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Enhancement in Stabilization Properties of Soil Using Waste Polypropylene Plastic Fiber

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ABSTRACT

Plastic fibres are found in different forms on earth as polyethylene or polypropylenes commonly known as polythene or plastic bags and badly affect the environment due to its non biodegradable nature. It may be recycled but in reality it is not in general practice, a large amount of these plastic fibres causing different environmental impact on earth. It is not biodegradable and takes more than 200 years to decompose. In our project work we have tried to reinforce the soil to stabilize it and make efficient use of this reinforced soil in various civil engineering works as embankment, dams, earth retaining structures, foundations, bridges, buildings etc. The aim of this project is to study and investigate the use of waste plastic fibre in geotechnical applications. for this purpose small pieces of plastic bags are thoroughly mixed in soil in different amount by its weight and performed different tests like Specific Gravity, OMC, MDD, Tri-axial test, Atterberg's limits etc. to determine its engineering and index behaviour. Polypropylene fibres imparted the reinforcing property to the soil due to which its shear strength and stabilization property are enhanced. The results obtained are compared for the different samples and inferences are drawn towards the usability and effectiveness of fibre reinforcement as a replacement for deep foundation or raft foundation, as a cost effective approach. Plastic fibres are similar to the roots of trees and vegetation which provides an excellent bonding to improve the soil and the suitability of natural slopes which further reduce the soil erosion. Results are found in the favour of utilization of plastic fibres in soil as reinforcement since the values of cohesion and angle of internal friction are considerably enhanced.

KEYWORDS - Polypropylene Fibre, Waste Utilization, Soil Stabilization, Sustainability.

INTRODUCTION

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. Thus we have to put a proper understanding and knowledge about the various properties of soils and the factors which affects these properties. Here, in this work, soil properties has modified with the help of randomly distributed polypropylene fibres obtained from waste materials. The improvement in the shear strength parameters of the soil has been made using this polypropylene fibre and comparative studies have been carried out between natural soil and modified soil. Generally plastic is found in various forms so it waste plastic is also available in variable form i.e. waste HDPE & LDPE (polyethylene), polypropylenes, plastic bottles etc. So we can utilize the available plastic in the form of fibres for experimental purposes. Here in this work I used polyethylene fibres after cutting polyethylene in different width to length ratios and then these fibres are mixed randomly with soil in different weight percentages. Plastic fibers when mixed with soil behave like a fibre reinforced soil. When plastic waste/fibres are randomly distributed throughout a soil mass, they imparts strength, isotropy and reduces chance of developing potential planes of weakness. During Stabilization of a soil mass there is a considerable change in shear strength and shrink swell potential of a soil, thus it helps improving the load bearing capacity of a sub grade soil to support pavement and foundations. Mixing of plastic waste fibres with soil can be done by concrete mixing plants or by self propelled rotary mixers on large scale and on small scale these fibres can be hand mixed. The most important improvement achieved through stabilization include better soil gradation, reduction in plasticity index or swelling potential, and increase in durability and strength. During wet condition stabilization may also used to provide a working platform for construction operation.

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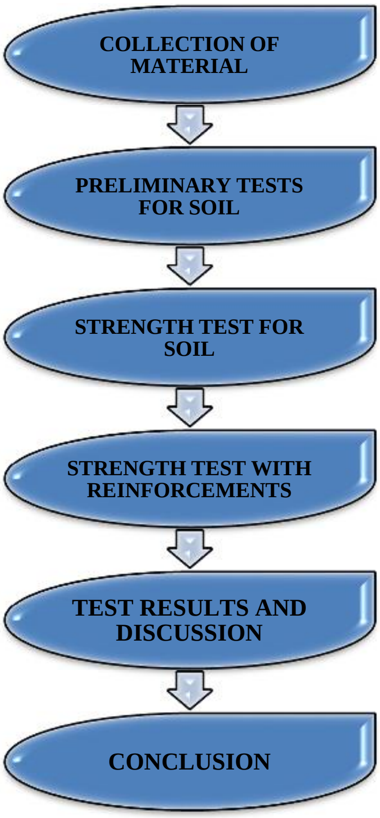
METHODOLOGY

The following tests are being carried out well before the reinforcement is added to properly determine the property of soil. These tests are used to find out the various characteristics of the soil. These tests help in determining properties such as size of soil, specific gravity, cohesiveness, Atterberg;s limits etc. The whole process is given by the following flow chart-



(i) Specific Gravity of Soil

Specific gravity of a substance denotes the number of times that substance is heavier than water. Specific Gravity of soil is determined in unreinforced soil and in different condition of reinforced soil. The value of different specific gravity is tabulated below-

Table 1- Specific Gravity of unreinforced and reinforced soil.

