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Inspector's Manual for Mechanically Stabilized Earth Walls

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16. Abstract
The scope of the project is to develop a condition rating system, creation of an inspector's manual to reference during inspection or address any training for inspectors at the district level. The research project will develop a MSE wall condition rating system and incorporate this system into the database being developed and create training and reference manuals.

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Disclaimer

As the Nebraska Department of Roads did not require a final report for this research, a PowerPoint presentation was adapted for publishing a final report.

Glossary

Coping

The coping is used at the top of the wall panels to provide an aesthetic finish to the wall top. Coping can be cast-in-place or prefabricated.

Geotextile Fabric (Filter)

Geotextile fabric (filter) is used to cover the back side of the joints between wall panels. Fabric keeps soil from moving through the joints while allowing any excess water to drain.

Base Pad

The base pad (leveling pad) is a non-reinforced concrete pad used to provide a level, consistent surface at the proper elevation.

Random Backfill

Random backfill is material derived from excavation during construction of the MSE wall.

Select Backfill

Select backfill is fill that meets gradation, corrosion, unit weight, internal friction angle and/or other requirements for a specific MSE wall.

Reinforcement

Soil reinforcement holds the wall face in position and reinforces the soil directly behind the panels. Soil reinforcement can be strips, grids, or mesh. Reinforcement can be made of steel (inextensible) or polymers (extensible).

Spacers

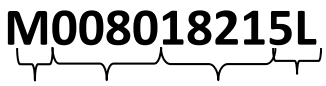
Wall panel spacers are typically ribbed elastomeric or polymeric pads. They are inserted between panels to mitigate panel-to-panel contact and ensure proper spacing. Proper spacing keeps the panels from having point contact and spalling the concrete. Some walls are constructed without spacers.

Wall Facing Panels

Wall facing panels are used to hold the soil in place behind the face of the wall. Panels are typically concrete but they can be metal, wood, block, mesh or other materials.

Locating the Desired Wall

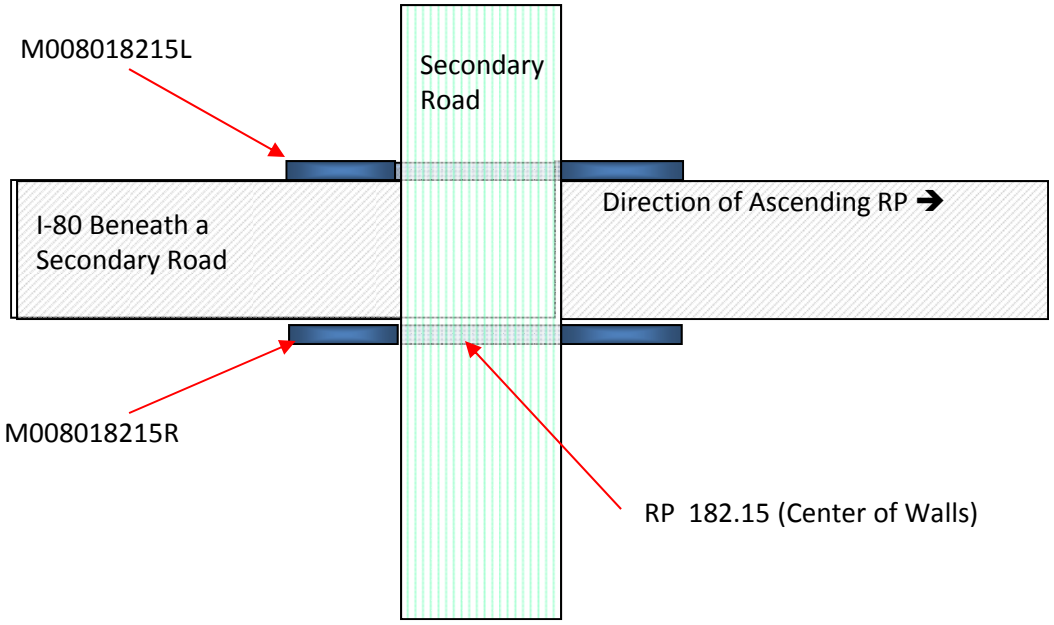
MSE Wall ID Numbering Convention



1. Indicates the type of wall present. "M" indicates a MSE wall, while "R" indicates a retaining or gravity wall.
2 Indicates the highway number associated with a specific wall. The MSE wall(s) form(s) one lateral boundary of this highway. Four spaces are provided. If the highway number is a 2 digit number, add two "0" as placeholders before the highway number (as illustrated above for I-80).
3. These five digits indicate the Reference Post location closest to the center of the wall.
4. The last digit is used to designate which side of the highway the wall is located on when the inspector is facing in the direction of ascending reference posts.

