Effect on Properties of Expansive Soil by using LDPE Plastic Wastes

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Abstract

soil is nature's gift. Expansive soil is one, which is unfit for its usage in subgrade. Also, civil engineers often face difficulties with this expansive soil. Because of its property of considerable swelling and shrinkage, expansive soil is not strong enough to be used in construction. In view of overcoming this limitations, expansive soil should be stabilized either by mechanical or chemical methods. Disposal of plastic became one of the major threat in this busy world. According to the survey conducted by CPCB (2014-15) nearly 15000 tons of plastic wastes are generated every year. Sustainable development could also be achieved by reducing the plastic content, as it is being reduced in this project. In this project, stabilization of expansive soil is achieved by the use of LDPE plastic waste (milk pouches) as strips of approximately 5mm width. Various test such as Standard Proctor, Unconfined Compressive Strength and California Bearing Ratio were conducted in conventional soil and also by adding different percentage of plastics in the soil. The test results were examined and studied thoroughly which reveals the optimum plastic content to be used for enhancing the strength parameters of the soil. The comparison of test results showed that the soil sample using plastic strips gives better results than that of conventional soil. Mixing of the plastic strips to the expansive soil proves to be one of the effective way for increasing the soil properties. Thus the plastic wastes could be minimized by reducing it effectively.

Keywords: *Stabilization, plastic strips, CBR, standard proctor, LDPE, Expansive soil, UCC.*

I. INTRODUCTION

Expansive soil is a type of clay that is known as a lightweight aggregate with a rounded structure, with a porous inner, resistant and hard outer layer. It is a clay or soil that is prone to large volume changes (swelling and shrinking) that are directly related to changes in water content. They swell when they imbibe water and shrinks or reduces its volume on evaporation of water. Because of their considerable shrinking and swelling they result in formation of cracks. Due to this reason, expansive soil proves to be unfit for the purpose of construction. Thus to overcome this limitations and to enhance the strength parameters, expansive soil should be stabilized by adding additives in it. Soil stabilization means adding and mixing the materials to improve the strength parameters and bearing capacity of soil by using various additives. Plastics bags are made of a non-renewable resource, which gives us more reasons to use recyclable shopping bags. Plastic bags are also flimsy and do not sit as well as either paper or cloth. They are a hazards to environment, if not disposed properly. Plastic bags clogs roadside drains, which could cause the flooding of the street at heavy rainfalls. The consumption of plastic bags and then its disposal has led to environmental challenges. Therefore there is a growing need to find an alternative way for reducing the emerging plastics. In this project, stabilization is done by using LDPE plastic wastes. LDPE plastic wastes (Milk pouches) are modified into strips of approximately 5mm width and added to expansive soil to increase the compressive strength, bearing capacity and degree of compactness of the soil. The plastic covers were chosen as an additive for stabilization, as 35% of total plastic wastes comprises of plastic covers. Also the use of plastic wastes doesn't affect the natural flow of drainage. Thus the use of plastic wastes for the purpose of stabilization leads to conservation of natural resources and paves a better way for the disposal of plastic wastes.

II. SCOPE AND OBJECTIVE

- To check the California Bearing Ratio (CBR) of soil using plastics as an admixture.
- To provide an alternative solution for the disposal of plastic waste.
- To adopt an economical solution for soil stabilization using plastic waste.
- To determine the optimum plastic content to be used.
- To reduce the evil effect caused by plastics on environment.

III. MATERIAL AND METHODOLOGY

A. Material

1. Black cotton soil:

In India, expansive soils are also called as Black Cotton Soil. The clayey soil used for the study was collected from kunnam taluk, perambalur district

of the Indian state of Tamil Nadu. They are characterized by high shrinkage and swelling properties.

2. *LDPE plastic:*

LDPE plastic were obtained from waste plastic cover (milk and curd pouches). After proper cleaning and air drying, the plastic covers were shredded into strips, each of average width of 5mm.

