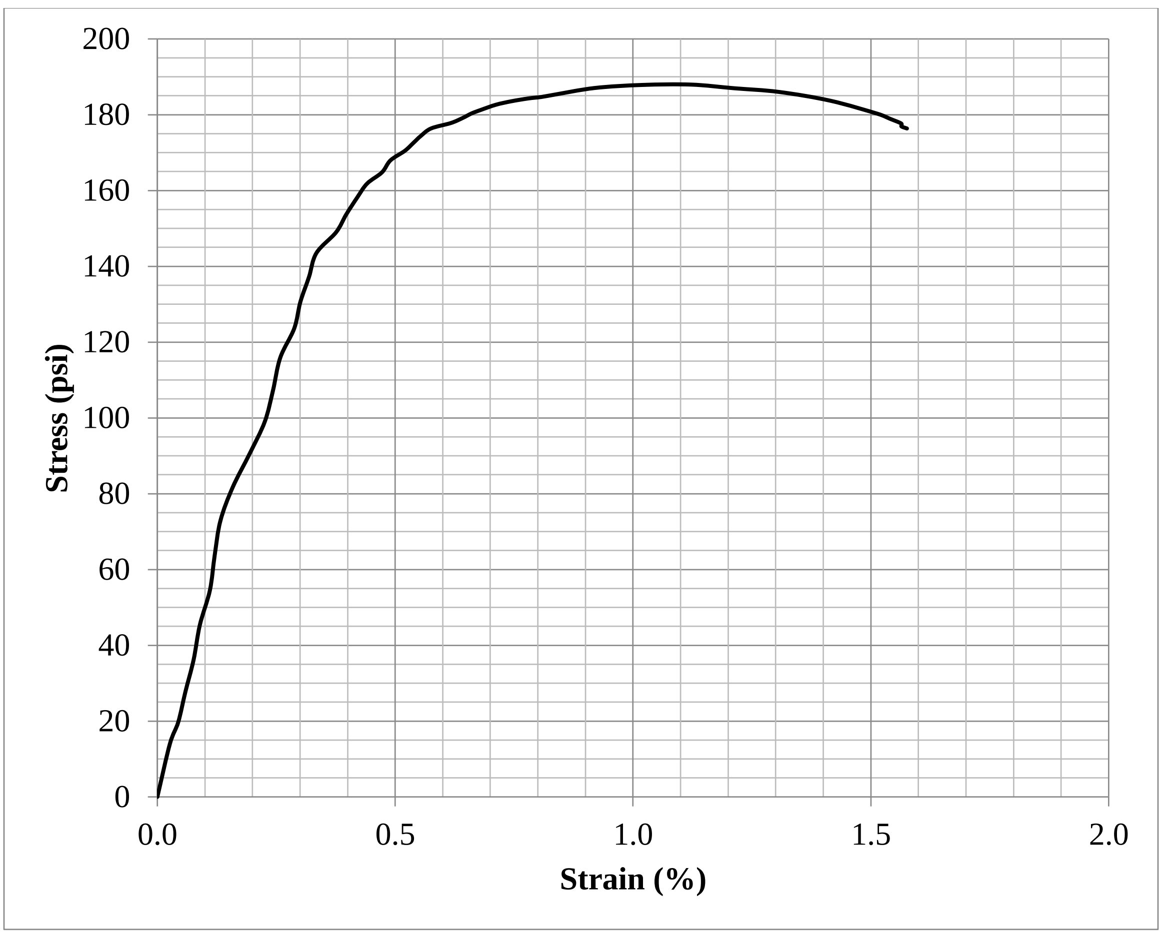
Testing Date	5/6/19
Diameter (in.)	2.045
Height (in.)	3.492
Weight (g)	252.8
Corrected Peak UCS (psi)	178.2
Corrected Failure Strain (%)	0.97
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-5-D
Molding Date	4/22/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	450 (459.9)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.1

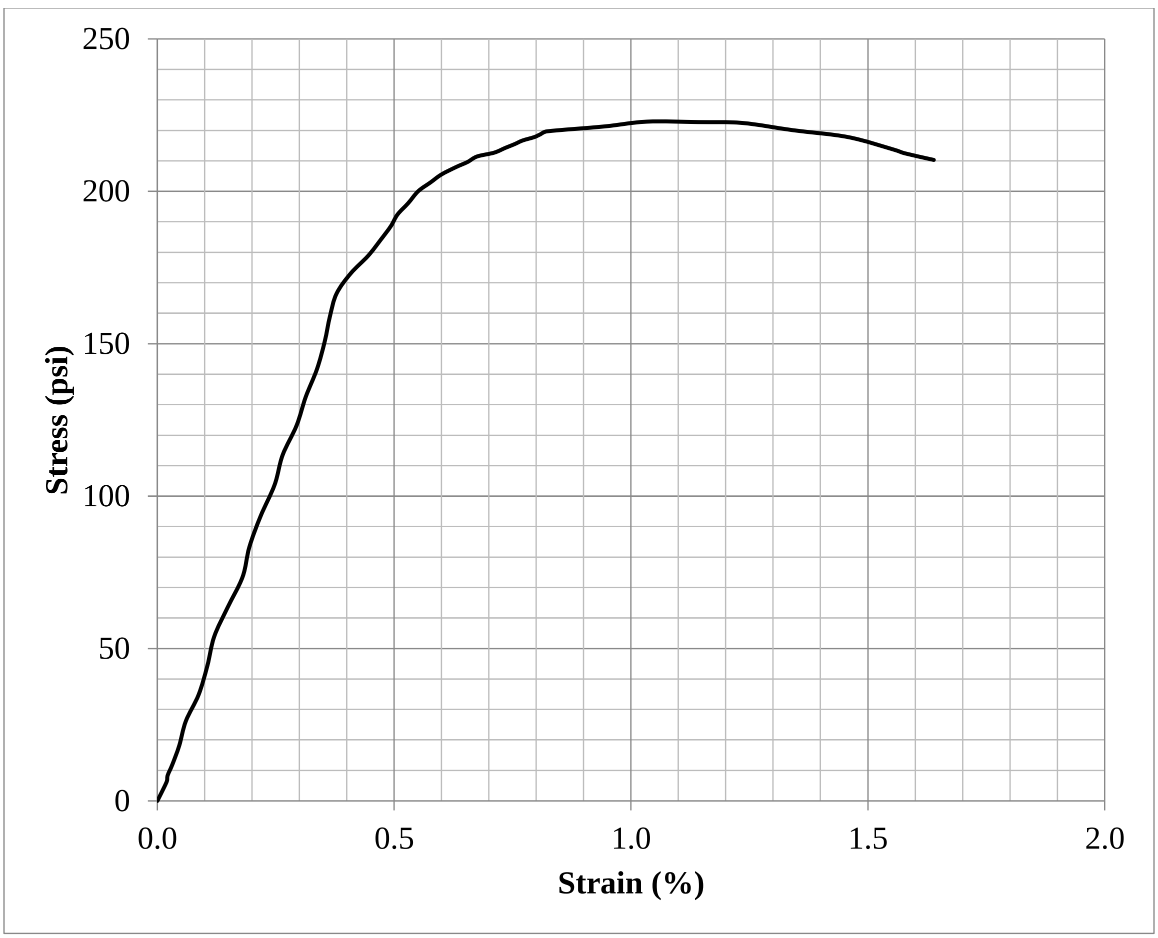
Testing Date	5/6/19
Diameter (in.)	2.045
Height (in.)	3.588
Weight (g)	259.2
Corrected Peak UCS (psi)	184.3
Corrected Failure Strain (%)	1.12
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-5-E
Molding Date	4/22/19
Curing Period (d)	30
$\alpha_{I\text{-}P}$ (kg/m^3)	450 (459.9)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.6

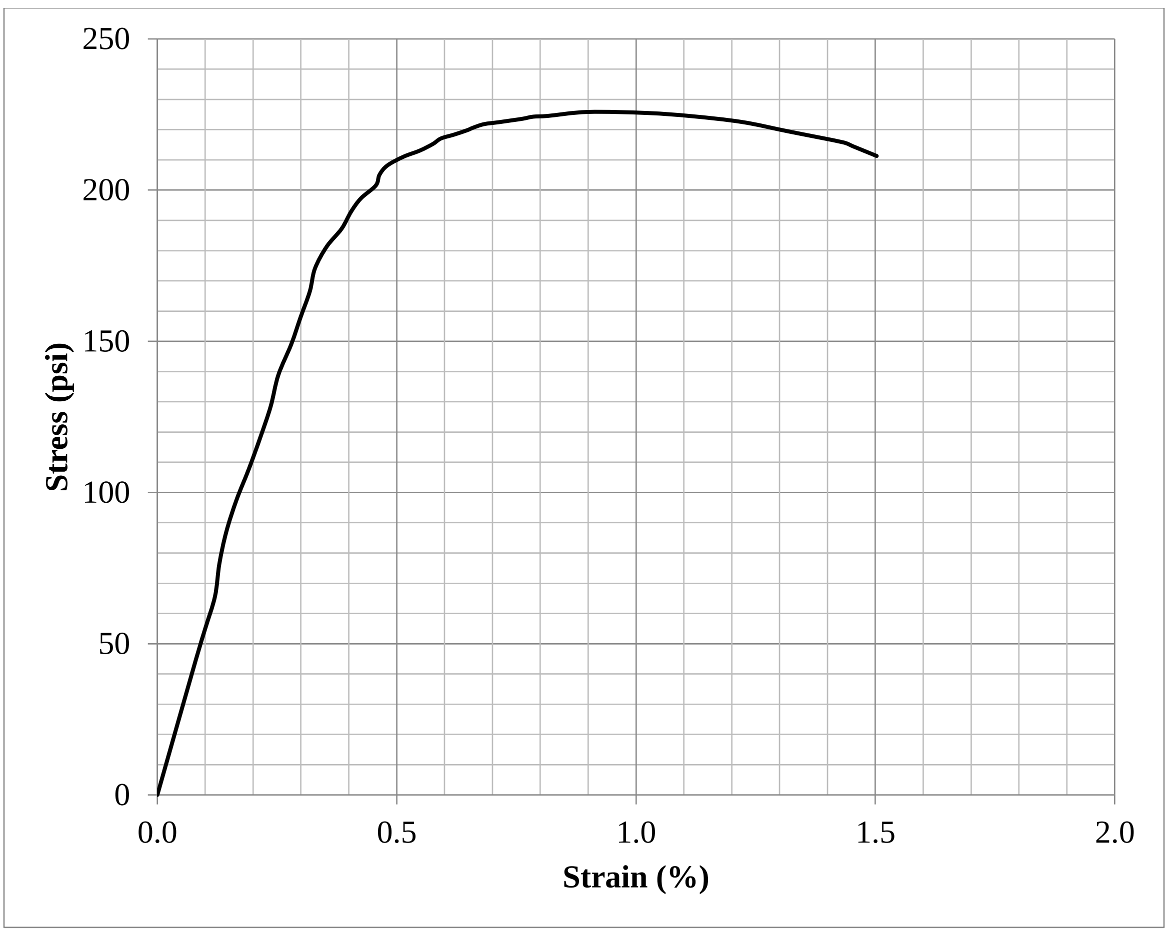
Testing Date	5/22/19
Diameter (in.)	2.044
Height (in.)	3.609
Weight (g)	261.6
Corrected Peak UCS (psi)	218.7
Corrected Failure Strain (%)	1.03
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-5-F
Molding Date	4/22/19
Curing Period (d)	30
$\alpha_{I\text{-}P}$ (kg/m^3)	450 (459.9)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.7

