



INDIANA DEPARTMENT OF TRANSPORTATION
Driving Indiana's Economic Growth

Design Memorandum No. 17-03
Technical Advisory

March 1, 2017

TO: All Design, Operations, and District Personnel, and Consultants

FROM: /s/ David Holtz
David Holtz
Director, Pavement Division

SUBJECT: Mechanically Stabilized Earth (MSE) Walls

REVISES: *Indiana Design Manual* Sections 402-6.02(02), 409-2.04(02), 409-3.03,
Figure 409-2G, and Figure 410-5(0)C (new)

EFFECTIVE: As Noted

The Department is implementing an MSE wall review process to determine the suitability of MSE walls for the project site. Revisions to the referenced sections of the *Indiana Design Manual* (IDM) provide addition guidance to enhance the quality of information provided to contractors as well as facilitate constructability.

Determination of MSE Wall Suitability

Effective immediately, all projects that contain an MSE wall will be evaluated for suitability for the project site. This includes both longitudinal MSE walls (non-bridge related) and MSE walls utilized adjacent to a bridge end bent. The selection criteria in IDM 410-5.01(05) in addition to the guidance included in this memo will be considered as part of the evaluation.

The table below describes the need for review based on the stage of project development as well as the timing and documents required.

Stage of Plan Development (as of the date of the memo)	Review by Geotechnical Services?	When to Submit	Information to Submit
Prior to Stage 1	Yes	Concurrent with Geotechnical Investigation Request	Stage 1 plans, including preliminary wall layout.
After Stage 1 and Before Stage 3	Yes	Immediately	Current plan set or Title Sheet, Plan and Profile, Detail Sheets*
After Stage 3	Yes, where guidance below has not been accounted for in the plans.	Coordinate with Geotechnical Services immediately	As determined during coordination with Geotechnical Services
* Detail sheets include wall layout/geometry, wall section view, known obstructions, known foundation improvement requirements.			

Please contact Athar Khan, Office of Geotechnical Services, atkhan@indot.in.gov to begin coordination.

For projects that have not complete a Stage 1 submittal, the Office of Geotechnical Services must provide concurrence that an MSE is suitable for the project site. A second submittal at Stage 3 may be necessary once project details are finalized.

For projects that have not completed the Stage 3 submittal, revisions to plans based on this memo are expected. For projects that are beyond the Stage 3 submittal, the need for revisions will be determined on a project-by-project basis.

IDM Revisions

The following sections of the IDM have been revised to provide additional guidance and set forth new requirements for MSE walls. These revisions aim to enhance the quality of information provided to contractors as well as facilitate constructability. The revisions are summarized below and are an attachment to this memo.

IDM 402-6.02(02) Structure Sizing – Alignment Pile sleeves should be assumed where an end bent is placed behind an MSE wall. The minimum distance from the edge of the pile sleeve to the back of the MSE wall panel is 3 ft.

IDM 409-2.04(02) Integral End Bent – Design Requirements, 409-3.03 Semi-Integral End Bent, and Figure 409-2G Figure 409-2G illustrates the minimum distance from the edge of the pile sleeve to the back of the MSE wall panel and preferred MSE wall configurations at an end bent.

IDM 410-5.01(06), Design Criteria

- Acute angles should be avoided because of construction difficulties, e.g. compaction in corners and placement of reinforcement. Where two intersecting walls form an enclosed angle, the angle is to be greater than or equal to 70 degrees.
- Sharp curves should be avoided in the wall layout. The curvature of the wall will impact the size of panel than can be provided. Typically a 10-ft wide panel can accommodate a radius of 100 ft., and a 5-ft wide panel can typically accommodate a radius of 50 ft.
- Utilities should not be placed through the reinforced zone. Where utility placement in the reinforced zone is unavoidable, future access must be provided to the utility without disrupting the reinforcement. The breakage or rupture of the utility must not have a detrimental effect on the stability of the MSE wall.

