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The performance of a highly modified binders for heavy duty asphalt pavements

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Abstract

Long-lasting asphalt pavements as a concept arose in the late XX century. According to assumptions it is possible to achieve durability even for 50 years. The key to achieve so long-lived is appropriate choice of an asphalt binder, except for the relevant properties of asphalt mixtures. A few years ago a new family of highly modified binders was created which was characterized by reversed-phase of polymer-bitumen mixture, and it is now a perfect example of a binder which fulfil the pavement longevity assumptions concept. Based on a new, special polymer which was developed by polymer industry, a new family of binders – Highly Modified Asphalts (HiMA), has been developed – 'hard' (EN 25/55-80, PG 94-22), 'middle' (EN 45/80-80, PG 82-28) and 'soft' (EN 65/105-80, PG 76-28). All binders were tested according to very wide test program. Results confirmed superior performance of tested binders and their very positive influence on asphalt. The paper presents tests results and analysis of polymer modified binders, HiMA type. The research has been done based on the European standards and according to the Superpave (PG grade system).

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Keywords: Highly modified asphalt; long lasting asphalt pavements; Superpave; PMB

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1. Introduction

Research conducted by numerous academic centers over recent decades has corroborated the claim that higher polymer content in binder produces additional quality benefits, substantially contributing to the durability improvement of asphalt pavements in terms of cracking & rutting resistance, and fatigue. Particularly encouraging was exceeding the limit of polymer (typically SBS – Styrene-Butadiene-Styrene) content (about 7% by mass), after which the polymer phase in the polymer-modified binder becomes continuous. However, such a significant quantity of SBS for binder modification carried with it specific technical consequences for the production and application of modified binder, connected with following aspects:

- stability problems during the storage and transport of modified binder,
- very high viscosity of polymer modified binder, which cause a need for higher temperatures and some problems on building site.

The above limitations were decreased by special polymer type – low viscous SBS with vinyl groups, which was developed specially of highly-modified binder (or Highly Modified Asphalt - HiMA).

2. Principle of HiMA

Research and implementation work on new highly modified binders with a new type of polymer have shown that they are products above standard functional properties, characterized by, inter alia, very good resistance to rutting, water and frost and excellent fatigue strength and cracking resistance [Timm et al. 2012, 2013; Kluttz et al. 2013; Willis et al. 2012; Scarpas et al. 2012].

In terms of structure, courses with HiMA maintaining high tolerance to increasing tensile strains (so-called fatigue strains) [Kluttz et al. 2009; West et al.] thus potentially allowing a reduction in the thickness of the set of asphalt courses. Full-scale testing conducted since 2009 on the experimental track in the US (NCAT Pavement Test Track) showed that the experiment based on reducing pavement thickness by 18% and simultaneous use of a highly modified, special HiMA binder was a success – the surface proved to be resistant to rutting and fatigue cracking [West et al. 2012].

The primary purpose behind highly-modified binders is to counteract pavement cracking and plastic deformations (rutting), and to increase the fatigue resistance of asphalt courses. The continuous polymer network (polymer phase), acting in the binder and bituminous mix as an elastic element, which strongly restricts crack propagation in asphalt mixture.

Since 2011, the three new highly-modified binders have been developed as a result of laboratory work and production tests. The purpose and applications of these PMBs are presented in table 1.

Table 1. PMB HiMA applications.

	Applications
25/55-80 HiMA	Typical asphalt base courses and asphalt base courses of long-life pavements (type: perpetual pavement), high modulus mixtures (EME/HMB).
45/80-80 HiMA	Wearing courses and binder courses of pavements exposed to very heavy loads and working at low temperatures, as well as for other courses in specific places, e.g. on bridges
65/105-80 HiMA	Special technologies, e.g. SAMI courses, for the production of asphalt emulsions used in slurry seal; because of its high penetration.

HiMA can be used in technologies and locations for which the required durability is very high.