Improving Soil Stability by using Geo-Grid Made by Waste Plastic Material (I.e. Packaging Ribs)

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Abstract— Road pavements are vulnerable (weak) to soil performance because the foundation of the pavement is a roads most important element. And if the sub grade layer of pavement consists of expansive soil (black cotton soil), due to changes in moisture content and subsequent shrinkage and swelling, it undergoes failure. Thus, for the construction on such type of soil it is required to improve the engineering properties of soil or to replace the soil itself. Replacing the existing soil might not be a practical and feasible option, thus it is required to stabilize the soil with suitable stabilizer. However the selection of stabilizer depends upon the type of sub-grade soil, type of soil improvement desired, availability of stabilizer, the required strength and durability of stabilized layer, various stabilizing techniques, environmental conditions and the most important cost factor. This paper reviews the work of various researchers on stabilization of soil and use of geo-synthetic materials in improving its strength. The present study investigates the improvement in the bearing capacity of silty clay soil with thin sand layer on top and placing geogrids at different depths. Model tests were performed for a rectangular footing resting on top of the soil to establish the load versus settlement curves of unreinforced and reinforced soil system. The test results focus on the improvement in bearing capacity of silty clay and sand on unreinforced and reinforced soil system in non-dimensional form. The results show that bearing capacity increases significantly with the increased number of geogrid layers. The bearing capacity for the soil increases with an average of 16.67% using one geogrid layer at interface of soils.

Key words: Soil Stabilization, California Bearing Ratio (CBR), Compressive Strength, Black Cotton Soil

I. INTRODUCTION

Since the beginning of mankind, the human races have attempted to create new ideas for the construction of structural system. Technique of improving the soil with geo-grid increase the stiffness and load carrying capacity of the soil through fractional interaction between the soil and geo-grid material improving laterite soil. The load coming on the road crust is transferred to the underlying soil. If the soil supporting the road crust is weaker, the crust thickness of road increases, which leads to the more cost of construction and most likely road pavement failures in the nearest future, but with the application of geogrids, it helps reduce cost of bringing in earth materials from a borrow pit, rather the initial earth materials found on the construction site is used for the road pavement.

Geo- grids used within a pavement system perform two functions which are separation and reinforcements. The primary function of geo-grids is used as pavements reinforcement, in which the geo-grid mechanically improves the engineering properties of the pavement system. Geogrids have been commonly used in highway and unpaved road applications to improve the pavement system performance through their interlocking ability of individual aggregate particles. Reinforced soil is a composite material which is formed by the association of frictional soil and tension resisting elements in the form of sheets, strips, nets, or mats of metal, synthetic fabrics or fiber reinforced plastics and arranged in the soil mass in such a way as to reduce or suppress the tensile strain which might develop under gravity and boundary forces. It is well-known facts that most granular soils are strong in compression and shear but weak intension. The performance of such soils can be substantially improved by introducing reinforcing elements in the direction of tensile strains in the same way as in reinforced concrete.

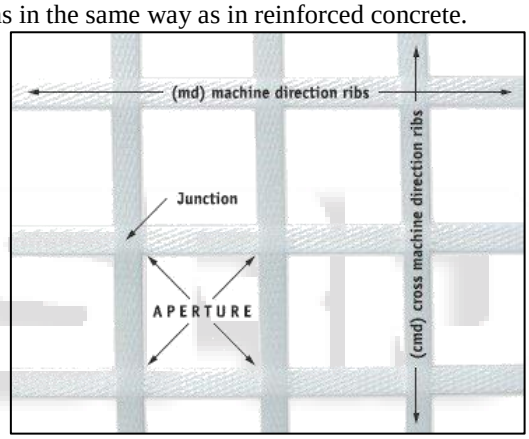

Fig. 1.1: Members of Geogrid

II. LITERATURE REVIEW

Mr. Akolade [1] Geo-grids provide interlocking of aggregate at the sub grade interface, provided that the aggregate locks into the grid structure that are of sufficient rigidity and geometry. The interlocking of the base aggregate and geo-grid is a function of the gradation and angularity of the aggregate and the geometry of the geo-grid. Weaker soils are generally clayey and expansive in nature which is having lesser strength characteristics. (1989).Geogrids are made from high molecular weight, high tenacity polyester multifilament yarns. The yarns are woven on tension in machine direction and finished with a polymeric coating geogrids are polymeric in nature with tensile strength varying from 100 to 220KN, They are either Technique of improving the soil with geo-grid increase the stiffness and load carrying capacity of the soil through fractional interaction between the soil and geo-grid material improving late rite soil. The load coming on the road crust is transferred to the underlying soil. If the soil supporting the road crust is weaker, the crust thickness of road increases, which leads to the more cost of construction and most likely road pavement failures in the nearest future, but with the application of geogrids, it helps reduce cost of bringing in earth materials from a borrow pit,