B. Methodology

1. *Standard Proctor test*:

This test is to determine the relationship between moisture content and degree of compactness (density) of the soil. In this test, soil sample required for a given specimen is taken and mixed with varying percentage of water and compacted with 5 layers, each layer being compacted by giving 25 blows using 2.5kg rammer dropped at a height of 30 cm. Results are obtained by plotting dry density vs. moisture content to find out the max dry density and optimum moisture for the soil.

2. *California Bearing Ratio (CBR):*

This is the most used test for evaluating the design of flexible pavement. This test is to determine the CBR for soil specimen by load penetration tests. Also, this test is used to evaluate the subgrade strength for roads and pavements. Generally CBR values are calculated for 2.5mm and 5mm penetration. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers.

3. *Unconfined Compressive Strength:*

This is the simple test used to determine the strength of the soil. This test is used to determine the shear parameters of the soil.

IV. RESULTS

A. Soil Characteristics:

Test was conducted to determine the characteristics of soil sample and the obtained results are tabulated below in table 1

Table 1

Specific Gravity	2.69
Liquid Limit	44%
Plastic Limit	22%
Plasticity Index	22%
Swell Index	55.56%
Hydrometer Analysis	Silty Clay
Maximum Dry Density	1.692 (g/cc)
Optimum Moisture Content	15.45%
Compressive Strength	0.142 (N/mm^2)
CBR	2.87%

B. Engineering Property Tests:

Tests were conducted on conventional soil sample and for the soil samples with the addition of plastics say 0.2%, 0.4%, 0.6%, 0.8%, 1%. The tests such as standard proctor, unconfined compression and California bearing ratio were conducted on soil sample as per the test procedure mentioned in IS 2720 (part 7, part 10 & part 16) and the result findings are tabulated below

Results for Standard Proctor test
Table 2

Soil Sample	*MDD (g/cc)*	*OMC (%)*
Untreated soil sample	1.691	15.47
99.8% soil+0.2%plastics	1.846	14.22
99.6%soil+0.4%plastics	1.794	13.60
99.4%soil+0.6%plastics	1.748	16.92
99.2%soil+0.8%plastics	1.881	14.38
99%soil+1%plastics	1.859	17.27

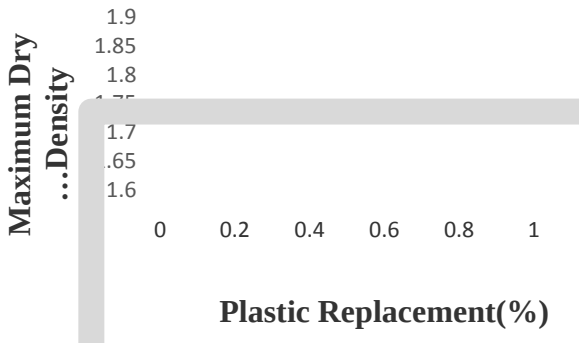

Figure 1: standard proctor results

Figure 1 shows the schematic curve of maximum dry density for plain soil and for soil sample with plastic replacement say 0.2%, 0.4%, 0.6%, 0.8%, 1%. The curve plotted, clearly picturize the change in MDD of soil from 1.69 g/cc to 1.88 g/cc for untreated soil and soil sample treated with 0.8% replacement of plastics in it. Also it indicates, further plastic replacement in soil decreases the value of MDD for soil. The increase in MDD is because of the addition of plastics and reduction of voids. Thus the addition of plastics will enhance good compaction which in turn reduces the OMC and increases the MDD of the soil.

