INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume 5, Issue 4)
Available online at: www.ijariit.com

Use of Triaxial GeoGrids for subgrade stabilisation and pavement optimization

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ABSTRACT

Triaxial Geo Grids were first founded in the year of 2007 so as to enable civil engineers to stabilize granular layers subjected to dynamic and static loads. Triaxial geogrid is having a 360° isotropic tensile properties, wherein on laying off the geogrid the aggregates interlock within a triangular slot, for which the efficient deep fibers of the triaxial geogrids assists in confining the aggregate particles. This, in turn, stabilizes the layer and enhances the performance of the subgrade resulting in pavement optimization. Prior to surfacing in the global market triaxial geogrids were under six years of development with a focus on improving the performance under trafficking of the granular layers in which they were included. This involved the use of full-scale testing facilities such as the Transport Research Laboratory (TRL) in the UK. This paper provides a general idea on the possibility to implement Triaxial Geogrids to form a mechanically stabilized layer (MSL) so as to save cost in term of material and construction effort especially in areas where the effective CBR of soil is found to be much below the permissible limit as per IRC specifications thereby extending the design life of the pavement structure. In addition, the proposed MSL would create a flexural stiff platform where the effects of the variable quality of support from the foundation soil can be smoothed out.

Keywords— *Triaxial GeoGrids, Pavement optimization*

1. INTRODUCTION

Geosynthetics have been successfully implemented for subgrade improvement and also for reinforcing the base for unpaved and paved roads in the past several decades. Several studies have depicted that geosynthetics which when properly placed in a roadway improves the performance of the road. It was pointed out in 1998 that the best location for implementing geosynthetics for subgrade was in between the layers of granular and subgrade materials. Since it provides a partition and lateral prevention of the overlayed granular material and a tensioned membrane effect when it gets deformed extensively.

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Fig. 1: Pavement test facility, TRL, UK

Wherein, for example, an existing pavement is proposed to be constructed over a subgrade with CBR value let's say from 2% - 3.0 %. This paper shall demonstrate value added by using triaxial geogrids in terms of pavement performance, pavement life, construction time and cost. Resulting in to improve bearing resistance of the subgrade, to mitigate the distress caused due to it and carry out pavement optimization.

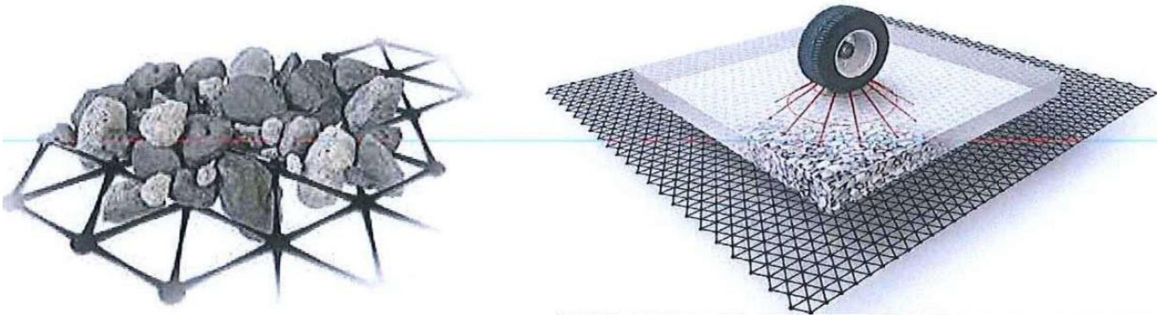

Fig. 2: Granular particles stabilized by triaxial geogrids

1.1 Why Triaxial over Biaxial geogrids?

Geotextiles and Geogrids being the two most common types of geosynthetics implemented in unpaved roads. Although there is found a substantial difference between the two. Wherein Non-woven Geo Textiles are used in drainages and separation while woven is used in confining and reinforcing the pavement. This confinement results in an increase of the base course modulus, which results in a wider range of distribution of stress impacted vertically over subgrade, hence a reduction of vertical subgrade deformation. Due to the interlocking spaces between the geomembranes, the geogrids can interlock with the aggregate in its base course, considering there is a proper bonding between the spacing size of the geogrids and the raw material particle size of the aggregates.

