Method for Determining the Unconfined Compressive Strength of Intact Rock Core Specimens

SC T 39

1. Scope

This method specifies the apparatus, instrumentation, and procedures for determining unconfined compressive strength of intact rock core specimens. This procedure is identical to ASTM D 2938 except that the cores are tested after cutting without grinding, and neoprene caps are used on the specimen ends.

2. Referenced Documents

2.1 ASTM Standards

- C 1231 Practice for Use of Unbonded Caps in Determination of Compressive Strength of Hardened Concrete Cylinders
- D 2216 Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock
- D 2938 Standard Test Method for Unconfined Compressive Strength of Intact Rock Core Specimens
- D 4543 Practice for Preparing Rock Core Specimens and Determining Dimensional and Shape Tolerances
- E 4 Practices for Load Verification of Testing Machines

3. Apparatus

3.1 Loading Device, of sufficient capacity to apply load at a rate conforming to the requirements set forth in subsection 7.3 of this procedure. It shall be verified at suitable time intervals in accordance with the procedures given in ASTM E 4, and comply with the requirements prescribed therein. The loading device may be equipped with a displacement transducer that can be used to advance the loading ram at a specified rate.

3.2 Platens, two steel platens are used to transmit the axial load to the ends of the specimen. They shall have a hardness of not less than 58 HRC. The bearing faces shall not depart from a plane by more than 0.32 in. (0.0125 mm) when the platens are new and shall be maintained within a permissible variation of 0.64 in. (0.025 mm). One of the platens should be spherically seated and the other a plain rigid platen. The center of the sphere in the spherical seat shall coincide with the center of the loaded end of the specimen. The spherical seat shall be lubricated to ensure free movement. The moveable portion of the platen shall be held

closely in the spherical seat, but the design shall be such that the bearing face can be rotated and tilted through small angles in any direction.

4. Safety Precautions

4.1 Many rock types fail in a violent manner when loaded to failure in compression. A protective shield should be placed around the test specimen to prevent injury from flying rock fragments.

5. Sampling

5.1 The specimen should be selected from the cores to represent a valid average of the type of rock under consideration. This can be achieved by visual observations of mineral constituents, grain sizes and shape, partings and defects such as pores and fissures, or by other methods such as ultrasonic velocity measurements.

6. Test Specimen

6.1 Prepare the specimen in accordance with the following steps. These steps are essentially ASTM D 4543 with the exception that the straightness and flatness tolerances are not checked, and the ends are not ground smooth.

6.1.1 Test specimens shall be cut as carefully as possible to right cylinders. The cuts shall be parallel to each other and at right angles to the longitudinal axis.

6.1.2 Determine the diameter of the test specimen to the nearest 0.01 in. (0.1 mm) by averaging two diameters measured at right angles to each other at about mid-height of the specimen. Use this average diameter for calculating the cross-sectional area. Determine the length of the test specimen to the nearest 0.01 in. (0.1 mm) at the centers of the end faces. *Note: when working in Standard Units, this length will also need to be converted to the nearest 0.001 ft by dividing by 12.*

6.1.3 The specimen shall have a length-to-diameter ratio (L/D) of 2.0 to 2.5 and a diameter of not less than 1.85 in. (47 mm). When cores of diameter smaller than the specified minimum must be tested because of the unavailability of larger diameter core, suitable notation of this fact shall be made in the report.

6.1.4 Determine the mass of the specimen to the nearest 0.01 lb. (0.01 kg)

6.1.5 The rock cores shall be capped with a neoprene cap conforming to the requirements of ASTM C 1231.

6.2 Optional – If the moisture content of the specimen is to be determined, follow the procedures in ASTM D 2216.

6.3 Optional - If the moisture condition is to be maintained, seal the specimen using a flexible membrane or apply a plastic or silicone rubber coating to the specimen sides.

7. Procedure

7.1 Check the ability of the spherical seat to rotate freely in its socket before each test.

7.2 Place the lower platen on the base or actuator rod of the loading device. Wipe clean the bearing faces of the upper and lower platens and of the test specimen, and place the test specimen on the lower platen. Place the upper platen on the specimen and align properly. A small axial load, approximately 25 lbf (100 N), may be applied to the specimen by means of the loading device to properly seat the bearing parts of the apparatus.

7.3 Apply axial load continuously and without shock until the load becomes constant, reduces, or a predetermined amount of strain is achieved. Apply the load in such a manner as to produce either a stress rate or a strain rate as constant as feasible throughout the test. Do not permit the stress rate or strain rate at any given time to deviate by more than 10 percent from that selected. The stress rate or strain rate selected should be that which produces failure in a test time between 2 and 15 minutes. The selected stress rate or strain rate for a given type shall be adhered to for all tests in a given series of investigation. Record the maximum load sustained by the specimen.

8. Calculations

8.1 Calculate the cross-sectional area of the specimen to the nearest 0.01 ft^2 (0.01 m^2) as follows:

$$A = (\pi D^2) / 4$$

Where: A = cross-sectional area, in^2 (mm^2) – *then convert to ft^2 or m^2*
D = average specimen diameter, in (m)

8.2 Calculate the volume of the specimen to the nearest 0.001 ft^3 (0.001 m^3) as follows:

$$V = A (L)$$

Where: V = volume, ft^3 (m^3)
A = cross-sectional area, ft^2 (m^2)
L = specimen length, ft (m)

8.3 Calculate the specimen unit weight to the nearest 1.0 lb/ft^3 (1.0 kg/m^3) as follows:

$$UW = M / V$$

Where: UW = specimen unit weight, lbs/ft^3 (kg/m^3)
M = specimen mass, lbs (kg)
V = volume, ft^3 (m^3)

8.4 Calculate the compressive strength in the test specimen from the maximum compressive load on the specimen and the initial computed cross-sectional area as follows:

$$\sigma = P / A$$

Where: σ = compressive strength, lbs/in^2 (kN/m^2)
P = maximum load, lbf (kN)
A = cross sectional area, in^2 (m^2)

9. Report

9.1 Source of sample including project name and location (often the location is specified in terms of the drill hole number and depth of specimen from the collar of the hole)
9.2 Date
9.3 Description of the rock (optional)
9.4 Moisture condition of specimen before test (optional)
9.5 Specimen diameter (optional)
9.6 Specimen height (optional)
9.7 Specimen unit weight
9.8 Unconfined compressive strength
9.9 Type and location of failure (optional)
9.10 Sketch of fractured specimen (optional)
9.11 Any variations in the requirements of the test method.

10. Example Calculations

10.1 Given: Average diameter = 2.15 in.
Length = 4.43 in.
Mass = 763.3 gms = 1.683 lbs.
Maximum load = 88,777 lbf.

10.2 Calculation: L/D = 4.43 in. / 2.15 in. = 2.1 (ok - between 2.0 and 2.5),
$A = \pi \times (2.15 \text{ in.})^2 / 4 = 3.63 \text{ in}^2$
$V = 3.63 \text{ in}^2 \times 4.43 \text{ in} = 16.1 \text{ in}^3 \rightarrow \times (1 \text{ ft}^3/1728 \text{ in}^3) = 0.009 \text{ ft}^3$
$UW = 1.683 \text{ lbs} / 0.009 \text{ ft}^3 = 187 \text{ lbs/ft}^3$
$\sigma = 88{,}777 \text{ lbf} / 3.63 \text{ in}^2 = \underline{24,456 \text{ psi}}$

Test results are reported on Lab Form SO113.