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# BEARING CAPACITY OF SOIL WITH CARBON FIBER ON WELDED WIREMESH

**Rijo Varghese[1] Tara Leander[2]**

[1]*M.tech student, Dept. of Civil Engineering, Marian Engineering College, Kerala, India*
[2]*Assistant Professor, Dept. of Civil Engineering, Marian Engineering College, Kerala, India*

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**Abstract-** *Soil bearing capacity is an essential measure for construction purposes. Geogrid reinforced soil system is commonly used for improving properties. It helps in improving tensile strength. In this study, chopped carbon fiber(CCF) is used to improve the bearing capacity of the soil. These components create a reinforcing network within the soil, by increasing its internal friction and cohesion. This results in improving shear strength and bearing capacity. Carbon fiber is stronger than other geogrids like steel fibers. 0.5, 1,1.5, 2, 2.5, 3% of carbon fiber is initially used. Through direct shear test optimum measure of shear strength is calculated. Then bearing capacity calculation is done with optimum shear strength of carbon fiber along with welded wire mesh (WWM) on plate load.*

***KeyWords***: Bearing capacity, Plate load test, direct shear test,CCF, WWM.

## 1. INTRODUCTION

Bearing capacity is one of the most important factors that we consider while construction of a building. In old times bearing capacity is not calculated for the construction of the building. But in modern Times building Constructions done in weakest soil also. New methods of stabilization on the soil are adopted for the construction. Pile foundations are also used to transfer load from the building at the greater death on soil in the case of weakest soil. Basically there are many tests for calculating bearing capacity including plate load test. Basically carbon fiber is a fiber which is stronger than Steel fibers. Powder Carbon fiber is used for analysis.

Soil is taken from mannanthala region. Along with the soil carbon fiber welded wire mesh is placed for the analysis. Bearing capacity of soil varies according to the soil type like silt, sand, clay and also varies due to material properties. Plate load tests are basically used for finding bearing capacity and settlement analysis. Dial gauge reading is measured in plate load test. Polyacryloriniye process is mainly used for majority of carbon fiber preparation. Cohesion and angle of internal friction can easily obtained from direct shear test.

## 2. LITERATURE REVIEW

Cui H et.al (2018) studied on effect of carbon fiber and nano silica on shear properties of silty soil and the mechanisms. The materials used are silty soil, carbon fiber and nano silica. 1%, 2%, 3% of carbon content and 1%, 2%, 3% of nano silica was used. Direct shear test was used for the analysis. Test is conducted for each percentage of carbon fiber and nano silica separately. Maximum shear strength obtained at carbon fiber of 2%, with carbon fiber only used. Maximum shear strength obtained at nano silica of 3%, with nano silica only used. Cohesion of sample with 2% carbon fiber and 3% of nano silica shows an increase of 15%.

Akbar A et.al (2021) studied on plate load tests for investigation of the load settlement behavior of shallow foundation on bitumen coated geogrid reinforced soil bed. Soft soil and geosynthetics used for the analysis. Different grades of geogrids, width of reinforcement (1.5B and 4.5B), number of reinforcing layers and varying end conditions are used for the analysis. 1m x 1m x 1m steel tank is used. While increasing layer of geogrids, vertical displacement is increased. Plate load test is used for the analysis. It is founded that bearing capacity of geogrid reinforced clay increased. Looped layout is more effective and optimum width is4.5B for the analysis. Settlement reduction factor also increased.

Consoli N.C et. al (2003) studied on the topic plate load test on fiber reinforced soil . Confining pressure, fiber is varied for the test. Plate load test, triaxial test are used for the analysis. From the observations Axial strain is larger than 20% from the initial case. Poly propylene fiber influence friction angle. Friction angle of compacted sandy soil and compacted fiber reinforced sandy soil are 30° and 31°.Cohesion intercept at failure of compacted sandy soil and compacted fiber reinforced sandy soil are 23KN/$m^2$ and 127 KN/$m^2$.Addition of polypropylene fiber improves strength of soil.

Bao X. et .al (2021) studied on the topic experimental investigation on mechanical properties of clay soil

reinforced with carbon fiber. Clay soil, carbon fiber are used for the analysis. 1%, 2%.3% wt carbon fiber and carbon fiber length 3mm, 6mm, 9m are prepared and used. Direct shear and UCC test is done. Normal pressure of 100, 200,300 and 400Kpa is used in direct shear test. While studying on soil, shear strength began to decrease after adding 2% of carbon fiber. Cohesion of reinforced soil specimens with 3, 6 and 9mm increased. Specimen of 6mm carbon fiber gives highest shear strength.

Mehrjardi G.T et. al (2017) studied on the topic Scale effect on the behavior of geogrid reinforced soil under repeated loads. Geosythetics, sand and gravel are materials used. Four different soil grain sizes, 2 different geogrid aperture sizes(20 x20mm and 25 x 25mm), three different loading plate sizes are varied for the analysis.. Plate load test is done for the analysis. Plate diameters used are 80,120,150. It is observed that Geogrid reinforced will increase bearing capacity upto 6.35 times. As the loading plate is enlarged, cyclic bearing capacity will be increased. The optimum nominal aperture size should be about 4 times the medium grain size.

