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Advanced Pavement Design Using Geo-Synthetic Material

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ABSTRACT
As on 10 May 2022, estimates the entire road length in India 6,603,293km (4,103,096mi) making the Indian road network, the second largest road network within the world after the USA. But the roads aren't giving the desired result due to poor CBR value. Roads in India have mostly the issues like the formation of potholes, ruts, cracks and localized depression and settlement, especially during season. These are mainly thanks to the insufficient bearing capacity of the sub-grade in water saturated condition. It's been tried to use the geo-grid material for increasing the bearing capacity of the sub-grade. Laboratory and simulated field CBR test are conducted on soil samples with and without the inclusion of geo-grid layer and also by varying the position of it within the mold. Use of geo-grid increases the CBR value of the sub-grade and thereby reduces the pavement thickness considerably up to 35-38% as trial and error. Studies are administered and influenced of parameters: soil plasticity, geo-grid tensile capacity soaking and un-soaking on CBR property is examined. Geo-grid has been effectively used for reinforcement of soils to recover the bearing capacity. Roads are arteries of a city and a rise in population increases traffic. Heavy traffic demands strong, smooth, durable and well-maintained road pavement and hence healthy and strengthened road network is important for socioeconomic development of a country. This study will have a positive impact on cost because it will reduce the Project as well as maintenance cost of the road. Our project will discuss intimately the process and its successful applications.

KEYWORDS: *Geo-grids, Reinforcement, CBR Value, Flexible Pavement, Sub-grade, Highway, Design, Expansive Soil, Soft soil.*

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I. INTRODUCTION

One of the major problems faced by the engineers in highway construction in plains and coastal areas of India is the presence of soft/ loose soil at ground level. Roads constructed over this loose soil demands higher thickness of granular materials leading to the high cost of construction. Alternately attempts of reducing the thickness of pavement layer to form an economic construction will lead to early damage to the pavement which in turn will make the road unserviceable within a short period after construction. This condition could also be further worsened if supplemented with poor drainage or lack of it. Some states of India is situated during a region of high rainfall area suffers from poor drainage as well as weak sub-grade condition. this is often one of the major causes of deplorable road condition in those states. Geo-grids used within a pavement system perform two of the first functions of Geo-synthetics: separation and reinforcements. thanks to the large aperture size associated with most commercial geo-grid products, geo-grids are typically not used for achieving separation of dissimilar material. the power of a geo-grid to separate two materials is a function of the gradations of the two materials and is generally outside the specifications for typical pavement materials. For this reason, separation may be a secondary function of geo-grids used in pavements. the first function of geo-grids used pavements in reinforcement, during which the geo-grid mechanically improves the engineering properties of the pavement system. The reinforcement mechanisms related to geo-grids.

OBJECTIVE OF STUDY

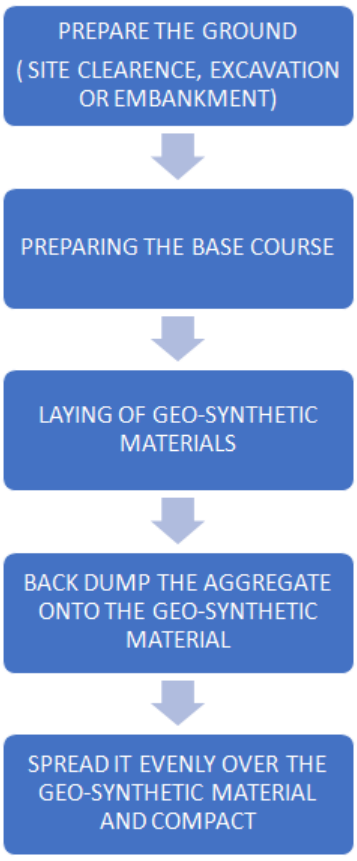
This study has the following objectives:

- To reduce the thickness of Pavement. So, as to reduce the cost of road construction.
- To Design Pavement thickness based on CBR and MSA traffic as per IRC: 37-2012.
- To increase the load carrying capacity of the road (Strength of road).
- To increase the service life of the road.