Soil Type	Specific Gravity
Normal Soil	2.52
Soil sample mixed with Fibres (0.15%)	2.52
Soil sample mixed with Fibres (0.20%)	2.51
Soil sample mixed with Fibres (0.25%)	2.51

(ii) Determination of Liquid Limit of Soil

This test is done to determine the liquid limit of soil as per IS: 2720 (Part 5) – 1985. The Liquid Limit of fine-grained soil is the water content at which soil behaves like a liquid, but has small shear strength.

Table 2- Liquid Limit of unreinforced and reinforced soil.

Soil Type	Liquid Limit
Normal Soil	28.9%
Soil sample mixed with Fibres (0.15%)	Cannot be determined due to fibre
Soil sample mixed with Fibres (0.20%)	Cannot be determined due to fibre
Soil sample mixed with Fibres (0.25%)	Cannot be determined due to fibre

(iii) Determination of Plastic Limit of soil

This test is done to find out the plastic limit of soil, as per IS: 2720 (Part 5) – 1985. The plastic limit of fine-grained soil is the water content of the soil below which it ceases to be plastic. It begins to crumble when rolled into threads of 3mm dia.

Table 3- Plastic Limit of unreinforced and reinforced soil.

Soil Type	Plastic Limit
Normal Soil	10.5%
Soil sample mixed with Fibres (0.15%)	Cannot be determined due to fibre
Soil sample mixed with Fibres (0.20%)	Cannot be determined due to fibre
Soil sample mixed with Fibres (0.25%)	Cannot be determined due to fibre

(iv) Determination of Shrinkage Limit

The shrinkage limit is the water content where further loss of water content will not result in any more volume reduction of soil.

Table 4- Shrinkage Limit of unreinforced and reinforced soil.

Soil Type	Shrinkage Limit
Normal Soil	8.45%
Soil sample mixed with Fibres (0.15%)	Cannot be determined due to fibre
Soil sample mixed with Fibres (0.20%)	Cannot be determined due to fibre
Soil sample mixed with Fibres (0.25%)	Cannot be determined due to fibre

(v) Determination of Optimum Moisture Content & Maximum Dry Density

Optimum water content or optimum moisture content (OMC) of the soil is the water content at which soil can be compacted to the maximum dry density (MDD).

Table 5- Optimum Moisture Contents & Maximum Dry Densities of unreinforced and reinforced soil.

Soil Type	OMC	MDD
Normal Soil	12.59%	1.91g/cc
Soil sample mixed with Fibres (0.15%)	12.57%	1.91g/cc
Soil sample mixed with Fibres (0.20%)	12.57%	1.90g/cc
Soil sample mixed with Fibres (0.25%)	12.56%	1.89g/cc

(vi) Determination of Shear Strength Parameters-

c & Φ are the shear strength parameter in which c is the cohesion of soil and Φ is angle of internal friction or angle of shearing resistance.

Table 6- Cohesion and angle of internal friction of unreinforced and reinforced soils.

Soil Type	**c**	**Φ**
Normal Soil	0.33kg/cm^2	11.15^0
Soil sample mixed with Fibres (0.15%)	0.35kg/cm^2	11.63^0
Soil sample mixed with Fibres (0.20%)	0.37kg/cm^2	12.01^0
Soil sample mixed with Fibres (0.25%)	0.37kg/cm^2	12.82^0

IMPORTANT OUTCOMES

There is remarkable change in consistency limits, maximum dry density and shear strength parameters of soil. Various test conducted on different sets of samples shows that results are in the favour of using polypropylene or plastic fibre in an appropriate amount in soil sub grade, while a simple drawback of the use of plastic fibre in soil that the permeability of soil is reduced little bit but overall performance of stabilized soil is good.

CONCLUSIONS

Fibre reinforcement will work as binding material so it can be used for strengthening of soil on erodible areas. Reinforced soil can be used for slope stabilization and soil retaining structures. Reinforced soil will not be prone to sudden failures; progressive failure will always be there. Overall it can be seen that fibre reinforced soil can be used for ground improvement technique especially in engineering projects on weaker soils. Although plastic fibres are non-degradable in nature so the stabilization takes place for a long duration. The problem of soil erosion can be reduced by using fibres in weak soils which are susceptible to erosion during wet weathers. Hence the sustainability of soil can be increased.

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