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Review on Stabilization of Soil Using Coir Fiber

Stuti Maurya[a], Dr.A.K.Sharma[b], Dr. P.K.Jain[c], Dr.Rakesh Kumar[d]
Department of Civil Engineering, Maulana Azad National Institute of Technology, Bhopal, India
stuti0707@gmail.com[a],aksphd2000@yahoo.com[b], pkjain10@rediffmail.com[c], rakesh20777@gmail.com[d]

Abstract:Soil stabilization has become a major issue in construction engineering and the researches regarding the effectiveness of using natural wastes are rapidly increasing. The use of natural fibers to reinforce soil is an old and ancient idea. Consequently, randomly distributed fiber reinforced soils have recently attracted increasing attention in geotechnical engineering. The main aim of this paper, therefore, is to review the, benefits, properties and applications of coir fiber in soil reinforcement through reference to published scientific data.
Keywords: California Bearing Ratio (CBR), Unconfined Compressive Strength (UCS), Optimum Moisture Content (OMC), Maximum Dry Density (MDD), Fly Ash (FA), Safe Bearing Capacity (SBC).

1. Introduction

Keeping in mind the large geographical area of India (3,287,240 sq. km) and population of India (125 million approximate) the vast network of structures and roads are required. (Singh and Mittal, 2014) The land available for construction is very less because of increasing urbanization and modernizations. Everywhere land is being utilized for various structures from an ordinary house to sky scrapers, from bridges to airports and from village road to highways or expressway. Soil being the cheapest and readily available construction material, has been popular with the civil Engineers, even though it being poor properties. Owing to this, construction of structures these days is being carried on land having weak or soft soil. Now, stability of any structure depends on the properties of soil. Using land having soft soil for construction leads to various ground improvement techniques such as soil stabilization and soil reinforcement. Most of the soil available are such that they have good compressive strength adequate shear strength but weak in tension/ poor tensile strength. To overcome the same, many researchers have concentrated their studies on the development of new such materials, through the elaboration of composites. (Chapale and Dhatrak, 2013)

The foundation of a building or road is an essential part for effective transmission of load to the subsoil present beneath it. The quality of soil has large impact on type of structure and its design. The expansive soils are examples of weak soils, which encountered in foundation engineering for bridges, highways, buildings, embankments etc. Expansive soil undergoes volume changes when they come in contact with water. They show alternate swelling and shrinkage properties. It expands during rainy season and shrinks during summer season. Expansive soil covers nearly 20% of the land mass in Indian. These soils possess weak properties due to presence of clay minerals known as “Montmorillonite”. Typical behavior of soil results into failure of structure in form of settlements cracks etc. Therefore it is important to remove the existing weal soil and replaced it with a non expansive soil or improves the properties of weak soil by stabilization. (Kharade et. al, 2014) Expansive soils exhibit generally undesirable engineering properties. They tend to have low shear strengths and to lose shear strength further upon wetting or other physical disturbances. They can be plastic and compressible. Cohesive soils can creep over time under constant load, especially when the shear stress is approaching its shear strength, making them prone to sliding. They develop large lateral pressures. They tend to have low resilient modulus values. (Brooks, 2009)

For all the above reasons, expansive soils are generally poor materials for construction. So to improve the soil properties stabilization or reinforcement of soil is done. Soil reinforcement is defined as a technique to improve the engineering characteristics of soil. In this way, using natural fibers to reinforce soil is an old and ancient idea. Consequently, randomly distributed fiber reinforced soils have recently attracted increasing attention in geotechnical engineering. (Hejazi et al, 2012).

For sustainable development use of locally available materials, waste material should be encouraged in order to save the natural resources for future generation. Natural fibres can be easily obtained in many tropical regions and available throughout the world. There are many types of natural waste material found in India like coir, bagasse, rice husk, sisal, jute, oil palm etc. Being good reinforcement materials there is a need to concentrate on improving properties of soils using cost-effective practices. (Barazesh, 2012)

2. Literature review:

Coir Fibre

The outer covering of fibrous material of a matured coconut, termed coconut husk, is the reject of coconut fruit. The fibers are normally 50–350 mm long and consist mainly of lignin, tannin, cellulose, pectin and other water soluble substances.(Hejazi,et. al,2012)

