Volume 6, Issue 4 (2019) 1-5 ISSN 2347 - 3258
International Journal of Advance Research and Innovation

EXPERIMENTAL STUDY ON SOIL STABILIZATION USING BASALT FIBER AND GROUND GRANULATED BLAST FURNACE SLAG IN ORGANIC SOIL

G. Ramachandran[1*], S. Monisha[2], P. Pradeepa[3], S. Srigayathri[4], T. Vikachini[5]
[*1] Assistant Professor, Department of Civil Engineering, Vivekanandha College of Civil Engineering, Tiruchengode
[2,3] UG Student, Department of Civil Engineering, Vivekanandha College of Civil Engineering, Tiruchengode
[4,5] UG Student, Department of Civil Engineering, Vivekanandha College of Civil Engineering, Tiruchengode

Article Info
Article history:
Received 25 January 2019
Received in revised form
20 February 2019
Accepted 28 February 2019
Available online 15 March 2019

Keywords
Soil stabilization, Basalt fiber, GGBS, Compaction, Unconfined compression test, Organic soil.

ABSTRACT
The organic soils are unsuitable for construction works due to its low shear strength, high swelling potential and poor bearing capacity. These types of soils can be treated by stabilization and compaction methods. In this paper the study on effective use of stabilization using basalt fiber and ground granulated blast furnace slag (GGBS) in varying proportions and the main objective of this study is to increase the geotechnical properties of soil. The study has been conducted with three different proportions of basalt fiber as 1%, 2%, 3% and ground granulated blast furnace slag as 3%, 6% and 9%. The reinforced soil where subjected to compaction and unconfined compressive test (UCS). The experimental results have shown effective increament in compressive strength and shear strength of the soil.

1. Introduction

Soil stabilization is used to reduce the permeability and to increase the shear strength and bearing capacity of soil. Generally, the cementitious materials are used. In this study we use basalt fiber which is obtained from crushed basalt rocks it is a non-metal inorganic fiber which acts as a reinforcement for soil. when compared to other fibers like carbon fiber, sisal fiber and polypropylene fiber it has many unique physical advantageous properties and it is specifically environment friendly and ground granulated blast furnace slag (GGBS) is a by-product produced from iron manufacturing process and its cementitious characteristics reduces the permeability of soil and it increases the strength of soil when compared to other additives it is economical and environment friendly.

2. Materials used

2.1 Soil

The organic soil is collected from Koduvai, Tirupur district. The soil sample which is collected from 1.5m below the ground surface and the Index and engineering properties of soil are shown in Table 1. The classification of soil is done as per the Indian standard classification and it shown that the soil taken is organic with intermediate plasticity (OI).

Fig.1 soil sample

Table 1. Geotechnical properties of soil

S.no	Geotechnical properties of soil	values
1.	Specific gravity	1.88
2.	Percentage of gravel (%)	0.1
3.	Percentage of sand (%)	19.4
4.	Percentage of silt (%)	69
5.	Percentage of clay (%)	11.5
6.	Liquid limit (%)	36%
7.	Plastic limit (%)	25%
8.	Plasticity index (%)	11
9.	IS classification system	OI
10.	AASHTO system	A-7-5
11.	Maximum dry density (g/ml)	5.61
12.	Optimum moisture content (%)	10%
13.	Swell index	18%

2.2 Basalt fiber

The basalt fiber is made from crushed basalt fiber from volcanic rocks it is a non-metallic natural fiber. It is economical and environment friendly when compared to other fibers, it has unique physical characteristics and excellent mechanical properties such as resistance to high temperature, acid and alkali resistance and wave adsorption characteristics. In this study chopped basalt fiber is used. It is brought from Go-green products, Chennai. The properties of basalt are given below.

