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Effects of Waste Glass Powder on the Geotechnical Engineering Properties Soils

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Abstract- Nowadays, in this advanced life, a huge number of different types of waste is produced. Various types of waste such as mechanical waste, gardening waste, clinic waste, private waste and tires are turning into a real danger to nature. It turns out to be more extreme on the unlikely possibility that they are non-biodegradable materials. The building architects used many waste materials to settle the friable mud and sandy soil. Glass waste, rice husk debris, marble dust, fly debris, stone debris, bagasse debris, emergency clinic waste, destroyed tires were used in various construction trials in a strategy called soil conditioning. These waste items are truly a matter of nature in the event that they are not properly arranged. In order to save costs and reduce natural contamination, this kind of reused waste material can be used. Soil amendment is characterized as a design methodology used to improve the construction properties of dirt, as well as to reduce soil deformations, for example, settlement, development, and compressibility. Many scientists have used different types of waste in soil treatment. Sweeping land can be used for development by treating it as a treatment using modern wastes, fly ash, rice husk debris (RHA), phosphorous gypsum, quarry dust, granulated heater slag and so on with or without foil as is concrete, bitumen, lime, calcium chloride and so on. Many experts have found that fibre-reinforced soils are likely to be composite materials that improve the basic behaviour of balanced and regular soils. Vast soils with fly debris bought a huge drop in increasing dirt weight. Elastic was used with concrete to reduce the increasing weight of dirty soil. California bearing proportion and unlimited compression quality have been extended in dirty soil with jute fiber expansion. The bearing limits, dry thickness and unlimited skid quality of the muddy mud were extended when the aluminum build-up and reused black top were included. All analysts discovered a shifted performance in improving the structural properties of wide soil. One of the provoking wastes of nature is the waste of glass and it is considered a head of strong waste. The volume of global glass production was estimated at almost 130 million tons in 2005. Around 850,000 tones of glass is consumed annually in Australia, with only 350,000 tones (40%) recovered for reuse. A huge amount of unused glass is thus covered in landfills. Biodegradation of glass normally takes 450 years. Subsequently, it turns out that it is more important to reuse it as a soil amendment. The physical properties of crushed glass are that they reveal high penetrability, low tensile strength, high crushing resistance, and these properties could improve its use in geotechnical construction works for soil treatment, bank construction and so on. The test of eco-friendly asphalt squares made from waste glass, fly and debris was completed and it was found that the compression and bending quality of the asphalt square is individually expanded by 37% and half. The expansion of waste glass has brought an expansion of dry density and CBR values and a reduction in the list of versatility, optimum moisture content. Ongoing research has found that the use of lime glass fly ash powder with mud significantly affects the quality of the dirt. Further research showed that the use of glass powder with soil up to 8.5% extended the unlimited quality of compression, fixation and internal grid point. The CBR value increases to the normal 10% when 20% crushed glass is mixed with 80% clay material. Squeezed waste glass and waste plastics were mixed up to 12% with the two types of soil, and it was found that the CBR (expanded to 5%) and the grind point expanded as the additions expanded, while the plasticity of the file and joint decreased. The frictional quality of fine-grained soils improved impressively with the expansion of pressed glass and suggested that this idea could be used to improve building properties. Research has shown that a mixture consisting of 80% silty material and 20% crushed waste glass can be used in subgrade and asphalt development. In this investigation, waste glass powder has been utilized as a stabilizer to improve the properties of locally accessible cohesion less soil. The study is focused on, Improving the locally available soil using some eco-friendly and cheap by-product. Evaluation of strength characteristics of un-stabilized as well as blended soil using different proportion of glass powder. Determination of appropriate proportion of glass powder to achieve the maximum gain in strength of soil.

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I. INTRODUCTION

Soil adjustment is a procedure of modifying or improving the geotechnical properties of soil, collects it fit for development purposes. Adjustment builds the heap bearing limit of the dirt while diminishes the compressibility and penetrability of soil. For planning purposes, new methods have been shaped to fix the geotechnical properties of the insecure soil. Soil adjustment, Removal of the undesirable materials and variable the ground water conditions are the for the most part three techniques managing updating of soil.

