EXPERIENCE WITH THE TRANSITION TO THE FUNCTIONAL TESTING OF ASPHALT MIXTURES

Petr Hyzl, Michal Varaus, Dusan Stehlik
Brno University of Technology, Institut of Road Structures, Czech Republic

Abstract

The testing of functional properties of asphalt mixtures started in Czech Republic already in 1976, when the first device for the determination of stiffness modulus was put into operation. At the moment Czech Republic is one of the 5 EU-countries, where the standards for functional testing have been introduced and where the compact system with various functional tests exists. Important part of the transition from empirical testing to the functional testing is the correct set up of parameters into the new European standards. This process led in the Czech Republic to the issue of the national annex-functional approach as the part of the standard EN 13108-1 Asphalt concrete.

Keywords: asphalt mixture, functional test, water sensitivity, compacting energy

1 Introduction

Procedure for the correct setting of parameters into the national annex to the European standard referred to as EN 13108-1 [2], implemented in the Czech Republic during the period 2004 - 2008, is described in more details under [1]. Currently the regular revisions of testing standards for asphalt mixtures of the range 12697 are carried out in the Czech Republic. The revisions is carried out in regular 5-year intervals. Their intention is to adjust or correct the testing procedures. These revisions are also appropriate for the possible amendment of the new testing procedures.
This happened in 2009 with the EN standard 12697-12 Bituminous mixtures - Test methods for hot mix asphalt - Part 12: Determination of the water sensitivity of specimen [3], where the original method of preparation of testing specimens (method A) was slightly revised and two new methods for assessment of resistance of asphalt mixtures against effects of water (methods B and C) were added. Method C is intended for soft asphalt mixtures that are not used in Czech Republic.
Below in the text of this article you can find a process that was required in the Czech Republic to compare the new method B with the existing (slightly modified) procedure described in the standard as method A. This process was important especially in order to verify whether methods A and B provide the same results and whether it will be necessary to change the required parameters in the standard EN 13108-1 [2].

2 Methodology

Comparison of results obtained by method A and B was carried out with asphalt mixtures of a asphalt concrete type, with variable maximum grain size of aggregates in the mixture, as well as various types and contents of bitumen. Samples of asphalt mixtures were taken from the mixing plant. Then the particular testing samples were prepared in the laboratory using

the Marshall compacting device [5] at a specific number of blows. The testing samples were then tested according to the standardized procedures set by the applicable standard (in the description of the method A and B). Finally the evaluation of the measured data and comparison of both methods was carried out.
Key parameters under review:

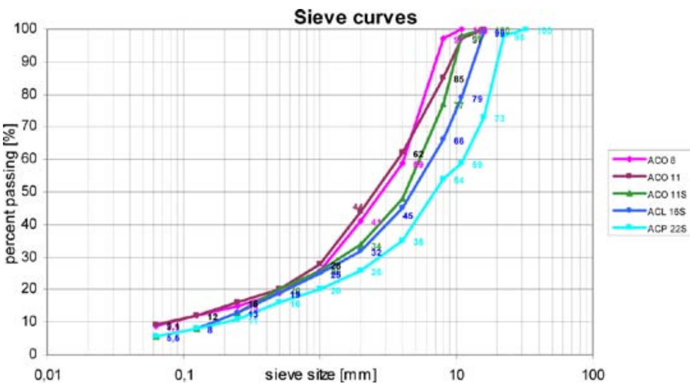
a Increase of the number of compacting blows (increase of the compacting energy) for method A and B from 2 x 25 blows to 2 x 35 blows by the Marshall impact compactor [5],
b Comparison of results obtained by methods A and B (i.e. ITSR and i/C parameters - see section 4).

3 Parameters of tested bitumen mixtures

Table 1 and Graph 1 contains basic parameters of asphalt mixtures that were used for the comparison of both methods.

