



SLOVENSKI STANDARD
SIST-TP CEN/TR 15352:2006
01-september-2006

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Bitumen and bituminous binders - Development of performance-related specifications:
status report 2005

Bitumen und bitumenhaltige Bindemittel - Entwicklung von auf das Gebrauchsverhalten
bezogenen Spezifikationen: Statusbericht 2005

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Bitumes et liants bitumineux - Elaboration de spécifications reliées aux performances :
rapport d'avancement 2005

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Ta slovenski standard je istoveten z: CEN/TR 15352:2006

ICS:

75.140

91.100.50

SIST-TP CEN/TR 15352:2006

en

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ICS 75.140; 91.100.50

English Version

Bitumen and bituminous binders - Development of performance-related specifications: status report 2005

Bitumes et liants bitumineux - Elaboration de spécifications axées sur les performances : rapport d'avancement 2005

Bitumen und bitumenhaltige Bindemittel - Entwicklung von auf das Gebrauchsverhalten bezogenen Spezifikationen: Statusbericht 2005

This Technical Report was approved by CEN on 27 November 2005. It has been drawn up by the Technical Committee CEN/TC 336.

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Foreword

This Technical Report (CEN/TR 15352:2006) has been prepared by Technical Committee CEN/TC 336 “Bituminous binders”, the secretariat of which is held by AFNOR.

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1 Executive summary

This Technical Report contains a synthesis of TC 336/WG 1 work on the development of second generation (performance-related) specifications for paving grade bitumens. It is a CEN Technical Report (TR) and will be regularly updated by TC 336.

TC 336 Working Groups are completing their work to produce 'harmonised' first generation European specifications and test methods for paving bitumens, including EN 12591 (paving grades), prEN 13924 (hard grades) and EN 14023 (PMB). These are based on existing (empirical) national standards.

A process, involving industry-wide participation, is being followed to ensure that, for the second generation standards, the performance relationships of a binder property are assessed before a specification is developed. The basic sequential steps are as follows:

- **Step 1:** identify the binder properties linked to the performance requirements of asphalt pavements,
- **Step 2:** select and standardise appropriate (new) test methods to measure these properties,
- **Step 3:** collect data and ensure field validation for establishing (new) binder specifications,
- **Step 4:** review the grading system according to the (new) specification.

The development work has reached Step 3. Although new tests methods, when identified, could still be added, the main thrust currently is on validation of the test methods selected by WG 1. There are two major tasks being undertaken;

- Literature review.

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A project, named "BiTVal", is being undertaken by FEHRL. The first phase of the project is to evaluate the published literature on relationships between bitumen characteristics and asphalt/pavement behaviour. A FEHRL report will make recommendations on use of binder tests by WG 1, and also identify gaps in the knowledge.

- Collection of data for existing bitumens using the selected test methods.

This CEN/TR contains a framework of properties and test methods, which is being used as the basis for data collection. The intention is to encourage widespread input from member states and the industry around Europe. As confidence in the validation of the (new) test methods is established it may be decided to introduce them progressively into the existing specifications according to priority of need.

It is, of course, recognised that the binder properties alone do not determine pavement performance. Other parameters, such as aggregate characteristics, mix design, manufacture and laying are also considered as important. Nevertheless the goal of the work of WG 1 is to propose a framework, which could include levels or classes, and which can be used in new performance-related specifications for paving grade binders.

The TC 336 business plan recognises that the development of new P-R specifications will be a long-term process. This Technical Report will be a living document, being regularly updated, to indicate the current state of progress of the work of WG 1.

2 Scope of the report

TC 336/WG 1 has agreed to produce a Technical Report (CEN-TR) to summarise and illustrate the ongoing work in the standardisation area with reference to the process of developing from traditional “empirical” based specifications to new “performance-related” specifications for paving bitumens, as required by the Mandate M/124. It was decided that it would be better to maintain such a report as an ‘informative’ document, which can be regularly amended and updated by TC 336/WG 1 as appropriate.

3 Introduction

The European Committee for Standardization (CEN) was formed in the early sixties and was charged with preparing common rules and standards to be used in all member countries to ensure no barriers to trade.

As part of that programme, new harmonised European specifications for paving grade bitumens are being developed in two stages:

- a) First generation (CEN/TC 19/SC 1, since 1990) – The working groups have completed their work to produce specifications and test methods for paving bitumens, for use throughout Europe, which were based on existing national standards. Such specifications (already published in 1999 as EN 12591, and now under revision after 5 years in use) are well known as empirical tests based specifications.