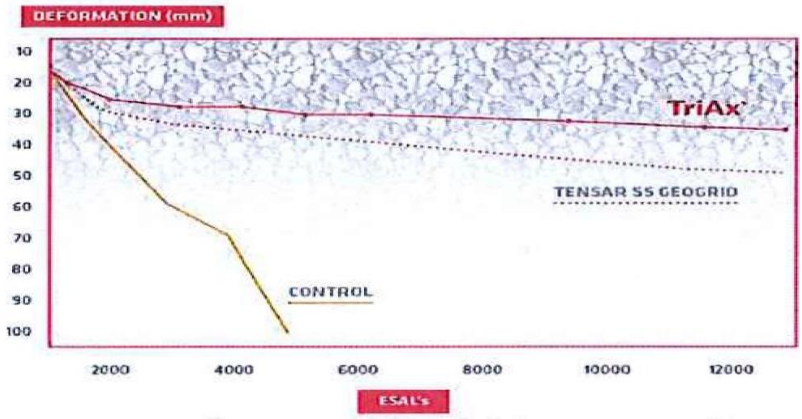

Fig. 3: Trafficking results of triaxial geogrid out-performing biaxial geogrids

Such surface distortion was analyzed and observed during the tests taken around 11,000 passes of the moving wheel load imposed on the granular fill of 30cm with Tri-Ax or Biaxial geogrids included at the base of each layer. Further, the result in Fig 3 shows that the section implemented with triaxial geogrids is deformed less than Bi-Axial geogrids.

Further differentiation work was done at TRL in the year 2013, where the triaxial geogrid performance was compared with biaxial, with similar test apparatus as shown in figure 2. But with a diff grade of biaxial geogrid included under the 30cm of granular fill. Wherein Fig. 4 and 5 compare the performances of Trix-Ax TX160 with a 30kN/m punched and drawn product and also a 30 Kn/m woven geo-grid respectively. In both cases, the deformation through triax proved much less than biax.

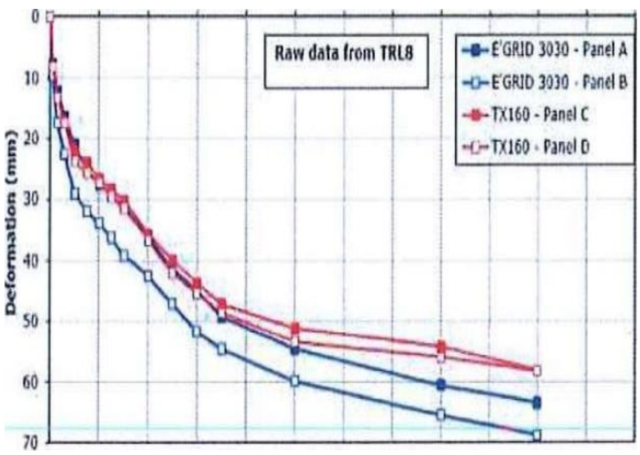

Fig. 4: Trafficking performance TX160 vs. "punched and drawn" 30kN/m biaxial geogrid

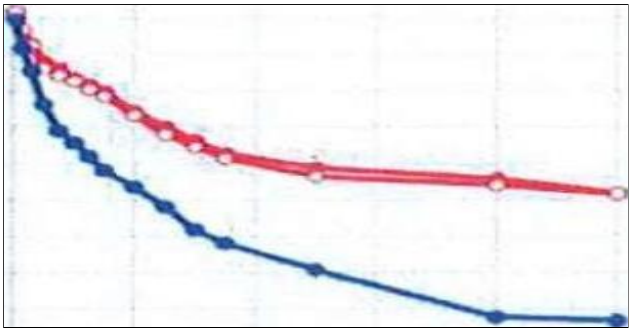

Fig. 5: Trafficking performance of TX160 vs. "woven" 30kN/m biaxial geogrid

2. LITERATURE REVIEW

(R. M. Koerner, 2005), Says that the primary use of reinforcement of roads with fabrics was trialed by South Carolina Highway Department. On publishing the reports in 1935 it showed that the roads are in very good condition where the application of fabric on primed earth reduced cracking and localized road failure.

(Motanelli, 1997,), states that Geogrids placed Granular Base Course and Sub base show a higher value of effective CBR for subgrade.

(Spalding to Eye road improvement scheme using Tensar MSL™,, 2009), where a Mechanically Stabilised Layer was used as an alternate pavement foundation for 22 km of a new highway in the Fens of East Anglia, this reduced *500mm* to 1000 mmm subgrade replacement.

(Naeini and Moayed, 2009), showed that usage of geogrid at the top, positioned geogrids a base course of gravel and sand subgrade, which resulted In the increased CBR value of the material.

Moreover, it was also experimented by (G. Gosavi, 2004), that the force withstanding phenomenon of earth, mixed geo-grid is acting as reinforcement on woven fabric and showed that the soaked tested CBR was about 4.9% without Geo-grids and thereafter applying geogrid the CBR showed substantial improvement.

