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IMPROVEMENT OF SUBGRADE PROPERTY OF ROADS BY USING GEOCELL

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Abstract: This paper presents in depth analysis and comparison of stabilization of sand in subgrade of road with and without geocell. In general, the tensile strength of the soil is poor. For this reason, the soil often needs to be strengthened. The main objectives of strengthening the soil mass are to improve stability, increase bearing capacity and reduce settlements and lateral deformation. There are several methods for improving the soil. One of the approaches is the use of geocell. Geocell is a well-known technique in soil reinforcement. The use of geocell three dimensions, can significantly improve the soil performance and reduce costs in comparison with conventional designs. In this paper, a review of experimental test carried on reinforced soil with synthetic materials specially geocell had been made. Test results indicated that the inclusion of reinforcement in the sand decreased settlements and leading to an economic design of the footings.

Index Terms **Geosynthetic, Geocell, soil reinforcement, experimental test.**

I. INTRODUCTION

The In any civil engineering construction work, there are two basic criteria's which are to be followed, firstly the structure should be safe against any type of failure and second is that structure should be economical as far as possible. When the structure is constructed over loose or weak soil then it is very difficult to follow these basic criteria. Poor soil condition usually is the reason behind the lack of strength, and associated deformability. Behaviour of soil is the most important parameter which we have to consider before the construction of any type of civil engineering structure. Failure in the structures takes place mainly because of the soil. Generally weak soils or poor soils cause the instability of overlying structures. In such soil failure takes place due to excessive settlement because of insufficient bearing capacity of the sub grade. Construction of civil engineering structures over weak soil can be a problem for any designer, so it is important for a civil engineer to improve the soil properties by some techniques. The Geocell is a three dimensional, polymeric, honeycomb-like structure of cells interconnected at joints. Because of this a better composite material is formed and the Geocell layer behaves as a stiffer mattress that redistributes the footing load over a wider area. On the application of load, the footing increases pressure on soil, because of which soil deforms laterally and exerts pressure on the membrane of the Geocell. Deformation in the Geocell membrane takes place because of the pressure from the soil. This circumferential deformation of membrane mobilizes stress in the Geocell membrane due to which increase in the confinement pressure of soil takes place. This increase in the confinement pressure increases the resistance against the deformation due to which soil can take more load. The interlocking and frictional resistance between the soil and membrane also contributes in the resistance against the deformation of soil Unpaved road stabilization / reinforcement using 3d-cellular confinement systems stabilizes the material of road subgrade, acting like a semirigid slab, loads are distributed latterly reducing subgrade contact pressures and minimizing deformations and settlement. Soil stabilization with geocell in road, highway construction, improves load distribution characteristics on paved and unpaved surfaces. Maintenance of paved and unpaved roads and highways has been a major issue for all road owner authorities. When the roads are not appropriately designed and constructed, life of the roads drastically reduces causing disruption of the traffic. Such roads develop pot-holes, develop uneven riding surfaces, and tend to settle over stretches, thereby disrupting traffic movement. Geocells in-filled with sand / metal as subgrade improve the strength of the pavement, reducing settlements, formation of reflective crack and pot-holes. Besides, use of geocells not only reduces the thickness of the pavement section but also significantly reduces downtime due to maintenance.

I. RESEARCH METHODOLOGY

The methodology used for this study could be divided in to following phases:

Selection Of Material

The first step in this study is selection of material. the material used geocell is high density polyethylene (HDPE), the cell size of geocell is 250x210 mm and aspect

Classification Of Soil

- SAND (0.075MM-4.750MM)
- SILT (0.002MM-0.075MM)
- CLAY (< 0.002MM) ding. Th

FOR THIS PROJECT WE USING SAND

- LARGE PARTICLE SIZE
- ALLOW DRAIN WATER QUICKLY
- REATAINING LESS WATER
- NO SHIFTING AS IT DRIES OR MOISTENS

Properties Of Sand

⇒ Fine aggregates should be free from lumps, silt and Organic impurities like habitats, Vegetable matter, grass, etc which affect the setting and binding property of concrete

⇒ It should be chemically inert.

⇒ It should be free from silt and clay.

⇒ Fine Aggregates should not contain more than 3 percent of silt.

⇒ It should not contain salts that contain sodium chloride that causes corrosion to reinforcement.

⇒ The grains should be sharp, angular and coarse.

⇒ The sand should be free from clay material and organic matters.

⇒ The grains should be of durable minerals.

⇒ It should be free from salts.

⇒ The gradation of grains size should be such as that it will give minimum voids.

