COMPARISON OF COMPACTION METHODS BY USING PINEAPPLE LEAF FIBER REINFORCED CLAY

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***Abstract*—The strength properties of soft soils are an important parameter. It can be achieve by reinforcement and depending on method of compaction. The purpose of this study is to reinforce clayey soil with kerosene treated pineapple leaf fiber (PLF) and study the effect of compaction using conventional ‘‘impact” compaction and ‘‘kneading pneumatic compaction method”. The kneading pneumatic compactor in laboratory, reproduce the compaction effect usually implemented in the field. Compared to impact compaction method, treated soil with kneading pneumatic compaction have better increase in maximum dry density and decrease in optimum moisture content value. So it shows better results as compared to other methods of compaction. The percentage of fiber change from 0.5% to 3%, the dry density increases by 25%. The optimum percentage of PLFs selected as 3%.**

Keywords— kneading pneumatic compaction, Pineapple leaf fiber, Maximum dry density, optimum moisture content

I. INTRODUCTION

The toughest challenge faced by geotechnical engineers these days is the construction of building in weak strata due to the rapid growth and industrialization. It leads to differential settlements and cracks of expansive soil due to volume changes. Therefore, the strength properties of such soft soils may in ideal circumstances is improved at an early stage, preferably before conducting construction works. A wide range of soil improvement methods has been used such as soil replacement, dynamic compaction, lime/cement columns, stone columns, and soil reinforcements with fibrous materials.

Natural fibre based composites are eco-friendly nature and also show peculiar properties. The natural fibre has an advantage of continuous supply, easy and safe handling, and biodegradable nature. Fiber-reinforced soils were used successfully on more than 50 embankment slopes in the United States between the year 1990 and 2006. The Pineapple leaf fibre (PLF) is very common in tropical regions and it is very simple to extract fibres from its leaves. In comparison to other natural fibres, pineapple leaf fibre (PALF) shows excellent physical and mechanical properties.

The fiber-reinforced clay specimens are generally prepared in the laboratory using conventional ‘‘impact” compaction methods (Proctor), although compacted clay systems in the field are typically constructed using equipment that produces high shear strains/‘‘kneading” action (e.g. sheep’s-foot rollers). In this study standard Proctor compactor and kneading pneumatic compactor are used.

Abhijith,R.,*etal*. (2018) study was carried out to Pineapple fibers were mixed with soil to find out strength gain in terms of direct shear strength. From the result, cohesion and internal friction increases with certain percentage of fiber content, after that it decreased. **Joseph,k, J., *et al.* (2017)** in this study, Nano modification of fibres helped to increase the dry density. The load bearing capacity of reinforced soil was found to be higher than the non-reinforced soil. Also it was observed that the shear strength parameters of the soil increases with fiber content. It was also found that with the increase of time the cohesion and angle of internal friction increase. **Er. VedParkash., *et al*(2017)** was to study about stabilization of clayey soil using Pine needles and calcium chloride. The addition of pine needles decreases MDD and OMC increases. It is due to flocculation among clay particles and pine needles, as a result size of pore voids increases, so better water holding capacity of soil mass. **Adesoji Adediran ., *et al.*(2017)**Investigations were carried out to study the effect of treated pineapple leaf fiber (PALF) on the mechanical properties and water absorption behavior of reinforced polyester composites. The fiber content increases within the matrix increase in the ultimate tensile strength and modulus of elasticity while there was decrease in the elongation at break. Flexural strength, flexural modulus and hardness properties of the developed composites increase linearly. The water absorption test showed amount of water absorbed by the composite increased with increase in the PALF weight fraction. **Mrs. Neenu M.,*et al*. (2016)** has investigated the effectiveness of

combination of rice husk ash (RHA) and lime as stabilizing agents. Various percentages of combination of RHA and lime are used in triaxial sample preparation and thus the optimum percentage of combination is worked out. It is observed that the addition of RHA and lime to Kuttanad clay alter its stress- strain response considerably. **Ahmed Elsharief.,*et al*.(2013)** has investigated the impact compaction generally resulted in breakage of the coarse aggregates and increase in fines content, decrease in plasticity index. The vibratory compaction caused minor changes to the gradation of the materials.

