732-R-310 MODULAR CONCRETE BLOCK RETAINING WALL

(Revised 02-21-13)

The Standard Specifications are revised as follows:

SECTION 732, BEGIN LINE 1, DELETE AND INSERT AS FOLLOWS:

SECTION 732 – ~~BLANK~~MODULAR CONCRETE BLOCK RETAINING WALL

732.01 Description

This work shall consist of design as required, furnishing materials, and placement of modular block wall units in accordance with 105.03. The modular block wall unit shall have ground reinforcement if shown on the plans or required by the manufacturer.

732.02 General Design Requirements

The modular block wall shall consist of an aggregate leveling pad, concrete modular block wall units, and if specified, ground reinforcement elements. Ground reinforcement shall have sufficient strength, frictional resistance, and quantity as required by design, and shall be mechanically connected to the facing units.

Modular block wall units shall be constructed as shown on the approved working drawings based on the requirements herein. The recommendations of the wall system supplier shall not override the minimum performance requirements shown herein.

The top of the modular block wall shall be designed to prevent the removal of the top course of blocks.

If the wall system provider needs additional information to complete the design, the Contractor shall be responsible for obtaining such information.

All appurtenances behind, in front of, under, mounted upon, or passing through the wall such as drainage structures, utilities, or other appurtenances shown on the plans shall be accounted for in the stability design of the wall.

The modular block wall design shall follow the general dimensions of the wall envelope shown on the plans. The working drawings shall show the location of the leveling pad at or below the theoretical leveling pad elevation shown on the plans. The top of the modular block wall unit shall be at or above the top of the wall elevation shown on the plans.

Cast-in-place concrete will not be an acceptable replacement for modular block wall unit areas indicated by the wall envelope.

Modular block wall units shall be designed to accommodate a differential settlement of 1 linear unit in 100. Where shown on the plans, slip joints to accommodate excessive or differential settlement shall be included.

Only one typical modular block face finish shall be used per contract.

732.03 Design Criteria

The maximum modular block wall unit face area shall be 1 sq ft. The minimum depth of modular block wall units shall be 9 in.

Modular block wall units shall be dry stacked in a running bond configuration. Vertically adjacent units shall be connected with an approved shear connection. Approved shear connections consist of steel pins, concrete lips on the blocks, or other connections as approved by the Engineer.

The internal stability shall be the responsibility of the Contractor. The design for internal stability shall be in accordance with the AASHTO LRFD Bridge Design Specifications. The design by the Engineer will consider the external stability of the modular block wall mass including the applied bearing pressure, overturning, sliding, and stability of temporary construction slopes.

(a) Geotechnical Considerations

The theoretical failure plane within the soil mass shall be analyzed so that the soil-stabilizing component extends sufficiently beyond the failure plane to stabilize the material. External loads which affect the internal stability such as those applied through piling, bridge footings, traffic, crashwall, or slope surcharge, shall be accounted for in the design. The sizes of all structural elements shall be determined such that the design load stresses do not exceed the factored stresses shown in the AASHTO LRFD Bridge Design Specifications.

The internal friction angle, φ, for the internal design of the modular block wall backfill volume shall be assumed to be 34°. The φ of the backfill behind the modular block wall backfill volume shall be assumed to be 30°. The φ for the internal design of the foundation soils shall be assumed to be 30°. For the external design parameters, such as but not limited to, bearing capacity, sliding, overturning, eccentricity, and global stability, the actual soil strength parameters used shall be obtained from the geotechnical report.

The factored applied bearing pressures under the stabilized mass for each reinforcement unit's length shall be indicated on the working drawings. It shall not exceed the maximum factored soil bearing resistance shown on the plans. Passive pressure in front of the wall mass shall be assumed to be zero for design purposes.

(b) Height of Wall for Internal Stability

The wall limits shall be defined by the wall envelope shown on the plans.

