

## Earth Fill

### 1. SCOPE

The work shall consist of construction of earth embankments, other earth fill as required by the drawings and specifications.

### 2. MATERIALS

All fill materials shall be obtained from required excavations and designated borrow areas. The selection, blending, routing and disposition of materials in the various fills shall be subject to approval by the Technician.

Fill materials shall contain no frozen soil, sod, brush, roots or other perishable materials. Unless otherwise specified, rock fragments incorporated in the fill shall be no larger than one-half of the lift thickness specified for each type of fill. Over-sized material shall be removed prior to compaction.

The types of materials used in the various fills shall be as listed and described in the special provisions and drawings.

### 3. FOUNDATION PREPARATION

Foundations for earth fill shall be stripped to remove vegetation and other unsuitable materials or shall be excavated as specified.

Except as otherwise specified, earth foundation surfaces shall be graded to remove surface irregularities and shall be scarified parallel to the axis of the fill or otherwise acceptably scored and loosened to a minimum depth of 2 inches. The moisture content of the loosened material shall be controlled as specified for the earth fill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earth fill as specified for subsequent layers of earth fill.

Earth abutment surfaces shall be free of loose, un-compacted earth in excess of 2 inches in depth normal to the slope and shall be at such a moisture content that the earth fill can be compacted against them to produce a good bond between the fill and the abutments.

Rock foundation and abutment surfaces shall be cleared of all loose materials by hand or other effective means and shall be free of standing water when fill is placed upon them. Occasional rock outcrops in earth foundations for earth fill, except in dams and other structures designed to restrain the movement of water, shall not require special treatment if they do not interfere with compaction of the foundation and initial layers of the fill or the bond between the foundation and the fill.

Foundation and abutment surfaces shall be no steeper than one horizontal to one vertical (1:1) unless otherwise specified. Test pits or other cavities shall be filled with compacted earth fill conforming to the specifications for the earth fill to be placed upon the foundation.

### 4. PLACEMENT

Fill shall not be placed until the required excavation and foundation preparation have been completed and the foundation has been inspected and approved by the Technician. Fill shall not be placed upon a frozen surface, nor shall snow, ice, or frozen material be incorporated in the fill.

Fill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified, or 8 inches if not specified. Materials placed by dumping in piles or windrows shall be spread

uniformly to not more than the specified thickness before being compacted. Hand compacted fill, including fill compacted by manually directed power tampers, shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of fill compacted by manually directed power tampers, or 6 inches if not specified.

Adjacent to structures, fill shall be placed in a manner which will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly. The height of the fill adjacent to a structure shall be increased at approximately the same rate on all sides of the structure.

Earth fill in dams, levees and other structures designed to restrain the movement of water shall be placed so as to meet the following additional requirements:

- a. The distribution of materials throughout each zone shall be essentially uniform, and the fill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material. Zone earth fills shall be constructed concurrently unless otherwise specified.
- b. If the surface of any layer becomes too hard and smooth for proper bond with the succeeding layer, it shall be scarified parallel to the axis of the fill to a depth of not less than 2 inches before the next layer is placed.
- c. The top surfaces of embankments shall be maintained approximately level during construction, except that a crown or cross-slope of approximately two percent shall be maintained to insure effective drainage, and except as otherwise specified for drain fill or sectional zones.
- d. Dam embankments shall be constructed in continuous layers from abutment to abutment except where openings to facilitate construction or to allow the passage of stream flow during construction are specifically authorized.
- e. Embankments built at different levels as described under (c) or (d) above shall be constructed so that the slope of the bonding surfaces between embankment in-place and embankment to be placed is not steeper than 3 feet horizontal to 1 foot vertical (3:1). The bonding surface of the embankment in-place shall be stripped of all material not meeting the requirements of this specification. The bonding surface shall be scarified, moistened and re-compacted when the new fill is placed against it to ensure a good bond with the new fill and to obtain the specified moisture content and density at the contact of the in-place and new fills.

## **5. CONTROL OF MOISTURE CONTENT**

Unless otherwise specified, the moisture content of the fill material shall be maintained within the range required to permit maximum compaction. The moisture content in plastic clays and silts should be such that when kneaded in the hand it will form a ball which does not readily separate when struck sharply with a pencil or which refuses to separate when pressed between the hands.

When working with sandy materials, the moisture content should be such that the material tends to form a ball under pressure, but seldom holds together.

The application of water to the fill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement

on the fill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet (yields free water when kneaded in the hand) when deposited on the fill shall either be removed or be dried to the proper moisture content prior to compaction.

