Transport
Roads & Maritime
Services

Test method T114

Maximum dry compressive strength of road construction materials

OCTOBER 2012

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	All	Revised and reformatted. Rammer tolerance as per AS 1289.5.2.1.	G. Donald	Nov 2007
Ed 2/Rev 1	2(c)(d); 5.1(b)(c); 5.2(c); 5.3; 6; 7(b), (c)	New style. Clarify OMC, documents listed. Alternative end of test. OMC changed to w_M. Reporting revised.	D Hazell	May 2011
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 T114 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T114

Maximum dry compressive strength of road construction materials

1. Scope

This Test Method sets out the procedure for the determination of the Maximum Dry Compressive Strength (MDCS) of road construction materials.

2. General

(a) The test is for materials with a Plasticity Index not greater than one

(b) Compaction is by 60 blows of a 4.9 kg rammer having a vertical free fall of 450 mm

(c) The Optimum Moisture Content (*OMC*) referred to in this test is not equivalent to the OMC determined using other compaction methods

(d) The following documents are referred to in this Test Method:

- (i) T105 Preparation of Samples for Testing (Soils)
- (ii) T120 Moisture Content of Road Construction Materials (Standard Method)
- (iii) AS 1141.52 Unconfined cohesion of compacted pavement materials
- (iv) AS 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- (v) AS 1289.5.2.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using modified compactive effort
- (vi) AS 2193 Calibration & classification of force-measuring systems

3. Apparatus

(a) A metal rammer with a 50 ± 0.4 mm face diameter and a drop mass of 4.9 ± 0.01 kg and equipped with a suitable device to control the height of drop to a free fall of 450 ± 2.0 mm.

NOTE: *A suitable form of hand apparatus is shown in Figure 2 of AS 1289.5.1.1 or AS 1289.5.2.1. Provided the essential dimensions are adhered to, mechanical forms of the apparatus may be used.*

(b) A rigid foundation to compact the specimen on (e.g. a concrete floor or a concrete block of at least 100 kg) with suitable attachments for firmly holding the mould base plate assembly during compaction

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

(d) A metal cube mould with sides having internal dimensions 70.7 ± 0.1 mm, a suitable guide mould, plunger, cube mould cramp and base plate

NOTE: *A suitable form of cube mould is shown in Figure 1 of AS 1141.52.*

(e) A parting tool

(f) A compression testing machine of at least 60 kN capacity and equipped with:

- (i) An upper bearing block with a spherical seat
- (ii) A load-indicating device that meets the accuracy and repeatability requirements of AS 2193 Grade C testing machines for the range of forces used in the test

NOTE: *Where an electronic data acquisition system is used to directly capture and record test data, it must have a precision at least equivalent to the apparatus replaced.*

(g) A dish and trowel or spatula, suitable for mixing water with the sample

(h) A suitable measuring cylinder

(i) Sealable airtight containers

(j) Light lubricating oil.

4. Preparation

Samples are to be prepared in accordance with T105.

5. Procedure

5.1 General

(a) Each sub-sample is prepared by recombining the + 4.75 mm and – 4.75 mm fractions as detailed in Step 5.2(c)

(b) Carry out testing of the sub-samples as described in Step 5.2 and Step 5.3

(c) The test is complete when either of the following is achieved:

(i) Three test results "straddle" the Optimum Moisture Content (*OMC*). Straddling has been achieved when:

- Three moisture contents lie between *OMC* - 2.5% and OMC + 2% with one result below *OMC* and one result exceeding *OMC*
- The increments between the moisture contents in ascending order lie between 1% and 2.5%

OR

(ii) Straddling has not been achieved but at least one test result meets the specified minimum MDCS

NOTE: *The method to determine MDCS will give a value greater than or equal to the maximum test result.*

5.2 Sub-sample 1

(a) Assemble mould components and tighten securely. Lubricate the mould with oil and wipe off any excess.

NOTE: *The mould may be lined with thin paper (e.g. newspaper) to facilitate removal of the specimen.*

(b) Place the assembly on the rigid foundation.

