INFLUENCE OF PINE NEEDLES ON SHEAR STRENGTH AND CALIFORNIA BEARING RATIO OF CLAYEY SOIL-AN EXPERIMENTAL INVESTIGATION

Sabahat Yahya[1], Saurabh Bali[2]
Mtech Scholar[1], Assistant Professor[2]
Department of Civil engineering, Galaxy Global Group Of Institutes, Haryana, India.

ABSTRACT
Clayey soils and their related abnormal behaviour such as excessive shrinkage, swelling, consolidation, settlement and cracking on drying has been the subject of many investigations. In recent years, an increasing need is being felt for various types of constructions in marginal; lower reclaimed lands and coastal areas which are not suitable normally for construction purposes. Clay, well known for its high compressibility and poor shear strength, pose numerous problems to builders. However, reportedly in many cases, these additives resulted in a decrease in plasticity and increase in hydraulic conductivity. As a result, there has been a growing interest in soil/fibre reinforcement. The paper presents the effect of Pine needles stabilization on strength behaviour of clayey soil. Pine needles were collected from locally available forest (Rajouri, J&K, India) and were chopped into 10 to 15mm lengths and left for sun drying till they turn yellowish brown in colour. Pine needles were then added randomly in clayey soil at different percentages (i.e. 0.5%, 1% 1.5%, 2%, 2.5%) by dry weight of soil. Soil samples randomly mixed with Pine needles were prepared at different water contents to determine the maximum dry density (MDD) and optimum moisture contents (OMC) of various samples .The soil samples were then subjected to (California bearing ratio) CBR and Shear Strength tests. The CBR test results shows that there is significant increase in CBR value and shear strength of soil reinforced with Pine needles.

Keywords: Clayey soil, pine needles, OMC, MDD, stabilisation, CBR.

1. INTRODUCTION

The primary purpose of reinforcing a soil mass is to improve its stability by increasing its bearing capacity, and by reducing settlement and lateral deformation. Conventional reinforcing methods make use of continuous inclusions of strips, fabrics, and grids into the soil mass. The random inclusion of various types of fibres is a modification of the same technique, in which the fibres act to interlock soil particles and aggregates in a unitary coherent matrix. Treatment of soft soils with natural product offers economical, ecological and environmental benefits. For the advantages, pine needle fibre is a versatile product, available abundantly, it is, as such a sure and economical answer. Treatment of soft soils with natural product offers economical, ecological and environmental benefits. The pine needle fibre also has strong characteristic and durable, making it suitable for use in the cementitious matrix for high performances structural element. Flexural properties are very important for construction materials, especially when their intended applications are in area such as country road or pavement.

1.1 OBJECTIVES

The following are the objectives of the study:
1. To determine the properties of clayey soil
2. To compare the effectiveness strength between treated and untreated clayey soil.
3. To find the effectiveness of pine needles in clayey soil.

2. MATERIALS AND METHODOLOGY

2.1. Material Used

2.1.1. Pine needles

Naturally available Pine needles were collected from local forest of Rajouri, J&K. Pine needles were separated and fibres were cut in length of 10 mm to 15mm.The properties of pine needles are given in table 1.

Table 1 : Properties of pine needles

S.NO	Material Properties	Values
1.	Fiber Length	10 mm to 15 mm
2.	Diameter	0.7 mm to 1.2 mm
3.	Colour when dry	Brown
4.	No. of fibres per g	200
5.	Holocellulose content	67.29%
6.	Pentosan	11.57%

2.1.2. Soil

The soil samples were collected from Dangri, a local place in Rajouri ($33^0 23'$N $74^0 18'$E). Prototypes for soils were created in the college of Engineering & Technology BGSB University Rajouri J&K geotechnical engineering lab.

Figure 1: sampling site

2.2. METHODOLOGY

Undisturbed samples were collected from the site and various tests were performed . In first series of tests the grain size analysis was done by using hydrometer. Then atterberg's limits like plastic limit, liquid limit, shrinkage limit of the virgin soil and also reinforced soil were found. In second series of tests, standard proctor test , unconfined compression test and California bearing ratio tests were done on both virgin and reinforced soil. Reinforcement of soil was carried by inclusion of pine needles. The pine needles were varied from 0.5% to 2.5% by weight of soil.

