

ITEM 802. STEPS AND RETAINING WALLS

802.1. CONCRETE STEPS

802.1.1. Description. This item shall govern the construction of reinforced concrete steps with or without buttress walls at the location(s) shown on the plans or as directed by the OWNER.

802.1.2. Materials. Material requirements shall be the same as those for Item 303. Portland Cement Concrete Pavement.

802.1.3. Construction Methods.

802.1.3.1. General. Concrete steps shall be constructed at the location(s) shown on the plans or as directed by the OWNER and as detailed on the plans.

802.1.3.2. Finishing. Concrete steps may be finished by the use of mortar topping and shall be troweled and lightly brushed.

802.1.3.3. Curing. Concrete steps shall be cured in accordance with the requirements of Item 305.1. Concrete Curb and Gutter.

802.1.4. Measurement and Payment. Concrete steps shall be measured by the sq.ft. (m²) of tread complete in place. If buttress walls are included, they shall be measured by the sq.ft. (m²) of wall top.

Concrete steps and buttress walls shall be paid for at the contract unit price bid, which price shall be full compensation for all excavation sand cushion; furnishing and placing all materials, including reinforcement and expansion joint material; and for all labor, tools, equipment and incidentals necessary to complete the work.

802.2. CONCRETE RETAINING WALLS

802.2.1. Description. This item shall govern the construction of concrete retaining walls of the size and shape detailed on the plans and at the location(s) shown on the plans. The requirements of Item 701.2. Structural Excavation, shall apply to the construction of retaining walls.

802.2.2. Materials.

802.2.2.1. Concrete. Concrete shall be of the grade specified on the plans and shall conform to the requirements of Item 702. Concrete Structures.

802.2.2. Reinforcing Steel. Reinforcing steel shall be of the size and type shown on the plans.

802.2.3. Construction Methods. Concrete retaining walls shall be constructed in accordance with the details shown on the plans and in conformance with the requirements of Item 701.2. Structural Excavation, and Item 702. Concrete Structures.

802.2.4. Measurement and Payment. Concrete used in the construction of retaining walls shall be measured by the cubic yard (m³). Calculations shall be based upon plan dimensions and quantities.

Structural excavation shall be measured in accordance with Item 701.2. Structural Excavation.

Reinforcing steel shall be measured by unit weight or as specified on the plans.

Payment for all work prescribed under this item shall be made at the unit prices bid for the various items delineated in this item above. This price shall be full compensation for all labor, tools, equipment, materials and incidentals necessary to complete the work.

When pay items are not provided for structural excavation and/or reinforcing steel, these items shall be subsidiary to the pay item for concrete for retaining walls.

802.3. SEGMENTAL RETAINING WALL SYSTEMS

802.3.1. Description. This item shall govern furnishing and installing segmental retaining wall (SRW) units to the lines and grades designated on the construction drawings or as directed by the Engineer. Site preparation, furnishing appurtenant materials, and installing appurtenant materials required for construction of the retaining wall as shown on construction plans and drawings are also included.

802.3.2. General. Segmental retaining wall systems are to be engineered on a site-specific basis only. The Engineer shall specify the special material and construction requirements for each location. Should the soil conditions encountered during construction differ from those used for the design, the Engineer shall review the design.

Work found to be deficient according to these specifications or the construction drawings must be corrected at the CONTRACTOR'S expense.

802.3.3. Materials.

802.3.3.1. General. The CONTRACTOR shall submit manufacturers' certifications two weeks prior to start of work stating that the SRW units and geotextile reinforcement meet specified requirements. The CONTRACTOR shall furnish one (1) unit in the color and face pattern specified by the OWNER for approval. The approved unit

shall be one of three (3) replacement units that the CONTRACTOR shall furnish the OWNER. The CONTRACTOR shall also furnish a square 12-inches-per-side (30-cm-per-side) or larger piece of the geotextile reinforcement specified if requested by the OWNER.

