EUROBITUME DATA COLLECTION PROJECT

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ABSTRACT

Eurobitume's Task Force Data Collection has created a comprehensive database of bitumen properties for many commercially available bitumens in Europe. The database includes penetration grades, hard grades, PMB and special binders that were commercially available at the time of the project.
The outcome of the data collection supports positions taken earlier by bitumen industry representatives in the CEN specification discussions with hard evidence, e.g. on the applicability and limits of test methods.
Simple tests can and should be used for simple binders. The introduction of more complex tests for simple binders should not be considered unless they provide substantial improvement versus today. Needle Penetration is a suitable test for all types of binders, but the interpretation of Ring and Ball Softening Point is different for paving grade and hard paving grades than for PMB. More complex binders require more tests. DSR equipment offers the possibility to replace several traditional test methods for PMB, e.g. Ring and Ball Softening point, or Dynamic Viscosity at 60°C, but parameters and limits still need to be agreed on. DSR also offers opportunities for testing simple binders, but this is not the recommended route as simple tests are satisfactory.

Keywords: Performance testing, Performance based standards, Functional specifications

1. INTRODUCTION

The standardisation of product specifications and test methods for bituminous binders used in paving applications is a European task carried out by CEN/TC 336 "Bitumen and Bituminous Binders" under a mandate given by the European Commission to CEN, the Comité Européen de Normalisation. European Regulations also state that, as far as possible, product properties should be described according to the performance of the end product.

In 2005, CEN/TC 336 "Bitumen and Bituminous Binders" finalised a Technical Report; CEN/TR 15352[1]. This Technical Report summarised the status of test methods used for assessing bitumen for hot mix applications or those discussed as candidate methods to address the performance of the binders. CEN/TR 15352 also included a proposal and template to start a European wide data collection on bituminous binders using conventional as well as newly developed test methods and at various ageing stages.

The purpose of the data collection is to permit assessment of various test methods which may be suitable for future bitumen specifications. It is recognised that the binder properties alone do not necessarily determine pavement, or even mixture performance. Other parameters, such as aggregate characteristics, mixture design, manufacture and application also play an important role in pavement performance. It is a requirement of CEN that product specifications must ensure that bitumens which are currently available and performing satisfactorily are not excluded and also that innovation is not discouraged.

Eurobitume's members, representing the majority of bituminous binders supplied within Europe, wished to contribute to the CEN task and acted by preparing an industry-wide data collection project to be made available to CEN experts. A database was compiled comprising 146 unique datasets representing commercially available binders in Europe.

The principles of the Eurobitume Data Collection, its outcome and recommendations as well as future developments are described in this paper.

2. DATA COLLECTION

2.1. Principles

In CEN/TR 15352, a template is given as a framework to systemise the data collection on bituminous binders. Conventional test methods such as Needle penetration or Softening Point Ring and Ball are part of the template as are more enhanced tests, e.g. using Dynamic Shear Rheometer (DSR) or Bending Beam Rheometer (BBR), as well as different ageing stages of the binders to be tested.

The template is identical for all binders to be tested and was editorially updated since its publication.

As the framework of the data collection was developed in 2005, new test methods developed since then are not included and conclusions can only be drawn related to the framework of the data collection.

2.2. Procedures and Lessons Learned

Because the project involved sharing of detailed technical data between bitumen producers, submissions to the database had to be anonymous and submitted data sets not traceable back to an individual company or supplier. The methodology and process needed to be checked carefully for legal compliance.

As a consequence, the gathering of data was carried out by an independent third party, the origin of the data sets is only known to the supplier of the individual data set and the independent third party.

As anonymity of the data had to be ensured a deadline for submission of new data was fixed after which no new data sets could be accepted. Data sets were incorporated in the data base as packages of several individual sets on two dates only to avoid any potential identification of individual data sets..

