Research Article Impact Factor: 4.226 ISSN: 2319-507X
A. I. Dhatrak, IJPRET, 2016; Volume 4 (9): 292-306 IJPRET

INTERNATIONAL JOURNAL OF PURE AND APPLIED RESEARCH IN ENGINEERING AND TECHNOLOGY

A PATH FOR HORIZING YOUR INNOVATIVE WORK

FIELD PERFORMANCE OF RANDOMLY ORIENTED PLASTIC WASTE IN SUBGRADE OF FLEXIBLE PAVEMENT

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Accepted Date: 15/03/2016; Published Date: 01/05/2016

Abstract — Several experimental studies have also been conducted to explore the effect of various parameters on the shear strength and compressibility characteristics of soils with randomly distributed plastic waste strips/chips in soil. The common results from the literature included the increase in shear strength, unconfined compressive strength and tensile strength of the soil. It is evident that the studies presented in literature focus mainly on the strength and deformation characteristics of soil with the reinforcement. Furthermore, the study on the use of plastic waste as a reinforcing material has been limited as field application approach. Hence in this project, 'Field Performance of Randomly Oriented Plastic Waste in Subgrade of Flexible Pavement' was studied, to determine the feasibility and effectiveness of the method in actual field construction

Keywords: Clayey Soil, Plastic Waste Strips/Chips, Model Flexible Pavement, Field CBR Test

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Access Online On:

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How to Cite This Article:

A. I. Dhatrak, IJPRET, 2016; Volume 4 (9): 292-306

PAPER-QR CODE

INTRODUCTION

Plastic waste problem is now become very critical issue in aspect of decomposition, which is a challenge to environmental control system. Now plastic is not used for particular use, it becomes addiction in daily life of human being as well as in industry. Huge quantity of plastic waste is found in MSW i.e. drinking bottle, carry bags, packing paper etc. This plastic can be effectively used for improving the performance of flexible pavement, also solve the problem of disposal of plastic waste. The aim of project is to improve engineering properties of soil by using plastic waste strips/ chips. On the basis various research paper studies, it is observed that the soil stabilization using waste plastic bottles chips is an alternative method for improvement of sub grade soil of pavement used for construction of flexible pavement. This project is based on the experimental work study on use of plastic waste in soil used for construction of flexible pavement and an attempt is made to control plastic waste pollution for green environment as Geo environment trend. The common results from the literature included the increase in shear strength, unconfined compressive strength and tensile strength of the soil. It is evident that the studies presented in literature focus mainly on the strength and deformation characteristics of soil with the reinforcement. Furthermore, the study on the use of plastic waste as a reinforcing material has been limited as field application approach. Hence in this project, 'Field Performance of Randomly Oriented Plastic Waste in Subgrade of Flexible Pavement' was studied, to determine the feasibility and effectiveness of the method in actual field construction

LITERATURE REVIEW

Sr No.	References	Evaluation Approach
1.	Babu, G.L. Sivakumar *et.al.* (2010)	There is a good improvement in the strength of soil with inclusion of plastic waste**.**
2.	K.Geetha Manjari *et.al.* (2011)	The compressibility and permeability reduced significantly with addition of a small percentage of plastic waste to the soil.
3.	A.K. Choudhary *et.al.* (2010)	Results of CBR tests demonstrated that inclusion of waste HDPE strips in soil with appropriate amounts improved strength and deformation behavior of subgrade soils

4.	Anas Ashraf *et.al.* (2011)	Using plastic bottles as a soil stabiliser is an economical and gainful utilization since there is scarcity of good quality soil for embankments and fills.
5.	Dr. D S V Prasad *et.al.* Vol. 13, Bund. D	Waste plastics and waste tyre rubber could be used as alternative reinforcement materials in place of conventionally used reinforcing materials.

