AS 1289.0—2000

AS 1289.0

Australian Standard™

Method of testing soils for engineering purposes

Part 0: General requirements and list of methods

Standards Australia

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Australian Standard™

Method of testing soils for engineering purposes

Part 0: General requirements and list of methods

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PREFACE

This Standard was prepared by the Standards Australia Committee CE/9, Testing of Soils for engineering Purposes, to supersede AS 1289.0—1991, *Methods of testing soils for engineering purposes*, Part 0: *General requirements and list of methods*.

The objective of this standard is to provide —

(a) a list of methods of test in the AS 1289 series;

(b) definitions for of terms used; and

(c) a list of requirements for testing.

At present, the AS 1289 series of methods comprises over 60 methods with additional methods in the course of preparation. In order to monitor the integrity of this series (i.e. its edition status), this Part (AS 1289.0) will be revised at regular intervals and will contain (as this edition does) a table that provides a complete up-to-date list of the methods as well as any supplementary information of a general nature.

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STANDARDS AUSTRALIA

Australian Standard

Method of testing soils for engineering purposes

Part 0: General requirements and list of methods

1 SCOPE

This Standard is fundamental to all of the methods in the AS 1289 series. It provides the following information:

(a) A list of methods in the AS 1289 series.

(b) Related documents.

(c) Definitions.

(d) Apparatus used in a number of methods in the series and the Standards with which that apparatus have to comply.

(e) Soil groups for use in a number of methods.

2 REFERENCED AND RELATED DOCUMENTS

2.1 Referenced documents

The following documents are referred to in this Standard:

AS
1141 Methods for sampling and testing aggregates
1141.3.1 Method 3.1: Sampling—Aggregates

1152 Specification for test sieves

1289 Method of testing soils for engineering purposes (Set)

1349 Bourdon tube pressure and vacuum gauges

1726 Geotechnical site investigation

2026 Density hydrometers

2163 Laboratory glassware—Measuring cylinders

2164 Laboratory glassware—One mark volumetric flasks

2165 Laboratory glassware—Burettes

2166 One-mark pipettes

2245 Glass filter funnels

2831 Thermometers—Solid stem—Long and short—For precision use

BS
733 Pycnometers
733.2 Part 2: Methods for calibration and use of pycnometers

1739 Specification for filter flasks

1752 Specification for laboratory sintered or fritted filters including porosity grading

4019 Specification for rotary core drilling equipment
4019.3 Part 3: Specification for System A—Metric units

4019.4	Part 4:	Specification for System A — Inch units
4019.5	Part 5:	Specification for wireless diamond drilling equipment — System A — Metric units

3 DEFINITIONS

For the purpose of this Standard the definitions below apply

3.1 Added moisture (*Z*)

In the rapid method of compaction control, the mass of moisture added to or removed from a specimen of wet soil at field moisture content is expressed as a percentage of the mass of wet soil. If moisture is added, Z is positive; if moisture is removed, Z is negative.

3.2 Air voids line

Line showing the dry density/moisture content relationship for soil containing a constant percentage of air voids (air voids lines are shown in Figure 1). The line is calculated from the following :

$$\rho_d = \frac{\rho_w\left(1-\frac{V_a}{100}\right)}{\frac{\rho_w}{\rho_s}+\frac{w}{100}} \qquad \ldots 3.2(1)$$

where

ρ_d = dry density of the soil, in grams per cubic centimetre

ρ_w = Density of water, in grams per cubic centimetre

V_a = Volume of air voids in the soil, expressed as a percentage of the gross volume of the undried material (see Clause 3.4.5)

ρ_s = soil particle density, in grams per cubic centimetre

w = Moisture content, expressed in percentage of mass of the dry soil

3.3 Boulders

Rock particles of size 200 mm or larger.

3.4 Bulk density(ρ)

Mass of a material (including solid particles, air voids and any contained water) per unit volume.

3.5 California Bearing Ratio (CBR)

Load, expressed as a percentage of a standard load, required to penetrate a specimen of soil for a specified distance at a given rate.

3.6 Clay fraction

Fraction of a soil composed of particles smaller in size than 2 μm.

3.7 Cobbles

Rock particles between 60 mm and 200 mm in size.

3.8 Coefficient of consolidation (c_v)

A coefficient relating to the time rate of consolidation of a soil as determined by the one-dimensional consolidation test.

3.9 Coefficient of permeability (k)

Superficial velocity of flow of water through soil under a unit hydraulic gradient at 20°C.

3.10 Coefficient of volume decrease (m_v)

Change in thickness per unit initial thickness of a soil layer subjected to a unit increase in pressure in one-dimensional consolidation.

