AUSTROADS TEST METHOD AG:AM/T010

VALIDATION OF A MULTI-LASER PROFILOMETER FOR MEASURING PAVEMENT RUTTING (REFERENCE DEVICE METHOD)

1 SCOPE

This test method defines the procedure for performing validation checks of the measurements of pavement rutting determined using a vehicle-mounted laser-based non-contact device (i.e. a multi-laser profilometer), compared to the measurements from a static or manual reference device.

This test method is one of two alternative validation methods required by Austroads Test Method AG:AM/T009 – *Pavement rutting measurement with a multi-laser profilometer*. The other validation method is Austroads Test Method AG:AM/T011.

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/T005. Distance measurement validation of road condition monitoring vehicles. March 2007.

Austroads Test Method AG:AM/T009. Pavement rutting measurement with a multi-laser profilometer. March 2007.

Austroads Test Method AG:AM/T011. Validation of a multi-laser profilometer for measuring pavement rutting (loop method). March 2007.

Austroads Test Method AG:AM/T012. Pavement rutting repeatability and bias checks for a multi-laser profilometer. 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 multi-laser profilometer as detailed in Austroads Test Method AG:AM/T009.

(b) A calibrated reference device (e.g. a transverse profile logger, rod and level, etc.).

(c) Equipment necessary for performing manual rut depth measurements (e.g. a straight edge).

5 PROCEDURE

5.1 Validation of distance measurement

Test Method AG:AM/T005 must be followed, and its check limits passed, in order to validate the distance measuring equipment used in the profilometer.

5.2 Validation of rutting measurement

Perform both of the following validations:

5.2.1 Static method

(a) For each wheelpath identify five discrete locations that cover the following wheelpath rut depths: 5 mm, 10 mm, 15 mm, 20 mm and 25 mm. (All sites must be within ± 2 mm of the stated rut depths). Alternatively, manufactured artificial transverse profiles may be used. Manually measure the rut depth of each of these profiles (e.g. using a straight edge).

(b) Place the survey vehicle above each of the aforementioned locations (or artificial profiles) and, whilst stationary, measure the rut depth with the laser system.

5.2.2 Comparative method

(a) Select five test sections of road pavement, each 500 m long, with the following characteristics:

- at least one 500 m test section must have an average rut depth (in either wheelpath) of between 3.0 and 6.0 mm (based on rutting reported at 100 m), i.e. the average of the five 100 m segments must fall within these limits
- similarly, at least one section must have average rutting of between 6.0 and 9.0 mm
- similarly, at least one section must have average rutting of between 9.0 and 12.0 mm
- the remaining two sections must have average rutting values greater than 5.0 mm and less than 25 mm
- at least two of the total 25 individual 100 m segments must have rutting of 15 mm or greater
- sections shall be selected so as to ensure that their surface characteristics (materials, texture, etc.) are representative of the road network(s) to be surveyed
- sections should be selected with sufficient lead-in to bring the inertial profilometer vehicle up to the highest test speed (nominally 100 km/h) at approach and sufficient length beyond the test site for safe operations.

(b) Measure the maximum rut depth in both the left and right wheelpaths, using either a transverse profile logger, rod and level (100 mm spacing) or a straight edge at a maximum interval of 50 m.

(c) Following Test Method AG:AM/T009, use the multi-laser profilometer to measure the maximum rut depth in both the left and right wheelpaths of each section at a test speed near the bottom of the profilometer's specified operating range. Repeat at a test speed near the mid-range of the profilometer's operating range. Repeat again at a test speed near the top of the operating range.

(d) Repeat (c) four times to obtain a total of five sets of readings for each of the three test speeds.

(e) Additionally, Test Method AG:AM/T012 must be followed, and its check limits passed, in order to validate the repeatability and bias error of test measurements for the equipment, operator, and driver.

6 CALCULATIONS

6.1 Static method

For each wheelpath calculate the rut depth measured by the multi-laser profiler at each location (or for each artificial profile).

