Geogrid Asphalt Reinforcement for Airport Taxiways & Runways

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Use of Geogrid for asphalt reinforcement is well established practice for strengthening and reinforcing of asphaltic overlay for achieving controlled performance. As 'Strain Absorbing Membrane Interlayer' (or SAMI). However the application of SAMI needs to address specific application requirement and varies entirely from one another.

Various Indian airport runways and Taxiways need improvement due to wearing of the overlay. It is also envisaged that the overlay need reinforcement for a new laying of the asphaltic layer with improved drainage consideration of the underlying flexible pavement. In this context it is pertinent to evaluate that the case in asphaltic pavement is not experiencing any subsidence/settlement or deformation problem, due to adequate availability of founding subgrade reaction due to rocky substrate.

For a wider solution the drainage design to the asphaltic pavement need to consider the absorption and dissipation of rainfall precipitation through especially constructed drainage galleries, particularly the asphaltic overlay, where only the peripheral sub-surface drains alone are not sufficient to ensure the dispersal of the runoff. Any excess rainfall absorbed but undissipated within the overlay (due to poor permeability of the overlay) will reduce the shear strength of the immediate founding layer and would assist the disintegration of asphaltic layer by lubrication of the bond between the aggregate particles. The absorbed water within the underlying stratum will also add to frost related stresses arising from piping of stored pore water rising to the Asphaltic overlay. Therefore ensuring the overlay remain free draining is an important criterion for effective performance of the overlay.

Geogrid as “Stress Absorbing Tensioned Membrane”

As well established data is available from several application over last two decades in advanced countries that the use of Geosynthetic Tensioned Membrane provide relief to the otherwise unreinforced asphaltic overlay which is relatively poor in handling tension. The induction of stress within the asphaltic overlay can be therefore minimised and eliminated by using appropriate SAMI layer, by choosing the specific "Integrally jointed Geogrid", as well as adhering fabric which provides reinforcement and reservoir of asphalt (as the case may be). Use of Geogrid as SAMI is mainly to provide a tensile inclusion. In such case the possible application of Geogrid in airfield pavement overlay may be classified as mainly three cases:

1. This may be used as Reinforcement to Asphaltic overlay against flexural bending or local subsidence as a basal layer. The loading in this case is transitory or cyclic in vertical direction. However such treatment is not generally done alone and needs additional consideration of pavement condition and may be used over distressed flexible pavement, unless the improvement of the flexible pavement proves to be difficult (such as for operational reason).

2. This may be used as reinforcement to Asphaltic overlay to absorb the horizontal drag from the traffic load such as landing and take off of aircraft. Such loading tends to shear off the overlay layer due to drag through tensile stresses and as the overlay modulus need improvement to address to the visco-elastic effect involving limiting strain requirement.

3. This may be used to reduce or eliminate fatigue and reflection cracking propagating from distressed founding pavement, whose cracks and fissures propagation due to vertical cyclic loading needs to be stopped using an tension membrane interlayer.

The applications in all three states use "Integrally jointed Polypropylene Bi-oriented geogrids", selected based on the requirement of design and analysis of boundary conditions. For example: Stress due to Flexural bending: This situation entails a fundamental consideration that the founding layer is semi yielding or prone to deformation (but not unyielding), leading to a flexural stress induced in binary direction in the overlay, which need to be stabilized using Bi-directional Tensile members (Geogrid). In this case the design demand to include a Bi-oriented Geogrid layer of strength that corresponds to stress induced in direct relation to the extent of deformation and it's spread over the application of loading such as Tire pressure of an aircraft). The stress induced by asphaltic aggregate particle interlocking into in the tensioned membrane (Geogrid being Visco-elastic), the extent of load mobilization is directly is dependant on the fabric visco-elastic, the extent of load mobilization is directly is dependant on the fabric visco-elastic.
in such cases depending on the extent of deformation use of two layers of PP Geogrid to the extent of 40 kN/m x 40 kN/m strength grade may even be necessary. It is pertinent to note that use of two layers of geogrids always provide better shear resistance against drag than one layer of 80 kN x 80 kN grid.

