APPENDIX C — FIELD-SCALE TESTING OF SMSE WALL

Field-scale testing of a shored MSE (SMSE) wall system was conducted at the Federal Highway Administration (FHWA) Turner Fairbanks Highway Research Center (TFHRC) in McLean, Virginia. This appendix presents results of the field testing program.

C.1 PURPOSE

The field-scale testing was conducted to examine two hypotheses with regard to SMSE systems, as follows:

- Primary Hypothesis – Construction of an MSE wall in front of a rigid backslope (i.e., shoring system) results in reduced external lateral loading on the MSE wall compared to a conventional MSE wall.

- Secondary Hypothesis – Fully-connected wall systems provide limited benefit for an SMSE wall system over an unconnected wall system.

C.2 TEST WALL DESIGN

The field-scale test model consisted of testing a wall with short MSE reinforcements (i.e., 0.25*H* to 0.39*H* [25 to 39 percent of the wall height, *H*]). The test wall was constructed using geogrid reinforcements with wire facing elements, typical to that used on many Federal Lands Highway (FLH) projects. Half of the wall (in plan) was constructed as an unconnected system, while half of the wall incorporated reinforcements attached to (or supported through) the shoring wall.

The field-scale test wall was constructed in a concrete pit at TFHRC in McLean, Virginia. The pit dimensions are approximately 7 m long by 5.6 m wide with a depth of approximately 5.5 m. The MSE wall was constructed with a facing batter of 1H:24V (horizontal:vertical). The shoring wall was constructed at a batter of 1H:6V behind the reinforced section. A plan view of the test wall configuration is illustrated in figure 41.

The minimum geogrid reinforcement length (measured at the bottom of the wall) was 1.4 m, corresponding to an aspect ratio of approximately 0.25. The reinforcement length increased from bottom to top, with the longest MSE reinforcement length (2.14 m) corresponding to an aspect ratio of 0.39. The vertical reinforcement spacing was set at a nominal 0.46 m, equivalent to the height of each wire facing element. Figures 42 and 43 provide typical cross sections for the unconnected and connected wall sections, respectively.

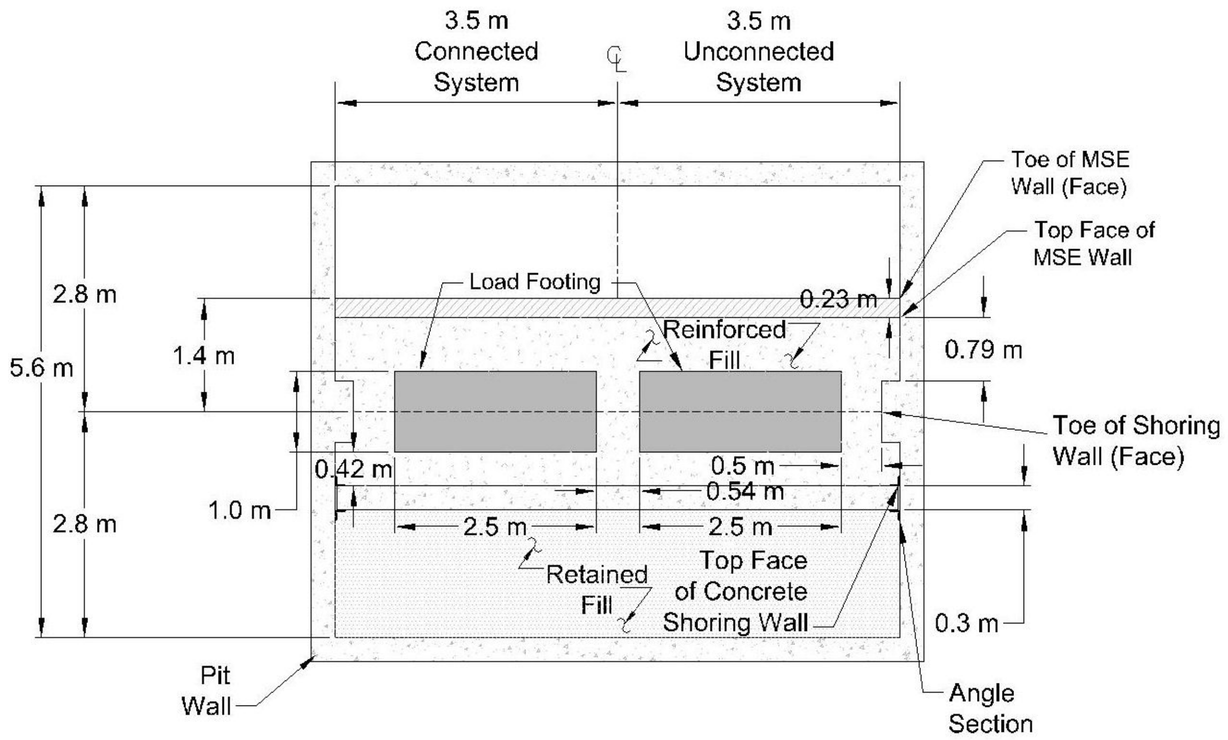

Figure 41. Schematic. Test wall plan view.

