STUDY ON STRENGTH OF LATERITE SOIL USING BITUMEN EMULSION AND ESP, CSA

(EGG SHELL POWDER AND COCONUT SHELL ASH)

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ABSTRACT

The civil engineers must study the properties of soil, such as its origin, grain size distribution, and ability to drain water, compressibility, shear strength and load bearing capacity. The civil engineering proposes the soil is unboned (un-cemented) material. The foundation of structure is most important of entire structure. The foundation must have more strength to support the entire structure. The stability of the structure of depends upon the soil which one is used as the foundation. Therefore the sub-grade soil normally replaced with stronger soil which is not economical. In this project an attempt has been made to increase the soil strength by adding the various admixtures which are available like egg shell powder and coconut shell ash replacing the soil. In this project we had made an attempt to find out the comparative results of various strength increasing tests on laterite soil by using the admixtures bitumen emulsion and also egg shell powder and coconut shell ash. The admixture bitumen emulsion is added at 5%, 10%, & 15% proportions. Similarly egg shell powder and coconut shell ash are also added at the same proportions. The initial strength of the laterite soil is determined through various tests like Sieve Analysis, Plastic Limit, Liquid Limit, Specific Gravity, Compaction, Unconfined Compression, California Bearing Ratio and Direct Shear tests. The same tests have been conducted with laterite soil added with bitumen emulsion and laterite soil added with egg shell powder and coconut shell ash. The results obtained are then compared with initial laterite soil and laterite soil added with admixtures.

Key words: Laterite soil, admixtures, shear strength, California bearing ratio, Compressibility.

1. INTRODUCTION

1.1. General:

Every man made structure resting on the ground needs safe and stable soil. To attain this safety and stability requirements the engineering properties of the soil beneath the structure or on the structure must be identified. However, obtaining these engineering properties of soils requires relatively more time and money. On the other hand investigating the index properties of a soil is much easier than other engineering properties; in terms of time, money and efforts. Moreover, most of the engineering properties of soils depend upon their index properties. Therefore, by obtaining the index property of soil that involves simpler and quicker method of testing, the engineering properties can be predicted satisfactory. Soil compaction, California bearing ratio and direct shear test are the most commonly used techniques in engineering projects such as highways, sub-grades, railways, pavements and foundations.

The main of these tests are to improve engineering properties of soils such as increase in dry density, reduction in compressibility leading to reduction in settlement, reduction in permeability, increase in shear strength and its load bearing capacity. Atterberg's limits and specific gravity tests are also considered to find out the moisture content of the soil.

1.2. Laterite soil:

Laterite is a soil and rock type rich in iron and aluminum and is commonly considered to have formed in hot and wet tropical areas. Nearly all laterite are of rusty-red coloration, because of high iron oxide content. They develop by intensive and long-lasting weathering of the underly the parent rock. Tropical weathering (laterization) is a prolonged process of chemical weathering which produces a wide variety in the thickness, grade, chemistry and ore mineralogy of the resulting soils. Laterites are a source of aluminum ore; the ore exists largely in clay minerals and the hydroxides, bauxites which resembles the composition of bauxite. In Northern Ireland they once provided a major source of iron and aluminum ores. Laterite ores also were the early major source of nickel.

MATERILAS

1.3. Bitumen Emulsion and its properties:

Bitumen emulsion procedure:

In this thesis, the strength of the soil is tried to improve by using bitumen emulsion. Bitumen emulsion is a, mixture of water and bitumen with an emulsifier. As the bitumen is an oil product it cannot be mixed with water directly. Hence an emulsifier (a surface active agent) is added with water before bitumen. Addition of emulsifier with water before adding to bitumen into a minute particles and keeps it dispersed in suspension.

Bitumen emulsion consists of three basic ingredients such as bitumen, water, and an emulsifying agent. Based on the specifications it may contain other additives, such as stabilizers, coating improvers, anti- strips, or break control agents. It is well known that water and asphalt will not mix, except under carefully controlled conditions using highly specialized equipment and chemical additives.

1.4. Kerosene:

The term emulsion means that dispersion of small droplets of one liquid in another liquid. Types of emulsion are oil in water (continuous phase is water and dispersion phase is an oily) and water in oil (continuous phase is an oil and dispersion phase is water). Here in this project we used kerosene as an emulsifying agent.

