1. gravity retaining wall (revised 2-2-2022)

Description. Furnish all materials, labor, and equipment necessary to design and construct concrete block gravity retaining wall(s) in accordance with these specifications, and to the lines, grades, and dimensions shown on the plans or otherwise established by the Project Manager. Work includes all excavation and grading necessary to construct the gravity retaining wall(s). Have a Montana licensed Professional Engineer oversee the retaining wall design(s) and sign and seal the design calculations and drawings.

Preliminary dimensions given on the plans are for estimating purposes only. Produce a design for a gravity retaining wall system that will establish:

Bottom elevation of leveling pad of the gravity wall.

Backfill type.

Number, type, and dimensions of concrete block units.

Quantity of backfill.

A drainage system that will provide free drainage behind the retaining wall.

A design that takes into account interferences such as pipes, utilities, or other appurtenances behind, passing through, passing under, or adjacent to the wall.

A design that takes into account guardrail, fence, signage, luminaires, or other appurtenances at the top of the wall.

Available Information. Available information developed by the Department or by the Department’s duly authorized representative includes the following items:

Project Geotechnical Report dated May 2013.

Boring Logs obtained in the area of the wall are included in the Special Provisions.

Contract Detailed Drawings for the proposed retaining wall(s).

Design Soil Properties. Use the following soil properties to design the gravity retaining wall:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Total Unit Weight, pcf | Drained Angle of Internal Friction, degrees | Undrained Cohesion, psf | Nominal (unfactored) Bearing Capacity, psf(1) |
| Retained Soil | 125 | 32 | - | - |
| Backfill Material | 125 | 34 | - | - |
| Foundation Soil | 125 | 32 | 750 | 4000 |

* + - * 1. Note: the nominal bearing capacity is based upon a footing width of \_\_\_ feet. Nominal bearing capacity will vary for different footing widths.

Gravity Retaining Wall Design Requirements.

Design the wall(s) in accordance with the most current AASHTO LRFD Specifications for Highway Bridges including current Interim Specifications for gravity retaining walls using the applicable resistance and load factors for prefabricated modular walls.

Use Allowable Stress Design methods (ASD) to assess overall stability.

The design life of the gravity wall is 75 years.

The design Peak Ground Acceleration (PGA) is 0.064g. (USGS)

See plans for the required minimum wall embedment.

The Department or Department’s representative evaluated the proposed wall layout and determined adequate global stability and bearing capacity. The design must include analyses at critical sections that clearly show acceptable limits for eccentricity, Capacity Demand Ratios equal to or greater than 1.0 for sliding and bearing capacity, and a Factor of Safety greater than 1.3 for overall stability. Ensure internal stability at each block level. Include the width of the concrete block units from the front face to the back face of the wall in the design computations and show this information on the wall shop drawings.

Design the wall(s) to tolerate total and differential settlements of up to 2 inches without damage to the concrete block units or structural integrity of the wall(s).

Design a drainage system behind the wall to drain water from the backfill and prevent hydrostatic pressure buildup behind the wall.

The wall may be battered at any angle from 0° (plumb) to 3.6° in its final position.

Design the wall to account for wall appurtenances and for interferences as noted in Sections B.6 and B.7 shown above.

Choose a concrete gravity wall system that will accommodate guardrail post or fence post placement and coordinate guardrail and fence placement with wall construction.

Materials. Use materials meeting the following requirements to construct the wall.

Concrete for Leveling Pads. Provide Class General Concrete or Controlled Low Strength Material (CLSM) for leveling pads as defined by this special provision.

Concrete Block Unit. Provide Class Structure Concrete or approved equal. Provide a sandstone texture or approved equal that extends 1.5 feet below finished grade for all exposed block faces. Submit a block brochure for texture and color selection to the Project Manager.

Backfill Material. Use Special Borrow meeting the requirements of these Special Provisions and the following additional requirements:

Gradation. Use backfill material meeting the following gradation requirements:

US Sieve Size Percent Passing

3 inch 100

1 inch 70 - 90

No. 4 20 – 40

No. 40 10 – 20

No. 200 0 – 5

Provide a minimum of 35% of the +No. 4 material with at least one fractured face.

Electrochemical Properties. Use backfill meeting the following electrochemical requirements:

Requirements Test Methods

Resistivity >3,000 ohm-cm AASHTO T-288

pH 5-10 AASHTO T-289

Chlorides <100 parts per million AASHTO T-291

Sulfates <200 parts per million AASHTO T-290

Organic Content <1% AASHTO T-267

If the resistivity is greater than or equal to 5000 ohm-cm, the chloride and

sulfates requirements may be waived.

