CHAPTER 4
SOIL-BENTONITE SLURRY WALLS

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4-1. GENERAL. At hazardous waste sites, Soil-Bentonite (S-B) slurry walls function as relatively impermeable barriers to either contain contaminated ground water or redirect clean ground water around contaminated areas. S-B slurry walls are typically a minimum of 600 to 1500 mm (2 to 5 feet) wide and are required to have an in-place permeability of less than or equal to 1×10^{-7} cm/s.

The major construction activities involved in building an S-B slurry wall are preparation of the site, slurry mixing, slurry hydration, trench excavation, backfill preparation, backfill placement, and site cleanup. The slurry is used to hold the trench open until backfill can be placed. Slurry is composed of water with 4-8 percent sodium bentonite added.

S-B backfill typically consists of a minimum of 2 percent bentonite, 20-40 percent fines (silt and clay), and has a moisture content of 25-40 percent. The density of the slurry in the trench must be at least 240 kg/m^3 (15 pounds per cubic foot) less than the density of the S-B backfill so that the S-B backfill will displace the slurry in the trench during construction. The mix design used for the S-B backfill can be specified by the Government or proposed by the contractor based on preconstruction compatibility testing.

a. Preconstruction Submittals. The contractor should provide preconstruction submittals as required by the specifications. The following is a list of typical submittal requirements.

(1) S-B Backfill Testing Plan describing the equipment, procedures, and materials to be used to determine an S-B backfill mix design.

(2) S-B Backfill Testing Report. This report should include a description of test results including proposed mix proportions, gradations, slumps, densities, permeabilities, and moisture contents.

(3) Slurry Trench Implementation Plan describing the general work sequence and layout of operations. The plan should include locations for storage and slurry preparation areas, contractor qualifications, equipment, utilization of excavated materials, trench cleaning methods, slurry and S-B backfill preparation, and site cleanup. Also, the contractor's plan should include a description of QC equipment and test procedures, and the name of the off-site laboratory proposed for use.

(4) Bentonite. A sample of the proposed bentonite is often submitted for QA testing.

(5) Backfill material. A sample of each type of backfill material is often submitted for QA testing.

(6) Water. Verify that mixing water test results comply with the requirements indicated in the specifications.

b. Construction Submittals. The contractor should provide construction submittals as required by the specifications. The following is a list of typical submittal requirements.

(1) Bentonite test results and a certificate of compliance for each lot of bentonite shipped to the site.

(2) Backfill gradation test results. Verify the backfill material conforms to the specified ranges gradation, Atterberg limits, and moisture content.

(3) As-built profile. Scale drawing and a profile of the completed slurry trench. If S-B backfill materials were prepared in batches, each batch should be delineated on the profile.

(4) Record of soundings taken during construction.

(5) Bentonite slurry mix. Record of bentonite slurry mix quantities, proportions of additives utilized, and adjustments in the slurry mix.

(6) S-B backfill material mix. A record of S-B backfill material mix quantities and adjustments.

(7) QC test results.

4-2. PRODUCTS.

a. Materials.

(1) Bentonite.

(a) Check that the bentonite conforms to the specifications. A certificate of compliance from the supplier should provide the specified criteria.

(b) Bentonite powder should be kept dry during storage.

(2) Water. Check that mixing water complies with the standards specified. If the local water supply does not meet the specifications the contractor may need to condition the water prior to use.

(3) Backfill Material. Check that the backfill material to be used for the S-B backfill material conforms to the gradations specified. In addition, Atterberg limits and moisture contents for the backfill should conform to the specified values.

b. Equipment.

(1) All equipment should be inspected in accordance with the provisions of EM 385-1-1 and the inspection checklist should be submitted by the contractor prior to use of the equipment.

(2) Trench Excavation Equipment.

(a) Check that the excavation equipment is capable of excavating the trench width in a single pass. Buckets utilized may be perforated to allow the drainage of slurry, and may include bottom cutter teeth.

(b) Check that the excavation equipment is capable of reaching at least 1.5 m (5 feet) deeper (or other depth as specified) than the maximum excavation depth as shown on the drawings.

(3) Mixing and Slurry Placement Equipment.

(a) Slurry mixing equipment should be capable of achieving

complete dispersion of bentonite and additives to produce a uniform slurry. Typically, venturi mixers are used for this operation, in conjunction with high-speed/high-shear centrifugal pumps.

(b) Check that stored slurry is mechanically or hydraulically agitated while in slurry storage ponds or tanks.

(4) Field Laboratory Equipment. Check that the specified field laboratory equipment is on site and in good working condition.

c. Mixes.

(1) Initial Bentonite Slurry. Check that the proper percentage of dry bentonite is added to produce the slurry, and that the slurry conforms to the properties listed in the specifications.

(2) Trench Bentonite Slurry.

(a) Verify slurry in the trench conforms to the properties listed in the specifications. Check the specifications for testing frequency of the trench slurry.

