STABILIZATION OF EXPANSIVE SOIL WITH POLYPROPYLENE FIBER

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Abstract:

Expansive soils present issues in plan, development and support of common structures. Part of research is proceeding to improve the properties of expansive soils. The test results assembled over the previous years demonstrate the potential for utilization of various kinds of fiber in improving properties of expansive soils. In this examination impact of arbitrarily situated polypropylene fibers on CBR esteem, UCS esteem and shear parameters utilizing direct shear test is contemplated. Fiber content is shifted from 0.0% to 0.4% in ventures of 0.1% (S0-S4 tests). Results demonstrate improved soil properties. UCS esteem increments from 7.4% to 24.43%; CBR esteem expands 23.55% to 59.88% ; union increments from 5.9% to 26.80% and point of inward rubbing increments from 24.84% to 53.79% with increment of fiber content from 0.1% to 0.4% contrasted with 0.0% fiber content(S0 test).

Keywords: CBR value, Cohesion & angle of internal friction, Expansive Soil, Polypropylene fibers, UCS Value

I. INTRODUCTION

Expansive soils are the soils which require due worry by the geotechnical engineers. They can make broad harm common structures, if not sufficiently treated. Out of the numerous options, as of late consideration is centered around soil reinforcement with various sorts of fibers. Untruth et.al. [4], showed that there were noteworthy increments in shear quality, strength and pliancy of a strong soil after reinforcement with discrete polypropylene fiber. Puppala and Musenda [8] examined the impact of discrete and haphazardly arranged polypropylene fiber reinforcement on expansive soil stabilization. As indicated by the outcomes, fiber reinforcement improved the properties examined. A.S. Soganci [2] explored the impacts of discrete polypropylene fibers on UCS esteem and swell potential with fiber substance of 0.5%, 0.75% and 1.0%. Examination revealed increment in UCS esteem and lessening in swell potential with increment of fiber content. Present examination is completed to set up the utilization fiber reinforcement in improving expansive soil properties.

II. EXPERIMENTAL INVESTIGATION

2.1. PROPERTIES OF SOIL

The soil utilized for examination is a common dark cotton soil gathered from "Nerwada" close RGM College, and is appeared in Fig 1. The soil is blended completely according to the "quartering or riffling" process. After careful blending the whole soil is gone through 4.75mm sifter.

Table.1 Sieve analysis observations

Sieve size (mm)	Soil retained (g)	Percent retained (%)	Cumulative Percent retained (%)	Percent finer (%)
4.75	0	0	0	100
2.36	1	0.50	0.50	99.50
1.18	6	3.00	3.50	96.50
0.600	7	3.50	7.00	93.00
0.425	3	1.50	8.50	91.50
0.300	5	2.50	10.99	89.01
0.150	6	3.00	13.99	86.01
0.075	4.5	2.48	16.23	83.76
Pan	167.7	83.77	100	0

Fig.1 Soil sample

Wet sieve analysis is carried out on the black cotton soil and dry sieve analysis is carried out on the retained soil sample of wet sieve analysis.

Sieve analysis observations are shown in Table.1. The Hydrometer analysis is performed on the soil passing through the 75µ sieve. Hydrometer analysis observations are shown in Table 2.

Table.2 Hydrometer Analysis

Particle size, D (mm)	Rc2=Rh C	% Finer w.r.t mass taken	% Finer w.r.t total mass
0.0409	29.0	99.06	82.91
0.0296	28.0	95.64	80.05
0.0216	26.0	88.81	74.33
0.0158	24.0	81.98	68.61
0.0116	21.0	71.73	60.03
0.0087	19.0	64.90	54.32
0.0064	16.0	54.65	45.70

0.0046	13.5	46.11	38.59
0.0033	11.5	39.28	32.80
0.0024	10.0	34.16	28.59
0.0017	8.5	29.03	24.29
0.0010	6.0	20.49	17.15

From sieve analysis and hydrometer analysis the grain size distribution curve is plotted and is shown in Fig 2.