MATERIAL & METHODOLOGY

Plastic Waste

In this study, waste plastic bottles strips/chips was used, which was produced from drinking water bottles. Drinking water bottles are also locally called as Bislari Bottle. Waste plastic strips/ chips are locally available in MIDC Amravati which is produce from waste drinking water bottles. Plastic strips/chips produced in MIDC by Plastic Granulator. Plastic granular is simple mechanical unit, fitted with sharp cutter, which is cuts plastic waste into Plastic waste strips. Plastic Strips/chips were randomly mixed with soil. The plastic waste strips/chips, which was used in project shown as figure 1

Figure1. Waste Plastic Bottle Strips /Chips.Soil

The Soil used, in these investigations was obtained from the premises of Govt. Engineering College, Amravati. The properties of soil were determined by standard test procedures and tabulated as per provision of IS codes of practice. The routine tests were done for characterization of soil.

Methodology

Various laboratory tests were performed to determine the compaction characteristic, strength characteristic and stress strain. Characteristic of soil mixed with varying percentage of randomly oriented plastic bottles strips/chips. It was mainly included compaction test to determine OMC and MDD, and CBR soaked & unsoaked tests to determine the effectiveness as well as optimum percentage of plastic waste in the soil.

Laboratory CBR tests were perform to calculate the optimum percentage of plastic waste strips/chips. In this test, plastic waste strips were mixed with soil in percentage of dry weight of soil ie 0%, 0.5%, 1.0%, 1.5%, 2.0% 2.5% etc.

Clayey soil mixed with optimum percentage of plastic strips/chips by randomly oriented is called composite soil. Composite subgrade is earth embankment of road work improved with randomly oriented optimum percentage of plastic waste strips/chips. Artificial and composite subgrade layer of model pavement were constructed on field as per relevant IRC standards. Unsoaked and soaked field CBR were performed on artificial and composite subgrde as per IS 2720 (Part31):1990.

LABORTORY DETERMINATION

Index Properties of the Soil

The properties of the clay soil were determined by standard test procedure and tabulated in table 1

Table 1 Index Properties of Soil

Sr No	Property	Values
1	Specific Gravity of Soil (%)	2.67
2	Liquid Limit (%)	54.32
3	Plastic Limit (%)	27.21
4	Shrinkage Limit (%)	13.00
5	Plasticity Index (%)	27.11
6	Gravel (%)	1.40
7	Sand (%)	18.60
8	Silt and Clay (%)	80.00
9	IS Classification	CH
10	Maximum Dry Density (kN/m3)	16.00

11	Optimum Moisture Content (%)	19.60
12	Compressive Strength (kN/m2)	16.25

Compaction Properties

The maximum dry density and optimum moisture contents of the soil with different percentage of plastic strips contents are reported in the Table 2 These data indicate that the maximum dry density decreases with the increase in the plastic strips/chips content, which is due to lower density of plastic strips than the soil particles. The moisture content vs dry density relationships of the plain and composite soil are shown from figure 2.

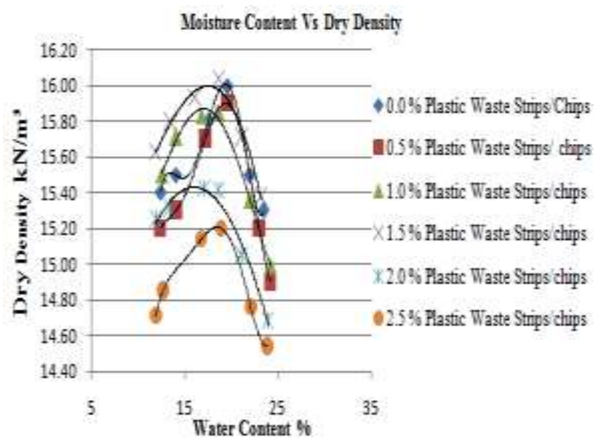

Figure 2. Moisture Content Vs Dry Density Relationships of the Plain and Composite Soil

Table 2 MDD & OMC for Randomly Mixed Soil with Different Percentage of Plastic Strip

Plastic Content (%)	OMC (%)	MDD (kN/m³)
0 (Plain Soil)	19.60	16.00
0.5	19.60	15.90
1.0	18.59	15.85
1.5	18.69	16.00
2.0	18.71	15.41
2.5	18.94	15.20

California Bearing Ratio

The laboratory unsoaked and soaked CBR tests were performed with varying percentage of plastic waste strips/chips randomly oriented in soil .i.e. 0%, 0.5%, 1.0%, 1.5%,2.0%2.5% .

