Inculcating The Timber Fiber Waste Into The Stabilized Expansive Soil With Fal-G Bricks Dust

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Abstract- *Expansive soil is a problematic soil for Civil Engineers because of its low strength and cyclic swell-shrink behaviour. Stabilization using solid wastes is one of the different methods of treatment, to improve the engineering properties and make it suitable for construction. Construction of pavement sub grades for roads and railways on black cotton soil (BC soil) is highly risky on geo-technical grounds because such soil is susceptible to differential settlements, poor shear strength and high compressibility. To avoid these situations from the field soil stabilisation is the realistic procedure. The main theme of the present study is to stabilise various engineering properties of the expansive soil by using waste material is Timber Fibre Waste as an alternative to Fal G Bricks Dust. FaL-G is the product name derived from a cementitious mixture composed of Fly ash (Fa), Lime (L) and Gypsum (G). It is a low-cost and environmental-friendly material. FaL-G in certain proportions, as a building material is an outcome of innovation. It gains strength like any other hydraulic cement in the presence of water and is water resistant with time. This project describes the compaction and strength behaviour of Timber waste fibres of different percentages of 0%, 0.5% 1% 1.5% and 2%.Fal g bricks dust of different percentages of 0%, 4%, 8%, 12% and 16%.The tests which were carried out are Modified compaction test, California bearing ratio test, unconfined compression test. The test result indicates that strength properties at optimum combination for expansive soil. Timber Fiber Waste Specimens with Fal G Bricks Dust is appreciably better than untreated BC soil. And also the strength of the mixed soil increases with increase in days.*

Keywords- Expansive soil, Timber Fiber Waste, Fal G Bricks, UCS.

I. INTRODUCTION

Expansive soils are a worldwide problem that poses several challenges for civil engineers. They are considered a potential natural hazard, which can cause extensive damage to structures, if not adequately treated. Such soils swell when given an access to water and shrink when they dry out (Al-Rawas et al. 2002). In general, expansive soils have high plasticity, and are relatively stiff or dense. The expansive nature of soil is most obvious near the ground surface where the profile is subjected to seasonal, environmental changes. The pore water pressure is initially negative and the deposit is generally unsaturated.

II. REVIEW OF LITERATURE

Kaniraj&Vasant (2001) studied fly ash –soil specimens compacted at the MDD-OMC state and they were found to exhibit brittle behavior in unconfined compression test. The brittle behavior is more marked in cement stabilized specimens than in un-stabilized specimens. The fibers inclusions change the behavior in both instances to ductile behavior. The increase in the unconfined compressive strength of un-stabilized fly ash-soil specimens due to fibers inclusions depends on the unconfined compressive strength of the unreinforced specimens. The unconfined compressive strength of a fly ash- soil mixture increases due to addition of cement and fibers. Depending on type of mix and curing period, the increase in unconfined compressive strength caused by the combined action of cement and fibers is either more than or nearly equal to the sum of the increase caused by them individually.

Kumar et al (2007) studied the addition of polyester fibers with lime, fly ash and sand was observed to stabilize and improve the geotechnical properties of clayey soils Lawtonet al. (1993) has shown that incorporation of polymeric multi-oriented geo-synthetic inclusions within sandy soils caused substantial improvements in strength and stiffness.

Maher and Woods (1990) have shown that fibers increased the dynamic shear modulus and damping ratio of sandy soils subjected to dynamic resonant-column and torsion shear tests.

III. MATERIALS USED AND THEIR PROPERTIES

The details of the various materials used in the laboratory experimentation are reported in the following sections.

3.1. Expansive Soil

The soil used was a typical black cotton soil collected from **muramalla** East Godavari District, Andhra Pradesh State, India. The properties of soil are presented in the Table 3.1. All the tests carried on the soil are as per IS specifications. Table 3.1 shows the Properties of Expansive Soil.

