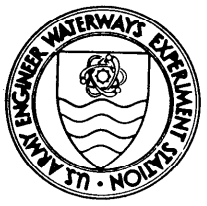
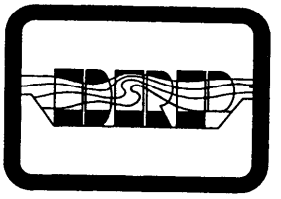
DRP-2-01
August 1990



Dredging Research Technical Notes



Suggested Methods for Use of the Point Load Tester in Dredging Applications

Purpose

This technical note introduces the point load test as a means of providing a strength index useful in dredging applications. Since this test was originally developed for hard rock index testing, its use for the weak and saturated rock typical of many coastal deposits requires special procedures. This note is not intended as a self-contained instruction for performing point load tests. Rather, it supplements previously published standard procedures. The reader should refer to the referenced publications as recommended herein.

Background

The point load test was developed as an index test for strength classification of rock materials. During the past two decades the point load tester has been successfully used for quick field evaluations of drill core and rock fragments. Point loading allows for the testing of hard rock materials using a small hand-portable test apparatus. The point load index, I_s, may be correlated with other common strength parameters such as unconfined compressive strength (UCS).

Dredging contractors' claims are often based on material strength changes. The point load test would allow for quick on-site monitoring of dredged material strength. The point load test also has potential in dredging exploration because tests can be performed on core immediately while material is in as-taken condition, and the usual precautions for handling and storage can be eliminated. Tests can be performed in a short time at minimal costs, so that where material is variable, numerous point load tests can be performed to monitor changes, and results

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can be correlated with a small number of conventional UCS tests. Although published information on the point load test relates to harder rock, some Districts have already used the point load tester on dredged material. No correlations with UCS have been available for the weaker, saturated material typical of many coastal deposits. Procedures for conducting point load tests on such materials have not been established but are currently under development. Present research indicates special considerations are necessary when testing these weaker materials.

Additional Information

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Present Research

Comparative testing of intact rock is a part of the ongoing work in DRP work unit Descriptors of Rock Materials to be Dredged. To date, UCS and point load strength tests have been completed on dredged material from two sites and on selected uniform sandstones. Both wet and dry tests are being conducted on each material to establish wet versus dry strength relationships. Although such comparative testing is necessarily long-term and, therefore, final results do not exist, the testing of these weaker, saturated materials has produced interim results indicating that:

1. UCS-to-point load strength correlations may be useful for much weaker materials than previously thought. The limited results show correlations within the variability of dredge site-obtained materials. Tests on the more uniform saturated sandstones showed good correlations (although these materials were stronger).

2. Additional considerations may be necessary for use of the point load tester on weak and saturated rock materials. These are discussed below along with a brief description of the point load test.

Point Load Tester

Point load tests are performed by loading the sample between two platens having 60-deg conical points with a 5-mm point radius. Thus, a sufficient point load can be provided to fail even hard igneous samples using a small portable test apparatus. A typical load capacity is 10,000 to 15,000 lb (US Army Engineer Waterways Experiment Station (WES) 1982), which is more than adequate to fail the higher strength rocks when testing NX-size core. The apparatus consists of an

adjustable passive platen and an active platen providing the load through a hydraulic ram; pressure is provided by a second piston manually advanced by a mechanical screw with handle or by a manually operated reciprocating piston with check valve. A hydraulic pressure gage records pressure at failure, and the gage reading is multiplied by the area of the piston to give total point load, P, on the specimen. Different gages can be used to produce accurate readings for both very high and very low point loads to accommodate a wide range of rock materials. More detailed requirements for test apparatus geometry, measuring provisions, and calibration are given in the Corps' Rock Testing Handbook, RTH Std 385-82 (WES 1982), and in the International Society for Rock Mechanics' (ISRM) Suggested Method for Determining Point Load Strength (ISRM 1985), which has been incorporated in the new Rock Testing Handbook (WES 1989). The new Rock Testing Handbook will soon be distributed to all District and Division offices.

Point Load Index

The point load strength index, I_s, is determined by dividing P by D_e^2 where D_e is the equivalent diameter. The index for a given size core is directly proportional to the material's tensile strength and can be correlated with UCS as discussed below. For good estimates of UCS a good correlation must exist between compressive and tensile strength for the material in question. Point load tests may be performed on core specimens without standard preparation or on a series of irregular rock fragments. Tests can be carried out using three different sample geometries.

In the first sample geometry, tests on core may be performed diametrically in which case no preparation of ends is required. For this test, the nearest end point must be at least one radius away from the plane of loading.

In the second sample sample geometry, the core may be loaded axially. For the axial test the core ends must be sawn to produce a plane for the platens to bear upon; however, no accurate preparation is required, such as grinding of the ends. In this case, a length-diameter ratio of at least one should be used, and I_s is computed using $D_e^2 = 4\,A/\pi$ where A is equal to width times distance of the minimum cross-section area of a plane through the loading platens. This test has the advantage that very short core pieces can be tested.

The third sampling geometry is the irregular lump test, which can be performed where no core is available in which case the equivalent diameter D_e^2 is computed as above and should be as close as possible to the site-size core diameter, especially where point load tests are also conducted. The irregular lump test is best performed using a width-to-length ratio between 0.3 and 1.0, preferably close to 1.0. In all of the above point load tests, ten or more samples should be tested for each material, more if the rock is not uniform.