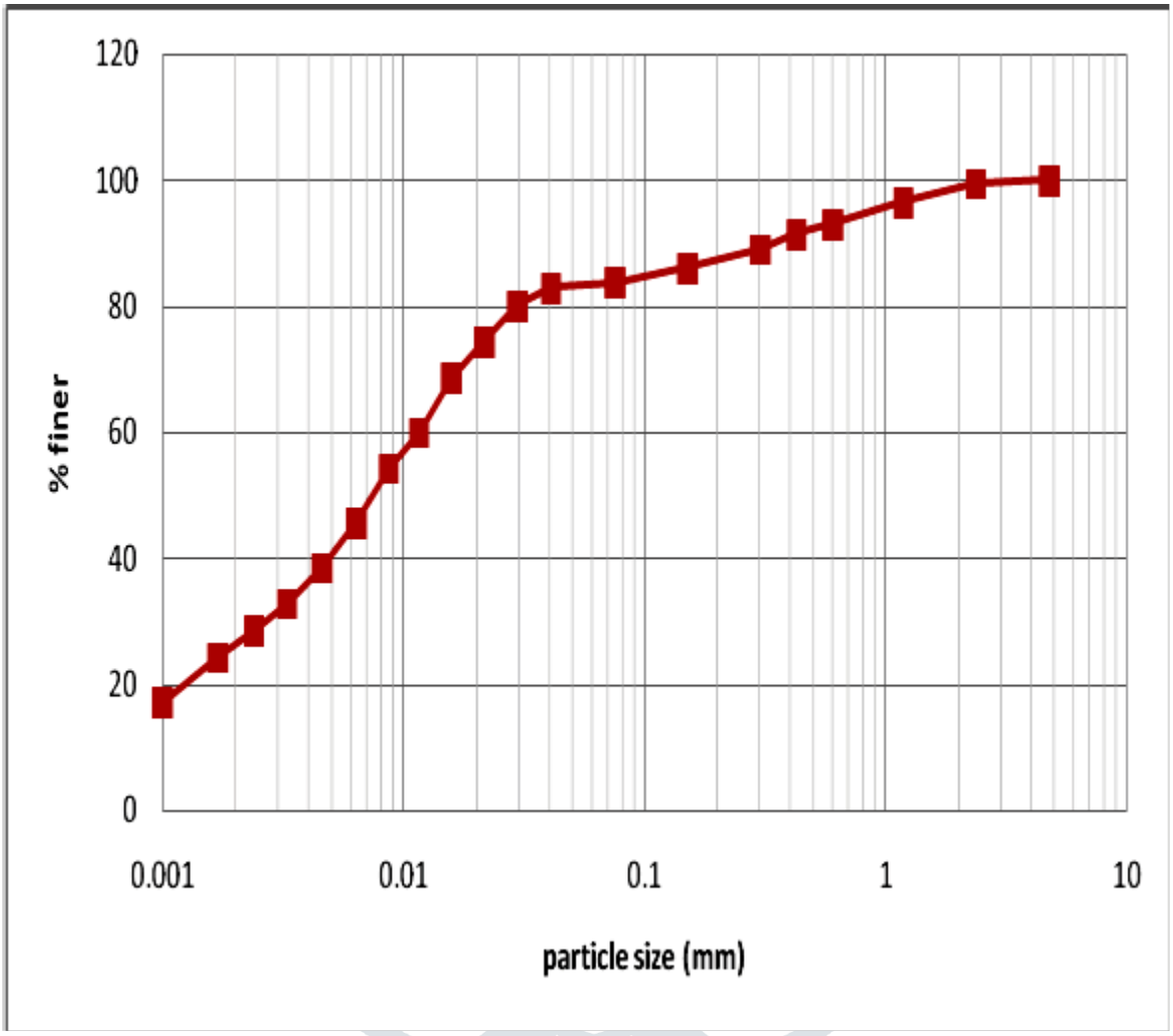

Fig 2 Sieve analysis- Grain size distribution

Physical properties of soil Liquid limit, plastic limit, specific gravity and free swell index are determined and are shown in Table 3. As per IS soil classification the soil is classified as Clay with High Compressibility with group symbol CH.

