

Effects of Fibre on Strength Properties of Soil at Different Depth of Soil Layers

Dilip Kumar¹, Ashish Gupta²

¹Assistant Professor, Department of Civil Engineering,
Madan Mohan Malviya University of Technology, Gorakhpur, UP-273010, India

²Assistant Professor, Department of Civil Engineering,
Bundelkhand Institute of Engineering & Technology, Jhansi, U.P.-284128, India

Abstract: Construction of building and many civil engineering structures on weak or soft soil is very risky and dangerous on geotechnical grounds because this type of soil is take place settlements, poor bearing capacity, weak strength parameters and high compressibility of soil. Improvement of load bearing capacity of the soil may be undertaken by a variety of ground improvement techniques like soil stabilization, vibroflotation and fiber reinforced earth technique of soil etc. fiber reinforced earth technique is a very effective ground improvement technique because of its cost effectiveness, easy adaptability and reproducibility and workability etc. Therefore, In this Research paper, it is experimentally carried out to investigate the effects of the fiber on engineering properties of the soil at different layers. Polypropylene fiber has been used as the reinforcement material and it was included in to the soil at two different layers, i.e.0, 40, 80 mm. The main objective of this investigation had been focused on the strength behavior of the soil reinforced with polypropylene fiber. The fiber reinforced soil samples were subjected to compaction, permeability, shear strength and California Bearing Ratio (CBR).

Keywords: Soil, polypropylene fiber, Shear strength, CBR test

1. Introduction

Application of soil strengthening or stabilized range from mitigate of complex slope hazardous to increase the sub grade stability. A numbers of studied have been conducted to investigate the influence of randomly oriented fiber on engineering behaviors of soils. The purpose of this investigation was identifying the influence of fibers variables on performance of fiber reinforced soils-fly ash, sand and cement specimens. A series of laboratory UCS test were carried with polypropylenes and polyester with different length. The inclusions of randomly distributed fibers significantly improve the unconfined compressive strength of soils and their mixtures (sand, cement and fly ash). Kaniraj and Havangi (2001) conducted an experimental program to study the individual and combined effect of randomly oriented fibers inclusions and cement stabilization on the geotechnical characteristics of fly ash-soil mixtures. Over the years, field experiments and research information have been collected and studied on the behaviors of soil cement mixtures, and quite a few studied have been conducted for fiber reinforcement in soil cement mixtures. Lawton EC, Khire MV, Fox NS (1993) discuss the benefits of prototypical geosynthetic multioriented inclusions applied to ottowa sand and silts sands. Gray DH, Ohasahi H. (1983) find the increase in shear strength with increasing fibre length. Mahar MH, Gray DH (1994) static response of sand reinforced with randomly distributed fibers. Freitag DR (1986) soil randomly reinforced with soil. Ranjan G, Vasam RM, Charan HD (1996) examined distinct relationship between the grain size of given soils and fibre bond strength. Leung C, KY (1992) provided a derivation of fiber bond strength. We know that the variation in properties of soil is very large between two nearly places .This variations creates to the problem in construction and understand the behavior of sub-surface soil. In India fiber reinforcement is not a very old technique for soil stabilization. Its use is recently started

in India. But in developed countries this technique is being used from many years.

Among the various uses of fiber the major quantity of fiber may be use for Geotechnical engineering applications such as construction of embankment, increases of strength of sub-surface of roads ,backfill etc. In present work, an attempt has been made to look into the utilization of fiber in sub-surface strata (for highway).

In this report a review of feasibility of fiber reinforcement for construction purposes has been presented and related environmental aspects have been highlighted. It is expected that the utilization of fiber for beneficially purposes will not only help optimum planning and utilization of soil for construction purposes but also helps in increasing the bearing capacity of soil. The fiber can be used in different forms like sheet form or thread form. This report discusses the effect of fiber on engineering properties of soil. The main objective of this work is to find out whether the use of fiber is advantageous for soil stabilization or not

2. Experimental Program

In this programmed, we get a brief idea about different tests, which, we are going to perform for our experimental studies. For this we are going to perform following tests:

- (a) Proctor Compaction Test (OMC/MDD)
- (b) California Bearing Ratio (CBR)
- (c) Permeability Test
- (d) Direct Shear Strength Test

Table 1: Engineering Properties of soil

S. No	Property	Values
1.	Liquid limit, LL (%)	58
2.	Plastic limit, PL (%)	28
3.	Plasticity index, PI (%)	30

4.	Shrinkage limit, SL (%)	12
5.	Specific gravity ,G	2.70
6.	Optimum moisture content, OMC (%)	15.00
7.	Maximum dry density (gm/cc), MDD	1.502
8.	Clay content, (%)	42
9.	Silt content, (%)	30
10.	Sand content, (%)	28

A Polypropylene fiber sheet is used for performing the above experiment.