1. *For a wall with a level surcharge, the design height of the wall, H, shall be measured from the theoretical top of the leveling pad to the top of the coping or to the gutter line of the traffic barrier. The top of the wall shall be the theoretical top of the face panels only where a coping or barrier is not used.*

2. *For a wall with a sloping surcharge, the design height of the wall, Z, shall be measured from the theoretical top of the leveling pad to a point above the top of the wall as calculated from the formula as follows:*

$$Z = H + \frac{0.3H\tan\beta}{1-0.3\tan\beta}$$

where:

β = *surcharge slope angle as measured from the top of the coping, and*

H = *height of the wall from the theoretical top of the leveling pad to the top of the coping.*

3. *For an abutment face, the design height of the wall, H, shall be measured from the theoretical top of the leveling pad to the top of the roadway surface.*

(c) Ground Reinforcement

The ground reinforcement length shall be the controlling length resulting from the internal or external design or as shown on the plans. All of the ground reinforcement shall extend to and shall be connected to the modular block wall units.

The ground reinforcement shall be the same length from the bottom to the top of each wall section regardless of the type of ground reinforcement used. Differing ground reinforcement elements shall be marked for ease of construction. This element may be used individually or in a prefabricated grouping.

The ground reinforcement for modular block wall sections shall be sized using the lesser of the factored loads for each specific connection and each specific reinforcing element. The connection's applied factored load and effective pullout length shall be determined in accordance with the AASHTO LRFD Bridge Design Specifications.

For mats, grids, or strip steel, the minimum zinc coating thickness shall be 2 oz/sq ft. Such thickness shall be assumed to be 4 mils for purpose of calculation of reduced structural section.

Where the presence of opposing walls limits the length of ground reinforcing, the design shall account for the reduced length and internal and external stability calculations shall be made to check for adequate factor of safety.

732.04 Submittals

The Contractor shall submit working drawings and design calculations in accordance with 105.02. Wall construction operations shall not begin until the Contractor receives written notice that the working drawings are approved.

(a) *The working drawings shall include all details, dimensions, quantities, cross-sections, and general notes necessary to construct the wall and shall include, but shall not be limited to the following:*

1. *Plan and elevation sheets showing views which detail the placing position and connection of all ground reinforcing elements in areas where piling, utility, or other structures are near the wall.*

2. *Plan sheets of the wall that indicate the offsets from the construction centerline to the face of the wall at all changes in horizontal alignment.*

3. *Elevation views of the wall which shall include the following:*

   a. elevations at the top of the wall at all horizontal and vertical break points at least every 50 ft along the face of the wall,

   b. all steps in the aggregate leveling pad,

   c. the designation as to the type of modular block wall unit,

   d. the length of ground reinforcement units,

   e. the distance along the face of the wall to where changes in length of the ground reinforcement occur,

   f. an indication of the original and final ground lines and maximum bearing pressures.

(b) All modular block wall units shall show all dimensions necessary to construct the element and the location of soil reinforcing system devices embedded in the units.

(c) The details for construction of walls around drainage facilities and the outletting of internal drainage from the modular block wall volume.

(d) All details of the architectural treatment.

(e) The details for diverting ground reinforcement around obstructions such as piles, catch basins, landscape plantings where the bottom of the root ball extends below the top level of ground reinforcement, and other obstructions.

(f) The details for mechanical connection between the modular block wall unit and the ground reinforcement.

MATERIALS

732.05 Materials

Materials shall be in accordance with the following:

Admixtures for Concrete 912.03*

Air Cooled Blast Furnace Slag 901.09
B Borrow 211.02
Coarse Aggregate, Class A or Higher, Size No. 91 904
Coarse Aggregate, Class D or Higher, Size No. 8.....904
Concrete 702
Fine Aggregate, Size No. 23.....904
Fly Ash 901.02
Geogrid, Type III.....918.05
Geotextile 918.03
Portland Cement .....901.01(b)
Structure Backfill 211.03.1
Water 913.01

* *Admixtures in accordance with ASTM C 1372 may be used for the modular block if approved by the Engineer.*

Aggregate for the leveling pad shall be compacted aggregate No. 53 and shall be in accordance with applicable requirements of 303. Drainage fill used immediately behind the modular block wall, as shown on the plans, shall be coarse aggregate No. 8 crushed stone or ACBF in accordance with 904.03.

Backfill material used in the modular block wall volume shall be structure backfill, type 3, in accordance with 211. Where ground reinforcement is required, nominal size aggregate No. 30 shall not be used. The size of the structure backfill selected for use in the reinforced area of the modular block volume shall remain the same for that wall's volume. If ACBF or coarse aggregate No. 8 are used, and soil, B borrow, structural backfill, or coarse aggregate No. 53 are to be placed above the ACBF or coarse aggregate No. 8, a single layer of geotextile shall be placed on top of the ACBF or coarse aggregate No. 8 in accordance with 616.11. A type C certification in accordance with 916 for the geotextile materials shall be furnished to the Engineer prior to use.

