AUSTROADS TEST METHOD ATM 192 [AGPT/T192]

Characterisation of the Viscosity of Reclaimed
Asphalt Pavement (RAP) Binder Using the
Dynamic Shear Rheometer (DSR)

Commentary

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**Preface**

This test method was prepared by the Bituminous Surfacings Working Group (BSWG) and the Asphalt Research Working Group (ARWG) acting on behalf of the Austroads Pavements Task Force (PTF). Representatives of Austroads, ARRB Group and the Australian Asphalt Pavement Association (AAPA) have been involved in the development and review of this test method.

The viscosity of binder recovered from RAP material is an important parameter in the design asphalt mixes containing RAP. The Dynamic Shear Rheometer (DSR) is a suitable device to measure the viscosity of the binder sample. The instrument operates by repeatedly shearing a disk-shaped sample placed between two parallel circular plates to a pre-set strain level under an oscillation loading mode. During the oscillation loading cycles, the peak force (torque), peak displacement and the time gap between the two peak values are recorded. These values are used to calculate the complex viscosity (*η\**) as the outcome of this test procedure.

**Scope**

The test method sets out the procedure for the determination of viscosity of binders recovered from RAP source materials, as well as of virgin binders and rejuvenators. The viscosity is determined under specific conditions of oscillation loading, using a commercial DSR device suitable to conduct testing of asphalt binders. Testing is performed to characterise the viscosity of the RAP binder under the following standard conditions: a temperature of 60°C, an oscillation rate of 1 rad/s and a strain amplitude of 0.1. The viscosity results obtained through this method can be used in the design of binder blends containing RAP binder, virgin binder and/or rejuvenator to a specified viscosity.

**Further Development**

This test method is under development and some changes in the test parameters may occur in the future.

**Safety Disclaimer**

**Warning: the use of this Austroads test method may involve hazardous materials, operations and equipment. This Austroads test method does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this Austroads test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.**

# References

The following documents are referred to in this method:

| **Austroads Test Methods** |
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| ATM 102 | Protocol for Handling Modified Binders in the Laboratory |
| ATM 191 | Extraction of bituminous binder from asphalt. |
| **Australian/New Zealand Standard** |
| AS/NZS 2341.2 | Methods of testing bitumen and related roadmaking products, Method 2: Determination of dynamic viscosity by vacuum capillary viscometer |
| AS/NZS 2341.21 | Method of testing bitumen and related roadmaking products – Method 21: Sample preparation. |
| **ASTM International** |
| ASTM D7175 | Determining the Rheological Properties of Asphalt Binder Using a Dynamic Shear Rheometer (DSR). |

# General

This test method provides a characterisation of the viscosity of the components of a binder blend containing RAP using a DSR device. Other conventional viscosity measurement methods (e.g. dynamic viscosity by flow through a capillary tube as described in AS/NZS 2341.2) could be used as an alternative approach. In such cases, this test method is not relevant and the users should follow the formal procedure as set by the relevant test method.

# Equipment

1. DSR that satisfies the mechanical/operational requirements of ASTM D7175.

*Note: DSR consists of a number of parts such as an environmental chamber, a loading device, and a data acquisition system. These parts may be attached to the main unit as a modular system or incorporated in the main unit depending on the design of a specific product. Regardless of the design, meeting requirements in ASTM D7175 ensures that the device is suitable for testing.*

1. Computer capable of operating the DSR manufacturer supplied control/data acquisition software.
2. 25.00 (± 0.05) mm diameter parallel metal test plates supplied by the DSR manufacturer.
3. Silicone rubber moulds for 25.00 mm plates supplied by the DSR manufacturer.
4. Trimming tool: Thin metal tool supplied by the DSR manufacturer or a spatula.
5. Heat source: Heat lamp (250 Watts recommended), hot plate operating at temperature of 150°C ± 5°C, or oven thermostatically controlled to operate at temperature of 100°C ± 5°C.
6. Small butane torch.
7. Compressed air supply.

## Verification of DSR

Verify the accuracy of the DSR relating to temperature control, test plate geometry and torque transducer in accordance with the calibration methods of ASTM D7175.

## Preparation of Apparatus

Preparation of the apparatus for testing shall be similar to configuration for testing in accordance with ASTM D7175. The instrument should be prepared for testing in accordance with the manufacturer’s instructions.

# Sample Preparation

## Sample Handling Precaution

Precautions required during sample handling are described in ATM 102.