⇒ It should be clean and free from coatings of clay and silt.

⇒ It should not contain organic matter.

⇒ It should be chemically inert

⇒ Sand is loose particles of hard broken rock, it comprises of grains from the disintegrated rock.

⇒ Sand should be such size that it should pass through I.S. sieve No.-480 [4.75mm]and should retain on I.S. No-5[0.05mm] as per Indian standards[I.S]

IV. RESULTS AND DISCUSSION

We have tested the stability of subgrade using geocell and without geocell. The above figure shows the systematic representation of test setup used in laboratory test. A wooden tank is used for stress and stability testing of subgrade of roads. Two dial gauge are used in setup which measure the displacement occurs due load in the sand. Initially the testing is done without geocells and readings are noted three times after that we used geocell and noted the reading in dial gauge.

Figure 1: 3D view of building.

I. RESULTS AND DISCUSSION

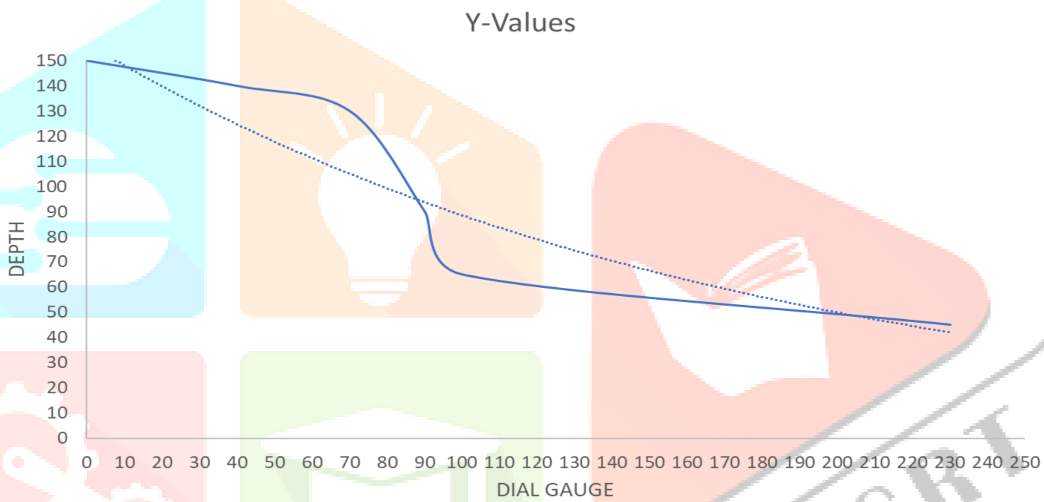

Figure 2: Testing Result And Data Interpretation With Geocell

DEPTH(MM)	DIAL GAUGE READING
150	0
140	40
130	70
90	90
65	100
45	230

The above figure 2 shows the test results of performance of stability of sand with geocell. We investigated the load transfer mechanism between sand and geocell by carrying out both experimental and numerical studies on the behavior of geocell-reinforced sand under a vertical load. The studies showed that geocells could increase the bearing capacity and elastic modulus of the reinforced sand by providing confinement for the infill material. Confined cohesionless soil within a geocell system, when subjected to vertical pressure, causes lateral stresses in the confined soil, causing it to tend to deform laterally. However, any lateral deformation of the geocell wall is restricted due to adjacent cells also filled with cohesionless soil, which is acted upon by similar vertical pressures which generate the same lateral stresses. We have taken the reading at different depth as we can see in above table. The depth of geocell is 65mm , the curve is exponentially decreases ,as depth is decreasing the dial gauge reading is increasing , there is sharp variation in curve at the depth of 65 mm ,which is the depth at which geocell is placed ,the behaviour of curve is changed from 65 mm that means the load bearing capacity of sand is increases by the use of geocell.