Table.3 Physical properties of soils

Property	Property Value
Specific gravity	2.413
Free swell index	37.8%
Liquid limit, w_L	61.0%
Plastic limit, w_P	30.0%
Plasticity Index=w_L-w_P	31.0%
Gravel	0%
Sand	16.24%
Silt	57.76%
Clay	26.00%
IS Classification	"CH- CLAY WITH HIGH COMPRESSIBILITY

2.1. Polypropylene Fibers

Polypropylene fibers, which are manufactured by Reliance Industries Ltd, are used in this investigation. Sample of polypropylene fibers are shown in Fig 3. Properties of polypropylene fibers used are shown in Table 4.

Fig.3 Polypropylene fibers

Table.4 Properties of polypropylene fibers

Index and strength parameters of PP-fiber	
Behavior parameters	Values
Fiber type	Single fiber
Unit weight	0.91 g/cm^3
Average diameter	0.034 mm
Average length	12 mm
Breaking tensile strength	350 MPa
Modulus of elasticity	3500 MPa
Fusion point	165 °C
Burning point	590 °C
Acid and alkali resistance	Very good
Dispersibility	Excellent

2.1.1. Proportion of Fibers

The extent of polypropylene fibers considered for examination is appeared Table 5. The extents are assigned as S0 to S4 dependent on variety of polypropylene from 0% to 0.4%.

Table.5 Proportions of Fibers

Proportion Designation	Proportion of Polypropylene as percentage of dry soil
S0	0.0
S1	0.1
S2	0.2
S3	0.3
S4	0.4

III. RESULTS & DISCUSSIONS

3.1. COMPACTION TEST

Is Light Compaction test is accomplished for S0 - S4extents to decide the Greatest dry thickness (MDD) and Ideal dampness content (OMC). Compaction test results are plotted and appeared in Fig 5. Fig 6 demonstrates the variety of MDD with variety % of fibers. It is seen that, as the fiber content expands MDD increments up to 0.2% and afterward diminishes. Fig 7 demonstrates the variety of OMC with variety of % of fibers. It is seen that with the expansion of fiber content the OMC increments directly

