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SOIL STABILIZATION USING ROCK DUST AND SLUDGE

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ABSTRACT

The combined effects of two wastes Sludge and Rock dust on, compaction characteristics, California Bearing Ratio (CBR), Shear strength parameters and Swelling pressure of an expansive soil have been discussed in this project. The effect of molding water content on CBR of Sludge-Rock Dust stabilized expansive soil and the economy of Sludge and Rock dust stabilization has also been discussed.

KEYWORDS: Expansive Soil, Sludge, Quarry Dust, Optimum moisture content (OMC), California Bearing Ratio.

INTRODUCTION

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve their required properties in a soil needed for the construction work.

Although abundant plastic waste contaminating the environment may be utilized as reinforcing materials, a potential pozzolanic material (rice husk ash blended with lime) possesses superior properties in stabilizing soils. Engineering behavior of the stabilized clayey/silty soil reinforced with randomly distributed discrete plastic waste fibers is investigated in this paper. The results indicate that the proposed method is very effective to improve the engineering properties of the clayey/silt soil in terms of compressive, tensile, and shear strength, which further enhanced the stability and durability of the soil. Based on the compressive strength, California bearing ratio (CBR), shear strength, and failure characteristics, the optimum amount of fiber mixed in soil/lime/rice husk ash mixtures ranges from 0.4-0.8% of the dry mass.

Koteswara Rao. D , M.Anusha, P.R.T. Pranav, G.Venkatesh [1]suggested that the technology of road construction is subjected to changes to cope up with changing vehicular pattern, construction materials and sub grade condition.Ashkan GHolipoor Norozi , Siavash Kouravand and Mohammad Boveiri[2]suggested soil stabilization means alteration of the soils properties to meet the specified engineering requirements. Methods for the stabilization are compaction and use of admixtures. Lime, Cement was commonly used as stabilizer for altering the properties of soils. Arshad Husain , Khan Roohul Abad and Nadeem Ahmad khan[3] suggested utilization of waste materials in agriculture products reduces the technical and environmental problems of plants wastes. Although rice husk ash (RHA) is a valuable admixture for concrete and soils, only about 5% of the total available RHA is used for improvement their properties.

DESCRIPTION AND WORKING

Proctor Compaction Test:
This experiment gives a clear relationship between the dry density of the soil and the moisture content of the soil. The experimental set up consists of:

i)Cylindrical metal mould (internal diameter: 10 cm and internal height 12.5cm)
ii)Detachable base plate
iii)Collar (5cm effective height)
iv)Rammer (2.5kg)

Compaction process helps in increasing the bulk density by driving out the air from the voids. The theory used in the experiment is that for any compactive-effort, the dry density depends up on the moisture content in the soil. The maximum dry density (MDD) is achieved when the soil is compacted at relatively high moisture content and almost all the air is driven out, this moisture content is called Optimum Moisture Content (OMC). After plotting the data from the experiment with water content as the abscissa and dry density as the ordinate, we can obtain the OMC and MDD.

Standard Proctor Equipment:

FORMULAE:

Wet density=$\frac{weight\ of\ wet\ soil\ in\ mould(gms)}{volume\ of\ mould(cc)}$

Moisture content %=$\frac{weight\ of\ water\ (gms)}{weight\ of\ dry\ soil(gms)} X100$

Dry density γ_d(gm/cc) = $\frac{wet\ density}{1+\frac{moisture\ content}{100}}$

California Bearing Ratio:

Sieve the sample through 20mm IS sieve. Take 5kg of the sample of soil specimen. Add water to the soil in the quantity such that optimum moisture content is reached. Then soil and water are mixed thoroughly. Spacer disc is placed over the base plate at the bottom of mould and a coarse filter paper is placed over the spacer disc. The prepared soil water mix is divided into five. The mould is cleaned and oil is applied. Then fill one fifth of the mould with the prepared soil. That layer is compacted by giving 56 evenly distributed blows using a hammer of weight 4.89kg. The top layer of the compacted soil is scratched. Again second layer is filled and process is repeated. After 3rd layer, collar is also attached to the mould and process is continued. After fifth layer collar is removed and excess soil is struck off. Remove base plate and invert the mould. Then it is clamped to base plate.