Kerosene is a thin, clear liquid formed from hydrocarbons obtained from fractional distillation of petroleum between 150 °Cand 275 °C, resulting in a mixture with a density of 0.78-0.81 g/cm^3 composed of carbon chains that typically contain between 6 and 16 carbon atoms per molecule. As water cannot be mixed with bitumen, kerosene is used as an emulsifier that helps the water to be mixed easily with bitumen.

1.5. Coconut shell ash:

The use of coconut shell powder in the field of soil stabilization has not yet been properly exploited. Hence an experimental study on effect of coconut shell ash on strength of soil is made. It has different properties that make it suitable as soil stabilizer such as durability, high toughness, abrasion resistance etc. Coconut shell has long standing use and it is environmental friendly.

The coconuts were procured from a nearby local temples and shops. The coconuts were broken manually to drain out the water. The coconut half shells were sundried for (3-4 days).Sun drying was necessary to the easy removal of meat from the inner shells of the coconut pieces. After scrapping the meat from the inner shells, the inner portions of the shells were cleaned using knives. The fiberson the outer shells were also scrapped and cleaned. Emery paperwas used to clean the outer shells. Coconut shells were burned using kerosene or petrol, and the coconut shell burned was then ramered into fine powder particles to make it pass through 600microns sieve and hence the amount of coconut shell ash passed through 600microns sieve was used in this thesis**.**

Coconut shell composition:

COMPOUND	PERCENT
Cellulose	33.61
Lignin	36.51
Pentosans	29.27
Ash	0.61

Coconut shell

Coconut Shell Powder

1.6. Egg shell powder:

Chicken eggshell is a waste material from domestic sources such as poultries, hatcheries, homes and fast food restaurants. Eggshells were air dried for 2 days to facilitate easy milling. After air drying the eggshells were manually broken and rammed into powder forms which were collected in polythene bags. The egg shell powder was finally sieved through 600 microns sieve. Eggshell powder contains 99.83% of (CAO) and remaining consists of (AL2O3), (SIO2), (CL), (CR2O3), MNO and CUO inn very small traces. Due to more composition of calcium carbonate in egg shell powder has a high strength and we used this material in our project to stabilize the laterite soil by adding 5%, 10%, 15% to the weight of soil taken and calculated for various tests and result were compared.

Egg shells

Egg Shell Powder

METHODOLGY

Index tests on the natural laterite soils were carried out in accordance with the procedures obtained in IS 2720, step percentages of bitumen emulsion and coconut shell and egg shellby dry weight of soil (5,10 and 15%) was introduced into the soil.

The following tests were carried out on the Laterite soil

•Natural moisture content test
•specific gravity (Density Bottle method)
•Compaction test (Standard proctor test)
•California bearing ratio test
•Compressive Strength test
• Direct shear test

Geotechnical Properties

Results of test carried out on the natural Laterite soil are summarized in table II

Geotechnical Properties of the untreated Laterite soil.

PROPERTY	VALUE
Specific Gravity	*2.37*
Liquid Limit	*25.55%*
Plastic Limit	*13%*
Plastic Index	*12.55%*
Unified soil classification system (USCS)	*C L*
Maximum Dry Density (MDD)	*1.7g/cc*
Optimum moisture content (OMC)	*34.7%*
Natural Moisture content	*17.36%*

Sieve Analysis:

A sieve analysis (or) gradation test is a practice or procedure used (commonly used in civil engineering) to assess the particle size distribution (also called gradation) of a granular material.

The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of non-organic or organic granular materials including sands, crushed rock, clays, granite, feldspars, coal, and soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common. With the details obtained from grain size distribution curves, to determine the suitability of soil for different field of construction.

