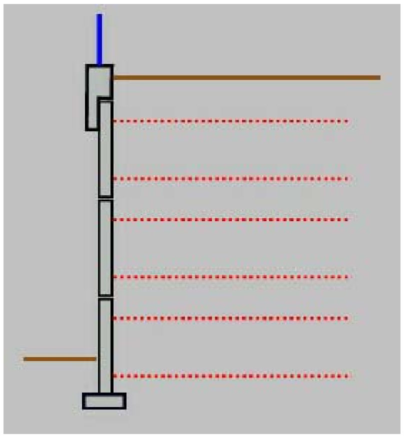
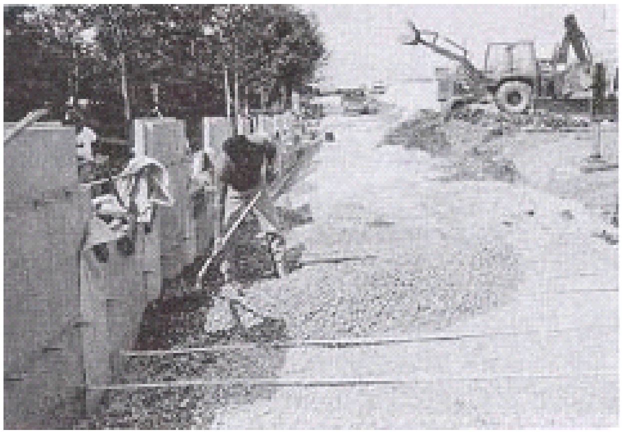
Mechanically Stabilized Earth Structures

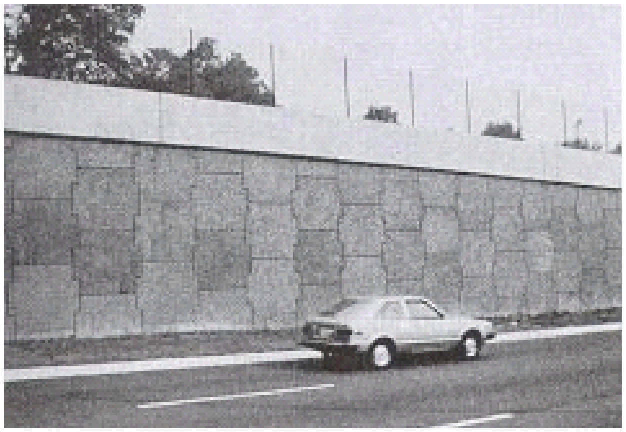
International Society for Soil Mechanics and Geotechnical Engineering



A segmental, precast facing mechanically stabilized earth wall employs metallic (strip or bar mat) or geosynthetic (geogrid or geotextole) reinforcement that is connected to a precast concrete or prefabricated metal facing panel to create a reinforced soil mass.



Construction of MSE wall



Completed MSE wall

Principles

The reinforcement is placed in horizontal layers between successive layers of granular soil backfill. Each layer of backfill consists of one or more compacted lifts. A free draining, nonplastic backfill soil is required to ensure adequate performance of the wall system. For walls reinforced with metallic strips, load is transferred from the backfill soil to the strip reinforcement by shear along the interface. For walls with ribbed strips, bar mats, or grid reinforcement, load is similarly transferred but an additional component of strength is obtained through the passive resistance on the transverse members of the reinforcement. Metallic reinforcement and high modulus geosynthetic reinforcement, which are relatively inextensible, require less deformation to mobilize shear strength as compared to geotextiles and lower modulus geogrids. Facing panels are typically square, rectangular, hexagonal, or cruciform in shape and are up to 4.5 m^2 in area.

Types

MSEW - Mechanically Stabilized Earth Walls, when the face batter is generally steeper then 70 degrees.

RSS - Reinforced Soil Slopes, when the face batter is shallower.

Applications

MSEW structures are cost effective alternative for most application where reinforced concrete or gravity type walls have traditionally been used to retain soil, including bridge abutments and wingwalls, dikes as containment structures, dams, seawalls, and bulk storage structures.

RSS structures are cost effective alternatives for new construction where the cost of embankment fill, right-of-way, and other considerations may make a steeper slope desirable. Another use of reinforcement in engineered slopes is to improve compaction at the edges of a slope to decrease the tendency for surface sloughing.

Design

For MSEW

Current practice consists of determining the geometric and reinforcement requirements to prevent internal and external failure using limit equilibrium methods of analysis.

- External stability evaluations treat the reinforced section as a composite homogenous mass and evaluate the stability according to conventional failure modes for gravity type wall systems.

- Internal stability: significant advances took place after a fundamental research and analysis of instrumented structures (Christopher et al. 1989) which established that the state of stress internally developed is a function of reinforcement used, or its stiffness (geotextile, geogrid, metal strip or metal grid) and its density within the reinforcement soil zone. The results of this research have been synthesized in a simplified coherent gravity method adopted by the FHWA.

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Special design criteria are required to address performance criteria, corrosion of steel reinforcement elements, deterioration of exposed facing elements to aggressive environments or freeze-thaw cycles and the potential deterioration of polymer reinforcement in the ground

For RSS

The design concepts used for reinforced slope design are similar to those used for design of unreinforced slopes in that satisfactory factor of safety must be provided for all possible failure modes. The reinforcement is represented by concentrated force within the mass that intersects the potential failure surface. By adding the failure resistance provided by this force to the resistance already provided by the soil, a factor of safety equal to the rotational stability safety factor is inherently applied to the reinforcement.

Typically:

- Circular or wedge type potential failure surfaces are used
- The relationship between driving and resisting forces or moments determines the slope factor of safety
- Reinforcement layers intersecting the potential failure surface are assumed to increase the resisting moments based on their tensile capacity and orientation, typically neglecting shear and bending strength.
- The tensile capacity of the reinforcement layer is taken as the minimum of its allowable pullout resistance behind the potential failure surface and its long term allowable strength

Advantages

- wall system construction is relatively rapid and does not require specialized labor or equipment
- limited foundation preparation is required
- wall system is flexible and can accommodate relatively large total and differential settlements without distress
- reinforcement is light and easy to handle
- concrete facing panels permit greater flexibility in the choice of facing and architectural finishes
- since wall system is flexible, it is well - suited for applications in regions of high seismicity.

Disadvantages

- wall system requires relatively large base width
- use of metallic reinforcement requires that backfill meet minimum electrochemical requirements for corrosion protection
- allowable load for geosynthetic reinforcement must be reduced to account for creep, durability, and construction damage
- wall system may not be appropriate for applications: 1. Where it may be necessary to gain future access to underground utilities; 2. At locations subject to scour; or 3. Involving significant horizontal curvature.

For RSS:

- Specifications and contracting practices have not been standardized

RECOMMENDED READING

ASCE Geotechnical Special Publication No. 69 (1997). "Ground Improvement, Ground Reinforcement, Ground Treatment Development 1987 - 1997". Edited by R. Schaefer.

AASHTO (1992, 1997). Standard Specifications for Highway Bridges. Section 5.8 Washington, D.C.

Christopher B.R. et al. (1989). Reinforced Soil Structures, Volume I, Design and Construction Guidelines. FHWA RD-89-043. Washington D.C.

Elias V. and Christopher B.R. (1996) Mechanically Stabilized Earth Walls and Reinforced Soil Slopes. Design and Construction Guidelines. FHWA SA-96-071. Washington D.C.

NCMA (1993) Design Manual for Segmental Retaining Walls (Modular Concrete Block Retaining Wall Systems). First Edition. National Concrete Masonry Association. Herndon, VA.