

ISPECIFICATIONS FOR BRIDGE CONSTRUCTION

SECTION 25

MECHANICALLY STABILIZED EARTH WALLS

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25.1 General

This specification is for the design, supply, fabrication and construction of mechanically stabilized earth (MSE) retaining walls with precast concrete facing panels. MSE retaining walls shall include, but not be limited to, excavation for the wall, concrete leveling pads, precast concrete panels, compacted granular backfill, soil reinforcement, perforated drain pipe complete with filter fabric sock, surface drains, cast-in-place concrete wall coping, traffic barrier, pedestrian railing, permanent safety railing or fence, hardware and all associated materials.

MSE retaining walls shall be designed and constructed in accordance with the provisions contained herein and as determined by the Department and the Consultant.

The Contractor shall supply all necessary materials. All components of the MSE wall system shall be supplied from one MSE supplier.

25.2 Design

25.2.1 Design Requirements

Location, layout, geometry control, global stability and allowable bearing capacity requirements shall be as specified in the contract documents. The Contractor's design responsibility shall include internal stability and all elements for a complete MSE wall system.

The most stringent requirements of the current version of the following standards shall be met:

- CAN/CSA S6 – Canadian Highway Bridge Design Code
- AASHTO LRFD Bridge Design Specifications
- Alberta Transportation Bridge Structures Design Criteria
- Alberta Transportation Roadside Design Guide Section H7.6

The design life for all MSE wall components shall be 100 years.

Highway and bridge surface drainage shall be controlled and channeled away from the back of the MSE walls and mechanically stabilized earth mass.

Weeping drains consisting of perforated 150 mm diameter pipe complete with filter sock shall be provided near the front and the back bottom corner of the mechanically stabilized earth mass. The weeping drains shall be day lighted or connected for positive drainage. A water level within the mechanically stabilized earth mass shall be assumed to be at the invert level of the weeping drains.

MSE walls with traffic running parallel to the top of the wall shall have rigid bridge barriers meeting the requirements of CHBDC Section 12. Such bridge barriers shall be located on top of the MSE walls and supported on the moment slab to resist sliding and overturning. Flexible guardrail systems shall not be used. All obstacles, such as sign supports and lighting posts, mounted on top of the barriers shall meet set-back and clearance requirements specified in the Roadside Design Guide. The MSE wall design shall account for all load effects from such accessories.

Water carrying appurtenances, such as catch basins, drainage inlets/outlets, culverts etc., shall preferably be placed away from, or close to the end of the soil reinforcement zone, and provisions shall be made to mitigate the detrimental effects of potential leakage.

Obstructions such as foundation piles and associated casings, or casings for future pile installations in the soil reinforcement zone, shall be accommodated with appropriate arrangement of soil reinforcing around such obstructions. For those MSE wall systems that lend themselves to splaying of the soil reinforcement, the splay angle shall not exceed 20° from the perpendicular of the facing panel. For other MSE wall systems, coverage ratios of soil reinforcement shall be specifically developed for each project.

Pedestrian railing and permanent safety railing or fence may be mounted on top of MSE wall coping.

Minimum precast concrete panel thickness shall be 140 mm, excluding any additional thickness required for aesthetic surface treatment. Minimum cover to reinforcing steel shall be 50 mm on both the front and back faces.

Precast concrete panels shall be designed to accommodate a differential settlement of 100 mm in 10 metres of length along the wall. The spacing between adjacent panels shall be designed to be 20 mm nominal.

Joints between panels should have a lip and recess (ship lap) configuration so that joint material is protected and overall aesthetics is enhanced. Butt joints may also be used if the Contractor can provide a backing board with sufficient strength and durability to meet 100 years life expectancy requirement.

Acute corners less than 70° inside panels shall not be allowed.

Special corner units shall be used when interior angle between adjacent panels is 130° or less.

The top of the cast-in-place concrete wall coping shall be smooth and have no steps or abrupt changes in height.

MSE wall panels shall be fully supported by compacted backfill without voids on the non-exposed side.

For stepped leveling pads, the maximum elevation difference between adjacent steps shall not exceed 1250 mm. The minimum length of each stepped section shall be 1500 mm.

