INFLUENCE OF PINE NEEDLES ON INDEX PROPERTIES AND OPTIMUM MOISTURE CONTENT OF CLAYEY SOIL-sAN EXPERIMENTAL INVESTIGATION

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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. Previous studies mainly evaluated the effects of additives such as lime, cement and sand on these characteristics of clays. Initial results indicated that the soil characteristics were improved. 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 of (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.

Keywords: Clayey soils, Pine needles, CBR, OMC, MDD.

1. INTRODUCTION

The concept of earth reinforcement is an ancient technique and demonstrated abundantly in nature by animals, birds and the action of tree roots. These reinforcements resists tensile stress developed within the soil mass thereby restricting shear failure. Reinforcement interacts with the soil through friction and adhesion. The inclusion of randomly distributed discrete fibre increases strength parameters of the soil as in case of reinforced concrete construction.
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. 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.
Use of natural fibre in civil engineering for improving soil properties is beneficial because they are cheap, locally available, biodegradable and eco-friendly material. The natural fibre reinforcement causes significant improvement in tensile strength, shear strength, and other engineering properties of the soil. Among various natural fibres, pine needles are one of such natural fibres, being used as reinforcing material in soil stabilization. Fibres especially those obtained from renewable resources such as natural fibre have attracted an increasing attention during the last decade due to environmental concerns. These natural fibres are considered as the most suitable alternative to synthetic fibre for use in various fields.
In current investigation the effect of Pine needles stabilization on strength behaviour of clayey soil was studied. Pine needles collected from locally available forest (Rajouri, J&K) chopped into 10mm to 15mm length has been added randomly in clayey soil at different percentages (i.e. 0.5%, 1% 1.5%) by dry weight of soil. Soil samples randomly mixed with Pine needles were prepared at maximum dry density (MDD) and optimum moisture contents (OMC) and subjected to (California bearing ratio) CBR tests, unconfined compression tests and standard proctor tests. By carrying out this study, the following objectives will be achieved:
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.	Fibre 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

3. 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.

4. TEST RESULTS

Table 1:Properties of test soil

S.no	***Soil property***	***Soil sample***
1	Site from where soil was taken	Dangree (28km from BGSBU)
2	Colour of soil	Light brown
3	Nature of soil	Clay type
4	Natural moisture content (w%)	10.32
5	Specific gravity G	2.78
6	Liquid limit (%)	33.8
7	Plastic limit (%)	25

