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Soft soil geogrid reinforcement impact on bearing capacity values.

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Abstract

The quality and life of pavement is greatly affected by the type of subgrade, sub base and base course materials. The most important of these is the type and quality of subgrade soil. If the California bearing ratio (CBR) of these subgrades is low, it needs more thickness of pavement in order to support the same load . Decrease in the availability of suitable subbase and base materials for pavement construction has lead to a search for economic method of converting locally available problematic soil to suitable construction materials. From this study it is clear that there is considerable improvement in California Bearing Ratio (CBR) of sub-grade due to geogrid reinforcement. In case of no reinforcement (Geogrid) the soaked CBR value was 2.9% and when geogrid was placed at 0.2H from the top of the specimen the CBR increases to 9.4%.

Rezumat

Calitatea şi durata de conservare a îmbrăcăminţii rutiere sunt afectate în mare măsură de tipul substratului şi al materialelor folosite în stratul de fundaţie şi în cel de bază. Cele mai importante sunt tipul şi calitatea materialelor din fundatie. Dacă valoarea California Bearing Ratio(CBR) este mică, atunci este nevoie ca îmbrăcămintea rutieră să fie mai groasă pentru a putea susţine aceeaşi încărcătură. Diminuarea disponibilităţii unui substrat adecvat sau a unor materiale de bază pentru construcţia îmbrăcăminţii rutiere au dus la căutarea unor metode economice pentru schimbarea straturilor de fundatie problematice cu materiale adecvate. Din acest studiu reiese clar faptul că s-au adus îmbunătăţiri considerabile la California Bearing Ratio (CBR) prin ranforsare cu geogrile. În cazul în care nu s-au făcut ranforsări (geogrile), valoarea CBR a fost de 2.9%, iar când s-au utilizat geogrile la 0,2H, CBR a crescut la 9.4%.

Keywords: CBR, geogrids, geotextiles, MDD, OMC, reinforcement, .

1.Introduction

Desirable properties of sub-grade are high compressive and shear strength, permanency of strength under all weather and loading conditions, ease and permanency of compaction, ease of drainage and low susceptibility to volume changes and frost action. Since sub-grade soils vary considerably, the interrelationship of texture, density, moisture content and strength of sub-grade materials is complex. are sub-grade, sub-base, base course and hearing course effect of geogrid reinforcement on maximum dry density (MDD), optimum moisture content (OMC), California Bearing Ratio and E value of sub-grade soils.

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In addition, reinforced soils are often treated as composite materials in with reinforcement resisting tensile stress and interacting with soil through friction. Although three is lot of information and experience with geo-synthetic reinforcement of sub-grade soils, many pavement failures still occur. These failures may be due to lack of understanding of how these materials influence the engineering properties of sub-grade soils and what is the optimum position of reinforcement. Therefore a compressive laboratory program is required to study strength characteristics of both reinforced and un-reinforced sub-grade soils also to investigate their behaviors under cycle loading.

This work describes the beneficial effects of reinforcing the sub-grade layer with a single layer of geogrid at different positions and thereby determination of optimum position of reinforcement layer. The optimum position was determined based on California Bearing Ratio (CBR value) and unconfined compression tests were conducted to decide the optimum position of geogrid.

2. Literature survey

The concept of reinforcement is not new. Early civilizations commonly used sun-dried soil bricks as a building material. Somewhere in the experience it became an accepted practice to mix the soil with straw or other fiber available to them to improve the properties (Dean, 1986). Various materials were used in reinforcement of both pavement materials and sub-grade soils. They can vary greatly, either in form (strips, sheets, grids, bars, or fibers), texture (rough or smooth), and relative stiffness (high such as steel or relatively low such as polymeric fabrics), (Donald and Ohashi, 1983). Haas (1985) showed that flexible pavements could be effectively reinforced with the polymer geogrid.

This involves asphalt thickness savings from 50 mm to 100 mm, or the ability to carry two or three times more traffic loads for equal thicknesses. Nejad and Small (1996) investigated the influence of geogrid reinforcement of the granular base of a flexible pavement constructed on sand. They found that geogrid could significantly decrease the permanent deformation in the pavement by 40% to 70%.

Ling and Liu (2001) carried out some static and dynamic tests on model sections to find out the contribution of geo-synthetic reinforcement to the stiffness and strength of asphalt pavements. The reinforcement layer (geogrid) was laid above the sub-grade and a final layer of asphalt concrete was placed. The study showed that the settlement over the loading area of reinforced pavement was reduced when compared with un-reinforced pavement.

Srinivas Rao, B. and Jagloxshmi S (2008), carried out effect of fiber reinforcement of soil sub-grade beneath flexible pavements, in this work the study on strengthening of soil sub-grade with polymer reinforcement was carried out. The CBR test was carried out without fiber reinforcement. The CBR value of soil without fiber is 3.3%. After addition of fiber reaction the high CBR value was achieved.