## Binder Recovery from RAP Source Material

The binder sample is extracted from the RAP material using the binder recovery process as described in ATM 191, or appropriate alternative method as specified by the road agency. Four grams of recovered binder sample should be sufficient to conduct duplicate DSR testing as required by this method.

*Note: Other binders (e.g. virgin binder) can also be tested according to this method if required. In such cases, this step is not needed.*

## Preparation of the Binder Sample for DSR Testing

The sample preparation procedure described in this section is primarily for where the amount of binder sample available for testing is very small (e.g. RAP binder).

1. Prepare the DSR device for testing according to Section 3.2 and set the temperature to 60.0 ± 0.1°C.

*Note: This includes turning on the compressed air supply (if required for the device in use), the DSR, the computer and the control/data acquisition unit. A preparation procedure known as ‘Zero-gap’ may be required at the target temperature if the device does not do this automatically.*

1. Gently heat the binder sample with the heat source until sufficiently fluid to be stirred and poured.

*Note: For binders that do not have quantity restrictions (e.g. virgin binders or rejuvenators) samples can be heated in accordance with AS/NZS 2341.21.*

1. Pour a sufficient amount of sample (typically 0.8 g) onto the silicone rubber mould. Note that testing shall be initiated within two hours of pouring the sample.

*Note 1: ASTM D7175 method provides a number of different sample mounting methods (from sample container to DSR test plate). Any of the methods can be used but only the procedure that uses a silicone rubber mould is described in this test method for brevity. Most DSR manufacturers provide silicone rubber moulds that were designed for this part of the procedure. The silicone rubber mould should have an appropriately sizes/shaped indentation to assist forming a disk-shaped sample when poured onto the indentation.*

*Note 2: The silicone rubber mould method described here may not be appropriate if the sample has very low viscosity (e.g. rejuvenator). An appropriate sample mounting method is to be selected from ASTM D7175 depending on the design of a specific DSR device in use.*

1. Increase the gap between the upper and lower plates to allow sufficient room for sample mounting.
2. Transfer the binder sample in the silicone rubber mould to the centre of the lower test plate. If not correctly centred, use the silicone rubber mould to gently adjust the position of the sample.
3. Lower the upper plate onto the binder sample so the gap between the test plates is 1.05 mm. This should squeeze the excess binder out from the plate perimeter.
4. Observe whether there is excess binder present in all directions between the two plates. If the sample fails to completely fill the space between the two plates (e.g. any section of the plate is visible or empty), discard the sample and repeat the sample mounting procedure with a new sample.
5. If correctly prepared, trim the excess binder using the trimming tool from around the perimeter of the gap between the two plates. Briefly heating up the trimming tool with a butane torch or the heat source can assist neat trimming.
6. Decrease the gap further to 1.00 mm. A slight bulge (refer to Figure 3.3 of ASTM D7175) of the binder sample around the perimeter of the two plates should be noticeable.
7. Condition the binder sample at the test temperature of 60.0 ± 0.1°C for 15 ± 5 minutes.

# Measurement of Complex Viscosity

1. Set the DSR to a strain controlled oscillation test mode as follows:
	1. Oscillation frequency of 1 rad/s
	2. Strain amplitude of 0.1 (i.e. 10%)
2. Apply around 10 cycles of pre-conditioning oscillation loads, immediately followed by around 10 cycles of main oscillation loads.

*Note: For information, ASTM D7175 prescribes 8 to 16 cycles for pre-conditioning and main oscillation loads.*

1. Record the average value of the complex viscosity (*η\**) from the data obtained during the main 10 cycles of loading as an outcome of a single run test.

*Note: Most DSR manufactures provide a control and data acquisition system that allows the user to set up necessary test parameters as above. The average value of complex viscosity will automatically be calculated from the 10 individual readings in most cases (i.e. only the averaged value of the individual readings from the 10 main loading cycles will be reported to the user).*

1. Run a duplicate sample by repeating Steps 5 (a) to 5 (c).
2. Calculate the average value of the complex viscosities (*η\**) of the duplicate samples.

# Test Report

The following shall be reported:

1. Average of the duplicate complex viscosity results (*η\**) to three significant figures in Pa∙s.

**Amendment Record**

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| Substitution | Old clause removed and replaced with new clause |
| New | Insertion of new clause |
| Removed | Old clauses removed |