SURFACE SHAPE USING A STRAIGHTEDGE

1 SCOPE

This method describes procedures for the determination of the surface shape of any sub-grade or pavement layers using straightedges of various lengths, a spirit level or smart level and a wedge measuring device.

2 SAFETY

This method does not attempt to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this method to establish appropriate occupational health and safety practices that meet statutory regulations.

3 REFERENCED DOCUMENTS

The following documents are referenced in this method:

Main Roads Western Australia
WA 0.1 Random Sample Site Location

4 APPARATUS

(a) Straightedge 3.00 m ± 0.010 m in length, 2.00 m ± 0.010 m in length or 1.2 m ± 0.005 m in length. The width of the straightedge shall not be greater than 25 mm and the depth of the straightedge shall be not less than 50 mm. The straightedge shall not deviate by more than 1.00 mm from a flat surface.

NOTE: A suitable straight-edge may be manufactured from 50 x 25 x 3 mm hollow rectangular aluminium.

(b) Spirit level 600 mm ± 2 mm in length made of light metal construction with the vial visible from the top surface or an electronic “smart level” of the same length and fitted with a cross-fall function. Smart levels used shall have a calibration error, of less than or equal to ± 0.1 degrees, when calibrated at increments of 45 degrees within the range 0 degree to 315 degrees.

(c) Wedge measuring device with graduated markings to show deviation and cross-fall. A typical wedge measuring device is shown at Figure 1.

NOTE: The wedge-measuring device detailed in Figure 1 is for use with a 600 mm long spirit level only. The use of spirit levels of different length may invalidate the results obtained.

(d) Broom.

(e) 25 mm Spacer blocks manufactured from aluminium (optional).

5 DEFINITIONS

Rut – a vertical deformation of a pavement surface formed by the wheels of vehicles.

Transverse Surface Profile – the shape of a pavement surface measured in a vertical plane transverse to the traffic flow.

Cross-fall – the slope, at right angles to the alignment, of the surface of any part of a carriageway.

Shoving – lateral displacement of pavement structure by braking, accelerating or turning vehicles.

Maximum Deviation from Straightedge – the greatest deviation (space) between the top of a road surface and the lower side of a straightedge placed on the road surface.

6 APPLICATION

The shape of a road surface or pavement layer may be measured for amongst other reasons compliance to specified requirements, research, failure investigations, rehabilitation surveys, calibration of a digital laser profiler or a post crash analysis. Straightedges with different lengths may be used to determine the pavement shape, however each straightedge may produce a different result for the property being determined, e.g. cross-fall. Table 1 provides guidance on the use of various sizes of straightedge, however where the length of a straightedge has been specified then that size should be used for the measurement.

7 PROCEDURE

7.1 Determination of Maximum Deviation from Straightedge

(a) Select a sample site, in accordance with Test Method WA 0.1.

NOTE: Typically within a road construction situation numerous sample sites will be tested. To avoid the introduction of bias into the testing process, the number of sample sites to be tested and whether sample site selection is to be by random or systematic selection should be determined prior to the commencement of testing.

(b) Place the straightedge in any position (orientation) on the sample site and with the 25 mm edge in contact with the pavement surface. If the sample site is within the crowned area of the road, the straightedge shall be placed approximately parallel to the road centreline.
NOTE: The surface immediately under the straightedge should be free of loose stones and other debris. If necessary, sweep the area clean using a broom.

(c) Visually determine the position of maximum deviation of the road surface from the straightedge. At the point of maximum deviation of the road surface from the straightedge slide in the wedge measuring device until the upper surface of the wedge measuring device and the lower surface of the straightedge just touch.

NOTE: Where the profile (shape) of the surface changes abruptly, it is permissible to use the straightedge with only one end supported. Refer to Figure 2.

(d) Read the deviation as shown on the measuring device to the nearest 1 mm.

7.2 Determination of Rut Depth

(a) Select a sample site, where specified, in accordance with Test Method WA 0.1.

NOTE: Refer to Note 7.1 (a)

(b) Place the straightedge centrally across the sample site (wheel path) at right angles to the direction of traffic and with the 25 mm edge in contact with the pavement surface beyond the width of the rut. Where the straightedge is unable to span the full width of a rut a longer straightedge shall be used.

NOTE: Refer to Note 7.1 (b).

(c) Visually determine the position of maximum deviation of the road surface from the straightedge. At the point of maximum deviation of the road surface from the straightedge slide in the wedge measuring device until the upper surface of the wedge measuring device and the lower surface of the straightedge just touch.

(d) Read the deviation as shown on the measuring device to the nearest 1 mm and record this as the rut depth. Record the presence of any shoving on the edges of the wheel path.