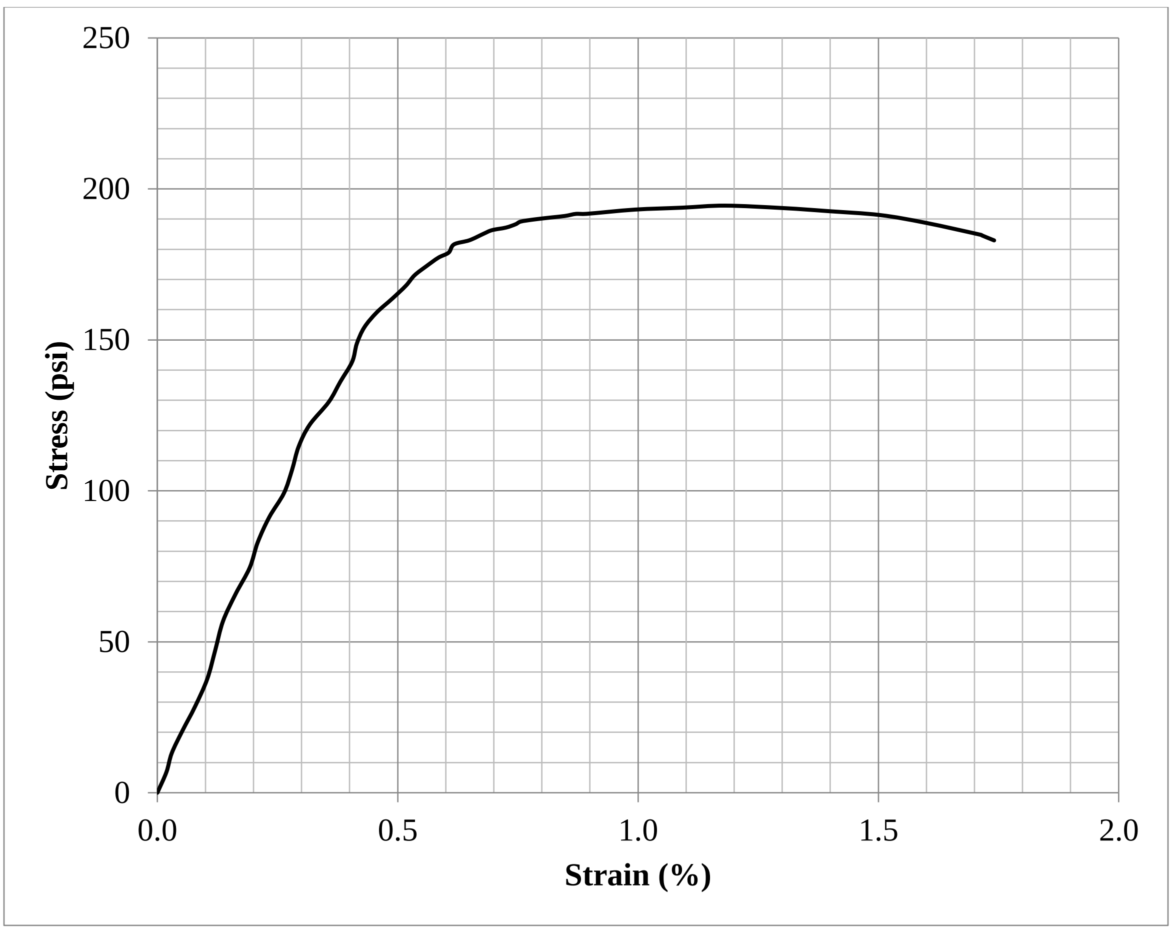
Testing Date	5/22/19
Diameter (in.)	2.046
Height (in.)	3.702
Weight (g)	268.5
Corrected Peak UCS (psi)	222.4
Corrected Failure Strain (%)	0.90
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-6-A
Molding Date	4/22/19
Curing Period (d)	7
$\alpha_{I\text{-}P}$ (kg/m^3)	500 (510.5)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.3

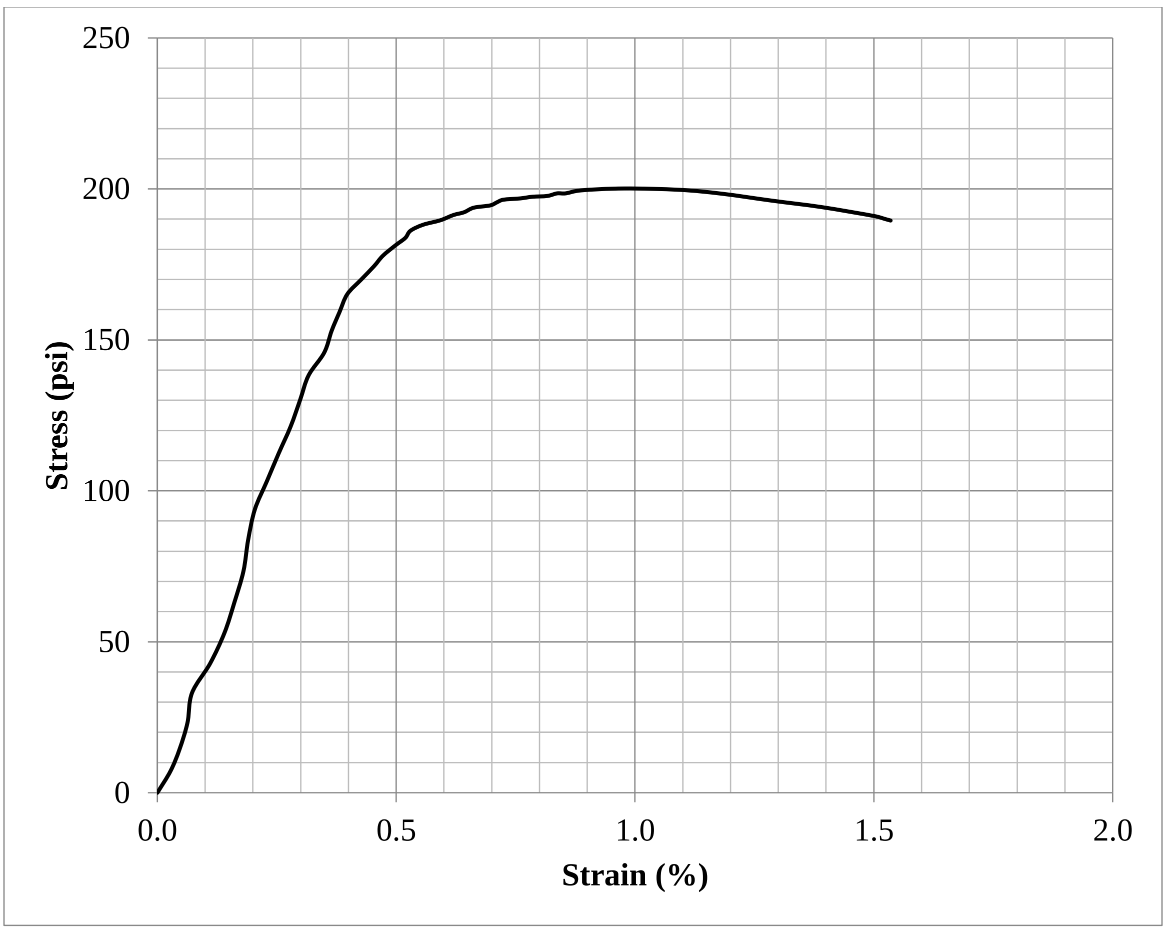
Testing Date	4/29/19
Diameter (in.)	2.049
Height (in.)	3.712
Weight (g)	274.6
Corrected Peak UCS (psi)	191.5
Corrected Failure Strain (%)	1.18
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-6-B
Molding Date	4/22/19
Curing Period (d)	7
α_{I-P} (kg/m^3)	500 (510.5)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.7