The connected portion of the field-scale test wall was achieved by developing a frictional connection with the geogrid reinforcements extended through the shoring wall (compressed between adjacent shoring wall beams) a minimum of one meter and placed in compacted retained fill. The connection detail is provided in figure 44.

The reinforced and retained fill portions of the field-scale test wall were constructed using mortar sand locally-available at TFHRC. This material was also used for Phase II of the centrifuge modeling (appendix B). Material properties of the mortar sand are discussed in appendix B.

Load was applied to the wall using two load footings with dimensions of 2.5 m by 1 m, as illustrated in figure 41. The load footing transmitted load over approximately 35 percent of the reinforced fill surface at the top of the wall.

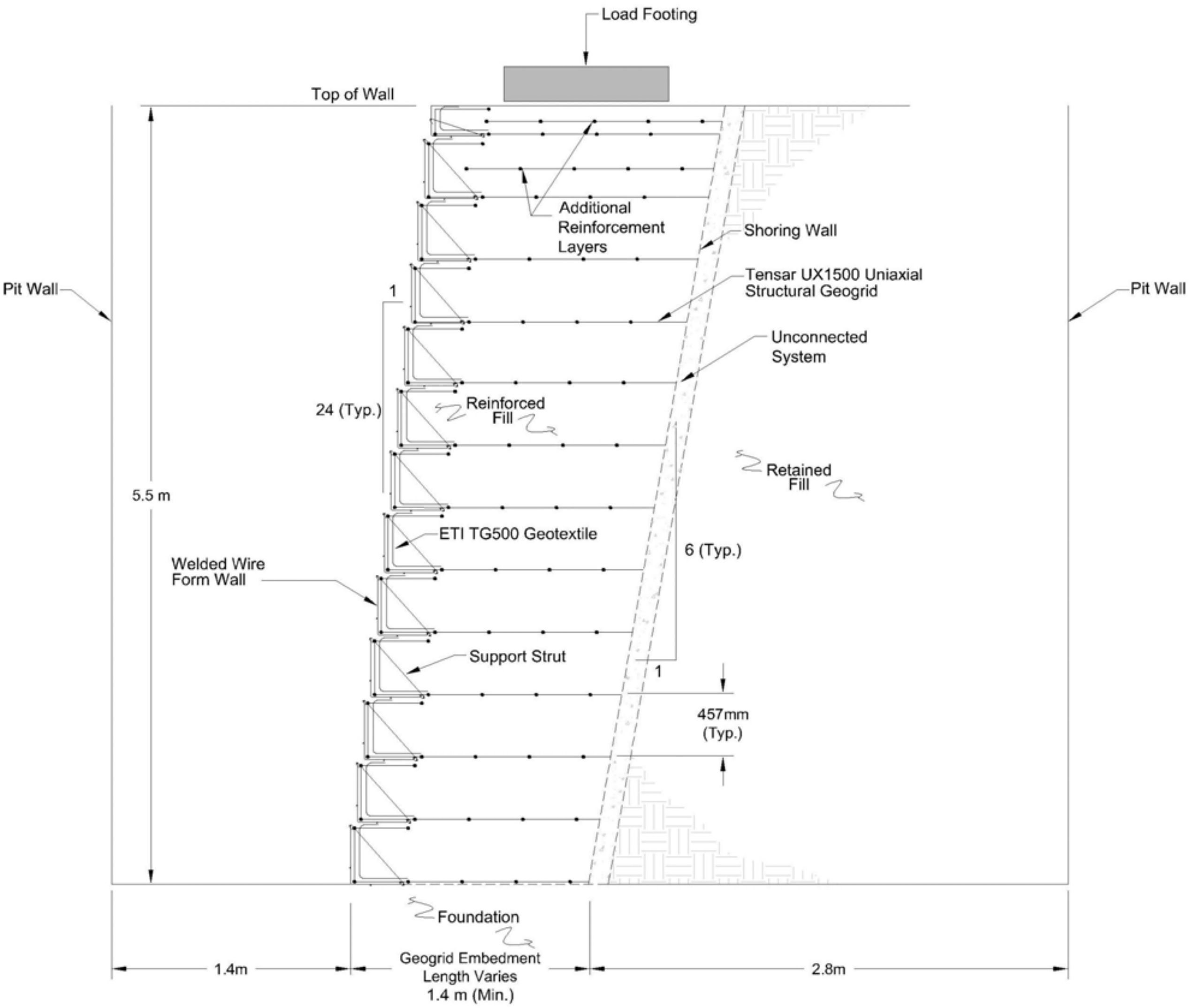

Figure 42. Schematic. Typical field-scale test wall cross section with unconnected system.