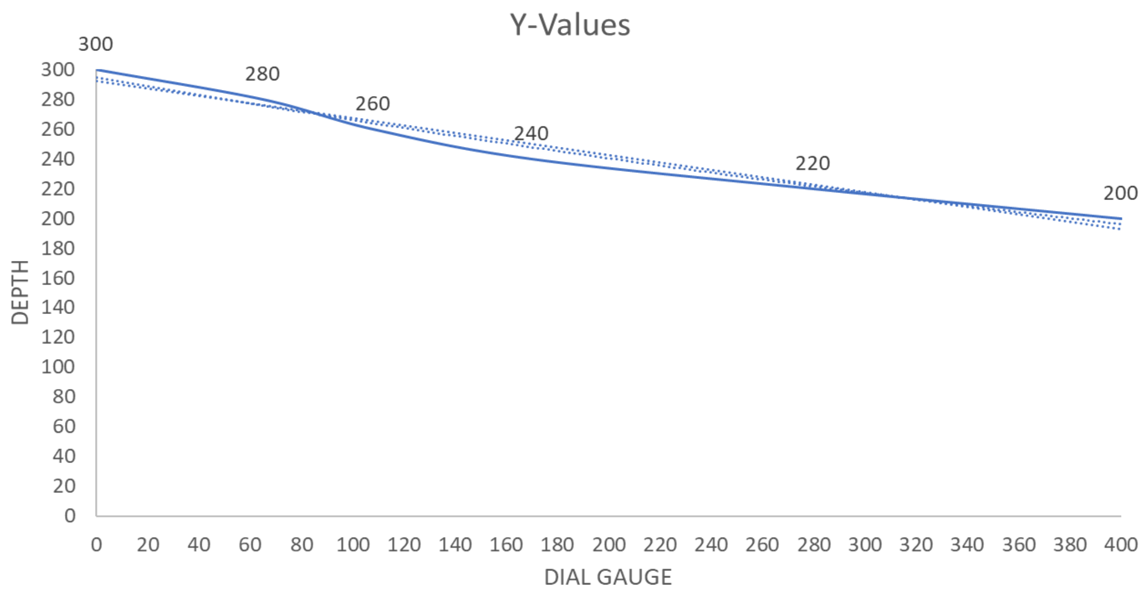

Figure 2: testing without geocell

DEPTH (MM)	DIAL GAUGE READINDS
300	0
280	65
260	108
240	170
220	280
200	400

The above shows the test results without geocell in the sand ,the curve is exponentially decreasing, we see the sudden increase in readings at higher depth ,so that stability of sand is very less .when it subjected to vertical stress the lateral deformation is higher ,as we can see in above table .we taken different reading at different depth .there is no sudden change in graph .so stability is less if we don't use geocell in it .

Comparative Analysis With Conventional Methods:

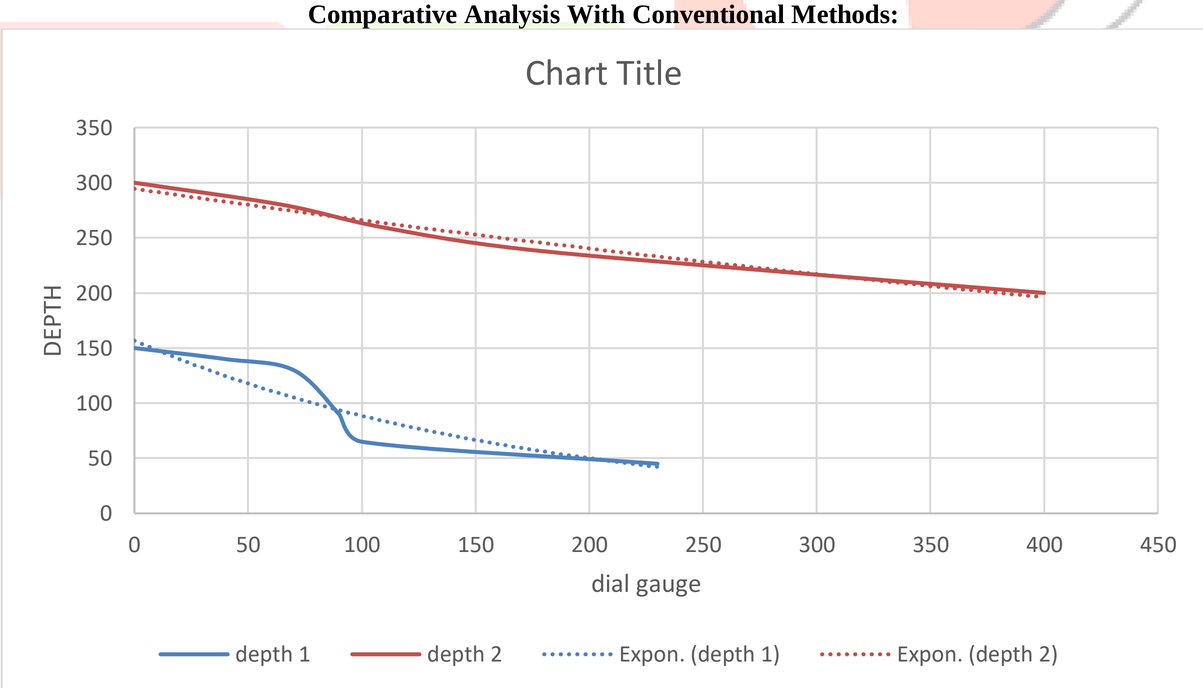

Figure 3: comparative analysis with conventional method

The comparative analysis of both test results is given above .we see huge difference in stability in subgrade if we use geocell and without geocell .so we conclude that geocell increase the load bearing capacity of sand .

