OPEN GRADED ASPHALT SURFACING

INTRODUCTION

Open Graded Asphalt (OGA) is a porous asphalt material that produces a highly textured surface. It provides a safer wet weather surfacing by reducing the amount of surface water leading to improved visibility and skid resistance. It also generates lower tyre noise compared to other bituminous surfacings.

VicRoads standard OGA is designed with a large proportion of 10 mm nominal size coarse aggregate with only a small amount of fine aggregate.

The first use of OGA by VicRoads was on the Tullamarine Freeway at Strathmore in 1975 to reduce wet weather accidents due to a slick surface on the existing asphalt surfacing. The result was an outstanding success with a significant reduction in wet weather accidents.

Since 1975 OGA has been placed on numerous urban freeways and other roads, not only for good skid resistance, but also for its significant reduction of noise and water spray. OGA was also used on the Western Highway and Calder Freeway to reduce the incidence of skidding accidents associated with “Black Ice”.

The requirements of OGA are specified in VicRoads Standard Specification 417 and Guide Notes.

CHARACTERISTICS OF OGA SURFACING

OGA surfacing has the following characteristics:

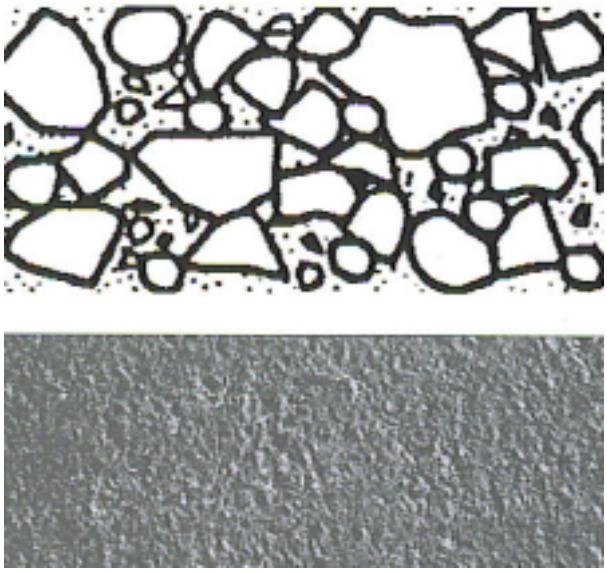
- Decreases the presence of surface water during heavy rainfall significantly reducing the likelihood of aquaplaning and also improving driver visibility by reducing water spray from tyres;
- Significantly improves the visibility of line marking in wet conditions because of its high surface texture;
- Decreases the average traffic tyre noise levels by up to 3 dbA compared with Dense Graded Asphalt (DGA) and up to 5 dbA compared with a Size 14 sprayed sealed surfacing;
- Maintains a high level of surface friction by removing water beneath the tyre enabling good contact with the surfacing. An appropriate PSV aggregate needs to be used;
- Helps prevent the formation of “Black Ice” in wet frost prone areas by providing a high surface texture and sufficient porosity to remove surface water needed for the formation of “black ice”;
- Usually has a shorter service life compared to DGA or Stone Mastic Asphalt (SMA) due to more rapid oxidation caused by entry of water and air into the porous surface;
- More costly than DGA mixes because of the higher binder content and use of a modified binder;
- Normally considered as a non-structural asphalt layer for pavement design purposes because OGA is not designed to meet any minimum strength requirement.

Water spray from DGA surface

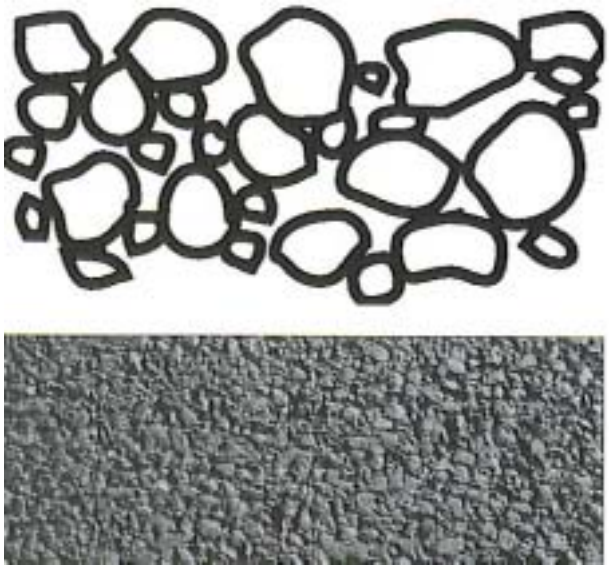
Reduction in water spray after placement of OGA

MIX DESIGN

The VicRoads Standard Specification Section 417 is a "recipe" based mix with a specified target grading for the aggregates, a target binder content of 6.5% by mass, air voids of about 20% and a minimum of 1% by mass of added hydrated lime filler. It also requires the use of a modified binder to achieve greater resistance to shear deformation and ravelling.



