PERFORMANCE OF REINFORCED BITUMEN SHEETS FOR WATERPROOFING OF CONCRETE BRIDGE DECKS IN ACCORDANCE WITH THE EUROPEAN PRODUCT STANDARD

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ABSTRACT

Bridges are vital links in our road networks. Hence, bridge policy and management have a considerable economic impact. In this context, waterproofing concrete bridge decks to protect them against infiltrating water, entrained de-icing salt, etc. is essential with a view to ensuring long service life. The implementation of the European Construction Products Directive has led, among other things, to the creation of a harmonized European standard on bitumen sheets for waterproofing of concrete bridge decks. This European standard stipulates the essential performance characteristics for the sheets and the test methods to be used. With the financial support of the Belgian Federal Public Service "Economy", the Belgian Road Research Centre has studied the implementation of the European standard and its implications for the Belgian regulations. Some test methods were new in Belgium and had to be imported, while other Belgian methods had to be adapted. The test methods were applied to various products in order to determine appropriate performance values. These values have been included in the Belgian technical approval guideline for the products concerned. Suggestions have been made to improve certain test methods.

1. INTRODUCTION

On 21st December 1988 the Council of the European Communities issued the Construction Products Directive (CPD) to promote the free movement of construction products in Europe. This directive intends to harmonize national regulations. The CPD defines the essential requirements to be met by construction products. Manufacturers must declare that their products meet the requirements before they can put them on the market with a CE mark.

Reinforced bitumen sheets for waterproofing concrete bridge decks are subject to the following essential requirements:

- mechanical strength (essential requirement 1);
- safety in use (essential requirement 4).

The durability of products is implied in these two requirements.

The European Commission mandated the European Committee for Standardization (CEN) to have the harmonized characteristics for CE marking and the level of conformity attestation defined by its competent Technical Committee 254 (TC254). Working group 6 (WG6) of TC 254 was assigned the task of drafting a product standard and the standards on performance tests specific to bridge waterproofing sheets (the other characteristics being identical to those of roof waterproofing systems). Table 1 reviews the standards developed.

Table 1 – Review of European standards on reinforced bitumen sheets for concrete bridge decks and other concrete surfaces trafficable by vehicles – performance characteristics.

EN	Title	Published
	Flexible sheets for waterproofing – Waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles	
13375	Specimen preparation	2004
13596	Determination of bond strength	2004
13653	Determination of shear strength	2004
14223	Determination of water absorption	2005
14224	Determination of crack bridging ability	Version 2 2010
14691	Determination of compatibility by heat conditioning	2005
14692	Determination of the resistance to compaction of an asphalt layer	2005
14693	Determination of the behaviour of bitumen sheets during application of mastic asphalt	2007
14694	Determination of resistance to dynamic water pressure after damage by pre-treatment	2005
14695	Definitions and characteristics	13/01/2010

The standards on the test methods were completed first and were published from 2004 onwards. However, their application could not become mandatory before the product standard was published. This happened in January 2010, which means that CE marking will be mandatory as of 1st October 2011.

BRRC carried out a preliminary study:

- to gain an insight into the changes that would result from the use of the European test methods instead of the familiar Belgian test methods;
- to elaborate the new test methods that had not been used before in Belgium;
- to assess the impact of changes in the test conditions on the results of existing tests;
- to allow the (re-)establishment of criteria;
- to detect any imperfections in the test methods so as to be able to suggest improvements during the five-yearly revisions of the standards;
- to be prepared by the day the mandatory application comes into force.

This study was undertaken for those characteristics which at the time were sure to be included in the future product standard.

2. COMPARISON OF THE EXISTING AND THE FUTURE SITUATION

To assess which characteristics needed investigation, a comparison was first made between, on the one hand, the Belgian requirements laid down in guidelines G0001(07) (specifications) en G0002(06) (operational procedures) for obtaining technical approval (aTg mark) of reinforced polymer-bitumen sheets used as waterproofing materials for bridges and roof-top car parks and, on the other, the draft European product standard prEN 14695 "Flexible sheets for waterproofing – Reinforced bitumen sheets for waterproofing of concrete bridge decks and other concrete surfaces trafficable by vehicles – Definitions and characteristics."