A surcharge weight of 2.5kg is placed on top surface of soil. Mould containing specimen is placed in position on the testing machine. The penetration plunger is brought in contact with the soil and a load of 4kg (seating load) is applied so that contact between soil and plunger is established. Then dial readings are adjusted to zero. Load is applied such that penetration rate is 1.25mm per minute. Load at penetration of 0.5,1,1.5,2,2.5,3,4,5,7.5,10 and 12.5mm are noted.

Standard Load Values:

Penetration(mm)	Standard Load(kg)	Unit Standard Load(kg/cm2)
2.5	1370	70
5	2055	105
7.5	2630	134
10.0	3180	162
12.5	3600	183

FORMULAE:

Load = $\frac{\text{no of divisions X 190}}{100}$

CBR (2.5mm penetration)=$\frac{\text{Load}}{1370}$X100

CBR (5mm penetration)=$\frac{\text{Load}}{2055}$X100

Black Cotton Soil:

A local expansive soil was used in the experimental program.
The geotechnical properties of soil are:
i) a) Sand size – 14% b) Silt size – 25% c) Clay size – 62%
ii)Specific Gravity: 2.38
iii)Color: Black
iv)Odor: Nil

Rock Dust:

The Rock Dust used for laboratory testing program was collected from a crusher unit situated at Vijayawada.
The geotechnical properties of the rock dust are:
i)Gravel size – 3%
ii)Sand size – 81%
iii)Silt size – 16%
iv)Specific Gravity: 2.82
v)Color : Grey
vi)Odour : Nil

Sewage Sludge:

The geotechnical properties of sludge are:
i)Grain size: a) Gravel size – 3% b) Sand size – 81% c) Clay size – 1.92%
ii)Specific gravity – 1.42

RESULT AND ANALYSIS

Experimental Results of Black cotton soil:
1.Atterberg's Limits:
i)Liquid Limit – 60%
ii)Plastic Limit – 50%
iii)Shrinkage Limit – 9.67%
iv)Plasticity Index – 10%
2.Compaction Characteristics: a) OMC – 15% b)MDD – 1.68 g/cc
3.Soaked CBR: 3.74%
4.Unsoaked CBR: 14.79%
5.Shear Strength Parameters:
i)Cohesion(c) – 0.38kg/cm^2
ii)Angle of internal friction(φ) – 13^o
iii)Shear Stress – 0.6kg/cm^2
iv)Normal Stress – 8.33*10^{-3}kg/cm^2
6.Free Swell Index = 25%
Experimental Results of (Black Cotton Soil + Rock Dust):
1.Atterberg's Limits:
i)Liquid Limit – 60%
ii)Plastic Limit – 50%
iii)Shrinkage Limit – 9.67%
iv)Plasticity Index – 10%
2. Compaction Characteristics: a) OMC – 15% b)MDD – 1.68 g/cc
3. Soaked CBR: 3.74%

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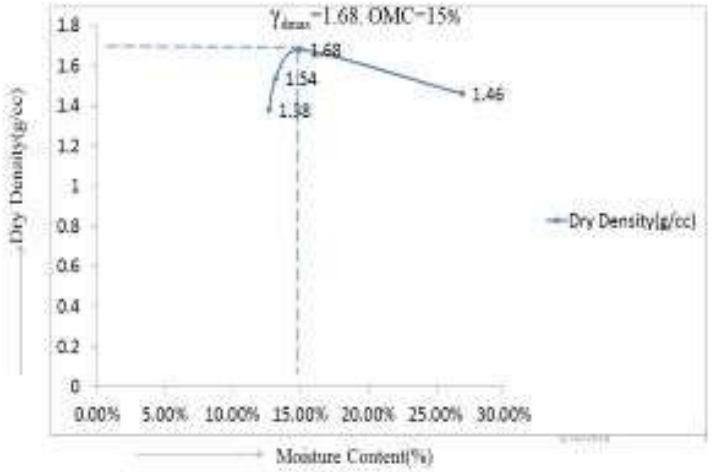
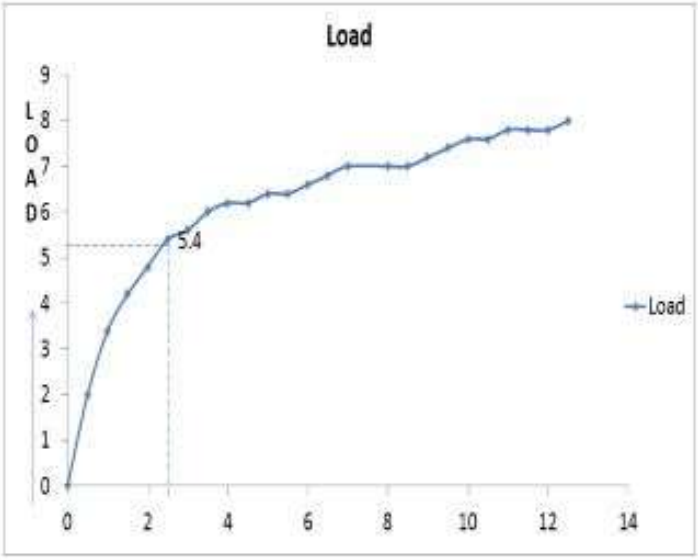
4. Unsoaked CBR: 14.79%
5. Shear Strength Parameters:
i)Cohesion(c) – 0.38kg/cm^2
ii)Angle of internal friction(φ) – 13^o
iii)Shear Stress – 0.6kg/cm^2
iv)Normal Stress – 8.33*10^{-3}kg/cm^2
6.Free Swell Index = 25%