Geocells filled with cohesionless material form rigid mats capable of distributing imposed loads. The mechanics of geocells as a load carrying system is illustrated in Figure

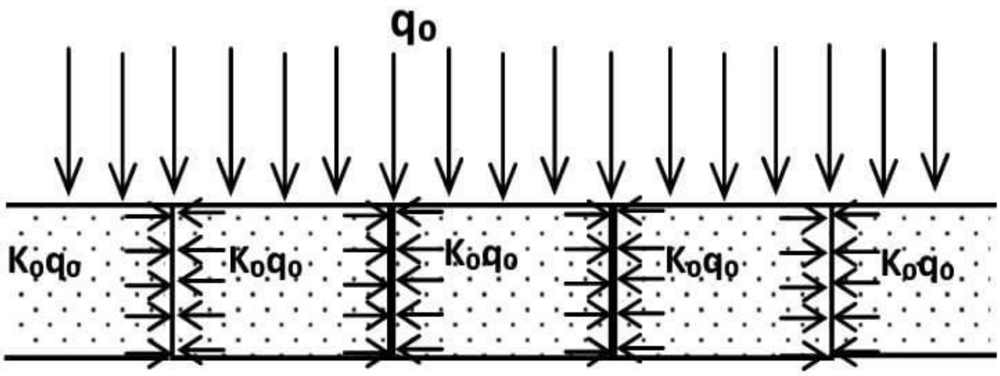

Figure 4: The mechanics of geocells as load support systems

Confined cohesionless soil within a geocell system, when subjected to vertical pressure, causes lateral stresses in the confined soil, causing it to tend to deform laterally. However, any lateral deformation of the geocell wall is restricted due to adjacent cells also filled with cohesionless soil, which is acted upon by similar vertical pressures which generate the same lateral stresses. The high hoop strength of the geocell wall also constrains lateral movement. If q_o is the vertical pressure, the lateral stresses generated along the walls of the individual cells would be $K_o q_o$ where K_o is the coefficient of earth pressure "at rest", i.e. (1-sinφ) where φ is the angle of internal friction of the infill soil. This increases the shear strength of the confined soil, thus creating a stiff mattress, which contributes to distributing the load over a wider area. This horizontal stress acting normal to the cell wall increases the vertical frictional resistance between the infill and the cell wall, which diminishes the stress of the applied load on the ground below the geocell.

This phenomenon of geocells is used to advantage in transferring relatively heavy vertical loads onto relatively weak soils by spreading the load over large areas. This includes use of geocells as basal reinforcement for earth embankments on soft foundations. Geocells can also be used below spread footings, strip footings, raft foundations and grade slabs on weak soils. Trials are underway in Tamil Nadu, using geocells within the ballast layer of railway track. The swelling characteristics of expansive soils can also be overcome by judicious use of geocells below foundations and roads.

CONFINEMENT EFFECT

due to the three-dimensional structure, the geocell can provide lateral confinement to soil particles within cells as shown in figure. The geocell provides the vertical confinement in two ways:

1. The friction between the infill material and the geocell wall.
2. The geocell-reinforced base acts as a mattress to restrain the soil from moving upward outside the loading area.

Han *et al*. (2008a, b) investigated the load transfer mechanism between infill and geocell by carrying out both experimental and numerical studies on the behavior of geocell-reinforced sand under a vertical load. The studies showed that geocells could increase the bearing capacity and elastic modulus of the reinforced sand by providing confinement for the infill material. The tensioned membrane or beam effect is referred as the tension developed in the curved geocell-reinforced mattress to resist the vertical load (Rajagopal *et al*., 1999, Dash *et al*., 2004, Zhou and Wen, 2008). However, to mobilize the tensioned membrane effect, the pavement structure must deform significantly (Giroud and Han, 2004a). As the geocell reinforced section is stiffer than the surrounding soil, the curved surface exerts upward reaction and reduces the net stress applied to the subgrade.

