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Engineering Behaviour of Waste Plastic Chips with Clayey Soil

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ABSTRACT
Plastic is everywhere in our daily life. The Disposal of non-biodegradable waste material such as Plastics, Scrap Tires, Tubes etc. are becoming a serious problem, especially in urban area, in terms of its dumping in the dustbins, clogging of drains, reducing soil fertility and creating aesthetic problems etc. Therefore these waste plastic is either landfilled or incinerated. Both these activities are not eco-friendly as it pollutes the land and the air. In such conditions, locally available clayey soil mixed with randomly distributed waste rubber tyre can be used to increase strength and decrease deformability in subgrade of in a cost- effective manner.
This paper presents the stabilization of locally available clayey soil using randomly distributed waste rubber tyre at varying sizes and percentages by dry weight of soil. Compaction tests and California Bearing Ratio (CBR) tests were conducted to investigate the behavior of clayey soil mixed with waste rubber tyre-tube. From the test results, it was observed that with the increase in percentage of waste tyre-tube chips in clayey soil, maximum dry density decreases whereas optimum moisture content increases. Further, both the value of unsoaked and soaked CBR at OMC, of the waste tyre-tube chips-clayey soil composite have been increased with the increase in percentage of waste tyre- tube chips up to a certain limit.
Key words: *Waste rubber tyre, Non-biodegradable, Eco-friendly, Deformability, cost- effective California Bearing ratio test.*

I. INTRODUCTION

More than hundred million tons of Waste rubber tyres are discarded every year in India itself. It creates a challenging problem to society due to disposal problem of such waste, occasional hazards due to fire accident on such tyre waste, and environmental pollution. Nonstop accumulation of such waste without any planned disposal system provides rise to high pressure on reduction land available for human use due to increasing land for accommodating undisposed waste rubber tyres and creates pollutions associated with dump yards for such waste everywhere. Use of rubber tyre chips along with clay in different proportion has been examined by many researchers as better backfill and more cost-effectiveness. Model surface footing tests on unreinforced and reinforced foundation medium with different fiber contents indicated that fiber reinforcement of 0.75% shows maximum improvement in the bearing capacity nearly by 50% (Naval and Kumar, 2013). These tyre materials may be used as construction material in cases where such properties will be great benefit, for example in construction of landfill leachate collection system. As a result of use of shredded tyre chips in landfill leachate collection system, is now getting fastest growing market application.

However, most extensive possibility of consuming tyre waste by large volume and thereby solving the problem of the disposal of such waste in large amount possibly lies in their use as fill material for highway construction, which are taking at a high enormous rate all over the world, for fast development of infra-structure. The rubber tyre chips having resilience, height weight and high strength, may be used with locally available soils in suitable proportion to achieve maximum gain in quality and decrease in cost of construction of such highways. However, proper engineering analysis is necessary for such exercise. Several studies have been made with waste rubber tyre to observe the characteristics of soil-waste rubber tyre mix composites. Lee et al. (1999), Rao and Dutta, (2001) etc. studied on the stress-strain relations and strength behaviour of sand-rubber tyre chips mix composites. They observed higher strength of soil-waste rubber tyre mix composites due to increase in percentage of rubber chips up to a certain limit.

In the present study, an experimental programme has been undertaken to investigate the beneficial effects of mixing rubber tyre chips on engineering properties of locally available clayey soils. Different percentages and varying sizes of scrap cycle tyre-tube chips have been used to identify the possible use in highway construction in a cost effective manner.

II. MATERIALS USED:

A. Clayey soils: Locally available clayey soil was used in this experimental study. The Clayey soil is classified as „CL" as per ISclassification. The physical properties of clayey soil used are given in Table 1.

Table 1: Physical Properties of Clayey soil

Properties	**Clayey soil**
Classification (IS)	CL
Specific gravity	2.62
Coefficient of uniformity, C_u	3.74
Maximum dry density (gm/cc)	1.534
Optimum moisture content (%)	16.22
Unsoaked California bearing ratio (%)	3.7
Soaked California bearing ratio (%)	3.3

B. Waste tyre tube chips: Waste tyre tubes were collected from local market and processed in the laboratory by cutting into small pieces of various sizes of 13mm x 13mm, 3mm x 25mm, and 13mm x 38mm. In our study, different sizes of waste tyre tube chips were mixed randomly with clayey soil at different percentages of 4%, 6%, 8%, and 10%.

III. TEST PROGRAMME:

In this study to investigate the effect of inclusion of waste tyre-tube chips on compaction and strength characteristics of locally available Clayey soil, standard Proctor test and unsoaked & soaked CBR tests were conducted for clayey soil mixed with randomly distributed waste tyre-tube chips varying percentages and sizes. All the tests were conducted as per relevant I.S. codal provision.

IV. EXPERIMENT AND RESULT

Standard Proctor test and unsoaked & soaked CBR tests have been conducted in the laboratory as per I. S. Codal provision, for different series of Clayey soil - tyre tbe chips composite. The results of these tests are given in the table 2.

