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COMPARATIVE STUDY OF SOIL STABILIZATION WITH ADDITION OF GLASS, BASALT AND POLYPROPYLENE FIBRES

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Abstract: Soil of varying liquid limit was used in the current study by adding glass, polypropylene and basalt fibres to stabilize the soil. This study was conducted on the soil samples to analyze the index and engineering properties. The tests were performed in the laboratory by varying the various fibres percentages from 0.5% to 2% by the weight of soils. The fibres of 12mm length are used in this study. From the experimental results, *MDD* and *UCS* values are increased and *OMC* decreases. For Red soil, *UCS* increased with addition of 0.5% *PP* fibres by weight of soil. For Black cotton soil, *UCS* increased with addition of 1% glass fibres by weight of soil. It is concluded that addition of Glass fibres gives high compressive strength as compared with other fibres for Black cotton soil and for Red soil *PP* fibres which gives high compressive strength as compared with others fibres.

Index Terms - Red soil, Black cotton soil, PP fibres, Glass fibres, Basalt fibres

1. INTRODUCTION

A reliable and efficient method for changing critical soil properties is soil stabilization. For stabilizing expansive soils, a variety of reinforcement techniques are available, including surcharge loading, thermal methods, rewetting, soil replacement, compaction control, and moisture control. These methods are widely used for construction of roads, slope stabilization and railway embankments. In general, soils are stabilized to improve their toughness and longevity or to stop soil erosion and dust accumulation. Different locations have different soil characteristics. Different techniques are used to stabilize soil and before they are used in the field they are tested in the lab using soil samples [4]. One type of geosynthetic material used to increase soil stability is fibres. These serve as reinforcement and separation components in flexible pavement systems. The fibres are used to build roads, which have been acting as separators in the stabilization area. The main use of fibres is for this. The material composition of both natural and synthetic (*artificial*) fibres is typically used to classify them. Natural fibres are widely used and biodegradable, such as jute fibre (*Geojute*) and coir nets. The synthetic fibres are not biodegradable and are made of synthetic polymer materials. For two purposes, synthetic fibres are used between the subgrade. One is to increase the subgrades bearing capacity, and the other is to increase drainage effectiveness. The main reason for adding these materials to the soil is to separate the different soil layers or grades and to keep the fabric reinforcement in the soil for the duration of the structure. The tensile strength of the soil, maximum dry density, and water content will all increase with an increase in fibre content.

2. LITERATURE SUMMARY

The following points can be comprehended by literary analysis:

- The index properties and engineering properties of unreinforced samples and soil samples stabilized with fibres are leads to increase in the bearing capacity of fine grained soils. The use of fibers has drastically limited the amount of water the soil can absorb.
- The study examined the advantages of using glass fibres as a reinforcing component in soil. Glass fibre added to soil increases compressive strength and related properties. Mixing of soil with more length fibre has give better performance as compared to short length fibre [5], [11], [16].
- Polypropylene fibre can be used to stabilize clayey soil. Author concluded that adding 1% of stabilizer was the ideal amount of Polypropylene fibre. Compaction characteristics, *UCS*, Direct shear test, and *CBR* by varying percentages of fibres are improved [2], [4], [10], [12], [14],[17].

- Basalt fibre can significantly increase the subgrade soil strength and improve the structural design of highway pavement. Black cotton soil compaction properties can be enhanced by basalt fiber reinforcement. The *MDD* was raised with an increase in fibre content increased [3], [6], [7], [8].

3. MATERIALS AND METHODOLOGY

3.1 GLASS FIBRES

Glass fibre made of Alkali resistances (*AR*) is used in this study. The supplier is Swastic International in Jaipur. The *AR* Glass fibres properties are listed in Table 3.1

Table 3.1: Properties of Glass fibres

Properties	values
Filament diameter	14 microns
Specific gravity	2.68
Softening point	860° C
Electric conductivity	Very low
Chemical resistance	Very high
Modulus of elasticity	72GPa
Tensile strength	1100 – 1700 MPa
Length	12mm
Zirconia %	16 – 19%

Figure 3.1: Glass Fibres

3.2 POLYPROPYLENE (*PP*) FIBERS

The most popular synthetic fibres used as a reinforcement material for concrete and soil improvement is *PP* fibre(*Parashuram Lokre*). *UCS* and shear strength can be raised by adding *PP* fibres to the soils reinforcement. The supplier is Jogani Constructions. The *PP* fibres properties are listed in table 3.2.