If the top surface of the preceding layer of compacted fill or a foundation or abutment surface in the zone of contact with the fill becomes too dry to permit suitable bond it shall either be removed or scarified and moistened by sprinkling to an acceptable moisture content prior to placement of the next layer of fill.

## 6. COMPACTION

Unless otherwise specified, earth fill shall be Class C compaction, by one or a combination of the following methods:

- A. Controlled movement of the hauling and spreading equipment over the area so that the entire surface area of each lift will be traversed by not less than 1 tread track of the loaded earth-moving equipment traveling in a direction parallel to the axis of the fill.
- B. Each lift shall be compacted by not less than two complete passes of padfoot/tamping foot style roller (roller modified with trapezoidal pads attached to a drum) exerting a minimum pressure of 100 pounds per square inch.

The completed fill shall be constructed to the lines and grades shown on the plans or as staked by the Technician, plus the allowance indicated for settlement.

## 7. COMPACTION ADJACENT TO STRUCTURES

Unless otherwise specified, fill adjacent to structures shall be compacted to a density equivalent to that of the surrounding fill by means of hand tamping or manually directed power tampers, plate vibrators, or walk-behind, miniature, or self-propelled rollers.

Heavy equipment including backhoe-mounted power tampers, or vibrating compactors and manually-directed vibrating rollers, shall not be operated within 3 feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within 5 feet of any structure. Compaction by means of drop weights operating from a crane or hoist will not be permitted.

The passage of heavy equipment will not be allowed: (1) over cast-in-place conduits prior to 14 days after placement of the concrete; (2) over cradled or bedded precast conduits prior to 7 days after placement of the concrete cradle or bedding; or (3) over any type of conduit until the backfill has been placed above the top surface of the structure to a height equal to one-half the clear span width of the structure or pipe or 3 feet, whichever is greater.

Compacting of fill adjacent to structures shall not be started until the concrete has attained the strength specified. The strength will be determined by compression testing of test cylinders cast by the Technician for this purpose and cured at the work site in the manner specified in ASTM Method C 31 for determining when a structure may be put into service.

When the required strength of the concrete is not specified as described above, compaction of fill adjacent to structures shall not be started until the time intervals shown in Table 1 have elapsed after placement of the concrete.

TABLE 1

Structure	Time Interval
Vertical or near-vertical walls with earth loading on one side only (Retaining walls, counterforts, impact basins)	14 days
Walls backfilled on both sides simultaneously	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	7 days
Conduits and spillway risers, cast-in-place (inside forms removed)	14 days
Conduits, precast, cradled	2 days
Conduits, precast, bedded	1 day
Cantilever outlet bents (backfilled both sides simultaneously)	3 days

## 8. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE FILL

Fill placed at densities lower than the specified minimum density or at moisture contents outside the specified acceptable range of moisture content or otherwise not conforming to the requirements of the specifications shall be reworked to meet the requirements or removed and replaced by acceptable fill. The replacement fill and the foundation, abutment and fill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

## 9. TESTING

During the course of the work, the Technician may perform such tests as are required to identify materials, and determine compaction characteristics, moisture content, and density of fill in place. Tests performed by the Technician will be used to verify that the fills conform to the requirements of the specifications. Protocol for testing shall follow the following ASTMs unless otherwise specified in the Special Provisions.

### In-place Densities of Earth Fill

ASTM D1556: Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.

ASTM D2167: Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.

ASTM D2937: Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

ASTM D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

### Moisture Content at the Time of Compaction

Values of moisture content determined by ASTM D2216 are considered the true value of soil moisture. Values determined using the other ASTMs can be verified by comparison to values obtained by ASTM D2216.

ASTM D2216: Standard Test Methods for Laboratory Determination of Water

(Moisture) Content of Soil and Rock by Mass.

ASTM D4643: Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating.

ASTM D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

#### Correction for Oversize Particles

When the materials to be tested contain more than 5 percent by dry weight of oversize rock particles, correction for oversize particles shall be made.

ASTM D4718: Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles.

Such tests are not intended to provide the Contractor with the information required by him for the proper execution of the work and their performance shall not relieve the Contractor of the necessity to perform tests for that purpose.

### **10. MEASUREMENT AND PAYMENT** (Used only if applicable)

For items of work for which specific unit prices are established, each item will be measured to the nearest unit applicable. Payment for each item will be made at the agreed-to unit price for that item. For items of work for which specific lump sum prices are established, payment will be made at the lump sum price.

Such payment will constitute full compensation for all materials, labor, equipment, tools, and all other items necessary and incidental to the completion of the work.

Compensation for any item of work shown on the drawings or described in the special provisions but not listed on the bid schedule will be considered incidental to and included in the pay items listed on the bid schedule.