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Effect of HDPE Plastic on the Unconfined Compressive Strength of Black Cotton Soil

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Abstract: Black Cotton soil which is a type of expansive soil, has the property of swelling excessively when wet and shrinks highly when exposed to dry conditions showing terrible surface cracks and due to this an uneven surface is created. This condition arises due to a mineral known as montmorillonite and presence of fine clay particles. The soil changes its shape rapidly due to addition of water.The soil occupies more than 20 % of the surface area of India.

The aim of this research is to study the effect of HDPE plastic waste on the unconfined compressive strength of soil. The HDPE plastic (40 micron) waste was added at a proportion of 1.5%, 3%, 4.5% and 6% of the weight of dry soil. At the end of the study it was concluded that the addition of plastic waste had increased the unconfined compressive strength of black cotton soil. For the waste added, the maximum strength obtained at 4.5% was 287.32KN/m^2 and from natural soil it was 71.35KN/m^2.

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Keywords: HDPE plastic, black cotton soil, unconfined compressive strength, shear test.

I. INTRODUCTION

The behaviour of expansive soils is very uncertain when it is subjected moisture changes. These changes pose considerable challenge for the civil engineers during construction activities specially while constructing foundations. The strength of soil changes when water occupies large spaces in the voids of the soil. The general recognizable features of this effect are excessive compression of soil, collapsing behaviour, high impermeability, high swelling capacity and low shear strength. These undesirable characteristics make the black cotton soil unfit for construction purposes, hence they need to be stabilized before they can be put to use. Though black cotton has unfavourable characteristics for infrastructural developments, they are useful as agents of environmental protection and waste disposal.

Expansive soils like black cotton soils cover huge areas in several countries. It is dark grey to black in colour. In India alone it covers more than 20% of area. They are predominant in states of Maharashtra, Karnataka, Madhya Pradesh, Andhra Pradesh. These soils undergo huge volumetric changes when exposed to extreme dry or wet conditions. This is due to the presence of a mineral known as montmorillonate.

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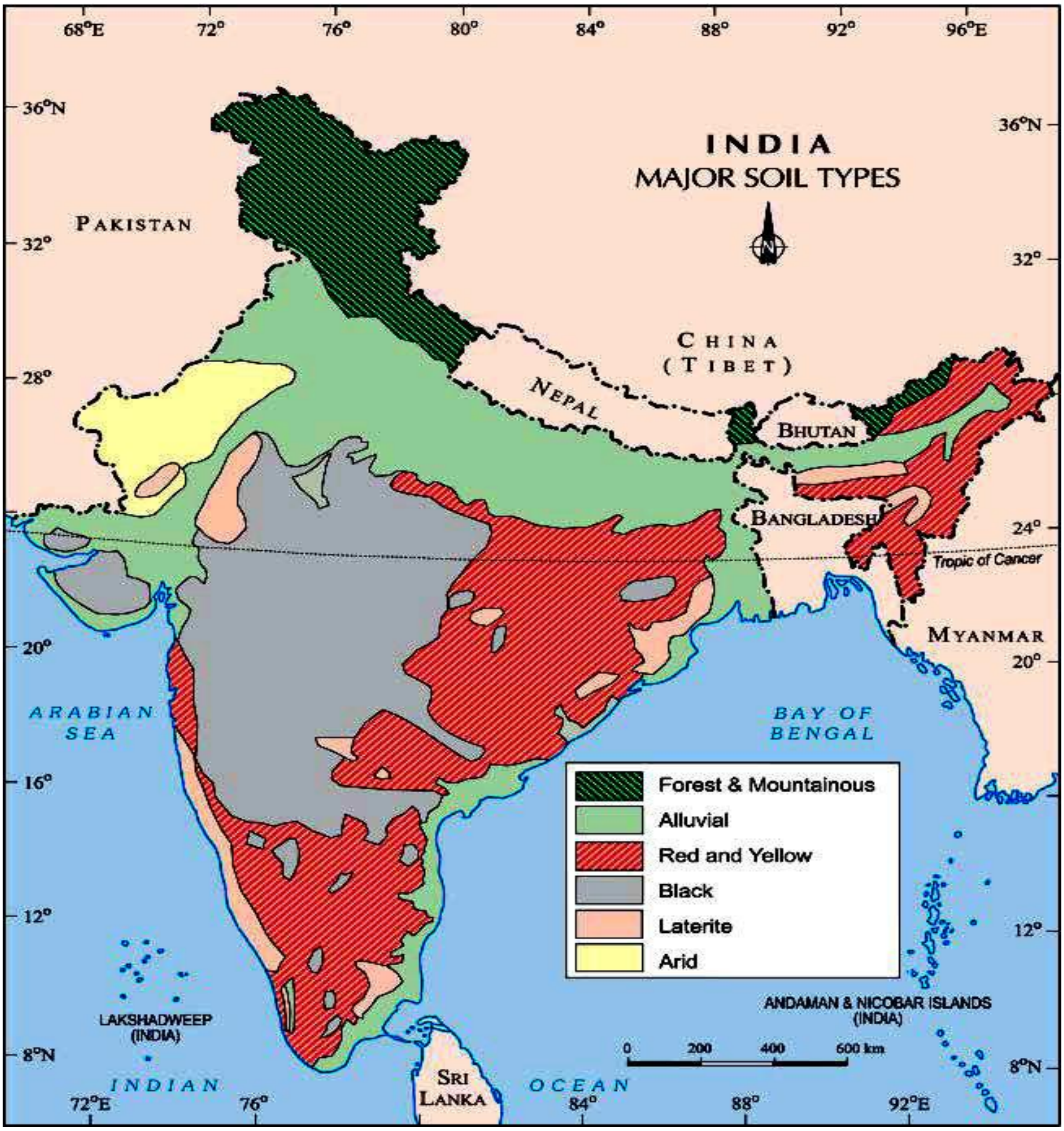

