LABORATORY INVESTIGATION OF CLAYEY SOIL BY USING STEEL SLAG WASTE

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Abstract: Clayey soil is poor in quality and they will result in poor asphalt support and eventually influences the asphalt execution and its life period. Clayey soil also affects the design and construction of the pavement, resulting in higher cost of construction and early failure of pavement and many items discarded by people, organizations and companies have the potential to be reused for their original purposes or for new ones. Reuse allows people to get the most out of the products they buy and saves them money as well. Additionally, reusing products conserves natural resources and saves valuable landfill space. Need of soil stabilization is in view of greater structures, overwhelming versatility, railroad tracks and poor quality nature of soil and so forth. In this study, Maximum dry density (MDD) and optimum moisture content (OMC) values are obtained by performed standard proctor test (compaction test) on percentages (5%, 10%, 15%, 20%, 25%) of soil slag mixture.

Keywords: Steel slag, Soil stabilization, maximum dry density, CBR value.

1.1 INTRODUCTION

Stabilization of soil is that term in which designing properties of soil are changed with the assistance of another material and enhance the building properties of soil. Need of soil adjustment is a direct result of greater structures, substantial versatility, railroad tracks and poor quality nature of soil and so forth. All things considered if soil surface isn't sufficient so that will be reason for mishap. In present due to enhancement in mechanical territories just as enhancement in their wastage's and their wastage can be utilized as stabilizer admixture. To enhance quality of soil, include a few admixtures so as to enhance the building properties of soil. There are numerous admixture are generally utilized as stabilizer like fly fiery remains, bond, lime, slag, stone residue and so forth. Clayey soil has property of pliancy because of water. It is hard, non-plastic and fragile at drying state. These sorts of progress in property make issues on work. To unravel this issue a few stabilizers are blended. Steel slag is created when steel is making. There are numerous components like fineness, carbon content, iron substance, degree and so on fundamentally control the quality of soil treated with steel slag.

1.2 THE HISTORY OF SOIL STABILISATION

The Stabilization of soils has been performed for centuries. It was perceived before the Christian time started that specific geographic districts were tormented with surface materials and encompassing conditions

that made the development of armed forces and merchandise troublesome, if certainly feasible, over the ways among towns and towns. The Mesopotamians and Romans independently found that it was conceivable to enhance the capacity of pathways to convey traffic by blending the powerless soils with a balancing out specialist like pummeled limestone or calcium. This was the primary compound adjustment of powerless soils to enhance their heap conveying. Bounce forward a couple of years to the war in Vietnam, the US military were searching for strategies for quick adjustment of powerless soils for help of its missions around the world. In the course of recent years they had utilized concrete and lime these being the best stabilizers for street and landing strip applications, yet despite the fact that with watchful investigation of ground conditions and the make-up of the current soils these conventional stabilizers had a therapeutic powerful. They earnestly required a stabilizer that could be utilized rapidly without completing broad site tests that would expand the quality of the pervasive delicate earth type neighborhood soils quickly to help the arrival and take-off of overwhelming C-17 and C-130 flying machine traffic on their brief landing strips.

1.3 OBJECTIVES OF STUDY

Following are the various objectives of the study:

1. To determine the index and engineering properties of the soil samples.
2. To determine the optimum content of steel slag in soil.
3. To determine the strength properties and CBR value of the soil.
4. Determination of strength of soil by using standard proctor test and unconfined compressive strength test and how soil's plastic limit and liquid limit results are obtained.
5. Gain of strength characteristics of soil using different percentage of steel slag.