IDM 410-5.01(07), Figure 410-5(0)C (New), Information to be Shown on Plans

- Drainage systems are required for all MSE walls. Figure 410-5(0)C illustrates a typical MSE wall cross sections and provides the drainage details to be included on plans.
- A plan view showing all obstructions and their offset from the back of the MSE wall is required on the MSE Wall Details sheet. Obstructions include but are not limited to, piles, pile sleeves, catch basins, signal or sign foundation, guardrail posts, and culverts. Where an obstruction projects through the MSE wall panel, the obstruction should also be shown in an isolated section and elevation view.
- Modifications to the wall design to avoid obstructions must be shown in the MSE Wall working drawings. Design options for obstructions within the reinforced zone are described in the *AASHTO LRFD Bridge Design Specifications*, section 11.10.10.4.

402-6.0 DESIGN FACTORS

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402-6.02 Structure Sizing [Rev. Mar. 2017]

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402-6.02(02) Alignment [Rev. Mar. 2017]

The horizontal and vertical alignment will be determined for the overall roadway within the project limits, and the bridge will be designed consistent with the roadway alignment. See Chapter [53](#) for geometric-design criteria. The desirable horizontal and vertical alignment objectives are as follows.

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3. End Bent. The end-bent configuration impacts the required structure length and shall be accounted for in the sizing of the structure. The following will apply.

- a. The clearance from the top of the berm to the bottom of the superstructure shall be at least 6 in., with a maximum of 1'-8". The minimum berm width is 3 ft. See Figure [402-6K](#).
- b. Wingwalls will be required for each beam structure.
- c. The spillslope for a water crossing is limited to a maximum of 2:1, except for a structure located within the backwaters of the Ohio River, where the spillslope is 3:1. For an overpass structure, the required crossed-roadway-section clear-zone width shall be considered in the setting of spill slopes.
- d. Where utilizing an MSE retaining wall at an end bent, a minimum distance of 3 ft. is required between the back of the wall panel and the edge of the pile sleeve or the pile (where sleeves are not required). For determining preliminary structure span length, a 24-in pile sleeve should be assumed. The need for pile sleeves will be determined by the Office of Geotechnical Services. *LRFD* 11.10.11 provides additional information regarding the placement of obstructions in the reinforced soil zone.

409-2.0 INTEGRAL END BENT

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409-2.04(02) Pile Connection and Plans Details [Rev. Mar. 2017]

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11. MSE Wall. If placed behind an MSE retaining wall, the end bent should be configured as shown in Figure [409-2G](#). See *LRFD* 11.10.8 and Section 410-5.0(07) of this manual for MSE wall drainage information.

409-3.0 SEMI-INTEGRAL END BENT

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409-3.03 Details [Rev. Mar. 2017]

Figure [409-3A](#) shows details for Method 1. Figure [409-3B](#) shows details for Method 2. Figure [409-3C](#) shows details for the joint-protection sheeting. Figure [409-3D](#) shows details pavement-ledge details for

integral and semi-integral end bents. All applicable information shown in the figures shall be shown on the plans.

Wingwalls details are similar to those for an integral end bent except for the connection method. The wingwall is connected to the bent below the seat elevation. See Figure [409-5A](#) for suggested wingwall-dimensioning details. The minimum wingwall thickness of a wingwall shall be 1 ft.

See *LRFD* 11.4.1 and 11.6.6 for additional drainage information.

If placed behind an MSE retaining wall, the end bent should be configured as shown in Figure [409-2G](#). See *LRFD* 11.10.8 and Section 410-5.0(07) of this manual for MSE wall drainage information.

410-5.01 Mechanically-Stabilized-Earth (MSE) Wall [Rev. Mar. 2017]

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410-5.01(04) Description of MSE Wall System [Rev. Mar. 2017]

Figure 410-5(0)C shows the typical cross section of an MSE wall.

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410-5.01(06) Design Criteria [Rev. May 2012, May 2013, Mar. 2017]

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5. **Acute Angles.** Acute angles should be avoided because of construction difficulties, e.g. compaction in corners and placement of reinforcement. Where two intersecting walls form an enclosed angle, the angle is to be greater than or equal to 70 degrees.

