WEST VIRGINIA DEPARTMENT OF TRANSPORTATION
DIVISION OF HIGHWAYS
MATERIALS CONTROL, SOILS AND TESTING DIVISION

MATERIALS PROCEDURE

STANDARD METHOD FOR DETERMINATION OF THE POINT LOAD STRENGTH INDEX OF ROCK

1.0 PURPOSE

1.1 To establish a procedure for determining the point load strength index of rock used for estimating the unconfined compressive strength of intact rock core specimens.

2.0 SCOPE

2.1 Specimens in the form of rock cores, blocks, or irregular lumps that are isotropic and anisotropic can be tested by this test method.

2.2 This test method can be performed in the field or laboratory.

2.3 This is an index test and is intended to be used to classify and characterize rock.

2.4 This test method applies to compressive strength over 2200 psi (15 MPa).

3.0 REFERENCES

3.1 ASTM D 5731 Standard Test Method for Determination of the Point Load Strength Index of Rock

3.2 ASTM D 5079 Practices for Preserving and Transporting Rock Core Samples

3.3 International Society for Rock Mechanics (ISRM)

3.4 Peabody Group Using the Point Load Test to Determine the Uniaxial Compressive Strength of Coal Measure Rock

4.0 EQUIPMENT

4.1 A point load tester comprised of a loading frame, conical and flat platens, a load (P) indicator, and a means for measuring the distance (D), between the two platen contact points.

4.2 Measuring Device: A caliper or a steel rule to measure the width (W), with an accuracy of +/- 5% of specimens for all but the diametral test.

4.3 Miscellaneous Items: Diamond saw, chisels, and rock hammer.

5.0 DEFINITIONS

5.1 Point Load Strength Index – An indicator of strength obtained by subjecting a rock specimen to an increasingly concentrated point load applied through a pair of conical platens until failure occurs.

6.0 SPECIMEN PREPARATION

6.1 Sampling: When testing core or block specimens, at least ten specimens should be selected. When testing irregular-shaped specimens obtained by other means, at least 20 specimens should be selected. However, if unable to obtain the required minimum number of samples, perform the test annotating the reason and number of samples obtained. A minimum number of three samples are needed to perform the statistical calculation required.

6.2 Dimensions: The specimen's external diameter shall not be less than 1.2 inches (30 mm) and not more than 3.4 inches (85 mm), with the preferred dimension about 2.0 inches (50 mm).

6.3 Anisotropic Rock: When a specimen is shaly, bedded, schistose or otherwise observably anisotropic, it should be tested as close to the direction of design loading as possible. If the bedding plane from the horizontal is equal to or greater then an angle of 45^{o}, testing should be conducted parallel to the bedding plane. If the bedding is less than 45^{o}, testing is conducted normal to the bedding plane. Core trimming may be required to facilitate proper placement of the specimen between platens (Figure 6).

6.4 Size and Shape Requirements: For axial, diametral, block or irregular shape, specimen testing shall conform to the recommendation shown in Figure 6.1.

The specimens shall be free from irregularities that can generate stress concentrations. Anisotropic specimens may require trimming their edges to facilitate loading (Figure 6).

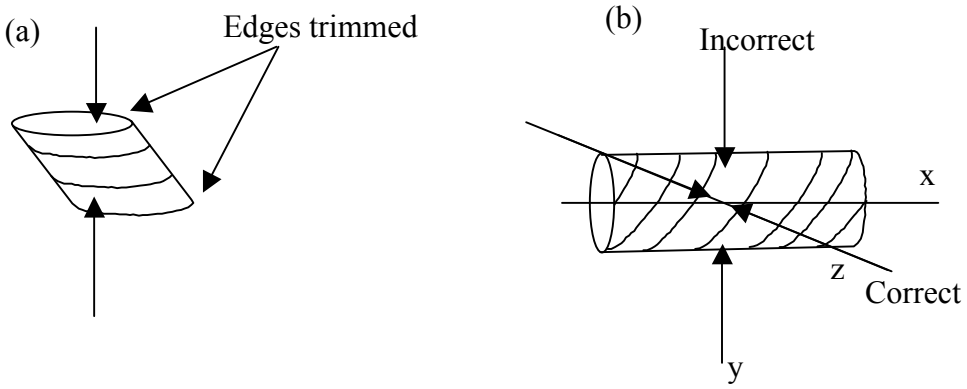


Figure 6: Loading directions for test on anisotropic rock.