Where staged construction is required and large differential settlement is expected between stages, appropriately located full height vertical slip joints shall be provided.

25.2.2 Submissions and Consultant Review

Design notes and shop drawings shall be stamped, signed and sealed by a professional engineer, registered to practice in the Province of Alberta.

Design notes shall be presented in a legible and logical format, and shall be sufficiently detailed to allow a technical review of design concepts and assumptions used in the design. Where necessary, the design package shall be accompanied by properties of materials used together with the appropriate test certificates.

Shop drawings shall be legible and of adequate quality to be reproduced and microfilmed. Each drawing shall have sufficient blank space for the Consultant's acceptance stamp.

As a minimum, shop drawings shall contain:

- Alberta Transportation bridge file number and project name on each drawing.
- Design criteria and materials lists.
- Wall layout plan and elevation complete with dimensions and elevations, and typical wall cross-sections.
- All component and connection details.
- Site drainage and drainage details.

Two copies of the design notes and five copies of the shop drawings shall be submitted to the Consultant for review and acceptance at least three weeks in advance of scheduled fabrication.

The design notes and shop drawings will be reviewed by the Consultant solely to ascertain conformance with codes and specifications. Responsibility of the final design remains solely with the Contractor. The Consultant's acceptance of the shop drawings shall not be construed as relieving the Contractor from his responsibility for errors or omissions in the calculations and drawings or for the proper completion of the work in accordance with the Contract.

After the Consultant's review, the Contractor shall revise the drawings and calculations as required to the satisfaction of the Consultant without any additional cost to the Department.

Prior to commencing fabrication, all shop drawings shall be clearly signed by the Department's Consultant as verification that the Consultant has completed his review and accepted the Shop Drawings.

The Contractor shall incorporate as-built conditions and re-submit the revised design notes and shop drawings for records at the completion of construction.

25.3 Materials

25.3.1 Concrete Materials

The fabrication of precast concrete panels shall conform to the requirements of Section 7 “Precast Concrete Units” of the Specifications for Bridge Construction. Any panel with crack exceeding 0.15 mm in width or 0.1 mm/m² (of panel area) in length shall be rejected. The concrete for the panels shall be Class HPC, conforming to the requirements of Section 4.4 “Class and Composition of Concrete” of the Specifications for Bridge Construction, with the exception that maximum aggregate size shall be 14 mm. The concrete leveling pads and the MSE wall coping shall conform to the requirements of Section 4 “Cast-In-Place Concrete” of the Specifications for Bridge Construction. The concrete for the leveling pads shall be Class B and the concrete for the wall coping shall be Class HPC. Chamfered edges shall be created around the periphery of all precast facing panels. The exposed faces of the precast panels and the cast-in-place wall coping shall have a Class 2 finish.

25.3.2 Concrete Reinforcing Materials

Reinforcing steel is to be in accordance with Section 5 “Reinforcing Steel” of the Specifications for Bridge Construction.

Reinforcing steel shall conform to CAN/CSA G30.18 Grade 400 deformed billet steel bars and be epoxy coated.

25.3.3 Soil Reinforcing Materials

Steel reinforcement shall be galvanized in accordance with the current edition of ASTM Standard A123/A123M. Geosynthetic reinforcing shall meet AASHTO LRFD Bridge Design Specifications Clause 11.10.6.4.3b. The requirements “for applications involving severe consequences of poor performance or failure” shall apply. Results of product specific durability studies carried out to determine the product-specific long term strength reduction factor (RF) shall be submitted for the Consultant’s review and approval. These studies shall be used to estimate the short term and long term effects of the environment factors on the strength and deformational characteristics of the geosynthetic reinforcement throughout the specified design life.

Geosynthetic reinforcing materials shall satisfy the requirements of the following tests:

- GG 1-87 “Standard Test Method for Geogrid Rib Tensile Strength”
- GG 2-87 “Standard Test Method for Geogrid Rib Junction Strength”
- GG 3-90 “Standard Test Method for Tensile Creep Testing of Geogrids”
- GG 4-05 “Standard Practice for Determination of the Long Term Creep Design Strengths of Geogrids”

Geosynthetic reinforcing materials shall contain stabilizers or inhibitors to prevent degradation of properties due to ultraviolet light exposure.