6. **Wall Curves.** Sharp curves should be avoided in the wall layout. The curvature of a wall will impact the size of panel that can be provided. Typically, a 10-ft wide panel can accommodate a radius of 100 ft. and a 5-ft wide panel can accommodate a radius of 50 ft.

7. **Utilities.** Utilities should not be placed through the reinforced zone. Where utility placement in the reinforced zone is unavoidable, future access must be provided to the utility without disrupting the reinforcement. The breakage or rupture of the utility must not have a detrimental effect on the stability of the MSE wall.

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410-5.01(07) Information to be Shown on Plans [Added May 2012, Rev. Dec. 2012, Mar. 2017]

Wall Envelope. The wall envelope should be determined from the plans' elevation view with three control lines. Control Line 1 defines the elevation of the top of coping, or wall, if no coping is used. Control Line 1 should be shown on the elevation view with stations and elevations in conjunction with

cross-section locations. It should be located on the back face of the MSE wall or coping. Control Line 2 defines the elevation of the existing or proposed ground line in front of the wall. Control Line 3 defines the elevation of the top of the leveling pad. It is obtained by offsetting a minimum distance of 2 ft below the proposed ground line in front of the wall to the top of the leveling pad. All control lines should be shown and identified as such on the plans. Control Lines 1 and 3 should also be labeled as neat lines.

The minimum area required for the wall to be constructed should be defined by means of an envelope. The limits of the envelope are the beginning- and end-of-wall stations and the locations of Control Lines 1 and 3. From this information, a wall-elevation view along the front face of the wall showing leveling-pad and step locations, elevations, and dimensions should be prepared and shown on the plans as conceptual information for the contractor. The minimum area within the envelope described above should be the pay quantity for the wall. Figure [410-5\(0\)B](#) shows the difference between the minimum area required and an estimated amount of additional surface area required to construct the wall based on the wall-panel sizes and leveling-pad step increments described below. The area below Control Line 3 is conceptual information for the contractor and should not be included in the panels' pay quantity because it can vary depending on the wall system the contractor chooses. Pay quantities for each wall should be shown on the plans.

The plans should show the minimum height from the top of the leveling pad to the existing or proposed ground line, as required. The plans should also show all stations and offsets relative to the survey centerline on the back face of the wall for the beginning and ending points, and all such offsets for turn-point locations where the wall forms an angle. Leveling-pad steps should be in 2.5-ft increments. The bottom of the pad should be level.

Drainage. Details for drainage of the surface-water infiltration and reinforced-soil backfill should be included for all MSE walls. Figure 410-5(0)C shows the standard drainage details. It is the designer's responsibility to determine the elevation of the drainage pipe such that it will drain and outlet adequately.

Wall Panels. Panels of 10-ft length by 5-ft height should be assumed. The top of the wall or coping may be sloped. The standard panel thickness should be taken as 6 in. The decorative panel thickness should be taken as 9 in. Panel sizes and wall thickness should not be shown on the plans, as the wall-system manufacturer will show these values on the working drawings.