Compaction curve for Black Cotton Soil:





From the above graph, it is evident that:
Optimum Moisture Content(OMC) = 15%
Maximum Dry Density(MDD) = 1.68g/cc

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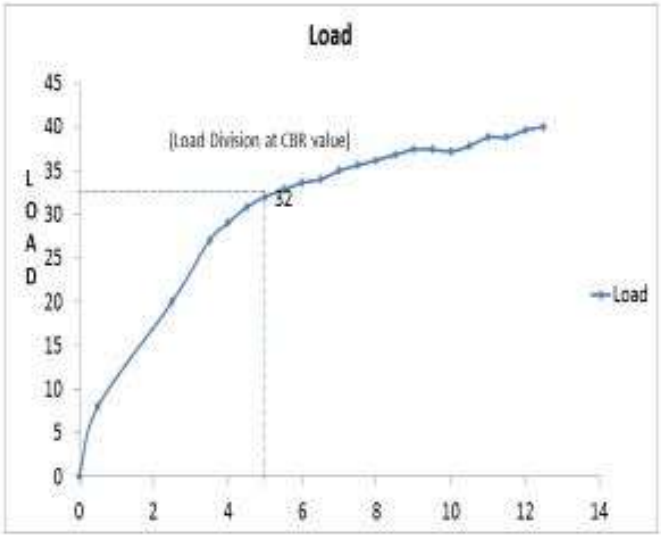
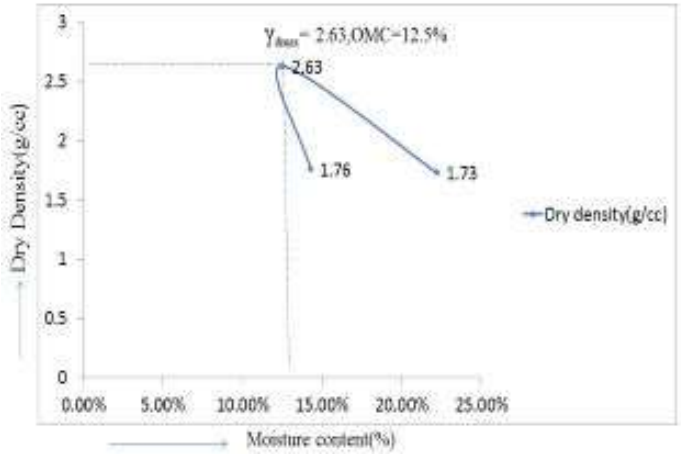
Soaked CBR curve for Black Cotton Soil:
From the above graph, it is evident that:
a)2.5 mm penetration corresponding load = 51.3kg
b)2.5 mm penetration corresponding CBR value= 3.74%



Unsoaked CBR curve for Black Cotton Soil:
From the above graph, it is evident that:
a)2.5 mm penetration corresponding load = 304kg
b)2.5 mm penetration corresponding CBR value = 14.79%

Compaction Curve for B.C+ 75% Rock Dust:



From the above graph, it is evident that:
Optimum Moisture Content(OMC) = 12.5%
Maximum Dry Density(MDD) = 2.63g/cc

