Comparitive Studies on the Improvement of Weak Soil using Coarse Aggregates and Shredded Tyre Strips

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***Abstract*— Engineers often face problem in constructing road bed on weak subgrade soil. These soils can be strengthened by adding various types of materials, by compacting them into required CBR value as per highway requirements. This work intended to be done on soil collected from Pallipuram area. The material requires to improve the strength characteristic are coarse aggregates of 10-12mm size and tyre crumbs. The study aims to find the compaction results, i.e. OMC and MDD at different percentage of aggregate and tyre crumbs used separately with the soil. Using the results from the test, California bearing ratio test (CBR) are conducted with the OMC and MDD obtained for each proportion. The value of CBR should be improved as per IRC codes and Indian Standard codes. The optimum combinations of the result are used to develop an acceptable subgrade mix. The compaction test with different percentages of aggregate and tyres, the CBR value of maximum OMC s and for the optimum proportion are to be tested.**

Keywords— Weak soil stabilization, coarse aggregates, proctor compaction test, CBR test.

I. INTRODUCTION

The construction of pavements on soils which do not possess sufficient strength to support the wheel loads, is the major problem faced by the Engineers. For that the pavements should be provided with a suitable subgrade. Certain modification techniques shall be employed for stabilizing on these weak sub grades. The purpose of subgrade modification is to enhance the strength, reduce the moisture content, shrinkage and swelling characteristics of soil. The subgrade performance mainly depends on CBR value. It is crucial for highway engineers to develop a subgrade with a California Bearing Ratio (CBR) value of at least 10. Research has shown that if a subgrade has a CBR value less than 10, the sub base material will deflect under traffic loadings in the same manner as the subgrade and cause pavement deterioration. Higher the CBR value for a particular soil, the more will be the strength and thinner will be pavement. For this improvement the materials like aggregates and tyre shreds can be used. Well-graded and non-plastic aggregates are used to replace the poor subgrade materials. Also shredded tyres exhibit very good frictional properties when mixed with soils by enhancing the strength of soils internally and provides them with stability. In this study the subgrade improvement was done by mixing aggregates. The aggregates can be used in different proportions on subgrade. The intention is mainly for improving the highway subgrade as per specifications. The literatures suggest various method with these materials on soil. In some studies it's mentioned that mixing the materials and when used in layers also improve the CBR value.

II. MATERIALS USED AND METHODOLOGY

1. Soil

Soil used for this study is silty sand and is light reddish in colour was collected from Pallipuram area near Kazhakootam, Trivandrum. The strength of the soil is found out by conducting CBR test. The properties of the soil used for the study are listed in Table 1.

TABLE 1:
GEOTECHNICAL PROPERTIES OF SOIL

Soil Properties	**Value**
Natural moisture content	14.5%
Specific gravity	2.66
Maximum dry density(g/cc)	1.71
Optimum moisture content (%)	18.5
Liquid limit (%)	43.6
Plastic limit (%)	29.2
Shrinkage limit	19.4
Plasticity index	14.4
CBR	3%
Percentage gravel (%)	1.45
Percentage silt (%)	6.2
Percentage sand (%)	92.35
Type of soil	ML

2. Coarse Aggregate

The aggregates used for the study is collected from the Quarry near Vellayani.the size of the aggregates used in this study varies from 10-12mm.

TABLE 2: PROPERTIES OF AGGREGATES

Size of Aggregates(mm)	10-12
Density of Aggregate(kN/m3)	20.9
Impact Strength(%)	10-20
Specification of aggregate	Strong
Specific gravity	1.02

Fig. 2. Soil collected

Fig .3. 10-12mm sized aggregates

3. Waste tyre crumbs

Tyre crumbs passing through 4.75 mm sieve was taken for the test. Specific gravity of tyre crumbs obtained to be 1.12.

Fig.4. Tyre crumbs

A. Methodology

The experimental studies include conventional CBR tests as per IS 2720-Part 16 and Standard proctor compaction test as per IS 2720- Part 7.

Standard propctor compaction test was conducted on soil mixed with different proportions of aggregates (10,20,30,40,50%) and the OMC(optimum moisture content) and MDD(maximum dry density) were determined.CBR tests were conducted on soil mixed with varying proportions of aggregate at OMC and MDD.The optimum percentage of aggregate is selected from CBR values thus obtained.

Also the tyre crumbs are sieved through 4.75mm sieve and added in different percentage on soil for obtaining the optimum moisture content and maximum dry density. It was added in 5, 7.5,10 and 12.5% in soil. The OMC and MDD value was obtained. Then the cbr test was performed by mixing the crumbs in soil. The strength improvement was noted.

