Transport
Roads & Maritime
Services

Test method T119

Field density of road construction materials (Sand replacement method)

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Revision Summary

Ed/Rev Number	Clause Number	Description of Revision	Authorisation	Date
		Reformatted and Revision Summary Added	D. Dash	May 1999
		Date on Test Method Revised to Agree with Date on Revision Summary	D. Dash	Feb 2001
Ed 2/Rev 0		Revised and reformatted. Pronumerals in formulas standardised. Notes revised.	G. Donald	September 2007
Ed 2/Rev 1	3(i), 4.1(b), 5(a), (d)(iii), d(iv), h(i), h(ii), h(iv), (i), k(ii), 6(a), (d), 7(d)	Additional description of processes.	D Hazell	Sept 2008
Ed 2/Rev 2	7(d)	Corrected accuracy.	D Hazell	Feb 2009
Ed 2/Rev 3	3(h), 6(e)	Tolerance of mould. Symbol for density.	D Hazell	Sept 2009
Ed 2/ Rev 4	3(h)	Tolerance of mould.	D Hazell	Jan 2010
Ed 3/ Rev 0	All	Reformatted RMS template	J Friedrich	October 2012

Note that Roads and Maritime Services is hereafter referred to as 'RMS'.

The most recent revision to Test method T119 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T119

Field density of road construction materials (Sand replacement method)

1. Scope

This test method sets out the procedure to determine the field wet or dry density of in situ road construction materials using the sand replacement method.

2. General

(a) This is a field test of either natural or compacted material in situ

(b) The Test Method is applicable to an earthworks or pavement layer containing up to 40% by mass of particles retained on a 37.5 mm AS sieve

(c) The Test Method may not be applicable for cohesion less materials such as sand and aggregates

3. Apparatus

(a) At least two pouring containers of about 4.5 Litre capacity fitted with a sealing cap and equipped with a tapering pouring spout

(b) A metal field density tray with a hole centrally located and perimeter edges turned up approximately 25 mm high. Tray sizes of approximately 300 mm and 400 mm square are suitable for holes of 150 mm and 200 mm diameter respectively

(c) A density ring or its equivalent

Note: A suitable design is shown in Figure 3 of AS 1289.5.3.2.

(d) A quantity of plastic moulding material if required (e.g. play dough)

(e) A supply of clean, dry, one-sized sand free from organic matter, or equivalent approved material

Note: Sand to be preferably screened to pass a 1.18 mm AS sieve and retained on a 300 μm AS sieve.

(f) Suitable tools for excavating holes in soils, gravels and crushed rock materials (e.g. hammer or mallet, chisel, brick bolster, trowel, spoons, scoops, spatula, paint brushes, vacuum cleaner, etc)

(g) A steel straightedge, about 300 mm long, about 25 mm wide and about 3 mm thick, preferably with a bevelled edge

(h) A cylindrical metal calibrating container with an internal diameter of 150 ± 5 mm and a volume of approximately 2 Litres

NOTE: For layers greater than 200 mm, the metal calibrating container is 150 ± 5 mm internal diameter and approximately 5 litre capacity.

(i) A balance of suitable capacity with a limit of performance of not greater than ±5 grams

(j) Sealable airtight containers suitable for curing moist samples of approximately 15 Litres capacity

(k) Metal dishes of suitable size

(l) Apparatus for moisture content determinations in the field

(m) A 300 mm ruler

(n) A 37.5 mm AS sieve

(o) A wire basket of approximately 200 mm diameter and approximately 400 mm high

(p) A water bath of sufficient dimensions that completely immerses the wire basket with a clearance of at least 75 mm around the circumference and 50 mm from the bottom

4. Preparation

4.1 Poured Density of Sand

(a) Make a separate determination of mean poured density for each batch of sand and each operator using the following steps

(b) Determine the internal volume (V_c) in mL of the calibrating container by either:

(i) Measuring the quantity of water in mL required to fill the container

OR

(ii) Calculation using the internal diameter (D) and height (H) measured to the nearest 0.2 mm (refer to Calculation 6(a))

(c) Clean and dry the calibrating container and determine its mass (M_1)

(d) Fill the pouring container with the sand

NOTE: *The pouring spout used in calibrating the sand and in filling the hole must be similar in design, dimensions and of the same materials.*

(e) Pour the sand into the calibrating container using the pouring container in an even stream. Keep the pouring spout approximately 25 mm above the surface of the sand in order to form a central cone. Slightly overfill the calibrating container and screed off excess sand with a straightedge, without compacting the sand, to provide a surface level with the top of the container. Ensure that the calibrating container is not vibrated or knocked during this step

NOTE: *Ensure that the pouring spout is full of sand at all times during a pour. At least 500 g of sand should be left in a container at the end of pouring from the container.*

Avoid interruptions to the sand flow when pouring. Do not disturb the flow of sand (e.g. fingers partially blocking the orifice of the spout).