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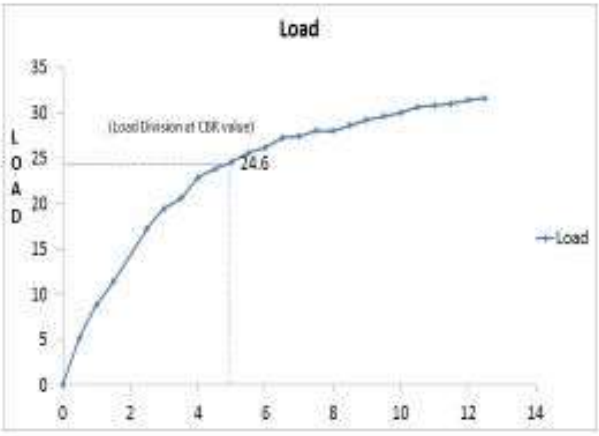
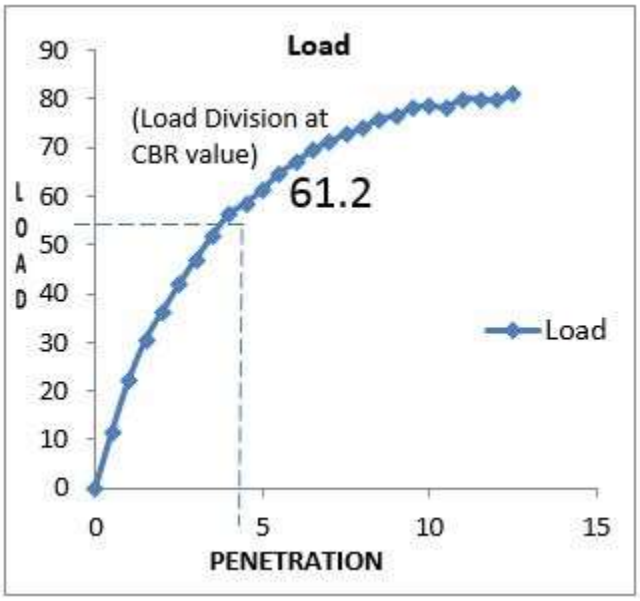
Soaked CBR curve for B.C + 70% Rock Dust:



From the graph it is that:
a)2.5 mm penetration corresponding load = 163.4kg
b)2.5 mm penetration corresponding CBR value = 11.92 %

Unsoaked CBR curve for B.C + 55% Rock Dust:



From the above graph, it is evident that:
a)2.5 mm penetration corresponding load = 397.1kg
b)2.5 mm penetration corresponding CBR value = 28.98 %

CONCLUSION

On the basis of present experimental study, the following conclusions are drawn:

1. Based on the results from Proctor Compaction test on Pure Black Cotton Soil mixing with Rock Dust of 10%, 15% up to 75% with 5% increment, it is found that the values of Proctor Compaction test shows a net increment of its Dry Density from 1.68 to 1.77g/cc, 1.78g/cc up to 2.63g/cc and the net decrease in Moisture Content was from 15% to 14.3%, 12.5% up to 10%.
2. So there is a net increment in Dry Density from 1.68g/cc to 2.63g/cc at 75% rock dust and net decrement in Optimum Moisture Content from 15% to 10% at 25% rock dust.
3. When the Sludge is mixed with Black Cotton Soil starting from 2% to 14%, there is a net increment in Dry Density from 1.68g/cc to 1.81g/cc at 5% of Sludge mixing and there is a net decrement in Optimum Moisture Content from 15% to 9.57% at 4% Sludge Mixing.
4. On observing the results of Un-soaked California Bearing Ratio Test of Pure Black Cotton soil on mixing with Rock Dust of 10%, 15% up to 75% with 5% increment, it is found that there is an increment from 14.79 to 18.86, 15.26 up to 28.99 and when mixing with Sludge of 2%, 5% up to 10% with 2% increment, it is found that there is an increment from 22.92 to 33.84 at 5% of Sludge.
5. Soaked CBR values for pure B.C is 3.74, when mixed with Rock dust CBR value is 11.37.So there is an increment
6. When the Sludge is mixed with Black Cotton Soil starting from 2% to 14%, there is a net increment in Dry Density from 1.68g/cc to 1.81g/cc at 5% of Sludge mixing and there is a net decrement in Optimum Moisture Content from 15% to 9.57% at 4% Sludge Mixing
7. When mixing with Sludge of 2%, 5% up to 10% with 2% increment, it is found that there is an increment from 22.92 to 33.84 at 5% of Sludge.

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