(Road Construction Over Very Weak Soils Krimpernerwaard,, 1993), deals with a project in the year 1993, in the area of the Krimpernerwaard in the west of Holland, where a new 11km long pipeline was needed for the transportation of drinking water. The area contains a very soft clay type soil, having a 12 m deep, 3 layer surface in a soil sample, whose CBR also gets increased when compared with unreinforced soil in both soaked and unsoaked stage.

(Ground Stabilisation of a School Sports Facility in Grigiškės, Lithuania, 2011) where the natural subgrade consisted of low strength, highly variable soil with a potential for differential settlement, wherein implementation of triaxial geogrid provide a stabilized foundation to the final sports facility construction, which was 20% cheaper than a unstabilized thick layer of crushed stone.

3. PROBLEM STATEMENT

In spite of so many successful incidents where implementation of geogrids has been incorporated in several European countries, the triaxial geogrid is still to be implemented in the Indian Road Congress, for which the U.S based companies like Tensar Corp, is really finding it difficult to properly enter in the Indian Market, which can actually result in optimization of pavement to a great extent.

4. OBJECTIVE

To analyze the feasibility of incorporating Triaxial Geogrids for Subgrade stabilisation and Pavement optimization in Indian Road.

5. CASE STUDY: PROJECT NAME: SIX LANING OF KALYANI EXPRESSWAY PROJECT, WEST BENGAL

This paper provides a primary thrust towards an expressway, under West Bengal Highway Development Corporation Limited, where the proposed widening project alignment passes through stretches of soil having low soaked CBR value and the CBR of the borrow area material at the most location available is less than the minimum requirement defined by the IS code.

5.1 Introduction

Government of West Bengal is carrying out six laning of Kalyani expressway (Phase II) from Muragaccha to Kampa under the authority of West Bengal Highway Development Corporation Limited (WBHDCL) under EPC mode in the district of North 24 Parganas, where the CBR value was found to be 3%.

It based on the CBR value (3%), cross-section details (corresponding to CBR = 3 % as per IRC 37) and required design MSA (150 MSA). Based on this information, a multilayer MSL proposal has been prepared over simulated ground conditions.

5.2 Type of pavement

Flexible Pavement CBR (effective) - 3 % Design MSA - 150 MSA.

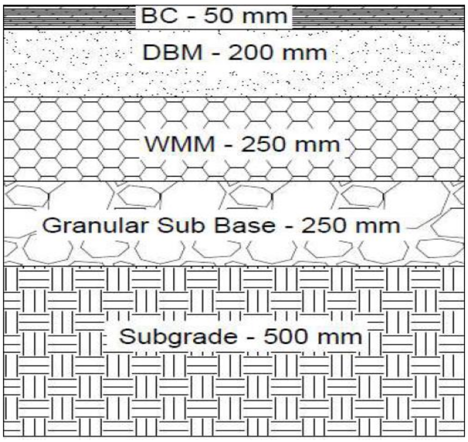

Fig. 6: Section of pavement as per IRC 37:2018 - 3% CBR

5.3 Problem Identification

The proposed widening project alignment passes through stretches of soil having low soaked CBR value and the CBR of the borrow area material at the most location available is less than the minimum requirement defined by the IS code.

5.4 Proposed solution with Stabilisation using Triaxial Geogrids forming mechanically stabilized the layer

Majority of studies indicate appreciable improvement in pavement performance due to use of triaxial geogrids in the pavement. The development of the interlock at the soil – grid interface restricts the movement of soil particles, this stabilisation effects helps in creating a flexurally stiff platform which smoothens the variations of resistance available along the alignment and prevents distress in the pavement.