7.3 Determination of Transverse Surface Profile

(a) Select a sample site where the transverse profile needs to be measured.

NOTE: The measurement of the transverse profile is usually undertaken for research purposes and the use of statistical sampling may not be necessary.

(b) Sweep the surface of the sample site clean using a broom.

(c) Place the straightedge across the width of the lane at right angles to the direction of traffic.

NOTE: Where the road surface is uneven place the straightedge on to 25 mm blocks (or feet) at each end of the beam to lift the straightedge above the road surface.

(d) At 0.1 m intervals along the length of the straightedge determine the deviation of the straightedge from the road surface in accordance with Procedure 7.1 (c)

(e) Read the deviation as shown on the wedge measuring device to the nearest 1 mm and record this as the surface profile at each 0.1 m interval.

NOTE: Where spacer blocks are used to lift the straightedge off the road surface subtract 25 mm from each result. Where the deviation is less than zero record this as a negative value.

7.4 Determination of Cross fall

7.4.1 Using a Spirit Level

(a) Select a sample site in accordance with Test Method WA 0.1.

(b) Place the straightedge on the sample site with the straightedge at approximately right angles to the centreline of the road, free of the road crown and with the 25 mm edge in contact with the pavement surface.

NOTE: Refer to Note 7.1 (b).

(c) Place the spirit level centrally on the upper edge of the straightedge and approximately parallel to the edges of the upper surface of the straightedge.

(d) Insert the tip of the wedge measuring device under the lower end of the spirit level. Whilst holding the upper end of the spirit level stationary on the straightedge slowly slide the wedge measuring device under the spirit level until the indicator bubble in the vial is centred.

(e) Read the cross fall to the nearest 0.25%, where the bottom surface of the spirit level touches the upper surface of the wedge measuring device. Designate the crossfall as C1.

(f) Reverse the spirit level and repeat Procedure 7.4.1 (d)

(g) Read the cross fall, to the nearest 0.25%, where the bottom surface of the spirit level touches the upper surface of the wedge measuring device. Designate the cross fall as C2.

7.4.2 Using a Smart Level

(a) Select a sample site in accordance with Test Method WA 0.1.

(b) Place the straightedge on the sample site with the straightedge at approximately right angles to the centreline of the road, free of the road crown and with the 25 mm edge in contact with the pavement surface.

NOTE: Refer to Note 7.1 (b).
(c) Place the smart level centrally on the upper edge of the straightedge and approximately parallel to the edges of the upper surface of the straightedge.

(d) Set the smart level to measure % cross fall. Record and designate the reading as $C_1$.

(e) Reverse the position of the smart level. Record and designate the reading as $C_2$.

8 CALCULATION

Calculate the cross fall of the road surface using the formula:

$$\text{Cross fall \%} = \frac{C_1 + C_2}{2}$$

9 REPORTING

Report the following information:

(a) The maximum deviation of the road surface from the straightedge, at each sample site, to the nearest 1 mm.

(b) The rut depth, at each sample site, to the nearest 1 mm. Record the presence of any shoving on the edges of the wheel path.

(c) The surface profile at 0.1 m intervals, at each sample site, to the nearest 1 mm. Where the calculated deviation is less than zero report the value as negative.

(d) The cross-fall of the road surface, at each sample site, to the nearest 0.25%.

(e) The size of straightedge used for the testing.

(f) The location of each sample site with at least the following information:

- Road name
- Carriageway and lane
- Chainage or SLK
- Wheel path if tested.

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<th>Straightedge Length (m)</th>
<th>Cross-fall</th>
<th>Rut Depth</th>
<th>Max Deviation from Straightedge</th>
<th>Transverse Surface Profile</th>
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<td>No</td>
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</tr>
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<td>Yes (Note ii)</td>
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<td>Yes</td>
<td>No</td>
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</table>

TABLE 1

NOTES:

i. Where a 1.2 m straightedge is unable to span the full width of a rut a longer straightedge may be used.

ii. A 2 m straightedge should only be used to measure rut depth when undertaking calibrations of digital laser profile meters.
**NOTE:**

1. Deviation in mm markings refer to the vertical height from the base of the wedge and are to be taken to ±0.1 mm.
2. Crossline % markings have been calculated for a 600 mm spirit level, examples shown.
3. All crossline and deviation markings and numerals to be black engraved onto upper surface of wedge.
4. All dimensions in millimetres.
FIGURE 2

Conforming road surface

Straightedge (supported one end only)

Maximum deviation (mm)

10 ISSUING AUTHORITY

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11 REVISION STATUS RECORD

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