Ground Improvement Technique for Railway Embankment

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Abstract

In this technological era, development of infrastructures such as railway, roadway, bridges, special buildings etc. are increasing tremendously. Due to paucity of useful land and strength of soil, engineers have to improve soil properties like shear strength, bulk density, permeability, void ratio, water holding capacity etc. by adopting different ground improvement techniques. The one of the method among ground improvement techniques is reinforcing the soil with materials like steel, stainless steel, aluminium, fibers, fiber glass, nylon, and polyester, polyamides in the form of other strips or grids, combination of grids and Geotextiles. The main purpose of reinforcing a soil mass is to improve its stability, increasing its bearing capacity and reduce Settlements and Lateral deformations. Geotextiles and geomembranes, widely speaking are synthetic fibres used to stabilize structures built on soil having poor conditions. Lots of ground improvement techniques are available in today's market. Such as vibro compaction, vibro replacement, ground freezing, grouted stone columns, dry deep soil mixing, vacuum consolidation, preloading, heating etc. Among them geocell reinforcement is recently developed technique. The aim of this study is to increase bearing capacity of soil in railway embankment by ground improvement technique named as "geocell".

Keyword- Bearing Capacity, Geocell, Railway Embankment, Soil

I. INTRODUCTION

Generally, many people may not know about the early development of geocell cellular confinement system is that the material was not always black. In fact, early testing of a "grid confinement" system include wax coated craft paper; plastic drainage pipe matrix fastened with staples; paper-thin, hexagon-shaped, glued-aluminum; low-and medium-density materials; pure polyethylene without UV stabilization; and square cells similar to old-fashioned egg cartoon separators. What is more, geocell have a wide scope in improvement of soil parameters. Such as for controlling the erosion of soil in steep slope construction, for providing more stability to bases of railway track which prevents protection against falling ballast or soil or any other material of formation. Construction of firm, stiffer and stronger earth embankment can be done easily by the aid of geocell for confining the soil. Typical figure of geocell fig1.

A. Aim

To enhance the soil properties with the use of geocell.

B. Objective

- To study the different ground improvement techniques.
- To study the characteristic of geocell.
- To study the formation of existing railway track with all components.
- To compare characteristic of different soil parameters with and without using geocell.

C. Scope

During these days, geocells are being used in some specific areas only however, there will be a huge scope of geocell for improvement of ground in the horizon years. Such as, Geocell can be used for upgrading current infrastructure of railway embankment to meet future demand of traffic. Also it can be used for rehabilitation up to 2000 km and strengthening of existing weak formation of railway track. Geocells are very useful construction of railway track having heavy traffic on soft soil having poor bearing capacity. Geocells are the only prefabricated three-dimensional geosynthetics with significant 3rd dimension properties. Thus they are easily transported as flat strips welded at regular intervals, and massive quantities are not the problem. Geocells are easy to install and do not require any specific skills for labour work. They can be easily installed in any weather condition. Thus can be used for construction of railway embankment having poor site condition and lack of skilled labour.

Fig. 1: typical geocell

Source: www.4shared.com

II. METHODOLOGY

A. Procedure

1) Step 1: collect disturbed soil sample from nearby site.
2) Step 2: find out soil properties like liquid limit, OMC, MDD etc.
3) Step3: prepare the specimen of different tests with the soil only in three to four layers according to test requirement.
4) Step 4: add geocell in sample at varying depth to find effective depth.
5) Step 5: perform various test on sample to find different soil properties like CBR (California bearing ratio), plate load.
6) Step 6: compare different soil properties such as bearing capacity, shear strength, strength and cost of all results for soil with and without geocell.

B. List of Different Test for Soil

- Sub soil Geotechnical Investigations (Borehole method) including collection of undisturbed samples and Standard Penetration Test (SPT).
- Dynamic Cone Penetration Test (DCPT).
- Field Density, Moisture Content and Void Ratio Test.
- Standard and Modified Compaction Proctor Test.
- Static and Cyclic Plate Load Test.
- Field CBR Test by Dynamic Cone Penetration.
- Specific Gravity and Porosity Test.
- Grain Size Analysis by Sieving and Hydrometer.
- Atterberg Limits and Indices.
- Soil Classification.
- Consolidation Test.
- Unconfined Compression Test.
- Direct Shear Test.
- Triaxial Compression Test.

