Wall Modular Block Mechanically Stabilized Earth, Item 532.0300.S.

A Description

(1) This special provision describes designing, furnishing materials and erecting a permanent earth retention system in accordance with the lines, dimension, elevations and details as shown on the plans and provided in the contract. The design life of the wall and all wall components shall be 75 years.

B Materials

B.1 Proprietary Mechanically Stabilized Earth Modular Block Wall Systems

(1) The department specifies approved modular block mechanically stabilized earth wall products on the department's approved product list.

(2) Proprietary wall systems may be used for this work, but must conform to the requirements of this specification and be pre-approved for use by the department's Bureau of Structures, Structures Development Section. The name of the companies supplying pre-approved material shall be furnished within 25 days after the award of contract. The department maintains a list of pre-approved systems of retaining walls. To be eligible for use on this project, a system must have been pre-approved and added to that list prior to the bid opening date.

(3) Applications for pre-approval may be submitted at any time. Applications must be prepared in accordance with the requirements of chapter 14 of the department's Bridge Manual. Information and assistance with the pre-approval process can be obtained by contacting the Structures Development Section in Room 601 of the Hill Farms State Transportation Building in Madison or by calling (608) 266-8494.

B.2 Design Requirements

(1) It is the responsibility of the contractor to supply a design and supporting documentation as required by this special provision for review by the department to show the proposed wall design is in compliance with the design specifications.

(2) The design/shop plans shall be prepared on reproducible sheets 11 inch x 17 inch, including borders. Each sheet shall have a title block in the lower right corner. The title block shall include the project identification number and structure number. Design calculations and notes shall be on 8 1/2 inch x 11 inch sheets, and shall contain the project identification number, name or designation of the wall, date of preparation, initials of designer and checker, and page number at the top of the page. All plans and calculations shall be signed, sealed and dated by a professional engineer licensed in the State of Wisconsin.

(3) The design of the Wall Modular Block Mechanically Stabilized Earth shall consider the internal stability of the wall mass, including the reinforcement pullout resistance. The design shall be in compliance with the current AASHTO Standard Specifications for Highway Bridges including interim specifications, the standard specifications, and standard engineering design procedures as determined by the department. The walls shall be designed for the heights shown on the plans and 100% of the soil reinforcement shall be connected to the wall facing. The maximum value of the angle of internal friction of the wall backfill material shall be assumed to be 30 degrees without certified test values.

(4) The embedment to the top of the leveling pad shall be 1 foot 6 inches or as specified in the plan or AASHTO Section 5.8.1 minimum, whichever is greater. Potential depth of frost penetration at the wall location shall not be considered in designing the wall for depth of leveling pad. Vertical earth pressure shall be determined using the Meyerhof distribution. A connection factor of safety of 1.5 at 0.75 inch deformation is required. A geosynthetic waterproof membrane is not required to cover the reinforced mass.

(5) The minimum length of soil reinforcement measured from the back face of the wall shall be equal to 0.7 the wall height or as shown on the plan. In no case shall this length be less than 6 feet. The soil reinforcement shall extend 3 feet beyond the theoretical failure plane in all cases. The maximum vertical spacing of soil reinforcement layers shall be two times the block depth (front face to back face) or 32 inches, whichever is less. The first (bottom) layer of reinforcement shall be placed no further than 12 inches above the top of the leveling pad, but at least one block height above the leveling pad. The last (top) layer of soil reinforcement shall be no further than 24 inches below the top of the uppermost block.

(6) Submit the following to the engineer for review: complete design calculations, explanatory notes, specifications, and detailed plans and shop drawings for the proposed wall system. Submit them no later than 21 days prior to beginning construction of the wall. The detailed plans and shop drawings shall include all details, dimensions, quantities and cross-sections necessary to construct the walls. The design calculations and notes shall clearly indicate the factor of safety against pullout and the design soil pressure beneath the wall footing and retained earth mass. Four copies of shop drawings and two copies of the design calculations and supporting materials shall be submitted.

B.3 Wall System Components

(1) Materials furnished under this contract shall conform to the requirements hereinafter provided.