3. Results

We will see the recorded observations and performed calculations of different tests. Also the graphs of different tests with their respective results are shown for all tests which are performed on the soil sample. The engineering Properties of soil with fiber and without fiber are as following table.

Table 2: Engineering Properties of soil with fiber

Properties	OMC (%)	MDD (gm/cc)	Coefficient of Permeability (K) (cm/sec)	Shear Strength		CBR (%)
				C(kN/m ²)	Φ (°)	
Soil Sample No Fiber is used	15.00	1,502	6.043×10^{-6}	3.57	29.00	3.65
Fiber is used at a Depth of 40mm	15.80	1,751	3.457×10^{-6}	3.87	30.80	4.00
Fiber is used at a Depth of 80mm	16.00	1,764	4.012×10^{-6}	4.02	31.20	3.74

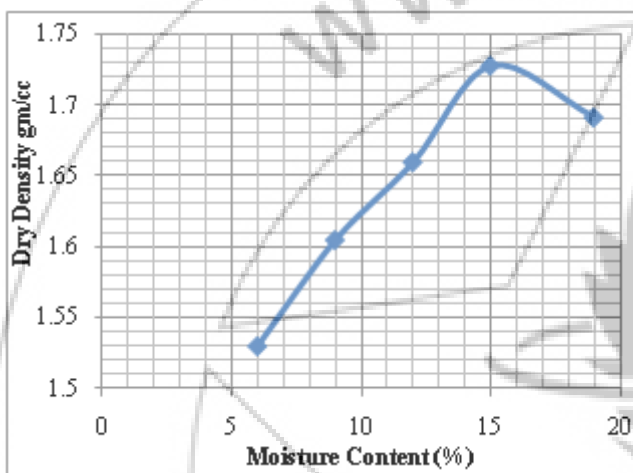


Figure 1: Compaction Curve when no Fiber is used

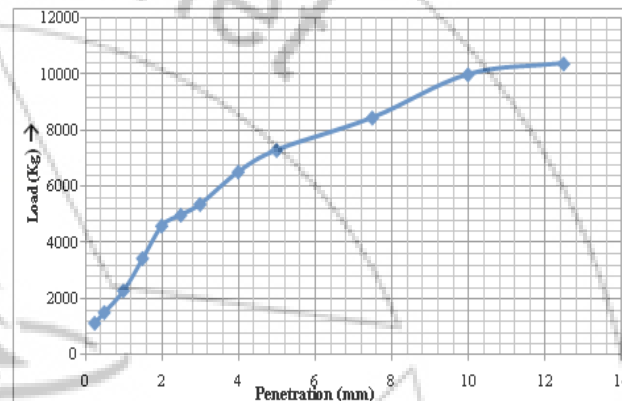


Figure 3: Compaction Curve when Fiber is used at a Depth of 80mm

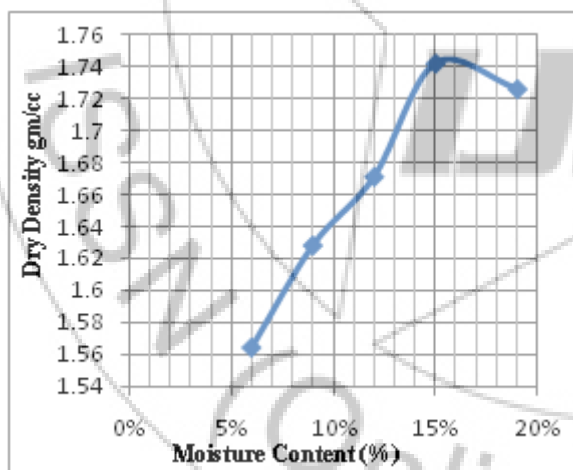


Figure 2: Compaction Curve when Fiber is used at a Depth of 40mm