Table 3.2: Properties of PP fibres

Properties	values
Specific gravity	0.92
Softening point	165° C
Colour	White
Elongation at break	12-17%
Tensile strength	670 MPa
Length	12mm

Figure 3.2: PP Fibres

3.3 BASALT FIBERS

The chopped basalt fibres are used in this study. It is supplied from Delhi *CF* Composites. The Basalt fibres properties are listed in table 3.3.

Table 3.3: Properties of Basalt fibres

Properties	values
Sustained operating temperature	+680ºC
Minimum operating temperature	(-)260º C
Melting temperature	1450º C
Density	2.6 g/cc
Tensile strength	3200-3850 MPa
Filament diameter	13-20 microns
Elastic modulus	93 GPa
Elongation at break	3.15%

Figure 3.3: Basalt Fibres

3.4 RED SOIL

The red soil required for the experiments is collected from the Govt Frist Grade College, Lakshmi Nagar, Badami Taluk. The soil sample which is collected from 1.5m below the ground surface and the properties of soil sample are shown in Table 3.4. The soil sample is carried out to the laboratory in bag. The soil is then sieved from 4.7mm sieve IS sieve and passing soil is oven dried, then used for tests.

Table 3.4: Properties of Red soil

Properties of soil	Description
Specific gravity	2.59
Liquid limit	37%
Plastic limit	18.93%
Plastic index	18.07%
Grain size analysis Gravel Sand Silt and clay	 2.45 % 57.41% 40.14%
Maximum dry density	18.34 kN/m^3
Optimum moisture content	18%
UCS	75.15 kN/m^2
Indian Standard Soil Classification	SC

Figure 3.4: Red Soil

3.5 BLACK COTTON SOIL

In this experiment 2 soil samples were collected. The black cotton -1 sample is collected from the Govt Urdu Primary School, Navalagund Taluk and this soil sample which is collected from 1.m below the ground surface. The black cotton -2 soil samples is collected from the Prarthana Public School, Sai park road, Bijapur district and this soil sample which is collected from

0.5.m below the ground surface. The properties of soil sample are shown in Table 3.5.The soil sample is carried out to the laboratory in bag. The soil is then sieved from 4.75mm sieve IS sieve and passing soil is oven dried, then used for tests.

Table 3.5: Properties of Black cotton soil

Properties of soil	**Description**	
Soil samples	**Black cotton soil -1**	**Black cotton soil -2**
Specific gravity	2.32	2.68
Liquid limit	65%	82%
Plastic limit	40.78%	37.33%
Plastic index	24.22%	44.67%
Grain size analysis Gravel Sand Silt and clay	 1.38 % 18.55% 80.06%	 3.66 % 26.99% 69.34%
Maximum dry density	13.53 kN/m^3	14.22 kN/m^3
Optimum moisture content	33%	28%
UCS	85.69 kN/m^2	131.20 kN/m^2
Free swell index	40%	130%
Indian Standard Soil Classification	MH - OH	CH

Figure 3.5.a: Black cotton Soil -2

Figure 3.5.b: Black cotton Soil -1

3.6 METHODOLOGY

The project methodology is as follows:

- The soil sample taken from the location is first cleaned of any observable foreign objects such as leaves, plastic, etc.
- Next, according to IS: 2720, the soils various index properties including sieve analysis, *LL*, *PL*, and moisture content are determined.
- The Standard Proctor Test can be used to determine the ideal moisture content and *MDD.*
- The test sample for the *UCS* Test is constructed using the *OMC* discovered in the proctor test and the associated strength parameters are discovered.
- The Standard Proctor and *UCS* tests are now carried out for each fibre content using 0.5%, 1%, and 2% of the dry weight of the soil as fibre content.

