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Performance Evaluation of Flexible Pavement on Different Subgrades with Industrial Waste

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***Abstract* - Fly ash, an industrial waste with a current utilization rate of about 55%, presents an opportunity for such stabilization. By replacing a portion of the subgrade with fly ash and reinforcing it using bitumen-coated chicken mesh at varying percentages and layer placements, the stability of the pavement can be enhanced. This reinforcement has been shown to significantly improve the California Bearing Ratio (CBR), with maximum strength achieved when 15% of the soil is replaced with fly ash and four layers of bitumen-coated chicken mesh are used. Additionally, incorporating plastic waste into the subgrade at various percentages further affects properties such as Unconfined Compressive Strength (UCS), CBR, Maximum Dry Density (MDD), and Optimum Moisture Content (OMC). These values are calculated in the laboratory and compared with those of unmodified soil to evaluate the improvements in strength and performance.**

Keywords: Unconfined Compressive Strength (UCS), CBR, Maximum Dry Density (MDD), and Optimum Moisture Content (OMC). Stabilizing.

I. INTRODUCTION

Fly garbage used, especially in the concrete, its basic environmental advantages including: • Extending the tenure of strong lanes and structures by enhancing strong quality • Net diminishing in imperativeness uses and ozone hurting substance and other horrible air radiations when fly flotsam and jetsam is used to replace or remove manufactured bond. • Decline in the proportion of coal start things which must be organized in the landfills, and • Security of other normal assets and materials. The introduction of a black-top system depends to a huge degree on properties of the concealed soil layer. When the subgrade layer shows broad nature, it impacts the introduction of the black-top structure and results in a shorter assistance life. Damages upheld by blacktops in view of the augmentation of the fundamental subgrade layer can be as contorting and parting in both versatile (dark top) and unyielding (strong) pavements, similarly as throw related thumps; both of these lead to ride bother. Parts made in black-tops further grant sogginess interference into sub soils, which further cripples the essential layers. As a rule, the enormity and level of damages to black-top structures can be wide, debilitating the estimation of the boulevards and in every way that really matters making them clumsy for drivers; these pavements require visit bolster works out.

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Figure 1: Fly Ash

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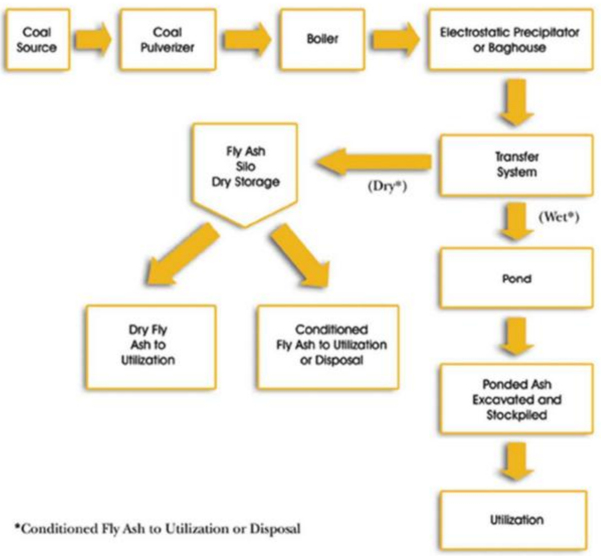

Figure 2: Utilization of Industrial Fly Ash

II. LITERATURE SURVEY & BACKGROUND

Research carried out by Manu et al, (2015) showed results close to that of Anthony et al, (2014) but suggest CPHA can be used in the production of Compressed Earth Bricks with CPHA not passing 10%. Their research showed that as the percentage of CPHA of dry weight increase, it increases the alkalinity of the Earth brick and any increase beyond 10% should result in a slight decline in engineering properties of the improved earth bricks. It also shows that CPHA cannot pass as a Pozzolanic material. In a bid to reduce solid waste in the environment a re-use for Shredded Rubber Tyre SRT which is a non-biodegradable waste has been found in road construction Humprey and Nickel, (1997), Ghate et al, (2014), Gary et al, (1996), Ayothiraman and Abilash, (2011), Amin (2012) and Ajay and Jawaid, (2013) . Jagtar and Vinod (2017) Used (SRT) to stabilize a clayey soil collected from Banur near Chandigarh. SRT was cut in various sizes such as 10mm, 20mm, and 30mm in width and 20mm, 40mm, and 60mm in length. Different percentages ranging from 5%, 10%, and 15% was used on the soil. The MDD and OMC results of all sizes indicate a reduction in MDD and the increase in the OMC as percentage increases due to the light weight of the rubber tire and water absorption respectively. From the CBR test, the optimum value was at 10mm by 20mm at 5%, which yielded 1.93% (28.66% increase) as against the virgin soil CBR value of 1.50%. This would reduce construction cost as pavement thickness will reduce. Plastic waste (made into strips) was used to stabilize Black Cotton Soil which has a CBR value of 1.0%, OMC of 20.5%, MDD of 1.62gm/cc, the Compressive strength of 90.8 kg/cm2 , Plasticity index of 35.2% and swelling Index of 65.3%. This research shows that plastic is a good stabilizing material, especially at 4% where CBR is 11.70%, OMC of 18.5% and MDD of 1.81gm/cc Ekta et al, (2019). Sewage sludge is also used in road construction as carried out by Lin et al (2017), Lin et al, (2015), Tay et al.