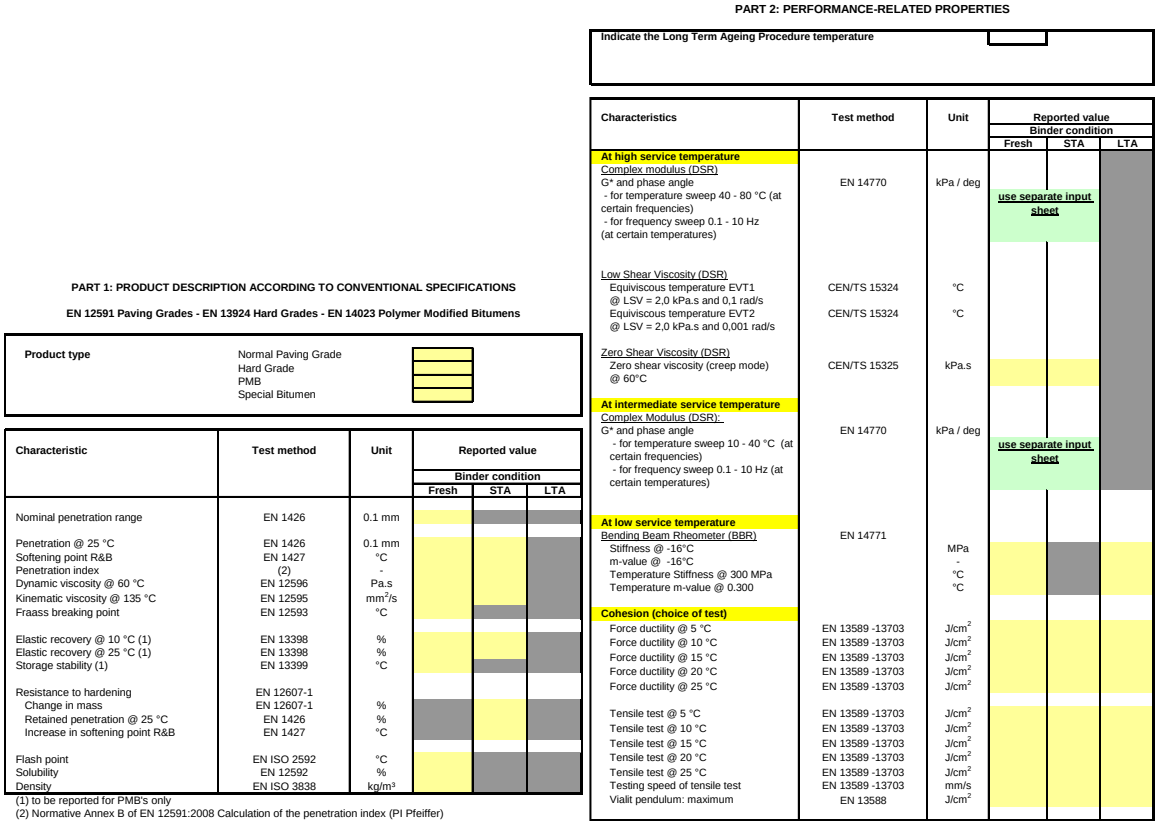
After receipt of the data sets each cell needed to be checked for errors, such errors included data being provided in the wrong format, examples of this were;

- Wrong units being used, e.g. g/ml instead of kg/m³ for binder density.
- Incorrect binder type being selected, e.g. paving grade bitumen rather than PMB.
- Typographical errors, e.g. omission of decimal point

The Task Force (TF) responsible for the data base decided that no corrections would be done without the confirmation of the supplier of the data set that there really was a mistake. Because the data owner was not traceable, all suppliers of data sets had to be addressed to check suspect data for errors and, in case corrections

were necessary the suppliers were asked to contact the independent administrator and instruct him to replace the incorrect data set. This was a time consuming process.

In addition, in cases where only very few data were available, information which might lead to traceability of data had to be removed. An example of this was that only one supplier was using the Rolling Cylinder Ageing Test (EN 15323). If details on the ageing method had been left in the database this supplier would have been identifiable. Therefore information on the test method for Long Term Ageing had to be deleted before sharing the data base to avoid traceability. The template for the data collection had to be updated to take this into account.



PART 1: PRODUCT DESCRIPTION ACCORDING TO CONVENTIONAL SPECIFICATIONS

EN 12591 Paving Grades - EN 13924 Hard Grades - EN 14023 Polymer Modified Bitumens