A first finding was that a number of characteristics investigated in Belgium were not addressed in the European draft. Among the items not included were the thickness of material under the reinforcement, tests on longitudinal joints, crack susceptibility, resistance to manoeuvring vehicles, shear strength under static conditions, and resistance to flow on sloping substrates. Secondly, the European document defined a few characteristics not considered as such in Belgium: watertightness under dynamic water pressure, water absorption – in Belgium a test is used to measure the influence of humidity in the upper part of waterproofing systems on bubbling in mastic asphalt protection layers – and shear susceptibility under dynamic conditions, both before and after heat conditioning. A third observation related to the test methods for characteristics included in both, such as strength of bond to the substrate and the asphalt layer, bleeding of binder from the sheet into a mastic asphalt protection layer, and resistance to compaction of an asphalt layer. No, minor or major differences were alternately found in the test conditions here; it was considered that they could lead to different results and consequently to the setting of different requirements.

A separate European standard has been developed for specimen preparation. It differs from the Belgian operating procedure mainly in the concrete to be used for the substrate and in the compositions of the asphalt layers to be used.

3. SELECTION OF TESTS FOR THE EXPERIMENTAL STAGE

Based on the findings from the above-described comparison, the following list of test methods was defined for investigation in the experimental stage:

- water absorption (EN14223);
- specimen preparation (EN 13375);
- shear strength without (EN 13653) and with heat conditioning (EN 14691);
- bond strength (EN 13596);
- behaviour during the application of a mastic asphalt layer (EN 14693);
- resistance to compaction of an asphalt layer (EN 14692).

Two test methods, viz. those for the determination of crack bridging ability (EN 14224) and resistance to dynamic water pressure after pre-treatment with a puncturing tool (EN 14694), were not investigated, because it was insufficiently certain at the time whether they would be adopted for inclusion in the product standard.

The tests were performed on three or four sheets produced in Belgium:

- an APP-modified bitumen sheet compatible with mastic asphalt and asphalt concrete (4 or 5 mm thick);
- an SBS-modified bitumen sheet compatible with mastic asphalt (4 mm thick);
- a combined sheet (AS) compatible with mastic asphalt (4 mm thick);
- a combined sheet (AS) compatible with asphalt concrete (5 mm thick).

4. EXPERIMENTAL STAGE

4.1 Water absorption (EN 14223)

The determination of water absorption was included, as water sensitivity may affect the functional behaviour of reinforced bitumen waterproofing sheets. A note in the scope of the standard clarifies that it is primarily the reinforcement's ability to absorb water which is examined by this test.
In this test, the increase in mass of batches of five conditioned test specimens is investigated after immersion in water.

This standard is the only one in the series considered here which contains precision data. These are based on a European ring analysis made in accordance with ISO 5725-2 for water absorption values between 0.2 and 5.1 %.

Table 2 reports the mean results for three sheets frequently used in Belgium, with the standard deviations in brackets. The requirement for repeatability as set in the standard could be met for all the batches. However, a significantly higher standard deviation was found for the APP5 sheet than for the other two sheets. Algae growth on the test specimens could be a possible explanation.

Table 2 – Water absorption by three sheets according to EN 14223.

Sheet	Water absorption (%)
APP5	0.89 (0.17)
AS4	0.18 (0.08)
AS5	0.21 (0.03)

4.2 Specimen preparation

A separate European standard has been developed for specimen preparation. The size of the specimens shall be such that the required test specimens can be taken from them e.g. by sawing; a zone of 5 cm along the edges must not be used. Requirements are made to the base specimen concrete and to the asphalt layers covering the sheet.

4.2.1 Concrete substrate

Since a number of performance characteristics are directly related to good bond of the sheet to its substrate, the requirements to be met by the base specimen concrete are very important. The reference concrete is type MC (0.45) as specified in EN 1766 Reference concretes for testing, i.e., micro-concrete with a maximum aggregate size D of 8 or 10 mm, a cement content of 410 or 395 kg/m³ (respectively), and a water/cement ratio of 0.45.