Soil is a blend of characteristic issue, for example, minerals, gases, liquids, and other life frames that together help life. Earth's relationship of soil is the pedosphere, which has four basic limits: it is a mode for plant development; it is a technique for water stockpiling, flexibly and its cleaning; it is a modifier of Earth's atmosphere; it is a living natural surroundings for living creatures; the entirety of which, it modifies the fruitfulness of soil. Soil is an aftereffect of the effect of environment, rise (tallness, direction, and tendency of domain), living creatures, and its parent materials (interesting minerals) teaming up after some time. It tenaciously gets created by strategy for different physical, compound and regular strategies, which fuse enduring with related breaking down.

Given it's disperse quality and strong inner connectedness, it is seen as a natural network by soil tree huggers. Most soils have a dry mass (thickness of soil considering voids when dry) somewhere in the range of 1.1 and 1.6 g/cm3, while the dirt molecule thickness is a lot higher, in the scope of 2.6 to 2.7 g/cm3.Squander glasses were taken from the closest glass preparing plant in Ambala, Haryana. The waste glasses were washed, dried and afterward separated into a powder by utilizing a sledge furthermore, covering it with a bit of fabric to abstain from raveling. The glass powder was gone through the sifter number 200. The going through with the end goal that strainer had been taken.

II. RESULTS

Liquid Limit Test was conducted on virgin soil as well as on soil samples mixed with varying percentages of Glass Powder. Test procedure is already discussed in the previous section. The liquid limit of virgin soil as well as of soil samples mixed with varying percentages of Glass Powder is Tabulated in Table 1 and shown in Figure 1.

Table 1. Liquid Limit Results.

S. No	Mix	Liquid Limit (%)
1	Soil	47.21
2	Soil + 2.5 % Glass Powder	42.87
3	Soil + 4.5 % Glass Powder	38.77
4	Soil + 6.5 % Glass Powder	36.87
5	Soil + 8.5 % Glass Powder	33.21
6	Soil + 10.5 % Glass Powder	31.80

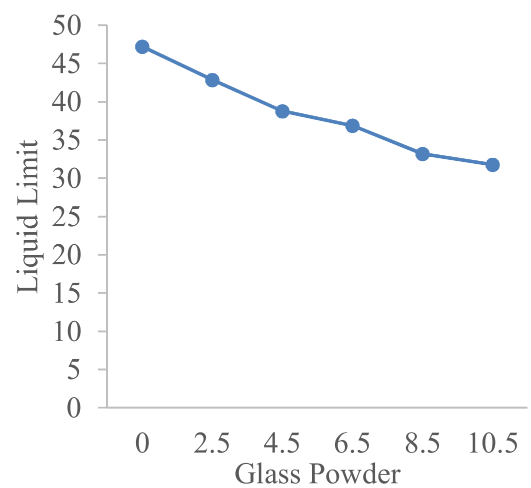

Fig 1. Liquid limit of soil with Different percentages of Glass Powder.

1. Plastic Limit Test Results:

Table 2. Plastic Limit Results.

S. No	Mix	Plastic Limit (%)
1	Soil	26.21
2	Soil + 2.5 % Glass Powder	24.3
3	Soil + 4.5 % Glass Powder	21.90
4	Soil + 6.5 % Glass Powder	19.33
5	Soil + 8.5 % Glass Powder	17.65
6	Soil + 10.5 % Glass Powder	16.45

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Plastic Limit Test was conducted on virgin soil as well as on soil samples mixed with varying percentages of Glass Powder. Test procedure is already discussed in the previous section. The plastic limit of virgin soil as well as of soil samples mixed with varying percentages of Glass Powder is Tabulated in Table 2 and shown in Figure 2.

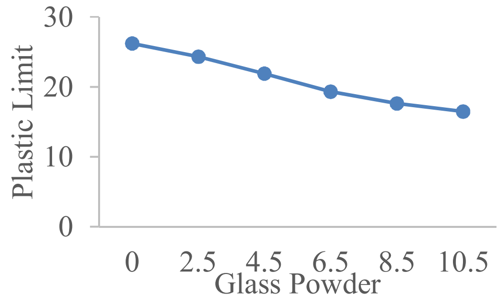

Fig 2. Plastic limit of soil with Different percentages of Glass Powder.

2. Plasticity Index Test Results:

The plasticity Index of virgin soil as well as of soil samples mixed with varying percentages of Glass Powder is Tabulated in Table 3 and shown in Figure 3.

