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Effectiveness of Sugarcane Straw Ash and Pulverized Used Paper for Stabilization of Vertisols Soil

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ABSTRACT: In the discipline of civil engineering, the foundation plays a crucial role in supporting and containing loads of complete structures. Therefore, a foundation needs to be strong enough to increase any structure's useful life. The soil has a direct impact on the structure's foundation. Vertisols soil is soil with unstable and weak soil that needs to be stabilized to make the soil suitable for construction purposes. The study is to determine the effectiveness of the pulverized used paper and sugarcane straw ash as stabilizers of vertisols soil in San Isidro, Nueva Ecija. Natural soil was classified as A-7-6 of AASTHO classification system and CH as group name classified by USCS classification system, indicates that the soil is high in clay. The index properties of the natural soil showed that it is poor and weak soil that is not applicable for engineering purposes. Liquid limit and plasticity index values of 60% and 35%, respectively, suggested that the soil is in high plasticity. There is a gradual decrease in the plasticity index to a value of 25% at 15% SCSA+PUP as compared to natural vertisols soil with 35%, this indicates that the soil is progressively stabilizing. In addition, there are increases in the compaction parameters and CBR value of 14.0283 kN/m^3 and 5.47 at 100% MDD compared to natural vertisols soil with values of 13.69476 kN/m^3 and 4.83 at 100% MDD, respectively. But these values fall from the requirement suggested of sub-base coarse, however, there are considerable changes in the vertisols soil using SCSA and PUP. This research aimed to determine the effectiveness of SCSA and PUP in stabilizing the vertisols soil.

KEYWORDS: Sugarcane Straw Ash, Pulverized Used Paper, Vertisols soil, Stabilization, California Bearing Ratio, Plasticity Index, Compaction

CHAPTER I
THE PROBLEM AND ITS SETTING
INTRODUCTION

The most important component of nature is the soil, which provides for all of life's main aspects, including food, shelter, and clothing. In addition, buildings, highways, and other construction activities must be placed on stable, strong soil strata in order to be stable, in civil engineering, the foundation is crucial for supporting and restraining loads of the entire building. Hence, a foundation needs to be strong enough to prolong any structure's life span which the soil directly affects a building's foundation. In addition, the engineering properties of the soil are needed to be able to determine the workability and durability of the soil. However, it is common to find soils that are unsuitable for establishing buildings and roadway infrastructures on new sites, particularly when creating a newly developed environment. Vertisols soils are like Black Cotton soils with a high potential for swelling and shrinking as a result of a change in moisture content and are one of the major soils of the Philippines, that due to the volume change that these soils show when exposed to moisture, they are frequently regarded as a problem to the foundation. Soil stabilization is the process of improving a soil's physical characteristics, such as its shear strength and bearing capacity. This can be accomplished by controlled compaction, adding suitable admixtures, such as cement, lime, sand, or fly ash, or using geotextiles or other geosynthetic materials. But the problem is that the material of soil stabilizing was have kept the cost of construction of stabilized soil financially high.

In addition, in all emerging economies, waste material is a problem mostly because of mass trash production. Large volumes of trash have been produced worldwide as a result of the continued increase of industrialization and urbanization. Although industry expansion is vital for the country's progress, its harmful effects on the environment cannot be disregarded. The use of sugarcane straw ash (SCSA) and pulverized used paper (PUP) will encourage waste management at a low cost, minimize pollution caused by these wastes, and strengthen the farmer's financial condition when this waste is sold, which in turn supports more productivity. Additionally, sugarcane straw ash (SCSA) and pulverized used paper (PUP) as soil stabilizer manufacture used less energy than chemical stabilizer production. Abdulsattar (2015) to support the soil and keep it from buckling under the weight of the building's construction, the geotechnical engineer must thoroughly understand soil stabilization. To stabilize soil, cement and lime are frequently used as chemicals. However, as time went on, the costs of these two materials rose, the production of cement pollutes the environment, and harvesting the raw materials for cement production causes the reduction of non-renewable resources. For these reasons, this research will be very helpful in reducing the excessive use of cement for geotechnical engineering purposes.

Martirena et al. (2012) studied the pozzolanic activity of an SCSA by X-ray diffraction and thermogravimetric analyses. They reported that the SCSA was comparable to rice husk ash (RHA), which is the most important agricultural-sourced of pozzolan. In addition, Fungaro et. Al (2014) Silica is the primary element in sugarcane straw ash, with trace amounts of compounds made of aluminum, calcium, potassium, and iron. Furthermore, Siddique et. Al (2016) silica has of its extreme fineness and high silica content has been recognized as a pozzolanic material conforming to the specifications of ASTM C1240 for use as a supplementary cementitious material.

Amu et al., (2011) investigated the lateritic soil's geotechnical characteristics while stabilizing it with sugar cane straw ash. They discovered that adding 8% sugar cane straw ash increases the value of OMC, CBR, and UCS. They came to the additional conclusion that sugarcane straw ash can function as a powerful soil stabilizer. Furthermore, Chakraborty et. al (2016) concluded that there is an increase in the strength of soil as unconfined compressive strength (UCS) and California bearing ratio (CBR) increases.

Moreover, Phan et. Al (2021). Due to its capacity to absorb and hold water, paper sludge ash, a cinder produced of paper sludge, has significant potential if utilized as a complement to cement in stabilizing dredging clayey soil. Herman et. Al (2022) Waste paper ash (WPA) is being used increasingly in the field of civil engineering, both as a binder to stabilize clayey soil sand and as a potential raw material for the synthesis of porous silica. It is used in mortars, concretes, supplemental cementing materials, and bricks. In addition, Balochi et al. (2020) the waste paper ash (WPA) from the X-ray Diffraction (XRD) results revealed the presence of calcite, lime, portlandite, quartz, halite, calcium silicate, gehlenite, and aluminum, CaO, SiO2, Al2O3, Fe2O3, and Cl make up the majority of the waste paper ash's (WPA) chemical makeup, accounting for as much as 84%.

Furthermore, the United States Department of Agriculture (n.d) said vertisols are clayey soils having deep, wide fissures and slickness within 100 cm of the soil surface at various times throughout the year. When dry, they contract, and when wet, they expand. Because they share a common quantity and kind of clay. The University of Idaho (n.d) said clay-rich soils called vertisols to shrink and expand in response to variations in moisture content. The soil volume decreases and large, wide cracks appear during dry times. As the soil gets wetter, its volume then increases. When vertisols are dry, they can create huge cracks that can be several centimeters or inches wide and up to one meter (three feet) deep. These soils can shift, causing roadways to buckle and building foundations to shatter (Lindbo 2015).

Moreover, Philippine Rice Research Institute (2008) the soil taxonomy of Nueva Ecija was investigated then as the result, soil here in Nueva Ecija were some called Vertic soils or Vertisols soil or what they called as the soil series "Bantog" and "Zaragoza" which is a very fine textured soil with high clay content of >60% and has isohyperthermic temperature regime. It is a Vertisols soil, dominated by shrink-swell clays that cause deep wide cracks, slickness, very sticky when wet. Bantog soil has a ph value of 7.2 to 7.6, soil can be classified according to its pH value as neutral.

CONCEPTUAL FRAMEWORK

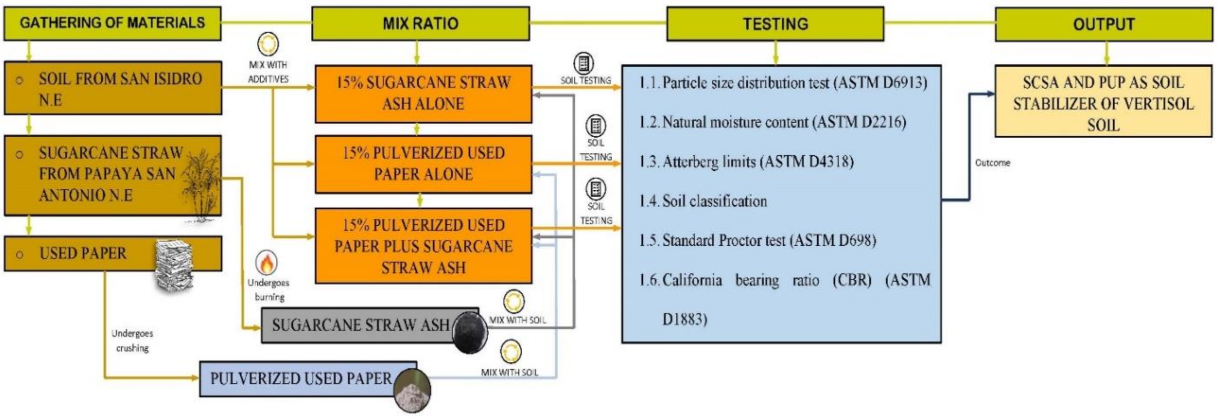

Figure 1. Research Paradigm

The figure shows the conceptual model of the study of the effectiveness of sugarcane straw ash and pulverized used paper for the stabilization of vertisols soil.

The first frame of the figure shows the input of the study which is the gathering of the soil sample, sugarcane straw, and waste paper. The sugarcane straw will undergo burning to make it ash sugarcane straw ash (SCSA). In addition, the used paper will undergo of crushing to obtain pulverized paper.

Moreover, the second frame shows the mixing ratio where the researchers use a proportion of 15% of sugarcane straw ash alone, 15% of pulverized use paper alone, and 15% of both sugarcane straw ash and pulverized used paper.

Then the third frame is the natural soil sample and the soil sample with SCSA and PUP now undergoes soil properties testing which is the Particle Size Distribution, Natural Moisture Content, Specific Gravity, Atterberg Limit, Soil Classification, Standard Proctor Test, and California Bearing Ratio.

Furthermore, the fourth frame is the output of the study which shows that the sugarcane straw ash and pulverized used paper are possible in the stabilization of Vertisols soil.

Statement of the Problem

This study focuses on determining the effectiveness of utilizing sugarcane straw ash and pulverized used paper in the soil stabilization of vertisols soil.

Specifically, it will seek answers to the following questions:

1. Determine the geotechnical properties of natural vertisols soil using ASTM standard.
2. Determine the geotechnical properties of vertisols soil with 15% sugarcane straw ash, vertisols soil with 15% pulverized used paper, and 15% sugarcane straw ash + pulverized used paper using ASTM standards for evaluating the effectiveness of admixtures for the soil stabilization.
3. Determine the soil-bearing capacity of natural vertisols soil and treated soil using the California Bearing Ratio (ASTM D1883).
4. Determine the effect of the sugarcane straw ash and pulverized used paper in the soil properties of vertisols soil.

Hypothesis

Based on the problem which the study attempts to answer, the following were tested:

1. The use of sugarcane straw ash and pulverized used paper in the soil stabilization of vertisol soil can be possible for soil stabilization.

The Objective of the Study

The following are the derive objectives of this study:

- To examine the soil properties of in situ vertisols soil.
- To examine the soil properties or treated soil with sugarcane straw ash alone, pulverized used paper alone, and with both sugarcane straw ash and pulverized used paper with 15% by weight.
- To carry out strength assessment tests on natural and treated vertisols soil.

Significance of the Study

This study about the effectiveness of sugarcane straw ash and waste paper ash for stabilization of vertisols soil was conducted to benefit the following:

Student - this study will benefit the student to understand whether it is feasible to use sugarcane straw ash and pulverized used paper to strengthen vertisols soils and encourage them to explore the use of organic waste materials in construction materials.

Community – this study will benefit the community by producing agricultural waste as a soil stabilizer, lessen the negative environmental impact of chemically produce stabilizer, and support the farmer's financial condition.

Engineers – this study will benefit engineers as to encourage them to do more eco-friendly and low-cost soil stabilizer that is made up of sugarcane straw ash (SCSA) and pulverized used paper (PUP) and it will serve as useful research to them that will aid in the ongoing search for alternative engineering materials.

Future researchers – this study will benefit future researchers that serves as their platform to do another timely research and to encourage them to do another study for innovation using alternative materials.

Scope and Limitation of the Study

This study aims to focus on determining the effectiveness of utilizing sugarcane straw ash and pulverized used paper in the soil stabilization of vertisols soil gathered from San Isidro, Nueva Ecija. This study is focused on stabilizing vertisols soil treated with sugarcane straw ash, pulverized used paper, and both sugarcane straw ash and pulverized used paper as additives at 15%. Furthermore, natural vertisols soil and treated soil will be tested to determine their soil properties and the effect of additives.

Definition of Terms

The following terms are hereby defined according to their uses in this study to understand more the study.

Atterberg Limit. These limits distinguished the boundaries of the several consistency states of plastic soils.

California Bearing Ratio (CBR). Is performed in construction materials laboratories to evaluate the strength of soil subgrades and base course materials.

Liquid limit. The moisture content when the groove closes for 1/2in after 25 drops of the cup.

Natural Moisture Content. Natural moisture content is the water weight ratio to the solids' weight in a given mass of soil. This ratio is usually expressed as a percentage.

Particle Size Distribution. This graph is generated to illustrate the average particle size, the smallest particle size, and the largest particle size.

Plastic Limit. Is determined by repeatedly remolding a small ball of moist plastic soil and manually rolling it out into a 1/8in the thread.

Plasticity Index. Is calculated using liquid limit and plastic limit testing results.

Pulverized Used Paper. Is a waste generated by the paper recycling industry. It is produced when dewatered waste paper sludge. Then undergoes of crushing to make it ash.

Soil Stabilization. Is defined as chemical or physical treatments that increase or maintain soil's stability or improve its engineering properties.

Soil Classification. Focuses on classifying soils into mappable, georeferenced units that have a spectrum of similar attributes.

Sugarcane Straw Ash. Is a byproduct of the sugar industry. During the sugarcane harvest, the stem and leaves are chopped together, and a cleaning process separates the cane from the straw. The remaining straw is dumped on the ground, and the stem is harvested to make sugar. Then the straw undergoes of burning to make it ash.

Vertisols Soil. Are clay-rich soils that shrink and swell with changes in moisture content. During dry periods, the soil volume shrinks, and deep wide cracks form.

Chapter II
METHODS AND PROCEDURE

Research Design

This study used experimental methods of research to test the effectiveness of SCSA and PUP in stabilization of vertisols soils. The experimental design was applied by the researchers to determine, analyze, and interpret data to show the effectiveness of sugarcane straw ash and pulverized used paper for stabilization of vertisols soil. According to Blakstad (2008), the word experimental research has a range of definitions. In the accurate sense, experimental research is what we call a true experiment.

Furthermore, he explained that it is an experiment where the researchers manipulate one variable, and control/randomizes the rest of the variables. It has a control group, the randomly assigned participants between the groups, and the researchers only tests the effect one at a time. Knowing what variable(s) you want to check and measure is also significant.

Locale of the Study

The research, the planning of experiments as well as the gathering of the soil sample, will take place at the Poblacion, San Isidro, Nueva Ecija, Philippines. As this place is a clayey or vertic lowland area and has large amounts of fertile soil where the vertisols soils were commonly classified, which was the main soil target of this research topic. This study chose the place because it is near in our homeland and to help stabilize those places by our own made additives where problematic soils are located. The testing of the sample will take place at Astec Materials Testing Corporation located at MacArthur Highway, San Fernando, Pampanga. The study will be conducted in the Second Semester of Academic Year 2022-2023.

Research Instrument

The data-gathering instruments used by the researchers to gather information for the study was observation.

Observation does not just mean seeing. It is most often used to include hearing as well as using other senses to collect information. In real life, it's common for the processes of analyzing, evaluating, perceiving, and reacting to appear synchronous.

One category of observation is for research. This category includes any representation which is carried out for the primary purpose of creating public theories. The researchers are the primary earner, and although ultimately most researchers would like their theorizing to make a positive difference in practices, the focus is initially on generating descriptions and plausible explanations of educational phenomena. Data are gathered using carefully designed and focused observation schedules. Consenting observers will often be given general information about the observation beforehand, but will generally have to wait some considerable time before being informed about the outcomes, which are almost always made public. (Malderez, 2002)

Data Gathering

The soil sample was gathered in San Isidro, Nueva Ecija where most of the soil was vertisols soil. The soil was obtained at the desired depth of one meter getting the middle portion undisturbed and getting a disturbed sample, the soil sample will be placed in a storage box and labeled it. In obtaining the sugarcane straw the researchers will collect a large amount of sugarcane straw and let it dry under the sun then afterward it will undergo burning then the ash will store in a storage box. For waste paper the researchers will collect a large amount of waste paper then soaked it in water for 24 hours then let it dry to under the sun the it will undergo of shredding until it turns into ash, then the ash will store in a container.

