# A Review on the Performance of Geosynthetic Reinforced Asphalt Overlays

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*Abstract*— While there is noteworthy field validation of the advantages of geosynthetic-reinforced hot mix asphalt (HMA) overlays, their utilization has concentrated on limiting the implementation of fatigue cracking, reflective cracking, and permanent deformations. The application of geosynthetics in HMA overlays may also enhance the mechanical performance of controlling deformations and diminishing strains in the asphalt layers. In particular, geogrids in black-top overlays are also expected to create reinforcement mechanisms that add to the structural capacity for the pavement. Geogrid interlayer between the asphalt layers is a useful technique for the alleviation of reflective cracking and the advancement of fatigue life of asphalt structures. This paper aims to review the application of geosynthetics in asphalt pavements and their advantages. The observations demonstrate that the geogrid reinforcement enhances the service life of a flexible pavement by increasing the fatigue life and restricting reflective cracking.

***Keywords:*** Hot Mix Asphalt, Geosynthetics, Reflective Cracking

## I. Introduction

Geosynthetics are sorted into various kinds as per their applications. For the asphalt pavement reinforcement purposes, geogrid, geotextiles, and geocomposite (which is in truth a blend of geotextile and geogrid) are the ones generally utilized in extending the service life of a pavement. For over 40 years, geosynthetic materials, specifically, 'geogrids' have been used widely as a rehabilitation solution for distressed pavements to mitigate the fatigue crack propagation. Due to their high strength and stiffness, geogrids have been utilized recently in the design of new pavement structures to develop the performance, to increase the service life, and therefore to minimize the maintenance costs (Nguyen, Blanc, Kerzrého, and Hornych, 2013). The asphalt mixture applied to the surface of the base layer of a flexible pavement serves to transfer the axle loads and keep water from infiltrating into primary unbound layers (Epps et al., 2000). Because of applied axle loading, there are various types of structural distresses that can influence bituminous surface layers, including longitudinal deformations along the wheel path (rutting), and fatigue cracking. Lately, due to an increase in vehicular traffic loads and climatic conditions, rutting is one of the most continuous defects which is found in the bituminous pavements. This is one of the primary distresses that can contrarily influence the bituminous surface of pavement, especially in hot climates. The geosynthetics reinforcement of flexible pavement is one of the ways to combat rutting and fatigue cracking. Geogrids are high-durable expelled sheets of polyethylene or polypropylene with gaps punched to deliver a standard, grid-like pattern. Geogrids are very stiff contrasted with the strands of geotextiles and have a higher modulus; this impact is more grounded when the grid reinforcement is laid at mid-depth of the pavement structure, rather than Inclusion at the bottom. Fig. 1. Represents the various distresses usually occurred in flexible pavements.


Fig. I: Major failures in flexible pavements: (a) Fatigue cracking (b) Rutting (c) Pothole formation

## II. Literature review

*1) Komatsu et al. (1998)*

This research has provided a full-range correlation with the effect of the mesh size and tensile modulus characteristics of geogrids on the permanent deformations of flexible pavement structures. Further, durability such as plastic flow resistance and resistance to crack propagation of the geogrid-reinforced bituminous concrete was examined in a reduced scale utilizing the wheel tracking test. The geogrid-reinforced pavements indicated significant increases in the durability in comparison with the control section without reinforcement. The behavior of the plastic flow was investigated in respect of the general creep model, and the tests of asphalt concrete plastic flow resistance, recommend that durability increases with the size of grid openings.

*2)* Ling *and* Liu. *(2001)*

This study describes the mechanical performance of geosynthetic-reinforced asphalt pavement under monotonic, cyclic, and dynamic loading conditions. A geogrid interlayer was installed at the bottom of the asphalt concrete layer to working as tensile reinforcement. The load was applied under the plane strain condition at the top of the asphalt concrete layer using a rigid rectangular footing. The strains that were established along the length of the geogrid over time and at different load levels were observed. Two different kinds of geogrid reinforcements were utilized, and their restraining effects on the layered system were compared. The study demonstrated that geosynthetic reinforcement improved the stiffness and bearing capacity of the asphalt concrete pavement. Under cyclic loading, the service life of the asphalt concrete layer was prolonged in the existence of geosynthetic interlayers. The stiffness of the geogrid and its interlocking properties were accelerated the restraining effect within the asphalt layers.

*3) Ali Khodaii et al. (2009)*

This study focuses on addressing the effects of geosynthetic reinforcement with respect to mitigating reflection cracking in asphalt overlays. The main objective of this study was to examine the impact of geosynthetic reinforcement and its optimum position on the development of permanent deformation. Results from this study demonstrate that a significant decrease in the rate of crack propagation in geogrid reinforced samples compared to unreinforced samples. And it is observed that the position of the geogrid and temperature affected the crack propagation patterns in asphalt overlays. In addition to that Inclusion of geogrid at one-third thickness of the overlay from the bottom, provides the maximum service life.

