

PC-17 *RETAINING WALLS*

Refer to: ITD Standard Specifications, Sections 210 and 512.

For assistance, contact the Geotechnical Engineer at ITD Headquarters.



BMP Objectives

- Perimeter Control
- Slope Protection
- Borrow and Stockpiles
- Drainage Areas
- Sediment Trapping
- Stream Protection
- Temporary Stabilizing
- Permanent Stabilizing

Definition and Purpose

Retaining walls are structures that are constructed to support almost vertical (steeper than 70 degrees) or vertical slopes of earth masses. All walls over 5 feet in height shall be engineered.

Different common retaining wall types include the following:

- **Rigid Gravity and Semi-Gravity Walls:** These walls are often constructed of reinforced concrete, un-reinforced concrete, or stone masonry. The rigid gravity walls develop their soil retaining capacity from their dead weights. The semi-gravity walls, such as cast-in-place concrete cantilever walls, develop resistance to overturning and sliding from self-weight and weight of soil above the wall footing.
- **Prefabricated Modular Gravity Walls:** These walls include crib walls, bin walls, and gabion walls. A crib wall, concrete or timber, is a gravity retaining structure that consists of interlocking concrete or timber elements. Each crib unit is filled with compacted granular soil. A bin wall, concrete or metal, is constructed of adjoining closed-face or open-face bins. Each bin unit is filled with compacted granular soil. Gabion walls consist of baskets made of galvanized steel mesh or PVC coated wire mesh. The baskets are filled with durable rock ranging in size from 4 to 8 inches.
- **Non-Gravity Cantilevered Walls:** These walls develop lateral resistance through the embedment of vertical wall elements and support retained soil with wall-facing elements. Vertical wall elements are normally extended deep in the ground to provide lateral and vertical support. The vertical wall elements can be piles, drilled shafts, steel sheet piles, etc. Wall faces can be reinforced concrete, metal, or timber. Cantilevered walls are generally limited to a maximum height of about 20 feet.
- **Anchored Walls:** These walls typically consist of the same elements as the non-gravity cantilevered walls but derive additional lateral resistance from one or more tiers of

anchors. The anchored walls are typically used in the cut situation, in which the construction proceeds from the top to the base of the wall.

- **Mechanically Stabilized Earth (MSE) Walls:** These walls normally include a facing element and a reinforcement element embedded in the backfill behind the facing. The facing element can be concrete, panel or segmental block, or steel wire mesh. The reinforcement element can be either metallic (strip, grid, wire mesh) or geosynthetic (geotextile, geogrid). MSE walls are often used to support fills and when substantial total and differential settlement are anticipated. Most of the MSE walls are proprietary, and a list of pre-approved MSE walls for use can be obtained from the Geotechnical Engineer at ITD Headquarters Resources Center.

Appropriate Applications

Retaining walls are often used near the toe of a cut or fill slope, so that a flatter slope can be constructed to prevent or minimize slope erosion or failure. They can also be used to keep a toe of a slope from encroaching into a wetland area or into a stream and thus prevent potential undercutting of the toe by flowing water.

Limitations

Retaining walls, in most instances, are considered a permanent measure. Cost and site-specific design requirements limit their use to situations where other stabilization measures would be ineffective or aesthetically unacceptable.

- Non-engineered walls should not be used where traffic is expected near the top of the wall.
- Rock retaining walls have a maximum height of about 10 feet.
- Railroad tie retaining walls require a firm foundation to anchor the wall.
- Some MSE walls have height restrictions. Backfill must meet specific materials property requirements to avoid corrosion of the backfill metallic reinforcements. MSE walls should not be used when utilities will be located within the reinforced backfill zone unless access is provided to those utilities.

The use of retaining walls below the high water mark of a stream or other water body (waters of the U.S.) should be carefully evaluated due to Section 404 permit requirements. A Section 404 permit and an Idaho Department of Water Resources Stream Alteration Permit may be required.