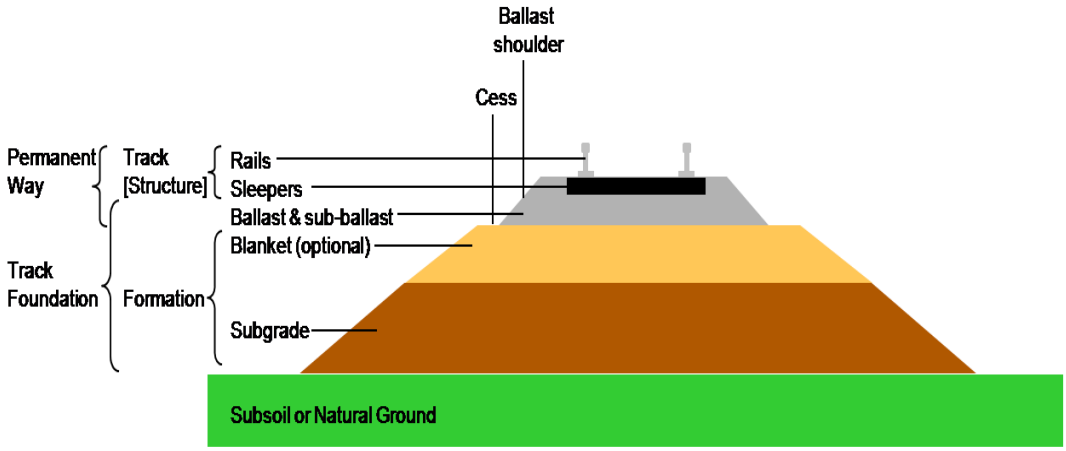

Fig. 2: railway embankment cross-section

C. Ground Improvement Technique

– Vibro Techniques
  - Vibro Compaction
  - Vibro Replacement (Stone Columns)
  - Grouted Stone Columns (GSC)
  - Vibro Concrete Columns (VCC)
– Dry Deep Soil Mixing
– Vacuum consolidation
– Preloading
– Heating
– Ground freezing

D. Different Technique List for Different Site

Technique	*Site Location*	*Purpose*
Vibro Replacement	*LACTC Flyover, Los Angeles* *SFM Rail yard, San Francisco*	*Densification of loose silty sands* *Mitigation of liquefaction potential*
Deep Soil Mixing	*Alameda Corridor, Los Angeles*	*Stabilisation of in-situ soils*
Lime/Flash Injection	*Santa Fe Railroad, St. Joseph, MO*	*Sub grade stabilisation*
Compaction Grouting	*Union Pacific ,Railroad, Kansas* *CSX Railroad, Georgia* *Union Pacific Embankment Tunnel, Longview, Texas*	*Filling of voids in the shale* *Densification of soil mass*
Jet Grouting	*Tilford Tunnel, Atlanta, Georgia* *Charles Street Bridge, Rhode Island* *Union Pacific Storm Drain Tunnel, Texas*	*To replace the existing support* *To increase stability of the slope* *To stabilise the large soil mass*
Chemical Grouting	*West River Bridge, New Have,* *Connecticut Claremont DetentionBasin, Albuquerque, New Mexico*	*Stabilisation of granular soils* *Solidification of sandy soils*
Mini Piles	*Canton Viaduct, Canton, Massachusetts* *Straight Creek Bridge, Tazewell, Tennessee*	*To form load bearing elements* *To form a deep foundation system*
Anchors	*Embankment slide, Green Bottom, West Virginia*	*To form an earth retention System*