Preparing a mixing board that will serve as the mixing area so that no materials will spread out and will not be mixed with other foreign materials that can lead to an inaccurate result. The raw materials will then combine at additives of 15%. Then the prepared sample will undergo of testing, in which the Particle Size Distribution, Natural Moisture Content, Specific Gravity, Atterberg Limit, Soil Classification, Optimum Moisture Content, Maximum Dry Unit Weight, And California Bearing Ratio.

Data Analysis and Technique

Different tests on the natural and stabilized vertisols soils were carried out in accordance with the procedures of ASTM standards, for the stabilized soil specimens, percentages of sugarcane straw ash and pulverized used paper with 15% additives were placed into the soil. A series of tests were conducted on both natural and treated soils. The soil properties of vertisols soil were studied in terms of particle size distribution test (ASTM D6913), natural moisture content (ASTM D2216), specific gravity (ASTM D854-02), California bearing ratio (CBR) (ASTM D1883). and Atterberg limits (ASTM D4318). The Atterberg limits included liquid limit, plastic limit, and plasticity index. The soil classification was determined using the Unified Soil Classification System (USCS) (ASTM D2487) and the American Association of Highway and Transportation Officials (AASHTO) Soil Classification System (ASTM D3282-15). Additionally, a Standard Proctor test (ASTM D698) was performed to assess the optimum moisture content and maximum dry unit weight.

1.1 Particle size distribution test (ASTM D6913)

The particle size distribution of the natural soil was determined using the method specified by ASTM D6913 code. It states that soil particles come in various sizes and forms. This test procedure divides particles into size ranges and their mass is quantified for each range. To calculate the particle-size distribution, these data are combined (gradation). The gradation of soil between the 3-in. and 6-in. is determined by this test method using square opening sieve criteria. No. 200 (75-mm) and 75-mm sieves. It will also determine the mass retained on each size. To determine the mass retained in each sieve the equation is used then graph in a semi-logarithmic scale.

$$\boldsymbol{Percent\ finer} = \frac{\boldsymbol{Cumulative\ mass\ retained\ each\ sieve}}{\boldsymbol{\Sigma\ Soil\ Mass}}$$

1.2 Natural moisture content (ASTM D2216)

All moisture content determination was done by the oven drying method as specified by the ASTM D2216 code. A test specimen is dried to a consistent ass in an oven at 110°+/-5°C. It is thought that water is lost while drying. The dry specimen’s mass and the water’s mass are used to compute the water content. The water content is calculated from the equation.

$$\boldsymbol{w = \frac{m_2 - m_3}{m_3 - m_1} \times 100}$$

Where:

w=moisture content

m_1 = mass of container (g)

m_2 = mass of container and wet soil (g)

m_3 = mass of container and dry soil (g)

1.3 Atterberg Limit (ASTM D4318)

A fundamental criterion of the characteristics of fine-grained soil is the Atterberg limits. It can take on one of four phases, including solid, semi-solid, plastic, or liquid, depending on how much water is in the soil. Because a soil's consistency and behavior vary from state to state, so do its engineering properties. So, a change in the behavior of the soil can be used to determine the border between each condition. The Atterberg limits can be used to distinguish between various silts and clay types as well as between clay and silt. Albert Atterberg established these restrictions, and Arthur Casagrande later refined them.

1.3.1 Liquid limit (ASTM D4318)

As ASTM D4318 stated that determining the liquid limit of soil sample passing through sieve No. 40 was the liquid limit cup was filled with the soil paste, which was then leveled with the use of a spatula. With the use of a grooving tool, a clear and precise groove was created in the center. The number of blows necessary to force the two parts of the soil that were separated by the groove to close over a length of about 12 mm was counted. On the basis of a small sample of the soil paste, the water content was calculated.

A couple of additional trial were performed with various consistencies or moisture content concentrations. The soil samples were produced with such consistency that between 10 to 25, 25 to 35, and more than 35 blows would be needed to close the groove. On the semi-logarithmic graph, the link between the number of blows and moisture contents was plotted, with the logarithm of the blows on the x-axis and the moisture contents on the y-axis known as the flow chart. The liquid limit of the vertisols soil was determined to be the moisture level that corresponds to 25 blows from the flow curve.

1.3.2 Plastic limit (ASTM D4318)

The water concentration at which soil begins to behave plastically is known as the plastic limit (PL). The same method that was used to determine the liquid limit (LL), the proportion of the material passing through a sieve No. 40 was also used to determine the plastic limit. The two hands' palms were used to mold a sample of the moist dirt. The sample was rolled into two subsamples, each of which was split into parts. A stroke is defined as one full motion of the hand forward and returning to the starting position again. The rolling pace was between 80 and 90 strokes per minute. The threads were rolled until they were 3 mm in diameter as stated in ASTM D4318 Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. This process of alternate rolling was carried out until the soil could no longer be wrapped into a thread and the thread broke under the pressure needed for rolling. The soil thread pieces were gathered, the moisture content was evaluated, and the plastic limit was recorded then the equation was used to determine the average plastic limit.

$$\boldsymbol{PI = \left(\frac{W_2 - W_3}{W_3 - W_1}\right) X100}$$

Where:

W_1=mass of the moisture can

W_2=mas of moisture can plus moist soil

W_3=mas of moisture can plus dry soil

1.3.3 Plasticity index (ASTM D4318)

The plasticity index (PI) is computed as the difference between the liquid limit (LL) and the plastic limit (PL) as ASTM D4318 stated.

Calculate the plasticity index as follows:

$$\boldsymbol{PI = LL - PL}$$

where:
LL = liquid limit
PL = plastic limit

1.4 Soil Classification

1.4.1 Unified Soil Classification System (USCS) (ASTM D2487)

To classify soil, it is divided into two parts, more than 75 micron IS sieve size makes up 50% or more of the total weight of the material in soils with a coarse grain. Fine-grained soils: In these soils, at least 50% of the total weight of the constituents is smaller than the IS sieve size of 75 microns. The following categories of fine-grained soils are further separated based on the following arbitrarily chosen liquid limit values, which is a good indicator of compressibility.

1.4.2 American Association of Highway and Transportation Officials (AASHTO) Soil Classification System (ASTM D3282-15)

Based on their relative expected quality for road embankments, sub-grades, sub-bases, and base, the AASHTO Soil Classification System divides soils into seven primary classes, A-1 through A-7. Subgroups are created for some of the groups, including A-1-a and A-1-b. A Group Index can also be computed to estimate a soil's anticipated performance within a group. The relative amounts of gravel, coarse sand, fine sand, and silt-clay must first be determined in order to assign a soil's AASHTO classification, and based on the gradation, and plasticity index.

1.5 Standard Proctor test (ASTM D698)

Standard proctor test was carried out in accordance with ASTM D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil These test procedures include the laboratory compaction techniques used to establish the connection between the dry unit weight of soils and their water content when they are compacted in a compactor mold. A rammer was used to drop a mold from a height of 12.0 in.

Three layers of soil pass in sieve No. 4 with a specified water content are added to a mold with specific dimensions, and each layer is compacted with 25 blows from a rammer dropped from a height of 12.00 in. The final dry unit weight is calculated. The process is repeated enough times for a variety of molding water contents to create a correlation between the soil's dry unit weight and molding water content. When this data is shown, a curved relationship is represented. The compaction curve is used to calculate the ideal water content and standard maximum dry unit weight. The equation is use to determine the dry unit weight and moisture content of the soil.

$$\gamma = \frac{(W_2 - W_1)g}{V}$$

$$w = \frac{W_{mc+ms} - W_{mc+ds}}{W_{mc+ds} - W_{mc}} X100$$

$$\gamma d = \frac{\gamma}{w + \frac{1}{Gs}}$$

$$R = \frac{\gamma_{d(field)}}{\gamma_{d(max-lab)}}$$

Where:
γ=bulk unit weight
W_1=weight of empty mold
W_2=weight of mold plus moist soil
g=gravitational foce (9.81 m/s^2 or 32.17 ft/s^2)
W_{mc}=mass of moisture can
W_{mc+ms}=mass of moisture can plus moist soil
W_{mc+ds}=mass of can plus dry soil
w=moisture content
R=relative density of compaction
γd=dry unit weight

1.5.1 Optimum Moisture Content (OMC)

The optimum moisture content is the percentage of moisture that corresponds to the moisture- Dry Unit Weight curve's peak the point where the two lines connect. optimum moisture content plotted at the x-axis.

1.5.2 Maximum Dry Unit Weight (MDD)

The maximum Dry Unit Weight is the Dry Unit Weight at the optimal moisture content corresponding to the apex point of intersection of the two lines of the moisture- Dry Unit Weight curve. Maximum Dry Unit Weight plotted at the y-axis.

1.6. California bearing ratio (CBR) (ASTM D1883)

The Bearing ratio of the soil sample were tested in accordance with ASTM D1883 Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils states that the CBR (California Bearing Ratio) of pavement subgrade, subbase, and base course materials can be ascertained using this test procedure using laboratory compacted specimens. The primary purpose of the test method is to assess the strength of cohesive materials with maximum particle sizes less than 3/4 in. (19 mm).

The mold was filled with approximately 5 kg of the vertisols soil sample, with natural soil and treated soil, and compacted to the British Standard Light compactive effort and ideal moisture content. For this compactive effort, three (3) layers of soil samples were compacted using a rammer, each getting 65 blows.

After being crushed, the foundation plates were taken off, and the specimens were then put into a tight plastic bag to cure. To prevent moisture loss from evaporation, plastic bags were employed. The specimen was placed on the CBR testing apparatus after being cured for seven (7) days, after which they were taken out of the plastic bags and given a new base plate. The specimen was penetrated by the plunger at a constant rate. Every 0.25 mm of penetration was measured using the dial reading that indicated force until the maximum of 12.7 mm or, alternately, until failure then recorded the data. The specimens' bottoms underwent similar testing. The CBR were observe at the penetration length of 2.5mm and 5mm then the equation was use.

$$CBR = \frac{PT}{PS} X100\%$$

Where:

PT = Corrected test load corresponding to the chosen penetration from the load penetration curve.

PS = Standard load for the same penetration.

CHAPTER III
PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

In this chapter, all the data acquired by the researchers—including their analysis and interpretation of the results—will be presented. The data and outcomes were presented using graphs and tables and carefully and accurately reviewed to address the questions rooted in the problem statement.

Test results are carried out on the natural and treated vertisols soil are summarized in Table 01.

Table 01. Geotechnical Properties of Natural and Treated Vertisols Soil

Item No.	PROPERTY	Natural soil	15% PUP	15% SCSA	15% SCSA+PUP
1.	Percentage passing sieve No. 200	89%	98%	94%	91%
2.	Liquid limit	60%	59%	62%	61%
3.	Plastic Limit	25%	27%	36%	36%
4.	Plasticity Index	35%	32%	26%	25%
5.	AASHTO Classification	A-7-6 (35)	A-7-6 (37)	A-7-5 (31)	A-7-5 (28)
6.	Unified Soil Classification System (USCS)	CH	CH	MH	MH
7.	Maximum Dry Unit weight	13.69476 kN/m^3	14.02830 kN/m^3	13.28274 kN/m^3	13.90077 kN/m^3
8.	Optimum Moisture Content (OMC)	21.84%	24.85%	29.48%	26.18%
9.	California Bearing Ratio (CBR) @100% MDD	4.83	3.83	4.44	5.47
10.	California Bearing Ratio (CBR) @90% MDD	3.81	2.95	2.43	4.18

3.1 Particle size distribution test (ASTM D6913)

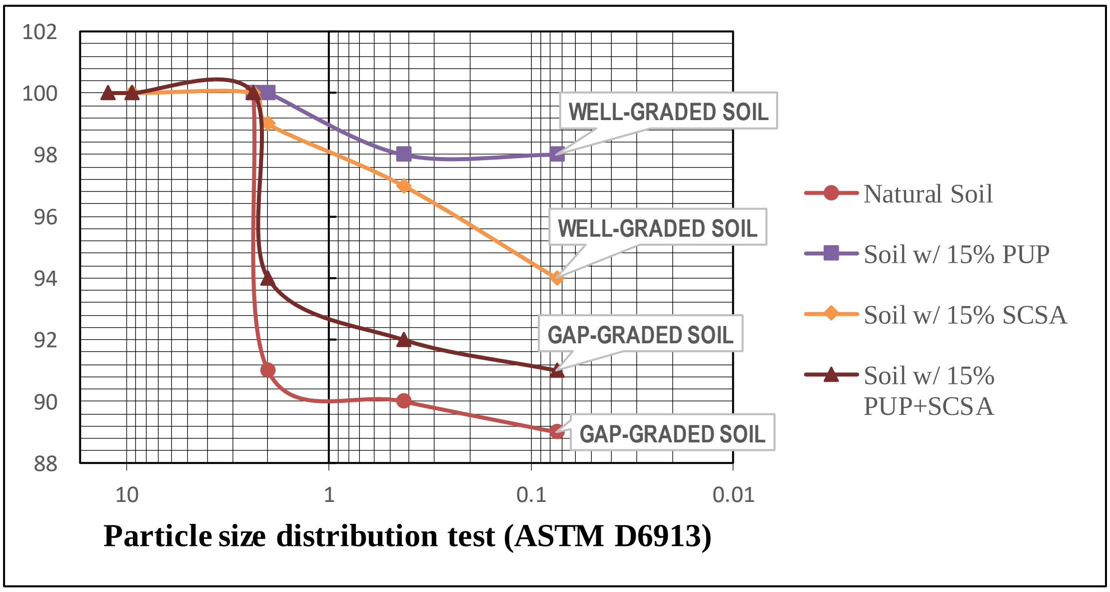

Figure 02. Particle Size Distribution of Natural and Treated Vertisols Soil

Figure 02. represents the distribution of soil particle sizes on natural vertisols and treated soil with sugarcane straw ash and pulverized used paper content. It is seen from Figure 02. showed the natural vertisols soil and all additives generated a similar curve pattern. This might be the result of similar flocculation and bulk aggregation. It was shown from the graph that the natural soil and soil with 15% SCSA+PUP shows a gap-graded curve which these soils are compose of large and small particles. The problems associated with gap-graded soils, such as high permeability, low uniformity, and poor seepage stability, must be addressed (Zhang et. al, 2020). Moreover, soil with 15% PUP and 15% SCSA shows a well-graded curve which these soils are commonly have highly proportion of size particle.

3.2 Natural moisture content (ASTM D2216)

The natural moisture content was carried out with collected three samples of undisturbed soil. The samples weighs 130 grams, 170 grams and 159 grams, respectively. After drying the soil, the researchers weighed it and measured it to be 120 grams, 160 grams, and 150 grams, respectively. After calculating the moisture content of each sample, the average moisture content is obtained with the result of 21.50%

3.3 Atterberg Limit (ASTM D4318)

3.3.1 Liquid Limit

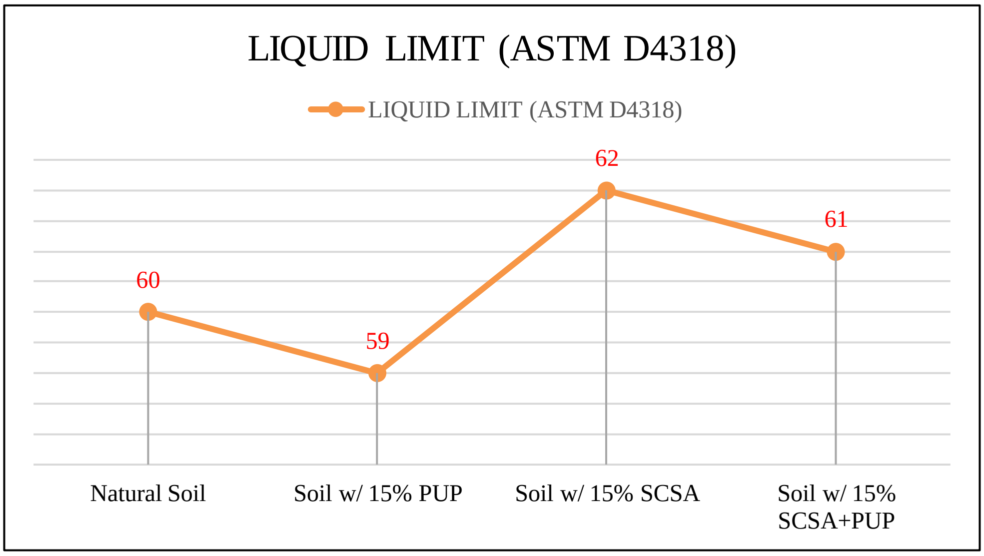

Figure 03. Liquid Limit of Natural and Treated Vertisols Soil

The liquid limit characterizes the critical moisture content of soil transforming from the liquid state to the plastic state. The liquid limit is important for understanding the stress history and general properties of the soil encountered during construction. The result of this study shows in figure 03 that the soil with 15% SCSA has the highest liquid limit of 62%. The soil with 15% SCSA+PUP has the second highest liquid limit of 61%. Followed by the natural soil and soil with 15% PUP with liquid limit of 60% and 59%, respectively.