A. Scope

- Cracks and differential settlement expansive soil can be reduced by using reinforced soil.
- Kneading pneumatic compactor in laboratory reproduce the construction procedures usually implemented in the field with constant energy.
- Compaction parameters are determined with both method of compaction.

II. MATERIALS

A. Natural Clay

The soil sample was collected from a depth of around 9 to 10 m below ground level from a construction site near Edathua, Alappuzha district as shown in fig.1.

Fig.1 Natural Clay

The initial test conducted and the test results are tabulated in table 1.

TABLE 1: PROPERTIES OF CLAY.

Sl.No	Property	Value
1	Initial moisture content	69.4%
2	Specific gravity	2.6
3	Liquid limit	105%
4	Plastic limit	38%
5	Plasticity index	67%
6	Optimum moisture content	29%
7	Dry density	1.23g/cc
8	Percentage of gravel	1%
9	Percentage of sand	10%
10	Percentage of silt	43.1%
11	Percentage of clay	46%
12	Soil classification	CH
13	Cohesion	0.386kg/cm^2
14	Φ value	2˚

B. Pineapple leaf fibers (PLF)

The Tonne of pineapples are being Producing every year, very small portions are being used in the field of energy production and feedstock. The expansion of bio composites will accelerate industrial usage that would release the possibilities to reduce the wastage of renewable materials. In this study PLFs was collected from Kurichy, Kottayam.

C. *Modification of PLFs*

Improve the strength and durability of fiber by kerosene treatment. Fiber is natural organic material, which absorbs huge water content and has short life period and it is bio-degradable. Coating kerosene to fiber will act as thin layer which prevent water absorptions. The kerosene treatments of PLFs are shown in fig.2.

Fig.2 Modification of PLFs

D. Water absorption test

The Water absorption test for PLFs were performed in laboratory as per IS specifications (as shown in fig.3) and results obtained as in below.

Fig.3 Water absorption test

- Water absorption test on uncoated PLF =283.7%
- Water absorption of kerosene coated PLF = 152.2%

III. EXPERIMENTAL PROCEDURE

The kerosene coated Pineapple Leaf Fiber (PLF) mixed with clay and compacted by using standard Proctor compactor and kneading pneumatic compactor. This helps to investigate the compaction characteristics.

IV. RESULTS AND DISCUSSIONS

A. Standard proctor compaction test

The non-treated PLFs of 0.5%,1%,1.5%,2%,2.5% & 3% of weight of soil and also kerosene treated PLFs of 0.5% to 3% of weight of soil was used for Standard proctor compaction tests as shown in fig.4.

Fig.4 PLFs mixing with soil

The kerosene added 2 times the weight of fiber one hr before commence the compaction test. the results were tabulated below table.2.

TABLE 2: STANDARD COMPACTION TEST RESULTS

Sl.No	Percentage of fiber (%)	Non-treated fiber		Kerosene treated fiber	
		OMC (%)	MDD (g/cc)	OMC (%)	MDD (g/cc)
1	0.5	21	1.5	28	1.58
2	1	23	1.52	27	1.43
3	1.5	25	1.47	25	1.39
4	2	25	1.39	23	1.34
5	2.5	27	1.30	21	1.26
6	3	29	1.24	19	1.19

From impact compaction test with non-treated PLFs, the OMC increased and MDD was decreased as shown in fig.4. The OMC increased due to higher water absorption nature of fiber and MDD decreased due to lower value of specific gravity of fiber as compared to soil.