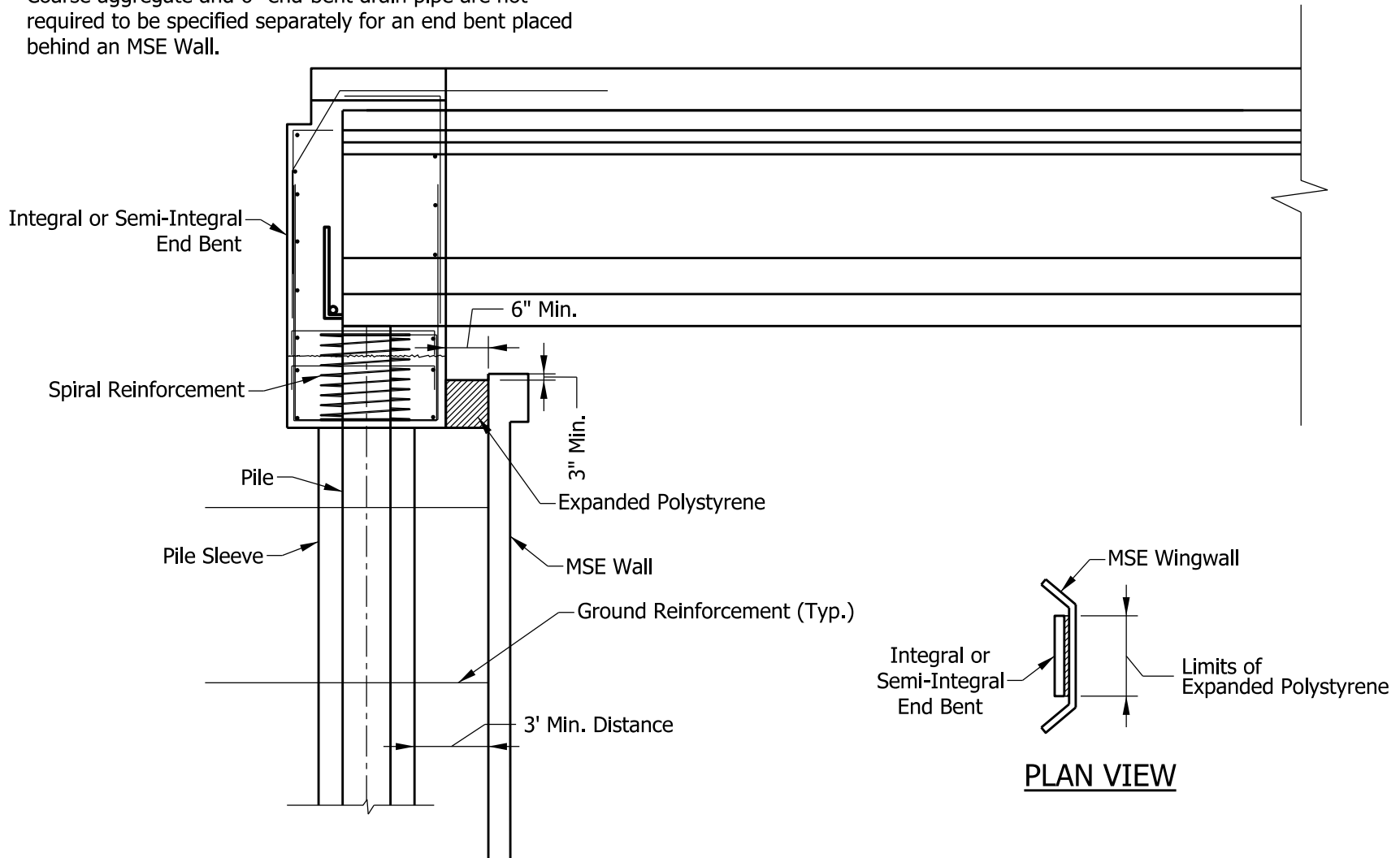
Elevation View. An elevation view should show and label all obstructions that project through an MSE wall panel by station and elevation. A section view may be considered to provide additional details as needed. The beginning and ending locations should be checked to determine where the final grading elevations are equal both in front of and behind the wall, whereby the wall is no longer required.

Plan View. A plan view on the MSE Wall Details sheet should show and label obstructions and their offset from the back of the wall panel. Obstructions include but are not limited to, piles, pile sleeves, catch basins, signal or sign foundation, guardrail posts, and culverts. Where obstructions cannot be avoided, the wall-system designer must modify the wall design using one of the methods in *LRFD* 11.10.10.4. Details to avoid obstructions must be shown in the MSE wall working drawings.

MSE Wall at an End Bent. When an end bent is placed behind an MSE wall, expanded polystyrene should be shown for gap between the front face of the end bent and the back of the MSE wall. Do not show Styrofoam or extruded polystyrene. See Figure 409-2G, End Bent Placed behind MSE Wall for additional details.