B.3.1 Leveling Pad

(1) For all walls over 5 feet tall measured from the top of the leveling pad to the top of the wall, provide a wall leveling pad that consists of poured concrete masonry, 6 inches deep by 12 inch

(minimum) wide Grade A as provided in section 501 of the standard specifications. The leveling pad shall be as wide as the proposed blocks or a minimum of 12 inches which ever is greater. The bottom row of blocks shall be horizontal and 100% of the block surface shall bear on the leveling pad. If any portion of the wall is over 5 feet tall, a concrete leveling pad shall be used for the entire length of the wall. All walls with a structure number assigned (such as R-XX-XXX) shall be built using the concrete leveling pad given above regardless of wall height. The leveling pad shall step to follow the general slope of the ground line. The leveling pads steps shall keep the bottom of the wall within one block thickness of the minimum embedment, i.e., a minimum embedment plus an additional embedment of up to one block's thickness. Additional embedment may be detailed, but will not be measured for payment.

(2) For walls that are less than or equal to 5 feet in height and do not have a wall number assigned to them, a compacted 1 foot deep by 2 foot wide leveling pad made from base aggregate dense 1 1/4-inch in conformance with section 305 of the standard specifications may be used.

B.3.2 Wall Facing

(1) Wall facing units shall consist of precast modular concrete blocks. All units shall incorporate a mechanism or devices that will develop a mechanical connection between vertical block layers. Units that are cracked, chipped, or have other imperfections in accordance with ASTM C1372 or excessive efflorescence shall not be used within the wall. A single block type and style shall be used throughout each wall. The color and surface texture of the block shall be as given on the plan or chosen by the engineer.

(2) The top course of facing units shall be a solid precast concrete unit designed to be compatible with the remainder of the wall. The finishing course shall be bonded to the underlying facing units with a durable, high strength, flexible adhesive compound compatible with the block material. A formed cast-in-place concrete cap may also be used to finish the wall. A cap of this type shall be designed to have texture, color, and appearance that complement the remainder of the wall. The vertical dimension of the cap shall not be less than 3 1/2 inches. Expansion joints shall be placed in the cap to correspond with each 24 inch change in vertical wall height or at a maximum spacing of 10 feet. Concrete for all cast-in-place caps shall be Grade A and shall conform to the requirements of 501.4 of the standard specifications.

(3) Block dimensions may vary no more than ±1/8 inch from the standard values published by the manufacturer in accordance with ASTM C1372. Blocks must have a minimum depth (front face to back face) of 8 inches. The minimum front face thickness of blocks shall be 4 inches measured perpendicular from the front face to inside voids greater than 4 square inches. Also the minimum allowed thickness of any other portions of the block is 2 inches. The front face of the blocks shall conform to plan requirements for color, texture, or patterns.

(4) Cementitious materials and aggregates for modular blocks shall conform to the requirements of ASTM C1372 Section 4.1 and 4.2. Modular blocks shall meet the following requirements.

Test	Method	Requirement
Compressive Strength (psi)	ASTM C140	5000 min.
Water Absorption (%)	ASTM C140	6 max.
Freeze-Thaw Loss (%) 40 cycles, 5 of 5 samples 50 cycles, 4 of 5 samples	ASTM C1262 (1)	 1.0 max. (2) 1.5 max. (2)

(1) Test shall be run using a 3% saline solution.

(2) Test results that meet either of the listed requirements for Freeze-Thaw Loss are acceptable.

(5) All blocks shall be certified as to strength, absorption, and freeze-thaw requirements unless, due to contract changes, certified blocks are not available when required. At the time of delivery of certified blocks, furnish the engineer a certified test report from a department-approved independent testing laboratory for each lot of modular blocks. The certified test report shall clearly identify the firm conducting the sampling and testing, the type of block, the date sampled, name of the person who conducted the sampling, the represented lot, the number of blocks in the lot, and the specific test results for each of the stated requirements of this specification. A lot shall not exceed 5000 blocks. The certified test results will represent all blocks within the lot. Each pallet of blocks delivered shall bear lot identification information. Block lots that do not meet the requirements of this specification or blocks without supporting certified test reports will be rejected and shall be removed from the project at no expense to the department.