(c) Prepare the Sub-sample:

(i) Remove the two fractions for the Sub-sample from the sealed containers

(ii) Wet the fraction retained on the 4.75 mm AS sieve to at least saturated surface wet condition

(iii) Mix the wet fraction from Step (ii) with the fraction passing the 4.75 mm AS sieve

(iv) Adjust the moisture content of the Sub-sample to provide results that "straddle" the OMC as described in Step 5.1(b)

NOTE: *For the first sub-sample it is usual to aim for OMC and then with subsequent sub-samples, adjust each moisture content appropriately to achieve "straddling".*

(v) Thoroughly mix the sub-sample

(d) Place sufficient material from the sub-sample into the mould so that after compaction the top of the specimen is 0 to 5 mm above the mould

NOTE: *Prior to compaction ensure that the material is evenly distributed in the mould and levelled.*

(e) Place the plunger on the top of the material in the mould

(f) Compact the material into the mould using 60 blows from the 4.9 kg rammer falling freely from 450 mm. Hold the rammer vertically and ensure that it strikes the central portion of the plunger

(g) Carefully remove the mould guide and the plunger

NOTE: *If the mould is overfilled by more than 5 mm or under filled, the sample is to be replaced by a new sub-sample.*

(h) Carefully separate the cube moulds

NOTE: A parting tool may be required to separate the moulds.
Where used, the paper lining may be left on the specimen during weighing, drying and testing.

(i) Select a face of the specimen that is at right angles to the direction of compaction. Mark the face to be loaded (refer to Figure 1) or discard the specimen if it is damaged (e.g. cracked, distorted or broken corners)

(j) Determine the wet mass of the specimen to the nearest 1 g (M_W)

(k) Air dry the specimen for at least 12 hours

(l) Dry the specimen to Constant Mass using the procedure described in T120

(m) Allow to cool. Determine the mass of the specimen to the nearest 1 g (M_D)

(n) Determine the following measurements to the nearest mm with reference to Figure 1:

(vi) Each of the widths: W_1, W_2, W_3, W_4

(vii) Each of the lengths: L_1, L_2, L_3, L_4

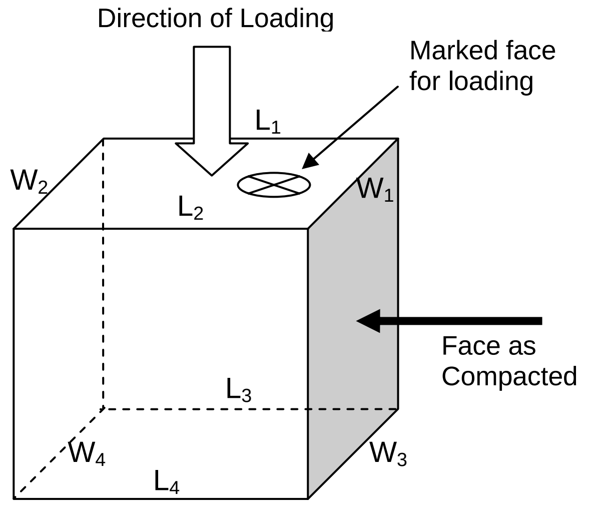

Figure 1–Orientation of Specimen and Dimensions to be Measured

(o) Place the specimen on the lower bearing block of the compression testing machine with the marked face uppermost. Make sure that the vertical axis of the specimen is aligned with the centre of force of the upper bearing block. Bring the upper bearing block to bear on the specimen, ensuring that the seating load is uniformly applied

NOTE: The seating load is to be the minimum required to ensure firm contact over the surface of the specimen.

(p) Apply the force at a uniform rate on the specimen:

(viii) If the machine is mechanised, the rate is to be 30± 6 kN/min

(ix) If the machine has a hand operated pump, the rate is to be approximately 0.5 kN/sec

NOTE: Avoid jerking the pump handle, particularly at the beginning and end of each stroke.

(q) Record the force (P) at failure of the specimen to the nearest 0.5 kN

5.3 Additional sub-samples

(a) Repeat Steps 5.2(a) to 5.2(q) using additional Sub-samples until the requirement in Step 5.1(c) is achieved

6. Calculations

(a) Calculate the average cross sectional area (A) of the specimen as follows:

$$A = \frac{(W_1 + W_2 + W_3 + W_4) \times (L_1 + L_2 + L_3 + L_4)}{16}$$

Where:

A = Average Cross Sectional Area of Specimen (mm2)

W_1, W_2, W_3, W_4 = Widths of specimen (mm) (refer to Figure 1)

L_1, L_2, L_3, L_4 = Lengths of specimen (mm) (refer to Figure 1)

(b) Calculate the moisture content (w) of the specimen as follows:

$$w = \frac{(M_W - M_D)}{M_D} \times 100\%$$

Where:

w = Moisture Content (%)

M_D = Mass of dry specimen (g)

M_W = Mass of wet specimen (g)

(c) Calculate the Dry Compressive Strength (*DCS*) of the specimen to the nearest 0.05 MPa as follows:

$$DCS = \frac{P}{A} \times 1000$$

Where:

DCS = Dry Compressive Strength (MPa)

P = Force at failure (kN)

A = Average Cross Sectional Area of Specimen (mm^2)

(d) Use one of the procedures described in Appendix A to determine whether straddling of the OMC has been achieved (refer to Step 5.1(c))