3. RESULTS:

3.1.1. Effect of pine needles on the California Bearing Ratio

3.1.1.1. California Bearing Ratio Test Curve For Unreinforced Soil

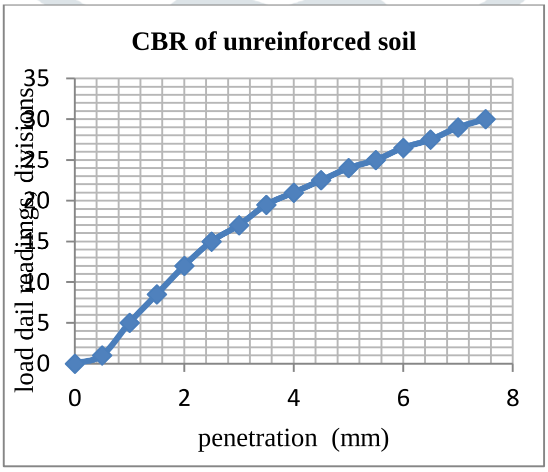

Fig 2: CBR for unreinforced soil

CBR value = 6.35%

<u>Correction is required</u>

Corrected CBR at 2.5 = 852.00/13700 = 0.06218×100 = 6.21%

Corrected CBR at 5.0 = 1335.22/20550 = 0.064974×100 = 6.49%

CBR value = 6.49%

3.1.1.2. California Bearing Ratio Test Curve For soil reinforced with 0.5% pine needles

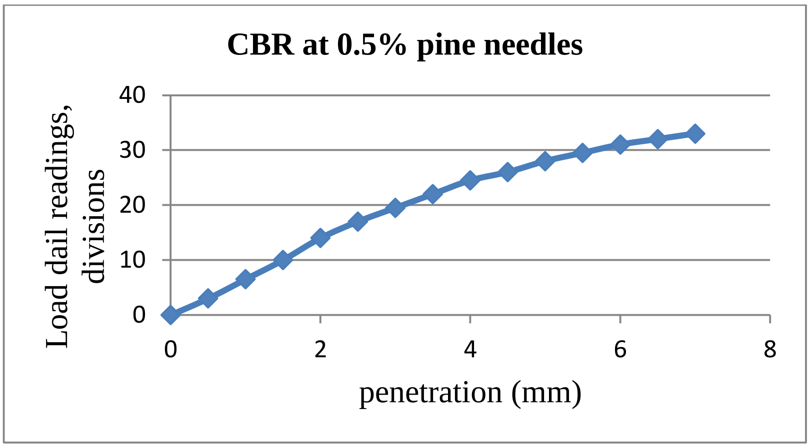

Fig 3: CBR at 0.5% pine needles

Correction is not required

CBR value = 7.46%

3.1.1.3. California Bearing Ratio Test Curve For soil reinforced with 1.0%pine needles

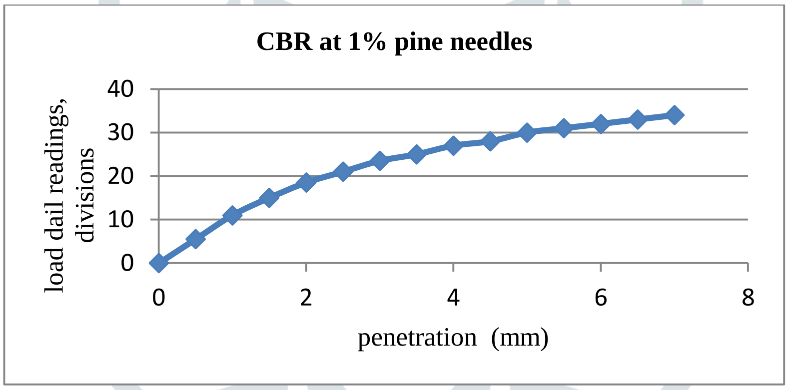

Figure 4 : california bearing ratio at 1.0% pine needles.

