NEW ZEALAND STANDARD

METHODS OF TESTING SOILS FOR CIVIL ENGINEERING PURPOSES

Part 4
Soil compaction tests

4.2
DETERMINATION OF THE MINIMUM AND MAXIMUM DRY DENSITIES AND RELATIVE DENSITY OF A COHESIONLESS SOIL

TEST 4.2.1
Minimum dry density

4.2.1.1
Scope
This method provides a standard technique for the laboratory determination of the minimum dry density of a cohesionless soil (see Notes (1) and (2)). The laboratory density may be used for comparison with field determinations but should not be considered as an absolute value.

4.2.1.2
Related documents
The provisions of Part 1 of this Standard are applicable to and shall be read in conjunction with, this method of test.

4.2.1.3
Apparatus

(a) A cylindrical metal mould conforming to the nominal size requirements given in table 4.2.1. The sides and base of the mould shall be of sufficient rigidity to retain its form under rough usage.

(b) An appropriate pouring device (see table 4.2.1) such as either:

  (i) A conical metal funnel of capacity 1.2 to 1.8 litres and with an included angle of 45° to 60° and having a cylindrical spout of nominal dimensions 20 mm diameter by 150 mm long (see Note (3)), or

  (ii) A metal scoop with a flat base and width not more than half the diameter of the mould.

(c) A balance of suitable capacity readable and accurate to 0.1 % of the mass of soil required to fill the mould.

(d) A drying oven complying with the requirements of 1.4.2 of Part 1 and of sufficient capacity to accommodate all of the test sample.

(e) A metal dish or tray of suitable size to hold the sample during the drying or filling process.

(f) A steel straightedge of length at least 1.5 times the diameter of the mould used.

4.2.1.4
Sample preparation

(a) By adequate mixing and subdividing obtain a sub-sample from material that has been prepared in accordance with the procedure described in 1.6.3 of Part 1. The size of the sub-sample shall be dependent on the size of mould selected which shall be consistent with the maximum particle size shown in table 4.2.1.

  NOTE – If the maximum particle size of the material tested is smaller than the maximum particle size of the material supplied to the laboratory, the mass of the oversize material discarded shall be measured and recorded for calculation of the percentage of the mass discarded (see 4.2.1.7.1 (b)).

(b) Dry the sub-sample to constant mass in an oven at 105 °C to 110 °C.

4.2.1.5
Procedure

(a) Select the mould and pouring device suitable to the maximum size of particle in the

Single User PDF Terms & Conditions

You have material which is subject to strict conditions of use. Copyright in this material is owned by the New Zealand Standards Executive. Please read these terms and conditions carefully, as in addition to the usual range of civil remedies available to Standards New Zealand on behalf of the New Zealand Standards Executive for infringement of copyright, under New Zealand law every person who infringes copyright may be liable to a fine of up to $10,000 for every infringing copy or imprisonment of up to 5 years, or a fine of up to $150,000 or imprisonment not exceeding 5 years.

You have access to a single-user licence to read this non-revisable Adobe Acrobat PDF file and print out and retain ONE printed copy only.

We retain title and ownership of the copyright in this PDF file and the corresponding permitted printed copy at all times.

Under this license use of both the PDF file and the single permitted printed copy of this PDF file you may make are restricted to you. Under no circumstances are you permitted to save, sell, transfer, or copy this PDF file, the one permitted printed copy of this PDF file, or any part of either of them.

You undertake that you will not modify, adapt, translate, reverse engineer, decompile, disassemble or create derivative works based on any of the downloaded PDF file, nor will you merge it with any other software or document, even for internal use within your organization.

Under no circumstances may this PDF file be placed on a network of any sort without our express permission.

You are solely responsible for the selection of this PDF file and any advice or recommendation given by us about any aspect of this PDF file is intended for guidance only and is followed or acted upon entirely at your own risk.

We are not aware of any inherent risk of viruses in this PDF file at the time that it is accessed. We have exercised due diligence to ensure, so far as practicable, that this file does not contain such viruses.

No warranty of any form is given by us or by any party associated with us with regard to this PDF file, and you accept and acknowledge that we will not be liable in any way to you or any to other person in respect of any loss or damage however caused which may be suffered or incurred or which may arise directly or indirectly through any use of this PDF file.

