

# Australian Standard<sup>®</sup>

AS 2891.14.15:2018

## Methods of sampling and testing asphalt

### Method 14.15: Mean, standard deviation coefficient of variation and characteristic values

#### PREFACE

This Standard was prepared by the Australian members of Joint Standards Australia/Standards New Zealand Committee CE-006, Asphalt and Sprayed Surfacing.

After consultation with stakeholders in both countries, Standards Australia and Standards New Zealand decided to develop this Standard as an Australian Standard rather than an Australian/New Zealand Standard.

#### METHOD

#### 1 SCOPE

This Standard sets out the method for calculating the mean, the unbiased standard deviation, coefficient of variation and characteristic values of a set of test results.

These values are most commonly specified for density ratio and per cent air voids determined in accordance with AS/NZS 2891.14.5 but may also be applied to other test results for asphalt, other construction materials and processes.

#### 2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

- |            |   |
|------------|---|
| 1289       | Methods of testing soils for engineering purposes   |
| 1289.1.4.1 | Method 1.4.1: Sampling and preparation of soils—Selection of sampling or test sites—Random number method            |
| 1289.1.4.2 | Method 1.4.2: Sampling and preparation of soils—Selection of sampling or test sites—Stratified random number method |

AS/NZS

- |           |   |
|-----------|---|
| 2891      | Methods of sampling and testing asphalt   |
| 2891.14.5 | Method 14.5: Field density tests—Density ratio and percent air voids of compacted asphalt |

Main Roads Western Australia Engineering Road Note 8, Statistically based quality control for density in road construction.



### 3 GENERAL

When any or all of the mean, standard deviation, coefficient of variation and characteristic values of a set of test results are to be determined, they shall be calculated in accordance with this Standard. It shall be permissible to reject abnormal test results before performing the calculation. A result may be assessed as being abnormal only if a specific reason for its abnormality is clearly evident (see Main Roads Western Australia Engineering Road Note 8). The reason for its rejection shall be reported.

In practice, specifications may require that test sites for each result be essentially randomly selected in accordance with an appropriate test method such as AS 1289.1.4.1 or AS 1289.1.4.2.

The actual statistical values to be calculated will depend on the specification requirements.

Individual results obtained in the appropriate test shall not be rounded before use in calculations.

As the results to be reported have been subject to statistical analysis, they shall be reported to a greater precision than that indicated in the individual test methods, but to not more than one extra significant figure (for example, for density ratio determined in accordance with AS/NZS 2891.14.5 where individual results are reported to the nearest 0.5%, the statistical values may be reported to the nearest 0.1%).

### 4 CALCULATIONS

Calculate the following, as required:

- (a) The mean of the individual test results ( $\bar{\chi}$ ) from the following equation:

$$\bar{\chi} = \frac{1}{n} \sum_{i=1}^n \chi_i \quad \dots 4(1)$$

where

$\bar{\chi}$  = mean of individual test results for  $i = 1, 2, 3, \dots, n$

$n$  = number of test results

$\chi_i$  = individual test result for  $i = 1, 2, 3, \dots, n$

- (b) The standard deviation(s) of the individual test results from the following equation:

$$s = \sqrt{\sum_{i=1}^n \frac{(\chi_i - \bar{\chi})^2}{n-1}} \quad \dots 4(2)$$

where

$s$  = standard deviation of the individual test result for  $i = 1, 2, 3, \dots, n$

$\bar{\chi}$  = mean of individual test results for  $i = 1, 2, 3, \dots, n$

$n$  = number of test results

$\chi_i$  = individual test result for  $i = 1, 2, 3, \dots, n$



- (c) The coefficient of variation ( $V$ ), in percent, from the following equation:

$$V = 100 \frac{s}{\bar{\chi}} \quad \dots 4(3)$$

where

$s$  = standard deviation of the individual test result for  $i = 1, 2, 3, \dots, n$

$\bar{\chi}$  = mean of individual test results for  $i = 1, 2, 3, \dots, n$

$V$  = coefficient of variation, in percent

- (d) The upper or maximum ( $CV_u$ ) and lower or minimum ( $CV_l$ ) characteristic values from the following equations:

$$\begin{aligned} CV_u &= \bar{\chi} + ks \\ CV_l &= \bar{\chi} - ks \end{aligned} \quad \dots 4(4)$$

where

$CV_u$  = upper or maximum characteristic value of the test results

$CV_l$  = lower or minimum characteristic value of the test results

$s$  = standard deviation of the individual test result for  $i = 1, 2, 3, \dots, n$

$\bar{\chi}$  = mean of individual test results for  $i = 1, 2, 3, \dots, n$

$k$  = acceptance constant dependent on the number of test results and the percent defective as detailed in the specification

NOTE: The acceptance constant ( $k$ ) is usually detailed in the specification. However, when this value is not specified, the commonly used values are shown in Table A1 of Appendix A. Alternatively, the value may be derived from the tables listed in Main Roads Western Australia Engineering Road Note 8.

## 5 TEST REPORT

The following shall be reported, as required:

- The characteristic values of the test results and the acceptance constant used.
- The mean value of the test results.
- The standard deviation of the test results.
- The number of individual values used.
- Any individual results excluded from the calculations and the reason for the rejection.
- Reference to this Standard, AS 2891.14.15.

Additional information, as required by the test methods used to determine individual values, shall also be reported.



APPENDIX A  
ACCEPTANCE CONSTANTS  
(Informative)

The acceptance constant ( $k$ ) is usually detailed in the specification. However, when this value is not specified, the commonly used values are shown in Table A1.

Other values may be derived from the tables listed in Main Roads Western Australia, Engineering Road Note 8.

**TABLE A1**  
**ACCEPTANCE CONSTANTS**  
**(for a one-sided unknown variability compliance scheme**  
**with the probability of acceptance equal to 90%)**

| Number of test results | Acceptance constant ( $k$ ) | Number of test results | Acceptance constant ( $k$ ) |
|------------------------|-----------------------------|------------------------|-----------------------------|
| 6                      | 0.719                       | 13                     | 0.877                       |
| 7                      | 0.755                       | 14                     | 0.890                       |
| 8                      | 0.783                       | 15                     | 0.901                       |
| 9                      | 0.808                       | 20                     | 0.947                       |
| 10                     | 0.828                       | 25                     | 0.978                       |
| 11                     | 0.847                       | 30                     | 1.002                       |
| 12                     | 0.863                       | 50                     | 1.059                       |

## NOTES

NOTES

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This Australian Standard® was prepared by Committee CE-006, . It was approved on behalf of the Council of Standards Australia on 16 May 2018 and published on 1 June 2018.

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The following are represented on Committee CE-006:

ARRB (Australian Road Research Board)  
Australian Asphalt Pavement Association  
Australian Chamber of Commerce and Industry  
AUSTROADS  
National Association of Testing Authorities Australia

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