Test Method T173

Field wet density of road construction materials (nuclear gauge in direct transmission method)

Issue No. 4.0 | 19 April 2022

This version is a draft issued for stakeholder's comments.

The template formatting has been adjusted and RMS has been replaced by Transport for NSW.

Please use the attached comment form and return completed forms to test.method.feedback@transport.nsw.gov.au

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About this release

Title:	Field wet density of road construction materials (nuclear gauge in direct transmission method)
Test method number:	T173
Author:	Materials Technology
Authorised by:	

Summary of changes

Issue number	Clause number	Revision description	Authorised by	Publication date
Issue 4.0	All 5.1.1 (d)(ii) 5.2	Document restructured and reformatted to TfNSW template. Record of the PNMDG dry density and field water content added. Clarified testing of the lower part of a deep lift stabilised or heavily bound pavement course.		
Ed 3 / Rev 0	All	Reformatted template.	J. Friedrich	October 2012
Ed 2 / Rev 1	4.1, 4.3(a) & (b)	Automatic depth sensor required. Clarify sampling requirements.	D. Hazell	October 2008
Ed 2 / Rev 0	All	New issue. New clauses 4.1, 4.2, 4.3, 4.4, 5.2 and revision to clause 6. Dry Density conversion added.	G. Donald	November 2007
Ed 1 / Rev 1	3(a)	Generally revised - For issue – P Walter.	D. Dash	February 2000
Ed 1 / Rev 0	All	Draft issue.		November 1999
		Reformatted and revision summary added.	D. Dash	May 1999

NOTE: The functions of the former State Government agency Roads and Maritime Services (RMS or Roads and Maritime) are now administered by Transport for NSW.

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Test Method T173

Field wet density of road construction materials (nuclear gauge in direct transmission method)

1 Scope

This test method sets out the procedure to determine the field wet density of road construction materials using a portable nuclear moisture density gauge (PNMDG) in the direct transmission mode of operation.

2 General

(a) This test method is applicable to a single layer (cannot be used for 2 or more layers) of earthworks or pavement and is applicable to soils having not more than 20% by mass of particles retained on the 37.5 mm sieve.

(b) This test method can also be used to determine the field wet density of the lower part of a deep lift stabilised or heavily bound pavement course where time constraints are imposed on time taken to test.

NOTE: Where stabilised pavement material has been placed using cementitious binders and is considered as deep lift stabilised or heavily bound pavement course, the field wet density of the lower and upper layer of the deep lift course can be determined using Clause 5.2. The bound material is required to be compacted within its nominated working time as determined in TfNSW test method T147.

CAUTION: Follow the safety requirements on the Material Safety Data Sheets for hazardous chemicals when handling and using cementitious binders.

(c) The field moisture content result obtained from the PNMDG is not to be used in further calculations or reported.

3 Equipment

(a) The apparatus is identical to that described in test method AS 1289.5.8.1. Section 4 Apparatus, with the following additional requirements:

(i) The PNMDG must be capable of carrying out direct transmission density measurements to 0.001 t/m^3 at probe depth intervals not exceeding 25 mm, within the range of 50 mm to 300 mm and be operated using the automatic depth sensor. Backscatter method is not to be used.

CAUTION: The PNMDG contains radioactive materials which may be hazardous to health and is to be used and managed in accordance with relevant statuary regulations, codes of practice and radiation management plans.

(ii) Suitable equipment to excavate a sample from the test location.

(iii) Sealable airtight containers to minimise sample and moisture loss.

(iv) Measuring device capable of reading to the nearest 10 mm.

(v) Equipment and apparatus to perform TfNSW test method T120.

4 Gauge calibration and operational checks

The PNMDG calibration and operational checks are determined in accordance with AS 1289.5.8.1. Clause 5.

5 Procedure

5.1 Wet density of a single layer

5.1.1 Wet density determination

(a) Locate test sites in accordance with:

(i) TfNSW Specification Q Annexure Q/L, L3 Statistical Techniques and apply the requirements of TfNSW Specification Q Annexure L.

OR

(ii) Project specific requirements.

OR

(iii) As directed by the Principal.

(b) Determine the wet density in accordance with test method AS 1289.5.8.1 Section 6 Procedure (a) to (f) for a single layer at depth 'X' mm as shown in Figure 1.

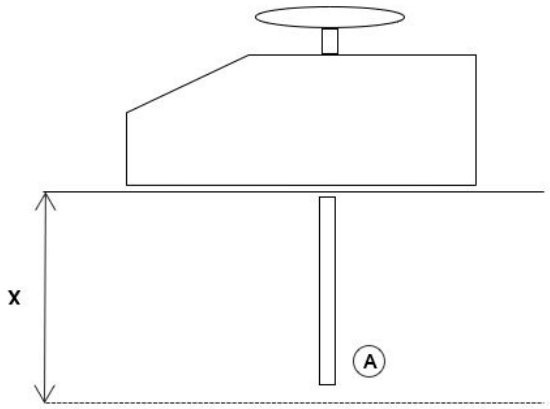

Figure 1. Probe position for a single layer

(c) Record the field wet density (FWD_X) for the depth 'X' with the probe at position 'A'.