Fig. 1 Major soil types in India

In this current study, high density polyethylene(HDPE) plastic was added to the soil and its unconfined compressive strength changes were studied. HDPE plastic is widely used as day-to-day carrier of materials.

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II. LIST OF EXPERIMENTS PERFORMED

1.) Natural Soil

a) Moisture content
b) Sieve analysis
c) Specific gravity
d) Atterberg limits
e) Standard &Modified proctor test
f) Direct shear test
g) Unconfined compression test

2.) Reinforced Soil

a) Standard &Modified proctor test
b) Unconfined compression test

III. MATERIALS

1.) Black Cotton Soil

Black cotton soil samples were collected from **English Medium school construction project atKatraj(Pune)** from a depth of 5m .The disturbed sample was then sealed in plastic bags to avoid loss of moisture during transportation. The soil was air dried and passed through IS425 Micron size Sieve and then oven dried at 110^{o}C before putting it for test. The properties of black cotton soil were found by performing different basic experiments and results have been shown in tabular form as follows:

S.NO	PROPERTY	VALUE
1	Specific Gravity	2.58
2	Liquid Limit	69%
3	Plastic limit	31%
4	Shrinkage limit	11.5%
5	Plasticity Index	38%
6	Optimum Moisture Content(OMC)	25%
7	Maximum Dry Density(MDD)	15.8KN/m3
8	Unconfined Compressive Strength	71.35KN/m^2
9	C(Cohesion)	0.3
10	Angle of internal friction	23^{0}30’

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NOTE 1: From sieve analysis It was seen that the sample is well graded (coefficient of curvature=1.088) and not uniformly graded (coefficient of uniformity=6.8).

NOTE 2: As plasticity index =38>17 the sample is high plastic (Degree of plasticity) and cohesive (Degree of cohesiveness)

NOTE 3: Graph obtained from standard and modified proctor test is as bellow:

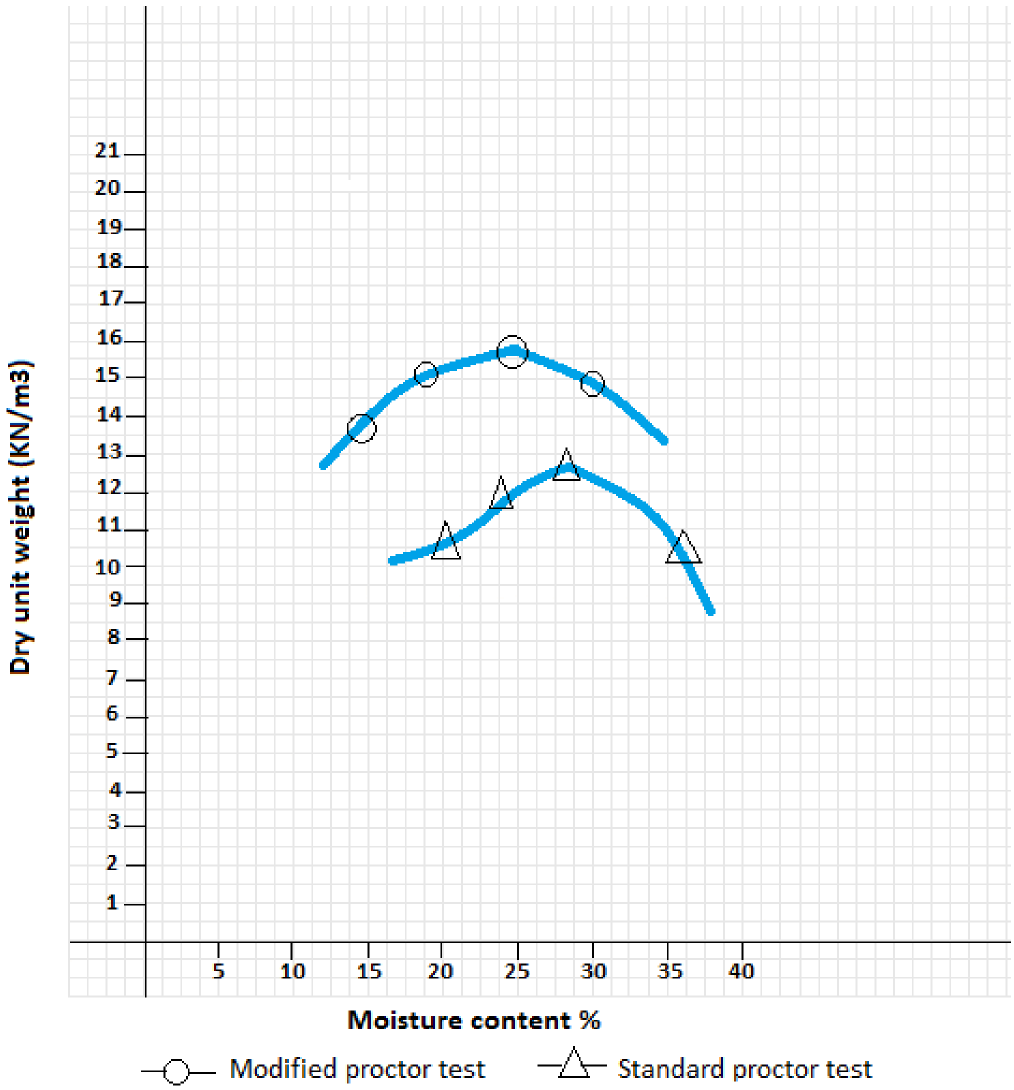

Fig. 2 Comparison of Standard and Modified Proctor test values

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NOTE 4: Graph of direct shear test from which C (Cohesion) and Angle of friction were found is as below:

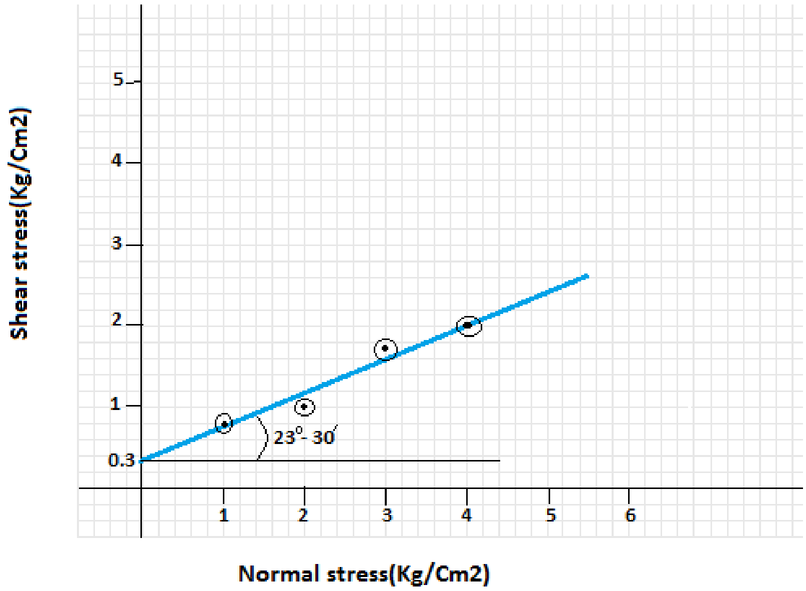

Fig. 3 Shear test without HDPE plastic

2.) HDPE (40 Micron) PLASTIC BAGS

The plastic bags were obtained from local general merchandise stores. The type of plastic bagused for this experiment is HDPE (40 Micron).

IV. TEST SPECIMEN

In the beginning undisturbed sample of size 15cm and 3.7cm in diameter was made of original soil only. The specimen prepared was tested and the unconfined compressive strength of the soil was found without the waste plastic. Then the plastic was added in small pieces of 1cm x 1cm in proportions of 1.5%, 3%, 4.5% and 6%. The size of specimen obtained was same as earlier.

Fig.4 Testing Machine

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IV. PROCEDURE

The initial length and diameter of the sample was recorded. Both the sides of the specimen were levelled finely so that full surface contact was established between the specimen and the apparatus. It was then placed in the apparatus.