802.3.3.2. Delivery, Storage and Handling. The CONTRACTOR shall check materials upon delivery to assure that specified type and grade of materials have been received and proper color and texture of SRW units have been received.

SRW units shall be sound and free of cracks or other defects that would interfere with the proper placing of the unit or significantly impair the strength or permanence of the structure. Units showing cracks longer than ½-inch (13mm) shall not be used within the wall.

Retaining wall units shall be stored above ground on wood pallets or blocking, shall protect materials from damage, and shall prevent excessive mud, wet cement, epoxies, and like materials which may affix themselves from coming in contact with retaining wall materials.

802.3.3.3. SRW Systems.

802.3.3.3.1. Unit Production. Color, texture, finish, face pattern geometry, type (solid or hollow), strength and structural requirements, maximum moisture absorption, size and weight dimensions and ratios of SRW units shall be specified per project and indicated on the plans. If units are not solid, fill which is contained within the dimensions of the units shall be included as effective weight. SRW units shall include an integral concrete shear connection flange/locator or pins, clips or some other device to provide proper setback and shear resistance.

Segmental retaining wall units shall be machine formed, Portland cement concrete blocks specifically designed for retaining wall applications and shall conform to applicable standards in Table 802.3.3.3.1.(a) Segmental Retaining Wall Unit Standards. Where values specified on the plans disagree with referenced standards, the plans shall take priority. All vertical surfaces that will be exposed after completion of wall shall have a split face, textured surface.

Table 802.3.3.3.1.(a) Segmental Retaining Wall Units

Standard Designation	Topic
ASTM C90 Standard Specification for Load bearing Concrete Masonry Units	Hollow Load Bearing Masonry Units
ASTM C1262 Test Method for Evaluating the Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units	Freeze-Thaw Durability of Manufactured Concrete Masonry Units and Related Concrete Units
ASTM C1372 Standard Specification for Segmental Retaining Wall Units	Segmental Retaining Wall Units

802.3.3.3.2. SRW System Testing. Segmental retaining wall system testing shall conform to standards listed in Table 802.3.3.3.2.(a) Segmental Retaining Wall Unit Tests. Compressive strength test specimens shall conform to the saw-cut coupon provisions of Section 5.2.4 of ASTM C140 Test Methods for Sampling and Testing Concrete Masonry Units and Related Units, with the following exception: Coupon shall be taken from the least dimension of the unit of a size and shape representing the geometry of the unit as a whole.

Table 802.3.3.3.2.(a) Segmental Retaining Wall System

Test Designation	Topic
National Concrete Masonry Association SRWU-1	Test Method for Determining Connection Strength of Segmental Retaining Wall
National Concrete Masonry Association SRWU-2	Test Method for Determining Shear Strength of Segmental Retaining Wall
ASTM C140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units	Sampling and Testing Concrete Masonry Units

802.3.3.3.3. Backfill Soils. The backfill soils shall be tested in accordance with the standards listed in Table 802.3.3.3.3.(a) SRW Backfill Soil Tests.

Table 802.3.3.3.3.(a) SRW Backfill Soil Tests

Test Designation	Title
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM 4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

Backfill soil shall be free of debris. Native materials may be used provided they meet design criteria unless otherwise specified. The backfill material shall consist of the inorganic USCS soil types GP, GW, SW, SP, SM meeting the gradation described in Table 802.3.3.3.3.(b) SRW Backfill Soil Gradation, as determined in accordance with ASTM D422. The maximum particle size of poorly graded gravels (GP) (no fines) should not exceed ¾-inch (1.9-cm) unless field tests have been performed to evaluate potential strength reductions to the geotextile due to damage from larger sized aggregate. The plasticity of the fine fraction shall be less than 20.

Table 802.3.3.3.3.(b) SRW Backfill Soil Gradation

Sieve Size	Percent Passing
2-inch	100
¾-inch	100-75
No. 40	0-50
No. 200	0-35

802.3.3.3.4. Drainage aggregate. Aggregate shall be angular, clean stone or granular fill meeting the gradation in described in Table 802.3.3.3.4.(a) SRW Drainage Aggregate Gradation as determined in accordance with ASTM D422.