2.1 LITERATURE REVIEW ON STEEL SLAG

Magdi Zumrawi studied on the Laboratory Study of Steel Slag Used in Stabilizing Expansive Soil. In this study, the soil was initially air dried and pulverized. The soil samples were prepared by sieving through sieve no. 4 (4.75mm) and then oven dried at 105-110 □C for 24 hours. The steel slag was subjected to crushing and sieving through sieve no. 4 (4.75mm). The soil mixed with steel slag at six different contents (0%, 5%, 10%, 15%, 20% and 30%). The dry soil mixed with each percent of steel slag then subjected to testing. Laboratory tests were conducted to determine the properties of the natural and stabilized soils. The tests carried out include consistency limits, compaction proctor, free swell and unconfined. This study has concentrated on the effect of Steel Slag stabilizer on engineering properties in particular the swelling and strength properties of a highly expansive soil. Comparing the results obtained for the natural and stabilized soils revealed that SS has significant effect on strength parameters and considerable improvement in plasticity and swelling properties. Addition of SS to the soil increased the dry density and decreased the

optimum moisture content as well as increased the unconfined compressive strength. It is concluded that the use of steel slag to enhance properties of expansive soil is successful and beneficial.

Isaac Akinwumi studied on the application of soil and its modification by using steel slag. This research report focuses on investigating how pulverized EAF slag modifies the plasticity, strength and permeability of a lateritic soil, and identifies the extent of the correlation between each of these engineering properties and the addition of steel slag. This study provides experimental insights that show that pulverized steel slag was beneficially used to improve the plasticity, uncured strength and drainage characteristics of the lateritic soil without any adverse swell behaviour observed. The improvement in the uncured strength of the soil was limited to the application of 8% steel slag to the soil. Addition of 8% of steel slag to the soil increased its unsoaked CBR by 40% and its unconfined compressive strength by 66.7 kN/m^2, while the liquid limit, plastic limit and plasticity index were reduced by 6.3%, 4.0% and 2.3%, respectively. Cation exchange between the soil and the steel slag was identified as the major factor that influenced the modification of the engineering properties of the soil by the addition of steel slag. It influenced the reduction in the used water layer and led to the agglomeration of clay-size particles in the soil-slag mixtures.

D. Koteswara rao et al studied on the effect of steel slag for the improvement of clayey soil for foundation beds. In this study the effect of steel slag on the strength properties of marine clay has been studied. The soil used in this study is marine clay, obtained from Kakinada Sea Ports Limited, collected at a depth of 1.5m from ground level. Steel slag was collected from Visakha Steel plant, Vishakhapatnam. It is found that the O.M.C of the marine clay has been decreased by 29.3% on addition of 13% steel slag when compared with untreated marine clay. the C.B.R. value of the marine clay has been increased by 973.2% on addition of 13% steel slag when compared with untreated marine clay.

3.1 EXPERIMENTAL PROCEDURE

3.1.1 LIQUID LIMIT TEST

A Casagrande's liquid limit device was used. Prior to the commencement of the test, the sample was oven-dried, pulverized and sieved through the BS Sieve 36 (0.425mm). A representative sample was mixed with small amount of water at the start of the test and a part of the moist soil sample was placed in the brass cup using a knife-edge

