RTH 103-93

PREPARATION OF TEST SPECIMENS

1. Scope

1.1 In order to obtain valid results from tests on brittle materials, careful and precise specimen preparation is required. This method outlines preparatory procedures recommended for normal rock mechanics test progress.

2. Collection and Storage

2.1 Test material is normally collected from the field in the form of drilled cores. Field sampling procedures should be rational and systematic, and the material should be marked to indicate its original position and orientation relative to identifiable boundaries of the parent rock mass. Ideally, samples should be moistureproofed immediately after collection either by waxing, spraying, or packing in polyethylene bags or sheet. (Example: For moistureproofing by waxing, the following procedure can be used for core that will not fail apart in handling.

(a) Wrap core in a clear thin polyethylene such as GLAD WRAP or SARAN WRAP,

(b) Wrap in cheese cloth,

(c) Coat wrapped core with a lukewarm wax mixture to an approximate 1/4-in. (6.4-mm) thickness. The wax should consist of a 1 to 1 mixture of paraffin and microcrystalline wax, such as Sacony Vacuum Mobile Wax No. 2300 and 2305, Gulf Oil Corporation Petrowax A, and Humble Oil Company Microvan No. 1650.

Cores that could easily be broken by handling should be prepared using the soil sampling technique described on pages 4-20 and 4-21 of EM 1110-2-1907, 31 March 1972[9.1]). They should be transported as a fragile material and protected from excessive changes in humidity and temperature. The identification markings of all samples should be verified immediately upon their receipt at the laboratory, and an inventory of the samples received should be maintained. Samples should be examined and tested as soon as possible after receipt; however, it is often necessary to store samples for several days or even weeks to complete a large testing program. Every care must be taken to protect stored samples against damage. Core logs of samples should be available.

3. Avoidance of Contamination

3.1 The deformation and fracture properties of rock may be influenced by air, water, and other fluids in contact with their internal (crack and pore) surfaces. If these internal surfaces are contaminated by oils or other substances, their properties may be altered appreciably and give misleading test results. Of course, a cutting fluid is required with many types of specimen preparation equipment. Clean water is the preferred fluid. Even so, one must be cognizant of the effect of moisture on the test specimens. While it may be impossible to exactly duplicate the in situ conditions even if they were known, a concerted effort should be made to simulate the environment from which the samples came. Generally, there are three conditions to be considered:

(a) Hard, dense rock and low porosity will not normally be affected by moisture. This type of material is normally allowed to air-dry prior to testing to bring all samples to an equilibrium condition. Drying at temperatures above 120 °F (49 °C) is not recommended as excessive heat may cause an irreversible change in rock properties.

(b) Some shales and rocks containing clay will disintegrate if allowed to dry. Usually the disintegration of diamond drill cores can be prevented by wrapping the cores as they are drilled in a moistureproof material such as aluminum foil or chlorinated rubber, or sealing them in moistureproof containers.

(c) Mud shales and rock containing bentonites (e.g., tuff) may soften if the moisture content is too high. Most of the softer rocks can be cored or cut using compressed air to clear cuttings and to cool the bit or saw.

It is imperative to determine very early in the test program the moisture sensitivity of all types of material to be tested and to take steps to accommodate the requirements throughout the test life of the selected specimens.

4. Selection

4.1 Under the most favorable circumstances, a laboratory determination of the engineering properties of a small specimen gives an approximate guide to the behavior of an extensive, nonhomogeneous geological formation under the complex system of induced stresses. No other aspect of laboratory rock testing is as important as the selection of test specimens to best represent those features of a foundation which influence the analysis or design of a project. Closest teamwork of the laboratory personnel and the project engineer/geologist must be continued throughout the testing program since, as quantitative data become available, changes in the initial allocation of samples or the securing of additional samples may be necessary. Second in importance only to the selection of the most representative undisturbed material is the preparation and handling of the test specimens to preserve in every way possible the natural structure of the material. Indifferent handling of undisturbed rock can result in erroneous test data.

