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EFFECT OF STONE DUST ON THE STRENGTH CHARACTERISTICS OF BLACK COTTON SOIL STABILIZED WITH RICE HUSK ASH

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Abstract - ***Over the past few decades Road infrastructure in India is developing at a quick pace. A decent pavement is required for the safe, comfortable and prudent development of traffic. The thickness of road relies on geotechnical properties of subgrade soil and traffic intensity. The construction expense can be extensively reduced by choosing neighborhood resources including locally available soils for the bottom layers of the pavement. In the present circumstance as the industrialization and urbanization is occurring, it has created numerous unsafe and non-perilous wastes. This prompts draining landfill space, soil contamination and numerous different risky impacts; henceforth in this study use of waste (i.e., Rice husk ash) for enhancing the soil properties is made. In the present study influence of stone dust on the quality characteristics of Rice husk ash stabilized black cotton soil to increase the features of subgrade soil were determined. Atterberg's limit, Compaction, Unconfined Compressive Strength (UCS) and California Bearing Ratio (CBR) experiments were carried out on the specimens of native soil and BC soil with stabilizers. Different specimens have been made by taking soil with different percentage of stone dust (5%, 10%, 15%, 20% and 25%). The correlation of the results with or without stone dust has been done. All test were led according to IS 2720 standards. The results demonstrated less value of strength parameters for BC soil, but after the stabilization BC soil indicated increased value of CBR, UCC. For better stabilization result, the optimal percentage of Soil: Rice husk ash: Stone dust was found to be 75: 10: 15***

Key Words: *Rice husk ash, stone dust, MDD,OMC, UCS and CBR*

1. INTRODUCTION

In India, the black cotton soil covers a range of around 0.8 million sq. km. which is around 20% of the aggregate area zone. It is considered as dangerous soil because of hindering volume changes with variety in moisture content. When it interacts with water it demonstrates tremendous swelling while it shrinks with the decline in water substance and creates cracks on drying. Now days the usage of waste items with soil has picked up consideration because of the deficiency of suitable soil and expanding issues of mechanical waste administration.

The dark color of black cotton soils is because of the vicinity of iron, manganese and titanium in the diminished state. This dirt's are framed under states of poor waste from essential rocks, or in some cases limestone under exchange wet and drying conditions. Leftover far reaching soil stores possessing a vast part of south and focal India are weathered items created from hidden guardian shakes, for example, basalt, quartzite, schist or limestone.

Huge amount of soil is utilized as a part of the development of roadways however adequate measure of soil of obliged quality may not be accessible effortlessly. Likewise, the expense included in extraction of good quality, normally accessible material is expanding step by step. Successful usage of minor materials as a road development material has been a challenge to the contemporary and imminent designers. This determination give various critical advantages to the developing business and to the nation all in all by protection of common assets, diminishment in the mass of waste to landfills, decreasing the expense of improvement resources, bringing down disposing expenses and by propelling an uncontaminated and green surroundings.

1.1 Rice Husk Ash

Rice husk is a standout amongst the most generally accessible rural wastes in numerous rice producing nations around the globe. In larger piece of rice conveying countries an incredible piece of the husk conveyed from treatment of rice is either smoldered or dumped as waste. Bursting of Rice husk in encompassing air leaves a store, called rice husk cinder (Ash). Rice husk evacuation amid rice refining, makes transfer issue due to less commercial interest. Likewise, dealing with and transportation of Rice Husk is precarious on account of its low density. Rice Husk Ash is an exceptional circumstance danger to land and enveloping locale where it is dumped.

1.2 Stone dust

River sand is expensive due to extreme cost of conveyance from natural sources. Additionally substantial consumption of these sources makes natural issues. As ecological conveyance and different limitations make the accessibility and less utilization of river sand, an alternative item for construction industry should be found. Due to the high requirement for aggregates and rubble for building purposes, stone quarries and crushers are exceptionally regular. On view of the distinctive quarry waste, stone dust is one, which is produced in plenty. Quarry dusts are considered as one of the well acknowledged and in addition practical ground improvement technique for weak soil deposits. They provide the primary function of strengthening and thus improve the deformation and strength characteristics of weak soil regions. Properties of stone dust basically rely on upon the properties of the parent rock such, such as chemical and mineralogical arrangement, physical and substance steadiness, petrographic qualities, specific gravity, hardness, strength, pore structures and color.

