Australian Standard®

AS 1289.5.1.12017

Methods of testing soils for engineering purposes

Method 5.1.1: Soil compaction and density tests—Determination of the dry density/moisture content relation of a soil using standard compactive effort

1 SCOPE

This Standard sets out a method for the determination of the relationship between the moisture content and the dry density of a soil, when compacted, using standard compactive effort (596 kJ/m^3). Compaction is conducted over a range of moisture contents to establish the maximum mass of dry soil per unit volume achievable for this compactive effort and its corresponding moisture content. The procedure is applicable to that portion of a soil that passes the 37.5 mm sieve. Soil that passes the 19.0 mm sieve is compacted in a 105 mm diameter mould. Soil that contains more than 20% of material retained on the 19.0 mm sieve is compacted in a 152 mm diameter mould.

This test method may be used for establishing a maximum dry density and optimum moisture content for the determination of other engineering properties.

NOTES:

1 For compaction control testing, the use of alternative test methods such as AS 1289.5.7.1 may be considered.

2 Corrections for oversize material are not covered in this Method but may be made using Method AS 1289.5.4.1 when required for compaction control.

2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1289		Methods of testing soils for engineering purposes
1289.1.1	Method 1.1:	Sampling and preparation of soils—Preparation of disturbed soil samples for testing
1289.2.1.1	Method 2.1.1:	Soil moisture content tests—Determination of the moisture content of a soil—Oven drying method (standard method)
1289.2.1.2	Method 2.1.2:	Soil moisture content tests—Determination of the moisture content of a soil—Sand bath method (subsidiary method)
1289.2.1.4	Method 2.1.4:	Soil moisture content tests—Determination of the moisture content of a soil—Microwave-oven drying method (subsidiary method)
1289.2.1.5	Method 2.1.5:	Soil moisture content tests—Determination of the moisture content of a soil—Infrared lights method (subsidiary method)
1289.2.1.6	Method 2.1.6:	Soil moisture content tests—Determination of the moisture content of a soil—Hotplate drying method

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1289.2.3.1	Method 2.3.1:	Soil moisture content tests—Establishment of correlation—Subsidiary method and the standard method
1289.3.1.1	Method 3.1.1:	Soil classification tests—Determination of the liquid limit of a soil—Four point Casagrande method
1289.3.1.2	Method 3.1.2:	Soil classification tests—Determination of the liquid limit of a soil—One point Casagrande method (subsidiary method)
1289.3.5.1	Method 3.5.1:	Soil classification tests—Determination of the soil particle density of a soil—Standard method
1289.3.9.1	Method 3.9.1:	Soil classification tests—Determination of the cone liquid limit of a soil
1289.3.9.2	Method 3.9.2:	Soil classification tests—Determination of the cone liquid limit of a soil—One-point method
1289.5.4.1	Method 5.4.1:	Soil compaction and density tests—Compaction control test—Dry density ratio, moisture variation and moisture ratio
1289.5.4.2	Method 5.4.2:	Soil compaction and density tests—Compaction control test—Assignment of maximum dry density and optimum moisture content values
1289.5.7.1	Method 5.7.1:	Soil compaction and density tests—Compaction control test—Hilf density ratio and Hilf moisture variation (rapid method)
1289.6.1.1	Method 6.1.1:	Soil strength and consolidation tests—Determination of the California Bearing Ratio of a soil—Standard laboratory method for a remoulded specimen

ISO

3310	Test sieves—Technical requirements and testing (series)

3 DEFINITION

For the purpose of this document, the definition below applies:

3.1 Competent person

A person who has acquired, through education, training, qualification or experience, or a combination of these, the knowledge and skill enabling that person to perform the required task correctly and safely.

4 APPARATUS

The following apparatus is required:

(a) Steel moulds, of a size dependent on the maximum size of material being tested, as follows:

(i) *For compaction of material passing a 19.0 mm sieve Mould A*: A cylindrical metal mould having an internal diameter of 105 mm and effective height of 115.5 mm fitted with a detachable baseplate and a removable collar assembly about 60 mm high, both of which can be firmly attached to the mould, complying with the tolerances given in Table 1.

