Utilization of waste Coconut coir fiber in soil reinforcement

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Abstract - Coconut fiber or coir fiber is obtained from the coconut shell. Coconut fiber is very cheap, economical and easily available in the market .It can be used to impart the various engineering properties such as shear strength, tensile strength, bearing capacity and many other properties by using various proportions and size of the coir fiber. By introducing the coconut coir fibers in the soil the development of the frictional forces increases between the soil particles and the reinforcement fibers.

Keywords - Coconut fiber, shear strength, soil reinforcement, internal friction.

1.Introduction

Soil reinforcement may be defined as the process of improving the engineering properties of the soil by incorporating various types of fibers mainly coconut coir fibers, jute fibers etc. Various soil improvement techniques have been used to enhance the engineering properties of soil. Soil reinforcement by fiber material is considered an effective ground improvement method because of its flexibility, cost effectiveness, adaptability and its reproductivity. By incorporating the coconut fibers in the soil improves the geotechnical properties, thus making the soil more resistant to the external forces such as tensile forces, shear stress and other compressive forces as well.

In ancient times the soil reinforcement was done using the roots of plants to provide tensile strength to soil , as soil have higher compressive strength as compared to the tensile strength because of its poison`s ratio.

Shukla Devdatt, Rajan Shikha, Saxena A.K., Jha A.K. (2015) collected the fibrous portion of coconut extracted from the green nut. Coir that extracted consists of rotting the husk in fresh water and then removing the organic material that binded the fiber. Diameter is approximately 0.5mm. The coir fibers were cut into small pieces of 3cm to 5cm, as that percentage remained 0.25, 0.50, 0.75, 1%.

Gbenga Matthew Ayininuola*, Peter Oluseyi Oladotum (2016) Used The soil samples were dried thoroughly and stock-piled was piled for laboratory work.The Coconut were collected from coconut vendor in Ibadan, and were processed and extracted manually and separated into strands of approximately 4cm long.

Deepjyoti Das, Dhrubajyoti Kaundinya, Raja Sarkar, Bikramjit Deb (2016) have reported that for the purpose of this work, the coconut fibers used were kept in finite lengths ranging approximately to the size of 15mm. These fibers were then extracted from the coconut shell, and were soaked in fresh water and then sun dried.

PROPERTIES OF COCONUT FIBER.

Physical properties

Generally coconut fiber length is 6 to 8 inches and the density of the order of 1.40 g/cc. The diameter of the single coconut fiber is almost 0.1mm to 1.5mm . The modulus of rigidity is approximately equal to 1.8924dyne/cm^2. The Coconut coir fibers are capable of resisting strain 4-6 times greater than other fibres **.**

Chemical properties

The coconut coir fiber contains liganin 45.84%, cellulose 43.44%, hemicellulose 0.025%, pectins and other compounds 0.03%.

The use of coconut fiber improve the efficiency of soil reinforcement by increasing the tensile strength. Coconut fibers are two main types brown fibers and white fibers. Brown fibers are obtained from ripe or mature coconuts white fibers are obtained from green or immature coconuts .

2.MATERIALS AND METHODOLOGY

Shukla Devdatt, Rajan Shikha, Saxena A.K., Jha A.K. (2015) For studying, the effect of coconut fiber on expansive soil, the coconut fiber was added from 0.25% to 1% at an increment of 0.25% .

The following tests were conducted on expansive soils and the soil containing the coconut fiber as per IS code

1. Compaction characteristics .
2. Soaked California Bearing Ratio Test.
3. Unsoaked California Bearing Ratio.

Gbenga Matthew Ayininuola*, Peter Oluseyi Oladotum(2016) Selected the Soil samples and were collected from three different locations respectively . The soil samples were totally air dried and cleaned and stock piled to perform the laboratory tests. Coconut were brought from coconut vendor in Ibadan, processed carefully so that the fibers were extracted and separated manually into strands of about 4cm long. The sieve analysis was done to determine the distribution of the coarser, large sized particles in the soil, while the hydrometer method was used to determine the distribution of the fine particles in the soil samples. Compaction test was carried out to determine the optimum moisture content at which the maximum dry unit weight was attained

for all the three soil samples using standard proctor apparatus (SPT apparatus). California bearing ratio and shear strength test were carried out on the soil samples with the sample specimens for the tests prepared based on the outcome of the compaction test results.

Deepjyoti Das, Dhrubajyoti Kaundinya, Raja Sarkar , Bikramjit Deb (2016) Used samples for this research work is sand. Sieve analysis was done as per the provisions of IS 383-1970 , provided the details that sample belongs to Zone III and having a Fineness Modulus of 3.19.

