# 23. EARTHFILL

1. SCOPE

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

Earthfill is composed of natural earth materials that can be placed and compacted by construction equipment operated in a conventional manner.

Earth backfill is composed of natural earth materials placed and compacted in confined spaces or adjacent to structures (including pipes) by means of hand tamping, manually directed power tampers or vibrating plates, or equivalent.

2. MATERIALS

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

Fill materials shall contain no frozen soil, sod, brush, roots or other perishable materials. Rock particles larger than the maximum size specified for each type of fill shall be removed prior to compaction of the fill.

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

3. FOUNDATION PREPARATION

Foundations for earthfill 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 two (2) inches. The moisture content of the loosened material shall be controlled as specified for the earthfill, and the surface materials of the foundation shall be compacted and bonded with the first layer of earthfill as specified for subsequent layers of earthfill.

Earth abutment surfaces shall be free of loose, uncompacted earth in excess of two inches in depth normal to the slope and shall be at such a moisture content that the earthfill 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 earthfill, 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 not steeper than one (1) horizontal to one (1) vertical unless otherwise specified. Test pits or other cavities shall be filled with compacted earthfill conforming to the specifications for the earthfill to be placed upon the foundation.

4. PLACEMENT

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

Earthfill shall be placed in approximately horizontal layers. The thickness of each layer before compaction shall not exceed the maximum thickness specified in Section 10 or shown on the drawings. Materials placed by dumping in piles or windrows shall be spread uniformly to not more than the specified thickness before being compacted.

Hand compacted earth backfill shall be placed in layers whose thickness before compaction does not exceed the maximum thickness specified for layers of earth backfill compacted by manually directed power tampers.

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

Earthfill and earth backfill 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 earthfill shall be free from lenses, pockets, streaks or layers of material differing substantially in texture, moisture content, or gradation from the surrounding material. Zone earthfills 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 two (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 (2) percent shall be maintained to ensure effective drainage, and except as otherwise specified for drainfill 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 in the contract.

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 three (3) feet horizontal to one (1) foot vertical. The bonding surface of the embankment in place shall be stripped of all material not meeting the requirements of this specification, and shall be scarified, moistened and re-compacted when the new earthfill is placed against it. This is to insure a good bond with the new earthfill and to obtain the specified moisture content and density at the contact of the in place and new earthfills.

5. CONTROL OF MOISTURE CONTENT

During placement and compaction of earthfill and earth backfill, the moisture content of the materials being placed shall be maintained within the specified range.

The application of water to the earthfill materials shall be accomplished at the borrow areas insofar as practicable. Water may be applied by sprinkling the materials after placement on the earthfill, if necessary. Uniform moisture distribution shall be obtained by disking.

Material that is too wet when deposited on the earthfill shall either be removed or be dried to the specified moisture content prior to compaction.

If the top surface of the preceding layer of compacted earthfill or a foundation or abutment surface in the zone of contact with the earthfill 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 earthfill.

6. COMPACTION

Earthfill. Earthfill shall be compacted according to the following requirements for the class of compaction specified:

Class A Compaction. Each layer of earthfill shall be compacted as necessary to provide the density of the earthfill matrix not less than the minimum density specified in Section 10 or identified on the drawings. The earthfill matrix is defined as the portion of the earthfill material finer than the maximum particle size used in the compaction test method specified.

Class B Compaction. Each layer of earthfill shall be compacted to a mass density not less than the minimum density specified.

Class C Compaction. Each layer of earthfill shall be compacted by the specified number of passes of the type and weight of roller or other equipment specified, or by an approved equivalent method. Each pass shall consist of at least one passage of the roller wheel or drum over the entire surface of the layer.

Earth backfill. Earth backfill adjacent to structures shall be compacted to a density equivalent to that of the surrounding in-place earth materials or adjacent required earthfill or earth backfill. Compaction shall be accomplished by means of hand tamping or manually directed power tampers, plate vibrators, walk-behind, miniature, or self-propelled rollers. Unless otherwise specified, heavy equipment including backhoe mounted powertampers, or vibrating compactors and manually directed vibrating rollers, shall not be operated within two (2) feet of any structure. Towed or self-propelled vibrating rollers shall not be operated within five (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 pre-cast conduits prior to seven (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 two (2) feet, whichever is greater, except as may be specified in Section 10.