2 EXPERIMENTAL STUDY

2.1 Test Materials

- **Black Cotton Soil**

The BC soil was procured from Yelandur village in Chamarajanagar district. The Properties of black cotton soil are shown in Table-2.1

Table -2.1: Properties of black cotton soil

PROPERTIES	VALUE
1. Specific-Gravity (IS 2720: Part 3)	2.47
2. Grain Size Distribution (IS 2720: Part-4) a) Gravel b) Sand c) Fines	 1.40 31.84 66.76
3. Liquid-limit (%) (IS 2720: Part 5)	60
4. Plastic-limit (%)(IS 2720: Part 5)	33.82
5. Plasticity-Index (%)(IS 2720: Part 5)	26.18
6. Free Swell index (%)	65
7. IS classification of soil	CH
8. HRB classification	A-7-6
9. Proctor/Compaction test (IS 2720: Part 8) a) Maximum Dry Density (g/cc) b) Optimum Moisture content (%)	 1.64 21

- **Stone Dust**

The Marble dust was obtained from Mangala crushers located at Bangalore. The chemical properties are as listed in Table -2.2 respectively.

Table -2.2: Chemical properties of Stone dust used

Properties	(%) By mass
CaO	29.34
SiO_2	6.23
Al_2O_3	4.7
Fe_2O_3	0.7

- **Rice Husk Ash**

Processed Rice husk ash (RHA) was obtained from a Rajalaksmi Rice mill situated at Bannur town in Mysore district, Karnataka. The properties of rice husk ash are as recorded in Table- 2.3 and Table- 2.4 respectively.

Table -2.3: Physical properties of Rice Husk Ash used

Appearance	Blackish grey powder
Odour	Odourless
Specific Gravity	2.4
Bulk density (kg/m^3)	96
Storage	Avoid contact with moisture

Table -2.4: Chemical properties of Rice Husk Ash used

Properties	(%) By mass
CaO	2.34
SiO_2	88.02
Al_2O_3	5.57
Fe_2O_3	1.2
Specific Gravity	2.4

3. RESULTS AND DISCUSSIONS

3.1 Specific Gravity

Chart-3.1 shows that the specific gravity of BC soil alone is 2.47. But Specific gravity of the RHA stabilized BC soil goes on increase rapidly with the addition of stone dust upto 20%, further addition makes the specific gravity a fairly significant increase.

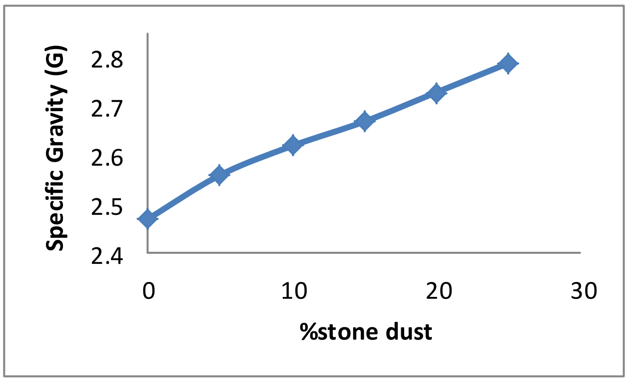

Chart- 3.1: Variation of Specific Gravity for varying percentage of stone dust

3.2 Atterberg Test

Chart-3.2 and Chart-3.3 shows that the liquid limit of BC soil alone was 60%. Adding various proportion of stone dust has significant effects on the liquid limit of the RHA stabilized BC soil; the liquid limit goes on decreases rapidly. The plastic limit of BC Soil alone was 33.82%. Addition of various fraction of stone dust has substantial effects on the plastic limit of the RHA stabilized BC soil, the plastic limit goes on decreases rapidly and the Plasticity index was found to decreases from 26.18 to 18.24. Further increase in stone dust with RHA stabilized BC soil also decreases the Plasticity index, but it is fairly significant.

