Stabilization of soil by sand

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BACHELOR OF SCIENCE IN CIVIL ENGINEERING
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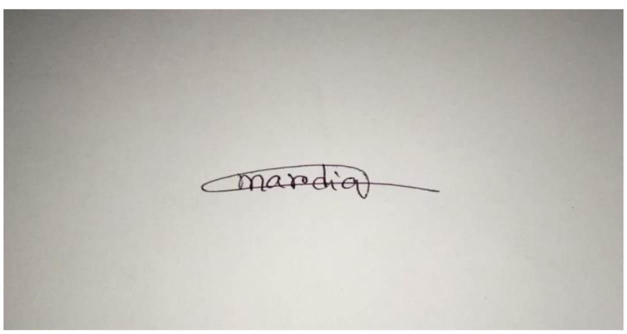
Thesis Acceptance Form

The thesis titled 'Effect of Sand Content on Dry Density and Moisture Content of Compacted, Semi-Circular and Local bus in Dhaka City' submitted by MISHKATUL KABIR, ID No: 163-47- 274 ;TIPU SULTAN, IDNo:163-47-229;ANWAR HOSSAIN,IDNo:163- 47-280;S.M. RASEL RANA,IDNo:163-47-258; MD. SAHARIAR MAHABUB , ID No: 163-47-244, Session2016-2017has been accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of CivilEngineering.



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Acknowledgement

It is the kindness of almighty Allah, the most generous and the most merciful, who choose me and enable me to undertake such a massive taskI would like to express my utmost gratitude and sincere appreciation to my thesis Supervisor Kawsar Alom, Lecturer, Department of Civil Engineering for his extreme generosity, keen interest, continuous encouragement, invaluable guidance,outstanding suggestions, incredible dedication and unparalleled patience. I feel obliged to deliver thanks to him for providing us the scope, timely direction and necessary support to undertake and complete the study.I wish to express my deep sense sense of gratitude to all my teachers of Department of Civil Engineering for theirbenevolent cooperation and encouragement during the study. I appreciate the cordiality of the lab assistant Mr Julfiqar for his help.

Dedication

This all work of thesis and project dedicated to our honorable supervisor Mardia Mumtaz who helped us a lot and inspired us to complete this work.

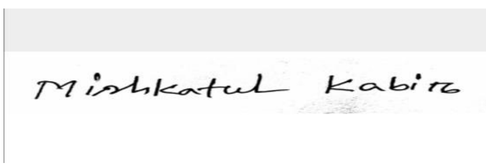
Thank you Madam.

Abstract

Clayey soils often exhibit undesirable engineering behaviour such as low strength, swelling and shrinkage characteristics etc. To improve these properties, the common method followed is stabilization. An experimental program carried out in this study aims to highlight the physical mechanisms of stabilization of an expansive soil by adding an inert material (sand). The study aimed to analyze the effect of stabilization on the variation of soil consistency and the results have shown that soil consistency improved appreciably. The findings of the laboratory testing procedures also presented substantial improvement in strength with the addition of sand percentages up to 60% by weight of soil, as well a noticeable alteration in the moisture-density relation. The soil tested could be used as subgrade material in pavement structures for low volume bearing roads, after its stabilization with fine sand. A further step in the investigation process could be the analysis of the swelling potential of clayey soils in conjunction with the addition of other waste materials along with sand, as well as the cost-benefit relationships of stabilization with sand in large projects like the highway construction

Declaration

It is hereby declared that this thesis has been prepared in the partial fulfillment of therequirementsforthedegreeofBachelorofCivilEngineeringintheDepartment of Civil Engineering, Daffodil International University, Dhaka, and this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.



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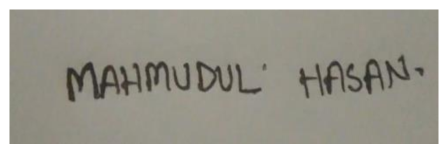

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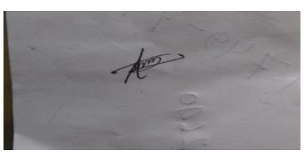

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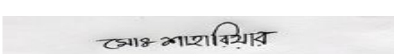

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1. Introduction

Subgrade assumes a significant job in safe and financially savvy asphalt development, given that the materials are reasonable. For the most part, there is a prerequisite for the improvement of both the pliancy and the bearing limit of neighborhood soils. The adjustment strategies are a typical proposal for such objectives to be accomplished. There are numerous methods for soil adjustment and the decision between them relies upon a few financial, useful and natural boundaries. Discrete procedures are substance adjustment, warm adjustment, adjustment by added substances, for example, lime and concrete.Sand is a normally happening granular material. As a result of its high burden bearing limit in restricte condition, sand could be utilized as a filler material. In this way, sand could be utilized in shifting extents as admixture to firm soils adjusting the properties of versatility, compaction and quality of the blends (Khemissa et al., 2015; Louafi et al., 2012). This work meant to assess the research center outcomes acquired at the point when a dark dirt soil was tried for the dry thickness dampness relationship and for the unconfined compressive quality after the admixture of sand in various extents.Soils demonstrating volumetric changes when they react to changes in their dampness content are described as broad. Such soils display expanding shrinkage and regularly result to harm on common building developments like the transportation foundation. The alteration in soil volume is incredibly dependent on both the mineralogy of materials making the soils and their degrees in the earth mass. Issues in particular structures have developed in various spots in Greece; occurrences of such unsafe errands are the National Road near Thebes, Central Greece, along a 20 km territory (Gkasios et al., 2000), and the typical road arrangement of N. Evros prefecture (Papakyriakopoulos et al., 2006), where geotechnical issues have been noted.Various experts have applied inactive materials to soils, as a procedure for offsetting them (Bengraa et al., 2005; Kaoua et al., 1994; Lamara et al., 2005; Louafi et al., 2011). Regardless of the way that the assessment works have shown that the extension of inactive materials is a promising system for offsetting such soils,there are up 'til now many open requests on the lead of an updated soil that require answers from the pros' area. In this work, the effect the development of sand on the characteristics of a clayey soil is being mulled over. In an investigation work (Chavali et al., 2014) it was found that the most extraordinary dry thickness of mud sand mix improved in with the development of sand up to 30%; starting there it decreased. In a comparative report, the perfect clamminess content reduced up to 30% sand content from that point on it extended hardly. There is an energy for exploring the simultaneous movement of sand and various materials in change fundamentals . Sharma et al. went after usage of sand, rice husk flotsam and jetsam and waste plastic fiber for improving compaction characteristics of clayey soil for use as subgrade material. The effect of materials, for instance, fly flotsam and jetsam or stream sand on compaction, and quality characteristics of dull cotton soil has been comprehensively analyzed in countries like India where issues are experienced as a result of cyclic growing and contracting behavior of the soils. Basically, advancement plans in which sand is used as a stabilizer as opposed to cement or lime could provoke restricted advancement costs for boulevards passing on medium thickness traffic.An investigation work in Uganda exhibited that most extraordinary dry thickness (MDD) and perfect soddenness content (OMC) extended from 1867 to 2357 kg/m3 and decreased from 16.5 to 8.5%, exclusively, at sand blends of 20-100% while the unconfined compressive quality lessened from 787 to 95 kPa at sand blends of 20-60%.As per modification techniques followed in order to improve the earth, the better soil particles are superseded with coarser particles of sand admixture. In such a way, a uniform level of particles in the earth is made and the composite mix surrounded has both association and grinding. Furthermore, when suitably mixed, set and compacted at site, the soil shows improved weight passing on limit

OBJECTIVES:

- To improve these characteristics such as low strength, swelling and shrinkage etc.
- The study aimed to analyse the effect of stabilization on the variation of soil consistency.

