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Study of Compaction and Consolidation Behavior of Soil Reinforced With Waste Plastic Fibres

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ABSTRACT

In this paper a lab examination has been completed to assess the impact of waste plastic fiber on compaction and union practices of supported soil. The underlying phase of the test program incorporates the investigation of the impact of plastic fiber (as support material) on most extreme dry thickness (MDD) and ideal dampness content (OMC) with various sizes and substance. In this exploratory review, crude plastic container strands has been utilized in three diverse angle proportions (AR), for example 2 (size=10 mm X 5 mm), 4 (size= 10 mm X 2.5 mm) and 8 (size=10 mm X 1.25 mm). These various sizes of plastic strips have been blended in with nearby sandy-sediment soil with earth (Fine Sand = 40.15%, Silt = 30.90%, and Clay = 28.95%) in four unique rates 0.00, 0.25, 0.50 and 1.00% by dry load of the dirt. From the present test concentrate on remolded fiber supported soils, it has discovered that, pressure record (Cc) and coefficient of volume change (mv) values diminishes with the expansion of strands in soil from upto 0.50%, yet values increments with additional increment of plastic filaments upto 1.00% in soil. 90% of all out pressure happens inside 96 seconds for 800 kN/m^2 load with the consideration of the plastic strands in soil with perspective proportion 8 and fiber content of 1.00%.

KEYWORDS: Plastic bottle fibre, Compression Index, Coefficient of volume change, Coefficient of consolidation.

INTRODUCTION

With the growth of cities and industrial areas the availability of land for construction with sufficient bearing capacity and settlement within permissible limit becomes depleted. The geotechnical engineers have been forced to construct at given site with given soil condition. Among the various alternatives, for strengthening the existing weak soil, reinforcing the soils with some additive elements is one such successful alternative. In this present study, waste plastic bottle fibre has been used as a reinforcing element to minimise settlement or consolidation and to increase the rate of consolidation of soil.

The concept of reinforced soil was first given by Vidal of France in 1966. Since then significant advances have been made in the design and construction of geotechnical structures such as retaining walls, foundations, embankments, pavements, etc. In compaction with systematically reinforced soil, randomly distributed fibre reinforced soils exhibit some advantages. Randomly reinforcing the soil by using HDPE strips obtained from waste plastic bottles may provide an easy and an economical means to improve the engineering performance of existing soil.

Compressibility behaviour of compressible soil leads to settlement of any structure on it. To know the compressibility behaviour determination of compression index (c_c), coefficient of volume change (m_v) and coefficient of consolidation (c_v) is essential.

The concept of fibre reinforced soils has been developed quite extensively over the past few decades. Based on the laboratory tests, previous researchers established that there was an increase in strength and stability of soils (Gray and Ohashi 1983, Vijayasingam and Heng 2003, Kar and Pradhan 2011). Abdi et al. (2008) worked on fibre reinforced soils and concluded that consolidation settlements, swelling and crack formation reduces substantially. They have also reported that the hydraulic conductivity increased slightly by increasing fibre content and also with the length of fibre in the mix. Manjari et al. (2011) performed a series of laboratory experiments to study compressibility and permeability behaviour of plastic waste mixed sand and observed that the compressibility and permeability reduced significantly with addition of a small percentage of plastic waste to the soil. Gray and Ohashi (1983) based on the direct shear test result indicated that fibre reinforcement increased the peak shear strength and limited post peak reductions in shear resistance. Freitag (1986) represented that randomly distributed fibre in a compacted fine-grained soil could result in greater stiffness. Heimdahl and Drescher (1999) reported that the orientation of reinforcement in a particular direction might result in anisotropy of the soil mass that could result in a decrease of directional strength. On the contrary, the primary advantages of randomly distributed fibres are the absence of potential planes of weakness that can develop parallel to oriented reinforcement (Maher and Gray 1990). Prabhakar and Sridhar (2002) used randomly distributed sisal fibre as reinforcement in a c-ϕ soil at four different percentages of fibre content, i.e. 0.25, 0.5, 0.75 and 1% by weight of raw soil and four different lengths of fibre, i.e. 10, 15, 20 and 25 mm and found significant improvement in the shear strength parameters (c and ϕ) of the soil. Consoli et al. (2003) studied the load–settlement response by conducting plate load tests on a thick homogeneous stratum of compacted sandy soil, reinforced with randomly distributed polypropylene fibres. The strength was found to increase continuously at a constant rate, regardless of the confining pressure applied, not reaching an asymptotic upper limit, even at axial strains as large as 25%. Nagrale et al. (2005) studied the improvement of CBR value of subgrade soil with inclusion of polypropylene fibres and concluded that 1.50% fibre with area ratio 100 and 84 would be the optimum quantity in clayey soil and fine sand respectively. Maheshwari, Desai and Solanki (2011) performed a series of model footing tests to check the feasibility of using polypropylene fibres as a reinforcing material below footing with the idea of upgrading the engineering behaviour of clay soil as a subsoil for the foundation. They had performed their test with three different fibre contents (0.25, 0.50, and 1.00%) and three depths of placement of fibre reinforced soil (b/2, b/4, b, where b is width of footing). From these series of test it has been reported that bearing capacity of soil increased from 64 kN/m^2 to 250 kN/m^2 with the introducing polypropylene fibres. Das and Pal (2012) studied the consolidation characteristics of silty-clay soil mixed with fly ash and observed that the value of

