Chapter 5
Laboratory Testing

5-1. General

As shown in Figures 4-1 and 4-2, material testing is part of both the Site Selection and the Design Investigations. In terms of timing or scheduling, laboratory material testing would be performed as close to concurrent with the subsurface exploration stages as possible. EM 1110-1-1804 provides guidance and information on types of soil and rock tests for various design applications. EM 1110-2-1906, the Corps of Engineers Rock Testing Handbook (USAEWES 1993), and ASTM (1994a through 1994d) all provide detailed information on the procedures for conducting tests on soil and rock materials. Rock and soils tests are informally divided into two categories: index tests to identify and classify the materials, and engineering properties tests to supply parameters for design analyses. The following paragraphs discuss the applicability of selected tests for test quarry design.

5-2. Petrographic Examination

A detailed discussion of recommended practice for petrographic examination of rock cores is contained in the Corps of Engineers Rock Testing Handbook (USAEWES 1993). Petrographic examinations are conducted to describe, classify, and determine the relative amounts of the sample constituents, identify the sample lithology, to determine the sample fabric, and to detect evidence of rock alteration. The identification of rock constituents and determination of fabric and micro-structural features assist in the recognition of properties that may influence the engineering behavior of the rock. Complete petrographic examination may require the use of such procedures as light microscopy, x-ray diffraction, differential thermal analysis, and infrared spectroscopy. The selection of specific procedures should be made by an experienced petrographer in consultation with geologists and engineers responsible for the design and execution of the test quarry program.

5-3. Weight/Volume Properties

The weight/volume and pore properties of a rock material include specific gravity of solids, porosity and absorption, apparent and bulk specific gravity, moisture content, and degree of saturation. These properties are directly important to predictions of "swell" or "bulking" and serve as index tests relating rock strength and deformability. As a general rule, for test quarry design, bulk specific gravity and absorption are the minimum weight/volume tests that need to be performed. If a quarry is intended to produce dimension or derrick stone, absorption and adsorption may provide an indication of the rock's long-term resistance to freeze-thaw and slaking. The relationships between bulk specific gravity (G_m), absorption (A_B), and porosity of the rock particles (n_r) are given below. The porosity here refers to the permeable voids associated with individual rock particles and not to the porosity of a compacted mass of such rocks.

$$G_m = \frac{A}{B - C} \tag{5-1}$$

$$A_B = \frac{B - A}{A} \tag{5-2}$$

$$n_r = A_B \times G_m \tag{5-3}$$

where

A = weight of oven-dry specimen

B = weight of saturated surface-dry specimen

C = weight of saturated surface-dry specimen in water

5-4. Strength Tests

Unconfined compressive strength is a well known index test relating intact rock strength and deformability. Further, it can be used with rock mass quality descriptors to infer rock mass strength parameters (Hoek and Bray 1981). Unless there are specific requirements relating to rock slope design problems, there is no need to perform tests such as the triaxial shear or direct shear tests. An inexpensive and rapid test which correlates to unconfined compressive strength is the point load test (Bieniawski 1975). This test is growing in popularity and can be performed either in the laboratory or the field.

5-5. Rock Durability Tests

Laboratory durability tests are divided into those that simulate accelerated weathering and those that measure physical properties. Accelerated weathering tests usually include wet and dry (Designation D 5313; ASTM 1994a), freeze and thaw (Designation D 5312; ASTM 1994a), sodium sulphate soundness and magnesium sulphate soundness (Designations D 5240 and C 88; ASTM 1994a and 1994b, respectively). Physical property tests include

absorption (Designation C 127; ASTM 1994b), Los Angeles Abrasion (Designation C 535; ASTM 1994b), and slake durability (Designation D 4644; ASTM 1994c).