Implementation of geocells in low bearing capacity soil

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ABSTRACT: The author describes the general use of geocells in road base stabilization and the principles of load distribution especially in soft soils. The paper goes to describe some actual applications where it was obligatory to use geocells where space/room were limited and it was impossible to implement the conservative system. One of the applications has been monitored over three years.

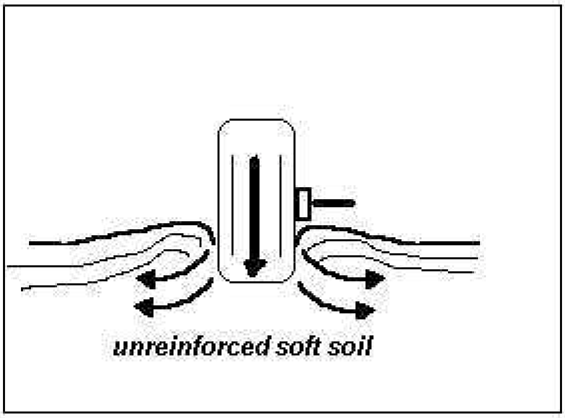
1 INTRODUCTION

The use of geocells in soft soils:

It has been recognized that low bearing capacity soils have to be replaced or improved in order to enable vehicles, human—beings (in footpath) to pass through (or even as substantial foundation). The surface of the tier, footstep, foundation toe that touches the soil sinks inside. The soil is running to the sides, caused by low bearing capacity and low cohesiveness, turning place to the narrow surface that touches the place.

Soil replacement is a finger rule which usually solves the problem, but it is not always available, or the space is limited.

Use filled geocells with local soil implemented on soft soil surface, improves soil bearing capacity by a good distribution of the vertical loads. Thus, very limited touch surface will be multiplied/tripled and transformed to be very wide surface which touches the soil. (Figures 1 and 2).



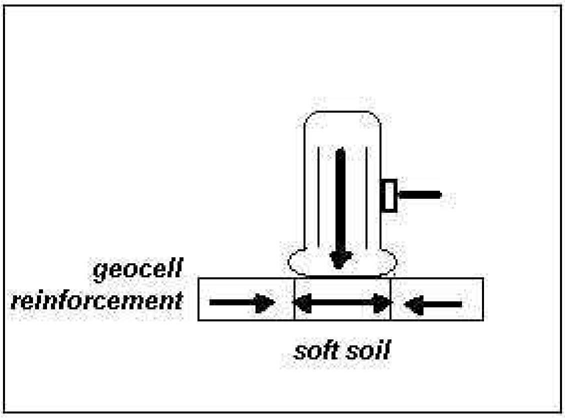


Figure 1: Soft soil behavior during loading.
Figure 2: Improvement of soft soil by good distribution.

The author calls the European Union which had done positive progress towards the standardization of geosynthetics, to include geocells in this classification in order

Uno. To open other designing opportunities in less expensive costs.
Due. To keep quality standards under control.

2 CASE HISTORIES

2.1 *Implementation of Volta-Cell over saturated clay soil*

2.1.1 *Location and description of site*

The site is located in Netufa Valley (Northern part of Israel) and is under the water authorities responsibility. 12km of wide open canal that delivers potable water from the Galilee Lake to Netufa had to be maintained and secured. The idea was to construct a permanent light structure service road along the canal. As the soil is silty and clay to depth of 1.5m, with presence of water table, almost every design was prone to permanent maintenance along its life span because of pumping effect.

2.1.2 *History*

The canal is an artificial and exists over 40 years. As maintenance start to play main issue, and the service way was temporary constructed causing lot of circular sinking in the mud problems, especially during winter and spring time, so, it was an obligation to construct suitable structure. (See Fig. 3 – Netufa Valley 1)

Figure 3: Netufa Valley: service and condition

2.1.3 *Planning and technical research*

Considering water table level, soil type conditions, time limits and budget caused to choose an alternative which contained reinforced light weight structure based on geocell confinement system. Recommendations and design principles have been taken from Aasshtto guide for design of pavement structure. Road width was 4.8m, length 5.5 km.

Adjustment of conditions has been considered, thus final cross section was planned as seen in Figure 4.

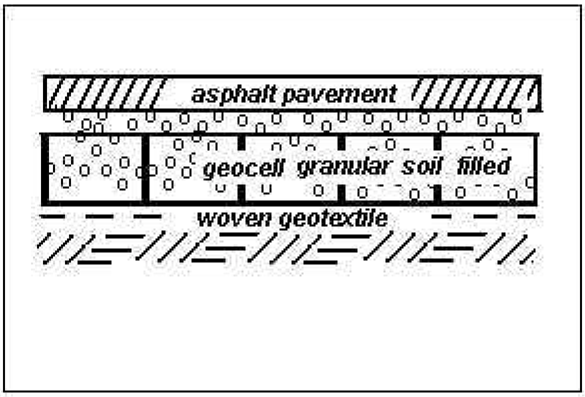


Figure 4: Road cross-section

2.1.4 *Installation*

Four steps have been planned for installation:

1. Leveling and compacting the sub base to its optimal density (97%)
2. Laying woven geotextile (40 kN/m x 40 kN/m) for separation and improvement of bearing capacity.
3. Over the woven geotextile, GCS (geocell confinement system) 40/150 (40 cells/m^2-150mm cell height) have been laid and stretched to its optimal extension. Pins have been inserted in both sides of the road in order to keep the geocell net expanded during the filling. Two more lines of pins have been inserted in the middle, that would keep the level surface of geocell-net stable (avoiding shifting up when compacting).

