International Journal For Technological Research In Engineering
Volume 6, Issue 7, March-2019 *ISSN (Online): 2347 - 4718*

SOIL STABILIZATION BY GROUNDNUT SHELL ASH AND WASTE FIBER MATERIAL

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Abstract: The main objective of this paper is to explore the use of groundnut shell ash and waste fiber material in geotechnical applications and to evaluate the effects of groundnut shell ash and waste polypropylene fibers on the shear strength of unsaturated soil by carrying out direct shear tests and unconfined compression tests on the soil sample. The results obtained are compared and inferences are drawn towards the usability and effectiveness of groundnut shell ash and fiber reinforcement as a replacement for deep foundation or raft foundation, as a cost effective approach.
Keywords: Ground nut shell ash, polypropylene fiber, direct shear test and unconfined compressive strength test.

I. INTRODUCTION

For any land-based structure, the foundation is very important and has to be strong to support the entire structure. In order for the foundation to be strong, the soil around it plays a very critical role. So, to work with soils, proper knowledge about their properties and factors which affect their behavior is essential. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work.

From the beginning of construction work, the necessity of enhancing soil properties has come to the light. Ancient civilizations of the Chinese, Romans and Incas utilized various methods to improve soil strength etc., some of these methods were so effective that their buildings and roads still exist. In India, the modern era of soil stabilization began in early 1970's, with a general shortage of petroleum and aggregates, it became necessary for the civil engineers to look at the means to improve soil rather than replacing the entire poor soil at the building site. Soil stabilization was used but due to the use of obsolete methods and also due to the absence of proper technique, soil stabilization lost favor. In recent times, with the increase in the demand for infrastructure, raw materials and fuel, soil stabilization has started to take a new shape. With the availability of better research, materials and equipment, it is emerging as a popular and cost-effective method for soil improvement. Different methods can be used to improve and treat the geotechnical properties of the problematic soils (such as strength and the stiffness) by treating it *in situ*. These methods include densifying treatments (such as compaction or preloading), pore water pressure reduction techniques (such as dewatering or electro-osmosis), the bonding of soil particles (by ground freezing, grouting, and chemical stabilization), and use of reinforcing elements (such as geotextiles and stone columns) Here, in this study, soil stabilization has been done with the help of groundnut shell ash and randomly distributed polypropylene fibers obtained from waste materials. The improvement in the shear strength parameters has been stressed upon and comparative studies have been carried out using different methods of shear resistance measurement.

II. PREPARATION OF SOIL SAMPLES

Following steps are carried out while mixing the groundnut shell ash and fiber to the soil-

All the soil samples are compacted at their respective maximum dry density (MDD) and optimum moisture content (OMC), corresponding to the standard proctor compaction test

The groundnut shell ash is added at 3%, 6%, and 9%

Content of fiber in the soil is herein decided by the following equation:

$$\rho_f = \frac{W_f}{W}$$

Where, ρ_f = Ratio of fiber content Wf = Weight of the fiber

W = Weight of the air-dried soil

The different values adopted in the present study for the percentage of fiber reinforcement are 0.05, 0.1, and 0.15.

In the preparation of samples, if fiber is not used then, the air-dried soil was mixed with an amount of water that depends on the OMC of the soil.

If groundnut shell ash was used, the adopted quantity of groundnut shell ash was first mixed into the air – dried soil by hand, so that a fairly homogeneous mixture is obtained, and then mixed with an amount of water that depends on the OMC of the soil.

If fiber reinforcement was used, the adopted content of fibers was first mixed into the air-dried soil in small increments by hand, making sure that all the fibers were mixed thoroughly, so that a fairly homogenous mixture is obtained, and then then mixed with an amount of water that depends on the OMC of the soil.

III. PROPERTIES OF UNREINFORCED SOIL SAMPLE

S.NO	DESCRIPTION	VALUE
1	Specific Gravity	2.53
2	Free Swell Index	13%
3	Liquid Limit	38%
4	Plastic limit	22%
5	Plasticity Index	16%
6	Maximum Dry Density	1.85 gm/cm^3
7	Optimum Moisture Content	16.2%
8	Cohesion	0.225 Kg/cm^2
9	Angle of Internal friction	22.1^0
10	Unconfined compressive strength	0.122 Mpa

IV. EFFECT OF GROUND NUT SHELL ASH ON SHEAR STRENGTH PROPERTIES OF SOIL

Groundnut shell ash was first mixed into the air – dried soil by hand, so that a fairly homogeneous mixture is obtained, and then it is mixed with an amount of water that depends on the OMC of the soil. Later the soil sample is compacted up to the maximum dry density. The direct shear test and the unconfined compressive strength test were conducted on those soils samples.

