

Australian/New Zealand Standard™

AS/NZS 2891.14.3:2013

Methods of sampling and testing asphalt

Method 14.3: Field density tests—Calibration of nuclear thin-layer density gauge using standard blocks

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee CE-006, Asphalt and Sprayed Surfacing, to supersede AS/NZS 2891.14.3:1999.

METHOD

1 SCOPE

This Standard sets out the methods for the following:

- The calibration of the density systems of a nuclear thin-layer density gauge, using standard blocks. The density calibration equations, so derived, define the relationships between density count ratio and field density reading.
- The calibration of the depth factor systems of a nuclear thin-layer density gauge, using standard blocks and plates. The depth factor calibration equations, so derived, define the relationships between the depth factors and the thickness of a surface (top) layer.

NOTE: The gauge calculates the density of a surface layer of nominated thickness, using the densities measured at two different backscatter systems (system 1 and system 2) and the depth factors for the nominated thickness.

An adjustment of the calibration equation is determined for each material tested from measurements of field density, as detailed in AS/NZS 2891.14.2.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

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| 1289 | Methods of testing soils for engineering purposes |
| 1289.5.8.4 | Method 5.8.4: Soil compaction and density tests—Nuclear surface moisture-density gauges—Calibration using standard blocks |
| 1289.5.8.5 | Method 5.8.5: Soil compaction and density tests—Nuclear surface moisture-density gauges—Density of a Type A or Type C standard density block |

AS/NZS

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| 2891 | Methods of sampling and testing asphalt |
| 2891.14.2 | Method 14.2: Field density tests—Determination of field density of compacted asphalt using a nuclear thin-layer density gauge |

3 SAFETY PRECAUTIONS

The equipment used in this procedure utilizes radioactive materials which may be hazardous to health unless proper precautions are taken. Therefore, it is essential that operators receive instruction on potential hazards and precautions, together with routine safety check procedures such as the use of personal radiation monitors, source leak testing and the use of radiation survey meters. Statutory regulations cover the use and transport of radioactive substances and users shall ensure that these regulations are complied with, for the State or Territory in which the instrument is to be used.

4 APPARATUS

The following items of apparatus are required for the correct performance of the calibration (additional apparatus may be required for the correct usage of a particular model of gauge).

4.1 Nuclear thin-layer density gauge

Complete with the manufacturer's handbook for the gauge, and the manufacturer's reference block.

4.2 Set of standard density blocks, Type A or C

As defined in AS 1289.5.8.4.

4.3 Set of magnesium plates and a set of aluminium plates

Each plate set shall include plates with thicknesses of 25 mm and 100 mm and at least two plates with thicknesses evenly spaced within the 25 mm to 100 mm range. The actual thickness of each plate shall be known within 0.2 mm. Each plate shall have the minimum dimensions of 550 mm in length and 450 mm in width. The top and bottom surfaces of each plate shall be parallel, and finished plane with an out-of-flatness not exceeding 0.1 mm. The density ($\rho_{P,Mg}$ and $\rho_{P,Al}$) of each set of plates, where Mg and Al define the magnesium and aluminium plate sets respectively shall be assigned in accordance with Appendix A. The plates may form part of the substrata specified in Clause 4.4.

4.4 Magnesium and aluminium substrata standard density blocks

As defined in AS 1289.5.8.4, sets of magnesium plates and aluminium plates, as defined in Clause 4.3, with a minimum combined thickness of 150 mm. The density ($\rho_{S,Mg}$ and $\rho_{S,Al}$) of each substratum, where Mg and Al define the magnesium and aluminium substrata respectively, shall be assigned in accordance with Appendix A.

4.5 Radiation monitoring apparatus and personal radiation monitors

As required by the regulatory authority.

5 PROCEDURE

5.1 Preparation for calibration

The calibration apparatus shall be stored under cover to protect it from the effects of weather.

Before a calibration is commenced, it shall be ensured that the calibration apparatus is sufficiently clear of other nuclear gauges or other sources of radiation to ensure that there is no detectable effect on the counts displayed by the gauge. In buildings that are restricted in the available area, it may be necessary to provide shielding to achieve this requirement.

The location for the standard count determinations and the gauge function checks shall be at least 1 m from any vertical projection.

There shall be a minimum clearance of 1 m from any vertical projection that is above the level of the top of either the standard density blocks or the substrata, as appropriate.

It shall be ensured that the gauge is in good working order and that the base of the gauge, the manufacturer's reference block, the standard blocks, the sets of plates and the substrata are clean.

