EXPERIMENTAL INVESTIGATION OF EXPANSIVENESS SOIL BY USING FLY ASH AND POLYPROPYLENE FIBRE

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Abstract

In Indian economy the infrastructure is the major sector in which overall development is going on. the expensive soil are causing number of damages to the structures as compare to other natural hazards. Thus, worldwide these soils are considered to be problematic soil so, as to utilized these soil in effective way, proper treatment to the soil is required, with the same intention, an attempt is made to modify engineering properties of black cotton soil by using fly ash and various percentage of polypropylene fibres. The Atterdberg's limit, California Bearing Ratio (C.B.R.), Unconfined Compressive Strength (U.C.S.) tests were carried out on the samples of soil with fly ash and polypropylene fibre and the samples are tested after 3days, 7 days and 14 days. Fly ash added to the soil in dry state in constant percentage (by weight) 15% and polypropylene fibres in 0%, 0.5%, 1.0%, 1.5 %. Comparisons of these admixtures are done on the basis of test results obtained.

Keywords :- *Plasticity Index, Unconfined Compressive Strength, California Bearing Ratio, polypropylene fibres, fly ash*

Introduction :

Expansive black cotton soils occur in climatic zones characterize by alternate wet and dry seasons. The expansive soils have a properties of swelling and shrinkage during the alternate wet and dry seasons. Such cyclic swell shrink movements of the ground cause considerable damage to the structures founded on them. The increased optimum water content, shrinkage limit and strength and reduced the swelling potential, liquid limit, plasticity index and maximum dry density of the soil by addition of lime. But the further additions can increase swelling in soils with high sulfate contents, decrease in plasticity of soils and excessive lime treatment contribute to brittle failure characteristics of soils that lead to rapid and great loss in strength when failure occurs. The previous studies have shown that addition of fibre reinforcement caused significant improvement in the strength and decreased the stiffness of the soil. More importantly, fibre reinforced soil exhibits greater toughness and ductility and smaller loss of post peak strength, as compared to soil alone. One of the main advantages of randomly distributed fibres is the maintenance of strength isotropy and the absence of potential planes of weakness that can develop parallel to oriented reinforcement. For the modification and improvement in the engineering properties of soil the discrete fibre can be considered as good earth reinforcement material.

MATERIALS AND PROPERTIES

Soil

For this study the soil Black cotton soil is selected which is taken from village Lihigaon Kampti, Nagpur, Maharashtra. Owing to high initial moisture content, the soil was air dried first and then broken into pieces in the laboratory. The properties of soil are determined by standard test procedures and tabulated in Table1.

Table 1: Properties of soil (Expensive soil)

S. N.	Properties		value
1.	Colour		Black
2.	Specific Gravity of soil	IS2720 PART III	2.396
3.	Degree of Expansiveness		Very High
4.	**Atterberg limits**		
	i. Liquid limit	IS2720 PART V	74.5%
	ii. Plastic limit		41.25%
	iii. Shrinkage limit		13.2%
	Plasticity index%		33.25%
6.	Free swell index	IS2720 PART XI	80%
7.	**Compaction characteristics**		
	i Optimum Moisture Content	IS2720 PART VIII	26.94%
	ii Maximum dry density	IS2720 PART VIII	1.44 g/cc
8.	California Bearing Ratio.(CBR)	IS2720 PART XVI	2.72
	UCS(unconfined compressive strength)	IS2720 PART X	2.66kg/cm2
9.	Grain size distribution	IS2720 PART IV	
	i Gravel		1%
	ii Sand		9%
	iii Clay and silt		90%

Fly ash

Fly ash had collected from the Koradi power plant Nagpur, Maharashtra. The properties of fly ash used in study is shown in table table 2

Table 2: Chemical Composition And Physical Properties Of Fly Ash

CHEMICAL PROPERTIES	VALUE
Silicon dioxide Sio_2	1.30
Aluminium oxide Al_2O_3	25.70
Ferric oxide Fe_2O_3	5.30
Calcium oxide CaO	5.60
Potassium oxide K_2O	0.60
Sodium oxide Na_2O	0.40
Magnesium oxide MgO	2.10
PHYSICAL PROPERTIES	**VALUE**
Specific gravity	2.16
Loss of ignition	0.90
Moisture	0.30

Polypropylene Fibre

For the investigation, polypropylene fibre was used and that provided by Dolphin Floats Pvt Ltd., Pune. The length of fibres was maintained at 12mm and is randomly mixed with soil in 0.5 %, 1.0 %, & 1.5% percentages by dry weight of soil. The physical properties are shown in Table 3.

