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USE OF IRON SLAG TO REINFORCE SOIL AND TO PREVENT SEEPAGE

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Abstract – *In civil engineering the construction of any project will greatly depend on geotechnical properties of soil. Sometime the soil cannot fulfill the requirements for the construction, so to overcome this problem reinforcement of soil is done. Reinforcement of soil is the process of mixing another material in an appropriate proportion to enhance the properties of the soil. The purpose of our study is to reinforce the soil with iron slag which is an industrial waste, so as to improve the properties of soil i.e. strength and seepage. For this we have performed the tests like Proctor test, vane shear test, permeability test with falling head method, tests for Atterberg limits and CBR test taking slag percentages as 3%, 6% and 9%. Permeability test will help us determine water seepage capacity through soil with and without slag.*

Key Words: Soil reinforcement, Slag, Permeability, Strength, Geotechnical Properties etc.

1. INTRODUCTION

Soil is a heterogeneous substance that has various properties and these differ location to location. One of the properties of soil is porosity. It is a property that allows the water to pass through it. This property of the soil is the reason for the formation of ground water. Due to this property only the ground water may get polluted by seepage of the leachate. Also at some places the soil is weak in strength and hence does not allow the construction to take place as it cannot bear Load transfer by foundation. So in order to enhance load bearing capacity of soil and to prevent seepage we have used Iron Slag. The various tests are conducted to compare properties of soil, before and after addition of Iron Slag.

1.1 Slag

Slag is a glass like byproduct that is left over when a desired metal is extracted from its raw ore by the process of smelting. Slag is usually a waste matter that is directly dumped into the landfills. It is formed in bulk quantities in metal casting industries as a waste product. Slag is a mixture of silicon dioxide and metal oxides.

Fig -1: Iron Slag

2. PROBLEMS

There is a major problem of pollution in Metro cities because of production of waste in large quantities. These wastes can be household waste, bio medical waste or any other. Municipal solid waste is generally dumped in a landfill and when rain occurs the seeping starts. This rain water takes all the impurities along with it and form a black thick liquid called leachate. This pollutes ground water and needs to be stopped. Also Soil at some locations is not suitable for construction. It is week in shear and hence it can't be used for laying of Foundation.

3. REMEDIAL MEASURES

Using of Iron Slag with the soil to reinforce it and to prevent seepage can be a useful remedial measure. Slag can stabilize the soil as well as can prevent seepage. Using slag of size comparable to a greater part of the soil can not only fill up the void but can actually reinforce it. Hence providing Adequate Shear strength. These all Testing can be performed using tests like Permeability, Proctor Compaction Test, California Bearing Ratio Test, Vane Shear Test etc.

4. METHODOLOGY

A. Material Collection.
B. Determining the Properties of Normal Soil.
C. Addition of Iron Slag to the Soil Sample.
D. Test on Soil Sample with Slag
E. Comparison of Result.
F. Conclusion.

The following experiments are conducted based on IS codes:

A. Determination of soil specific gravity
B. Particle size distribution by sieve analysis
C. Determination of Soil index properties (Atterberg Limits)
D. Liquid limit by Casagrande's Apparatus
E. Plastic limit
F. Determination of maximum dry density (MDD) and the corresponding Optimum Moisture Content (OMC) of the soil by standard proctor compaction test
G. Determination of shear strength by California Bearing Ratio Test.
H. Determination of Shear Strength by Vane Shear Test.
I. Determination of Hydraulic Conductivity/ Permeabilty by Falling Head Method.

