Transport Roads & Maritime Services

NSW GOVERNMENT

Test method T271

Ball penetration test

APRIL 2012

Revision Summary

Ed/Rev Number	Clause Number	Description of Revision	Authorisation	Date
		Reformatted and Revision Summary Added	D Dash	May 1999
		Date on Test Method Revised to Agree with Date on Revision Summary	D Dash	Feb 2001
Ed 2/Rev 0	All	New Issue.	J Friedrich	Apr 2012

Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test method T271 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T271

Ball penetration test

1. Scope

This test method sets out the procedure for determining the depth of penetration by a steel ball dropped onto a road surface under the impact of a standard load.

2. General

(a) The ball penetration measure is used to:

(i) Indicate whether the pavement is suitable to apply the prime seal based on the level of compaction and dry-back.

(ii) Indicate the hardness of a primerseal.

(iii) In design, help estimate the embedment allowance for sealing aggregate over an existing surface (e.g. over primes, slick or fatty asphalt).

NOTE: Not reliable for existing seals owing to effect of aggregate.

(b) The following document is referred to in this Test Method:

(i) AS 2891.5 Methods of sampling and testing asphalt - Determination of stability and flow - Marshall procedure.

3. Apparatus

(a) Ball Penetrometer Unit.

(i) Type 1 Ball Penetrometer Unit without a self-standing frame:

- Conform to a Marshall hammer mass and drop height as given in AS 2891.5.
- Hammer fitted with a 19 mm case hardened hemispherical foot (i.e. 'ball').
- A method of measuring the relative penetration of the foot to the nearest 0.5 mm (either the shaft can be scribed or a fitted dial gauge).
- Fitted with a levelling bubble.

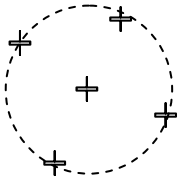
OR

(ii) Type 2 Ball Penetrometer Unit with a self-standing frame (Appendix A.1 and A.2).

- Drop hammer conforming to a Marshall hammer mass and drop height as given in AS 2891.5.
- Supporting frame with adjustable feet to ensure that the hammer is held vertical.
- 19 mm case hardened steel ball, a screw-in 19 mm case hardened hemispherical foot and a screw-in 19 mm case hardened flat (blank) foot.
- A method of measuring the relative penetration of the steel ball to the nearest 0.5 mm.

(b) Temperature sensor suitable for measuring surface temperature with at least 0° to 100 C range and limit of performance of 1°C.

4. Preparation



(a) Select the sample location to be typical of the road surface. The sample consists of test point at the centre and then 4 test points at about a 100 mm radius from the centre test point and evenly spaced.

(b) Clear away loose material from the sample location.

(c) Where the surface is obviously a soft bitumen surface, carry out the ball penetration test according to Step 5.2, otherwise according to Step 5.1.

5. Procedure

5.1 Ball penetration

(a) Assemble the Ball Penetrometer ready for use according to the manufacturer's instructions.

NOTE: Remove any transit pins (e.g. pins B and C for Type 2 as shown in Appendix A.1. To carry the Type 2 Ball Penetrometer, grip the external frame at just below the midway and lift gently.

(b) Position the Ball Penetrometer over the test point. Adjust position to ensure that the ball is not resting directly on stone or aggregate.

NOTE: The gaps between aggregates is acceptable.

(c) For a bitumen surface, allow the hammer unit to rest on the surface for about 1 min. If the ball sinks into the seal, carry out the test according to Step 5.2.

NOTE: No impact is applied to the surface.

(d) Steady the Ball Penetrometer in an upright in a vertical position so that the levelling bubble is approximately centred. Where provided, adjust the levelling feet.

NOTE: Type 2: Rest one knee firmly on the unit's base, at the same time grasp the rear of the unit near the top. The free hand is used to raise the hammer weight.

(e) Zero the direct measurement scale:

(i) Type 1: Attach the dial gauge (if required). Zero the collar against the scribed shaft and reset the dial gauge (if fitted). Remove the dial gauge (if fitted).

(ii) Type 2: Adjust the thumb screw and locking nut on top of the hammer.

NOTE: Locking of the thumb screw is optional.

(f) Apply one blow to the surface by raising the hammer weight to the top of the unit and allowing the hammer to fall freely to directly impact the surface.

(g) Measure and record the depth of penetration (*D*) to the nearest 0.5 mm:

(i) Type 1: Reattach the dial gauge (if required) and read the ball penetration depth using the scribed shaft or the dial gauge.

(ii) Type 2: Read the ball penetration depth using the scribed shaft.