Table 3 Properties of Polypropylene fibre

PROPERTIES	VALUES
Fibre type	Single
Average length	12mm
Unit weight	0.92g/cc
Tenacity	4.5-5GDP
Melting point	165^0C
Acid resistance	High
Alkali resistance	Full
Salt resistance	High
Absorption	Nil
Elongation	12-15%
Breaking tensile strength	350MPa
Electrical conductivity	Low
Thermal conductivity	Low

Fig. 1 Polypropylene fibre used for the study

EXPERIMENTAL PROGRAMME

Sample Preparation

The samples were prepared by dry blending of soil fly ash and fibre, with required amount of water obtained from standard proctor test. In preparation of fiber reinforced samples, the fibers were added to moist mixture of soil fly ash. The samples were mixed manually with proper care to get homogeneous mix.

Sample I	Soil + 15% Fly ash
Sample II	Soil + 15% Fly ash + 0.5 % Fibre
Sample II	Soil + 15% Fly ash + 1.0 % Fibre
Sample II	Soil + 15% Fly ash + 1.5 % Fibre

Experiment details

The following Soil Properties were studied by using various percentages of materials.

1. Atterberg Limits
2. Proctor Compaction Test
3. California Bearing Ratio

4. Unconfined Compressive strength

RESULTS AND DISCUSSION

Atterberg Limits

Liquid limit

The liquid limit of soil with and without fly ash. It was noticed that the percentage of Liquid limit was increases with the flyash soil by 18.12 %. to the soil without flyash

Sample	Liquid Limit
Soil	74.50%
Soil + 15 % Fly ash	61.00%

Plastic limit

The plastic limit of soil with and without fly ash was carried out. The plastic limit value was decreases with using fly ash by 15.15 % to the soil without flyash and the reduction of plasticity index was an indication of improvement of soil property. The soil samples were changed from having more plasticity to silty behavior, which is in terms of favorable workability.

Sample	Plastic Limit	Plasticity Index
Soil	41.25%	33.25%
Soil + 15 % Fly ash	35.00%	26.00%

Compaction Tests

The compaction tests on un-reinforced and reinforced soil fly ash mixes were conducted in accordance with Indian Standards Specifications (Bureau of Indian Standard (BIS) 1980 I.S.2720 (7)).

Proctor Compaction characteristics

With the fly ash to the soil, the maximum dry density and optimum moisture content was found by Proctor compaction test as per IS 2720. The variation of OMC by using flyash and fibre. It was noticed that the Optimum moisture Content of clay goes on increasing with the addition of fly ash and fibre. The variations in maximum dry density was decreases by using fly ash and fibre.

Sample	MDD	OMC
I	1.440 gm/cc	26.94%
II	1.379 gm/cc	29.50%
III	1.365 gm/cc	30.20%
IV	1.312 gm/cc	34.68%

Unconfined Compression Strength Tests

Test Specimens of size 38 mm x 76 mm were prepared using mould by compacting samples in the three layers at maximum dry unit weight and optimum moisture content. Determined by conducting Standard Proctor Test. Unconfined Compression Strength tests were conducted in accordance with Indian Standards Specifications (Bureau of Indian Standards,(BIS)1973 I.S.2720 (10)).

UCS Sample	UCS in Kg/cm2 Curing period in days			
	3days	7days	14days	21days
I	2.58	2.86	3.12	3.42
II	2.67	3.22	3.74	4.33
III	2.98	5.21	8.72	10.12
IV	2.76	4.12	5.32	6.24

California Bearing Ratio (CBR) Tests

CBR tests was conducted on specimens prepared using a cylindrical mould of 150 mm diameter and 175 mm height. The specimens were prepared by compacting samples in three layers at maximum dry unit weight and optimum moisture content determined by conducting Standard Proctor Test. The tests were conducted in accordance with Indian Standards Specifications (Bureau of Indian Standards,BIS) 1979 I.S.2720 (16)).

CBR Sample	CBR in Kg/cm2 Curing period in days			
	3days	7days	14days	21 days
I	2.8	3.38	4.15	5.12
II	5.63	5.94	6.3	6.62
III	10	10.53	11.01	11.32
IV	4.75	4.89	5.02	5.62

Conclusion

From the experimental program following conclusion has been made.

1. With the increase in percentage of Fly Ash, liquid limit and plastic limit increases and plasticity index decreases.
2. In the UCS by addition of 15% flyash and 1 % of polypropylene fibre in the soil get the maximum result there after the decrease with increasing fibre percentage
3. In the CBR by addition of 15% flyash and 1 % of polypropylene fibre in the soil get the maximum result there after the decrease with increasing fibre percentage

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