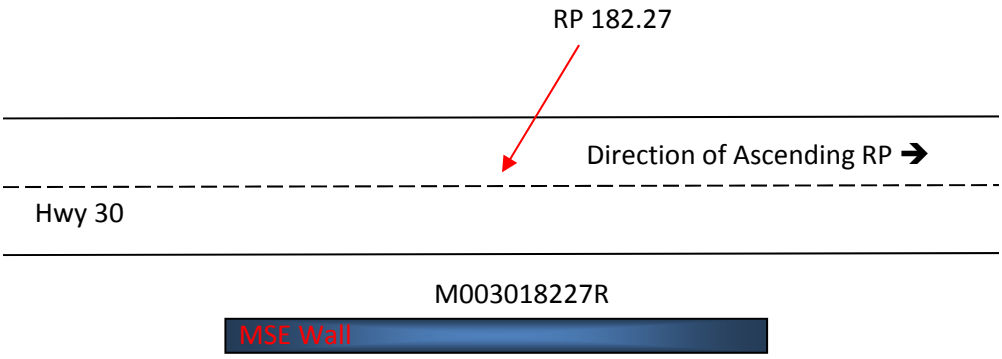
There are many difference scenarios where MSE or retaining walls are present. The following examples describe some of the most common scenarios. Instructions on how to assign ID numbers to specific walls are shown for each scenario.

Scenario 1 - Secondary Road Bridge Over a Highway or Interstate



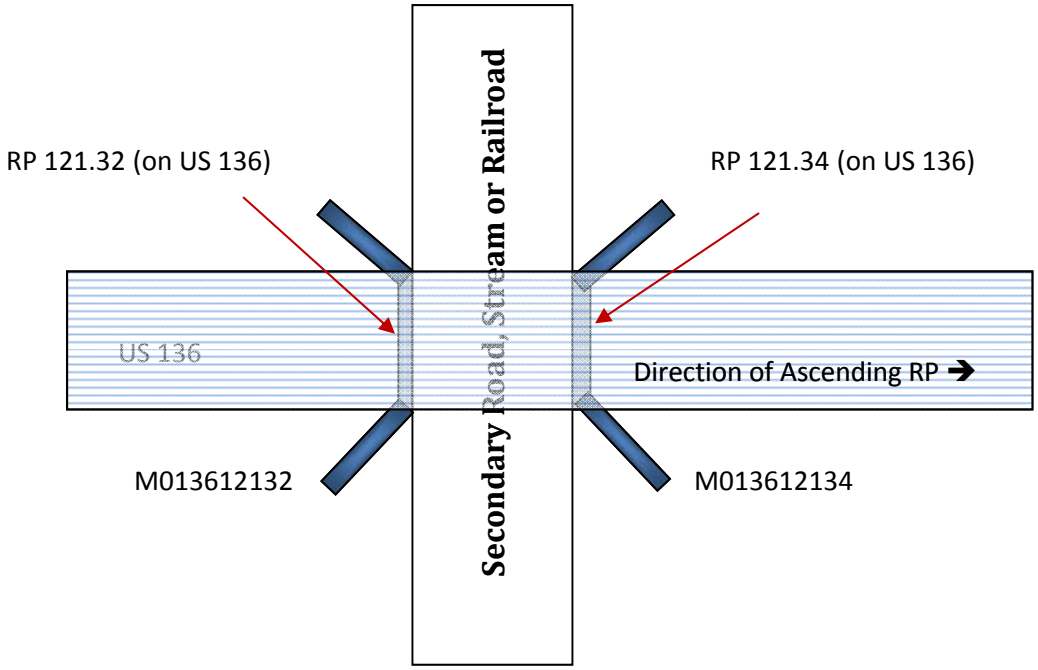
This figure shows a situation where a county bridge passes over an interstate highway. The center of both walls is located at approximately RP 182.15 on Interstate 80. In this situation, the wall identification number is the same, except for the last digit (R or L), which indicates whether the specific wall is to the left or right when facing in the direction of ascending RP numbers.