3.3.2 Plastic Limit

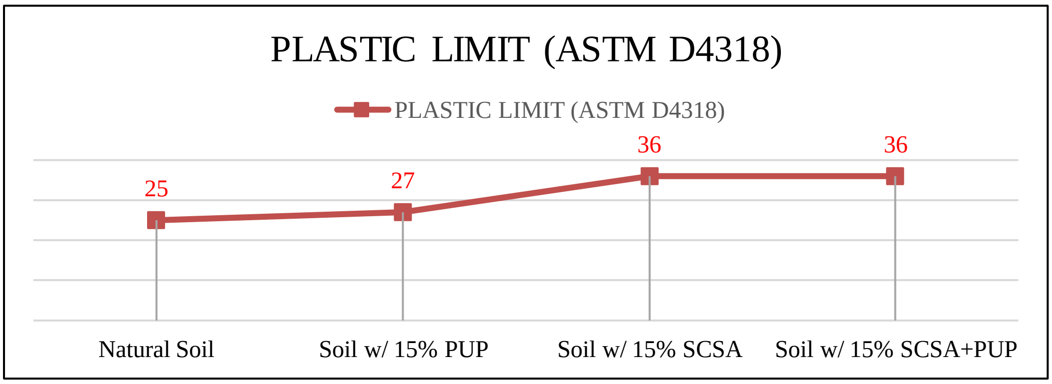

Figure 04. Plastic Limit of Natural and Treated Vertisols Soil

The figure 04 shows the Plastic Limit (PL) of the natural and treated vertisols soil, plastic limit is the water content at the change from a plastic to a semi-solid state. According to the results gathered by the researchers, soil with 15% SCSA and soil with 15% SCSA+PUP has the highest plastic limit which is 36%. Followed by soil with 15% PUP with 27% PL. The sample that has the least PL is the natural soil having a PL of 25%.

3.3.3 Plasticity Index

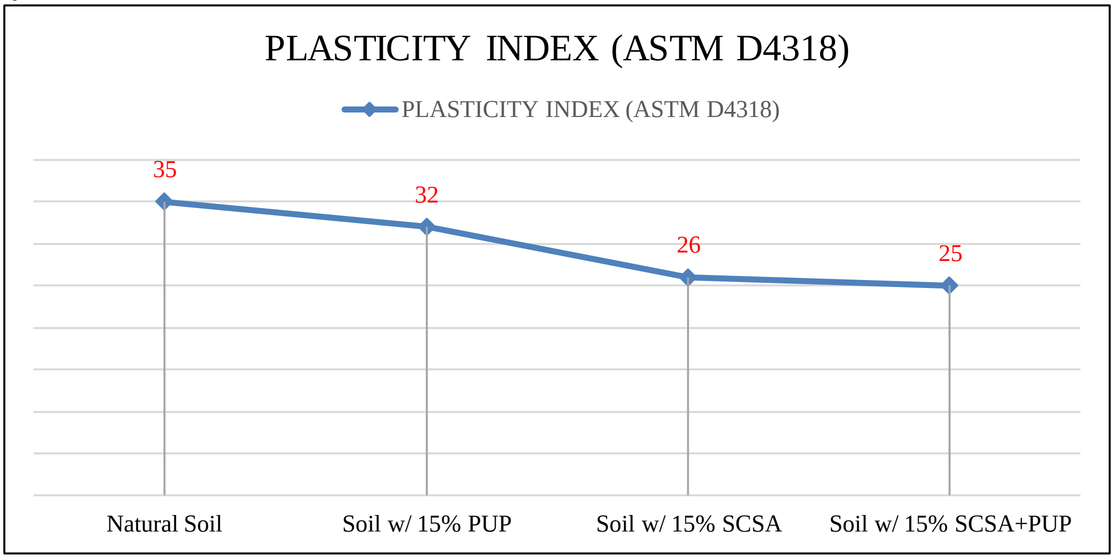

Figure 05. Plasticity Index of Natural and Treated Vertisols Soil

The plasticity index is the size of the range of water contents where the soil exhibits plastic properties. Figure 05 shows the plasticity index of natural and treated vertisols soil, it indicates the fineness of the soil and its capacity to change shape without altering its volume. The result was carried out and shows that the natural soil sample has the highest plasticity index having a result of 35%. It is followed by the soil with 15% PUP with 32% PI. The second least PI is the third sample which is the soil with 15% SCSA having a PI of 26%. Followed by the sample having the least PI which is the soil with 15% SCSA+PUP having 25%. These values of plasticity index describe that all samples are high in plasticity, however there are decrease in plasticity compared to the natural vertisols soil. The decrease in plasticity index gives a sign that the soil is progressively stabilized soil (Mtallib, 2011). The reduction of plasticity index of soil is an indicative of improvement (ASTM D4609).

3.4 Soil Classification

The natural vertisols soil also with the treated soil was classified as A-7-6 and A-7-5 subgroup by the American Association of Highway and Transportation Officials (AASTHO) classification system where the description of the soil was merely Clayey soil a fine-grained material with more than 35% passing through sieve no. 200. Furthermore, there are observe decrease in the group index of 15% SCSA+PUP and 15% SCSA with a according to Table 01 item 5 a value of 28 and 31, respectively, compared to group index of the natural vertisols soil with a value of 35, while there is a slightly increase in the group index of soil with 15% PUP. These is a good sign of improving the natural vertisols soil, lower the value higher is the quality of the sub-grade and greater the value, poor is the sub-grade (The constructor, n.d). Moreover, using the Unified Soil Classification System (USCS), the natural vertisols soil together with the 15% PUP and the 15% SCSA together with the 15% SCSA+PUP was classified as CH and MH, respectively, where these soils are fine grained soils with equal or less than of 50% fraction thereof retained in sieve No. 200, here soils are Inorganic clays of high plasticity or fat clays and Inorganic silts or silty soil, respectively.

3.5 Standard Proctor test (ASTM D698)

3.5.1 Optimum Moisture content (OMC)

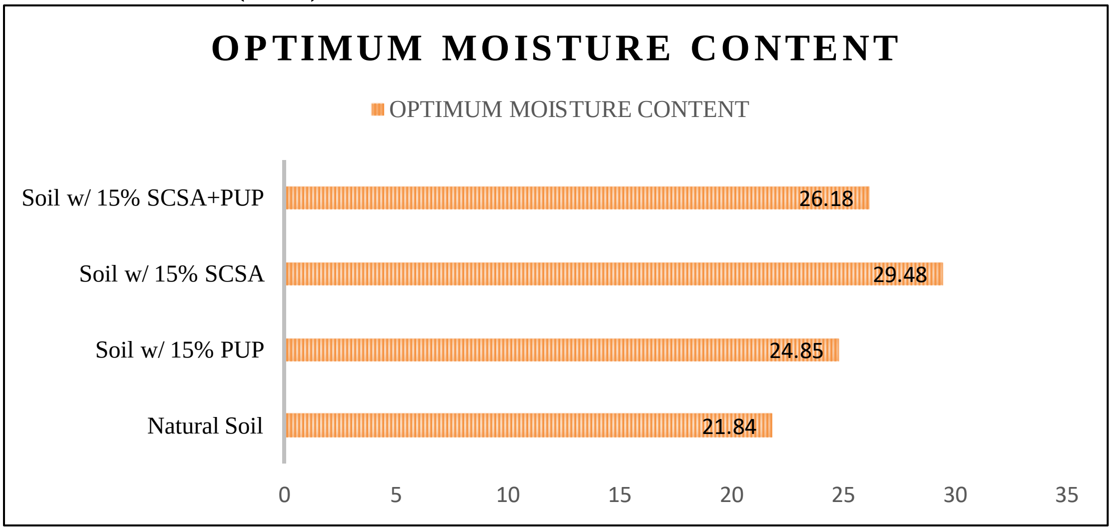

Figure 06. Optimum Moisture Content of Natural and Treated Vertisols Soil

The variation of moisture content was shown in figure 06 where there are increase in treated soil with 15% SCSA, 15% PUP and 15% SCSA+PUP at 29.48%, 24.85% and 26.18%, respectively, compare to the optimum moisture content of natural vertisols soil with 21.84%.

3.5.2 Maximum Dry Unit weight (MDD)

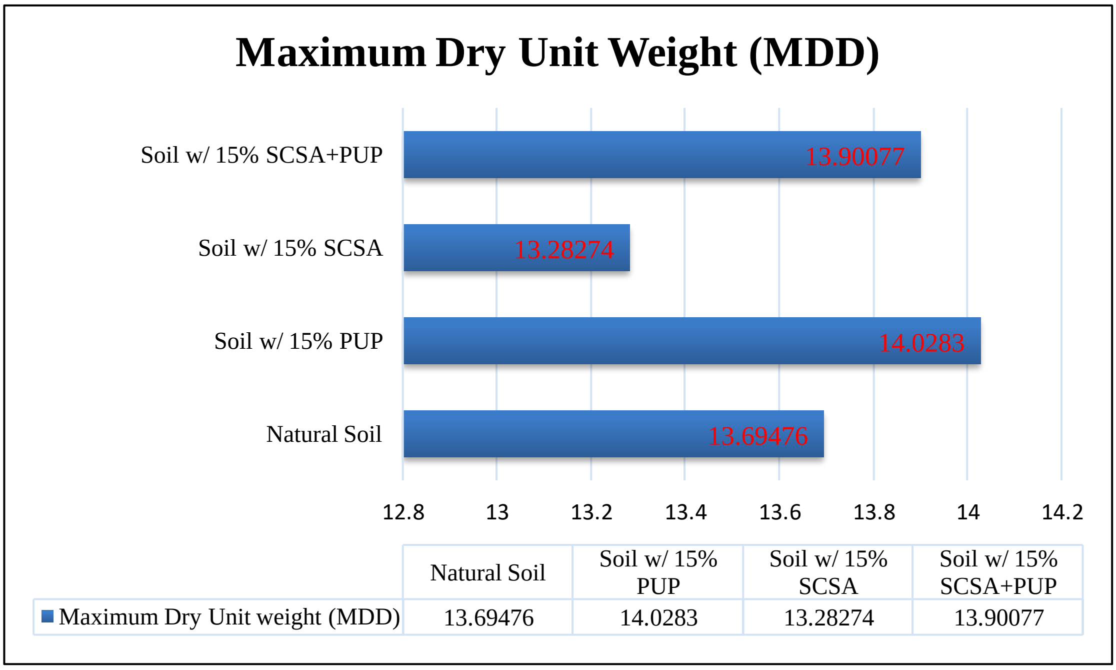

Figure 07. Maximum Dry Unit Weight of Natural and Treated Vertisols Soil

The variation of maximum dry unit weight with natural and treated vertisols soil were carried out in figure 07, for the natural vertisols soil, the maximum dry unit weigh was 13.69476 kN/m^3, and for the 15% SCSA there were a decrease observe in maximum dry unit at 13.28274 kN/m^3, while there is gradual increase observe in maximum dry unit weight in both additive at 15% SCSA+PUP as the 15% PUP has the greater increase at 13.90077 kN/m^3 and 14.0283 kN/m^3, respectively. In general, more strength, less permeability, and better volume stability can be expected from soils as their dry density increases (Ravindra, 2017). The increase in dry unit weight of soil is an indication of an increase in strength was achieve by the treatment (ASTM D4609).