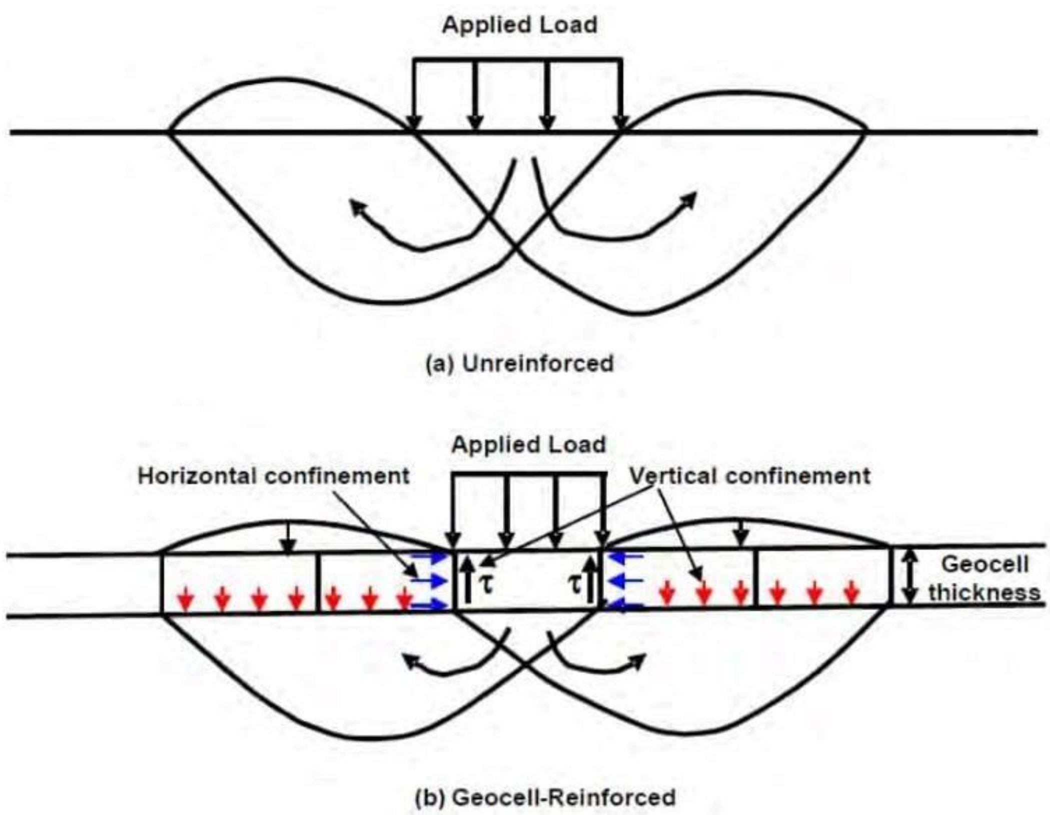

figure 5: Unreinforced and geocell-reinforced soil behavior

V. CONCLUSION

Experimental study results obtained by previous researchers on reinforced soil with synthetic material can be concluded as follows:

⇒ The conclusion of this research paper is that by using the geocell in subgrade the stability of subgrade improves.

⇒ Without using geocell failure of subgrade occurs suddenly at very depth.

⇒ The presence of geogrid in the soil makes the relationship between the settlement and applied pressure of the reinforced soil almost linear until the reaching to the failure stage.

⇒ The reinforcement reduces the magnitude of the final settlement.

⇒ The reinforcement's efficiency in reducing the maximum footing settlement decreased as the height and width of geocell were increased.

⇒ In case of sand beds, the increased performance of the footing is observed to increase in footing settlement.

⇒ With increase in the number of planar reinforcement layers, the height of geocell reinforcement and the reinforcement width, the bearing pressure of the foundation bed increases and the footing settlement decreases.

⇒ For bearing capacity greater than 200% and reductions in settlement by 75% can be achieved with the application of geocell reinforcement, where as planar reinforcement arrangements can only deliver 150% and 64% for these two quantities, respectively.

⇒ With the provision of a geocell layer, indicating that the geocell mattress transmits the footing load to a deeper depth, thereby bringing about a higher load carrying capacity.

⇒ The value of the mobilized shear stress ratio for geocell supported footings are only 0.35– 0.5 unlike the unreinforced footing where it reaches 1.

⇒ . The cumulative settlement increased with the number of load cycles with a gradually decreasing rate.

⇒ For the same number of load cycles, the cyclic load induced settlement increases with increasing initial monotonic load.

⇒ he displacement per load cycle increases with decreasing the load frequency.

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