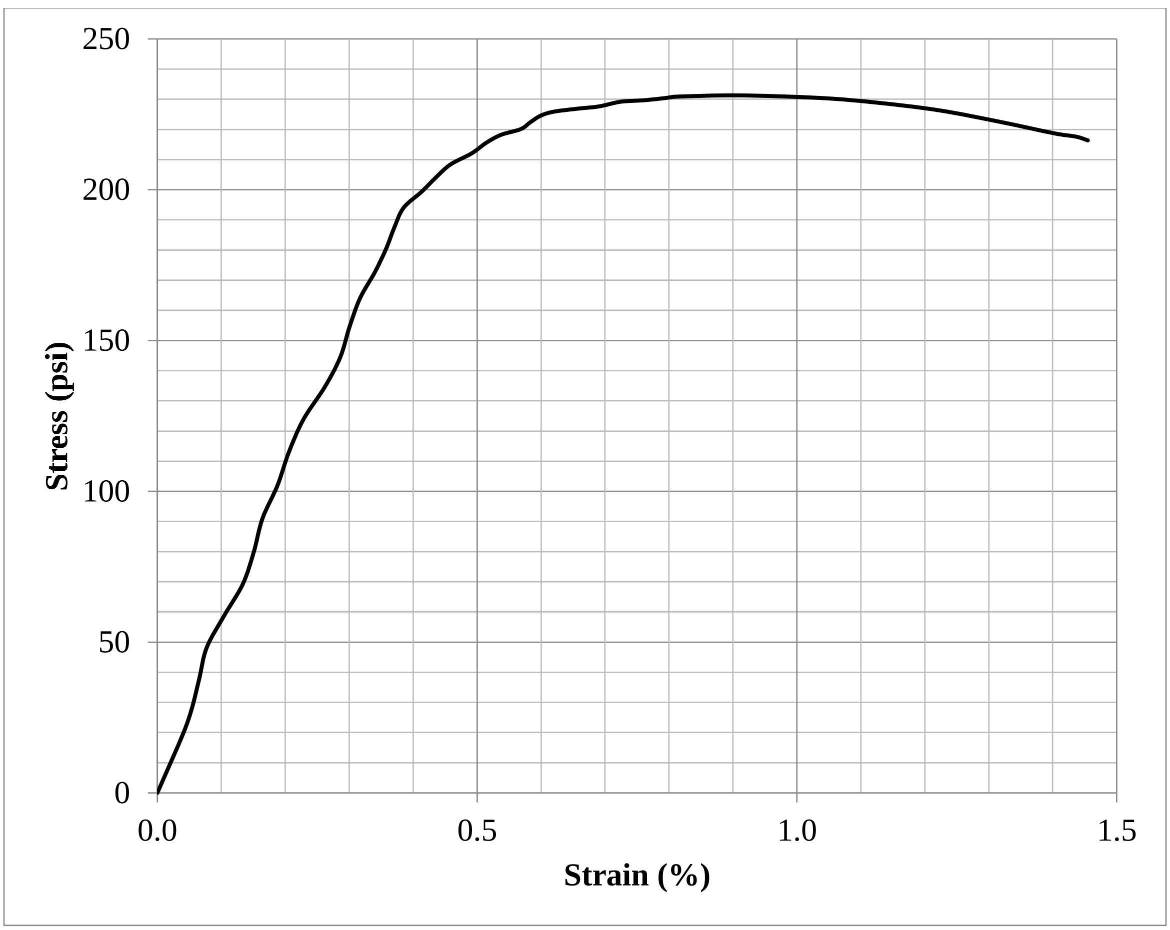
Testing Date	4/29/19
Diameter (in.)	2.047
Height (in.)	3.708
Weight (g)	274.7
Corrected Peak UCS (psi)	197.1
Corrected Failure Strain (%)	0.98
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-6-C
Molding Date	4/22/19
Curing Period (d)	14
$\alpha_{I\text{-}P}$ (kg/m^3)	500 (510.5)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	3.0

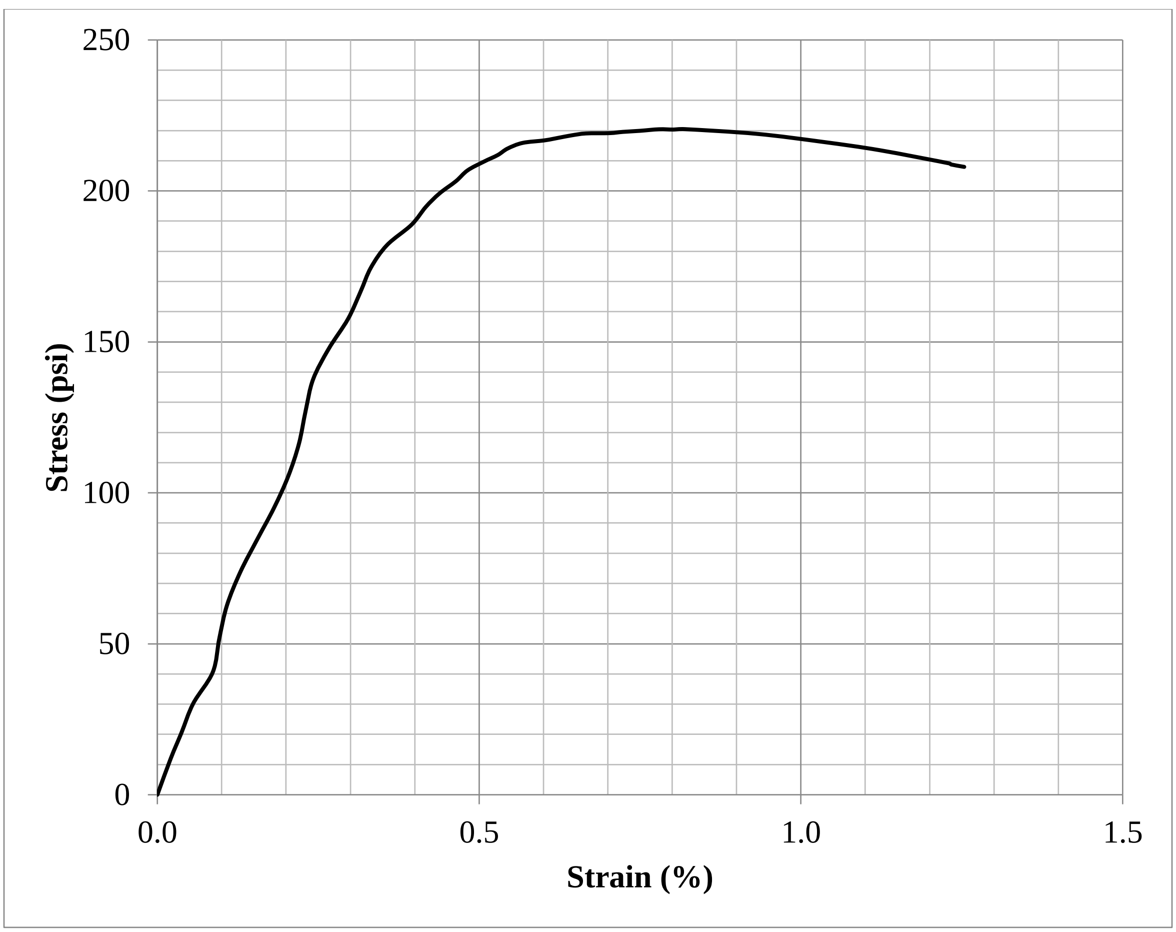
Testing Date	5/6/19
Diameter (in.)	2.047
Height (in.)	3.662
Weight (g)	272.2
Corrected Peak UCS (psi)	227.4
Corrected Failure Strain (%)	0.91
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-6-D
Molding Date	4/22/19
Curing Period (d)	14
α_{I-P} (kg/m^3)	500 (510.5)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	3.6

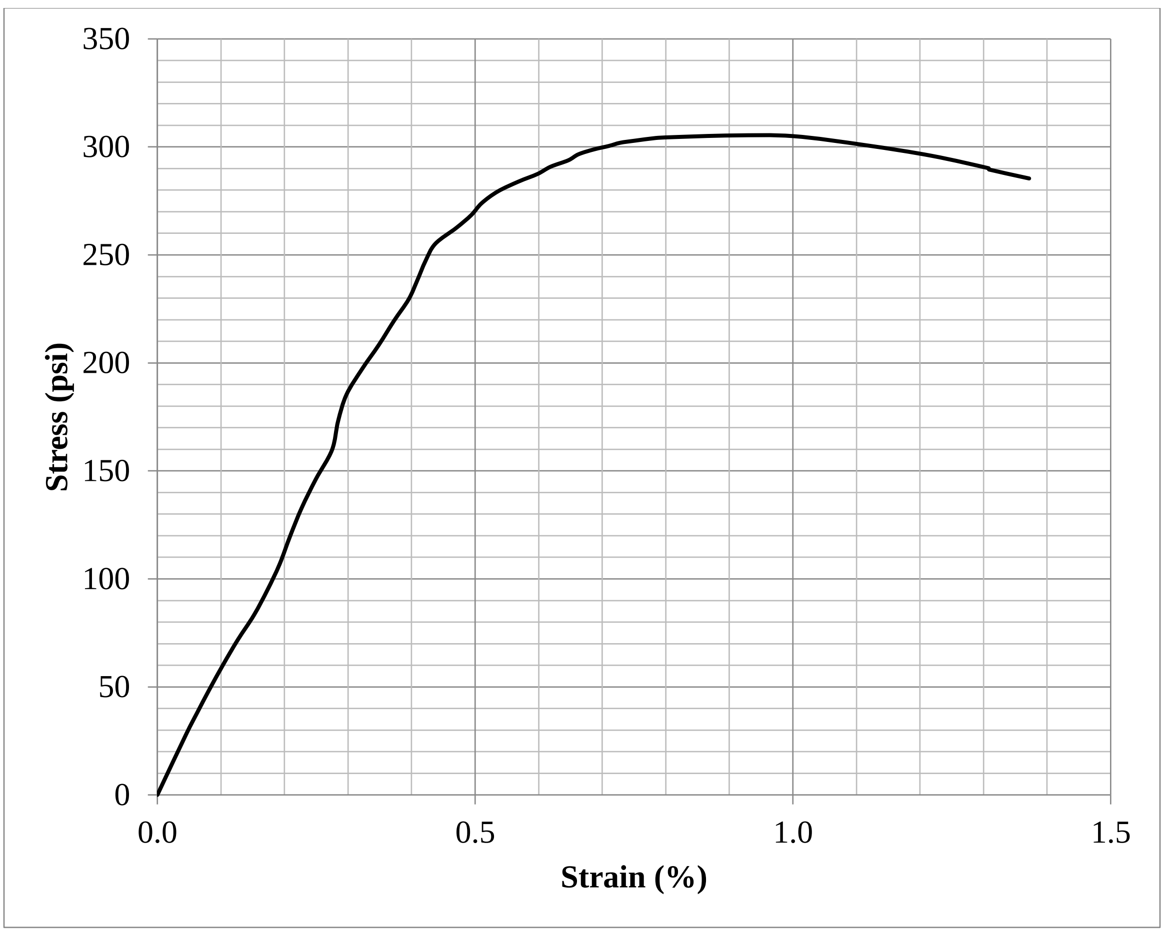
Testing Date	5/6/19
Diameter (in.)	2.051
Height (in.)	3.738
Weight (g)	278.2
Corrected Peak UCS (psi)	217.3
Corrected Failure Strain (%)	0.82
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-6-E
Molding Date	4/22/19
Curing Period (d)	30
α_{I-P} (kg/m^3)	500 (510.5)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.7