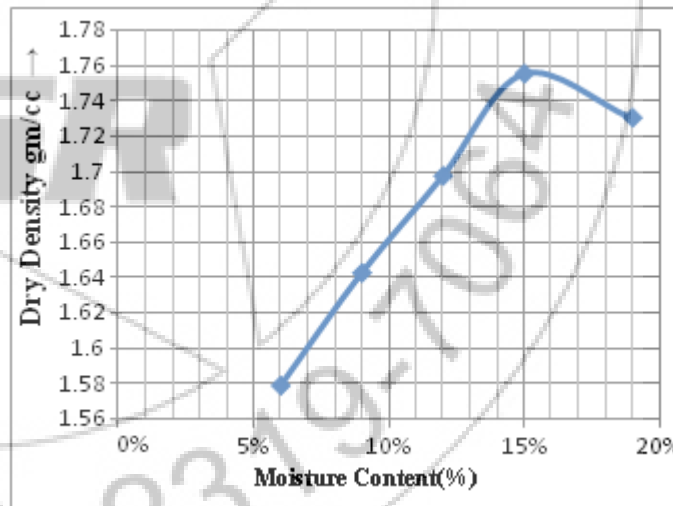


Figure 4: CBR Value when no Fiber is used

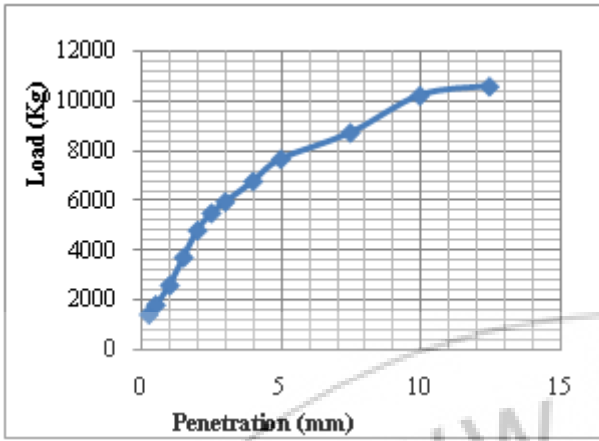


Figure 5: CBR Value when Fiber is used at a Depth of 40mm

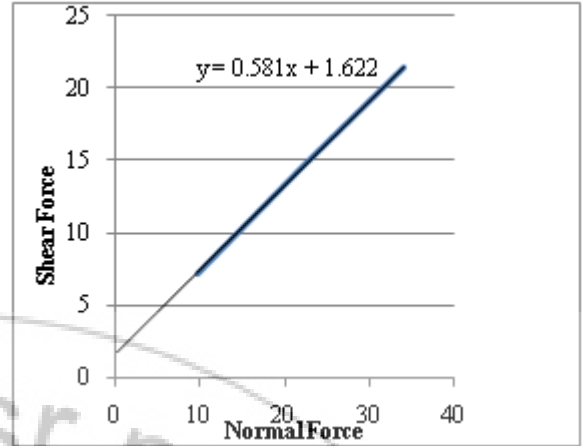


Figure 9: Shear Strength when Fiber is used at a Depth of 80mm

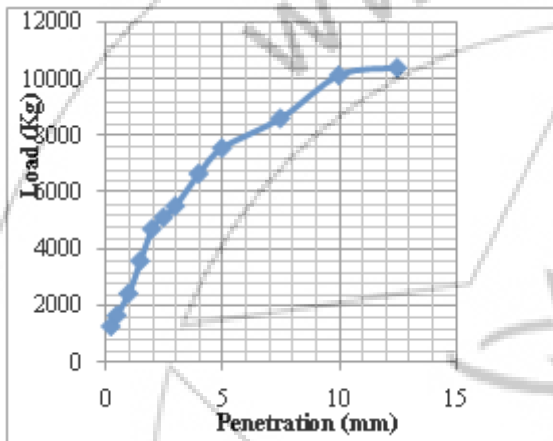


Figure 6: CBR Value when Fiber is used at a Depth of 80mm

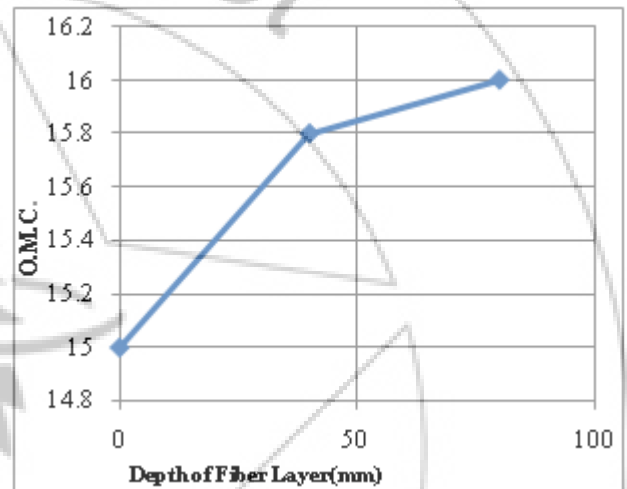


Figure 10: Comparative graph of OMC & Depth of Fiber Layer

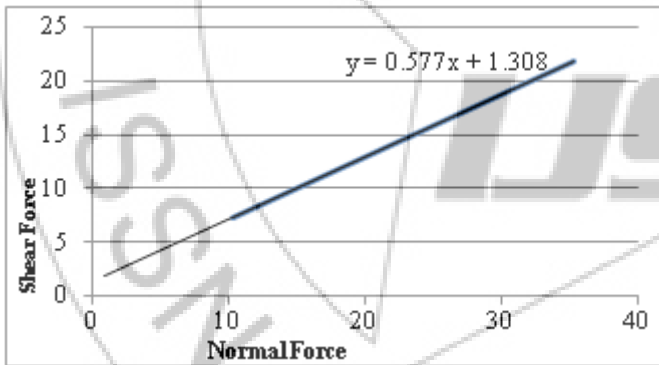


Figure 7: Shear Strength when no Fiber is used

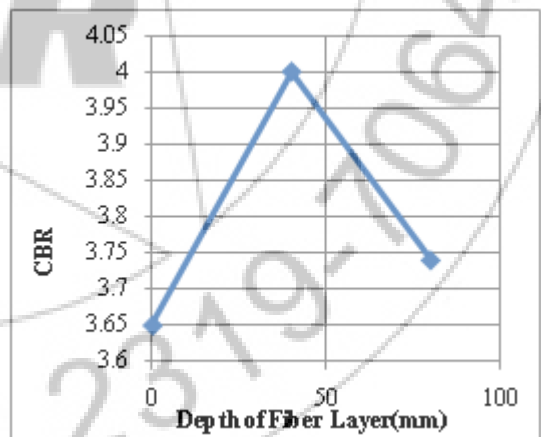


Figure 11: Comparative graph of CBR & Depth of Fiber Layer

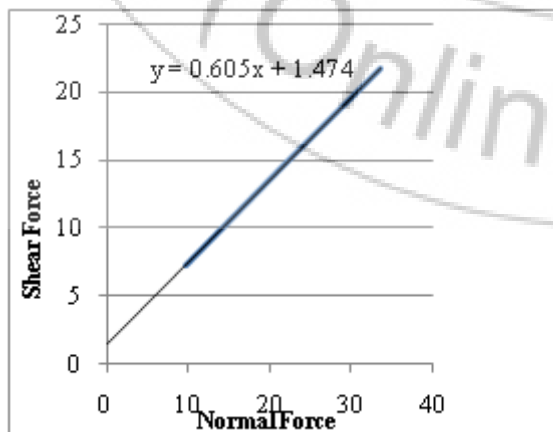


Figure 8: Shear Strength when Fiber is used at a Depth of 40mm

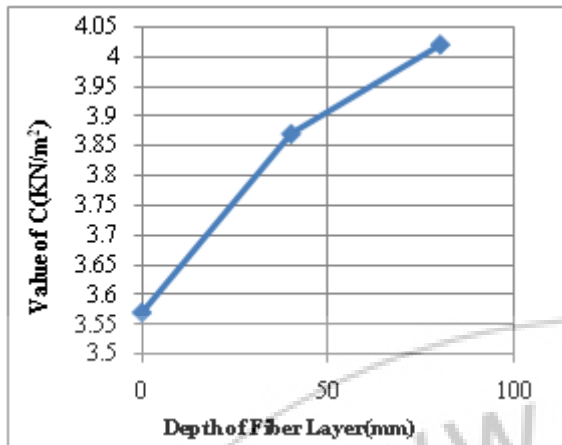


Figure 12: Comparative graph of Cohesion & Depth of Fiber Layer

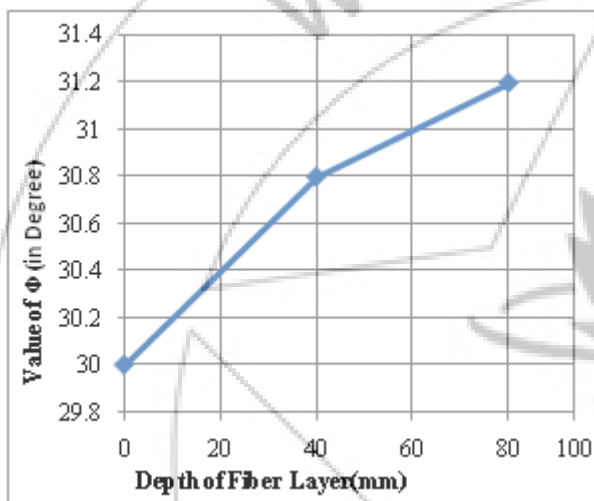


