Review On Geogrid Application In Flexible Pavement

Ms. Pranoti V Pawar[1]

Research Scholar
Department of Civil Engineering
Pillai HOC College of Engineering and Technology, Rasayani
Maharashtra, India

Prof. Ms. Madhulika Sinha[2]

Assistant Professor
Department of civil Engineering
Pillai HOC College of Engineering and Technology, Rasayani
Maharashtra, India

---***---

***Abstract*—**Flexible pavements are those that have absolutely little or inconsiderable flexural strength and are flexible in their structural action under load. It was observed that urban areas road are not the mark due to financial and technical issues. Thus there is a need to develop an economical flexible pavement having a high durability, which required the past history of flexible pavement in terms of performance & also need to find the various drawbacks & failure of pavement. Thus we have gone through few literatures on flexible pavement and collected the required information which we have representing in this paper.

Keywords*— *Geosynthetic material, Flexible pavement, recycled aggregate, Interface shear strength, CBR test.

I. INTRODUCTION

In Flexible pavements are failure due to rapid growth of vehicle drives traffic. Among the various modes of failure are most important rutting, Fatigue. So these problems the engineers are forced to design new construction materials. In this flexible pavement failure they decided the use of Geosynthetic material and also the civil construction industry had a huge amount of wastes during the construction new building and the demolition or reformation. Most Geosynthetic are made from polypropylene, polyester, or synthetic polymers of polyethylene, PVC, natural fibers. The word is derived from: Geo = earth or soil + Synthetics = man-made. The use of recyclable aggregation can reduce the cost of construction materials, reduce the amount of landfill waste, reduce transportation and energy costs for importing virgin aggregates, and conserve natural resources by adding less virgin to road construction projects. Recycling collectively is usually produced by crushing, screening and reinforcing of cast concrete, removing plastic and sometimes asphalt, etc. Several agencies are seriously considering the economic and environmental benefits of using recycled aggregate in roadways and are facing challenges to maintain high Safety road infrastructure. Wheel load is distributed over a subgrade-base interface as shown in (figure- 1)

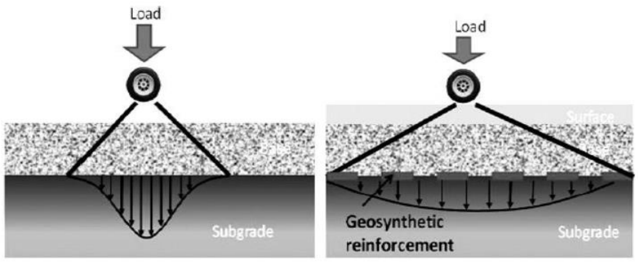

Figure-1: Relative load distribution at subgrade-base interface for reinforced and un-reinforced flexible pavement

II. LTERATURE REVIEW

A. *Murad Abu-Farsakh, et.al (2012)[1]*

In their research paper, they conducted a test experimental in that, the study carries out by repeated load triaxial (RLT) test evaluated the flexible and permanent deformation of Geogrid with the granular base specimens. In that the five geogrids specimens were used such as three rectangle or biaxial and two triangles or triaxial in different tensile modulus and aperture geometry. After the test result found the geogrid arrangement/ location on the specimen it had largest improvement, and also in the effect of moisture content was also higher improvement, but in the resilient deformation/ resilient modulus had not appreciable improvement of the specimens.

B. *Jie Han, et.al. (2014)[2]*

In their paper, the Geosynthetic material used of recycled aggregate for improve the mechanical properties and long-term durability. Also, they found permanent deformation, creep deformation, degradation, stress distribution, and crack propagation. In that reviews the research work is done on the use of Geosynthetic to stabilize Recycled Aggregate including Recycled Asphalt Pavement (RAP), Recycled Concrete Aggregate (RCA), and Recycled Ballast (RB). These RAP, RCA, and RB is used for base course materials for sustainable roadway construction and also used for the construction of the load-bearing layer in the railway track.