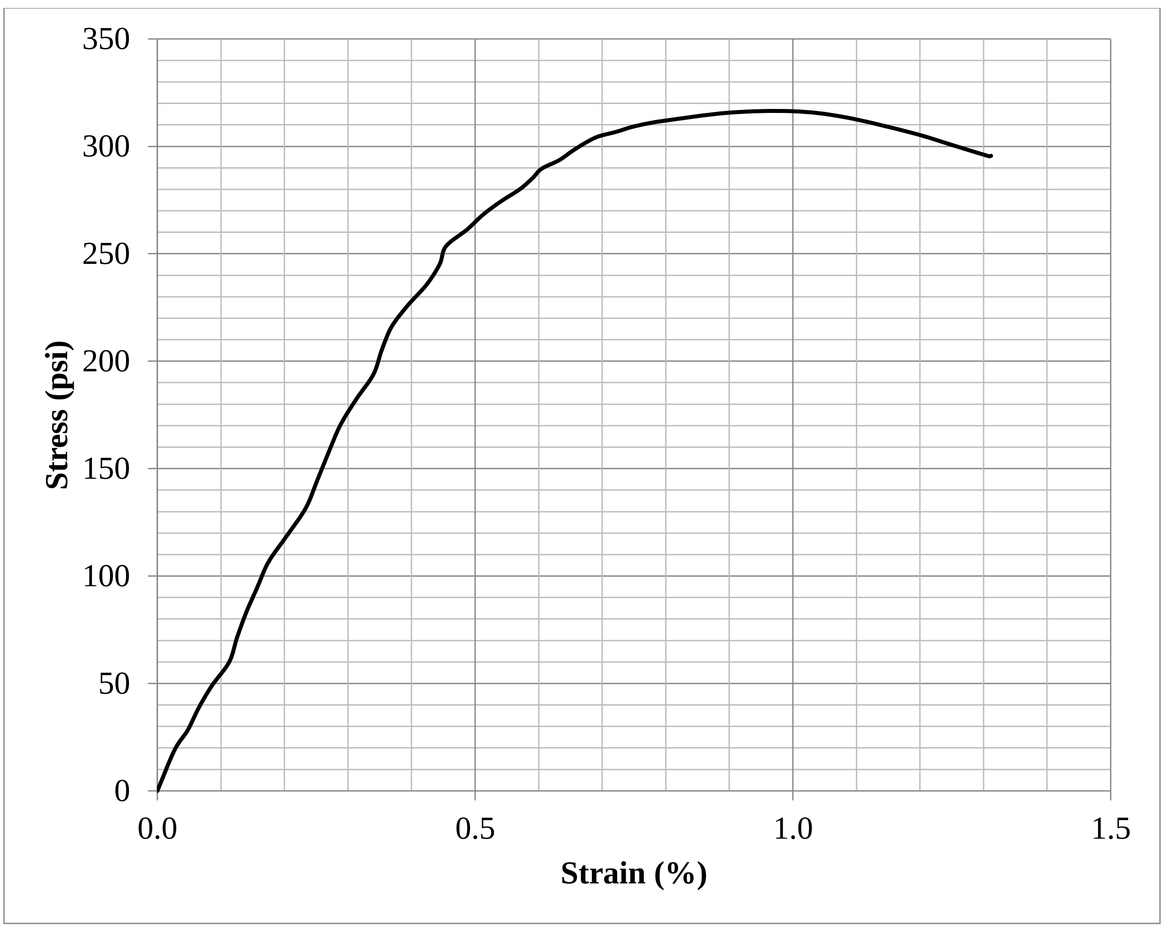
Testing Date	5/22/19
Diameter (in.)	2.049
Height (in.)	3.742
Weight (g)	280.0
Corrected Peak UCS (psi)	301.1
Corrected Failure Strain (%)	0.91
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-6-F
Molding Date	4/22/19
Curing Period (d)	30
α_{I-P} (kg/m^3)	500 (510.5)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.9

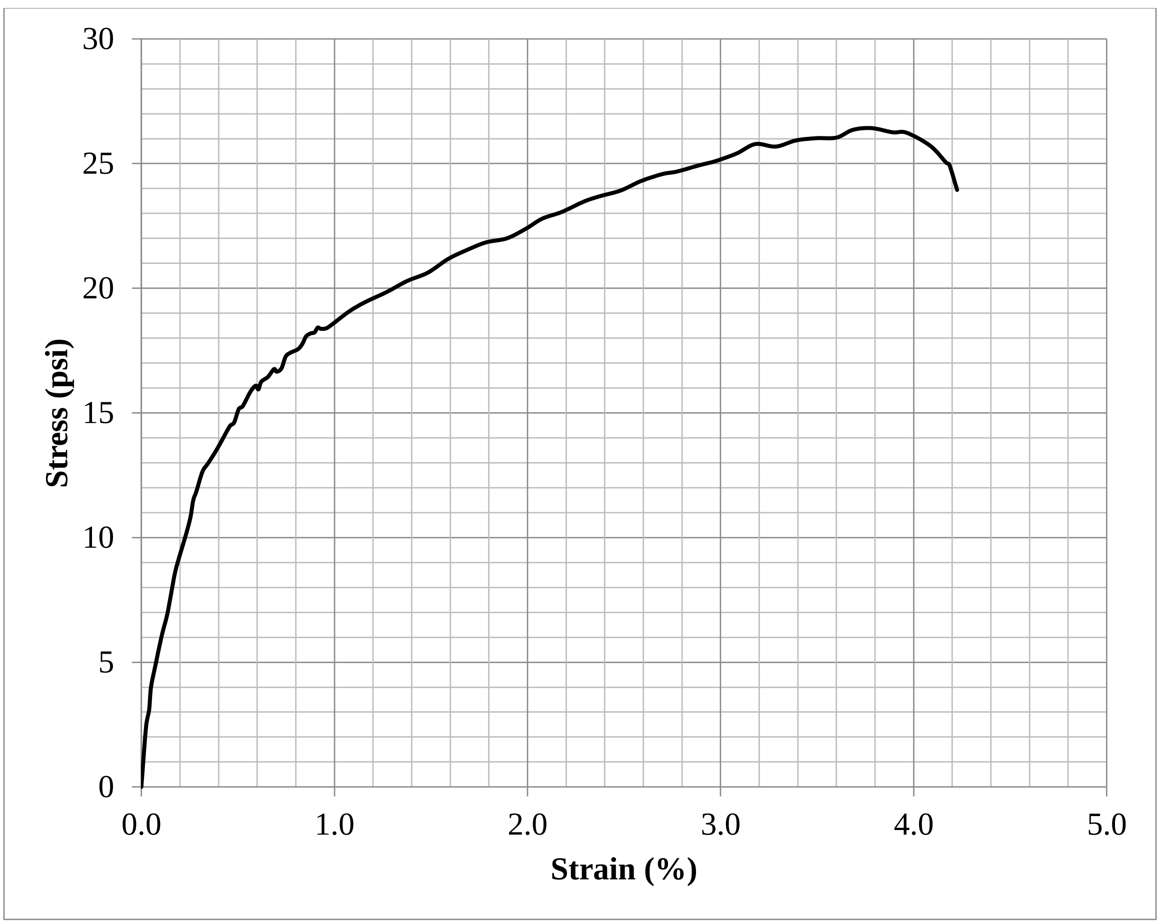
Testing Date	5/22/19
Diameter (in.)	2.047
Height (in.)	3.643
Weight (g)	273.9
Corrected Peak UCS (psi)	310.8
Corrected Failure Strain (%)	1.00
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-7-A
Molding Date	5/20/19
Curing Period (d)	9
α_{I-P} (kg/m^3)	200 (206.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	1.6

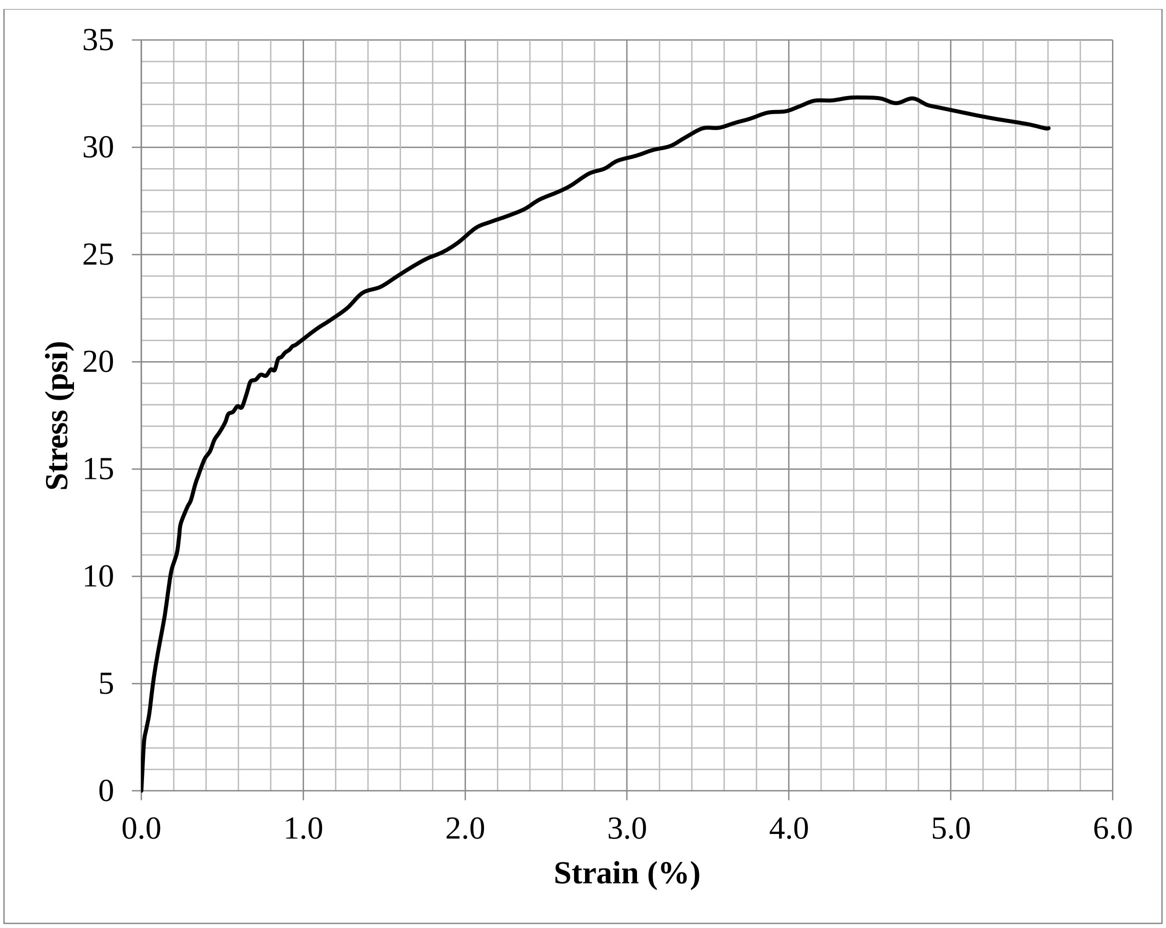
Testing Date	5/28/19
Diameter (in.)	2.036
Height (in.)	3.676
Weight (g)	234.3
Corrected Peak UCS (psi)	26.0
Corrected Failure Strain (%)	3.78
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-7-B
Molding Date	5/20/19
Curing Period (d)	9
α_{I-P} (kg/m^3)	200 (206.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	1.9