Table 3. PlasticityIndex Results.

S. No	Mix	Plasticity Index (%)
1	Soil	21.0
2	Soil + 2.5 % Glass Powder	18.57
3	Soil + 4.5 % Glass Powder	16.87
4	Soil + 6.5 % Glass Powder	17.54
5	Soil + 8.5 % Glass Powder	15.56
6	Soil + 10.5 % Glass Powder	15.35

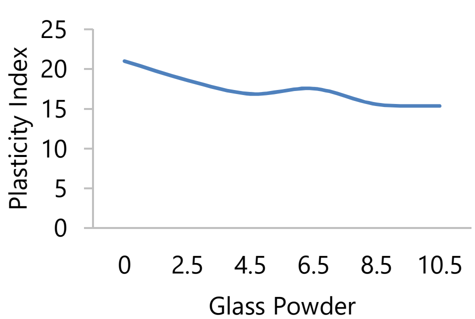

Fig 3. Plasticity Index of soil with Different percentages of Glass Powder.

3. Maximum Dry Density and Optimum Moisture Content Test Results:

Standard Proctor's compaction tests are carried out on soil admixed with glass powder at various percentages ranging from 0% to 10.5 % by weight of the soil in increment of 2 %.The maximum dry density and optimum moisture content of virgin soil as well as of soil samples mixed with varying percentages of glass powder is Tabulated in Table 4 and shown in Figure 4 and Figure 5.

Table 4. Maximum Dry Density and Optimum Moisture Content

S. No	Mix	Maximum Dry Density	Optimum Moisture Content
1	Soil	1.69	16.75
2	Soil + 2.5 % Glass Powder	1.75	15.92
3	Soil + 4.5 % Glass Powder	1.81	14.86
4	Soil + 6.5 % Glass Powder	1.86	13.21
5	Soil + 8.5 % Glass Powder	1.9	10.22
6	Soil + 10.5 % Glass Powder	1.92	9.33

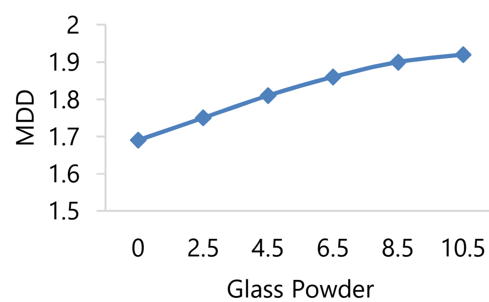

Fig 4. MDD of soil with Different percentages of Glass Powder.

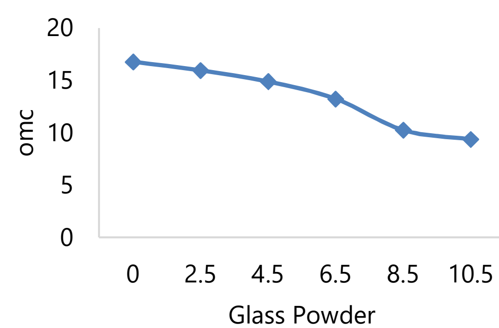

Fig 5. OMC of soil with Different percentages of Glass Powder.

4. California Bearing Ratio Test Results:

California Bearing Ratio Tests are carried out on soil admixed with glass powder at various percentages ranging from 0% to 10.5 % by weight of the soil in increment of 2 %.The California Bearing Ratio Test results of virgin soil as well as of soil samples mixed with varying percentages of Glass Powder Tabulated in Table 7 and shown in Figure 6, 7.

Table 5. CBR Results.

S. No	Mix	California Bearing Ratio	
		Un-Soaked	Soaked
1	Soil	1.22	1.23
2	Soil + 2.5 % Glass Powder	3.5	1.35
3	Soil + 4.5 % Glass Powder	6.2	3.1
4	Soil + 6.5 % Glass Powder	9.3	5.4
5	Soil + 8.5 % Glass Powder	14.6	7.8
6	Soil + 10.5 % Glass Powder	21.4	9.3

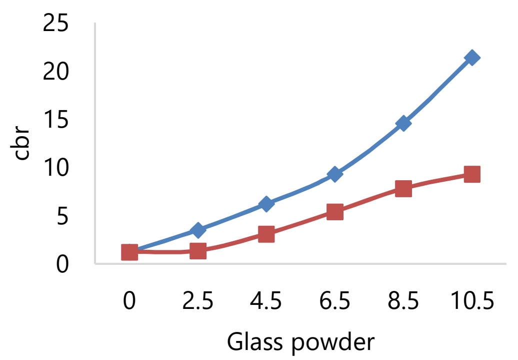

Fig 6. CBR of soil with Different percentages of Glass Powder.