3.6 California bearing ratio (CBR) (ASTM D1883)

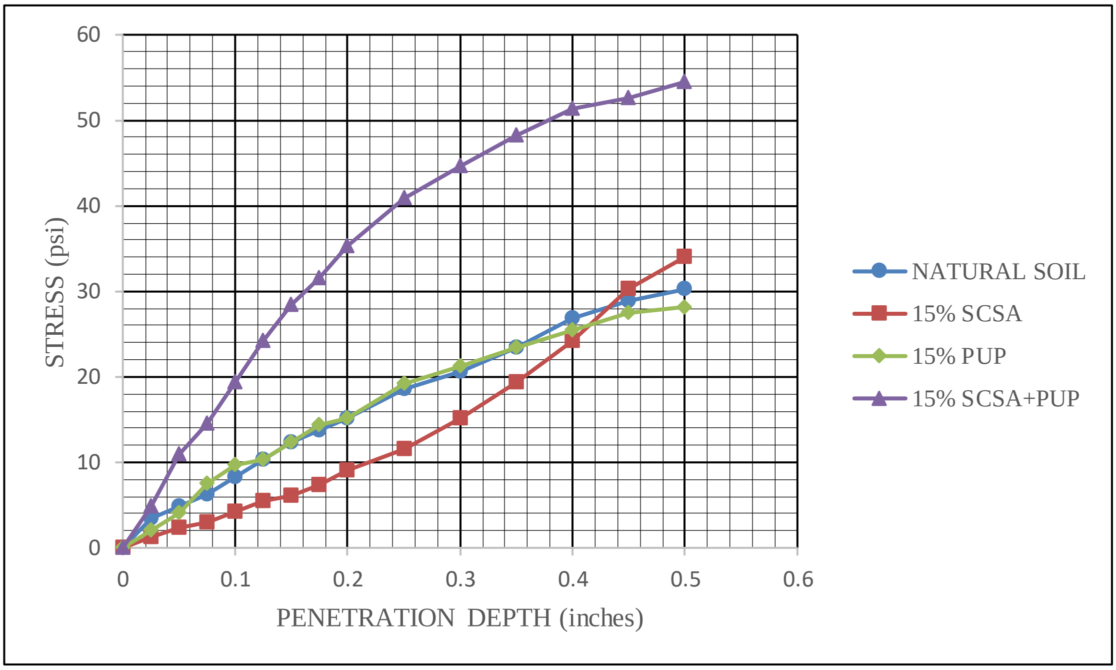

Figure 08. California Bearing Ratio (CBR) Penetration; 10 Blows

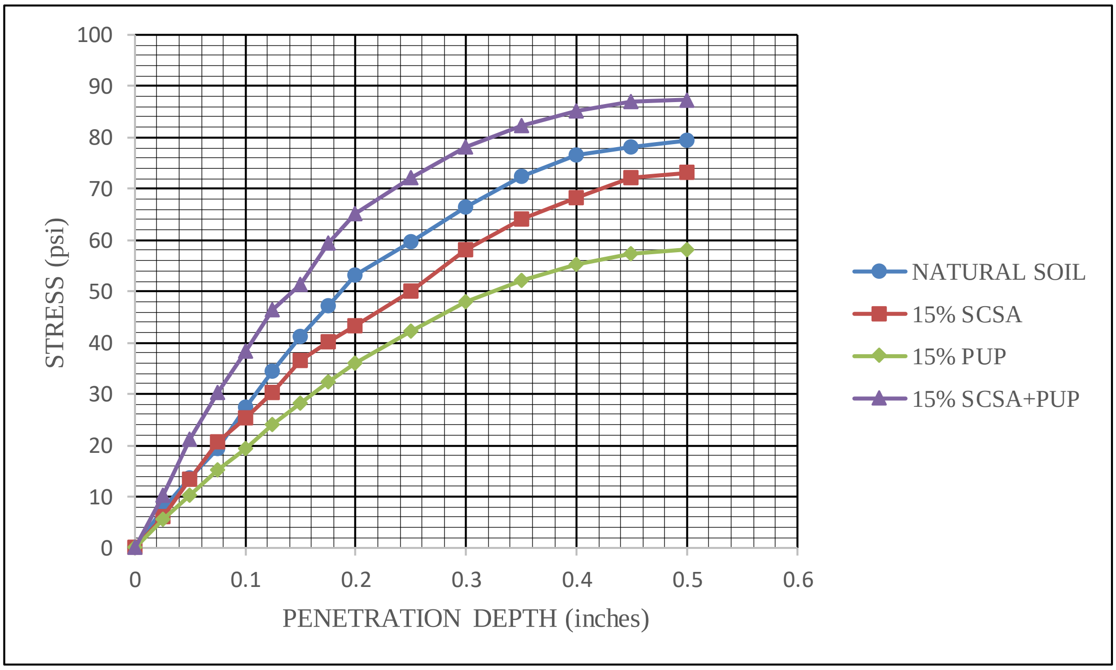

Figure 09. California Bearing Ratio (CBR) Penetration; 30 Blows

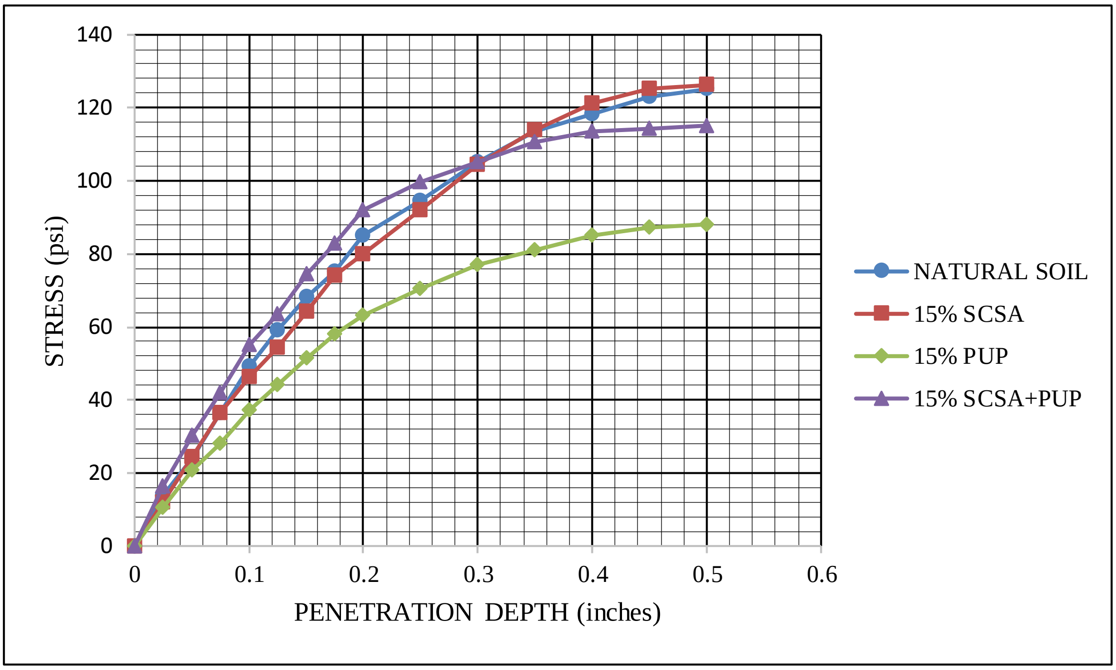

Figure 10. California Bearing Ratio (CBR) Penetration; 65 Blows

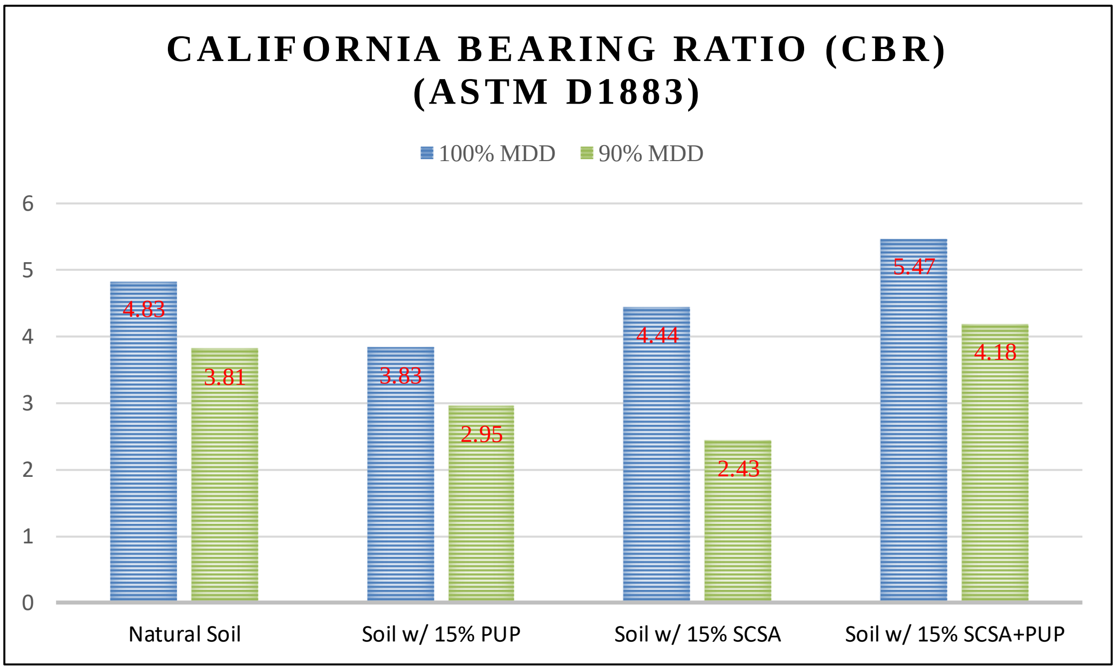

Figure 11. California Bearing Ratio (CBR) of Natural and Treated Vertisols Soil

The variation of results in the California Bearing Ratio was indicated in Figure 11, a slight decrease in CBR in 15% SCSA and 15% PUP at 4.44 at 100% MDD, 2.43 at 90% MDD and 3.83 at 100% MDD, 2.95 at 90% MDD, respectively, was observed. However, there is an increase of CBR at 15% SCSA+PUP at 5.47 at 100% MDD and 4.18 at 90% MDD although the increase is still very much required, as Southern Testing (2023), a CBR value of 2% typically corresponds to clay, although other sands may have a CBR value of 10%. A high-quality sub-base will have a maximum value of 80-100%.

CHAPTER IV
SUMMARY, CONCLUSION, AND RECOMMENDATION

Summary

Vertisols soils are Black Cotton soils with the potential for swelling and shrinking due to moisture content change. Soil stabilization is the process of enhancing the physical properties of soil, such as shear strength and bearing capacity, through controlled compaction, admixtures such as cement, lime, sand, fly ash, and geotextiles. In addition, sugarcane straw ash revealed that there are highly presence of silica content and waste paper has a composition of calcium silicate, that these are one of the compositions of cement that is why this material can possibly increase the strength of vertisols soil. Based on the obtained and interpreted data, the following have been summarized, the proportion of soil that passes a No. 200 sieve ranges from 89% for unmodified soil to 98% for PUP 94% for SCSA to 91% for a mixture of the two. Three undisturbed soil samples were used to measure natural moisture. Samples weigh 130, 170, and 159 grams. After drying the soil, researchers weighed it at 120, 160, and 150 grams. The average moisture content of each sample is 21.50%. In terms of Liquid limit, the soil containing 15% SCSA has a maximum liquid limit of 62%. The soil containing 15% SCSA+PUP have the second highest liquid limit (61%) of all soils. The natural soil and soil containing 15% PUP with liquid limits of 60% and 59%, respectively, come next. For the Plastic index, natural soil has the highest plasticity index at 35%. Soil ranks second with 15% PUP and 32% PI. The third sample, soil with 15% SCSA and 26% PI, had the second-lowest PI. Soil with 15% SCSA+PUP has 25% PI. In addition, decreases in plasticity index are indicative of soil that is becoming more stable with time. Next is the Classification of soil, the American Association of Highway and Transportation Officials (AASTHO) categorization scheme just described the natural vertisols soil and treated soil as A-7-6 and A-7-5 subgroups. Clayey soil is fine-grained with over 35% passing Sieve No. 200. The Unified Soil Classification System (USCS) classified the natural vertisols soil, 15% PUP, 15% SCSA, and 15% SCSA+PUP as CH and MH, respectively. These soils are fine-grained soils with equal or less than 50% fraction retained in Sieve No. 200, and they are inorganic silts or silty soil and inorganic clays of high plasticity. Based on OMC or Optimal Moisture Content, soil treated with 15% SCSA, 15% PUP, and 15% SCSA+PUP increased to 29.48%, 24.85%, and 26.18%, respectively, when compared to the optimal moisture content of natural vertisols soil, which was 21.84%. The maximum dry unit weight of the natural vertisols soil was 13.69476 kN/m^3, while the 15% SCSA had a decrease at 13.28274 kN/m^3. The 15% PUP had the greatest increase at 13.90077 kN/m^3 and 14.0283 kN/m^3. CBR decreased somewhat in 15% SCSA and 15% PUP at 4.44 at 100% MDD, 2.43 at 90% MDD, and 3.83 at 100% MDD, 2.95 at 90% MDD. However, both sugarcane straw ash and pulverized use paper increased CBR by 15% to 5.47 at 1005 MDD and 4.18 at 90% MDD, which is still needed, as Southern Testing (2023), a CBR value of 2% typically corresponds to clay, although other sands may have a CBR value of 10%. A high-quality sub-base will have a maximum value of 80-100%.

Conclusion

Based on the results of this investigation, the following conclusions are classified:

1. The natural vertisols soil sample was classified as the A-7-6 subgroup with a group index of 35 of the AASHTO classification system and CH as a group symbol classified by the USCS classification system and described as fat clay. A liquid limit of 60% and a plasticity index of 35% that these soils describe as high in plasticity. The engineering properties of the vertisols soil showed that it has poor and weak soil, as it is an expansive clay as per NSCP 2015 section 303.5. Compaction parameters of 13.69476 kN/m^3.
2. The soil sample with 15% PUP was classified as the A-7-6 subgroup with a group index of 32 of the AASHTO classification system and CH as a group symbol classified by the USCS classification system and described as fat clay. A liquid limit of 59% and plasticity index of 32%, compared to natural vertisols soil with plasticity index of 35% it has observed that there are decrease in plasticity. Gradual increase in compaction parameters of 14.02830 kN/m^3 compared to natural vertisols soil with 13.69476 kN/m^3,

The soil sample with 15% SCSA was classified as the A-7-5 subgroup with a group index of 26 of the AASHTO classification system and MH as group symbol indicates Inorganic silty soil. A liquid limit of 62% and plasticity index of 26%, compared to natural vertisols soil with plasticity index of 35% it has observed that there are decrease in plasticity. There are observe a decrease in compaction parameters of 13.28274 kN/m^3 compared to natural vertisols soil with 13.69476 kN/m^3.

The soil sample with 15% SCSA+PUP was classified as the A-7-5 subgroup with a group index of 25 of the AASHTO classification system and MH as group symbol indicates Inorganic silty soil. A liquid limit of 61% and plasticity index of 25%, compared to natural vertisols soil with plasticity index of 35% it has observed that there are decrease in plasticity. There are observe a gradual increase in compaction parameters of 13.90077 kN/m^3 compared to natural vertisols soil with 13.69476 kN/m^3.

3. The natural soil has a bearing capacity of 4.83 and 3.81 at 100% MDD and 90% MDD, respectively. In 15% SCSA+PUP, an increase was observed in the bearing capacity with a value of 5.47 and 4.18 at 100% MDD and 90% MDD, respectively. Compared with natural vertisols soil with 4.83 and 3.81 at 100% MDD and 90% MDD, respectively. A slightly decrease in bearing capacity with a value of 4.44 and 2.43 at 100% MDD and 90% MDD, respectively, was observed in 15% SCSA compared with natural vertisols soil with 4.83 and 3.81 at 100% MDD and 90% MDD. The bearing capacity of 15% PUP has slighthly decrease with a value of 3.83 and 2.95 at 100% MDD and 90% MDD, respectively, compared with natural vertisols soil with 4.83 and 3.81 at 100% MDD and 90% MDD, respectively. Based on the results, The natural soil has a bearing capacity of 4.83 and 3.81 at 100% MDD and 90% MDD, respectively. As an outcome of the results, all the soil samples fall below

the standard suggested for most geotechnical works. In addition, the 15% SCSA+PUP has shown the highest value of bearing capacity.

4. As the result the 15% SCSA+PUP shows a considerable good sign of stability and ground improvement technique, a decrease in plasticity index is a desired and good sign of development because decreases in PI boost the stability of these soils, but still samples were high in plasticity. Brings in an improvement in the compaction parameters of the study soils, by increasing the maximum dry unit weight of the soils compared to natural vertisols soil. Reveal that soil containing SCSA+PUP has a higher CBR value than natural vertisols soil the effect of the SCSA+PUP improves the strength of the soil. It can be used more profitably as an admixture with a conventional stabilizer such as lime and cement. The result shows that SCSA+PUP can be used as an admixture with conventional stabilizers such as lime and cement.

Recommendation

From the result obtain the following recommendation were carried out:

- Establish more tests that may potentially determine the soil strength that is not considered in the study.
- To assess the soil behavior under the alterations, utilize a different mixing ratio and the diameter of the particle of sugarcane straw ash and pulverized used paper in stabilizing soil.
- Establish cost comparison between Conventional stabilizer and SCSA and PUP as soil stabilizer.
- SCSA and PUP may use as an admixture to conventional stabilizers.
- Use another type of soil to determine the behavior of the soil using SCSA and PUP as stabilizers.