3.11 Compaction

Process of packing soil particles more closely together by rolling or other mechanical means so that air is removed from the voids thus increasing the dry density of the soil.

3.12 Cone friction ratio (F_R)

Ratio of the cone skin friction to the cone end resistance.

3.13 Cone liquid limit (w_{CL})

Moisture content at which the soil passes from the plastic state to the liquid state as determined by the cone liquid limit test using a cone penetrometer.

3.14 Cone plasticity index (I_{CP})

Numerical difference between the cone liquid limit and the plastic limit of a soil.

3.15 Cone resistance (q_c)

Load reaching the point of a cone penetrometer divided by the projected bearing area of the cone.

3.16 Cone skin friction (f_s)

Total load carried by the friction jacket of a friction cone penetrometer divided by the surface area of the jacket.

3.17 Consolidation

Process of packing soil particles more closely together over a period of time by the application of continued pressure resulting in the expulsion of water or air (or both) from the voids.

3.18 Converted wet density (*CWD*)

In the rapid method of compaction control, the wet density of a laboratory specimen converted to the wet density at the field moisture content.

3.19 Core shrinkage index (I_{cs})

The percentage strain per *pF* change in total suction as determined by core shrinkage testing.

3.20 Degree of saturation (S_r)

Volume of water in the voids, expressed as a percentage of the total volume of voids in an undried soil.

3.21 Density index (I_D)

A measure of the state of compactness of a cohesionless soil with respect to the loosest state and densest state at which it can be placed by the laboratory procedures for minimum and maximum densities described.

3.22 Dispersive soils

Soils that have the ability to pass rapidly into suspension in the presence of water.

3.23 Distilled water

Distilled water or deionized water (see Clause 3.66).

3.24 Dry density (ϱ_d)

Mass of a material per unit volume of undried material after drying to constant mass at 105°C to 110°C.

3.25 Dry density moisture content relationship

Relationship between dry density and moisture content of a soil when a given compactive effort is employed (see Figure 1).

3.26 Dry density ratio (R_D)

Percentage ratio of the dry density of the soil to the maximum dry density of that soil as determined by a laboratory compaction test.

3.27 Electrical resistivity

Measure of the ability of a soil to oppose the flow of an electric current.

3.28 Emerson class number

Classification number related to the dispersive nature of a soil and attributed to a soil following a series of simple tests involving the action of water on soil samples in accordance with a set procedure and observed reactions.

3.29 Field vane shear strength (s)

Undrained shear strength of a soil for rapid rates of loading as measured by the field vane shear test. It applies to soil in both the undisturbed and the remoulded conditions.

3.30 Gravel fraction

Fraction of a soil composed of particles ranging in size from 2 mm to 60 mm. The gravel fraction may be subdivided into coarse, medium and fine sizes as follows:

Gravel	Nominal size	AS 1152 sieve sizes
Coarse	60 mm to 20 mm	63 mm to 19 mm
Medium	20 mm to 6 mm	19 mm to 6.7 mm
Fine	6 mm to 2 mm	6.7 mm to 2.36 mm

3.31 Hilf density ratio (R_{HD})

In the rapid method of compaction control, the ratio of the field wet density of a soil to the maximum converted wet density of that soil expressed as a percentage. While being theoretically equal to the dry density ratio (R_D) of the soil, it may be slightly different to R_D because of variations in testing techniques, such as curing.

3.32 Laboratory density ratio (*LDR*)

The ratio of the dry density of a laboratory compacted specimen to the maximum dry density of the material (Clause 3.38), expressed as a percentage.

3.33 Laboratory moisture ratio (*LMR*)

The ratio of the moisture content of a laboratory specimen to the optimum moisture content of the material (Clause 3.42), expressed as a percentage.

3.34 Linear shrinkage (*LS*)

Decrease in length expressed as a percentage of the original length when a sample of soil is oven-dried from a moisture content close to the liquid limit, as determined by the linear shrinkage test.

3.35 Liquid limit (w_L)

Moisture content at which the soil passes from the plastic to the liquid state as determined by the liquid limit test.

3.36 Loaded shrinkage index (I_{ls})

Percentage change in vertical strain per pF change in total suction as measured under load.

3.37 Matric (Total) suction (u(pF))

The negative gauge pressure, relative to the external gas pressure on the soil water, to which a solution, identical in composition with the soil solution, has to be subjected in order to be in equilibrium through a porous membrane wall with the water in the soil.