Product type	Normal Paving Grade Hard Grade PMB Special Bitumen	

Characteristic	Test method	Unit	Reported value – Binder condition: Fresh	STA	LTA
Nominal penetration range	EN 1426	0.1 mm			
Penetration @ 25 °C	EN 1426	0.1 mm			
Softening point R&B	EN 1427	°C			
Penetration index	(2)	-			
Dynamic viscosity @ 60 °C	EN 12596	Pa.s			
Kinematic viscosity @ 135 °C	EN 12595	mm^2/s			
Fraass breaking point	EN 12593	°C			
Elastic recovery @ 10 °C (1)	EN 13398	%			
Elastic recovery @ 25 °C (1)	EN 13398	%			
Storage stability (1)	EN 13399	°C			
Resistance to hardening	EN 12607-1				
Change in mass	EN 12607-1	%			
Retained penetration @ 25 °C	EN 1426	%			
Increase in softening point R&B	EN 1427	°C			
Flash point	EN ISO 2592	°C			
Solubility	EN 12592	%			
Density	EN ISO 3838	kg/m^3			

(1) to be reported for PMB's only

(2) Normative Annex B of EN 12591:2008 Calculation of the penetration index (PI Pfeiffer)

PART 2: PERFORMANCE-RELATED PROPERTIES

Indicate the Long Term Ageing Procedure temperature

Characteristics	Test method	Unit	Reported value – Binder condition: Fresh	STA	LTA
At high service temperature					
Complex modulus (DSR)					
G* and phase angle - for temperature sweep 40 - 80 °C (at certain frequencies) - for frequency sweep 0.1 - 10 Hz (at certain temperatures)	EN 14770	kPa / deg	use separate input sheet		
Low Shear Viscosity (DSR)					
Equiviscous temperature EVT1 @ LSV = 2,0 kPa.s and 0,1 rad/s	CEN/TS 15324	°C			
Equiviscous temperature EVT2 @ LSV = 2,0 kPa.s and 0,001 rad/s	CEN/TS 15324	°C			
Zero Shear Viscosity (DSR)					
Zero shear viscosity (creep mode) @ 60°C	CEN/TS 15325	kPa.s			
At intermediate service temperature					
Complex Modulus (DSR):					
G* and phase angle - for temperature sweep 10 - 40 °C (at certain frequencies) - for frequency sweep 0.1 - 10 Hz (at certain temperatures)	EN 14770	kPa / deg	use separate input sheet		
At low service temperature					
Bending Beam Rheometer (BBR)	EN 14771				
Stiffness @ -16°C		MPa			
m-value @ -16°C		-			
Temperature Stiffness @ 300 MPa		°C			
Temperature m-value @ 0.300		°C			
Cohesion (choice of test)					
Force ductility @ 5 °C	EN 13589 -13703	J/cm^2			
Force ductility @ 10 °C	EN 13589 -13703	J/cm^2			
Force ductility @ 15 °C	EN 13589 -13703	J/cm^2			
Force ductility @ 20 °C	EN 13589 -13703	J/cm^2			
Force ductility @ 25 °C	EN 13589 -13703	J/cm^2			
Tensile test @ 5 °C	EN 13589 -13703	J/cm^2			
Tensile test @ 10 °C	EN 13589 -13703	J/cm^2			
Tensile test @ 15 °C	EN 13589 -13703	J/cm^2			
Tensile test @ 20 °C	EN 13589 -13703	J/cm^2			
Tensile test @ 25 °C	EN 13589 -13703	J/cm^2			
Testing speed of tensile test	EN 13589 -13703	mm/s			
Vialit pendulum: maximum	EN 13588	J/cm^2			

Figure 1. Data collection template used for the data base

3. OUTCOME

3.1. Data Base

Eurobitume compiled a database comprising 146 unique datasets representing commercially available binders including 69 normal paving grades (NPG), 58 Polymer Modified Binders (PMB), 15 hard paving grades and 4 special binders, i.e. those not complying with an existing European Specification. The database also contained a data graphing function, an example of this can be seen in figure 2. A report detailing the findings was also prepared. Since completion, the Eurobitume Data Base has been made available for CEN/TC 336 members and experts.

In respect of lessons learned during the process;

- All in all, the complete data base consisted of approximately individual 60 000 data points. The handling of the data sets of various bituminous binders from all over Europe, each data set containing about 400 data points, had to be done carefully in order to avoid transformation errors. Version control of the data base was essential, given that numerous errors were introduced by data holders and cleaning of the data required re-submission of data sets.
- To ensure that data sets from different laboratories were comparable and ensure that the data base was valid, it was essential to ensure that all tests were carried out according to the same test conditions. Test method standards changed during the process of data collection, e.g. because of revision. This will need to be considered when adding further data sets.

- The availability of test equipment is different for individual test methods. For some test methods, only relatively few data are available, therefore the statistical power of the data base needed to be considered during analysis of the submitted data.

