



## DESIGN DIRECTIVE

**To:** Distribution

**From:** Erik J. Stoothoff, P.E. *EJS*  
Chief Engineer

**Date:** April 16, 2021

**RE:** Retaining Wall Design Criteria

---

This design directive identifies the MBTA's requirements for the design of Retaining Walls. In the event that conditions warrant deviation from this directive, the Engineer of Record shall submit a request for a waiver to the Chief Engineer.

Retaining Walls shall be designed as prescribed by codes listed below. MBTA Standards shall apply only where code does not address a topic or the MBTA requires a standard above and beyond the code. The more stringent requirement shall always apply.

### **OBJECTIVE**

The objective of this design directive is to clarify the MBTA's requirements for Retaining Wall Design in an effort to provide durable, reliable and maintainable retaining walls for MBTA projects and to ensure consistent design criteria across the MBTA System.

### **CODES AND STANDARDS**

Retaining walls shall be designed and constructed per the requirements of the following:

- AREMA Manual for Railway Engineering of The American Railway Engineering and Maintenance-of-Way Association, commonly referred to as AREMA;
- AASHTO LRFD Bridge Design Specifications of the American Association of State Highway and Transportation Officials, commonly referred to as "AASHTO LRFD Specifications";
- Standard Specifications for Highway Bridges of the American Association of State Highway and Transportation Officials, commonly referred to as "AASHTO Specifications." (Used for Allowable Stress Design Load Combinations and/or for evaluation of existing structures as applicable);
- AASHTO Guide Specifications for LRFD Seismic Bridge Design;
- AASHTO Guide Specification for Service Life Design of Highway Bridges;
- National Fire Protection Association (NFPA) 130, Standard for Fixed Guideway Transit and Passenger Rail Systems, commonly referred to as "NFPA 130";

- MBTA Guide Specifications for Structural Design of Rapid Transit and Light Rail Structures, commonly referred to as the “MBTA Guide Specifications”;
- MBTA Railroad Operations Directorate;
- MassDOT LRFD Bridge Manual Parts I, II, and III of the Massachusetts Department of Transportation, commonly referred to as “MassDOT LRFD Bridge Manual”;
- Standard Specifications for Highways and Bridges of the Massachusetts Department of Transportation, commonly referred to as “MassDOT Specifications”;
- 780 CMR Massachusetts State Building Code of the Commonwealth of Massachusetts, commonly referred to as the “Massachusetts Building Code”;
- The Structural Welding Code – Steel, AWS D1.1, (AWS D 1.1) of the American Welding Society

## **DESIGN PRICIPALS**

### **General:**

1. Retaining walls located within a rail corridor, rail yard, or which otherwise support rail loading, shall be designed in accordance with the AREMA Manual for Railway Engineering. Where retaining walls are subject to highway loading, the design shall be in accordance with the AASHTO LRFD Specifications. Where both of the previous two conditions apply, the most stringent requirements shall be met.
2. Retaining walls constructed as part of a station or other building structure with an exposed face of over 4 vertical feet, may be subject to the requirements of the Massachusetts State Building Code and state building permitting. The AHJ shall be consulted for confirmation of such requirements on a case-by-case basis.
3. Retaining wall types shall be selected on a case-by-case basis, based on the following principles (in no particular order):
  - Design loading
  - Soil conditions
  - Constructability
  - Construction costs
  - Maintenance requirements
  - Aesthetics
4. Design loading for retaining walls supporting earth within the railroad zone of influence, or for retaining walls supporting structures that support train loading, shall include appropriate train live load surcharge. The zone of influence is defined at the area contained within a line that extends horizontally 5.5-feet off the centerline of adjacent track at the top of tie elevation, then down on a 2 (horizontal) to 1 (vertical) slope.
5. Where train live loading occurs, the surcharge shall be calculated using AREMA criteria and the following train loading:
  - a. Commuter rail track: Cooper E-80 + Impact.
  - b. Transit rail track: In accordance with the MBTA Guide Specifications
6. Allowable bearing pressures and other soil properties shall be as recommended by a

licensed geotechnical engineer. The maximum soil bearing pressure and allowable soil bearing pressure shall be shown on the design plans.

7. The engineer of record shall establish appropriate allowable wall deflection criteria on a project-by-project basis.
8. The recommendations of the AASHTO Guide Specification for Service Life Design of Highway Bridges shall be used to achieve the minimum required service life with the assumption that the minimum required amount of maintenance will be performed to keep the asset in a state of good repair over the life of the asset.
9. Retaining walls supporting public spaces with an exposed height of greater than 18-inches shall be protected with fencing or guardrail along the top of wall designed in accordance with the Massachusetts State Building Code.

Retaining walls supporting ROW track infrastructure or non-public spaces with an exposed height of greater than 4-feet shall be protected with ROW fencing or guardrail along the top of wall. Where used, guardrail shall be design in accordance with the requirements of OSHA 1910.29(b).