Table 1 Properties of Expansive Soil

S no	Properties	Value		
1	Grain Size Distribution	Sand Size Particles 8%	Silt Particles 15%	Clay particles 77%
2	Specific gravity	2.64		
3	Differential free swell	119%		
4	Atterberg's Limits	Liquid Limit 83.35%	Plastic Limit 38.25%	Plasticity Index 45.10%
5	IS soil classification	CH		
6	Compaction Properties	Optimum Moisture Content 28.26%	Max. Dry Density 1.36g/cc	
7	California Bearing Ratio(CBR)	Un soaked C.B.R 2.78%	Soaked C.B.R 1.88%	
8	Shear Strength Parameters	Cohesion 0.40kPa	Angle of Internal Friction 0.1 Deg	

3.2 Fal G Bricks dust

The Fal G Bricks dust is taken in this project is procured from Jindal fal G industry, Near Aditya Nagar, ADB Road.

3.3 Timber Waste: It is collected from the timber cutting Factory Kakinada.

Table 2: Variation of Index Properties of Expansive soil with % of FGBD

S.No.	Samples	Liquid Limit(%)	Plastic Limit(%)	Plasticity Index(%)
1	100% ES	83.35	38.23	45.12
2	100% ES+ 2% FGBD	79.52	40.23	39.29
3	100% ES+ 4% FGBD	75.25	43.25	32
4	100% ES+ 6% FGBD	69.25	45.36	23.89
5	100% ES+ 8% FGBD	65.22	48.23	16.99
6	100% ES+ 10% FGBD	60.22	51.22	9

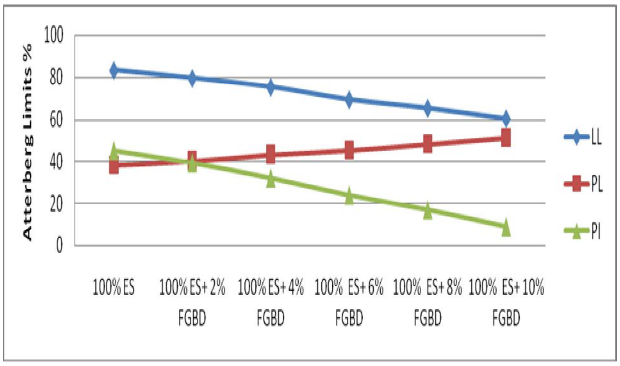

Fig: 1 Shows the Variation of Atterberg Limits with addition of FGBD

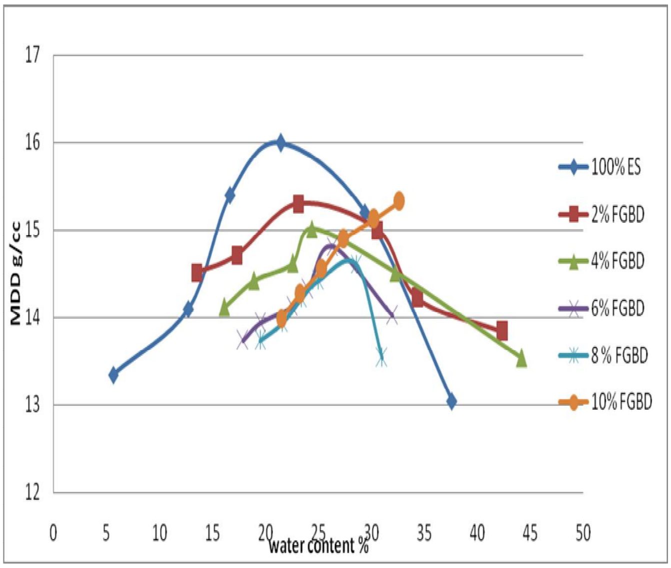

Fig: 3 Shows the OMC & MDD for treated with FGBD to the Expansive soil.