E. Comparison of Graph Between With Or Without Geocell

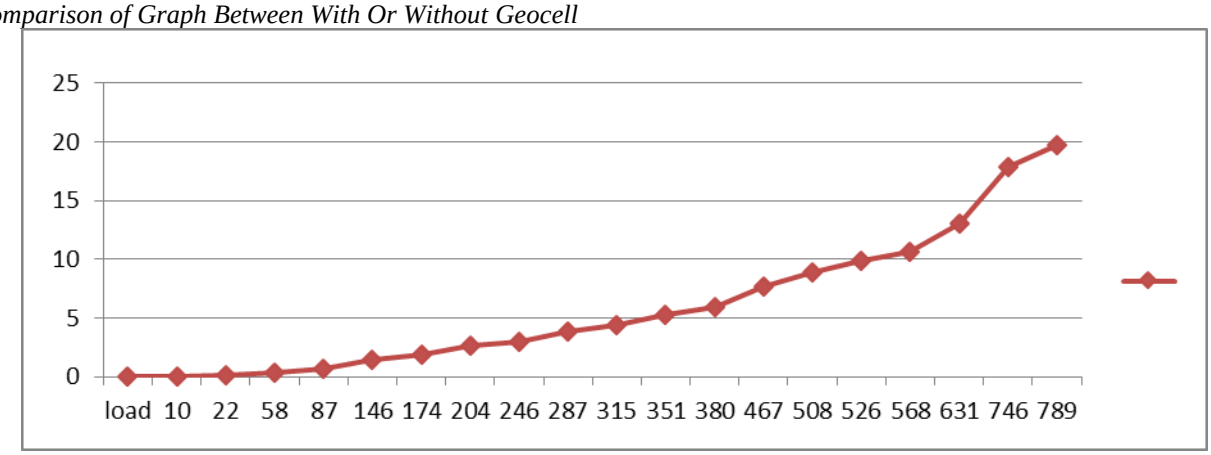

Fig. 3: load versus displacement graph for soil

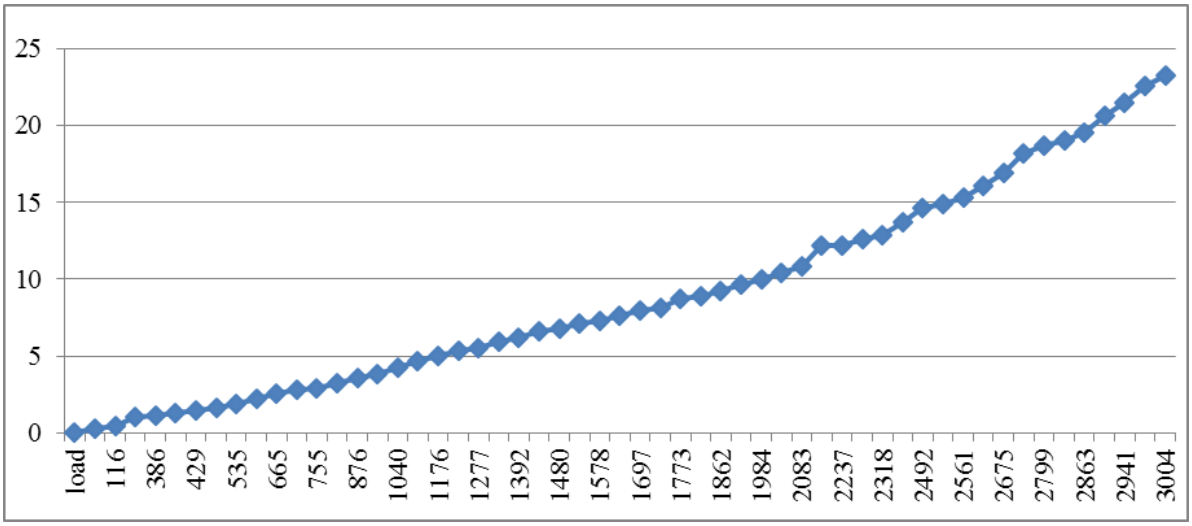

Fig. 4: load versus displacement graph for geocell with 5mm soil layer on geocell

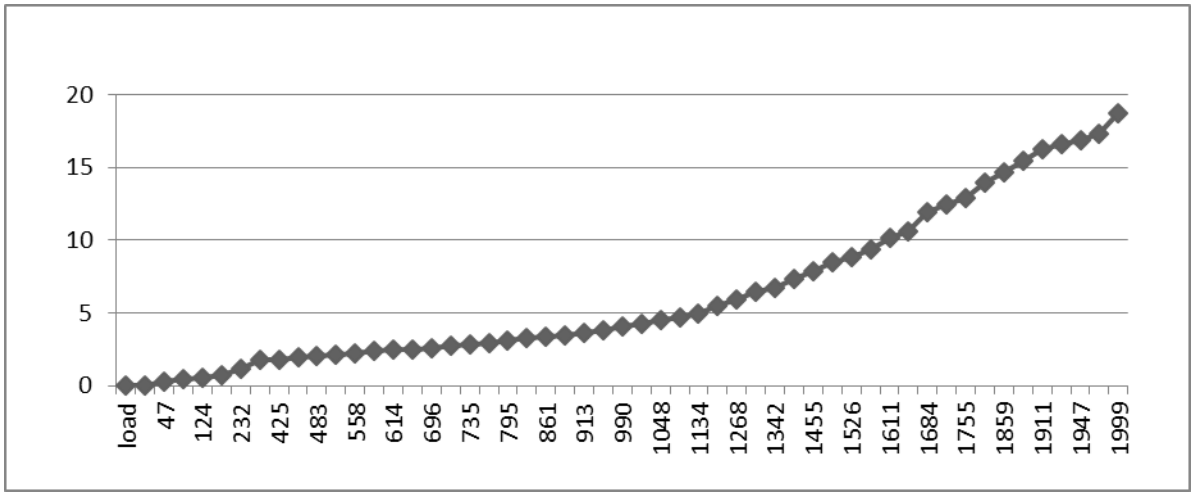

Fig. 5: load versus displacement graph for geocell with 8mm soil layer on geocell

III. RESULT

By comparing two graphs of load versus displacement, we can conclude that the effective depth of soil above geocell is 8/5times the depth of geocell.

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