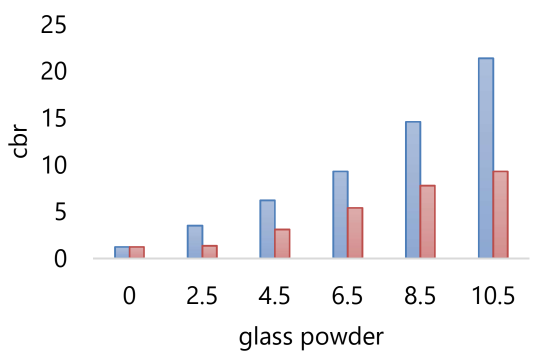

Fig 7. CBR of soil with Different percentages of Glass Powder (Column View).

5. Unconfined Compressive Strength Test Results

Unconfined Compressive Strength Test are carried out on soil admixed with glass powder at various percentages ranging from 0% to 10.5 % by weight of the soil in increment of 2 %.The Unconfined Compressive Strength Test results of virgin soil as well as of soil samples mixed with varying percentages of Glass Powder is Tabulated in Table 6 and shown in Figure 8.

Table 6. UCS Test Results.

S. No	Mix	UCS (KN/m2)
1	Soil	61.35
2	Soil + 2.5 % Glass Powder	71.42
3	Soil + 4.5 % Glass Powder	86.76
4	Soil + 6.5 % Glass Powder	105.76
5	Soil + 8.5 % Glass Powder	133.45
6	Soil + 10.5 % Glass Powder	119.23

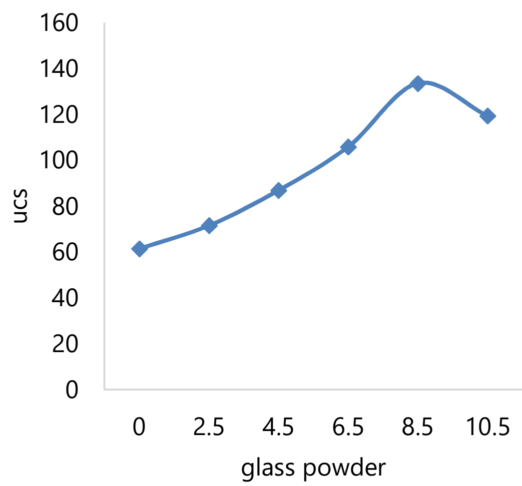

Fig 8. UCS of soil with Different percentages of Glass Powder.

6. Direct Shear Test Results:

Direct Shear Test are carried out on soil admixed with glass powder at various percentages ranging from 0% to 10.5 % by weight of the soil in increment of 2 %.The Direct shear Test results of virgin soil as well as of soil samples mixed with varying percentages of Glass Powder is Tabulated in Table 7 and shown in Figure 9, 10.

Table 7. Direct Shear Test Results.

S. No	Mix	Direct Shear Test	
		Cohesion (KN/m2)	Angle of Internal Friction
1	Soil	40.55	25.3
2	Soil + 2.5 % Glass Powder	52.54	31.3
3	Soil + 4.5 % Glass Powder	61.65	34.8
4	Soil + 6.5 % Glass Powder	74.11	38.1
5	Soil + 8.5 % Glass Powder	96.55	41.7
6	Soil + 10.5 % Glass Powder	104.13	43.7

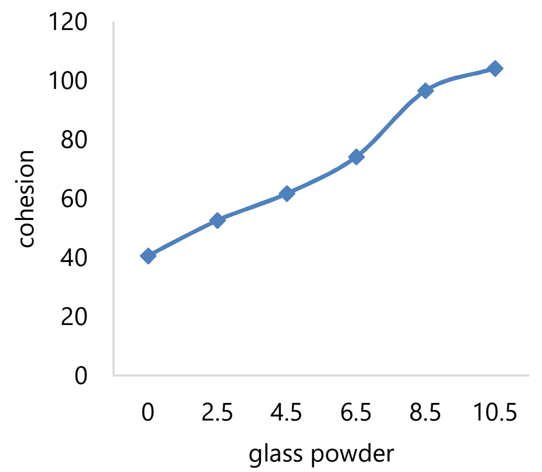

Fig 9. Cohesion of soil with Different percentages of Glass Powder.

