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STABILIZATION OF SUB GRADE SOIL BY USING FOUNDRY SAND WASTE

Prashant Kumar*, Prof. M.C.Paliwal, Prof. A.K.Jain

*M .Tech. Scholar (Civil),Department of Civil and Environment Engineering, NITTTR,Bhopal, India
Associate Professor,Department of Civil and Environment Engineering, NITTTR,Bhopal, India
Professor, Department of Civil and Environment Engineering, NITTTR,Bhopal, India

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ABSTRACT

Due to various construction development projects undertaken all over the world there is a substantial increase in the production of waste materials like concrete, fly ash, plastic, rice husk, foundry sand etc. which create disposal problems. Foundry waste sand is produced in large quantity in foundry industries and is disposed in open land. Therefore use of foundry waste sand in foundation of buildings and in road constructions to improve bearing capacity of soil and to reduce the area of open land needed for its disposal and to preserve environment through resource conservation.Soil is a base of a structure which supports the structure from beneath and distributes the load effectively. The present study deals with stabilization of soil by using foundry waste sand in different proportion in original soil. In this study laboratory tests such as Atterberg's Limit Test, Direct Shear Test and California Bearing Ratio (CBR) Test were carried out for both modified and unmodified soil. The results show that Maximum Dry Density and CBR values were improved after addition of foundry waste sand to the soil.

KEYWORDS: Foundry waste sand, Bearing capacity, Land filling, Stabilization, Direct Shear test, California Bearing Ratio (CBR) test.

INTRODUCTION

Foundry sand is top quality silica sand that's a by product from the assembly of every ferrous and non ferrous metal casting. Metal foundries use massive amount of sand as a part of the metal casting method. Once used sand should not be reused within the metal works, which termed as foundry sand. Foundry sand production is almost six to ten million tons annually in India. Like several waste products foundry sand has useful applications to different industries.There are two basic forms of foundry sand available, green sand (often named as molding sand) that uses clay as the binder material, and chemicals bonded sand that uses polymers to bind the sand grains along. Green sand consists of 85% to 95% silica, 2% to 12% clay, 2% to 10% carbonaceous additives like bituminous coal and 2% to 5% water. Green sand is generally utilized in foundries. The silica sand resists high temperatures whereas the coating of clay binds the sand along. The water adds plasticity. The carbonaceous additives stop the burn on or fusing of sand onto the casting surface. Chemicals bonded sand consists of 93% to 99% silica and 1% to 3% chemical binder. The most common chemical binder used are phenol-urethanes, epoxy-resins, fury alcohol, and sodium silicates. So in this thesis an effort has been made to use this material as a stabilizing (improving engineering properties) material for the soil. The waste materials for soil stabilization have become popular by considering environment and economy. In the present study some quantity of soil is replaced by different proportions of foundry waste and different tests were conducted to find the Atterberg limits, maximum dry density, Direct shear test and California bearing ratio values.The broad objective of the present work is to carry out the experimental studies on the potential use of fines obtained from foundry waste as stabilizing material for improving the strength of sub grade soil.

MATERIALS AND METHODS

Sub Grade Soil:

The soil sample was collected after removing the top soil by 200 mm depth. The soil was air dried, pulverized and sieved with 4.75 mm Indian Standard as for the requirement of the various laboratory test.

Stabilizing Material:

Fines obtained from foundry waste material used as stabilizing material for the present project work. After crushing of the materials the coarser will gets removed from the fines. The fines passing through 10 mm sieves were used as soil stabilizing material for this work.

Test Conducted on Original Soil:

Atterberg's Limit Test:

The water content at which the soil changes from one state to the other state is known as consistency limits or Atterberg's limits. Atterberg's limits were conducted to determine liquid limit, plastic limit and plasticity index of original soil as per specifications of IS: 2027(Part 5) 1985. The value of liquid limit and plastic limit are directly used for classifying the original soil sample according to the Indian standards of soil classifications.

Liquid Limit Test:

The water content at which the soil changes from the liquid state to the plastic state is known as liquid limit. The value of liquid limit is important in calculating the flow index, toughness index and plasticity index. The value of liquid limit is giving an idea about the plasticity, Cohesiveness, Shear strength, compressibility, permeability and state of cohesive soils. This test is conducted to determine the relation between water content and no. of blows as per the procedure mentioned in IS: 2720 (Part 5) 1985.