Table 802.3.3.3.4.(a) SRW Drainage Aggregate Gradation

Sieve Size	Percent Passing
1-inch	100
¾-inch	75-100
No. 4	0-60
No. 40	0-50
No. 200	0-5

802.3.3.3.5. Drainage Pipe. Pipe shall be a perforated or slotted PVC, or corrugated HDPE pipe, and shall meet relevant requirements under Item 501. Underground Conduit Materials.

802.3.3.3.6. Leveling Pad/Base. Material for leveling pad (base) shall be as shown on the construction drawings. Material may consist of compacted sand, gravel, crushed stone or combination thereof. Lean, unreinforced concrete with a strength of 200-psi to 300-psi (1379-kPa to 2068-kPa) may also be used as a leveling pad material. A reinforced footing may also be required.

802.3.3.3.7. Geotextiles. Geotextile reinforcement used in segmental retaining wall systems may consist of polyester fiber geogrid or geotextile, polyethylene expanded sheet geogrid, polypropylene woven geotextile or other appropriate geotextiles manufactured for use as soil reinforcement. Geotextile manufacture shall conform to applicable standards. The geotextile manufacturer shall have a manufacturing quality control program that includes independent laboratory testing of Tensile Strength, Melt Flow Index (HDPE), and Molecular Weight (Polyester). Geotextile testing shall conform to standards Table 802.3.3.3.7.(a) SRW Geotextile Tests.

Geotextiles used for segmental retaining walls shall resist peeling, cracking, and stripping, and shall be treated as necessary to meet this requirement.

Table 802.3.3.3.7.(a) SRW Geotextile Tests

Test Designation	Title/Topic
ASTM D4595	Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method
ASTM D5262	Test Method for Evaluating the Unconfined Tension Creep Behavior of Geosynthetics
Geosynthetic Research Institute GRI-GG4	Determination of Long Term Design Strength of Geogrids
Geosynthetic Research Institute GRI-GG5	Determination of Geogrid Pullout
National Concrete Masonry Association SRWU-1	Test Method for Determining Connection Strength of SRW

802.3.4. Construction Methods. Construction methods for each type unit shall be provided by the manufacturer and approved by the Engineer based on the site-specific use.

802.3.4.1. Inspections. The CONTRACTOR shall examine the areas and conditions under which the retaining wall is to be erected and notify the OWNER in writing of conditions detrimental to the proper and timely completion of the work. Work shall not proceed until unsatisfactory conditions have been corrected. The CONTRACTOR shall promptly notify the Engineer of any site conditions that may affect wall performance or may require a reevaluation of the wall design.

CONTRACTOR'S field construction supervisor shall have demonstrated experience and be qualified to direct all work at the site.

802.3.4.2. Excavation. Excavation shall be carried out to the lines and grades as shown on the plans and in accordance with methods in Item 701.2. Structural Excavation.

802.3.4.3. Foundation Soil and Base Preparation.

802.3.4.3.1. Foundation Soil. Following the excavation, the foundation soil shall be examined by the Engineer to assure actual foundation soil strength meets or exceeds the assumed design bearing strength. Soils not meeting the required strength shall be removed and replaced with backfill soils, as directed by the Engineer. Foundation soil shall have adequate moisture content, be proofrolled, and compacted to 95% standard Proctor density, or density specified on the plans, and inspected by the Engineer prior to placement of leveling pad materials. Standard Proctor density shall be determined per ASTM D698.

802.3.4.3.2. Leveling Pad/ Base. Base materials shall be installed upon undisturbed soils or prepared foundation soils. The leveling pad (base) shall be placed as shown on the construction drawings with a minimum thickness of 6-inches (150mm) when composed of aggregate and a minimum of 1-inch (25mm) and maximum of 3-inches (76mm) when composed of concrete. The leveling pad shall extend laterally at least a distance of 6-inches (150mm) from the toe and heel of the lower most SRW Unit. Soil leveling pad material shall be compacted to provide a firm, level-bearing surface on which to place the first course of units. Base materials shall be prepared to ensure complete contact of retaining wall unit. When approved by the OWNER, well-graded sand may be allowed to smooth the top, but shall not exceed ½-inch (13mm) of leveling sand.