III. RESULTS AND DISCUSSION

A. *Compaction Curves of Soil mixed with Varying Proportions of Aggregates .*

The OMC and MDD were obtained by conducting the standard proctor compaction test. The different percentage of aggregate from 10% to 50% was mixed uniformly in the soil sample. The variation of OMC and MDD was plotted. With that OMC the CBR test was conducted to obtain the strength of subgrade. It can be seen from the fig 5 that as the aggregate percentage increases the OMC value decreases and the MDD value increases upto 40% aggregate mix.

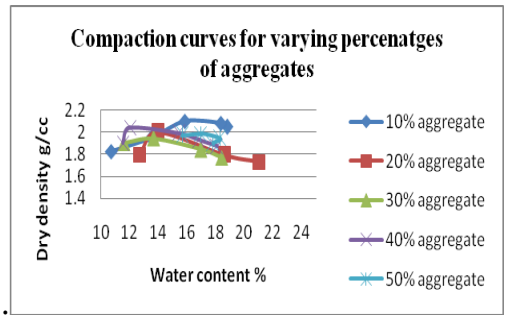

Fig .5. Compaction curves for varying percentage of aggregates

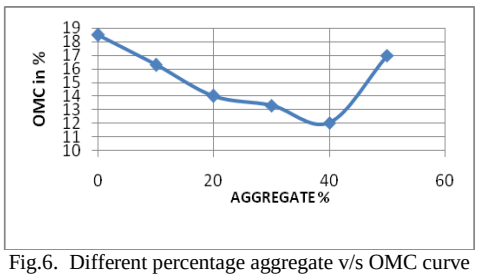

Fig.6. Different percentage aggregate v/s OMC curve

From fig 6 it is clearly shown that upto 40% of aggregate the OMC is decreases and thereafter an increase trend is observed.

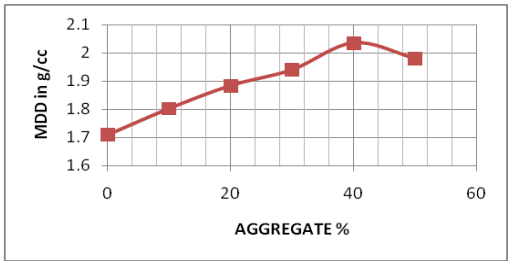

Fig.7. Different percentage aggregate v/s MDD curve

From fig 7 it can be seen that the MDD value increase upto 40% aggregate mix and after that having a decreased value.

TABLE 3: VARIATION OF DIFFERENT PERCENTAGE AGGREGATE WITH THEIR OMC, MDD & CBR VALUE.

Aggregate %	OMC(%)	MDD (kN/m^3)	CBR Value (%)
0	18.5	17.1	3
10	16.3	18.03	14.38
20	14	18.84	29.57
30	13.29	19.4	63.14
40	12.03	20.35	104
50	17	19.8	15.98

This table 3, shows the variation of MDD and OMC of different percentage aggregate mixed in soil. There is an increase in MDD till 40% then decreases. Likewise the OMC value decreases till 40% then increases. So the optimum mix range considered to being 40%.

B. *CBR Variation*

The variation of cbr value in different percentage of aggregate mixed in soil is shown in fig.8.

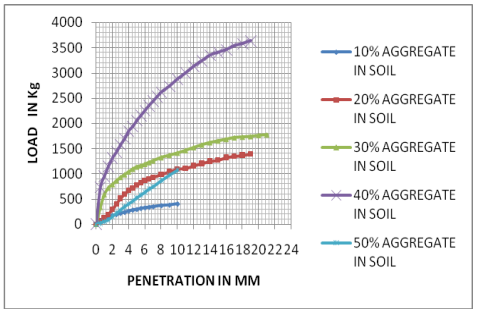

Fig .8. Cbr value of different percentage of aggregate in soil.

Fig 8 clearly indicates that the strength of soil increase with increase in percentage of aggregate. Beyond a percent of 40% a decrease in strength was observed.

TABLE 4: VARIATION OF DIFFERENT PERCENTAGE AGGREGATE WITH INCREASE IN CBR VALUE.

AGGREGATES (%)	PERCENTAGE INCREASE OF CBR VALUE (%)
0%	3
10%	3.79
20%	8.86
30%	20.05
40%	33.66
50%	4.33

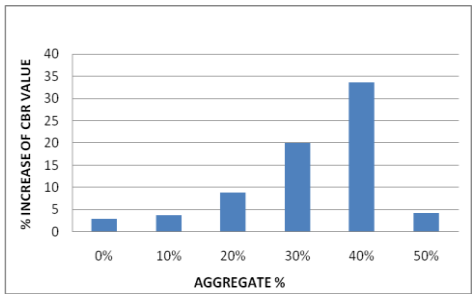

Fig. 9. Increase in CBR value of different percentage of aggregate in soil

The CBR strength of aggregate mixed in soil increases till 40% and gives a value of 104%, and then it decreases for 50% mix in soil. There is an increase of 33.66% of cbr strength from that of unreinforced soil. This value validates the IS specification.