The findings of the laboratory testing procedures also presented substantial improvement in strength with the addition of sand percentages up to 25 % by weight of soil

2. Materials and Methods

The dirt examples for the research center examination were gathered at an area where the thickness of expanding soils fluctuates from a couple of meters to a few many meters, showing up in 1 to 3 meters superimposed layers which are exchanging with sand, rock or cobble layers. The earth content, as well as the mechanical conduct, of these dirts likewise differs significantly from site to site. The mud tested had a dim grayish shading. The grain size appropriation of the chose clayey soil has been resolved by both the dry strategy (AASHTO T27-11) and hydrometer investigation. The grain size dissemination of the dirt is appeared in table 1 and figure1

Soil Collection and Preparation :

Red Soil : DIU Main Campus
Gray Soil : Saver
Sand : Sylhet

SAMPLE	Gs	LL(%)	PL(%)	IP(%)	FM
Soil (Red Color)	2.73	33.5	23.25	10.26 (CL Type)	_
Soil (Gray Color)	2.74	32.5	19.92	12.58 (CL Type)	_
Sand	2.67	_	_	_	2.9 (Coarse Sand)

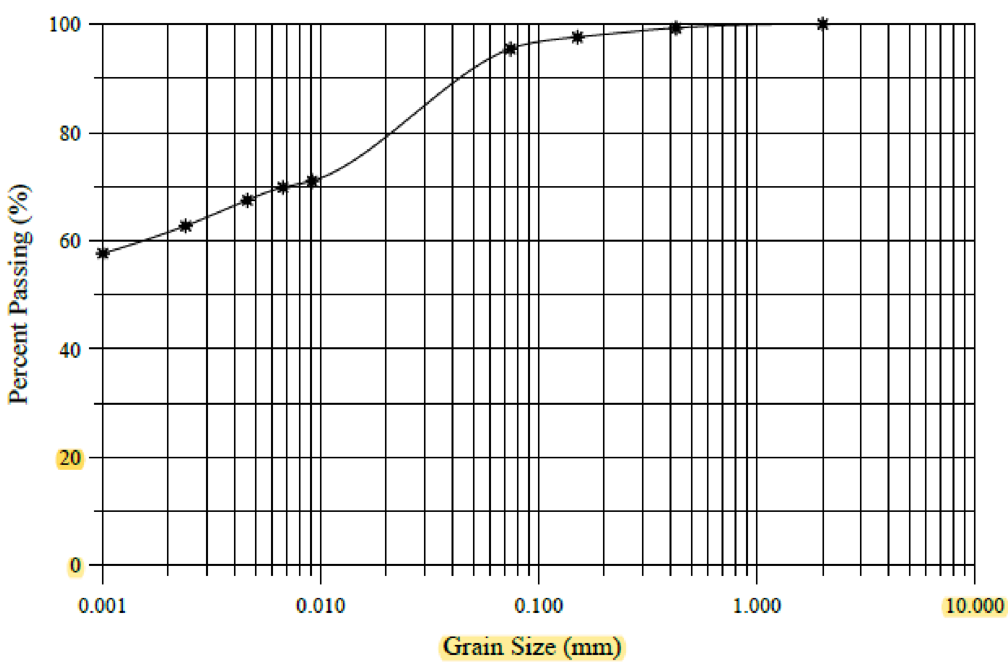


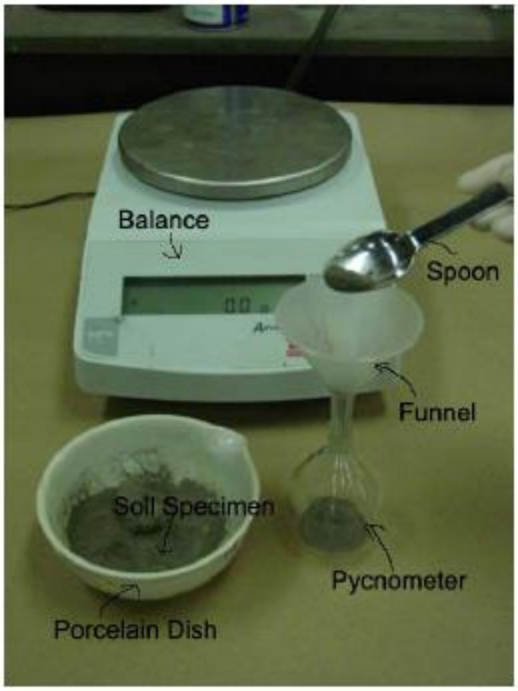
Figure 1 - Soil grain size distribution.

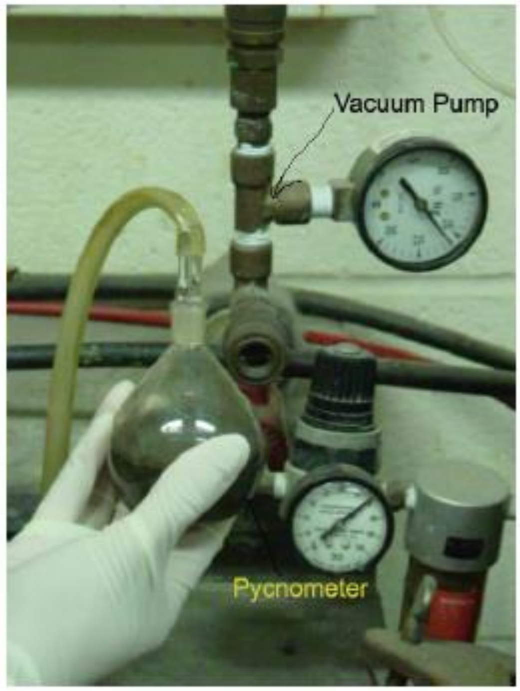
Specific Gravity of Soil

Purpose: This lab is performed to determine the specific gravity of soil by using a pycnometer. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature Standard Reference: ASTM D 854-00 – Standard Test for Specific Gravity of Soil Solids by Water Pycnometer**.**

- Significance: The specific gravity of a soil is used in the phase relationship of air, water, and solids in a given volume of the soil.

- Equipment: Pycnometer, Balance, Vacuum pump, Funnel, Spoon





Apparatus

Test Procedure:

- Determine and record the weight of the empty clean and drypycnometer, WP.
- Place 125g of a dry soil sample (passed through the sieve No. 10) in the pycnometer. Determine and record the weight of the pycnometer containing the dry soil, WPS.

- Add distilled water to fill about half to three-fourth of thepycnometer. Soak the sample for 10 minutes.

- Apply a partial vacuum to the contents for 10 minutes longer, to removethe entrapped air.

- Stop the vacuum and carefully remove the vacuum line from pycnometer.

- Fill the pycnometer with distilled (water to the mark), clean the exterior surface of the pycnometer with a clean, dry cloth.Determine the weight of the pycnometer and contents, WB.

- Empty the pycnometer and clean it. Then fill it with distilled water only (to the mark). Clean the exterior surface of the pycnometer with a clean, dry cloth. Determine the weight of the pycnometer and distilled water, WA

- Empty the pycnometer and clean it.

