IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684, p-ISSN: 2320-334X
PP 06-12
www.iosrjournals.org

Behavior of Mat Footing Resting on Coir Fibre Reinforced With Sand

R.Sridhar[1], M.T.Prathap kumar[2]
[1](Research scholar,Ghousia college of Engg,Ramanagaram and Department of civil Engineering, Alva's Institute of Engineering& Technology,Karnataka,India)
[2](Department of civil Engineering, Reva Institute of Engineering &Management,Karnataka,India)

***ABSTRACT*:** In this present investigation, mat footing resting on sand was considered.Theload test has been carried out with coir fibre of different length reinforced in sand. It is observed that, the applied bearing pressure versus settlement response of different coir fiber lengths is significantly larger than that for the unreinforced case and settlement reduction factor increases significantly with increase in length of fibre.
***Keywords: coir fibre, Load test,mat footing,settlement reduction factor*.**

I. INTRODUCTION

1.1. Behavior of Reinforced Soil Under Static Loads

In the earlier stages, most of the research work and construction projects reported were mainly confined to application of the concept of reinforced earth to the problem of retaining earth and slope stabilization. Later, in view of the reinforced earths potential for use in other areas investigations in several other areas of its application were carried out. The foundation problem was also attracted the attention of research workers. A laboratory investigation on the application of reinforced earth for foundation problem was first reported by Yang (1972) and thereafter most comprehensive work on this problem was reported by Binquet and Lee (1975). Since then various investigators have tried the foundation problem by the application of the concept of reinforced earth using various reinforcing materials. In this review salient features of Investigations carried out so far in this field have been brought out.

1.2. Principle of reinforced earth

Soil mass is generally a discrete system which consists of soil grains. It cannot bear tensile stresses and this is particularly true in the case of cohesion less soil like sand. Such soils cannot be stable on steep slopes and relatively large strains are caused when external loads are imposed on them. Reinforced earth is a composite material, a combination of soil and reinforcement suitably placed to bear the tensile stresses developed and also to improve the resistance of soil in the direction of greatest stress. The presence of reinforcement alters the stress field giving a restraint mostly in the form of friction or adhesion so thatless strains induced and tension is avoided.

The coir fibers have been found to have good strength characteristics and resistance to bio-degradation over a long period of time. Coir fiber is extracted from green coconut husk after retting in flowing, circulating or changed water (lagoon-river) for a period of minimum 3 months. Long retting will withdraw much acid and pectin, which can cause oxidation and shorter life of the fiber. India is the largest producer (66% of world production) of coir fiber from the husk of coconut fruit. Indiscriminate destruction of potentially useful materials owes much to the lack of alternate end uses of coir fibers.

1.3. Scope of present work

The objective of the present investigation is to determine the effect of introducing coir fiber reinforced soil layer over soil stratum. The results of the present experimental investigation will be analyses to determine the following

I. Effect of coir fiber reinforced sand on bearing capacity and settlement of the model footing..

II. Effect of percentage of coir fibre on the bearing capacity and settlement of model footings.

II. LITERATURE SURVEY

According to the studies conducted by Maher M.H. (1994) the improved mechanical properties (i.e. strength and ductility) of clay as a result of fiber inclusion may be useful in maintaining the structural integrity of landfill liners and covers.

Also fiber reinforced soils are currently being used for soil stabilization of shallow slope failures, construction of new embankments with marginal soils etc. when the heavy clay in a slope is exposed to wet and dry weather cycle, causes fissures and cracks to develop in the slope surface, thus allowing surface water to infiltrate. During a long wet season, the ground water will not only be trapped in these fissures and cracks, but it will also have enough time to soak the clay adjacent to these fissures and cracks. As the soil saturation increases, the shear strength decreases due to the interaction between the water and clay particles. The water molecules will change the fabric structure of the soil, breaking the bonds between clay particles. Fiber treatment can be applied to improve the stability of clayey soil slopes. According to the studies conducted, fiber inclusions have been found to reduce both tension cracking and the shrinkage/swell potential of low plasticity clay. Improvements in the resistance to desiccation cracking were also noted by Zhang Z.D. and Farrag K. (2001), as suggested by Zornberg J.G. et al (2002), fiber reinforcement is used for stabilization of evapotranspirative cover systems constructed on steep landfill slopes. In this application, fiber reinforcement would provide not only increased stability, but also resistance against erosion and desiccation cracking. According to the studies conducted by Gregory G.H. and Chill D.S. (1998), another slope stabilization application in which fiber reinforcement offers other benefits in relation to continuous planar inclusions is in projects involving the localized repair of failed slopes.