Composition and manufacture are no problem. Strict requirements are made for curing after casting:

Day 1:	in the mould at (20 ± 2)°C; either under polyethylene sheeting or at not less than 95 % relative humidity;
Day 2 through 28:	under water at (20 ± 2)°C.

Subsequent storage is to take place at (21 ± 2)°C and (60 ± 10) % relative humidity, until ready for testing.

Requirements are made for the surface characteristics of the finished product, to be obtained by surface preparation. Tensile bond strength shall be at least 2.5 MPa, which is no problem with the concrete mixture as specified (if manufactured correctly). As for roughness, the surface shall have a texture of 0.5 to 1 mm measured with the sand patch test described in EN 1766. In our opinion, the summary description of this test (in terms of materials and execution) may lead to errors. The sand (rounded or angular?) is not commercially available in aggregate size 0.05 – 0.1 mm. Surface texture could also be determined by European standard EN 13036-1 Part 1: Measurement of pavement surface macrotexture depth using a volumetric patch technique. Glass beads (in size 0.18 – 0.25 mm) are used in this standard and the test procedure is described more strictly.

Comparative tests using the procedures of EN 1766 and EN 13036-1 showed that lower texture values were found with EN 1766. Using this method may result in a very coarse texture which still meets the requirement. Several sheet welders made remarks about very coarse texture during the preparation of specimens. Given the importance of the texture of concrete substrates in determining the performance characteristics of bitumen sheets, it would be better to switch over to EN 13036-1 and desirable to set up a European ring analysis.

4.2.2 Mastic asphalt (MA) layer

The mixture to be used for the tests is fully described in the standard and makes no specific demands. It is comparable to the mixture specified in the Belgian standard specifications for protection layers, except that the aggregate size is limited to 8 mm instead of 6.3 mm and that the penetration grade of the bitumen is 40/60 rather than 35/50.

A number of trials were made with mixtures while varying mixing time, bitumen content and filler content (within the limits specified in the standard), to see what would be the effect on indentation (determined by NBN EN 12697-20 Indentation using cube or Marshall specimens – indentor pin of 500 mm² – 40°C – readings after 30 and 60 min). The underlying idea was to use indentation as a test to prove the constancy of mixtures, so as to avoid time-consuming analyses. The tests clearly indicated that continued mixing at a high temperature leads to a decrease in indentation (the mixture becomes stiffer), that differences in bitumen content become apparent from 0.9 % onwards, and that differences in filler content begin to be observable at about 3.5 %. Although these findings are calling for further validation on more mixtures in future, they open up perspectives for indentation to be used as a rapid identification test.

4.2.3 *Asphalt concrete (AC) layer*

The mixture for the tests is described in the standard and can be compared to the Belgian mixture AB-4C for surface courses. The bitumen content of this mixture (5.9 ± 0.5 %) is more than 1 % higher than usual in Belgium for a protection layer applied on a sheet (AB-3C).

The standard stipulates that this mixture shall be compacted to obtain a void content between 5 and 9 %. Since no method is specified for the determination of that content (to be calculated from bulk density and maximum density), the use of existing European standards is an obvious choice. Several methods are available for bulk density, as described in EN 12697-6 Determination of bulk density of bituminous specimens. The SSD (Saturated Surface Dry) method is to be used for mixtures with a void content ≤ 7 %, and the sealed specimen method for mixtures with a void content between 7 and 10 %. A void ratio between 5 and 9 %, therefore, covers the fields of application of both methods. Investigations have shown that the SSD method (which is simpler than the sealed specimen method) can be used in all cases for determining the percentage of voids in dense asphalt concrete, regardless of whether this percentage is above or below 7 %.
Operators who are nevertheless apprehensive of slightly underestimating the void ratio with the SSD method should make sure that their specimens are compacted to a void content well below the upper limit of 9 %. It would be advisable to specify the method to be used when revising the standard.