Corresponding Author,
E-mail address: srigayathri235@gmail.com;
:
http://www.ijari.org

Table 2. Properties of basalt fiber

S.no	Properties	Values
1.	Density (g/cm^3)	2.65
2.	Elastic modulus (GPa)	85.9
3.	Breaking elongation (%)	3.12
4.	Tensile strength (MPa)	2611
5.	Length (mm)	15
6.	Filament diameter (μm)	17

Fig.2 Basalt fiber

2.3 Ground granulated blast furnace slag (GGBS)

The ground granulated blast furnace slag is a by product material from manufacturing of iron. It acts as a pozzolanic material. It is bought from Erode. The specific gravity of ground granulated blast furnace is 2.68.

3. Methodology

To find the index properties soil (specific gravity, plastic limit, liquid limit, moisture content, swell index) the laboratory tests were conducted as per the IS code (IS 2720). The soil and the proportioned soil with stabilizing agents then subjected to compaction test and unconfined compression test (UCS) in varying proportions.

4. Results and discussion

4.1 Proctor compaction test

This experiment is to obtain the relation between moisture content (OMC) and max dry density (MDD). This test is conducted in varying proportions. This test shows the compaction characteristics of untreated soil and proportioned soil. The OMC and MDD is an important factor which defines the strength properties of soil. The optimum moisture content seems to be increase and the MDD value decreases in further increasing the proportions of fiber. The optimum moisture content and maximum dry density was found to be 14% and 5.72 (g/ml).

Fig.3 Proctor compaction test

Table 3. Results obtained from proctor compaction test

Mix proportions	OMC (%)	MDD (g/cc)
Untreated soil	10	5.60
B.F 1% GGBS 3%	8	5.63
B.F 1% GGBS 6%	8	5.72
B.F 1% GGBS 9%	10	5.61
B.F 2% GGBS 3%	14	5.48
B.F 2% GGBS 6%	14	5.39
B.F 2% GGBS 9%	12	5.42
B.F 3% GGBS 3%	10	5.44
B.F 3% GGBS6%	12	5.48
B.F 3% GGBS 9%	14	5.49

