3-8 MECHANICALLY STABILIZED EMBANKMENT

General Requirements

There are numerous retaining system configurations with layered soil reinforcement. However, Mechanically Stabilized Embankment (MSE) as referred to herein is solely composed of precast concrete face panels and metallic welded wire mat soil reinforcement.

There are two configurations available – the current 5 by 5 which supersedes the classic 2 by 12. The classic 2 by 12 MSE design, developed by Translab in the 1980's, was standardized with a face panel measuring 2 foot by 12 foot. This allowed for recycled metal beam guard railing to be substituted for the concrete face panels where required by project specific design criteria. This design, by the ASD method and in metric units, will be retained by the ERS specialist on Bridge Standard Detail Sheets XS 13-010-1 through 7. The remainder of the information in this section will be specific to the new design as follows.

The current 5 by 5 design, available on Bridge Standard Detail Sheets XS 13-020-1 through 6, in English units, has a face panel measuring 5 foot by 5 foot. This panel size can accommodate a variety of all-over textured or specially designed architectural finishes, and is a size more readily substituted by various proprietary systems available on the market. This design is by the LFD method as set forth in AASHTO Bridge Design Specifications (BDS) 2000 and modified by Caltrans BDS 2004. It is anticipated that this design will need minor updates for the LRFD method when fully implemented for retaining systems.

Loading

Standard loading cases are as shown in Figure 1. Additional loads must be handled separately. See Caltrans BDS Chapter 5. Please note that since the load factors utilized for MSE design were determined by calibration of the safety factors utilized in the ASD method, the ASD method will return similar results. Consequently load cases and load factors are not included herein.

Seismic design for MSE should include conventional pseudo-static loading during global stability analyses. Internal seismic loading is not utilized in MSE design.

