SECTION 7

PAVEMENT TESTING

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BENKELMAN BEAM DEFLECTION TEST

1. SCOPE

This test method sets out the procedure for measuring the deflection of a flexible pavement using the Benkelman Beam.

The method is derived from RTA NSW T160.

2. APPARATUS

(a) Benkelman beam apparatus fitted with a suitable vibrator.

(b) Truck:

i. Load: The vehicle must have an 8.2 ± 0.2 tonne load over the rear axle equally distributed by each set of dual wheels. The rear axle mass of the test vehicle shall be determined with full tanks of fuel and chains on board.

ii. Tyres: The following guidelines should be followed in respect to tyres for Benkelman Beam vehicles. These requirements apply to the tyres on the dual wheels of the ballasted axle.

Size:	10 x 20, preferably 12 ply but higher ply ratings are acceptable, i.e. 14 ply.
Construction:	Diagonal ply (i.e. cross ply or bias ply)
Tread Pattern:	"Highway" type. Lug type not acceptable.
Pressure:	550 kPa ± 10 kPa
Spacing:	Tyres should be 300 mm apart, measured centre to centre of the dual wheels.
Wear:	It is essential that all four tyres on the rear axle show the same degree of wear.

iii. Tyre pressure gauge

(c) Thermometer (0-100^{O}C) with 1^{0} divisions.
(d) Asphalt hole punch and light oil.
(e) 10m tape.
(f) Notebook, worksheets.
(g) Camera.

3. DEFINITION

The rebound deflection bowl is the shape of the deflection profile as the truck moves off the test point. It is determined from measurements of deflection using the Benkelman Beam, at 0mm, 300mm, 600mm, 900mm and 2700mm and 6000mm spacings.

4. PREPARATION

i. - Obtain truck capable of carrying 8.2t over the back axle, with correct axle tyre configuration.
- Ensure truck has chains and blocks for securing load.
- Check tyre pressure.

ii. Arrange for a forklift or crane to load the ballast to equal 8.2t.

iii. Ensure the distribution of 4.1t load over near wheel by measuring with mobile scales or otherwise.

iv. Benkelman Beams

- Ensure beams are calibrated
- Ensure both beams are functioning satisfactory
- Ensure dial gauges are working
- Ensure that the dial gauge vibrators are functioning

v. Traffic Control

- Arrange suitable traffic control measures, including staff, signs, flashing lights and radios where required.

vi. Staff

- 1 x distance measure and caller
- 1 x Truck Driver
- 2 x Beam Operators

vii. Conduct test run to ensure all equipment is functioning correctly.

5. SETTING OUT

Include the following information in the report: -

i. Pavement Temperature
ii. Air Temperature
iii. Thickness of asphaltic concrete layer, if appropriate.

i. Road name
ii. Road number from PRP Register
iii. Lane No. Inbound or Outbound
iv. Date and Time
v. Test location, chainage, wheelpath, distance and pavement width.

Lanes are numbered from left to right, looking in the direction of traffic flow with lane 1 being the outer or slow lane. Where there is a change in the number of lanes over the length under test, care must be taken to indicate the direction and lane number. A sketch plan is to accompany the test results.

Spacing of the test sites should be such that at least 10 measurements are taken in each length over which the pavement and surrounding conditions appear uniform. The spacing of the test sites is dependent on the length and uniformity of the section and the following table below may be used as guide:

- 10m for all construction control testing, otherwise
- 25m for section length less than 1 km
- 50m for section length between 1 to 2km
- 100m for section length between 2-5km
- 200m for section length more than 5km

iv. Deflections shall be measured in the wheelpaths.

6. PROCEDURE

(a) Select and mark the point on the pavement, which is to be tested. See Note 1.
(b) Centre the dual wheels of the truck approximately 1.5m behind the selected test site.
(c) Insert the probe of the Benkelman beam between the dual wheels and place it on the selected test site (1.5m from the tip of the beam to the axle), ensuring that the tyres of the truck will not touch the beams.
(d) Remove the locking pin from the beam and adjust the rear leg until the dial gauge is in the midrange of its travel.
(e) Turn on the vibrator.
(f) Set the dial gauge at zero.
(g) Creep the truck slowly forward and take readings of the Benkelman beam gauge as the truck moves past the zero point, 200mm, 400mm, 600mm, 900mm, 1,200mm and 1,500mm spacings. Stop the truck 2.7m from the zero point and record the gauge reading when the rate of recovery is equal or less than 25μm per minute.
(h) Drive the truck forward to 6m and record the gauge reading when the rate of recovery is equal or less than 25μm per minute.
(i) Turn off the vibrator.
(j) For asphaltic concrete pavement, record the pavement temperature and air temperature at least once every hour.
(k) Record the air and road temperature approximately every 1-2 hours.
(l) At each test site record and rate the pavement shape and condition including the surface type and any cracking etc.