Compacting of earth backfill adjacent to structures shall not be started until the concrete has attained the strength specified in Section 10 for this purpose. The strength will be determined by compression testing of test cylinders cast by the Contractor's quality control personnel for this purpose and cured at the work site in the manner specified in ASTM 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 earth backfill adjacent to structures shall not be started until the following time intervals have elapsed after placement of the concrete.

| Structure | Time Interval |
|---|---|
| Vertical or near-vertical walls with earth loading on one side only | 14 days |
| Walls backfilled on both sides simultaneously | 7 days |
| Conduits and spillway risers, cast in-place (with inside forms in place) | 7 days |
| Conduits and spillway risers, cast-in place (inside forms removed) | 14 days |

| Structure | Time Interval |
|---|---|
| Conduits, pre-cast, cradled | 2 days |
| Conduits, pre-cast, bedded | 1 day |
| Cantilever outlet bents (backfilled both sides simultaneously) | 3 days |

7. REWORKING OR REMOVAL AND REPLACEMENT OF DEFECTIVE EARTHFILL

Earthfill 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 earthfill. The replacement earthfill and the foundation, abutment and earthfill surfaces upon which it is placed shall conform to all requirements of this specification for foundation preparation, approval, placement, moisture control and compaction.

8. TESTING

During the course of the work, the Engineer will perform such quality assurance tests as are required to identify materials; determine compaction characteristics; determine moisture content; and determine density of earthfill in-place. Tests performed by the Engineer will be used to verify that the earthfills conform to contract requirements of the specifications and not as a replacement for the Contractor's quality control program.

Densities of earthfill requiring Class A compaction will be determined in accordance with ASTM D 1556, D 2167, D 2922 or D 2937 except that the volume and moist weight of included rock particles larger than those used in the compaction test method specified for the type of fill will be determined and deducted from the volume and moist weight of the total sample prior to computation of density or if using the nuclear gauge, added to the specified density to bring it to the measure of equivalent composition for comparison. The density so computed will be used to determine the percent compaction of the earthfill matrix. Unless otherwise specified, moisture content will be determined by one of the following methods: ASTM D 2216, D 3017, D 4643, D 4944, or D 4959.

9. MEASUREMENT AND PAYMENT

For items of work for which specific unit prices are established in the contract, the volume of each type and compaction class of earthfill and earth backfill within the specified zone boundaries and pay limits will be measured and computed to the nearest cubic yard by the method of average cross-sectional end areas or by methods outlined in Section 10 of this specification. Unless otherwise specified in Section 10, no deduction in volume will be made for embedded items such as, but

not limited to: conduits, inlet structures, outlet structures, embankment drains, sand diaphragm and outlet, and their appurtenances.

The pay limits shall be as defined below, with the further provision that earthfill required to fill voids resulting from over-excavation of the foundation, outside the specified lines and grades, will be included in the measurement for payment only where such over-excavation is directed by the Engineer to remove unsuitable material and where the unsuitable condition is not a result of the Contractor's improper construction operations as determined by the Engineer. Earthfill beyond the specified lines and grades to backfill excavation required for compliance with OSHA requirements will be considered subsidiary to the earthfill bid item(s).

Method 1 The pay limits shall be as designated on the drawings

Method 2 The pay limits shall be the measured surface of the foundation when approved for placement of the earthfill and the specified neat lines of the earthfill surface.

Method 3 The pay limits shall be the measured surface of the foundation when approved for placement of the earthfill and the measured surface of the completed earthfill.

Method 4 The pay limits shall be the specified pay limits for excavation and the specified neat lines of the earthfill surface.

Method 5 The pay limits shall be the specified pay limits for excavation and the measured surface of the completed earthfill.

Method 6 Payment for each type and compaction class of earthfill and earth backfill will be made at the contract unit price for that type and compaction class of earthfill. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work.

Method 7 Payment for each type and compaction class of earthfill and earth backfill will be made at the contract unit price for that type and compaction class of earthfill. Such payment will constitute full compensation for all labor, materials, equipment and all other items necessary and incidental to the performance of the work, except furnishing, transporting, and applying water to the foundation and earthfill materials. Water applied to the foundation and earthfill materials will be measured and payment will be made as specified in Construction Specification 10.

All Methods The following provisions apply to all methods of measurement and payment. Compensation for any item of work described in the contract but not listed in the bid schedule will be included in the payment for the item of work to which it is made subsidiary. Such items and the items to which they are made subsidiary are identified in Section 10 of this specification.