25.3.4 Safety Rail Materials

Safety rail shall be fabricated in accordance with Section 12 "Bridgerail" of the Specifications for Bridge Construction.

25.3.5 Backfill Materials

The structural backfill shall be "Crushed Aggregate Material" meeting the requirements of the following table:

Metric Sieve Size (CGSB 8-GP-2M)	Designation/Class		
	Crushed Aggregate Material Des 2 Class 20	Crushed Aggregate Material Des 2 Class 25	Crushed Aggregate Material Des 2 Class 40
Sieve Size µm	Percent Passing	Percent Passing	Percent Passing
125 000			
80 000			
50 000			
40 000			100
25 000		100	70 - 94
20 000	100	82 - 97	
16 000	84 - 94	70 - 94	55 - 85
10 000	63 - 86	52 - 79	44 - 74
5 000	40 - 67	35 - 64	32 - 62
1 250	22 - 43	18 - 43	17 - 43
630	14 - 34	12 - 34	12 - 34
315	9 - 26	8 - 26	8 - 26
160	5 - 18	5 - 18	5 - 18
80	2 - 10	2 - 10	2 - 10
% fractures by weight (2 faces)	60+	60+	50+
Plasticity Index		NP - 6	NP - 6
L.A. Abrasion Loss Percent Maximum		50	50

*Note: For MSE wall systems consisting of geosynthetic soil reinforcement, the backfill designation/class should be chosen by the designer based on expected performance of the geosynthetic reinforcement.

The physical properties of the structural granular backfill material selected by the Contractor shall be used by the MSE wall supplier in the design of the MSE walls. The selected structural granular backfill material shall also meet the following electrochemical parameters:

REQUIREMENTS FOR STEEL REINFORCING

Select Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
Resistivity	≥ 3000 ohm-cm	G57	T 288-91 I
pH	5 - 10	G51	T 289-91 I
Chlorides	≤ 100 ppm	G512	T 291-91 I
Sulphates	≤ 200 ppm	G516	T 290-91 I
Organic Content	≤ 0.1%	D2974	N/A

REQUIREMENTS FOR GEOSYNTHETIC REINFORCING

Select Backfill Requirements		Test Method (ASTM)	Test Method (AASHTO)
pH	3 - 12	G51	T 289-91 I
Organic Content	≤ 0.1%	D2974	N/A
Design Temperature at the Wall Site	≤ 30°C	N/A	N/A

In no case shall any backfill material placed within 2.0 m of the face panels have more than 5% passing the 0.75 mm sieve size.

25.3.6 Sealer Materials

Sealer shall be applied to the exposed concrete surfaces of the precast concrete panels and the cast-in-place wall coping in accordance with Section 4.25 "Type 1c Sealer" of the Specifications for Bridge Construction.

25.3.7 Geotextile Filter Fabric

Non-Woven geotextile filter fabric shall be in accordance with the following table of minimum average roll value properties:

Non-Woven Geotextile Filter Fabric	
Specifications and Physical Properties	
Grab Strength	650 N
Elongation (Failure)	50%
Puncture Strength	275 N
Burst Strength	2.1 MPa
Trapezoidal Tear	250 N
Minimum Fabric Lap to be 300 mm	

25.4 Construction

The Contractor shall employ qualified personnel experienced in constructing MSE walls to complete this work. The MSE wall shall be installed in accordance with the supplier's recommendation. The supplier of the MSE wall system shall provide a qualified representative on site to advise the erection crew regarding construction procedures. The representative shall be present for a minimum of 25% of the time throughout the construction of all phases of MSE wall as determined by the wall supplier.

The construction of the MSE wall system shall conform to the details on the approved shop drawings.