Over geocell height, 100mm of granular material has been placed, thus after wetting and compaction, level above cell surface should be 50mm.

Sensitive points at both edge sides of road are described in figure 9 a,b.
Decreasing the damage at this points will cause widening the road by 0.4m (0.2m at both sides).

Asphalt over lay of about 7cm. have been placed. Figure No 12 describe final position during wintertime with presence of water table in road structure, consolidation observed was 3mm.

Figure 5: Installation step b.

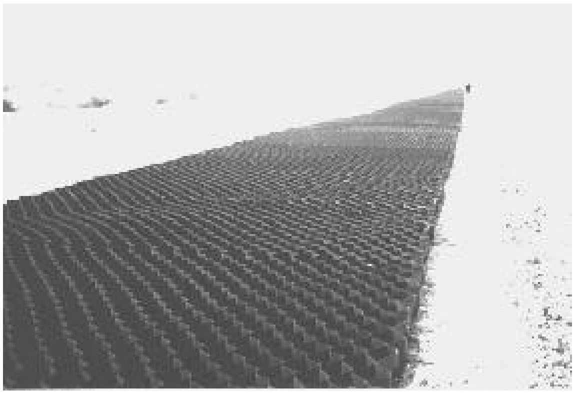


Figure 6: Installation step c.

Figure 7: Filling granular material.

Figure 8: Filling granular material.

Figure 9a: Sensitive point at edge size.

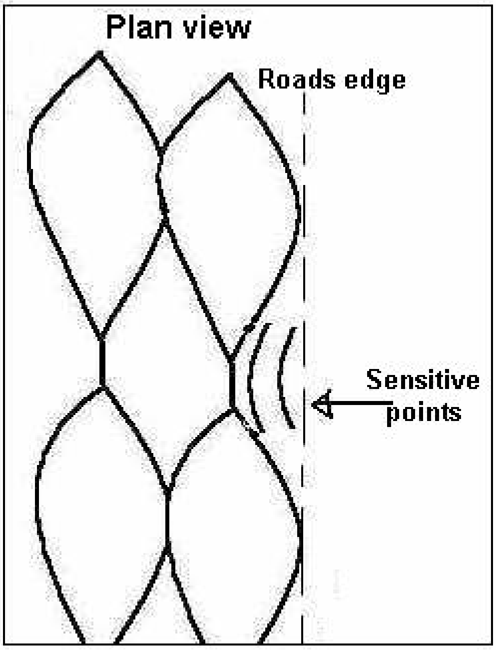


Figure 9b: Sensitive point at edge size.

2.2 *Construction of light rural road with Geocell Confinement System*

2.2.1 *Location and description*

Ayalon Valley is located South-East to Tel-Aviv Airport. Type of soil existing in the valley is sandy clay (20%-30% sand consistence). Since roads in agriculture fields are not well organized (at least officially), and they function good during nine months, as soil is hard. The rest three months during wet season access to agriculture fields by regular vehicles, is impossible. See figure 10.

2.2.2 *Planning and technical reasons:*

As rural roads authorities have been looking for suitable solution, the following approach have been considered:

Based on study of Bathurst (1993), Mhaisar (1994), Garidel (1986) and Gourves (1996) which confirm that confinement reinforcement will be increased in correlation with the number of cell/m^2 and cell height.

Figure 10: Saturated agriculture field.

The designer looked for the smallest cell size with optimal cell height, that will resist medium truckload of (double axle) 4.5 tons.

68 cells/m^2 geocell type 75mm cell height have been submitted, filled with local soil, no separation underneath. The road will be constructed in units of 150m length and 4.5m width.

Installation:

Compaction of sub base to achieve optimal density (96%-97%).

Laying the geocell and filling with local soil (50mm above geocell surface), wetting the surface, compacting to achieve optimal density (96%-97%) (See Fig.11)

Figure 11: Agriculture access road installation.

Results and conclusions:

The installation of the service road in Netufa valley had been observed for three years, though the structure is light, it showed excellent resistance to vertical loads (See figure 12).

The access roads to agriculture fields have been tested for one year. Improvements in structure, as higher cell wall (150mm-200mm), should provide better performance for bigger loads (See figure 13, rural road results 1).

The installations presented here have proved successful in providing suitable solution financially and technically.

The geocell structure obtained has higher mechanical properties than without reinforcement or with two-dimensional reinforcement systems, thanks to perfect distribution system of loads.

Some time, the alternative of geocells in limited space should avoid installation of reinforced concrete (or any other conservation system), that alternative will provide much more flexibility in design.

Figure 12: Netufa Valley results.

Figure 13: Agriculture road results.

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