RC 422.03

PAVEMENT ROUGHNESS
(Inertial Laser Profiler Method)

1. SCOPE

This test method sets out the procedure for pavement roughness expressed in terms of the International Roughness Index (IRI) and NAASRA roughness count (NRM) using an inertial laser profiler. This test is normally performed in conjunction with testing for rutting and surface texture using VicRoads Test Methods RC 422.04 and RC 422.05 respectively.

2. DEFINITIONS

(a) The IRI (International Roughness Index)

The IRI is the roughness index determined by applying a mathematical model (referred to as the quarter-car (World Bank) model) which has the dynamic vertical response of a simulated response-type road roughness measuring vehicle along a single wheel-path of measured road profile. The IRI is expressed in terms of accumulated vertical displacement of the simulated suspension in metres per measured kilometre (m/km). IRI can be reported in different ways, as follows:

- Single Track IRI

  The IRI based on a quarter car model run over a single wheel path of longitudinal profile.

- Lane IRI
  This is a composite IRI value representing the roughness of a road lane section. It is determined by averaging two individual, Single Track IRI values obtained separately in each wheel-path of a lane (at 0.75 metres either side of the lane mid-track).

(b) A Surface Profile of a line on a surface is the representation of the vertical locations of points on the line against their horizontal distances along the line from a specified starting point.

3. APPARATUS

(a) Inertial Profiler consisting of:

(i) a vehicular platform capable of transporting testing equipment, mounting the profile measuring equipment and travelling at speeds between 25 and 100 km/hr;

(ii) accelerometer(s) to establish the inertial reference which enables reference to be maintained at the level resolution and accuracy required for the displacement measurement transducer(s);

(iii) a displacement transducer (laser device) which measures the distance between the accelerometer and the travelled surface. The combination of the accelerometer and the displacement measurement transducer shall ensure a precision of measurement in elevation to at least 0.2 mm.

The displacement transducer(s) shall be set so that they will operate within mid-range during normal operations.

Note: When it is proposed to measure the profile of two wheel paths simultaneously, a laser transducer/accelerometer combination shall be used for each wheel path. The lateral distance between the displacement transducers to measure the wheel paths shall be 1.5 m. i.e. 0.75 m from the centreline of a lane.

(iv) a distance measuring transducer capable of measuring the distance travelled to a precision of 0.1%. This tranducer shall provide input to the data logger to record the distance travelled from the start of the ride quality survey;

(v) data logger capable of capturing the output data from the transducers at known equal intervals not greater than 50 mm within the range of wave lengths of at least 0.5 metre to 50 metres;

(vi) computer to analyse the data applying the 'quarter-car' model to obtain the IRI for a single wheel track and for lane IRI;

(b) Operator's manual.

(c) Flat stainless steel base plate at least 25 mm thick, 75 mm wide and at least 300 mm long. The plate shall be machined plane with an out-of-flatness not exceeding 0.1 mm.

(d) Stainless steel step gauge blocks with the two large faces parallel to within 0.1 mm. At least three blocks, one of 25 ± 0.1 mm thick, one 50 ± 0.1 mm thick and the other 75 ± 0.1 mm thick. (Other blocks of known thickness to the tolerances shown may be used but must cover a range of at least 50 mm of the transducer measurement.)

(e) Bulls eye spirit level.

(f) Device for measuring the geographic coordinates of the start and end of survey.

4. CALIBRATION AND CHECKS

4.1 Component Checks

(a) Calibrate accelerometers and vertical displacement transducers in the laboratory at least every two years.

(b) Check the vertical displacement transducers using the step gauge blocks and the flat plate at least after each 3000 km of use of the profiler. Make adjustments to the output of the device to ensure that readings are within 0.25 mm of the block thickness.

(c) Check the operations of the accelerometers to ensure that they are placed and held vertically on the profiler.

4.2 Verification Checks

Perform verification checks for roughness and distance prior to and after each network survey and at least every twelve months in accordance with Test Method RC 422.10.

4.3 Repeatability and Bias Checks

Perform repeatability and bias checks prior to each network survey and at about each 3000 km tested during the survey in accordance with Test Methods RC 422.11 and RC 422.12.

5. PROCEDURE

5.1 General

Testing shall not be performed when it is raining or when there is water on the pavement surface.

Operate the vehicle at a relatively constant speed within the range 25 to 100 km/hr maintaining a line of longitudinal travel within the wheel paths of the traffic.

5.2 Pre-Operation Checks

(a) Prior to commencement of the test, check that the accelerometer readings are zero whilst the vehicle is static.

(b) Repeat a previous run or bounce the vehicle whilst static about 10 times and check that the vertical movement of the vehicle due to bounce does not affect the transducer outputs and that each laser responds to the movement of the vehicle.

5.3 Profile Survey

(a) Ensure that the vehicle is travelling within the required speed range as it approaches the start of the survey.

(b) Measure the surface profile along each wheel path in each lane travelling at a relatively constant speed maintaining a line of longitudinal travel within the wheel paths of traffic. Record the profile data at a maximum of 50 mm intervals (smaller intervals may be used).

(c) Record unusual physical features that may affect the ride quality readings.

(d) Record the start and end geographic coordinates of the survey.

(e) Record significant cross roads, intersections, kilometre marks, reference markers (see VicRoads publication: *A Guide to SRRS Data Collection in the Field*) and other features to enable the location system used to be referenced to the data recorded. There shall be no more than 5 km between reference markers recorded within the survey.

6. CALCULATIONS

Calculate the following:

(a) The single track IRI using the quarter car model for each wheel path for each 100 m section being tested;

(b) The lane IRI for each lane for each 100 m section being tested;

(c) If required, the NAASRA roughness for each lane for each 100 m section being tested using the following equation:

NAASRA (counts/km) = 26.49 (lane IRI) - 1.27.

7. REPORT

Report the following:

(a) The start and end geographical position of the survey;

(b) The single track IRI for each wheel path for each 100 m section to the nearest 0.01 m/km;

(c) The lane IRI for each 100 m section to the nearest 0.01 m/km;

(d) If required, the NAASRA roughness in counts/km to the nearest whole number for each lane for each 100 m section;

(e) Relevant details as recorded in Steps 5.3(c) and 5.3(e).

8. REFERENCE

Additional informationl is included in:

ASTM E950 – 98. Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference.

Austroads Guidelines for Road Conditioning Monitoring, Part 1 - Pavement Roughness.

Australian Road Research Board Research Report ARR 164 NAASRA roughness meter calibration by the road-profile-based International Roughness Index (IRI).

"On the Calculation of International Roughess Index from Longitudinal Road Profile". Transport Research Record 1501 (1995), pp 1-12.