After screeding, the container may be tapped to settle the sand in the container to prevent loss of sand during the weighing.

(f) Determine the mass of the container plus contents (M_3)

(g) Calculate the poured density of the dry sand (C) according to Calculation 6(b)

(h) Repeat Steps (d) to (g) until the range of three consecutive measurements of poured density does not exceed 0.01 g/mL

(i) Calculate the mean poured density of the sand (C_m) in g/mL

5. Procedure

(a) Fill the required number (n) of pouring containers with the calibrated sand and replace the sealing caps. Determine the mass of each pouring container, cap and sand (M_n). Label each container with the mass (M_n)

(b) Expose a flat area of the material to be tested (approximately 450 mm square), and trim down to a level surface to receive the field density tray or ring

(c) A field density ring must be used when the surface is irregular (e.g. stony). If a field density ring is not required, proceed to Step (e)

NOTE: *An error will result in the density determination due to irregularity of the surface if the density ring is not used. This error is reduced with increased depth of hole.*

(d) When using a field density ring, determine the mass of sand that fills the density ring:

(i) Place the field density ring in position on the surface. If sand is likely to escape under the density ring (i.e. the surface is irregular), fill the irregularities between surface and ring with the plastic moulding material

(ii) Remove any loose material from the surface within the field density ring (e.g. using a vacuum cleaner)

(iii) Remove the cap and attach the pouring spout to pouring container '1'.
The mass of pouring container '1', cap and sand is $S = M_1$

(iv) Pour the sand into the density ring using the same pouring method as that used in Step 4.1. Pour enough sand to slightly overfill the ring

NOTE: *For low profile density rings the pouring method in Step 4.1 may be impractical. In such cases, use a series of regularly spaced cones inside the ring to reduce disturbance by the screeding process.*

(v) Use the straight edge as a screed to wipe the sand gently across the ring to level the surface, without compacting the sand

(vi) Collect the excess sand from screeding and return to pouring container '1'. Determine the mass of pouring container '1', cap and remaining sand (T)

(vii) Remove the sand from the ring using the same method as previously used to remove loose material and discard

(e) Place the field density tray on the surface or over the field density ring (if used)

NOTE: *The larger field density tray is used for coarser grained materials.*

(f) Using the density tray opening as a guide, excavate a cylindrical hole with a diameter slightly less than the tray opening and to the depth of the layer being tested. The sides of the hole are to be essentially vertical. Place all the excavated material in an airtight container. If a density ring is used, do not disturb the ring and do not extend hole laterally beyond the ring opening

NOTE: *The depth of excavation should not exceed 200 mm. However, for layers greater than 200 mm, the hole can be excavated to greater than 200 mm when using the 5 litre metal calibrating container.*

Care is necessary to avoid loosening material in the sides of the excavated hole. Any particles which are loosened should be removed and included in the excavated material.

Brush the final amounts from the hole into a small scoop or spoon and place in the airtight container.

(g) Remove the density tray but leave the density ring in place (if used). Measure and record the depth of excavation

(h) Determine the mass of sand that fills the hole and density ring (if used)

(i) Remove the cap and attach the pouring spout to the pouring container. Pour the sand into the hole using the same pouring method as that used in Step 4.1. Pour enough sand to slightly overfill the hole and density ring (if used). For deep holes, use two or more pouring containers of sand as required

NOTE: *Trickle filling to top up a hole is allowed provided the amount needed is less than 20 g of sand.*

(ii) The mass of pouring container/s, caps and sand $D = \sum M_n$

NOTE: *If more than one pouring container is used to fill the hole then 'D' is the total mass of the pouring containers.*

(iii) Use the straight edge as a screed to wipe the sand gently across the ring to level the surface, without compacting the sand