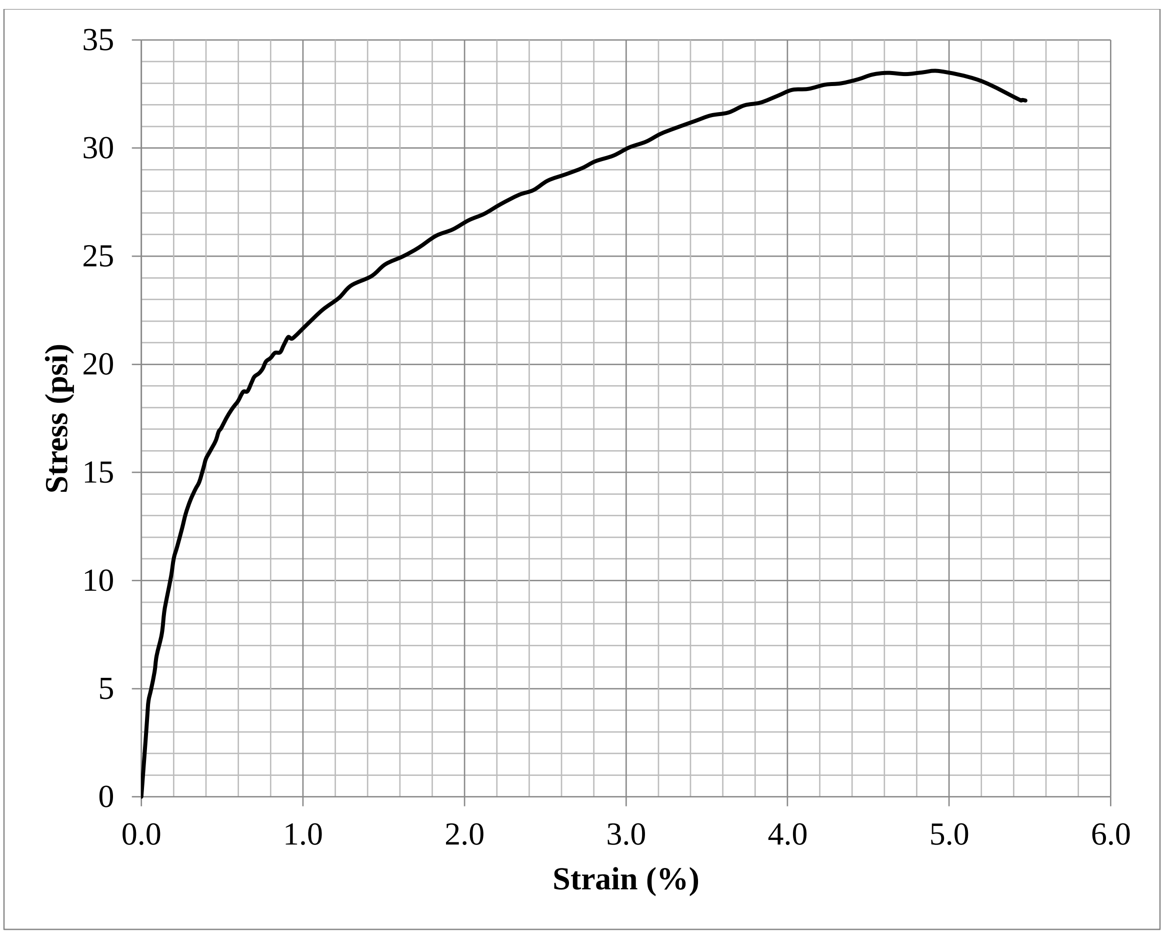
Testing Date	5/28/19
Diameter (in.)	2.041
Height (in.)	3.418
Weight (g)	220.7
Corrected Peak UCS (psi)	31.5
Corrected Failure Strain (%)	4.45
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-7-C
Molding Date	5/20/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	200 (206.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	1.7

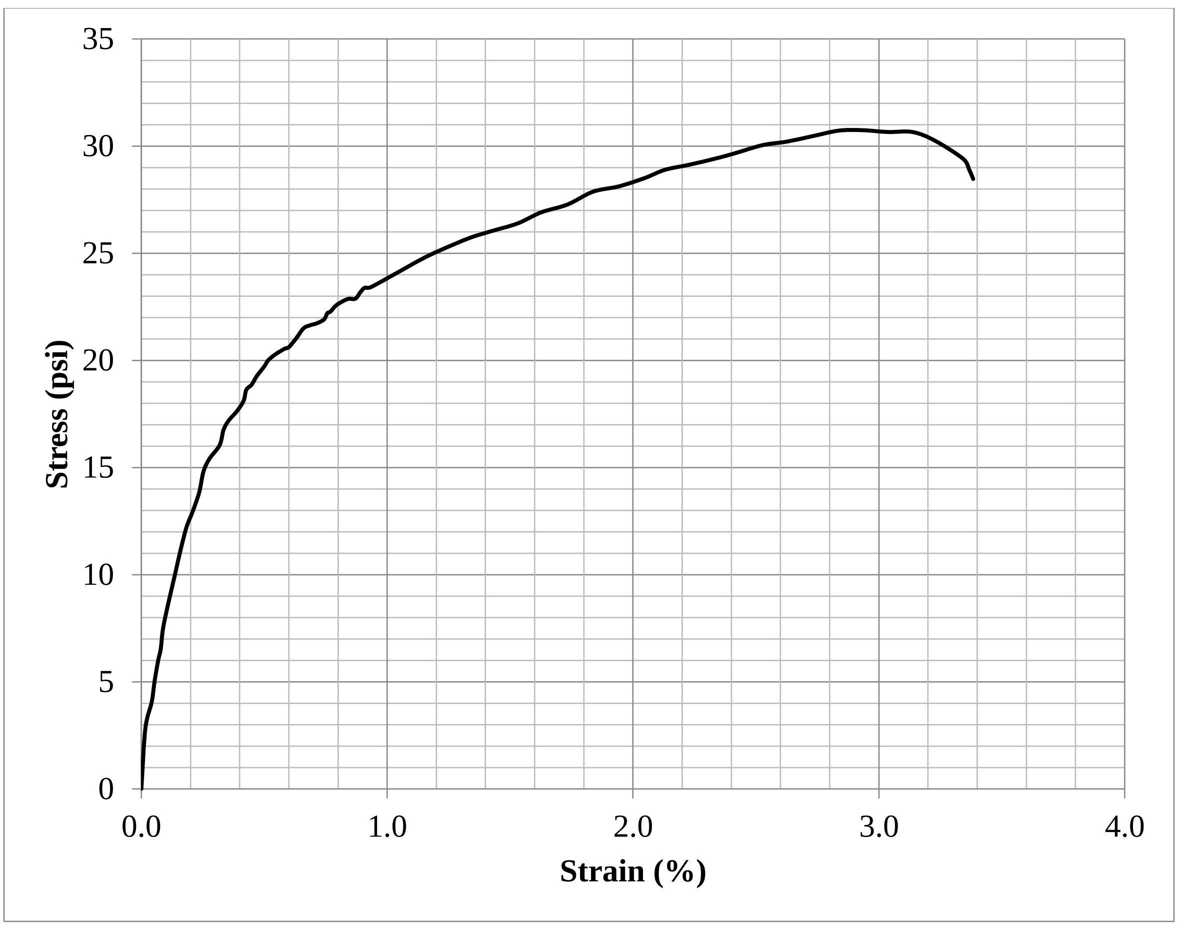
Testing Date	6/3/19
Diameter (in.)	2.027
Height (in.)	3.359
Weight (g)	214.8
Corrected Peak UCS (psi)	32.6
Corrected Failure Strain (%)	4.94
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-7-D
Molding Date	5/20/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	200 (206.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.4

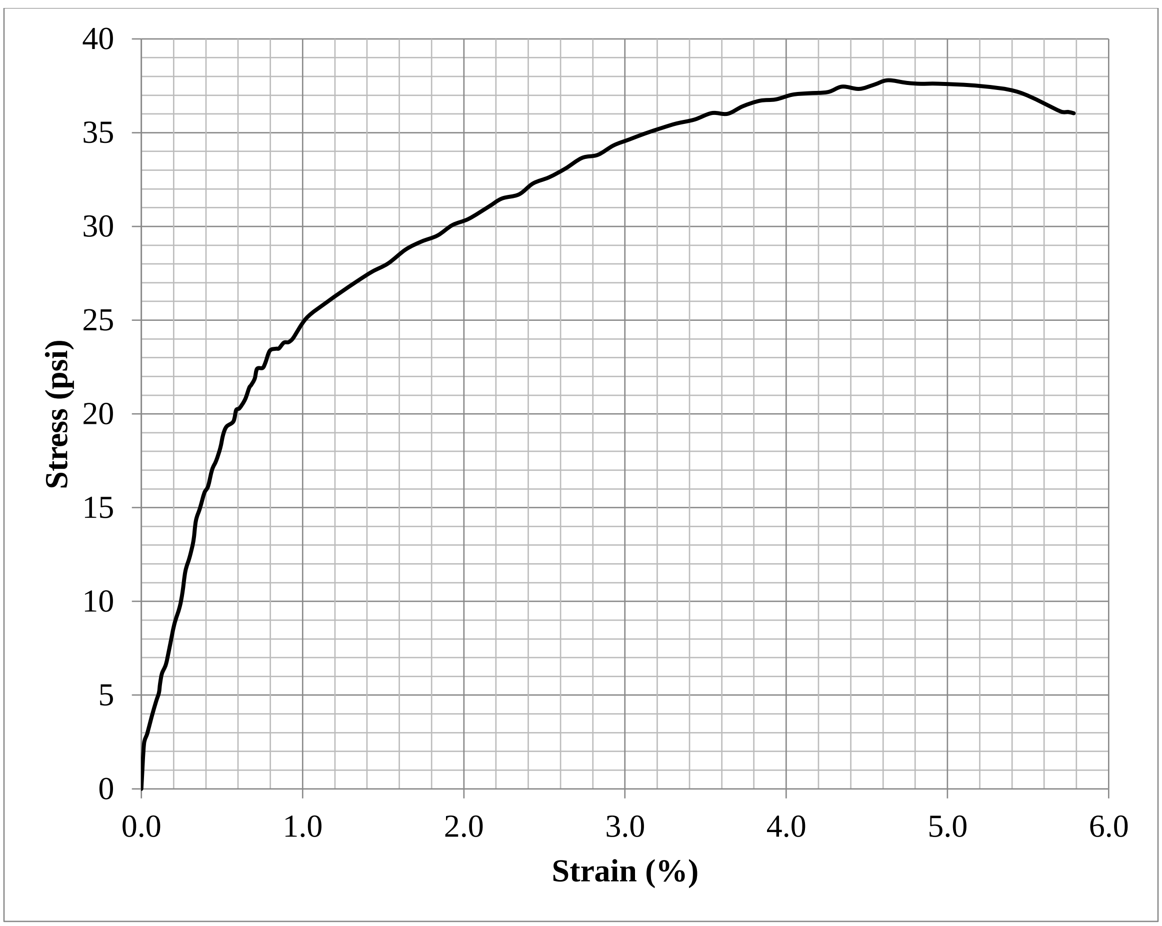
Testing Date	6/3/19
Diameter (in.)	2.027
Height (in.)	3.621
Weight (g)	231.4
Corrected Peak UCS (psi)	30.2
Corrected Failure Strain (%)	2.93
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-7-E
Molding Date	5/20/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	200 (206.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	1.8