6.4 Water Content: Each specimen should be tested at the in-situ water content. Exercise caution when handling, shipping and storing specimen to ensure the original moisture content is preserved.

6.5 Marking and Measuring Specimens: Indicate the desired test orientation of the specimen by marking lines on the specimen. These lines are for centering the specimen in the point load machine to ensure proper orientation during testing.

6.6 Measuring: Measure each dimension of each specimen at three different places. Average each of the three values to obtain the dimension, in each direction, used in the calculations.

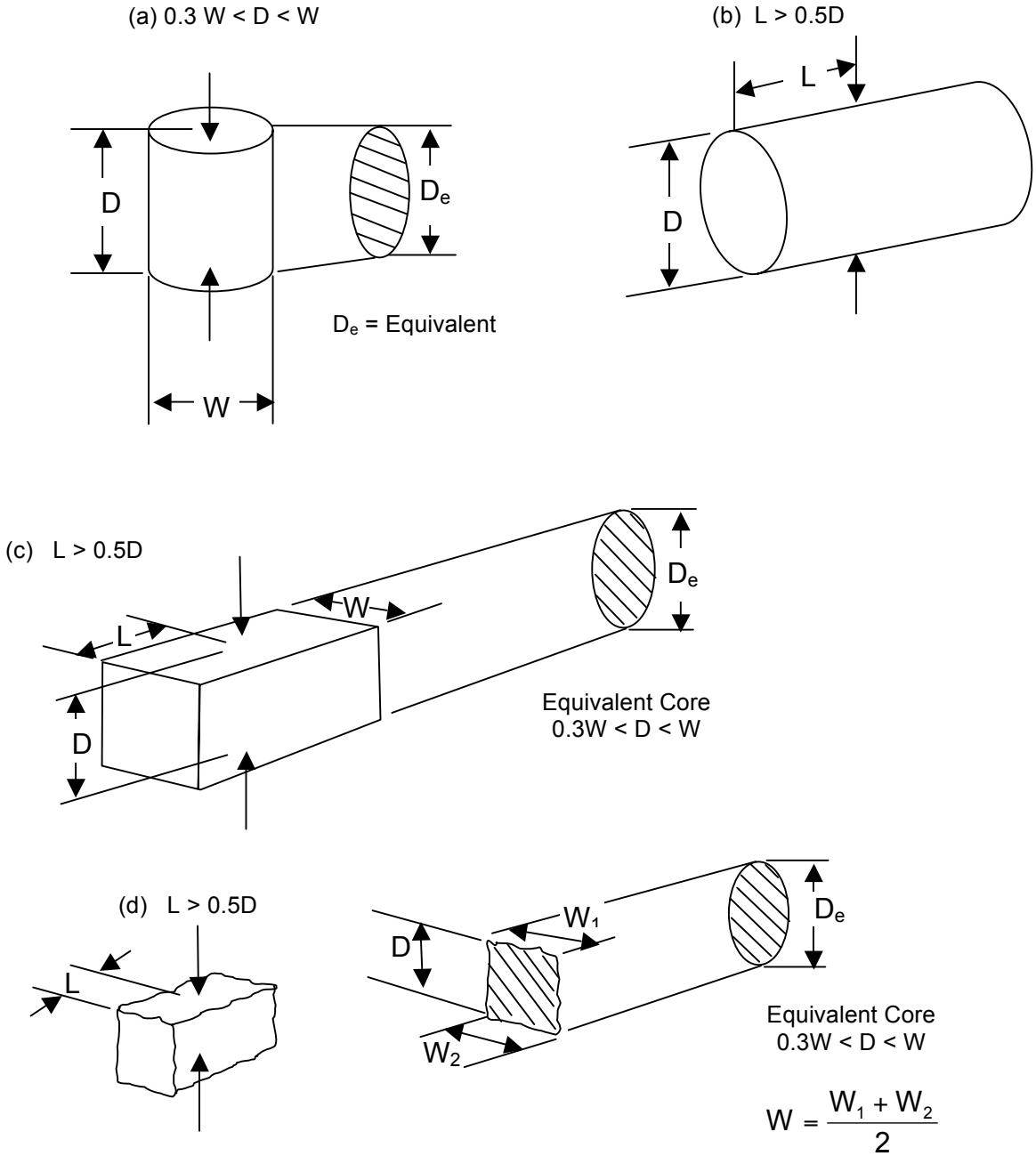


Figure 6.1: Load Configurations and Specimen Shape Requirement for (a) the Diametral Test, (b) the Axial Test, (c) the Block Test, and (d) the Irregular Lump Test.

7.0 PROCEDURE

7.1 Axial Test

7.1.1 Core specimens with length/diameter ratio of 1/3 to 1.0 are suitable for axial testing (Figure 6.1(b)). A suitable method to prepare specimens is saw-cutting (laboratory) or chisel-splitting (field).

7.1.2 Insert the specimen in the test machine such that when the platens are closed, they make contact along a line perpendicular to the core end faces.

7.1.3 Measure and record the distance D between platen contact points. If significant platen penetration occurs, the dimension D to be used in calculating point load strength should be the value D′, measured at the instant of failure. Record the width (W), normal to the loading direction, with an accuracy of ± 5%.

7.1.4 Increase the load steadily until failure occurs within 10 to 60 seconds, and record the failure load (P). Reject the test if the fracture surface fails to pass through both loading points. (Figure 7(d)).

7.1.5 Repeat Procedures 7.2.2 – 7.2.4 for each specimen.

7.2 Diametral Test

7.2.1 Specimens suitable for diametral testing will have a length to diameter ratio greater than 1.0.

7.2.2 Insert the specimen into the point-load machine and close the platens to make contact along the core diameter. If significant platen penetration occurs, the dimension D is to be used in calculating point load strength should be the value D′ measured at the instant of failure. Ensure that the distance L, between the contact points and the nearest free edge, is at least 0.5 times the core diameter (D) (Figure 6.1(a)).

7.2.3 Determine and record the distance D (Figure 6.1(a)).

7.2.4 Steadily increase the load until failure occurs, and record failure load (P). The load rate is such as to complete the test within 10 to 60 seconds. Reject the test if the fracture surface passes through only one platen loading point (Figure 7(d)).