4. RESULTS AND DISCUSSIONS

Proctor test is carried on each of the three different stabilized soil composites. *OMC* and *MDD* are determined and results are presented below:

4.1. BLACK COTTON SOIL -1 RESULTS

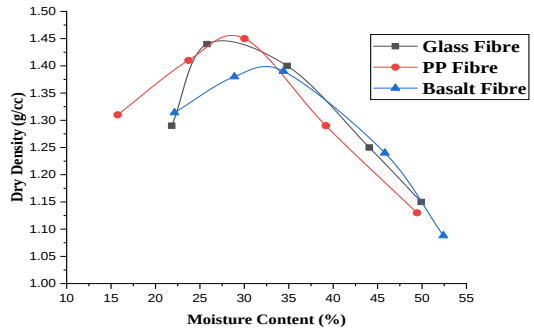

Figure 4.1.a: 1% Fibres

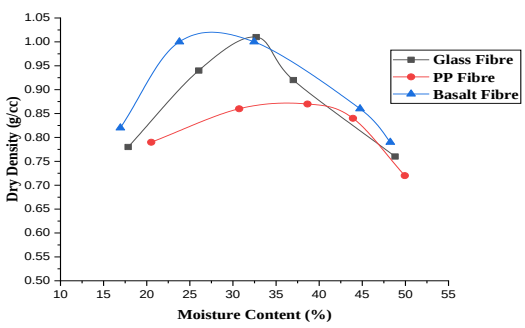

Figure 4.1.b: 2% Fibres

Addition of 1% fibres for Black cotton soil -1, the *MDD* values are increased and *OMC* values are decrease. From the above figure the variation of *MDD* with addition of 1% *PP* fibres by weight of soil increases from 13.53 kN/m^3 to 14.22 kN/m^3 and *OMC* decreases from 33% to 29%. From the results the mixing of Black cotton soil -1 with *PP*fibres has give better performance as compared to Basalt and Glass fibres.

4.2 RED SOIL RESULTS

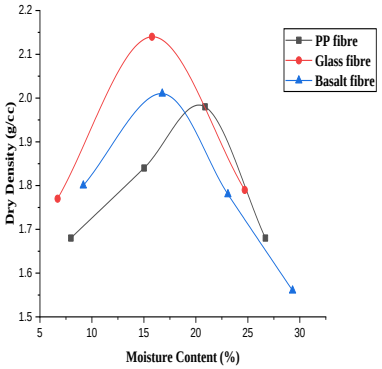

Figure 4.2.a: 0.5% Fibres

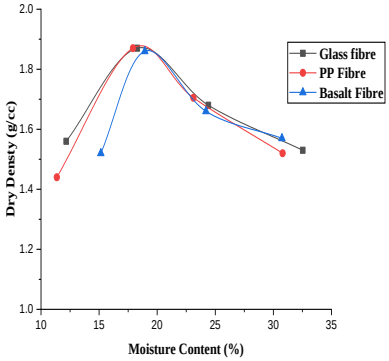

Figure 4.2.b: 1% Fibres

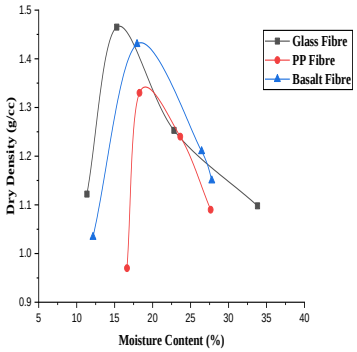

Figure 4.2.c: 2% Fibres

Additions of 0.5% fibres for Red soil, the MDD values are increased and *OMC* values are decrease. From the above figure the variation of *MDD* with addition of 0.5% Glass fibres by weight of soil increases from 18.34 kN/m^3 to 21.58 kN/m^3 and *OMC* decreases from 18% to 15%. From the results the mixing of Red soil with Glass fibres has give better performance as compared to Basalt and *PP* fibres.