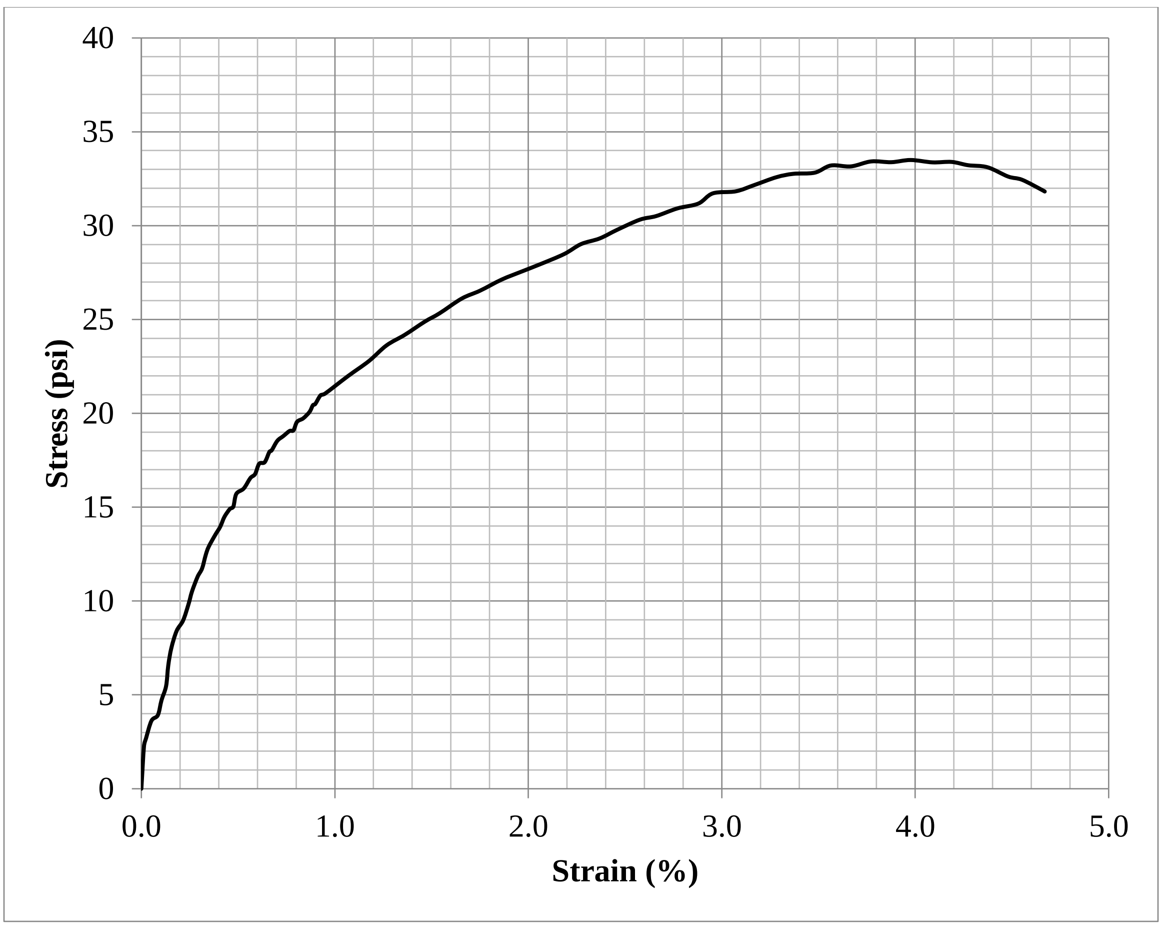
Testing Date	6/17/19
Diameter (in.)	2.029
Height (in.)	3.618
Weight (g)	235.0
Corrected Peak UCS (psi)	37.1
Corrected Failure Strain (%)	4.63
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-7-F
Molding Date	5/20/19
Curing Period (d)	28
$\alpha_{I\text{-}P}$ (kg/m^3)	200 (206.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	1.4

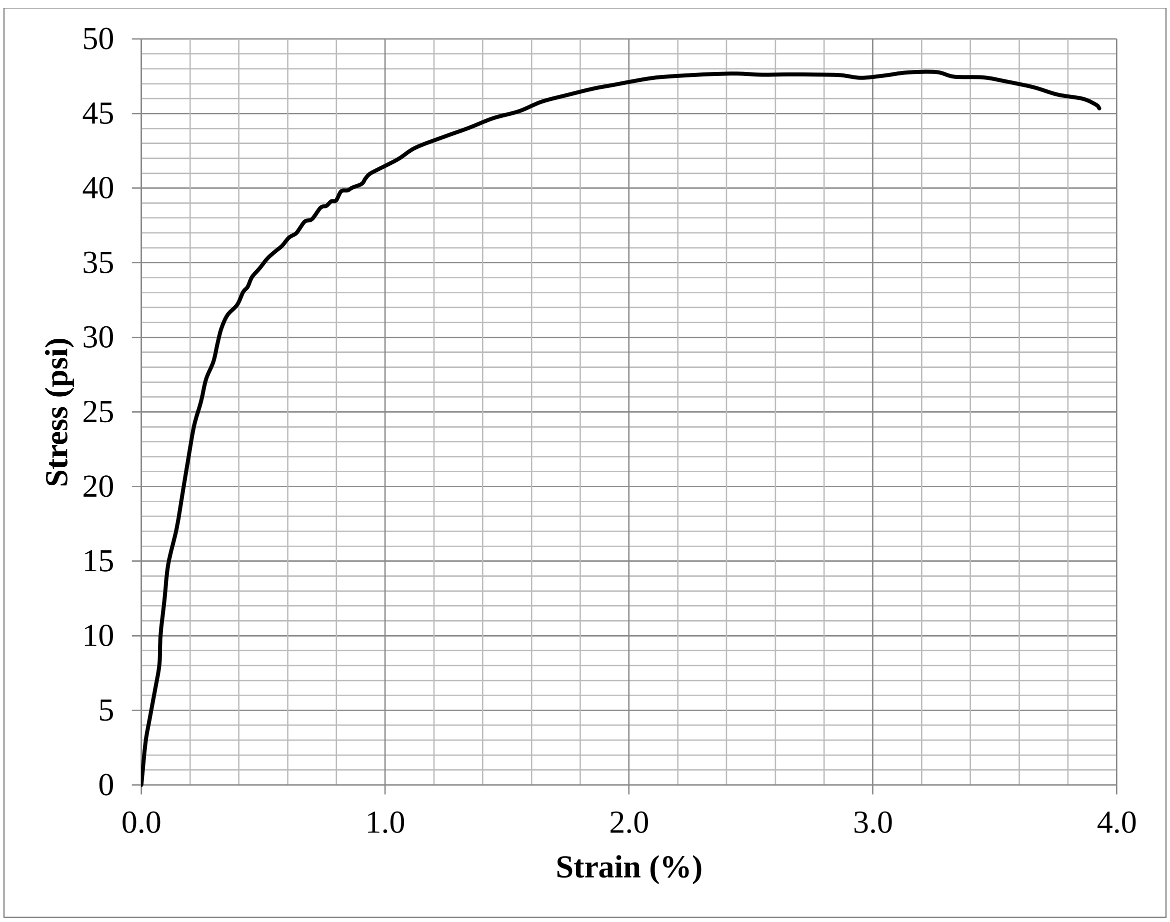
Testing Date	6/17/19
Diameter (in.)	2.023
Height (in.)	3.700
Weight (g)	239.3
Corrected Peak UCS (psi)	33.0
Corrected Failure Strain (%)	3.98
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-8-A
Molding Date	5/20/19
Curing Period (d)	9
$\alpha_{I\text{-}P}$ (kg/m^3)	300 (308.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.5