3.38 Maximum dry density (*MDD*)

Dry density of a soil obtained using a specified amount and type of compactive effort (standard or modified) at the optimum moisture content (see Figure 1).

3.39 Moisture content (w)

Mass of water that can be removed from the soil, by drying to constant mass at 105°C to 110°C, expressed as a percentage of the dry mass.

3.40 Moisture ratio (R_m)

The percentage ratio of the moisture content of a soil to its optimum moisture content (Clause 3.42).

3.41 Moisture variation (w_v)

Difference between the optimum moisture content (w_o) and the field moisture content (w_f) of the soil.

3.42 Optimum moisture content (w_o)

Moisture content of a soil at which a specified amount and type of compactive effort will produce the maximum dry density (see Figure 1).

3.43 Particle size distribution

Percentages of the various grain sizes present in a soil as determined by sieving, sedimentation or other means.

3.44 Standard penetration test (*SPT*) (*N*)

Number of blows of a standard mass falling a specified distance required to drive a split tube sampler a specified distance into the soil at the bottom of a borehole.

3.45 Percentage air voids (V_a)

Volume of air voids in the soil expressed as a percentage of the gross volume of undried material.

3.46 Percent dispersion (*PD*)

Percent ratio of the proportion of a soil finer than 0.005 mm particle dimension not using a dispersion agent, divided by the proportion of a soil finer than 0.005 mm particle dimension using a dispersion agent, expressed as a percentage.

3.47 Permanent strain (ε_p)

The percent unrecoverable strain experienced by a specimen placed under load.

3.48 Pinhole dispersion

Classification with related description of the degree of dispersivity of a soil ranging from highly dispersive (DI) to completely erosion resistant (NDI), determined from measurements and observations made in a series of flow tests with head variations, through a 1 mm in diameter pinhole in the sample soil.

3.49 Plasticity index (I_p)

Numerical difference between the liquid limit and the plastic limit of a soil.

3.50 Plastic limit (w_p)

Moisture content at which the soil becomes too dry to be in a plastic condition as determined by the plastic limit test.

3.51 Quartering

Reduction in quantity of a large sample of material so as to obtain a representative portion of the original material.

NOTE: See AS 1141.3.1 for a description of this performance process.

3.52 Remoulded

Compacted in a mould.

3.53 Resilient modulus (E_r)

The ratio of repeated deviator stress over recovered during repeated load cycles.

3.54 Riffling

Reduction in quantity of a large sample of material by dividing the mass into two representative, approximately equal, halves by passing the sample through an appropriately sized riffle (or riffle box). The process is repeated until a sample of the required size is obtained.

3.55 Sample

Soil submitted to the laboratory for testing.

3.56 Sand equivalent (*SE*)

Empirical measure of the quantity and type of fines in the fraction of soil which passes a 4.75 mm AS 1152 sieve.

3.57 Sand fraction

Fraction of a soil composed of particles ranging in size from 60 µm to 2.0 mm. The sand fraction may be subdivided into coarse, medium and fine sizes as follows:

Sand	Nominal size	AS 1152 sieve size
Coarse	2.0 mm to 600 µm	2.36 mm to 600 µm
Medium	600 µm to 200 µm	600 µm to 212 µm
Fine	200 µm to 60 µm	212 µm to 75 µm

3.58 Saturation line (zero air voids line)

Line showing the dry density/moisture content relationship for soil containing no air voids. The saturation line is also shown in Figure 1. It is obtained by putting $V_a = 0$ in the formula for air voids line (see Clause 3.2).

3.59 Shrink-swell index (I_{ss})

The percent vertical strain per *pF* change in total suction.

3.60 Silt fraction

Fraction of a soil composed of particles between the sizes 60 μm and 2 μm. The silt fraction may be subdivided into coarse, medium and fine sizes. For practical purposes an AS 1152 75 μm sieve and clay may be used to separate the silt from coarser fractions.

(a) Coarse silt...60 μm to 20 μm; or

(b) Medium silt...20 μm to 6 μm; or

(c) Fine silt...6 μm to 2 μm.

3.61 Soil

Any naturally occurring deposit forming part of the earths' crust and resulting from weathering or breakdown of rock formation or from the decay of vegetation. For the purpose of this Standard, soil also includes materials produced from rock sources, artificially produced materials, or mixtures of these materials and stabilizing agents, which are used for engineering purposes in place of or in conjunction with naturally occurring materials.

3.62 Soil particle density (ϱ_s)

Mass of soil particles per unit volume of dry material excluding permeable voids, after drying to constant mass at 105°C to 110°C.

3.63 Specimen

Portion of a sample upon which a test is made.