5. EXPERIMENTAL INVESTIGATION

Soil with Iron slag

Liquid Limit Test

Moisture Content (%) = w = $(W_w/W_d)*100$

Table -1: Liquid Limit for Soil with Iron slag

Wheat Husk Percentage	3%	6%	9%
No. of Blows	25	25	25
Wt. of empty container in gm,W_1	16	16	16
Wt. of container + wet soil in gm, W_2	40	33	26
Wt. of container + dried soil in gm, W_3	34	29	20
Wt. of oven dried soil in gm, $W_d=W_3-W_1$	18	13	04
Wt. of water in gm, $W_w=W_2-W_3$	06	04	06
Moisture content of Soil (%)	33.33	30.76	28.96

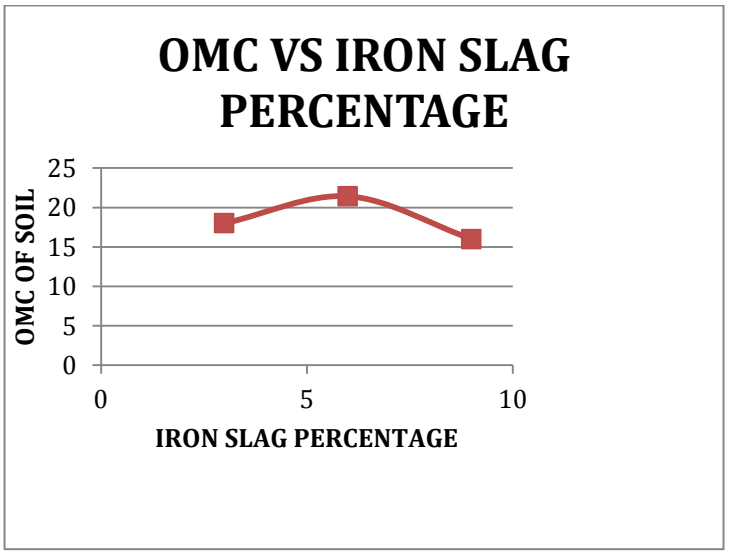
Plastic Limit Test

Moisture Content (%) = w = $(W_w/W_d)*100$

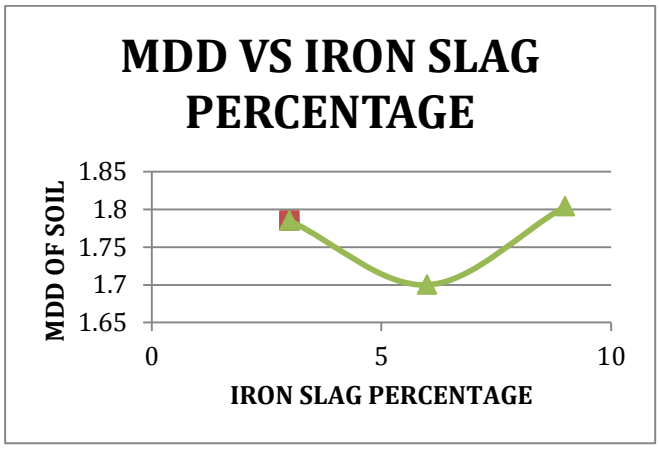
Table -2: Plastic Limit for Soil with Iron slag

Wheat Husk Percentage	3%	6%	9%
Wt. of empty container in gm,W_1	16	16	15
Wt. of container + wet soil in gm, W_2	29	26	30
Wt. of container + dried soil in gm, W_3	26	25	24
Wt. of oven dried soil in gm, $W_d=W_3-W_1$	10	09	09
Wt. of water in gm, $W_w=W_2-W_3$	03	01	06
Water content (%)	30	11.11	8.91

Procter compaction test



Graph -1: OMC vs Iron slag percentage(3%,6%,9%)



Graph -2: MDD vs Iron slag percentage (3%,6%,9%)

Table -3: CBR Values of Soil

% Iron Slag& Lime	CBR Value @2.5mm Penetration (%)	CBR Value @5mm Penetration (%)
3% Iron Slag	1.132	1.120
6% Iron Slag	4.329	4.209
9% Iron Slag	10.970	10.465