(6) A department-approved independent testing laboratory shall control and conduct all modular block sampling and testing for certification. Prior to sampling, the manufacturer's representative shall identify all pallets of modular blocks contained in each lot. All pallets of blocks within the lot shall be numbered and marked to facilitate random sample selection. The representative of the independent testing laboratory shall identify five pallets of blocks by random numbers and shall then select one block from each of these pallets. Solid blocks used as a finishing or top course shall not be selected. The selected blocks shall remain under the control of the person who conducted the sampling until shipped or delivered to the testing laboratory. All pallets of blocks within a lot shall be strapped or wrapped to secure the contents and tagged or marked for identification. The engineer will reject any pallet of blocks delivered to the project without intact security measures. At no expense to the department, the contractor shall remove all rejected blocks from the project.

(7) The department may conduct testing of certified or non-certified modular blocks lots delivered to the project. The department will not do freeze-thaw testing on blocks less than 45 days old. If a random sample of 5 blocks of any lot tested by the department fails to meet any of the requirements of this specification (nonconforming), the contractor shall remove from the project site all blocks from the failed lot not installed in the finished work at no cost to the department, unless the engineer allow otherwise. Nonconforming blocks installed in the finished work will be considered approved by the department as stated in subsection 106.5(2) of the standard specifications and any adjustment to the contract price will not exceed the price of the blocks charged by the supplier.

B.3.3 Geogrids

(1) Geogrid supplied as reinforcing members shall be manufactured from long chain polymers limited to polypropylene, high-density polyethylene, polyaramid, and polyester.

(2) Geogrids shall form a uniform rectangular grid of bonded, formed, or fused polymer tensile strands crossing with a nominal right angle orientation. The minimum grid aperture shall be 0.5 inch. The geogrid shall maintain dimension stability during handling, placing, and installation. The geogrid shall be insect, rodent, mildew, and rot resistant.

(3) The geogrid shall be furnished in a protective wrapping that shall prevent exposure to ultraviolet radiation and damage from shipping or handling. The geogrid shall be kept dry until installed. Each roll shall be clearly marked to identify the material contained.

(4) The wall designer shall supply the allowable Tension Reinforcement Load (T_A) used in the design for each reinforcement layer. The wall system composed of geogrid and modular blocks wall shall be from a preapproved supplier. The current list of preapproved geogrids and their corresponding modular blocks is maintained by the department's Structures Development Section and may be obtained by calling 608-266-8494. Only geogrid and modular blocks preapproved before contract letting will be allowed in the construction of the wall.

(5) The value of T_A for a specific geogrid shall be the lowest value as determined by the following two methods for each layer used.

1. The Ultimate Tensile Strength (T_{ult}) divided by the factors RF_{ID}, RF_{CR}, RF_D and FS.

Hence,

$$T_A = \frac{T_{ult}}{RF_{ID} \, x \, RF_{CR} \, x \, RF_D \, x \, FS}$$

where:

T_{ult} = is the ultimate tensile strength of the reinforcement determined from wide width tensile tests (ASTM D4595) for geogrids, or rib tensile test (GRI:GG1), but at a strain rate of 10% per minute.

RF_{ID} = strength reduction factor to account for installation damage to the reinforcement. In no case shall RF_{ID} be less than 1.1.

RF_{CR} = strength reduction factor to prevent long-term creep rupture of the reinforcement. In no case shall RF_{CR} be less than 1.2.

RF_D = strength reduction factor to prevent rupture of the reinforcement due to chemical and biological degradation. In no case shall RF_D be less than 1.1.

FS = a global safety factor which accounts for uncertainties in structure geometry, fill properties, externally applied loads, overstress due to load nonuniformities, and uncertainties in long-term reinforcement strength shall be 1.5.

Values for RF_{ID}, RF_{CR}, and RF_D shall be determined from product specific test results.