4.3 Determination of shear strength (EN 13653) and determination of shear strength after heat conditioning (EN 14691)

Belgian experts have always paid great attention to the shear strength of bitumen waterproofing systems. The static shear test developed in Belgium, which made it possible, using a predictive programme, to assess the development of the shear behaviour of such systems with time, was not included in the European list of test methods. A dynamic shear test has been opted for at the European level. The current Belgian test method for shear behaviour simulates the static shearing of a waterproofing system by its own mass and by the superimposed mass, the gradient, and the temperatures to which the system is exposed. The European test method is a simulation of the impact of dynamic forces to which waterproofing systems are exposed. As a result, the information gathered from this dynamic test is different from that obtained in a static test. Owing to its dynamic nature, the European test simulates other performance aspects such as resistance to braking forces.

The European test consists in compressive loading of a rectangular parallelepipedic test specimen comprising a concrete substrate, a tack coat, a bitumen sheet and a mastic asphalt or asphalt concrete layer. The load is applied at a constant displacement rate of 10 mm/min. The test specimen is inclined (in the longitudinal direction) at an angle of 15° to the vertical line and the force is applied through the centre of the waterproofing sheet. The test is performed at 23°C. The result is shear strength calculated as the ratio between maximum force and the surface area of the test specimen multiplied by the cosine of 15°. Photo 1 shows the set-up for the test.

Photo 1 – Equipment for the determination of shear strength according to EN 13653.

The same test is used to verify whether a sheet in service (welded on concrete and covered by an asphalt layer) can preserve its characteristics over time. To demonstrate this in an accelerated way, the test specimens are subjected to heat conditioning. Bitumen sheets may be subject to oxidation, migration, diffusion and absorption of compounds present within the system and/or in the layers to which they are bonded. Such modifications may affect the mechanical behaviour of a sheet.

The first experience with these tests was gained on three bitumen sheets. The results are summarized in table 3. Compatibility C (%) is calculated by the following formula: $C = (\tau_{maxC} / \tau_{max0}) \cdot 100$,

where: τ_{max0} = shear strength without heat conditioning (N/mm²);
τ_{maxC} = shear strength after heat conditioning (N/mm²).

Shear strength is increased by heat conditioning (hence C > 100 %).

Table 3 – Results for the compatibility of different systems according to EN 14691.

Sheet / asphalt layer system	τ_{max0} (N/mm²)	τ_{maxC} (N/mm²)	C (%)
AS5/AC	0.145	0.224	154
AS4/MA	0.106	0.231	218
APP/AC	0.266	0.407	153
APP/MA	0.240	0.389	162
SBS/MA	0.156	0.210	135

No values for repeatability (r) and reproducibility (R) are indicated in either of the two standards. A mean r value of 0.07 MPa could be determined for the systems without heat conditioning. The determinations of shear strength on batches of test specimens from the various preparations per sheet yielded results ranging from very consistent to widely diverging in nature. This obviously does not make the setting of requirements any easier.

There is certainly a need for further experience with these tests and it is desirable to set up a ring analysis for that purpose.

4.4 Determination of bond strength (EN 13596)

The bond of the sheet to both its substrate and its protection layer is a very important parameter for the waterproofing system and to overlying surfacing to work properly. Belgian operators have been using test specimens of (100 x 100) mm² and a tensile force with a displacement rate of 2 mm/min. The European test requires test specimens 50 mm in diameter or (50 x 50) mm² in area, and a constant rate of increase in tensile force of 0.15 N/mm².s. Both tests are performed at 23°C. The result reported for bond strength is stress at maximum force. The change in the conduct of the test could cause the Belgian requirements for bond strength to become inapplicable.

Tests were carried out on four sheets welded to a concrete substrate and covered with an asphalt layer or not. A computer-controlled tensile testing machine was used and the test specimens (three per test) were obtained by sawing. From the results (with standard deviations in brackets) it appears that bond strength is always greater for the concrete/sheet system than for the entire system. Regardless of the presence of an asphalt layer, failure occurs at the sheet/tack coat interface, within the sheet itself (above or below the reinforcement, or (in one case) at the sheet/AC interface.