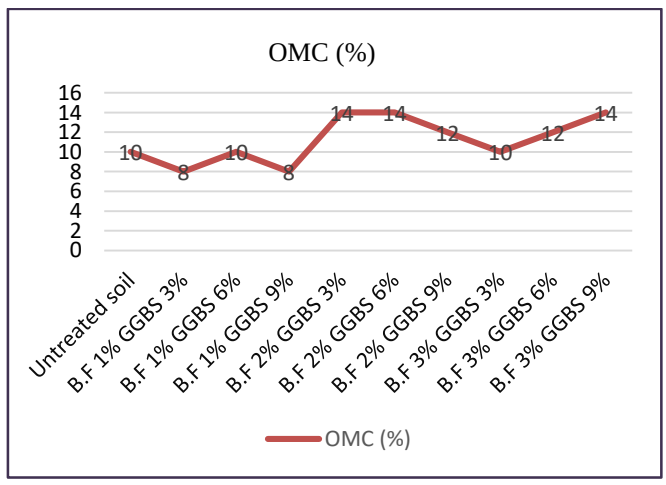

Fig.4 Variation in OMC characteristics

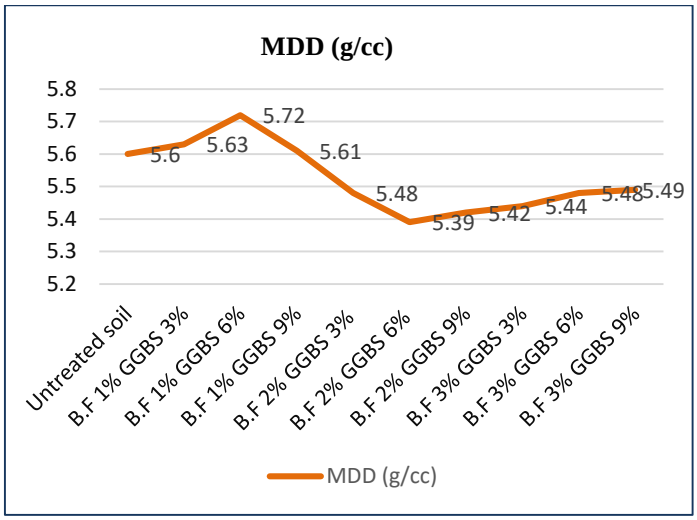

Fig.5 Variation in MDD characteristics

Fig.6 Compaction test samples

4.2 Unconfined compression test

The unconfined compressive strength is conducted to obtain the compressive strength of the soil. In this study the test is conducted in undrained condition. The strength can be identified from the stress-strain relationship curve obtained from the test results. The Maximum strength attained in the proportion of 2% basalt fiber and 6%GGBS is 183kN/m^2.