The toughness and ductility of the fiber reinforced soils are beneficial for anti-earthquake geo structures. The use of fiber reinforcement within the soil mass in seismically active areas can significantly increase the yield acceleration used in design. According to Maher M.H. and Woods R.D. (1990), under dynamic loading conditions, the use of fibers in sands provided increased resistance to liquefaction and a higher dynamic shear modulus.One of the primary advantages of randomly distributed fibers is the absence of potential planes of weakness that can develop parallel to oriented reinforcement. The alignment may result in anisotropic of the soil mass that could result in decrease of directional strength. However, advantage of using randomly distributed fibers is the maintenance of strength isotropy.

According to Maher M.H. and Gray D.H. (1990), ease in mixing is one among the advantages of using randomly distributed fiber reinforced soil in stabilization and strengthening works. Discrete fibers are simply added and mixed randomly with soil, which does not need much expertise.

According to Maher M.H. and Gray D.H. (1990), ease in mixing is one among the advantages of using randomly distributed fiber reinforced soil in stabilization and strengthening works. Discrete fibers are simply added and mixed randomly with soil, which does not need much expertise.

Consoli et al **[2005]** carried out high pressure isotropic compression tests on samples of a uniform fine sand at different initial specific volumes, reinforced with randomly distributed polypropylene fibers (0.5% by weight, 24mm in length and 0.023mm thick), as well as on non-reinforced sand specimen.Analysis of the results identified changes in the isotropic compression behavior due to the random inclusion of fibers into the sand. Two distinct and parallel normal compression lines were observed for the fiber-reinforced and non-reinforced sand. The fibers were exhumed after testing and it was found that fibers had both extended and broken, indicating that the fibers tend to suffer large plastic tensile deformations before breaking and that the fibers act under tension even in isotropic compression.

Consoli et al [2005]**,** Suggested a mechanism shown to explain these observations, in which the fibers both extend and break under tensile stress, even if the overall applied stress is isotropic.

The initial fiber shape is represented here as straight, which is simplistic. The isotropic compression causes relative movement among particles and consequently produces tensile stresses in the fibers located among them. There is also the possibility of an additional mechanism of fiber breaking during testing by squeezing and crushing of the sand particles, cutting the fibers trapped between them.

III. MATERIALS

3.1 Sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. Sand is formed by disintegration of sedimentary rocks by weathering action. Locally available sand was used for the present experimental investigation which has been taken from Hariharain Karnataka. Sand was sieved through IS 2.00mm sieve size in order to have uniform size. The specific gravity of the soil particle was determined by the pycnometer method, three tests were carried out producing an average value of 2.66. According to the unified soil classification system, the soil is classified as poorly graded sand with letter symbol SP. The particle size distribution was determined using dry sieving method and the properties of sand used are as shown in Table 3.1.

Table 3.1 Properties of sand

Specific gravity (Gs)	2.66
Coefficient of uniformity (Cu)	4.48
Coefficient of curvature (Cc)	0.960
Type of sand	SP (poorly graded sand)
Relative density of sand in experiments	70%
γ_{dmax} (gm/cc)	1.62
γ_{dmin} (gm/cc)	1.37

γ_d= 1.52 gm/cc

3.2 Coir fibres

Coir is a biodegradable organic fiber material which is rigid, strong, and tensile in nature. The rate of decomposition of coir is much less than any other natural fiber. This characteristic is due to the high lignin content in the fiber due to this unique feature of coir it is chosen for thiswork.Coir is a one of the cheaply available organic material and for the present study coir was purchased from place called Gubbi in Karnataka

IV. MODEL FOOTING TEST

4.1 Testing procedure

Load settlement test using 50mm diameter model footing were conducted in the laboratory in a steel test tank. Whose dimensions are given below. The size of the tank selected such that it minimizes the scale effect of the model footing used. The inside dimensions of the tank were as follows:

- Diameter of the tank (d) = 250mm
- Height of the tank (H) = 300mm
- Area $\pi/4*d^2$ =11,783cc

- Weight of the sand (W) = $\gamma_d * V$ = 17.90 Kg

For conducting model tests specified weight of 17.90Kg sand was poured in to the test tank. The height of fall to achieve the desired relative density (70%) was determined a priori by performing a series of trials with different heights of fall. The sand was compacted in 3 layers by giving suitable number of blows. At the prescribed depths of reinforcement placement, the pouring of sand was temporarily stopped and the reinforcement was placed on the surface of the sand.