The first generation standards, including EN 12591, EN 13924 (hard grades) and EN 14023 (PMB), and their associated test methods, are summarised in Annex A.

- b) Second generation (CEN/TC 336, since 2000) – The next task of the working groups is to produce specifications that are more Performance-Related, to reflect the binder contribution to the performance of the asphalt pavement, with the inclusion of existing or new properties and test methods, as appropriate.

Bitumen specifications have remained relatively unchanged over the last forty years and the specifications now being developed represent a very significant step forward for all involved contributors such as producers, asphalt suppliers, contractors and administrations all over Europe.

4 Motivation and expected benefits

In the EC’s acceptance of the CEN/TC 336 response to the Mandate, it was stated:

“The Commission understand that the standards, which will be developed, are the generation of empirical specifications. CEN/TC 336 is encouraged to develop new specifications, performance-related, as soon as possible, after finalisation of the first generation standards. If TC 336 considers there is a need to change some of the performance characteristics for the second generation of standards, in line with a performance based approach, a revision of the mandate should be proposed by CEN/TC 336 to the Commission.”

The second generation of standards can be more ‘market-driven’. The aim is good quality asphalt roads that perform well throughout their lifetime. Specifications and standards should meet both the technical and commercial needs of the asphalt industry and its customers, and it is important these needs are properly identified and understood.

The overall purpose of the specification system will be to ensure that binders can be evaluated on a fair and comparable basis, that the appropriate binder can easily be selected for a particular application and that the binder can be used with confidence in its quality. Ideally, the system should be suitable throughout Europe, for all types of climatic and traffic conditions, for a large variety of pavement applications, and applicable to all categories of binders: conventional, special and modified bitumens.

5 From pavement performance requirements to binder properties

It is important that the market needs are correctly identified and addressed, therefore the involvement of key stakeholders has been sought: road owners and authorities, specifiers, road contractors, asphalt and binder producers. A good and effective communication between all these players was necessary for a satisfactory development of the WG 1 programme.

It is, of course, recognised that the binder properties alone do not determine pavement performance. Other parameters, such as aggregate characteristics, mix design, manufacture and laying are also considered as important. A process is being followed to ensure that, for the second generation standards, the performance relationships of a binder property are assessed before a specification is developed. The basic sequential steps are as follows:

- **Step 1:** identify the binder properties linked to the performance requirements of asphalt pavements,
- **Step 2:** select and standardise appropriate (new) test methods to measure these properties,
- **Step 3:** collect data and ensure field validation for establishing (new) binder specifications,
- **Step 4:** review the grading system according to the (new) specification.

6 Preliminary phase (1999 – 2003)

In order to take a systematic approach to second generation binder specifications the European bitumen/asphalt industry has made major efforts in recent years to define the “performance-related” requirements for paving binders.

In 1999, Eurobitume organised a workshop with global attendance representing all sides of the asphalt industry, and delegates collectively identified the principle performance requirements of asphalt pavements and then related these to the appropriate binder properties and thence to the possible tests required to measure these properties. Figure 1 summarises the outcome from that workshop, and the starting point for much of the work since.