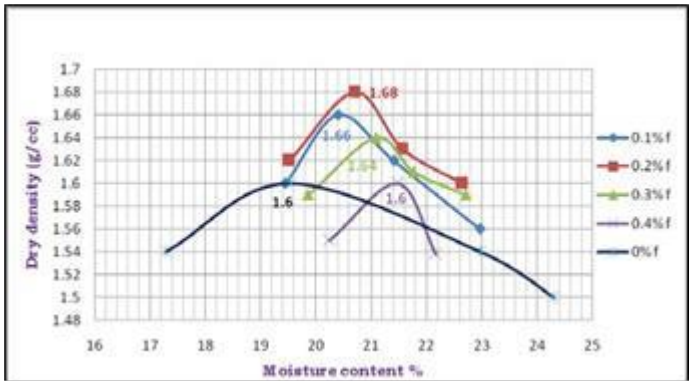

Fig.5 Compaction curves for soil mixed with different % of fibers

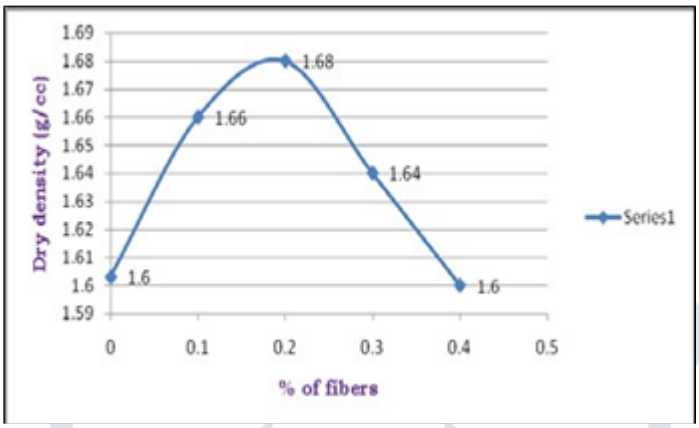

Fig.6 Variation of MDD with variation % of fibers

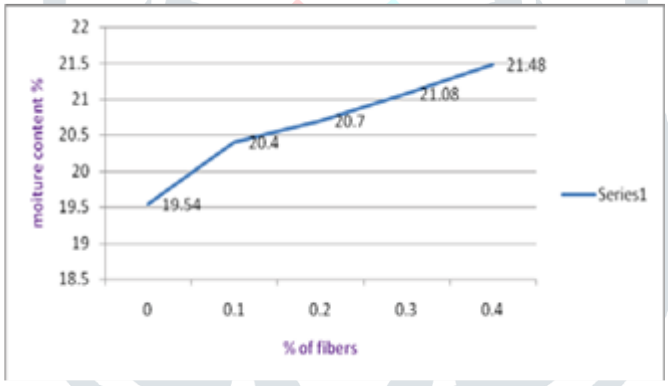

Fig.7 Variation of OMC with variation % of fibers

3.2. Unconfined Compressive Strength(UCS)

Tests are set up for S0 - S4by blending fiber with dry soil according to the extent, included separate OMC water content acquired from compaction test and compacted the example utilizing IS light compaction in 2250 cm3 IS standard form. At that point UCS test examples with size 38x76 mm are removed from the shape utilizing test extractor. At that point the examples are tried in UCS contraption. Table 8 indicates UCS test results. Diagram plotted between compressive pressure and displacement for S0-S4 tests is appeared in Fig 9. Table 9 demonstrates the UCS esteems for S0 - S4tests. Fig 10 demonstrates the variety of UCS with various extents of fibers. It is seen that with the expansion of fiber content the UCS increments straightly. With the expansion of fiber content from 0.1% to 0.4% the UCS increments from 7.4% to 24.43% contrasted with S0 test.

Table 8: Compressive stress vs displacement for S0 - S4samples

Deformation/ Displacement (mm)	Compressive stress values at different % of fiber content				
	0%	0.1%	0.2%	0.3%	0.4%
0	0	0	0	0	0
0.5	0.013	0.015	0.015	0.0195	0.0244
1	0.026	0.0265	0.0287	0.03	0.0331
1.5	0.035	0.038	0.0395	0.0438	0.0483
2	0.0458	0.048	0.048	0.0545	0.0567
3	0.062	0.0646	0.066	0.0709	0.071
4	0.072	0.077	0.0786	0.0848	0.0892
5	0.0796	0.0838	0.088	0.0878	0.0943
7	0.0835	0.0897	0.0938	0.0995	0.1039
11	0.0358	0.052	0.061	0.0726	0.0769