Fig-1:Liquid Limit Test

Fig -2: Liquid Limit Apparatus

Plastic Limit Test:

This test is conducted to determine the water content at which the soil will just begin to roll into a thread of 3 mm in diameter as per the procedure mentioned in IS: 2720(Part 5) 1985.

Plasticity Index (PI):

The plasticity index (PI) is a measure of the plasticity of soil. The plasticity index is the range of water contents where the soil shows plastic properties. The plasticity index of the soil is the difference between the liquid limit and the plastic limit (PI = LL - PL). Soil with a high PI tends to be clay, lower PI tends to be silt, and PI of 0 (non Plastic) tend to have little or no silt or no clay. Plasticity Index (PI) = Liquid Limit (LL) – Plastic Limit (PL)

Test conducted on original soil as well as for the soil mixed with foundry waste fines in varying percentage (i.e. 5%, 10%, 15% and 20%):

Standard Proctor Test (For Heavy Compaction):

Standard Proctor tests were conducted to determine optimum moisture content and maximum dry density of original soil and for the soil mixed with different percentages of fines obtained from foundry waste (i.e. 5%, 10%, 15% and 20%) by weight of the soil solids. This tests were conducted to prepare specimens at maximum dry density by adding desired optimum moisture content as per specifications of IS: 2720 (Part7) 1980.

Fig-3: Standard Proctor Test

California Bearing Ratio (CBR) Test:

The California bearing ratio (CBR) test is done for calculating the suitability of the sub grade and the materials used in the sub base and base of a flexible pavement. In the present study, California bearing ratio(CBR) tests were conducted to determine the strength of the original soil as well as for the soil mixed with different percentage of fine foundry waste (i.e. 5%,10%,15% and 20 %) by weight of the soil. The test was conducted in accordance with IS: 2720 (Part 16) 1987. California bearing ratio (CBR) is the ratio of force per unit area required to penetrate into a soil mass with circular plunger of 50 mm diameter at the rate of 1.25mm/min. CBR value at 2.5mm penetration is generally higher than that at 5.0mm penetration. CBR value corresponding to 2.5mm penetration is reported as CBR of the material. However if the CBR value corresponding to 5.0mm penetration is higher than that of 2.5 mm, than the test is repeated for check. If the same results are obtained again, the higher value corresponding to 5.0 mm penetration is reported as the CBR value. Material passing 20mm sieve only is used for the test.

Fig-4: Sample for CBR Test

Fig-5: CBR Test Apparatus

Direct Shear Test:

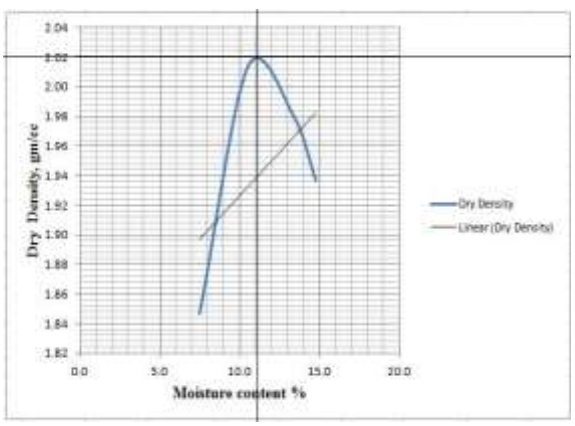
In design of foundation, retaining walls, bridge slabs, sheet pilings, etc., the values of the angle of internal friction and cohesion of the soils are needed for the design. Direct shear test is done to find out these parameters.The thought of direct shear is easy and largely suggested for granular soils, generally on soils containing some cohesive soil content. The cohesive soils have problems concerning dominant the strain rates to drained or undrained loading. In granular soils, loading will continuously assumed to be drained. In direct shear test the soil sample is placed in a square box that is split into upper and lower halves. Lower section is mounted and upper section is pushed or force horizontally relative to different section so forcing the soil sample to shear on the horizontal plane separating two halves. Beneath a selected normal force, the shear force is increased from zero till the sample is totally sheared.

