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RESEARCH ARTICLE

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A STUDY ON SUBGRADE PERFORMANCE OF EXPANSIVE SOILS STABILISED WITH CRUMB RUBBER AND FLYASH

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ABSTRACT

Expansive soils are always considered as most problematic soils to any geotechnical engineer because of their high swelling and shrinkage nature. This kind of swelling and shrinkage nature with respect to moisture fluctuations exists in expansive soils due to presence of montimorillonite mineral. The structures constructed over these soils mainly over the pavement sub-grade are followed by huge settlements and structural damages. To overcome the above problems, an expansive soil should be treated by an artificial means which is known as soil stabilization. Soil stabilization done by using different conventional stabilizers aims in improving the engineering behavior of soil. Many studies were done in the past concern to soil stabilization of expansive soils by using some conventional stabilizers like lime, cement and combinations etc. In the present study non recyclable and conventional materials like crumb rubber and fly ash are selected as stabilisers for modifying the soil properties. The natural expansive soils collected for the study will be blended with different percentages of stabilizers like crumb rubber ,fly ash & different percentages of both combinations and laboratory tests were conducted on the blended soil samples to evaluate the effectiveness of selected stabilisers in stabilization of expansive soils selected for subgrade. The crumb rubber is added at percentages of 4%, 8%, 12%, 16% and also with combination of fly ash with percentages of 15% and 30%.

Keywords: -Black cotton soil, crumb rubber, Fly ash, MDD, OMC,CBR, Subgrade.

1. INTRODUCTION

Soils are formed by weathering (mechanical or chemical disintegration) of rocks when a rock surface gets exposed to atmosphere for an appreciable time. The soils thus formed may be of different types. Among them Black cotton soil is one of the major soil deposits in India..The black cotton soils cover an area of about 200,000 square miles and thus form about 20% of the total area of India. These soils tend to high swelling and shrinking nature when subjected to moisture fluctuations. They are characterized by extreme hardness and cracks when they are in dry condition. The performance of the subgrade of pavements as foundations for pavements but when these are to be constructed on highly expansive soils like black cotton soils they leads to failure of the pavements due to swelling and shrinking operations causes vertical deformations in the soil mass. The failure in such pavements takes place in the form of settlement, heavy depression, cracking and unevenness. Thus there is need to improve the soils

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that are selected for the construction of pavements. The selection of stabilizers always plays a vital role on the affect over the degree of improving the subgrade expansive soils. Inour country, the rate of solid waste accumulation from industries and agricultural fields is found to be increasing day by day at a very rapid rate from last few years. Mainly the rubber waste from scrap tires(crumb rubber) is being generated and producing in large volumes causing an increasing hazardous effect to the eco system. In order to eliminate the hazardous effect of these accumulations and in terms of sustainable development there is at most concern in the recycling processes of these solid wastes. Use of waste material and end residual deposits like crumb rubber from scrap tires rebutting industries and fly ash from thermal power plants for improving soil is very advantageous because they are very cheap in cost which enhances the soil stabilization as economical as possible.

2. Overview of Literature Review

[1]. When soil mixed with crumb rubber content, it is observed that MDD and OMC decreases with increase in percentage of crumb rubber content on soil.

[2]. When soil mixed with crumb rubber content, it is observed that MDD and OMC decreases with increase in percentage of crumb rubber content on soil.

[3]. The UCS value increased with increase in % of crumb rubber content and the optimum percentage of crumb rubber was observed at 10% and 15%.

[4]. The water content percentage and density (g/cc) curves indicates that addition of RHA results in an increase in OMC and decrease in MDD, while these values decrease with addition of FA powder.

[5]. The investigation revealed that CRP altered the engineering properties of problem clay and 5% CRP has been chosen as the optimum CRP to get desired properties.

[6]. In this work, the possibility of using crumb rubber powder was an additive to improve the strength of soft soil was investigated. Two types of problematic clay soils are stabilized with the various percentages of crumb rubber (5, 10, 15 and 20%).

3. Experimental investigations

3.1 MATERIALS USED

3.1.1 BLACK COTTON SOIL: The soil used for the present study was collected from the area of Amalapuram, East Godavari district, Andhra Pradesh.