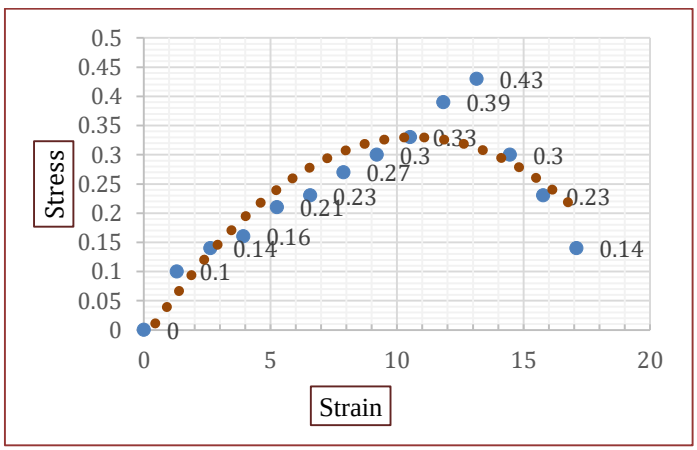

Fig.7 UCS results for untreated soil

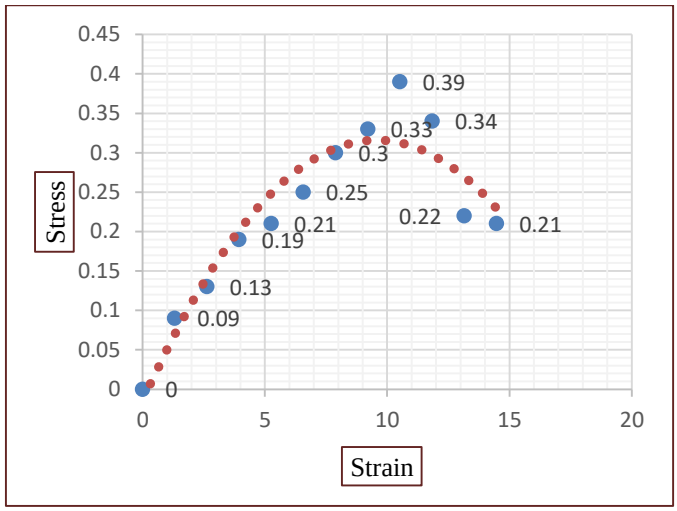

Fig.7 UCS results for 1% basalt fiber and 3% GGBS

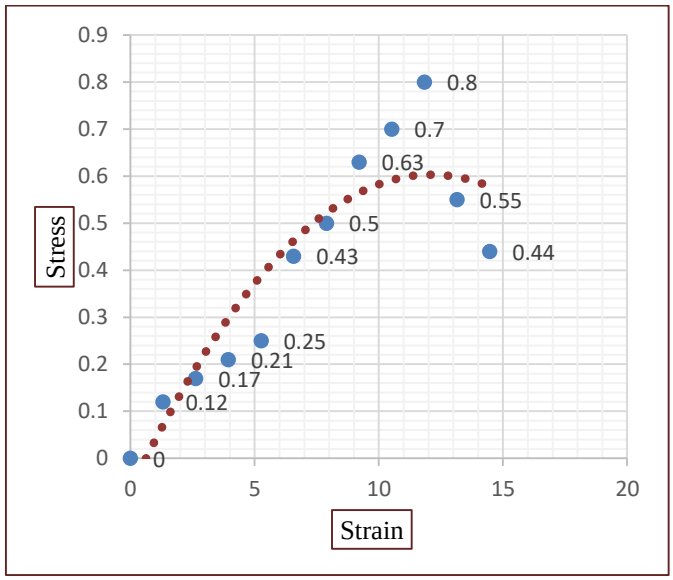

Fig.8 UCS results for 1% basalt fiber and 6% GGBS

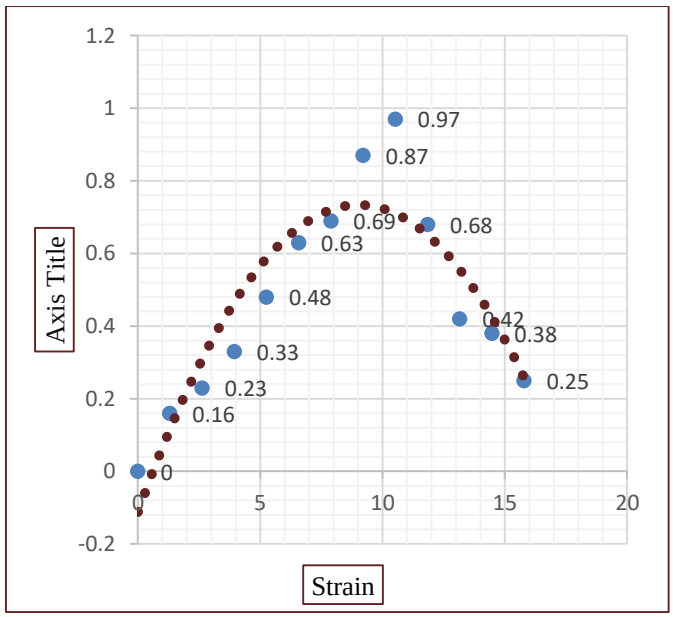

Fig.9 UCS results for 1% basalt fiber and 9% GGBS

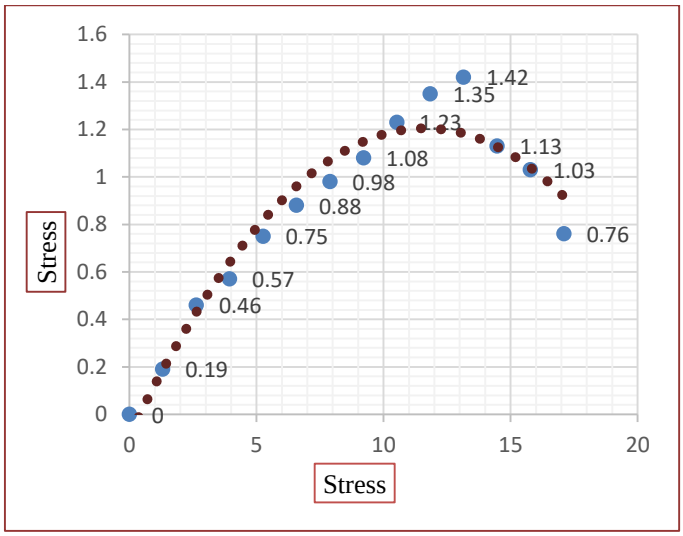

Fig.10 UCS results for 2% basalt fiber and 3% GGBS

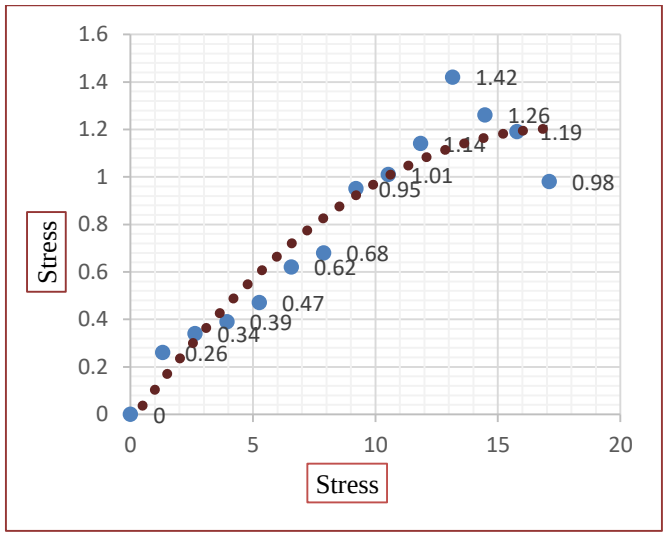

Fig.13 UCS results for 3% basalt fiber and 3% GGBS

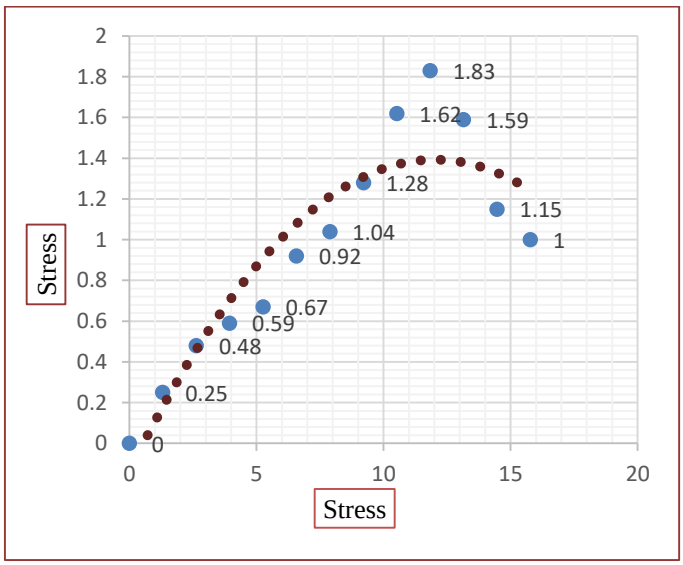

Fig.11 UCS results for 2% basalt fiber 6% GGBS