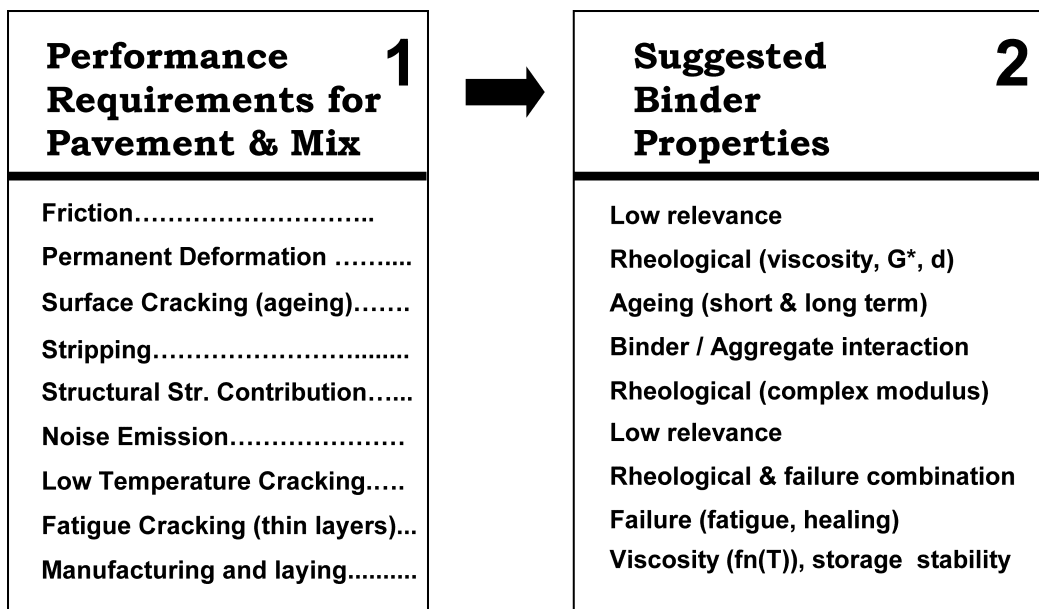


Figure 1 — EUROBITUME - Industry Workshop, Luxemburg, 1999

In 2000, CEN/TC 336 was established and the 'new' WG 1 started work on development of a new performance-related specification for paving binders. This includes PMBs as well as unmodified binders, and so amalgamates the work of the old WG 1 and WG 4.

Working Group 1 decided from the beginning to establish Task Groups to work on the three key properties that were identified at Workshop '99, as essential parts of any new specifications for paving binders:

- high (service) temperature properties (TG 1),
- low (service) temperature properties (TG 2), and
- ageing and conditioning (TG 3).

For these topics there was considerable existing background information and test methods from the US, particularly from the SHRP project developments. These were taken into account together with published development work from around the world.

Other properties and test methods have been subsequently added to the list in an ongoing process to address the identified performance requirements, in particular:

- adhesion;
- cohesion;
- fatigue.

In parallel with the above, there have been two major exercises to update and refresh the thinking on the outcomes of the Workshop 99.

i) **BiTSpec project**

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In 2002/03, a series of regional seminars, supported by Eurobitume and the European Asphalt Pavement Association (EAPA), were held around Europe, on the subject of "Bituminous Binder Testing and Specifications", culminating in the BiTSpec Seminar in Brussels, in June 2003. The seminars were well attended by representatives from all parts of the industry, and the outputs from that project were made available to WG 1, ref. Eurobitume BiTSpec Proceedings, 2003.

ii) **TC 336 Advisory Group**

CEN/TC 336 Advisory Group (which is constituted by the five key European road industry stakeholder groups) also provided a comprehensive report in 2003 on the subject of "Binder requirements", compiled from individual position papers from the Eurobitume, EAPA, FEHRL, WERD (now renamed CERD), IISRP. The final report is being used by WG 1, ref. TC 336/AG N9, 2003.

7 Detailed review of binder properties and their potentially associated test methods

7.1 General

The input from EAPA on the needs for asphalt pavement performance is summarised in the form of the table shown in Annex B. This is considered as fundamental input to the work of TC 336/WG 1/TG 5. For each binder property, WG 1 has considered the possible/available test methods, see below. Test method selection is an ongoing part of the work of the working groups. At this stage, it is important to maintain an "open door" to new ideas and suggestions. Therefore CEN/TC 336 will continue to monitor development elsewhere, particularly in the USA (SuperPave) and to select relevant options for evaluation. In particular, new proposals can be expected from work in:

- US binder research programmes,

- CEN Ad-Hoc Group adhesion/durability (TC 336/TC 227), and
- RILEM.

The current status of evaluation of test methods by WG 1 is summarised in this chapter, and in more detail in Annex C.

At this stage, several test methods have been harmonized for some properties in order to gain experience with their use before selecting the most appropriate one.

7.2 Elevated service temperature property

Several tests are available for measuring viscosity/rheology at different temperatures, including the "high road service temperature" range.

Seven test methods have been evaluated by TG 1:

- softening point, vacuum capillary, dynamic viscosity, complex modulus DSR, Low/Zero Shear Viscosity ZSV (oscillation & creep modes), Australian viscosity.

7.2.1 Current status of standardisation

Table 1 shows a summary of the status of WG 1 evaluation and standardisation of the test methods; for more details see Annex C.