Table 3 shows the result of CBR tests of soil at varying plastic strips/chips contents. The results shows that there is an increase in CBR values due to plastic strips reinforcement within a range from 11% to 30% for unsoaked condition and 40% for soaked condition. The maximum improvement in unsoaked CBR value is 6.4% at 1.5% plastic strips/chips randomly oriented in soil, and maximum improvement in soaked CBR value is 3.0% at 2.0% plastic strips/chips randomly oriented in soil.

As per IRC-37, flexible pavement should be design at 4 day soaked CBR value. Therefore for present study, optimum plastic strip content is 2.0% Hence 2.0% plastic strips content and 3.0% soaked CBR value can be used for design flexible pavement with composite subgrade as a Geo- environmental trend. The load- penetration curves obtained from the CBR tests for plain soil and randomly oriented with strip contents ranged from 0 % to 2.5 % are shown in figure 3 and 4.

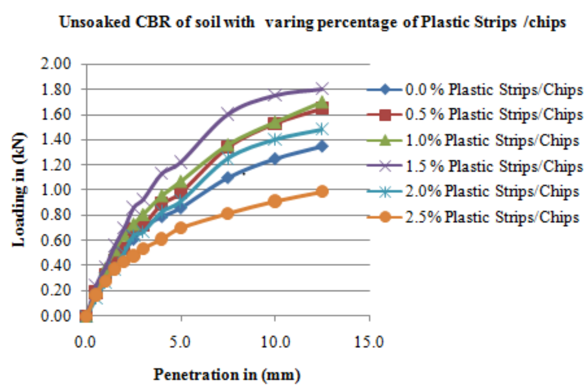

Figure 3. Unsoaked CBR of soil with varying percentage of Plastic Strips /chips

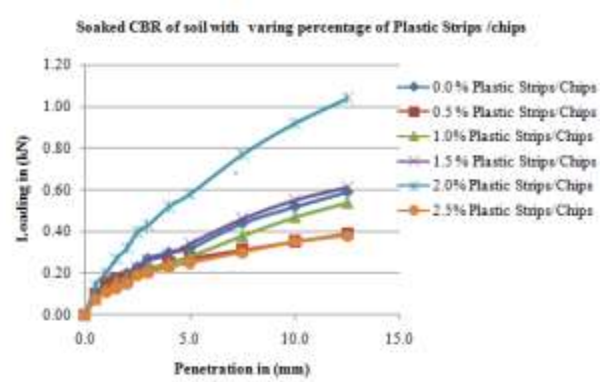

Figure 4. Soaked CBR of soil with varying percentage of Plastic Strips /chips

Table 3 CBR Values for Randomly Mixed Soil with Different Percentage of Plastic Strip

Plastic Strips/chips randomly oriented in soil (%)	Unsoaked (%)	Soaked (%)
0.0	4.5	1.7
0.5	5.1	1.5
1.0	5.4	1.6
1.5	6.4	1.7
2.0	4.8	3.0
2.5	3.6	1.4

FIELD DERTERMINATION

1. Field CBR Test

Unsoaked and soaked field CBR tests were performed on composite and artificial subgrade of model flexible pavement as per IS 2720 (Part 31): 1990. Combined patch of composite (5m x 3m x 0.30m) and artificial subgrade (5m x 3m x 0.30m) layer of model flexible pavement was constructed in camps of Government college of Engineering Amravati per IRC: 36-1970.

Figure 5.Combined Artificial and Composite Subgarde of Model Flexible Pavement

Figure 6. Typical Setup for Unsoaked Field CBR on Artificial Subgrade of Model Flexible Pavement

Figure 7. Typical Setup for Unsoaked Field CBR on Composite Subgrade of Model Flexible Pavement

Figure 8. Arrangement for Soaked Field CBR Test

Figure 9. Performed Soaked Field Tests on Artificial and Composite Subgrade

Figures 5 to 9 show the setup and arrangement for unsoaked and soaked field CBR test, which were performed in present study.