If ground reinforcement is required, it shall be either steel in accordance with 910.07 or geogrid. The ground reinforcement supplied shall be the same type as that used with the pullout test and shall be consistent throughout the contract work. If the ground reinforcement is steel, structure backfill shall be in accordance with the backfill requirements for retaining wall systems contained in 211.03.1.

(a) Concrete Modular Block Wall Units

Concrete modular block retaining wall units shall be in accordance with ASTM C 1372, except for the modifications below, and shall have a minimum compressive strength of 4,000 psi at 28 days. Modular block wall units utilizing type I or II cement will be considered acceptable for placement in the wall when 7-day strengths exceed 3,500 psi. The modular block wall unit's compressive strength shall be considered acceptable regardless of curing age when compressive test results indicate that the compressive strength is in accordance with the requirements stated above.

Retarding agents, accelerating agents, coloring pigments, or additives containing chloride shall not be used without approval.

1. Testing and Inspection

a. *Material properties shall be in accordance with the requirements of 732.05 in lieu of Section 4.*

b. *Table 1, "Strength and Absorption Requirements", shall be modified to require that the average compressive strength, when sampled and tested in accordance with ASTM C 140, of a three CMU compressive strength sample shall be 4,000 psi with no individual unit less than 3,500 psi. Maximum absorption shall be 6%.*

c. *Freeze-thaw durability testing shall be completed in accordance with Section 8.3 by a laboratory approved by the Department. Test results on all mix designs used in the manufacture of modular blocks shall have been completed in accordance with ASTM C 1372. If a change to the mix design, such as proportioning or material source, is desired, the modified mix design shall be retested for freeze-thaw. A type A certification in accordance with 916 for the freeze-thaw durability testing shall be submitted to the Engineer prior to use of the blocks.*

d. *Sampling and testing of the manufacturer's production lots will be conducted by the Engineer in accordance with ASTM C 140. If the compressive strength test result does not meet the requirements of 732.05(a), the production lot units may not be used. The manufacturer may resample the same production lot in the presence of the Engineer for retesting. The Engineer will test the additional samples in accordance with ASTM C 140. If the retested samples meet the requirements of 732.05(a), the production lot may be used. If the retested samples do not meet the requirements of 732.05(a), all the units from the production lot may not be used.*

2. Rejection

Units shall be subject to rejection due to failure to be in accordance with the requirements specified above. In addition, the following defects may be sufficient cause for rejection.

a. *Defects which indicate imperfect molding.*

b. *Defects which indicate honeycombed or open texture concrete.*

c. *Defects in the physical characteristics of the concrete, such as broken or chipped concrete, or color variations, or dunnage marks on the front face due to excessive form oil or other reasons.*

The Engineer will determine whether spalled, honeycombed, chipped, or otherwise defective concrete shall be repaired or be cause for rejection. Repair of concrete, if permitted, shall be completed in a satisfactory manner. Repair to concrete

surfaces, which are to be exposed to view after completion of construction shall be subject to approval.

3. Marking

The date of manufacture, the production lot number, and the place mark shall be clearly scribed on the rear face of each unit or on each shipping pallet.

4. Handling, Storage, and Shipping

All modular block wall units shall be handled, stored, and shipped so as to eliminate the danger of chipping, cracks, fractures, and excessive bending stresses.

(b) Blank

CONSTRUCTION REQUIREMENTS

732.06 General Requirements

The wall supplier representative shall provide technical instruction, guidance in preconstruction activities including the preconstruction conference, and on-site technical assistance to the Contractor during construction.

732.07 Foundation Preparation

The foundation for the modular block wall shall be graded level for the width shown on the plans. Foundation preparation shall otherwise be in accordance with 731.07.

At each foundation level, an aggregate leveling pad shall be provided as shown on the plans.

732.08 Retaining Wall Excavation

Excavation shall be in accordance with 731.08.

732.09 Wall Erection

Modular block wall units shall be stored to minimize contact with the ground or being covered by standing water. Modular block wall units having face discoloration shall not be used.