(b) Verify that slurry is allowed to hydrate (typically, for a minimum of 8 hours) prior to being placed in the trench.

(c) Slurry additives to increase or decrease viscosity should be approved prior to use. It is advisable to consult with the designers about the use of additives to control or adjust slurry properties.

(3) S-B Backfill Material.

(a) Verify S-B backfill material meets the properties listed in the specifications.

(b) Look for poorly mixed S-B backfill. S-B backfill should be thoroughly mixed so that all particles are coated with slurry.

d. Quality Assurance Testing. Check the specifications or QA Plan to see if samples need to be submitted for QA testing. Typically, samples for QA testing should be collected at the same time as QC samples, however, at a reduced frequency. This allows comparison of the QA and QC test results. Ensure QA and QC sample numbers are correlated so that test results can be easily compared.

4-3. EXECUTION.

a. Work Platform. Check that the work platform is constructed to the lines and grades shown on the drawings. Check for proper compaction and material requirements as described in the specifications.

b. Trench Excavation.

(1) The up-gradient portion of the slurry trench should be excavated before the down-gradient portion of the slurry trench.

(2) Check that the excavation is vertical (within 2 percent). This is normally accomplished with plumb line measurements.

(3) Check that the full depth of the trench has been excavated

prior to placement of the S-B backfill.

(4) Measure the depth of the trench when the top of the key layer has been reached, and also after the key has been excavated into the key layer. The soil that is excavated should be continuously logged by QA personnel to verify that subsurface conditions are similar to those anticipated.

(5) Generally, the trench excavation should not precede the toe of the S-B backfill slope by less than 9 meters (30 feet) or more than 30 meters (100 feet). Just prior to extended non-work periods, S-B backfill may be brought to the toe of the excavation (to minimize the amount of open trench).

(6) Check that the full depth of the trench has been reached and overlapped at all intersecting segments of the wall. Generally, a minimum overlap of 1500 mm (5 feet) of overlap is required.

(7) Check for trench collapses by depth probing. Ensure that collapsed soils are removed prior to S-B backfill placement.

c. Placement of Slurry.

(1) Slurry should be placed in the trench at the start of excavation.

(2) Monitor the slurry level within the trench. Typically, slurry is maintained a minimum of 900 mm (3 feet) above the ground water level and no more than 600 mm (2 feet) below the surface of the work platform.

(3) Check the density of the slurry, especially near the middle and bottom of the trench, to ensure that density requirements are met. Check the specifications for testing frequencies.

(4) If the density of the slurry in the trench is too high (generally greater than 1360 kg/m^3 (85 pcf)), desanding of the slurry may be required. This process may involve the use of desanding equipment, or replacing the slurry in the trench with fresh slurry.

d. Excavated Material.

(1) Check that the excavated materials are properly stockpiled. They may have to be covered if vapor emissions are a problem.

(2) Check that stockpile placement is not too close to the trench, which may cause trench collapse. Stockpile placement distances should be described in the specifications. Contact the designer if they are not.

e. Trench Cleaning. Verify that the trench bottom has been cleaned prior to S-B backfill placement. Often, the trench bottom is cleaned by the use of an air lift pump to remove material which has settled out of the slurry. The trench bottom should be checked after periods of inactivity such as an overnight work stoppage.

f. Soil-Bentonite Backfill Mixing and Placement.

(1) Check that the S-B backfill material has been thoroughly mixed into a homogeneous mass. Depending on the project, S-B backfill may be mixed in a separate mixing area and trucked to the trench or mixed along the side of the trench with a dozer. If mixed

using a dozer, verify the mix is not being diluted with subgrade soils.

(2) The S-B backfill should be initially placed into the bottom of the trench by tremie or clamshell methods. A sloped starter trench outside the limits of the work can also be constructed. the starter trench allows the S-B backfill to slide down to the bottom of the trench.

(3) Subsequent batches of S-B backfill should be placed at the top of the backfill slope.

(4) The slope of the S-B backfill face should be probed to assure that a constant slope is maintained. This will assure that no pockets of slurry are trapped within the S-B backfill.

g. Soundings.

(1) Check that soundings of the excavation and S-B backfill are taken every 6 meters (20 feet) or as otherwise specified.

(2) The following elevations are typically recorded: a) Top of key stratum; b) Bottom of trench excavation; c) Bottom of trench prior to backfilling; and d) Profile of the backfill slope.

(3) An "as-built" profile should be kept by the contractor which includes descriptions of materials encountered, extent of excavation after each day's work, and S-B backfill batch placement locations.

h. Treatment of the Top of Completed Slurry Trench.

(1) Check the specifications to determine if a temporary soil cover should be placed over completed portions of the slurry trench. Generally, the final trench cover should not be installed immediately after S-B backfill placement to allow settlement to occur.

(2) Prior to the installation of the final trench cover, settled areas should be filled with approved material.

i. Cleanup. Excess trench spoils, unused S-B backfill, and excess slurry should be properly disposed of as indicated in the specifications.