Data Analysis:

Calculate the specific gravity of the soil solids using the following formula:

W (W W)

Specific Gravity,G W

0 A B

0

S + −

=

Where:

W0 = weight of sample of oven-dry soil, g = WPS - WP

WA = weight of pycnometer filled with water

WB = weight of pycnometer filled with water and soil

SPECIFIC GRAVITY DETERMINATION
DATA SHEET

Date Tested: September 10, 2002

Tested By: CEMM315 Class, Group A

Project Name: CEMM315 Lab

Sample Number: B-1, SS-1, 2'-3.5'

Sample Description: Gray silty clay

Specimen number	1	2
Pycnometer bottle number	96	37
W_P = Mass of empty, clean pycnometer (grams)	37.40	54.51
W_{PS} = Mass of empty pycnometer + dry soil (grams)	63.49	74.07
W_B = Mass of pycnometer + dry soil + water (grams)	153.61	165.76
W_A = Mass of pycnometer + water (grams)	137.37	153.70
Specific gravity (G_S)	2.65	2.61

ATTERBERG LIMITS TEST

INTRODUCTION: The Atterberg limits are a basic measure of the nature of a fine-grained soil. Depending on the water content of the soil, it may appear in four states: solid, semi-solid, plastic and liquid. In each state the consistency and behavior of a soil is different and thus so are its engineering properties. Thus, the boundary between each state can be defined based on a change in the soil's behavior. The Atterberg limits can be used to distinguish between silt and clay, and it can distinguish between different types of silts and clays. These limits were created by Albert Atterberg, a Swedish chemist.They were later refined by Arthur Casagrande.

AIM:

To determine the liquid and plastic limits of the given soil sample.

Apparatus :

- FOR LIQUID LIMIT DETERMINATION: The device required are the mechanical fluid breaking point gadget, cutting instrument, porcelain vanishing dish, level glass plate, spatula, palette blades, balance, broiler wash bottle with refined water and holders.

- FOR PLASTIC LIMIT DETERMINATION: The mechanical assembly comprises of a porcelain vanishing dish, around 12 cm in width (or a level glass plate, 10 mm thick and around 45 cm square), spatula, around 8 cm long and 2 cm wide (or palette blades, with the sharp edge around 20 cm long and 3 cm wide, for use with level glass plate for blending soil and water), a ground-glass plate, about 20×15 cm, for a surface for moving, balance, stove, holders, and a bar, 3 mm in width and around 10 cm long

- **Shrinkage limit**: As far as possible (SL) is the water content where further loss of dampness won't bring about any more volume decrease.

  As far as possible is considerably less normally utilized than as far as possible and as far as possible.

- **Plastic breaking point**: As far as possible (PL) is the water content where soil begins to display plastic conduct. A string of soil is at its plastic cutoff when it is moved to a width of 3 mm or starts to disintegrate. To improve consistency, a 3 mm measurement bar is frequently used to check the thickness of the string when directing the test. (Otherwise known as Soil Snake Test).

- **Fluid breaking point**: Liquid limit' (LL or) is characterized as the discretionary furthest reaches of water content at which the dirt is going to go from the plastic state into the fluid state. At this breaking point, the dirt has a little estimation of shear quality, losing its capacity to stream as a liquid.In different words, as far as possible is the base dampness content at which the dirt will in general stream as a fluid.

PROCEDURE

❖FOR DETERMINATION OF LIQUID LIMIT:

The dirt example should pass 425–µ IS Sieve. An example of about 1.20 N ought to be taken. Two kinds of scoring instruments—Type A (Casagrande type) and Type B (ASTM type)— are utilized relying on the idea of the dirt. The cam raises the metal cup to a predetermined stature of 1 cm from where the cup drops Up on the square applying a blow on the last mentioned. The turning is to be performed at a predefined pace of two revolutions for each second. The scoring device is intended to cut a standard notch in the dirt example only before giving blows.

- ❖Air-dried soil test of 1.20 N passing 425–μ I.S. Sifter is taken and is blended in with water and plied for accomplishing consistency. The blending time is indicated as 5 to 10 min. by certain specialists. The dirt glue is put in as far as possible cup, and leveled off with the assistance of the spatula. A perfect and sharp furrow is cut in the center by methods for a scoring device. The wrench is pivoted at around 2 cycles for every second and the quantity of blows required to make the parts of the dirt pat isolated by the score meet for a length of around 12 mm is checked. The water content is resolved from a little amount of the dirt glue.

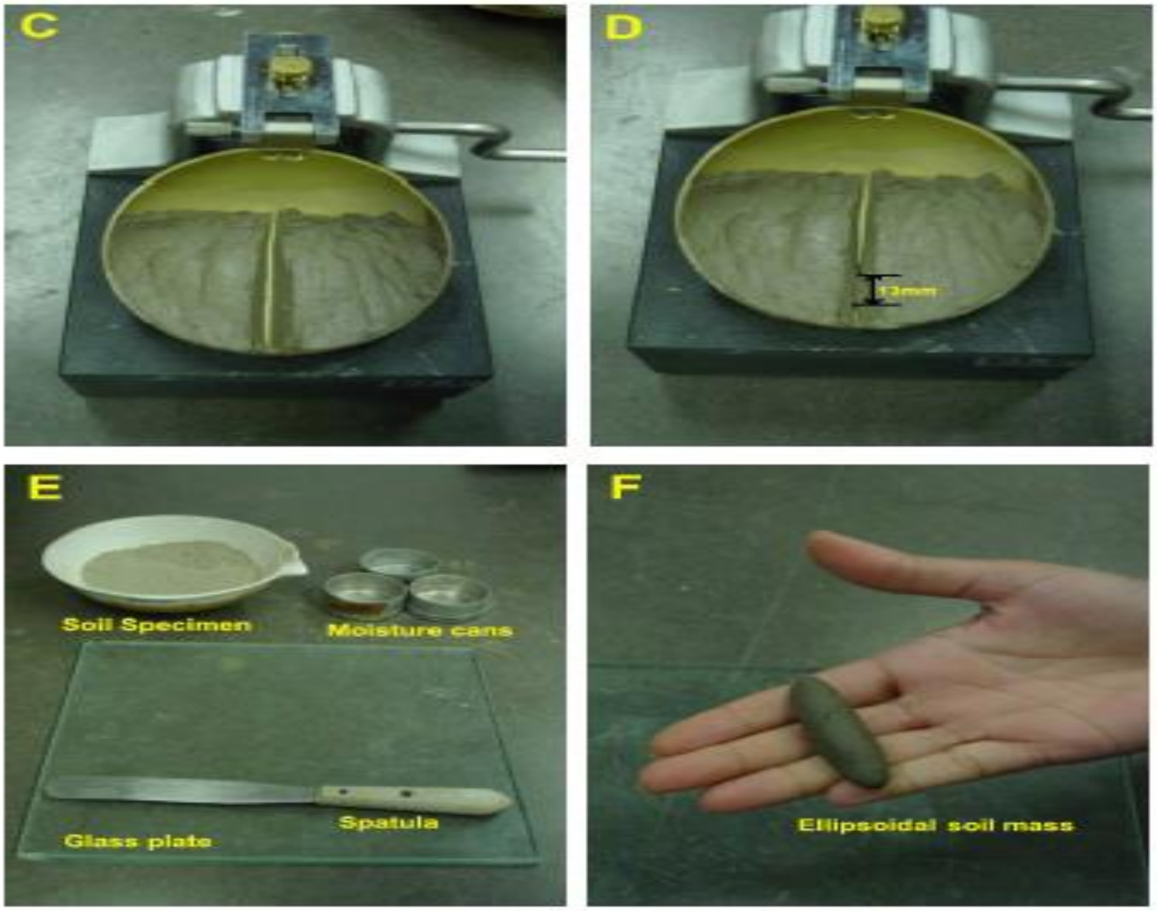
- ❖This activity is rehashed a couple of more occasions at various textures or dampness substance. The dirt examples ought to be set up at such textures that the quantity of blows or stuns required to close the section will be less and more than 25. The connection between the quantity of blows and relating dampness substance in this way got are plotted on semi-logarithmic diagram paper, with the logarithm of the quantity of blows on the x-hub, and the dampness substance on the y-hub. The diagram along these lines got, i.e., the best fit straight line, is alluded to as the ‗Flow-chart' or ‗Flow bend'.

