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EFFECTIVE USE OF WASTE PRODUCTS IN GROUND IMPROVEMENT

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ABSTRACT

Evaluation Studies were carried out by using the different waste materials in the gravel which contributes to reduce environmental pollution. Randomly distributed fiber/coir reinforced in gravel has recently attracted increasing attention in geotechnical engineering. One of the most promising approaches in this area is to solve two problems with one effort i.e. elimination of solid waste problem on one hand and provision of a needed construction material on other. Disposal of a variety of wastes in an eco friendly way is the thrust area of today's research. This paper investigates to determine the % of waste plastics/coconut coir with gravel by conducting direct shear and CBR tests. From the test results, the optimum percentage of waste plastics and coconut coir with gravel are 0.3% and 0.2% respectively and also gravel with waste plastics shows better performance as compared to gravel with coconut coir.

Keywords: *Gravel, Waste Plastics, Coconut Coir, and Shear and CBR Tests*

Introduction

Many highway agencies, private organizations and researchers are doing extensive studies on waste materials and research projects concerning the feasibility and environmental suitability. The amount of wastes as increased year by year and disposal becomes a serious problem. It is necessary to utilize the waste affectively with technical development in each field. Reinforced earth technique has been gaining popularity in the field of civil engineering due to its highly versatile and flexible nature. It has been used in the construction of retaining walls, embankments, earth dams, foundation beds for heavy structures on soft grounds, viaduct bridges and other applications Henry Vidal (1968), Hausmannn (1990), Rao (1996). The practice of reinforced earth technique became easy and simple with geosynthetics. Inspite of its wide use in various engineering practices; its application in the construction of pavements is very much limited Prasada Raju (2001).Reinforcement of soils with natural and synthetic fibres is potentially an effective technique for increasing soil strength. The growing interest in utilizing waste materials in civil engineering applications has opened the possibility of constructing reinforced soil structure with unconventional backfills, such as waste plastics. The results of direct shear tests performed on sand specimens by Gray and Osashi (1983) indicated increased shear strength and ductility, and reduced post peak strength loss due to the inclusion of discrete fibers.

The coir is a naturally occurring fiber derived from the husk of coconut fruit. It is abundantly available at very low cost in India. A large number of coir products are manufactured by coir board in Kerala for various geotechnical applications in the form of grids, textiles and mats. Natural fibers will not cause environmental problems. The natural fibers are cheap compared to artificial fibers, for long run these natural fibers will undergo

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biodegradation, exception is for coir fibers. Coir, which is reputed to be the strongest and most durable natural material Ramanatha Ayyar et al., (2002), Sivakumar Babu et al., (2008), which is cheaply and abundantly available in India and in a few other Asian countries where coconuts are grown and subsequently processed. Unlike synthetic reinforcing materials, coir is biodegradable; however, due to its high lignin content (about 46%), degradation of coir takes place much more slowly than that in the case of other natural materials. Increasing awareness and demand for environment friendly engineering solutions give coir an edge over synthetic reinforcing materials. This is in spite of the fact that strong fibers like coir which have a very high lignin content can be effectively made use of as a reinforcing material, provided they are given suitable treatment Ramesh et al., (2010).

This paper investigates the performance of industrial waste plastics/coconut coir mixed in gravel materials and to find the optimum percentage. It was observed from the laboratory direct shear and CBR test results that, gravel reinforced material with waste plastics showed better performance as compared to coconut coir reinforced with different percentages of reinforcing materials.

Materials Used and Properties

The following materials are used in this study.

Gravel: Gravel was collected from Dwarapudi village, near Rajahmundry, East Godavari Dt., is used as base material for this investigation. The soil properties are OMC = 15.23%, MDD = 18.20 kN/m^3, I.S. Classification = Poorly Graded Soil, Liquid Limit = 36%, Plasticity Index=12, Specific Gravity =2.54, Cohesion = 0.6, Angle of Friction = 38 and Soaked CBR = 6.13%.

Waste Plastic Strips: Waste plastic strips having a size of 12 mm × 6 mm and a thickness of 0.5 mm was used as reinforcement material in this study, as shown in Fig. 1.

Coconut Coir: Coconut coir fibre was collected from locally available coir industry in Amalapuram, East Godavari District. Coir is used as fiber reinforcement material and its aspect ratio size of 0.1 x 25mm as shown in Fig.2.

