Standard Test Method for Determination of the Point Load Strength Index of Rock

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Summary of Test Method

This index test is performed by subjecting a rock specimen to an increasingly concentrated load until failure occurs by splitting the specimen. The concentrated load is applied through coaxial, truncated conical platens. The failure load is used to calculate the point load strength index and to estimate the uniaxial compressive strength.

Significance and Use

When extensive testing is required for preliminary and reconnaissance information, alternative tests such as the point load test can be used in the field to reduce the time and cost of compressive strength tests.

Rock specimens in the form of either core (the diametral and axial tests), cut blocks (the block test), or irregular lumps (the irregular lump test) are tested by application of concentrated load through a pair of truncated, conical platens. Little or no specimen preparation is required.
Apparatus

General—A point load tester consists of a loading system typically comprised of a loading frame, platens, a measuring system for indicating load, $P$, (required to break the specimen), and a means for measuring the distance, $D$, between the two platen contact points. The equipment shall be resistant to shock and vibration so that the accuracy of readings is not adversely affected by repeated testing.

**Loading System:**

The loading system shall have a loading frame with a platen-to-platen clearance that allows testing of rock specimens in the required size range. Typically, this range is within 30 to 85 mm so that an adjustable distance is available to accommodate both small and large specimens.

The loading capacity shall be sufficient to break the largest and strongest specimens to be tested.
Truncated, conical platens, as shown on Fig. 2, are to be used. The 60° cone and 5-mm radius spherical platen tip shall meet tangentially. The platens shall be of hard material such as tungsten carbide or hardened steel so they remain undamaged during testing.

**FIG. 2 Platen Dimensions (Point Load Strength Index Test)**

*Load Measuring System:*

A load measuring system, for example a load cell or a hydraulic pressure gage, that will indicate failure load, \( P \), required to break specimen.

Measurements of failure load, \( P \), shall be to a precision of \( +\text{-}5\% \) or better of full-scale load-measuring system, irrespective of the size and strength of specimen that is tested.

*Distance Measuring System:*

The distance measuring system, a vernier direct reading scale, should connect to the loading frame for measuring the distance, \( D \), between specimen-platen contact points to an accuracy of \( +\text{-}2\% \).

An instrument such as a caliper or a steel rule is required to measure the width, \( W \), (with an accuracy of 65 %) of specimens for all but the diametral test.
Procedure

*Diametral Test:*

1. Core specimens with length/diameter ratio greater than one are suitable for diametral testing.

2. Insert a specimen in the test device and close the platens to make contact along a core diameter. Ensure that the distance, \( L \), between the contact points and the nearest free end is at least 0.5 times the core diameter.

3. Determine and record the distances \( D \) and \( L \).

4. Steadily increase the load such that failure occurs within 10 to 60 s, and record failure load, \( P \). The test should be rejected if the fracture surface passes through only one platen loading point.

5. The procedures in 2-4 are repeated for each specimen of the rock type.
Axial Test:

1. Core specimens with length/diameter ratio of 1/3 to 1 are suitable for axial testing. Suitable specimens can be obtained by saw-cutting or chisel-splitting.

2. Insert a specimen in the test machine and close the platens to make contact along a line perpendicular to the core end faces.

3. Record the distance, $D$, between platen contact points. Record the specimen width, $W$, perpendicular to the loading direction, with an accuracy of $\pm 5\%$.

4. Steadily increase the load such that failure occurs within 10 to 60 s, and record failure load, $P$. The test should be rejected if the fracture surface passes through only one platen loading point.

5. The procedures in 2-4 are repeated for each specimen of the rock type.
**Block and Irregular Lump Tests:**

1. Rock blocks or lumps, 30 to 85 mm, and of the shape shown in Figures below are suitable for the block and the irregular lump tests. The ratio, $D/W$, should be between $1/3$ and $1$, preferably close to $1$. The distance $L$ should be at least $0.5W$.

2. Insert a specimen in the testing machine and close the platens to make contact with the smallest dimension of the lump or block, away from edges and corners.

3. Record the distance $D$ between platen contact points. Record the smallest specimen width, $W$, perpendicular to the loading direction. If the sides are not parallel, then calculate $W$ as $(W_1 + W_2)/2$ as shown on Fig. 3. This width, $W$, is used in calculating point load strength index irrespective of the actual mode of failure.
Calculation

Uncorrected Point Load Strength Index—The uncorrected point load strength $I_s$ is calculated as:

$$I_s = \frac{P}{D_{e}^2}, \text{ MPa}$$

where:

$P =$ failure load, N,

$D_{e} =$ equivalent core diameter $5 \, D$ for diametral tests, m, and is given by:

$D_{e}^2 = D^2$ for cores, mm$^2$, or

$D_{e}^2 = \frac{4A}{\pi}$ for axial, block, and lump tests, mm$^2$;

where:

$A = WD =$ minimum cross-sectional area of a plane through the platen contact points.

NOTE 1—If significant platen penetration occurs in the test, such as when testing weak sandstones, the value of $D$ should be the final value of the separation of the loading points, $D^\prime$. Measurements of core diameter, $D$, or specimen width, $W$, made perpendicular to the line joining the loading points are not affected by this platen penetration and should be retained at the original values. The modified values of $D_{e}$ can be calculated from:

$D_{e}^2 = D \times D^\prime$ for cores, $= \frac{4}{\pi} W \times D^\prime$ for other shapes
**Size Correction Factor:**

1. $I_s$ varies as a function of $D$ in the diametral test, and as a function of $De$ in axial, block, and irregular lump tests, so that a size correction must be applied to obtain an unique point load strength value for the rock sample and one that can be used for purposes of rock strength classification.

2. The size-corrected point load strength index, $I_s(50)$, of a rock specimen is defined as the value of $I_s$ that would have been measured by a diametral test with $D = 50$ mm.

3. When a precise rock classification is essential, the most reliable method of obtaining $I_s(50)$ is to conduct diametral tests at or close to $D = 50$ mm. Size correction is then unnecessary. For example, in case of diametral tests on NX, core diameter = 54 mm and size correction to $D = 50$ mm is not necessary. Most point load strength tests are in fact performed using other specimen sizes or shapes. In such cases,

4. The most reliable method of size correction is to test the specimen over a range of $D$ or $De$ values and to plot graphically the relation between $P$ and $De$. If a log-log plot is used, the relation is a straight line. Points that deviate substantially from the straight line may be disregarded (although they should not be deleted). The value of $I_s(50)$ corresponding to $De = 2500$ mm$^2$ ($De = 50$ mm) can be obtained by interpolation and use of the size-corrected point load strength index calculated as shown in 5.

5. When neither 3 nor 4 is practical (for example when testing single-sized core at a diameter other than 50 mm or if only a few small pieces are available), size correction may be accomplished using the formula:

$$I_s(50) = F \times I_s$$  \hspace{1cm} (3)
The “Size Correction Factor $F$” can be obtained from the
from the expression:

$$F = (De/50)^{0.45} \quad (4)$$

For tests near the standard 50-mm size, only slight error is introduced by using the approximate expression:

$$F = \sqrt{De/50} \quad (5)$$

*Estimation of Compressive Strength*—
The estimated uniaxial compressive strength can be obtained by using the following formula:

$$\delta_{uc} = C I_{s}(50) \quad (6)$$

where:

$\delta_{uc}$ = uniaxial compressive strength,

$C$ = factor that depends on site-specific correlation between $duc$ and $I_{s}(50)$, and

$I_{s}(50)$ = corrected point load strength index.