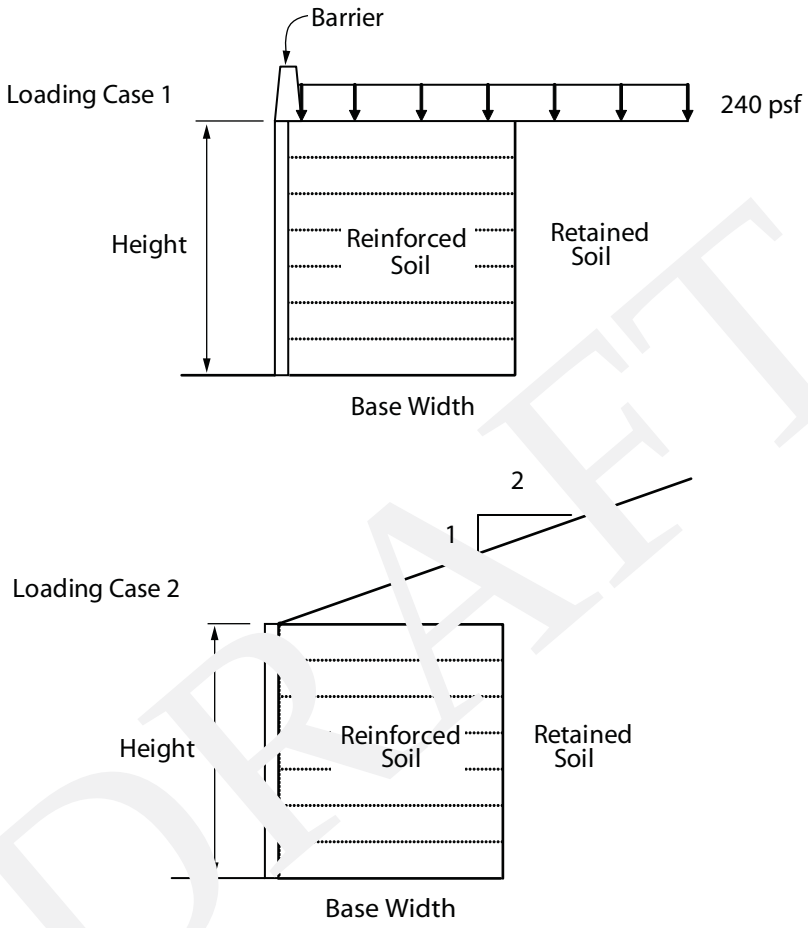

Figure 1

Soil Reinforcement Design Layouts

Tables 1 and 2 define a layout for the welded wire mat soil reinforcement corresponding to the 5 by 5 panel. For this layout to be used, the base width must be a minimum of 70% of the height for loading condition 1. Under loading condition 2, the base width must be increased to at least equal to the height. No additional loading is accounted for in these design layouts. These layouts need be modified to meet the design requirements of additional loads.

Bottom Panels

The layout pattern for the precast concrete facing panels of the 5 by 5 MSE is a vertical running bond. Therefore the bottom panels of the MSE will switch from full height of 5 feet to a half height of 2.5 feet every other column of panels. This makes it convenient to step the bottom elevations at intervals of 2.5 feet where needed. The leveling pad is not a footing and so does not contain steel reinforcement.

Top Panels

The standard details show a minimum dimension for the top panel which will accommodate both the development length necessary for the panel connections to the soil reinforcement, as well as the typical coping details. Where layouts incur less height available at the top panel then these minimum dimensions, the additional facing height needs to be added to the top of the next lower panel of that column. This may result in a panel with three layers of soil reinforcement attached. Top of wall elevations vary too much from project to project for typical detail layouts. Special details are therefore required.

Drainage

Corrosion will shorten the life of an MSE. A standard underdrain placed under the welded wire mat soil reinforcement will drain excess moisture away and reduce long term corrosion. Underdrain outlets should be placed as necessary to drain or at least every 200 feet along the length of the underdrain. At sags in the underdrain profile, separate outlets should placed for each direction of flow. The outlets may be installed to drain through the facing panels, but placement under the leveling pad is preferred. The underdrain outlets may be shown either on the MSE layout, or incorporated with the drainage profiles in the road plans, as appropriate for the complexity of the resulting drainage system.

Additionally, a chimney drain may be installed at the back of the excavation, when high levels of ground water are anticipated, or as recommended in the Foundation Report from Geotechnical Services.

Inspection Wires

Unlike most other types of retaining systems, the load carrying members of an MSE are the soil reinforcements buried in the embankment material where they cannot be inspected over the life of the facility and after seismic events. Inspection wires are made of the same galvanized steel as the soil reinforcements and installed at the same time within the embankment materials, but are sized small enough to be removed for inspection periodically or when otherwise needed. They should be located near the center of the precast panels that will still be accessible after final grading and installation of all barriers, fences, signs, etc.

A set of 18 inspection wires is required for every MSE section of at least 100 feet long with a height equal to or greater than 17 feet. Sets should be located approximately 500 feet apart, along the LOL. Array the wires to roughly cover the surface evenly from top to bottom of the exposed face. Place wires in every fourth panel column along the LOL (20 feet apart) and number them according to the typical layout as shown in Figure 2. In MSE that are not sized large enough to accommodate this typical layout, place at least one row of 6 wires along the LOL and number according to the top row of the typical layout.