Figure 13: Comparative graph of Angle of Repose

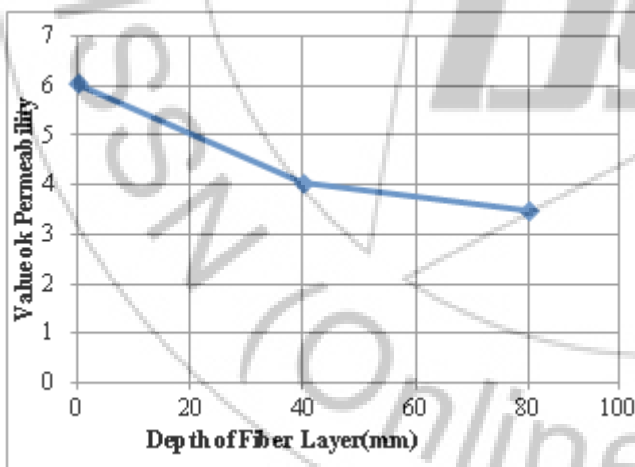


Figure 14: Comparative graph of Coefficient of permeability & Depth of Fiber Layer

4. Conclusion

It may be concluded that the ground improvement by fiber reinforcement of the clay & different admixtures is not very clear at the present stage there is no definite criteria for evaluating the strength property the effect of fiber & different admixture the soil inclusions on the ucs, shear strength parameter of the soil specimen where determined

the shear strength of fiber reinforced soil is improved due to addition of different fiber.

The use of fiber in Geotechnical engineering, for Stabilization of soil by providing fiber reinforcement to it is advantageous. Two advantages namely (a) Increase in bearing capacity of soil and (b) reduction in the erosion of top soil by water. Mass scale utilization of fiber can be carried out especially in that area which are very much important or prone to heavy damage due to flood. This work is an attempt to check the feasibility of fiber in the soil stabilization by providing fiber reinforcement to the soil.

1. Load carrying capacity of road soil increases with increasing the number of layer of fiber in sub-soil strata.
2. The settlement of foundation decreases with increasing the thickness of fiber.
3. The OMC of the soil increases from 15% to 15.8% and 16%, when the fiber is used at a depth of 40mm and 80mm.
4. The CBR value of soil first increases from 3.65 to 4.0 when the fiber is used at a depth of 40mm and this value decreases to 3.74 when we use it at a depth of 80mm.
5. The value of coefficient of permeability reduces from 6.043×10^{-6} to 4.012043×10^{-6} and 3.457043×10^{-6} when the fiber is used at a depth of 40mm and 80mm.
6. Similarly, the value C (KN/m²) changes from 3.57 to 3.87 and 4.02, when the fiber is used at a depth of 40mm and 80mm. And the value of Φ (in degree) changes from 29 to 30.8 and 31.2.