C. *Compaction Curves Of Soil Mixed with Varying Percentage of Tyre crumbs.*

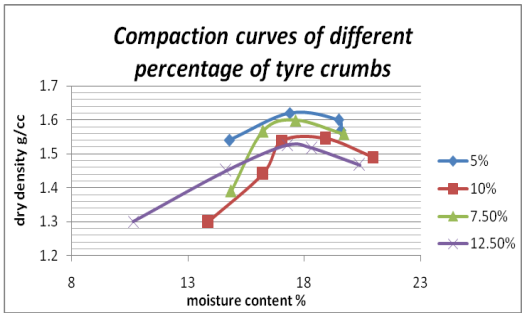

Fig .10. Compaction curves for varying percentage of tyre crumbs

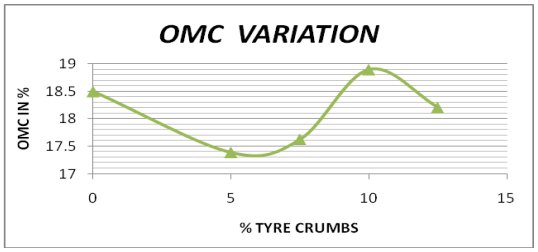

Fig. 11. Omc variation curves for varying percentage of tyre crumbs

From fig 11 it is clearly shown that the omc is varying sinusoidaly, first it decreases and thereafter an increase in value is observed and shows a decreasing trend. This may be due to the negligible water absorption capacity of the crumb rubber.

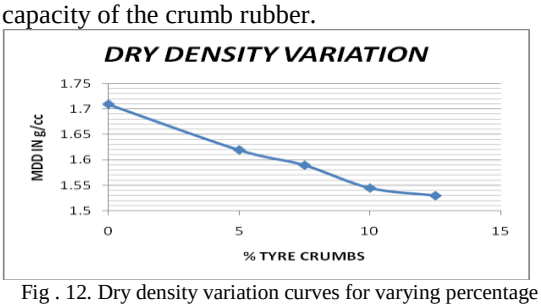

Fig . 12. Dry density variation curves for varying percentage of tyre crumbs

From fig 12 it can be seen that the MDD value decreases, which is due to the lower specific gravity of tyre crumbs.

D. *CBR Variation of tyre crumbs mixed in soil.*

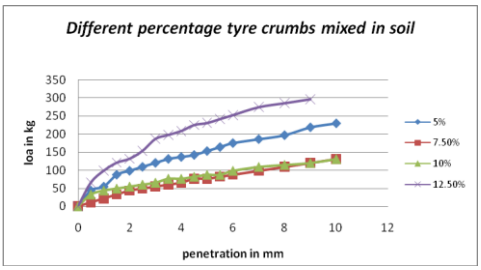

Fig .13. CBR value of different percentage of tyre crumbs in soil.

TABLE 5: VARIATION OF DIFFERENT PERCENTAGE TYRE CRUMBS WITH INCREASE IN CBR VALUE.

% OF TYRE CRUMBS	*CBR STRENGTH IN %*	*INCREASE IN CBR VALUE (%)*
0	**3**	**0**
5	**7.9**	**1.63**
7.5	**3.73**	**0.24**
10	**4.4**	**0.47**
12.5	**11.18**	**2.73**

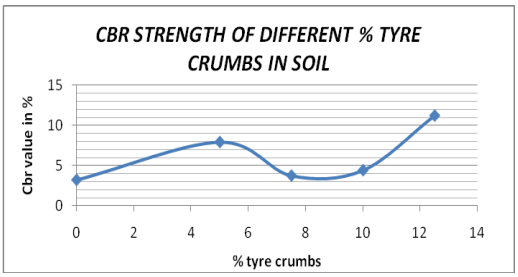

Fig. 14. CBR value of different percentage of tyre crumbs in soil.

IV. CONCLUSION

When aggregate was mixed in soil sample, there was an increase in dry density value till 40% and thereafter it decreases. Likewise the optimum moisture content value decreases till 40%, then increase for 50%.This shows that 40% aggregate mixed in soil by percentage gives the optimum mix range. The CBR strength increased for reinforced soil than unreinforced soil with a CBR value of 104% for 40% aggregate mixed in 60% soil, i.e about 33.66% increase in value was obtained. So aggregates are best suited for subgrade strength improvement.

Tyre crumbs show a decreasing in dry density, which is due to the lower specific gravity of tyre crumbs. Strength is increased the addition of increasing percentage of tyre crumbs. This also meets the subgrade strength of highways

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