NOTE: A suitable design is shown in Figure 1.

(ii) *For compaction of that fraction of the soil material that passes a 37.5 mm sieve but contains more than 20% of material that would be retained on a 19.0 mm sieve Mould B*: A cylindrical metal mould having an internal diameter of 152 mm and effective height of 132.5 mm fitted with a detachable baseplate and a removable collar assembly about 60 mm high, both of which can be firmly attached to the mould, complying with the tolerances given in Table 1.

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NOTES:

1 A suitable design is shown in Figure 1.

2 A mould meeting the requirements of AS 1289.6.1.1 used with a steel spacer disc of 150 ±0.5 mm diameter and sufficient height to provide an effective specimen height of 132.5 mm is a deemed-to-satisfy alternative to Mould B.

(b) A 2.7 kg steel hammer as shown in Figure 2 and of dimensions given in Table 1. The design of the hammer shall permit the hammer to fall freely through the specified drop height, and shall ensure that there is a clearance not greater than 6 mm between the wall of the mould and the hammer during use. Alternatively, a mechanical compactor may be used, provided it meets the essential requirements of drop height, mass and energy input, and a solid base for the mould to rest on. The difference between maximum dry density determinations using manual or mechanical compaction shall be not greater than 2%.

NOTE: When a 152 mm diameter mould is used in a mechanical compactor that does not permit the hammer to be moved to compact around the periphery of the mould, a sector foot having a cross-sectional area equivalent to the area of the circular hammer face may be used to enable uniform compaction over the complete area of soil in the mould. Wear in the support mechanism of a mechanical apparatus that has a baseplate that rotates between blows may occur and cause energy to be absorbed in the mechanism. Therefore, at regular intervals comparison checks should be made between maximum dry density and optimum moisture content test results obtained using hand compaction and those using mechanical compaction.

(c) A level rigid foundation on which to compact the specimen (for example, a sound concrete floor about 100 mm or more in thickness or a concrete block of at least 100 kg mass).

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

(e) Sieves, 37.5 mm and 19.0 mm, complying with ISO 3310 series.

(f) A steel straightedge, about 250 mm long, 25 mm wide and 3 mm thick, preferably with one bevelled edge.

(g) Miscellaneous mixing apparatus, such as a pan or bowl, a spoon, trowels and water spray, suitable for thoroughly mixing increments of water with the soil.

(h) A rule graduated in millimetres or a layer depth gauge.

(i) Sealable containers to prevent moisture loss.

(j) A sample extractor such as a jack, lever, frame or other suitable device for extracting compacted soil specimens from the mould (optional).

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TABLE 1

DIMENSIONS AND TOLERANCES FOR SUITABLE MOULDS AND HAMMER

Apparatus	Dimension	Tolerance
MOULDS		
Mould A: 105 mm diameter		
Internal diameter, mm	105.0	±0.5 (see Note 1)
Height, mm	115.5	±0.5 (see Note 1)
Nominal volume, cm^3	1000	±15
Mould B: 152 mm diameter		
Internal diameter, mm	152.0	±1.0 (see Note 1)
Effective height, mm	132.5	±0.5 (see Note 1)
Nominal volume, cm^3	2400	±35
HAMMER		
Diameter (round foot), mm	50	±0.4
Radius (sector foot), mm	74	±0.5 (see Note 2)
Arc of segment (sector foot), degrees	41	±0.5 (see Note 2)
Area of hammer, mm^2	1964	±31
Drop, mm	300	±2.0 (see Note 3)
Mass, kg	2.7	±0.01 (see Note 3)
Energy delivered per blow, J	7.94	±0.08
Number of layers	3	
Number of blows/layer: Mould A	25	
Mould B	60	
Energy input, kJ/m^3	596	±14

NOTES:

1 Either but not both of the tolerances may be exceeded, provided the specified tolerance of volume is not exceeded.

2 Either but not both of the tolerances may be exceeded, provided the tolerance of the area is not exceeded. Diameter and radius of arc of segment are measured 3 mm behind the face of the hammer.

3 Either but not both of the tolerances may be exceeded, provided the appropriate tolerance of energy delivered per blow is not exceeded.

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