The dampness content relating to 25 blows fromhe stream bend is taken as the fluid restriction of the dirt. This is the commonsense meaning of this cutoff with explicit reference to as far as possible mechanical assembly and the standard method suggested. Experience shows that, for example, bend is really a straight line.

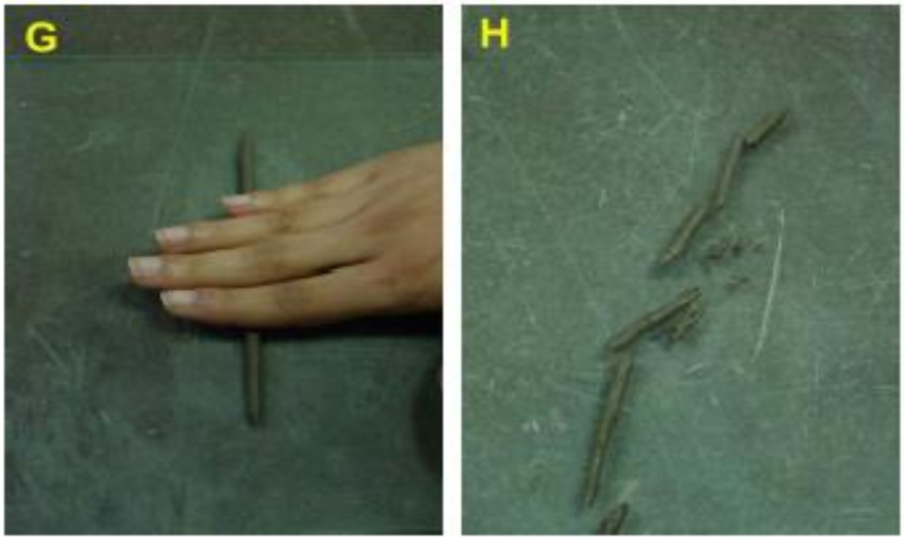
❖FOR DETERMINATION OF PLASTIC LIMIT:

An example weighing about 0.20 N from the altogether blended bit of the material passing 425–µ IS strainer is to be taken. The dirt will be blended in with water so the mass gets sufficiently plastic to be handily molded into a ball. The blending will be done in a vanishing dish or on the level glass plate. On account of clayey soils, adequate time (24 hrs.) ought to be given to guarantee uniform appropriation of dampness all through the dirt mass. A ball will be shaped and moved between the fingers and the glass plate with simply enough strain to fold the mass into a string of uniform breadth all through its length. The pace of rolling will be somewhere in the range of 80 and 90 strokes for every moment, considering a stroke one complete movement of the hand forward and back to the beginning position once more. The rolling will be done work the strings are of 3 cm measurement. The dirt will at that point be worked together to a uniform mass and moved once more. This procedure of substitute rolling a massaging will be proceeded until the string disintegrates under the weight required for rolling and the dirt can never again be folded into a string. At no time will endeavor be made to deliver disappointment at precisely 3 mm breadth. The disintegrating may happen at a measurement more noteworthy than 3 mm; this will be viewed as a palatable end point, gave the dirt has been folded into a string of 3 mm in distance across preceding. The bits of disintegrated soil string will be gathered and the dampness content decided, which is as far as possible'. The historical backdrop of the dirt example will likewise be accounted for.

1. OMC value is with respect to the specific amount of compaction energy applied to the soil.



Engineering Properties of Soils Based on Laboratory Testing



ATTERBERG LIMITS DATA SHEETS

Liquid Limit Determination

Sample no.	1	2	3	4
Moisture can and lid number	11	1	5	4
M_C = Mass of empty, clean can + lid (grams)	22.23	23.31	21.87	22.58
M_{CMS} = Mass of can, lid, and moist soil (grams)	28.56	29.27	25.73	25.22
M_{CDS} = Mass of can, lid, and dry soil (grams)	27.40	28.10	24.90	24.60
M_S = Mass of soil solids (grams)	5.03	4.79	3.03	2.02
M_W = Mass of pore water (grams)	1.16	1.17	0.83	0.62
w = Water content, w%	23.06	24.43	27.39	30.69
No. of drops (N)	31	29	20	14

Plastic Limit Determination

Sample no.	1	2	3
Moisture can and lid number	7	14	13
M_C = Mass of empty, clean can + lid (grams)	7.78	7.83	15.16
M_{CMS} = Mass of can, lid, and moist soil (grams)	16.39	13.43	21.23
M_{CDS} = Mass of can, lid, and dry soil (grams)	15.28	12 .69	20.43
M_S = Mass of soil solids (grams)	7.5	4.86	5.27
M_W = Mass of pore water (grams)	1. 11	0.74	0.8
w = Water content, w%	14.8	15.2	15.1

Plastic Limit (PL)= Average w % = $\frac{14.8 + 15.2 + 15.1}{3} = 15.0$

Standard Proctor Compaction Test

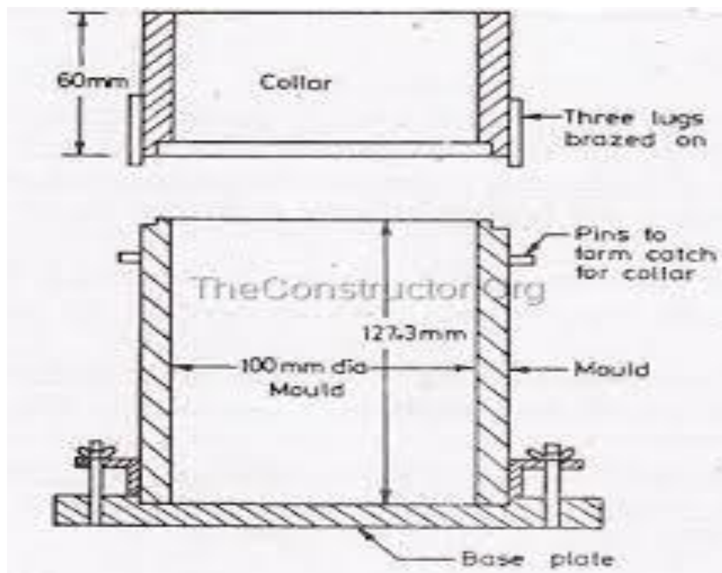
The standard Proctor Compaction test was developed by R.R Proctor in 1933. Proctor showed that:

- The soil moisture content and the degree of dry density to which the soil is prepared to be compacted maintain a definite relationship.
- The Optimum moisture content (OMC) or Optimum Water Content (OWC) is the moisture content at which the soil attains maximum dry density. This

❖ Scope of Standard Proctor Compaction Test

The scope of the Standard proctor compaction test is to determine the relationship between the moisture content and the density of the soil that is compacted in a mold with a rammer of 2.5kg dropped at a height of 305mm.Relationship between maximum dry density and optimum moisture content of soil can be obtained from soil compaction curve obtained from Standard Proctor Compaction Test. This relationship helps in determining the optimum water content at which the maximum dry density of soil can be attained through compaction.