Correction is not required
CBR value = 8.29%

3.1.1.4. California Bearing Ratio Test Curve For soil reinforced with 1.5%pine needles

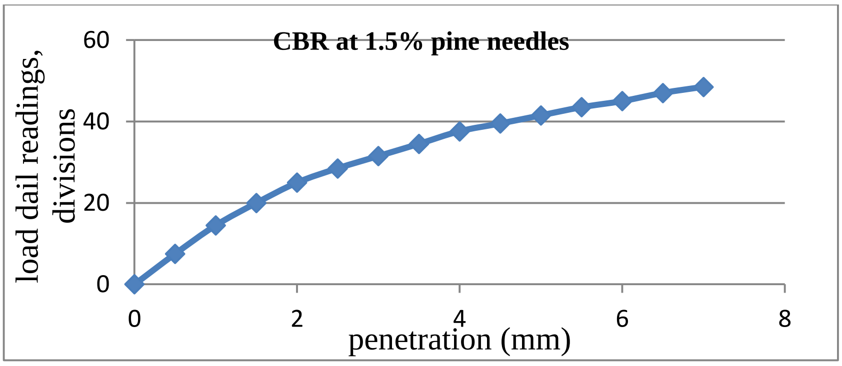

Figure 5 : california bearing ratio at 1.5% pine needles.

Correction is not required
CBR value = 11.19%

3.1.1.5. California Bearing Ratio Test Curve For soil reinforced with 2.0%pine needles

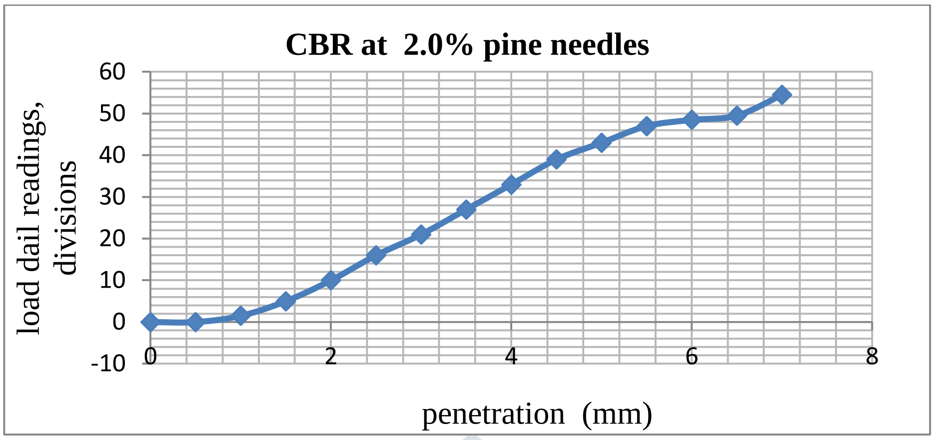

Figure 6 : California bearing ratio at 2.0% pine needles.

Correction is required
CBR value = 12.99%

3.1.1.6. California Bearing Ratio Test Curve For soil reinforced with 2.5% pine needles

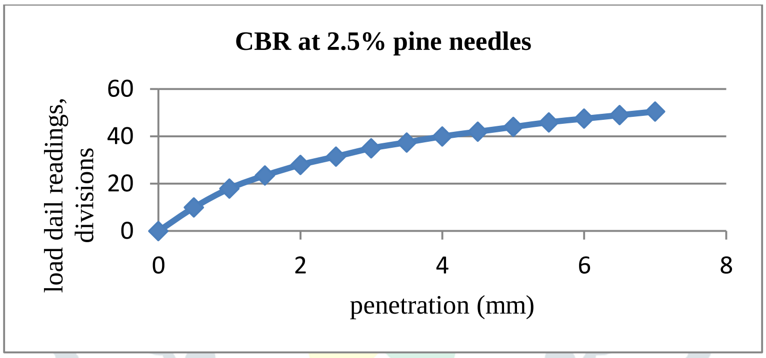

Figure 7 : California bearing ratio at 2.5% pine needles.