Results for California Bearing Ratio
Table 3

Soil Sample	*CBR%*
Untreated soil sample	2.87
99.8%soil+0.2%plastics	2.96
99.6%soil+0.4%plastics	3.05

99.4%soil+0.6%plastics	3.13
99.2%soil+0.8%plastics	3.85
99%soil+1%plastics	2.93

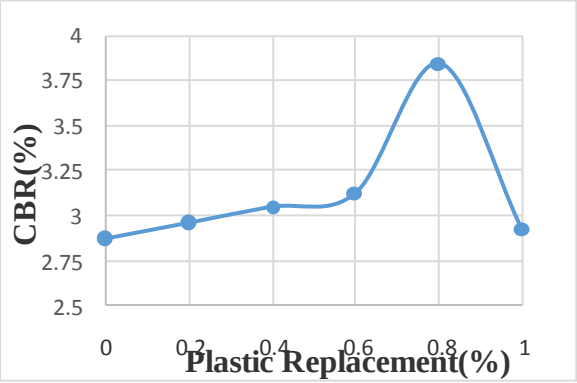

Figure 2: CBR Results

Figure 2 shows the schematic curve of California bearing ratio for plain soil and for soil sample with plastic replacement say 0.2%, 0.4%, 0.6%, 0.8%, 1%. The curve plotted, clearly picturize the change in CBR of soil from 2.87% to 3.85% for untreated soil and soil sample treated with 0.8% replacement of plastics in it. Also it indicates, further plastic replacement in soil decreases the value of CBR for soil. The increase in CBR is because of the addition of plastics. Thus the addition of plastics will enhance good bearing strength which in turn increases the strength of subgrade of roads and pavements.

Results for Unconfined Compression test
Table 4

Soil sample	*Compressive strength (N/mm^2)*
Untreated soil sample	0.142
99.8% soil+0.2% plastics	0.145
99.6%soil+0.4%plastics	0.148
99.4%soil+0.6%plastics	0.157
99.2%soil+0.8%plastics	0.163
99%soil+1%plastics	0.139

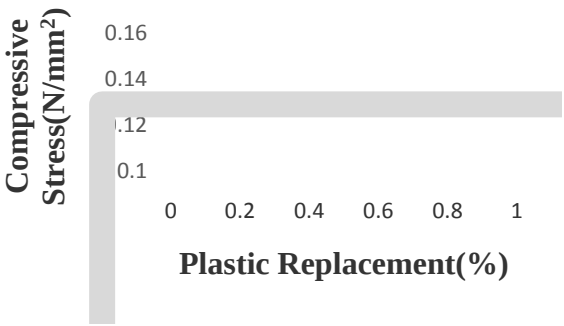

Figure 3: UCC Results

Figure 3 shows the schematic curve of Unconfined Compressive Strength for plain soil and for soil sample with plastic replacement say 0.2%, 0.4%, 0.6%, 0.8%, 1%. The curve plotted, clearly picturize the change in UCC of soil from 0.142 N/mm^2 to 0.163 N/mm^2 for untreated soil and soil sample treated with 0.8% replacement of plastics in it. Also it indicates, further plastic replacement in soil decreases the value of UCC for soil. The increase in UCC is because of the addition of plastics. Thus the addition of plastics will enhance good cohesion to soil which in turn increases the shear strength of the soil.

V. CONCLUSIONS

This project is took in hand to overcome the limitations of expansive soil. Through many referrals, plastics were used as stabilizing agent in this paper. Also this paper suggests that proper binding and adding of plastic strips will enhance the strength parameter of the soil and paves a path to achieve stabilization of expansive soil in an economic and effective way. The following results were obtained through various tests.

1. The replacement of 0.8% of plastic as an additive has stabilized the soil with increased dry density and decreased moisture content.
2. The value of CBR was found to be increased in addition of 0.8% plastic strips.
3. The value of UCC was also found to be increased in addition of 0.8% plastic strips.
4. Further increase of plastics to 1% showed the decrease in strength and bearing capacity of the soil.
5. The optimum percentage of plastics to be used to improve the strength parameter of expansive soil is suggested to be 0.8%.

The advantageous thing about this project is the use of waste plastics for the purpose of stabilization as it is free of costs (wastes that is abundantly available). Also, this paper provides the effective management and disposal of wastes. This clearly proves that plastics can be added to mitigate the issue on expansive soil. Further research and development in this field may bring out better solutions for this kind of issues.

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