802.3.4.4. Segmental Retaining Wall Unit Installation. All SRW units shall be installed at the proper elevation and orientation as shown on the wall profiles and details on the construction plans or as directed by the Engineer. The SRW units shall be installed in general accordance with the manufacturer's recommendations, including the sequence of SRW unit, drainage material and backfill courses. Typically, the maximum stacked vertical height of wall units, prior to unit drainage fill and backfill placement and compaction, shall not exceed two courses. The specifications and drawings shall govern in any conflict between the two requirements.

Lay out of curves and corners shall be installed in accordance with the plan details or in general accordance with SRW manufacturer's installation guidelines. Walls meeting at a corner shall be interlocked and continuous.

First course of SRW units shall be leveled side-to-side, front-to-rear and with adjacent units, and aligned to ensure intimate contact with the leveling pad. Excess debris shall be cleaned from the top of units before installation of the next course.

Damaged units shall be replaced with new units during construction.

SRW units shall have positive horizontal interlock. Shear/connecting devices shall be installed according to manufacturer's recommendations.

802.3.4.5. Drainage Materials Placement. Drainage aggregate shall be installed to the line, grades, and sections shown on the final plans. All voids between and within concrete wall units shall be filled with drainage aggregate. Drainage fill shall be placed to the thickness shown on the construction plans behind units, minimum 12-inches (30cm).

Drainage collection pipes shall be installed to maintain gravity flow of water outside the reinforced soil zone. The drainage collection pipe shall daylight into a storm water conduit manhole or other location along a continuous slope at an elevation lower than the lowest point of the pipe within the aggregate drain, as approved by the Engineer.

802.3.4.6. Geotextile Reinforcement Placement. The type and strength of the reinforcing geotextile shall be as shown on the construction plans. All geotextile reinforcement shall be installed in accordance with manufacturer's recommendations at the proper elevation and orientation as shown on the wall profiles and details on the construction plans or as directed by the Engineer.

At the elevations shown on the final plans, the geotextile reinforcement shall be laid horizontally on compacted backfill and on top of the concrete SRW units. Embedment of the geotextile in the SRW units shall be consistent with SRW manufacturer's recommendations. Correct orientation of the geotextile reinforcement shall be verified by the CONTRACTOR to be in accordance with the geotextile manufacturer's recommendations. The highest strength direction of the geotextile must be perpendicular to the wall face.

Geotextile reinforcement layers shall be one continuous piece for the entire embedment length. Overlap of the geotextile in the design strength direction (perpendicular to the wall face) shall not be permitted.

Tracked construction equipment shall not be operated directly on the geotextile reinforcement. A minimum of 6-inches (15cm) of backfill is required prior to operation of tracked vehicles over the geotextile.

802.3.4.7. Backfill Placement. The reinforced backfill shall be placed as shown in the construction plans in the maximum compacted lift thickness of 10-inches (25cm), or 6-inches (15cm) where hand compacted, and shall be compacted at a moisture content within 2% of optimum to 95% standard Proctor density, or density specified on the plans. Standard Proctor density shall be determined per ASTM D698. The backfill shall be placed and spread in such a manner as to eliminate wrinkles, movement or damage of the geotextile reinforcement and the SRW units.

Only hand-operated compaction equipment shall be allowed within 3-feet (0.9m) of the back of the SRW unit.

At the end of each day's operation, the CONTRACTOR shall slope the last level of backfill away from the wall units to direct water runoff away from the wall face. The CONTRACTOR shall not allow surface runoff from adjacent areas to enter the wall construction site.

At completion of wall construction, final backfill shall be placed to the lines and grades indicated on the plans.