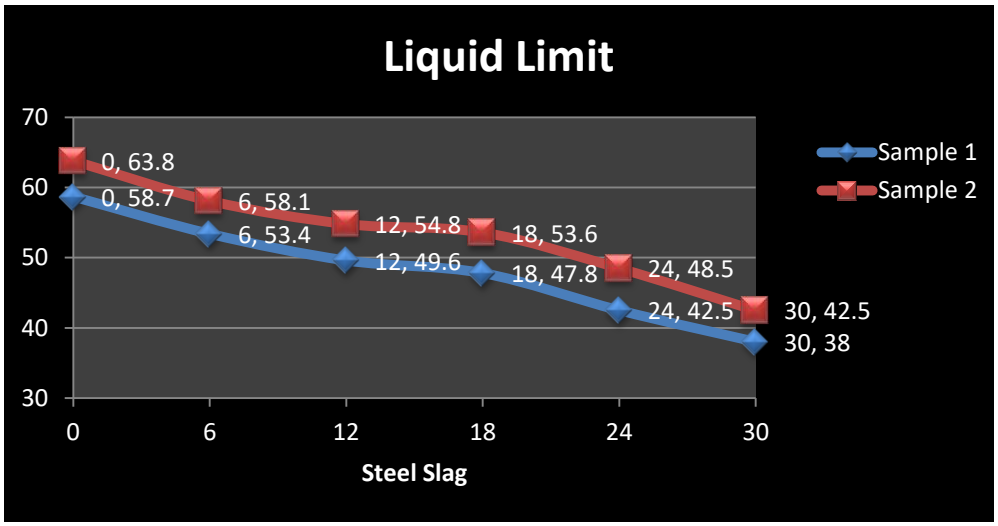

Figure 1: Liquid limit of soil with Different percentages of Steel slag

3.1.2 PLASTIC LIMIT

The thoroughly mixed moist soil sample used for the liquid limit determination was spread on a glass plate and left for about 30 minutes.

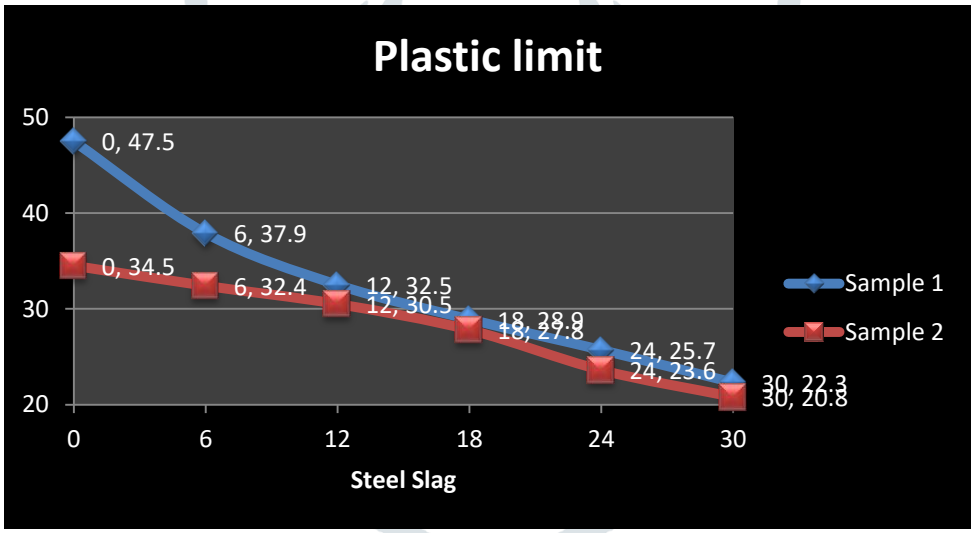

Figure 2: Plastic limit of soil with Different percentages of Steel slag

3.1.3 COMPACTION PROPERTY OF SOIL

A representative portion of the clayey soil sample was taken for modified Proctor compaction tests. Sufficient quantity (6 kg) of oven-dried soil sample was mixed in a large mixing pan.

Table 1: Optimum Moisture Content and Maximum Dry density of soil

Sr. No	Mix Sample	Sample 1		Sample 2	
		Optimum Moisture	Maximum Dry	Optimum Moisture	Maximum Dry

		Content	Density	Content	Density
1.	**Soil**	28.40	1.53	27.57	1.47
2.	**Soil + 6 % Steel Slag**	27.50	1.59	27.32	1.49
3.	**Soil + 12 % Steel Slag**	25.90	1.63	25.58	1.62
4.	**Soil + 18 % Steel Slag**	24.32	1.72	22.95	1.70
5.	**Soil + 24 % Steel Slag**	22.32	1.64	22.65	1.62
6.	**Soil + 30 % Steel Slag**	21.93	1.62	19.65	1.58