**Stress due to Horizontal Drag:** This situation arises out of the horizontal tyre drag from the aircraft landing and taking off and tends to shear or peel off the overlay against the frictional force between the overlay and the pavement underneath. This demands use of a reinforcing material to improve the shearing resistance with a provision of a Geogrid layer. But this Geogrid must be selected as compatible to the working deformation rate of the asphalt (typically @ 4-5%); otherwise the two as a composite will not work in unison (Example: Welded Steel mesh will not serve the purpose of reinforcement within an asphalt overlay although it may contribute very high tensile strength). Normally the cyclic deformation in such airfield cases vary between 4-5% for unreinforced asphalt, therefore one should choose a Geogrid to perform with a high modulus at 4-5% range compatible at asphaltic strain level. If the Geogrid, for example a knitted Glass fibre mesh, is not selected to be strain compatible to the Asphalt, the asphalt will have risk and possible tendency to slip over the reinforcement since the Glass grid will resist deformation in greater extent relative to the asphalt overlay.

The use of glass fiber Geogrid is thus unsuitable for strain incompatibility for flexural loading as described above, as the glass fiber has low deformation characteristic (maximum elongation is 2.5% at peak load) due to high working range of modulus, although they are suitable for application within overlay due to high sustenance of application temperature of 145-160°C.

Modern tests conducted in applications in Europe show use of Polypropylene integrally jointed Geogrid provide far superior performance due to strain compatibility over glass fibre based knitted Geomesh (which can provide very high temperature tolerance up to 180°C). The strain compatibility (denoting availability of required modulus at low strain) and not essentially very high modulus of glass fibre, is the key to mobilize adequate reinforcing effect at 4-5% strain range. Also due to integral junction ideally PP geogrid is better suited to address use of SAMI against horizontal drag. It is therefore recommended to use PP geogrids, whose costs are lesser than Glass geomesh. Peak strength of 40 x 40 kN/m is considered sufficient for most airfield resurfacing application.

**Stress due to propagation of cracks:** The fatigue cracks induced in underlying layer is arrested by adoption of a stress absorption membrane interlayer with a layer of Geogrid and asphalt absorbing nonwoven Geotextile.

**Drainage Considerations**

Many airfields, particularly one in coastal belt or in North Eastern states (such as Guwahati, Dibrugarh, Goa etc) experience excessive rainfall intensity over a protracted monsoon season as well as during a single day, thereby leading to absorption of surface runoff within the cracked pavement overlay.

Typically from available rainfall data we assess a maximum rainfall precipitation (for example: 25mm per hour in a single occasion in a day). This rainfall when intensifies, is assumed to lead to absorption of about 50% within the asphalt overlay. Assuming a overland Flow rate of 2.5 x 10^-4 m^3/m/Sec at 1:100 surrounding soil gradient, the runway surrounding top soil of say 300mm thickness would need a Hydraulic conductivity of 8.3 x 10^-2 m/sec. This is too high to ensure without a
A comprehensive laboratory research program to investigate geogrid reinforcement of granular base layers of flexible pavements was carried out at the University of Waterloo and involved repeated load tests on varying thicknesses of reinforced and unreinforced granular bases. This research paper is available at Transportation Research Board Business Office in Washington, USA. Other controlled variables included reinforcement location and subgrade strength. The purpose of this paper is to explain geogrid reinforcement mechanisms in granular base applications through analysis of stress, strain, and deflection measurements. The results of that research are first compared with fabric reinforcement and failure criteria. For high-deformation systems both fabric and grid can be effective in tension membrane action, but for low-deformation systems the interlock and confining action of a grid is required to provide effective reinforcement. The Waterloo work showed that permanent deformation of both types of systems can be significantly reduced by using geogrid reinforcement in the granular base. It is concluded that, for optimum effect, geogrid reinforcement should be placed at the base-subgrade interface of thin base sections and near the midpoint of thicker bases. Moreover, the zone of such placement should not involve elastic tensile strains in the grid that are greater than 0.2 percent. Under these conditions, geogrid reinforcement can be highly effective in reinforcing the granular base material and thereby extend the life of a structure.