Table: 1 Properties of Coir

Physical Properties of Coir	
Length (inches)	6.8
Density(g/cc)	1.40
Tenacity (g/Tex)	10.0
Breaking Elongation (%)	30
Diameter (mm)	0.1 to 1.5
Rigidity of Modulus(Dyne/cm^2)	1.89
% of Swelling in Water	5
Chemical Composition of Coir (%)	
lignin	45.84
cellulose	43.44
Ash	2.22
Pectin's and its compound	3.00
Water soluble	5.25
Hemi-cellulose	0.25
Moisture at 65% RH	10.5

Fig -1: Waste Plastic Strips

Fig -2: Coconut Coir

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Index Properties

Standard procedures recommended in the respective I.S. Codes of practice [IS: 2720 (Part-5) - 1985; IS: 2720 (Part-6)-1972],were followed while finding the Index properties viz. Liquid Limit, Plastic Limit and Shrinkage Limit of the samples tried in this investigation.

Compaction Properties

Compaction Properties: Optimum moisture content and maximum dry density of gravel were determined according to I.S heavy compaction test (IS: 2720 (Part VIII).

Direct Shear Tests

The direct shear tests were conducted in the laboratory as per IS Code (IS: 2720 (Part-13)-1986) as shown in Fig.3. Different percentages of reinforcing materials used in gravel materials were presented in table 2. The required percentage of waste Plastics/coconut coir by dry unit weight of gravel was mixed uniformly with the soil. The water content corresponding to OMC of untreated soil was added to the soil in small increments and mixed by hand until uniform mixing of the reinforcement strips was ensured. The soil was compacted to maximum dry density (MDD) of untreated soil. The specimens were tested in a 6 cm × 6 cm square box at normal stresses of 3, 5, 7, 9 N/mm^2 for each percentage of waste plastics/coconut coir with gravel and sheared at a rate of 1.25 mm/min. The graph was plotted between normal stress and shear stress at failure for each percentage of reinforcement materials for obtaining the shear strength parameters.

California Bearing Ratio (CBR) Tests

Different samples were prepared in the similar lines for CBR test using gravel reinforced with waste plastics/coconut coir and the details of which are given in table 2. The CBR tests were conducted in the laboratory for all the samples as per I.S.Code (IS: 2720 (Part- 16)-1979).

Table -2: Different Percentages of Reinforcing Materials

Material	Reinforcing Material	% of Reinforcing Material
Gravel	Waste Plastic Strips	0.0, 0.1, 0.2, 0.3, 0.4, 0.5
	Coconut Coir	0.0, 0.1, 0.2, 0.3

Discussion on Test Results

I.S heavy compaction, direct shear and CBR tests were conducted by using different percentages of waste plastics/coconut coir were mixed with gravel for finding the optimum percentage.

Fig.3 Direct Shear Test Apparatus

Fig.4 California Bearing Ratio Test

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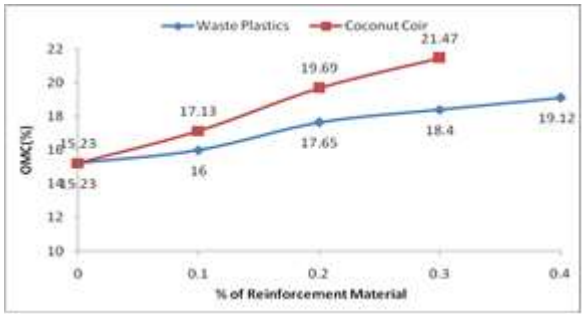

Fig.5 Variation of OMC values for Gravel Reinforced with Different Percentages of Waste Plastic Strips/Coconut Coir Fiber

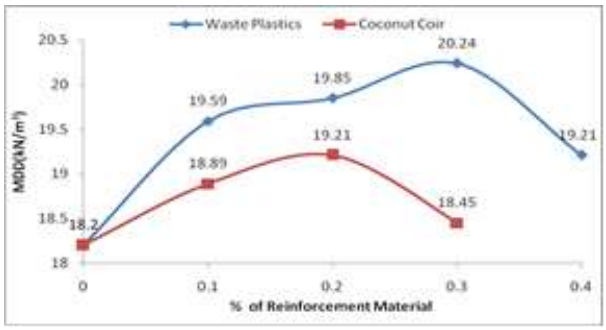

Fig.6 Variation of MDD values for Gravel Reinforced with Different Percentages of Waste Plastic Strips/Coconut Coir Fiber

From the compaction test results it is observed that gravel reinforced with waste plastics/coconut coir , the OMC increases continuously where as the MDD for waste plastics increases from 18.2 kN/m^3 to 20.24 kN/m^3 up to 0.3% and for coconut coir 18.2 kN/m^3 to 19.21 kN/m^3 up to 0.2% beyond it decreases respectively as shown in figs.5 and 6.