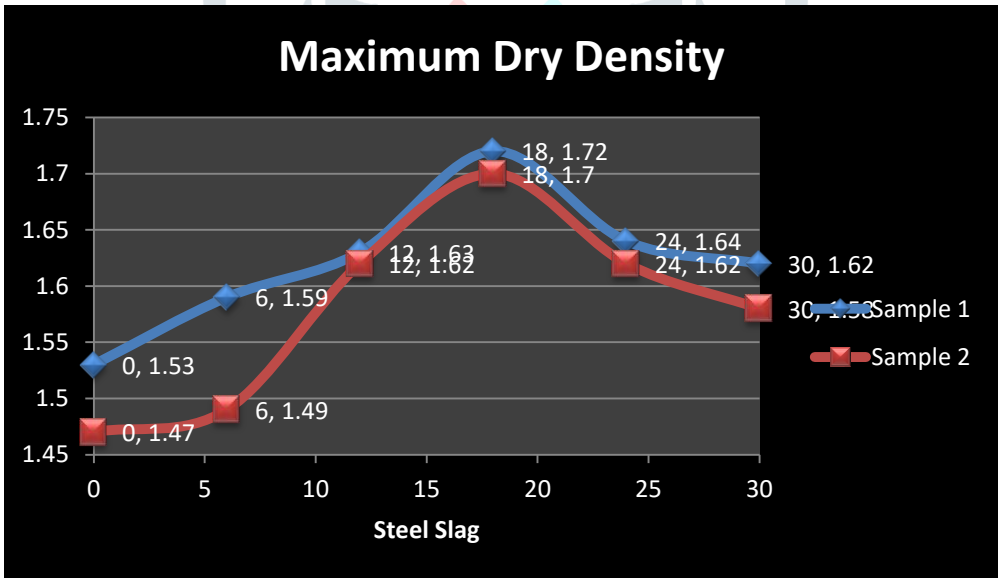

Figure 4.6: Maximum Dry Density of soil with Different percentages of Steel slag

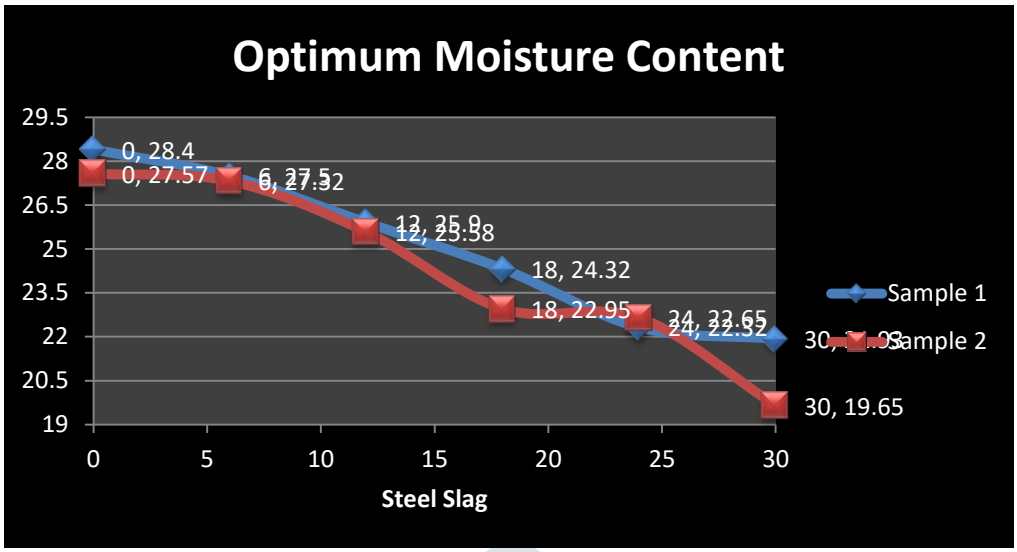

Figure 4.7: Maximum Dry Density of soil with Different percentages of Steel slag

3.1.4 UNCONFINED COMPRESSIVE STRENGTH

A cylindrical sample-forming device was used to produce a compacted cylindrical sample (of 50mm diameter and 100 mm height) at the optimum moisture content for each of 0 %, 6 %, 12 % , 18 %, 24 % and 30 % slag addition.