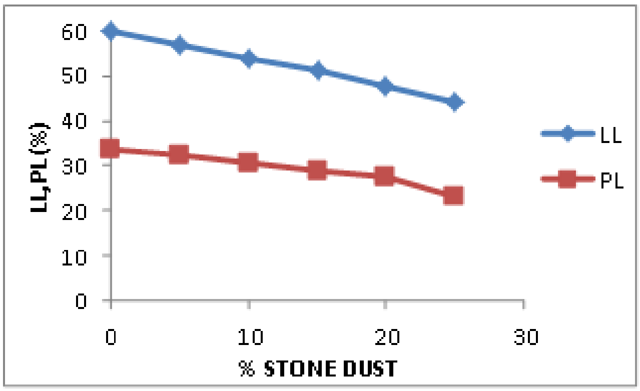

Chart-3.2: Variation in LL and PL with varying percentage of Stone dust

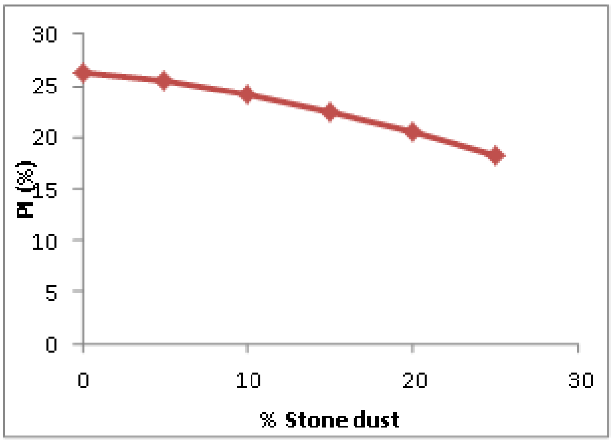

Chart-3.3: Variation in PI with varying percentage of stone dust

3.3 Compaction Test

Chart-3.5 and Chart-3.6 shows that by adding 5% of stone dust, the MDD of BC soil stabilized with optimal fraction (10%) of Rice husk ash increases to 1.65 g/cc from 1.64 g/cc and the OMC reduces from 21% to 20.80%. When 25 % stone dust was added, the MDD of soil increases to 1.796 g/cc and the OMC decreases to 18.10%.

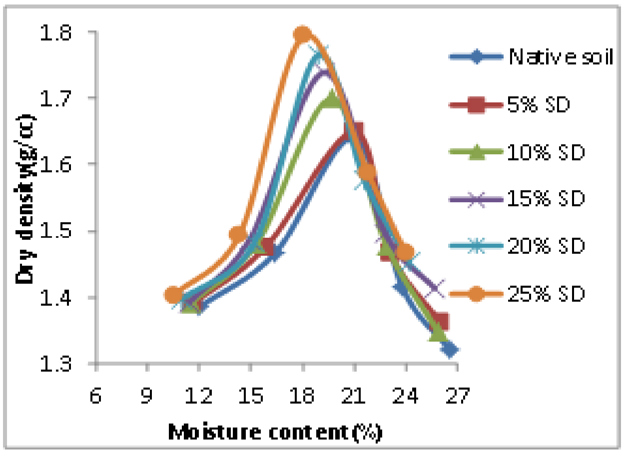

Chart-3.4: Variation in compaction curves for RHA stabilized BC soil with varying percentage of Stone dust

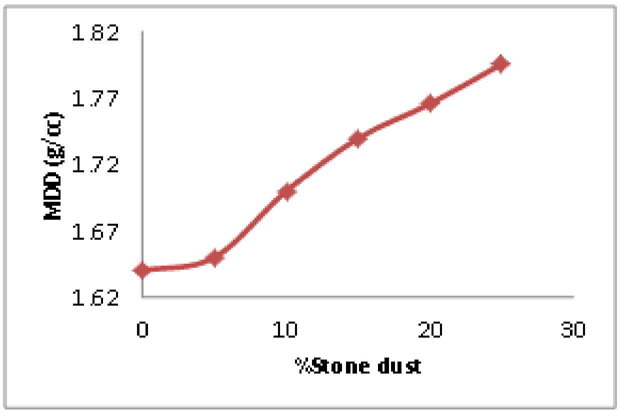

Chart-3.5: Variation of maximum dry density for RHA stabilized BC soil with varying percentage of stone dust.