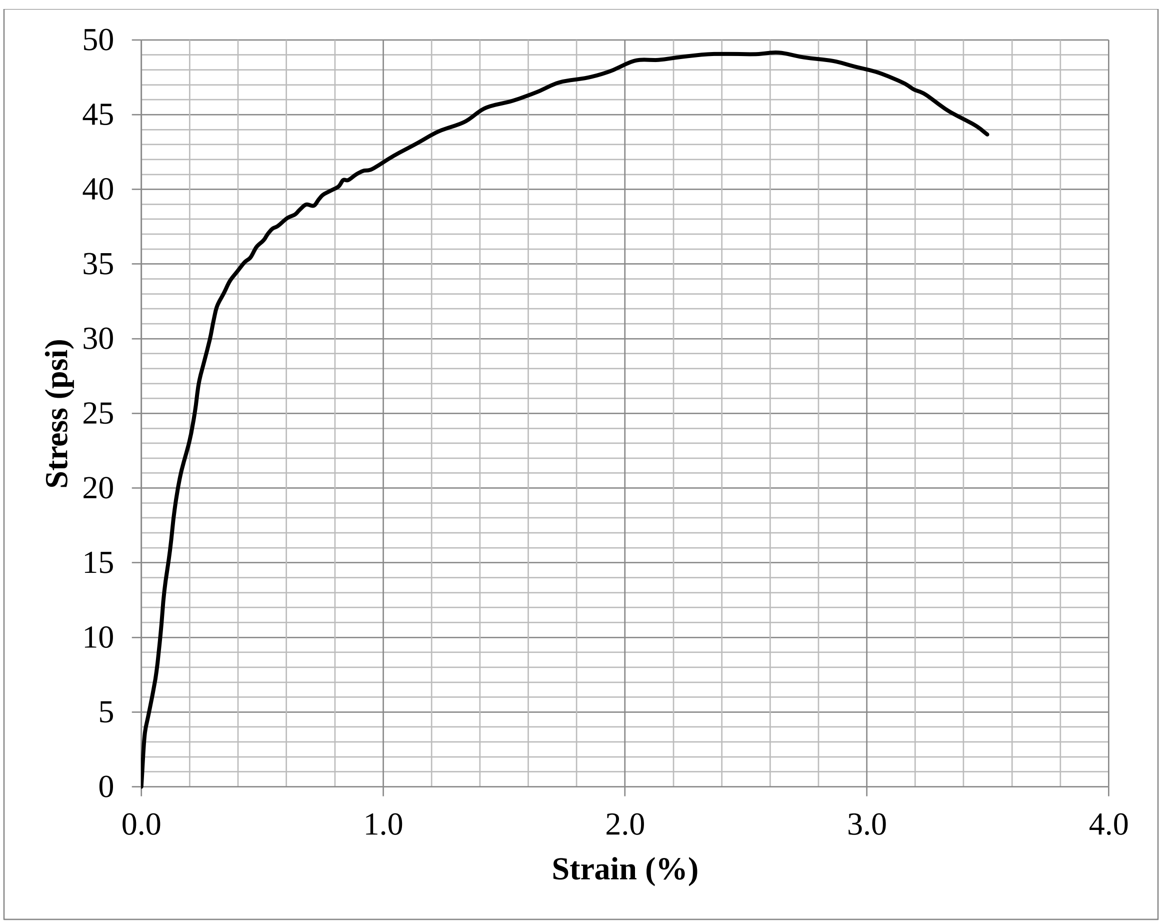
Testing Date	5/28/19
Diameter (in.)	2.040
Height (in.)	3.579
Weight (g)	240.6
Corrected Peak UCS (psi)	46.8
Corrected Failure Strain (%)	3.26
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-8-B
Molding Date	5/20/19
Curing Period (d)	9
α_{I-P} (kg/m^3)	300 (308.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	3.2

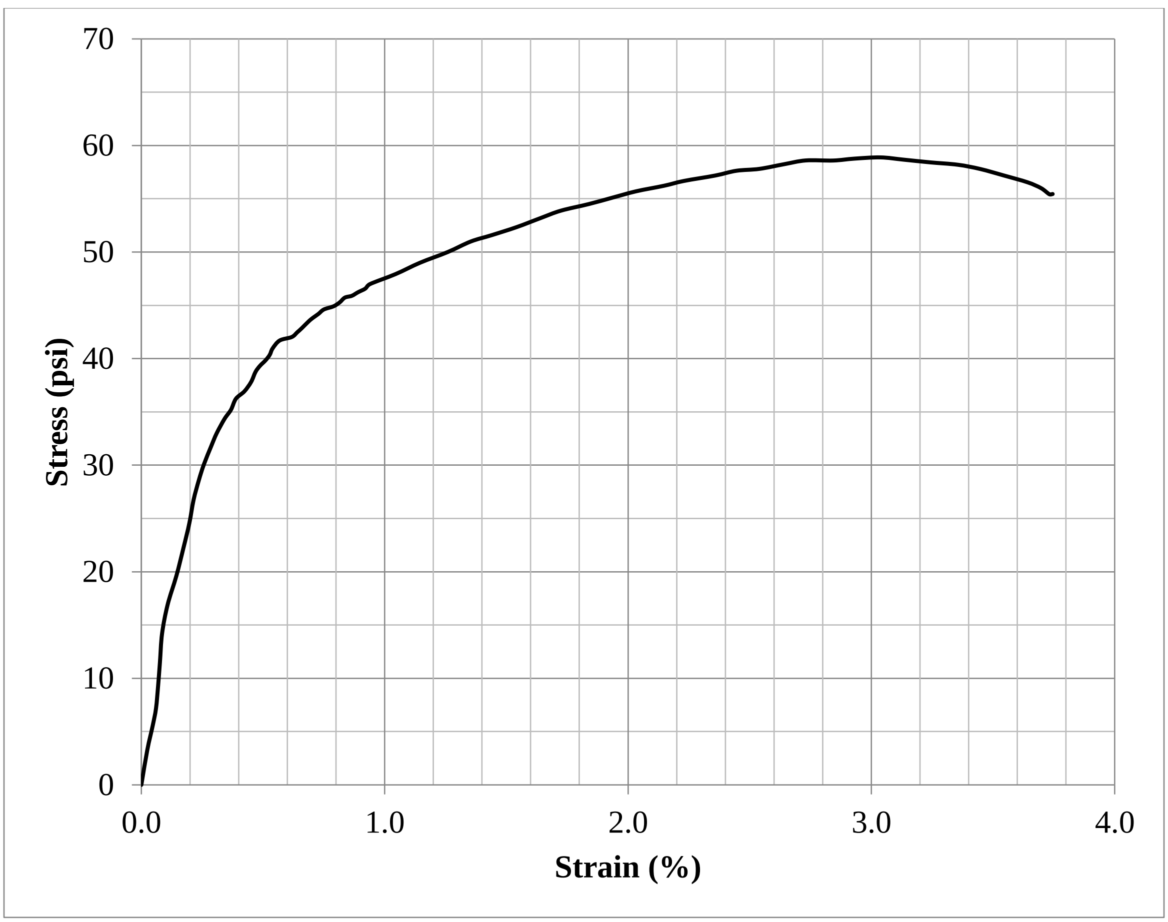
Testing Date	5/28/19
Diameter (in.)	2.035
Height (in.)	3.657
Weight (g)	246.5
Corrected Peak UCS (psi)	48.4
Corrected Failure Strain (%)	2.64
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-8-C
Molding Date	5/20/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	300 (308.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.6

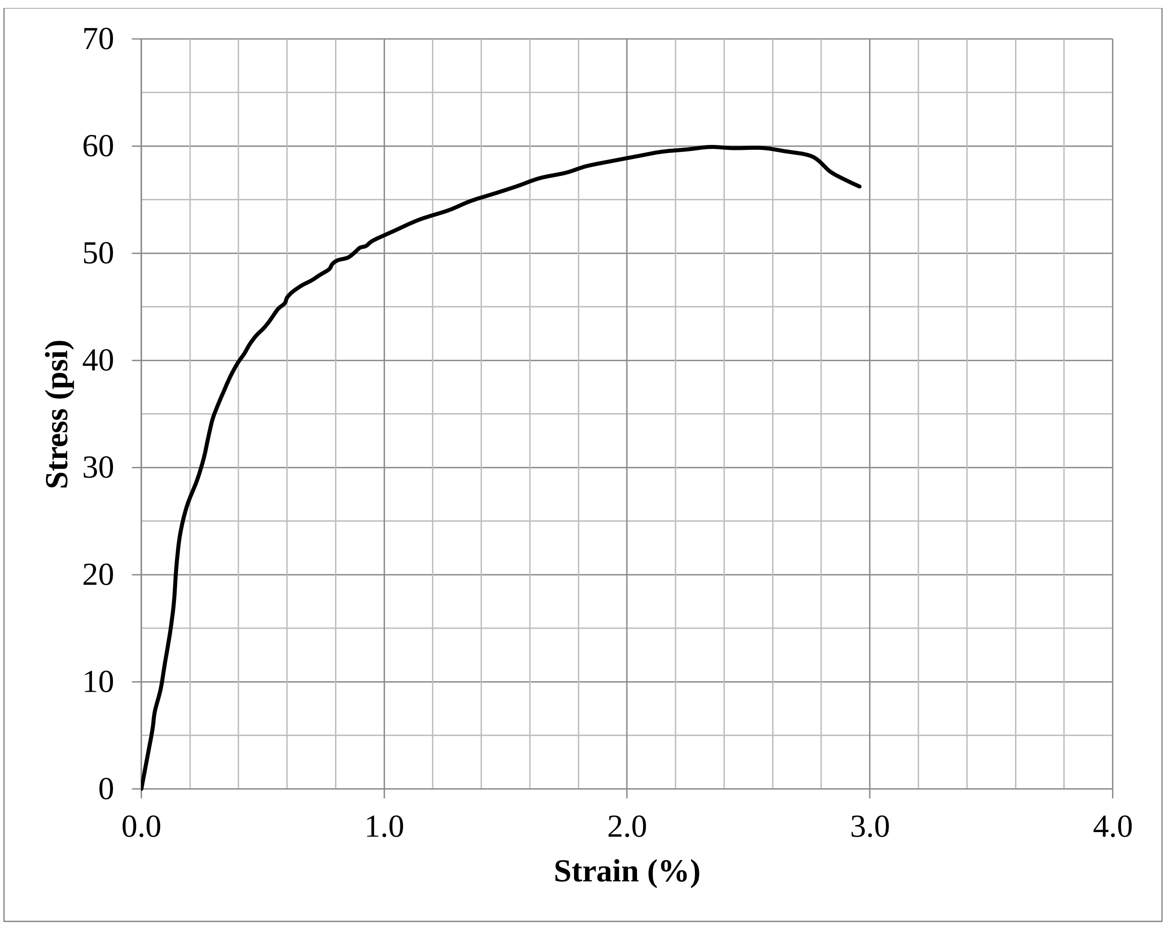
Testing Date	6/3/19
Diameter (in.)	2.038
Height (in.)	3.598
Weight (g)	241.6
Corrected Peak UCS (psi)	57.8
Corrected Failure Strain (%)	3.04
ASTM C39 Fracture Type	N/A



Data Sheet: Specimen UCS Test

Specimen ID	50-8-D
Molding Date	5/20/19
Curing Period (d)	15
α_{I-P} (kg/m^3)	300 (308.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.4