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I L Muthreja1, Dr R R Yerpude, Dr J L Jethwa [2] this study is an attempt to introduce geogrids in improving stability of coal mine waste dumps. The results from Numerical and Physical Modelling show similar trend in respect of stability of waste dumps. This proves the application of geogrids in improving the stability of coal mine waste dumps. Thus by using geogrids, higher dumps, accommodating large overburden, can be designed. The coal mining industry will certainly be relieved from the problem of land acquisition, which is becoming difficult day by day in India and at the same time ensuring the stability of waste dumps. Geogrid reinforcements are manufactured from highly durable polymers that can maintain strength, stiffness, and soil interaction over extended design lives. Typical design lives may range from 1 to 2 years for a temporary reinforced soil structure, to 120+ years for a permanent reinforced soil structure. The use of geogrids has not been applied in the Indian coal mining industry as yet. Coal mine waste dumps consist of loose broken rock material mainly consisting of sandstone, shale, and soil. The behaviour of this material is similar to soil as discussed above. The use of geo synthetics/geogrids will definitely help in improving the stability of waste dumps.

Mrs. Neetu B. Ramteke,Prof. T. R. Arora,Prof. Anilkumar Saxena [3] Although the research that has been performed on geo-grid reinforced soil gives wide variety of results on several issues from which the following qualitative conclusions can be drawn: A geo-grid reinforced soil is stronger and stiffer and gives more strength than the equivalent soil without geo-grid reinforcement. Geo-grids provide improved aggregate interlock in stabilizing road infrastructure through sub-grade restraint and base reinforcement applications Roads constructed on poor sub-grade soil requires a larger thickness of pavement which can be reduced by inclusion of Geo-grid. Which increases the bearing capacity of the sub-grade, reduce the differential settlement of the pavement, increases the life of the pavement and also reduces the cost due to saving incurred in the reduction of the special fill material? Geo-grid can be placed in one or more layers in subgrade soil. Geo-grid reinforcement can be used to prevent or reduce rutting caused by the bearing capacity failure of the base or sub-grade and by the lateral movement of base course or sub-grade material.

III. TEST MATERIAL

Soil specimen, geogrid made by packaging strips

A. Data on Generation of Waste Plastic Packaging Strips

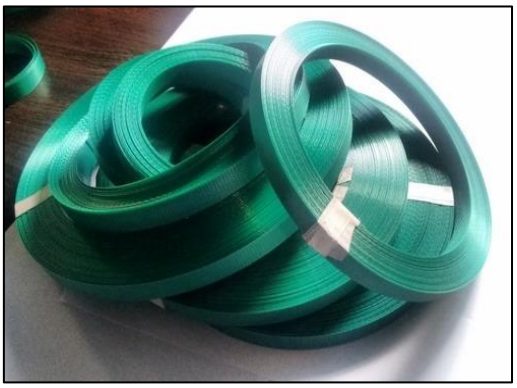

Fig. 3.1: Plastic Packaging Strip

Packaging is defined as any material which is used to contain, protect, handle, deliver or present goods. Packaging waste can arise from a wide range of sources including supermarkets, retail outlets, manufacturing industries, households, hotels, hospitals, restaurants and transport companies. Items like glass bottles, plastic containers, aluminum cans, food wrappers, timber pallets and drums are all classified as packaging. And Packaging strips is one of important material from them which used for packaging and made by Polypolystyrene (PS). The total quantity of generated packaging materials rose from 79.0 million tons in 2005 to 81.5 million tons in 2008. Afterwards the volume dropped to 76.6 million tons in 2009 and recovered in 2010 to 78.5 million tones and, in 2011, to 79.9 million tones. This was the first time a drop in packaging volume had occurred in the country since 1998 or in the country since 2005. This decline of all packaging materials might be due to the economic slump in 2009, as the GDP in the country turned negative in 2008–2009. In 2012 there was a second drop in the volume of total packaging waste: the country presented a total of 78.7 million tons, which was a decrease of 1.5 % compared with 2011. In 2014, all packaging waste materials experienced an increase compared to 2013 which resulted in a total volume of packaging waste of 82.5 million tons of generated waste a rise of 3.9 % compared with 2013.

Fig. 3.2: Plastic packaging strip used for packing the goods

Where geogrid to be used?

There are several major markets for geogrids. These are base reinforcement, earth retaining wall construction including veneer stabilisation, the segmental retaining wall market, embankment reinforcement and pile cap platforms. Biaxial geogrids are primarily used in base reinforcement applications, while the uniaxial geogrids are often used in the other markets. This document will only be concentrating on base reinforcement and biaxial geogrids. The base reinforcement market is just what the name implies. These are

applications where an engineer is trying to improve the performance of a gravel base over poor soils, trying to minimise the amount of gravel in the base course design, or increasing the life of the surface cover, concrete or asphalt. Geogrids are used under parking lots, airport runways, gravel construction roads, highways, dam levees and rail road tracks. And for that it is essential for engineers to achieve economy for gaining maximum stability of soil in easiest way.