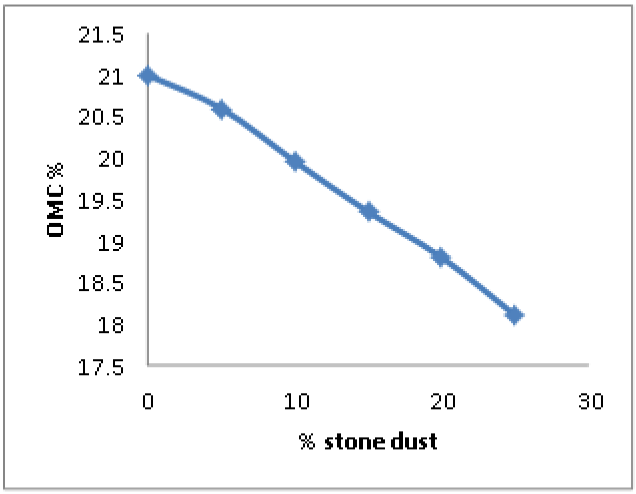

Chart-3.6: Variant of optimum moisture content for RHA stabilized BC soil with varying percentage of stone dust

3.4 Unconfined Compressive Strength Test

Chart-3.7 shows that, by increasing the RHA fraction, the UCS of soil increases till 10%, further adding of RHA decreases the UCS of the BC soil. Thus 10% RHA was considered optimum for stabilization of native soil with different percentages of stone dust

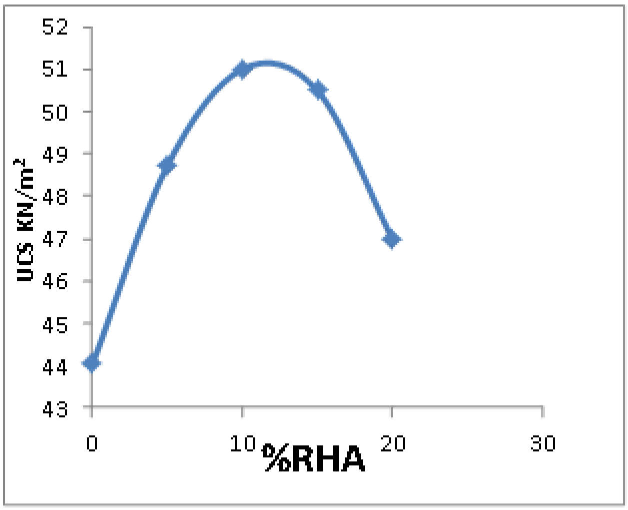

Chart-3.7: Variations in UCS curves with varied ratio of Rice husk ash

Chart-3.8 shows that, adding varied percentage of stone dust has substantial impact on the UCS of the BC soil stabilized with RHA. On adding stone dust up to 15 %, the UCS of soil increases to 73.78 kN/m² from 44.03 kN/m² (0 curing days), 77.70 kN/m² (7 curing days), 81.62 kN/m² (14 curing days), 89.46 kN/m² (28 curing days). Continued adding of stone dust showed reduction in the UCS of the soil.

