

AUSTROADS TEST METHOD AG:AM/T008

VALIDATION AND REPEATABILITY CHECKS FOR A DEFLECTOGRAPH

1 SCOPE

This test method defines the procedures for collecting reference data and for conducting the following:

- (a) validation checks for deflectograph equipment
- (b) repeatability checks for deflectograph equipment.

Specific deflectograph machines may be known by proprietary names (e.g. the VicRoads designed deflectograph is known as the Pavement Strength Evaluator (PaSE)).

The procedure is confined to well referenced and regularly tested section(s) of pavement. The validation check makes use of reference data that has been regularly collected and updated, by the data supplier, over a period of time.

The test method has not been verified by field experience, and engineering judgement should be exercised when considering and acting upon the results obtained.

2 REFERENCED DOCUMENTS

Austrroads Test Method AG:AM/T005. Distance measurement validation of road condition monitoring vehicles. March 2007.

Austrroads Test Method AG:AM/T007. Pavement deflection measurement with a deflectograph. March 2007.

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

3 DEFINITIONS

- (a) Characteristic deflection

The characteristic deflection is defined as the mean deflection plus a factor times its standard deviation as follows:

$$D_c = \bar{X} + kSD$$

where

D_c = characteristic deflection

\bar{X} = mean of the deflection data

k = factor (based on the assumption of a normally distributed sample)

SD = standard deviation of the deflection data

For a 90th percentile characteristic level (typical), the value of k is 1.30

(b) Reporting interval

The length in which at least 20 contiguous test points will be collected.

(c) 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

- (a) A calibrated deflectograph as detailed in Austrroads Test Method AG:AM/T007.

5 PROCEDURE

- (a) Test Method AG:AM/T005 must be followed, and its check limits passed, in order to validate the distance measuring equipment used in the deflectograph. Test Method AG:AM/T005 requires five sets of measured distance readings. When validating a deflectograph it is acceptable to use three sets of readings instead of five sets.
- (b) Select a clearly defined section of a lane of 1.5 km total length with a range of pavement maximum deflections – particularly between 0.5 mm and 1.5 mm. The section must be representative of the pavement to be surveyed.
- (c) Following Test Method AG:AM/T007, use the deflectograph to measure the deflection bowls in both the left and right wheelpaths.
- (d) Determine the characteristic deflections for each reporting interval.
- (e) Repeat (b) and (c) until five sets of deflection measurements have been taken.

6 CALCULATION

6.1 Validation check

- (a) Calculate the mean characteristic deflection value for each reporting interval (i.e. the average of the five repeat readings).

(b) Determine the overall correlation:

Using least squares regression, a line of best fit between the mean characteristic deflections and the reference data should be determined as well as the coefficient of determination of the line (r^2):

$$D_{Average} = A \cdot D_{Reference} + B$$

where

$D_{Reference}$ = reference characteristic deflection from the reference dataset

$D_{Average}$ = average characteristic deflection of the five repeat runs

A = regression equation slope

B = regression equation intercept

(c) Determine the average percentage difference:

This is the overall average of the percentage differences for each reporting interval between the average of the five runs of the deflectograph being tested and the reference data set. It is obtained as follows:

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

where

$D_{Reference}$ = reference characteristic deflection of the reporting interval from the reference dataset

$D_{Average}$ = average characteristic deflection of the five repeat runs for the reporting interval

n = total number of reporting intervals in the analysis

6.2 Repeatability checks

6.2.1 Repeatability Requirement 1

Determine the coefficient of variation (i.e. the standard deviation expressed as a percentage of the mean), $S_n\%$, for each reporting interval for each series of repeat measurements as follows:

$$S_n\% = 100 \cdot \frac{S_n}{\bar{X}_n}$$

where

$$S_n = \sqrt{\frac{\sum_{i=1}^N (X_{ni} - \bar{X}_n)^2}{N-1}}$$

$$\bar{X}_n = \frac{\sum_{i=1}^N \bar{X}_{ni}}{N}$$

n = reporting interval number

N = total number of measurements in reporting interval n

X_{ni} = characteristic deflection of reporting interval n
from measurement i

6.2.2 Repeatability Requirement 2

Determine the average of the reporting interval coefficients of variation, $\bar{S}\%$, as follows:

$$\bar{S}\% = \frac{\sum_{n=1}^{n_s} S_n\%}{n_s}$$

where

n_s = total number of reporting intervals

6.2.3 Repeatability Requirement 3

Using least squares regression, determine the coefficient of determination, r^2 , when the individual mean characteristic deflections for each reporting interval (dependent variable, y) are regressed against the average of the five repeat runs for each reporting interval (independent variable, x).

7 REPORTING

7.1 General

Report the following:

- (a) type of check (i.e. validation or repeatability)
- (b) the location of the test site used
- (c) date and time of checks
- (d) identification of deflectograph used

- (e) operator and driver of the deflectograph.

7.2 Validation checks

Report the following:

- (a) the slope (A), intercept (B) and r^2 of the overall correlation equation determined in 6.1(b)
- (b) a statement as to whether the tested deflectograph passes the overall validation check, with an r^2 of at least 0.95 representing a pass¹
- (c) the average percentage difference calculated in 6.1(c)
- (d) a statement as to whether the tested deflectograph passes the average percentage difference check, with a pass representing average percentage differences of less than or equal to the limit previously established over time.

OR

Acceptance is based upon judgement of the reasonableness of any differences between deflections measured either in repeat runs on the same day, or between tests at the same test locations in successive surveys, after allowing for strength changes due to seasonal and other effects.

7.3 Repeatability checks

Report the following:

- (a) the characteristic deflection for each reporting interval for each of the repeat runs
- (b) the coefficient of variation for each reporting interval for each series of repeat measurements as determined in 6.2.1
- (c) the average of the reporting interval coefficients of variation, r^2 , as determined in 6.2.2
- (d) the coefficient of determination, r^2 , when the individual characteristic deflection values for each reporting interval are regressed against the mean values for that reporting interval, as determined in 6.2.3
- (e) a statement as to whether Repeatability Requirement 1 has been passed – a pass is achieved when 95% of all values reported in (b) are $\leq 5\%$
- (f) a statement as to whether Repeatability Requirement 2 has been passed – a pass is achieved when the value reported in (c) is $\leq 3\%$
- (g) a statement as to whether Repeatability Requirement 3 has been passed – a pass is achieved when all values reported in (d) are ≥ 0.95 .

8 FAILED VALIDATION OR REPEATABILITY CHECKS

In the event that the deflectograph fails the validation or repeatability checks, causes for the failure must be investigated, defects rectified and this test method repeated.

¹ Whilst the target r^2 is set at 0.95, the best value that could be achievable will be dependent upon the type and variability of the test site pavement, the accuracy of re-positioning the equipment along the site, and other device-specific characteristics. After extended use, experience with the characteristics of the site might warrant a reduction in the r^2 value required.

AMENDMENT RECORD

Amendment No.	Sections amended	Action ¹	Date
1 (Initial release)	All (Graham Foley, Graham Foley & Associates & 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			