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APPENDICES

ASTEC
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- Subsurface Soil Investigation
- Plate Load Test
- Compressive / Flexural Strength of Concrete
- Three Edge Bearing Test for Concrete Pipes
- Concrete Coring
- Rebound Hammer Test
- Quality Test of Soil & Aggregates
- Field Density Test / CBR Test
- Tensile Test of Steel Materials
- Quality Test of Portland Cement
- Verification / Calibration of Testing Equipment
- Ultrasonic Thickness Gauge Determination of Steel Materials
- Structural Load Test

Client :	**Ms. Patricia V. Villarico**	Test Report No :	**SA-4112-B2-23**
Attention :	**Thru: NEUST**	Test Request Form No. :	**27783-B3**
Project :	**Research**	Date Received :	**10-Mar-23**
Location :	**Cabanatuan City, Nueva Ecija**	Date of Test :	**March 30 to April 13, 2023**
Sample Delivered :	**2 Sacks Natural Soil**	Date of Report :	**April 17, 2023**
Delivered By :	**Ms. Patricia V. Villarico**	Tested By :	**JBAGaraniel/JCAgner**
Sampled By: :	**Ms. Patricia V. Villarico**	Encoded By: :	**MJMDelen**
Source :	**San Isidro, Nueva Ecija**	Checked By :	**MAMDagos**

REPORT OF TEST ON NATURAL SOIL

	Sample Result
A. SIEVE ANALYSIS (ASTM D 422)	
Sieve Size	**% Passing**
No.8	**100**
No.10	**91**
No.40	**90**
No.200	**89**
B. ATTERBERG LIMIT (ASTM D 4318)	
Liquid Limit	**60**
Plastic Limit	**25**
Plasticity Index	**35**
C. MOISTURE DENSITY RELATIONS OF SOIL USING MODIFIED EFFORT (ASTM D 1557)	
Maximum Dry Density, g/cc	**1.396**
Optimum Moisture Content,%	**21.84**
D. CALIFORNIA BEARING RATIO OF LABORATORY COMPACTED SOILS (ASTM D 1883)	
CBR Value @ 100% MDD	**4.83**
CBR Value @ 95 % MDD	**3.81**

Remarks:
1.This report give the result carried out as sample submitted to the labora
2.This report shall not be reproduced except in full, without the written approval of the Laboratory
3. n/r - no request ; n/s - not specified

Authorized Signatory:
Laboratory Supervisor
For and On-behalf of ASTEC Materials Testing Corporation

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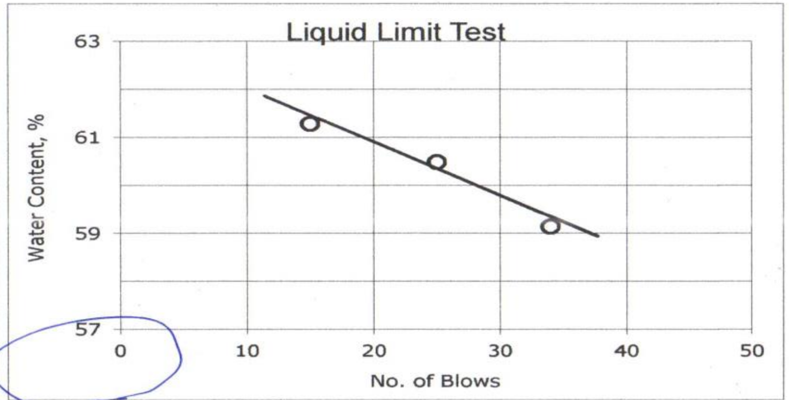
Delivered By :	Ms. Patricia V. Villarico	Tested By :	JBAGaraniel/JCAgner
Sampled By: :	Ms. Patricia V. Villarico	Encoded By: :	MJMDelen
Source :	San Isidro, Nueva Ecija	Checked By :	MAMDagos

ATTERBERG LIMITS
ASTM D 4318

Sample		Natural Soil				
		Liquid Limit Test			Plastic Limit	
Trial No.		1	2	3	1	2
Tare No.		L-5	L-11	L-14	P-1	P-16
Number of Blows		15	25	34		
Weight of Can	g	7.20	6.99	7.25	3.56	3.60
Weight of wet Soil w/ can	g	15.47	14.48	17.91	11.55	10.98
Weight of dry soil w/ can	g	12.33	11.66	13.95	9.94	9.48
Weight of water	g	3.14	2.82	3.96	1.61	1.50
Weight of soil	g	5.13	4.66	6.70	6.39	5.88
Water Content	%	61.28	60.48	59.13	25.21	25.54
Liquid Limit (LL)	%	60			USCS Symbol	
Plastic Limit (PL)	%	25				
Plasticity Index (PI)		35				



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ASTEC

Client : **Ms. Patricia V. Villarico**
Attention : **Thru: NEUST**
Project : **Research**
Location : **Cabanatuan City, Nueva Ecija**
Sample Delivered : **2 Sacks Natural Soil**
Delivered By : **Ms. Patricia V. Villarico**
Sampled By : **Ms. Patricia V. Villarico**
Source : **San Isidro, Nueva Ecija**

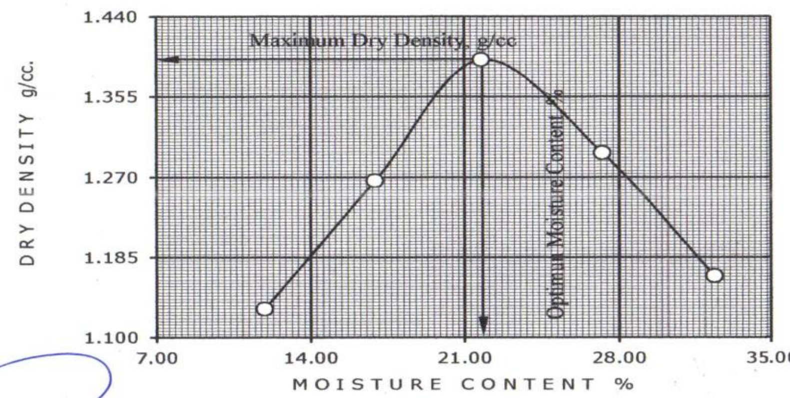
Test Report No. : **SA-4112-B2-23**
Test Request Form No. : **27783-B3**
Date Received : **10-Mar-23**
Date of Test : **March 30 to April 13, 2023**
Date of Report : **17-Apr-23**
Tested By : **JBAGaraniel/JCAgner**
Encoded By : **MJMDelen**
Checked By : **MAMDagos**

MOISTURE & DENSITY RELATION OF SOIL
ASTM D 1557

DESCRIPTION OF MATERIALS:		Natural Soil				
TRIAL NUMBER		1	2	3	4	5
WATER ADDED , cc.		0	150	300	450	600
MASS IN GRAMS	MOLD + WET SOIL	3901.3	4104.5	4309.1	4262.6	4162.7
	MOLD	2709.8	2709.8	2709.8	2709.8	2709.8
	WET SOIL	1191.5	1394.7	1599.3	1552.8	1452.9
WET DENSITY , g/cc		1.265	1.481	1.698	1.648	1.542
CAN NUMBER		SND-3	JCA-328	MC-04	K-9	MC-29
MASS IN GRAMS	CAN + WET SOIL	893.4	1071.7	1133.8	1063.3	1024.3
	CAN + DRY SOIL	807.0	952.7	970.2	889.2	834.9
	WATER	86.4	119.0	163.6	174.1	189.4
	CAN	82.2	249.4	218.6	249.9	249.2
	DRY SOIL	724.8	703.3	751.6	639.3	585.7
WATER CONTENT %		11.92	16.92	21.77	27.23	32.34
DRY DENSITY g/cc.		1.130	1.266	1.394	1.296	1.165

Height , mm : 116.1
Volume , cc : 942
Hammer Wt. Kg. : 4.54
Hammer Drop, mm : 457

Blows /Layer : 25
No. of layer : 5
Max. Dry Density, g/ **1.396**
Opt. Moisture Conter **21.84**



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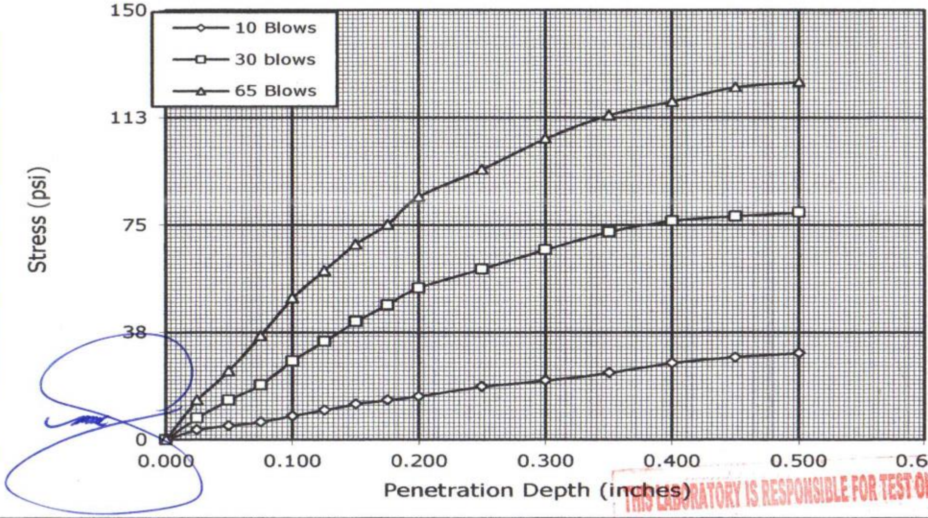
Client : **Ms. Patricia V. Villarico**
Attention : **Thru: NEUST**
Project : **Research**
Location : **Cabanatuan City, Nueva Ecija**
Sample Delivered : **2 Sacks Natural Soil**
Delivered By : **Ms. Patricia V. Villarico**
Sampled By: : **Ms. Patricia V. Villarico**
Source : **San Isidro, Nueva Ecija**

Test Report No : **SA-4112-B2-23**
Test Request Form No. : **27783-B3**
Date Received : **10-Mar-23**
Date of Test : **March 30 to April 13, 2023**
Date of Report : **17-Apr-23**
Tested By : **JBAGaraniel/JCAgner**
Encoded By: : **MJMDelen**
Checked By : **MAMDagos**

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883

	Penetration		
Depth	10	30	65
0.000	0.00	0.00	0.00
0.0250	3.44	7.56	13.74
0.0500	4.81	13.74	24.05
0.0750	6.18	19.24	36.31
0.1000	8.24	27.48	49.35
0.1250	10.31	34.35	59.08
0.1500	12.37	41.20	68.30
0.1750	13.74	47.07	75.15
0.2000	15.12	53.06	84.88
0.2500	18.55	59.68	94.51
0.3000	20.61	66.35	105.15
0.3500	23.36	72.54	113.37
0.4000	26.80	76.45	118.15
0.4500	28.86	78.08	123.20
0.5000	30.23	79.39	125.06
Swell (%)	***3.17***	***4.17***	***6.12***



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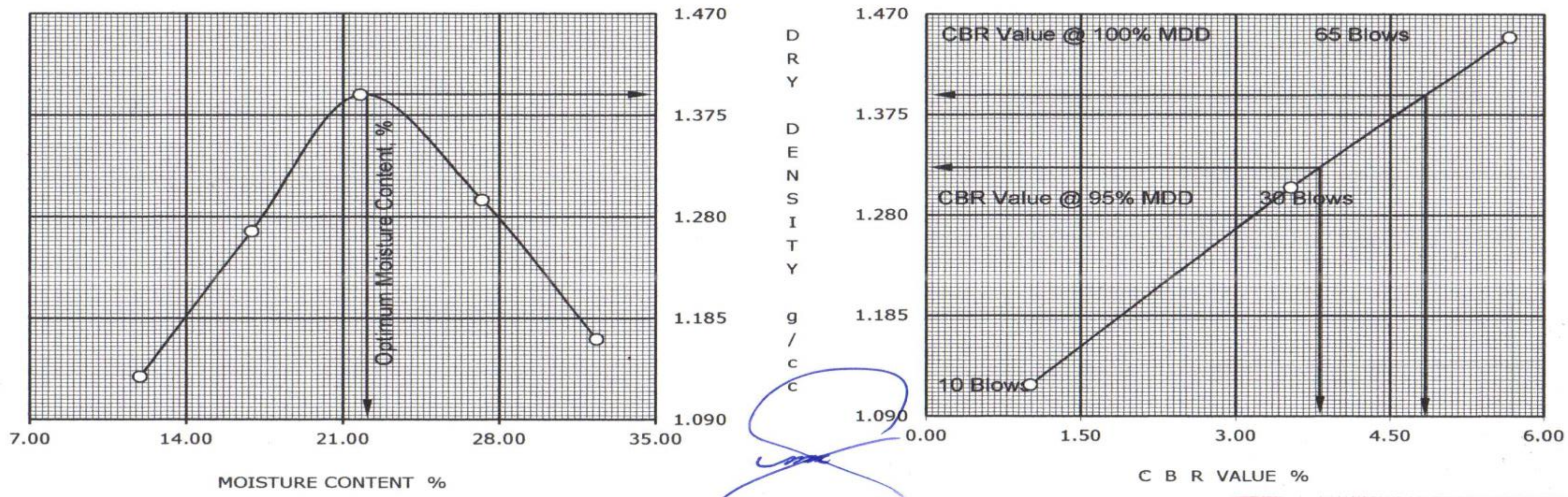
Client : **Ms. Patricia V. Villarico**
Attention : **Thru: NEUST**
Project : **Research**
Location : **Cabanatuan City, Nueva Ecija**
Sample Delivered : **2 Sacks Natural Soil**
Delivered By : **Ms. Patricia V. Villarico**
Sampled By : **Ms. Patricia V. Villarico**
Source : **San Isidro, Nueva Ecija**

Test Report No. : **SA-4112-B2-23**
Test Request Form No. : **27783-B3**
Date Received : **March 10, 2023**
Date of Test : **March 30 to April 13, 2023**
Date of Report : **April 17, 2023**
Tested By : **JBAGaraniel/JCAgner**
Encoded By : **MJMDelen**
Checked By : **MAMDagos**

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883



C B R VALUE @ 100 % MDD **4.83**
C B R VALUE @ 95 % MDD **3.81**

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Materials Testing Corporation
A Geotechnical and Materials Testing Laboratory
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- Subsurface Soil Investigation
- Plate Load Test
- Compressive / Flexural Strength of Concrete
- Three Edge Bearing Test for Concrete Pipes
- Concrete Coring
- Rebound Hammer Test
- Quality Test of Soil & Aggregates
- Field Density Test / CBR Test
- Tensile Test of Steel Materials
- Quality Test of Portland Cement
- Verification / Calibration of Testing Equipment
- Ultrasonic Thickness Gauge Determination of Steel Materials
- Structural Load Test

Client :	**Ms. Patricia V. Villarico**	Test Report No :	**SA-2486-B3-23**
Attention :	**Thru: NEUST**	Test Request Form No. :	**27783**
Project :	**Research**	Date Received :	**10-Mar-23**
Location :	**Cabanatuan City, Nueva Ecija**	Date of Test :	**March 27 to April 5, 2023**
Sample Delivered :	**2 Sacks 15% SCA**	Date of Report :	**April 17, 2023**
Delivered By :	**Ms. Patricia V. Villarico**	Tested By :	**ATV/FNAE**
Sampled By: :	**Ms. Patricia V. Villarico**	Encoded By: :	**MJMDelen**
Source :	**San Isidro, Nueva Ecija**	Checked By :	**MAMDagos**

REPORT OF TEST ON 15% SCA

	Sample Result
A. SIEVE ANALYSIS (ASTM D 422)	
Sieve Size	**% Passing**
3/8"	**100**
No.4	**100**
No.10	**99**
No.40	**97**
No.200	**94**
B. ATTERBERG LIMIT (ASTM D 4318)	
Liquid Limit	**62**
Plastic Limit	**36**
Plasticity Index	**26**
C. MOISTURE DENSITY RELATIONS OF SOIL USING MODIFIED EFFORT (ASTM D 1557)	
Maximum Dry Density, g/cc	**1.354**
Optimum Moisture Content,%	**29.48**
D. CALIFORNIA BEARING RATIO OF LABORATORY COMPACTED SOILS (ASTM D 1883)	
CBR Value @ 100% MDD	**4.44**
CBR Value @ 95 % MDD	**2.43**

Remarks:
1.This report give the result carried out as sample submitted to the labora
2.This report shall not be reproduced except in full, without the written approval of the Laboratory
3. n/r - no request ; n/s - not specified

Authorized Signatory:
MICHAEL ANGELO M. DAGOS
Laboratory Supervisor
For and On-behalf of ASTEC Materials Testing Corporation

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Calamba Laboratory (B1) - Km. 54 Bo. Makiling, Calamba, Laguna Tel. Nos.: [049] 545-2028; [02] 8736-3769; [0960] 893-4622
Cavite Laboratory (B2) - 102 Sampaloc 1, Palapala, Dasmariñas, Cavite Tel. Nos.: [046] 437-7470; [02] 8245-7997; [0960] 892-6065
Pampanga Laboratory (B3) - Unit A Genesis Building, Mc Arthur Hiway, San Isidro, San Fernando , Pampanga Tel. Nos.: [0968] 410-9261; [0915] 889-3733
Sta. Rosa Laboratory (B4) - Lot 2 & 3 Blk. C3, Villa Caceres Comm. Complex, Balibago, Sta. Rosa, Laguna Tel. No. [02] 726-5942; [0933] 520-0505; [0995] 364-9289
Cebu Laboratory (B7) - No. 42-B Sacris Road, Brgy. Bakilid, Mandaue City, Cebu; Tel. Nos.: (032) 239-6575; [02] 8245-2969; [0933] 062-1057
Email Address: astec.testing@yahoo.com
Website: www.astectesting.com