C. *Satish Pandey, et.al (2015)[3]*

In their research paper, they discussed the use of Geosynthetic materials like geogrid and geotextile for the bituminous pavement and for road infrastructure. In this the Geosynthetic material was used in subgrade for separation and stabilization, in concluded that the geogrid reinforcement in the pavement was placed in a base course and subgrade layer it decreases the vertical strain and in the bottom of the reinforcement it reduces the horizontal tensile strain in the bituminous pavement surface. This paper shows that Geosynthetic material improved service life, reduce the thickness of the pavement, and easy to build it.

D. Hao Wu, et.al (2015)[4]

In their research paper, they use four types of geogrids with different aperture and stiffness with river sand and for gravel base course. The RRR (Rutting Reduction Ratio) and TBR (Traffic Benefit Ratio) were calculated in base with geogrid were benefited and rut depth was improved. The LWT (Load wheeler tester) in the river sand rut depth was improved by 25-30% with use of GD1 compare to no-Geogrid, similarly from 35-40% improved with use of GD2. Whereas Original gravel rut depth was improved by 55-60 %, 25-30% and 40-45% with use of GD2, GD3 and GD4 compared with no-Geogrid. In their research paper following types of geogrid used for testing (Figure 1).

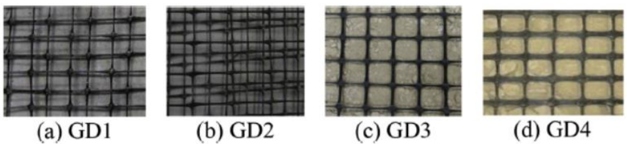

Figure- 2: Geogrids used for testing

E. E. M. Ibrahim, et.al. (2017)[5]

The In their paper, the effectiveness of geogrids in flexible pavement reinforcement was investigated throughout in full laboratory testing and finite-element analysis. The Laboratory testing consist of routine material specialization, flexible modulus testing, and five paving sections. The pavement prototype section in the laboratory was constructed in a steel container with a 5cm AC layer, a 15cm granular base layer was reinforced with four different depth and 30cm subgrade. Based on the analysis the reinforcement of the granular base layer with geogrid showing the reduction in tensile strain in the pavement system in comparison with pavement without reinforcement. The maximum reduction in tensile strain has come when the geogrid is placed directly under the AC layer. The best state of geogrid reinforcement to reduce tensile stress was found to be directly below the AC layer and then to the height of the granular base layer measured from the bottom to 33-50% of the base layer.

Considering the approximate values from the graph tensile strain has been increased by placing the geogrid in the various layers from following reading was found, and shown in table no.1 – Analysis of increase in percentage variation in strain due to placing of geogrid at various level.

Table 1: Analysis of increase in percentage variation in strain due to placing of geogrid at various level.

Strain Gauge	Tensile strain				
	CS	B0	B1/3H	B1/2H	BH
Sg0	1120	330	170	170	200
Sg0.5H	850	700	190	675	590
SgH	1600	2900	550	400	300

F. Alaa M.Ali et.al (2018)[6]

In their review paper, they studied improvements of pavement matrix life cycling when reinforcing by Geosynthetic, this reinforcement was improved the drainage quality of subgrade soil and improved the reducing surface rutting. This research concluded that evaluation of reinforcing Geosynthetic materials in highway application the CBR test can be misleading and found to be the repeated load testing which simulated the actual loading condition is more realistic. According to the testing performed by the authors, it was observed that type1, Type 2, Type 3 of Geosynthetic material reinforcement in pavement the surface rutting was decreased (Improvement) by 50-55%, 45-50%, and 35-40% compared without reinforcement. The Type 2 reinforcement was found less surface rutting as compared to without reinforcement.

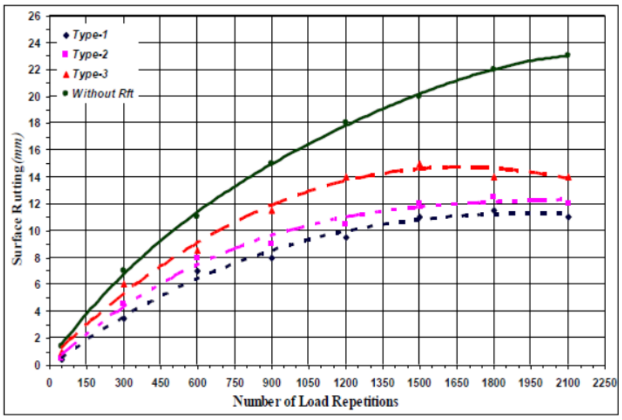

Figure- 3: Effects of type of reinforcement on progressive surface rutting for subgrade at soaking condition (Base Course = 100mm)