Coconut palms are mainly cultivated in the tropical regions of the world and the product from the palm is applied in food and non-food products, which sustains the livelihood of people all over the globe. The coconut palm comprises of a white meat which has a total percent by weight of 28 surrounded by a protective shell and husk which has a total percent by weight of 12 and 35 respectively. The husk from the coconut palm comprises of 30% weight of fibre and 70% weight of pith material. The fibre are extracted from the husk by several

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methods such as retting, which is a traditional way, decortications, using bacteria and fungi, mechanical and chemical process , for the production of building and packaging materials, ropes and yarns, brushes and padding of mattresses and so on. (Pillai, 2003)

Coir or coconut fiber belongs to the group of hard structural fibers. The coir fiber is elastic enough to twist without breaking and it holds a curl as though permanently waved. The inclusion of fibers had a significant influence on the engineering behavior of soil-coir mixtures. The addition of randomly distributed polypropylene fibers resulted in substantially reducing the consolidation settlement of the clay soil. Length of fibers has an insignificant effect on this soil characteristic, whereas fiber contents proved more influential and effective. Addition of fiber resulted in decrease in plasticity and increase in hydraulic conductivity. As a result there has been a growing interest in soil/fiber reinforcement. The work has been done on strength deformation behavior of fiber reinforced soil and it has been established beyond doubt that addition of fiber in soil improves the overall engineering performance of soil. Fiber mixed with soil has been used in many countries in the recent past and further research is in progress for many hidden aspects of it. Fiber mixed with soil is effective in all types of soils (i.e. sand, silt and clay). The coir fiber is one of the hardest natural fiber available because of its high content of lignin; coir is much more advantageous in different Application for erosion control, reinforcement and stabilization of soil and is preferred to any other natural fibers. (Singh and Mittal, 2014).Due to its high lignin content, coir degradation takes place much more slowly than in other natural fibers. So, the fiber is also very long lasting, with infield service life of 4–10 years. The water absorption of that is about 130–180% and diameter is about 0.1–0.6 mm.
Coir retains much of its tensile strength when wet. It has low tenacity but the elongation is much higher. The degradation of coir depends on the medium of embedment, the climatic conditions and is found to retain 80% of its tensile strength after 6 months of embedment in clay. Mainly, coir fiber shows better resilient response against synthetic fibers by higher coefficient of friction. The percentage of water absorption increases with an increase in the percentage of coir. Tensile strength of coir-reinforced soil (oven dry samples) increases with an increase in the percentage of coir. (Hejazi et al, 2012)

2.1. Advantages of coir fibre

1. It's a renewable resource and CO_2 neutral material.
2. The fiber is abundant, non-toxic in nature, biodegradable, low density and very cheap.
3. The fibre has a high degree of retaining water and also rich in micronutrients.
4. The fibres instead of going to waste are explored for new uses, which in turn provide gainful employment to improve the standard living condition of individuals.(Pillai,2003)

2.2. Physical properties of coir fibre

Length in inches	6-8
Density (g/cc)	1.40
Tenacity(g/Tex)	10.0
Breaking Elongation%	30%
Diameter in mm	0.1 to 0.5
Rigidity of Modulus	1.8924dyne/cm^2

Table 1. (Source:Ravi Shankar et al, 2012)

2.3. Chemical properties of coir fibre:

Lignin	45.84%
Cellulose	43.44%
Hemi –Cellulose	0.25%
Pectin's and related Compound	3.0%
Water soluble	5.25%
Ash	2.22%

Table 2. (Source: Ravi Shankar et al, 2012)

2.4. Coir fiber in soil stabilization:

Singh and Mittal (2014) conducted an experimental study on clayey soil mixed with varying percentage of coir fiber. Soil samples for unconfined compression strength (UCS) and California bearing ratio (CBR) tests are prepared at its maximum dry density corresponding to its optimum moisture content in the CBR mould without and with coir fiber. The percentage of coir fiber by dry weight of soil is taken as 0.25%, 0.50%, 0.75% and 1% and corresponding to each coir fiber content unsoaked and soaked CBR and UCS tests are conducted in the laboratory. Tests result indicates that both unsoaked and soaked CBR value of soil increases with the increase in fiber content. Soaked CBR value increases from 4.75% to 9.22% and unsoaked CBR value increases from 8.72% to 13.55% of soil mixed with 1% coir fiber. UCS of the soil increases from 2.75 kg/cm² to 6.33 kg/cm² upon addition of 1% randomly distributed coconut fiber. Adding of coconut coir fiber results in less thickness of pavement due to increase in CBR of mix and reduce the cost of construction and hence economy of the construction of highway will be achieved. This is because of composite effect of natural fiber changes the brittle behavior of the soil to ductile behavior.