25.4.1 Conformance Criteria

The Contractor shall provide formalized documentation, sealed and signed by the engineer, who is responsible for each of the following construction phases and prior to commencement of each subsequent construction activity:

- Foundation base preparation
- On-site delivery of all components
- Alignment of precast wall panels as per contract requirements
- Backfill material gradations and compaction requirements

25.4.2 Excavation

Excavation for the wall shall be carried out in conformance with Section 1 “Excavation” of the Specifications for Bridge Construction. Excavation shall be done to establish grades to within reasonably close conformity to the design grades and limits shown on the drawings and shop drawings. The foundation subgrade shall be proof rolled to identify any soft spots. Soft material shall be removed and replaced with compacted granular material to the satisfaction of the geotechnical consultant. Temporary excavation support as required shall be the responsibility of the Contractor. In addition, the Contractor shall establish the locations and extents of all underground services in the work area prior to commencement of work. All underground service locations shall be clearly marked and protected during the course of construction. All damages to existing services resulting from the Contractor’s operations shall be repaired at the Contractor’s expense.

25.4.3 Backfill

Backfill shall be in accordance with Section 2 “Backfill” of the Specifications for Bridge Construction and shall include the supply, placing and compaction required for construction of the MSE walls. Backfill placement shall closely follow erection of each course of panels. Backfill shall be placed in such a manner as to avoid any damage or disturbances of the wall materials or misalignment of the face panels. All wall materials that are damaged during backfill placement shall be removed and replaced at the Contractor’s expense. Any misalignment or distortion of the face panels due to placement of backfill shall be corrected by the Contractor at his expense.

A minimum 300 mm wide strip of filter fabric shall be installed behind all face panel joints. An adhesive shall be used to hold the fabric securely against the panels.

No equipment shall be allowed to run directly on the soil reinforcement. Backfill compaction shall be performed in such a manner that the compactor shall move in a direction parallel to the wall panels and work toward the end of the soil reinforcement away from the wall facing. Only hand operated power tampers and vibrators shall be used for compaction within 1000 mm of the wall panels. The Contractor shall slope the last level of backfill material away from the wall panels, at the completion of each day’s work to direct potential run-off away from the wall face. In addition, the Contractor shall not permit any surface runoff from adjacent areas to enter the wall construction site.

25.4.4 Precast Panel Tolerance

Precast concrete panel manufacturing tolerances shall be as described in CSA A23.4. The tolerance after installation shall be:

1. The flatness tolerance of wall surfaces measured in any direction shall not exceed 10 mm/m
2. The offset of adjacent panel edges at joints shall not exceed 10 mm
3. The variation for minimal joint gap shall not exceed 1.5 mm/m
4. The overall vertical tolerance of the completed wall (top and bottom) shall not exceed 13 mm/3 m of wall height.

Should any panels be out of tolerance, the backfill shall be removed and the panels reset to the proper tolerance.

To facilitate construction of the cast-in-place concrete coping, nominal-sized, pre-formed holes in the precast panel are permitted providing the holes are located a minimum of 100 mm above the coping soffit.

25.4.5 Material Storage

The Contractor's lay-down area shall be level graded to ensure the panels are safely and uniformly supported on timber bearing blocks. Precast concrete panels shall be stacked on timber planks or pallets and separated by timber blocks as required by the precast design engineer. Soil reinforcing material and connectors shall be stored clear of the ground. All materials shall be covered and protected from rain, snow, dirt and ultraviolet light. The precast panels shall be stored such that the uniform color of the panels is maintained and protected from staining or discoloration.

25.5 Payment

Measurement for payment for the design and construction of mechanically stabilized earth wall will be by square metre of installed precast panel wall face measured in place.

Payment will be made at the unit price bid for "**Mechanically Stabilized Earth Wall**", and will be full compensation for design and construction including, but not limited to such items as all excavation, backfill and compaction below the MSE walls where required; all excavation, leveling pad construction, backfill and compaction within and beyond the MSE wall zone necessary for construction of the MSE wall; the supply and installation of precast concrete panels complete with epoxy coated reinforcing steel; cast-in-place concrete coping complete with epoxy coated reinforcing steel; soil reinforcement; sealer; drains; traffic barriers; the supply and installation of galvanized steel safety railing including anchor bolts and concrete swale at the top of the MSE wall; and all labour, material, equipment, tools and incidentals necessary to complete the Work.

All costs associated with the design of the MSE wall will be considered incidental to the Work, and no separate or additional payment will be made.