Correction is not required
CBR value = 12.64%

3.1.2. Effect of pine needles on Unconfined compression test

3.1.2.1. Unconfined compression test curve of unreinforced soil

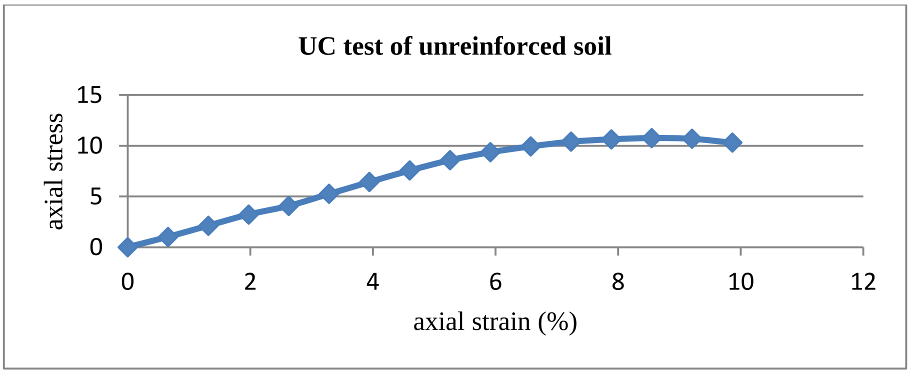

Figure 8: variation of axial stress and axial strain for unreinforced soil

Unconfined compressive strength $q_u = 10.69 N/cm^2$
So, shear strength = $S = C_u = q_u \div 2 = 10.69/2 = 5.34 N/cm^2$
Where C_u = cohesion.

3.1.2.2. Unconfined Compression Test curve of soil reinforced with 0.5% pine needles

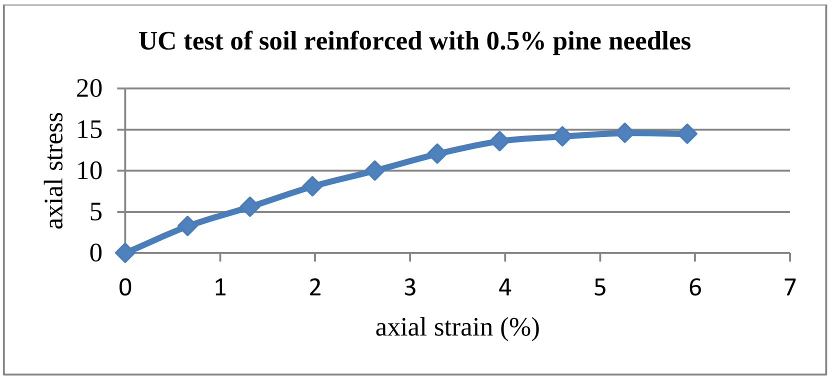

Figure 9: variation of axial stress and axial strain with 0.5% pine needles

Unconfined compressive strength q_u = 14.58N/cm^2
So, shear strength = S = C_u = $q_u \div 2$ = 14.58/2 = 7.27N/cm^2
Where C_u = cohesion

3.1.2.3. Unconfined Compression Test curve of soil reinforced with 1% pine needles

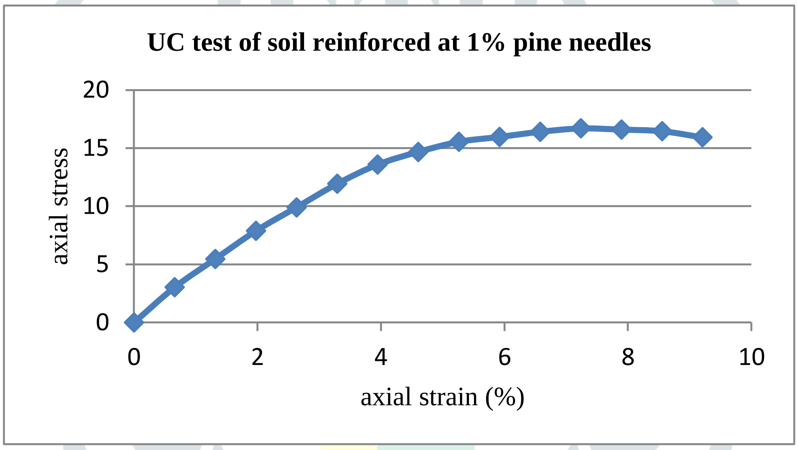

Figure 10: variation of axial stress and axial strain with 1% pine needles

Unconfined compressive strength q_u = 16.70N/cm^2
So, shear strength = S = C_u = $q_u \div 2$ = 16.70/2 = 8.35N/cm^2
Where C_u = cohesion