7.2.5 Repeat procedure 7.1.2 – 7.1.4 for each specimen.

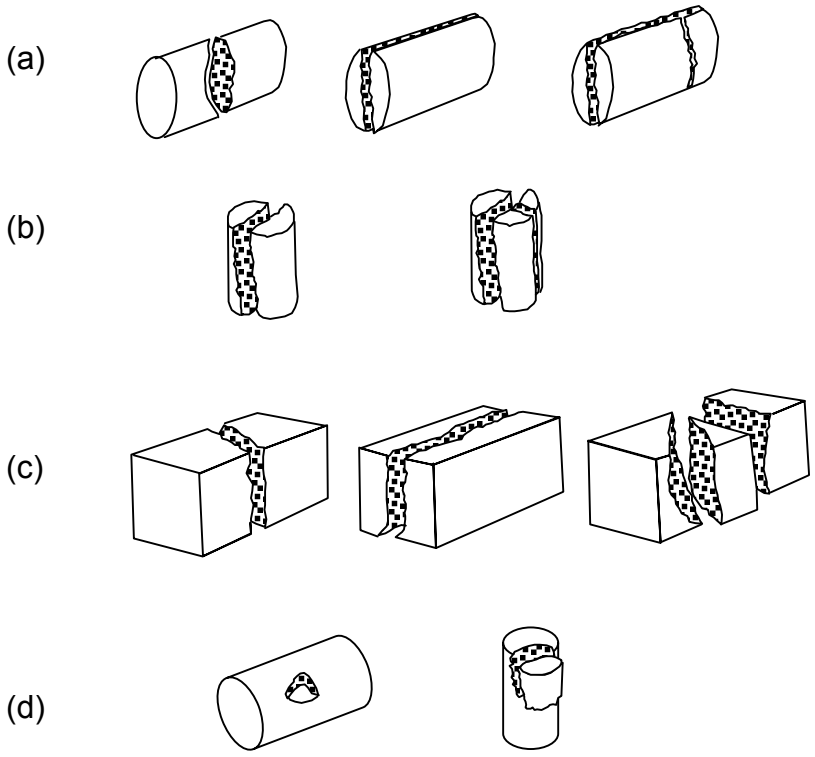


Figure 7: Typical Modes of Failure for Valid and Invalid Tests

7.3 Block and Irregular Lump Test

7.3.1 Rock specimens with a block or lumps of size 1.0 – 3.5 inches and of the shape in Figure 6.1(c) and (d) are suitable for testing. The D/W ratio should be between 1/3 and 1 (preferably close to 1). Distance L should be at least 0.5W.

7.3.2 Insert the specimen in the testing machine and close the platen, making contact with the least lateral dimension (Figure 6.1(c) and (d)).

7.3.3 Record the distance between platen contact points (D). If significant platen penetration occurs, the dimension D to be used in calculating point load strength should be the value D′ measured at the instant of failure. Record the smallest specimen width perpendicular to the loading direction (W), regardless of the actual mode of failure. For nonparallel sides, $W = (W_1 + W_2)/2$ (Figure 6.1(d)).

7.3.4 Increase the load steadily until failure occurs within 10 to 60 seconds; record the failure load (P). Reject the test if the fracture surface fails to pass through both loading points (Figure 6.1(d)).

7.3.5 Repeat Procedures 7.3.2 – 7.3.4 for each specimen.

7.4 Anisotropic Rock

7.4.1 Samples that consist of cores drilled though weakness planes should be tested in a direction that gives the greatest strength value.

7.4.2 When axial testing, specimens edges may need to be trimmed to create a surface that, facilitate loading (Figure 6(a)).

7.4.3 When diametral testing, ensure the load is applied along a single weakness plane (Figure 6(b)).

7.4.4 The ideal situation is when the core axis is perpendicular to the plane of weakness. To obtain the best results the angle between the core axis and the normal to the weakness plane should not exceed 30^o (Figures 6.1(a) and (b)).

7.4.5 If the sample consists of core drilled through weakness planes, a diametral test can be conducted first, spaced in such a manner that will yield pieces that can be tested axially, if required.

7.4.6 If the sample consists of blocks or irregular lumps, it should be tested with the load applied perpendicular to planes of weakness.

7.4.7 If the platen penetrates the specimen significantly, dimension D′ measured at the instant of failure is used in calculating point load strength. The error in assuming D to be its initial value is negligible when the specimen is large or strong. The dimension at failure may always be used as an alternative to the initial value and is preferred.