3.64 Triaxial compressive strength

Maximum value of the principal stress difference ($\sigma_1 - \sigma_3$) as measured in undrained compression in the triaxial test. Where a maximum does not occur the value is taken at an axial strain of 20%.

3.65 Void ratio (*e*)

Ratio of the volume of voids (containing air or water, or both) in a soil to the volume of solids.

3.66 Water

Potable water, with the exception of water used in soil chemical tests where the use of distilled water is mandatory (see Clause 3.23).

3.67 Wet density (ϱ)

Mass of a material per unit volume of undried material.

4 APPARATUS

4.1 General

The apparatus required by these methods shall comply with the appropriate Standards listed in Clause 2.

4.2 Drying ovens

4.2.1 *General requirements*

The purpose of a drying oven is to dry a sample of soil to a constant mass in accordance with AS 1289.2.l.l.

Drying ovens shall meet the following requirements:

(a) Be provided with a thermometer whose sensing element will accurately reflect the temperature in the oven. The temperature indicator shall be located so that it can be observed from the working space in front of the cabinet, and shall be readable to ±0.5°C.

(b) Be fitted with an adjustable automatic control device for maintaining the oven temperature within the range 105°C to 110°C when empty and with the vents open. The oven temperature shall be measured with the thermometer.

(c) Be adequately vented to permit escape of moisture-laden air.

(d) The maximum temperature at any point shall not exceed the specified upper limit of 110°C. The maximum temperature attained shall be determined by placing maximum reading thermometer(s) or thermocouple, readable to ±0.5°C, at the eight corners and at the centre-point of the working space of the preheated oven.

These temperature readings shall be determined when the oven is empty and with the vents open.

All of the above measurements shall be taken after a minimum of 12 h continuous operation with the door closed and the forced ventilation operating if fitted.

4.2.2 *Loading*

When the oven is fully loaded, sufficient clearance shall be left around the sides and between the shelves to permit the free circulation of air through the oven.

4.2.3 *Efficiency*

An oven of satisfactory efficiency shall have a minimum average evaporation rate of 15 g/h and a minimum of 10 g/h for any individual dish when tested as follows:

(a) Preheat the empty oven with the vent open and with the indicated temperature between 105°C and 110°C, for a minimum of 12 h.

The vent shall be open as far as possible consistent with the attainment of the temperature requirement.

(b) For ovens of about 0.15 m^3 volume, place a Petri dish of 100 ±1 mm diameter and approximately 50 mm height, near each of the four corners of both of the top and bottom shelves leaving a 50 mm space between the dishes and the sides, back or door. Initially each dish shall contain 200 g of water at 20 ±2°C.

For ovens of greater or less volume than 0.15 m^3, increase or reduce the number of Petri dishes by one for each 0.03 m^3, greater or less than 0.15 m^3 and arrange the dishes as evenly as possible leaving a 50 mm gap between them. Leave a 50 mm space between the dishes and the sides, back or door.

(c) Record the time of closing the doors of the oven at the commencement of the test and continue heating for 4 h without adjustment from the preheat conditions.

(d) After 4 h remove the Petri dishes from the oven, cover and allow to cool before determining the mass of water evaporated.

(e) For each Petri dish, calculate the rate of evaporation in grams per hour. If the water of any dish has completely evaporated, assume the rate of evaporation of that dish as 50 g/h. Also calculate the average rate of evaporation.

4.2.4 *Rate of loading*

The rate of loading of the oven with samples of soil shall be restricted so that the indicated temperature of the loaded oven returns to 105°C to 110°C in at least 18 h of any 24 h working period.

4.3 Balance calibration and accuracy of mass determination

Balances shall comply with the limit of performance requirements specified in the individual test methods. For a balance of limit of performance (±F) there is not more than five chances in one hundred that the measured mass will lie outside ±F of the true value.

NOTE: The use and calculation of limit of performance is shown in, PROWSE, D.B. *The Calibration of Balances* Commonwealth Scientific and Industrial Research Organization, Melbourne: 1985.

5 SOIL GROUPS

For the purposes of the methods in the AS 1289 series, soils are grouped as follows:

(a) Fine-grained soils-soils containing not less than 80% passing a 2.36 mm AS 1152 sieve.

(b) Medium-grained soils-soils containing not less than 80% passing a 19 mm AS 1152 sieve.

(c) Coarse-grained soils-soils containing not less than 80% passing a 37.5 mm AS 1152 sieve.

Any soil shall be regarded as belonging to the finest-grained group appropriate under the definitions given above. This grouping is not a soil classification framework and soils should be described as detailed in AS 1726.