Table 3: Expansive soil treated with different percentages of FGBD

S.No.	Sample	OMC (%)	MDD (KN/m^3)
1	100% ES	21.42	15.99
2	100% ES+2% FGBD	23.1	15.3
3	100% ES+4% FGBD	24.39	15.01
4	100% ES+ 6% FGBD	26.3	14.81
5	**100% ES+ 8% FGBD**	**28.57**	**14.61**
6	100% ES+ 10% FGBD	30.22	14.51

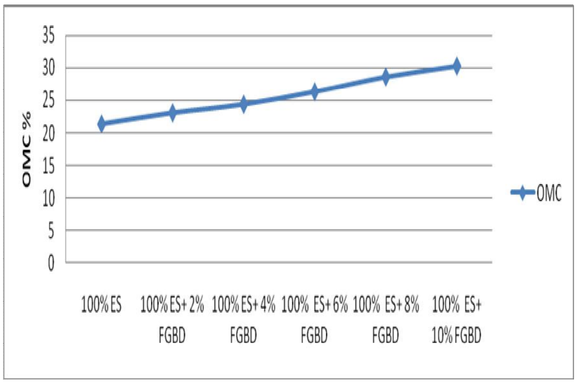

Fig: 4 Shows the OMC for treated with FGBD to the Expansive soil.

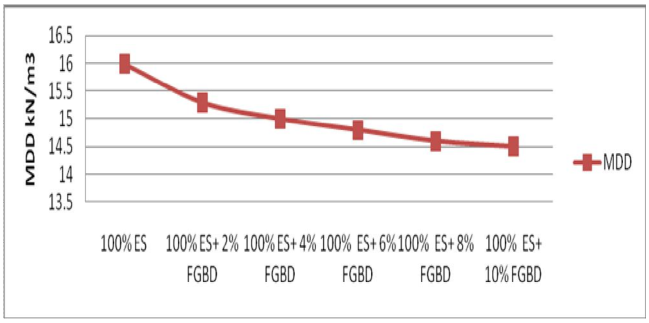

Fig: 5 Shows the MDD for treated with FGBD to the Expansive soil.

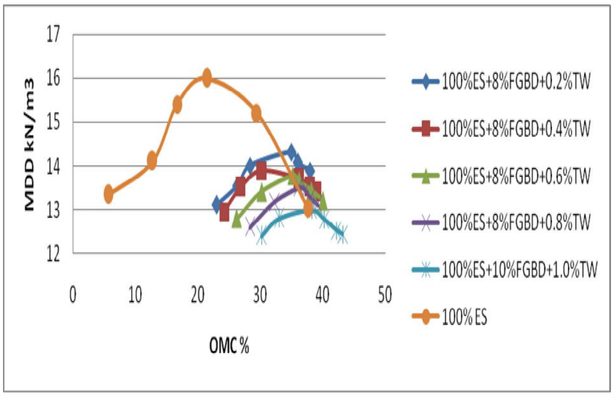

Fig: 6 Shows the OMC & MDD for treated with 8% FGBD and different percentages of TW to the Expansive soil.

Table 4 Expansive soil treated with FGBD and TW and Obtained OMC & MDD Values

S.No.	Sample	OMC (%)	MDD (KN/m³)
1	100% ES	21.42	15.99
2	100% ES + 8% FGBD+0.2%TW	32	14.3
3	100% ES + 8% FGBD+0.4%TW	33.32	13.9
4	100% ES + 8% FGBD+0.6%TW	35.22	13.78
5	100% ES + 8% FGBD+0.8%TW	37.89	13.48
6	100% ES + 8% FGBD+1.0%TW	38.99	13.2

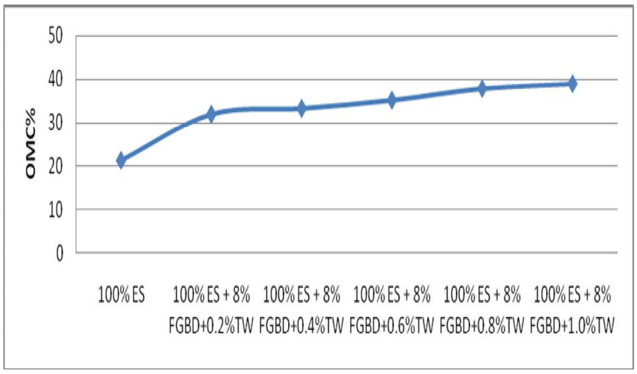

Fig: 7 Shows the OMC for treated with 8% FGBD and different percentages of TW to the Expansive soil.