III. OBJECTIVES OF THE WORK

- To improve the value of Geotechnical properties of natural unmodified soil.
- To find optimum % of waste plastic to five maximum value of cbr value.

IV. RESULT

Table 1: Compaction Curve for OMC and Percentage of Plastic Waste

SAMPLE	OMC (%)
Unmodified soil	16.1
Soil + 0.2 % plastic waste	15.4
Soil + 0.4 % plastic waste	14.4
Soil + 0.6 % plastic waste	14.1
Soil + 0.8 % plastic waste	14.7
Soil + 1 % plastic waste	15.1
Soil + 1.2 % plastic waste	16.2

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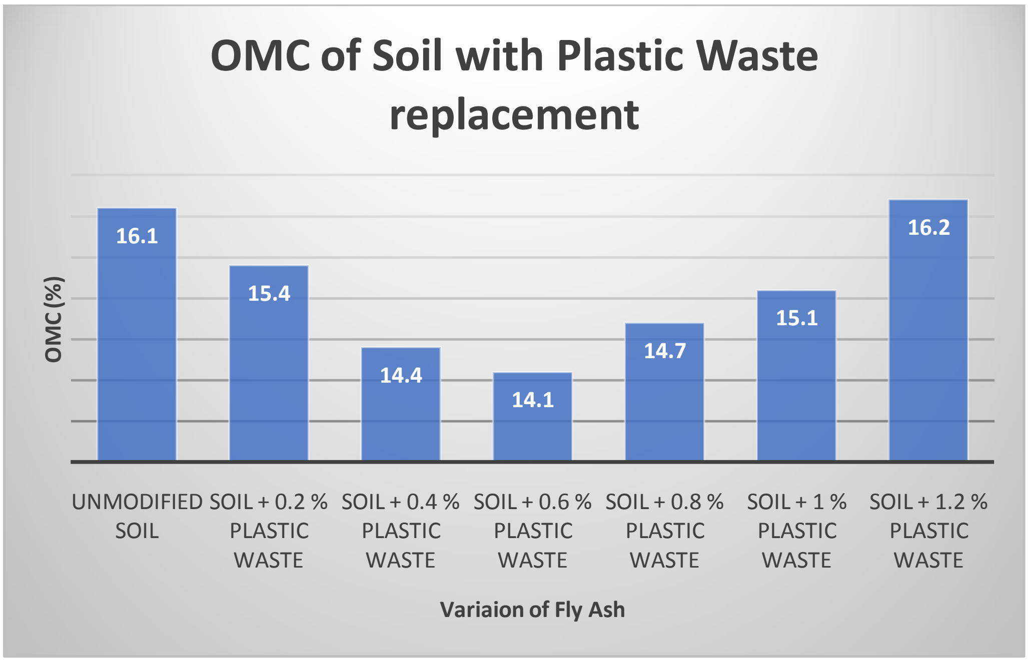

Figure 3: OMC of soil with plastic waste replacement

Table 2: Compaction Curve for MDD and Percentage of Plastic Waste

SAMPLE	MDD (%)
Unmodified soil	1.62
Soil + 0.2 % plastic waste	1.67
Soil + 0.4 % plastic waste	1.74
Soil + 0.6 % plastic waste	1.83
Soil + 0.8 % plastic waste	1.86
Soil + 1 % plastic waste	1.92
Soil + 1.2 % plastic waste	1.81