G. Apichat Suddeepong et.al (2018)[7]

In their research paper the geogrid and RCA were investigated between the effect of aperture size, tensile strength of geogrids, normal stress, and gradation on shear interaction with the use of large-scale direct shear test (LDST) apparatus. This geogrid reinforcement of RCA can improve the flexural and tensile strength of pavement structure to high traffic loading. The interface shear strength was found to be highly dependent upon the aperture width of the geogrids, D, as well as the RCA particles finer than the aperture width of geogrid, FD. The proposed relationship will be useful for a rapid assessment of the interface shear strength coefficient of geogrid reinforced RCA based on the aperture size of geogrids and RCA gradation properties.

The vertical displacement for small large sample reinforced with geogrid found to be 3 to 4 times, 1.5 to 2 times, and 2 to 2.5 times when compared with RCA for interface shear strength of 50 KPa, 100 KPa, 200 KPa respectively, similarly for small size sample reinforced with geogrid found to be 0 to 0.5 times when compared with RCA for all the interface shear strength. With constant shear stress there is increase in horizontal displacement even after the maximum stress. Thus it is also concluded that for a particular normal stress, the large sized sample shear strength is higher than that of the small-sized sample.

H. Ralph Haas et.al [8]

In their paper shows the grid reinforcement is distributed the Load-induced stresses in flexible pavement. It also discuss the geogrid reinforcement of granular base reinforcement mechanisms and the application of structure stress-strain deflection. In that concluded, geogrid reinforcement should be forced on the base subgrade interface for optimal effect. The without a thin base section and close to a dense base, such placement zones cannot be flexible tensile stresses in the grid that are greater than 0.2 percent.

III. CONCLUSIONS

From all the literature mentioned above it was found that:

A. The RRR and TBR were benefited from the rut depth are effective of geogrid reinforcement and also the LWT test was proved that using the type of geogrid (GD1, GD2, GD3, and GD4) reinforcement is more effectively on river sand base and gravel base.

B. A geonet is better than a geotextile and it improves the layer of subgrade soil drainage quality and also improvement in reduces the rutted surface.

C. Shear strength in larger size sample is higher than that of small size sample particularly in normal stresses.

D. In granular base layer with geogrid reinforcement was reduce tensile strain as compared to without reinforcement. But in this layer the compressive strains (rutting) is also reduces.

E. In their different zones, geogrid reinforcement was placed and this reduced the rutting, deformation, and it extended the life of pavement structure.

F. The Geogrid reinforcement placed between the base course and subgrade layer decreases the vertical strain (rutting) and improves the service life of the pavement.

G. The use of paving fabric in the bituminous layer it slows down the process of reflection of cracks.

H. The geogrid reinforcement was prepared with the granular specimen in dry and optimum condition and this highly improved than wet condition. The reinforcement was improved the resilient deformation and resilient modulus of granular specimen.

I. The Geogrid reinforcement was placed in double location (such as upper and lower location) it largest improvement in granular specimen and the upper location also slightly improve.

J. Geosynthetic materials with recycled aggregate, recycled ballast are used in the flexible pavement it reduces the vertical and lateral deformation and increases the long term durability.

K. The Geogrid improves the flexible pavement performance and reduce crack propagation and also distributes the load on the base layer.

ACKNOWLEDGMENT

The authors have taken this opportunity and are highly delighted to thanks Professor Ms. Madhulika Sinha, Department of Civil Engineering, Pillai HOC College of Engineering and Technology, for their valuable guidance and support we also like to thank Mr. Shrikant Varpe for providing technical support.

REFERENCES

[1] Murad Abu-Farsakh, A.M.ASCE, Gael Souci, George Z. Voyiadjis, F.ASCE, and Qiming Chen, (2012), "Evaluation of Factors Affecting the Performance of Geogrid-Reinforced Granular Base Material Using Repeated Load Triaxial Tests", Journal of Materials in Civil Engineering © ASCE / JANUARY 2012 [7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[2] Jie Han, Jitendra K. Thakur, (2014), "Sustainable roadway construction using recycled aggregates with geosynthetics", Elsevier Journals [7] M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.

