Role of Geo-Grid in Enhancing the Bearing Capacity of Soil
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Abstract:
This paper determines the bearing capacity of four different types of soil and placing geogrids at different depths. Soil is one of the main basic materials in design and construction in civil engineering works, due to the high demand on the maintenance and development of efficient infrastructure (railways, roads and buildings). This paper investigates basic property of different types of soils, such as Red soil (RS), Black cotton soil (BC), Laterite soil (LS) and Alluvial soil (AS) and increase the bearing capacity by using Bi-axial geogrid. The soil samples were taken to the laboratory for experiments to determine Grain size, Specific gravity, Atterberg limits, Compaction test (MDD & OMC), Direct shear test, unconfined compression test and California Bearing Ratio (CBR) by laying the geogrid at different layers like Top, Bottom, Middle and 1/3rd & 2/3rd from the base of the mould to determine the strength of soils. The bearing capacity of Laterite soil, Black cotton soil and Alluvial soil is increases when the geogrid is placed at the top and bearing capacity of Red soil is increases when the geogrid is placed at middle.

Keywords: CBR, Bi-axial geogrid.

I. INTRODUCTION
The geogrid material has gained the attention in the field of geotechnical engineering as it is used to improve the bearing capacity of soil. For the last three decades, many studies have been carried out based on the beneficial effects of the geogrid material on the load bearing capacity of the soil. Several researches have conducted that the bearing capacity of the soil is increases by the reinforcement of geogrid. A geogrid is defined as the geosynthetic material consisting of connected parallel sets of tensile ribs with apertures of sufficient size to allow strike through surrounding soil or other geosynthetic material. Geogrids are made from high molecular weight, high tenacity polyester with polymeric coating, the geogrid sheets are permeable and flexible, the geogrid carries tensile strength varying from 100 to 220KN. Soil alone carries compressive forces however with the help of geogrid it is able to carry tensile forces also. In this study we have used bi-axial geogrid as they carry the strength both in X and Y directions. In this project we have used four different types of soils namely Red soil, Black cotton soil, Laterite soil and Alluvial soil.

RED SOIL: Red soil have two broad classes
1) Red loam with cloddy structure and allow content of concretionary materials
2) Red earths with loose, permeable top soil and a high content of secondary concretions.

LATERITE SOIL: These soils are red to reddish yellow in colour and low in N, P, K, lime and magnesia. These soils are formed in-situ under conditions of high rainfalls with alteration dry and wet periods.

BALCK COTTON SOIL: In India large area is occupied by the black cotton soil, which absorbs water, swells, becomes soft and loses strength. These are mostly clay soil and form deep cracks during dry season. These soils are deficient in nitrogen, phosphoric acid and organic matter but rich in calcium, potassium and magnesium.

II. METHODOLOGY
The specific gravity of soil samples is determined by using IS 2720 (part-3)-1980 and the particle size distribution by using sieve analysis as per IS 2720 (part-4)-1985. Three trials were conducted and average of three is obtained for the sake of accuracy. The standard proctor test was conducted to determine the optimum moisture content (OMC) and maximum dry density (MDD) as per IS 2720(part-7 & 8)-1974. The Atterberg limits were calculated by using casagrandes for liquid limit and plastic limit of the soil samples as per IS 2720 (part-5)-1985. Tests had conducted to determine the angle of friction by unconfined compression strength (UCS) as per IS. And Direct shear to determine the cohesion of the soil sample as per IS. To carry out the CBR test as per IS 2720 (part-16) on red soil, first the soil is kept for drying for 24hrs in an oven for about 105-110 0C and cooled at room temperature. The weight of the soil is calculated by multiplying the volume of the CBR mould and MDD of the soil. The soil is mixed with the water upto optimum moisture content (OMC).

III. RESULTS
Four soil samples were acquired from four different places. Red soil is collected from NH4 near chalgere, black cotton soil is collected from magod road, ranebennur, alluvial soil is collected from Tungabhadra river near harihar and laterite soil is collected from mangalore. The results of the soils used in this study are presented in the below figures and tables.
SPECIFIC GRAVITY
Specific gravity is defined as the ratio of the weight of a given volume of soil solids at a given temperature to the weight of an equal volume of distilled water at that temperature. The specific gravity of soils used in this study is tabulated below. The specific gravity of the Red soil, Black cotton soil, Laterite soil and Alluvial soil is 2.4, 2.2, 3.1 and 2.4 respectively.