*4) Virgili et al. (2009)*

This study illustrates the reinforcement effect on fatigue life improvement, reflection cracking, and the accumulation of permanent deformations in the pavement systems. Based on the experimental study, it was observed that the tensile modulus of asphalt pavement was enhanced by incorporating grid reinforcement within the bituminous mixture. Moreover, horizontal tensile strains are regulated through geogrids, which are stiff when under tension. Besides, the opportunity provided by geogrids for aggregates from the top and bottom layers to interlocking effect should logically prompted greater friction between layers. Therefore, the geogrid reinforced flexible pavement is showing more resistant to surface deflections than unreinforced sections.

*5) Siriwardane et al. (2010)*

This research illustrates the effectiveness of glass fiber grids as a reinforcement of the asphalt layer in a flexible pavement system. The investigation included both experimental works as well as computer analysis of pavement sections. Twenty flexible pavement sections (with and without glass fiber grids) were built and tried in the testing program as a part of the experimental study. The Inclusion of a geogrid reinforcement layer spreads the vehicular load over a larger area in the lower layers of the pavement section, and it was significantly reducing vertical stresses. Although a non-reinforced thicker asphalt layer causes lower subgrade stresses than that corresponding to a thinner reinforced asphalt layer, the measured deformations deliberate that the thinner reinforced asphalt section performs better than the non-reinforced thicker asphalt section.

*6) G. Ferrotti et al. (2012)*

In this survey, the reinforcement of asphalt concrete layers with particular concern to the effect of different surface coatings was studied on the performance of fiberglass reinforced asphalt concrete samples. The experimental program as consisting of two different stages. Results from the whole experimental program indicated that the thermosetting epoxy resin presents an adhesion tensile strength more than treatment with a thermosetting 50% elasticized epoxy resin. From the interface shear tests, it is observed that geogrid surface coating which is able to maximize interlayer shear resistance between asphalt layers, whereas there are other surface treatments that are unfavorable for grid performance.

*7) Canestrari et al. (2013)*

This research is about the evaluation of the geogrid reinforcement effect in terms of both flexural and interlayer bonding effect. In this context, extensive research had been done by consisting the predictive effectiveness of different experimental approaches and to examine the behaviour of various geogrid types. From the interfacial shear tests, it is evident that the presence of a geogrid leads to a reduction in interfacial shear resistance. In contrast, the residual interlayer friction is not affected by the grid reinforcement. The de-bonding effect is observed explicitly with the glass fiber geogrid, which is described by the higher thickness and torsional stiffness than carbon fiber geogrid. Four-point bending repeated load tests were carried out on two-layered asphalt systems showed that geogrids lead to a significant increase of permanent deformation resistance, especially at greater load configurations.

*8) Pasquini et al. (2013)*

This research evaluates the viability of pavement rehabilitation with fiberglass geogrids. Therefore, a real-scale field trial was developed in this research program and observed with the help of falling weight deflectometer measurements. Even though the existence of geogrid between the asphalt layers causes an interlayer de-bonding effect. The large-scale shear tests were performed that the presence of the geogrid negatively affects the interlayer bonding effect. However, the use of polymer-modified emulsion as a tack coat reduces this de-bonding effect. The application of tack coat on the larger mesh size of the grid imparts higher shear resistance. Besides, quartz sand grid coating is positively triggering the interfacial shear properties of reinforced specimens,

*9) SM Mounes et al. (2015)*

This study enhances the geosynthetics reinforcement in hot mix asphalt and their effect with respect to the pavement distress. In this study, a dynamic creep test was executed on bituminous concrete samples reinforced with four different types of geogrids as well as unreinforced sections. The fiberglass grids adapted in this study consisting of two different sizes of mesh openings and two tensile strengths, understanding the effect of the grid opening size and tensile modulus characteristics of the grids on the permanent deformation. The results from the experimental program recommended that not only grid elongation properties but also grid mesh size is the great importance in controlling the permanent deformation.

*10) Correia1 and Zornberg. (2018)*

This study reported the advantages of geosynthetics application at the bottom of the asphalt overlays. This project consists of large-scale model tests, including geogrid reinforced and unreinforced asphalt layers. With the help of accelerated pavement test facility, dynamic loads are applied to check the fatigue behavior of the asphalt layers. Multiple pavement sections were built using polyvinyl alcohol geogrid as a reinforcement. The outcomes show a significant increment in pavement structural performance, as measured by the decrease of strains in the bituminous concrete layer, and it limits issues related to reflective cracking. The utilization of geogrid reinforcement was additionally found to prompt lessen rutting and lateral movements in the surface layer.