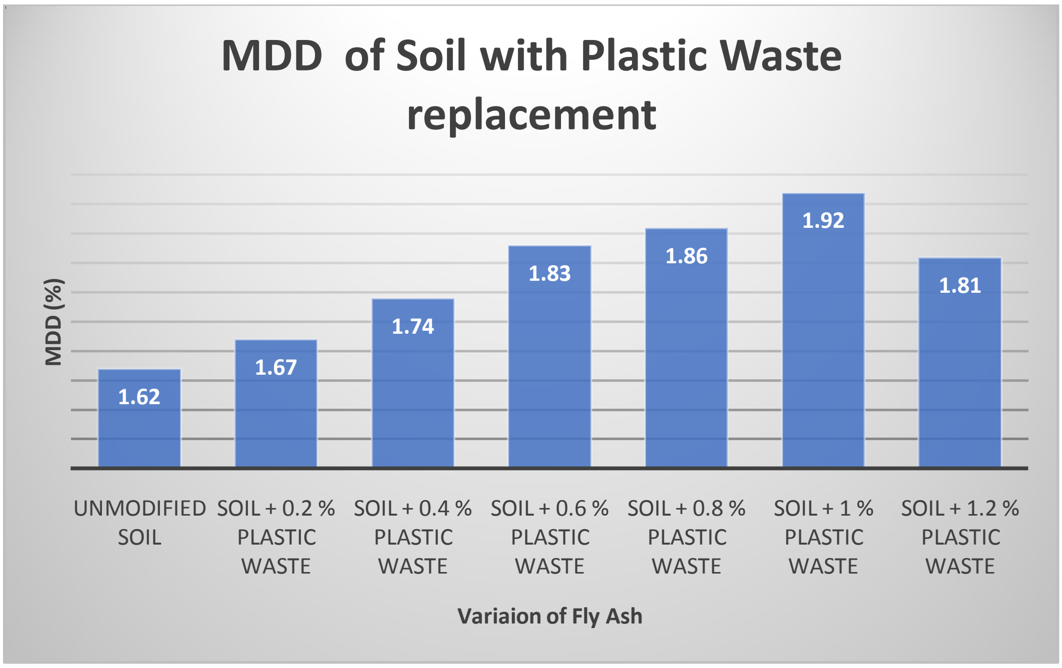

Figure 4: MDD of Soil with Plastic Waste replacement

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From the above graphs, the water content of unmodified soil is 16% and that of the dry density is 1.62 respectively. After the addition of plastic waste in the soil, the water content decreases and its dry densities increases up to certain extent. The maximum dry density value is found to be 1.91 gm/cc and is obtained at an optimum moisture content of 1% replacement of plastic waste in the soil. So, this maximum value of dry density, optimum moisture contents are considered for the CBR, California Bearing Ratio and UCS, Unconfined Compressive Strength tests. The retardation in the water content in soil is because of the absorption of moisture by plastic.

Table 3: Variation of CBR values at different percentages of Plastic Waste

S.No.	SAMPLE	CBR (%)
1	Unmodified soil	2.92
2	Soil + 0.2 % Plastic Waste	3.08
3	Soil + 0.4 % Plastic Waste	3.14
4	Soil + 0.6 % Plastic Waste	3.22
5	Soil + 0.8 % Plastic Waste	3.89
6	Soil + 1 % Plastic Waste	4.11
7	Soil + 1.2 % Plastic Waste	3.86