Fig. 9 Compressive Stress vs Displacement for S0 – S4samples

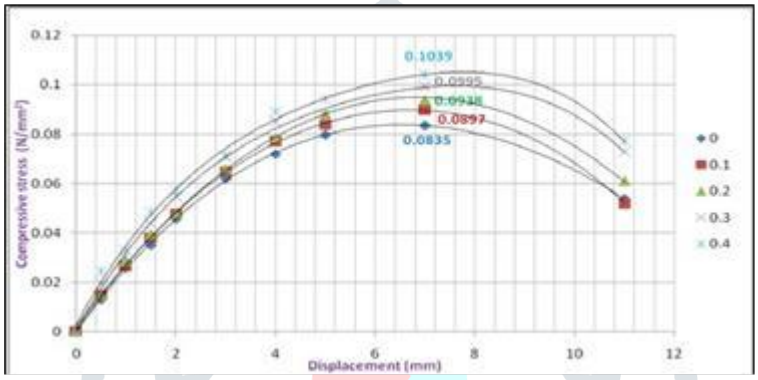

Table.9 UCS values S0 - S4samples

Sample	% of fibers	UCS	% increase in UCS compared to F0
F0	0	0.0835	-
F1	0.1	0.0897	7.4
F2	0.2	0.0938	12.33
F3	0.3	0.0995	19.16
F4	0.4	0.1039	24.43

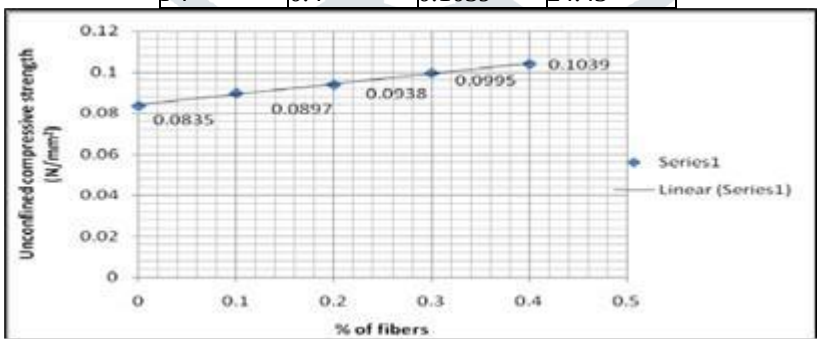

Fig 10: Variation of UCS with % of fiber mixed in soil

3.2. Direct Shear Test

Tests are set up for S0 - S4by blending fiber with dry soil according to the extent, included particular OMC water content got from compaction test and compacted the example utilizing IS light compaction in 2250 cm3 IS standard form. At that point direct shear test examples with size 60x60x25 mm are separated from the shape utilizing test extractor. At that point the examples are tried in direct shear device at 1.25 mm/min shear stacking rate. Table 6 demonstrates the greatest shear pressure esteems and comparing typical pressure esteems at disappointment for S0 – S4samples. Mohr Coulomb disappointment envelope is plotted for S0 - S4tests and is appeared in Fig 8. From the Fig

8, incline catch conditions for S0 - S4 tests in the structure y = mx + c is acquired, where „c' is the union esteem and „m' speaks to the slant of the line from which point of inward contact is determined.

Table.6 Maximum shear stress values and corresponding normal stress values at failure for S0 - S4samples

Sample	% fibers	Maximum Shear Stress (N/mm2)		
		σ1=0.1 (N/mm 2)	σ1=0.2 (N/mm 2)	σ1=0.3 (N/mm2)
S0	0	0.099	0.1192	0.1566
S1	0.1	0.11	0.14	0.183
S2	0.2	0.12	0.159	0.203
S3	0.3	0.129	0.161	0.216
S4	0.4	0.136	0.168	0.228