Tiwari and Mahiyar (2014) have tested individual behavior of FlyAsh Crushed Glass & Coconut Coir Fiber with soil, which shows that for adding 10%, 15%, 20%, 25% & 30% FA with soil produces highest CBR of value 4 at max 25%, after that curve height decreases gradually. Similarly on adding 3%, 5% & 7% they obtained highest CBR of value 3 .1 at 7% CG after curves falls down enormously. Also for adding 0.25%, 0.5%, 0.75%, 1% & 1.25%.of CCR we obtained max curve height at CBR value of 3.6 after that curve should successive depletion.

Hence they determined from experimental results for combinations made for 25%FA, 7% & 1%CCF to set range for combination for this 48 trial samples are made. During this trial C.B.R, curve attains highest value at 5.2 and falls down 2.2 and again it goes to 3.8, for different set of combination.

Chapale and Dhatrak (2013) focused on effect of coir on bearing capacity and settlement of footing with parameters such as thickness of reinforced layer (B, B/2, B/4) with 0.25%, 0.5%, 0.75% & 1.0% of coir using the laboratory model tests on square footings supported on highly compressible clayey soil reinforced with randomly distributed coir fiber. Provision of coir reinforced layer increases bearing capacity ratio up to 1.5 to 2.66. There is significant increase in bearing capacity of clayey soil with the inclusion coir fibers. At 25 mm depth of fiber reinforced soil (B/4) and 0.50% fiber content the SBC is maximum. There is no need to place the fiber reinforced soil throughout the depth as the soil is affected to a significant depth of 2 to 2.5 times the width of footing. Only one fourth width of footing (B/4) is sufficient for increasing the SBC. In general, the results shows that the provision of coir reinforced layer, reduces the settlement and improves the bearing capacity , which found to be economical techniques among various types of bearing capacity improvement techniques.

H.P. Singh (2013) studied the influence of coir fibers on shear strength parameters (c and ϕ) and stiffness modulus (σ_d /ϵ) of fly ash. In the present investigation, samples of fly ash compacted to its maximum dry density at the optimum moisture content were prepared without and with randomly distributed coir fiber for triaxial compression tests. The coir fiber were taken as 0.25 %, 0.5 %, 0.75 % and 1 % by dry weight of fly ash and the shear strength parameters (c and ϕ) and stiffness modulus (σ_d /ϵ) of reinforced fly ash for each fiber content was determined in the laboratory. Finally these strength parameters (c, ϕ and σ_d /ϵ) of reinforced fly ash were compared with that of unreinforced fly ash. Tests results indicate that on inclusion of coir fiber, the shear strength parameters and stiffness modulus of fly ash increases. It was also observed that on increasing the fiber content, the values of these strength parameters further increases and the improvement is substantial at fiber content of 1 %.Thus there is a significant improvement in the strength parameters of fly ash due to inclusion of coir fiber**.**

Singh and Gill (2012) studied the effect of geo-grid reinforcement on maximum dry density (MDD), Optimum Moisture Content (OMC), California Bearing Ratio (CBR) of sub-grade soil. The clayey type of soil and one type of geo--grid were selected for this study. From the study it is clear that there is considerable improvement in California Bearing Ratio (CBR) of sub-grade due to geo-grid reinforcement. In case of without reinforcement (Geo-grid) the soaked CBR value was 2.9% and when geo-grid was placed at 0.2H from the top of the specimen the CBR increases to 9.4%.

Vaidya et. al, The stabilization of the fly ash with cement alone or in conjunction with polypropylene fibers is effective in order to enhance the either strength parameter-compression as well as tensile strength. The strengths (UCS as well as BTS) increase up to 1% fiber in all the mixes and thereafter, it decreases. The value of the strengths (UCS and BTS) increases with increase in curing period. The rate of gaining the strength in most of the cases are rapid during initial phase of curing, i. e., up to 14 days curing. The value of strengths (UCS as well as BTS) in respect of un- soaked sample is higher than that in case of soaked sample. At higher curing period such as 14 days considered in the present study, the durability of stabilized fly ash gets improved due to formation of pozzolanic reaction with the addition of cement. Both the strengths- compressive as well as tensile- is found to be higher in case of 20% cement contents and corresponding to 1% fiber in case of either samples, i.e., un soaked and soaked, indicating the optimum performance of the mix with 20% cement contents and 1% fibers.

