Australian Standard®

Methods of testing bitumen and related roadmaking products

Method 4: Determination of dynamic viscosity by rotational viscometer

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CH/25 on Bitumen and Related Products for Roadmaking to supersede AS 2341.4—1980.

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is only for information and guidance.

METHOD

1 SCOPE This Standard sets out procedures for the determination of dynamic viscosity of bituminous materials at a defined shear rate, using constant rate of rotation viscometers with standard concentric cylinder measuring geometries.

2 REFERENCED AND RELATED DOCUMENTS

2.1 Referenced documents The following documents are referred to in this Standard:

AS/NZS	
2341	Methods of testing bitumen and related roadmaking products
2341.1	Part 1: Precision data—Definitions
AS	
3882	Rheology—Glossary of terms and classification of properties

2.2 Related document Attention is drawn to the following related document:

DIN	
53019	Determination of viscosities and flow curves using standard design rotary viscometers with a standard geometry measuring system

3 DEFINITIONS For the purpose of this Standard, the definitions given in AS 3882 apply.

4 PRINCIPLE The material being tested is sheared in the annular space between two concentric cylinders by rotating the inner cylinder (rotor) at a constant speed and keeping the outer cylinder (cup) stationary. The torque generated in the drive to the inner cylinder by the viscous resistance of the material is measured by a torque transducer, usually by the angular displacement of a torsion element, such as a spring or torsion bar. (See Figure 1.)

The viscosity determination consists of establishing the relationship between the shear stress and the shear rate, which are determined from the measured torque and rotational speed, respectively, and the rotor/cup geometry.

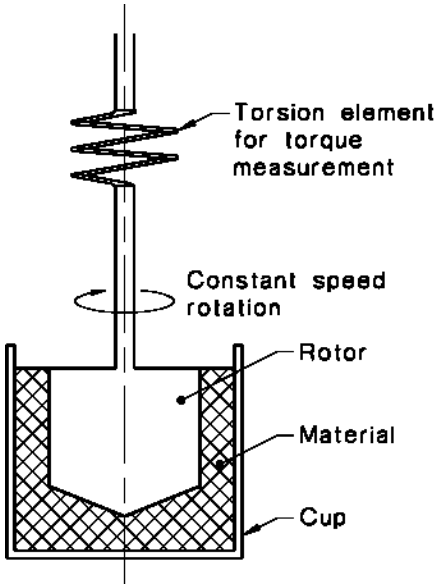

FIGURE 1 ROTOR/CUP ASSEMBLY
ILLUSTRATING PRINCIPLE OF VISCOSITY MEASUREMENT
USING A ROTATIONAL VISCOMETER

5 APPARATUS

5.1 Rotational Viscometer The rotational viscometer shall consist of the following:

(a) *Basic instrument* The basic instrument shall have a facility for holding a measuring system, consisting of a cup and rotor, for generating a range of defined rotational speeds and for measuring the resulting torque.

The apparatus shall have an accuracy of torque measurement of better than 1% of full scale reading, and an accuracy of 1% or better for the rotational speeds.

(b) *Measuring system* The measuring system (cup and rotor) shall essentially conform to DIN 53019 and have a standard geometry as shown in Figure 2. The dimensions shall be as indicated to ensure a geometrically similar flow field for viscosity measurements using different types of rotational viscometers. This is an important consideration when the material characteristics deviate from newtonian behaviour.

NOTE: Other measuring systems with different geometries, such as described for earlier instruments in Appendices A and B, may be used, but are not recommended. Errors can occur due to fitting problems and air entrapment when dealing with hot materials such as bituminous binders.

5.2 Temperature control device The instrument shall be fitted with a temperature control device capable of maintaining the sample temperature within 0.1°C.

This can be a temperature-controlled bath for direct immersion of the measuring system, a temperature-controlled circulator supplying liquid to a thermostatting jacket surrounding the measuring system, or other means such as an electrically heated metal block incorporating the measuring system.

An indicating thermometer shall be fitted to the temperature control device for monitoring the sample temperature.

Preferred geometric ratios:

$\frac{r_2}{r_1} \leqslant 1.1$

$\frac{h}{r_1} \geqslant 3$

$\frac{t'}{r_1} \geqslant 1$

$\frac{t''}{r_1} \geqslant 1$

$\frac{r_s}{r_1} \leqslant 0.3$

$90° \leqslant \alpha \leqslant 150°$

LEGEND:
r_1 = radius of rotor (m)
r_2 = radius of cup (m)
r_s = radius of shaft (m)
h = height of rotor (m)
t' = distance of bottom edge of rotor from bottom of cup
t'' = length of immersed part of the shaft
α = apex angle of the cone at the bottom of the rotor

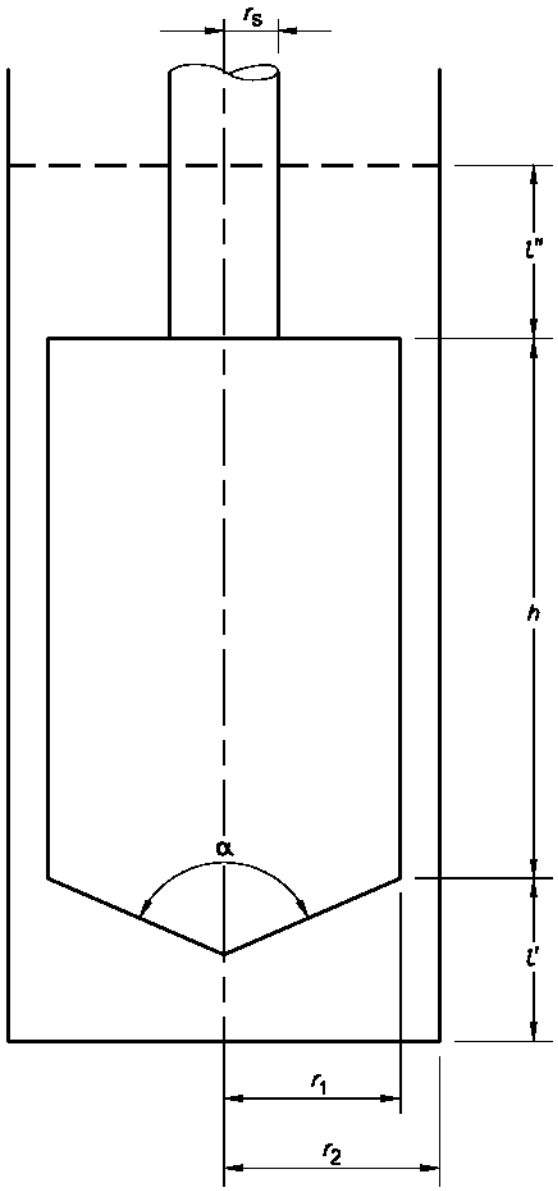

FIGURE 2 STANDARD MEASURING SYSTEM

6 CALIBRATION

6.1 General Apart from checking that the indicated rotational speeds are correct, there are two calibration requirements for the instrument, in the following order:

(a) Establish the calibration constant for the instrument with a particular measuring system. This is done by directly measuring the torque characteristics of the instrument, or by means of a standard calibrating fluid of known viscosity at room temperature.

This calibration shall be done at least once a year.

(b) Establish the relationship between 'effective' temperature of the test sample and the temperature indicated by the measuring thermometer using a standard calibrating fluid of known viscosity at the required test temperature.

This calibration shall be done when initially setting up the instrument, and whenever any significant changes have occurred.