Table 1 Basic parameters of tested mixtures

Mixture identification	Bitumen content	Bitumen type	Compacting temperature
ACO 8	5.9 %	70/100	145°C
ACO 11	5.6 %	70/100	145°C
ACO 11 S	5.6 %	PmB 50/90	155°C
ACL 16 S	4.8 %	50/70	150°C
ACP 22 S	4.2%	50/70	150°C



Graph 1 Sieve curves of tested mixtures

4 Testing procedures

Method A determines the indirect tensile strength of the tested samples (bitumen samples in the cylindrical shape). The set of cylinder-shaped testing samples is divided into two groups based on their size and all samples are tempered. One group is kept in air at a laboratory temperature. The other group of samples is saturated by water and placed on a perforated insert in the vacuum chamber filled by distilled water with temperature of (20 ± 5) °C up to the level of at least 20mm above the upper surface of the samples. In the course of (10 ± 1) min. an absolute (residual) pressure (6.7 ± 0.3) kPa is established in the vacuum chamber. The pressure is then reduced in steps in order to prevent from damage to the testing samples by expanding air. The required pressure is maintained for the period of (30 ± 5) min. Then the

atmospheric pressure is slowly introduced in the vacuum chamber. Testing samples are kept submerged in the water for another (30 ± 5) min. and then they must be moved to water bath with a temperature of 40°C for approx. 72 hours.
After tempering the indirect tensile strength is determined using samples from both groups, in accordance with the standard EN 12697-23 [4], at testing temperature of 15°C. The indirect tensile strength ratio between the group of samples tempered in water bath and samples kept in air shall be calculated and interpreted as ITSR parameter (percentage value).

Figure 1 Test set-up for the method A

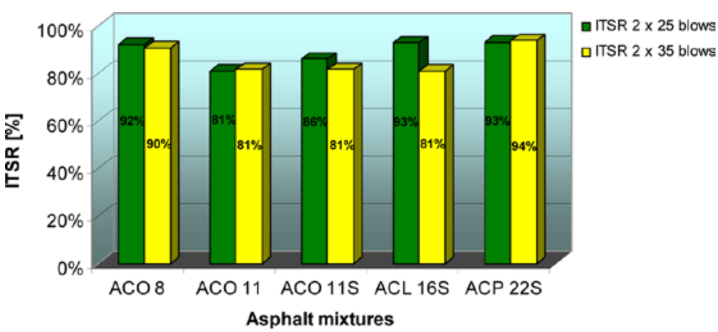
Method B determines the compressive strength using cylinder-shaped asphalt test samples. The set of cylinder-shaped testing samples is divided into two groups based on their size and all samples are tempered. The first group of samples is kept under temperature of 18°C at humidity of 50%. The other group of samples is saturated by water – it must be placed on a perforated plate insert in the vacuum chamber. An absolute (residual) pressure of (47 ± 3) kPa is established in the vacuum chamber. The required pressure is maintained for the period of (60 ± 5) min., with water introduced to the chamber at the maintained pressure up to the level of at least 20mm above the upper surface of the tested samples. Then the samples shall be kept submerged in the water for another (120 ± 10) min. at pressure of (47 ± 3) kPa. The group of wet samples shall be then placed in water bath with a temperature of (18 ±1) °C for 7 days ± 2 hours.
After tempering the compressive strength shall be determined for samples in both groups at temperature of 18°C. The compressive strength ratio between the group of samples tempered in water bath and samples kept in air shall be calculated and interpreted as i/C parameter (percentage value).

Figure 2 Test set-up for the method B

5 Evaluation of measured data

5.1 Effect of the compacting energy on method A

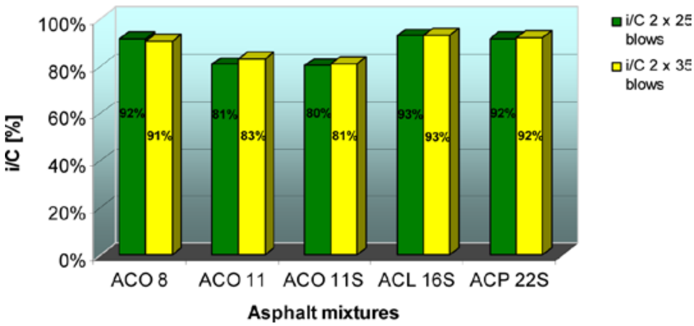
The effect of the number of compacting blows (compacting energy) on the results obtained by method A for all tested mixtures is shown in Graph 2. Yellow represents results of compacting by 2 x 35 blows while green are the results of compacting by 2 x 25 blows.



