Experimental Results on Warm Asphalt Mixes in Czech Republic

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Summary

One of the environmentally most important factors of asphalt pavements is the energy demand necessary due to satisfactory workability and compactability of an asphalt layer. Economical energy consumption on one hand and sufficient quality of asphalt pavements on the other hand can be seen as important factors of its sustainability. Both characteristics have therefore crucial role in the so called environmental compatible pavement structure. There are several possibilities or techniques how energy demand can be reduced and durability preserved or increased. Important set of these techniques, called warm asphalt mixes has been in this respect developed during the last ten years in Europe and the United States. There are several possibilities, how these mixes can be produced.

The paper presents warm asphalt mixes experimentally prepared and assessed with various additives of synthetic waxes or polyphosphoric acid. For the experimentally prepared asphalt mixes a comparison of their mechanical as well as rheological properties is summarized and discussed.

Keywords: warm asphalt mixes, low-viscosity bituminous binders, asphalt mix characteristics.

1. Introduction

Gradually, low-temperature or warm asphalt mixes become technologies with increasing applicability in a number of countries. On one hand, this is due to attempts to reduce energy demands or improve asphalt mix workability under fixed processing temperature while, on the other hand, some examples also demonstrate an effort to improve certain characteristics of the asphalt mix or binder by the use of a suitable additive to allow a modification of viscous behaviour. Recently, road construction has experienced the onset of additives based on synthetic waxes or zeolites. Similarly, mostly in the USA, the addition of polyphosphoric acid (PPA) is used; its application does not primarily intend to reduce the working temperature but improve the performance characteristics of the mixes and workability when the usual polymers have been substituted (partially or fully) with the organic additive. A certain improvement of viscous behaviour is an appreciated accompanying occurrence that might be further enhanced by combining the additive with others used primarily to reduce the working temperature. However, in such cases, it will always be important to perform, besides laboratory assessment of the binder and asphalt mix characteristics from the point of view of road construction, chemical analysis as well, which should identify certain concerns, risks or advantages associated with combinations of multiple additives.

2. Warm asphalt mix – present status

In relation to the general effort towards reducing energy demands and greenhouse gas emissions, alternatives to traditional asphalt mix technologies are sought. The significance of the issue might even increase in the case of mastic asphalt where higher working temperatures are employed, which at present constitute a problem primarily from the point of view of safety risks upon assessing such

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application under the European union REACH (Registration, Evaluation and Authorization of Chemicals) regulation. Therefore, neighbouring Germany has already adopted a measure restricting, from January 1, 2008, mastix asphalt mixes in the form of warm mixes where the maximum working temperature is guaranteed at 220-230°C only.

On the other hand, a completely different reason may be given for the use of compacted warm asphalt mixes. With respect to the fact that, in a number of cases, asphalt mixes are used during adverse weather conditions (particularly under low air temperatures oscillating around 5°C), warm mixes allow an extension of the safe interval for laying and sufficient compaction. In this case, it is assumed that the asphalt mix is produced under the usual working temperature however, as it is possible to compact the mix until it reaches 90°C, the temperature range for the processing of the mix at the site is extended.

To allow the best possible use of warm asphalt mixes, it is naturally necessary to sufficiently specify and define their mechanical and, in particular, rheological characteristics. Assessments of asphalt mixes with various additives to facilitate identification of individual additives' advantages and subsequent design of combinations, is similarly important.

3. Experiment set up

From the conceptual perspective, the objective was to choose the additives currently most frequently used to reduce the working temperature or to improve the viscosity of the bitumen or asphalt mix. At the same time, at least in some cases, the additives should have been tested in practical applications and some experience described in construction should be available. From the point of view of methodology, several asphalt mixes were designed with binders applied that had been modified by the selected additives. In addition, a reference mix was prepared - asphalt mix with a common 50/70 binder. This mix was intended to allow comparison of the effects of individual additives at a basic level. The mixes were evaluated both from the perspective of physical and mechanical characteristics, as well as from the perspective of rheological properties:

- determination of Marshall stability and deformation at temperature of 60°C;
- indirect tensile strength test at 15°C including the assessment of water susceptibility;
- resistance to permanent deformation (rutting) determined at 50°C using air bath;
- stiffness modulus determination at 5°C, 15°C and 27°C; and
- low temperature characteristics of selected asphalt mixes tested by bending beam test at 0°C and by two loading speeds (1.25 $mm.min^{-1}$ and 50 $mm.min^{-1}$).

Within the framework of our research, individual additives were used in combination with the 50/70 distilled bitumen as well as with selected PmBs. This paper deals only with mixes, where the 50/70 bitumen was used. To verify all alternatives in an asphalt mix, a uniform asphalt concrete type ACL16S (asphalt concrete for binder courses) according to the CSN EN 13108-1 standard was selected. The quantity of binder in the mix was designed as 4.2%-wt., what can be considered, if compared with experience in other countries, as relatively low.

4. Conclusions

The aim of the experimental assessment of so called warm asphalt mixes was the comparison of presently most frequently used additives, which enables production of low-viscous bituminous binders. Results presented in this paper can in no case be considered as full-range analysis of asphalt mix possibilities for each additive. The addition of 3 %-wt. FT paraffin and amide wax in bitumen resulted from the amount recommended by the manufacturer. In the case of PPA additive the chosen portion was the same like of FT paraffin and against the specifications mentioned by the manufacturer. This modification at the end lead to ambiguous results of asphalt mix performance. It has to be stated as well, that the extent of binder ageing has not been proven, although the existing foreign experience have not document so far any negative impact especially in the case of additives based on synthetic waxes. Likewise the behaviour of the asphalt mix in low temperature range has not been fully tested and experimental assessment of fatigue behaviour has to be performed as well. Notwithstanding the results confirm the potential of used additives not only because of reduction in energy demand as repeatedly validated by foreign experience, but also because of partial improvement of asphalt mix behaviour.