HIGHWAYS DEPARTMENT

GUIDANCE NOTES ON APPLICATION OF POLYMER MODIFIED STONE MASTIC ASPHALT

Research & Development Division

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Contents

1. Introduction

1.1 This set of Guidance Notes updates the applications of the following three types of polymer modified stone mastic asphalt as surfacing materials on bituminous carriageways,

- polymer modified stone mastic asphalt with 6mm nominal maximum aggregate size (PMSMA6)
- polymer modified stone mastic asphalt with 10mm nominal maximum aggregate size (PMSMA10)
- highly modified stone mastic asphalt with 10mm nominal maximum aggregate size (HMSMA10)

2. Background

2.1 Guidance Notes No. RD/GN/030 was issued in December 2001 introducing the use of stone mastic asphalt (SMA) as a surfacing material for heavily trafficked roads. Since then SMA has been extensively used as the surfacing layer on heavily trafficked bituminous carriageways in Hong Kong. Approaching 2010, more frequent occurrence of rutting and shoving on SMA has been noted and these defects sometimes appeared shortly after construction, in particular during hot season.

2.2 The Research and Development (R&D) Division launched an investigation study in 2009 with a view to identifying the causes of such premature failures, which concluded that the major cause of such problem was attributed to instability of SMA under high local temperature. With the use of Styrene-Butadiene-Styrene (SBS) polymer having performance grade not less than PG76 of the Performance-Graded Asphalt Binder Specification under AASHTO M320, PMSMA10 was introduced to enhance the durability of the asphalt.

2.3 Since the promulgation of Guidance Notes No. RD/GN/038 in April 2012, PMSMA10 has been more extensively used in Hong Kong road network. Except on some road sections with extremely heavy traffic loading, it is observed that PMSMA10, together with intact base course layer, can improve the conditions of carriageway pavements from early deformation and rutting.

2.4 As the number of vehicles growth rapidly in 2010s, R&D Division collaborated with the Hong Kong Polytechnic University (PolyU) launched a study on application of more durable asphalt using highly modified bitumen (the Study). With the use of a larger amount of SBS polymer, highly modified bitumen with performance grade not lower than PG82 and viscosity at 60°C greater than 70,000 Pa.s, HMSMA10 was introduced under the Study.

2.5 To evaluate the applicability of HMSMA10 in local roads in Hong Kong, site trials of HMSMA10 was commenced since November 2018. Up to May 2022, 35 trials on HMSMA10 have been conducted. With enhanced performance in terms of rutting resistance, ageing resistance and fatigue resistance as well as the potential benefit of having fewer maintenance and thus lower social cost, HMSMA10 is recommended to be used more widely on new projects and pavement preservation.

2.6 In parallel, R&D Division launched another study with PolyU on application of PMSMA6 as a low noise road surfacing (LNRS) for local roads in 2016 with site trial

commenced in 2019. The relevant guidance on the use of PMSMA6 as LNRS is given in the latest version of Guidance Notes No. RD/GN/011.

3. Types of Polymer Modified Stone Mastic Asphalt

3.1 The mix designs for different types of polymer modified stone mastic asphalt are shown in Table 1 for reference. Owing to the use of high binder content, fibres are added to reduce the binder drain. The mix designs and specifications for different types of polymer modified stone mastic asphalt may be subject to change when required. The up-to-date specifications for these materials in the most recently awarded Highways Department road maintenance term contract should always be referred to.

Table 1: Mix Designs for Different Types of Polymer Modified Stone Mastic Asphalt

Properties		PMSMA6	PMSMA10	HMSMA10
Nominal maximum aggregate size		6 mm	10 mm	10 mm
Particle size distribution	BS test sieve	Percentage by mass passing		
	14 mm	100	100	
	10 mm	98 – 100	93 – 100	
	5 mm	75 – 90	26 – 48	
	2.36 mm	20 – 30	21 – 35	
	1.18 mm	10 – 20	-	
	75 μm	6 – 12	9 – 14	
Bitumen type		Pre-blended type polymer modified bitumen having performance grade not lower than PG76 of the Performance-Graded Asphalt Binder Specification		Pre-blended type polymer modified bitumen having performance grade not lower than PG82 of the Performance-Graded Asphalt Binder Specification
Bitumen content as percentage of total mass of material		6.0 % min.		
Fibre content as percentage of total mass of material		0.3 % min.		
Draindown percentage as determined from binder draindown test		0.3 % max.		
No. of blows per side at Marshall compaction		75 nos.		
Marshall stability		6 kN min.		
Air voids in mix (VIM) as a percentage of total bulk volume		7 % - 10 %	3.5 % - 4.5 %	
Voids in mineral aggregate (VMA) as a percentage of total bulk volume		17.0 % min.		

4. Areas of Application

4.1 Compared with conventional wearing course (WC) material using penetration grade 60-70 binder, and PMSMA10 using polymer modified bitumen, the capital cost of HMSMA10 is higher owing to the use of a higher grade bitumen (i.e. polymer modified bitumen with larger amount of polymer content). Considering its better performance and durability, HMSMA10 is recommended for wider use as surfacing material for local roads with heavy traffic flow and area under frequent braking. Moreover, to cater for practical production issues and to enhance flexible pavement performance against potential climate change effects and ever increasing traffic loading, it is the intention to gradually replace bituminous mixtures using polymer modified bitumen (i.e. PG76) by their highly modified counterpart (i.e. modified PG82) in a longer term for better durability and thus fewer social and environmental impacts.