II. LITERATURE REVIEW

1. **Giroud and Noirway** (1982) after an extensive study developed design chart of unpaved pavement for using geosynthetic at the interface of the base layer and Subgrade soil. Ramaswamy and Aziz (1989) did an experimental investigation on the behavior of jute reinforced subgrade soil under dynamic load.
2. **Mehndiratta et al** 1993 and Patel, 1990 have reported that standard mold ofdiameter equal to 3 times the plunger diameter is found to be inadequate for determination of CBR value as the small size mold will provide additional confinement to geotextile. Therefore, the diameter of the mold is increased to 5 times the plunger diameter. Also, to determine the effect of lateral confinement on CBR value of reinforced soil, mold plunger diameter ratio (D/d) is varied from 2 to 5 while the vertical pressure (surcharge), thethickness of the specimen, method of compaction is kept the same as the standard test.Also, to determine the effect of lateral confinement on CBR value of reinforced soil, mold plunger diameter ratio (D/d) is varied from 2 to 5 while the vertical pressure (surcharge), the thickness of the specimen, method of compaction is kept the same as the standard test.
3. .**Mehndiratta et al** (2005) conducted CBR and plate load test on unreinforced and geotextile reinforced subgrade. It was observed that the increase in elastic moduli of coir reinforced layer when coir is replaced by synthetic geosynthetic geotextiles are only 5percent. They also investigated the durability of coir by accelerating its degradability It was observed that phenol treated coir extends the life of coir. Rao (2007) has published acompilation of his work on geosynthetics and state of the art developments.
4. **Babu et al**, 2008 has developed a design methodology using IRC guidelines for the design of coir geotextiles reinforced road on the basis of laboratory experiment data and mathematical formulations.
5. **Gosavi et al** also investigated the strength behavior of soils reinforced with mixed geogrid woven fabric and showed that the soaked CBR without the geogrid was about 4.9% and after application of the geogrid test results showed an improvement in the CBR value. Naeini and Moayed indicated that using a geogrid at top of the layer 3 in a soil sample with different plasticity index causes a considerable increase in the CBR value compared with unreinforced soil in both soaked and unsoaked conditions. In order to quantify the amount of increase in the penetration resistance, the reinforcement ratio is taken into consideration. The reinforcement ratio according to is defined as the ratio of the Load with the geotextile to the Load without the geotextile.

III. METHODOLOGY



NOTE: On very soft sub-grades, if the geo-grid is to provide some reinforcing, pre-tensioning ofthe geo-synthetic should be considered. For pre-tensioning, the area should be proof rolled by a heavily loaded, rubber-tired vehicle such as a loaded dump truck

IV. EXPERIMENTAL RESULTS

CALIFORNIA BEARING RATIO (CBR TEST):

1. WITH GEO-GRID:

SL No:	Penetration in mm (C_1)	Proving Ring Readings (C_2) KN	Proving Ring Readings in division ($C_3=C_2*5$)	Load in Kg $C_4=C_4*0.915$
1	0.0	0.0	0.0	0.0
2	0.5	3.7	18.5	16.9
3	1.0	4.9	24.5	22.4
4	1.5	5.6	28.0	25.6
5	2.0	6.7	33.5	30.7
6	2.5	7.5	37.5	34.3
7	4.0	7.7	38.5	35.2
8	5.0	8.1	40.5	37.1
9	7.5	8.5	42.5	38.9
10	10.0	9.2	46.0	42.1
11	12.5	9.5	47.5	43.5

CBR Test Data with Geo-grid @ H/2 from Bottom

SL No:	Penetration in mm (C_1)	Proving Ring Readings (C_2) KN	Proving Ring Readings in division ($C_3=C_2*5$)	Load in Kg $C_4=C_4*0.915$
1	0.0	0.0	0.0	0.0
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10	10.0	9.2	46.0	42.1
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CBR Test Data with Geo-grid @ H/2 from Bottom

SL No:	Penetration in mm (C_1)	Proving Ring Readings (C_2) KN	Proving Ring Readings in division ($C_3=C_2*5$)	Load in Kg $C_4=C_4*0.915$
1	0.0	0.0	0.0	0.0
2	0.5	7.9	39.5	36.1
3	1.0	9.1	45.5	41.6
4	1.5	9.8	49.0	44.8
5	2.0	10.9	54.5	49.9
6	2.5	11.7	58.5	53.5
7	4.0	11.9	59.5	54.4
8	5.0	12.3	61.5	56.3
9	7.5	12.7	63.5	58.1
10	10.0	13.4	67.0	61.3
11	12.5	13.7	68.5	62.7

CBR Test Data with Geo-grid @3H/4 from bottom

V. FINAL RESULTS

These are the final results from our experimental program:

CBR Value Variation with Geo-grid Application in Soil Sample

Description	CBR Value
Without geo-grid	1.67
With geo-grid @ H/4 from the bottom	1.80
With geo-grid @H/2 from the bottom	2.50
With geo-grid @ 3H/4 from the bottom	3.91

VI. CONCLUSION

The positive effects of geo-grid reinforced sub-grade courses can economically and ecologically be utilized to scale back aggregate thickness. And it also can increase the life of the pavement and can also decrease the overall cost of the pavement construction with an increased lifetime. The study investigated the appliance of geo-grids to sub-grade material as a form of reinforcement to road construction. The inclusion of the geo-grid considerably increases the strength of poor soils, which is reflected within the higher CBR values. It has been observed that the highest sub-grade strength is achieved when it is placed at 3H/4 for a single layer although has a satisfactory result at H/2 and H/4 respectively. On reinforcing the soil, there's a considerable increase in performance of the sub-grade in the un-soaked condition. the utilization of geo-grids as reinforcement to poor soils improves its strength. it's non-bio degradable and therefore durable; it also increases the ultimate service life of the pavement. the utilization of Geo-grids should be encouraged as an efficient and modern form of improving road construction on poor sub-grade materials. Further research should be analyzed in ascertaining the effect of geo-grids on sub-grade soils under the un-soaked condition.

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