Guidelines for how to determine RF_{ID}, RF_{CR}, and RF_D from product specific data are provided in FHWA Publication No. FHWA SA-96-071 "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines" Appendix B, and in FHWA Publication No. FHWA SA-96-072 "Corrosion/Degradation of Soil Reinforcements for Mechanically Stabilized Earth Walls and Reinforced Soil Slopes".

2. The geogrid connection load (T_B) divided by the factor FS = 1.5. Hence,

$$T_A = \frac{T_B}{FS}$$

The Geogrid Connection Load (T_B) is defined as the maximum tension load that may be developed in a geogrid reinforcement layers that will result in no more than 0.75 inches of deformation. This value shall be determined from tests conducted on the same facing blocks and grids as proposed for the wall and shall cover a range of overburden pressures comparable to those anticipated in the proposed wall. The value of T_B for any specific layer shall be determined for the overburden pressure applied to that specific layer. The test shall

be conducted on grid samples at least 8 inches wide and at a rate of elongation not exceeding 0.05 inches per minute. The geogrid shall remain normal to the block face during loading. The contractor shall provide to the engineer all load test data used to determine the value of T_B.

(6) Submit the following items for the review and acceptance of the engineer.

1. The Allowable Reinforcement Tension Load (T_A) for the geogrid to be supplied.
2. The values of T_{ult}, RF_{ID}, RF_{CR}, RF_D and T_B used to determine T_A.

(7) Work on the wall shall not begin until the engineer accepts these submittals.

B.3.4 Galvanized Metal Reinforcement

(1) In lieu of polymeric geogrid earth reinforcement, galvanized metal reinforcement may be used. Design and materials shall be in accordance with Section 5.8.6.1.1 of the current AASHTO Specifications.

B.3.5 Connectors

(1) Pins, rods, clips, or other devices used to develop mechanical interlock between facing unit block layers shall be manufactured from corrosion resistant materials. Furnish documentation that establishes and substantiates the design life of such devices.

B.3.6 Backfill Materials

(1) Wall Backfill, Type A, shall comply with the requirements for Coarse Aggregate No. 1 as given in 501.2.5.4.4 of the standard specifications. All backfill placed within a zone from the base of the leveling pad to the top of the final layer of wall facing units and within 1 foot behind the back face of the wall shall be Wall Backfill, Type A. This includes all material used to fill openings in the wall facing units.

(2) Wall Backfill, Type B, shall comply with the requirements for Grade 1 Granular Backfill as contained in 209.2.2 of the standard specifications. All backfill placed in a zone extending horizontally from 1 foot behind the back face of the wall to 1 foot beyond the end of the reinforcement and extending vertically from the base of the leveling pad to the top of the final layer of all facing units shall be Wall Backfill, Type B.

(3) All backfill used within the reinforced zone shall have a pH of 4.5 to 10 as determined by AASHTO Procedure T-289. In addition to the above, backfill used on walls with metallic reinforcement shall have a chloride content of less than 100 parts per million as determined by AASHTO Procedure T-291, sulfates of less than 200 parts per million as determined by AASHTO Procedure T-290, and an electrical resistivity greater than 3000 ohms per centimeter as determined by AASHTO Procedure T-288. Prior to placement of the backfill, obtain and

furnish to the engineer certified test results that the backfill material complies with the requirements of this specification. For design, the maximum value of the angle of internal friction of the wall backfill material shall be assumed to be 30 degrees without certified test values. All testing shall be performed by an independent certified laboratory.

(4) All other backfill materials required to finish the wall and restore the ground surface may be select material available on the project that meets the engineer's approval.

C Construction

C.1 General

(1) Place the wall facing units in accordance with the manufacturer's instructions and to the lines, elevations, batter, and tolerances as shown on the plans. Center the initial layer of facing units on the leveling pad; then level them and properly align them. Fill formed voids or openings in the facing units with wall backfill, Type A. Sweep clean of all debris each layer of facing units before placing the next layer of facing units.

(2) Install all pins, rods, clips, or other devices used to develop mechanical interlock between facing unit layers in accordance with the manufacturer's directions.

