AUSTROADS TEST METHOD AG:AM/T003

VALIDATION OF AN INERTIAL LASER PROFILOMETER FOR MEASURING PAVEMENT ROUGHNESS (LOOP METHOD)

1 SCOPE

This test method defines the procedure for performing validation checks of the measurements of pavement roughness determined using a vehicle-mounted inertial laser-based non-contact device (i.e. a laser profilometer).

This test method is one of two alternative validation methods required by Austroads Test Method AG:AM/T001 – *Pavement roughness measurement with an inertial laser profilometer*. The other validation method is Austroads Test Method AG:AM/T002.

This procedure was developed by the Roads and Traffic Authority New South Wales (RTA NSW) and has been used by a number of Australian road agencies to accredit profilometers for project and network level roughness surveys. RTA NSW's use of the procedure has been specifically confined to a well documented 32 km long 'Roughness Calibration Loop' located approximately 60 km north of Sydney.

The procedure involves comparison of roughness data from the profilometer requiring validation against a reference set of roughness data.

This procedure is designed to:

(a) ensure the calibration of the profilometer (including host vehicle and installed instruments)

(b) assess the ability of the driver to track consistently

(c) assess the ability of the operator to accurately correlate road condition data with physical location of the road.

This method is based on statistical principles to establish the extent of random variability between similar devices. A 95% confidence limit has been chosen as the basis for warranting that two devices are giving equivalent results. Resolution of differences is facilitated by: long term use of the same reference sites; availability of additional laser profilometers; and by detailed analysis of repeat runs of each device.

Validation of the expected outcome (i.e. a 95% confidence limit) requires compliance to principles of: fixed number of repeat runs (five); standard 100 m test result intervals; and the test length representing the expected range of roughness (the 32 km of the RTA NSW loop exhibits a wide range of roughness). It is expected that shorter lengths (e.g. 10 km) may be adequate, but it is mandatory to represent a wide range of roughness within the length and to undertake the full set of repeat runs.

This test method does not address all occupational health and safety issues associated with its use. It is the responsibility of the user to operate in accordance with appropriate legislation.

2 REFERENCED DOCUMENTS

Austroads Test Method AG:AM/T001. Pavement roughness measurement with an inertial laser profilometer. March 2007.

Austroads Test Method AG:AM/T002. Pavement roughness validation checks for an inertial laser profilometer (Reference device method). March 2007.

International Organization for Standardization (ISO) 1994, Quality management and quality assurance: vocabulary, ISO 8402, ISO, Geneva.

3 DEFINITIONS

(a) Validation

ISO (1994) defines 'validation' as:

> confirmation, through the provision of objective evidence that requirements for a specific intended use or application have been fulfilled.

4 EQUIPMENT

The following equipment is required:

(a) A calibrated inertial laser profilometer as detailed in Austroads Test Method AG:AM/T001.

(b) The RTA NSW Roughness Calibration Loop, or other suitably prepared loop. The RTA NSW loop consists of two separate sites in close proximity, one on an old but sound and stable section of the Pacific Highway, now mainly used for local access, and the other on the Sydney/Newcastle Freeway which is a road that is generally maintained to a relatively high standard (refer Section 1).

(c) A reference dataset, which is obtained by averaging the results (based on 100 m sections) of five repeat runs by an independent laser profilometer (the reference device). On their loop, RTA NSW conducts regular repeat runs with the reference device to ensure that the reference data remains valid.

5 PROCEDURE

(a) Following Test Method AG:AM/T001, use the inertial profilometer to measure the single track IRI in both the left and right wheelpaths of the Roughness Calibration Loop, and also record the location of the relevant control points.

(b) Repeat (a) until five sets of profile measurements are made (giving a total survey distance of approximately 161 km).

6 CALCULATIONS

(a) Exclude data for sections shorter than 100 m.

(b) Calculate the average roughness value for each 100 m (i.e. the average of the five repeat readings).

(c) Determine the overall correlation:

Using least squares regression, a line of best fit between the average 100 m results determined in (b) and the reference data set should be determined as well as the coefficient of determination of the line (r^2):

$$r_{\text{Average}} = A \cdot r_{\text{Reference}} + B$$

where

$r_{\text{Reference}}$ = reference roughness from the reference dataset

r_{Average} = average roughness of the five repeat runs

A = regression equation slope

B = regression equation intercept

(d) Determine the average percentage difference:

This is the overall average of the percentage differences for each 100 m section between the average of the five runs of the profilometer being tested and the corresponding reference data. It is obtained as follows:

$$\text{Average percentage difference} = \frac{100}{n} \cdot \sum_{i=1}^{n} \frac{r_{\text{Average}} - r_{\text{Reference}}}{r_{\text{Reference}}}$$

where

r_{Average} = average roughness of the five repeat runs for the 100 m section

$r_{\text{Reference}}$ = reference roughness of the 100 m section from the reference dataset

n = the total number of 100 m sections in the analysis.

7 REPORTING

Report the following:

(a) date and time of validation checks

(b) identification of laser profilometer and base instruments used

(c) driver of the profilometer vehicle

(d) operator of the profilometer equipment

(e) the slope (A), intercept (B) and r^2 of the overall correlation equation determined in 6(c)

(f) a statement as to whether the tested profilometer passes the overall correlation check, with an r^2 of at least 0.95 representing a pass

(g) the average percentage difference determined in 6(d)

(h) a statement as to whether the tested profilometer passes the average percentage difference check, with average percentage differences of ≤ ±5% representing a pass.

8 FAILED VALIDATION

In the event that the profilometer fails the validation process, causes for the failure must be investigated, defects rectified and this test method repeated.

AMENDMENT RECORD

Amendment No.	Sections amended	Action [1]	Date
1 (Initial release)	All (Michael Moffatt, ARRB)	New	26 March 2007

[1] Key:

Format	change in format
Substitution	old section removed and replaced with new section
New	insertion of new section
Removed	old section removed