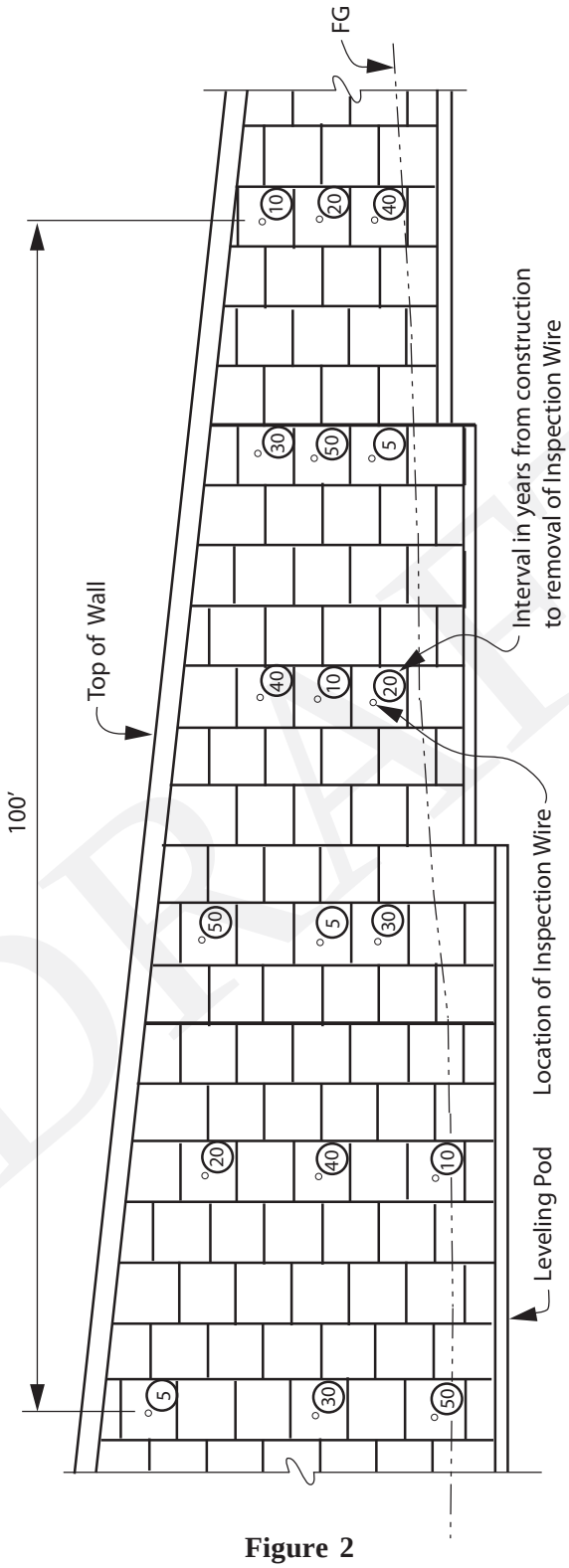

Figure 2

Loading Case 1

Maximum Height, ft	10	12.5	15	17.5
Minimum Base Width, ft	8	9	11	12
Top Levels of Mesh Over	2 @ W11 x W11 + 6" x 9" 2 @ W11 x W11 + 6" x 12"	2 @ W11 x W11 + 6" x 9" 2 @ W11 x W11 + 6" x 12" 1 @ W11 x W11 + 6" x 18"	2 @ W11 x W11 + 6" x 9" 2 @ W11 x W11 + 6" x 12" 1 @ W11 x W11 + 6" x 18" 1 @ W11 x W11 + 6" x 24"	2 @ W11 x W11 + 6" x 9" 2 @ W11 x W11 + 6" x 12" 1 @ W11 x W11 + 6" x 18" 2 @ W11 x W11 + 6" x 24"

Maximum Height, ft	20	22.5	25	27.5
Minimum Base Width, ft	14	16	18	19
Top Levels of Mesh Over	2 @ W11 x W11 + 6" x 9" 3 @ W11 x W11 + 6" x 18" 3 @ W11 x W11 + 6" x 24"	5 @ W11 x W11 + 6" x 18" 4 @ W11 x W11 + 6" x 24"	5 @ W11 x W11 + 6" x 18" 5 @ W11 x W11 + 6" x 24"	5 @ W11 x W11 + 6" x 18" 5 @ W11 x W11 + 6" x 24" 5 @ W11 x W11 + 6" x 30"