Table 2: Summary of Results of compaction and unsoaked CBR tests

Description of Mix	x length(mm)	MDD	OMC	Unsoaked CBR	Soaked CBR
Clayey soil	-	1.534	16.22	3.7	3.3
Clayey soil + 4% Waste plastic chips	13 x 13	1.501	15.35	5.8	5.4
Clayey soil + 6% Waste plastic chips		1.482	15.42	6.3	5.8
Clayey soil + 8% Waste plastic chips		1.458	15.54	7.2	6.6
Clayey soil + 10% Waste plastic chips		1.46	15.65	7.1	6.4
Clayey soil + 4% Waste plastic chips	13 x 25	1.493	15.42	5.9	5.6
Clayey soil + 6% Waste plastic chips		1.472	15.56	6.6	6.3
Clayey soil + 8% Waste plastic chips		1.441	15.63	7.5	7.3
Clayey soil + 10% Waste plastic chips		1.429	15.73	7.3	6.8
Clayey soil + 4% Waste plastic chips	13 x 38	1.477	15.44	5.7	5.5
Clayey soil + 6% Waste plastic chips		1.456	15.58	6.4	5.9
Clayey soil + 8% Waste plastic chips		1.433	15.68	7.4	6.8
Clayey soil + 10% Waste plastic chips		1.417	15.81	7.2	6.6

4.1 COMPACTION TEST:

The Standard Proctor tests were conducted as per IS 2720 (Part-VII) on clayey soil - waste tyre-tube chips mix composites to determine the optimum moisture content (OMC) and maximum dry density (MDD). The clayey soil was mixed with randomly distributed waste tyre-tube of varying percentages (4%, 6%, 8%, and 10%.) and sizes (13mm x 13mm, 13mm x 25mm, and 13mm x 38mm) and standard proctor test were conducted on these mixtures. The OMC and MDD values obtained from the standard Proctor test are given in table 2 and variation of MDD and OMC with percentage of waste tyre tube chips are shown in fig. 1 and 2 respectively.
From these figures, it can be observed that with the increase in percentage of waste tyre-tube chips, the MDD value of Clayey soil - waste tyre-tube chips mix composites decreases whereas OMC value increases significantly. The decrease in MDD is due to the light weight natureof crumb rubber in comparison with soil.

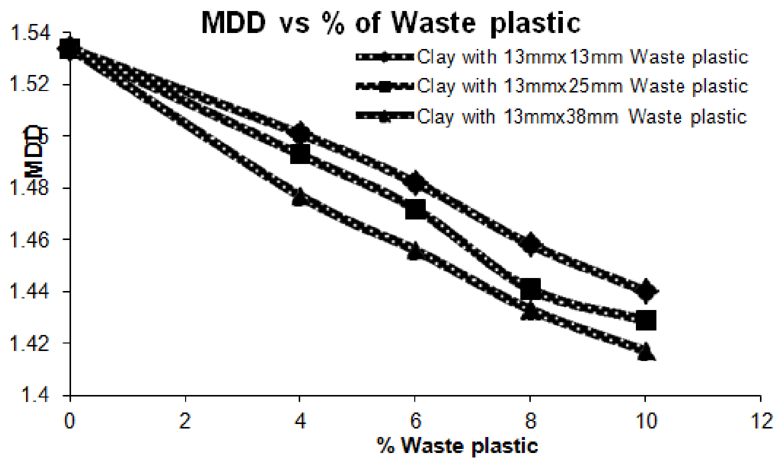

Fig. 1: Variation of MDD of clayey soil with % of tyre chips.

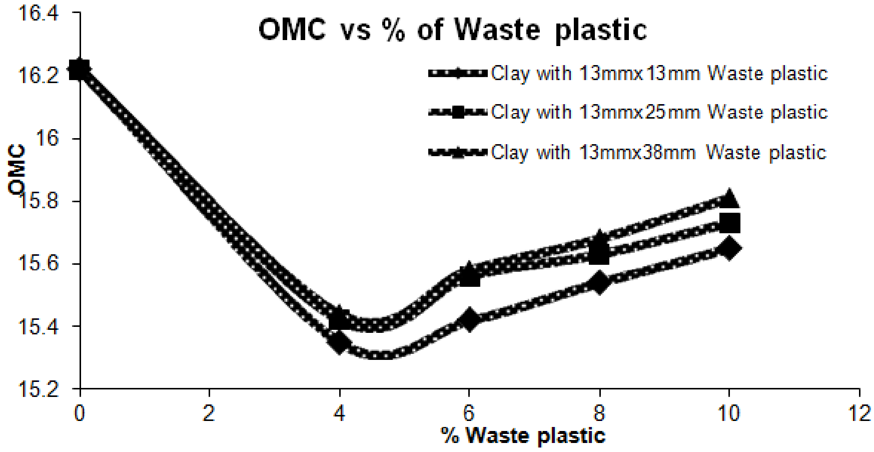

Fig. 2: Variation of OMC of clayey soil with % of tyre chips.