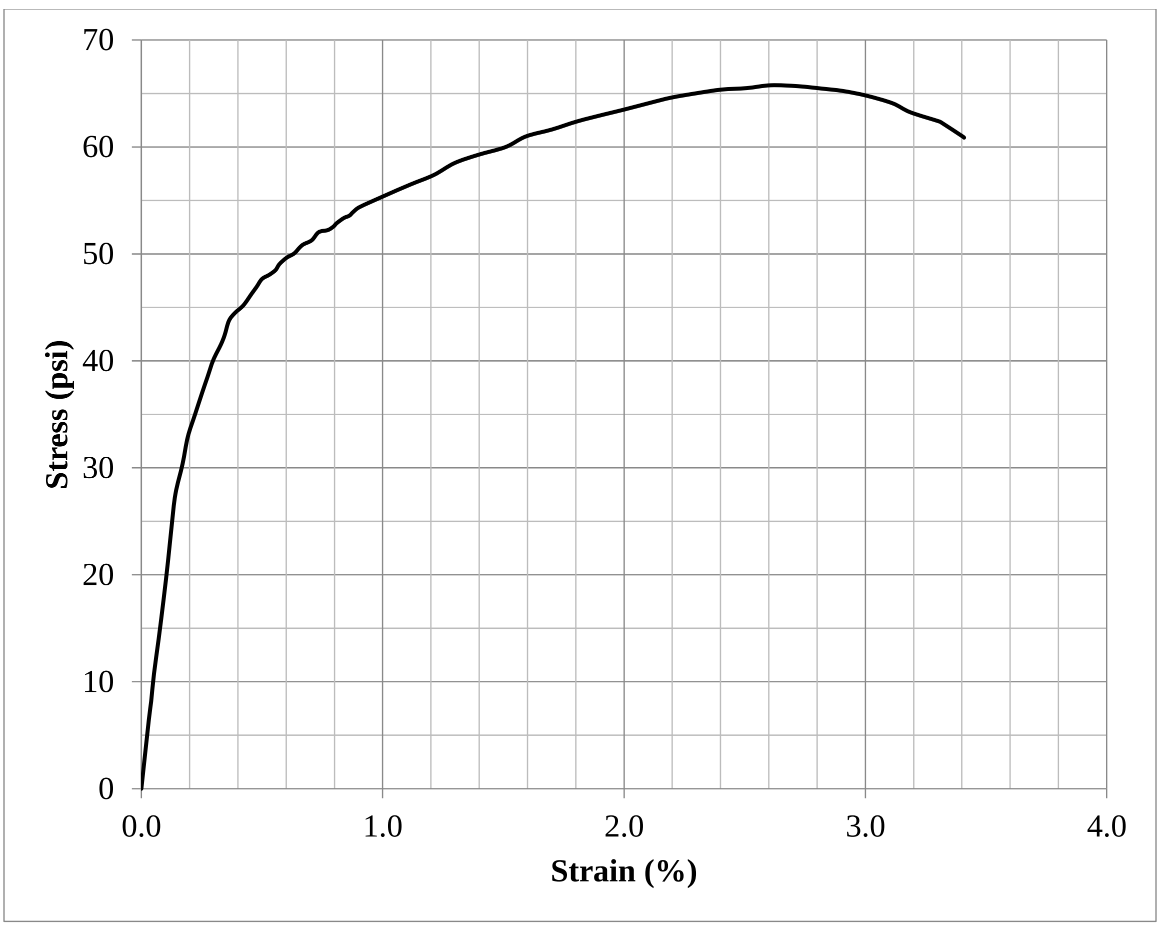
Testing Date	6/3/19
Diameter (in.)	2.036
Height (in.)	3.598
Weight (g)	240.9
Corrected Peak UCS (psi)	58.8
Corrected Failure Strain (%)	2.34
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-8-E
Molding Date	5/20/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	300 (308.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.4

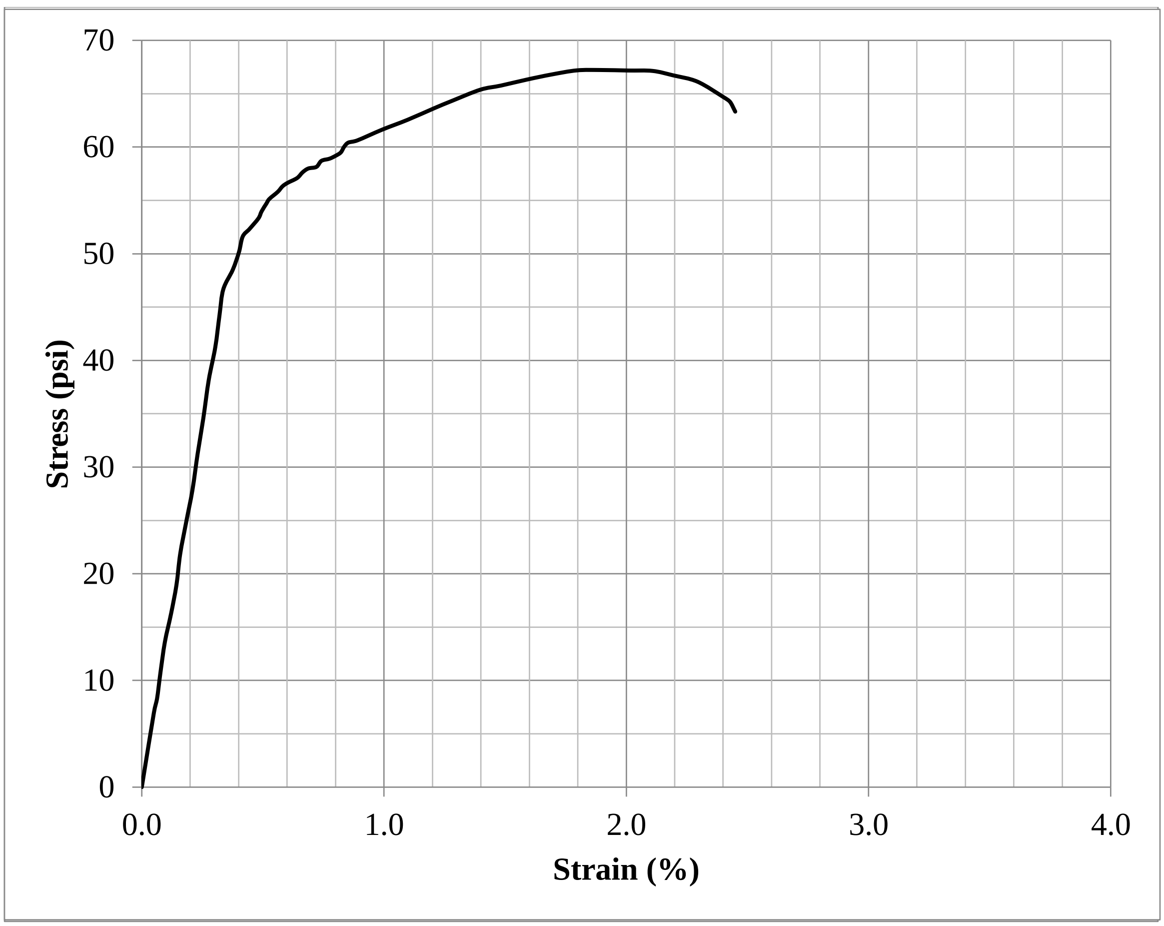
Testing Date	6/17/19
Diameter (in.)	2.039
Height (in.)	3.650
Weight (g)	246.9
Corrected Peak UCS (psi)	64.7
Corrected Failure Strain (%)	2.61
ASTM C39 Fracture Type	4



Data Sheet: Specimen UCS Test

Specimen ID	50-8-F
Molding Date	5/20/19
Curing Period (d)	28
α_{I-P} (kg/m^3)	300 (308.3)
w:b	0.6
Soil OM (%)	57.5
Bleed Water (g)	2.5

Testing Date	6/17/19
Diameter (in.)	2.037
Height (in.)	3.627
Weight (g)	245.4
Corrected Peak UCS (psi)	66.0
Corrected Failure Strain (%)	1.90
ASTM C39 Fracture Type	4



Appendix M. Results of Equation Fittings for All Inorganic Specimens and for All Specimens

This appendix discusses the results of fittings of Equations 11a and 11b to the data set which includes only inorganic soil-binder mixture specimens. The results of fittings of Equations 11a and 11b, as well as Equations 12a through 12c, to the entire set of data from this research are also presented and discussed. Table M1 summarizes the coefficients from these fittings. The fitting coefficients determined by Ju (2018) are also included for reference.

Table M1. Summary of fitting coefficients and R^2 values for predictive UCS equation for fitting including only inorganic specimens and for fittings including all specimens.

Data Set	a_T Formulation	e_0	e_1	e_2	$e_{3,1}$	$e_{3,2}$	e_4	e_5	e_6	R^2
Inorganics only	No a_T	91.3	0.135	0.260	-1.64	0.000	2.26	N/A	N/A	0.954
All	No a_T	101	0.183	0.245	-1.67	0.000	1.93	N/A	N/A	0.966
	Prop. a_T	101	0.181	0.246	-1.67	0.000	1.94	0.000	N/A	0.966
	Power a_T	103	0.188	0.244	-1.66	0.000	1.71	7.34	4.81	0.974
	Linear a_T	104	0.193	0.242	-1.67	0.000	1.67	0.306	1.93	0.976
Ju (2018)	No a_T	94.1	0.168	0.250	-1.63	0.484	2.12	N/A	N/A	0.964

Table M1 shows that the coefficient values for the fitting to the cement-treated inorganic specimens (Soil 0) tested in this research are similar to those determined by Ju (2018), who used the same inorganic soil as Soil 0. This indicates that the two studies exhibit continuity of results.

The most significant difference between the coefficient values for the current fitting and that of Ju (2018) is for $e_{3,2}$, which reflects the influence of curing temperature on UCS. The value of $e_{3,2}$ determined from this research is zero for Soil 0, while Ju (2018) found this value to be 0.484 for the same soil. The zero value of $e_{3,2}$ for the Soil 0 specimens is not considered reliable, most likely for the following reasons: (1) the Soil 0 specimens were cured under a relatively narrow temperature range of 22 to 26 °C; (2) for three out of the five Soil 0 batches, curing temperatures were estimated entirely from ambient temperature data at the NWS Blacksburg station; and (3) the regression analyses were done with a lower bound of zero on $e_{3,2}$ to prevent identifying a minimum with a negative influence of curing temperature on UCS.

For the cement-treated organic soil batches, a somewhat wider range of curing temperatures was in effect (18.9 to 26.0 °C), and the temperature values were dominated by direct measurements. However, for the regressions done using all UCS data from this research, the value of $e_{3,2}$ is still zero, which indicates that the data from the Soil 0 batches dominates evaluation of $e_{3,2}$. This likely occurred because the majority of the specimens with UCS above 500 psi are from Soil 0 and high-strength specimens tend to dominate the regression analyses.

A side effect of unreliable zero values of $e_{3,2}$ is that the regression analyses attempt to compensate by adjusting other coefficient values. Consequently, the reliability of the coefficient values in Table 6 for regressions that have $e_{3,2}$ values at or very close to zero should not be considered as reliable as the regressions that have $e_{3,2}$ values significantly above zero.