802.3.4.8. SRW Cap Unit Installation. When SRW caps are specified, they shall be properly aligned and glued to underlying units with a suitable, flexible, high-strength all-weather adhesive recommended by the manufacturer. Rigid adhesive or mortar is not acceptable. Cap units may be cut to obtain the proper fit.

802.3.4.9. Completion. The retaining wall will not be considered complete until accepted by the OWNER.

If final grading, paving, landscaping, and/or storm drainage installation adjacent to the wall is not placed immediately after wall completion, the CONTRACTOR shall provide temporary surface drainage to ensure water runoff is not directed at the wall nor allowed to collect or pond behind the wall until final grading and surface drainage construction adjacent to the wall is completed.

CONTRACTOR shall remove debris caused by SRW construction and leave adjacent paved areas broom clean.

802.3.5. Measurement and Payment. Measurement of segmental retaining wall shall be on an installed square foot basis computed on the total face area of wall installed. Wall height is taken from the top of the leveling pad to the top of the wall.

Payment for the wall will be made on an installed square foot basis at the contract unit price. Payment shall include all labor, preparation, equipment, materials, tools, testing, and incidentals necessary to complete the work.

802.4. COFFERDAMS

802.4.1. Description. Cofferdam is a temporary watertight chamber used for construction underwater.

802.4.2. General. Cofferdams for foundation construction shall be carried well below the bottom of the footings and shall be well braced and reasonably watertight. The interior dimensions of cofferdams shall provide sufficient clearance inside the walls for constructing forms and driving piles and to permit pumping outside the forms.

If, in the judgment of the CONTRACTOR, the clearance provided on the plans between the outside line of the footing and any pipe or interior wall or surface is not sufficient to permit the driving of piles or building of forms, it may provide such necessary clearance, structuring the cofferdam sufficiently large to provide such clearance as it may deem necessary. Any such enlargement in excess of 1-ft (30-cm) outside the dimensions of the footing as shown on the plans shall be considered as being for the sole purpose of expediting the work of the CONTRACTOR, and such excavation and backfill shall be at the CONTRACTOR'S expense.

Cofferdams which are tilted or moved out of position by any cause during the process of sinking shall be plumbed or enlarged so as to provide the necessary clearance and proper pier location, and such work shall be at the CONTRACTOR'S expense.

In streams or tidal waters at a time of probable flood, cofferdam walls shall be vented at low water elevation to insure equal hydrostatic head both inside and outside of the cofferdam during the period of pouring and settings of seals.

No shoring shall be permitted in cofferdams which shall induce stress, shock or vibration in the permanent structure.

When permitted by the OWNER, cross struts or bracing may extend through foundation concrete. Struts or bracing shall be removed and the resulting space filled with concrete of the same mix as that specified for the surrounding concrete.

For substructure work, the CONTRACTOR shall submit drawings showing its proposed method of cofferdam construction and other details left open to its choice or not fully shown on the plans. The type and clearance of cofferdams, insofar as such details affect the character of the finished work, shall be subject to the approval of the OWNER, but other details of design shall be left to the CONTRACTOR who shall be responsible for the successful construction of the work. The drawings shall be submitted at least 30-days in advance of the time the CONTRACTOR begins construction of the cofferdams.

After completion of the substructure, the cofferdams with all sheeting and bracing shall be removed at least 2-ft. (60cm) below the level of the streambed by the CONTRACTOR at its expense, and such removal shall be performed in a manner that shall not disturb or mar the finished concrete or masonry.