(3) All excavation for the Wall Modular Block Mechanically Stabilized Earth shall conform to section 206 of the standard specifications. At the end of each working day, provide good temporary drainage such that the backfill shall not become contaminated with run-off soil or water if it should rain. Do not stockpile or store materials or large equipment within 10 feet of the front face of the wall.

C.2 Backfill

(1) Place backfill materials in the areas as indicated on the plans and as detailed in this specification. Backfill lifts shall be no more than 8-inches in depth. Backfilling shall closely follow erection of each course of wall facing units. Compact wall backfill Type A with at least three passes of lightweight manually operated compaction equipment acceptable to the engineer.

(2) Compact wall backfill Type B as specified in 207.3.6 of the standard specifications. For walls with a maximum height of any portion greater than 5 feet, compact Wall Backfill Type B to 95% of maximum density as determined by AASHTO T-99, Method C. Perform compaction testing. Conduct testing at a minimum frequency of 1 test per 2 foot layer per 200 feet of wall, or major portion thereof. Deliver documentation of all compaction testing results to the engineer at the time of testing. The department may perform quality control compaction tests on walls less than 5 feet in height to ensure compliance with 207.3.6 of the standard specifications.

(3) Conduct backfilling operations in such a manner as to prevent damage or misalignment of the wall facing units, soil reinforcement, or other wall components. At no expense to the department, correct any such damage or misalignment as directed by the engineer. A field representative of the wall supplier shall be available during wall construction to provide technical assistance to the contractor and the engineer.

(4) Do not operate tracked or wheeled equipment on the backfill within 3 feet from the back face of modular blocks. The engineer may order the removal of any large or heavy equipment that may cause damage or misalignment of the wall facing units.

C.3 Soil Reinforcement

(1) Place soil reinforcement at the positions and to the lengths as indicated on the accepted shop drawings. Compact and level backfill materials below the reinforcement layer prior to reinforcement placement. Take care that backfill placement over the positioned soil reinforcement elements does not cause damage or misalignment of these elements. Correct any such damage or misalignment as directed by the engineer. Do not operate wheeled or tracked equipment directly on the soil reinforcement. A minimum cover of 6 inches is required before such operation is allowed.

C.4 Geogrid Layers

(1) Place and anchor geogrid material between wall unit layers in the same manner as used to determine the Geogrid Connection Load (T_B). Place the grid material so that the machine direction of the grid is perpendicular to the wall face. Each grid layer shall be continuous throughout the lengths indicated on the plans. Join grid strips with straps, rings, hooks or other mechanical devices to prevent movement during backfilling operations .Prior to placing backfill on the grid, pull the grids taunt and hold in position with pins, stakes or other methods approved by the engineer.

C.5 Steel layers

(1) Place the steel reinforcement full width in one piece as shown on the plans. No splicing will be allowed. Maintain elements in position during backfilling.

C.6 Geotechnical Information

(1) Geotechnical data to be used in the design of the wall is given on the wall plan. The allowable soil bearing capacity is given on the plan. After completion of excavation, the department's District Soils Engineer will inspect the site and will determine if the foundation is adequate for the intended loads. Allow the District Soils Engineer two working days to perform the inspection.

D Measurement

(1) The department will measure Wall Modular Block Mechanically Stabilized Earth in area by the square foot of face on a vertical plane between the top of the leveling pad and a line indicating the top of wall including wall cap or copings as required and shown on the plans. Unless ordered by the engineer, wall area constructed above or below these limits will not be measured for payment.

E Payment

(1) The department will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
532.0300.S	Wall Modular Block Mechanically Stabilized Earth	SF

(2) Payment is full compensation for supplying a design and shop drawings; preparing the site, including all necessary excavation and disposal of surplus materials; supplying all necessary wall components to produce a functional system including cap and copings; constructing the retaining system; providing backfill, backfilling, and performing compaction testing; and for furnishing all tools, labor, equipment, and incidentals necessary to complete the contract work. Parapets, railings, and other items above the wall cap or coping will be paid for separately.

(3) Any required topsoil, fertilizer, seeding or sodding and mulch will be paid for at the contract unit price of topsoil, fertilizer, seeding or sodding and mulch, respectively.

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