5. Coring

5.1 Virtually all laboratory coring is done with thin-wall diamond rotary bits, which may be detachable or integral to the core barrel. The usual size range for laboratory core drills is from 6-in.-diam (152.4-mm) down to 1-in. (25.4-mm) outside diameter. Typical sample diameters for uniaxial testing are 2.125 in. (54 mm). Drilling machines range from small quarry drills to modified machine shop drill presses. Almost any kind can be adapted for rock work by fitting a water swivel, but a heavy, rigid machine is desirable in order to assure consistent production of high quality core. The work block must be clamped tightly to a strong base or table so as to prevent any tilting, oscillation, or other shifting. To avoid unnecessary unclamping and rearrangement of the work block, it is desirable to have provision for traversing the drill head or the work block. Traversing devices must lock securely to eliminate any play between drill and work. The drill travel should be sufficient to permit continuous runs of at least 10 to 12 in. (254 to 304.8 mm), without need for stopping the machine. Optimum drilling speeds vary with bit size and rock type, and to some extent with condition of the bit and the characteristics of the machine. The general trend is that drill speed increases as drill diameter decreases; also, higher drill speeds are sometimes used on softer rocks. The broad range of drill speeds lies mainly between 200 and 2,000 rpm. No hard-and-fast rules can be given, but an experienced operator can easily choose a suitable speed by trial. Some core drills are hand-fed, but it is desirable to have some provision for automatic feed. The ideal feed arrangement is a constant-force hydraulic feed which can be set for each bit size and rock type, but such machines are quite rare. Constant-force feed can be improvised by means of a weight and pulley arrangement. On adapted metal-working drill presses, the automatic feed rate for a given drill size and rock type can be determined; however, since there is a danger of damaging the machine or the core barrel if too high a feed rate is used, an electrical overload breaker should be provided.

6. Sawing

6.1 For heavy sawing, a slabbing saw is adequate for most purposes. For exact sawing, a precision cutoff machine, with a diamond abrasive wheel about 10 in. (254 mm) in diameter, and a table with two-way screw traversing and provision for rotation are recommended. The speed of the wheel is usually fixed, but the feed rate of the wheel through the work can be controlled. Clean water, either direct from house supply or recirculated through a settling tank, is the standard cutting and cooling fluid. For crosscutting, core should be clamped in a vee-block slotted to permit passage of the wheel. By supporting the core on both sides of the cut, the problem of spalling and lip formation at the end of the cut is largely avoided. Saw cuts should be relatively smooth and perpendicular to the core axis in order to minimize the grinding or lapping needed to produce end conditions required for the various tests.

7. End Preparation

7.1 Due to the rather large degree of flatness required on bearing surfaces for many tests, end grinding or lapping is required. Conventional surface grinders provided the most practical means of preparing flat surfaces, especially on core samples with diameters greater than approximately 2 in. (50.8 mm). Procedures are essentially comparable to metal working. Quite often a special jig is constructed to hold one or more specimens in the grinding operation. The lathe can also be used for end-grinding cylindrical samples. A sample is held directly in the chuck, rotated at 200 to 300 rpm, and the grinding wheel, its axis inclined some 15 deg (0.26 radian) to the sample axis, is passed across end of the sample with rotating at 6,000 to 8,000 rpm. The "bite" ranges from about 0.003 in. (0.0762-mm) maximum to less than 0.001 in. (0.0254 mm) for finishing, and the grinding wheel is passed across the sample at about 0.5 in. (12.7 mm) per minute. For core diameters of 2-1/8 in. (54 mm) or less, a lap can be used for grinding flat end surfaces on specimens, although producing a sufficiently flat surface by this method is an art. To end-grind on the lap, a cylindrical specimen is placed in a steel-carrying tube which is machined to accept core with a clearance of about 0.002 in. (0.0508 mm). At the lower end of this tube is a steel collar which rests on the lapping wheel. The method requires use of grinding compounds and, hence, is not recommended where other methods are available.

8. Specimen Check

8.1 In general terms, test specimens should be straight, their diameter should be constant, and the ends should be flat, parallel, and normal to the long axis. Sample dimensions should be checked during machining with a micrometer or vernier caliper; final dimensions are normally measured with a micrometer and reported to the nearest 0.01 in. (0.254 mm). Tolerances are best checked on a comparator fitted with a dial micrometer reading to 0.0001 in. (0.00254 mm). There is a technique for revealing the roughness and planes qualitatively. Impressions are made by sandwiching a sheet of carbon paper and a sheet of white paper between the sample end and a smooth surface. The upper end of the sample is given a light blow with a rubber or plastic hammer, and an imprint is formed on the white paper. Areas where no impressions are made indicate dished or uneven surfaces. The importance of proper specimen preparation cannot be overemphasized. Specimens should not be tested which do not meet the dimensional tolerances specified in the respective test methods.

9. References

9.1 Department of the Army, Office, Chief of Engineers, "Soil Sampling," EM 1110-2-1907, Washington, D.C., 1972.