Scenario 2 – Stand-Alone Wall Along a Highway



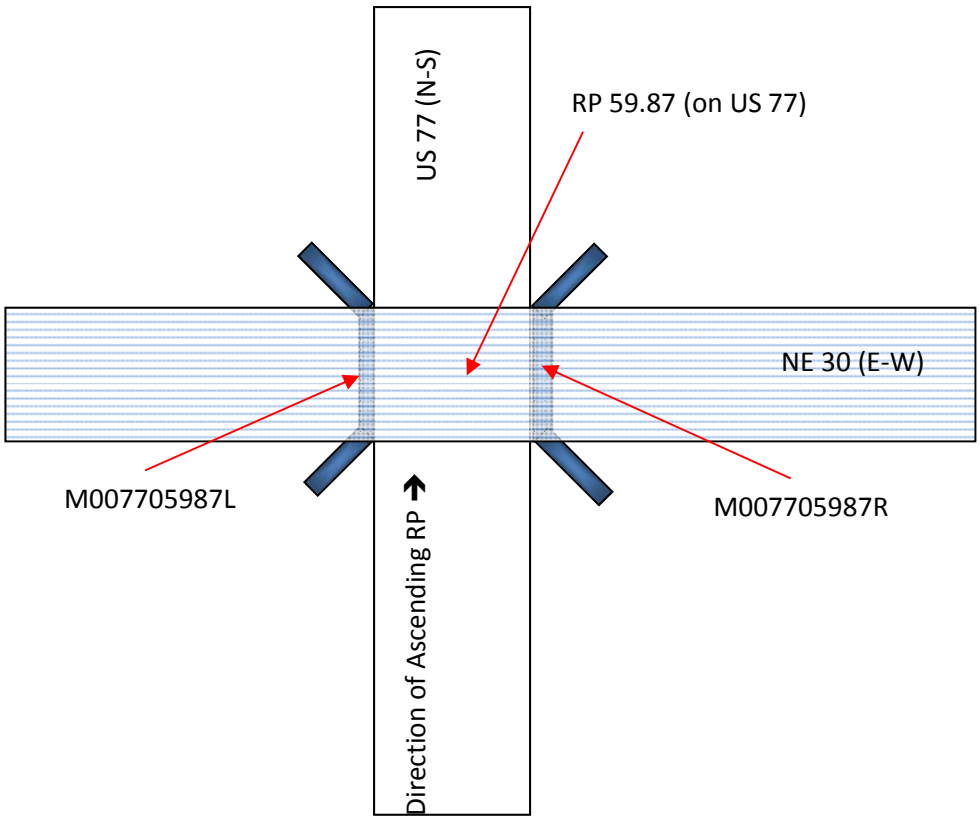
This figure shows a stand-alone wall along one side of a highway. The center of the wall is located nearest RP 182.27 and the wall is to the right when facing in the direction of ascending reference post numbers. If the wall was a retaining wall instead of a MSE wall, the first character would be R in lieu of M and the nomenclature would read R003018227R.

Scenario 3 – Highway Over a Secondary Road, Stream or Railroad



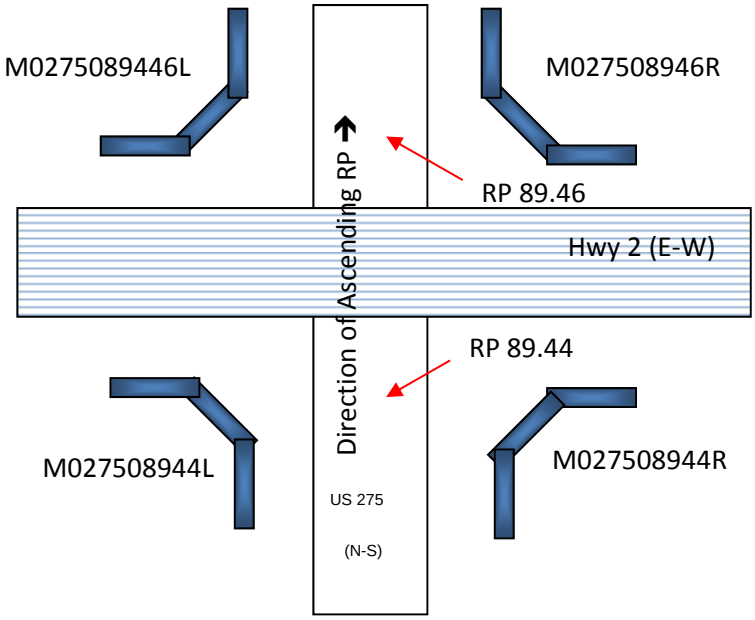
This figure shows a situation where a highway passes over a secondary road, stream or railroad. The center of one wall is located near RP 121.32 (on US 136) while the center of the other wall is located near RP 121.34 (on US 136). In this situation, the wall identification number corresponds to the location of each specific wall's center with regard to reference posts along the numbered highway. R and L are not used. Wingwalls, which may be MSE or retaining walls, are considered to be components of each primary wall.

