ODOT Design & Construction Requirements for MSE Walls

Peter Narsavage, P.E.
Foundation Engineering Coordinator
Ohio Department of Transportation
Office of Structural Engineering
2006 Ohio Transportation Engineering Conference
A brief history

- ODOT has used MSE walls since the 1980’s.
- In 2004, responsibility for MSE wall construction was assigned to State Construction Geotechnical Engineer.
- Through 2004 and 2005, problems with MSE wall construction were investigated by OCA and OSE.
A brief history

- OSE started preliminary development of a long-term MSE wall inspection program.
- ODOT begins to develop a new supplemental specification for MSE walls.
- Roundtable with contractors and suppliers scheduled for December, 20, 2005.
A brief history

- December 7, 2005, District 6 shut down a three-lane collector-distributor road along I-270 in northeast Columbus because of an MSE wall problem. Drainage appears to be the cause.
- December 20, 2005, ODOT began a preliminary inspection program of all MSE walls built by ODOT. Inspections are completed within a month.
Problems

- Sand leaking from joints
- Settlement of panels
- Uncontrolled drainage
- Deteriorating panels
Sand leaking from slip joint
Sand pile under vertical joint

07/01/2005
Settlement of panels
Erosion along MSE wall
Void beneath slab

Joint separation
Final resting place of MSE wall fill
Another bridge with erosion along MSE wall
Water probably flowed through horizontal joint.
Deteriorating panel
More deteriorating panels
Preliminary inspection program

- Districts inspected each MSE wall.
- Completed inspections by Jan 20, 2006
- 339 Walls
- 30 percent have sand leaking from joints
- 32 percent have vegetation in joints
- 19 percent have cracked panels
- 11 percent have bowed or bulging walls
- 13 percent have some erosion
- 9 percent have problems with drainage system
Sealing joints
MSE wall inspection program

• OSE will use the information from the preliminary inspections to develop an inspection program.
• The program will be similar to the bridge inspection program, in that it will include:
  • An inventory
  • An inspection cycle
  • An inspection manual
  • Training and inspector qualification
Design changes for MSE walls

Implemented in July 2006 revisions to BDM

- Preference for straight MSE wall alignments
- Abutments supported on spread footings only under certain conditions
- Consider drainage around MSE walls
- Avoid utilities through or underneath MSE walls
Preference of wall geometry at bridges

1. Straight walls
2a. Walls turned back up to 45 degrees (change of wall alignment = 135° to 179°)
2b. Walls turned back with large radius
3. Walls turned back at 46 to 90 degrees

Do not use acute corners!
Straight MSE wall
MSE wall turned back 45 degrees
MSE wall turned back with curve
MSE wall turned back 90 degrees
Avoid acute corners!
Avoid acute corners and minimize obstructions

Don’t do this.
Do you think this backfill is well compacted?
Bridge abutments at MSE walls

- If MSE wall is on bedrock, use spread footings to support bridge abutment.
- If MSE wall is on soil, consider possible settlement of the MSE wall...
  - Use piles if the bridge is a continuous multi-span structure or if the bridge is constructed part width in phases.
  - If the bridge is single-span and not constructed part width, either spread footings or piles may be used to support the bridge abutment.
Bridge abutments at MSE walls

• For piling – minimum of 3′-6″ from the back face of the facing panels to centerline of the front row pile

Should avoid this situation
Bridge abutments at MSE walls

• For spread footing – minimum of 3’ from the back face of the facing panels to the front face of the footing and minimum of 5’ from back face to centerline of bearings
Drainage around MSE walls

- Control of roadway drainage is critical around MSE walls. The major problems with MSE walls have been related to the loss of drainage control.
- Provide barrier with a catch basin to collect the drainage.
- Locate catch basin 25’ past the limit of the MSE wall soil reinforcement, where possible.
- Continue barrier 10’ past catch basin.
- Use a minimum 30’ approach slab for structures with MSE walls at the abutments.
Utilities and MSE walls

- Avoid utilities through or underneath MSE walls.
- When it can’t be avoided, encase the utility in a protective conduit that extends 10’ beyond the limits of the select granular backfill.
- Pipe culverts through MSE walls should be avoided.
- Water and sewer lines within 10’ of an MSE wall shall also be encased.
Other new MSE wall requirements

• Obstructions, such as piles, utilities, catch basins, etc. need to be shown on the plan, elevation, and typical sections for the MSE wall drawings.
• 45 degree slope of Select Granular Backfill
• 1’ undercut with geotextile fabric and Item 203, Granular Material, Type C
• Bottom 3’ of SGB meets gradation requirements for Item 304
Other new MSE wall requirements

- 45° Slope
- Retained soil
- 3' SGB, Item 304
- 1' Item 203, Granular Material Type C
- Geotextile Fabric
- Select Granular Backfill
- Item 203, Granular Material Type C
Undercuts

No separate undercut and backfill pay item
If undercut beyond the standard 1’ is required...

