

## USING REINFORCED SOIL FOR CONSTRUCTION OF RETAINING STRUCTURES AND EARTH SLOPES

### INTRODUCTION

In reinforced soil, the strength of the soil is significantly improved by placing tensile reinforcing elements which enable the safe construction of vertical or very steep slopes. Reinforced soil retaining structures have been constructed over time using straw, tree branches, and plant material. However, modern mechanically stabilized earth (MSE) walls first appeared in the 1960s using embedded steel strips affixed to rigid facing elements as soil reinforcement elements. In order to solve corrosion of steel reinforcement strips in MSE structures, geosynthetic reinforcement was introduced in the 1980's and geosynthetic reinforced soil (GRS) structures grew in popularity.

Due to their advantages, the utilization of reinforced soil retaining structures in the form of walls, bridge abutments, and slopes has become more widespread. Ease of installation, quick construction, and cost are the main advantages of reinforced walls compared to conventional reinforced concrete walls. These cost-effective flexible structures can also tolerate much greater settlements than reinforced concrete rigid walls, and may eliminate the need for deep foundation installation. Specifically, with increasing height of soil to be retained and poor subsoil conditions, the cost of reinforced concrete retaining walls increases rapidly.

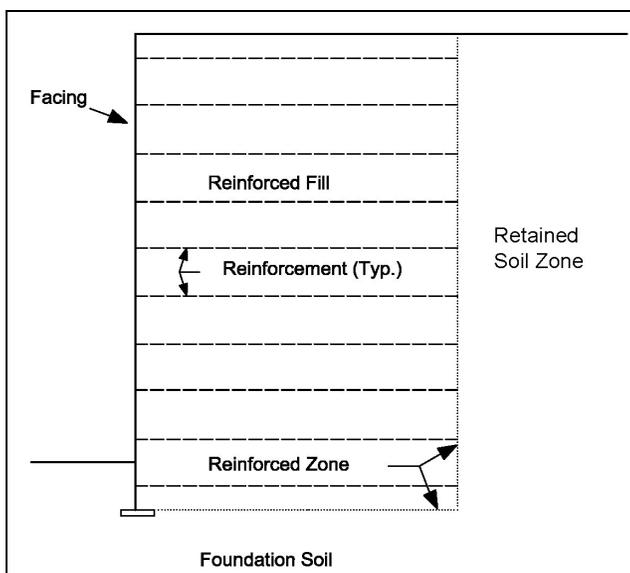


FIGURE 1: TYPICAL CROSS-SECTION OF A REINFORCED SOIL STRUCTURE



(U.S. DEPT. OF TRANSPORTATION, FHWA-GEC110)

FIGURE 2: APPLICATION OF REINFORCED SOIL WALL IN A ROAD CONSTRUCTION PROJECT

Figure 1 displays a typical cross-section of a reinforced soil structure which includes the reinforced soil zone, reinforcement element, retained soil zone behind the reinforced soil zone, and facing elements. Facing is a component of the reinforced soil system used to prevent the soil from erosion and outside weathering. The facing elements are the only visible part of the completed structure and the type of facing elements used control the aesthetics of the structure. Availability and cost are also important factors in the determination of facing type. Common facings include precast concrete panels, dry cast modular blocks, gabions, welded wire mesh, shotcrete, polymeric cellular confinement systems, and wrapped sheets of geosynthetics.

### APPLICATION IN ROAD CONSTRUCTION PROJECTS

Reinforced soil retaining walls are extensively utilized in transportation construction, such as shown in Figure 2. The reinforced soil structure can have a vertical slope which is a significant advantage in the projects in which the right-of-way for embankment is restricted and needs to be minimized.

### APPLICATION AS BRIDGE ABUTMENT

According to Federal Highway Administration (FHWA), there are approximately 600,000 bridges in the United States, and many of them have functional or structural deficiencies. Because of financial issues, the repair or replacement of these structures has been challenging. As a result, the use of more economical means of bridge construction such as MSE (steel reinforced) and GRS (geosynthetic) abutments has been of interest

over the last few decades and reinforced soil abutments have been utilized in many transportation projects in the United States. Figure 3 presents a bridge reinforced abutment.

### APPLICATION IN SLOPE STABILIZATION

Due to high strength, reinforced soil is also utilized to construct earth sloped structures with face inclination of less than 70 degrees. In this case, multiple layers of reinforcement are placed in the slope during construction or reconstruction to reinforce the soil and provide increased slope stability. Reinforced soil slope structures are cost-effective alternatives for new construction and reconstruction where the cost of fill, right-of-way, and other considerations may make a steeper slope desirable. Figure 4 presents a reinforced soil slope.

### OTHER APPLICATIONS

In addition to the aforementioned applications, the reinforced soil can be utilized for other applications including:

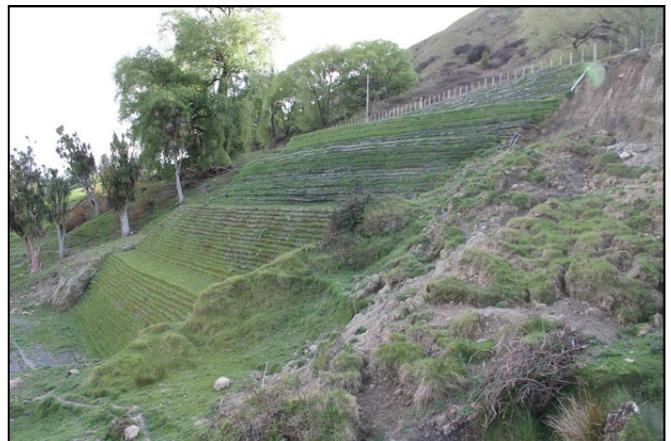
- Dikes to prevent flooding
- Temporary structures, especially as a temporary detour in highway reconstruction projects
- Containment structures for water and waste impoundments around oil and gas storage tanks
- Bulk materials storage area
- Marine structures
- Dams including increasing the height of existing dams

### CONCLUSION

Reinforced soil systems are extensively utilized as retaining structures and in slopes, as well as for other uses, due to their advantages over more conventional solutions. As cost-effective structures, they can easily be installed in a short period of time in all weather conditions. Because of their flexibility, these structures respond well against earthquake load. Their flexibility also makes them a very competitive alternative at sites with compressible foundation soils since they can tolerate higher settlement than rigid structures.



FIGURE 3: BRIDGE REINFORCED ABUTMENTS



(PHOTO COURTESY OF GEOFABRICS, N.Z.)

FIGURE 4: REINFORCED SOIL SLOPES

#### Other Engineering UPDATES of Interest:

[UPDATE # 31: Foundation Construction in Difficult Close-Quarter Conditions](#)

[UPDATE # 42: Advantages of Reinforced Earth Over Other Earth Retainage Systems](#)

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