1.1Unsoaked Field CBR Test

Unsoaked field CBR tests were performed on composite and artificial subgrade of model flexible pavement as per IS 2720 (Part 31): 1990. Figure 10 shows load penetration curve for unsoaked field CBR test on artificial subgrade.

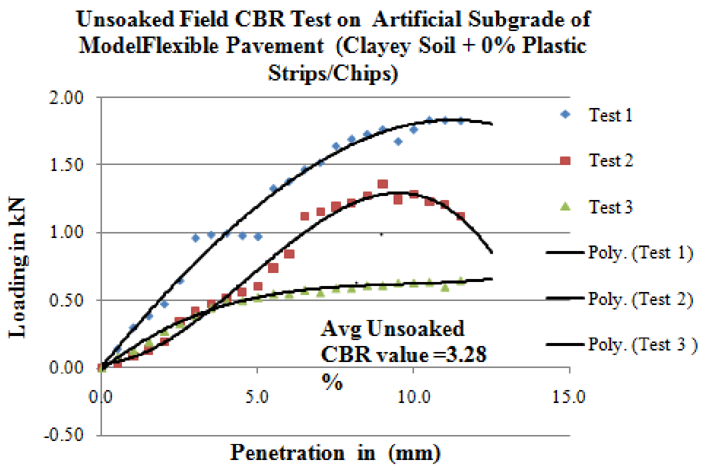

Figure 10. Unsoaked Field CBR Test on Artificial Subgrade of Model Flexible Pavement

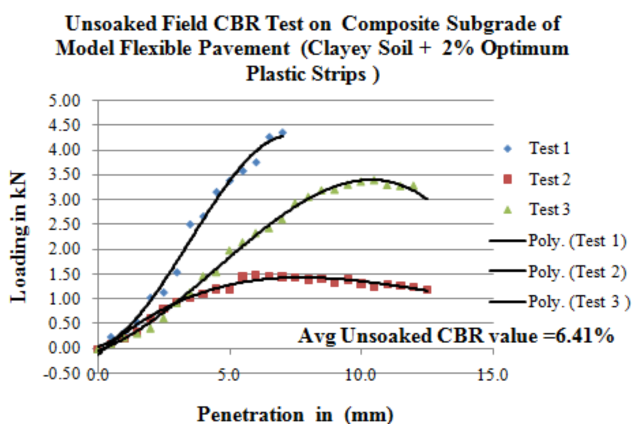

Figure 11. Unsoaked Field CBR Test on Composite Subgrade of Model Flexible Pavement

Figure 11 shows load penetration curve for unsoaked field CBR test on composite subgrade

Table 4. Comparison between Artificial and Composite Subgrade for Unsoaked Field CBR Test

Sr No	Unsoaked Field CBR Strata/Layer	Test No	Unsoaked CBR Value (%)	Avg CBR Value (%)	Increase/ decrease Unsoaked CBR value w.r.t Artificial Subgrade (%)
1	Artificial Subgrade 0 % Plastic Strip/Chips	1	4.83	3.28	-
		2	2.56		
		3	2.45		
2	Composite Subgrade Clayey soil + 2% Optimum plastic strips/chips	1	8.48	6.41	48.82
		2	6.11		
		3	4.65		

Table 4 shows comparison between unsoaked field CBR test on artificial and composite subgrade. Summary of unsoaked field CBR test on artificial and composite subgrade of model flexible pavement is show below

i. Unsoaked field CBR values of artificial and composite subgrade are 3.28 and 6.41% respectively.

ii. Composite subgrade is more effective in field application, than artificial subgrade. Since unsoaked field CBR increased from 3.28 to 6.41%

iii. Strength of Composite subgrade increased by 48.82 % due to randomly oriented optimum 2% plastic waste in soil. This can be help to develop a new pavement stabilization technique.

1.2 Soaked Field CBR Test

Soaked field CBR tests were performed on composite and artificial subgrade of model flexible pavement as per IS 2720 (Part 31): 1990. Figure 12 shows load penetration curve for soaked field CBR test on artificial subgrade.