5.2 Gauge function check

Gauge function checks shall be performed in accordance with the procedures specified for the gauge and the results shall be recorded. If the results of these checks fail to comply with the specified requirements, the function checks shall be repeated. If the results of the repeat function checks fail to comply with the specified requirements, the gauge shall be withdrawn from service until the reason for the fault is determined and the fault rectified.

5.3 Standard count check

The check shall be performed in accordance with AS/NZS 2891.14.2 for each density system.

5.4 Determination of density and depth factor calibration data

For each measurement system the procedure shall be as follows:

- (a) Obtain and record an initial standard density count for the gauge on the manufacturer's reference block in accordance with the procedure specified by the manufacturer. Use a counting period of at least 4 min.
- (b) Place the gauge on a standard density block. The gauge shall be clear of any access holes and the edges of the block. Lower the probe to the test position.
- (c) Obtain and record five 4-minute counts, in accordance with the manufacturer's instructions.
- (d) Repeat Steps (b) and (c) for the remaining standard density blocks.
- (e) Place the 25 mm thick magnesium plate on top of the aluminium substratum. Place the gauge on the magnesium plate ensuring that the gauge is well clear from any access holes and the edges of the plate. Lower the probe to the test position. Obtain and record one 4-minute count.
- (f) Repeat Step (e) at least four times. For each repeat, increment the thickness of the magnesium plate by using the other magnesium plates, either individually or stacked. Include zero thickness where the gauge is placed directly on the aluminium substratum.
- (g) Place the 25 mm thick aluminium plate on top of the magnesium substratum. Place the gauge on the aluminium plate ensuring that the gauge is well clear from any access holes and the edges of the plate. Lower the probe to the test position. Obtain and record one 4-minute count.
- (h) Repeat Step (g) at least four times. For each repeat, increment the thickness of the aluminium plate by using the other aluminium plates, either individually or stacked. Include zero thickness where the gauge is placed directly on the magnesium substratum.
- (i) Obtain and record a final standard count for the gauge in accordance with and at the same location as Step (a). If this value falls outside the limits determined in accordance with AS/NZS 2891.14.2, the values determined from Steps (a) to (h) shall be rejected, and a new calibration shall not be carried out until the reason for the standard count being outside the limits has been determined and the fault rectified.

Initial and final standard counts together with the complete calibration data shall be determined in one day.

6 CALCULATIONS

6.1 Density data

The following density data shall be calculated:

- The mean of the initial and final standard density counts obtained from Clause 5.4, Steps (a) and (i), respectively.
- The mean of the density counts on each standard density block obtained from Clause 5.4, Steps (c) and (d).
- The density count ratio (*DCR*) on each standard density block by dividing the mean density count obtained from Step (b) by the mean standard density count obtained from Step (a).

6.2 Density calibration constants

For system 1 and 2, calculate the density calibration constants in accordance with AS 1289.5.8.4 for the appropriate type of standard density blocks.

6.3 Depth factor data

For each measurement system and each plate set, the following shall be calculated:

- The density count ratio at each thickness (including zero thickness), by dividing the density count obtained from Clause 5.4, Steps (e), (f), (g) and (h) by the mean standard density count obtained from Clause 6.1, Step (a).
- The predicted density (ρ_i) at each thickness (including zero thickness), using the constants obtained in Clause 6.2, Step (a) or (b), with the appropriate field density equations.

6.4 Depth factor calibration constants

The procedure shall be as follows:

- For magnesium plates overlying an aluminium block determine, using curve fitting, the value of $A_{Mg,i}$ using the following equation:

$$\rho_i = (\rho_{S,Al} - \rho_{P,Mg})e^{(-A_{Mg,i}t)} + \rho_{P,Mg} \quad \dots 6.4.1$$

For aluminium plates overlying a magnesium block determine, using curve fitting, the value of $A_{Al,i}$ using the following equation:

$$\rho_i = (\rho_{S,Mg} - \rho_{P,Al})e^{(-A_{Al,i}t)} + \rho_{P,Al} \quad \dots 6.4.2$$

For each system calculate the value of A_{i2} using the following equation:

$$\frac{A_{i2} = (A_{Mg,i} - A_{Al,i})}{2} \quad \dots 6.4.3$$

where

ρ_i = predicted density, in tonnes per cubic metre, for system i to the nearest 0.001 t/m³

$\rho_{P,Mg}, \rho_{P,Al}$ = density, in tonnes per cubic metre, adjusted for mass attenuation, of magnesium and aluminium plate sets respectively, to the nearest 0.001 t/m³

$\rho_{S,Mg}, \rho_{S,Al}$ = density, in tonnes per cubic metre, adjusted for mass attenuation, of magnesium and aluminium substrata respectively, to the nearest 0.001 t/m³

i = number of system (1 = system 1, 2 = system 2)