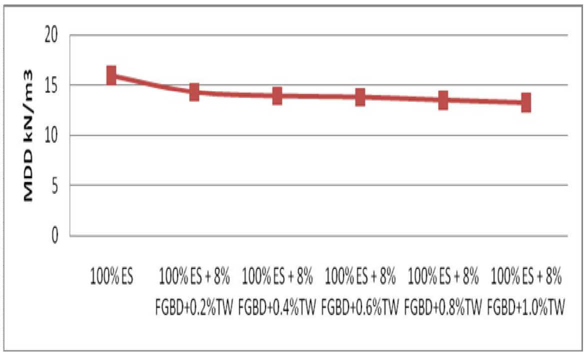

Fig: 8 Shows the MDD for treated with 8% FGBD and different percentages of TW to the Expansive soil.

Table 5 Expansive soil treated with FGBD and Obtained DFS Values

S.No.	Particulars	DFS %
1	100% ES	119
2	100% ES+ 2% FGBD	106
3	100% ES+ 4% FGBD	100
4	100% ES+ 6% FGBD	95
5	100% ES+ 8% FGBD	89
6	100% ES+ 10% FGBD	86

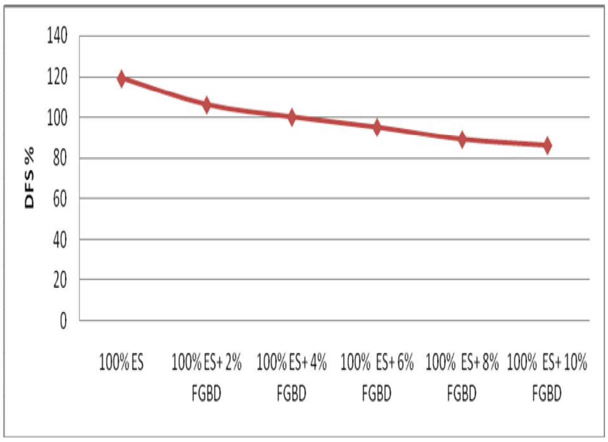

Fig: 9 Shows the DFS for treated with different percentages of FGBD to the Expansive soil

Table 6 Expansive soil treated with FGBD and TW and Obtained DFS Values

S.No.	Particulars	DFS %
1	100% ES	119
2	100% ES + 8% FGBD+0.2%TW	89
3	100% ES + 8% FGBD+0.4%TW	85
4	100% ES + 8% FGBD+0.6%TW	82
5	100% ES + 8% FGBD+0.8%TW	78
6	100% ES + 8% FGBD+1.0%TW	71

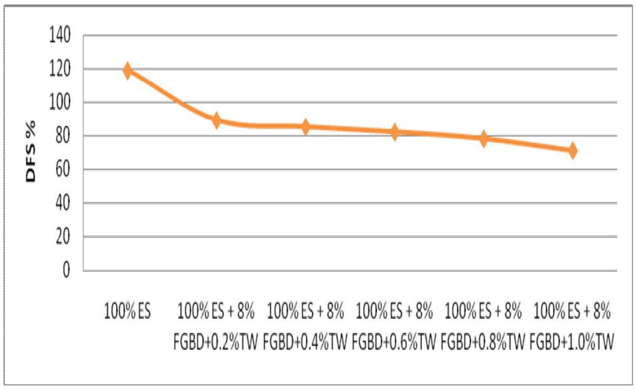

Fig: 10 Shows the DFS for treated with 8% FGBD and different percentages of TW to the Expansive soil

Table 7 Expansive soil treated with FGBD and Obtained Soaked & Un-soaked CBR values

S.No.	Particulars	CBR % (Un-Soaked)	CBR % (Soaked)
1	100% ES	2.78	1.88
2	100% ES+ 2% FGBD	3.5	2.3
3	100% ES+ 4% FGBD	4.2	2.9
4	100% ES+ 6% FGBD	4.7	3.5
5	**100% ES+ 8% FGBD**	**5.3**	**3.8**
6	100% ES+ 10% FGBD	5.2	3.6