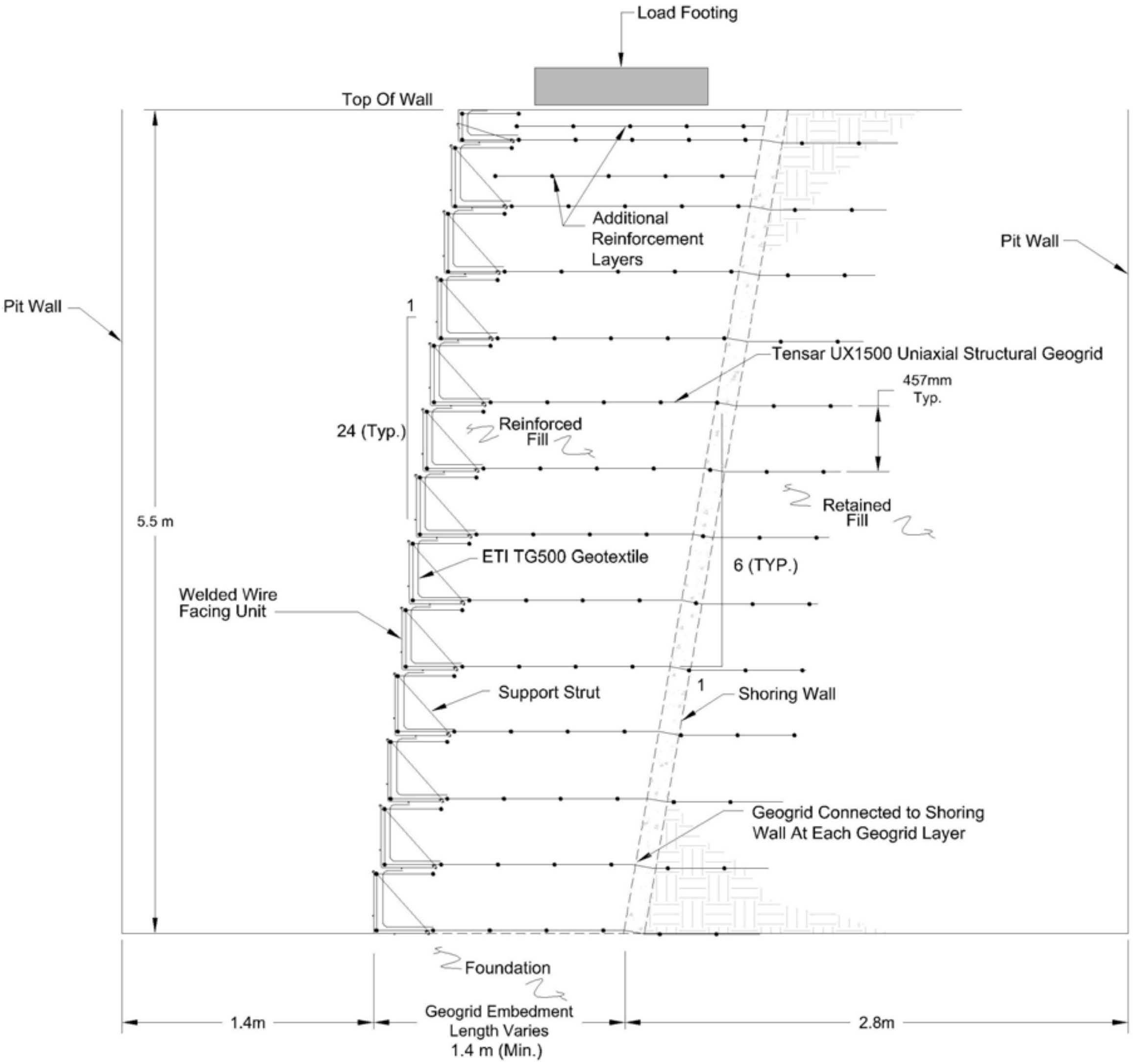

Figure 43. Schematic. Typical field-scale test wall cross section with connected system.