Regardless of where you were when you received this PDF file you accept and acknowledge that to the fullest extent possible you submit to New Zealand law with regard to this licence and to your use of this PDF file.

sample, as indicated in table 4.2.1. Determine the mass of the mould, and record the reading of this and all further mass determinations to the nearest 0.1 % of the mass of soil required to fill the mould. Determine the volume of the mould to 1 part in 1000 either from direct measurement, or from weighing the water required to fill the mould. If the latter method is used take the density of water corresponding to its temperature (see table 4.2.2).

(b) With the dry mould on a stable base, fill it to overflowing by placing material as loosely as possible, using the pouring device in the manner described in item (c) or (d) below. Do not disturb the mould during filling (see Note (4)).

(c) When placing by pouring funnel, place the spout on the bottom of the mould, fill with at least 1.2 litres of material, then lift to allow the material to flow in a steady stream so that, at any time, the free fall is not more than 20 mm. At the same time, move the pouring funnel in a spiral motion to form layers of uniform thickness with the minimum of segregation.

(d) When placing by means of a scoop, mix and spread the material in a dish or on a tray in such a manner as to obtain a uniform mixture. To minimize segregation, take scoops full at random and remix and respread the remaining material as required. In transferring the material to the mould, allow the material to slide off the side of the mould, rather than to fall onto the bottom of the mould or onto the previously placed material.

(e) Strike off the material by means of the steel straightedge or, in the case of coarse material, carefully remove any pieces projecting so that the surface voids and the amount of material projecting above the mould, are judged to be reasonably equal in volume.

(f) Determine the mass of the mould and contents and record. Record also the mass (M) of the contents.

(g) Repeat steps (b) to (f). If the two values of M differ by less than 2 %, use the lower value. Otherwise repeat steps (b) to (f) again. If from these three values, two are obtained within 2 %, use the lower value of those two. Otherwise repeat the whole test.

4.2.1.6
Calculations
Calculate the minimum dry density ($\varrho_{d\,min}$) of the material from the formula:

$$\varrho_{d\,min} = \frac{M}{V} \ldots\ldots\ldots t/m^3$$

where M = mass of dry material in the mould (g)
V = volume of the mould (ml)

4.2.1.7
Reporting of results

4.2.1.7.1
Report the following:

(a) The date of test

(b) The maximum size of particle used in the test (mm)

(c) Percentage of oversize material discarded

(d) The minimum dry density (t/m^3) to the nearest 0.02

(e) The nominal volume of the mould used (L).

4.2.1.7.2
State that the result was obtained in accordance with this Standard Test Method.

NOTES ON TEST 4.2.1

(1) Soils for which this method is applicable may contain up to 5 % by mass of soil particles passing a 75 μm sieve, except that silty sands with non-plastic fines may contain up to 12 % passing a 75 μm sieve.

(2) The test method may be used for soils with maximum size particles of 75 to 200 mm and will require a mould size dependent on the grading of the material. The diameter and depth of the mould shall not be less than 3 times the maximum particle size for well graded soils but may need to be up to 5 times the size for gap graded or uniformly graded soils.

(3) A sand flow cone as specified in NZS 3111 section 19 may be modified to suit.

(4) It is important to ensure that the mould is not knocked or bumped during the filling or levelling procedures since such action is likely to cause settlement of the material and invalidate the test result. Should there be any jarring of the mould during the filling or levelling procedures, the test should be started again from step 4.2.1.5(b).

Table 4.2.1
MAXIMUM SIZE OF PARTICLE AND DIMENSIONS OF APPARATUS FOR STANDARD MOULDS

Nominal volume of mould	*Maximum size of particle*	*Nominal internal diameter of mould*	*Nominal mass of sample*	*Pouring device*
L	mm	mm	kg	
1	4.75	105	5	Funnel
3	19.0	150	12	Scoop
15	37.5	250	40	Scoop
30	75.0 to 200 (see Note (2))	350	80	Scoop
Column 1	2	3	4	5

Table 4.2.2
ABSOLUTE DENSITY OF WATER (t/m^3) OVER TEMPERATURE RANGE 5 ° – 30 ° C

Degrees C	*Density*	*Degrees C*	*Density*
5	1.0000	18	0.9986
6	0.9999	19	0.9984
7	0.9999	20	0.9982
8	0.9998	21	0.9980
9	0.9998	22	0.9978
10	0.9997	23	0.9975
11	0.9996	24	0.9973
12	0.9995	25	0.9970
13	0.9994	26	0.9968
14	0.9992	27	0.9965
15	0.9991	28	0.9962
16	0.9989	29	0.9959
17	0.9988	30	0.9956
Column 1	2	3	4