3.1.2.4. Unconfined Compression Test Curve of soil reinforced with 1.5% pine needles

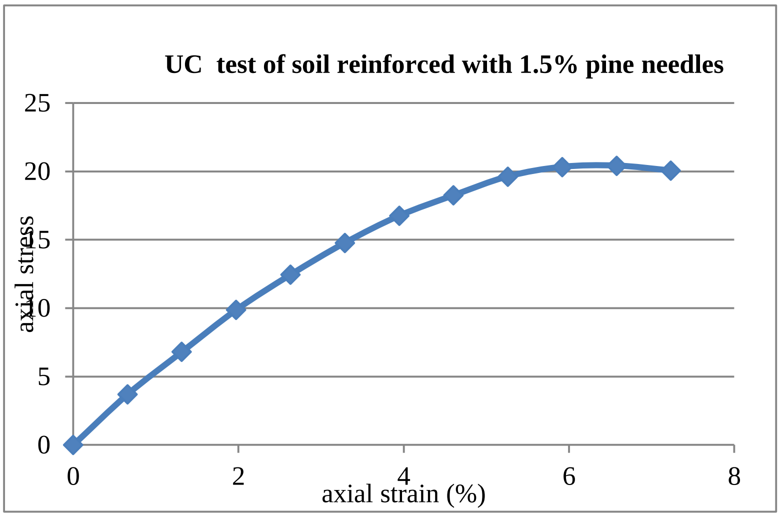

Figure 11: variation of axial stress and axial strain with 1.5% pine needles

Unconfined compressive strength $q_u = 20.42\ N/cm^2$
So, shear strength = $S = C_u = q_u \div 2 = 20.42/2 = 10.21 N/cm^2$
Where C_u = cohesion.

3.1.2.5. Unconfined Compression Test Curve of soil reinforced with 1.5% pine needles

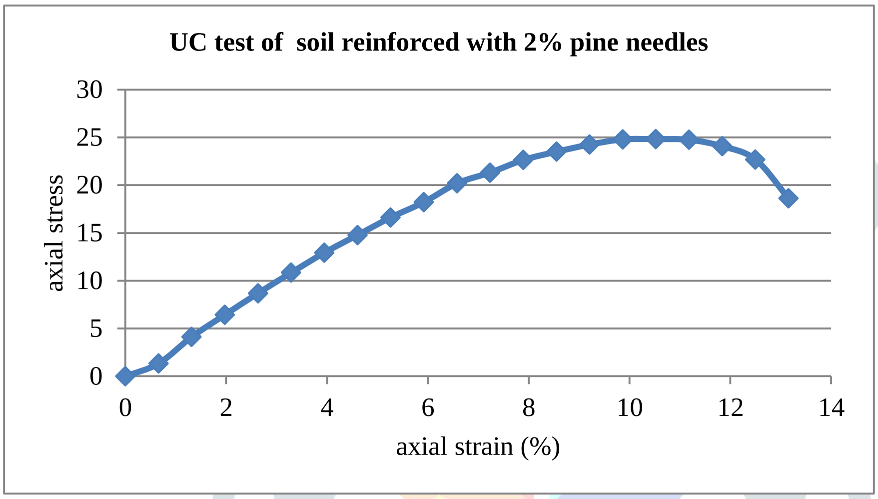

Fig 12: variation of axial stress and axial strain with 2% pine needles

Unconfined compressive strength $q_u = 24.83 N/cm^2$
So, shear strength = $S = C_u = q_u \div 2 = 24.83/2 = 12.41 N/cm^2$
Where C_u = cohesion.