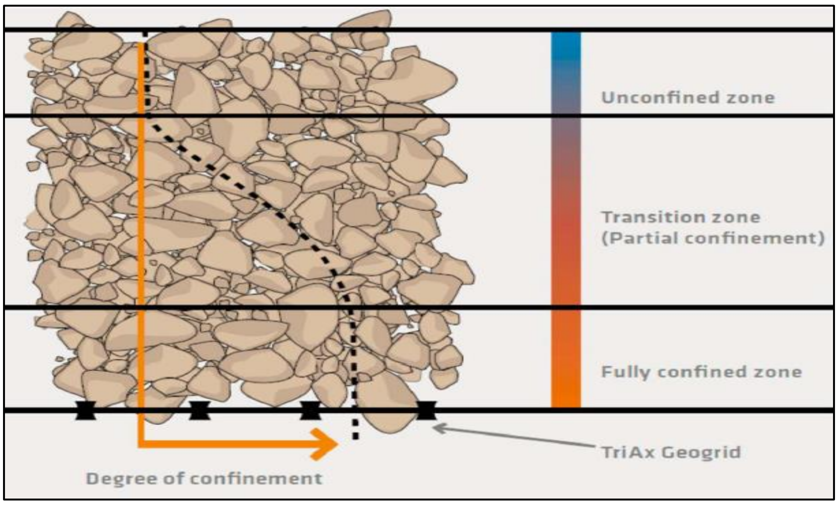

Fig. 7: Mechanically Stabilised Layer – composite layer formation due to interlock

6. RESULT

- Cost-effective solution for applying Geogrid.
- MSA Achieved with design section with reference to Tensar design software
- CBR: 3 %
- Design MSA: 150
- MSA achieved with stabilised and optimised section = 159

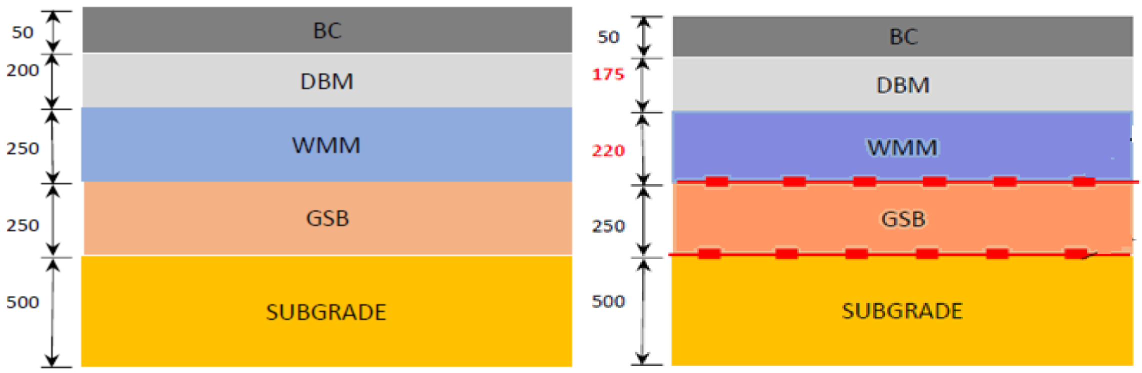

Fig. 8: Non-Stabilised Cross-Section of Pavement as Per IRC 37:2018 vs. Cross-Section of Pavement Stabilised and Optimised With Tensar Triax Tx 160

Table 1: Rates for various materials

Thickness reduction in various layers due to use of Tensar TriAx TX 160				
Layer	**Reduction in thickness in mm**	**Rate per Cum (assumed)**	**Saving per Sqm achieved with TriAx Geogrid use**	**Unit**
BC	0		0	Rs/Sqm
DBM	25	7520	188	Rs/Sqm
WMM	30	2630	78.9	Rs/Sqm
GSB	0		0	Rs/Sqm
SUBGRADE	0		0	Rs/Sqm
Total saving in materials due to use of TriAx Geogrids =			266.9	Rs./Sqm
TriAx TX 160 Geogrid cost per Sqm =			196	Rs./Sqm
Net Saving per Sqm of road area =			70.9	Rs./Sqm
Considering 7.5 m lane width, Net cost saving per km=			5,31,750 Rs	

7. CONCLUSION

This proposal can be used to be able to optimize the whole pavement structure achieving an overall thickness reduction of 13 %. Pavement costs were also reduced through the reduction of earthworks activities. As well as doubling the predicted pavement life along with stabilizing the soft ground condition. In this way challenging road projects having CBR way too less has permissible value, wherein subgrade replacement seems the only option and is very cost-effective, the triangular geometry of Triaxial Geogrids provides a different triangular aperture structure, which gives a full 360-degree high radial stiffness to the ground. Moreover the benefits of the application of triaxial geogrids are:

- More than 30 years of installation and intensive testing has demonstrated that the installation of Tensar ground stabilisation geogrids allows for a reduction in aggregate thickness without loss of performance.
- When ground stabilisation geogrid is introduced, a given sub-base thickness can carry more than 2.5 times more traffic.
- Soil bearing capacity gets increased.
- Controlling differential settlement and Capping weak deposits by providing provide the lateral restraint to aid full compaction and increased stiffness
- Spanning voids ground stabilisation geogrids are effectively used for sub-base construction over shallow mine-workings, shafts and swallow holes.

8. REFERENCES

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