**International Journal of Engineering, Management, Humanities and Social Sciences Paradigms (IJEMHS)**
**Volume 30, Issue 02, Quarter 02 (April to June 2018)**
**ISSN (Online): 2347-601X**
**www.ijemhs.com**

# RANDOMLY DISTRIBUTED FIBER REINFORCED SOIL FOUNDATIONS SUBJECTED TO AXIALLY OBLIQUE LOADING

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## ABSTRACT

The potential advantages of fiber supported soil establishments over unreinforced sands exposed to slanted burdens are examined utilizing absolute of 93 limited scope model balance load tests. The impact of soil support (level of strands), impact of thickness of built up layer, impact of soil thickness and impact of burden tendency on some unmistakable boundaries like extreme bearing limit, vertical settlement and flat disfigurement are examined in this review. Test outcomes demonstrate that the utilization of fiber supported sand acquires extensive improvement extreme bearing limit, vertical settlement and flat disfigurement of establishment. A measurable model utilizing various direct relapse examination dependent on present exploratory information for anticipating the settlement (Sp) of square balance on supported sand at any heap applied was done where the reliant variable was anticipated settlement (Sp).

KEYWORDS: Inclined loading; Fiber reinforced sand; Square footing; Ultimate bearing capacity; Bearing capacity ratio; Vertical settlement ratio

## INTRODUCTION

Footings which serve as foundations for retaining walls and framed structures may get subjected to other loads also in addition to the vertical load. Also for designing the foundations subjected to earthquake forces appropriate values of horizontal and vertical coefficients should be properly evaluated. The footings which are subjected to these types of loadings are resolved in two parts: (1) An eccentric vertical load and (2) An axially oblique load. In this study we are analyzing the footings which are subjected to only axially oblique load with the help of small scale footing load tests.

Randomly distributed fiber reinforced soil (RDFS) is among the latest techniques in which fibers of desired type and quantity are added in the soil, mixed and laid in position. The main advantage of randomly placed fibers is the absence of potential planes of weakness that can develop parallel to the oriented reinforcement.

Majority of work on RDFS is confined to triaxial tests [Andersland and Khattak (1979), Maher and Gray (1990), Al-refeai (1991), Michalowski and Zaho (1996), Ranjan *et al.* (1996), Charan (1996), Michalowski and Cermak (2002), Prabhakar and Sridhar (2002), Ahmad *et al.* (2010), Diambra *et al.* (2010)]**,** with some tests on direct shear test [Fatani *et al.* (1991), Yetimoglu and Salbas (2003), Tang *et al.* (2010), Falorca and Pinto (2011)], unconfined compressive strength test [Maher and Ho (1994)], and few on CBR tests [Benson and Khire (1994), Charan (1996), Nataraj and McManis (1997), Kumar *et al.* (1999), Yetimoglu et al. (2005), Kumar *et al.* (2008)], model tests on footing [Consoli et al. (2003), Kumar et al. (2011)]. However in all these studies for model footing tests the load applied is concentric and generally strip footing is used.

A number of experimental studies on the subject of oblique loading have been conducted by several researchers using different type of reinforcement [Saran and Aggarwal, (1991), Patra *et al*., (2006), Saran *et al*., (2008)]. They studied the problem of generally strip footings reinforced with geogrid.

In the present study, small scale footing load tests have been performed on unreinforced soil and soil reinforced with randomly distributed polypropylene fibers to study the behavior of square footing subjected to axially oblique loading. Here the effect of thickness of reinforced soil layer, fiber percentage, relative density and angle of inclination on bearing capacity, vertical settlement and horizontal deformation have been studied in detail.

# MODEL TESTING PROGRAM

## Soil properties

The sand is classified as poorly graded sand (SP) by the Unified soil classification system with minimum and maximum density of 13.8 kN/m3 and 17.09 kN/m3 respectively, Cu and Cc of 2.09 and 0.98 respectively and specific gravity of 2.61.

## Reinforcement properties

Corrugated polypropylene fibers "ENDURA HPP 45" with 45mm length and specific gravity of 0.91 were used as reinforcement throughout this investigation.

A plastic fabric sheet with maximum tensile strength of 8.46 kN/m is also placed at an interface of reinforced and unreinforced layer to act as a separator which also acted as reinforcing material.

## Test series description

Total of Ninety-three model tests as described in Table 1, were conducted on square footing resting on unreinforced and reinforced sand subjected to axially oblique loading. The testing was conducted in three phases. Phase I is comprised of three tests conducted on totally unreinforced sand at three different inclination angles (i) of 5°,10° and 15° with the vertical compacted at 25% relative density ($R_D$). Phase II tests (18 tests) were designed to examine the effect and strength contribution on bearing capacity of plastic fabric sheet placed at interface of two different layers of unreinforced sand at three different thicknesses of sand layers (0.5B, 0.75B and 1B). Here the load is applied at three different inclination angles of 5°, 10° and 15° and the layer above plastic fabric sheet is compacted at two different relative densities (25% and 55%) underlain by unreinforced sand compacted at relative density of 25%. Phase III involved 72 tests conducted on a sand bed with top layer of sand reinforced with four different fiber percentages by weight of sand (0.5%, 0.75%, 1% and 1.25%) compacted at two different relative densities and underlain by unreinforced sand compacted at relative density of 25% with plastic fabric sheet placed at interface of reinforced and unreinforced.

# CONCLUSIONS

Ninety three small scale model tests were conducted to evaluate the benefits of fiber reinforced square footings and based on this study the following conclusions were drawn:

1. The BCR values increase with the increase in thickness of the reinforced layer but the rate of gain is less after 0.75B thickness and the SR values decrease with increase in thickness of the reinforced layer and this rate of decrease is more pronounced when thickness of reinforced sand layer is 1B.
2. With only plastic fabric sheet at 0.5 B below the base of the footing, the value of ultimate bearing capacity increases by 23.3%, 19.6% and 11.4% in comparison to the unreinforced soil at load inclination of 5°, 10° and 15° to the vertical. It further increases by 27.5%, 25.8% and 17.2% in comparison to the unreinforced soil with plastic fabric sheet at 0.75B at load inclination of 5°, 10° and 15° to the vertical. After which this effect goes on decreasing with the increase in depth of placement of plastic fabric sheet.
3. With the increase in percentage of fiber, there is improvement in terms of bearing capacity ratio, vertical settlement ratio and horizontal deformation ratio but the rate of improvement is very small if the percentage of fiber is increased beyond 1%.
4. The model test results show that the gain in bearing capacity of a square footing resting on sand after reinforcing the soil with randomly distributed fibers and fabric sheet at the interface is more when reinforced soil is compacted with high relative density i.e., 55%

as compared to the reinforced soil compacted at 25% relative density keeping all other parameters same.

5. There is good gain in terms of vertical settlement ratio and horizontal deformation when reinforced soil bed is compacted at more density i.e., 55% instead of 25% relative density.
6. A statistical model using multiple linear regression analysis based on present experimental data for predicting the settlement ($S_p$) of square footing shows that the observed and predicted values of settlement are matching very well.

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