With the exception of a soil classifications test and some soil compaction and density tests, soils with a greater proportion of material than 20% retained on a 37.5 mm AS 1152 sieve, cannot be usefully examined by the methods in AS 1289.

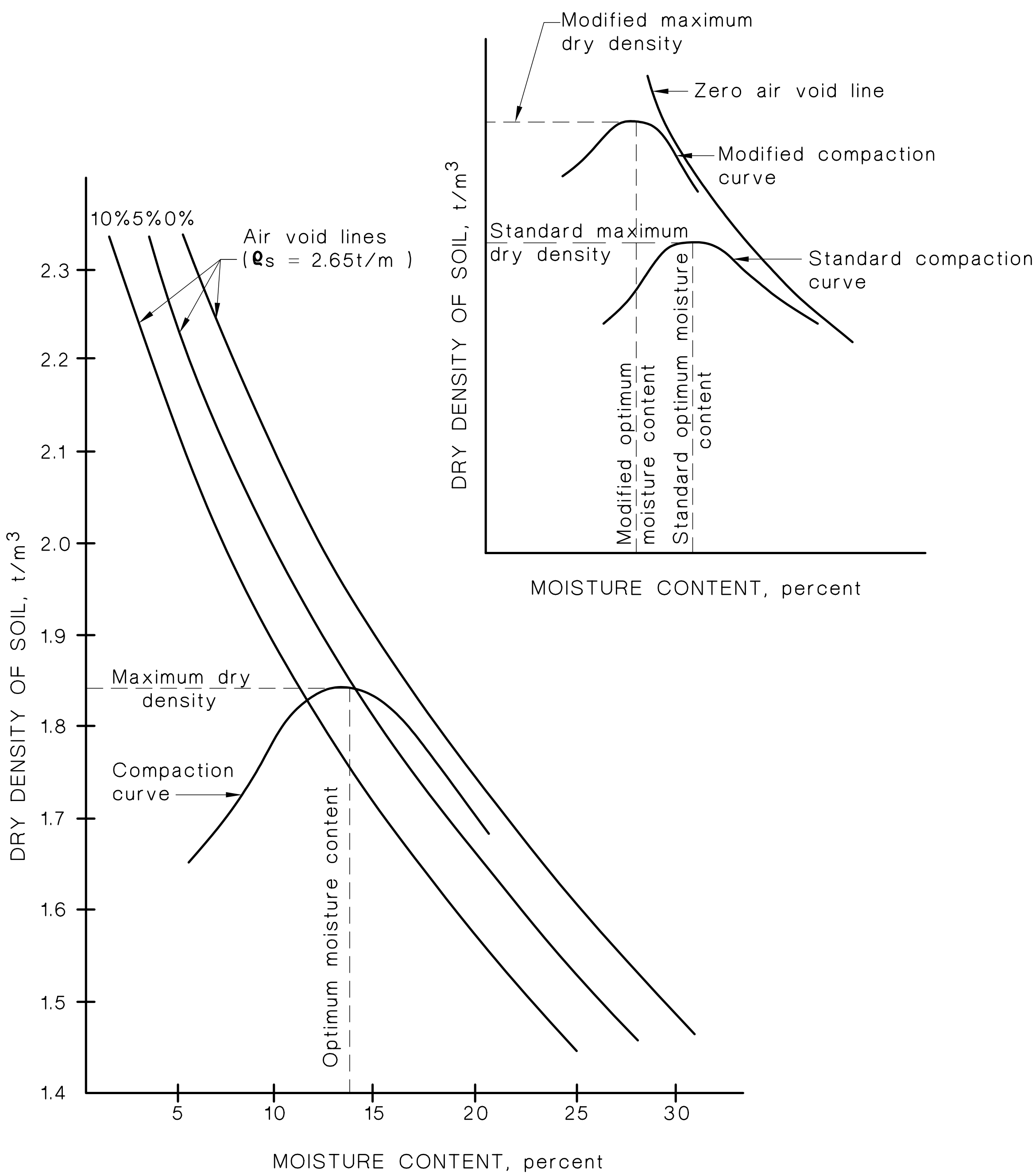

FIGURE 1 DEFINITIONS OF TERMS USED IN COMPACTION TESTS

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Standards Australia

PO Box 1055 Strathfield NSW 2135

Administration Phone (02) 9746 4700 Fax (02) 9746 8450 Email mail@standards.com.au

Customer Service Phone 1300 65 46 46 Fax 1300 65 49 49 Email sales@standards.com.au

Internet www.standards.com.au

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