4.2 Table 2 provides general guidance on selection of surfacing material for road sections with different traffic levels under **new road projects**. Designers are reminded to refer to the latest version of Guidance Notes No. RD/GN/042 for the general principles and technical consideration about the selection of rigid or flexible pavements.

4.3 For **existing roads**, maintenance offices can refer to the guidance in formulation of rehabilitation schemes in the latest version of Guidance Notes No. RD/GN/039. In this connection, an existing road section falling into a particular group in Table 2 does not imply that the surfacing material recommended for that group must be used. In the transition period when both PMSMA10 and HMSMA10 are available in the market, they can be applied as appropriate with due consideration of the maintenance history of individual road sections. Local maintenance experiences and other relevant considerations should be taken into account in selecting the most suitable resurfacing option. As a general guidance, for a road section developed with predominant distress of rutting / shoving in less than 5 years since last resurfacing or expecting to have a substantial increase in traffic flow in near future, a stronger surfacing material should be considered.

4.4 Despite the improved durability of HMSMA10, it must be emphasized that there is still a limit on this new mix against heavy traffic loading. Permanent deformation in the form of shoving or rutting may still occur when HMSMA10 is subjected to very heavy and slow or "stop and go" traffic, especially under hot summer season. Consideration should be given to replace the carriageway with more stiff material, such as concrete pavement, at such locations. Nevertheless, for bus stop zone and sharp turn locations with very heavy traffic, rigid pavement is considered more suitable from the long term maintenance point of view while HMSMA10 would still be a surfacing material option for preservation of bituminous pavement.

4.5 For local road sections requiring LNRS, PMSMA6 should be used. Reference should be made to the latest version of Guidance Notes No. RD/GN/011. However, if a road section was already laid with a stronger surfacing material, such as PMSMA10 or HMSMA10, PMSMA6 is not suitable to be applied.

Table 2: Recommended Type of Surfacing Material on Local Roads

<table>
<tr><td rowspan="2">Area Definition
(Bituminous Carriageways)</td><td colspan="4">Traffic Levels
(Commercial vehicles per lane per day)</td></tr>
<tr><td>Up to 1500</td><td>1501 – 2500</td><td>2501 – 4000</td><td>Over 4000</td></tr>
<tr><td>Single and dual carriageways (straight sections and minor junctions)</td><td colspan="3">WC</td><td>PMSMA10 /HMSMA10[Note 5]</td></tr>
<tr><td>Gradient 5% to 10%, longer than 50m
Bend radius 100m – 250m</td><td colspan="2">WC</td><td colspan="2">PMSMA10 /HMSMA10[Note 5]</td></tr>
<tr><td>Approaches to roundabouts, traffic signals, pedestrian crossings and railway crossings, and similar
Gradient steeper than 10%, longer than 50m
Roundabout and bend radius <100m</td><td>WC</td><td colspan="3">PMSMA10 /HMSMA10[Note 5]</td></tr>
</table>

Notes:

1. Commercial vehicles include all medium/heavy goods vehicles and buses classified in the Annual Traffic Census issued by the Transport Department.
2. Annual average daily traffic and percentage of commercial vehicles at appropriate stations listed in the Annual Traffic Census should be referred to in determining the no. of commercial vehicles per lane per day of a road section. For the procedure of calculating the traffic level, reference can be made to the latest version of Guidance Notes No. RD/GN/042, Pavement Design for Carriageway Construction. If there are no core or counting stations in the road section, the relevant data of adjacent roads in the areas should be referred to. Manual traffic counting may be required if necessary.
3. Friction course (FC) materials should be used on high speed roads to improve skid resistance and reduce the risk of aquaplaning when vehicles are travelling at high speeds as stipulated in the latest version of Guidance Notes No. RD/GN/032.
4. Rigid pavement would be more suitable for road section with frequent chemical attack or bus stop zone and sharp turn locations with heavy vehicles. Reference can be made to Guidance Notes No. RD/GN/042.
5. HMSMA10 should be used in new road projects. For preservation of existing road pavements, both PMSMA10 and HMSMA10 can be applied as appropriate. See paragraph 4.3 for details.

4.6 On roads with normal to high daily traffic volume, the skid resistance of PMSMA10 / HMSMA10 attributable to its micro texture would be shortly reduced to that similar to WC due to the repeated tyre/road surface interaction. Application of anti-skid surface dressing could be considered if higher skid resistance is demanded. On the other hand, the skid resistance of PMSMA10 / HMSMA10 on roads of extremely low traffic can maintain at a high value for a reasonably long period of time after construction. Therefore, for road sections with low daily traffic flow of less than 300 vehicles per lane, PMSMA10 / HMSMA10 alone could be used as anti-skid surface. Application of extra anti-skid surface dressing material using aggregates of high polished stone value such as calcined bauxite on top of PMSMA10 / HMSMA10 is usually unnecessary in this situation.

4.7 For WC road surfacing, when epoxy based anti-skid dressing is to be laid, the existing WC has to be replaced with PMSMA10 / HMSMA10 first due to the incompatibility between the low elastic modulus of wearing course and the high elastic modulus of the epoxy based anti-skid dressing. In the circumstances the anti-skid dressing shall be overlaid about 4 weeks after replacement of the WC.