Khalaj O et.al (2015) studied on the topic Improvement of pavement foundation response with multi-layers of geocell reinforcement: Cyclic plate load test. Geocell reinforcement, well graded sand are used for the analysis. Loading and unloading cycles and vertical spacing between geocell layers has been varied for the test. Then plate load test is done. Observations indicate that use of four layers of geocell reduces the total and residual plastic settlements. The resilient settlement is increased by 145%

## 3. MATERIALS AND EXPERIMENTAL SETUP

### 3.1 SOIL

The soil used in this study was excavated 2m below the ground level. The soil was collected from Mannanthala region, Trivandrum. Basic soil properties are shown in Table

-1. Particle size distribution curve is analysed in detail. According to the IS specifications, the obtained soil is poorly graded sand. Particle size distribution curve is shown in chart 1.

Table – 1: Properties of soil

| PROPERTY | VALUE |
|---|---|
| Specific gravity,G | 0.15 |
| Moisture content(%) | 2.69 |
| Cc | 4.52 |
| Cu | 0.92 |
| Percentage of fine sand, medium sand and coarse sand (%) | 87.07 |
| Percentage of gravel (%) | 12.43 |
| Percentage of sit and clay (%) | 0.5 |
| Cohesion(kg/cm$^2$) | 0.15 |
| Angle of internal friction | 45 |

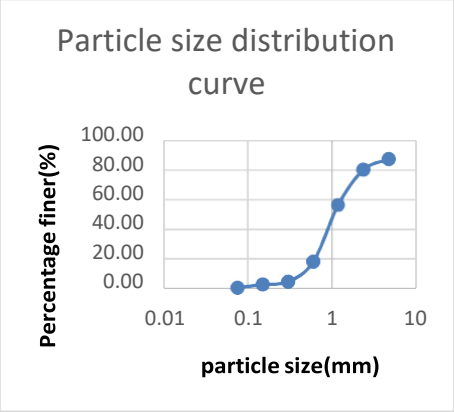


chart - 1: Particle size distribution curve

### 3.2 Chopped carbon fiber (CCF)

Carbon fiber, renowned for its exceptional mechanical properties such as high tensile strength, stiffness, and resistance to corrosion and fatigue, is a lightweight material widely utilized across diverse industries. Its applications span from aerospace and sports equipment to automotive and rotor blade manufacturing. Properties are shown in table-2 and figure is shown in chart- 2

Table – 2: Properties of CCF

| Material overview | SI |
|---|---|
| Moisture content | 0.5% |
| Unpacked bulk density | 350g/L |
| Fiber length | 3mm |

### 3.3 Welded wire mesh (WWM)

Mild steel is the material used as welded wire mesh. Totally 4 welded wire meshes are used. The vertical distance between each layer is kept constant as 0.25B and the top distance from the top layer of the sand to top layer of welded wire mesh is varied by (U/B) ratio as 0.25, 0.5, 0.75,1. Properties of welded wire mesh are shown in the diagram. Properties are shown in table 3 figure shown in chart 3.

Table – 3: Properties of WWM

| Material | Properties |
|---|---|
| Material | 2.25 |
| Size | 49.5cm*49.5cm |

### 3.4 Experimental Set Up

Basically we all know plate load is used to find bearing capacity and settlement. Here we have 50cm x 50cm tank and plate of thickness 10cmx10cm and figure is shown in chart 4.

chart – 2 :chopped carbon fiber, Source - Construction and building materials

DOI:https://doi.org/10.1016/j.conbuildmat.2018.08.181, CCF is taken from pooja elastomers from experimental analysis.

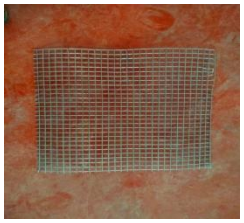

chart – 3: Welded wire mesh, (material collected from KSM tube and steel, Thiruvananthapuram for the analysis)

chart – 4: Plate load setup

## 4. RESULTS AND DISCUSSION

### 4.1EXPERIMENTAL RESULTS AND DISCUSSION

#### 4.1.1 Dry density of CCF content

Dry density analysis is initially done with varying content of CCF from 0.5 to3%.maximum dry density was observed at 2% of CCF at 1.39g/cc. chart- 5 shows dry density variation.

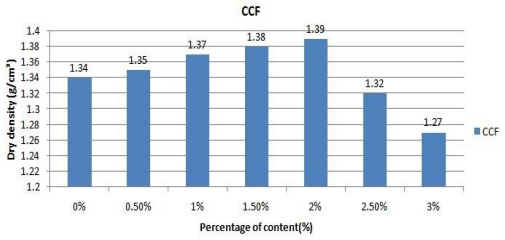


chart – 5: dry density variation

#### 4.1.2 shear strength

shear strength is analysed for each content of CCF. Maximum value of CCF was 3.14kg/cm$^2$ which were at 2% CCF. Chart 6 shows shear strength variation.

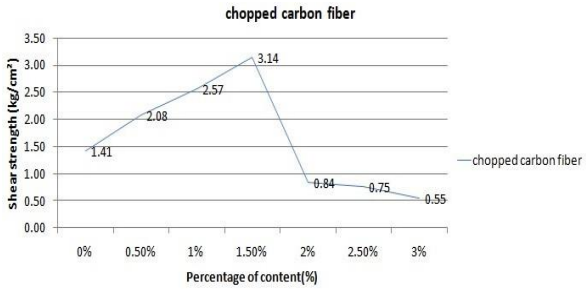


chart – 6: Shear strength variation of different CCF

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