3.1.2.6. Unconfined Compression Test Curve of soil reinforced with 2.5% pine needles

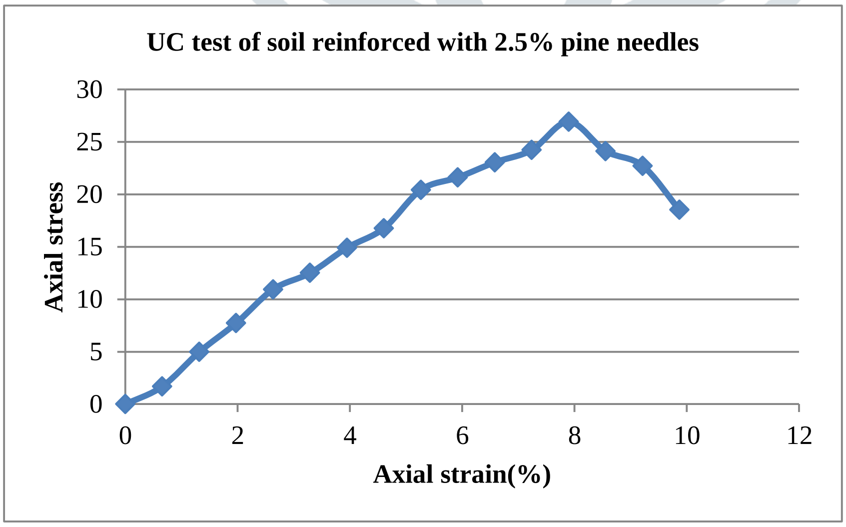

Fig 13: variation of axial stress and axial strain with 2.5% pine needles

Unconfined compressive strength $q_u = 26.93 N/cm^2$
So, shear strength = $S = C_u = q_u \div 2 = 26.93/2 = 13.46 N/cm^2$
Where C_u = cohesion

3.2. Variation of California bearing ratio (CBR) with percentage of pine needles :

Table 2: variation of CBR with pine needles

S.no	*% of pine needles*	*CBR*
1	0	6.49
2	0.5	7.46
3	1	8.29
4	1.5	11.19
5	2	12.99
6	2.5	12.64

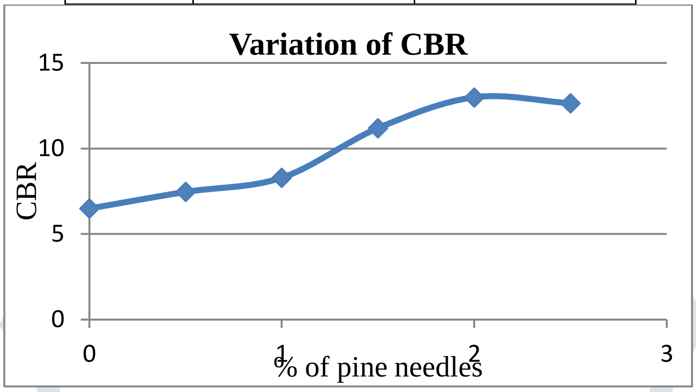

Fig 14: variation of CBR with pine needles

3.3. Variation of Unconfined compressive strength with percentage of pine needles

Table 3: variation of UCT with pine needles

S.no	% of pine Needles	Shear strength (N/cm^2)
1	0	5.38
2	0.5	7.29
3	1	8.35
4	1.5	10.21
5	2	12.41
6	2.5	13.465