Scenario 4 – Two Highways Crossing



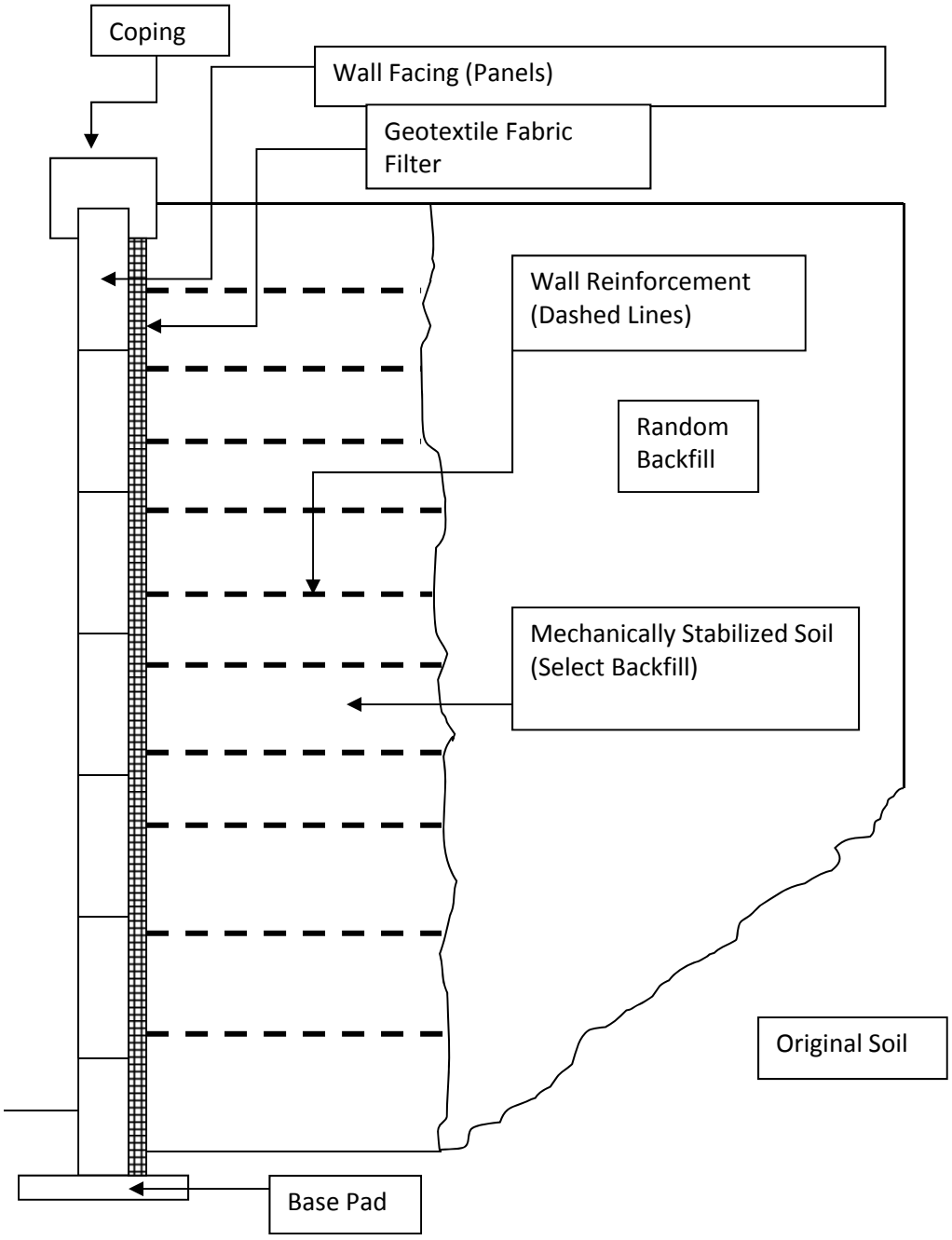
This figure shows a situation where two highways cross. The center of both walls is located at approximately RP 59.87 on US 77. In this situation, the North-South highway is the basis for wall nomenclature. The wall identification number is the same, except for the last digit (R or L), which indicates whether that specific wall is to the left or to the right when facing in the direction of ascending RP numbers along the North-South highway.

