

COMMENTARY TO AG:PT/T123 - TOUGHNESS OF POLYMER MODIFIED BINDERS (FORCE DUCTILOMETER)

PREFACE

This modified binder test method was prepared by the Bituminous Surfacing Research Reference Group on behalf of Austroads. Representatives of Austroads, ARRB Group and Industry through the Australian Asphalt Pavement Association (AAPA) have been involved in the development and review of this test method.

FOREWORD

Polymer modified binders (PMBs) exhibit complex rheological behaviour and, consequently, simple testing equipment will not provide a satisfactory measure of their characteristics. Toughness is a property which is considered to be an important PMB performance characteristic and is an indication of the cohesive strength of a PMB under strain and retention of that strength during extension.

SCOPE

This method is applicable to PMBs.

Further Development

There are no further plans for the development of this test method.

TOUGHNESS OF POLYMER MODIFIED BINDERS (FORCE DUCTILOMETER)

1 REFERENCED DOCUMENTS

The following documents are referred to in this method:

AUSTROADS

AG:PT/T101 Method of sampling polymer modified binders, polymers and crumb rubber

AG:PT/T102 Protocol for handling polymer modified binders in the laboratory

AS

2341 Methods of testing bitumen and related roadmaking products

2341.11 Method 11: Determination of ductility

ASTM

E 1 Standard specification for ASTM thermometers

2 APPARATUS

The following apparatus is required:

- a. **Ductilometer** - as specified in AS 2341.11, with the following modifications:
 - i. *Load measuring device* - a suitable load measuring device and appropriate output conditioning electronics is required to couple to the fixed sample end in a manner that allows the force developed in the sample to be monitored through the test.
 - ii. *Where a load cell is used under water (simplest assembly), the cell must be rated for total immersion.*
 - iii. *An alternative arrangement positions the load cell outside the bath and couples to the fixed sample assembly via a lever or a rigid coupling.*
 - iv. In all cases, the load cell must be axially loaded (in compression or tension), and a practical method of calibration supplied.
- b. **Brass mould** - as specified in AS 2341.11, modified to achieve straight sided specimens.
- c. **Thermometer** – A suitable thermometer is IP 39 C or ASTM 90C, as specified in ASTM E 1.
- d. **Chart recorder** - capable of recording the output of the load cell conditioner (suitably scaled) and with chart speeds in the range 10 mm per minute to 100 mm per minute.

- e. **Forced convection oven** - a forced convection oven capable of heating to 180°C and maintaining a temperature within $\pm 5^\circ\text{C}$ of the temperature at which sample heating is required for sample preparation.
- f. **Balance** - of suitable capacity, with a setpoint accuracy of 0.001g.

3 PROCEDURE

3.1 General

PMBs are complex mixtures of polymers and a variety of petroleum products. If handled in accordance with the directions of the suppliers, there should be no significant risk. The hazard of burns with PMBs is greater than with standard bitumens, due to the (normally) higher handling temperatures. It is recommended that notices, describing the action to be taken in the event of bitumen or PMB burns, should be displayed in the laboratory in the areas where bitumen and PMBs are handled. A suitable warning could be as follows:

WARNING: HOT BITUMEN & PMBs CAN CAUSE BURNS

The following precautions should be taken when handling bitumen, or PMBs:

- a. Eye protection, such as safety glasses and/or face shields, shall be worn when handling hot bitumen or PMBs.
- b. Heat-resistant gloves, with close-fitting cuffs, and other suitable protective clothing, shall be worn when handling hot bitumen or PMBs.
- c. There shall be no smoking while handling hot bitumen or PMBs.
- d. While the material is still cold, loosen the lid of the sample container (invert the can and warm the lid, if necessary), or punch a hole in the lid.
- e. Examine the cold sample for the presence of water. If water is thought to be present, drain most of it out, or blow with clean compressed air to evaporate the free water.

3.2 Sample preparation

Samples for testing shall be provided in accordance with AG:PT/T101 and AG:PT/T102.

3.3 Measurement

- a. Pour the sample into the ductility moulds, filling to a slight excess (see Note 1). Allow the specimens to cool at room temperature for 30 minutes, then place in the water bath (at the test temperature) for a further 30 minutes.
- b. Trim the excess sample from mould with a warmed knife.
- c. Allow the trimmed specimens to stand in the water bath for 90 minutes at a temperature which is within $\pm 0.5^\circ\text{C}$ of the specified test temperature.

- d. Remove the side pieces of the moulds and transfer the briquettes to their position in the ductilometer (see Note 2).
- e. Set the ductilometer in motion at 50 mm per minute recording the output from the load cell such that the peak output is in the range 50 to 100 percent of full scale on the chart recorder. (see Note 3). Continue the test until the sample breaks, or the force drops to an effective zero (less than 0.3 N).

5 CALIBRATION

The method of calibration will vary according to the method of installation of the load cell. In general, a technique using a length of piano wire, pulley and an appropriate range of known masses (1 kg = 9.8 N) can be used. Calibration is normally performed outside the bath with an assembly that simulates the geometry of the loading assembly in normal service. Care should be exercised to ensure that the loads are applied in the same manner as occurs during testing.

6 CALCULATION

The calculation of toughness by force ductilometer (chart recorder method) is as follows:

- a. Photocopy the chart record and determine the mass of a known area (reference area) of the chart (copy) using an analytical balance. Note its length, in m of instrument travel (using the chart speed and instrument rate of travel) and height, in N, from the load cell calibration and chart recorder sensitivity.
- b. Cut out the trace (copy) between the zero load line and the recorded trace and determine its mass using an analytical balance.
- c. Determine the Toughness of the sample at the test temperature using the following equation:

$$\text{Toughness} = \frac{100M_1HL}{M_2}$$

where

M_1 = mass of trace, in g.

M_2 = mass of reference area, in g.

H = height of reference area, in N.

L = length of reference area, in m.

Note 4: Height and length result from the chart recorder calibrations.

7 INFORMATION TO BE REPORTED

The following information shall be reported:

- a. Toughness, in N.m

- b. The maximum force, F , in N
- c. The distance at which the maximum force was observed (mm).

8 PRECISION

No inter-laboratory testing has been conducted for the range of PMBs currently available. However, preliminary studies indicate that results obtained from different laboratories should not be considered suspect unless they differ by more than 30% from the mean.

Notes

1. A suitable release agent should be used on the appropriate surfaces of the mould to aid removal of the sample prior to testing. Soft soap has served this purpose.
2. When testing at low temperatures, care should be exercised during removal of the side mould plates. A convenient technique is to push the assembly longitudinally, releasing the end pieces (grips), side-pieces and sample from the base plate. The side pieces are then readily removed from the sample.
3. A PC-based data acquisition system can be used in place of the chart recorder. The area under the curve is calculated by an integration technique.

AMENDMENT RECORD

Amendment No.	Clauses amended	Action	Date
1	Commentary Page	New	June 2005
	Footer and header	Format	
	Applied revised test method number	Format	
	Applied new styles	Format	
2	Applied new test method numbers	Substitution	March 2006
	Moved notes to the end of the method	Format	

Key

Format	Change in format
Substitution	Old clause removed and replaced with new clause
New	Insertion of new clause
Removed	Old clauses removed