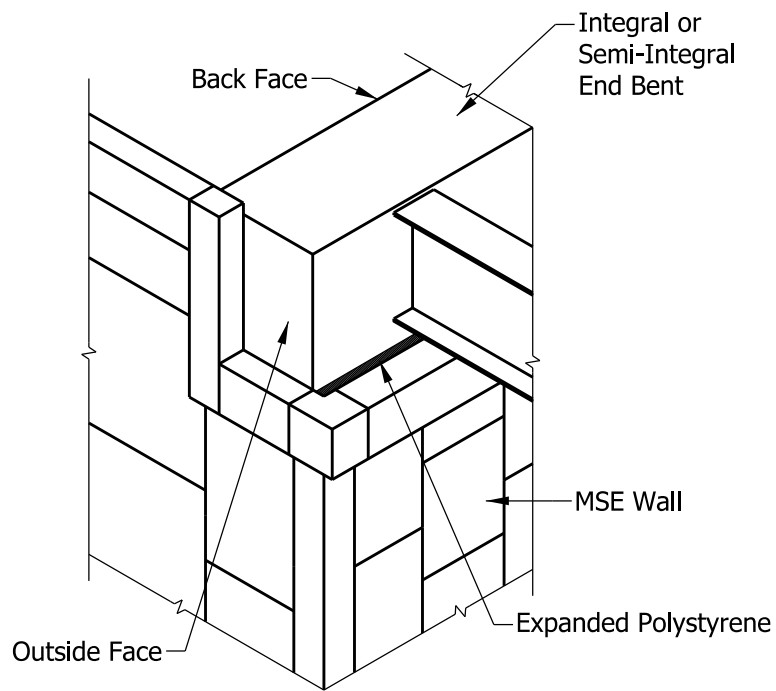
NOTE:

Coarse aggregate and 6" end-bent drain pipe are not required to be specified separately for an end bent placed behind an MSE Wall.