Upon filling the tank with sand to the top, the top surface of sand was levelled and the model footing was placed on the predetermined alignment such that the load from the loading jack was transferred concentrically to the footing. The magnitude of loads applied to the footing was recorded with the help of a sensitive recalibrated proving ring of 10KN capacity placed between the hydraulic jack and the reaction beam. Each load increment was maintained constant until the rate of displacement was less than 0.01mm/h. Displacement(settlement) of the model footing was measured using 3 dial gauges (Dg1, Dg2 and Dg3 . The displacements reported are the average of 3 dial gauge readings, which were nearly identical. In all of the experiments, the loading was continued until footing displacement reached 50mm. Before starting each test, the test tank was completely emptied and then refilled with sand. All of the experiments were repeated to verify the consistency of the test data.

V. LOAD SETTLEMENT CHARACTERISTICS FOR COIR FIBER REINFORCED SAND

5.1. Introduction

Model footing of diameter 50mm has been used to study the load settlement characteristics of reinforced earth compacted over soil stratum using coir fibers of different lengths placed at different depth ratio.

In order to study the effect of thickness of the reinforced earth, the depth of reinforced zone from the bottom face is measured as u and the u/b ratios considered in this study are 0.4, 0.8 and full depth of the tank.

VI. Model footing test results

Table 6.1 shows , pressure in KN/m² corresponding to unreinforced sand and sand reinforced with optimum percentage of 0.2% with different u/b ratio of 0.4, 0.8 and full depth of the tank.

Table 6.1: Bearing pressure at S=25mm & S=40mm

u/b	Coir fiber length in mm	Bearing pressure(KN/m²)	
		S=25mm	S=40mm
Unreinforced sand		300	367.16
0.4	10mm	1005.24	1558.28
0.8		2172.41	3389.70

Full depth		**1203.90**	**1733.97**
0.4	**20mm**	**1183.29**	**1706.09**
0.8		**2392.48**	**3661.45**
Full depth		**1360.45**	**1899.96**
0.4	**30mm**	**1711.08**	**2189.74**
0.8		**2504.07**	**4015.11**
Full depth		**1440.70**	**2202.68**

Table 6.2 show variation of bearing capacity ratio (BCR) v/s depth ratio. The BCR is defined as the ratio of bearing pressure of reinforced sand to the bearing pressure of the un-reinforced sand at a specified settlement. It can be seen from these figures that the BCR value is maximum corresponding to u/b = 0.8. Hence, for a given optimum fibre content the effective depth of the reinforced zone that may have significant increase in bearing capacity of reinforced sand when compared to un-reinforced sand is around depth ratio of u/b = 0.8. Thus, there is always a necessity to consider the significant influencing depth of u/b = 0.8 in the design of footing resting on coir fibre reinforced sand. Increase in depth of fibre zone beyond this depth ratio does not contribute to increase in bearing capacity which is a significant find of the present experimental study.

Table 6.2:Summarized values of BCR obtained corresponding to different values of Normalized settlement

Test series	Variable parameters	BCR corresponding to various normalized settlement					
		5%	10%	15%	20%	25%	30%
10mm coir fiber length	0.4	2.5	2.8	3.2	3.6	4	4.4
	0.8	3	3.4	3.8	4.4	4.8	5.2
	Full depth	2.6	3	3.4	4	4.4	4.8
	0.4	2.6	2.9	3.4	3.8	4.4	4.6

20mm coir fiber length	0.8	3.2	3.6	3.9	4.6	5	5.4
	Full depth	2.8	3.1	3.6	4.2	4.6	5
30mm coir fiber length	0.4	2.8	3.1	3.6	4	4.6	4.8
	0.8	3.4	3.8	4.1	4.8	5.2	5.6
	Full depth	3	3.4	3.8	4.4	4.8	5.2

VII. CONCLUSION

1. The applied bearing pressure versus settlement response of different coir fiber lengths is significantly larger than that for the unreinforced case.