4.2 SOAKED AND UNSOAKED CBR TEST:

Unsoaked and Soaked CBR tests were conducted as per IS: 2720 (Part-X) on Clay - waste tyre chips mix composites to evaluate the strength characteristics of clayey soil. Randomly distributed waste tyre-tube of varying percentages (4%, 6%, 8%, and 10%.) and sizes (13mm x 13mm, 13mm x 25mm, and 13mm x 38mm) were mixed with clayey soil. The unsoaked and soaked CBR values obtained from the laboratory CBR test are given in table 2 and the variation of unsoaked and soaked CBR with percentage of tyre chips are shown in fig.3 and4 respectively.

From these figures, it is observed that the CBR values of Clayey soil - tyre tube chips mix composite increases with increase of percentage of tyre tube chips and reaches a maximum value and after that it decreases slowly with further inclusion of waste tyre tube chips within the range of the testing programme. The maximum unsoaked and soaked CBR value of clayey soil obtained from the laboratory test are 7.5 and
7.3 respectively for addition of 8% waste tyre tube chips size of 13mm x 25mm.

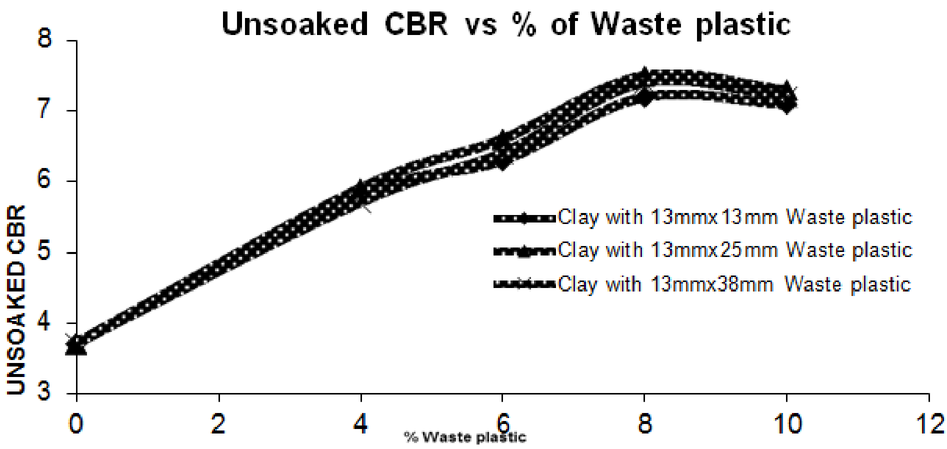

Fig. 3: Variation of unsoaked CBR of clayey soil with % of tyre chips.

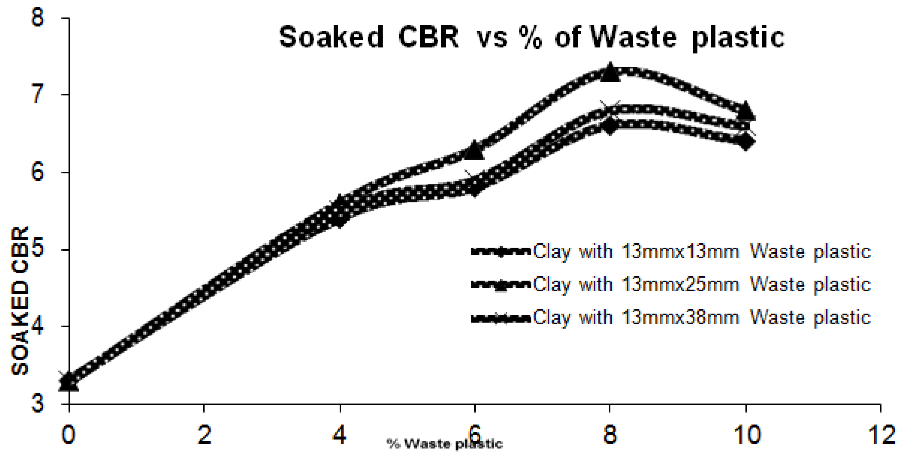

Fig. 4: Variation of soaked CBR of clayey soil with % of tyre chips.

V. CONCLUSION:

On the basis of the results of experimental investigation made above, following conclusions may be drawn.

1. It was observed that the maximum dry density of Clayey soil decreased with the increase in percentage of waste tyre-tube chips. This is due to light weight nature of waste tyre-tube chips. On the other hand, the optimum moisture content of Clayey soil increased with the increase in percentage of waste tyre-tube chips.
2. There is a considerable increase in the unsoaked CBR value for Clayey soil due to mixing of randomly distributed waste tyre-tube chips. The maximum improvement in unsoaked CBR value is due to addition of waste tyre tube chips size of 13mm x 13mm. And optimum percentage of waste tyre tube chips is 9% of the dry weight of Clayey soil for all sizes of waste tyre tube chips used. Further the addition of waste tyre-tube chips to Clayey soil lead to a decrease in CBR values.

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