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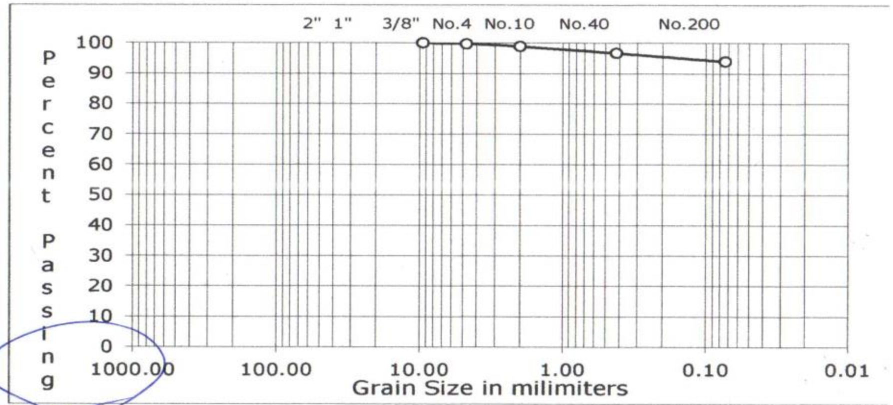
Client :	Ms. Patricia V. Villarico	Test Report No :	SA-2486-B3-23
Attention :	Thru: NEUST	Test Request Form No :	27783
Project :	Research	Date Received :	10-Mar-23
Location :	Cabanatuan City, Nueva Ecija	Date of Test :	March 27 to April 5, 2023
Sample Delivered :	2 Sacks 15% SCA	Date of Report :	17-Apr-23
Delivered By :	Ms. Patricia V. Villarico	Tested By :	ATV/FNAE
Sampled By: :	Ms. Patricia V. Villarico	Encoded By: :	MJMDelen
Source :	San Isidro, Nueva Ecija	Checked By :	MAMDagos

SIEVE ANALYSIS TEST
ASTM D 422

Sample Identification				15% SCA
Tare No.				F-07
Weight of Tare, grams				270.2
Weight of Sample with Tare, grams				1,121.8
Weight of Sample w/o Tare, grams				851.6
Sieve Size		Weight	Percent	Percent
Inches	mm	Retained,g	Retained	Passing
3/8"	9.52	0	0.0	100
No.4	4.75	2.4	0.3	100
No.10	2.00	7.1	0.8	99
No.40	0.42	18.3	2.1	97
No.200	0.074	23.6	2.8	94



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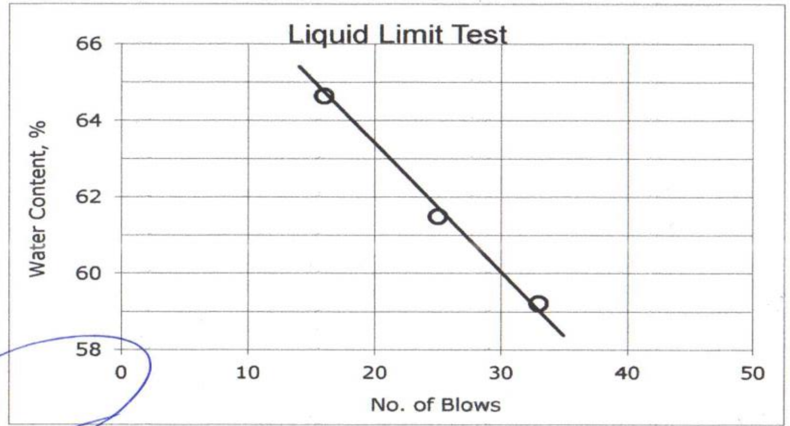
Client :	**Ms. Patricia V. Villarico**
Attention :	**Thru: NEUST**
Project :	**Research**
Location :	**Cabanatuan City, Nueva Ecija**
Sample Delivered :	**2 Sacks 15% SCA**
Delivered By :	**Ms. Patricia V. Villarico**
Sampled By: :	**Ms. Patricia V. Villarico**
Source :	**San Isidro, Nueva Ecija**

Test Report No :	**SA-2486-B3-23**
Test Request Form No. :	**27783**
Date Received :	**10-Mar-23**
Date of Test :	**March 27 to April 5, 2023**
Date of Report :	**17-Apr-23**
Tested By :	**ATV/FNAE**
Encoded By: :	**MJMDelen**
Checked By :	**MAMDagos**

ATTERBERG LIMITS
ASTM D 4318

Sample		15% SCA				
		Liquid Limit Test			Plastic Limit	
Trial No.		1	2	3	1	2
Tare No.		AT-17	AT-0	AT-24	AT-25	BS
Number of Blows		16	25	33		
Weight of Can	g	7.36	7.01	7.61	7.00	7.47
Weight of wet Soil w/ can	g	17.37	16.36	16.51	14.25	13.94
Weight of dry soil w/ can	g	13.44	12.80	13.20	12.33	12.22
Weight of water	g	3.93	3.56	3.31	1.92	1.72
Weight of soil	g	6.08	5.79	5.59	5.33	4.75
Water Content	%	64.64	61.49	59.21	36.02	36.21
Liquid Limit (LL)	%	62			USCS Symbol	
Plastic Limit (PL)	%	36				
Plasticity Index (PI)		26				



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Client :	**Ms. Patricia V. Villarico**
Attention :	**Thru: NEUST**
Project :	**Research**
Location :	**Cabanatuan City, Nueva Ecija**
Sample Delivered :	**2 Sacks 15% SCA**
Delivered By :	**Ms. Patricia V. Villarico**
Sampled By :	**Ms. Patricia V. Villarico**
Source :	**San Isidro, Nueva Ecija**

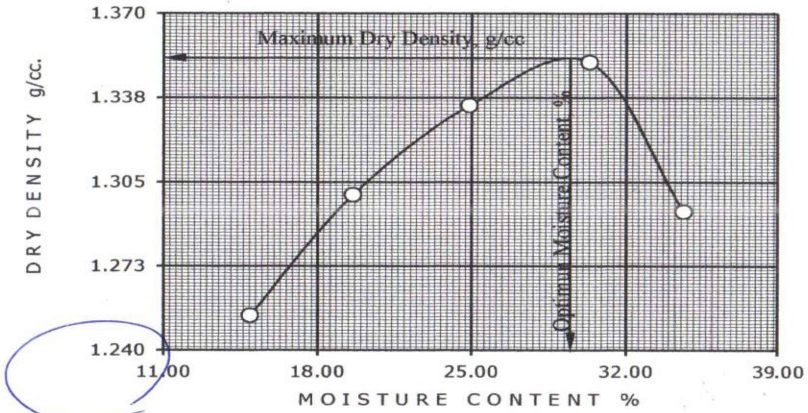
Test Report No. :	**SA-2486-B3-23**
Test Request Form No. :	**27783**
Date Received :	**10-Mar-23**
Date of Test :	**March 27 to April 5, 2023**
Date of Report :	**17-Apr-23**
Tested By :	**ATV/FNAE**
Encoded By :	**MJMDelen**
Checked By :	**MAMDagos**

MOISTURE & DENSITY RELATION OF SOIL
ASTM D 1557

DESCRIPTION OF MATERIALS:		15% SCA				
TRIAL NUMBER		1	2	3	4	5
WATER ADDED , cc.		0	100	200	300	400
MASS IN GRAMS	MOLD + WET SOIL	4105.1	4214.4	4321.7	4411.8	4393.3
	MOLD	2724.9	2724.9	2724.9	2724.9	2724.9
	WET SOIL	1380.2	1489.5	1596.8	1686.9	1668.4
WET DENSITY , g/cc		1.441	1.555	1.667	1.761	1.742
CAN NUMBER		RB-16	RB-17	RB-18	RB-13	RB-12
MASS IN GRAMS	CAN + WET SOIL	250.6	366.1	294.8	330.9	225.6
	CAN + DRY SOIL	220.1	308.8	239.3	257.8	171.7
	WATER	30.5	57.3	55.5	73.1	53.9
	CAN	16.1	16.4	16.4	16.7	16.1
	DRY SOIL	204.0	292.4	222.9	241.1	155.6
WATER CONTENT %		14.95	19.60	24.90	30.32	34.64
DRY DENSITY g/cc.		1.253	1.300	1.335	1.351	1.293

Height , mm	:	116.1
Volume , cc	:	958
Hammer Wt. Kg.	:	4.54
Hammer Drop, mm	:	457

Blows /Layer	:	25
No. of layer	:	5
Max. Dry Density, g/		**1.354**
Opt. Moisture Conter		**29.48**



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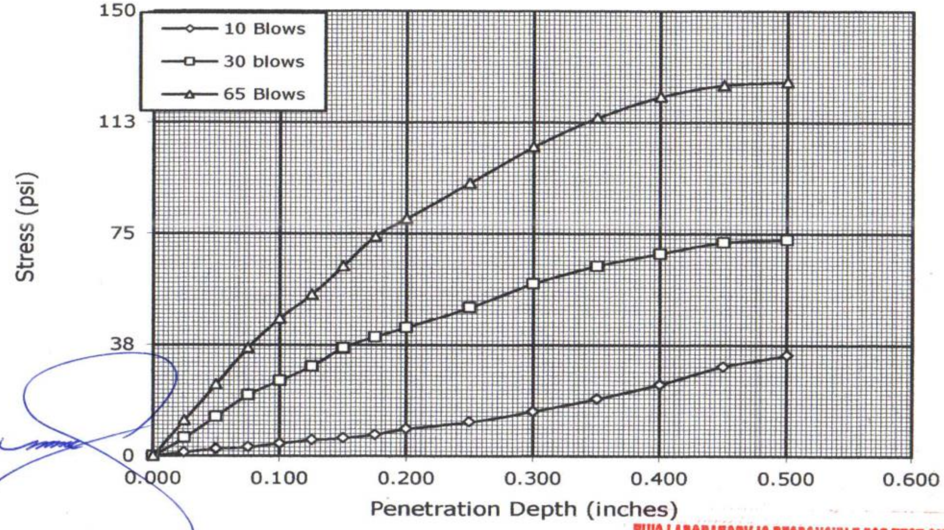
Client :	Ms. Patricia V. Villarico
Attention :	Thru: NEUST
Project :	Research
Location :	Cabanatuan City, Nueva Ecija
Sample Delivered :	2 Sacks 15% SCA
Delivered By :	Ms. Patricia V. Villarico
Sampled By: :	Ms. Patricia V. Villarico
Source :	San Isidro, Nueva Ecija

Test Report No :	SA-2486-B3-23
Test Request Form No. :	27783
Date Received :	10-Mar-23
Date of Test :	March 27 to April 5, 2023
Date of Report :	17-Apr-23
Tested By :	ATV/FNAE
Encoded By: :	MJMDelen
Checked By :	MAMDagos

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883

	Penetration		
Depth	10	30	65
0.000	0.00	0.00	0.00
0.0250	1.21	6.06	12.11
0.0500	2.42	13.33	24.23
0.0750	3.03	20.59	36.49
0.1000	4.24	25.44	46.42
0.1250	5.45	30.29	54.49
0.1500	6.06	36.49	64.17
0.1750	7.27	40.21	74.03
0.2000	9.09	43.32	80.06
0.2500	11.51	50.14	92.14
0.3000	15.14	58.21	104.33
0.3500	19.38	64.17	114.07
0.4000	24.23	68.31	121.22
0.4500	30.29	72.12	125.15
0.5000	34.01	73.07	126.23

Swell (%)	*3.10*	*4.22*	*6.39*



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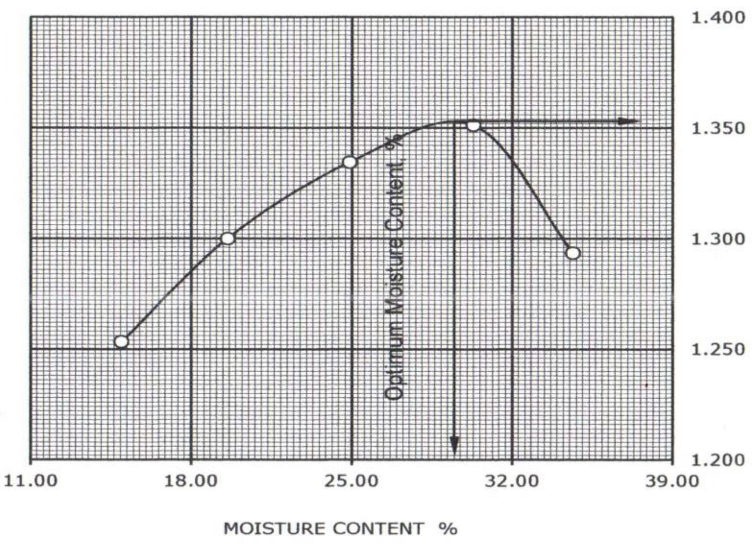
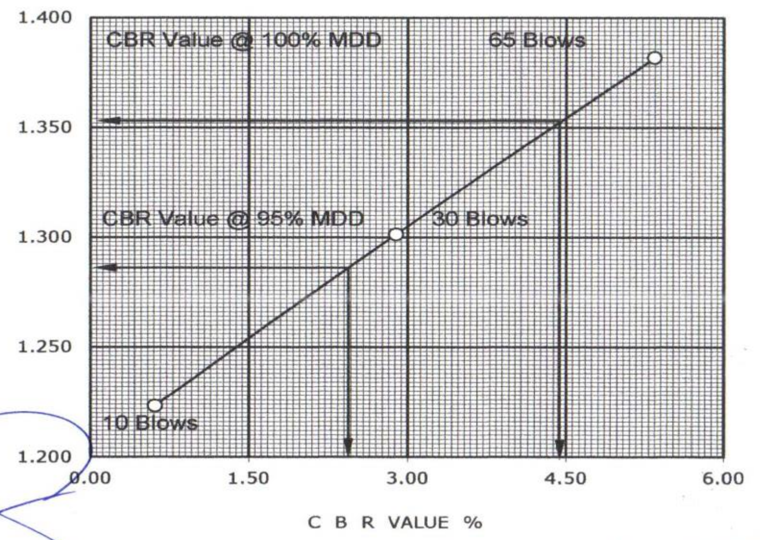
Client : **Ms. Patricia V. Villarico**
Attention : **Thru: NEUST**
Project : **Research**
Location : **Cabanatuan City, Nueva Ecija**
Sample Delivered : **2 Sacks 15% SCA**
Delivered By : **Ms. Patricia V. Villarico**
Sampled By : **Ms. Patricia V. Villarico**
Source : **San Isidro, Nueva Ecija**

Test Report No. : **SA-2486-B3-23**
Test Request Form No. : **27783**
Date Received : **March 10, 2023**
Date of Test : **March 27 to April 5, 2023**
Date of Report : **April 17, 2023**
Tested By : **ATV/FNAE**
Encoded By : **MJMDelen**
Checked By : **MAMDagos**

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883



DRY DENSITY g/cc



C B R VALUE @ 100 % MDD	**4.44**
C B R VALUE @ 95 % MDD	**2.43**

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- Subsurface Soil Investigation
- Plate Load Test
- Compressive / Flexural Strength of Concrete
- Three Edge Bearing Test for Concrete Pipes
- Concrete Coring
- Rebound Hammer Test
- Quality Test of Soil & Aggregates
- Field Density Test / CBR Test
- Tensile Test of Steel Materials
- Quality Test of Portland Cement
- Verification / Calibration of Testing Equipment
- Ultrasonic Thickness Gauge Determination of Steel Materials
- Structural Load Test

Client :	**Ms. Patricia V. Villarico**	Test Report No :	**SA-4113-B2-23**
Attention :	**Thru: NEUST**	Test Request Form No. :	**27783-B3**
Project :	**Research**	Date Received :	**10-Mar-23**
Location :	**Cabanatuan City, Nueva Ecija**	Date of Test :	**March 30 TO April 13, 2023**
Sample Delivered :	**2 Sacks 15% PUP**	Date of Report :	**April 17, 2023**
Delivered By :	**Ms. Patricia V. Villarico**	Tested By :	**JBAGaraniel/JCAgner**
Sampled By: :	**Ms. Patricia V. Villarico**	Encoded By: :	**MJMDelen**
Source :	**San Isidro, Nueva Ecija**	Checked By :	**MAMDagos**