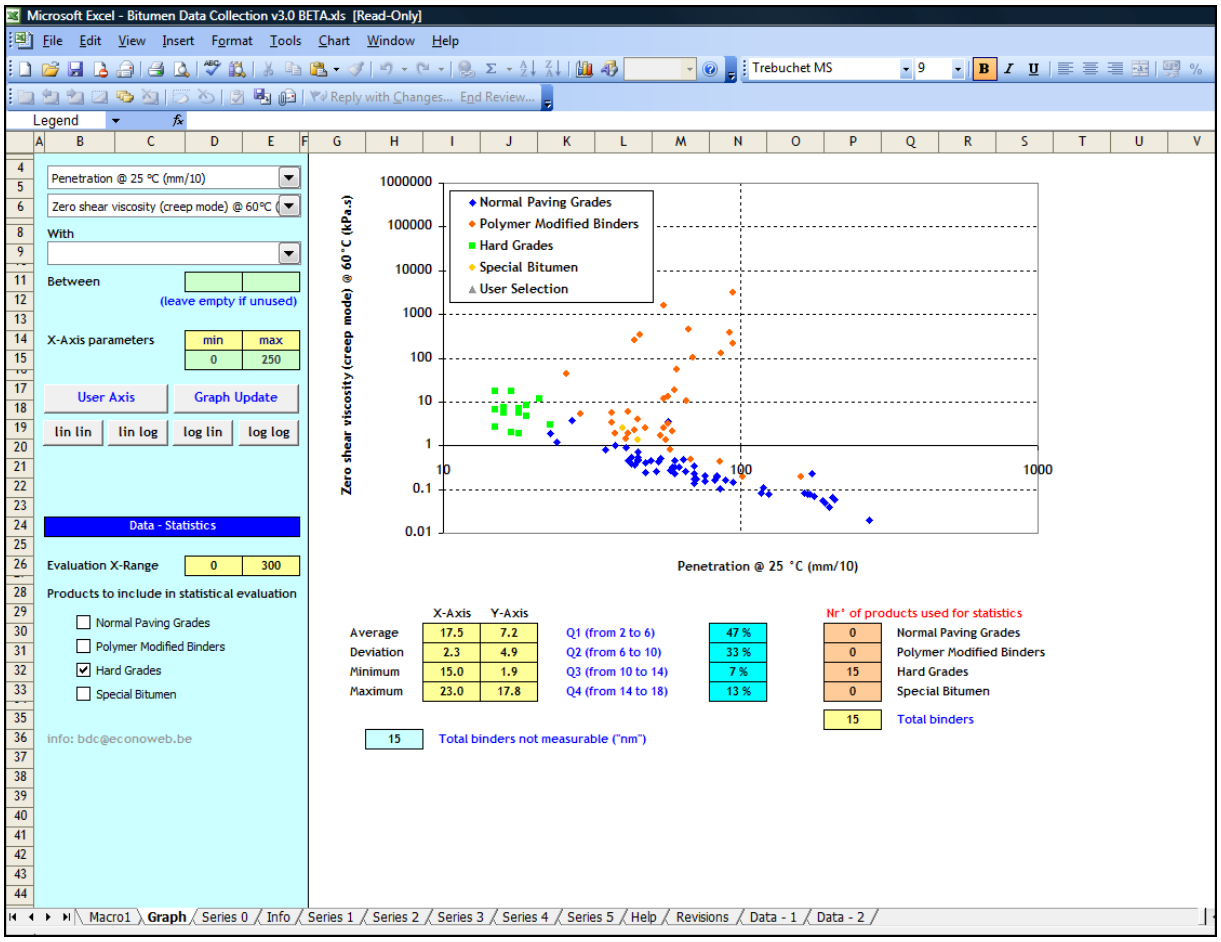


Figure 2. Screenshot of the Eurobitume data collection data base

3.2. Position Paper on Test Methods

In addition to the data base Eurobitume produced a position paper[2]. The Position paper provides practical experience such as timing, precision, suitability for the various types of binders, with available information on test methods. It also gives background on additional information gained when testing aged binders and recommends promising procedures which might be useful for future specifications.

In order to provide information on the test methods used during the data collection, practical experience with test methods was collected in a systematic approach. Additionally, correlation checks were undertaken for all available test methods in order to determine whether certain properties could be considered to be performance related. The purpose of these statistical checks was not to describe or compare individual binders, as it was not the intention of the Data Collection to collect limit values for future specifications.