GRAIN SIZE DISTRIBUTION
The grain size distribution test was conducted to determine the particle size distribution of soil samples. The results of which are shown in below tables and figures.

Table 1. Results of Sieve analysis on Red soil

<table>
<thead>
<tr>
<th>IS Sieve size in mm</th>
<th>Weight of soil retained (gm)</th>
<th>% weight of soil retained</th>
<th>Cumulative % retained C</th>
<th>Cumulative % of passing N=100-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>148</td>
<td>7.4</td>
<td>7.4</td>
<td>92.6</td>
</tr>
<tr>
<td>4.75</td>
<td>348</td>
<td>17.4</td>
<td>24.8</td>
<td>75.2</td>
</tr>
<tr>
<td>2</td>
<td>248</td>
<td>12.4</td>
<td>37.2</td>
<td>62.8</td>
</tr>
<tr>
<td>1</td>
<td>324</td>
<td>16.2</td>
<td>53.4</td>
<td>46.6</td>
</tr>
<tr>
<td>0.6</td>
<td>134</td>
<td>6.7</td>
<td>60.1</td>
<td>39.9</td>
</tr>
<tr>
<td>0.425</td>
<td>90</td>
<td>4.5</td>
<td>64.6</td>
<td>35.4</td>
</tr>
<tr>
<td>0.212</td>
<td>254</td>
<td>12.7</td>
<td>77.3</td>
<td>22.7</td>
</tr>
<tr>
<td>0.15</td>
<td>214</td>
<td>10.7</td>
<td>88</td>
<td>12</td>
</tr>
<tr>
<td>0.075</td>
<td>158</td>
<td>7.9</td>
<td>95.9</td>
<td>4.1</td>
</tr>
<tr>
<td>pan</td>
<td>76</td>
<td>3.8</td>
<td>99.7</td>
<td>0.3</td>
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</tbody>
</table>

Table 2. Results of Sieve analysis on Black cotton soil

<table>
<thead>
<tr>
<th>IS Sieve size in mm</th>
<th>Weight of soil retained (gm)</th>
<th>% weight of soil retained</th>
<th>Cumulative % retained C</th>
<th>Cumulative % of passing N=100-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>184</td>
<td>9.2</td>
<td>9.2</td>
<td>90.8</td>
</tr>
<tr>
<td>4.75</td>
<td>328</td>
<td>16.4</td>
<td>25.6</td>
<td>74.4</td>
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<tr>
<td>2</td>
<td>282</td>
<td>14.1</td>
<td>39.7</td>
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<td>98.5</td>
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<tr>
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<td>0</td>
<td>98.5</td>
<td>1.5</td>
</tr>
<tr>
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<td>1.5</td>
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<td>0.1</td>
<td>98.75</td>
<td>1.25</td>
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Table 3. Results of Sieve analysis on Alluvial soil

<table>
<thead>
<tr>
<th>IS Sieve size in mm</th>
<th>Weight of soil retained (gm)</th>
<th>% weight of soil retained</th>
<th>Cumulative % retained C</th>
<th>Cumulative % of passing N=100-C</th>
</tr>
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<tbody>
<tr>
<td>10</td>
<td>100</td>
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<td>5</td>
<td>95</td>
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<tr>
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<td>176</td>
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<td>13.8</td>
<td>86.2</td>
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<td>106</td>
<td>5.3</td>
<td>19.1</td>
<td>80.9</td>
</tr>
<tr>
<td>1</td>
<td>74</td>
<td>3.7</td>
<td>22.8</td>
<td>77.2</td>
</tr>
<tr>
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<td>2.1</td>
<td>24.9</td>
<td>75.1</td>
</tr>
<tr>
<td>0.425</td>
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<td>35</td>
<td>65</td>
</tr>
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<td>37.2</td>
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<td>58.8</td>
<td>41.2</td>
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<td>81.4</td>
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<td>96.7</td>
<td>3.3</td>
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<td>pan</td>
<td>56</td>
<td>2.8</td>
<td>99.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Table 4. Results of Sieve analysis on Laterite soil