4.3 BLACK COTTON SOIL -2 RESULTS

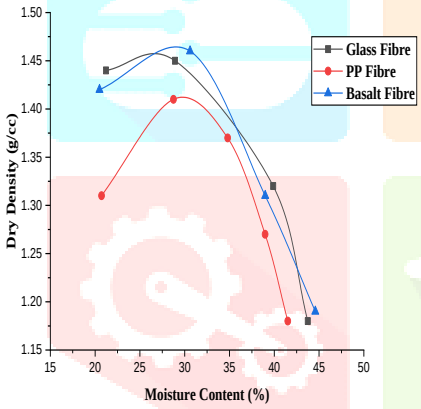

Figure 4.3.a: 0.5% Fibres

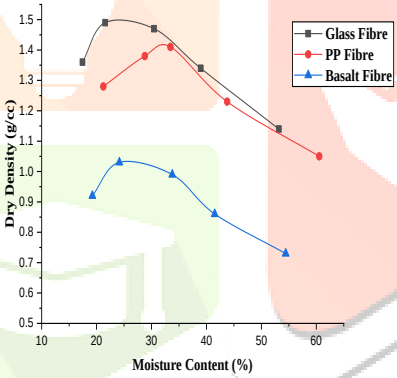

Figure 4.3.b: 1% Fibres

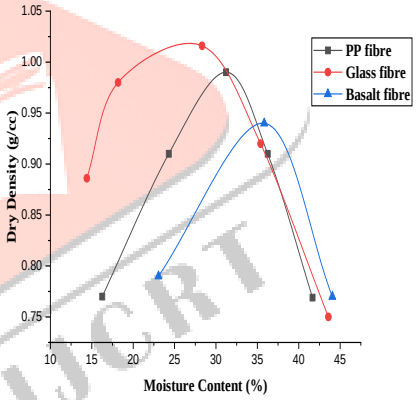

Figure 4.3.c: 2% Fibres

Addition of 1% fibres for Black cotton soil -2, the *MDD* values are increased and *OMC* values are decrease. From the above figure the variation of *MDD* with addition of 1% Glass fibres by weight of soil increases from 14.22 kN/m^3 to 14.51 kN/m^3 and *OMC* decreases from 29% to 24%. From the results the mixing of Black cotton soil -2 with Glass fibres has give better performance as compared to Basalt and *PP* fibres.

4.4 COMPARISON OF STANDARD COMPACTION TEST RESULTS

From the results obtained the comparisons of standard compaction test results shown in table 4.4.

Table 4.4: Comparison results of Compaction tests

		Black cotton soil -2		Black cotton soil -1		Red Soil	
		MDD **(kN/m^3)**	***OMC*** **(%)**	***MDD*** **(kN/m^3)**	***OMC*** **(%)**	***MDD*****(kN/m^3)**	***OMC*** **(%)**
0%		14.22	29	13.53	33	18.34	18
0.5%	Glass Fiber	14.32	28	---	---	21.58	15
	Basalt Fiber	14.32	30	---	---	20.60	15
	PP Fiber	13.93	28	---	---	18.63	15
1%	Glass Fiber	14.51	24	14.02	26	18.24	18
	Basalt Fiber	10.98	23	13.63	34	18.24	18
	PP Fiber	13.93	33	14.22	29	18.34	17
2%	Glass Fiber	10.2	25	9.9	32	14.32	16
	Basalt Fiber	10.59	32	10	27	14.02	17
	PP Fiber	9.71	32	8.53	37	13.04	18

UCS test is carried on each of the three different stabilized soil composites. The *UCS* values are determined and results are presented below:

4.5 BLACK COTTON SOIL -1 RESULTS

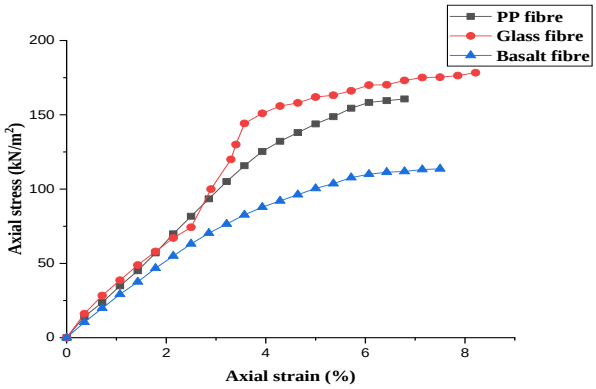

Figure 4.5.a: 1% Fibres

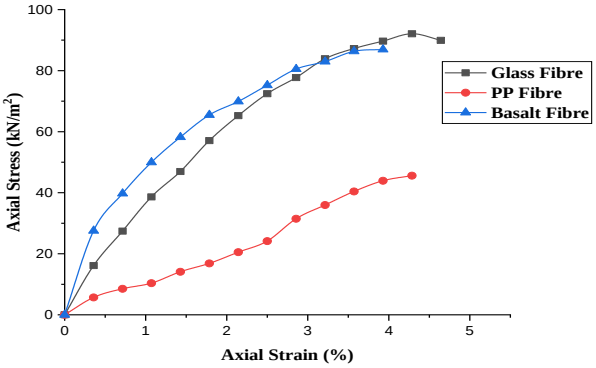

Figure 4.5.b: 2% Fibres

Additions of 1% fibres for Black cotton soil -1, the *UCS* values are increased. From the above figure the variation of *UCS* with addition of 1% Glass fibres by weight of soil increases from 85.69 kN/m^2 to 178.34 kN/m^2. From the results the mixing of Black cotton soil -1 with Glass fibres has give better performance as compared to Basalt and *PP* fibres.