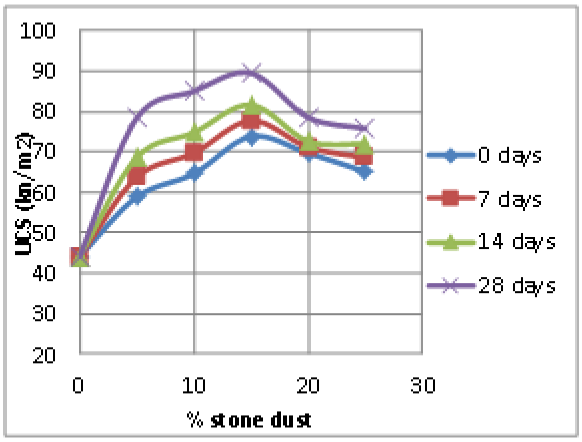

Chart-3.8: Variation in UCS for varied curing periods

Chart-3.8: Variation in UCS for varied curing periods

3.5 California Bearing Ratio Test

Chart-3.9 shows that, the CBR value of BC Soil alone was 2.37 on unsoaking and 1.41 on soaking condition. Adding of various percentage of stone dust to RHA stabilized BC soil the unsoaked CBR value increased rapidly from 2.37 to 10.43 when 15% stone dust was added; further adding of stone dust decreases the CBR value. In Soaked condition the CBR value increased rapidly from 1.41 to 5.67 on adding 15% stone dust, continued addition of stone dust caused reduction in the CBR value.

Table 3.1: CBR variations for BC soil stabilized with RHA and with varying percentage of Stone dust.

Mix Proportion (%)	CBR (%) Unsoaked condition	CBR (%) soaked condition
BC Soil	2.37	1.41
BC Soil+ 10%RHA	3.92	2.52
BC Soil+ 10%RHA +5%SD	5.24	3.69
BC Soil+ 10%RHA + 10%SD	7.38	4.42
BC Soil+ 10%RHA + 15%SD	10.43	5.67
BC Soil+ 10%RHA + 20%SD	9.15	4. 65
BC Soil+ 10%RHA + 25%SD	8.69	4.28

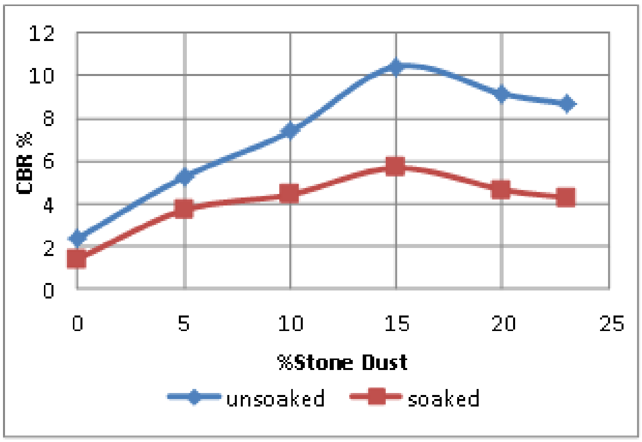

Chart-3.9: Variation in CBR for RHA stabilized BC soil with varying percentage of stone dust

4. CONCLUSIONS

Following conclusions drawn from results acquired from the different lab assessments conducted.

• The optimal proportion of Rice husk ash found to stabilize black cotton soil is 10%.

• On adding the varied percentages of stone dust to the black cotton soil stabilized with optimum ratio of rice husk ash, the plasticity index of the soil reduces from 26.18 % to 18.24% with the increase in the percentage of stone dust which was found to be promising.

• Addition of different ratio of stone dust to the black cotton soil stabilized with optimum ratio of rice husk ash, the MDD goes on increasing and OMC goes on decreasing.

• Adding the various ratio of stone dust to the black cotton soil stabilized with optimum ratio of rice husk ash, for both soaking and unsoaking condition the CBR value increased till 15% stone dust, further adding of stone dust reduces the CBR value of the BC soil. There is a 340% increment CBR value in unsoaked condition and 302% increase CBR value in soaking condition when related with natural soil.

• Unconfined compressive strength improved nearly by 103% of the virgin soil after adding 15% stone dust. Adding more stone dust reduces the UCS of the BC soil.

• For better stabilization result, the optimal percentage of Soil: Rice husk ash: Stone dust was found to be 75: 10: 15.

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