<table>
<thead>
<tr>
<th>IS Sieve size in mm</th>
<th>Weight of soil retained (gm)</th>
<th>% weight of soil retained</th>
<th>Cumulative % retained C</th>
<th>Cumulative % of passing N=100-C</th>
</tr>
</thead>
<tbody>
<tr>
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<td>22.8</td>
<td>77.2</td>
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<tr>
<td>4.75</td>
<td>774</td>
<td>38</td>
<td>60.8</td>
<td>39.2</td>
</tr>
<tr>
<td>2</td>
<td>396</td>
<td>19.8</td>
<td>80.6</td>
<td>19.4</td>
</tr>
<tr>
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<td>98</td>
<td>4.9</td>
<td>85.5</td>
<td>14.5</td>
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<td>0.6</td>
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<td>3.5</td>
<td>88.9</td>
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<tr>
<td>0.425</td>
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<td>2.2</td>
<td>91.1</td>
<td>8.9</td>
</tr>
<tr>
<td>0.3</td>
<td>40</td>
<td>2</td>
<td>93.1</td>
<td>6.9</td>
</tr>
<tr>
<td>0.212</td>
<td>22</td>
<td>1.1</td>
<td>94.2</td>
<td>5.8</td>
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<tr>
<td>0.15</td>
<td>26</td>
<td>1.25</td>
<td>95.4</td>
<td>4.6</td>
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<td>0.075</td>
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<td>1.4</td>
<td>96.8</td>
<td>3.2</td>
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<tr>
<td>pan</td>
<td>18</td>
<td>0.9</td>
<td>97.75</td>
<td>2.25</td>
</tr>
</tbody>
</table>

ATTERBERG LIMIT TEST
Atterberg limits are initial tests conducted on soil sample. Liquid limit and plastic limit are shown in below table.

Table 5. Results of Atterberg limits (LL % PL)

<table>
<thead>
<tr>
<th>Name of the Soil</th>
<th>LL in %</th>
<th>PL in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED SOIL</td>
<td>28</td>
<td>40</td>
</tr>
<tr>
<td>BLACK COTTON SOIL</td>
<td>46</td>
<td>25</td>
</tr>
<tr>
<td>LATERITE SOIL</td>
<td>34</td>
<td>-</td>
</tr>
<tr>
<td>ALLUVIAL SOIL</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

COMPACATION TEST: Standard proctor test was conducted to determine the MDD and OMC of each soil as per IS. The results of which are given in below table.
Table 6. Results of MDD and OMC

<table>
<thead>
<tr>
<th>Name of the Soil</th>
<th>MDD in g/cc</th>
<th>OMC in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED SOIL</td>
<td>1.9</td>
<td>11</td>
</tr>
<tr>
<td>BLACK COTTON SOIL</td>
<td>1.8</td>
<td>16</td>
</tr>
<tr>
<td>LATERITE SOIL</td>
<td>2.3</td>
<td>19</td>
</tr>
<tr>
<td>ALLUVIAL SOIL</td>
<td>1.9</td>
<td>8</td>
</tr>
</tbody>
</table>

California Bearing Ratio (CBR)
The results of CBR without geogrid and with geogrid at different depth and number of layers are shown in below figures. There was increase in the bearing load in red soil when geogrid placed at middle (1/2)H and in laterite, black cotton and alluvial soil when geogrid is placed at top(H).
Figure 8. Results of CBR test on Alluvial soil with Geogrid

IV. CONCLUSIONS

This study determines the application of geogrid on the different type of soil. The geogrid increases the bearing capacity of soils, which shows in the higher CBR value. The investigation shows that increase the bearing capacity of the different soils by placing of geogrid at different depth. It was shows that the maximum bearing capacity is obtained when geogrid is place at top of the mould in Laterite soil, Alluvial soil and Black cotton soil and geogrid is placed at middle of the mould in Red soil. There is continuously an increase in the performance of the soils in the dry condition. Use of geogrid as reinforcement to the poor soils to increase the maximum load carrying capacity. It is un-combustible and durable, it also increase the service life soil in construction. Reduces lateral spreading of the base course also increases confinement leading to the stiffer base. In road and rail geogrid reduces section thickness. The use of geogrid will allow forces to transfer throughout a much larger area. Biaxial geogrid can be used in any direction and have equal strength on both directions.

V. ACKNOWLEDGEMENT

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VI. REFERENCES