Apparatus for Standard Proctor Compaction Test The apparatus consists of a standard mold of 4 inches in internal diameter. The effective height of this standard mold is 4.6 inches. The maximum capacity of the mold is 1/30 cubic foot. The apparatus is shown in the figure-1 below.



The mold consists of a detachable base plate. The top of the mold consist of two 2-inch height collar which is removable. The soil is added into the mold in three layers, each layer undergoing 25 blows. This compaction is carried out by means of a 5.5 pound rammer falling from a height of 12 inches.

Indian Standard Specification – IS:2720 (Part VII) recommended specification for standard proctor test have some minor modifications and metrifications. The cross-section of the apparatus used as per Indian codes are shown in figure-2. The diameter of the mold is 100mm with a height of 127.3mm. The capacity of the mold is 1000ml.

The rammer used has a mass of 2.6 kg. This undergoes free drop of 310 mm with a face diameter of 50 mm. The soil compaction is carried out in three layers. The height of collar is 60 mm which is removable. The mold is placed over a detachable base plate.In certain cases, the soil taken for testing may retain on 4.75mm sieve. If this amount is greater than 20%, then a mold of larger internal diameter say 150mm is employed. This mold has a height of 127.3 mm and a capacity of 2250 ml.

Procedure for Standard Proctor Test

The procedure for carrying out the standard Proctor test are as follows.

- Collect the soil sample weighing 3kg. The sample must be 3kg after air drying it. Usually, this soil will be pulverized soil that passes through 4.75mm sieve. If the soil is coarse-grained type, the water is added such that its water content comes to 4%.

- If the soil is fine-grained, water is added to make its water content to 8%. The water content of the sample after addition must be less than the optimum water content.
- The soil after the addition of water is mixed thoroughly and covered with a wet cloth. This sample is kept aside for 15 to 30 minutes for undergoing the maturing process.
- Next, the apparatus is prepared by cleaning the mold thoroughly. The mold has to be dried and greased lightly. The mass of the mold with base plate and without collar is weighed. Let it me (Wm).
- The mold placed over solid base plate is then filled with prepared matured soil to one-third of the height. This layer will take 25 blows with the rammer. The rammer has a free fall height of 310 mm.[Note: If a bigger mold is used, the no: of blows for each layer will be 56 no's. Here the capacity of the mold will be 2250 ml


PROCTOR COMPACTION TEST
A BASIC GUIDE

- The compaction must be done in such a way that the blows are evenly distributed over the surface of each layer.
- Next, the second layer is added. Before adding the second layer the top of the first layer has to be scratched. Now the soil is filled to two-thirds of the height of the mold. This too is compacted with 25 blows.
- Later the third layer is added. It is compacted similarly. The final layer must project outside the mold and into the collar. This amount must not be greater than 6mm.
- The bond between the soil in the mold and the collar is broken by rotating the collar. Next the collar is removed and the top layer of soil is trimmed and levelled to the top layer of mold.
- Next, the mass of the mold with compacted soil and base plate is determined (W_{ms}). Hence the mass of the compacted soil (W_s) is determined as: $\mathbf{W_s = Wm - W_{ms}}$
- The mass of compacted soil and the volume of the mold gives bulk density of the soil. From the bulk density the dry density can be determined for the water content used (w).

- The same procedure from (1-8) is repeated by increasing the water content in the soil by 2 to 3%. Each test will provide a different set of values of water content and dry density of soil. From the values obtained **compaction curve** is graphed between the dry density and water content.

Calculations for Compaction Curve

- Weight of Compacted Soil (Ws) in grams.

$$\mathbf{W_s = Wm - W_{ms}} \quad \text{Eq.1}$$

- Bulk Density (ρ) in gm/ml

$$\rho = \frac{Ws}{V} \quad \text{Eq.2}$$

- Dry Density (ρ_d) , w = water content

$$\rho_d = \frac{\rho}{1+w}$$

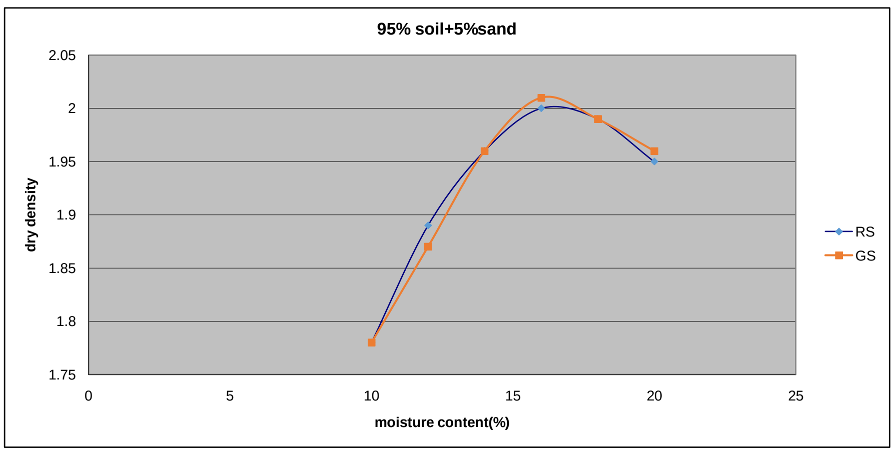
$$\rho_d = \frac{\rho}{1+w}$$

Compaction Curve of Soil – Maximum Dry Density and Optimum Water Content

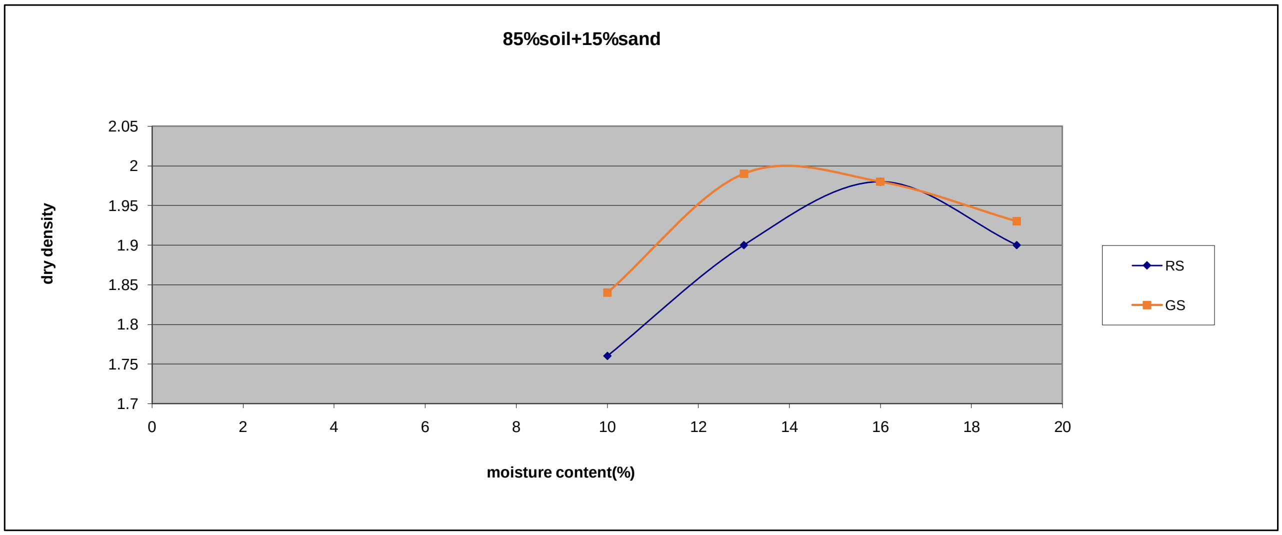
The compaction curve is the curve drawn between the water content (X-axis) and the respective dry density (Y-axis). The observation will be initially an increase of dry density with an increase in the water content. Once it reaches a particular point a decrease of dry density is observed.