8.0 CALCULATIONS

8.1 Data and calculations shall be recorded on the attached form. Values shall be reported to the following degree of accuracy:

W	**1**
D	**1**
L	**1.00**
P	**1.00**
D_e^2	**1**
F	**1.00**
I_s	**1.0**
I_{s50}	**1.0**

8.2 Uncorrected Point Load Strength Index—The uncorrected point load strength I_s, expressed in megapascals (MPa), is calculated as:

$$I_s = \frac{P}{D_e^2} \quad (1)$$

where:

P = failure load, N,

and for Diametral Testing

D_e = equivalent core diameter = D for diametral tests (see Figure 6.1), and is given by:

$D_e^2 = D^2$ for cores,

and for Axial Testing

$D_e^2 = 4\frac{A}{\pi}$ **for axial, block, and lump tests,**

where:

A = WD = minimum cross-sectional area of a plane through the platen contact points (see Figure 6).

$D_e^2 = D\,D'$ **for cores** $= \frac{4}{\pi} WD'$ **for other shapes** **(2)**

Size Correction Factor: Precise rock classification is important, the preferred method of obtaining $I_s(50)$ is to conduct tests at or close to: D = 50 mm. Size correction is then unnecessary. Most point load strength tests are in fact performed using other specimen sizes or shapes.

8.3 Therefore, size correction is necessary and must be applied. Size correction may be accomplished using the formula:

$$I_{s(50)} = F \times I_s \quad (3)$$

The "Size Correction Factor F" can be obtained from the expression:

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

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

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

8.4 The relationship between UCS and the point load strength is expressed as:

$$UCS = (K)\, I_{s50} = 21\, I_{s50} \quad (6)$$

Where:

K = conversion factor = 21 (Peabody 2005)

8.5 Mean Value Calculations

8.5.1 The Mean values of Is(50) is to calculated by deleting the two highest and two lowest values from the ten, or more valid test, and calculating the mean of the remaining values. If significantly fewer specimens are tested, only the highest and lowest values are to be deleted and the mean calculated from those remaining.

8.6 Coefficient of Variance (CV), *Relative Standard Deviation*

8.6.1 Calculate the Coefficient of Variance as follows:

$$CV = \frac{S}{\overline{X}} \times 100$$

where:

CV = Coefficient of Variance
S = Standard Deviation
$\overline{X}$ = mean

9.0 DOCUMENTATION

9.1 The attached form shall include the following information for documentation:

9.1.1 Source of sample including project name, location, and, if known, storage environment. The location may be specified in terms of borehole number and depth of specimen from the collar of the hole.

9.1.2 Physical description of sample including rock type and location and orientation of discontinuities, such as, apparent weakness planes, bedding planes, schistosity, or large inclusions, if any.

9.1.3 Date of sampling and testing,

9.1.4 General indication of the moisture condition of test specimens at the time of testing, such as, saturated, as received, laboratory air dry, or oven dry. In some cases, it may be necessary to report the actual water content as determined in accordance with Test Method D 2216.

9.1.5 Average thickness and average diameter of the test specimen.

9.1.6 The maximum applied load "P".

9.1.7 The distance "D" or D8, or both, if required.

9.1.8 Direction of loading (parallel to or normal to plane of weakness).

9.1.9 The number of specimens tested.

9.1.10 The calculated uncorrected (*Is*) and corrected *Is(50)* point load strength index values.

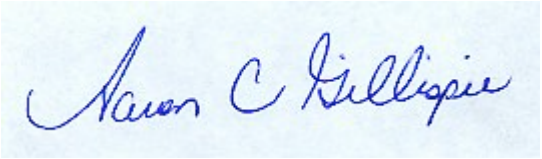
9.1.11 The estimated value of uniaxial compressive strength (d*uc*), Method of reporting results is based on the number of test and the coefficient of variance 0.35 (35%).

a. If there are eight or more test results, the highest and lowest test results are ignored and the Mean is reported.

b. If there are less than 8 test results and the COV is equal to, or greater than 0.35, the Mean for all test results is reported.

c. If there are less than 8 test results and the COV is less than 0.35, the Median is reported.

9.1.12 Type and location of failure, including any photographs of the tested specimens before and after the test.



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