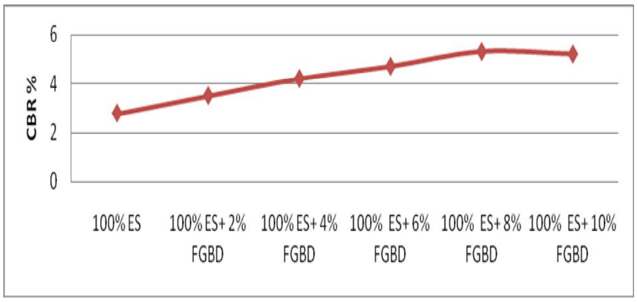

Fig: 11 Shows the Variation of & Un-soaked CBR values with different percentages of FGBD

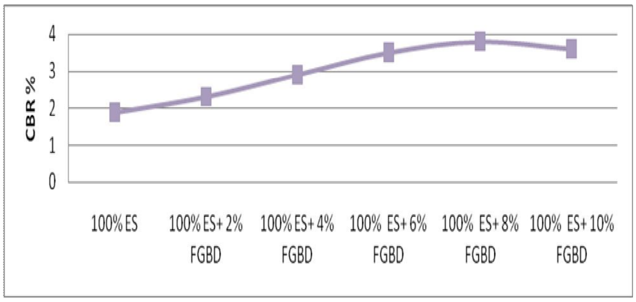

Fig: 12 Shows the Variation of Soaked CBR values with different percentages of FGBD

Table 8 Expansive soil treated with FGBD and TW and Obtained Soaked & Un-soaked CBR values

S.No.	Particulars	CBR % (Un-Soaked)	CBR % (Soaked)
1	100% ES	2.78	1.88
2	100% ES + 8% FGBD+0.2%TW	5.3	3.8
3	100% ES + 8% FGBD+0.4%TW	5.5	4.38
4	100% ES + 8% FGBD+0.6%TW	6.2	4.98
5	100% ES + 8% FGBD+0.8%TW	7	5.8
6	100% ES + 8% FGBD+1.0%TW	8.5	6.6

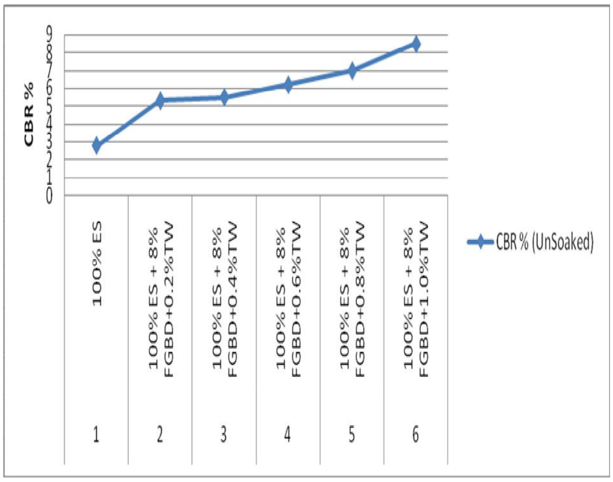

Fig: 13 Shows the Variation of Un-soaked CBR values with 8% of FGBD and different percentages of TW

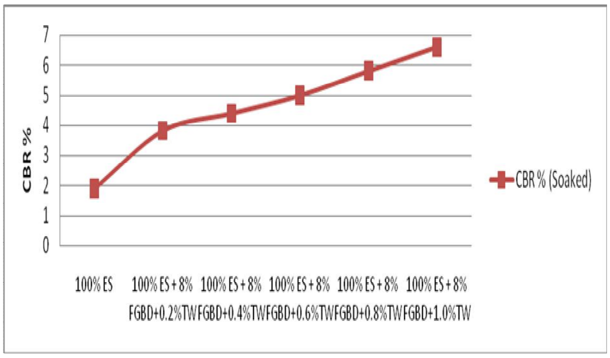

Fig: 14 Shows the Variation of Soaked CBR values with 8% of FGBD and different percentages of TW