Karthika et.al (2011) have stabilized the soil with coir geotextile. For performing the CBR test, the geotextile was placed at a mid depth of the mould while compacting. In the field simulation test for the measurement of rut depth, a layer of geotextile was provided at a depth of 15cm and above that the soil was compacted in layers to form the subgrade and CBR of soil reinforced with geotextile is increased to 12 %. CBR of soil stabilized with 5 per cent fly ash and 2.5 per cent cement and reinforced with geotextile is found to be excellent and comes to 28 per cent.

3. Conclusion:

Coir fiber is a useful biodegradable waste that improves strength and stiffness of all types of soil coir used in different proportion and different lengths affect the soil properties. Further work can be done on degradation of coir waste.

References:

i. *Bujang I. Z., Awang M. K. and Ismail A. E. (2007). Study on the Dynamic Characteristic of Coconut Fibre Reinforced Composites. Regional Conference on Engineering Mathematics, Mechanics, Manufacturing & Architecture, Malaysia.*

ii. *Chaple Parag M and Dhatrak A I (2010). Performance of Coir fiber Reinforced Clayey Soil. The International Journal of Engineering and Science (IJES) ||Volume||2 ||Issue|| 4 ||Pages|| 54-64.*

iii. *Hejazi Sayyed Mahdi, Zadeh Mohammed Sheikh, Abtahi Sayyed Mahdi and Zadhoush Ali (2012). A simple review of soil reinforcement by using natural and synthetic fibers. Construction and Building Materials 30, 100-116.*

iv. *Kharade Amit S., Suryavanshi Vishal V., Gujar Bhikaji S. and Deshmukh Rohankit R., (2014) Waste product 'bagasse ash' from sugar industry can be used as stabilizing material for expansive soils IJRET: International Journal Of Research In Engineering And Technology EISSN: 2319-1163 | PISSN: 2321-7308 volume: 03 issue: 03 | March.*

v. *Mittal Shelly and Singh R. R. (2014). Improvement of local subgrade soil for road constuction by the use of coconut coir fiber. IJRET: International Journal of Research in Engineering and Technology, Volume: 03 Issue: 05 | May.*

vi. Pillai Sudhakaran M. (2003). Ecofriendly plastics/remedial measures for environment sustailability, Coir Board Government of India. 4th International R&D conference for Water and Energy for 21st century, 28-31 January. Aurangabad.

vii. R. Karthika, g. R. Amruthalekshmi, anju k. Peter, m. Mohamed sajeer and a. K. Raji (2011). Study of rut behaviour of coir reinforced black cotton soil using wheel tracking apparatus. Proceedings of Indian Geotechnical Conference. December 15-17, Kochi (Paper no. J-258).

viii. Ravi Shankar A.U., A. Chandrasekhar and Bhath Prakash (2012).Experimental Investigation on Lithomargic Clay Stablized with sand and Coir. Indian Highways: A Review of Road and Road Transport Development. Vol.40 No.2.pages.21-31.

ix. Reinforced with Coir Fibres. A thesis submitted in B.Tech Civil Engineering, Malaysia, Phang.

x. Singh H. P. (2013). Strength and Stiffness Response of Itanagar Fly Ash Reinforced with Coir Fiber. International Journal of Research in Science, Engineering Innovative and Technology, Vol. 2, Issue 9, September 2013.

xi. Tiwari Amit and Mahiyar H. K. (2014). Experimental Study on Stabilization of Black Cotton Soil by Fly Ash, Coconut Coir Fiber & Crushed Glass. International Journal of Emerging Technology and Advanced Engineering. Volume 4, Issue 11, November.

xii. Vaidya M.K., Chore H.S, Kousitha P. And Ukrande S.K., Geotechnical Characterization Cement - Fly Ash –Fibers Mix, IOSR Journal Of Mechanical And Civil Engineering (IOSR-JMCE) Issn: 2278-1684, Pp: 60-66