EVALUATION PROCEDURES OF SEDIMENT MATERIAL FOR CANAL SEALING

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December 1956
Revised January 1958

CER58RTS4

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Introduction

The tests described herein have been designed to evaluate prospective clay materials for use in sediment sealing work. The establishment of procedures and criteria for these tests follow the same approach as Dr. H. G. Fisk, Director of the Natural Resources Research Institute in Laramie, Wyoming and are mostly purely arbitrary. Therefore, the results are intended for comparison between samples and bear little absolute significance by themselves. However, such results seem to be adequate for application in the field.

It may be noted that any test result is only as reliable as the accuracy of the techniques employed. The techniques used in the following tests have been perfected in the Colorado State University sediment sealing project laboratory to the extent that repeatable results can be obtained within a reasonable margin of consistency. As laboratory equipment and technique improve and knowledge in the sediment sealing field broadens, the procedures and criteria will be revised; consequently, it will be necessary to bring this manual up to date from time to time.

Sampling Instructions and Preliminary Testing

Natural deposits of clay vary considerably with location. Therefore, samples should be collected from several locations, with a stake marking each outcrop.

A simple preliminary test can be used to find out if the clay samples are of high enough quality to warrant further detailed testing. For this, the sample should be air-dried and ground to below 1/8-in. size. Place about 1/2-in. of the dry material in a quart mason jar, marking the jar to show the top of the layer. Then fill the jar with soft water without disturbing the clay. Observe how fast the clay layer wets and note any swelling. A good quality bentonite soaks through very slowly (several weeks for powdered material), and swells 8 to 12 times in volume.

After the clay is thoroughly wet, shake until it is completely dispersed in the water, then set the jar on a table and observe how fast the material settles out of suspension. A good quality bentonite has very little grit that will settle out; most of the sample remains dispersed, keeping the water cloudy or muddy almost indefinitely.

Sample Preparation

When a sample is received at the laboratory it is opened and registered. Registration consists of assignment of a code number and recording the date, job, sender, tests required, description of appearance and condition, and other data pertinent to each particular sample. In order to obtain representative specimens of convenient size for testing, all of the material in each sample is crushed and ground until it will pass through a U.S. No. 8 sieve (2.36-mm size). The sample is then successively quartered to approximately 400 cc in volume. This is considered a representative specimen to be placed in a paper box bearing the appropriate code number and heated in an oven to 110°C for several days. The material for testing is taken from this box and it is weighed after the box has been cooled to room temperature in a desiccator.

Grit Determination

From a cooled sample box, 20 gm of oven-dry material is weighed by means of an analytical balance. The weighing process must be rapid because the oven-dry material tends to acquire moisture from the atmosphere. For this reason the precision in weighing is not carried beyond 0.001 gm.

The weighed material is then placed in a soil testing cylinder of 1000-ml capacity. Approximately 300 ml of tap water is added and mixed with the material. In some cases it is allowed to stand overnight in order to achieve complete soaking. A specially built mixer unit, shown in Fig. 1, is used for agitation under an air pressure of 10 psi for at least 10 minutes. This air-blowing technique of mixing avoids crushing of particles, which could yield misleading results. When the mixer is removed a jet of water from a wash-bottle is used to wash carefully into the cylinder all material adhering to the mixing rod.

The suspension is then washed through a 325-mesh sieve (44-micron size). The material retained on the sieve is thoroughly washed with a jet of water to ensure that only grit (particles larger than 44-micron size) remains on the sieve screen. This is then quantitatively transferred into a tarred aluminum weighing dish and dried in an oven heat of 110°C. When the grit is dry its weight may be determined on the analytical balance after it is cooled to room temperature in a desiccator. The grit content is expressed in per cent by weight on gross oven-dry weight basis, or per cent grit content = $\frac{\text{Net dry weight of grit in gm}}{20} \times 100$.

In most commercial bentonites the grit content will not exceed 6 per cent. Some contain as low as one per cent grit.