No values for repeatability (r) and reproducibility (R) are indicated in this standard as well. It is specified that mean bond strength shall be calculated from a minimum of three accepted results of valid tests. However, it is not explained what is to be understood by “valid”. In the tests performed, standard deviations from 6 to 21 % were obtained per three test specimens exhibiting the same plane of failure. With different planes of failure (AS4), they can be as high as 31 %. The standard does not clearly state whether such a result can be accepted. In our experience, it remains risky to give an assessment of bond strength on the mere basis of results obtained on three test specimens of (50 x 50) mm². Additionally, there is a fear that edge effects may become very important when testing such small specimens (the surface area is only ¼ of the surface area specified in the Belgian method).

Table 4 – Mean results of bond strength on sheets and systems according to EN 13596.

Sheet / asphalt layer	Bond strength EN13596 (MPa)	Sheet / asphalt layer	Bond strength EN 13596 (MPa)
APP5	0.92 (0.054)	AS4	0.66 (0.204)
APP5/AC	0.73 (0.121)	AS4/MA	0.58 (0.100)
APP5/MA	0.76 (0.126)		
AS5	0.88 (0.084)	SBS	0.79 (0.162)
AS5/AC	0.82 (0.103)	SBS/MA	*

* No measurement possible owing to a defect in the sheet, which prevented the increase in force from being implemented.

Table 5 compares bond strengths determined by the European and the Belgian test, for three batches of test specimens. European concrete substrates were used in both cases. The values found in the European test were invariably higher.

Table 5 – Comparison of bond strengths between EN 13596 and the Belgian method, each time on substrates as specified in EN 13375.

System	EN 13596 Bond strength (MPa)	Belgian test Bond strength (MPa)	Difference (MPa)
APP4	0.99	0.82	0.17
SBS4	0.79	0.53	0.26
AS/GA	0.48	0.21	0.27

4.5 Resistance to compaction of an asphalt layer (EN14692)

When a waterproofing sheet is to be covered with an asphalt layer requiring compaction, it must be certain that the sheet will not be perforated during this compaction. Not all sheets are compatible with such a layer.

The European standard specifies two methods for the determination of the resistance to compaction of an asphalt layer. The first is the French method, while the second is the Belgian method implemented with the asphalt layer described in Section 4.2.3. The major difference between the two is that the sheet is fully bonded in the French method, whereas in the Belgian method a de-bonding interface is laid between the sheet and the base specimen and between the sheet and the asphalt layer. In the French method, a watertightness test is to be performed on the sheet/asphalt layer system (after the concrete has been removed) when perforations have been detected during visual inspection. If this system passes the watertightness test, it is considered as resistant. The watertightness test used in the Belgian method is different. It is performed when the sheet exhibits no perforations visible to the naked eye. If the sheet passes this test, it is considered as resistant.

In order to verify whether the two methods yield the same results, the French method was implemented on sheets that had previously passed the Belgian test. The French method led to the same conclusions. However, it was found that wrong conclusions could be drawn when the watertightness test was performed anyway – needlessly, since there were no perforations –, just to test the equipment. Not a single waterproofing sheet turned out to pass the watertightness test. In our experience, this is due to the high void ratio of the compacted asphalt layer. The required value – between 5 and 9 % – must be achieved by light compaction. This probably results in a weak asphalt layer that makes no contribution in the watertightness test. The only successful test was performed with a normal lab-compacted asphalt layer (voids content: 3.2 %). Consequently, we consider that the requirements for the void content of the compacted asphalt layer need to be revised. It was also found during execution that the temperature specified for the pressure cell during the installation of the test specimens is much too high, which causes drainage of bitumen from the sheet (drops forming on the underside of the grid of the water pressure cell); also, the sealing bitumen tends to flow away, casting doubt on the quality of sealing along the walls.

No precision data is available for this test too.