The maximum peak point of the soil compaction curve obtained is called the Maximum dry density value. The water content corresponds to this point is called the **Optimum water content (O.W.C) or optimum moisture content (O.M.C)**

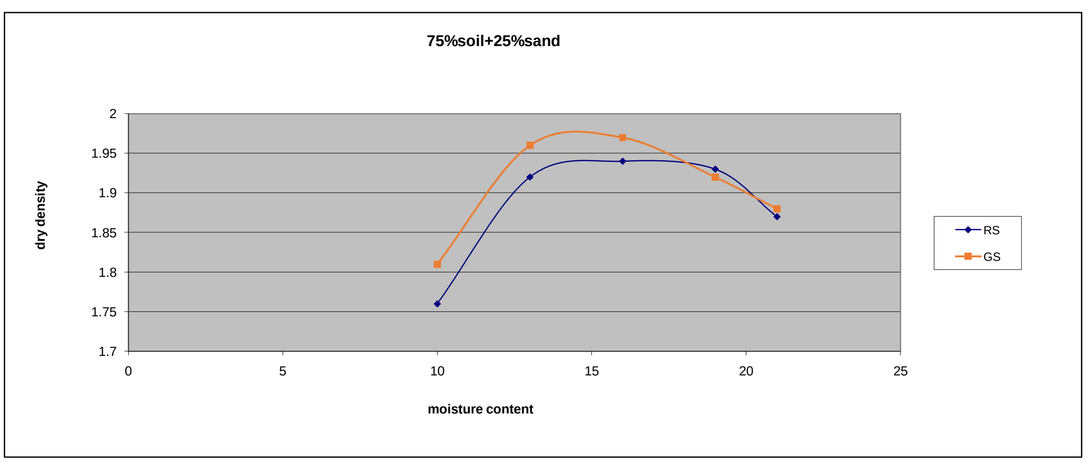
Test Methodology : Soil95% + Sand5%



Soil85% + Sand15%



Soil75% + Sand25%



The graph shown in figure-3 is the **compaction curve**. Initially for a water content lesser than O.M.C the soil is rather stiffer in nature that will have lots of void spaces and porosity. This is the reason for lower dry density attainment.
When the soil particles are lubricated with the increase in the water content, the soil particles will be densely packed resulting in increased density. Now beyond a limit (OMC) the addition of water will not bring a change in dry density or will decrease the dry density.

The graph represents a zero-air void or 100 % saturation line. This is based on the theoretical maximum dry density where it occurs when there is 100 % saturation. As the condition of zero voids in soil is not real and a hypothetical assumption, the soil can never become 100% saturated.

The theoretical maximum dry density can be determined by the equation

$$(\rho_d)_{\text{the max}} = \frac{G\,(\rho w)}{1+wG} \quad \text{Eq.4}$$

G = specific gravity of solids; ρ_w = mass density of water; w= water content; The theoretical zero void line can be drawn by plotting the theoretical maximum dry density in the compaction curve if the value of ‘w’ and G is known.

Modified or AASHTO Proctor Test

In order to perform construction for heavy loads like airways and highway construction, there comes the need for heavier compaction. The compaction energy provided by the standard proctor test is not sufficient, hence a Modified Proctor test or AASHTO Proctor test was developed.

The modified proctor test was altered and practised by AASHTO and ASTM. The mould used in modified proctor test has a internal diameter of 100mm and height of 127.3mm. This also has a detachable base plate as in the case of standard proctor test.

In order to provide higher compaction energy, the rammer is mechanically operated that has a face diameter of 50mm and the free-falling weight of the rammer is 4.89kg. The height of the drop is 450mm. The sample in the mold is given 25 blows for 5 layers.

The compaction energy provided by the modified proctor test is 4.56 times greater than the standard proctor test.

Results and Discussion

The fluid furthest reaches of both soil and soil-sand blends (passing the No. 40 strainer) was discovered utilizing the Casagrande technique. As far as possible qualities diminished with the expansion of sand. A similar pattern has been appeared by as far as possible qualities, however the rate was less exceptional than that of LL. The decline in versatility list esteems is for the most part because of the reduction of LL values. The variety in Atterberg limits with the expansion of sand in different extents is appeared in Figure 2. Comparable discoveries have been accounted for in other test chips away at soil adjustment with sand (Roy, 2003; Ravi Shankar et al., 2012)

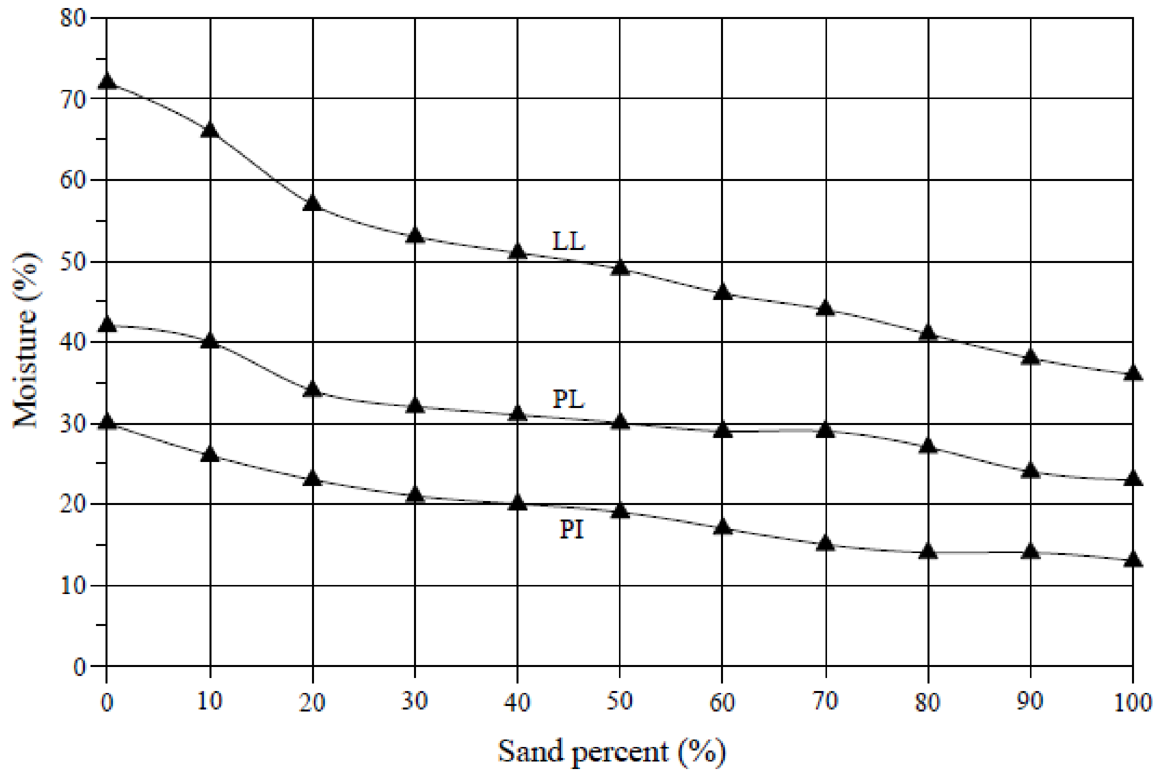


Figure 2 - Atterberg limits for soil mixtures with varying sand content.