Colloidal Yield Determination

Ten grams of material is weighed according to the same procedure as described in the grit determination, and placed in a soil testing cylinder of 1000-ml capacity. It is allowed to soak completely in approximately 300 ml of distilled water. The special mixer (Fig. 1) is used under a pressure of 10 psi and for at least 30 minutes or until the mixture is completely dispersed. More distilled water is added so that the surface level in the cylinder rises to the 1000-ml mark. With a stopper fitted to the mouth of the cylinder, the suspension is then shaken up for one full minute and allowed to stand undisturbed for a period of 24 hrs. In the case when the suspension exhibits a tendency to flocculate, 0.50 gm of sodium tripolyphosphate $Na_5P_3O_{10}$ is added as a dispersing agent. At the end of the standing period, a siphon is used to remove all the suspension from the cylinder. The sediment thus left in the cylinder is quantitatively transferred to a tarred beaker and dried in an oven heat of 110°C. The oven-dry weight of the sediment is considered to represent the non-colloidal fraction of the material, and the colloidal fraction can be calculated therefrom. The colloidal yield is expressed in percent by weight of the gross dry weight, that is:

$$\% \text{ Colloidal Yield} = \frac{10 - \text{Net oven-dry weight of sediment}}{10} \times 100$$

A high-quality commercial bentonite will normally yield more than 80 per cent stable suspended material extending over the entire length of the test cylinder; and no clear liquid can be discerned near the surface level after 24 hrs of standing. If the addition of a dispersing agent is required to prevent flocculation of the clay, it usually means that the clay is a calcium-dominated or low-swell variety.

Wall-Building Test[a]

This test provides a measure of the ability of the material to prevent water loss under pressure filter conditions. According to the

[a] After Fisk, for reference see:
H. G. Fisk. Bentonite with test methods and results of tests of Wyoming bentonites. Laramie, Wyoming, University of Wyoming. Natural Resources Research Institute, Bul. No. 2. Aug. 1946, 39 p.

practice of the oil drilling industry, a Baroid wall-building tester is used on a 6 per cent by weight bentonite suspension. For evaluation of suspensions used in canal sealing work, This test is significant only as a tool for comparing clays. An effort is being made to develop tests with greater significance for this purpose. For the present, the procedure of the oil drilling industry is followed, which furnishes comparative results.

A measured quantity of distilled water is poured into the mixing bowl of a high-speed rotary mixer. Small increments of a weighed quantity of the sediment material are slowly added while the mixer is in operation until a smooth suspension of 6 per cent by weight is obtained. The vessel of the tester is lined at the bottom with a piece of 3-1/2-in. diameter hardened filter paper.[1] Approximately 300 ml of the suspension is introduced into the vessel and the air-tight lid is mounted in place. A pressure of 100 psi from compressed air is applied while the filtrate for the first 30 minutes is collected into a graduated cylinder. The pressure is then released and the suspension remaining in the vessel discarded. The filter paper with the wall built by the suspension is gently rinsed with water. The approximate thickness of this wall in inches can be measured with a scale.

Good performance of a sample is indicated by low water loss and small wall thickness. A commercial bentonite will normally have a water loss of less than 30 cc in 30 min. and a wall thickness of less than 3/32 in.

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[1] For Baroid wall-building tester, specially hardened filter paper prepared by National Lead Company (Catalog No. 987) Houston, Texas.

Viscosity Determination[1]

The apparatus used for this test is the Baroid viscosimeter. It consists essentially of a cylindrical vessel in which the suspension is introduced and an open-end cylinder which can be made to rotate in the vessel. The cylinder is connected to a spindle shaft, which in turn is driven by a falling weight. A water bath is used to maintain a constant temperature of 21°C for the suspension.

The same 6 per cent suspension as in the wall-building test is used in this test. After the suspension is poured into the vessel and mounted into position, the temperature of the water bath is adjusted to read 21°C. By trial and error, the weight required to produce one complete revolution of the viscosimeter dial in a 6-second period (600 rpm of the cylinder) is determined. This is checked by repeating the timing with the same weight several times. The viscosity in centipoises of the suspension may be found directly from a calibration chart for this purpose.

This test has been run on prospective clays in comparison with results obtained by testing one of the commercial bentonites. The latter usually test out at a viscosity of 10 centipoises or more.

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1 After Fisk, for reference see:
H. G. Fisk. Bentonite with test methods and results of tests of Wyoming bentonites. Laramie, Wyoming, University of Wyoming, Natural Resources Research Institute, Bul. No. 2. Aug. 1946. 39 p.