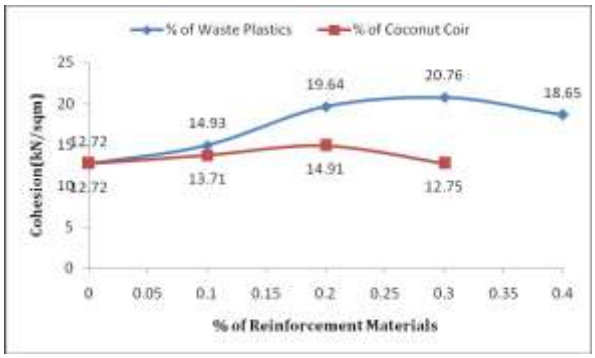

Fig.7 Variation of Cohesion for Gravel Reinforced with Different Percentages of Waste Plastic Strips/Coconut Coir Fiber

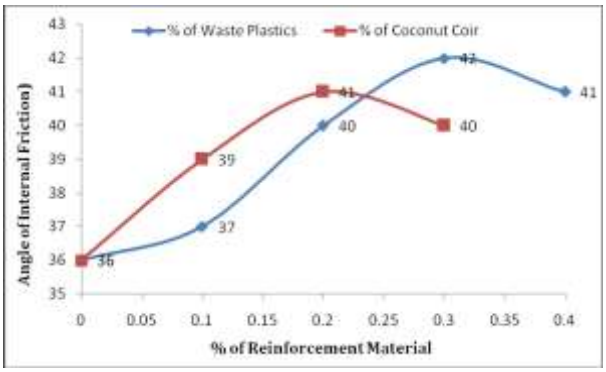

Fig. 8 Variation of Angle of Internal Friction for Gravel Reinforced with Different Percentages of Waste Plastic Strips/Coconut Coir Fiber

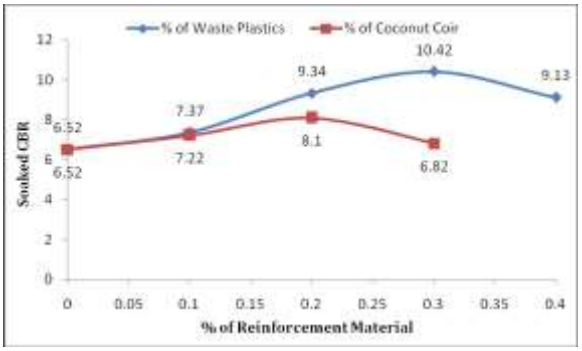

Fig. 9 Variation of Soaked CBR for Gravel Reinforced with Different Percentages of Waste Plastic Strips/Coconut Coir Fiber

From the test results it is observed that gravel reinforced with waste plastics has better performance as comparative to coconut coir reinforced gravel. From the direct shear test results , it is observed that for gravel reinforced with waste plastics, the cohesion and angle of internal friction values are increased from 12.72 to 20.76 kN/m^2 and 36^0 to 42^0 respectively with 0.3 % of waste plastics and there after decreased. It is also observed that gravel reinforced with coconut coir cohesion and

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angle of internal friction values are increased from 12.72 to 14.91 kN/m^2 and 36^0 to 42^0 respectively with 0.2 % of coir and there after decreased. Soaked CBR values are increased from 6.52 to 10.42 for 0.30 % of waste plastics and 6.52 to 8.1 for coconut coir at 0.2 % as shown in Figs.7 to9. From the results of direct shear and California Bearing Ratio tests, the optimum percentage of waste plastics and coconut coir are 0.3% and 0.2 % respectively.

Conclusion

The optimum percentages of waste plastics from the IS heavy compaction, direct shear and California bearing ratio tests for gravel materials are 0.3% and the optimum percentages of coconut coir mixed in gravel materials are 0.2 % respectively. From the result of compaction, direct shear and CBR tests, gravel reinforced with waste plastics has shown better performance as compared to coir reinforced gravel.

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