10. The design of existing retaining walls on MBTA property shall never be used as a precedent and/or justification for not achieving the requirements of this directive.

#### **Permanent Retaining Walls:**

1. Retaining walls shall be utilized as required to minimize property impacts, land acquisitions, impacts to wetlands and environmentally sensitive areas, and to facilitate grading around bridges and other structures.
2. Permanent retaining walls shall be designed with a minimum service life of 75-years. When supporting rail loads, the minimum service life shall be increased to 100-years.
3. Acceptable permanent retaining wall types include:
  - Concrete gravity, semi-gravity, cantilever, and counterfort
  - Anchored and non-anchored soldier beam with concrete facing or lagging<sup>1</sup>
  - Secant pile with concrete facing
  - Precast modular block (PMB)<sup>2</sup>
  - Anchored sheet pile with concrete facing
  - Cantilever sheet pile with concrete facing<sup>3</sup>
  - Soil nail with concrete facing<sup>3</sup>
  - Mechanically stabilized earth (MSE)<sup>2,3</sup> or PMB with soil reinforcement system
    1. Solder beams within 25-feet of track centerline shall be placed in pre-augured shafts, not driven.
    2. System type shall be subject to MBTA approval.
    3. Shall not be used within the railroad zone of influence or support train loading in any way.
4. Anchored soldier beam and anchored sheet pile walls may be permitted for use within the railroad zone of influence given that the following requirements are achieved:
  - a. The use of an anchored wall, in lieu of alternative retaining wall systems, offers superior value to the MBTA through cost savings and/or performance benefits.

- b. A vertical clearance of 5-feet shall be maintained between the top of rail and tie-back elevation at wall face.
  - c. Spacing of tie-backs shall be such that it does not preclude the installation of future OCS foundations or other future structures.
  - d. Suitable corrosion protection shall be provided taking into consideration the potential for stray current from present or future rail electrification.
5. Faces of retaining walls, for either cut or fill applications, shall be spaced sufficiently away from the centerline of track to be outside of the revenue vehicle dynamic envelope plus the minimum required walkway width, as required by NFPA 130, while also accommodating for wayside equipment and structures.
  6. Top of retaining walls shall extend a minimum of 6-inches above the required track ballast elevation.
  7. Retaining walls facing abutting properties shall maintain a 5-foot minimum clearance from the property line to allow for maintenance.
  8. Drainage for retaining walls shall be accomplished with the use of Weepholes or under drain systems. Weepholes shall utilize a minimum 4-inch diameter PVC pipe spaced at no more than 10-feet on center. Weepholes shall not drain directly into a walkway or roadway. Under drain systems, when used, shall contain cleanouts at changes in direction and at minimum 300-foot intervals. Under drain systems shall flow directly into an existing drainage system.

### **Temporary Retaining Walls**

1. Temporary shall be defined as being in service for no longer than the duration of the construction project. Any wall required to be in service for a longer period shall conform to the requirements of Permanent Retaining Walls.
2. Temporary retaining walls and shoring shall be designed and constructed in a manner that protects adjacent buildings, bridges, railways, roadways, and traffic, while allowing inspection access for existing facilities and structures.
3. Temporary retaining walls shall meet the requirements of the MBTA Railroad Operations Directorate.
4. Temporary retaining walls shall be designed with a minimum service life of 5-years. When a longer service life is projected, the retaining wall shall be considered as permanent and shall conform to the requirements of Permanent Retaining Walls.
5. Acceptable temporary retaining wall types include:
  - Sheet pile
  - Soldier beam and lagging<sup>1</sup>
  - Micro-pile and lagging
    1. Solder beams within 25-feet of track centerline shall be placed within pre-augured shafts, not driven.
6. The construction contractor shall be responsible for the design of temporary retaining walls. The engineer of record shall develop and include in the contract documents

performance criteria for the design of temporary retaining walls. The contractor's design shall be stamped by a professional engineer registered in the Commonwealth of Massachusetts. Design and use of temporary structures shall be subject to approval of the engineer of record and the MBTA.

7. The contractor shall be responsible for the preparation of design submittals for review and approval by the engineer of record. Submittals shall include the following at a minimum:
  - a. Stamped design calculations for all elements of the temporary shoring system.
  - b. Stamped engineering drawings to scale including plans, elevations, and representative sections illustrating critical dimensions.
  - c. Stamped construction sequencing plans detailing all steps required for safe installation, excavation, and removal of the temporary shoring system.
  - d. Stamped wall and track instrumentation and monitoring plans.
  - e. Product data for all materials used.
8. Temporary retaining wall and track instrumentation and monitoring plans shall be developed in accordance with the MBTA's *Construction Monitoring Programs* design directive.