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Table 1 — Elevated service temperature test methods

| Test method | Status EN Standardisation | Reference | Comments |
|--|---------------------------|------------|---|
| Softening point | YES | EN 1427 | Under revision, following the 5-year review in 2004 |
| Vacuum capillary | YES | EN 12596 | Under revision, following the 5-year review in 2004 |
| Dynamic viscosity | YES | EN 13702 | Part 1: published, 2003 Part 2: published, 2004 |
| Complex Modulus using DSR | YES | EN 14770 | Published, 2005 |
| Low Shear Viscosity LSV (oscillation mode) | YES | prEN 15324 | Standing for CEN enquiry, 2005 |
| Zero Shear Viscosity ZSV (creep mode) | YES | prEN 15325 | Standing for CEN enquiry, 2005 |
| Australian viscosity | NO | | Not selected for harmonisation |

7.2.2 Further work required

Following publication of the DSR method, work is required to confirm / validate appropriate parameters from the test.

For the new tests for Zero Shear Viscosity, further work is required to establish a correlation with road performance.

7.3 Intermediate service temperature property

The penetration test is currently used to assess binder properties at intermediate temperatures (typically 25 °C).

The measurement of complex modulus at various temperatures is also available, e.g. via the DSR (EN 14770) and could be related to the 'structural strength' in practice.

Measurements of stiffness can be made on the asphalt mixture itself using EN 12697-23 & 26: Structural Strength and Stiffness.

7.4 Low service temperature property

Several tests are available for measuring low temperature properties of paving bitumens; six have been evaluated by TG 2:

- Fraass breaking point, low temperature penetration, force ductility and tensile test, Bending Beam Rheometer (BBR), complex modulus, Direct Tension Test (DTT),
- one new test is now being evaluated: Fracture Toughness Test. This test may also be appropriate to evaluate other characteristics such as resistance of the binder to crack propagation due to fatigue stress.

7.4.1 Current status of standardisation

Table 2 shows a summary of the status of WG 1 evaluation and standardisation of the test methods; for more details see Annex C.

Table 2 — Low service temperature test methods

| Test method | Status EN Standardisation | Reference | Comments |
|----------------------------------|---------------------------|--|---|
| Fraass breaking point | YES | EN 12593 | Under revision, following the 5-year review in 2004 |
| Low temperature penetration | YES | EN 1426 SIST-TP CEN/TR 15352:2006 | Under revision, following the 5-year review in 2004 |
| Force Ductility and Tensile Test | YES | EN 13589 EN 13587 | Published, 2003 |
| Bending Beam Rheometer (BBR) | YES | EN 14771 | Published in, 2005 |
| Complex Modulus using DSR | YES | EN 14770 | Published, 2005 |
| Direct Tension Test (DTT) | NO | - | No decision made yet |
| Fracture Toughness | NO | - | Evaluation commencing |

7.4.2 Further work required

The Fraass test has been used in some countries to assess low temperature properties. However there is concern about the repeatability/reproducibility and P-R aspects of the test and it was always intended to seek an improved low temperature test (ref. EN 12591:1999, Annex C3).

The BBR is in process of standardisation and shows promise for use in P-R specifications in future. PMBs do not necessarily have the same critical stiffness as unmodified binders.

In the US a combination of BBR and DTT values have been proposed for specification purposes. The DTT has not yet been standardised as an EN; the precision of the method and correlation with binder performance need further study.

It is also possible that BBR data could be combined with data from existing EN tests such as Tensile Test or Force Ductility test.

7.5 Durability (or ageing simulation / conditioning)

Durability is a key requirement of the asphalt/pavement. To be assessed, it requires the identification of a minimum level of properties at the beginning of the service life (after asphalt mixing, laying and compaction) and the retention of such "initial" performance properties to a sufficient level to ensure the design life of the road is achieved. The binder itself has a part to play, and standards are being developed to "condition" the binder in the laboratory to equate to its condition in the road over time.

The procedures are used for two purposes:

- pre-treatment: to prepare a binder sample for further testing, in the condition expected in practice,
- binder evaluation: to compare the resistance to hardening.

The procedures cover two types of conditioning:

a) Short-Term (construction) ageing

[Related to changes during asphalt mixing /delivery /laying]

Four procedures have been evaluated by TG 3:

- Rolling Thin Film Oven Test (RTFOT),
- Thin Film Oven Test (TFOT),
- Rotating Flask Test (RFT), and
- Modified RTFOT.

b) Long-Term (in-service) Ageing

[Related to additional changes in the pavement during use. Tests are normally carried out on short-term aged binder]

Four procedures have been evaluated by TG 3:

- Pressure Ageing Vessel (PAV),
- High Pressure Ageing Test (HiPAT),
- Rotating Cylinder Ageing Test (RCAT), and
- Long-Term Rotating Flask Test (LTRFT).