

## Australian Standard®

AS 1289.6.4.1:2016

### Methods of testing soils for engineering purposes

#### Method 6.4.1: Soil strength and consolidation tests—Determination of compressive strength of a soil—Compressive strength of a specimen tested in undrained triaxial compression without measurement of pore water pressure

##### 1 SCOPE

This Standard sets out a basic test procedure applicable to cohesive soils and a procedure for determining the compressive strength of a specimen of soil in the triaxial compression apparatus under conditions in which the cell pressure is maintained constant, and in which there is no change in the total water content of the specimen.

This Standard is not suitable for cohesionless materials.

The specific conditions of the test procedure are to be defined by a geotechnical professional who is responsible for ensuring the test method is appropriate for the data required.

##### 2 REFERENCED DOCUMENT

The following document is referred to in this Standard:

AS

1289 Methods of testing soils for engineering purposes

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)

##### 3 APPARATUS

The following apparatus is required:

- (a) A triaxial test cell of dimensions appropriate to the size of the specimen, suitable for use with water as cell fluid and capable of withstanding a pressure of 1700 kPa. The cell shall be provided with a means of applying additional axial compressive load to the specimen through a loading ram.

The cell shall include a base pedestal of the same diameter as the test specimen. Where the base pedestal is not integral with the cell base, it shall be secured to the cell base so that the cap is level and axially aligned with the loading ram.

The top cap shall be the same diameter as the test specimen and its mass will be such that the vertical stress due to the top cap shall not exceed 1% of the maximum principal stress difference or 1 kPa, whichever is the greater. The top cap shall have either—

- (i) a central seating which will not transmit moment (a ball and cone assembly is suitable) to receive the loading ram; or
  - (ii) a means of creating a rigid connection with the loading ram. In this case an internal load cell shall be used to measure the deviator load.
- (b) Apparatus for applying, maintaining and measuring the desired pressure in the water within the cell to an accuracy of  $\pm 2$  kPa.
  - (c) An A grade machine capable of applying axial compression to the specimen at convenient speeds. A speed of application in the range 0.0005 to 5 mm/min is normally satisfactory. The machine shall be capable of applying an axial deformation of approximately one-third of the height of the specimen.
  - (d) Apparatus for measuring the additional axial load on the specimen to an accuracy of 0.5% or  $\pm 2$  kPa, whichever is the greater in the deviator stress at failure. This level of accuracy can best be achieved by the use of a load measuring device within the triaxial cell. If such a device is used it shall be insensitive to non-axial loads and the cell pressure, or capable of correction to allow for any influence of the cell pressure. If an external axial load measuring device is used it is important to ensure that friction between the piston and the sealing bushing does not influence the results. The alignment of the loading ram shall be such that it passes vertically through the bushing and no significant lateral loads are generated by its connection to the loading machine.
  - (e) Apparatus for measuring the axial deformation of the specimen to  $0.01 \pm 0.005$  mm, together with an adjustable reference point attached to the cell.
  - (f) The devices used to measure axial load and displacement shall be capable of being recorded automatically at regular intervals throughout the test.
  - (g) Seamless rubber membrane in the form of a tube, open at both ends, of internal diameter equal to the specimen diameter and of length approximately 50 mm greater than the height of the specimen. The membrane thickness should be selected having regard to the size, strength and nature of the soil to be tested. A thickness of 0.25 mm to 0.4 mm is normally satisfactory.
  - (h) Membrane stretcher to suit the size of the specimen.
  - (i) Rubber rings of circular cross-section and internal diameter smaller than the diameter of the top cap and base pedestal.
  - (j) Sampling tubes with a sharp cutting edge at the inner surface or a soil lathe, for preparing test specimens of the required diameter directly from a block sample in the laboratory.
  - (k) Sample extruder.
  - (l) Trimming device, e.g. split mould or mitre box and wire saw for obtaining plane ends normal to the axis of cylindrical specimens.
  - (m) Mould or formers and auxiliary apparatus, for preparing remoulded specimens.
  - (n) Apparatus for the determination of moisture content as described in AS 1289.2.1.1.
  - (o) A balance of appropriate capacity to measure the mass of the wet specimen.

#### 4 PREPARATION OF SPECIMENS

Procedures for the preparation of test specimens vary considerably in detail but the aim is to produce specimens of required dimensions while minimizing the disturbance and changes to moisture content. The diameter of the specimen is to be selected having regard to the character of the soil and the maximum size of particles present in the sample.

The minimum diameter shall be at least 5 times the diameter of the largest particle and never less than 38 mm. A diameter of 38 mm is acceptable for homogeneous fine-grained soils, but larger diameters are preferable as these minimize sample disturbance.

The test described is limited to specimens in the form of right cylinders with height to diameter ratio of  $2 \pm 2\%$ .

The preparation of specimens shall be as follows:

- (a) Obtain from a sample a subsample of the desired diameter in one of the following ways, as appropriate:
  - (i) From a thin walled sample tube, extrude a sufficient length to provide a test specimen of the required dimensions.
  - (ii) From a block sample, trim a soil cylinder of sufficient length to provide a test specimen of the required dimensions.
- (b) Place the subsample obtained by Step (i) or Step (ii) in the trimming device and prepare the ends, plane and parallel, to provide a test specimen of the required height.

#### 5 PROCEDURE

The procedure shall be as follows:

- (a) Measure and record the length, diameter and mass of the sample to a precision that will enable the bulk density to be calculated to an accuracy of  $\pm 1\%$ .
- (b) Place the specimen on the base pedestal and put the top cap on top of the specimen. Using the membrane stretcher, place the rubber membrane around the specimen and seal the membrane to the top cap and base pedestal by means of rubber rings.
- (c) Assemble the cell with the loading ram initially clear of the top cap of the specimen and place the cell containing the specimen in the loading machine. Admit the operating fluid to the cell and raise the pressure to the desired value.
- (d) Adjust the loading machine to bring the loading ram a short distance away from the seat on the top of the specimen. Bring the axial deformation measuring device into contact with the adjustable reference point. Select a rate of axial strain that will give a time-to-failure of about 5 to 10 min. This will normally be provided by a straining rate in the range of 1 to 2 percent per minute. With the ram moving at the selected test speed, record the reading of the load measuring gauge before it contacts the top cap as zero load. For a machine which measures the load inside the cell, read the load directly.
- (e) Adjust the loading machine to bring the loading ram just in contact with the seat on the top cap of the specimen and record the initial reading of the axial deformation gauge.
- (f) Commence compression and take a sufficient number of simultaneous readings of the load and deformation measuring gauges to define the stress/strain curve. Continue the test until either the maximum value of the load has passed or an axial strain of 20% has been reached. Unload the specimen and record the final reading of the load measuring gauge. If the difference between the final and initial readings of the load gauge exceeds 5% of the maximum applied axial load, the test shall be discarded unless the cause of the discrepancy can be recognized and allowed for in the calculations.