2. The bearing capacity of sand bed is maximum to depth ratio of u/b=0.8 and therefore decreases as the optimum percentage of coir fiber.
3. From the overall performance point of view of the model footing (i.e. both strength and settlement aspects), the optimum depth of coir fiber reinforcement zone is about 0.8b below the base of the model footing, where b=width of the footing.
4. Provision of coir fiber with different lengths improves the load carrying capacity of the model footing substantially at all levels of normalized settlement.
5. Settlement reduction factor increases significantly with increase in length of fiber. Hence length of the fiber has significant influence on reducing settlement.

VIII. REFERENCES

[1] Gerald P. Raymond (1992), "Reinforced sand behaviour overlying compressible sub grades", Journal of Geotechnical Engineering, Vol. 118, No. 11, 1663-1680.
[2] P.Vinod, AjithaB. Bhaskar, S. Sreehari (2009), "Behaviour of a square footing on loose sand reinforced with braided coir rope", Geotextiles and Geomembranes, vol. 27(2009), 464-474.
[3] Praveen kumargupta, Swami Saran and Ravikant Mittal (2006), "Behavior of fiber reinforced sand in different test conditions", Indian Geotechnical Journal, vol. 36, No. 3, 2006, 272-282.
[4] Binquet.J.&Lee.K.L.(1975), "Bearing Capacity Analysis of Reinforced Earth Slabs", Jnl. of Geotechnical Engg. Division, Proc, ASCE, Vol. 101, No Gt12, 1257-1276.
[5] Consoli, N.C., Preitto, P.D.M., and Ulbrich, L.A. (1998), Influence of fiber and cement addition on behavior of sandy soil, J. Geotech. Geoenviron. Eng., 124(12), 1211-1214.
[6] Consoli, N.C., Montardo, J.P., Prietto, P.D.M., and Pasa, G.S. (2002), Engineering Behaviour of a sand Reinforced with plastic waste, J. Geotech. Geoenviron. Eng., 128(6), 462-472.
[7] Consoli, N.C., Casagrande, M.D.T., preitto, P.D.M., and Thome, A. (2003), Plate load test on fiber reinforced soil, J. Geotech. Geoenviron. Eng., 129(10), 0951-0955.
[8] G. MadhaviLatha, Vidya S. Murthy2007 "Effects of reinforcement form on the behavior of geosynthetic reinforced sand" Indian Institute of Science, Bangalore 560012, India, Geotextiles and Geomembranes 25 (2007) 23–32., Volume 25, Issue 1, Pages 23–32.
[9] G L SivakumarBabu& A.K Vasudevan(2008)."Strength and stiffness response of coir fibre reinforced Tropical soil".
[10] G MadhaviLatha And AmitSomwanshi (2009), "Effect of reinforcement on the bearing capacity of square footings on sand.
[11] Hoe. I. Ling Et.Al(2001), "Post Earthquake investigation on several Geosynthetic reinforced soil retaining walls and Slopes", Soil Dynamics and Earthquake Engg, Vol. 21, No. 2, 297-313.
[12] IS: 2720 (Part XIII): (1986), "Indian Standard Methods of tests for soils- Direct Shear Test", Indian Standards Institution, New Delhi.
[13] K. M. Lee & V .R. Manjunath (soil –geotextile interference frication by direct shear test).(2000),Soil-geotextile interface friction by direct shear tests.
[14] Mandal, J.N And Dixit, R.N. (1986), "Response paper to: Under what situations are Geotextiles more effective than traditional methods for ground improvement and drainage", Proc. Ind. Geotech. Conf. Delhi. Vol-2, 195-199.

[15] Nagraja P.S (2006)"Behavior of reinforced sand beds subjected to monotonic, cyclic and dynamic loads" PhD thesis report UVCE, Bangalore University.
[16] Robert T. Wong and H. Bolton Seed (1975), "Cyclic loading liquefaction of gravelly soils", Journal of Geotechnical Engineering, Vol. 101, No. GT6, 571-583.
[17] Swami Saran (2009) "Reinforced soil" Published by Universal Press
[18] Temel Yetimoglu*, Omer Salbas "A study on shear strength of sands reinforced with randomly distributed discrete fibers" Atac 2 Sk., Umut Apt. 52/16, Kızılay-Ankara 06410, Turkey, Geotextiles and Geomembranes 21 (2003) 103–110, 5 December 2002
[19] Vidal, H., (1969), "The Principle of Reinforced earth ", Highway Research Record, 282, 1: 1-163