Maximum Height, ft	30	32.5	35	37.5
Minimum Base Width, ft	21	23	25	26
Top Levels of Mesh Over	10 @ W11 x W11 + 6" x 24" 2 @ W15 x W11 + 6" x 30"	10 @ W11 x W11 + 6" x 24" 3 @ W15 x W11 + 6" x 30"	10 @ W11 x W11 + 6" x 24" 4 @ W15 x W11 + 6" x 30"	10 @ W11 x W11 + 6" x 24" 5 @ W15 x W11 + 6" x 30"

Maximum Height, ft	40	42.5	45	47.5
Minimum Base Width, ft	28	30	32	33
Top Levels of Mesh Over	10 @ W11 x W11 + 6" x 24" 5 @ W15 x W11 + 6" x 30" 1 @ W20 x W11 + 6" x 30"	10 @ W11 x W11 + 6" x 24" 5 @ W15 x W11 + 6" x 30" 2 @ W20 x W11 + 6" x 30"	10 @ W11 x W11 + 6" x 24" 5 @ W15 x W11 + 6" x 30" 3@ W20 x W11 + 6" x 30"	5 @ W11 x W11 + 6" x 24" 5 @ W15 x W11 + 6" x 30" 5 @ W20 x W11 + 6" x 30"

Note – for heights less than 10 feet, all mesh is W11 x W11 + 6" x 9"
Mesh configuration =
Longitudinal wire size x transverse wire size +
Longitudinal wire spacing x transverse wire spacing

Table 1

Loading Case 2

Maximum Height, ft	10	12.5	15	17.5
Minimum Base Width, ft	10	13	15	18
Top Levels of Mesh Over	2 @ W11 x W11 + 6" x 9" 2 @ W11 x W11 + 6" x 12"	2 @ W11 x W11 + 6" x 12" 7 @ W11 x W11 + 6" x 24"	2 @ W11 x W11 + 6" x 12" 2 @ W11 x W11 + 6" x 18" 2 @ W11 x W11 + 6" x 24"	1 @ W11 x W11 + 6" x 18" 2 @ W11 x W11 + 6" x 24"

Maximum Height, ft	20	22.5	25	27.5
Minimum Base Width, ft	20	23	25	28
Top Levels of Mesh Over	3 @ W11 x W11 + 6" x 18" 5 @ W11 x W11 + 6" x 24"	2 @ W11 x W11 + 6" x 18" 7 @ W11 x W11 + 6" x 24"	10 @ W11 x W11 + 6" x 24"	10 @ W11 x W11 + 6" x 24" 1 @ W11 x W11 + 6" x 30"

Maximum Height, ft	30	32.5	35	37.5
Minimum Base Width, ft	30	33	35	38
Top Levels of Mesh Over	10 @ W11 x W11 + 6" x 24" 2 @ W15 x W11 + 6" x 30"	10 @ W11 x W11 + 6" x 24" 3 @ W15 x W11 + 6" x 30"	9 @ W11 x W11 + 6" x 24" 5 @ W15 x W11 + 6" x 30"	9 @ W11 x W11 + 6" x 24" 6 @ W15 x W11 + 6" x 30"

Maximum Height, ft	40	42.5	45	47.5
Minimum Base Width, ft	40	43	45	48
Top Levels of Mesh Over	9 @ W11 x W11 + 6" x 24" 6 @ W15 x W11 + 6" x 30" 1 @ W20 x W11 + 6" x 30"	9 @ W11 x W11 + 6" x 24" 6 @ W15 x W11 + 6" x 30" 2 @ W20 x W11 + 6" x 30"	8 @ W11 x W11 + 6" x 24" 6 @ W15 x W11 + 6" x 30" 4@ W20 x W11 + 6" x 30"	8 @ W11 x W11 + 6" x 24" 6 @ W15 x W11 + 6" x 30" 5 @ W20 x W11 + 6" x 30"

Note – for heights less than 10 feet, all mesh is W11 x W11 + 6" x 9"

Mesh configuration =

Longitudinal wire size x transverse wire size +

Longitudinal wire spacing x transverse wire spacing

Table 2