Ground nut shell ash (%)	3	6	9
Cohesion (Kg/cm^2)	0.241	0.257	0.272
Angle of internal friction	23.8^0	25.3^0	27.4^0
Unconfined compressive Strength (Mpa)	0.152	0.176	0.194

V. EFFECT OF POLYPROPYLENE FIBRE ON SHEAR STRENGTH PROPERTIES OF SOIL

Polypropylene fiber reinforcement was first mixed into the air-dried soil in small increments by hand, making sure that all the fibers were mixed thoroughly, so that a fairly homogenous mixture is obtained, and then mixed with an amount of water that depends on the OMC of the soil. Later the soil sample is compacted up to the maximum dry density. The direct shear test and the unconfined compressive strength test were conducted on those soils samples.

Polypropylene fibre (%)	0.05	0.10	0.15
Cohesion (Kg/cm^2)	0.262	0.284	0.313
Angle of internal friction	24.2^0	26.9^0	28.3^0
Unconfined compressive Strength (Mpa)	0.146	0.180	0.202

V. INFERENCES FROM DIRECT SHEAR TEST

- Due to 3% groundnut shell ash the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.241 Kg/Cm^2, a net of 7.11 %.
- Due to 6% groundnut shell ash the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.257 Kg/Cm^2, a net of 14.22 %.
- Due to 9% groundnut shell ash the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.272 Kg/Cm^2, a net of 20.89 %.
- Due to 3% groundnut shell ash the angle of internal friction of soil increases from 22.1^0 to 23.8^0 , a net of 7.69 %.
- Due to 6% groundnut shell ash the angle of internal friction of soil increases from 22.1^0 to 25.3^0 , a net of 14.48 %.
- Due to 9% groundnut shell ash the angle of internal friction of soil increases from 22.1^0 to 27.4^0 , a net of 23.98 %.
- Due to 0.05% polypropylene fiber the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.261 Kg/Cm^2, a net of 16.0 %.
- Due to 0.10% polypropylene fiber the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.284 Kg/Cm^2, a net of 26.22 %.
- Due to 0.15% polypropylene fiber the cohesion value of soil increases from 0.225 Kg/Cm^2 to 0.313 Kg/Cm^2, a net of 39.11 %.
- Due to 0.05% polypropylene fiber the angle of internal friction of soil increases from 22.1^0 to 24.2^0 , a net of 9.50 %.
- Due to 0.10% polypropylene fiber the angle of internal friction of soil increases from 22.1^0 to 26.9^0 , a net of 21.72% %.
- Due to 0.15% polypropylene fiber the angle of internal friction of soil increases from 22.1^0 to 28.3^0 , a net of 28.05 %.

VI. INFERENCES FROM UNCONFINED COMPRESSIVE STRENGTH TEST

- Due to 3% groundnut shell ash the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.152 Mpa, a net of 24.60 %.
- Due to 6% groundnut shell ash the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.176 Mpa, a net of 44.26 %.
- Due to 9% groundnut shell ash the Unconfined compression strength value of soil Increases from 0.122 Mpa to 0.194 Mpa, a net of 59.01 %.
- Due to 0.05% of polypropylene fiber the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.146 Mpa, a net of 19.67 %.
- Due to 0.10% of polypropylene fiber the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.180 Mpa, a net of 47.54 %.
- Due to 0.15% of polypropylene fiber the Unconfined compression strength value of soil increases from 0.122 Mpa to 0.202 Mpa, a net of 65.57 %.