Structure and appearance of Dense Graded Asphalt



Structure and appearance of Open Graded Asphalt

The specification also requires the mix to be resistant to binder drain down. If the mix cannot meet the Asphalt Binder Drain Off test requirement of 0.3% maximum binder loss by mass at 175^{0}C, cellulose or acrylic fibre varying from 0.15% to 0.3% by mass of total mix is added. If this test requirement is satisfied, there should not be a problem with binder drain off in transit to the job however this test is not always conclusive as there have some been instances where binder drain off has occurred even though the mix passes the test. If binder drain off occurs, binder and filler builds up in the bottom of the truck body requiring expensive cleaning and disposal of waste on a daily basis. Pockets of over rich material in the mix can cause "fatty" spots in the new surfacing or pockets of lean material may prematurely ravel in service.

VicRoads Standard Specification Section 417 is currently under review with the aim of implementing a more rational mix design procedure for OGA as the current recipe mix does not permit adjustments to be made to allow for aggregate source, degree of aggregate breakdown after compaction, size and shape of aggregate particles and for the type and content of filler and binder. All these factors can influence the air voids content of the mix and its consequent performance and behaviour. Therefore, to optimise the mix component proportions to achieve desirable performance criteria, it is likely that some elements of the Austroads mix design procedures described in Austroads AP-T20/02 will be introduced in the future.

The following mix design requirements are under consideration in the current revision of Standard Specification Section 417:

- Design Air Voids of about 20 to 25% after possibly 50 to 80 cycles of gyratory compaction to ensure that the mix will have sufficient porosity and noise reduction properties after placement and future trafficking;
- A slightly coarser grading envelope for the aggregates to enable higher air voids and surface texture to be readily achieved;
- Deletion of a specified target grading to enable the mix designer to select an optimum target grading required to meet various specified mix design requirements;
- A minimum binder film index of 20 micron to ensure that the mix is durable and will not suffer from premature ravelling;
- A maximum Abrasion Loss (Austroads Asphalt Particle Loss Test) of possibly 5% for a dry (unconditioned) test specimen and possibly 10% for a wet (conditioned) test specimen to ensure that the mix will have sufficient cohesion and binder adhesion to the aggregate, again to prevent premature ravelling;
- A maximum Binder Drain Off of 0.3% by mass at 175°C to help prevent binder drain off;

- Inclusion of a mandatory requirement for addition of 0.3% by mass of cellulose or acrylic fibre to extend the life of the mix by increasing time before ravelling occurs.

MIXING

On discharge from the plant, OGA should be within the temperature range of 155°C to 180°C depending on the ambient temperature and distance from the job. Placement should commence before the mix cools to less than 145°C to give sufficient time to fully compact the mix before it reaches 110°C after which little further compaction will occur.

The PMB commonly used for OGA is Class A20E, but the specification permits use of Classes A15E, A25E, A30P or A35P provided that all specified test requirements for the mix are met. PMB Class A10E may be specified for surfacing over concrete pavements (see below) and for pavements that lack sufficient stiffness to resist premature fatigue cracking.

PLACING AND COMPACTION

For best results, OGA should be placed during the period from October to April. Outside this period, cold conditions can rapidly cool the mix and make placement and compaction very difficult. The temperature of the pavement surface at the time of placement needs to be above 15°C to avoid rapid cooling of the mix resulting in poor compaction and surface finish.

Pavement Preparation: It is important that all cracks in the existing surface are sealed off with a highly modified PMB crack sealant prior to placing OGA.

Cracked/Weak Pavements: In cases where cracking is too extensive to effectively crack seal or where the pavement lacks sufficient stiffness and premature fatigue cracking of an underlying asphalt layer is likely, a SAMI treatment should be applied prior to placing the OGA (GeoPave Technical Note 5).

Tack Coat: To properly seal off and provide a strong bond to the existing pavement surface, the specification requires that a heavy water proofing tack coat of undiluted bitumen emulsion be applied at a minimum application rate of 0.5 L/m^2.