The statistics were carried out based on 90% confidence interval and, in order to produce robust conclusions with sufficient statistical power, only where at least ten data points were available for the analysis. Correlation between test results was checked for each of the four different types of binder (normal paving grades, PMB, hard paving grades, special binders) and for groups of them. However, only those results are given where most of the binders are included: e.g. if a correlation was determined for all binders, but also for paving grade bitumen only, only the correlation result for all binders was provided. The Eurobitume TF Data Collection considered that a correlation existed if $R^2 \geq 0.9$ for the regression graph determined.

Interestingly, in some situations extremely good correlations were noted for properties that were not fundamentally related, e.g. Penetration value and Ring & Ball Softening point showed an excellent correlation for paving grade bitumens. After consideration it was concluded that, in certain cases, the correlation existed because the data set was not random, i.e. paving bitumens complied with the specification EN12591 and this

was the underlying reason for the correlation. When good correlations were identified the TF considered whether the correlation was indeed due to a fundamental property, or whether it was an artefact of the data collection process. An indication of the complexity of the validation process can be seen in figure 3, where each property was correlated with the others.

3.3. Messages

The outcome of the data collection supports, with hard evidence, positions taken earlier by bitumen industry representatives in the CEN specification discussions, e.g. on the applicability and limits of test methods.

- Simple tests can, and should, be used for simple binders, i.e. paving grades. The introduction of more complex tests for simple binders should not be considered unless they provide substantial improvement versus today.
- Needle penetration is a suitable test for all types of binders, but the interpretation of ring and ball softening point is different for paving grade and hard paving grades compared with complex binders, such as PMB.
- Rheologically complex binders require more tests. The Dynamic Shear Rheometer (DSR) equipment offers the possibility to replace several traditional test methods for PMB, e.g. ring and ball softening point, or dynamic viscosity at 60°C, but parameters and limits still need to be determined. DSR also offers opportunities for testing simple binders, but this is not the recommended route as simple tests are satisfactory.
- For PMBs there is a need to measure high temperature properties in a better way than traditional tests allow. The determination of EVT1 from LSV-testing in DSR might offer a solution, but because the method and the standard are relatively new, further evaluation is necessary.
- The Dynamic Shear Rheometer is considered to be an important tool for testing in future, especially for modified binders. Some test methods do not appear to add value: e.g. Zero Shear Viscosity.
- None of the test methods measuring low temperature properties (Fraass Breaking Point and BBR) are completely satisfactory the way they are currently used.