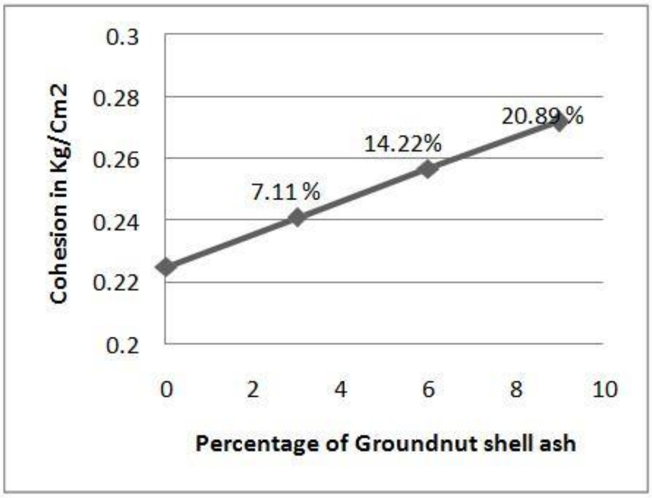


Fig : 1

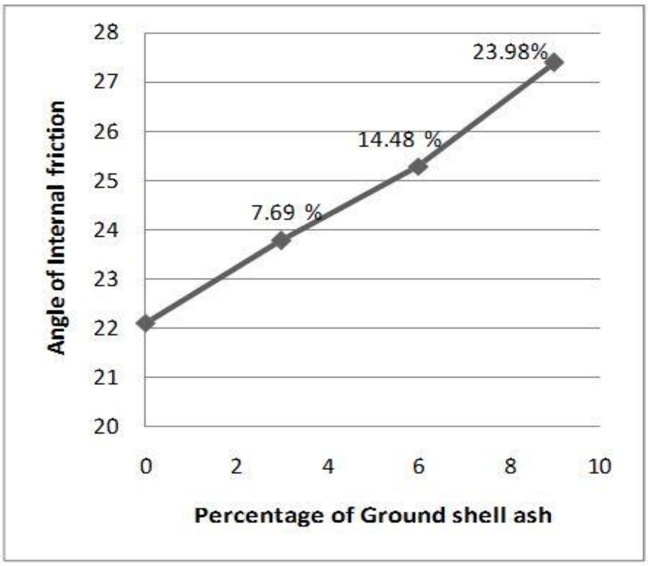
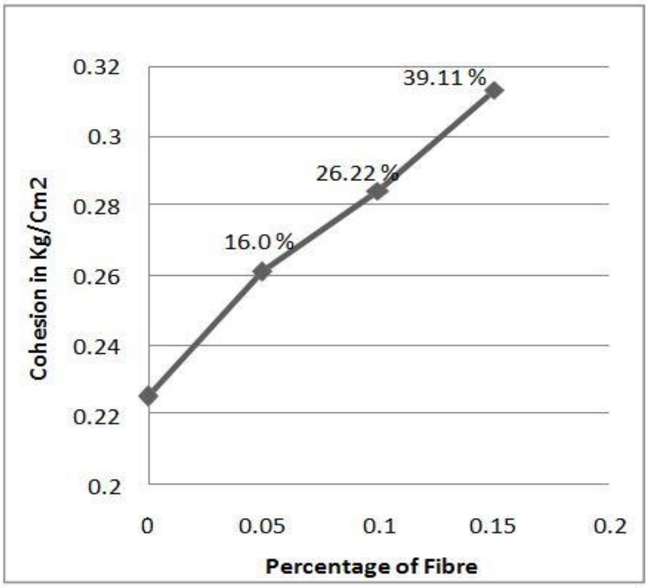


Fig : 2



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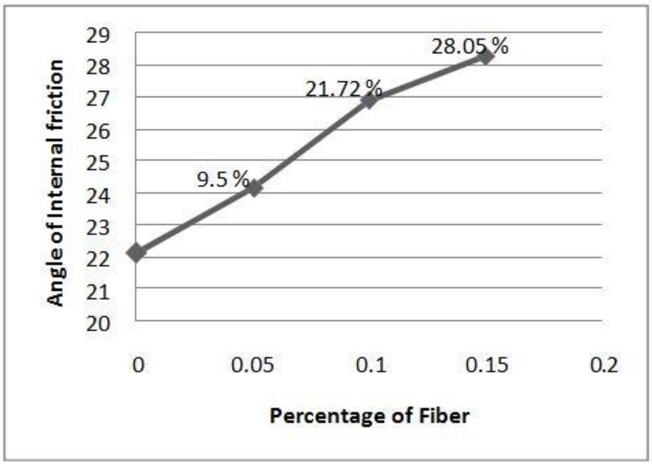

