Transport Roads & Maritime Services

NSW GOVERNMENT

Test method T166

Relative compaction 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	D. Dash	Feb 2001
Ed 1/Rev 0	All	Generally revised – Title changed. Expanded procedure and corrected formulas for Relative Compaction.	G. Donald	Nov 2007
Ed 2/Rev 0	2(c); 4; 5.2; 6.2(b), 7(b)(c)(e), Appendix	List documents; Preparation added. Non-cohesive term now used and revised calcs. Reporting to include plots according to Appendix.	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 T166 (other than minor editorial changes) are indicated by a vertical line in the margin as shown here.

Test method T166

Relative compaction of road construction

1. Scope

This Test Method describes the procedure for determining the relative compaction of road construction materials.

2. General

(a) This method is applicable for material containing up to 40% by mass of particles retained on a 37.5 mm AS sieve

(b) Use the procedure and calculations that correspond to the type of material being tested (i.e. cohesive or non-cohesive material)

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

(i) T105 Preparation of Samples for Testing (Soils)

(ii) T111 Dry Density/Moisture Relationship of Road Construction Materials

(iii) T112 Dry Density/Moisture Relationship of Road Construction Materials (Modified Compaction)

(iv) T119 Field Density of Road Construction Materials (Sand Replacement Method)

(v) T125 Field Density of Road Construction Materials (Balloon Densometer Method)

(vi) T162 Compaction Control Test (Rapid Method)

(vii) T164 Maximum Dry Density of Cohesionless Materials (by Vibration)

(viii) T165 Dry Density in Situ of Road Construction Materials (Fixed Volume Extractive Method)

(ix) T173 Field Wet Density of Road Construction Materials (Nuclear Gauge in Direct Transmission Mode)

3. Apparatus

No additional apparatus is required.

4. Preparation

Dry or wet density determined by the specified test methods.

5. Procedure

5.1 Cohesive Materials

(a) Determine the Relative Compaction based on wet densities:

(i) Determine the Field Wet Density (*FWD*) using T119, T125 or T173

(ii) Determine the Maximum Converted Wet Density *(MCWD)* of the material using T162

OR

(b) Determine the Relative Compaction based on dry densities:

(i) Determine the Field Dry Density (*FDD*) using T119, T125 or T173

(ii) Determine the Maximum Dry Density *(MDD)* of the material using T111 or T112

5.2 Non-Cohesive Materials

(a) Determine the Relative Compaction based on dry densities:

(i) Determine the Field Dry Density (*FDD*) using T119, T125, T165 or T173

(ii) Determine the Maximum Dry Density (*MDD*) using T164

6. Calculations

6.1 Cohesive Materials

(a) Where all the material passes the 37.5 mm sieve, calculate the relative compaction as follows:

$$\text{Relative Compaction} = \frac{FWD}{MCWD} \times 100\%$$

Where:

FWD = Field Wet Density (t/m³) (as determined by T119, T125 or T173).

MCWD = Maximum Converted Wet Density (t/m³) (as determined by T162).

OR

$$\text{Relative Compaction} = \frac{FDD}{MDD} \times 100\%$$

Where:

FDD = Field Dry Density (t/m³) (as determined by T119 or T125 or T173).

MDD = Maximum Dry Density (t/m³) (as determined by T111 or T112).

(b) Where the proportion of material retained on the 37.5 mm sieve is not more than 40%, calculate the Relative Compaction as follows:

$$\text{Relative Compaction} = \frac{FWD}{MWBD} \times 100\%$$

Where:

$$MWBD = \frac{100}{\left(\frac{P_0}{J_0}\right) + \left(\frac{100 - P_0}{J_m}\right)} \quad (\text{t/m}^3)$$

MWBD Maximum Wet Bulk Density (t/m³).

FWD = Field Wet Density (t/m³) (as determined by T119, T125 or T173).

P_0 = Proportion of oversize in field test (%) (as determined by T105 or T119).

J_0 = Density of oversize in field test (t/m³) (as determined by T105 or T119).

J_m = Maximum Wet Density of matrix (t/m³) (i.e. material passing 37.5 mm sieve) (as determined by T162).