Fig-6: Direct Shear Test

RESULTS AND DISCUSSION

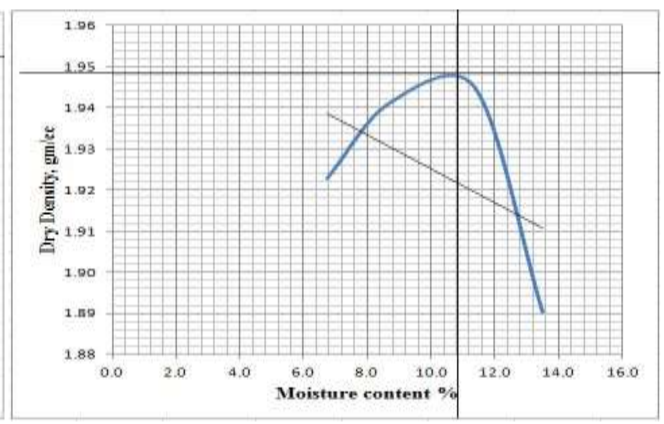
Details of the experiments carried out for the present work has been presented. Interrelationship between various parameters like Maximum Dry Density (MDD) and Optimum Moisture Content (OMC), California Bearing Ratio (CBR), obtained from the test results are presented in the graphical form.

Relationships between OMC and MDD for the original soil



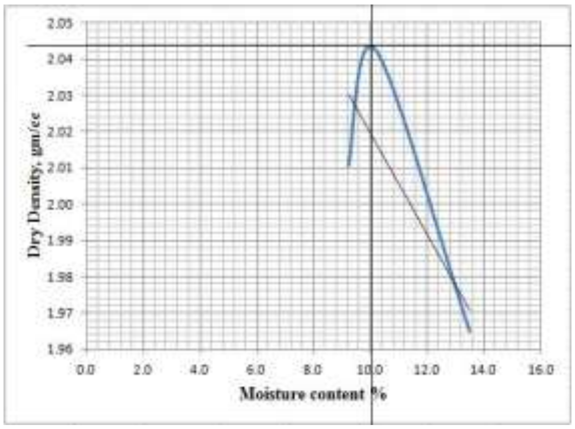
Graph-1

Relationships between OMC and MDD for the OS + 5% FW



