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Experimental Investigation on Soil Stabilization Process with the Help of Industrial Waste Materials

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Abstract

Soil stabilization is the method of improvising the properties of engineering materials which are related to soil and thus making it better stable. It is required when the soil which is available for construction purpose is not best suited for the required purpose. It is basically employed for reducing the compressibility and to enhance the bearing strength of the sub-grade type of soil. Site feasibility analysis for geotechnical related projects is so beneficial aspect before a project taking off. Site survey mainly takes place before the design process happens to understand the properties of subsoil based on which the decision on location of the project can be decided.

Soil stabilization basically aims at enhancing the strength of soil and increasing the resistance in order to soften with the help of water through bonding of the soil particles together, water proofing of the particles or combination of the two aspects. Basically, the technology provides an alternative provision based structural solution to the practical problem. The simplest stabilization processes are compaction and drainage process. The other process is by improving gradation of particle size and by adding binders to the weak soil particles.

In the present study tests are carried out in two phases. In the first phase of tests, stone dust is been used as an admixture and iron slag as a second admixture for the stabilization of soil.

In the first phase in order to achieve the better economy and for proper performance of structural materials, it is necessary to improve the geotechnical properties of soil. This paper basically presents the outcome of an experimental program undertaken to study the effect of stone dust at different percentage on soil. The test results like index properties, compaction and CBR test obtained at various proportions of stone dust of mixture are illustrated. In the second phase utilization of industrial waste materials in the improvement of problematic soils is a cost efficient and environmental friendly method. It helps in reducing disposal problems caused by the various industrial wastes.

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I. INTRODUCTION

This portion of paper mainly describes in brief, the materials used and the experimental methods adopted in conducting different laboratory tests.

1.1 MATERIALS employed

The details related to soil particles and sand which are used in this study are given below.

1. Stone dust 2. Iron slag

a) STONE DUST:

Stone dust is obtained as solid waste during the process of crushing of stones in order to obtain the aggregates. Now a day's various types of materials like lime, fly ash and cement are employed by the stone dust which exhibits high shear strength and is highly beneficial for its usage as a geotechnical material. It has a good permeability property and variation in water content does not seriously affect its desirable properties. Geotechnical properties are used in highway construction and it can be concluded that the CBR will steadily increased with increase in percentage of stone dust respectively. Furthermore, the improvement in CBR value can be contributed to most possible extent of aspect and more specifically in angle of shearing resistance.

Fig. 1 Stone dust

b) IRON SLAG: Steel industry has been producing the substantial quantity of waste material with good engineering characteristics and examining the behavior. In this steel industry, the various wastes which are produced from the mill during the process of preparing the steel bars is used for the stabilization of soil particles. The addition of waste materials which consisting of sand particles and skinny type of metal pieces changing the soil gradation, resulting in enhancement in the density value and strength of the stabilized material more specifically. The performance of the stabilized soil with respect to ever altering weather conditions is also very much improvised.

Fig. 2 Iron slag

c) SCOPE OF WORK

The experimental validation work consisting of the following steps: namely:

1. Determination of the maximum dry density (MDD) value and the corresponding optimum moisture content (OMC) value of the soil material by static compaction testing conditions.
2. Determination of CBR with the help of California bearing ratio test methodology.
3. In this paper, the variation of Dry density, CBR values and Moisture content for various mixed proportions of stone dust admixture is further added to the soil material.

TABLE 1: Comparison among MDD, OMC and CBR value

Percentage of stone dust replaced in	Compaction values	CBR

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soil material	**Moisture content in %**	**Maximum dry density g/cc**	**value in % ratio**
100% of soil +0% of stone dust	17	1.9	6.5
95% of soil + 5% of stone dust	12	1.97	8.66
90% of soil + 10%stone dust	12	2.0	6.29
85% of soil + 15% stone dust	11.8	2.12	1.399
80% of soil + 20% stone dust	11.50	1.96	5.47
75% of soil + 25% of stone dust	14	1.88	1.30
70% of soil+ 30% of stone dust	10.8	2.204	1.389
65% of soil+35% of stone dust	11.5	2.105	1.82
60% of soil+40% of stone dust	12.50	1.967	1.389
65% of soil+45% of stone dust	14.2	1.964	1.04
70% of soil+50% of stone dust	13	2.08	0.95

Concluding remark: It could be observed that, the maximum Dry density is around 2.204 g/cc occurred with the minimum Moisture content of 10.8% for the mix proportion of 70% of soil + 30% of stone dust.