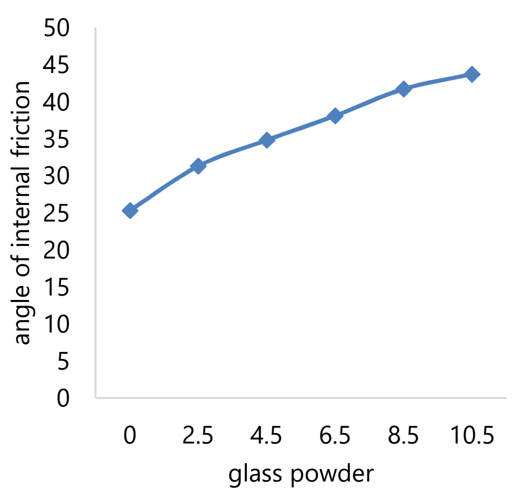

Fig 10. Internal Friction of soil with Different percentages of Glass Powder.

III. CONCLUSIONS

On the basis of test results following conclusions are drawn: -
It is concluded that for improving the properties of soil, waste glass powder is found to be useful. As the waste glass material is locally available and is also cheaply available it is found to be useful in economic solutions. Usage of Glass powder in soil stabilization helps in the reduction of environmental effects. It is seen from the results that with the increase in the percentage of glass powder liquid limit decreases, which will help in improving the sub grade. It is seen from the results that with the increase in the percentage of glass powder plastic limit decreases, which will help in improving the sub grade.

It is seen from the results that with the increase in the percentage of glass powder plasticity index decreases, which will help in improving the sub grade. It is seen from the results that with the increase in the percentage of glass powder MDD increase up to 8.5%, and after that it remains constant. MDD increases from 1.69% to 1.92%. It is seen from the results that with the increase in the percentage of glass powder OMC decreases. OMC decreases from 16.75% to 9.33%.

It is seen from the results that with the increase in the percentage of glass powder CBR increases, maximum value was found to be 21.4% and 9.3% respectively. It is seen from the results that with the increase in the percentage of glass powder UCS increase up to 8.5%, and after that it decreases. UCS increases from 61.35 KN/m2 to 133.45 KN/m2 and decreases to 119.23 after that. It is seen from the results that with the increase in the percentage of glass powder Shear strength increases. From the results it is seen that optimum percentage of Glass powder is 8.5%.

REFERENCES

[1] N.S. Pandian, K.C. Krishna, A. Sridharan, California bearing ratio behaviour of soil/flyash mixtures. Journal of Testing and Evaluation 29(2) (2001) 220-226.
[2] S.R. Kaniraj, V. Gayathri, Geotechnical behaviour of fly ash mixed with randomly oriented fiber

inclusions. Geotext. Geo membranes 21(3) (2003) 123-149

[3] O.O. Amu, A.B. Fajobi, S.O. Afekhuai, Stabilizing potential of cement and fly ash mixture on expansive clay soil. Journal of Applied Sciences 5(9) (2005) 1669-1673

[4] N. Degirmenci, A. Okucu, A. Turabi, (2007) Application of phosphogypsum in soil stabilization. Building and Environment 42(9) (2007) 3393-3398.

[5] R.S. Sharma, B.R. PhaniKumar, B.V. Rao, Engineering behaviour of remolded expansive clay blended with lime, calcium chloride and Rice -husk ash. Journal of Materials in Civil Engineering 20(8) (2008) 509-515

[6] E. Cokca, V. Yazici, V. Ozaydin, Stabilisation of expansive clays using granulated blast furnace slag (GBFS) and GBFS-cement. Journal of Geotechnical and Geological Engineering 27(4) (2009) 489-499.

[7] S. Bin-Shafique, K. Rahman, M. Yaykiran, I. Azfar, The long-term performance of twofly ash stabilized fine-grained soil sub base. Resources, Conservation Recycling 54(10)(2010) 666–672.