Soundness. Use materials that are substantially free of shale or other soft, poor durability particles. Use material having a magnesium sulfate soundness loss of less than 30 percent after four cycles, measured in accordance with AASHTO T-104, or a sodium sulfate loss of less than 15 percent after five cycles determined in accordance with AASHTO T-104.

Drainage Aggregate. Use Filter Material meeting the requirements of Section 701.05.

Drainage Pipe. Provide 4 inch (minimum) perforated polyethylene corrugated pipe conforming to AASHTO M 252 – Type SP, with Class 2 perforations.

Outlet Pipes and Cleanouts. Provide 4 inch (minimum) non-perforated polyethylene corrugated pipe meeting AASHTO M252 – Type S, for inlet cleanouts and outlet drains.

Provide splices, fittings, and connectors that will not impede flow or damage the drainage pipe and have sufficient strength to withstand construction handling and permanent loading.

Provide rodent guards for each drain outlet consisting of steel screen with ½ inch by ½ inch openings and a stainless steel clamp or pre-manufactured guards meeting the opening requirements. Drive one flexible, driveable delineator at each inlet/outlet drain location.

Drainage Geotextile. Cover all joints between blocks on the backside of the wall with Subsurface Drainage Geotextile Filter, High Survivability, Class A, meeting the requirements of Section 716. Wrap drainage aggregate and drainage pipe with drainage geotextile. Overlap geotextile a minimum of 1 foot.

Retaining Wall Design Submittals. A minimum of 20 working days before the planned start of wall excavation, submit electronic copies (PDF format preferred) of the complete design calculations and working drawings to the Project Manager for review. Include all details, dimensions, quantities, ground profiles, and cross-sections necessary to construct the wall. Verify the limits of the wall and ground survey data before preparing drawings. Include a block brochure for texture and color selection.

Design Calculations. Submit copies of the design calculations that include, but are not limited to, the following items:

Applicable code requirements and design references.

Retaining wall critical design cross-section geometry including soil/rock strata and location, magnitude, and direction of design slope or external surcharge loads and piezometric levels along with the Capacity Demand Ratios for end of construction, long-term conditions, and seismic loading.

Design parameters including drained and undrained soil/rock shear strengths, unit weights, and any other assumptions for each soil/rock strata along with reinforcing block materials.

Show all Capacity Demand Ratios from LRFD.

Show all Factors of Safety for overall stability analysis.

Design calculation sheets with the Design Firm’s Project Number, the MDT Project Number, the MDT UPN Number, wall location, stationing, date of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.

Design notes including an explanation of any symbols and computer programs used in the design. Accompany submitted computer output with supporting hand calculations detailing the calculation process.

Design calculations for wall block units and connections between the blocks.

Other design calculations.

Working Drawings. Provide copies of the drawings prepared, signed, and sealed by a Montana licensed Professional Engineer. Working drawings must include, but are not limited to, the following items:

A plan view of the wall(s) identifying:

A reference baseline and elevation datum.

The offset from the construction centerline or baseline to the face of the wall at its base at all changes in horizontal alignment.

Beginning and end of wall stations.

Permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structures, or other potential interferences within the limits of the wall excavation.

The centerline of any pipes, utilities, or other appurtenances behind, passing through, passing under, or adjacent to the wall.

The plan view location of guardrail, fence, signage, luminaires, or other appurtenances at the top of the wall.

An elevation view of the wall(s) identifying:

The elevation at the top of the wall, at all horizontal and vertical break points, and at least every 8 feet along the wall.

Elevations at the wall base.

Beginning and end of wall stations.

The distance along the face of the wall to all steps in the wall base.

Wall elevation view showing the location of wall drainage elements along the wall length.

Existing and finish grade profiles both behind and in front of the wall.

Specifications for block materials and connections.

General notes for constructing the wall(s) including construction sequencing, wall excavation, foundation preparation, wall erection, backfill placement and any other special construction requirements.

Horizontal and vertical curve data affecting the wall and wall control points. Include match lines or other details to relate wall stationing to centerline stationing.

A listing of the summary of quantities on the elevation drawing of each wall showing estimated square yards of wall face areas.

Retaining wall typical sections including excavation elevations, wall units, and wall batter.

Details, dimensions, and schedules for all block units, connections, and incidentals.