REPLACEMENT OF IRON SLAG:

Fig. 3 Replacement of Sand with Iron Slag.

Table 2 : Comparison of MDD, OMC and CBR value

Percentage of Iron slag replaced in soil particle	**Compaction value**		**CBR value in %**
	Moisture content in %	**Dry density g/cc**	
100% of soil +0% of Iron slag	17	1.9	6.5
95% of soil +5% of Iron slag	15.5	1.93	2.04
90% of soil +10% of Iron slag	12.5	2.06	5.85
85% of soil +15% of Iron slag	11.2	2.21	2.098

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80% of soil +20% of Iron slag	11.6	2.92	5.33
70% of soil +30% of Iron slag	10.2	2.4	4.109

Concluding remarks: It could be observed that, the maximum dry density is around 2.4 g/cc occurred with the minimum moisture content as 10.8% for the mixed proportion of 70% of soil content +30% of Iron slag.

II. COMPACTION CHARACTERISTICS OF STONE DUST

The following figure represents increasing and decreasing of MDD values with corresponding to their OMC values, when the stone dust admixture in particularly added to the soil are in different percentages ranging from 5% to 50%.

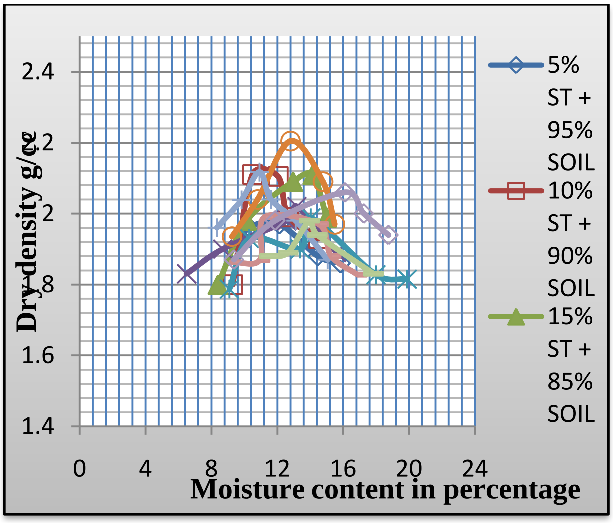

Fig. 4 Relationship between OMC and MDD values.

Concluding remarks: From the plot, it can be further observed that, there is decrease in OMC and increase in MDD value with increase in percentage of stone dust values. It is also observed that, the samples are being replaced with 30% of admixture yielded by MDD of 2.204 g/cc and OMC of 12.8 %.

Compaction Characteristics of Iron slag:

The fallowing figure represents increasing and decreasing MDD values with corresponding their OMC, when Iron Slag admixture added to the soil in different percentages from 5% to 30%.

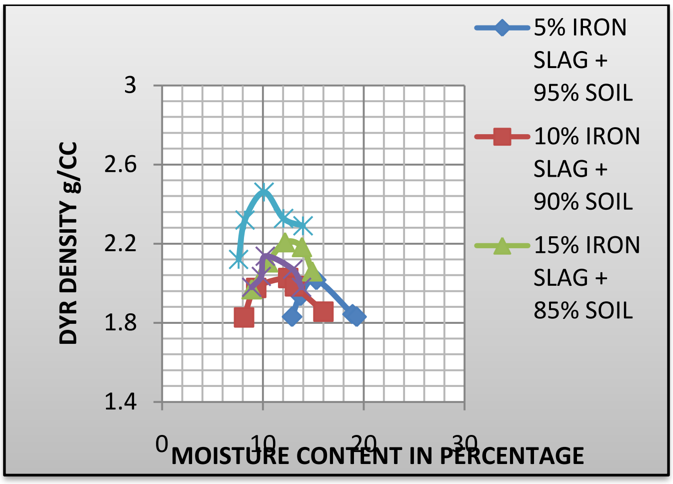

Fig. 5 Relationship between OMC and MDD

Concluding remarks: From fig. 5, it is observed that, there is decrease in OMC and rise in MDD value with corresponding increase in percentages of Iron Slag. It is also observed that, the sample which is replaced with 15% of admixture further yielded with MDD of 2.21 g/cc and OMC of 11.2%.

California bearing ratio characteristics plots:

The load-penetration curves of mixtures are studied from the California Bearing Ratio tests at different percentages of stone dust. The load-penetration curve is followed by ranges of 5% to 50% in steps of 5% increment respectively. The variation of California Bearing Ratio values at 2.5 mm penetration with various percentages of soil is

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plotted in Fig. 6. Also, the variation of California Bearing Ratio values at 5.0 mm penetration values with different percentages of soil is plotted further.