Scenario 5 – Multiple Walls Where Highways Cross/Merge



This figure shows a situation where two highways cross or merge. The center of one set of walls is located near RP 89.44 on US 275. The center of the other set of walls is located near RP 89.46 on US 275. In this situation, the North-South highway is again the basis for wall nomenclature. The wall identification number within each set of walls is the same, except for the last digit (R or L), which indicates whether that specific wall is to the left or right when facing in the direction of ascending RP numbers along the North-South highway.

Major Components of a MSE Wall



Wall Tilting

A panel wall showing a positive tilt.

Definition:

Panel Walls:
Inclination of the wall face from vertical or from its original inclination.

Modular Block & Gravity Walls:
Modular block walls often exhibit negative tilt due to the setback of each successive layer of blocks. Gravity walls are generally constructed with a slight negative tilt.

Wall Tilting

Panel Walls:

❖0– A section of or the entire wall has failed due to tilting.

❖1 – A section of or the entire wall is inclined to the extent that separation of panels is beginning to occur in the wall face.

❖3 – A section of or the entire wall is inclined outward at 10^{o} (2 inches Horizontal: 12 inches Vertical) to 15^{o} (3 inches Horizontal: 12 inches Vertical).

❖5 – A section of or the entire wall is inclined outward at 5^{o} (1 inch Horizontal: 12 inches Vertical) to 10^{o} (2 inches Horizontal: 12 inches Vertical).

❖7 – A section of or the entire wall is inclined outward at 0^{o}-5^{o} (1 inch Horizontal: 12 inches Vertical).

❖9 – There is no change in wall inclination from construction specifications.

Block Walls:

❖0 - Block wall has positive inclination.

❖5 - Block wall is vertical (it has no tilt).

❖9 - Block wall has negative inclination.

Structural Cracking

Separation of the corner of a precast panel as a result of structural cracking.

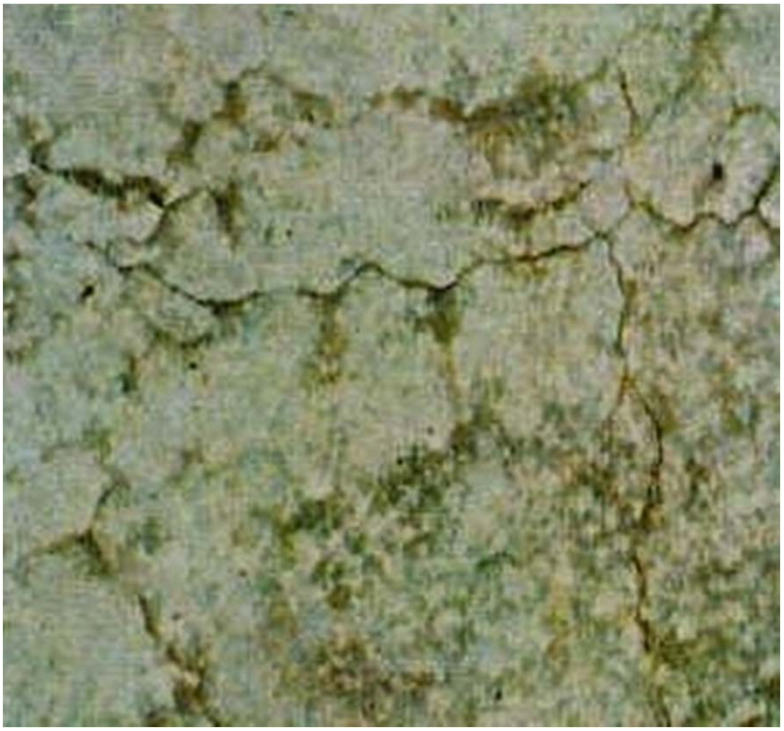
Definition:

Structural cracking is characterized by a separation which penetrates through the entire depth of the wall face. A crack which does not extend through the entire thickness of the wall face should be characterized as facial deterioration.

