Selecting reinforced fill soil for MSE retaining walls

A full-scale field test is currently being conducted to establish properties for "high fines" reinforced soils and associated design controls that give acceptable MSE wall performance.

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Mechanically Stabilized Earth (MSE) retaining walls on public sector transportation projects are generally conservatively designed with "low fines" reinforced soils. Private MSE walls are less conservatively designed, and use a variety of reinforced soils (NCMA recommends 35% < 0.075mm or greater). It is also clear from the literature that the combination of reinforced soil consisting of fine-grained soils (either "high" fines or "high" plasticity) and water in the reinforced zone were the principal reasons for serviceability problems (excessive deformation) or failure (collapse).

However, a higher quantity of fines can be safely allowed in the reinforced fill, provided the properties of the materials are well-defined and controls are established to address the design issues. The potential savings from replacing AASHTO reinforced fill materials with marginal reinforced fill materials could be in the range of 20% to 30% of current MSE wall costs.

A full-scale field test is currently being conducted in order to establish properties for “high fines” reinforced soils and associated design controls that give acceptable MSE wall performance. The field test includes provisions to demonstrate the role of porewater pressure in the reinforced fill and the importance of including a positive drainage system to obtain good wall performance. Based on the survey of the literature, to date, full-scale test or experimental MSE walls have not rigorously evaluated this important aspect.

The full-scale field test is primarily funded by the Transportation Research Board, under the National Cooperative Highway Research Project (NCHRP) 24-22, with a portion funded by the National Concrete Masonry Association (NCMA). The objective of NCHRP Project 24-22 is to develop selection guidelines, soil parameters, testing methods, and construction specifications that will allow the use of a wider range of reinforced fill materials within the reinforced zone of mechanically stabilized earth (MSE) walls.

NCHRP Project 24-22 includes four sections:

1) One section with an AASHTO A-1-a reinforced fill to provide a baseline of performance for current AASHTO and FHWA standards.

2) A second section with an AASHTO A-2-4 reinforced fill to demonstrate that non-plastic, silty sand materials with up to 35% fines (of no plasticity) can provide suitable reinforced fill for MSE walls.

3 & 4) The third and fourth sections with an AASHTO A-4 material to demonstrate that silty soils (50% fines) of low to moderate plasticity can provide suitable reinforced fill for MSE walls.

Welded wire was used for the wall face system. NCMA sponsored two additional sections utilizing dry-cast concrete modular block for the wall face. The two NCMA sections consist of the AASHTO A-1-a and A-4 reinforced fill soils used in the NCHRP sections.

Polyester geogrid is being used for the reinforcement in all sections, with the exception of one NCHRP section where nonwoven geotextile reinforcement with in-plane drainage capability was used.

An essential component of an MSE retaining wall that uses reinforced fill with “high fines” soil is aggressive drainage to prevent the buildup of porewater pressure in the reinforced zone. Porewater pressure produces an additional outward force that the wall must resist, and it reduces the strength of the soil that holds the wall in place. Therefore, the field test includes provisions to demonstrate the role of porewater pressure in the reinforced fill and the importance of including a positive drainage system to obtain good wall performance.

Figure 1 shows how this will be accomplished. A geocomposite drainage material has been placed at the back of the reinforcement in each test section. It was wrapped around a slotted drain pipe at the bottom of the reinforced fill that will remove water from the drain.

To simulate groundwater, water is pumped to a feed line at the top of the test sections. A system of valves will control the introduction of water from the feed line into the individual drainage soil zones of each test section via slotted, vertical fill pipes. This will initiate horizontal flow towards the wall and into the geocomposite drain for the wall. By controlling the head in the drainage soil (with the drain pipe open), the effect of rising groundwater level on the performance of the wall can be simulated. We would expect little, if any, effect on the test sections as long as the geocomposite drains function as designed.

This phase of the test is intended to demonstrate that various reinforced fill materials will provide suitable performance, even in areas with high groundwater conditions, as long as they are properly drained.