4.6 RED SOIL RESULTS

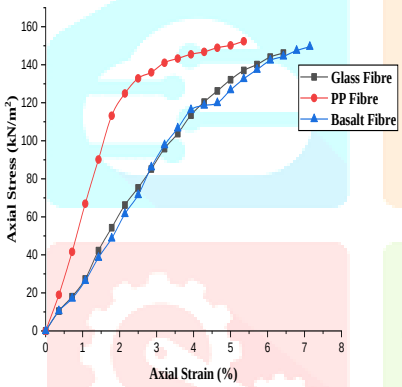

Figure 4.6.a: 0.5% Fibres

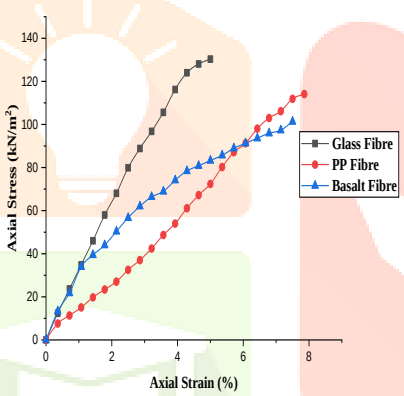

Figure 4.6.b: 1% Fibres

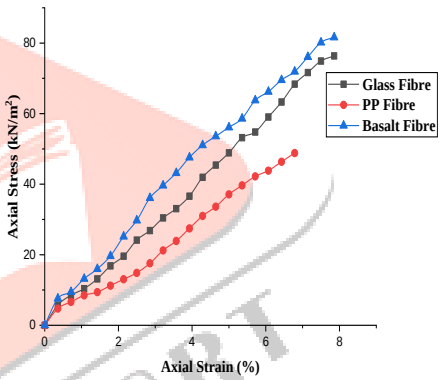

Figure 4.6.c: 2% Fibres

Additions of 0.5% fibres for Red soil, the *UCS* values are increased. From the above figure the variation of *UCS* with addition of 0.5% *PP* fibres by weight of soil increases from 75.15 kN/m^2 to 152.34 kN/m^2. From the results the mixing of Black cotton soil -2 with *PP* fibres has give better performance as compared to Basalt and Glass fibres.

4.7 BLOCK COTTON SOIL -2 RESULTS

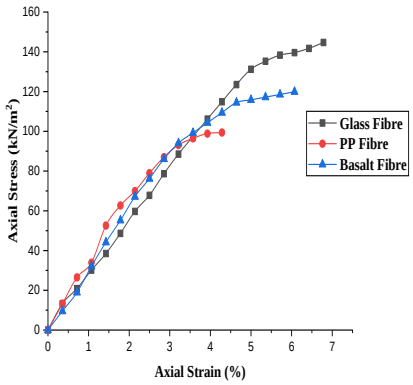

Figure 4.7.a: 1% Fibres

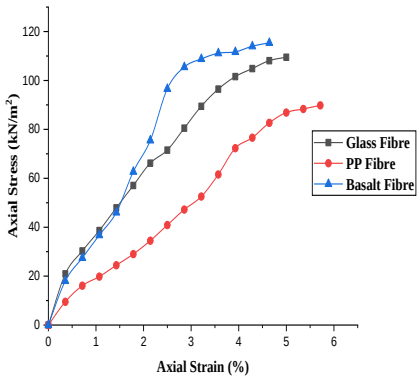

Figure 4.7.b: 0.5% Fibres

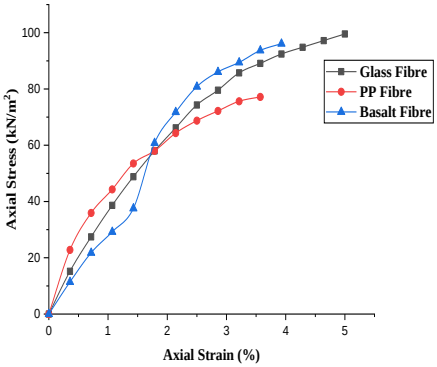

Figure 4.7.c: 2% Fibres

Additions of 1% fibres for Black cotton soil -2, the *UCS* values are increased. From the above figure the variation of *UCS* with addition of 1% Glass fibres by weight of soil increases from 131.2 kN/m^2 to 144.71 kN/m^2. From the results the mixing of Black cotton soil -2 with Glass fibres has give better performance as compared to Basalt and *PP* fibres.