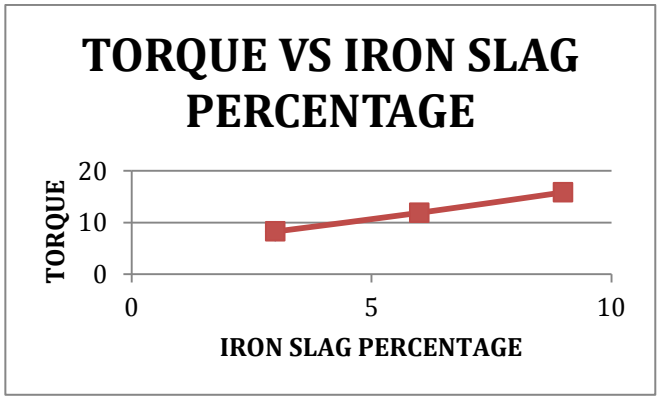
Vane shear test

Table no.- 4 vane shear test on normal soil

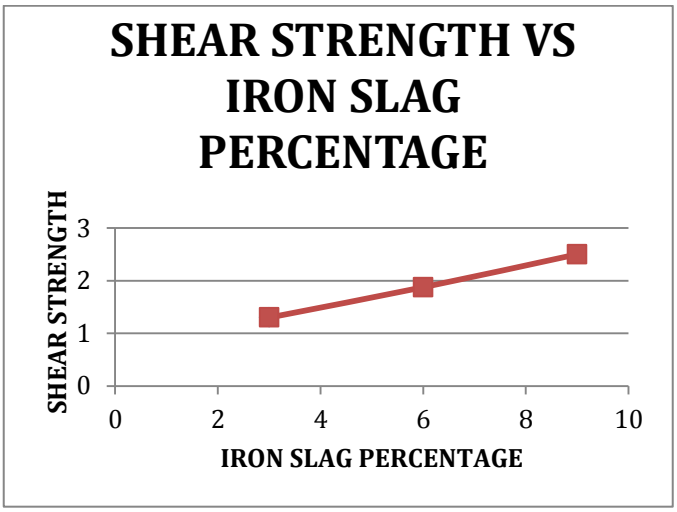
S.No.	Initial Reading (Degree)	Final Reading (Degree)	Difference	Torque T=spring constant * difference/ 180 (cmkgf)	Shear strength S=T/6.33 (kgf/cm2)
1	0	8	8	0.264	0.0417

Table no.-5 vane shear test on reinforced soil

S. No.	Iron slag percentage	Initial reading (degree)	Final reading (degree)	Difference	Torque T=spring constant * difference/180 (cmkgf)	Shear strength S=T/6.33 (kgf/cm2)
1	3%	0	25	25	8.25	1.30
2	6%	0	36	36	11.88	1.876
3	9%	0	48	48	15.84	2.502



Graph no.-3 torque vs iron slag percentage



Graph no.-4 shear strength vs iron slag percentage

Hydraulic conductivity of soil using falling head method

K=2.3*a*L*log(h1/h2) /A*t

Hydraulic conductivity for normal soil

k=77.72*10^(-5)cm/sec

Hydraulic conductivity for reinforced soil

Table no.-6 hydraulic conductivity of reinforced soil

S .no.	Iron slag percentage	Hydraulic conductivity
1	3	55.30*10^(-5) cm/sec
2	6	37.84*10^(-5) cm/sec
3	9	No percolation

6. CONCLUSION

From the tests above we have concluded that using Iron Slag at 3% with the soil is the best suited combination as at 6% OMC of the soil is increasing whereas the MDD of the Soil decreased and at 9% percolation has stopped completely which is not desirable as it will not leave any space for water percolation to the ground water. The test above shows that iron slag can be used to form an impermeable layer over the soil surface to avoid seepage of water. This property of iron slag can be used in designing and construction of earthen dams to prevent seepage of water hence helping increase strength of soil The impermeable layer property shown by iron slag can be used in landfill to prevent seepage of leachate to prevent the contamination of ground water Iron slag can be used in construction of road pavements to prevent the seepage of water as well as to increase its strength to prevent shear failure.

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