OR

$$\text{Relative Compaction} = \frac{\text{FDD}}{\text{MDBD}} \times 100\%$$

Where:

$$\text{MDBD} = \frac{100}{\left(\frac{P_0}{DD_0}\right)+\left(\frac{100-P_0}{MDD}\right)} \quad (\text{t/m}^3)$$

MDBD Maximum Dry Bulk Density (t/m³)

FDD = Field Dry Density (t/m³) (as determined by T119 or T125).

=

MDD = Maximum Dry Density of matrix (i.e. material passing 37.5 mm sieve or 19mm) (t/m³) (as determined by T111 or T112).

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P_0 = Proportion of oversize in field test (%) (as determined by T105 or T119).

DD_0 = Density of oversize in field test (t/m³) (as determined by T105 or T119).

6.2 Non-cohesive Materials

(a) Where all the material passes the 37.5 mm sieve, calculate the relative compaction as follows:

$$\text{Relative Compaction} = \frac{FDD}{MDD} \times 100\%$$

Where:

FDD = Field Dry Density (t/m³) (as determined by T119, T125, T165 or T173).

MDD = Maximum Dry Density (t/m³) (as determined by T164).

(b) Where the proportion of material retained on the 37.5 mm sieve is not more than 40%, calculate the Relative Compaction as follows:

$$\text{Relative Compaction} = \frac{FDD}{MDBD} \times 100\%$$

Where:

$$MDBD = \frac{100}{\left(\frac{P_0}{DD_0}\right)+\left(\frac{100-P_0}{MDD}\right)} \quad (\text{t/m}^3)$$

MDBD Maximum Dry Bulk Density (t/m³)

FDD = Field Dry Density (t/m³) (as determined by T119, T125, T165 or T173).

MDD = Maximum Dry Density of matrix (i.e. material passing 37.5 mm sieve or 19mm) (t/m³) (as determined by T164).

P_0 = Proportion of oversize in field test (%) (as determined by T105 or T119).

DD_0 = Density of oversize in field test (t/m³) (as determined by T105 or T119).

7. Reporting

Include the following data and results in the report:

(a) The compaction used (Standard or Modified)

(b) The proportion of material retained on the 37.5 mm sieve (P_0)

(c) The following results as appropriate:

(i) For cohesive materials report the Maximum Wet or Dry Bulk Density to 0.01 t/m^3

NOTE: Where the result is to be used in subsequent calculations, report to the nearest 0.001 t/m^3.

(ii) For non-cohesive materials report the Maximum Dry Bulk Density to 0.01 t/m^3

NOTE: Where the result is to be used in subsequent calculations, report to the nearest 0.001 t/m^3.

(d) The Relative Compaction to the nearest 0.5%

NOTE: Where the result is to be used in subsequent calculations, report the Relative Compaction to the nearest 0.1%.

(e) All test results for a compaction lot are to be plotted according to Appendix A

(f) Reference to the Test Methods used to determine Field Density and Maximum Density

(g) Reference to this Test Method

Appendix A: Calculating and Plotting Test Results

A.1 Plot of Soil/Moisture Relations

(a) Plot moisture content against dry density on the same graph the following:

(i) The 0% and 5% Air Voids Lines according to Step A.2

(ii) For all test results the following:

- Field dry density and field moisture contents
- Maximum Dry Density and Optimum Moisture Contents

(b) Label the plot with the soil particle density (ρ_p) in t/m^3 that is used in Equation A.2.1

A.2 Plot of Air Voids Line

(a) Calculate and plot Dry Density of soil for 0% air voids (ρ_0) against moisture content as follows:

$$\rho_0 = \frac{1}{\left(\frac{1}{\rho_p} + \frac{w}{100}\right)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ Equation A.2.1}$$

Where:

ρ_0 = Dry Density of soil at 0% air voids (t/m^3)

ρ_p = Density of soil particle (t/m^3)

= 2.67 t/m^3 unless otherwise determined

NOTE: Generally applicable to rocks and clays containing quartz and feldspars. Basaltic and artificial aggregates will require a separate determination.

w = Moisture Content as % of the mass of dry soil

NOTE: Suitable range of w for the data being plotted

(b) Calculate and plot Dry Density of soil for 5% air voids (ρ_5) against moisture content as follows:

$$\rho_5 = 0.95 \times \rho_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{ Equation A.2.2}$$

Where:

ρ_5 = Dry Density of soil at 5% air voids (t/m^3)

ρ_0 = Dry Density of soil at 0% air voids (t/m^3)