Table 9 Expansive soil treated with FGBD and Obtained UCS Values

S No	Particulars	Days UCS(kN/m2)			
		0	7	14	28
1	100% ES	350	350	350	350
2	100% ES+ 2% FGBD	420	452	580	690
3	100% ES+ 4% FGBD	480	520	720	798
4	100% ES+ 6% FGBD	530	630	890	910
5	**100% ES+ 8% FGBD**	**580**	**690**	**1002**	**1098**
6	100% ES+ 10% FGBD	560	655	1000	1095

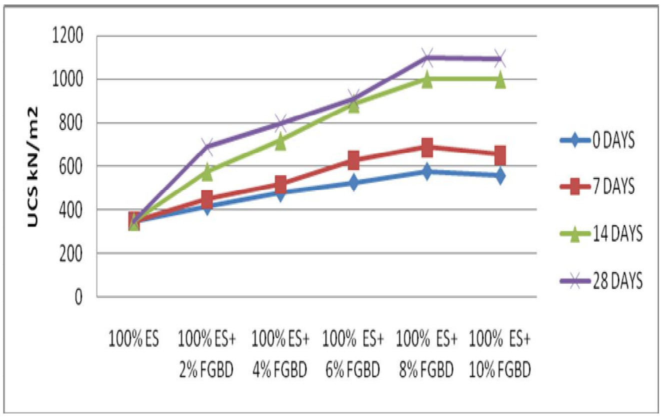

Fig: 15 Shows the UCS for treated with different percentages of FGBD to the Expansive soil

Table 10 Expansive soil treated with FGBD and TW and Obtained UCS Values

S No	Particulars	Days UCS(kN/m2)			
		0	7	14	28
1	100% ES	350	350	350	350
2	100% ES + 8% FGBD+0.2%TW	580	690	1002	1098
3	100% ES + 8% FGBD+0.4%TW	750	890	975	1100
4	100% ES + 8% FGBD+0.6%TW	956	1025	1200	1345
5	100% ES + 8% FGBD+0.8%TW	1230	1365	1457	1578
6	100% ES + 8% FGBD+1.0%TW	1359	1520	1756	1760

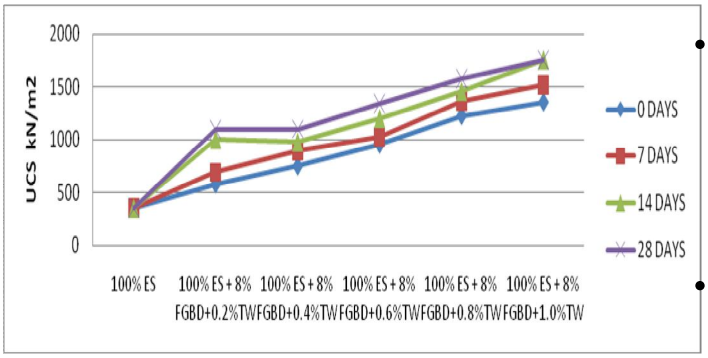

Fig: 16 Shows the UCS for treated with 8% FGBD and different percentages of TW to the Expansive soil

IV. CONCLUSIONS

Based on the received results and discussion thereof below conclusions are made:

- Optimum percentage of FGB obtained at exact 8%.
- Overall optimum (combination of 8% of FGB and Varying percentages of 0 to 1% of TW) obtained at 8% FGB and 0.8% TW after that the increase or decrease of value is nominal.
- The results of Liquid Limit tests on expansive soil treated with different percentages of FGB can be seen that with increase in percentage of FGB the liquid limit of soil goes on decreasing from 83.35% to 60.22% when FGB is increased from 0 to 10% as shown in fig. 5.1.
- The results of plastic Limit tests on expansive soil treated with different percentages of FGB can be seen that with increase in percentage of FGB the plastic limit of soil goes on decreasing from 38.23% to 51.22% when FGB is increased from 0to 10% as shown in fig 5.1
- The results of Plasticity Index of expansive soil treated with different percentages of FGB, it can be seen that with increase in percentage of FGB the plasticity Index of soil goes on decreasing from 45.12% to 9% when FGB is increased from 0 to 8% as shown in fig 5.1
- The overall increase of plastic limit, decrease of Liquid Limit due to the depress diffuse double layer.
- The results of Compaction tests on expansive soil treated with different percentages of FGB can be seen that with Decrease of MDD with the increasing addition of FGB, while the other side of OMC increasing. The MDD of soil goes on decreasing from 0% to 9.4% when FGB added at 8% as shown in fig. 5.4.
- The results of Compaction tests on expansive soil treated with different percentages of FGB can be seen that with Decrease of MDD with the increasing addition of FGB, while the other side of OMC increasing. The OMC of soil goes on increasing from 0% to 33.38% when FGB added at 8% as shown in fig. 5.4.
- The results of Compaction tests on expansive soil treated with 8% FGB and different percentages of TW can be seen that with Decrease of MDD with the increasing addition of TW and 8% FGB, while the other side of OMC increasing. The MDD of soil goes on decreasing from 0% to 18.62% when FGB added at 8% as shown in fig. 5.6.
- The results of Compaction tests on expansive soil treated with 8% FGB and different percentages of TW can be seen that with Decrease of MDD with the increasing addition of FGB, while the other side of OMC increasing. The OMC of soil goes on increasing from 0% to 76.89% when FGB added at 8% and 0.8% TW as shown in fig. 5.6.
- The reason for increasing OMC due to the effect of absorbing the moisture content by soil and dust particles whereas the MDD decreases because of escaping of soil particles from the Compaction Mould.
- The results of DFS tests on expansive soil treated with different percentages of FGB can be observed that the Decrease of DFS with the increasing addition of FGB. The DFS of soil goes on decreasing from 0% to 33.70% at added 8%FGB as shown in fig. 5.8.
- The results of DFS tests on expansive soil treated with 8% FGB and different percentages of TW can be seen that the

Decrease of DFS with the increasing addition of TW and 8% FGB. The DFS of soil goes on decreasing from 0% to 67.60% when FGB added at 8% as shown in fig. 5.9.

- The results of CBR tests on expansive soil treated with different percentages of FGB can be seen that with increase of un-Soaked CBR with the increasing addition of FGB. The Un-Soaked CBR of soil goes on increasing from 0% to 90.62% by adding 8% FGB as shown in fig. 5.10.
- The results of CBR tests on expansive soil treated with different percentages of FGB can be seen that with increase of Soaked CBR with the increasing addition of FGB. The Soaked CBR of soil goes on increasing from 0% to 102.12% when FGB added at 8% as shown in fig.5.11.
- The results of CBR tests on expansive soil treated with 8% FGB and different percentages of TW can be seen that the increase of Un-Soaked CBR with the increasing addition of TW and 8% FGB. The Un-Soaked CBR of soil goes on increasing from 0% to 205.71% when FGB added at 8% and different percentages of TW as shown in fig. 5.6.
- The results of CBR tests on expansive soil treated with 8% FGB and different percentages of TW can be seen that the increase of Soaked CBR with the increasing addition of TW and 8% FGB. The Soaked CBR of soil goes on increasing from 0% to 251.06% when FGB added at 0.8% and different percentages of TW as shown in fig. 5.6.
- The increase CBR due to the reason of formation of silicate zell.
- The results of UCS tests on expansive soil treated with different percentages of FGB can be seen that the increase of UCS with the increasing addition of FGB. The UCS of soil goes on increasing from 0% to 65.71% for 0 days, 0% to 97.14% for 7 days, 0% to 186.28% for 14 days and 0% to 213.71% for 28days by adding 8% FGB as shown in fig. 5.14.
- The results of UCS tests on expansive soil treated with 8% FGB and different percentages of TW can be seen that the increase of UCS with the increasing addition of TW and 8% FGB. The UCS of soil goes on increasing from 0% to 288.28% for 0 days, 0% to 334.28% for 7 days, 0% to 401.71% for 14 days and 0% to 402.85% for 28 days when FGB added at 8% and different percentages of TW as shown in fig. 5.15

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