(h) Lift the unit and check that no stone or aggregate is showing in the impression.

(i) Repeat Steps 5.1(b) to (h) a total of 5 times for each sample location.

(j) Where a bituminous surface is tested, record the temperature of the road surface (*T*) for each sample location to the nearest 1 C.

5.2 Ball Penetration on Soft Bitumen Surface

(a) This step is only for testing penetration of a soft bitumen surface using the Type 2 Ball Penetrometer.

(b) Assemble the Ball Penetrometer according to the manufacturer's instructions except for the following changes:

NOTE: Separate the frame only when it is evident that the hammer will sink into the seal under self-weight.

(i) Remove the detached upright section and the gauge pin:

- Replace the screw-in ball tip with the blank screw-in tip (refer to Appendix A.2).
- Remove pins A, B and C (refer to Appendix A.1).
- Detach the base of penetrometer frame by removing the two base thumb screws.

(ii) Assemble depth gauge (from pin of direct measurement scale) by removing graduated pin and reinserting perpendicularly in the slot provided.

(iii) Remove the 19 mm case hardened steel ball from the base.

(c) Place the 19 mm case hardened steel ball on the test point.

NOTE: To prevent the ball from rolling on flushed or graded surfaces, lay a transit pin on the road and place the ball inside the circular end.

(d) Centre the Ball Penetrometer base over the steel ball.

(e) Place the assembled depth gauge into the slots of the base sleeve (with the knurled end facing the steel ball). Measure down to the top of the steel ball by releasing the screw and lowering the knurled end onto the steel ball.

(f) Remove the gauge and record the initial measurement (D_1) to the nearest 0.5 mm.

(g) Place the hammer through the collar in the base so that the blank tip contacts the steel ball.

(h) Steady the Ball Penetrometer upright in position.

NOTE: Rest one knee firmly on the unit's base, at the same time grasp the rear of the unit near the top. The free hand is used to raise the hammer weight.

(i) Apply one blow by raising the hammer weight to the top of unit and allowing the hammer to fall freely and contact the ball.

(j) Remove hammer and replace the depth gauge (refer to Step 5.2(e)). Measure to the top of the steel ball (D_2).

(k) Lift the unit and check that no stone or aggregate is showing in the impression.

(l) Repeat the Steps 5.2(c) to (k) a total of 5 times for each sample location.

(m) Where a bituminous surface is tested, record the temperature of the road surface (T) for each sample location to the nearest 1°C.

6. Calculations

(a) Where Step 5.1(h) was used, calculate the ball penetration (D) at each test point to the nearest 0.5 mm as follows:

$$D = D_1 - D_2$$

Where D = Penetration depth at test point (mm)

D_1 = Initial measure to top of steel ball (mm)

D_2 = Second measure to top of depressed steel ball (mm)

(b) Calculate the average ball penetration (Pen) by averaging the 5 penetration depths (D) obtained from each test point.

(c) Determine the Ball Penetration depth (Pen_S) at standard summer road temperature for the sample location as follows:

$$Pen_S = Pen - K(T - T_S)$$

Where

Pen_S = Ball Penetration depth (mm) at standard summer road temperature

Pen = Average penetration depth (mm)

K = Factor (mm/°C) from Table 1

T = Temperature of road (°C)

T_S = Standard summer road temperature for location (°C) from Figure 1 (interpolate to nearest 1°C).

Table 1 – K Factors for Road Surfaces

Test Surface	K (mm/ C)
Granular base (not primed)	0.00
Single/single or double/double seal (not fatty)	0.04
Primer seal (not fatty)	0.06
Fatty seal, slurry seal, or slick or fatty asphalt	0.08

7. Reporting

Include the following results in the report:

(a) Location and date of test.

(b) Description of surface being tested.