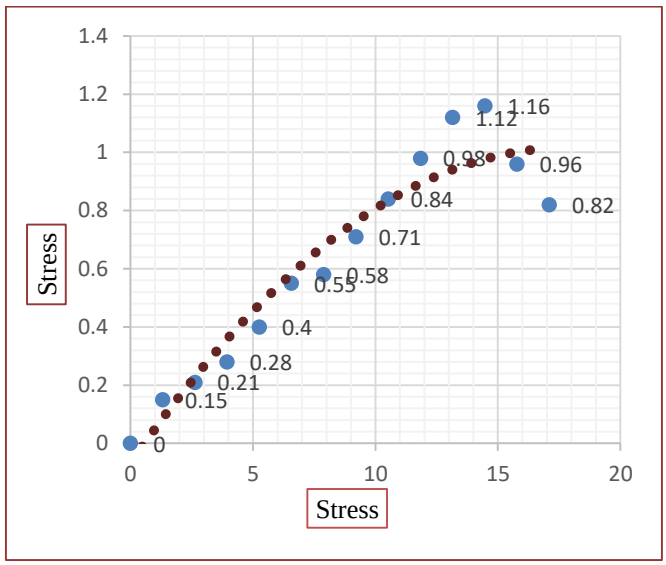

Fig.14 UCS results for 3% basalt fiber and 6% GGBS

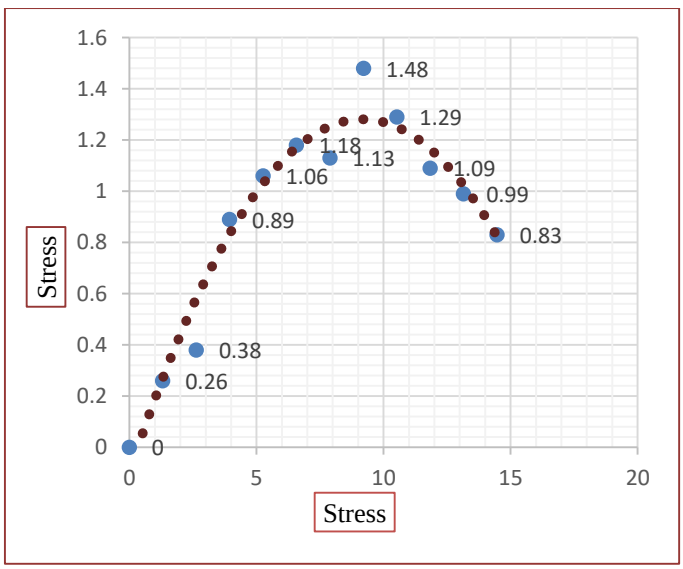

Fig.12 UCS results for 2% basalt fiber and 9% GGBS

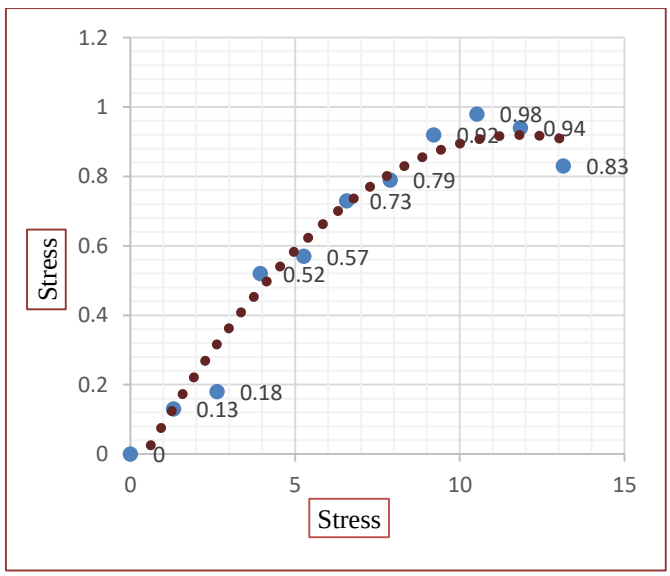

Fig.15 UCS results for 3% basalt fiber and 9% GGBS

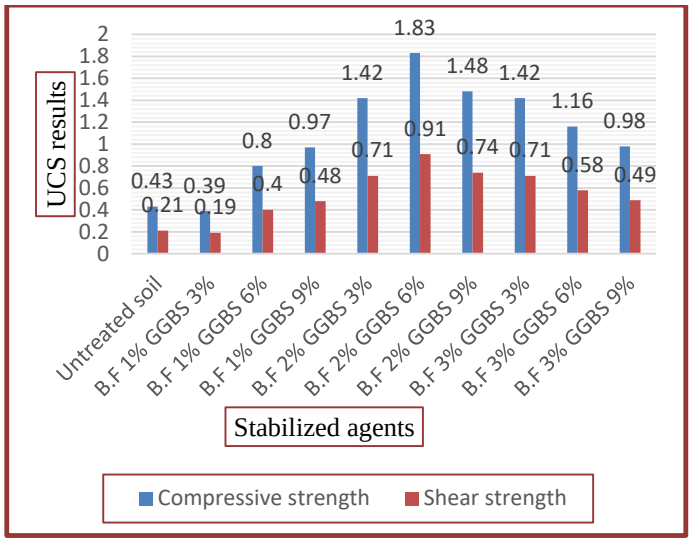

Fig.16 UCS results for untreated soil + proportioned soil

5. Conclusion

In this study the series of compaction test and unconfined test were conducted to study the behavior of soil with the addition of basalt fiber and GGBS in varying proportions.

Based on the compaction test it is found that OMC increases and MDD decreases. The optimum moisture content is 14% and Max dry density is 5.72 (g/cc).

Based on the unconfined compression test it is found that the combination of these two additives gives best compressive characteristics in the proportion of 2% basalt fiber and 6% GGBS. The maximum compressive strength obtained is (183kN/ml)

It is concluded that the proportioned soil is suitable for ground improvement techniques. The basalt fiber act as a reinforcement to increase the strength properties and GGBS act as cementitious it reduces the permeability and increase the shear strength of the soil.