S.NO	SIEVE NUMBER	MASS OF SOIL RETAINED (GRAMS)	CUMULATIVE MASS OF SOIL RETAINED	%OF CUMULATIVE SOIL RETAINED	%OF FINER PASSED
1	*4.75mm*	*165.29*	*165.29*	*16.52*	*83.52*
2	*2.8mm*	*55.07*	*220.36*	*22.03*	*77.97*
3	*1.70mm*	*177.58*	*397.94*	*39.79*	*60.21*
4	*600 μ*	*279.42*	*677.36*	*67.73*	*32.27*
5	*425 μ*	*85.77*	*763.13*	*76.31*	*23.69*
6	*300 μ*	*55.37*	*818.5*	*81.85*	*18.5*
7	*150 μ*	*123.96*	*942.46*	*94.24*	*5.76*
8	*75 μ*	*35.67*	*978.13*	*97.81*	*2.19*
9	*pan*	*14.10*	*992.23*	*99.22*	*0.78*

Grain size sieve analysis and Calculation

From the semi-log graph plotted the values obtained are

D10 = 0.20
D30 = 0.82
D60 = 1.2

Co-efficient of curvature Cc = D60/D10
i.e., 1.2/0.2 = 6 and then
Co-efficient of uniformity

$Cu = (D30)^2 / D60*D10$
i.e., $(0.82)^2/1.2*0.20 = 2.80$
The known conditions are

If Cu = 1 then soil is perfectly uniform graded.
If Cu >4 then soil is well graded gravel.
If Cu>6 then soil is well graded sand.
If Cc<1 then soil is poorly graded soil.
If Cc=3 then soil is well graded soil.

RESULT

1. Coefficient of Curvature, Cc= 6
2. Uniformity Coefficient, Cu= 2.80

Therefore according to above known conditions the laterite soil taken is perfectly uniformly graded.

MODIFIED PROCTOR COMPACTION

Introduction to Compaction:

The Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density. The term Proctor is in honour of R. R. Proctor, who in 1933 showed that the dry density of a soil for a given compaction effort depends on the amount of water the soil contains during soil compaction. His original test is most commonly referred to as the standard Proctor compaction test; later on, his test was updated to create the modified Proctor compaction test.

These laboratory tests generally consist of compacting soil at known moisture content into a cylindrical mould of standard dimensions using a compaction effort of controlled magnitude. The soil is usually compacted into the mould to a certain amount of equal layers, each receiving a number of blows from a standard weighted hammer at a specified height. This process is then repeated for various moisture contents and the dry densities are determined for each. The graphical relationship of the dry density to moisture content is then plotted to establish the compaction curve. The maximum dry density is finally obtained from the peak point of the compaction curve and its corresponding moisture content, also known as the optimal moisture content.

TEST AND PROCEDURE FOR LATERITE SOIL

Objective:

1. Determine the optimum moisture content and maximum dry density of laterite soil by proctor test
2. To plot the cure of zero air void.

Resources:

1. Cylindrical mould (capacity 1000 cc, internal dia 100 mm. effectiveheight 127.3 mm) Cylindrical mould (capacity 2250cc, internal dia 150 mm. effective height 127.30m.m)
2. Rammer for light compaction (face diameter 50 mm mass of 2.6 kg free drop or 310mm) Rammer for heavy compaction (face diameter 50 mm mass of 4.89 kg free drop 450 mm).

3. Mould accessories (detachable base plate removable collar)
4. I.S. serves (20 mm, 4.75mm).

General:

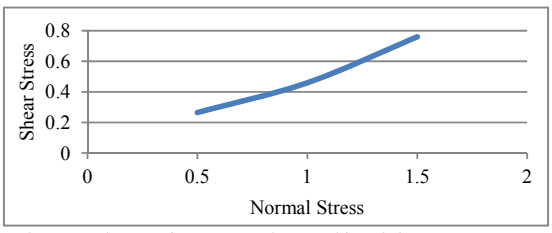
1. Balance (capacity 10kg, sensitivity 1gm)
2. Balance (capacity 200kg, sensitivity 0.01gm)
3. Drying oven (temperature 1000 C to 1100C)
4. Desiccators
5. Drying crucibles
6. Graduated jars
7. Straight edge
8. Large mixing pan
9. Spatula
10. Scoop

Precautions:

1. Adequate period is allowed for mixing the water with soil before compaction
2. The blows should be uniformly distributed over the surface of each layer.
3. Each layer of compacted soil is scored with a spatula before placing the soil for the succeeding layer.
4. The amount of soil used be just sufficient to fill the mould i.e. at the last layer the Surface of the soil should be slightly (5mm)above the top rim of the mould.
5. Mould should be placed on a solid foundation during compaction.