IV. PERFORMANCE ANALYSIS

Analysis is used to analysis of model for design changes. It gives simulation results against the new design or such material changing. In that first existing model analysis results and material changing and design changing model results are compared.

Following tests are used to analyzed performance of new design of geogrid made by packaging strips

A. Permeability

∑ Permeability without Geogrid
∑ Permeability with uniaxial Geogrid
∑ Permeability with Polypolystyrene (PS).

B. California Bearing Ratio (CBR)

∑ Permeability without Geogrig
∑ Permeability with uniaxial Geogrid
∑ Permeability with Polypolystyrene (PS).

C. Properties of Soil Sample

Water content of given soil sample in percentages = 10.45%
Optimum Moisture Content (OMC) = 15.01%
Maximum Dry Density = $5.47x10^{-4}gm/cm^3$
Specific gravity of given soil sample = 2.23
Coefficient of uniformity (Cu) = 26.031
Coefficient of curvature (Cc) = 0.67
The given soil sample is sand and it is well graded.

D. Result of Permeability Test

- Permeability of soil sample without geogrid = $4.57x10^{-4}lit/cm^3$
- Permeability of soil sample with GI geogrid = $4.42x10^{-4}lit/cm^3$
- Permeability of soil sample with geogrid made by packaging strips = $4.19x10^{-4}lit/cm^3$

Result of test California bearing ratio (CBR)

Penetration Plunger (mm)	Load on Proving Ring(Kg)	CBR Value (%)
2.5	59.740	4.36
5.0	88.620	4.31
7.5	100.56	3.82
10.5	109.33	3.43
12.5	120.92	3.35

Table 1: Observation table of CBR test without any geogrid

Penetration Plunger (mm)	Load on Proving Ring(Kg)	CBR Value (%)
2.5	66.190	4.83
5.0	95.370	4.64
7.5	115.86	4.40
10.0	129.43	4.07
12.5	142.60	3.96

Table 2: Observation table of CBR test with axial geogrid

Penetration Plunger (mm)	Load on Proving Ring(Kg)	CBR Value (%)
2.5	97.500	7.11
5.0	130.04	6.32
7.5	148.52	5.64
10.0	170.45	5.36
12.5	182.23	5.06

Table 3: Observation table of CBR test with geogrid made by packaging strips

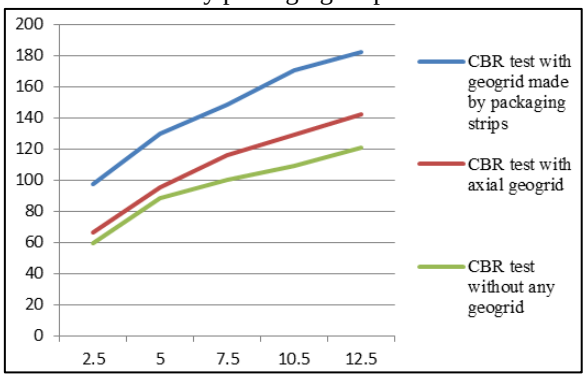

Fig. 4.1: Graph showing Load on Proving Ring vs Penetration on Plunger

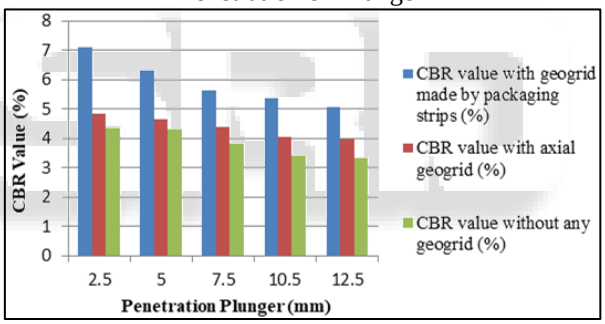

Fig. 4.2: Graph showing CBR values (%) of Observation Table 1, Table 2, Table 3.

V. CONCLUSION

From above study it is clear that the load bearing capacity induced in soil sample with geogrid made by packaging strips is greater than the load bearing capacity induced in soil sample without geogrid as well as load bearing capacity induced in soil sample with axial geogrid. Geogrid made by packaging strips increases load bearing capacity and also interlocking property of soil particles and hence it decreases the permeability of soil sample. By use of geogrid which is made by packaging ribs life span of these geogrids will increases because constituents of these strips is helps to slower the decomposition and these strips are also in chipper in cost as compare to axial and biaxial geogrids. The geogrids made by waste packaging strips fulfills all the properties and expectations of good geogrid. This geogrids are made up of plastic hence it also used in water logged areas as well as muddy areas to provide stability.

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