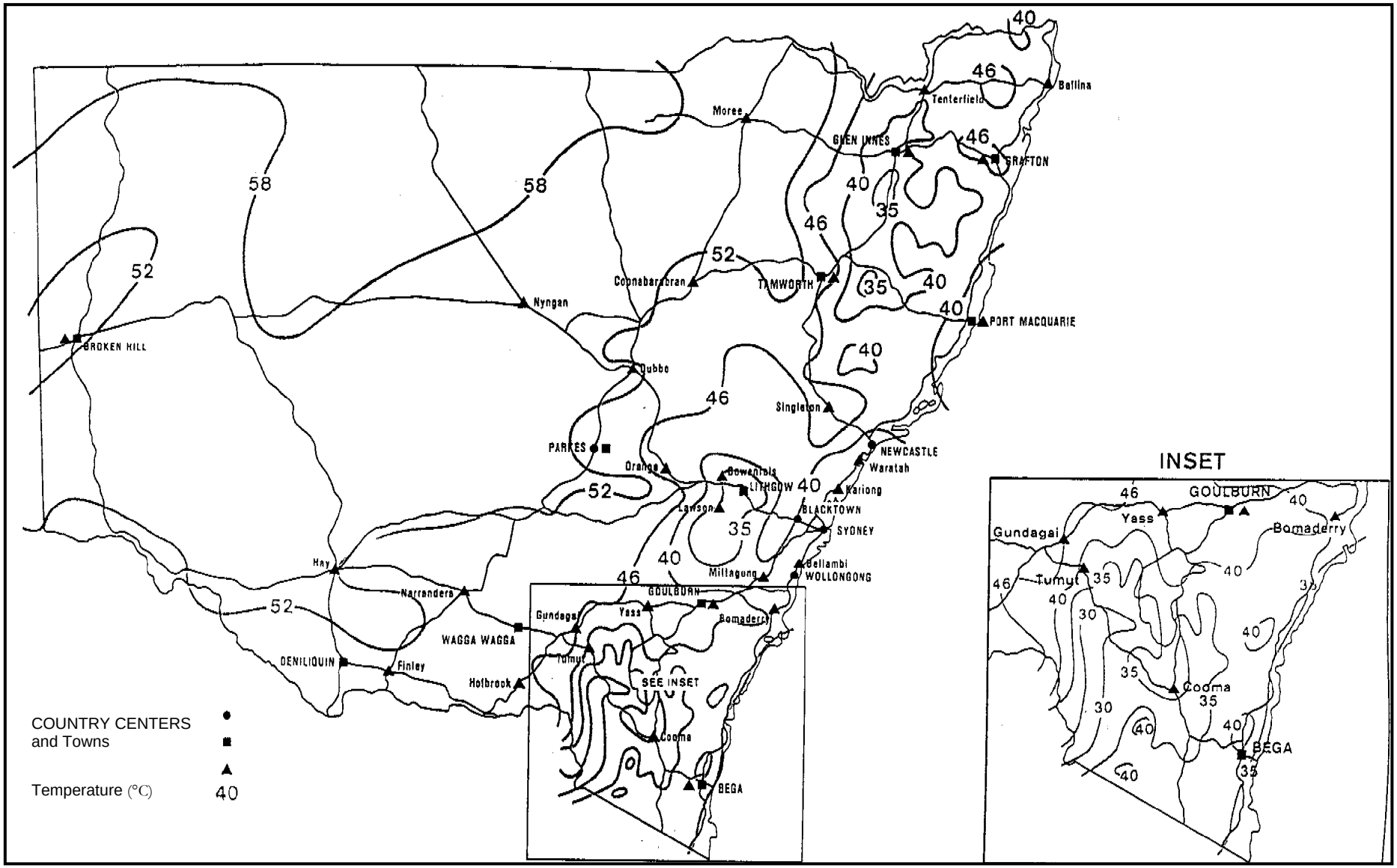
(c) Where testing unsealed granular bases, moisture content (if known).

(d) Where testing a bituminous surface, road surface temperature to nearest 1°C.

(e) The unadjusted ball penetration values (P) to the nearest 0.5 mm.

(f) The Ball Penetration (Pen_S) to the nearest 0.5 mm.

(g) Reference to this test method.