Table 3 CBR Parameter values

S.NO	**Percentage values**	**2.5 mm Penetrations**	**5.0 mm Penetrations**
1	100% Soil content	32.85	31.63
2	95%Soil+5%Stone dust	8.68	11.176
3	90% Soil +10% Stone dust	6.29	7.527
4	85% Soil +15% Stone dust	6.01	7.12
5	80% Soil +20% Stone dust	5.47	6.71
6	75% Soil +25% Stone dust	1.30	1.21
7	70% Soil+30% Stone dust	1.389	1.33
-8	65% Soil +35% Stone dust	1.82	2.37
9	60% Soil +40% Stone dust	1.389	1.33
10	55% Soil +45% Stone dust	1.04	0.98
11	50% Soil +50% Stone dust	0.95	0.20

SOIL-STONE DUST MIXTURE

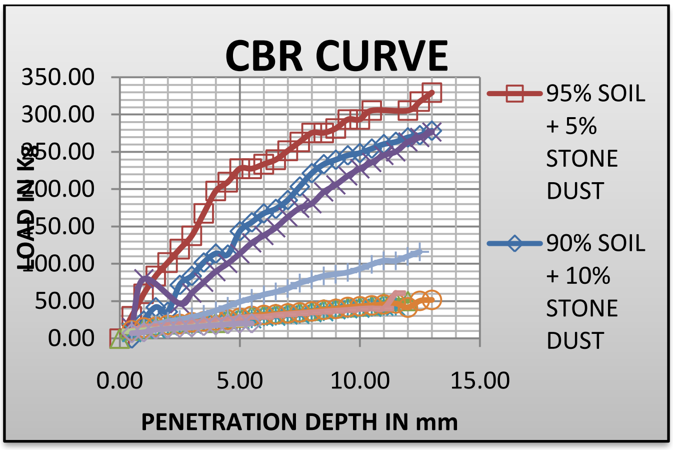

Fig 6: Load-Penetration Curves with various Percentages of stone dust

Concluding remarks: From Fig. 6, it is observed that, as the percentage of Stone Dust values increases considerably, CBR also increases in a reasonable manner. The optimum value of CBR is observed at penetration depth of 2mm as 1.389% and at depth of 5mm as 1.33%.

Soil-iron slag admixture:

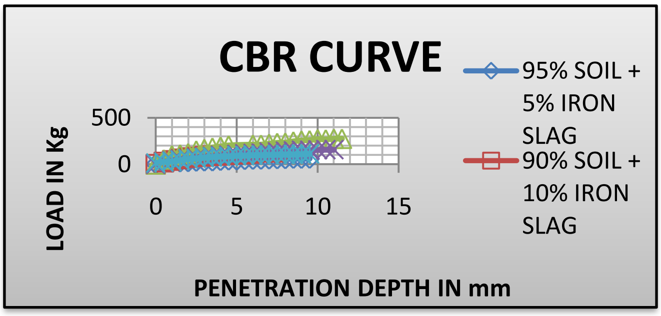

Fig 7: Load-Penetration Curves with various Percentages of iron slag

2.2 Concluding remarks: From the plot, it can be further observed that, as the percentage of Iron Slag increases considerably, the CBR value is also increasing in a reasonable trend. The optimum value of CBR is found at penetration depth of 2.5mm to be as 2.098% and at depth of 5 mm as 4.43%.

CONCLUSION

The following are the conclusions could be derived: namely:

- It can be observed that, the maximum Dry density value is 2.204 g/cc which is occurred with a minimum Moisture content of 12.8% for the mixed proportion of 70% soil +30% stone dust when compared further to other mixed proportion values.
- It could be observed that, the maximum dry density value is 2.4 g/cc which is occurred with minimum moisture content is obtained as10.8% for the mixed proportions of 70% soil+30%Iron slag when compared to other mixed proportions respectively.
- It can be also observed further that, the mixed proportions of 85% soil + 15% Iron slag giving maximum dry density of 2.2 g/cc is being compared to mixed proportion of 70% soil+30% of stone dust.
- It could be observed that, the Iron slag admixture giving the higher dry density values corresponding to the minimum moisture content than the stone dust admixture values. The value with rise in percentages of stone dust particle is observed that, the sample is being replaced with 30% of admixture which is yielded MDD of 2.204 g/cc and OMC of 12.8 %.

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