6.2 Comparative method

(a) Process each test run made by the multi-laser profiler at each test section and report the wheelpath rut depths in one metre segments. Extract the wheelpath rut depth measurements from the one metre segments that are closest to the corresponding locations at which the reference measurements were made (nominally every 50 metres).

(b) Determine the wheelpath rut depths at each 50 metre location measured by the reference device.

(c) For each of the three speeds, group the rut depth data measured by the multi-laser profilometer into a single set of data, totalling 500 records (one speed x five test sections x two wheelpaths x ten one metre intervals per test section x five repeat survey runs per test section). Using least squares regression, a line of best fit between the two sets of results should be identified for each speed in the form:

$$RutDepth_{Base} = A \cdot RutDepth_{Profilometer} + B$$

where

$RutDepth_{Base}$ = Rut depth calculated from the base reference measurements (i.e. either transverse profile logger, straight edge or staff and level)

$RutDepth_{Profilometer}$ = Rut depth calculated from the operational laser profilometer

A = regression equation slope

B = regression equation intercept

The coefficient of determination, r^2, for each regression must also be determined.

(d) Group all of the rut depth data measured by the multi-laser profilometer into a single set of data, totalling 1500 records (three speeds x five test sections x two wheelpaths x ten one metre intervals per test section x five repeat survey runs per test section). Using least squares regression, a line of best fit between the two sets of results should be identified in the form:

$$RutDepth_{Base} = A \cdot RutDepth_{Profilometer} + B$$

where

$RutDepth_{Base}$ = Rut depth calculated from the base reference measurements (i.e. either transverse profile logger, straight edge or staff and level)

$RutDepth_{Profilometer}$ = Rut depth calculated from the operational laser profilometer

A = regression equation slope

B = regression equation intercept

The coefficient of determination, r^2, for the regression must also be determined.

7 REPORTING

7.1 Validation of distance measurement

Report the items required by Test Method AG:AM/T005.

7.2 Validation of rutting measurement

7.2.1 Static measurement

For each wheelpath report the following:

(a) the location of each section tested

(b) date and time of validation checks

(c) identification of laser profilometer and base instruments used

(d) for each rut location and wheelpath, the assigned rut depth and the rut depth measured by the multi-laser profilometer calculated in 6.1

(e) a statement as to whether the multi-laser profilometer passes or fails validation of transverse profile measurement – the profilometer is considered to have passed the profile measurement validation if each of the measured rut depths are within ±1 mm or ±10%, whichever is the greater, of the assigned rut depths determined in 5.2.1(a).

7.2.2 Comparative measurement

(a) the location of each section tested

(b) date and time of validation checks

(c) identification of laser profilometer and base instruments used

(d) for each test section and survey speed, the calculated wheelpath rut depth values for each 50 metre location using both the multi-laser profilometer and the reference method

(e) for each of the three test speeds, the slope A, intercept B, and coefficient of determination, r^2, calculated in 6.2(c)

(f) for all of the results combined, the slope A, intercept B, and coefficient of determination, r^2, calculated in 6.2(d)

(g) a statement as to whether the profilometer passes or fails validation of profile measurement – the profilometer is considered to have passed the profile measurement validation if all the values reported in 6.2(c) and 6.2(d) fall within the following ranges:

- Automated device e.g. transverse profile logger

Individual speeds (6.2(c)):	$0.90 \le A \le 1.10$	$-2.5 \le B \le 2.5$ mm	$r^2 \ge 0.900$
Combined results (6.2(d)):	$0.925 \le A \le 1.075$	$-2.0 \le B \le 2.0$ mm	$r^2 \ge 0.925$

- Manual reference device e.g. two metre straight edge

Individual speeds (6.2(c)):	$0.85 \le A \le 1.15$	$-3.0 \le B \le 3.0$ mm	$r^2 \ge 0.80$
Combined results (6.2(d)):	$0.90 \le A \le 1.10$	$-2.5 \le B \le 2.5$ mm	$r^2 \ge 0.85$

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 (Richard Wix & 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