Drainage: OGA must always be placed above the lip of any kerb and channel or shoulder to ensure that any water entering the porous surfacing does not become trapped. Trapped water may cause premature ravelling or stripping of the binder from the aggregate. If the existing surface has poor shape or geometry that does not allow all water entering the mix to readily escape through the mix, the existing surface shape should be first corrected by a DGA regulation course (usually Size 10).

Limit of placement: For economic reasons and to minimise edge drop off at the kerb or shoulder, the thickness of Size 10 OGA is normally restricted to 25 to 30 mm. The edge of the new mat should extend on to the sealed shoulder by a distance of not less than 300 mm (minimum 150 mm) from the edge of the traffic lane. The painted edge line should not cover the exposed edge of OGA, as the paint will prevent water draining out of the porous OGA surfacing.

Compaction: A procedural basis of achieving compaction of OGA is used and would generally involve not less than 5 passes with a static steel wheel roller with a minimum overall mass of 6 tonnes. A multi wheel roller maybe used for secondary rolling if it is considered that damage to the fresh OGA will not occur.

Hand Placing: PMB modified OGA is difficult to place by hand. For areas where hand placing is unavoidable such as small irregular shaped areas and where there are no high traffic stresses, Class 170 bitumen can be substituted for a PMB provided at least 0.3% by mass of fibre is added to the mix to prevent binder paste drain off. Care is still required to achieve a good result.

URBAN FREEWAYS/ARTERIALS

For urban freeways/arterials it has been the normal practice to place OGA over the complete shoulder width on the high side of the pavement so that ponding of water and build up of detritus against the raised edge is prevented.

As Size 10 OGA cannot be feathered down to a thickness of less than 20 mm, DGA must be used to ramp down from the OGA surfacing to the existing surface along transverse edges.

OGA has a relatively low shear strength compared to DGA, and should not be used at signalised intersections or roundabouts where severe braking and acceleration occurs. In most cases, it is preferable to use a DGA or SMA for 50 to 100 metres on the approaches or alternatively, from the start of the turn lane taper, and extending through the intersection area to cover at least 30m of carriageway on the departure side.

GRANULAR PAVEMENTS

If OGA is to be placed over an existing sprayed sealed surface granular pavement, it is recommended that a 20 to 25 mm thick regulation layer of DGA be placed prior to placement of the OGA. This facilitates the future removal and replacement of the OGA without damage to the underlying seal and loosening of the granular base layer.

A SAMI should also be used in conjunction with the OGA on all thin asphalt surfaced granular pavements where the Design Traffic Loading exceeds of 3 x 10^6 ESAs because of the likelihood of premature fatigue cracking of the underlying DGA.

PLACING OGA ON CONCRETE SURFACES

In some cases it may be necessary to place OGA on concrete pavements to produce a consistent surface with adjacent areas of pavement. It is important that a strong bond is established between the OGA surfacing and the surface of the concrete and that the concrete surfacing is impervious to water.

VicRoads Code of Practice 500.22 only permits OGA to be placed over continuously reinforced concrete pavements. OGA placed over jointed concrete pavements results in wide reflection cracks developing in the OGA surfacing directly above the expansion joints. The OGA rapidly ravels at the edges of these cracks creating a serious maintenance problem and an increase in noise levels.

The following procedure is recommended when placing OGA over reinforced concrete surfaces:

1. Once the concrete has reached the specified 7 day strength, remove all traces of curing compound, dust and detritus. As some curing compounds prevent bonding and can be difficult and expensive to remove, particularly if hydro-blasting is required, moist curing or a bituminous curing compound should be used);
2. Allow the surface to dry and then prime it with very light cutback bitumen at a rate of application of 0.3 L/m^2 and allow it to cure for about five days. (Curing time can be reduced to less than 24 hours if a quick-drying primer is specified, but these primers are highly flammable, much more expensive and require adherent to strict safety procedures).
3. Apply a SAMI treatment to the primed surface to provide a strong bond and key for the OGA in addition to sealing off the concrete to prevent ingress of water (GeoPave Technical Note No.5);
4. If OGA is placed over any isolated expansion joints, a properly constructed expansion joint should be provided to fully contain the edges of the OGA.
5. If the concrete surface has poor shape and ride quality, a regulating layer of Size 7 or 10 DGA or SMA is recommended prior to placement of the OGA.

REFERENCES

- Austroads AP-T20/02 (Formerly APRG Report 18 - Selection & Design of Asphalt Mixes (Australian Provisional Guide)
- Austroads AP-T04 - Specification Framework for Polymer Modified Binders
- VicRoads Code of Practice 500.22 – Selection and Design of Pavements and Surfacing
- VicRoads Standard Specification Section 417 - Open Graded Asphalt

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