(e) Where straddling has been achieved, determine the following according to Appendix A:

(i) The Maximum Dry Compressive Strength (*MDCS*)

(ii) The Moisture Content (w_M) that corresponds to the *MDCS*

(f) Where straddling has not been achieved:

(iii) Check if any test result meets the specified minimum MDCS. Report the highest Dry Compressive Strength (*DCS*) as the Maximum Dry Compressive Strength (*MDCS*) and its corresponding moisture content (w_M)

(iv) Repeat the test if the previous step (Step 1.1.1(a)(iii)) is not achieved

7. Reporting

Include the following information, data and results in the report:

(a) The Maximum Dry Compressive Strength (*MDCS*) to the nearest 0.1 MPa

(b) The Moisture Content (w_M) that corresponds to the *MDCS* to the nearest 0.5%

NOTE: The moisture content (w_M) is not equivalent to the OMC determined using other compaction methods.

(c) “Straddling achieved” or “Straddling not achieved”

(d) Reference to this Test Method

Appendix A: Determination of Maximum Dry Compressive Strength and Optimum Moisture Content

Determine *MDCS* and *OMC* using either a mathematical or graphical procedure as described below.

A.1 Mathematical solution

The *MDCS* and *OMC* may be determined by one of the following mathematical procedures: (i) Non-linear regression plot; (ii) Cubic spline function; or (iii) Solution for vertex of a parabola with vertical axis, given 3 points closest to the *OMC*.

A.2 Graphical Solution - Vertex of a Parabola with Vertical Axis Given 3 Points

(a) From the available results, denote point **B** as the result with greatest dry compressive strength (closest to the *MDCS)*

(b) Denote point **A** as the result with moisture content just lower than that of point **B**

(c) Denote point **C** as the result with moisture content just higher than that of point **B**

(d) Draw a horizontal base line through point **A**

(e) If points **A**, **B** and **C** are equally spaced horizontally (i.e. equal increments of *w*):

- (i) Point **F** coincides with point **B**
- (ii) Point **G** is halfway between the baseline and point **C**
- (iii) Draw line **BG** to intersect the base line at **H**

(f) If points **A**, **B** and **C** are not equally spaced horizontally

- (i) Draw vertical lines through points **B** and **C**. Point **D** lies at the intersection of the horizontal line through A and the vertical line through **B**

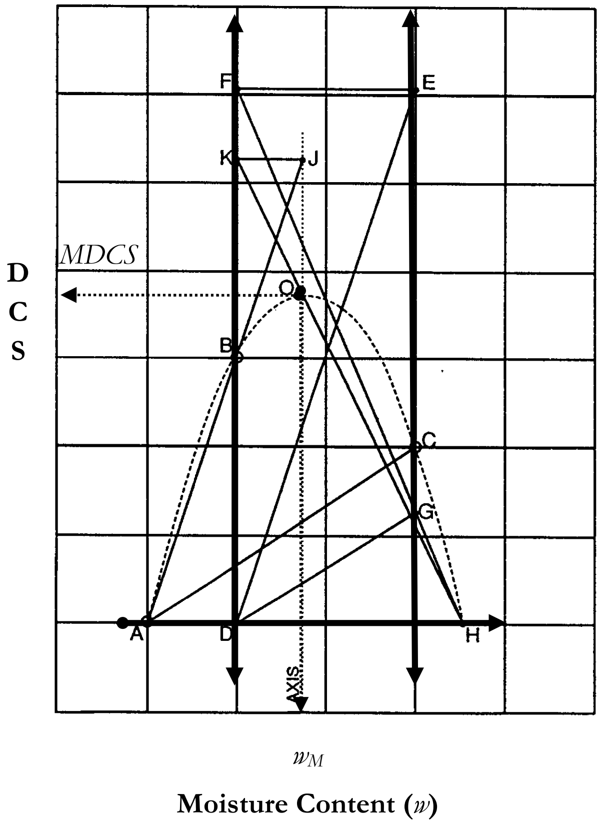

Figure 2–Graphical Solution for Peak Point of Parabola

- (ii) Draw a line **DE** parallel to **AB**. Point **E** lies on a vertical line through point **C** Project **E** horizontally to establish point F on a vertical line through point **B**
- (iii) Draw a line **DG** parallel to **AC**. Point **G** lies on a vertical line through **C**
- (iv) Draw line **FG** to intersect the base line at **H**

(g) Bisect base line **AH** to form the axis of the parabola. This defines the *OMC*

(h) Draw line **AB** to intersect axis of parabola at **J**. Project **J** horizontally to **K**, which lies on the vertical line through **B**

(i) Line **KH** intersects the axis at **O**, the vertex. This defines the *MDCS*