C.3 TEST WALL CONSTRUCTION

The test wall was constructed by TFHRC personnel in September and October 2004. The reinforced fill zone was placed in maximum 200 mm loose lifts, and the retained fill zone was placed in nominally thicker loose lifts. A backhoe was used to place bulk fill in the pit, and the fill was spread manually using shovels. Compaction of the reinforced and retained fill zones was achieved by using a vibratory plate compactor. Figure 45 is a photo of construction of the reinforced and retained fill zones.

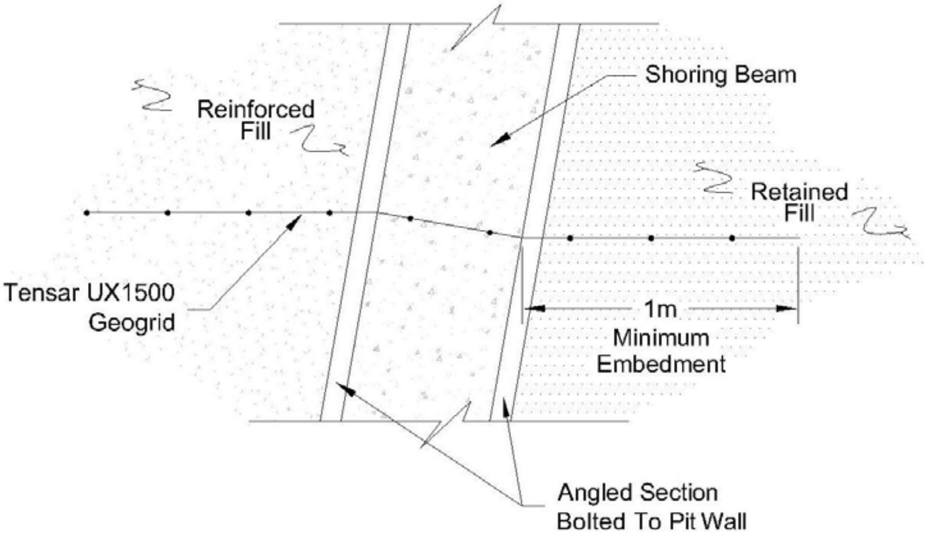

Figure 44. Schematic. Connection detail for connected wall system.

Figure 45. Photo. Reinforced fill compaction and retained fill placement.

During wall construction, nuclear density gage measurements were taken for each lift of reinforced fill (figure 46) to ensure that compaction met or exceeded the specifications, i.e., minimum of 95 percent standard Proctor maximum dry density in accordance with ASTM D698 (or per AASHTO T-99).(7, 62) A compaction test conducted on a sample of TFHRC mortar sand per AASHTO T-99 resulted in a maximum dry density of 15.3 kN/m^3 at an optimum moisture content of 17.4 percent.(7) Results of nuclear density gauge testing indicated that the reinforced fill portion of the field-scale test wall was over-compacted with densities corresponding to 102 to 105 percent of the AASHTO T-99 maximum dry density, and as a result not characteristic of typical wall construction.(7)

Figure 46. Photo. Nuclear density gage testing of reinforced fill zone.

The "shoring wall" was constructed using reinforced concrete beams fixed laterally at each end of the pit using angle sections bolted to the pit walls (figure 47). Each shoring beam was constructed with a height approximately equivalent to the height of each reinforced MSE wall layer for ease of installation. A crane was used to place the shoring beams in the pit, shown in figure 48.