When first introduced, point load strength was mainly used to predict UCS (Broch and Franklin 1972), which was the established test for general rock strength

classification. UCS is certainly the only widely accepted strength criteria for dredging applications today. However, even when making correlations to obtain UCS, the I_S should be given. I_S is size dependent and should be corrected to a standard size when published. The international standard diameter is 50 mm. The index, written $I_{S\,(50)}$, is often used directly for rock classification (ISRM 1985). The NX core size (54 mm) is close to this size and correction to NX size is recommended especially where the site exploration uses NX. The strength index would then be designated as $I_{S\,(NX)}$. Procedures for correcting as-taken I_S to a standard size are given in the Corps' Rock Testing Handbook (WES 1982, 1989) but the testing of samples close to a standard size is recommended to minimize error.

Unconfined Compressive Strengths

The correlation of I_S with UCS is both material specific and size dependent. Therefore, for best accuracy this correlation should be established for each site-specific material. In this case, a number of UCS tests would be necessary, but the time and cost savings for large numbers of strength tests would be significant using the point load tester. On the average, UCS is 20-25 times the point load strength ($I_{S\,(50)}$), but can vary over a much wider range (ISRM 1985). Where site-specific correlations or other material-specific information is not available, the UCS can be found using the size correlation graph (Figure 1) to obtain the index-to-UCS conversion factors. For example, a conversion factor of 23 is found if using the common NX (54 mm) core size.

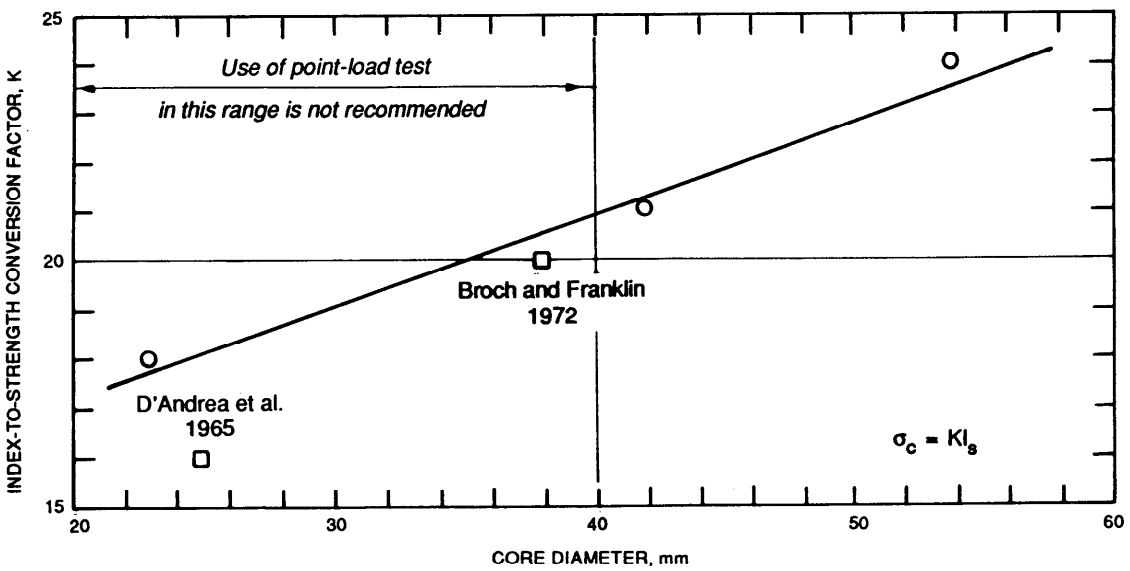

Figure 1. Size correlation graph for index-to-strength conversion (after Bieniawski 1975)

Point load tests on igneous and the harder sedimentary rocks could be expected to have a reasonable correlation with UCS using factors close to those given above. However, the weaker rock materials, which are typically dredged by mechanical means, may require a lower correlation factor. The limited point load and UCS tests performed to date on weaker dredged material indicate an average correlation factor near 20. The materials used in these tests had a large variation in strength, typical for the Southeast and Gulf Coast deposits. Correlation was certainly well within the variability of the material even using a factor of 23 for the NX-sized core. Additional comparative testing is underway and tests on several different materials will be run during the next year. A data base report on UCS correlations with point load strengths should be available in March 1991 on magnetic disk for field personnel using a point load tester.

Tests on Weaker and Nonuniform Rock

Recommendations are given in the Rock Testing Handbook and by the ISRM for point-load testing of anisotropic rock (WES 1982, 1989, and ISRM 1985). Additional special precautions need to be taken for weak, saturated rock which, even though essentially isotropic, may have local inclusions of weaker material. In this case, the point load platens should bear on the harder portions of the nonuniform sample to produce tensile loading of the overall cross section. Some coastal materials are such that the point load platens can produce a local crushing failure and embed without failing the entire sample. In such a case, a point load test is not possible. Thus far in the comparative testing program, material on which the platens produce local crushing is weak enough so that the entire cross section of the core can be loaded in compression with a point load tester. Direct UCS tests have been successfully made on such material using flat platens configured to pivot on the point load platens. Material having UCS values of 2,500 psi or more can be tested in the NX size with a point load tester if it is capable of testing the harder igneous rocks in its normal point loading mode. The use of the point load tester for direct UCS tests in the field would require a small rock cutoff saw for sample preparation and would not meet all of the requirements for standard laboratory tests; however, results should be as consistent as point load strengths and are quite suitable for a field-determined strength index.

Point Load Test Advantages

The point load test has proven to be a reliable method for determining rock strength properties, and portable equipment is commercially available which is suitable for field use. Major advantages of the point load test are:

1. Smaller forces are needed so that a small, portable test apparatus may be used.

2. Specimens in the form of core or even irregular shapes can be tested and no machining is required.

3. Tests can be done on the dredge or exploration platform using core or irregular fragments in as-taken conditions. Underwater coastal deposits frequently undergo dramatic strength changes with loss of water content.

4. More tests can be made for the same cost, which allows for adequate sampling even when rock conditions are variable.

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