

Australian Standard®

AS 4133.4.2.2—2013

Methods of testing rocks for engineering purposes

Method 4.2.2: Rock strength tests— Determination of uniaxial compressive strength—Rock strength less than 50 MPa

1 SCOPE

This Standard sets out the method for determining the uniaxial compressive strength of a rock sample in the form of specimens of regular geometry of strength less than 50 MPa. The test is intended for strength classification and characterization of intact rock.

NOTE: Where the measured strength using this method exceeds 50 MPa this method may result in a measured strength that is less than the strength obtained in test method AS 4133.4.2.1.

CAUTION: SOME OF THE TESTS SPECIFIED IN THIS STANDARD INVOLVE THE USE OF PROCESSES THAT COULD LEAD TO A HAZARDOUS SITUATION.

2 REFERENCED DOCUMENTS

The following documents are referenced in this Standard:

AS	
2193	Calibration and classification of force-measuring systems
4133	Methods of testing rocks for engineering purposes
4133.1.1.1	Method 1.1.1: Rock moisture content tests—Determination of the moisture content of rock—Oven drying method (standard method)
4133.4.2.1	Method 4.2.1: Rock strength tests—Determination of uniaxial compressive strength of 50 MPa and greater

3 APPARATUS

The following apparatus are required:

- A suitable loading machine meeting the requirements for a Class A force-measuring system, as defined in AS 2193, for applying and measuring axial load to the specimen. It shall be of sufficient capacity and capable of applying load at a uniform strain rate as specified in Clause 5.
- Discs having a Rockwell hardness of not less than 30 HRC, which shall be placed at the specimen ends. The diameter of the discs shall be the same as the diameter of the specimen. The thickness of the discs shall be not less than the larger of 15 mm or $d/3$ where d is the specimen diameter. Surfaces of the discs shall be ground and their flatness shall be within 0.02 mm. One of the two discs shall incorporate a spherical seat. The seat shall be lubricated with mineral oil so that it locks after the dead-weight of the cross-head has been picked up. The specimen, the discs and spherical seat shall be accurately centred with respect to one another and to the axis of load application of the loading machine.

The centre of curvature of the spherical seat surface shall coincide with the centre of the specimen top face.

- (c) A measuring instrument such as vernier or micrometer calipers capable of measuring specimen dimensions to a precision of 0.1 mm.

4 PREPARATION OF TEST SPECIMEN

4.1 Sampling

Prior to specimen preparation, samples should be stored in such a way as to preserve the natural water content. The period of storage should preferably not exceed 30 days. It is recognized that in some cases for some materials, e.g. shales, mudstone/claystones and laminites, it may be desirable to test specimens in 'as received' moisture condition. These materials may also deteriorate if stored for any length of time or are saturated. Such conditions should be noted in the test report. It is also recognized that in some cases for some materials, it may be desirable to test specimens in a fully saturated condition. If this is the case, the test report should note this and report how the specimens were saturated.

NOTE: See Appendix A for further information on the influence of moisture condition on rock strength.

4.2 Specimen preparation

The test specimen shall be prepared as follows:

- (a) From a suitable sample prepare a test specimen having the following characteristics:
 - (i) The test specimen shall be a straight circular cylinder having a length to diameter ratio of between 2.5 and 3.0, and a diameter of not less than 45 mm. The diameter of the specimen shall be at least ten times the size of the largest grain in the rock.

NOTE: While a test specimen length to diameter ratio in the range of 2.5 to 3.0 is specified in accordance with that recommended by the International Society for Rock Mechanics (ISRM), it is recognized that there is evidence suggesting that a minimum length to diameter ratio of 2.0 may be adequate particularly for rocks with strength less than 25 MPa. Therefore, while a ratio of between 2.5 to 3.0 is preferred, it is possible to extend this range to 2.0 to 3.0, to allow additional testing where core lengths are limited. Where the ratio is less than 2.5, it should be noted in the test report.
 - (ii) The ends of the specimen shall be cut parallel to each other to within 1° and at right angles to the sides of the specimen to within 1°.
 - (iii) The ends of the specimen shall be ground flat to 0.1 mm across the face with no surface irregularities. If the ends of the specimen cannot be ground or contain surface irregularities they may be capped using a capping material that has a strength greater than 50 MPa.
 - (iv) The sides of the specimen shall be free of abrupt irregularities and straight over the full length of the specimen.
- (b) Determine the diameters of the specimen to at least the nearest 0.1 mm across two diameters at right angles and at the centre and near the top and bottom of the specimen. Calculate the mean diameter of the test specimen from the six measurements.
- (c) Measure and record the height of the specimen to 0.1 mm.
- (d) If required, moisture condition the specimen prior to testing.

5 TEST PROCEDURE

The test procedure shall be as follows:

- (a) Load the specimen continuously and without shock. Apply the load to achieve a strain rate of no greater than 0.1 mm/min until failure occurs.

NOTES:

- 1 It is desirable that the rate of loading be adjusted to achieve failure of the specimen between 10 and 15 minutes, provided that this rate of loading does not exceed a displacement rate of 0.1 mm/min.
- 2 Where it is required to perform multiple cycles of loading and unloading, a suitable maximum load for the cycle may be taken as half the estimated failure loading.

WARNING: MANY ROCKS FAIL IN A VIOLENT MANNER WHEN LOADED TO FAILURE. APPROPRIATE MEASURES SUCH AS A PROTECTIVE SHIELD SHOULD BE USED TO PREVENT INJURY FROM ROCK FRAGMENTS.

- (b) Record the displacement rate applied.
- (c) Record the description of failure.
NOTE: Appendix B provides guidance on failure descriptions.
- (d) Photograph the specimen before testing and after failure.
- (e) Determine the moisture content of the specimen in accordance with AS 4133.1.1.1.

6 CALCULATION

Calculate the uniaxial compressive strength ($qu_{\max.}$) from the following equation:

$$qu_{\max.} = P/A$$

where

$qu_{\max.}$ = uniaxial compressive strength, in megapascals

P = applied load at failure, in newtons

A = original cross-sectional area of the specimen calculated using the average diameter, in square millimetres

7 TEST REPORT

The following shall be reported:

- (a) The uniaxial compressive strength of the test specimen, in MPa, expressed to two significant figures.
- (b) Description of failure.
NOTE: Appendix B provides guidance on failure descriptions.
- (c) Photographs of the test specimen before testing and after failure.
- (d) Source and identification (rock type) of test specimen.
- (e) Storage history, curing and environment.
- (f) Date of testing.
- (g) Average specimen diameter and height, in millimetres to the nearest 0.1 mm.
- (h) Moisture content of the specimen to the nearest 0.1 percent.
- (i) Rate of displacement and test duration.
- (j) Any other pertinent observations.
- (k) Reference to this test method, i.e. AS 4133.4.2.2.