Fig 1 : Black cotton soil in the field

3.1.2STABILIZERS: Crumb rubber, Fly ash

The materials which are used as stabilizers in this study are collected locally from the Kakinada

Fig 2 : crumb rubber

Fig 3 : Fly ash

Fig 4 : Samples of black cotton soil, flyash and crumb rubber

TABLE 1: PROPERTIES OF BLACK COTTON SOIL

SOIL PROPERTIES	RESULTS
Grain size analysis	Gravel- 1.2%
	Sand- 28.3%
	Fines-70.5%
Specific gravity	2.67
Liquid limit (%)	60
Plastic limit (%)	31
Plasticity Index	29
Free swell index	27
Compaction test (OMC) (%)	14
Compaction test (Max dry density) (g/cc)	1.584
(CBR) California bearing ratio test	2.5mm penetration 3.1%
	5mm penetration 1.95%

TABLE 2: PROPERTIES OF CRUMB RUBBER

S.No	TYPE OF RUBBER	CRUMB TYPE
1	Size	600µ to 300µ
2	Colour	Black
3	Specific gravity	1.12
4	Density	348 kg/m^3

TABLE 3: PROPERTIES OF FLY ASH

S.No	Particulars	Value
1	specific gravity	3.1 to 3.15
2	Colour	Grey
3	Density	1120 to 1500 kg/m^3
4	Size	10 to 100 microns

4. RESULTS AND DISCUSSIONS

The results obtained by conducting different tests are tabulated below.

TABLE 4: Results with Crumb rubber

Soil with different percentages of stabilizers	Modified Soil properties				
	Plasticity index	OMC %	MDD g/cc	CBR 2.5mm penetration %	CBR 5mm penetration %
Natural soil	29	14	1.585	4.1	2.95
Soil+4% crumb rubber	26	12.88	1.553	4.4	3.04
Soil+8% crumb rubber	17.6	12.21	1.516	5.2	3.52
Soil+12% crumb rubber	10.9	11.35	1.474	6.35	4.13
Soil+16% crumb rubber	8	12	1.442	9.45	6.98

TABLE 5: Results with Crumb rubber + 15% Fly ash

Soil with different percentages of stabilizers	Modified Soil properties				
	Plasticity index	OMC %	MDD g/cc	CBR 2.5mm penetration %	CBR 5mm penetration %
Natural soil	29	14	1.585	4.1	2.95
Soil+4% CR+15% Fly ash	11	13.52	1.571	12.1	9.3
Soil+8% CR+15% Fly ash	8.7	13.74	1.548	12.35	9.48
Soil+12% CR+15% Fly ash	8.4	14.85	1.519	9.4	7.92
Soil+16% CR+15% Fly ash	7.8	12.33	1.493	11.8	9.35

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TABLE 6: **Results with Crumb rubber +30% Fly ash**

Soil with different percentages of stabilizers	Modified Soil properties				
	Plasticity index	OMC %	MDD g/cc	CBR 2.5mm penetration %	CBR 5mm penetration %
Natural soil	29	14	1.585	4.1	2.95
Soil+4% CR+30% Fly ash	10.6	14.55	1.561	8.23	7.4
Soil+8% CR+30% Fly ash	7.2	14.12	1.532	10.15	8.92
Soil+12% CR+30% Fly ash	14.7	13.99	1.505	8.1	7.42
Soil+16% CR+30% Fly ash	12.8	15.15	1.466	6.32	5.88