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compression index (C_c) decreases with increase in fly ash content in the mix. The value of coefficient of consolidation (C_v) of local silty-clay soil increase with increase in fly ash content. Kar and Pradhan (2011) studied the strength and compressibility characteristics of local cohesive soil (CL) with random inclusion of polypropylene and coir fibres and observed that compression index as well as the coefficient of volume change decreased with increase in the fibre content. They also observed that the coefficient of consolidation increased with increase in fibre content.

MATERIAL AND METHODS

Materials

This investigation has been carried out with local sandy-silt soil with clay (fine Sand = 40.15%, silt = 30.90% and clay = 28.95%) and HDPE waste plastic bottle. These HDPE raw plastic bottle fibres has been used in three different aspect ratios (AR) i.e., 2 (10mm X 5 mm), 4 (10mm X 2.5mm) and 8 (10mm X 1.25mm). These different sizes of plastic strips are used with local sandy-silt soil with clay in four different percentages 0.00, 0.25, 0.50 and 1.00%.

Figure 1: Type- I plastic strips having size 5.0mm ×10mm

Figure 2: Type-II plastic strips having size 2.5mm × 10mm

Figure 3: Type-III plastic strips having size 1.25mm ×10mm

Properties of Soil

Basic properties of local soil are summarised in Table 1.

Table 1: Physical and engineering properties of local soil

Soil properties	**Test results**
Physical Properties	
Specific gravity	2.59
Liquid limit (%)	31.29
Plastic limit (%)	21.50
Shrinkage limit (%)	20.07
Plasticity index (%)	9.79
Grain size: Sand (Fine) (%)	40.15

Silt (%) Clay (%)	30.90 28.95
Engineering Properties	
Permeability (m/s)	6.60E-10
Compression index(C_c)	0.140
Shear angle (ϕ) (in degree)	10.82
Cohesion (c); (kN/m^2)	22.00
Optimum moisture content (OMC) (%)	17.10
Maximum dry density (MDD) (kN/m^3)	17.68

Properties of reinforcement

Waste plastic bottle is basically high density polyethylene type of plastic. HDPE is the most widely used resin for plastic bottles. This material is economical, impact resistant, and provides a good moisture barrier. HDPE is naturally translucent and flexible.

Table 2: Properties of waste plastic bottle fibres

Properties	Test results
Length(mm)	10
Width(mm)	1.25, 2.5 and 5
Thickness(mm)	0.20
Specific gravity	1.33

CONCLUSION

This study demonstrates the individual effect of waste plastic fibres on compaction and consolidation properties of local soil. Compaction and consolidation tests were conducted on unreinforced and reinforced soil.

The experimental results of compaction tests indicate that maximum dry density (MDD) of plastic reinforced soil decreases with increasing fibre content. The optimum moisture content (OMC) 17.10%, (for soil alone and soil mixed with waste plastic fibres) which is independent of the amount of fibres. As plastic fibre does not absorb water, OMC is independent of fibres content.

With the increase of plastic fibres in soil, compression index (C_c) and coefficient of volume change (m_v) of soil decreases up to 0.50% fibre content. But the values increases with further inclusion of plastic fibre of 1.00% in soil.

The values of coefficient of consolidation increases with the increase of plastic fibres in soil for aspect ratios 2, 4 and 8.

90% of total compression takes place within 96 seconds for 800 kN/m^2 load with the inclusion of the plastic fibres in soil of aspect ratio 8 and fibre content of 1.00%.

These waste plastic fibre reinforced soil of present study encouraging for potential use in the field of geotechnical engineering construction by enhancing the strength and reducing the settlement.

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