NOTES:

1. The truck should be parked for a minimum period of 3 minutes and the entire test shall be completed within approximately 4 minutes.
2. Check the truck tyres every 2-3 hrs and if necessary adjust to specified pressure.
3. For chip seal surfaces pavement temperature is not required.

7. DATA COLLECTION

(a) Obtain traffic data records (if required) such as:

- traffic counts
- percent commercial vehicles
- traffic distribution
- past traffic
- future traffic predictions

(b) Obtain information on the pavement configuration from previous records or conduct pavement dippings.

8. DATA ANALYSIS

8.1 Analysis of Field Data

Analyse the data to break the subject section of road into areas with similar values.

8.2 Required Deflection Data

Determine the maximum deflection:	(2 x dial gauge reading at 0mm distance)
Determine the Datum:	(6000mm reading)
Determine the residual rebound:	(maximum deflection – datum reading x 2) Note: can be + or -
Determine the rebound deflection:	(maximum deflection - residual deflection)
Determine the D300:	(300mm reading - datum) x 2
Determine the D600:	(600mm reading - datum) x 2
Determine the D900:	(900mm reading - datum) x 2
Determine the CBR:	(D900 read off from Chart 5)
Determine the tolerable deflection:	(CBR Vs ESA's from Chart 6)
Determine the D 200:	(((300mm reading - 0mm reading)/300) *200) + 0mm reading
Determine the D 250:	(((300mm reading - 0mm reading)/300) *250) + 0mm reading

8.3 Outliers

(a) Using the following procedure determine if any of the results are outliers.

i. Check for very large values.

Arrange the data in decreasing order, and calculate a statistic, γ

$$\gamma = \frac{\text{(max value) - (next max value)}}{\text{(max value) - (min value)}}$$

$$\gamma = \frac{\text{(max) - (max - 1)}}{\text{max - min}}$$

If γ exceeds the critical value given below, then discard max. (i.e. is an outlier)

n	3	4	5	6	7	8	9	$\geq$ 10
γ (n.05)	.941	.765	.642	.560	.507	.468	.437	.412

ii. In a similar way, we can test for very small values.

$$\gamma = \frac{\text{min + 1 - min}}{\text{max x - min}}$$

again, if γ exceeds the value in the table, then we discard it.

(b) Remove any outliers from any further calculation and recalculate all valves, (with the outliers removed).

8.4 Calculation

Determine if over the full length tested, there are distinct changes in the level of deflection over significant lengths, to warrant splitting up these lengths for separate analysis.

NOTE: These variations may be due to changes in surfacing type, pavement thickness, drainage conditions or topography.

After splitting the tested section into significant lengths, calculate the average (u), standard deviation (s), characteristic deflection (u+fs) and coefficient of variation (CV) values for each wheelpath and length. Abnormally high or low readings should be omitted form the statistical analysis.

9. REPORTING

The following test results and general information shall be included in the report:

- All beam testing field data recordings.
- All deflection data test results
- Pavement surface and shape recordings
- Pavement temperature
- Pavement air temperature
- Checks for outliers
- Location plans
- Photographs
- Road name
- Road number from PRP Register
- Lane no’s
- Inbound / Outbound
- Test direction
- Date and time of investigation
- Test location, chainage and offset
- Length of project and spacing of test sites
- Pavement width

TEST METHOD : NTTM 702.1
REVISED DATE: 06/03

FIELD PERMEAMETER TESTING OF BITUMINOUS SEALS

1. SCOPE

This test method describes the procedure for determining the infiltration rate of pavement surfaces using the Field Permeameter Ring. The test is applicable for thin asphalt and sprayed seal surfaces.

2. APPARATUS

Equipment required for the test includes:

(a) permeameter ring (bronze mould),
(b) slotted masses for securing the mould (approximately 20kg),
(c) suitable pavement sealing agents such as road marking paint, bitumen emulsion or potters clay.
(d) 113mm diameter template for marking the test site,
(e) potters clay for sealing the gap between the mould and the road surface,
(f) stop watch for timing the drop in head height,
(g) squeegee bottle and water, food colouring and detergent for the test,
(h) worksheets

3. PROCEDURE

The procedure consists of the following steps:

(a) Select the number and location of test sites to represent the characteristics of the seal being evaluated.

(b) Remove any dirt or loose material from the area to be tested by brooming and washing down with water, and then mop up any excess water on the surface.

(c) Place the permeameter on the pavement to ensure that the test surface is relatively flat.

(d) Mark the outline of the permeameter on the pavement surface with spray paint.

(e) Using the template, an annulus is marked on the nominated test site leaving an unmarked inner diameter of 113mm for the test (10,000 mm^2 surface area). The annulus of suitable sealant may be made by paint, emulsion or potters clay, depending on which material is best suited to the surface type under the prevailing weather conditions. To assist with drying times, several light applications of a spray paint sealant may be required instead of one heavy application. Other tests areas can also be prepared whilst the sealant dries or sets.