Details and dimensions for wall appurtenances such as barriers, guardrails, coping, drainage gutters, fences, signage, etc.

Details for constructing walls around utilities and drainage facilities (if applicable).

Details for terminating walls and adjacent slope construction.

Clearly show all details and requirements to place guardrail posts, fence posts, luminaire foundations, etc.

Have a Montana licensed Professional Engineer sign and seal the drawings and calculations. If the retaining wall Contractor uses a Consultant Designer, Subcontractor, or Manufacturer’s representative to prepare the design, the retaining wall Contractor still has overall contractual responsibility for both the design and the construction.

Submittals. Submit electronic copies of the wall drawings to the Department with the initial submission required in Section F. The Department will review the Contractor's submittals within 20 working days after receipt of a complete submission. If revisions are necessary, make the necessary corrections and resubmit the revised sets. After the drawings have been reviewed and found acceptable, furnish final copies of the drawings.

Do not begin wall construction or incorporate materials into the work until the submittal requirements are satisfied and found acceptable to the Department. Changes or deviations from the accepted submittals must be re-submitted and reviewed. No adjustments in contract time will be allowed due to incomplete submittals.

Revise the drawings when plan dimensions are revised due to field conditions or for other reasons. Within 30 days after completion of the work, submit copies of the as-built drawings to the Project Manager. Provide revised design calculations signed by the Professional Engineer of Record for all design changes made during the construction of the wall.

Construction Requirements. Construct the wall according to the approved set of working drawings, the special provisions, and the appropriate sections of the Specifications.

Backfill Source Approval. At least 20 working days before beginning wall construction, submit a sample from the proposed borrow source for backfill material.

Material Approval. Submit all concrete testing and acceptance results prior to starting field work.

Have a technical representative of the wall manufacturer on site during the beginning of wall construction to ensure that the wall is installed properly.

Excavation and Grading. Complete the excavation in conformity to the limits and construction stages shown on the plans. The contractor is responsible for temporary excavation support as required.

Foundation Preparation. Grade the foundation for the structure level for a width equal to the block width plus 1 foot or as shown on the plans. Except for foundations constructed on rock, compact the foundation soils in accordance with Section 203 prior to wall construction.

The surface should be smooth and level such that any shallow depressions or humps do not exceed 6 inches in depth or height. Proof-roll the subgrade and remove and replace any unsuitable foundation soils with backfill material meeting the requirements of this special provision.

MDT will provide a Geotechnical Section representative on-site to inspect the foundation materials for the wall(s). The Project Manager will notify the MDT Geotechnical Section a minimum of 7 calendar days prior to start of excavation and wall construction to schedule the on-site representative. The Geotechnical Representative will inspect the bottom of the excavation to determine whether foundation material of adequate strength has been reached.

Cure leveling pad concrete a minimum of 48 hours prior to concrete block unit placement.

Backfill Placement. Place backfill following each course of blocks. Place backfill in a manner that prevents any disturbance of the wall materials or misalignment of the block units. Remove and replace any wall materials that become damaged during construction at Contractor’s expense. Place backfill in maximum 8 inch loose lifts. Compact the backfill to a minimum of 95% of the maximum density determined by MT-230. Compact the backfill within 4 feet of the wall face using a lightweight mechanical tamper, roller, or vibratory system.

At the end of each day’s operation, slope the level of the backfill away from the wall facing to rapidly direct runoff away from the face. Do not allow surface water from adjacent areas to enter the wall construction site.

Wall Batter. The completed wall has a vertical tolerance of the wall (top to bottom) not exceeding 2 inches per 10 feet of wall height from the batter shown on the approved set of working drawings.

Corrective Action. If any defects are found in the wall, begin repairing the wall by a method approved by the Project Manager. Within 7 calendar days of determining the need for wall repairs, submit electronic copies of calculations and working drawings, stamped by the Professional Engineer of Record, to the Project Manager for modifications to the wall caused by the remedial action. Furnish all material and labor necessary to correct the wall at no cost to the Department.

Method of Measurement. Design, Construct Gravity Retaining Wall is measured by the square yard of wall face as measured from the top of wall to the top of the leveling pad, complete and in-place.

Basis of Payment. Payment for Design, Construct Gravity Retaining Wall is full compensation for all labor, equipment, materials, tests, investigations, and incidentals necessary to design and construct the gravity retaining walls.

Pay Item Measurement Unit

Design, Construct Gravity Retaining Wall Square Yard