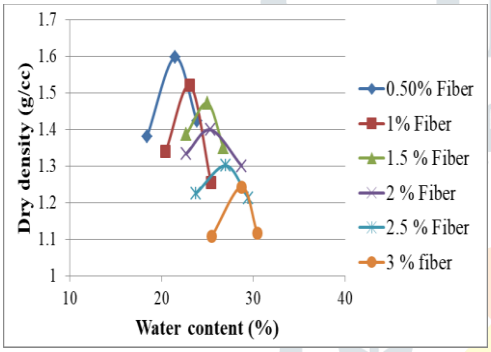

Fig.4.Compactin curve of non-treated soil

From impact compaction test with treated PLFs, the MDD decreased due to lower value of specific gravity of fiber and OMC decreased due to kerosene coated fibers are used as shown in fig.5.

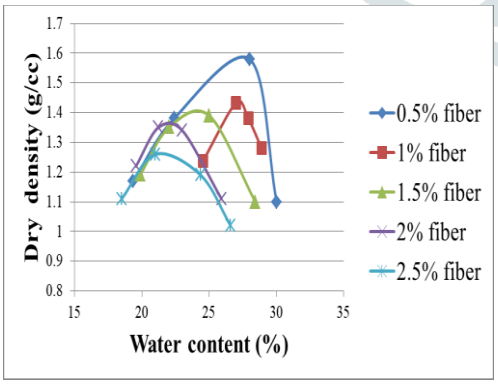

Fig.5 Compaction curve of treated soil

B. Kneading pneumatic compaction

For compacting heavy clay and silt clays, sheep foot rollers are found to be very effective. These rollers are employed in road and rail projects. The kneading pneumatic compactor is more realistic representation of sheep's foot rollers in the field. Tamper is loaded in air pressure by using air compressor. The compaction of soil is with kneading at constant energy. The working of the compactor is done by using solenoid valve, arduino board and relay board as shown in fig.6.

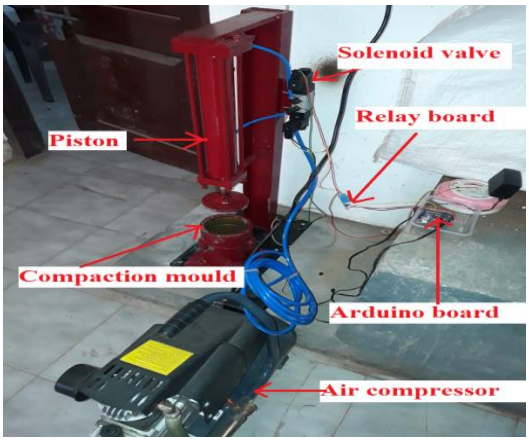

Fig.6 kneading pneumatic compactor

-***Compaction mould:*** Dimensions same as impact compaction mould.

-***piston***: weight= 2.5kg

Bottom diameter= 10cm

Dropped height= 30cm

-***Compaction effort per layer*** = 3 layer/35 psi/25 tamp/1 minutes.

C. Kneading pneumatic compaction test

The treated and non-treated PLFs of 0.5%,1%,1.5%, 2%, 2.5% & 3% of weight of soil was used and obtained results were tabulated below.

TABLE.3 KNEADING COMPACTION TEST RESULTS

Sl. No	Percentage of fiber (%)	Non-treated fiber		Kerosene treated fiber	
		OMC (%)	MDD (g/cc)	OMC (%)	MDD (g/cc)
1	0.5	21	1.2	30	1.28
2	1	23	1.28	28	1.35
3	1.5	25	1.32	26	1.39
4	2	27	1.45	24	1.45
5	2.5	28	1.52	22	1.52
6	3	30	1.58	20	1.59

From kneading pneumatic compaction with non-treated PLFs, the MDD and OMC increased. The MDD increased due to kneading action reduced air content and increase soil densification as shown in fig.7.