4.6 Behaviour during application of mastic asphalt (EN14693)

This characteristic needs to be tested only on sheets compatible with mastic asphalt, which does not apply to all sheets. Conventional mastic asphalt is laid at temperatures of about 220°C, and conventional asphalt concrete at 150 to 170°C. A disadvantage of this high laying temperature is that the bitumen in the underlying layer – in this case the bitumen sheet – can soften to such an extent that it bleeds into the mastic asphalt layer and even rises to the surface of it. This may result in the sheet losing so much binder that its waterproofing function is endangered. The mastic asphalt too may be weakened by this ingress of binder.

Belgium has a long-standing practice of determining this characteristic. The test was performed on the overlap of two sheets. Red mastic asphalt was applied at 250°C (worst case) onto this overlap. After cooling, no black specks due to binder bleeding from the sheet were allowed to be visible at the surface of the red mastic asphalt. If no such specks were observed, the investigation was continued by an IR survey of the binder extracted from a 1 cm thick slice of mastic asphalt taken 5 mm above the sheet (for the bottom 5 mm of the mastic asphalt it is assumed that some mixing occurs between the bitumen of the sheet and the mastic asphalt, which is necessary for good bond). The IR spectrum was not allowed to reveal any presence of polymer, since the mastic asphalt was bound with ordinary bitumen (without polymer) and any polymer detected could only come from the sheet. Finally, on a plane of failure through the test specimen (cold-fractured rather than sawn, as sawing may result in polymer-modified binder being spread over the mastic asphalt and erroneously interpreted as a sign of bleeding) it was checked under UV light whether any phases due to binder migrating from the sheet were present in the mastic asphalt (and, if so, to what level); this detection was based on the fluorescent properties of the polymers used. To meet the requirements, no black specks were allowed to appear at the surface of the red mastic asphalt and no polymer was allowed to be detectable in the IR spectrum of the binder recovered from the slice of mastic asphalt.

In the European test use is made of test pieces cut from a roll, UV-C lighting is used to detect specks at the surface of the red mastic asphalt in case of doubt, specks are quantified, observations are made on a sawn plane rather than on a plane of failure, inclusions of binder from the sheet in the mastic asphalt (either bonded to the sheet or in the bulk of the mastic asphalt) are measured and counted, and the decrease in thickness of the sheet after pouring of the mastic asphalt is determined.

Table 6 presents the mean results for three sheets compatible with mastic asphalt (SBS, APP5 and AS4) and for one sheet incompatible with mastic asphalt (AS5), in order to reveal certain phenomena indicating how the specks appear, what is the advantage of using UV-C, and how the inclusions can be observed.

Table 6 – Behaviour during application of mastic asphalt according to EN 14693.

	AS5*	SBS	APP5	AS4
BRRC test piece	3585	4815	3305	3584
Mean thickness before application (mm)	5.0	3.9	4.9	4.1
Specimen with red mastic asphalt	4495	4831	4493	4494
Mean thickness after application (mm)	3.7	3.3	4.7	4.0
Mean change Δt (mm)	1.3	0.6	0.2	0.1
Inspection of the surface				
Visual light	Scattered large black specks	A few small black specks	0 black specks	0 black specks
UV-C light	Numerous yellowish specks	No extra specks	Numerous yellowish specks	Limited number of yellowish specks
Quantification of specks, S (%)				
Mean S (%) (rounded off to the nearest 5 %)	15	0	10	5
Inspection of sawn faces				
Side A Inclusions under visual light Inclusions under UV-C light	0 0	0 0	0 0	0 0
Side B Inclusions under visual light Inclusions under UV-C light	0 0	0 0	0 0	0 0

* This sheet is incompatible with mastic asphalt.

UV-C lighting of the surface revealed specks in all compatible systems where no black specks had been observed in visible light. The test further indicated that the procedure is hard to implement correctly using only the data from the standard. Additional information on the difference in behaviour between APP (speck-susceptible) and SBS (inclusion-susceptible) is necessary to perform the test correctly. The standard erroneously recommends the use of UV-C light in case of doubt during the visual inspection of sawn faces. This is ineffective on sawn faces, owing to the presence of other (than polymer) fluorescent particles. In ref [1] it can be found that the use of UV light is inappropriate for that purpose. Further information is required when conducting surveys for inclusions.