• Show undercut as additional wall excavation.
• Backfill with Item 203, Granular Material, Type C or D.
• Geotextile fabric for foundation preparation remains 1’ below the bottom of the leveling pad.
Undercuts

1' Granular Material included with Foundation Preparation.

Additional Granular Material requires Item 203 pay item.
Supplemental Specification 840

Approved July 2006

- One specification that covers all accredited MSE wall systems for permanent MSE walls
- Added definitions
- Added material requirements
- Adjusted tolerances on facing panels and wall construction
- Greatly expanded construction section
- Created separate pay items for wall components
SS 840 – Definitions

Defines and standardizes terminology

- MSE Wall System
- Soil Reinforcement
- Facing Panels
- Connection Device
- MSE Wall System Supplier
- Accredited MSE Wall System
- Precaster
SS 840 – Material requirements

• For the joint cover, require
  • A woven, monofilament geotextile
  • 90% UV stability after 500 hours
  • Minimum width of 24 inches
• For Select Granular Backfill, require direct shear testing on material passing No. 10 sieve. $\varphi \geq 34^\circ$
• For foundation preparation, require a woven monofilament geotextile at the base of the undercut
SS 840 – Facing panels

• Precaster must be certified in accordance with Supplement 1073
SS 840 – Facing panels

- Maximum panel size is 5 x 5 feet
- Gives sizes of chips or spalls, and width of cracks that are cause for panel rejection
SS 840 – Construction

- Increased from 2 to 8 pages.
- Preconstruction meeting is required.

Foundation Preparation
- Compaction testing of foundation required.
- Department reviews foundation to verify bearing capacity. Usually performed by geotechnical consultant under consultant services.
- After acceptance, geotextile and 1’ of granular material placed and compacted.
SS 840 – Construction

- Leveling pad is 6” x 24”
- Leveling pad must be within 1/8” of elevation and cannot vary more than 1/8” in 10’.
- Facing panels cannot extend more than 6” beyond the end of the leveling pad at steps.
SS 840 – Construction

Extensive wall erection details, such as...

• Limit on shim size to start first row of panels
• Panels can’t extend past the leveling pad transversely.
• Joints must be between $\frac{1}{2}''$ to 1'' wide. Joint cover fabric must not be exposed.
• Excavation in front of the wall must be backfilled as soon as possible.
• Vertical and horizontal tolerances checked repeatedly.
Flashlight test to see if joint cover fabric is exposed
SS 840 – Construction

- SGB placed and compacted in a manner that places the soil reinforcement in tension.
- Each 8” lift of SGB placed by starting 3’ from facing panels and moving away from panels.
- The lift compacted in same manner.
SS 840 – Construction

- SGB within 3’ of facing panel is then placed and compacted.
- The compaction of each lift is tested. The compaction of every fifth lift is checked by ODOT.
SS 840 – Construction

Concrete Sealing

• Exterior surfaces sealed with epoxy-urethane sealer according to CMS 512.
• Do not damage joint cover fabric when preparing surface.
On-site assistance from supplier is required.
• Designer Note recommends 5 days for projects with less than 4 walls.
<table>
<thead>
<tr>
<th>Item</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanically Stabilized Earth Wall</td>
<td>SF</td>
</tr>
<tr>
<td>Wall Excavation</td>
<td>CY</td>
</tr>
<tr>
<td>Foundation Preparation</td>
<td>SY</td>
</tr>
<tr>
<td>Select Granular Backfill</td>
<td>CY</td>
</tr>
<tr>
<td>Porous Backfill with Filter Fabric</td>
<td>CY</td>
</tr>
<tr>
<td>Drainage Pipe</td>
<td>FT</td>
</tr>
<tr>
<td>Concrete Coping</td>
<td>FT</td>
</tr>
<tr>
<td>On-Site Assistance</td>
<td>Days</td>
</tr>
<tr>
<td>SGB Inspection and Compaction Testing</td>
<td>Lump Sum</td>
</tr>
</tbody>
</table>
Additional MSE wall pay items

203 Items
- Embankment
- Granular Material, Types B, C, and D
- Included with wall quantities

Item 503, Cofferdams, Cribs, and Sheeting
- Generally only for walls not at bridges, since the bridge plans will usually already include this item.
Implementation of SS 840

- ODOT is implementing SS 840 on all projects not already awarded, either by revising plans or preparing addenda.
- If “retrofitting” plans to fit SS 840, some changes are not required...
  - 45 degree slope for SGB is not required, since this will affect the limits for wall quantities.
  - Do not need to move piling or footing, since this will extend bridge.