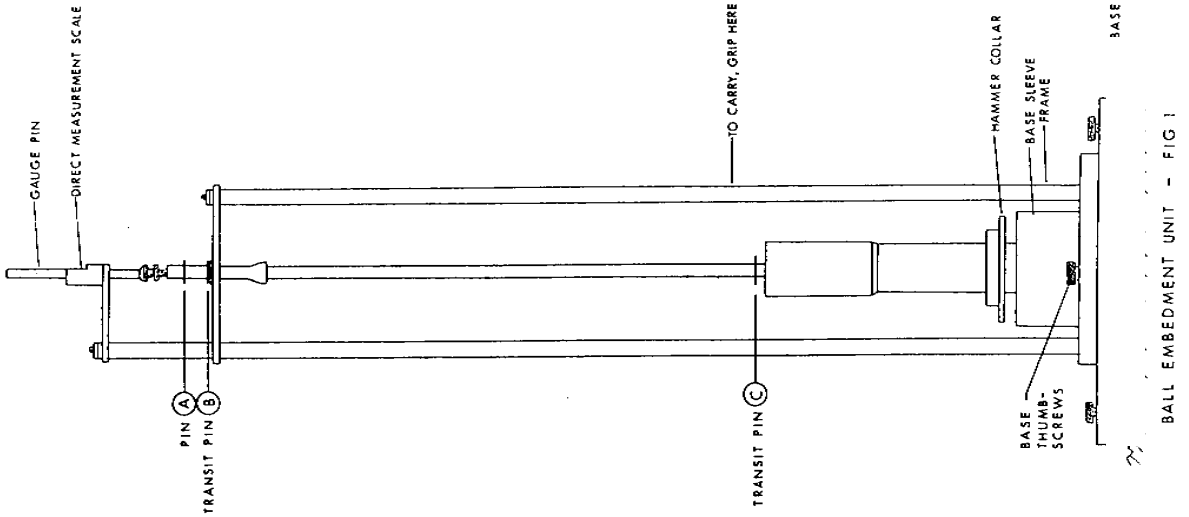


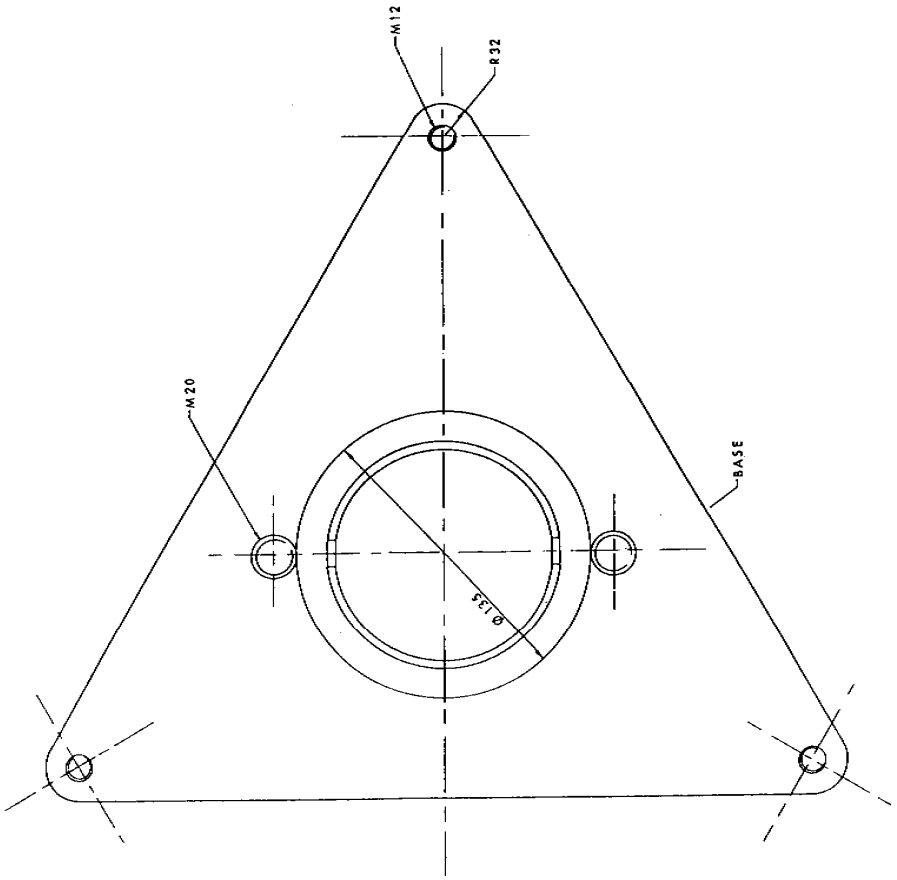
Information supplied by Dept of Science Bureau of Meteorology. Prepared 1988

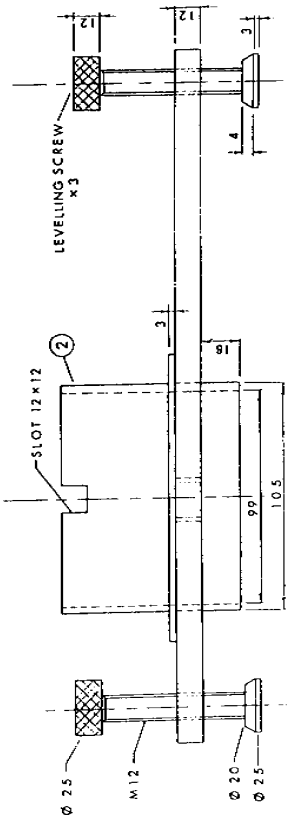
Figure 1 – Standard Summer Road Temperature (*Ts*) – NSW

Appendix A- Apparatus

A.1 Type 2 Ball Penetrometer







A.2 Type 2 Ball Penetrometer Hammer Unit