4.8 COMPARISON OF UNCONFINED COMPRESSIVE TEST RESULTS

From the results obtained the comparisons of *UCS* test results shown in table 4.8.

Table 4.8: Comparison results of UCS tests

		Black cotton soil -2	Black cotton soil -1	Red Soil
		qu (kN/m^2)	qu (kN/m^2)	qu (kN/m^2)
0%		131.20	85.69	75.15
0.5%	Glass Fiber	109.48	----	146.16
	Basalt Fiber	119.88	----	149.47
	*PP*Fiber	99.37	----	152.34
1%	Glass Fiber	144.71	178.34	130.29
	Basalt Fiber	115.34	113.65	101.32
	PP Fiber	89.80	160.69	114.09
2%	Glass Fiber	99.53	92.07	76.35
	Basalt Fiber	96.08	86.93	81.62
	*PP*Fiber	77.15	45.58	48.83

5. CONCLUSION

In this study Glass, Basalt and *PP* fibres were used to stabilize the soil samples resulting to improve the strength properties of soil by varying different percentage (0.5%, 1% and 2%). Various experiments were carried out to determining the behavior of fibres reinforced soil.

Based on the experiments conducted and results obtained it can be concluded that:

- The *MDD* decreases and *OMC* increases with the increase in fibres percentages. For Black cotton soil -1, the *MDD* values are increased from 13.53 kN/m^3 to 14.22 kN/m^3 and *OMC* decreases from 33% to 29% by adding the 1% of *PP* fibres.
- The *MDD* decreases and *OMC* increases with the increase in fibres percentages. For Red soil, the MDD values are increased from 18.34 kN/m^3 to 21.58 kN/m^3 and *OMC* decreases from 18% to 15% by adding the 0.5% of Glass fibers.
- The *MDD* decreases and *OMC* increases with the increase in fibres percentages. For Black cotton soil -2, the *MDD* values are increased from 14.22 kN/m^3 to 14.51 kN/m^3 and *OMC* decreases from 29% to 24% by adding the 1% of Glass fibres.
- The *UCS* decreases for further increase in fibres percentages. For Black cotton soil -1, the *UCS* values are increased with addition of 1% Glass fibres by weight of soil from 85.69 kN/m^2 to 178.34 kN/m^2.
- The *UCS* decreases for further increase in fibres percentages. For Red soil, the *UCS* values are increased with addition of 0.5% *PP* fibres by weight of soil increases from 75.15 kN/m^2 to 152.34 kN/m^2.
- The *UCS* decreases for further increase in fibres percentages. For Black cotton soil -2, the *UCS* values are increased with addition of 1% Glass fibres by weight of soil increases from 131.2 kN/m^2 to 144.71 kN/m^2.

From the experimental investigation concluded that Glass fibres which gives high compressive strength as compared with other fibres for black cotton soil and for red soil *PP* fibres which gives high compressive strength as compared with others fibres.

The Glass fibres are suitable for fine grained soils and *PP* fibres are suitable for coarse grained soil.

From the above conclusion fibres reinforcement is very effective in increase the shear strength of soil and cost effective way.