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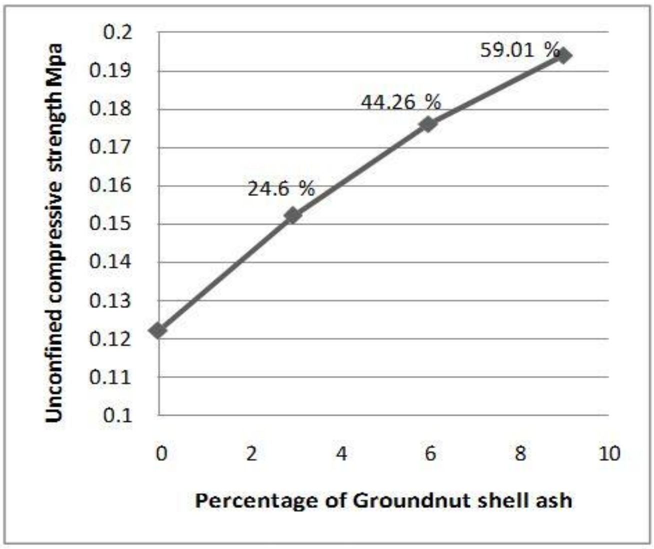

Fig : 5

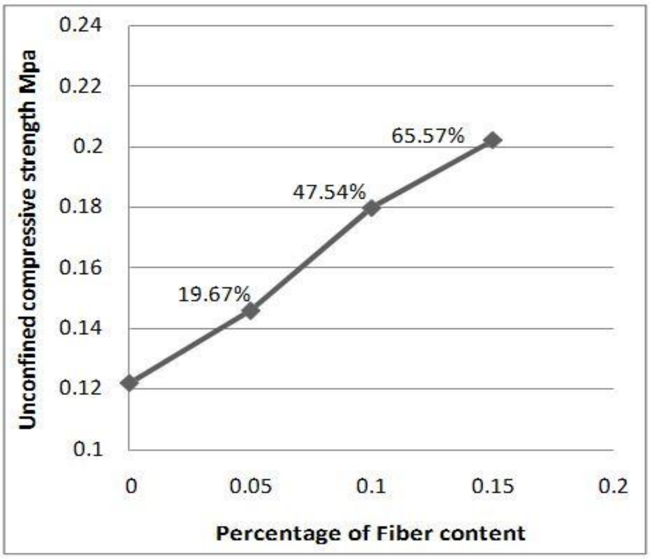

Fig : 6

VI. RESULTS AND DISCUSSION

- Based on direct shear test on soil sample, with groundnut shell ash percentages of 3%, 6% and 9%, the increase in cohesion was found to be 7.11%, 14.22% and 20.89% respectively (illustrated in Fig :1). The increase in the internal angle of friction (φ) was found to be 7.69%, 14.48% and 23.98% respectively (illustrated in Fig : 2). Since the net increase in the values of c and φ were observed to be 20.89%, from 0.225 kg/cm2 to 0.272 kg/cm2 and 23.89%, from 22.1^0 to 27.4^0 degrees respectively, for this soil, the groundnut shell ash is recommended.
- Based on direct shear test on soil sample with fiber reinforcement of 0.05%, 0.1% and 0.15%, the increase in cohesion was found to be 16%, 26.22% and 39.11% respectively (illustrated in Fig : 3). The increase in the internal angle of

friction (φ) was found to be 9.5%, 21.72% and 28.05% respectively (illustrated in Fig : 4). Since the net increase in the values of c and φ were observed to be 39.11%, from 0.225 kg/cm2 to 0.313 kg/cm2 and 28.05%, from 22.1^0 to 28.3^0 respectively, for this soil, randomly distributed polypropylene fiber reinforcement is recommended.

- Based on unconfined compressive strength test on soil sample with groundnut shell ash of 3%, 6% and 9%, the increase in unconfined compression strength was found to be 24.60%, 44.26% and 59.01% respectively (illustrated in Fig : 5).. This increment is substantial and applying it for soils similar to the this soil sample is effective.
- Based on unconfined compressive strength test on soil sample with polypropylene fiber of 0.05%, 0.1% and 0.15%, the increase in unconfined compression strength was found to be 19.67%, 47.54% and 65.57% respectively (illustrated in Fig : 6).. This increment is substantial and applying it for soils similar to the this soil sample is effective.

VII. CONCLUSIONS

Overall it can be concluded that the groundnut shell ash and polypropylene fiber reinforced soil can be considered to be good ground improvement technique specially in engineering projects on weak soils where it can act as a substitute to deep/raft foundations, reducing the cost as well as energy.

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