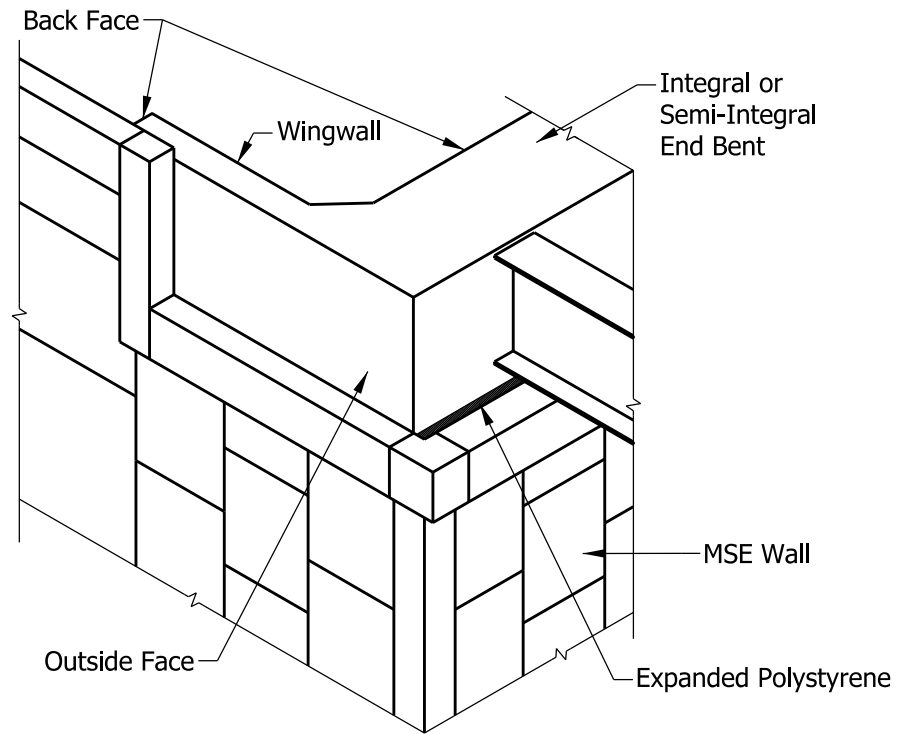


END BENT PLACED BEHIND MSE WALL

**Figure 409-2G
(Sheet 1 of 2)**



PREFERRED DETAIL
OPTION 1



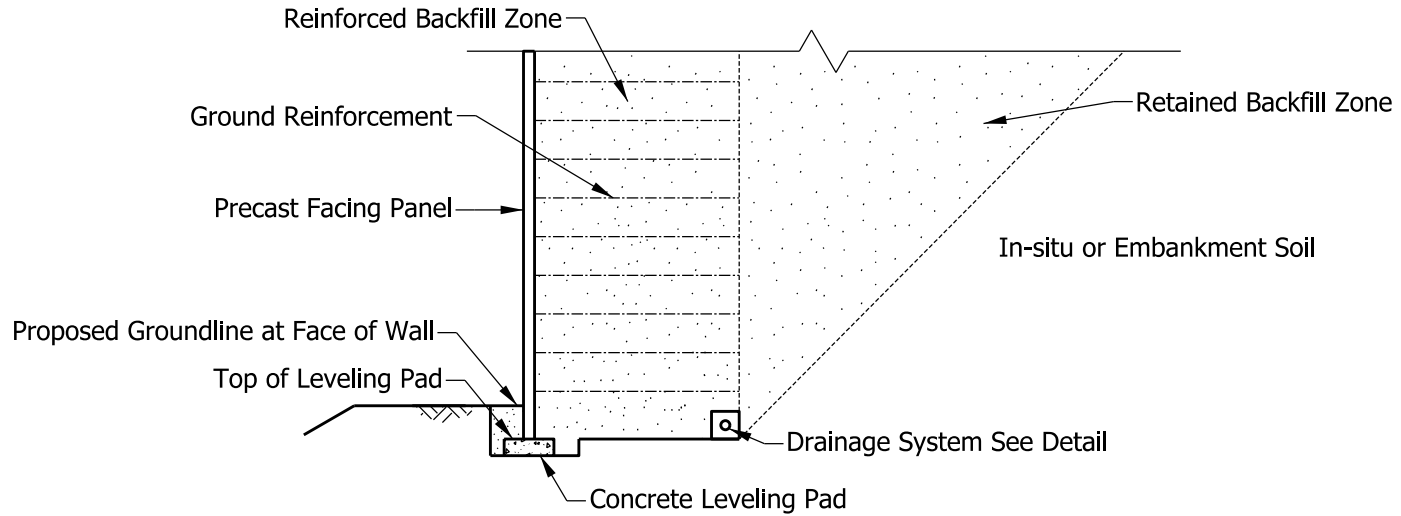
PREFERRED DETAIL
OPTION 2

NOTE:

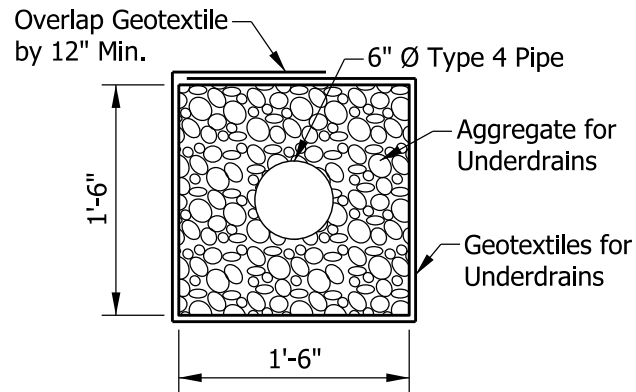
Where an MSE is placed parallel to the bridge approach roadway, it should be placed adjacent the outside face of the end bent or wingwall, but not cast against it. Sufficient clearance is needed to accommodate the thermal movement of the end bent. The MSE wall should not be placed abutting the back face of the end bent or wingwall.

END BENT PLACED BEHIND MSE WALL

Figure 409-2G
(Sheet 2 of 2)



MSE SECTION VIEW



MSE WALL DRAINAGE DETAIL

TYPICAL MSE WALL CROSS SECTION

Figure 410-5(0)C