(iv) Collect the excess sand from screeding and return to the pouring container. Determine the mass of pouring container/s, caps and remaining sand ($E = \sum M'_n$)

NOTE: *If more than one pouring container is used, E is the total mass of the pouring containers.*

(v) Remove the sand from the hole and discard

NOTE: *Where insufficient excavated material is available for additional testing (e.g. T111, T162), widen the hole over its full depth. Place the additional material in a separate sealed container.*

(i) Remove the excavated material from the container. Determine the mass of the excavated material (M_E)

(j) Screen the excavated material on the 37.5 mm AS sieve

(k) For the portion retained on the 37.5 mm AS sieve, determine the following:

(i) The mass of the material (M_O)

(ii) The volume of the material (V_O) using displacement as follows:

- Wet the material to approximately saturated surface dry condition

- Determine the mass of the material in air (L) in grams
- Determine the mass of the material immersed in potable water (K) at not more than 25°C in grams
- Calculate the volume (V_O) according to Calculation 6(f)

(l) For the portion passing the 37.5 mm AS sieve, determine the moisture content (w_f) in accordance with T120, T121 or T180

6. Calculations

(a) Calculate the internal volume (V_c) in mL of the calibrating container using dimensions as follows:

$$V_c = \frac{\pi \times D^2 \times H}{4 \times 1000}$$

Where:

V_c = Volume of the calibrating container (mL)

D = Diameter of the calibrating container (mm)

H = Height of the calibrating container (mm)

(b) Calculate the poured density of the sand (C) as follows:

$$C = \frac{(M_3 - M_1)}{V_c}$$

Where:

C = Poured density of the sand (g/mL)

M_3 = Mass of the calibrating container plus contents (g)

M_1 = Mass of the calibrating container (g)

V_c = Internal volume of the calibrating container (mL)

(c) Calculate the mean poured density of the sand (C_m) for a specific batch of sand and operator as the mean of at least three consecutive determinations of poured density

(d) Calculate the volume of sand used (V) as follows:

$$V = \frac{(D - E) - (S - T)}{C_m}$$

OR

$$V = \frac{(D - E)}{C_m}$$ .. .. where no density ring is used

Where:

V = Volume of hole (mL)

C_m = Mean poured density of sand (g/mL)

D = Mass of pouring container/s plus sand (g) before filling the hole (and density ring if used) (Step 1.1.1(h)(ii))

E = Mass of pouring container/s and contents after filling the hole (and density ring if used) (g) (Step 1.1.1(h)(iv))

S = Mass of pouring container '1' plus sand before filling the density ring (g) (Step 1.1.1(d)(iii))

T = Mass of pouring container '1' and contents after filling the density ring (g) (Step 1.1.1(d)(vi))

(e) Calculate the wet density and/or the dry density as follows:

$$\rho_W = \frac{M_E}{V}$$

OR

$$\rho_D = \frac{M_E}{V} \times \frac{100}{(100 + w_f)}$$

Where:

ρ_W = Wet Density (t/m³)

ρ_D = Dry Density (t/m³)

M_E = Mass of excavated material (g)

V = Volume of hole (ml)

w_f = Field moisture content (%)

(f) Calculate the proportion of oversize material (i.e. retained on 37.5 mm AS sieve) as follows:

$$P_O = \frac{M_O}{M_E} \times 100\% \text{ .. .. .. } (\leq 40\% \text{ retained on 37.5 mm AS sieve})$$

$$V_O = L - K$$

$$J_O = \frac{M_O}{V_O}$$

Where:

P_O = Proportion of oversize material (%)

M_O = Mass of material retained on the 37.5 mm AS sieve (g).

M_E = Mass of excavated material (g)

V_O = Volume of oversize material (mL)

L = The mass in air of the saturated surface dry oversize material (g)

K = The mass in water of the oversize material (g)

J_O = Field wet density of the oversize material (t/m³)

7. Reporting

Include the following in the report:

(m) The depth of excavation to the nearest 5 mm

(n) The field wet and/or dry density, as required, of the in situ material to the nearest 0.01 t/m³

(o) If required, the moisture content of the material in situ to the nearest 0.5%

NOTE: *Where the results are to be used for further calculations, report the density values to the nearest 0.001 t/m³ and moisture content values to the nearest 0.1%.*

(p) For oversize material, the proportion P_O to the nearest 0.01% and the density J_O to the nearest 0.001 t/m³

(q) Reference to this test method