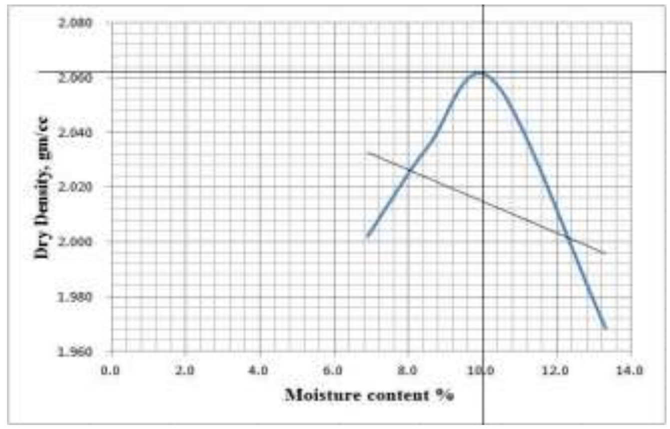
Graph-2

Relationships between OMC and MDD for the OS + 10%FW



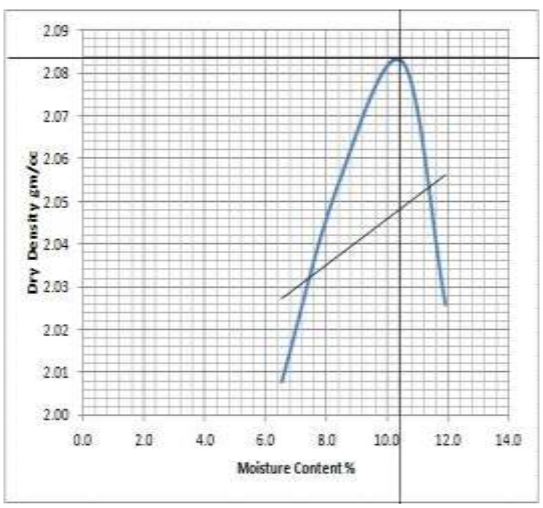
Graph-3

Relationships between OMC and MDD for the OS +15% FW



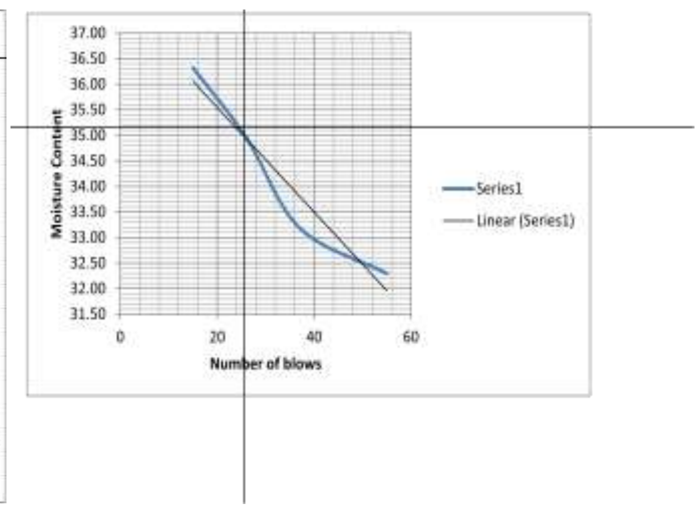
Graph-4

Relationships between OMC and MDD for the OS + 20%FW



Graph-5

Relationships between LL and PL for the original soil



Graph-6

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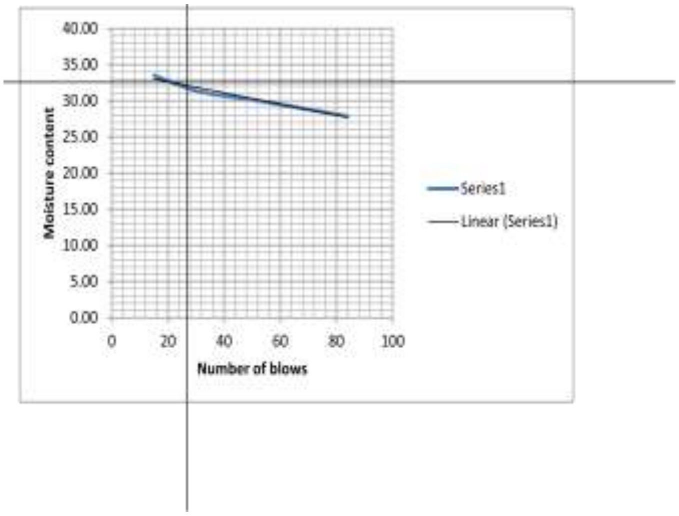
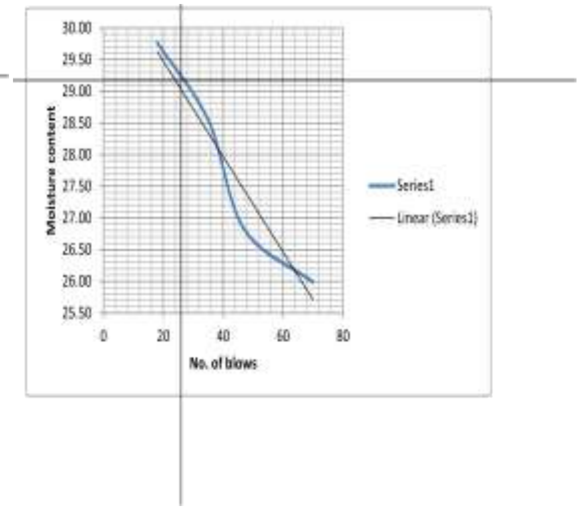
Relationships between LL
and PL for the OS + 5% FW