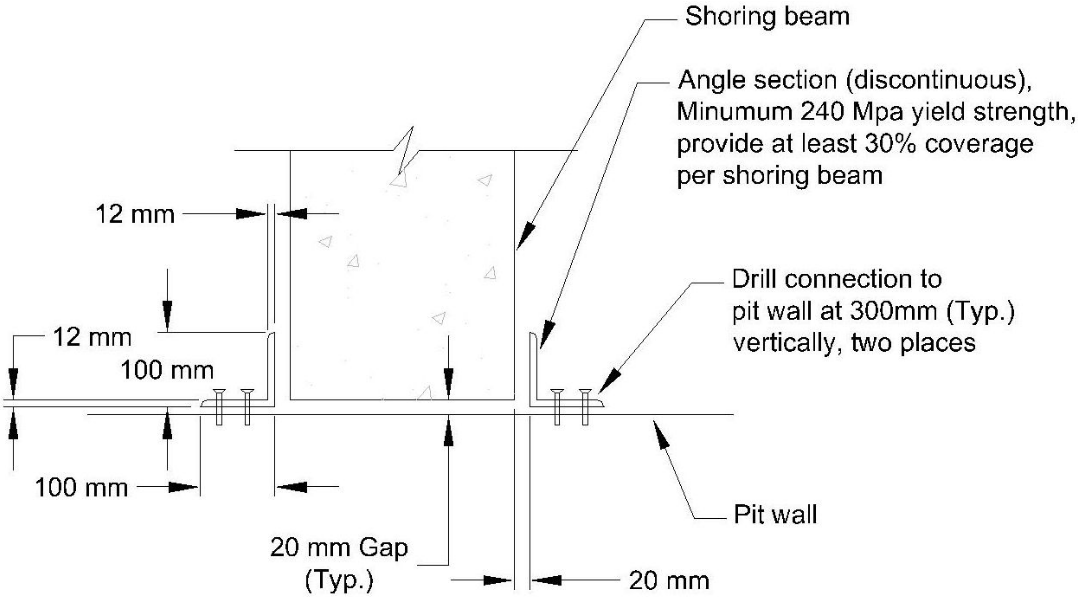

Figure 47. Schematic. Plan view of shoring beam connection to pit wall.

Figure 48. Photo. Installation of shoring beam.

Tensar® welded wire facing forms were used for the facing of the field-scale test wall. These facing units consist of L-shaped wire baskets supported with struts, as illustrated in figure 49. A geotextile wrap was installed adjacent to the wire facing to contain the reinforced fill.

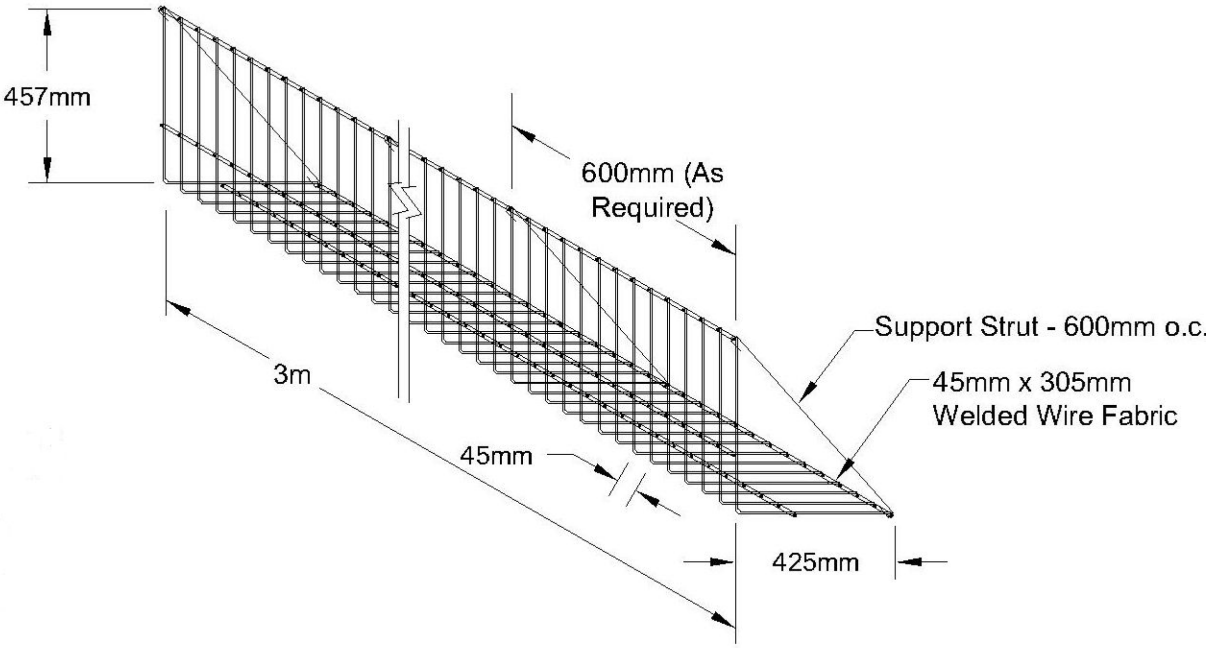

Figure 49. Schematic. Tensar® welded wire facing unit.

Tensar® UX1500MSE uniaxial structural geogrid manufactured from high density polyethylene (HDPE) was used as the MSE reinforcing elements (figure 50). UX1500MSE geogrid has a tensile strength of 52 kN/m at five percent strain, and an ultimate tensile strength of 114 kN/m. Two additional layers of geogrid were placed near the top of the wall to prevent bearing capacity failure of the soil due to the applied loading, as illustrated in figures 42 and 43.

Figure 50. Photo. Geogrid installation.