Professor Stelin, V.K., Prof. Ravi, E. and Arun Murugen, R.B.(in 2010) carried out the experiment on shrink Behavior of expensive clay using geo-synthetics. In this paper attempt is made to control the expansion on swelling clays with geo-synthetics. Swelling tests were conducted on expensive clay with varying orientation and number of layers of geogrid, geo-membrane and geo-textile and they found the result that the load carrying capacity of swollen clay with geogrid is high.

Raju, N. Ramakrishna (2010) reported that the usage of geo-synthetics in earth dams and embankments to provide additional stability. Reinforcement of embankment/filling on soft soil reduces construction material quantities, reduces land acquisition and reduces construction time.

3. Material selection and CBR testing

Material selection: One type of clayey soil was selected for this study. The index properties liquid limit, plastic limit and plasticity index were determined. Important physical properties and classification of soil are given in table no. 1.

Table 1. Physical properties of soil

Property	Soil
Dry Density (gm/cc)	[illegible]70
Optimum Moisture Content (OMC) %	16[illegible]
Specific gravity	2.60
Coefficient of uniformity (Cu)	[illegible]8
Coefficient of curvature (Cc)	0.18
Liquid Limit(%)	28
Plastic Limit(%)	15
Plasticity Index	13
Unified Classification	CL- Clay of low compressibility

One type of geogrid was used to reinforce the sub-grade soil. Various properties of geogrid considered for this study are given in table 2.

Table 2. Properties of Geogrid.

Property	Grid
Mesh aperture size(nominal) mm	22 x 22
Tensile strength in longitudinal direction at 2% strain (kN/m)	5.8
Stiffness in longitudinal direction (kN/m)	290
Elongation in machine direction	16.5%
Tensile strength in transverse direction at 2% strain (kN/m)	5.2
Stiffness in transverse direction (kN/m)	260

Elongation in transverse direction	10%

California bearing ratio (CBR) test

CBR tests were conducted on selected soil, unreinforced and reinforced with a single layer of geogrid. To reinforce a sample, the geogrid was placed in a single layer at different positions: 20%, 40%, 60% and 80% of the specimen height from the top surface. It was cut in the form of circular disc of diameter slightly less than that of the specimen to avoid separation in the specimen by the reinforcing layer. The dry weight required for filling the mould was calculated based upon the maximum dry density (MDD) and corresponding optimum moisture content was achieved from standard proctor test. A total of five samples of unreinforced and reinforced type were tested after soaking in water for four days. The load penetration curve was drawn for the soil samples with geogrid at different positions and the CBR values were obtained from these curves. Table 3 shows the results of CBR tests under different test conditions. It is clear that considerable amount of increase in CBR value of soil with geogrid reinforcement, for example, in case of unreinforced soil the CBR value is 2.9% and with geogrid reinforcement the CBR value increases to 9.4%. The highest increase in the CBR value was achieved when geogrid was placed at 20% depth from the top of the specimen.

Table 3. Results of CBR tests for different positions of geogrids

Sl. No.	**Position of geogrid from top of specimen**	**Unsoaked CBR**	**Soaked CBR**
1.	No geogrid	6.5	2.9
2.	0.2H	16.05	9.4
3.	0.4H	13.86	7.2
4.	0.6H	10.9	5.8
5.	0.8H	7.2	3.16

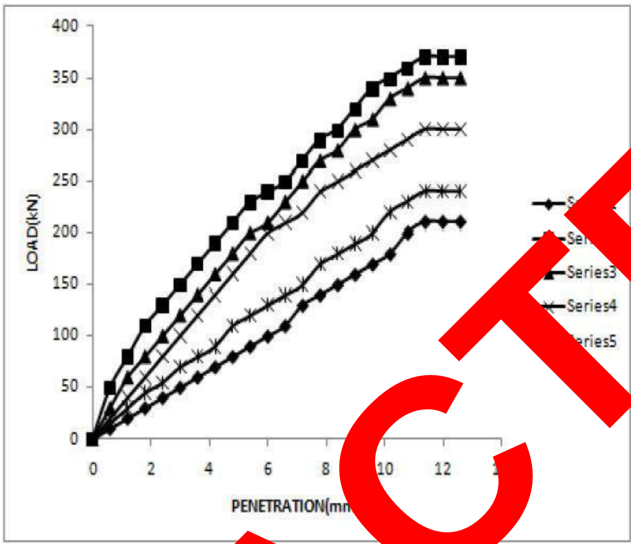

Figure 1. L[illegible] vs [illegible]tion curve

4. Conclusions

In the present study, re[illegible]fo[illegible] different layers of a flexible pavement are evaluated in terms of their stren[illegible] param[illegible]s like, CBR and E-value and the important findings of this research are summar[illegible]low:

1. The CB[illegible] of a [illegible] increases by 50-100% when it is reinforced with a single layer of geogrid. The a[illegible]unt of impr[illegible]ment depends upon the type of soil and position of geogrid.

2. C[illegible] of s[illegible]-grade soil is 3.6% without reinforcement and when geogrid was placed at 0.2H from [illegible] to[illegible]he C[illegible]R value increased to 8.7%.

3. Th[illegible]ress-s[illegible]in behavior of sub-grade soils under static load condition improved co[illegible] wh[illegible]grid was provided at optimum position.

6. [illegible]rences

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