4.1. Effect of the Pine needles on compaction characteristics (MDD & OMC) of clayey soil.

4.1.1. Compaction Proctor Test Of Unreinforced Soil Sample

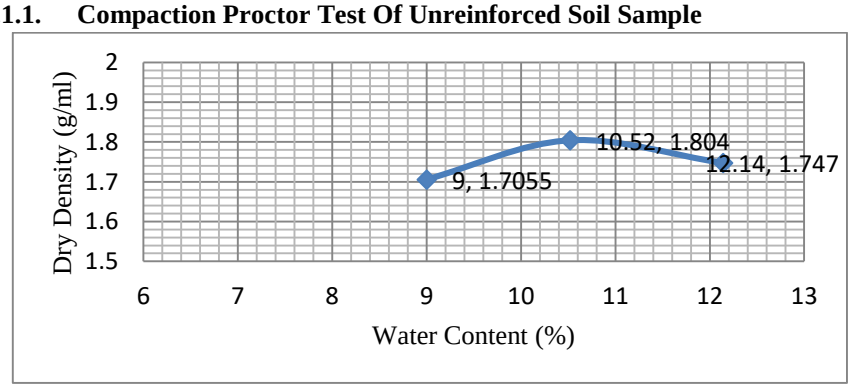

Figure 2: compaction test curve for plain soil

Result: Optimum Moisture content = 10.52%
Maximum dry density = 1.804 g/ml

4.1.2. Compaction Proctor Test Of Soil Sample reinforced with 0.5% pine needles

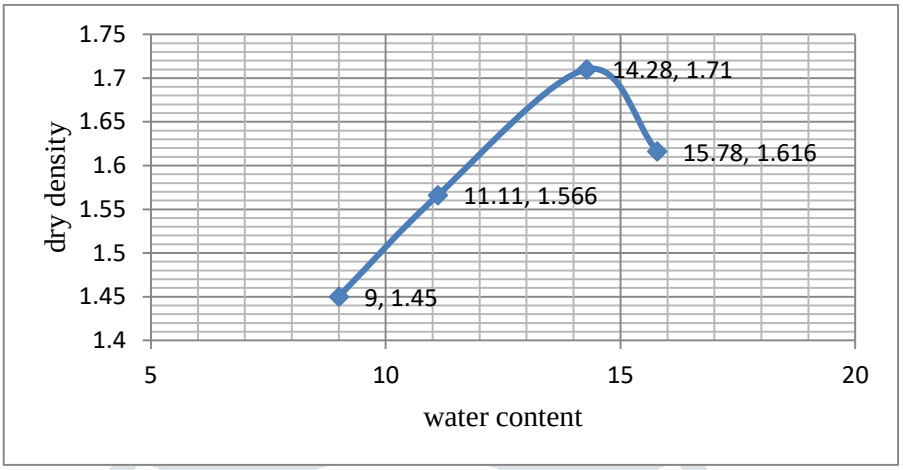

Figure3: compaction test curve at 0.5% pine needles

Results: Optimum Moisture content = 14.28%
Max dry Density = 1.71 g/ml

4.1.3. Compaction Proctor Test Of Soil Sample reinforced with 1.0% pine needles

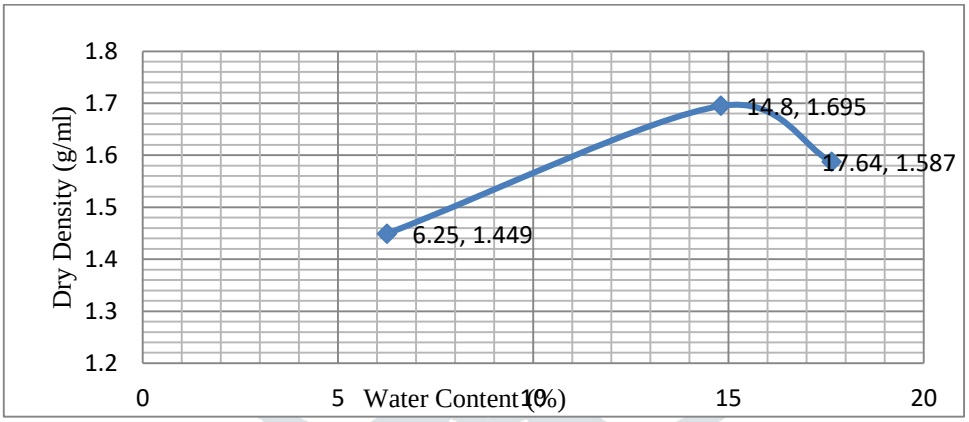

Figure 4: compaction test curve at 1% pine needles

Results: Optimum moisture content = 14.8%
Maximum dry density = 1.695 g/ml

4.1.4. Compaction Proctor Test Of Soil Sample reinforced with 1.5% pine needles

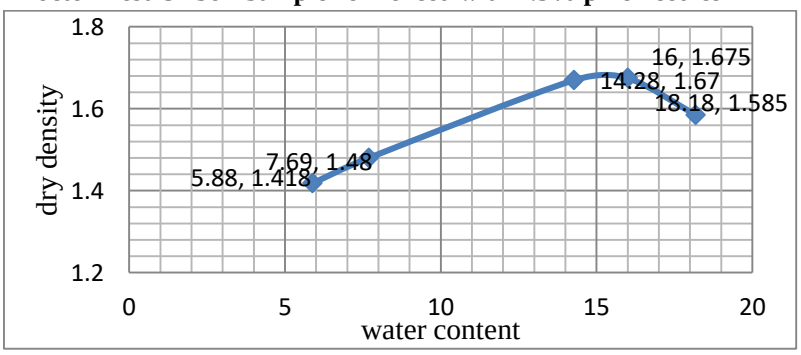

Figure 5:compaction test curve at 1.5% pine needles

Results: Optimum moisture content = 16%
Maximum dry density = 1.675 g/ml

4.1.5. Compaction Proctor Test Of Soil Sample reinforced with 2.0% pine needles

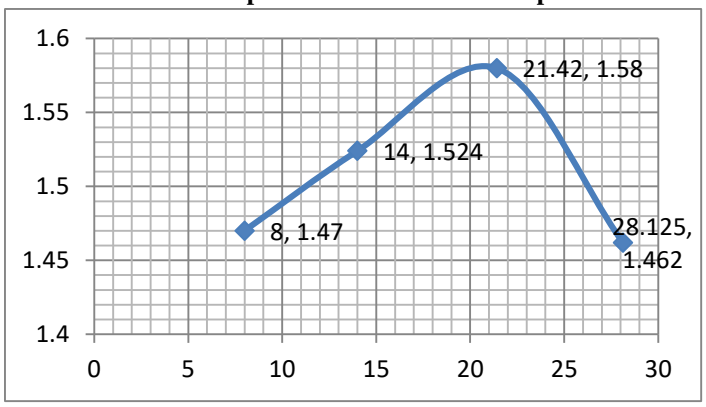

Figure 6:compaction test curve at 2% pine needles