Direct shrinkage of a dirt example is the decrease of one of its measurements, when the contained dampness being diminished from a given worth arrives at the most extreme soil dampness and further decrease

doesn't cause any dirt volume change. The direct shrinkage was determined utilizing molds to deliver half circle examples 140 mm long x 12.5 mm span. Soil tests blended in with water up to the fluid limit esteem had been set in the molds, as per BS 1377:Part 2:1990 determination.

The direct shrinkage of soil examples with various sand substance was communicated asLS(%)=(ΔL/L)x100 and is shown in Figure 3.

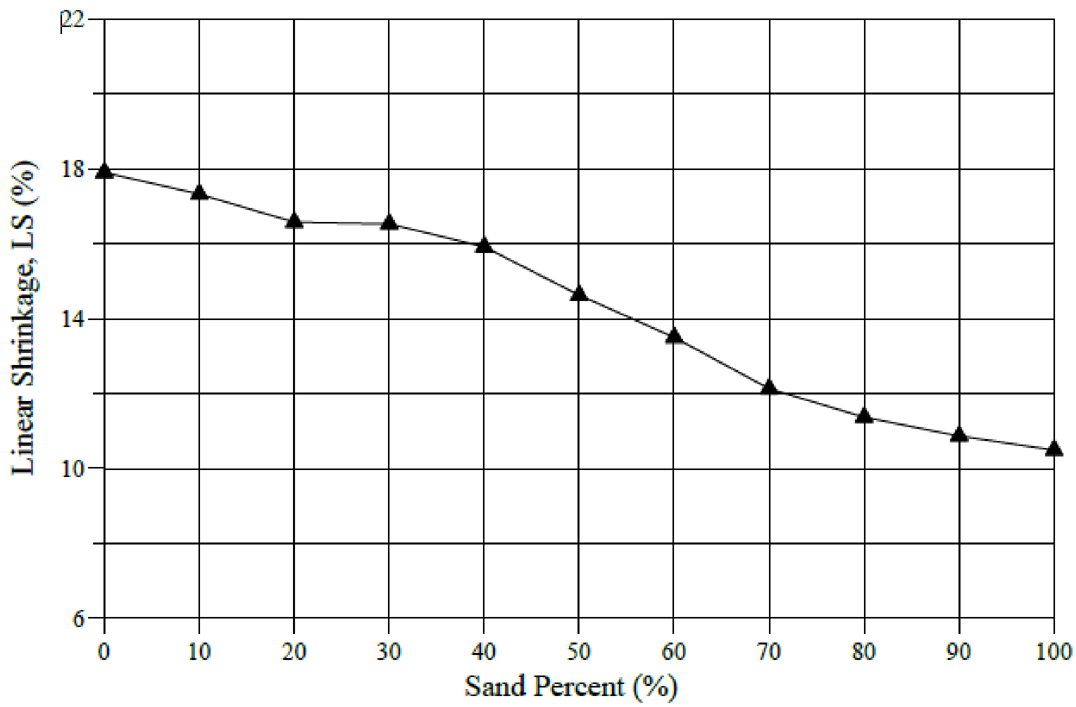


Figure 3 - Linear shrinkage for soil mixtures with varying sand content.

So as to locate the dry thickness dampness content connection with the standard Delegate compaction test, sand and soil tests passing the No. 4 (4.75 mm) strainer were utilized. The estimations of most extreme dry

thickness for the diverse soil-sand blends are introduced in Figure 4. A ceaseless increment of

MDD has been noted principally on account of the higher explicit load of the admixture material.

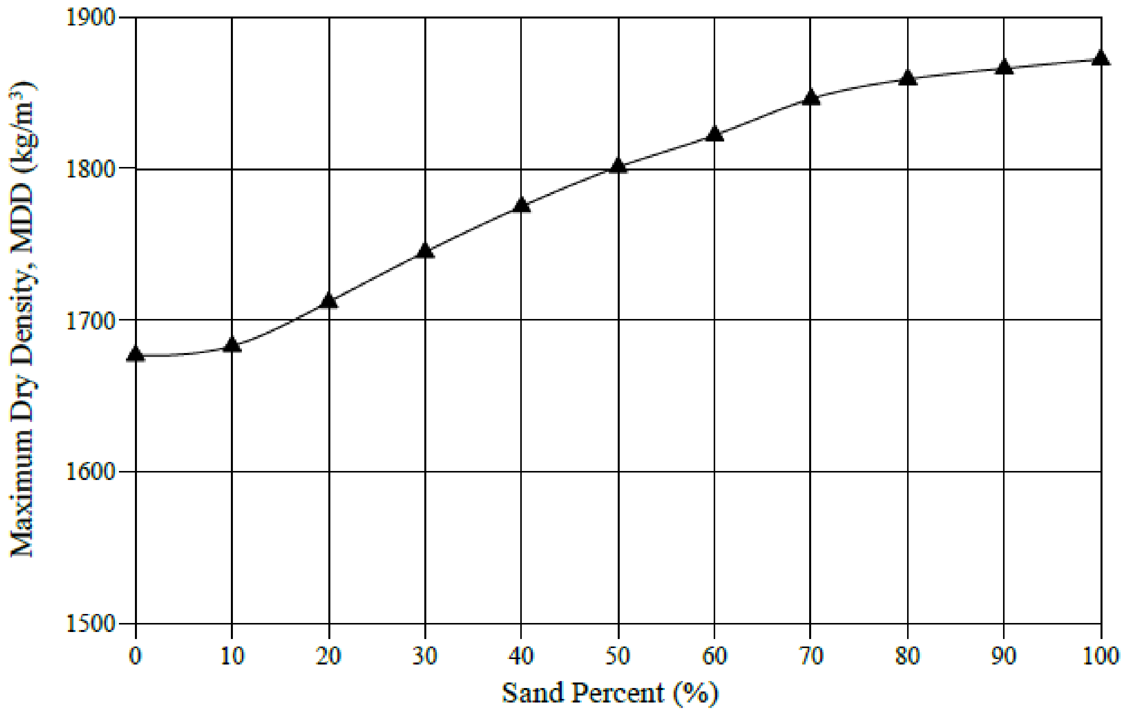
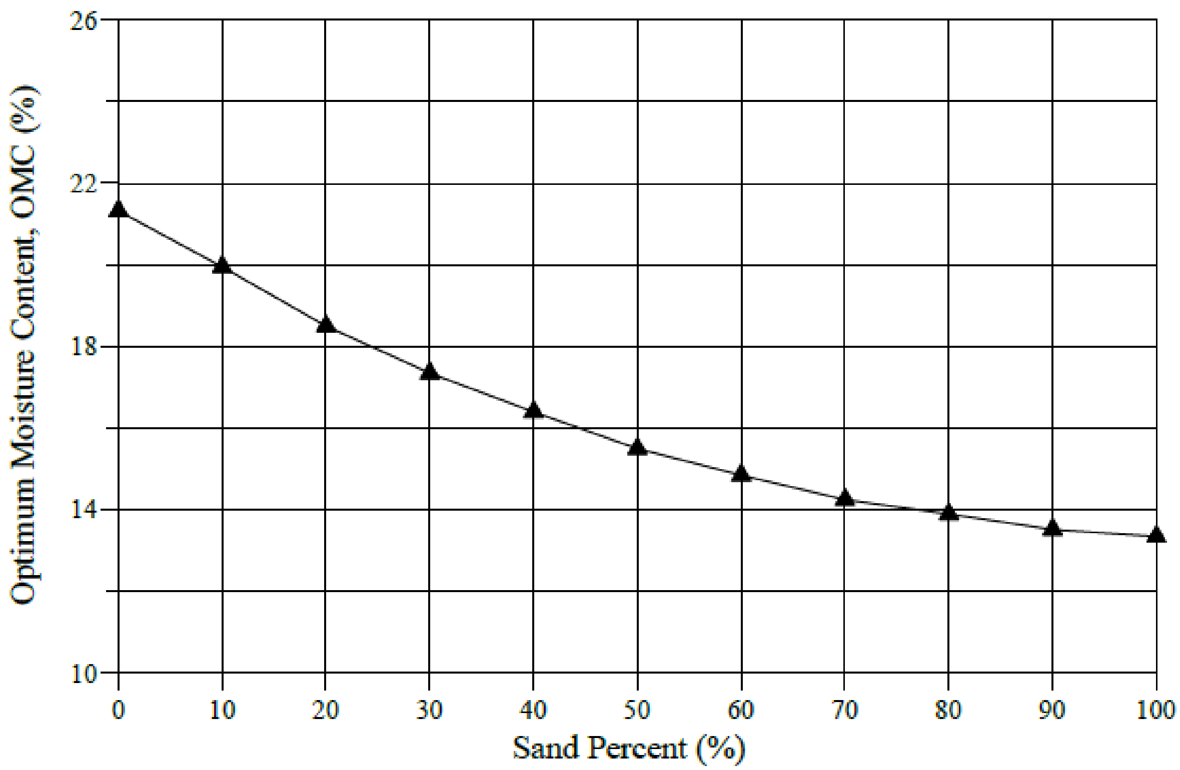