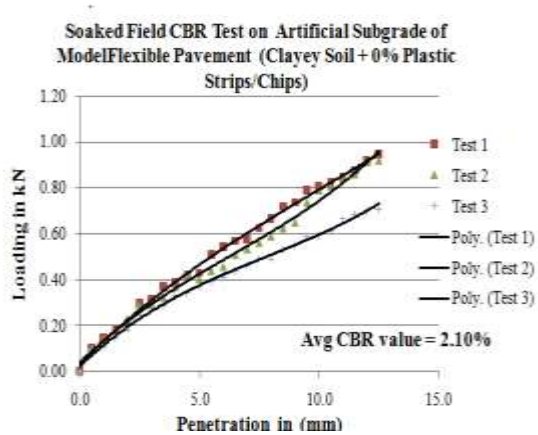

Figure 12. Soaked Field CBR Test on Artificial Subgrade of Model Flexible Pavement

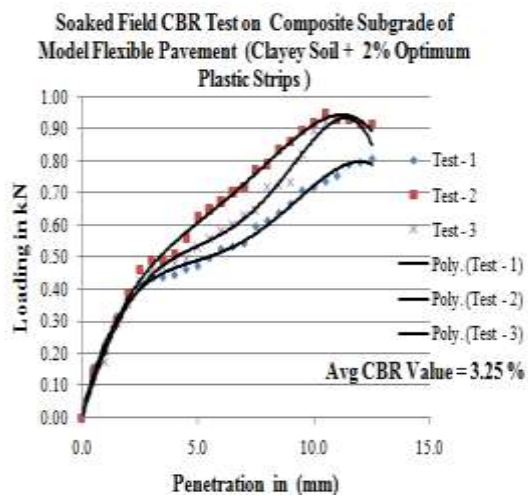

Figure 13. Soaked Field CBR Test on Composite Subgrade of Model Flexible Pavement

Figure 13. Shows load penetration curve for unsoaked field CBR test on composite subgrade of model flexible pavement.

Table 5 Comparative Chart between Artificial and Composite Subgrade Soaked for Field CBR Test

Sr No	Soaked Field CBR Strata/Layer	Test No	Soaked CBR value (%)	Avg Soaked CBR Value (%)	Increase/ decrease Soaked CBR value w.r.t Artificial Subgrade CBR value (%)
1	Artificial Sub grade 0 % Plastic Strip/Chips	1	2.22	2.11	-
		2	2.14		
		3	1.96		
2	Composite Sub grade Clayey soil + 2% Optimum plastic strips/chips	1	3.13	3.25	35.08
		2	3.44		
		3	3.18		

Table 5 shows comparative chart between soaked field CBR test on artificial and composite subgrade. Summary of soaked field CBR test on artificial and composite subgrade of model flexible pavement is show below

i. Soaked field CBR value of artificial and composite subgrade are 2.11 and 3.25 % respectively.

ii. Composite subgrade is more effective in field application, than artificial subgrade. Since Unsoaked field CBR increased from 2.11 to 3.25%.

iii. Strength of Composite subgrade increased by 35.18 % due to randomly oriented optimum 2% plastic waste in soil. This can be help to develop a new pavement stabilization technique.

CONCLUSION

The present study has shown quite encouraging results and following important conclusion can be drawn from the study

1. The Optimum plastic strip/chips content corresponding to maximum improvement in soaked CBR value is found to be 2.0 %

2. On basis of laboratory CBR test study, due to randomly oriented plastic in soil, unsoaked and soaked CBR values increased by 30 and 40% respectively. Therefore plastic waste strips/chips can be used as reinforcement/ stabilization material for subgrade.

3. Optimum percentage of plastic strip content is 2, which is founded at maximum soaked CBR valve i.e. 3%. Therefore 2% plastic strips /chips, and 3% soaked CBR value will be used for design of model flexible pavement.

4. On the basis of field CBR test study, we found that strength of composite subgrade increased by 35 and 48% in soaked and unsoaked condition respectively. This can be help to develop a new pavement stabilization technique.

5. Hence on the basis of laboratory test, construction of composite subrgade layer in field, and field CBR test, Model flexible pavement with randomly oriented plastic waste in composite subgrade should be applicable to rural area development.

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