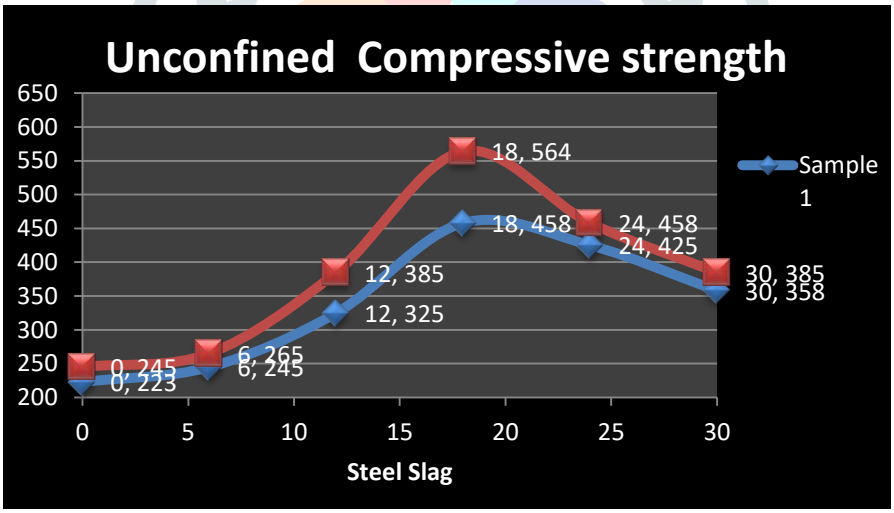

Figure 4.8: Unconfined Compressive strength of soil with Different percentages of Steel slag

3.1.5 CALIFORNIA BEARING RATIO (CBR) TEST

California Bearing Ratio (CBR) tests were conducted for the clayey soil sample with 0 %, 6 %, 12 %, 18 %, 24 % and 30 % steel slag addition respectively. Compacted soil sample were prepared in the CBR standard mould

Table 2: CBR TEST

Penetration (mm)	CBR VALUE					
	(Plain Soil)	Soil + 6 % Steel Slag	Soil + 12 % Steel Slag	Soil + 18 % Steel Slag	Soil + 24 % Steel Slag	Soil + 30 % Steel Slag
0.5	19.85	21.54	22.56	24.58	23.65	22.95
1.0	24.54	22.45	23.85	25.65	24.87	23.98
1.5	25.21	26.23	27.32	29.74	27.59	24.56
2.0	28.74	29.58	30.52	33.56	30.32	28.56
2.5	30.45	32.56	33.36	45.58	36.85	36.95
3.0	34.26	36.58	37.85	48.52	45.65	42.62
3.5	36.95	38.54	40.32	43.68	42.68	40.32
4.0	39.84	42.54	43.58	45.6	43.65	42.97
4.5	41.95	43.56	44.75	52.47	52.17	51.87
5	44.23	48.52	50.89	57.58	55.86	53.29
5.5	47.58	49.58	52.56	59.68	57.84	55.18
6.0	55.87	56.95	57.82	75.89	63.59	58.52

CONCLUSION

In this dissertation work, strength characteristics of clayey soil with steel slag have been studied. The following conclusions are derived from the test results of the experimental studies:

1. The primary benefits of using these additives for soil stabilization are

   Cost Savings: because slag is typically cheaper than cement and lime;

   Availability: because slag sources are easily available across the country from nearby steel plants.

2. This study provides experimental insights that show that pulverized steel slag was beneficially used to improve the plasticity, uncured strength and drainage characteristics of the clayey soil.
3. The liquid limit of soil is reduced by 52 % on addition of steel slag in the soil.
4. The Plastic limit of soil is reduced by 47% on addition of steel slag in the soil.
5. The specific gravity of soil increases on addition of steel slag in the soil.
6. Free swell index is significantly decreased as Steel Slag increases. At 30% Steel Slag, the free swell index of the soil is decreased and the reduction observed is almost by 63 %.
7. The literature study indicates that there is plenty of opportunity for utilization of integrated iron and steel slag.

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