Graph 2 ffect of the number of compacting blows (compacting energy) – method A

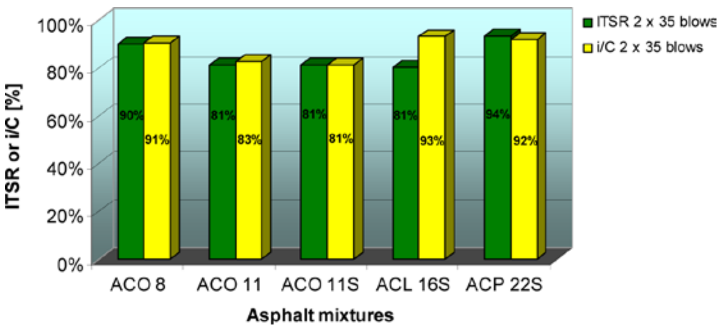
5.2 Effect of the compacting energy on method B

The effect of the number of compacting blows (compacting energy) on the results obtained by method A for all tested mixtures is shown in Graph 3. Yellow represents results of compacting by 2 x 35 blows while green are the results of compacting by 2 x 25 blows.



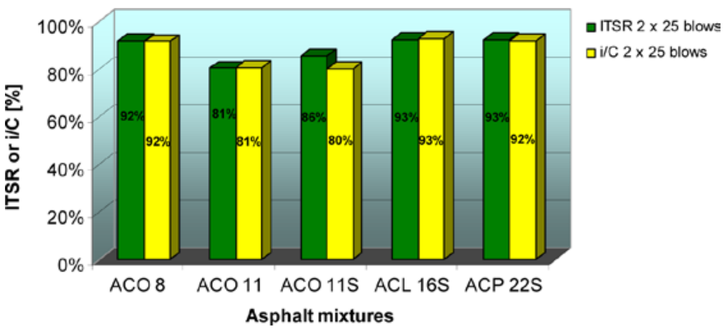
Graph 3 Effect of the number of compacting blows (compacting energy) - method B

Comparison of methods A and B at compacting energy of 2 x 25 blows



Graph 4 Comparison of methods A and B at compacting energy of 2 x 25 blows

Comparison of methods A and B at compacting energy of 2 x 35 blows



Graph 5 Comparison of methods A and B at compacting energy of 2 x 35 blows

6 Conclusions

The comparison of both methods set in the original and the new version of the standard EN 12697-12 using 5 types of asphalt mixtures was carried out. In total 120 testing samples were produced and tested, i.e. approx. 144 kg of material. Based on the evaluation of the measured data we can confirm that:

a Except for the mixture ACL 16 S no affection of the resulting ITSR parameter was found (for both methods) as a result of the change of compacting energy from 2 x 25 to 2 x 35 blows. This may be credited to the fact that ITSR parameter is a percentage ratio of two indirect tensile strengths (resp. compressive strength in case of method B).

b Comparison of methods A and B
- With compacting energy of 2 x 25 blows the results obtained by both methods are practically identical.
- With compacting energy of 2 x 35 blows the results obtained by both methods are practically identical, except for the mixture ACL 16S, where a difference of 12% was found in case of parameter ITSR compared with the parameter i/C.

In conclusion we must say that it was not necessary to propose the change of the standard parameters in the standard EN 13108-1 as a result of newly prescribed size of the compacting energy for method A. Newly introduced method B may be recommended for use as it provides practically identical results as method A. The only problem is still the time necessary for execution of the testing and the required treatment of the vacuum chamber to allow introduction of water under pressure. In order to confirm the presented findings, further testing is scheduled to be carried out with wider range of asphalt mixtures.

Acknowledgements

The article was written with the support of the research projects of Czech Ministry of Transport CG712-043-910 “Management system of secondary materials for road structures in the Czech Republic”, further 1F45B/066/120 “Introduction of European standards concerning the material specifications for improvement of the road serviceability, lifetime and traffic safety” and research project of Czech Ministry of Education MSM 0021630519 “Progressive reliable and durable constructions”.

References

[1] Varaus, M., Hyzl, P., Dasek, O. & Zdralek, P.: Experience with functional tests of asphalt concrete mixtures according to the new European standards in the Czech Republic, Euroasphalt and Eurobitume Congress, Copenhagen, Denmark, 2008

[2] EN 13108-1 Bituminous mixtures - Material specifications - Part 1: Asphalt Concrete

[3] EN 12697-12 Bituminous mixtures - Test methods for hot mix asphalt - Part 12: Water sensitivity of bituminous specimens.

[4] EN 12697-3 Bituminous mixtures - Test methods for hot mix asphalt - Part 23: Indirect tensile test

[5] EN 12697-30 Bituminous mixtures - Test methods for hot mix asphalt - Part 30: Preparation of specimen by impact compactor