Structural Cracking

- 0 - More than 50% of wall area shows structural cracking.
- 1 - Between 33 - 50% of wall area shows structural cracking.
- 3 – Between 20 - 33% of wall area shows structural cracking.
- 5 – Between 10- 20% of wall area shows structural cracking.
- 7 - Less than 10% of wall area shows structural cracking.
- 9 - None or only an insignificantly small wall area shows structural cracking.

Facial Deterioration



Nonstructural cracking with discoloration is documented as facial deterioration.

Definition:

Impairment of the quality, appearance or function of a wall face. Facial deterioration can be characterized by spalling, nonstructural cracking, deterioration of facing materials, discoloration or other phenomena. Cracks which do not extend through the total depth of the wall face should also be characterized as facial deterioration.

Facial Deterioration

❖0 - More than 50% of the wall area shows facial deterioration.

❖3 – Between 50% and 25% of the wall area shows deterioration.

❖6 – Less than 25% of the wall area shows deterioration.

❖9 - None or only an insignificantly small area of the wall shows facial deterioration.

Bowing of the Wall

Bowing caused by failure of reinforcement connections.

Definition:

An outward bend or curve in the horizontal or vertical direction (or both) along a wall face. Bowing results from embedment pullout or broken connections between reinforcement and facing materials on adjacent panels.

Bowing of the Wall

❖0 – Wall panels have bowed outward to the point where backfill loss is actively occurring through joints.

❖3 – Wall panels have bowed outward to the point where filter fabric is visible at the joints; connectors between adjacent panels have broken.

❖5 – Wall panels have bowed outward to where connectors between adjacent panels are visible and being deformed.

❖7 – Wall panels have bowed outward to the point where bowing is visible standing directly in front of the wall.

❖9 – No indication of bowing on the wall face.

Panel Staining

Discoloration of a wall face due to water moving through cracks.

Definition:

A discoloration or change in the appearance of the surface of one or more panels or blocks. Staining is caused by water containing minerals moving through wall joints or cracks.

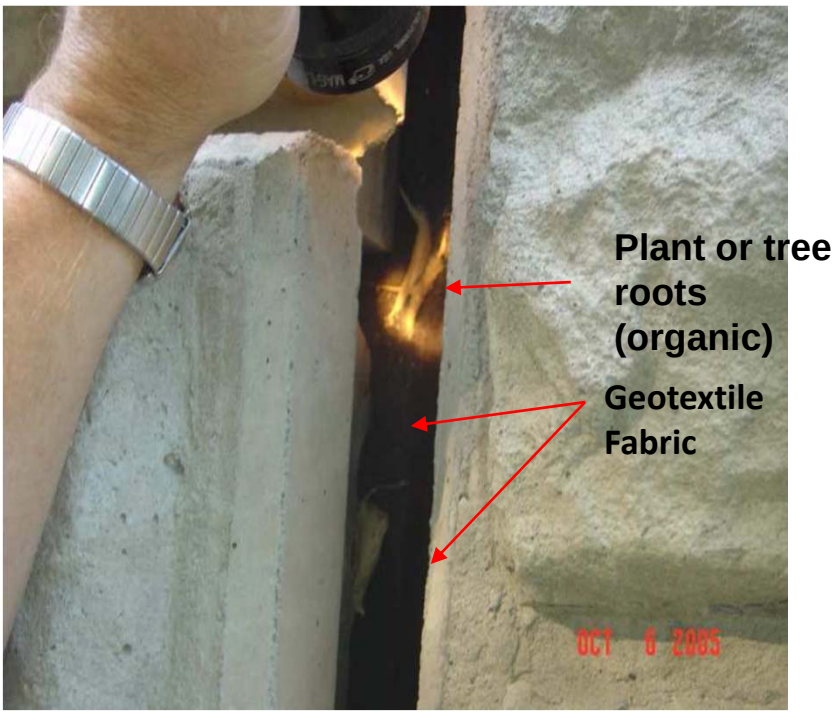
Panel Staining

❖0 - More than 50% of the wall surface is stained.

❖5- Less than 25% of the wall surface is stained.

❖9 - None or only an insignificantly small area of the wall surface is stained.

Exposure of Fabric at Joints



Organic material exposed between panels and filter fabric (behind the wall face).

Definition:

Joints in the wall face can be deformed to the point where the geotextile fabric behind the wall face becomes visible or protrudes through the joint. Filter fabric decomposes within a few months once exposed to ultraviolet radiation in sunlight.

Exposure of Fabric at Joints

❖0- