MATERIALS ENGINEERING BRANCH

Initial Skid Resistance of Stone Mastic Asphalt

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1. **SCOPE**

This guideline provides advice on the skid resistance of Stone Mastic Asphalt (SMA) during its early life when used as a wearing course. The advice is applicable to all sizes of SMA placed on the Main Roads WA network.

2. **REFERENCES**

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3. **BACKGROUND**

Following reports expressing concern regarding the early life skid resistance of Stone Mastic Asphalt a Steering Group was formed in Western Australia with representatives from Institute of Public Works Engineers Australia (IPWEA), Main Roads WA (MRWA) and Australian Asphalt Pavement Association (AAPA). The primary role of the Steering Group was to investigate whether SMA provides less surface friction during the early stage of its life cycle than anticipated by a road user, and other matters in relation to SMA.

On behalf of the Steering Group an investigation was undertaken by Main Roads WA to determine the surface characteristics of SMA placed in Western Australia. The investigation made conclusions about the characteristics of SMA indicating that in some circumstances the surface friction of SMA early in its life may be lower than anticipated by road users. This document provides guidance to asset owners and asphalt suppliers with regard to this issue. The advice has been provided on the knowledge currently available about the characteristics of SMA early in its life, however as the results of research becomes available this advice may change. The guidance note is not applicable to other types of asphalt.

4. **BASICS OF SKID RESISTANCE**

The skid resistance of road surfacings is a complex matter, with many variables that need to be considered. The Austroads *Guidelines for the Management of Road Surface Skid Resistance* provides a reference to assist in understanding material presented in this guideline.

Some factors that may affect skid resistance characteristics of a road surface include:

- **Surface characteristics:**
  - aggregate microtexture
  - pavement macrotexture
  - polished aggregate friction value (PAFV)

- **Vehicle characteristics:**
  - tyre tread depth and pattern
  - rubber characteristics of tyre
  - vehicle speed

Macrotexture (>0.5mm) is the surface texture of a road surface, ie. what an eye can readily see such as the texture of a sprayed seal, whereas Microtexture (< 0.5mm) is that provided by the surface of the aggregate particles. The PAFV is a test to determine the intrinsic resistance of aggregate to polishing under simulated conditions.
In dry conditions, skid resistance is provided by chemical bonds (adhesion friction) which are created and broken as the tyre rubber contacts the pavement aggregate. In wet conditions adhesion friction reduces as contact between a vehicle tyre and the road surface is reduced due to a film of water. In this circumstance it is important that the film of water beneath or in front of a tyre be displaced such that a tyre can make contact with the microtexture of the aggregate particles, establishing some chemical bonds.

Another main component of tyre-road friction is hysteretic friction, caused by deformation of the tyre rubber by projections from the road surface, mostly being stone particles. In wet road conditions hysteretic friction can become the dominant component to provide control to a vehicle driver. A tyre tread and the macrotexture of the road provide means by which water can be displaced from beneath the tyre. At higher vehicle speeds macrotexture becomes more important.

Tyre hysteresis occurs when a tyre deforms around protruding aggregate particles. Therefore road surfacings with greater macrotexture, such as a sprayed seal, would be expected to provide more hysteretic friction than would a dense graded asphalt (DGA) with lower macrotexture. SMA has a greater macrotexture than wearing course DGA, however it has what is termed as negative texture, where the surface voids are predominantly below the level of the top of the asphalt layer, similar to open graded asphalt. It is not known whether the greater texture of a SMA has the same effect of a positive texture of a sprayed seal.

The term “skid resistance” is basically the contribution that the macrotexture and microtexture make to the available level of friction to a vehicle at a single point in time. The level of friction will vary as a result of factors identified previously.

5. INVESTIGATION FINDINGS

The investigation of early life skid resistance of SMA surfaces revealed the following:

- The surface friction provided by SMA early in its life, whether the surface of a road was dry or wet, was about 10-20% lower in comparison to that provided by the SMA after the binder had worn from the surface;
- The early life surface friction of SMA was about 20% lower than dense graded asphalt;
- The early life surface friction of SMA in areas such as traffic lights may be below Austroads Investigatory levels (Austroads 2005);
- The early life surface friction of SMA in other areas is likely to be above relevant Austroads Investigatory levels;
- Gritting of the pavement surface may assist with the improvement of early life surface friction.

However it is most important to recognise that surface friction alone is not the only consideration and that at higher speeds in wet conditions, higher macrotexture is beneficial in reducing stopping distances. It must be noted that the conclusions were based on a small sample size. As a result of the investigation the following actions were recommended:

- Further trials to assess the effectiveness of surface grit
- Trials of different grit materials
- Further work to improve the method of applying of grit material
- Developing a case for maintaining a continuous friction tester in WA
6. SITES

Austroads 2005 includes investigatory levels of skid resistance for seven different categories of roads. Those categories and descriptions of applicable sites are shown in Table 1. The investigation indicated that the surface friction provided by SMA early in its life may be lower than the Investigatory Level for sites with the following description:

- Traffic light controlled intersections
- Roundabout approaches
- Curves with a radius ≤ 100m
- Roundabouts (see comments below).

Site categories 1, 2, 3, 6 and 7 are considered to be those where surface friction may be in more demand in comparison to categories 4 and 5 for manoeuvre free areas of roads particularly where a polymer modified binder is used in the SMA. At site categories 4 and 5 the early life surface friction of SMA is likely to be above relevant Austroads Investigatory levels.

<table>
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<th>Site Category</th>
<th>Site Description</th>
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| 1             | Traffic light controlled intersections  
Pedestrian / school crossings  
Railway level crossings  
Roundabout approaches |
| 2             | Curves with tight radius ≤ 250 m  
Gradients ≥ 5% and ≥ 50 m long  
Freeway/highway on/off ramps |
| 3             | Intersections |
| 4             | Manoeuvre-free areas of undivided roads |
| 5             | Manoeuvre-free areas of divided roads |
| 6             | Curves with radius ≤ 100 m |
| 7             | Roundabouts |

Table 1

With regard to roundabouts the speed of vehicles using the feature and its geometry are key aspects in deciding whether action is required. Vehicles using small sized roundabouts on urban feeder roads, where the posted speed limit is 60 km/hr or less and the median speed of vehicles on the roundabout is lower again, require less surface friction than would a vehicle using a larger roundabout with median speeds nearer the posted speed limit. On small urban roundabouts it is likely that the early life surface friction of SMA is adequate. On larger roundabouts with higher vehicle speeds the surface friction of the SMA early in its life may be lower than Austroads Investigatory Levels and therefore action is recommended. Action may not be required at sites other than those described above.
7. **GRITTING OF SMA**

Since the investigation of early life skid resistance of SMA research has been undertaken by Main Roads WA into the use of surface gritting to improve surface friction early in the life of SMA. Trials were applied using different types and sizes of materials and rates of application. The trials found that the following materials of a nominal size of 3mm improved the surface friction of the SMA.

- Black Granite from Barossa Quarries, South Australia
- Grey Calcined Bauxite from Guyana

The optimal application rate of the grit was found to be 1.5 – 2.0 kg/m².

With the possibility that the early life surface friction may be lower than Austroads investigatory levels it is recommended that grit be applied to the surface of SMA at site categories 1, 2, 3, 6 and 7. When gritting of SMA is required the locations where it is to be applied should be included in Annexure 502B of TDP Specification 502. The specification details by default the type and quantity of grit aggregate to be used and at what stage of the construction process the grit has to be applied.