References

- [1] Temel Yetimoglu, Muge Inanir and Orhan Esat Inanir, "A study on bearing capacity of randomly distributed fiber-reinforced sand fills overlying soft clay", Department of Civil Engineering, Ataturk University, 25240 Erzurum, Turkey.
- [2] Gray, D.H., Al-Refeai, T., 1986. Behavior of fabric versus fibre-reinforced sand. Journal of Geotechnical Engineering, ASCE 112 (8), 804–820.
- [3] Temel Yetimoglu and Omer Salbas, "A study on shear strength of sands reinforced with randomly distributed discrete fibres", Atac 2 Sk., Umud Apt. 52/16, Kızılay-Ankara 06410, Turkey.
- [4] Kaniraj, S.R., Havanagi, V.G., 2001. Behavior of cement-stabilized fibre-reinforced flyash-soil mixtures. Journal of Geotechnical and Geoenvironmental Engineering, ASCE 127 (7), 574–584.
- [5] Kumar, R., Kanaujia, V.K., Chandra, D., 1999. Engineering behavior of fibre-reinforced pond ash and silty sand. Geosynthetics International 6 (6), 509–518.
- [6] Michèle Dal Toé Casagrande¹, Matthew Richard Coop², and Nilo Cesar Consoli, Ph.D., research paper, "Behavior of a Fibre-Reinforced Bentonite at Large Shear Displacements".
- [7] By Shenbaga, R. Kaniraj¹ and Vasant G. Havanagi, "Behavior Of Cement-Stabilized Fibre-Reinforced Fly Ash-Soil Mixtures".
- [8] By J. D. Frost¹ and J. Han,² Members, Asce, "Behavior Of Interfaces Between Fibre-Reinforced Polymers And Sands".

- [9] Bauer, G.E., Oancea, A., 1996. Triaxial testing of granular soils reinforced with discrete polypropylene fibres. In: De Groot, M.B., Den Hoedt, G., Termaat, R.J. (Eds.), Proceedings of the First European Geosynthetics Conference on Geosynthetics: Applications, Design and Construction. A.A. Balkema, Rotterdam, The Netherlands, pp. 407–410.
- [10] Nilo Cesar Consoli, Márcio Antonio Vendruscolo and Pedro Domingos Marques Prietto, “Behavior of Plate Load Tests on Soil Layers Improved with Cement and Fibre”.
- [11] Nilo Cesar Consoli, Michéle Dal Toé Casagrande and Matthew Richard Coop,
- [12] “Effect of Fibre Reinforcement on the Isotropic Compression Behavior of Sand”.
- [13] Izgin, M., Wasti, Y., 1998. Geomembrane–sand interface frictional properties as determined by inclined board and shear box test. *Geotextiles and Geomembranes* 16 (4), 207–219.
- [14] Kaniraj, S.R., Havanagi, V.G., 2001. Behavior of cement-stabilized fibre-reinforced fly ash–soil mixtures. *Journal of Geotechnical and Geoenvironmental Engineering*, ASCE 127 (7), 574–584.
- [15] Karla Salvagni Heineck, Matthew Richard Coop and Nilo Cesar Consoli, “Effect of Microreinforcement of Soils from Very Small to Large Shear Strains”.
- [16] Yi Cai, Bin Shi, Charles W.W. Ng, Chao-sheng Tang , “Effect of polypropylene fibre and lime admixture on engineering properties of clayey soil”, Department of Earth Sciences, Nanjing University, 210093, China, Department of Civil Engineering, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong Special Administrative Region.
- [17] Shear Strength of Unsaturated Clays”, Assistant Professor, Civil Engineering Department Imam Khomeini International University, Qazvin, Iran.
- [18] Han, J. (1997). “An experimental and analytical study of fibre reinforced polymer piles in sand and pile-sand interactions,” PhD dissertation, The Georgia Institute of Technology, Atlanta.
- [19] Kishida, H., and Uesugi, M. (1987). “Tests of the interface between sand and steel in the simple shear apparatus.” *Geotechnique*, London, 37(1), 45–52.
- [20] G. Venkatappa Rao R. K. Dutta and Ujwala D., “Strength Characteristics of Sand Reinforced with Coir Fibres and Coir Geotextiles”, Professor, Department of Civil Engineering, Indian Institute of Technology, New Delhi, India.
- [21] Glogowski, P. E., Kelly, J. M., McLaren, R. J., and Burns, D. L. (1992). “Fly ash design manual for road and site applications.” Final Rep. Prepared for Electric Power Research Institute, Palo Alto, Calif.
- [22] Gray, D. H. (1970). “Role of woody vegetation in reinforcing soils and stabilizing slopes.” *Proc., Symp. on Soil Reinforcement and Stabilizing Techniques*, 253–306.
- [23] Mahyar Arabani, Akbar K. Haghi And Mehdi Veis Karami, “A Study on the Strength Behavior of Stabilized Clayey Sands Using Lime-Polyamide Fibre”, Dept. of Civil Engineering, the University of Guilan, Rasht, Iran.
- [24] Ezzat William, “An Evaluation of the Role of Fabric on Stiffness and Shear Strength of Bringelly Shale”, Department of Civil Engineering, The University of Sydney, Australia.