[8] Ashraf Anas, Arya Sunil, Mariamma Joseph" Soil stabilization using raw plastic bottles", Journal of Engineering and Development, Vol. 17, Issue No.4, October 2013, pp- 489-492.

[9] BaraskarTushal, Ahirwar S.K, "Study on California bearing ratio of black cotton soil use waste copper slag', International Journal of structural and civil engineering research", Vol.3, Issue No.4, November 2014, pp- 44-56.

[10] Bhattarai Pragyan, Kumar Bharat, "Engineering behavior of soil reinforced with plastic strips", International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development (IJCSEIERD) Vol. 3, Issue No. 2, Jun 2013, pp- 83-88.

[11] Brooks R M., "Soil Stabilization with Fly Ash and Rice Husk Ash", International Journal of Research and Reviews in Applied Science, Vol. 01, Issue No. 3, December 2009, pp- 209-217.

[12] Butt Wajid, Gupta Karan, Jha J.N, "Strength behaviour of Clayey soil Stabilized with Saw Dust Ash", International Journal of Geo-Engineering, Issue No. 21, October 2016, pp- 7-18.

[13] Celestine O. Okagbue,"Stabilization of clay using wood ash" Journal of Materials in Civil Engineering, ASCE, Vol. 19, Issue No.1, January 2007, pp- 14-18.

[14] Chand.A Mohan, Babu V Ramesh, Babu B. Ramesh,. Niveditha K, "Behaviour of Black Cotton Soil with Addition of Copper Slag and Steel Slag", International Research Journal of Engineering and Technology, Vol .4, Issue No. 01, Jan-2017, pp- 752-758.

[15] Consoli, N. C., Montardo, J. P., Prietto and Pasa, G. S.," Engineering behavior of sand reinforced with plastic waste", Journal of Geo technical and Geo environmental Engineering. Vol.128, Issue No.6, 2002, pp- 462-472.

[16] E. Ravi, R. Udhayasakthi, T. Senthil Vadivel, "Enhancing the Clay Soil Characteristics using Copper slag Stabilization", Journal of Advances in Chemistry, Vol.12, Issue No. 26, December 2016,pp- 1212-1215.

[17] George Rowland Otoko, Braide K. Honest, "Stabilization of Nigerian deltaic laterites with sawdust ash", International Journal of scientific research and management, Vol 2, Issue No.8, August2014, pp- 69-75.

[18] Ghiassian H., Poorebrahim G., and Gray D. H., "Soil reinforcement with recycled carpet wastes". Waste Management Research, Vol. 22 Issue No. 2, 2004, pp- 108-114.

[19] Jayapal, S.Boobathiraja, M.Samuel Thanaraj, K.Priyadharshini, "Weak soil stabilization using different admixtures A comparative study", International Journal of engineering research and technology, Vol 3, Issue No.10, October 2014, pp- 57-63.

[20] Kaniraj, S. R. and Havanagi, V. G., "Behaviour of cement-stabilized fiber reinforced fly ash–soil mixtures" Journal of Geotechnical and Geo environmental Engineering, Vol. 12., Issue No.7, 2001,pp- 18-26.

[21] Karthik.S, Kumar Ashok. E Gawtham, P Elango, G, Gokul, D Thangaraj, "Soil Stabilization byUsing Fly Ash", IOSR Journal of Mechanical and Civil Engineering, Vol. 10, Issue No.6, Jan 2014,pp- 20-26.

[22] Kumar P. Rajendra, Kumar Praveen,. Maheswari G, "Laboratory Study of Black Cotton Soil Blended with Copper Slag and Fly Ash", International Journal of Innovative Research in Science, Vol. 6, Issue No.2, February 2017, pp- 1960-1967.

[23] Kumar Prashant,. Paliwal M.C, Jain A.K., "Stabilization of Sub Grade Soil by using Foundry Sand Waste", International Journal of Engineering Science and Research Technology,

Vol. 5 , IssueNo .9, September 2016, pp- 300-308.

[24] Maheshwari K.,"Behaviour of Fibre Reinforced Soil", Australian Geomechanics Journal, Vol. 44,Issue No. 4, December 2009, pp- 65-74.

[25] Malhotra Monica, Naval Sanjeev, "Stabilization of Expansive Soils Using Low Cost Materials" International Journal of Engineering and Innovative Technology, Vol. 02, Issue No. 11, May 2013, pp- 181-184.