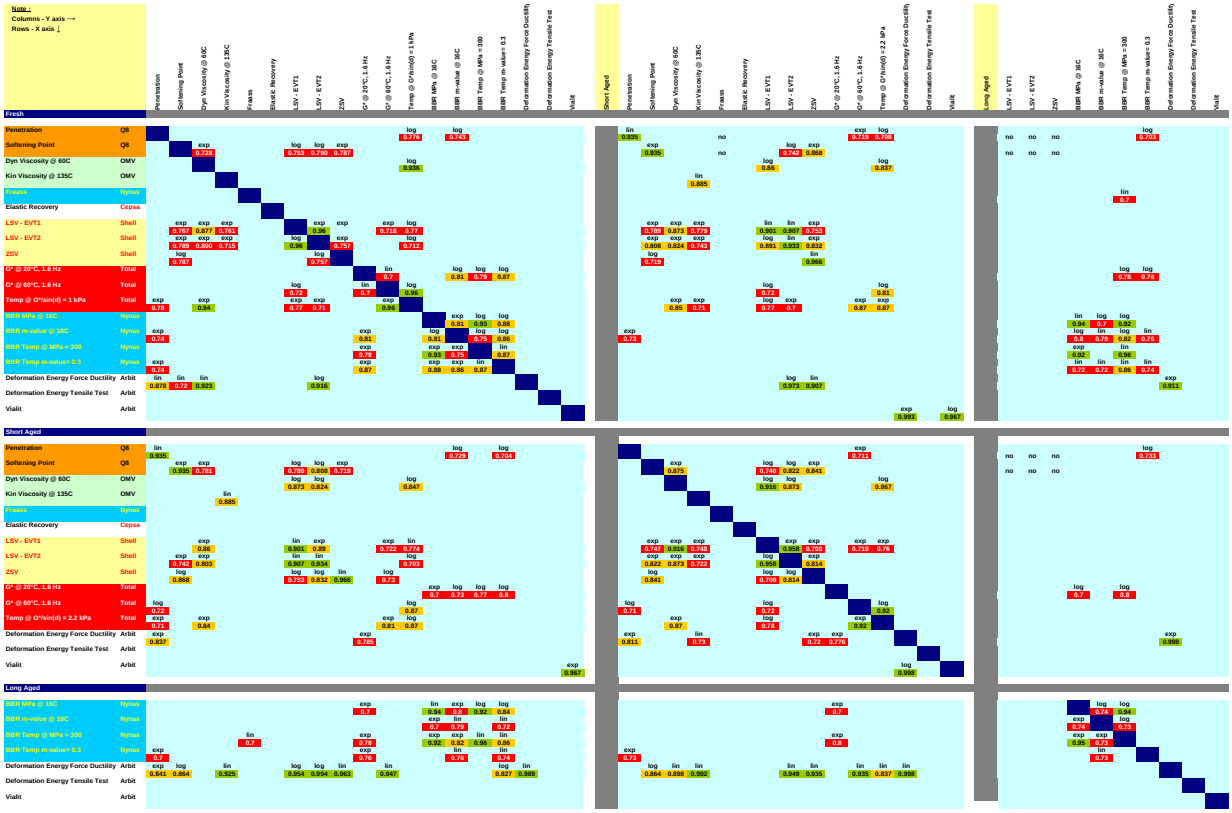


Figure 3. Screen capture of correlation evaluation

4. NEXT STEPS

4.1. CEN Data Collection

The Eurobitume Data Collection is the bitumen industry contribution to the CEN Data Collection project, initiated by publication of CEN/TR 15352. The Eurobitume position paper as well as the data base has been made available to CEN experts.

Eurobitume gained organisational as well as practical experiences with the population and management of the data base. When requested by CEN/TC 336, Eurobitume agreed to extend the Eurobitume data base using data provided by TC 336 members as well.

CEN members were requested to submit their data sets in 2010 and it is expected, that additional data sets will cover geographical regions beyond that of Eurobitume members as well.

Of course, the same principles of confidentiality of data sets, data submission and corrections apply for the CEN data holders as with the Eurobitume project.

4.2. Performance Related Specifications (PRS)

The Data Collection project is a systematic step towards performance related specifications for bitumen and bituminous binders in Europe. Its outcome assists to identify suitable test methods for the binders, as well as gaps into which further investigation and research may need to be carried out.

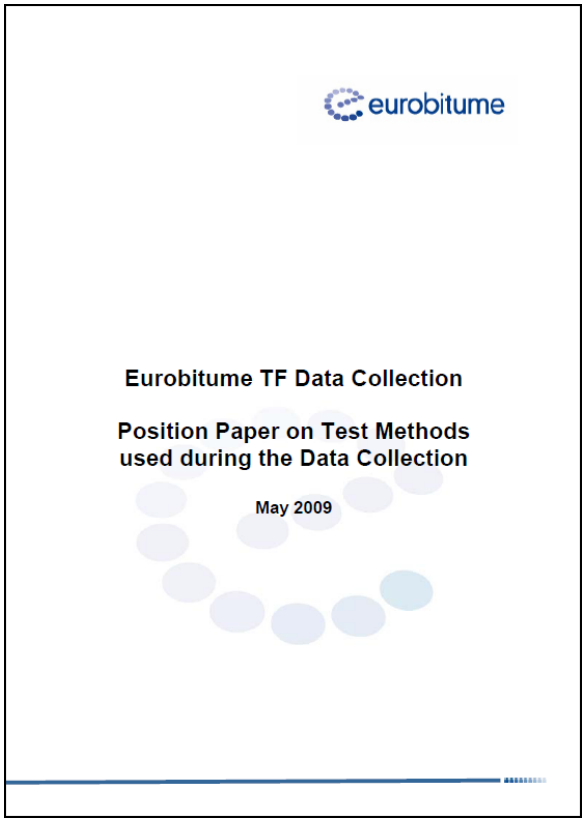


Figure 4. The Eurobitume Position paper

5. Acknowledgements

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6. References

[1] CEN/TR 15352 “Bitumen and bituminous binders – Development of performance-related specifications: status report 2005”

[2] Eurobitume TF Data Collection Position Paper on Test Methods used during the Data Collection, Eurobitume, May 2009