Fig. 5 Specimen

The dial gauge was adjusted to a suitable value. Load was applied on the specimen slowly and was increased in a suitable manner until a crack was seen. The apparatus was stopped and the value on the dial gauge was noted and unconfined compresion strengh were calculated

Fig.6 Specimen after failure

V. RESULT

After performing all the necessary tests on the black cotton soil for unconfined compressive strength , the following observations were made :

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1.) The unconfined compressive strength of black cotton soil indicated significant increase in strength on addition of HDPE plastic waste. The UCS value increased from 71.35KN/m^2 to 145.45KN/m^2 at 1.5%, 210.95KN/ m^2 at 3%, 287.32KN/m^2 at 4.5% and 234.71KN/m^2 at 6%. A decrease of strength was obtained at 6% as shown graphically

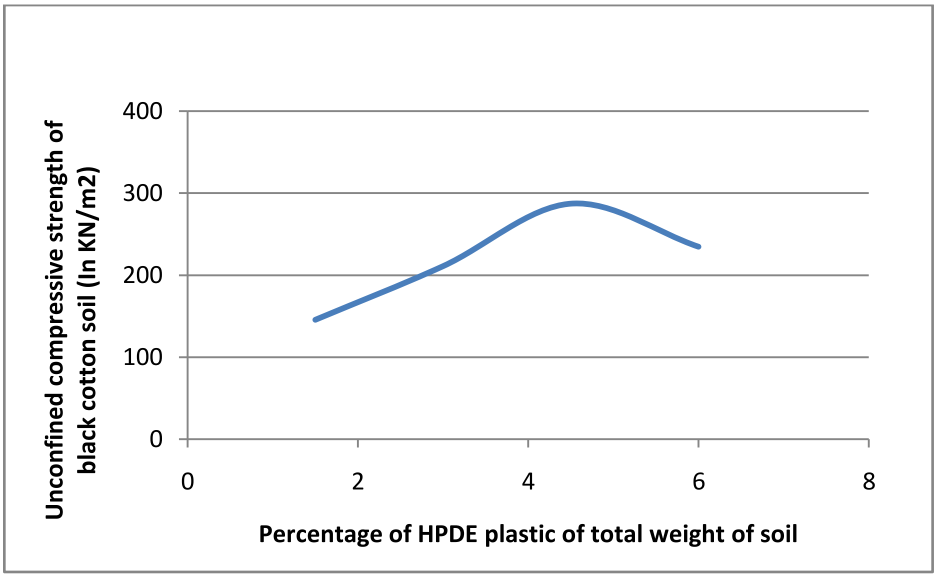
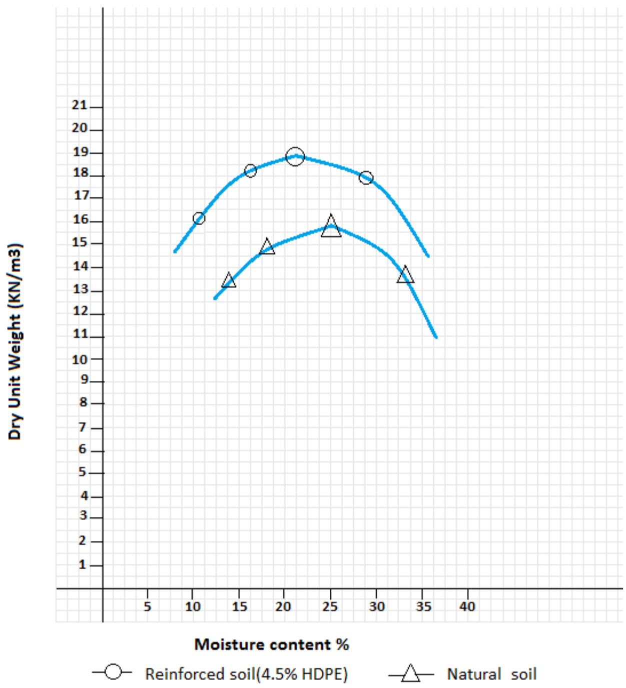


Fig.7 UCS value compared with percentage of plastic added

Note: Graph which gives comparision between the optimum moisture content and maximum dry unit weight of natural soil and reinforced soil is as bellow:



Fid.8 Comparison between optimum moisture content and dry unit weight

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VI. CONCLUSION

The following conclusion were made on the results obtained from the experiments performed:

1. The unconfined compressive strength of the black cotton soil increased upon addition of HDPE plastic waste.
2. The optimum UCS value was obtained at 4.5% of addition of HDPE plastic.
3. Increase in UCS by adding HDPE occured with increase in maximum dry unit weight at lesser OMC .
4. More detailed study can be done on the soil to observe the effect of plastic waste addition by conducting California Bearing Ratio test on the soil

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