REFERENCES

[1] Himadri Baruah (2015): "Effect of Glass Fibres on Red Soil" *International journal of advanced technology in enginerring and science*, Volume 3, issue 1, 217-213

[2] Sogant (2015): "The Effect of Polypropylene Fibre in the Stabilization of Expansive Soils" *International journal of geological and environmental engineering*, Volume 9, issue 8, 994-997

[3] C. P. Ndepete, S. Sert (2016): "Use of Basalt Fibres for Soil Improvement" *International conference on computational and experimental science and enginerring*, Volume 129, 355-357

[4] C. M. Sathya Priya, S. Archana, A. Bichu Albert, A. D. Deeraj (2117): "Stabilization of Clayey Soil Using Polypropylene Fibre" *International research journal of enginerring and technology*, Volume 04, issue 04, 1252-1255

[5] Fardin Asadollahia, Rauzbeh Dabiri (2017): "Effects of Glass Fibre Reinforced Polymer on Geotechnical Properties of Clayey Soil*" International journal for scientific research and development,* 73-83

[6] Pandit Vinod M, Chopada Rohit, Khabiya Tushar, Choudhary Ayushi, Gandhi Bhushan, Chhajed Deepali (2018): "Study Of Basalt Fibre On Compaction Characteristics Of Black Cotton Soil*" International journal for research in engineering application and management*, 850-852

[7] G. Ramachandran, S. Monisha, P. Pradeepa, S. Srigayathri, T. Vikachini (2019): "Experimental Study on Soil Stabilization Using Basalt Fibre and GGBS in Organic Soil" *International journal of advance research and innovation*, Volume 6, issue 4, 1-5

[8] Adla Prathyusha, Mudigonda Harish Kumar (2020): "Experimental Study on the Suitability of Basalt Fibre Reinforcement Red Soil for Highway Constructions" *International journal for research trends and innovation*, Volume 5, issue 1, 33-38

[9] Debi Prasanna Kanungo (2020): "Stabilization of Sand Using Different Types Of Short Fibres And Organic Polymer" *Journal of Hohai University*

[10] K Bibhu Jyothi Patro, Satyapriya Senapti (2020): "Stabilization of Clayey Soil by Using Polypropylene Fibre" *International research journal of engineering and technology*, Volume 7, issue 8, 3439-3443

[11] Parashuram Lokr (2020): "Stabilization of Black Cotton Soil by Using Glass Fibres" *International journal for scientific research and development*, Volume 8, issue7, 573-578

[12] P.A. Suriya, S.P. Sangeetha, R. Abirami, P. Subathra (2020): "Stabilization of Red Soil Using Polypropylene" *International journal for scientific research and development*

[13] Rizwan Qayoom Sheikh, Vishal Yadav, Ashish Kumar (2020): "Stabilization of Red Soil Used as a Sub Base Material" *International journal of scientific and technology research*, Volume 9, issue 2, 4539-4544

[14] Sandeep Chhokar, Vinod Kumar, Sonthwal (2020): "Soil Stabilization Using Polypropylene Fibre Materials" *international journals of creative research thoughts*, Volume 8, 910-913

[15] B. Priyadharshini Boopathiraj, P. Eshanthini (2021): "Experimental Study on Soil Stabilization Using Fibres" *International journal for scientific research and development*, 200-207

[16] Samer Rabab, Omar Al Hattamleh, Hussein Aldeeky, Bilal Abu Alfoul (2020): "Effect Of Glass Fibre On The Properties Of Expansive Soil And Its Utilization As Subgrade Reinforcement In Pavement Applications" *journal of Geotechnics, engineering*

[17] Jyotesh Kumar Choudhary, Udai Kumar Singh, Ranjeet Kumar Singh (2022): "Study on Stabilization of Soil Using Polypropylene Fibre Waste" *International research journal of engineering and technology*, Volume 9, issue 1, 270-276

[18] IS- 2720 part IV (1985) (reaffirmed 1995): "Indian Standard Method of Test for Soils. Grain Size Analysis" *Bureau of Indian Standards*. New Delhi.

[19] IS- 2720 part V (1985) (reaffirmed 1995): "Indian Standard Method of Test for Soils. Determination of Liquid and Plastic limit" *Bureau of Indian Standards*. New Delhi.

[20] IS- 2720 part VII (1985) (reaffirmed 1995): "Indian Standard Method of Test for Soils. Determination of Water Content – Dry Density Relation Using Light Compaction" *Bureau of Indian Standards*. New Delhi.

[21] IS- 2720 part X (1985) (reaffirmed 1995): "Indian Standard Method of Test for Soils. Laboratory Determination of UCS" *Bureau of Indian Standards*. New Delhi.

[22] IS- 2720 part 40 (1985) (reaffirmed 1995): "Indian Standard Method of Test for Soils. Free Swelling Index" *Bureau of Indian Standards*. New Delh