Fig 5: Comparison of plasticity index with soil+ crumb rubber

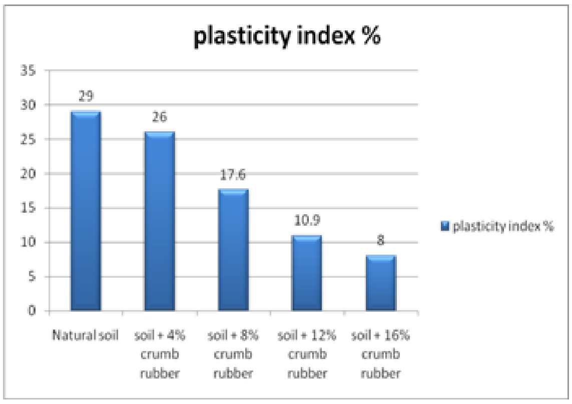

Fig 6: Comparison of plasticity index with soil+ crumb rubber+ 15% fly ash

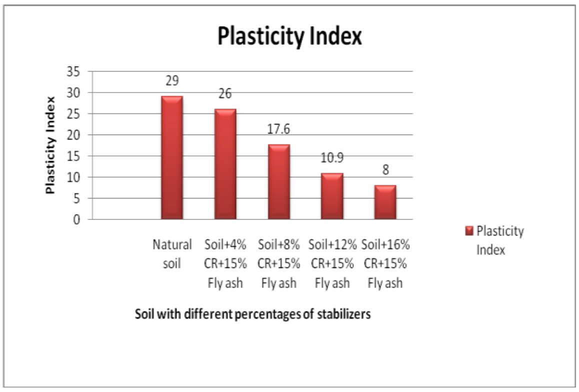

Fig 7: Comparison of plasticity index with soil+ crumb rubber+ 30% fly ash

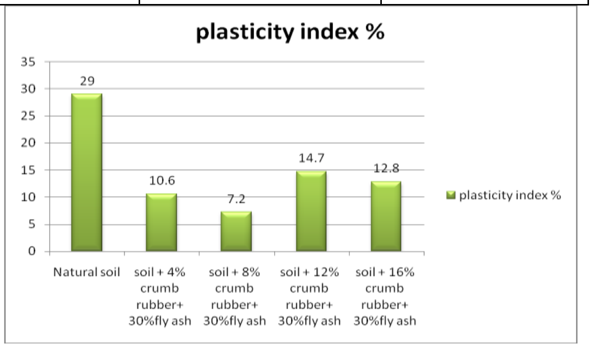

Fig 8: Comparison of OMC with soil+ crumb rubber

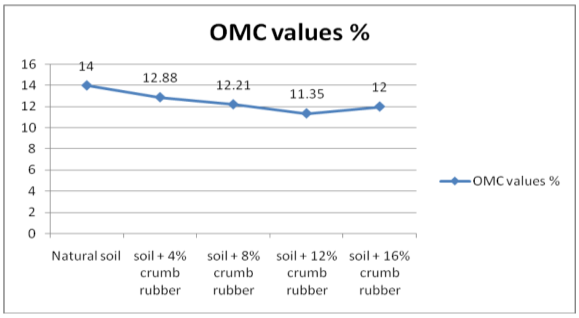

Fig 9: Comparison of MDD with soil+ crumb rubber+ 15% fly ash

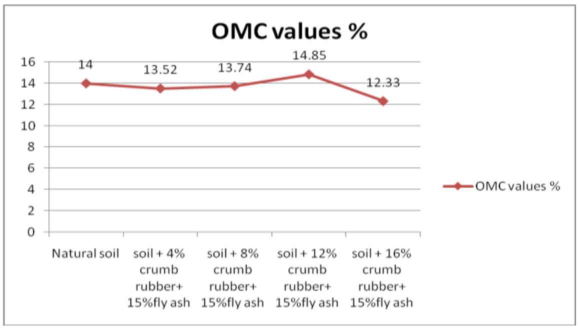

Fig 10: Comparison of OMC with soil+ crumb rubber+ 30% fly ash

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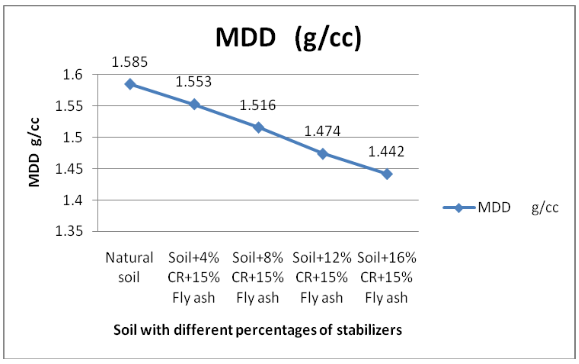