[3] Satish Pandey, U.K. Guru Vittal and Sunil Jain, (2015), "Utilization of Geosynthetic Reinforcement for Construction and Rehabilitation of Bituminous Pavement", Three Decades of Geosynthetic in India, 5-6 November 2015, New Delhi, India.

[4] Hao Wu, Baoshan Huang , Xiang Shu, Sheng Zhao (2015), "Evaluation of geogrid reinforcement effects on unbound granular pavement base courses using loaded wheel tester", Elsevier Journals, Geotextiles and Geomembranes 43 (2015).

[5] E. M. Ibrahim, S. M. El- Badawy, M. H. Ibrahim, A. Gabr, A. Azam. (2017) "Effect of geogrid reinforcement on flexible pavements", springer international publishing.

[6] Alaa M.Ali ,(2018), "Evaluation of Flexible Pavement Reinforced with Geosynthetics using Static and Dynamic Loading Tests", Article in International Journal of Engineering and Technical Research-May 2019.

[7] Apichat Suddeepong, Narong Sari, Suksun Horpibulsuk, Avirut Chinkulkijniwat, and Arul Arulrajah (2018), "Interface shear behaviors between recycled concrete aggregate and geogrids for pavement applications", Taylor & Francis Group, International Journal of Pavement Engineering.

[8] Ralph Haas, Jamie Walls, And R.G. Carroll, "Geogrid Reinforcement of Granular Bases Flexible Pavements", Transportation Association record.

[9] Rohan Deshmukh, Satyajit Patel, Subhodh Kapdnis, et.al,(2019) "Effective Utilization of Construction and Demolition Waste, Pond Ash in Combination with Geosynthetics in Flexible Road Pavement", Springer Nature Singapore Pte Ltd.

[10] Zornberg, J.G. (2011) "Advances in the Use of Geosynthetics in Pavement Design", Invited Keynote Paper, Proceedings of the Second National Conference on Geosynthetics.

[11] Vaibhav C. Patil, Rushikesh N. Patil, Omkar A. Shinge, Mangesh A. More, et.al, (2018) "Application of Geosynthetic Material in Construction of Flexible Road Pavement", Journal of advances and scholarly researchers in allied education.

[12] G. R. Harish, K. Madesh, N. Swathi, G. R. Vijayabhaskara Reddy and H. Deepak,(2019) "Use of Geosynthetics for Sustainable pavements", Springer Nature Singapore Pte Ltd.

[13] Alao, Olukayode Olawale (2011), "Use of Geosynthetics in Road Construction (Case Study – Geotextile)", Research gate Publications.

[14] MohammadReza Sharbaf (2016), "Laboratory Evaluation of Geogrid-Reinforced Flexible Pavements" UNLV Theses, Dissertations, Professional Papers, and Capstones. 2737.

[15] Arulrajah A, Rahman MA, Piratheepan J, Bo MW, Imteaz MA (2013) Interface shear strength testing of geogrid-reinforced con- struction and demolition materials. Adv Civ Eng Mater J 2(1):189–200

[16] Arulrajah A, Rahman MA, Piratheepan J, Bo MW, Imteaz MA (2013) "Evaluation of interface shear strength properties of geo- grid-reinforced construction and demolition materials using a modified large-scale direct shear testing apparatus", J Mater Civil Eng 26(5):974–982

[17] Arulrajah, A., Piratheepan, J., Disfani, M. M., and Bo, M. W. (2013), "Geotechnical and Geoenvironmental Properties of Recycled Construction and Demolition Materials in Pavement Subbase Applications," J. Mater. Civil Eng.

[18] Lekshmi Suku, Research Scholar, Sudheer S. Prabhu, Project Associate, G.L. Sivakumar Babu, Professor. (2017),"Effect of geogrid-reinforcement in granular bases under repeated loading", Elsevier Journals. Geotextiles and Geomembranes (2017) 1-13,

[19] Sarika B. Dhule, S.S. Valunjkar, S.D. Sarkate, S.S. Korrane,(2011) "Improvement of Flexible Pavement With Use of Geogrid",ResearchGate