Use of Geotextiles and Geogrids in Airfield Asphalt Pavements

Introduction

When placed at appropriate locations in a pavement and at the correct depth, geotextiles (fabrics) and geogrids can offer improvements in performance in terms of reducing rutting and limiting crack propagation. While there are distinct benefits in the use of geotextiles and geogrids, they have limitations, especially when it comes to the achieved bond and interlock strength at the layer interface. In roadway rehabilitation, design and specification, these limitations are well understood, and precautions are taken if geotextile/grids are nominated for high shear situations (braking and turning locations). Despite this, geotextiles and geogrids have sometimes been inappropriately used in airfield pavements where stresses are exceeded or placement depth is inadequate, resulting in a number of slippage failures.

This Technical Advisory note, documents the experience with and limitations of geotextiles and geogrids in Airfield pavements and gives guidance on how and when to incorporate them into pavement structures.

Geotextiles, Geogrids and Composites

Geotextiles used with asphalt are usually non-woven, needle punched and manufactured from polyester or polypropylene, with the more temperature resistant polyester generally being preferred in asphalt applications. Geotextiles are used to provide a tough membrane which can help spread loads to lower layers and hold cracking together to limit crack propagation to the asphalt surface. It is common to spread the geotextile over a sprayed bituminous tack coat to achieve better waterproofing and crack inhibition because bitumen is partly absorbed into the geotextile.

Geogrids used in asphalt are typically made by extruding, weaving or welding polymer strands or glass fibres into a grid pattern. These materials have both high tensile strength and stiffness at low elongation. Like geotextiles, they help by dissipating loads and can hold cracks together to limit crack propagation to the asphalt surface.

Composite geosynthetics combine a geogrid and a geotextile. The geotextile acts as a backing and helps with placement of the composite sheet onto the treated surface. In most cases the geotextile is impregnated with bitumen to provide a waterproof membrane and improve the bond between the asphalt layers. For the interpretation of the advisory, these geosynthetics are included in geotextiles.

Geotextiles, Geogrids and Composites in State Road Authority Specifications

While the benefits of geosynthetics are widely recognised in reducing rutting and mitigating cracking and are well understood, users need to be aware of limitations such as the potential loss of strength at layer interfaces due to the geotextile. While this is less significant with geogrids (with no textiles), due to their ability to “lock” into the aggregate, they still limit the interface strength. When geogrids are incorporated with a geotextile, the strength is similar to that of a geotextile.

The limitations of geosynthetics, in that they limit interface strength, have been well known and form parts of many SRA guidance notes, such as:

- Austroads [1]: For geotextiles and geogrids it should be noted that a minimum of 80mm of asphalt is recommended to be placed over the geogrid for optimum performance of the grid. (this is to remove the potential slippage plane away from the highest load locations)
- VicRoads [2] states “GRS should not be used on smooth surfaces in situations of high shearing turning or braking forces, such as heavily trafficked intersections, tight curves or steep grades. This is to reduce the possibility of slippage of the textile over the existing smooth surface.”
• DTMR (Qld) [3] “Geotextile SAMs and SAMIs should not be used in areas subject to high shear stresses (e.g. within street intersections, on steep grades, or other areas where changes in vehicle speeds occur regularly). Where significant shear forces will be applied to the surfacing by traffic (e.g. turning movements associated with roundabouts and intersections), geotextile SAMIs (under asphalt) should be avoided.”

Common SRA practice recommends a minimum of 80mm of asphalt be placed over a geosynthetic for optimum performance in high stress locations. Airfield surfaces often experience much greater stresses than roads, which must be factored into the choice of geosynthetic and the depth at which it is placed. When loading increases due to braking or high speed turning loads, the depth at which a geosynthetic is placed generally needs to increase to avoid interface slippage.

**Recent Experience with Geotextiles in Airfields**

Recent experience at a number of airfields has found that inappropriate use of geotextile/geogrids have been a contributing factor in slippage failures. Where geosynthetics have been placed in the upper 50mm of the pavement, the following pattern of failure has been observed at a number of separate airfields:

- Initially slippage (shoving) occurs as a horizontal movement of the surface of the pavement in the direction of loading principally in high stress situations, such as at the approach to holding positions and the approach to Rapid Exit Taxiways (RET) and turnaround bays. The movement has been most visible in the distortion of holding position lines and transverse grooves on runways, see Figure 1(a) following. This movement is typically present with little to no deformation in the wheel paths, or evidence of vertical bulging of the asphalt in front of the distortion. No other forms of distress are visible in early stages.
- Sometime after the initial movement is observed, half-moon or crescent shaped cracking develops in the pavement, see Figure 1 and 2 (b) following.

![Initial Slippage Movements](image1)

![Resulting crescent Shaped Cracking](image2)

**Figure 1** Airfield 1 Visual Condition of Asphalt

![Slippage cracking](image3)

![Slippage cracking](image4)

**Figure 2** Airfield 2 Slippage Cracking
• Investigation of the movement finds the bond at the interface is broken and little to no strength exists between the asphalt and geotextile/geogrid layer. Cores will separate at the interface.

Shear Strength of Interface

The assessment of the interface strength of asphalt placed with a geotextile/geogrid interlayer finds that the use of the geotextile lowers both the cohesion (adhesions) and the internal friction aggregate interlock at the interface. This is demonstrated in the following Figure, which shows a typical asphalt-on-asphalt interface and an asphalt-on-geotextile interface. The results consistently find that across the full range of expected airfield loadings, the strength of the geotextile/geogrid interface is less than a quarter that of a typical asphalt-on-asphalt interface.

![Figure 3 Direct Shear Testing](image)

Expected Mode of Failure

Where geotextiles are included in the upper 50mm of the pavement, slippage failure has been found to occur as a result of failure at the asphalt-on-geotextile interface. This failure is then followed by a tensile failure of the asphalt, typified by the slippage cracking (crescent shaped with arched ends pointed in the direction opposite that of tyre motion), as idealised Figure 4 following.

![Figure 4 Idealised Slippage Failure](image)
It has been found that for this type of slippage cracking to take place, all or most of the following need to occur:

- The location is at a location of high shear stresses; Rapid Exit Taxiways (RET), turn around bays and approach to holding bays.
- A geotextile/geogrid is placed in the pavement structure limiting interface strength.
- The geotextile interface is placed at the location of highest braking load and lowest strength to stress ratio in the pavement, 40-60mm deep.
- The shear stress produced by the braking tyre is in excess of the low shear strength of the interface, resulting in movement at the interface.
- Continuous movement at the interface, through braking applications results in breaking of the bond at the interface.
- Once the bond at the interface has been broken, the tensile strength of the overlay is exceeded, producing a crack behind the braking tyre.

Recommendations

Fundamental testing and filed observation have found that to limit the likelihood of slippage failure, designers need to consider the risk associated with the use of geosynthetics especially in high stress situations such as; approaches and within (RET), turn around bays and approaches to holding bays.

If in the view of the designer crack mitigation is required in high stress locations, alternative approaches should be investigated such as:

- Increasing cover of asphalt surfacing layer.
- Crack and seating of concrete slabs.
- Pressure grouting (mud jacking) of concrete slabs.

If the designer’s view is geosynthetics are still required, the designer should consider the following:

- Place any geosynthetic at a minimum of 100mm below the asphalt surface on an asphalt correction course.
- Apply tack coat to both the lower and upper surface of the geotextile, with laboratory testing undertaken to determine required tack coat application rate.
- Increase cohesion by using a high strength bond coat, which has been shown, to have doubled the cohesive strength over a CRS 60.

References

1 Austroads Guide to Pavement Technology, Part 4G
2 Technical Note TN 014 - Geotextile Reinforced Seals - VicRoads
3 Department of Transport and Main Roads Pavement Rehabilitation Manual