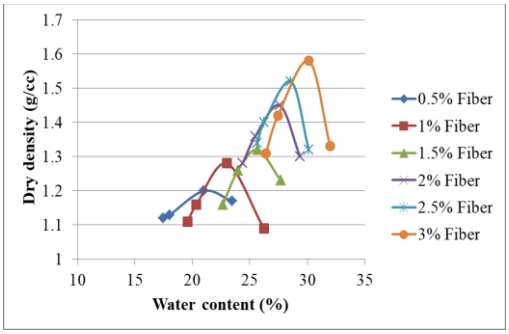

Fig.7 Compactin curve of non-treated soil

Kneading pneumatic compaction with kerosene treated PLFs, the OMC decreased and MDD increased as shown in fig.8. It is due to combined effect of kerosene treatment and kneading pneumatic compaction.

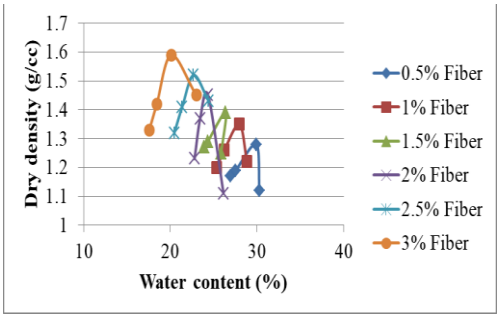

Fig.8 Compaction curve of treated soil

V. CONCLUSION

- Both magnitudes of compacting energy and type of compactive effort influence degree of compaction.
- Due to compaction air content & porosity in the soil reduced, as result of soil densification.
- Fiber act as interlock soil particles, mobilize tensile resistance and increase strength & stiffness of soil.
- Untreated fiber has less durability.
- Coating kerosene to fiber acts as thin layer and prevents water absorption.
- The optimum percentage of PLFs selected as 3%.
- From this study the effective method of compaction is the Kneading pneumatic compaction with kerosene treated PLFs.
- It shows better results compared to other methods of compaction.

REFERENCES

[1]. International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 04 Issue: 04 | Apr -2017, Elsevier. *"Effect of compaction characteristics and shear strength parameters of expansive soil reinforced with Nano modified coir fiber and lime".*

[2]. International Journal of Engineering Technology, Management and Applied Sciences, February 2016, Volume 4, Issue 2, ISSN 2349-4476, Elsevier."*A Study on the Compaction Characteristics and Stress-Strain behavior of Kuttanad Clay Stabilized with Rice Husk Ash and Lime".*

[3]. Mun, W., Teixeira, T., Balci, M.C., Svoboda, J., McCartney, J.S., 2016. "*Rate effects on the undrained shear strength of compacted clay"*. Soils Found. 56 (4), 719–731.ASCE.

[4]. Springer Science+Business Media Dordrecht 2013, Received: 5 May 2012/Accepted: Geotech Geol Eng (2013) 31:511–518, "*Effect of Random Inclusion of Wheat Straw Fibers on Shear Strength Characteristics of Shanghai Cohesive Soil".*

[5]. Hejazi, S., Sheikhzadeh, M., Abtahi, S., Zadhoush, A., 2012. "*A simple review of soil reinforcement by using natural and synthetic fibers"*. Constr. Build. Mater. 30, 100–116.ASCE.

[6]. Maheshwari, K., Desai, A., Solanki, C., 2011. "*Performance of fiber reinforced clayey soil.* Electron. J. Geotech. Eng. 16, 1067–1082.ASCE.

[7]. Abdi, M., Parsapajouh, A., Arjomand, M., 2008.*"Effects of random fiber inclusion on consolidation, hydraulic conductivity, swelling,*

[8]. International Journal of Innovative Research in Science, Engineering and Technology, An ISO 3297: 2007 Certified Organization Volume 6, Special Issue 4, March 2017, "*Effect of Lime on Geotechnical Properties of Marine Clay"* .

[9]. O¨ zkul, Z.H., Baykal, G., 2006.*"Shear strength of clay with rubber fiber inclusions"*. Geosynth. Int. 13 (5), 173–180.ASCE.

shrinkage limit and desiccation cracking of clays". Int. J. Civ. Eng. 6 (4), 284–292.