802.4.3. Construction Methods.

802.4.3.1. Excavation. Excavation shall include the following:

- (1) When concrete or masonry footings are to rest upon rock, the rock shall be removed to a depth sufficient to expose sound rock. The rock shall be roughly leveled off or cut to approximate horizontal and vertical steps, and shall be roughened. Seams in the rock shall be grouted under pressure or treated as the OWNER may direct. The cost thereof shall be included for payment in the quantities for the unit of the structure for which the excavation is made. When concrete or masonry footings are to rest on an excavated surface other than rock, care shall be taken not to disturb the bottom of the excavation, and the final removal of the foundation material to grade shall not be made until just before the concrete or masonry is placed.
- (2) Excavated material required to be used for backfill may be deposited by the CONTRACTOR in storage piles at points convenient for the rehandling of the material during the backfill operations. The location of storage piles shall, however, be subject to the approval of the OWNER, who may require that the survey centerline of the structure and the transverse or hub line of any unit of the structure be kept free of any obstruction.
- (3) Excavated material required to be wasted shall be disposed of as directed by the OWNER, and the disposal shall be in such manner as not to obstruct the stream or otherwise impair the efficiency or appearance of the structure or other part of the work.
- (4) Trench safety provisions of Item 107.19. Protection of Work and of Persons and Property shall be followed.
- (5) For all single and multiple box culverts, pipe culverts and pipe arch culverts, where the soil encountered at established footing grade is a quicksand, muck or similar unstable material, the following procedure shall be used unless other methods are called for on the plans: All unstable soil shall be removed below the bottom of the culvert. Such excavation shall be carried at least 1-ft. (30cm) beyond the horizontal limits of the surface on all sides. All unstable soil so removed shall be replaced with suitable stable material, placed in uniform layers of suitable depth for compaction as directed by the OWNER. Each layer shall be wetted, if necessary, and compacted by rolling or tamping as required to provide a stable foundation for the structure.
- (6) When the material encountered at footing grade of a culvert is found to be partially rock or incompressible materials and partially a soil or material that is compressible but otherwise satisfactory for the foundation,

the incompressible material shall be removed for a depth of 6-in. (15cm) below the footing grade and backfilled with a material similar to the compressible foundation used for the rest of the structure.

- (7) When the material encountered at footing grade of a bridge bent or pier is found to be partially of rock or incompressible material, and partially of a compressible material, the foundation shall not be placed until the OWNER has inspected the footing and authorized such changes found necessary to provide an adequate foundation.

802.4.3.2. Backfill. No backfill shall be permitted to be placed except in the presence of the OWNER. Structural backfill shall not be placed until the structure footings or other portions of the structure or facility have been inspected by the OWNER and approved for backfilling. As soon as practicable, all spaces excavated under this item and not occupied by the permanent structure shall be backfilled, except that no backfill shall be placed against any abutment or retaining wall until such structure has been in place at least 7-days. No backfill shall be placed adjacent to box culverts until the top slab has been in place at least 4-days. When called for on the plans, special backfill material, such as pit run gravel, shall be placed at the locations and in the manner called for on the plans. All other backfill material shall be earth, free of any appreciable amount of stone or gravel particles more than 4-in. (10cm) in the greatest dimension, large or frozen lumps, wood or other extraneous material, and shall be of such gradation as to permit thorough compaction as required by the OWNER. Class C or Class PC concrete as specified by the OWNER will be used in inaccessible locations when a mechanical device cannot compact to required densities and as directed by the OWNER, i.e., under pipes, roads, washouts, paving, etc. Compaction testing will be performed by the OWNER or its approved testing laboratory. If the compacted material does not meet the specified compaction, the CONTRACTOR will be required to rework the material and pay the cost of retesting.

802.4.4. Measurement and Payment. Measurement for payment when payment is provided in the special provisions shall be for material excavated within the limits shown on the plans or as directed by the OWNER. Unless otherwise provided in the special provisions or proposals, no payment shall be made for structural excavation or backfill as such, the cost thereof under normal circumstances being considered as included in the price bid for the construction or installation of the item to which such excavation or backfill pertain. Payment shall be made only when provided for in the special provisions or proposal. When provided for, payment for work performed under this specification shall be made at the unit price bid per cubic yard (m^3) for unclassified structural excavation, which price shall be full compensation for all excavation and backfill and for all materials, labor, tools and incidentals necessary to complete the work.