(d) Record the following data for each measurement from the PNMDG:

(i) Field wet density to 0.001 (t/m³) and corresponding density count.

(ii) Field dry density to 0.001 (t/m³).

(iii) Moisture content to 0.1 (%), field water content to 0.001 (t/m³) and corresponding moisture count.

(iv) The field density standard count and the field moisture standard count for the lot under test.

5.1.2 Sampling

(a) Excavate a hole directly below the location of the PNMDG after density measurement, to the depth at which the probe was extended. The sides of the hole are to be reasonably vertical.

(b) Remove and place all the excavated material in a sealable container and label in accordance with TfNSW test method T105 Appendix A – Processes A.7 Labelling

(c) Measure and record the depth of the layer (if visually possible) to the nearest 10 mm.

(d) Measure and record the average depth of the excavated hole to the nearest 10 mm.

5.2 Wet density of the lower part of a deep lift stabilised or heavily bound pavement course

5.2.1 Sampling

(a) Locate test sites of the lot under test after incorporation of the binder, mixing and prior to compaction, in accordance with;

(i) TfNSW Specification Q Annexure Q/L, L3 Statistical Techniques and apply the requirements of TfNSW Specification Q Annexure L.

OR

(ii) Project specific requirements.

OR

(iii) As directed by the Principal.

NOTE: For a deep lift stabilised pavement or heavily bound pavement course the sample is removed from the lot before compaction for the determination of maximum densities. Determination of the field wet density, is conducted after lot has been compacted. Ensure test locations are suitably marked to determine the field wet density.

(b) Excavate a sample to the full depth of the deep lift stabilised pavement course which would represent the footprint of the PNMDGs' base. The sides of the hole are to be reasonably vertical.

(c) Ensure that the excavated material is replaced with identical material to that of the surrounding pavement. The location of the sample for determination of laboratory maximum densities must be the same as that for TfNSW test method T173 (or T119).

(d) Remove and place all material from the excavation in a sealable container and label in accordance with T105 Appendix A – Processes A.7 Labelling.

(e) Measure and record the average depth of the excavated hole to the nearest 10 mm. If the depth is greater than 300 mm (maximum length of the PNMDG probe) then extend the excavation to the base of the deep lift stabilised or heavily bound pavement course being tested, measure and record the average depth of the course to the nearest 10 mm.

(f) Record if the material type within the deep lift stabilised or heavily bound pavement course does not appear to be homogeneous e.g., segregation, contamination, or different material.

(g) Record the date and time of commencement of mixing of the binder in the material at the sampling location, date and time of sampling and the commencement date and time of laboratory compaction to determine maximum densities as appropriate.

5.2.2 Wet density determination

(a) Locate test sites determined in Clause 5.2.1 (a).

(b) Determine the wet density in accordance with test method AS 1289.5.8.1 Clause 6 Procedure (a) to (f) for a single layer of bound material.

(c) Insert the probe to position 'A', located at the required depth within the lift 'X'. Record the depth 'Y' as shown in Figure 2.

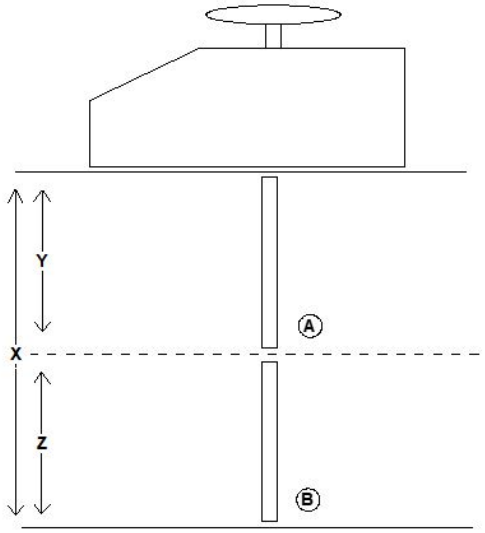

Figure 2. Probe position within a layer

(d) Record the field wet density (FWD_Y) for the lift 'Y' with the probe at position 'A'.

(e) When measuring the lower part of a deep lift stabilised or heavily bound pavement course, extend the probe to position 'B', located within 25mm the bottom of the lift or at a position where the PNMDG has been inserted to its maximum depth. Record the depth 'X' as shown in Figure 1.

(f) Record the field wet density (FWD_X) for the depth 'X' with the probe at position 'B'.

(g) Record the following data for each measurement from the PNMDG:

(i) Field wet density to 0.001 (t/m^3) and corresponding density count.

(ii) Field dry density to 0.001 (t/m^3).

(iii) Moisture content to 0.1 (%), field water content to 0.001 (t/m^3) and corresponding moisture count.