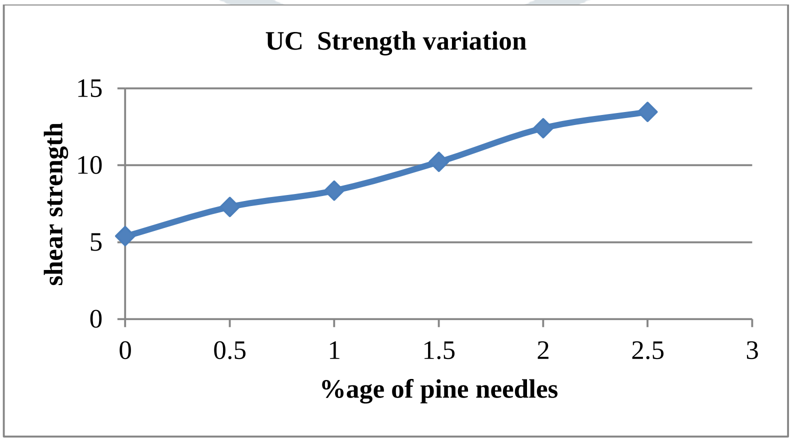

Figure 15: variation of unconfined compressive strength with pine needles

4. CONCLUSION

This study has shown that the improvements in the properties of the clay soil obtained herein are quite significant with the addition of pine needles as reinforcement. Very good results were obtained in terms of the clay soil properties when the percentage quantity of the pine needles was varied between 0.5% and 2.5% by mass of the soil.

Furthermore, it can be concluded based on the results obtained that pine needles can be effectively used as a soil stabilizer since it was able to produce considerable improvements in various soil properties. Such improvements included an achievement of the

CBR values of 12.64% obtained at 2.5% pine needles for unsoaked samples as against 6.35% for the control sample. Likewise, the shear strength of soil was originally recorded as 5.34N/cm^2 increased to 13.465 N/cm^2.

REFERENCES

I. Basic and Applied Soil Mechanics. Gopal Ranjan , ASR Rao, *New Age International publication*.

II. Geotechnical Engineering. C.Venkatramiah,*New Age Publishers.*

III. A simple review of soil reinforcement by using natural and synthetic fibers. Sayyed Mahdi Hejazi,Mohammad Sheikh zadeh , Sayyed Mahdi Abtahi , Ali Zadhoush

IV. http://saetaequina.com/files/1-s2_0-S0950061811006763-main.pdf

V. IS: 2720 Code For Geotechnical Engineering.

VI. Bledzeki A.K and Gassan J 1999 *Prog. Polym.* Sci. 24 221 Chakraborty A, Sain M and KortSchot M 2006 ACS *Symp. Series* 938 169.

VII. Chauhan GS, Bhatt S S, Kaur I, Sinha AS and Keith D S 2000 J. *Polym. Degrad. And Stabilisation 69 261*.

VIII. Chauhan G S, Lal H, Singa A S and Keith D S 2001 *Indian J Fiber and Textiles Res* 26 302.

IX. Gasson J, Bledxeki A K 1997 *Compos. Pt A Appl. Sci.* 28 1001.

X. Mao L, Imam S, Gordon S Cincelli P and Cincelli E 2000 *J. Polym. Environ.* 8 205.

XI. Matthew L, Joseph K U, Joseph R 2006 *Buil. Mater. Sci* 29 91.

XII. Nakegoeto A N and Yano H 2004 *Appl. Phy. Mater*.78 574.

XIII. Ray D , Sarkar B K, RANA A K , Bose N R 2001 *Buil. Mater. Sci* 24 129.

XIV. I S 2720 Pt I (1983) Indian Standard Code for preparation of soil samples. Bureau of Indian Standards, New Delhi.

XV. I S 2720 Pt 7 (1980) Method of Test for Soils: Determination of Water Content- Dry density Relationship using light compaction. Bureau of Indian Standards, New Delhi.

XVI. I S 2720 Pt 16 (1979) Method of Test for soils. Laboratory determination of CBR Bureau of Indian Standards, New Delhi.

XVII. Maher M. H. and Gray D. H. (1990), "Static Response of Sands Reinforced with Randomly Distributed Fibers", J. Geotech. Engg., ASCE, 116(11), 1661- 1677.

XVIII. Vasan R. M., Ranjan G. and Charan H. D. (1995), "Fiber Reinforced Soil: A New Method of Reinforced SoilSubgrade", Proc. National Seminar on Emerging Trends in Highway Engineering, Bangalore, 24.1-24.4.

XIX. IS: 1498-(1970) Classification and identification of soils for general engineering purposes. Bureau of Indian Standards, New DelhiGoogle Scholar

XX. IS: 2720-part 3(1) (1980) Method of test for soils: determination of specific gravity of fine grained soils. Bureau of Indian Standards, New DelhiGoogle Scholar

XXI. IS: 2720-part 4 (1985) Method of test for soils: determination of grain size distribution. Bureau of Indian Standards, New DelhiGoogle Scholar