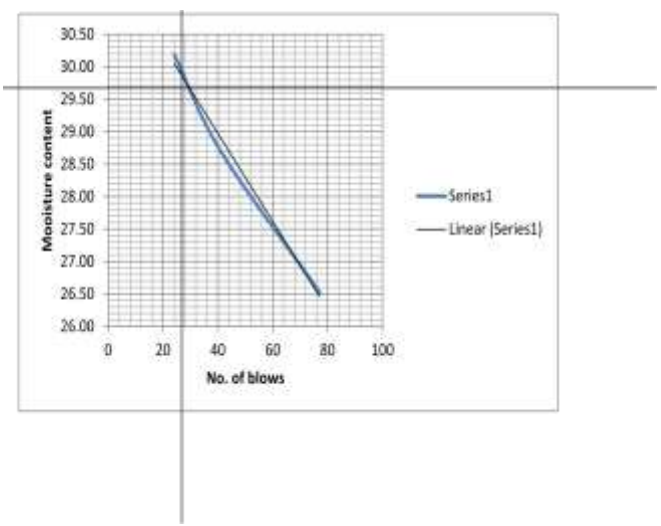
Graph-7

Relationship between LL
and PL for the OS + 10%FW



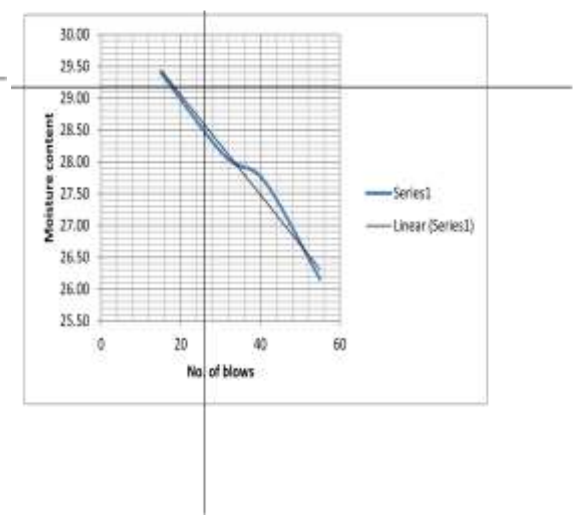
Graph-8

Relationships between LL
and PL for the OS + 15% FW



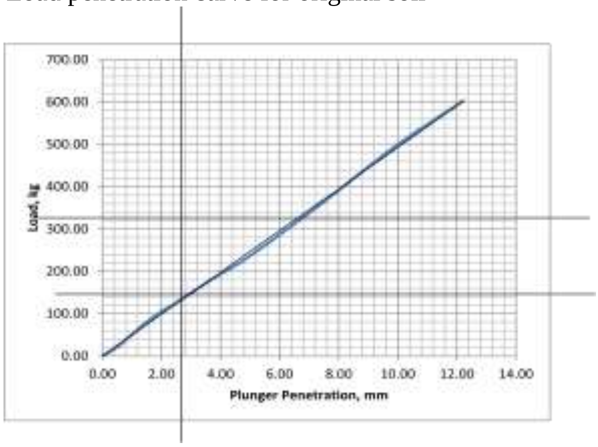
Graph-9

Relationships between LL
and PL for the OS + 20%FW



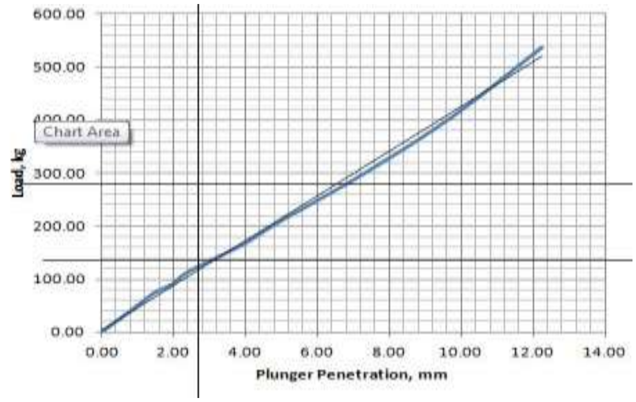
Graph-10

Load penetration curve for original soil



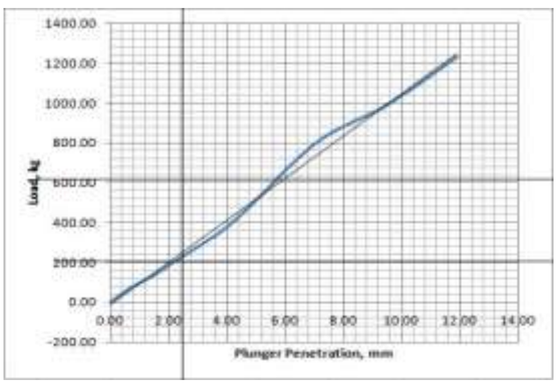
Graph-11

Load penetration curve for OS + 5% FW



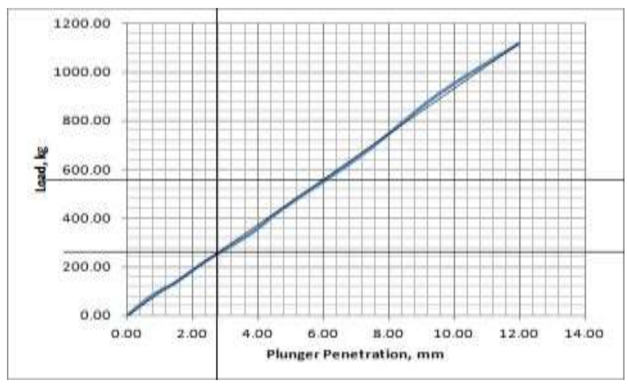
Graph-12

Load penetration curve for OS + 10% FW



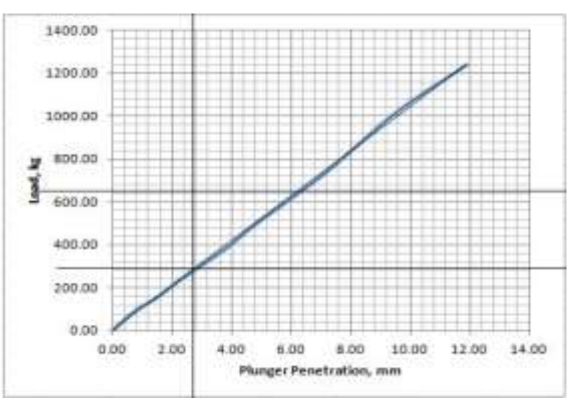
Graph-13

Load penetration curve for OS + 15% FW



Graph-14

Load penetration curve for OS + 20% FW



Graph-15

CONCLUSION

On the basis of the results obtained from the experiments investigation carried out in the present dissertation work, following conclusions can be drawn:-

SN	Test conducted	Material on which tests were conducted				
		OS	OS+5% FW	OS+10% FW	OS+15% FW	OS+20% FW
1	LL	35.1	32	29.6	29.1	28.5
3	PL	21.38	21.052	20.058	19.104	18.788
	OMC	11	11	10	10	11
5	MDD	2.02	2.032	2.043	2.061	2.084
6	CBR	8.9	12.46	15.32	16.86	18.21
7	Direct Shear c(kg/cm2)	1.1	1	0.8	0.5	0.3
8	Direct Shear $(degree)	22	25	26	27	29

- In order to evaluate the effectiveness of the foundry waste as a soil stabilizing material several tests were conducted on the soil and mixing various percentage of foundry waste in original soil.
- Table 5.1 shows that the Liquid Limit goes on reducing with the addition of foundry waste and hence it helps to reduce the drying shrinkage of the clayey soil which in turn will help to reduce the crack width of such a soil.
- Its optimum moisture content also shows a lower value of 10% of foundry waste which may be attributed to the reduction of soil cohesion with the addition of foundry waste which is a non-cohesive material.
- At 20% foundry waste addition level the optimum moisture content value shows an increase which may be attributed to interlocking effect between particles at higher percentage of foundry waste.
- CBR value of the soil also shows improvement with the addition of foundry waste.
- The CBR value of the soil improved from 8.9 to 18.21 with increasing percentage of foundry waste.
- Angle of internal friction of the soil also improved from 22 degrees to 28 degrees with the addition of foundry waste.
- All round improvement of soil's engineering properties with addition of foundry waste shows that foundry waste sand is a very good waste material for soil stabilization.

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