Precision data is, again, not available.

5. FINDINGS ABOUT THE TEST METHODS

In elaborating and implementing the tests, a number of problems and/or shortcomings have been found in the descriptions given in the European standards. These standards are the work of experts from the participating European countries (fifteen countries represented in CEN/TC254 WG6 at the time of drafting of the test methods). The lack of knowledge of new test methods or the effect of changes in test methods, or also the lack of laboratory practice, is at the basis of some imperfections in the first generation of these standards. Table 7 reviews the most important comments, with suggestions for improvements. The experience gained in this study will be very useful during the five-yearly revisions of the standards.

Table 7 – Review of comments on the test methods, with suggestions for improvements.

Test method	Item	Suggestion
EN 13375 Specimen preparation	Determination of the texture of the concrete substrate Asphalt layer: requirement for void content determination of void content	EN 13036-1 rather than EN 1766 No set values; require normal compaction EN 12697-6; make SSD method mandatory
EN 14223 Water absorption	Determination of mass after immersion	Add that no algae growth must be present
EN 13596 Bond strength	Test surface area Number of test specimens Precision data is lacking	Area of (100 x 100) mm² rather than (50 x 50) mm² At least 6; delete “valid” Set up a European ring analysis
EN 14653 Shear strength	Pressure cell capacity Rounding off of test result: not specified Precision data is lacking	No set maximum; specify that capacity must be suited to the systems to be tested To be specified after ring analysis Set up a European ring analysis
EN 14691	Precision data is lacking	Set up a European ring analysis
EN 14692 Behaviour during compaction of asphalt	For method 1: void content of the asphalt temperature of water pressure cell number of test specimens: 2 Precision data is lacking	 See above Maximum 120°C; If one test specimen leaks in the watertightness test and the other does not, the result of the test is “not resistant” Set up a European ring analysis

Table 7 – continued

Test method	Item	Suggestion
EN 14693 Behaviour during application of mastic asphalt	UV-C light on sawn faces	Abandon and inspect only in visual light
	Inclusions	Explain differences between APP and SBS
	Precision data is lacking	Set up a European ring analysis

6. NEW BELGIAN REQUIREMENTS

The technical approval guidelines G0001 (specifications) and G0002 (operational procedures) mentioned in Section 2 have been gradually adapted to the new situations. The standards for performance tests have been imported since 2006, for use in coexistence with the Belgian methods. This was also the right time to merge the two documents into one. The new document, G0001(2006), included both specifications and procedures, as well as provisional criteria for the new test methods.

In a new version released in 2011, the provisional criteria have been replaced with new criteria based on the study made at BRRC. They are presented in table 8.

Table 8 – New Belgian requirements to be met in the above-discussed tests.

Characteristic	Test method	Requirements
Water absorption	EN 14223	≤ 1 %
Bond strength	EN 13596	≥ 0.4 MPa (indiv.0.3 MPa)
Shear strength	EN 13653	≥ 0.1 MPa
Compatibility by heat conditioning	EN 14691	> 100 %
Resistance to compaction of an asphalt layer	EN 14692	watertight (method 2)
Behaviour during application of mastic asphalt	EN 14693	- proportion of specks ≤ 50 % - decrease in thickness ≤ 1 mm - number of inclusions ≤ 6

CONCLUSIONS

Based on the findings from the study, it can be stated that:

- the transition from the Belgian to the European test methods can be made without problems, thanks to the experience gained;
- there are imperfections in the standards, which need to be addressed in the five-yearly revisions of the standards;
- ring analyses should be set up to determine the precision of the test methods.

The study has made it possible:

- to set requirements for characteristics not investigated before in Belgium, based on new tests;

- to adapt the requirements for those characteristics tested by procedures in which the parameters have been changed.

REFERENCES

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