(f) A thick ring of potters clay is applied to the prepared annulus on the road pavement, ensuring that all surface voids are filled, and a water uniform surface is achieved.

(g) Place the permeameter centrally onto the prepared ring of potter's clay with the air bleed valve on the highest side of the test site. Ensure that the permeameter is securely seated into the potter's clay and a watertight bond is achieved.

(h) Place approximately 20 kg of slotted masses onto the permeameter with the slots aligned to allow access to the bleed valve.

(i) Insert the plastic viewing tube into the permeameter. Ensure the viewing tube is inserted far enough to come in contact with the stop lip of the permeameter.

(j) The air bleed valve is opened and the prepared water is poured in through the viewing tube to fill the permeameter. When water commences to flow out of the air bleed valve, close the air bleed valve whilst ensuring that all air has been expelled from the permeameter. The water level is then filled up to the desired head height (h1), and the test commences.

(k) The time interval (T) for the water head in the viewing tube to fall from h1 to h2 is timed using a stopwatch.

(l) Using the data obtained, the permeability of the sealed surface can be determined approximately in accordance with Hvorslev falling head formulae given below:

$$k = \frac{\pi D}{11 (T)} \ln \frac{h_1}{h_2}$$

(m) Describe the pavement seal type and condition.

4. REPORTING

Report the initial and final head height, the time taken for the water to drop from the initial to final head height, pavement seal type and condition, the pavement temperature, the infiltration rate, and the permeability as calculated using Hrorlev's and the falling head equations.

NOTES ON TEST:

1. Use a fine grained potters clay, stoneware grade, e.g. Walkers white. The consistency of the clay may need to be adjusted to ensure adequate workability.

2. Potable water shall be used for the testing, and this shall contain food colouring and approximately one drop of detergent/litre.

3. The level of h1 is usually 600, 500, 400, and 300mm, and thus the level of h2, which is 100mm less than h1, would be 500, 400, 300, and 200mm respectively.

Northern Territory Government
Department of Infrastructure, Planning and Environment

Road Projects Division

FIELD PERMEAMETER WORK SHEET

METHOD : NTTM 702.1
REVISED DATE : 06/03

PROJECT:						
LOCATION:						
WHEEL PATH:						
DATE:						
TEST No.:						
CHAINAGE:						
OFFSET:						
SURFACE DESCRIPTION:	DGA Asphalt OGA Asphalt SMA Asphalt	Seal Slurry	DGA Asphalt OGA Asphalt SMA Asphalt	Seal Slurry	DGA Asphalt OGA Asphalt SMA Asphalt	Seal Slurry
AGGREGATE SIZE mm:						
THICKNESS mm:						
SURFACE CONDITION :	Corrugations, Depressions , Shoving, Level, Rutting,		Corrugations, Depressions Shoving, Level, Rutting,		Corrugations, Depressions Shoving, Level, Rutting,	
BITUMEN CONDITION:	Very Lively/New, Lively Dull, Hard & Brittle	Rubber,	Very Lively/New, Lively Dull, Hard & Brittle	Rubber,	Very Lively/New, Lively Dull, Hard & Brittle	Rubber,
SURFACE TEXTURE:	Bleeding, Flushed, Black, Smooth, Matt, Hungry, Very Hungry	Raveling, Stripping, Delaminating	Bleeding, Flushed, Black, Smooth, Matt, Hungry, Very Hungry	Raveling, Stripping, Delaminating	Bleeding, Flushed, Black, Smooth, Matt, Hungry, Very Hungry	Raveling, Stripping, Delaminating
CRACKING:	Block, Crescent Shaped, Crocodile, Diagonal, Longitudinal, Transverse, Meandering,		Block, Crescent Shaped, Crocodile, Diagonal, Longitudinal, Transverse, Meandering,		Block, Crescent Shaped, Crocodile, Diagonal, Longitudinal, Transverse, Meandering,	
CONTRACTOR:						
MANUFACTURER:						
SPEED ZONE:						
TRAFFIC COMPOSITION:						
PAVEMENT TEMPERATURE:						
WEATHER CONDITIONS:						
LOCAL SITE DRAINAGE:						
COMMENTS ON SITE CONDITIONS:						
TEST No:						
DROP IN HEAD HEIGHT	**CLOCK**	**ELAPSED TIME**	**CLOCK**	**ELAPSED TIME**	**CLOCK**	**ELAPSED TIME**
h1 600 - h2 500 mm *						
h1 500 - h2 400 mm						
h1 400 - h2 300 mm						
h1 300 - h2 200 mm						
INFILTRATION RATE: *						
COMMENTS ON TEST:						