(h) The field density standard count and the field moisture standard count for the lot under test.

5.3 Field moisture content

Determine the moisture content (w_f) of the sample in accordance with TfNSW test method T120.

NOTE: Field moisture content may be determined during the preparation of the maximum density using TfNSW test method T111, T112, T119 or T162.

6 Calculations

6.1 Determining the wet density of the lower part of a deep lift stabilised or heavily bound pavement course

(a) Calculate the nominal field wet density of the lower part of the deep lift stabilised or heavily bound pavement course for the depth interval 'Z' using the following equation:

$$FWD_Z = \frac{(D_X \times X) - (D_Y \times Y)}{(X - Y)} \quad \ldots 6(1)$$

Where:

FWD_Z = Calculated nominal wet density for the lower depth (t/m^3).

D_Y = Field wet density gauge measurement at probe position '*A*' (t/m^3).

D_X = Field wet density gauge measurement at probe position '*B*' (t/m^3).

Y = Depth at probe position '*A*' (mm).

X = Depth at probe position '*B*' (mm).

Equation 6(1). Wet density lower part of a deep lift (FWD_Z)

6.2 Dry density determination

(a) Calculate the nominal field dry density for depth 'X' using the equation 6(2):

(i) For inclusion on the air voids line plot required in TfNSW test method T166.

(ii) Any other subsequent calculations.

NOTE: Other depths can be similarly derived, provided moisture content is determined to represent that course.

$$FDD_x = FWD_X \times \frac{(100)}{(100 + w_f)} \quad \ldots 6(2)$$

Where:

FDD_X = Calculated nominal dry density for depth '*X*' (t/m^3).

FWD_X = Field wet density for depth '*X*' (t/m^3).

w_f = Field moisture content (%) from layer '*X*' using TfNSW test method T120.

Equation 6(2). Dry density (FDD_x)

7 Reporting

Include the following data and results in the report:

(a) Client.

(b) Identification of sample (e.g., Stockpile number and tonnage, chainage and offset, lot number, location, sample number or source as required).

(c) Date sampled.

(d) Sampling method.

(e) Date sample received and tested.

(f) Description of sample or product (e.g., silty sand, DGB20, etc.).

(g) The information required under test method AS 1289.5.8.1 and the following:

  (i) Measured depth of the layer or lift (for deep lift stabilised pavement course) to the nearest 10 mm.

  (ii) Record if the material type within the layer or course does not appear to be homogeneous e.g., segregation, contamination, different material type.

  (iii) The date and time of commencement of mixing of the binder in the material at the sampling location.

  (iv) The date and time of sampling.

  (v) The date and time of commencement of laboratory compaction to determine maximum wet density.

(h) Where the wet density of the lower part of a lift (for deep lift stabilised pavement) is required:

  (i) The probe depth 'Y' for position 'A' (mm)

  (ii) The Wet Density (FWD_Y) for the depth 'Y' to the nearest 0.001 t/m^3.

  (iii) The probe depth 'X' at position 'B' (mm).

  (iv) The Wet Density (D_X) for the depth 'X' to the nearest 0.001 t/m^3.

  (v) The nominal calculated Wet Density (FWD_Z) for the lower part of the lift to the nearest 0.001 t/m^3.

  NOTE: Where the result is to be used in subsequent calculations (e.g., TfNSW test methods T166 or Specification QMS Q6, etc., report the densities to the nearest 0.001 t/m^3).

(i) Where required for further calculations:

  (i) The part of the deep lift stabilised or heavily bound being tested (i.e., upper, lower, or whole).

(ii) The field moisture content (w_f) to the nearest 0.1%.

(iii) The field dry density (FDD_X) to the nearest 0.001 t/m^3.

NOTE: Where the result is to be used in subsequent calculations (e.g., TfNSW test methods T166 or Specification QMS Q6, etc., report the densities to the nearest 0.001 t/m^3).

(j) Reference to this standard.

8 References

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- T119 (2012). "Field dry density of road construction materials (sand replacement method)." Transport for NSW.
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- Transport T147 (2012). "Working time for road construction materials (blended in the laboratory with slow setting binders)." Transport for NSW.
- Transport T162 (2022). "Compaction control test (Rapid method)." Transport for NSW.
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- T2105 (2012). "Correlation of moisture content with standard method." Transport for NSW.
- AS1289.5.8.1 (2007). "Methods of testing soils for engineering purposes Soil compaction and density tests – Determination of field density and field moisture content of a soil using a nuclear surface moisture-Density gauge – Direct transmission method." Standards Australia.
- QA Specification Q6 (2013). QA Specification Q6 Quality Management System (Type 6). Transport for NSW.

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If you have any questions or would like more information on this document, please contact Transport for NSW:

roads-waterways.transport.nsw.gov.au

standards@transport.nsw.gov.au

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Customer feedback
Locked Bag 928,
North Sydney NSW 2059

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