The Contractor shall perform the necessary work to verify that the foundation is at the correct elevation, that the wall is constructed to the correct alignment, and that the work is in accordance with the specified tolerances.

Modular block wall units shall be placed in successive horizontal lifts in the sequence shown on the plans as backfill placement proceeds. As backfill material is placed behind the units, the units shall be maintained in vertical position. Horizontal alignment tolerances shall not exceed 3/4 in. when measured with a 10 ft straightedge. Alignment shall be checked at each layer of modular block wall units after the backfill behind the modular block wall units has been compacted, and the results shall be recorded. Checking of alignments and tolerances shall include verifying that the modular block wall units are plumb over the entire height of the wall.

Ground reinforcement shall be placed normal to the face of the wall, unless otherwise shown on the plans and shall be constructed in accordance with 214.04.

732.10 Backfill Placement

Backfill placement shall follow erection of each course of modular block wall units. All sheeting and bracing shall be removed as the backfilling progresses. Backfill shall be placed so as to avoid damage or disturbance to the wall materials or misalignment of the modular block wall units. All material for backfill shall be subject to approval and shall be free from large or frozen lumps, wood, or other undesirable material. Wall materials that become damaged or disturbed during backfill placement shall be removed and replaced or corrected as directed. All misalignment or distortion of the modular block wall units due to placement of backfill outside the limits described herein shall be corrected as directed.

The work shall also include backfilling beyond the theoretical length of the ground reinforcement in accordance with the details shown on the plans and the disposal of surplus of unsuitable excavated materials as permitted.

Backfill placement and compaction shall otherwise be in accordance with 731.11.

732.11 Method of Measurement

The measurement of concrete modular block wall units with or without ground reinforcement and wall erection will be based on the square foot area contained within the neat line limits of the wall envelope shown on the plans and not that of the wall system supplier.

Common excavation will be measured by the cubic yard in accordance with 203.27(a) to the neat lines shown on the plans. Structure backfill and B borrow will be measured in accordance with 211.09. Unsuitable foundation materials, if found, will be measured in accordance with 211.09. Coarse aggregate No. 8 used as drainage fill will be measured by the cubic yard based on the theoretical volume to the neat lines as shown on the plans. Compacted aggregate No. 53, and ground reinforcement will not be measured. Geotextile materials will not be measured. Drainage of the backfill including piping and geotextile materials used in the drainage system will not be measured.

732.12 Stockpiled Modular Block Units

Partial payment may be made for block wall units stockpiled on the project site or at the Contractor's approved storage location. Partial payment will include the delivered cost of the units, as verified by invoices that include freight charges. The Contractor shall furnish the invoices. The partial payment will not exceed 75% of the contract unit price for modular block wall with or without ground reinforcement. Prior to authorizing partial payment, the Engineer will verify that the units are in accordance with 732.05(a).

732.13 Basis of Payment

The accepted quantities of modular block wall units with or without ground reinforcement will be paid for at the contract unit price per square foot. Erection of modular block wall units will be paid for by the square foot. Common excavation will be

paid for in accordance with 203.28. Structure backfill and B borrow will be paid for in accordance with 211.10. Unsuitable foundation materials will be paid for in accordance with 211.10. The accepted quantities of coarse aggregate No. 8 used as drainage fill will be paid for as aggregate for drainage fill at the contract unit price per cubic yard, complete in place.

Payment will be made under:

Pay Item	***Pay Unit Symbol***
Aggregate for Drainage Fill	*CYS*
Modular Block Wall Erection	*SFT*
Modular Block Wall with Ground Reinforcement	*SFT*
Modular Block Wall	*SFT*

The cost of designing the wall system, services including the testing laboratory, certified testing personnel, and the testing and inspection of modular block wall units shall be included in the cost of the pay items of this section.

The cost of materials, ground reinforcement if required, fasteners, cutting or altering the ground reinforcement at the site, repair or replacement of units damaged or removed due to backfill placement, compressive-strength retesting if required, retesting or replacing failed block units, and incidentals shall be included in the cost of the pay items of this section.

The cost of all labor and materials required for preparing the wall foundation, compacted aggregate No. 53, coarse aggregate No. 8 placed outside the neat lines as shown on the plans, replacement materials damaged during backfill placement if required, and erecting the modular block units shall be included in the cost of wall erection.

The cost of all labor and materials for geotextiles shall be included in the cost of the pay items of this section.