S. NO	NORMAL STRESS (Σ) KG/CM^2	PROVING RING READING (P) IN MM	SHEAR LOAD P*0.45 KG	SHEAR STRESS (T) KG/CM^2
1	*0.5*	*21.2*	*9.54*	*0.265*
2	*1*	*36.8*	*16.56*	*0.46*
3	*1.5*	*60.8*	*27.36*	*0.76*

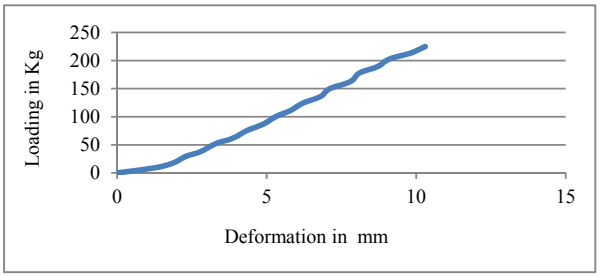
Direct shear test for Laterite soil with 10% ESP and CSA



Direct Shear for Laterite soil with 10% ESP and CSH

S. NO	DIAL GAUGE READING	PENETRATION IN MM	PROVING RING READING	LOAD IN KG
1	*50*	*1.3*	*2.2*	*9.40*
2	*100*	*1.9*	*4.3*	*18.38*
3	*150*	*2.3*	*6.9*	*29.49*
4	*200*	*2.8*	*8.9*	*38.04*
5	*250*	*3.3*	*12.2*	*52.15*
6	*300*	*3.9*	*14.6*	*62.41*
7	*350*	*4.3*	*17.*	*74.38*
8	*400*	*4.9*	*20.4*	*87.20*
9	*450*	*5.3*	*23.4*	*100.03*
10	*500*	*5.8*	*26*	*111.14*
11	*550*	*6.2*	*29*	*123.97*
12	*600*	*6.8*	*31.8*	*135.49*
13	*650*	*7.1*	*35*	*149.62*
14	*700*	*7.8*	*38*	*162.44*
15	*750*	*8.1*	*41.6*	*177.83*
16	*800*	*8.7*	*44.2*	*188.95*
17	*850*	*9.1*	*47.4*	*202.63*
18	*900*	*9.8*	*50*	*213*
19	*950*	*10.3*	*52.6*	*224.86*

CBR test for Laterite soil with 10% ESP and CSA



California Bearing Ratio for Laterite soil with 10% ESP and CSA

CONCLUSION

Based on the analysis of data obtained from laboratory soil testing and secondary data collection, the following conclusions are shown.

This study made a comprehensive examination of the effectiveness of soils on the performance of bitumen emulsion. The characteristics of soil sample were known from the tests conducted and the similar tests are conducted for the soil sample mixed with three different proportions of bitumen emulsion i.e.,

5%, 10%, 15%. The results indicate that with the increase of bitumen emulsion in the soil sample at 10% proportion ratio the soil strength is increased and after certain percentages it's getting decrease. The results are shown that the strength of the soil is good when 10% bitumen emulsion is added.

We can utilize the egg shell powder and coconut shell ash waste as a useful soil stabilizing material. This gives us the disposal of environmental wastes and also be economical in soil stabilizing. We used egg shell powder and coconut shell ash as soil stabilizer to the laterite soil in the proportions of 5%, 10% and 15% leads to increase in the maximum dry density and shear, bearing ratio of soil. According to our test results obtained 10% of egg shell powder and coconut shell ash gives us better increase in strength of initial laterite soil.

The results which came after carrying out all tests found successful which indicates that the admixtures added (bitumen and ESP and CSA) can be surely used as a laterite soil stabilizer. From the results it is proved that these admixtures were effective in stabilizing the soil at 10% and with further increase in admixtures lowers the strength of soil.

The bitumen emulsion can be mostly used in road construction and building foundations. Egg shell powder and Coconut shell ash which are environmentally bio-degradable can also be applied in building foundations and mostly effective in agricultural fields.

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