Design Parameters

- Most retaining walls require a site-specific design. Wall heights, requirements for drainage, and suitable materials must be determined through on-site investigation. MSE walls are normally designed by the manufacturer.
- An engineered retaining structure is a designed structure that is supported by plans and specifications signed and sealed by a Professional Engineer licensed in the State of Idaho.
- Non-engineered retaining structures may be designed by an engineer; however, if the design is not supported by the seal and signature, the retaining structure is not considered to be engineered. Non-engineered walls should not be used when traffic is expected near the top of the wall.

- Concrete retaining wall: An engineered concrete wall designed to stabilize a slope and retain the rock or soil behind it.
- Masonry retaining wall: A structure similar to a concrete retaining wall but using masonry blocks of specific design for aesthetic appeal. A masonry block wall consists of prefabricated segmental blocks that are stacked, keyed into or interlocked with each other. A masonry block wall may or may not include soil reinforcement. When soil reinforcement is included, a masonry block wall system is considered an MSE wall system.
- Rock retaining wall: A gravity wall constructed of rock materials to provide an aesthetically attractive method of supporting a soil mass. A rock retaining wall is suitable in situations where the wall is up to about 10 feet and where the slope is 2H:1V or flatter behind the wall.
- Railroad tie retaining wall: A retaining wall constructed of railroad ties. The wall must be securely anchored to the rock base or firm subsoil.
- Gabions: Single- or multi-celled rectangular wire mesh baskets that are filled with rock and wired together to form a retaining structure. Gabions can be used as retaining walls to mechanically stabilize over-steep slopes and are particularly useful where seepage is anticipated. Refer to the Standard Specifications for property requirements for gabions. Erosion control geotextile is often placed behind gabion baskets to prevent the fine material of the retained soil from entering the basket.
- Geosynthetic retaining wall: A flexible retaining wall constructed of geosynthetics, often a geotextile or geogrid. A geosynthetic wall is constructed by placing successive layers of fill material, each on a geosynthetic layer with the geosynthetic folded over and covering the face of the wall. The weight of the next layer of fill material then holds the folded geosynthetic from the previous layer in place.
- MSE retaining wall: These wall systems are normally used in a fill situation. Many of these wall systems can sustain large differential settlement.

Construction Guidelines

Rock retaining wall guidelines:

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- A footing trench shall be excavated at the location of the proposed wall.
- The largest rocks in the footing trench shall be placed with their longitudinal axis normal to the wall face. Subsequent rock layers shall be arranged so that each rock above the foundation course has a firm seating on the underlying rocks.
- The batter of the wall face shall be between ½H:1V and vertical, depending upon the height of the wall, the height of the slope, the width of the right-of-way, or other limitations on space.

- Fill material shall be placed behind the rock wall. The slope above the wall shall be maintained at 2H:1V or flatter. The footing trench shall be backfilled with excavated material.
- If a roadway is located at the toe of the wall, the roadway shall be paved up to the base of the rock wall and roadway curbs shall be provided for water transport. If a roadway is not located at the toe of the retaining wall, the backfilled material shall be sloped away from the wall.
- The stabilized slope shall be revegetated with a method applicable to the particular site.

Railroad tie retaining wall guidelines:

- Prepare the site by rough grading the ground surface. Set the bottom course of railroad ties onto a rigid base foundation material, and secure with pinning or metal collars.
- Place fill material behind the wall.
- Place next layer of railroad ties and fasten it to the lower layer.
- Place backfill and compact.
- Proceed in a similar fashion to the desired height.
- Revegetate the backfill behind the walls according to procedures applicable to the specific site.

Geosynthetic retaining walls:

- Do not allow equipment to operate directly on the geosynthetic.
- Contact ITD Headquarters Geotechnical Engineer for further guidance.
- All other walls should be constructed as designed by a Professional Engineer or as shown on the plans. A Special Provision for MSE retaining walls can be obtained from the Geotechnical Engineer at the Headquarters Resources Center.

Maintenance and Inspection

- Conduct inspections as required by the NPDES permit or contract specifications during construction.
- Periodic inspection and maintenance will be required based on post-construction site conditions.
- Make any repairs necessary to ensure the measure is operating properly.