Fig 11: Comparison of OMC with soil+ crumb rubber

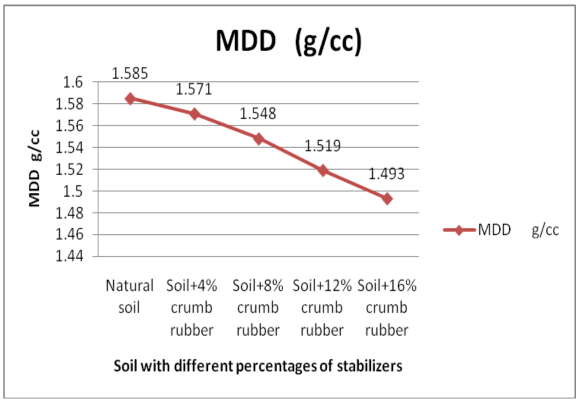

Fig 12: Comparison of MDD with soil+ crumb rubber+ 15% fly ash

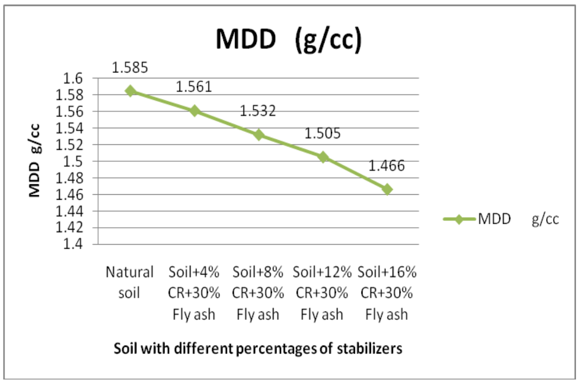

Fig 13: Comparison of MDD with soil+ crumb rubber+ 30% fly ash

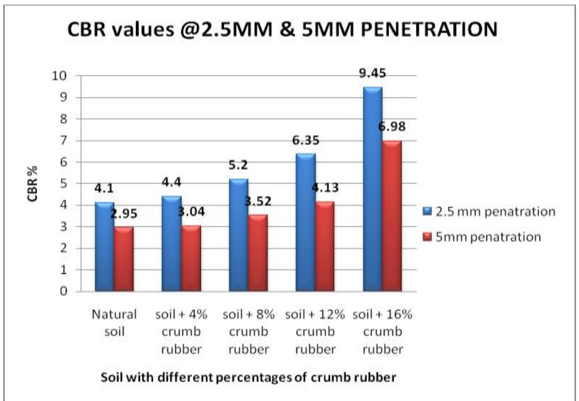

Fig 14: Comparison of CBR with soil+ crumb rubber

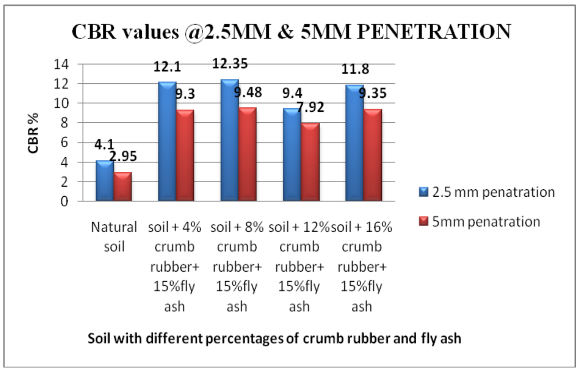

Fig 15: Comparison of CBR with soil+ crumb rubber+ 15% fly ash

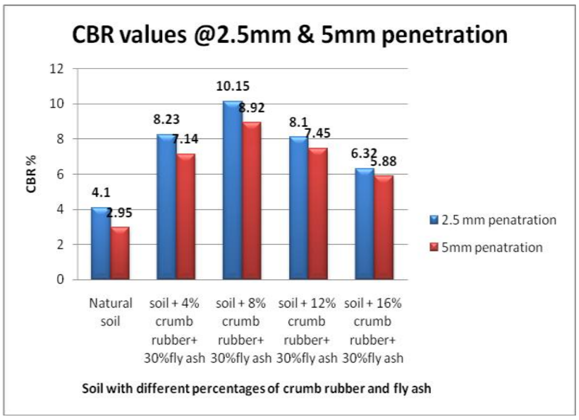

Fig 16: Comparison of CBR with soil+crumb rubber+ 30% fly ash

5. CONCLUSIONS.

From the results obtained by conducting the experimental investigations over the expansive soil blended with different percentages of crumb rubber and fly ash, the following conclusions can be done.

1. The OMC and MDD values are getting decreased gradually with increase in addition of crumb rubber.
2. The MDD values are also getting decreased with addition of fly ash along with crumb rubber which is decreased from 1.585 g/cc to 1.442g/cc at16% addition of crumb rubber and MDD is found to be 1.493g/cc at addition of 16% of crumb rubber+15% fly ash, 1.466g/cc at addition of 16% of crumb rubber+30% fly ash.
3. The liquid limit values are got decreased while the plastic limit is increased for soil blended with crumb rubber. The same phenomenon is seen for soil blended additionally with crumb rubber and fly ash.

4. There is a significant increase in CBR values with increase in addition of both crumb rubber at 16 % addition which is increased to 9.45% from 4.4%and for combination of crumb rubber and fly ash are observed as maximum values at (8% crumb rubber + 15% of fly ash) which is recorded as 12.35% and at (8% crumb rubber + 30% of fly ash) it is recorded as 10.15%.
5. Finallyit can be concluded that the combinations work outs effectively at percentage of 8% with the combination of fly ash at 15% and 30%. The stabilizers can be effectively utilised in improving the subgrade performance when a pavement is to be formed over a subgrade of expansive soils.

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