REPORT OF TEST ON 15% PUP

	Sample Result
A. SIEVE ANALYSIS (ASTM D 422)	
Sieve Size	**% Passing**
No.8	**100**
No.10	**100**
No.40	**98**
No.200	**98**
B. ATTERBERG LIMIT (ASTM D 4318)	
Liquid Limit	**59**
Plastic Limit	**27**
Plasticity Index	**32**
C. MOISTURE DENSITY RELATIONS OF SOIL USING MODIFIED EFFORT (ASTM D 1557)	
Maximum Dry Density, g/cc	**1.430**
Optimum Moisture Content,%	**24.85**
D. CALIFORNIA BEARING RATIO OF LABORATORY COMPACTED SOILS (ASTM D 1883)	
CBR Value @ 100% MDD	**3.83**
CBR Value @ 95 % MDD	**2.95**

Remarks:
1.This report give the result carried out as sample submitted to the labora
2.This report shall not be reproduced except in full, without the written approval of the Laboratory
3. n/r - no request ; n/s - not specified

Authorized Signatory:
Laboratory Supervisor
For and On-behalf of ASTEC Materials Testing Corporation

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SC# 062098-1056-030123
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Pampanga Laboratory (B3) - Unit A Genesis Building, Mc Arthur Hiway, San Isidro, San Fernando , Pampanga Tel. Nos.: [0968] 410-9261; [0915] 889-3733
Sta. Rosa Laboratory (B4) – Lot 2 & 3 Blk. C3. Villa Caseres Comm. Complex, Balibago, Sta. Rosa, Laguna Tel. No. [028] 736-5942; [0933] 520-0505; [0995] 364-9289
Cebu Laboratory (B7) - No. 42-B Sacris Road, Brgy. Bakilid, Mandaue City, Cebu; Tel. Nos.: (032) 239-6575; [02] 8245-2969; [0933] 062-1057
Email Address: astec.testing@yahoo.com
Website: www.astectesting.com

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PAMPANGA BRANCH • ASTEC

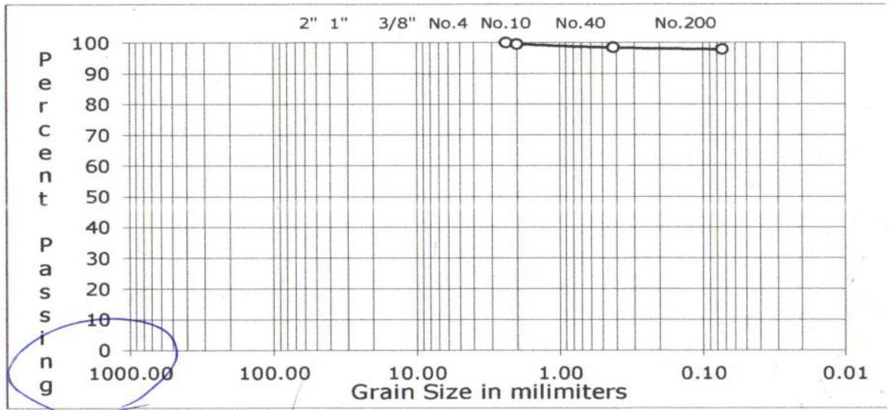
ASTEC

Client : **Ms. Patricia V. Villarico**
Attention : **Thru: NEUST**
Project : **Research**
Location : **Cabanatuan City, Nueva Ecija**
Sample Delivered : **2 Sacks 15% PUP**
Delivered By : **Ms. Patricia V. Villarico**
Sampled By: : **Ms. Patricia V. Villarico**
Source : **San Isidro, Nueva Ecija**

Test Report No : **SA-4113-B2-23**
Test Request Form No : **27783-B3**
Date Received : **10-Mar-23**
Date of Test : **March 30 to April 13, 2023**
Date of Report : **17-Apr-23**
Tested By : **JBAGaraniel/JCAgner**
Encoded By: : **MJMDelen**
Checked By : **MAMDagos**

SIEVE ANALYSIS TEST
ASTM D 422

Sample Identification				15% PUP
Tare No.				P-03
Weight of Tare, grams				151.5
Weight of Sample with Tare, grams				1,057.0
Weight of Sample w/o Tare, grams				905.5
Sieve Size		Weight Retained,g	Percent Retained	Percent Passing
Inches	mm			
No.8	2.38	0	0.0	100
No.10	2.00	3.9	0.4	100
No.40	0.42	10.6	1.2	98
No.200	0.074	5.7	0.6	98



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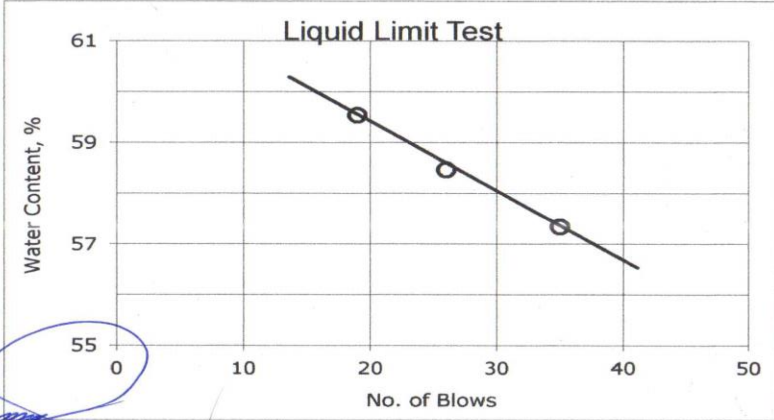
Attention :	Thru: NEUST		Test Request Form No. :	27783-B3
Project :	Research		Date Received :	10-Mar-23
Location :	Cabanatuan City, Nueva Ecija		Date of Test :	March 30 TO April 13, 2023
Sample Delivered :	2 Sacks 15% PUP		Date of Report :	17-Apr-23
Delivered By :	Ms. Patricia V. Villarico		Tested By :	JBAGaraniel/JCAgner
Sampled By: :	Ms. Patricia V. Villarico		Encoded By: :	MJMDelen
Source :	San Isidro, Nueva Ecija		Checked By :	MAMDagos

ATTERBERG LIMITS
ASTM D 4318

Sample		15% PUP				
		Liquid Limit Test			Plastic Limit	
Trial No.		1	2	3	1	2
Tare No.		L8	L16	L-1	P-31	P-33
Number of Blows		19	26	35		
Weight of Can	g	7.16	7.17	7.20	3.60	3.60
Weight of wet Soil w/ can	g	13.08	14.58	13.06	11.96	12.77
Weight of dry soil w/ can	g	10.87	11.85	10.92	10.20	10.84
Weight of water	g	2.21	2.73	2.13	1.76	1.93
Weight of soil	g	3.71	4.68	3.72	6.60	7.23
Water Content	%	59.53	58.46	57.34	26.74	26.72
Liquid Limit (LL)	%	59			USCS Symbol	
Plastic Limit (PL)	%	27				
Plasticity Index (PI)		32				



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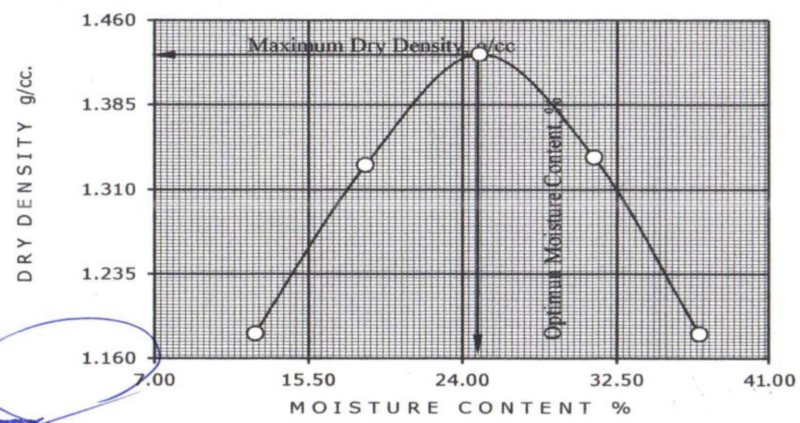
Project :	**Research**	Date Received :	**10-Mar-23**
Location :	**Cabanatuan City, Nueva Ecija**	Date of Test :	**March 30 to April 13, 2023**
Sample Delivered :	**2 Sacks 15% PUP**	Date of Report :	**17-Apr-23**
Delivered By :	**Ms. Patricia V. Villarico**	Tested By :	**JBAGaraniel/JCAgner**
Sampled By :	**Ms. Patricia V. Villarico**	Encoded By :	**MJMDelen**
Source :	**San Isidro, Nueva Ecija**	Checked By :	**MAMDagos**

MOISTURE & DENSITY RELATION OF SOIL
ASTM D 1557

DESCRIPTION OF MATERIALS:		15% PUP				
TRIAL NUMBER		1	2	3	4	5
WATER ADDED , cc.		0	175	350	525	700
MASS IN GRAMS	MOLD + WET SOIL	3963.3	4198.1	4392.8	4364.2	4235.7
	MOLD	2709.8	2709.8	2709.8	2709.8	2709.8
	WET SOIL	1253.5	1488.3	1683	1654.4	1525.9
WET DENSITY , g/cc		1.331	1.580	1.787	1.756	1.620
CAN NUMBER		NB7	NB-8	PG-12	MC-006	AST-B2
MASS IN GRAMS	CAN + WET SOIL	1017.7	885.5	915.9	736.0	1246.8
	CAN + DRY SOIL	913.3	758.9	782.6	580.0	976.4
	WATER	104.4	126.6	133.3	156.0	270.4
	CAN	82.9	79.2	248.0	80.4	246.8
	DRY SOIL	830.4	679.7	534.6	499.6	729.6
WATER CONTENT %		12.57	18.63	24.93	31.22	37.06
DRY DENSITY g/cc.		1.182	1.332	1.430	1.338	1.182

Height , mm	: 116.1	Blows /Layer	: 25
Volume , cc	: 942	No. of layer	: 5
Hammer Wt. Kg.	: 4.54	Max. Dry Density, g/	**1.430**
Hammer Drop, mm	: 457	Opt. Moisture Conter	**24.85**



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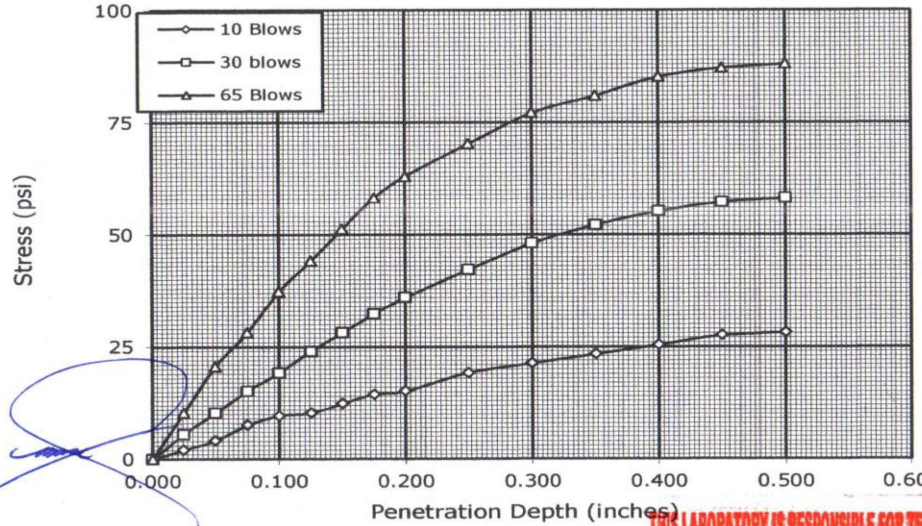
Attention :	Thru: NEUST	Test Request Form No. :	27783-B3
Project :	Research	Date Received :	10-Mar-23
Location :	Cabanatuan City, Nueva Ecija	Date of Test :	March 30 to April 13, 2023
Sample Delivered :	2 Sacks 15% PUP	Date of Report :	17-Apr-23
Delivered By :	Ms. Patricia V. Villarico	Tested By :	JBAGaraniel/JCAgner
Sampled By: :	Ms. Patricia V. Villarico	Encoded By: :	MJMDelen
Source :	San Isidro, Nueva Ecija	Checked By :	MAMDagos

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883

Depth	Penetration 10	30	65
0.000	0.00	0.00	0.00
0.0250	2.06	5.50	10.31
0.0500	4.12	10.31	20.61
0.0750	7.56	15.12	28.17
0.1000	9.62	19.24	37.29
0.1250	10.31	24.05	44.13
0.1500	12.37	28.17	51.25
0.1750	14.43	32.29	58.17
0.2000	15.12	35.98	62.99
0.2500	19.24	42.18	70.26
0.3000	21.30	48.04	77.11
0.3500	23.36	52.16	81.02
0.4000	25.42	55.17	85.21
0.4500	27.48	57.27	87.13
0.5000	28.17	58.17	88.09
Swell (%)	***3.29***	***4.28***	***6.65***



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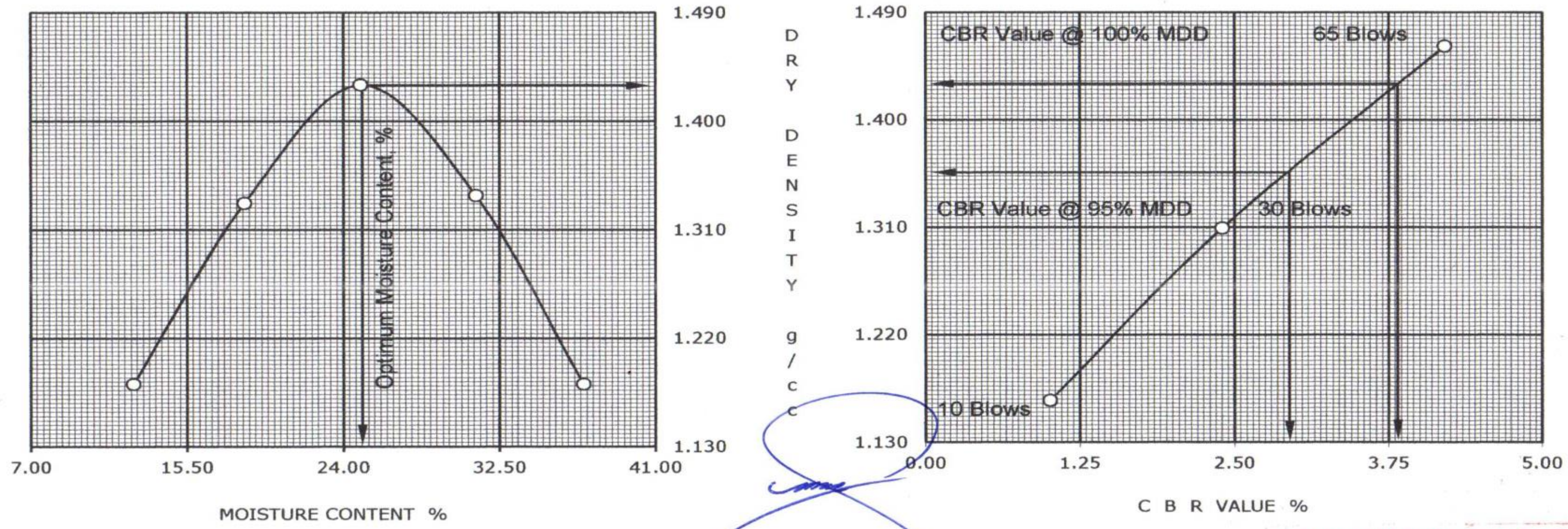
Project : **Research**	Date Received : **March 10, 2023**
Location : **Cabanatuan City, Nueva Ecija**	Date of Test : **March 30 to April 13, 2023**
Sample Delivered : **2 Sacks 15% PUP**	Date of Report : **April 17, 2023**
Delivered By : **Ms. Patricia V. Villarico**	Tested By : **JBAGaraniel/JCAgner**
Sampled By : **Ms. Patricia V. Villarico**	Encoded By : **MJMDelen**
Source : **San Isidro, Nueva Ecija**	Checked By : **MAMDagos**