6. Reference

[1] Anil Kumar Sharma and P.V. Sivapullaiah, (2016, March 14). Ground Granulated Blast Furnace Slag amended fly ash as an expansive soil stabilizer.*Soils and foundation*. [Online]. *Volume 56 (Issue 51)*, PP 205-212. Available: www.elsevier.com/locate/sandf

[2] Ashish Kumar Pathak, Dr. V. Pandey, Krishna Murari. J.P. Singh, (May 2014). Soil Stabilisation Using Ground Granulated Blast Furnace Slag. *Journal of Engineering Research and Applications ISSN: 2248-9622*. [Online]. *Volume 4 Issue 4 (Version 2)*, PP 164-171. Available: www.ijera.com.

[3] Aravalli, A.M. Hulagabali, H. Solanki and G.R. Dogagoungar. (2017). Enhancement of Index and

[4] Engineering Properties of Expansive Soil using Chopped Basalt Fiber. Presented at Indian Geotechnical Conference, IIT Guwahati, India. [Online].

[5] C.P. NDEPETE AND S. SERT, Use of Basalt Fibers for Soil Improvement (ICCESEN 2015). *Volume 130*.

[6] Dr. D. D Higgins. (September 2005). Soil Stabilisation with Ground Granulated Blast furnace Slag. UK Cementitious Slag Makers Association (CSMA).

[7] Laxmikant Yadu and Dr. R. K. Tripathi. (2013). Effects of Granulated Blast Furnace Slag in the Engineering Behaviour of Stabilized soil. Presented at Chemical, civil and mechanical tracks of 3rd Nirma university international conference. [Online]. Available: www.elseiver.com/locate/procedia.

[8] Lei Gao, Guohui Hu Xu, Junyi Fu, Chao Xiang and Chen Yang. (August 2015). Experimental Study on Unconfined Compressive Strength of Basalt Fiber Reinforced Clay Soil. [Online].

[9] PanditVinod M, Chopada Rohit, KhabiyaTushar, ChoudharyAyushi, Gandhi Bhushan and Chhajed Deepali, (2018). Study of Basalt Fiber on Compaction Characteristics of Black Cotton Soil. International Journal for Research in Engineering

Application & Management (IJREAM) ISSN: 2454-9150. Special Issue – ICRTET-2018. PP 850-853. [Online]. Available: www.ijream.org

[10] Qin-yong Ma, Zi-ming Cao, and Pu Yung, Experimental Research on Microstructure and Physical- Mechanical

[11] Properties of expansive soil stabilized with Fly Ash, Sand, and Basalt Fiber. (Volume 2018, Article ID 9125127, 13pages published october2018).

[12] Ruqayah Al-Khafaji, Hassnen M Jafer, Ammar Dulaimi, W.Atherton and Zahraa Jwaida. (May 2017). Soft soil stabilisation using ground granulated blast furnace slag.

[13] Ramanathan Ayothiraman and Anurag Singh, (March 2017). Improvement of soil properties by basalt fiber reinforcement.

[14] Sougat Mandal and J.P. Singh (December,2016). Stabilization of Soil using Ground Granulated Blast Furnace Slag and Fly Ash. *International Journal of Innovative Research in Science, Engineering and Technology ISO 3297: 2007*. [Online]. *Volume 5, (Issue 12)*. PP 2319-8753 Available: DOI:10.15680/IJIRSET.2016.0512038

[15] IS: 2720- part 3 sec.1- 1980 " Determination of specific gravity".

[16] IS: 2720-part 4 -1975 "Determination of sieve analysis.

[17] IS: 2720-part 5-1970 "Determination of Liquid and plastic limit".

[18] IS 2720-part 6-1972 "Determination of Shrinkage factors".

[19] IS 270- part 10-1973 "Determination of unconfined compressive strength".