## III. CONCLUSIONS

Based on the literature review, the mechanical performance of the geogrids has been reported, and the respective conclusions were drawn from the various research groups.

- Concerning the mechanical performance of geosynthetic reinforced asphalt overlays, geogrids have 2.5 times higher reinforcing capability than the geotextile reinforcement.
- Geosynthetics can be utilized to improve the service life by minimizing the fatigue cracking, rut depth, and controlling the reflective cracking.
- The improved fatigue life related to the reinforced bituminous overlays is inferable from the way that geosynthetic holds its stiffness even after losing the structural capacity of the flexible pavements under the impact of repeated traffic loading.
- Geogrids can mobilize the horizontal tensile stresses and dissipate the fracture energy of the crack through its elongation in the time of crack initiation and propagation towards the asphalt layers.
- The Inclusion of geosynthetic interlayers under an asphalt overlay contributes to enhancing the mechanical performance of the pavement structure.
- The flexural strength and bearing capacity of the flexible pavements can be improved by geogrids when embedded into the interface of the asphalt layers. In addition to that, it will increase the restraining effect with the geogrid interlocking effect and stiffness properties.
- The developed strains in the geosynthetic interlayer around the region of the loading area showed the restraining effect of geogrid. Further, there was a decrease in a settlement over the loading point of the geogrid reinforced section.

## REFERENCES

[1] Canestrari, Francesco, Leonello Belogi, Gilda Ferrotti, and Andrea Graziani. "Shear and flexural characterization of grid-reinforced asphalt pavements and relation with field distress evolution." Materials and Structures 48, no. 4 (2015): 959-975.
[2] Correia, N. S., and J. G. Zornberg. "Mechanical response of flexible pavements enhanced with geogrid-reinforced asphalt overlays." Geosynthetics International 23, no. 3 (2016): 183-193.
[3] Ferrotti, G., F. Canestrari, E. Pasquini, and A. Virgili. "Experimental evaluation of the influence of surface coating on fiberglass geogrid performance in asphalt pavements." Geotextiles and Geomembranes 34 (2012): 11-18.
[4] Khodaii, Ali, Shahab Fallah, and Fereidoon Moghadas Nejad. "Effects of geosynthetics on reduction of reflection cracking in asphalt overlays." Geotextiles and Geomembranes 27, no. 1 (2009): 1-8.
[5] Komatsu, Tamikuni, Hiroshi Kikuta, Yoshinobu Tuji, and Eijiro Muramatsu. "Durability assessment of geogrid-reinforced asphalt concrete." Geotextiles and Geomembranes 16, no. 5 (1998): 257-271.
[6] Ling, Hoe I., and Zheng Liu. "Performance of geosynthetic-reinforced asphalt pavements." Journal of Geotechnical and Geoenvironmental Engineering 127, no. 2 (2001): 177-184.
[7] Mounes, Sina Mirzapour, Mohamed Rehan Karim, Ali Khodaii, and Mohamad Hadi Almasi. "Evaluation of permanent deformation of geogrid reinforced asphalt concrete using dynamic creep test." Geotextiles and Geomembranes 44, no. 1 (2016): 109-116.
[8] Pasquini, Emiliano, Maurizio Bocci, Gilda Ferrotti, and Francesco Canestrari. "Laboratory characterisation and field validation of geogrid-reinforced asphalt pavements." Road Materials and Pavement Design 14, no. 1 (2013): 17-35.
[9] Siriwardane, Hema, Raj Gondle, and Bora Kutuk. "Analysis of flexible pavements reinforced with geogrids." Geotechnical and Geological Engineering 28, no. 3 (2010): 287-297.
[10] Virgili, A., F. Canestrari, A. Grilli, and F. A. Santagata. "Repeated load test on bituminous systems reinforced by geosynthetics." Geotextiles and Geomembranes 27, no. 3 (2009): 187-195.
[11] Walubita, Lubinda F., Abu NM Faruk, Jun Zhang, and Xiaodi Hu. "Characterizing the cracking and fracture properties of geosynthetic interlayer reinforced HMA samples using the Overlay Tester (OT)." Construction and Building Materials 93 (2015): 695-702.
[12] Wargo, Andrew, Seyed Amirshayan Safavizadeh, and Y. Richard Kim. "Comparing the performance of fiberglass grid with composite interlayer systems in asphalt concrete." Transportation Research Record 2631, no. 1 (2017): 123-132.
[13] Chai, Jinchun, Norihiko Miura, and D. T. Bergado. "Preloading clayey deposit by vacuum pressure with cap-drain: analyses versus performance." Geotextiles and Geomembranes 26, no. 3 (2008): 220-230.
[14] Zofka, Adam, Maciej Maliszewski, and Dominika Maliszewska. "Glass and carbon geogrid reinforcement of asphalt mixtures." Road Materials and Pavement Design 18, no. sup1 (2017): 471-490