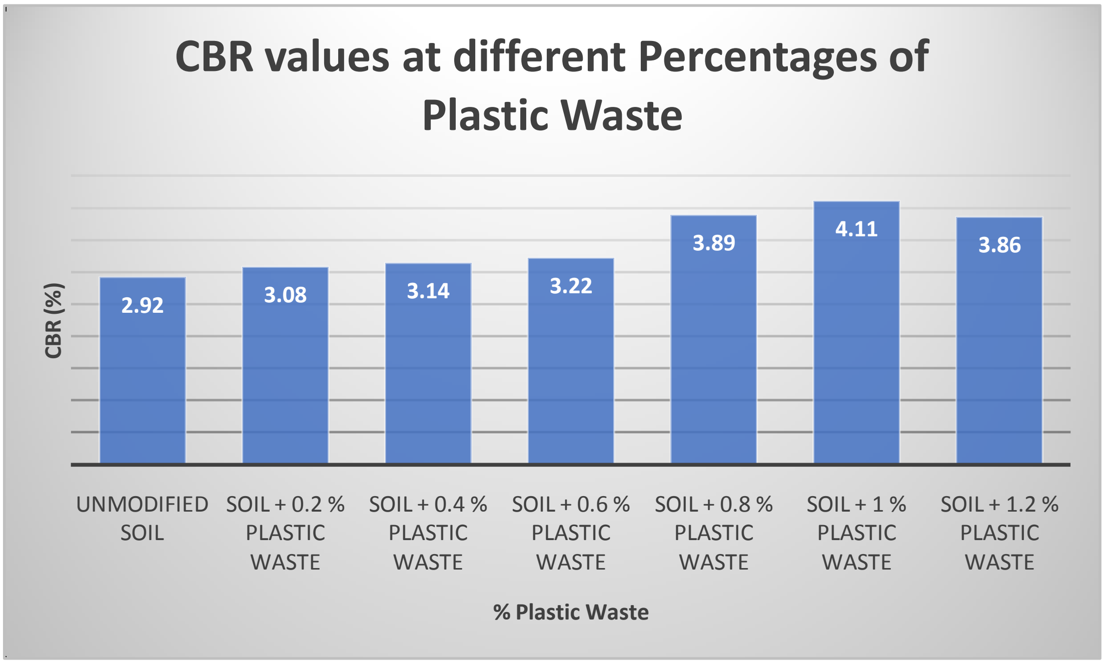

Figure 5: CBR values at different Percentages of Plastic Waste

The observed CBR for natural soil is 2.92% and the highest CBR value is found at 1% replacement of plastic waste in soil and is obtained as 4.11%. From the graph, the CBR value raises up to 1% replacement and later starts decreasing. Thus, increase in the CBR is obtained because of the stiffness developed by the plastic waste to the soil.

Table 4: Variation of UCS values at varying percentages of Plastic Waste

S.No.	SAMPLE	UCS (MPa)
1	Unmodified soil	0.15
2	Soil + 0.2 % Plastic Waste	0.152
3	Soil + 0.4 % Plastic Waste	0.159
4	Soil + 0.6 % Plastic Waste	0.165
5	Soil + 0.8 % Plastic Waste	0.174
6	Soil + 1 % Plastic Waste	0.178
7	Soil + 1.2 % Plastic Waste	0.162

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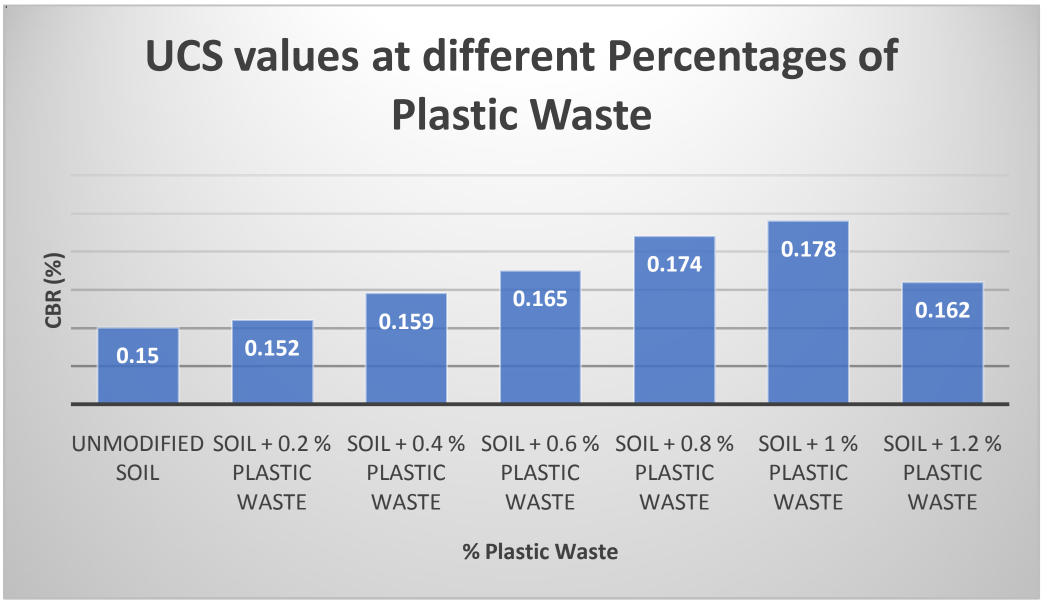

Figure 6: UCS values at different Percentages of Plastic Waste

The unconfined compressive strength of material replaced with 1% of plastic waste is observed to be 0.178 MPa maximum when differentiated with the UCS value of unmodified material. Based on those values obtained, the CBR value and UCS value are found to be greater at 1% replacement of plastic waste.

V. CONCLUSION

The optimal results for OMC and MDD were observed at a 1% replacement of plastic waste, with values of 15% moisture content and a maximum dry density of 1.91 g/cc. Furthermore, the California Bearing Ratio (CBR) improved significantly from 2.92% to 4.11%, indicating enhanced strength and stiffness of the soil with the 1% plastic waste substitution. Additionally, the unconfined compressive strength increased from 0.5 MPa to 0.178 MPa at the same level of plastic waste replacement.

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