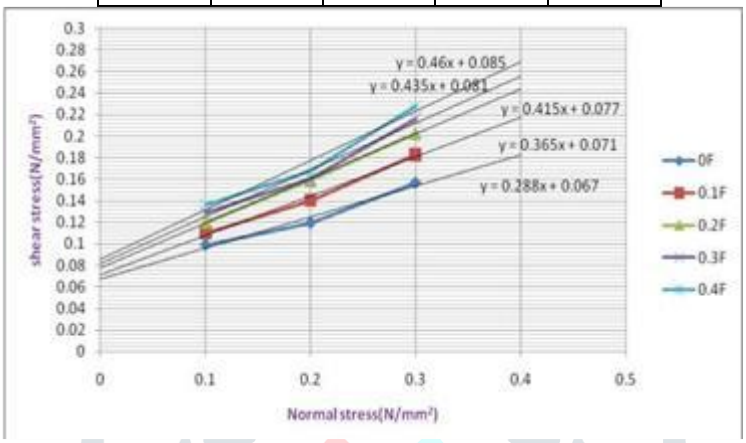

Fig.8 Mohr Coulomb failure envelope for S0- S4 samples

The cohesion „c" and angle of internal friction „Φ" for S0 - S4samples are shown in Table 7. It is observed that, with the increase of percentage of fibers from 0.1 % to 0.4 in the soil the cohesion and angle of internal friction increases from 5.9% to 26.80% and 24.84% to 53.79% respectively compared to S0sample.

Table 7: Cohesion & angle of internal friction values S0 - S4samples

Sample	% of fibers	Cohesion „c" (N/mm2)	% increase in„c" compared toF0	Angle of internal friction, „Φ"	% increase in„Φ" compared toF0
F0	0	0.067	-	16.06o	-
F1	0.1	0.071	5.9	20.05o	24.84
F2	0.2	0.077	14.9	22.53o	40.28
F3	0.3	0.081	20.89	23.50o	46.32
F4	0.4	0.085	26.80	24.70o	53.79

3.4. California Bearing Ratio(CBR) TEST

Samples are prepared for S0 - S4by mixing fiber with dry soil as per the proportion, added respective OMC water content obtained from compaction test and compacted the sample using IS light compaction in CBR mould. Unsoaked CBR test is performed with surcharge of 2.5 kg based the procedure stated in SP36.

Table.10 CBR values for S0 - S4samples

Sample	%of fibers	CBR	% increase in CBR compared to F0
F0	0	12.14	-
F1	0.1	15.00	23.55
F2	0.2	16.82	38.55
F3	0.3	17.68	45.63
F4	0.4	19.41	59.88

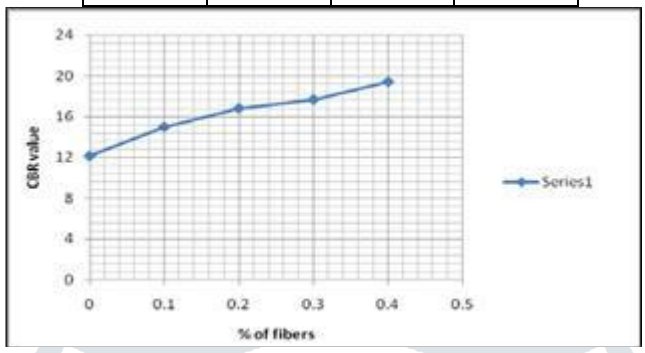

Fig. 11Variation of CBR value at with % of fibers mixed soil

Table 10 shows CBR values for S0 - S4samples. Fig11 shows the variation of CBR value with different proportions of fiber mixed soil. It is observed with the increase of % fiber content the CBR value increases approximately linearly. With the increase of fiber content from 0.1% to 0.4% the CBR value increases from 23.55% to 59.88% when compared to 0% fiber content (S0 sample).the UCS increases from 7.4% to 24.43% compared to S0 sample.

IV. CONCLUSION

- OMC of the soil is step by step expanded from 19.54% to 21.48% with consideration of fibers from 0% to0.4%.
- MDD increments from 1.6 gm/cc for 0% to most extreme estimation of 1.68 g/cc for 0.2% and afterward diminishes to 1.6 g/cc for 0.4% fibers expansion.
- With the expansion of level of fibers from 0.1 % to 0.4 % in the soil the attachment and edge of inner grating increments from 5.9% to 26.80% and 24.84% to 53.79% individually contrasted with F0sample.
- With the expansion of fiber content from 0.1% to 0.4%
- With the expansion of fiber content from 0.1% to 0.4% the CBR esteem increments from 23.55% to 59.88% when contrasted with 0% fiber substance (S0sample).
- Polypropylene fibers can utilized a choice to improve the expansive soil properties.

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