Figure 4 - Maximum dry density for soil mixtures with varying sand content.

The values of optimum moisture content followed a reverse trend ranging from 21% for the natural soil up to 13.5% for the ratio 1:1 soil to sand, as it is shown in Figure 5.


26
22
18
14
10
0
10
20
30
40
50
60
70
80
90
100
Optimum Moisture Content, OMC (%)
Sand Percent (%)

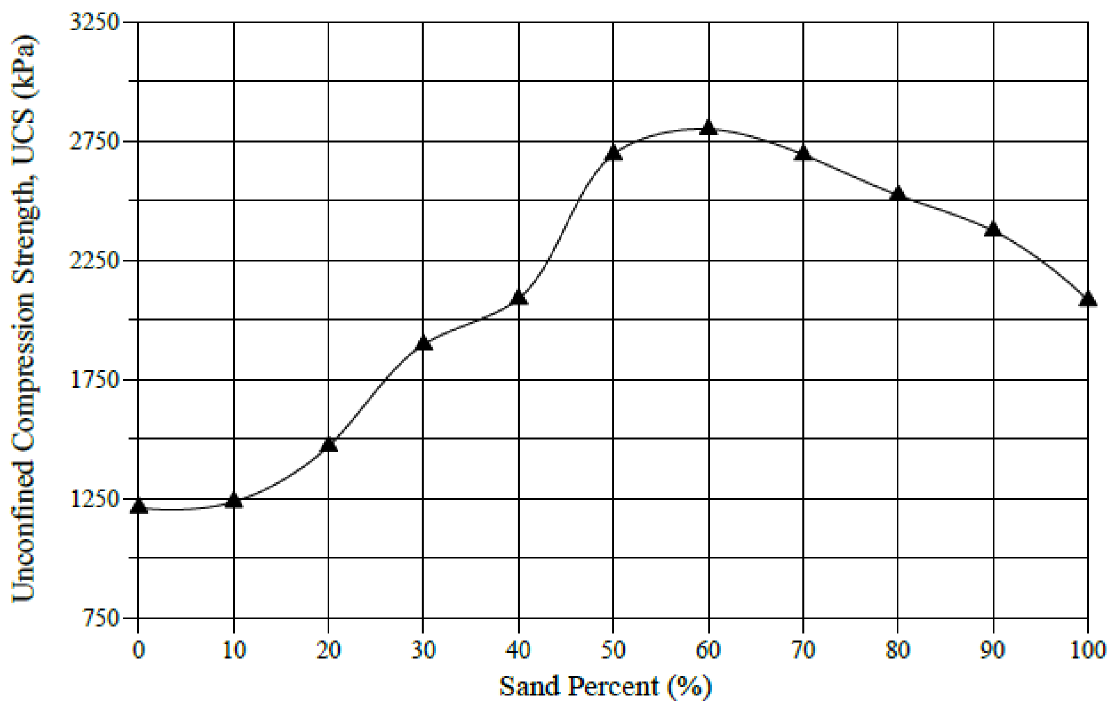


Figure 6 - Unconfined compression strength for soil mixtures with varying sand content.

The unconfined pressure quality has expanded for each sand expansion increase up to 60% sand (from 1211 to 2798) and afterward straightly diminished for every single other rate (Figure 6). The diminishing in quality qualities could be ascribed to less union between the particles in the blend.

It very well may be proposed that this extent is an ideal for soil adjustment with sand. When all is said in done, the compaction qualities have been upgraded (expanded greatest dry thickness and diminished ideal dampness content) with the expansion of sand as the dampness thickness bends have been moved left and upper. This reality prompts the end that the interest for water so as to accomplish the ideal field thickness esteems is lower. Then again, the quality increase came to the 131% with the expansion of sand 60% by soil weight

Conclusions

Since dangerous soils are an overall issue, there is an expanding interest for procedures to improve their conduct. Nations like Greece with their economies in emergency (low per capita salary) or having low concrete and lime creation, can utilize the adjustment with sand method in request to improve soils to be utilized as asphalt subgrades. In light of the exploratory outcomes on clayey soil settled with sand, it could be inferred that:

• As far as possible changed in a diminishing mode with the sand admixtures in rising rates. As far as possible qualities at first showed an abatement with the expansion of sand.

Further including expanded sand substance, the watched decrease in LL was little. The plastic limit indicated slight change (decrease) with the expansion of sand substance. The lower Pi qualities could be principally credited to the lessening of LL values.

- Direct shrinkage was diminished by 42% with adjustment. This finding can be deciphered as a sign that the dirt can be utilized as a subgrade material for development of adaptable asphalts in rustic streets with low traffic volume.

- Alluding to quality attributes, the estimations of UCS will in general increment until a pinnacle quality esteem had been reached with 60% sand by weight of soil.

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