Direct shear tests were performed on the soil sample. The initial results shown by the specimen without any reinforcing materials, at normal stresses of 0.5, 1.0 and 1.5kg/cm² was first obtained. Next, direct shear test was performed using coconut fiber as reinforcement at 1.0%, 2.0% and 3.0% by weight of soil. The graphs for maximum shear stress and normal stress were plotted to determine the value of angle of internal friction in each case.

The variation of angle of internal friction with fiber content was investigated and the optimum fiber content that was required was also evaluated.

3.RESULTS

Shukla Devdatt, Rajan Shikha Saxena A.K., Jha A.K.(2015) The compaction tests performed provided results that showed a decrease in Optimum Moisture Content (OMC) from 13.65% to 12.60 % and increase in Maximum Dry Density (MDD) values from 1.85 g/cc to 1.90 g/cc with the addition of Coconut coir Fiber content from 0% to 25%.

The soaked CBR test results indicates that the values increase from 3.9% to 9.6% as the Coconut coir Fibre content was increased from 0% to 1%.

Gbenga Matthew Ayininuola*, Peter Oluseyi Oladotum (2016) All control tests were conducted on samples with 0% fiber. Sample obtained from Academy Area, Iwo road was represented as I, Mokola Area was represented as M and Olorunda Abaa Area Academy Area represented as O.

The internal friction angle of soil samples I, M and O measured using tri-axial machine increased until the percentage of CCF added to the soil reached 1.2% and beyond this value, the angle of friction declined.

It was observed that I has Maximum Dry Density (MDD) of 1.792g/cm^3 at 0% Coconut fiber (CCF) inclusion, increased to 1.863g/cm^3 to 1.2% CCF and decreased to 1.801g/cm^3 at 1.5% CCF. Likewise sample M has MDD value 1.904g/cm^3 at 0% addition, increased to 2.243g/cm^3 at 1.2% and decreased to 1.982g/cm^3 at 1.5% CCF percentage. Sample O has a MDD value of 1.664g/cm^3 at 0% CCF, increased to 1.916g/cm^3 at 1.2% CCF and decreased to 1.877g/cm^3 at 1.5% CCF. The three soil samples attained Maximum Dry Density at 1.2% CCF. The increase in the dry density observed was as a result of coconut fiber content added to fill the interlocking spaces within the soil matrix.

Deepjyoti Das, Dhrubajyoti Kaundinya, Raja Sarkar, Bikramjit Deb (2016) It has been observed that the application of coconut fibres on sand results in an increase in the shear strength parameter, that is the angle of internal friction. The main cause of this increase is reasoned out to the fact that in absence of reinforcement, soil shows brittle failure. when coconut fibers were utilized , ductility is provided to the soil.

The optimum value of coconut fiber content, for obtaining maximum value of angle of internal friction is at 2,1%, at which the angle of internal friction is 39.20^o. Hence, it is observed that at the instant of optimum fiber content or maximum angle of internal friction, the soil undergoes general shear failure, while in the absence of coconut fibers, the soil is observed to undergo failure which is the transition between general shear failure and local shear failure.

Conclusion

Shukla Devdatt, Rajan Shikha Saxena A.K., Jha A.K.(2015) Based on the laboratory inspections on the expansive soils mixed with coconut fiber following are the main conclusions

By adding the coconut fiber in the expansive soil, soil has changed various compaction parameters.

The OMC has decreased and Dry Density of the soil got increased with increase in the coconut fiber content percentage.

Soaked CBR values has been increased with increase in the coconut fiber content. By adding 1% of coconut fiber in the soil CBR value increased from 3.9% to 8.6%.

From the above tests that were performed on the expansive soil by using various proportions of coconut fiber we have concluded that by adding the industrial waste like coconut fiber in the soil will not only save the wastage, it will also improve the various engineering properties of the soil as well.

Gbenga Matthew Ayininuola*, Peter Oluseyi Oladotum (2016) The research study revealed that the soil samples attained the peak values using coconut fibers at 1.2% . This observation showed that enough quantity of fiber is in the soil to hold its particles together to supplement the resistance of the soil against the external loadings.

Deepjyoti Das, Dhrubajyoti Kaundinya, Raja Sarkar, Bikramjit Deb (2016) The results from the laboratory has shown an increase in the value of angle of internal friction, by using the reinforcement material. The highest value in the increase in the parameter is 21.70%, corresponding to an optimum fiber content of 2.1%. Beyond the optimum content, a reduction in the angle of the internal friction is obtained.

Research can also be conducted on further enhancement of the cultivation of coconut, and the manufacture of the coconut fiber.

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