Results: Optimum moisture content = 21.42%
Maximum dry density = 1.58 g/ml

4.1.6. Compaction Proctor Test Of Soil Sample reinforced with 2.5% pine needles

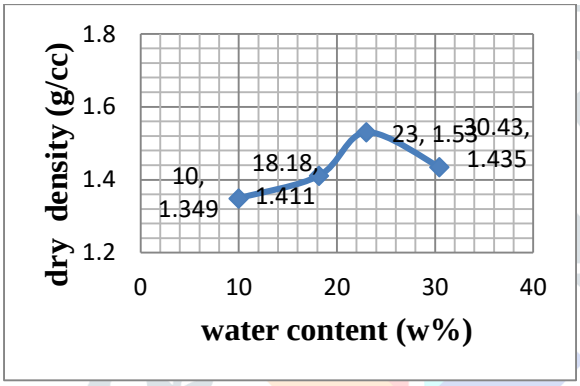

Figure 7: compaction test curve at 2.5% pine needles

Results: Optimum moisture content = 23%
Maximum dry density = 1.53 g/ml

4.2. Variation of OMC and MDD with the percentage of pine needles

Table 2: results of compaction proctor test

S.no	*% of pine Needles*	*OMC (%)*	*MDD (g/ml)*
1	0.0	10.52	1.804
2	0.5	14.28	1.710
3	1.0	14.80	1.695
4	1.5	16.00	1.675
5	2.0	21.42	1.580
6	2.5	23.00	1.530

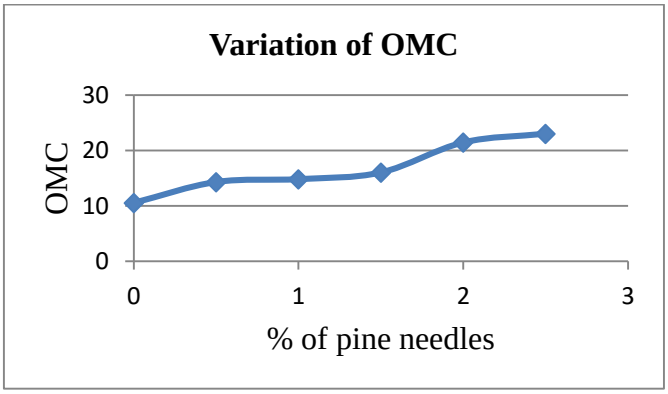

Figure 8: variation of OMC with pine needles

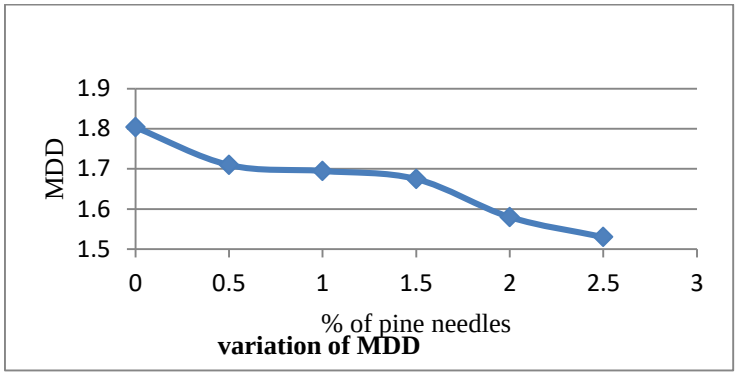

Figure 9: variation of MDD with pine needles

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 needled as reinforcement .Very good results were obtained in terms of the clay soil properties when the percentage quantity of the pine needles are varied between 0.5% and 2.5% by mass of the soil.

Such improvements included an achievement of the maximum value of OMC of 23% obtained at 2.5% pine needles when the original OMC was 10.52%.

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