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883



C B R VALUE @ 100 % MDD **3.83**
C B R VALUE @ 95 % MDD **2.95**

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A Geotechnical and Materials Testing Laboratory
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- Subsurface Soil Investigation
- Plate Load Test
- Compressive / Flexural Strength of Concrete
- Three Edge Bearing Test for Concrete Pipes
- Concrete Coring
- Rebound Hammer Test
- Quality Test of Soil & Aggregates
- Field Density Test / CBR Test
- Tensile Test of Steel Materials
- Quality Test of Portland Cement
- Verification / Calibration of Testing Equipment
- Ultrasonic Thickness Gauge Determination of Steel Materials
- Structural Load Test

Client :	**Ms. Patricia V. Villarico**	Test Report No :	**SA-2487-B3-23**
Attention :	**Thru: NEUST**	Test Request Form No. :	**27783**
Project :	**Research**	Date Received :	**10-Mar-23**
Location :	**Cabanatuan City, Nueva Ecija**	Date of Test :	**March 28 to April 11, 2023**
Sample Delivered :	**2 Sacks 15% PUP+SCSA**	Date of Report :	**April 17, 2023**
Delivered By :	**Ms. Patricia V. Villarico**	Tested By :	**ATV/FNAE**
Sampled By: :	**Ms. Patricia V. Villarico**	Encoded By: :	**MJMDelen**
Source :	**San Isidro, Nueva Ecija**	Checked By :	**MAMDagos**

REPORT OF TEST ON 15% PUP+SCSA

Sample Result

A. SIEVE ANALYSIS (ASTM D 422)

Sieve Size	% Passing
1/2"	100
3/8"	100
No.4	100
No.10	94
No.40	92
No.200	91

B. ATTERBERG LIMIT (ASTM D 4318)

Liquid Limit	61
Plastic Limit	36
Plasticity Index	25

C. MOISTURE DENSITY RELATIONS OF SOIL USING MODIFIED EFFORT (ASTM D 1557)

Maximum Dry Density, g/cc	1.417
Optimum Moisture Content,%	26.18

D. CALIFORNIA BEARING RATIO OF LABORATORY COMPACTED SOILS (ASTM D 1883)

CBR Value @ 100% MDD	5.47
CBR Value @ 95 % MDD	4.18

Remarks:
1.This report give the result carried out as sample submitted to the labora
2.This report shall not be reproduced except in full, without the written approval of the Laboratory
3. n/r - no request ; n/s - not specified

Authorized Signatory: MICHAEL ANGELO M. DAGOS, Laboratory Supervisor
For and On-behalf of ASTEC Materials Testing Corporation

Form revised 07/02
SC# 062098-1057-030123
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Cavite Laboratory (B2) - 102 Sampaloc 1, Palapala, Dasmariñas, Cavite Tel. Nos.: [046] 437-7470; [02] 8781-7090; [0960] 892-6065
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Client :	Ms. Patricia V. Villarico
Attention :	Thru: NEUST
Project :	Research
Location :	Cabanatuan City, Nueva Ecija
Sample Delivered :	2 Sacks 15% PUP+SCSA
Delivered By :	Ms. Patricia V. Villarico
Sampled By: :	Ms. Patricia V. Villarico
Source :	San Isidro, Nueva Ecija

Test Report No :	SA-2487-B3-23
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Date Received :	10-Mar-23
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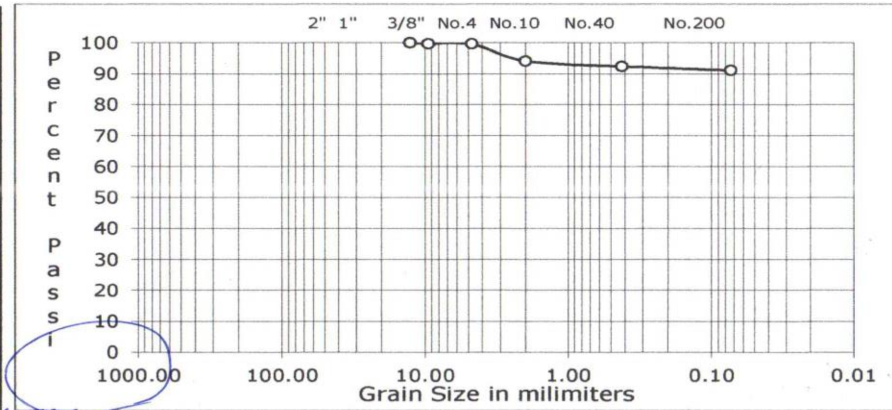
Date of Report :	17-Apr-23
Tested By :	ATV/FNAE
Encoded By: :	MJMDelen
Checked By :	MAMDagos

SIEVE ANALYSIS TEST
ASTM D 422

Sample Identification				15% PUP+SCSA
Tare No.				F-27
Weight of Tare, grams				266.6
Weight of Sample with Tare, grams				1,261.0
Weight of Sample w/o Tare, grams				994.4
Sieve Size		Weight Retained,g	Percent Retained	Percent Passing
Inches	mm			
1/2"	12.7	0	0.0	100
3/8"	9.52	2.4	0.2	100
No.4	4.75	1.3	0.1	100
No.10	2.00	54.3	5.5	94
No.40	0.42	17.2	1.7	92
No.200	0.074	13.0	1.3	91



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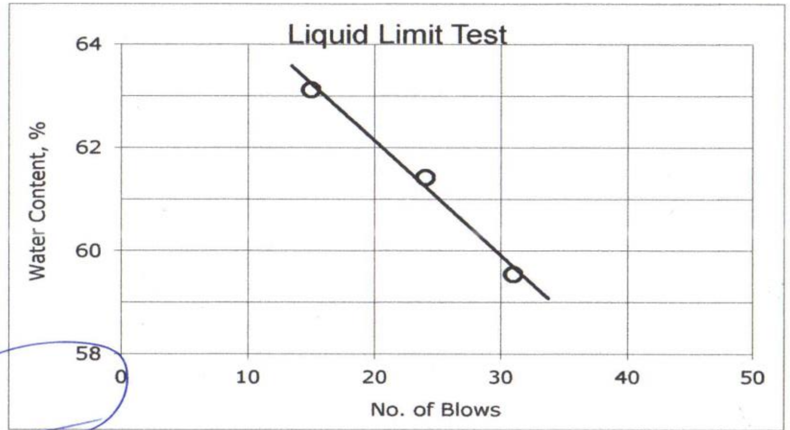
Source :	San Isidro, Nueva Ecija		Checked By :	MAMDagos

ATTERBERG LIMITS
ASTM D 4318

Sample		15% PUP+SCSA				
		Liquid Limit Test			Plastic Limit	
Trial No.		1	2	3	1	2
Tare No.		AT-15	AS-1	ATT-28	AT-3	AT-27
Number of Blows		15	24	31		
Weight of Can	g	9.40	9.69	9.94	9.88	7.31
Weight of wet Soil w/ can	g	19.66	19.02	18.97	16.42	13.83
Weight of dry soil w/ can	g	15.69	15.47	15.60	14.69	12.10
Weight of water	g	3.97	3.55	3.37	1.73	1.73
Weight of soil	g	6.29	5.78	5.66	4.81	4.79
Water Content	%	63.12	61.42	59.54	35.97	36.12
Liquid Limit (LL)	%	61			USCS Symbol	
Plastic Limit (PL)	%	36				
Plasticity Index (PI)		25				



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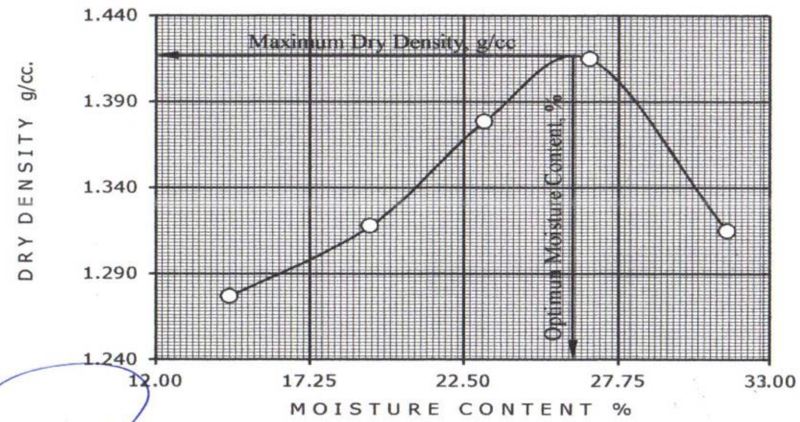
Source :	San Isidro, Nueva Ecija	Checked By :	MAMDagos

MOISTURE & DENSITY RELATION OF SOIL
ASTM D 1557

DESCRIPTION OF MATERIALS:		15% PUP+SCSA				
TRIAL NUMBER		1	2	3	4	5
WATER ADDED , cc.		0	100	200	300	400
MASS IN GRAMS	MOLD + WET SOIL	4125.9	4230.7	4351.9	4443.1	4380.7
	MOLD	2724.9	2724.9	2724.9	2724.9	2724.9
	WET SOIL	1401	1505.8	1627	1718.2	1655.8
WET DENSITY , g/cc		1.462	1.572	1.698	1.794	1.728
CAN NUMBER		RB-7	RB-13	RB-10	RB-18	RB-19
MASS IN GRAMS	CAN + WET SOIL	255.2	351.8	308.0	384.1	289.0
	CAN + DRY SOIL	224.9	297.6	253.1	306.5	223.7
	WATER	30.3	54.2	54.9	77.6	65.3
	CAN	16.4	16.7	16.5	16.7	16.2
	DRY SOIL	208.5	280.9	236.6	289.8	207.5
WATER CONTENT %		14.53	19.30	23.20	26.78	31.47
DRY DENSITY g/cc.		1.277	1.318	1.378	1.415	1.315

Height , mm :	116.1	Blows /Layer :	25
Volume , cc :	958	No. of layer :	5
Hammer Wt. Kg. :	4.54	Max. Dry Density, g/	**1.417**
Hammer Drop, mm :	457	Opt. Moisture Conter	**26.18**



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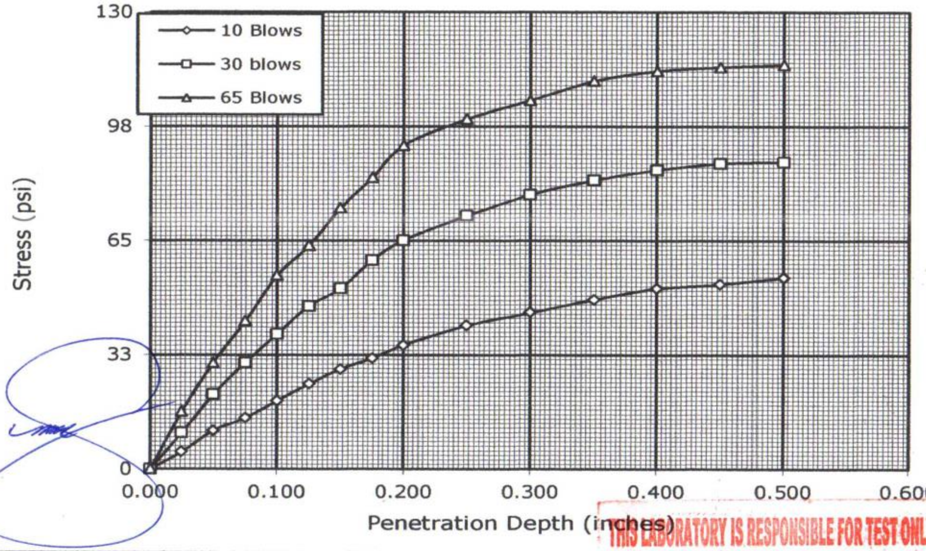
Tested By :	**ATV/FNAE**
Encoded By: :	**MJMDelen**
Checked By :	**MAMDagos**

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883

	Penetration		
Depth	10	30	65
0.000	0.00	0.00	0.00
0.0250	4.85	10.30	16.35
0.0500	10.90	21.20	30.29
0.0750	14.54	30.29	42.08
0.1000	19.38	38.35	55.11
0.1250	24.23	46.42	63.54
0.1500	28.47	51.39	74.34
0.1750	31.53	59.45	82.92
0.2000	35.25	65.13	92.14
0.2500	40.84	72.12	99.61
0.3000	44.56	78.16	105.05
0.3500	48.28	82.29	110.49
0.4000	51.39	85.15	113.36
0.4500	52.63	87.05	114.43
0.5000	54.49	87.37	115.14
Swell (%)	***3.09***	***4.94***	***6.82***



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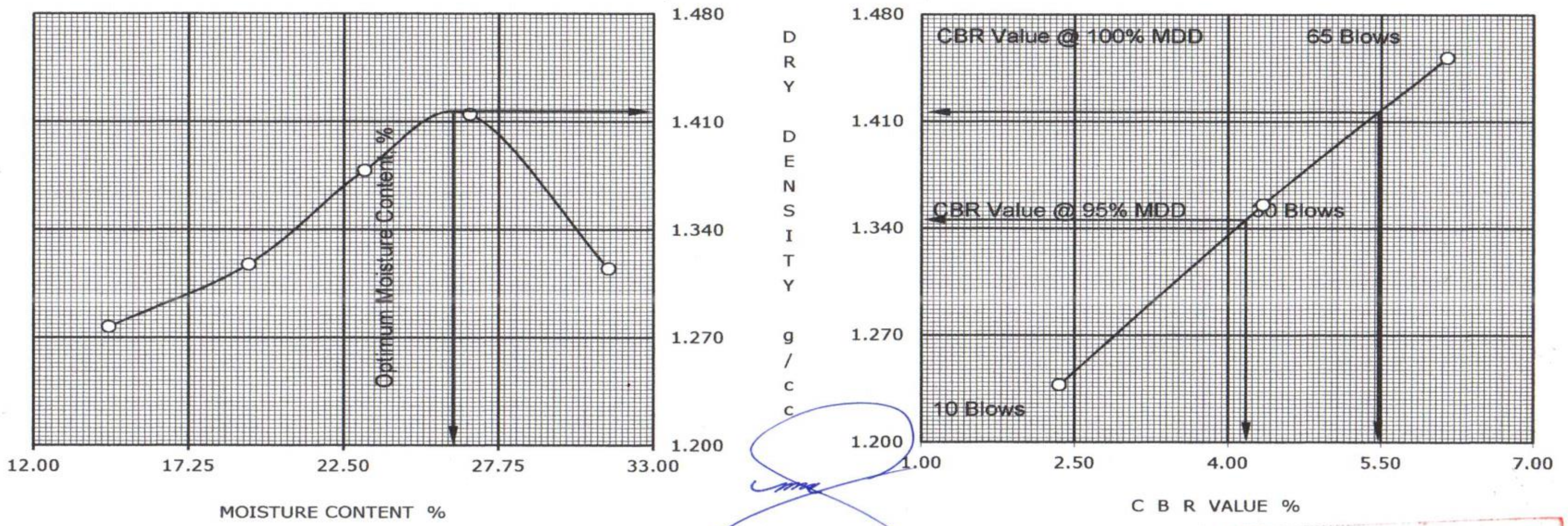
Source : **San Isidro, Nueva Ecija**	Checked By : **MAMDagos**

CALIFORNIA BEARING RATIO OF SOIL
ASTM D 1883



C B R VALUE @ 100 % MDD	**5.47**
C B R VALUE @ 95 % MDD	**4.18**

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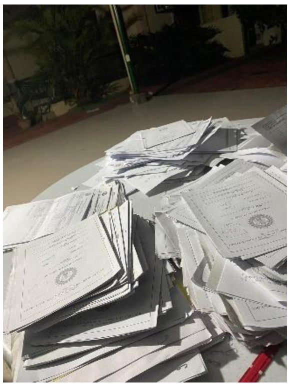
DOCUMENTATION

- **Gathering of Materials**








- **Burning of sugarcane straw and shredding of papers**






Preparation of materials





- **Material Testing at DPWH accredited Geotechnical testing Center at Pampanga**




ACKNOWLEDGEMENT

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-THE RESEARCHERS

DEDICATION

The researchers wholeheartedly dedicate this piece of work to their loving and caring parents, friends and classmates, teachers, and to our Kind and Almighty God who guided them in producing this research study.

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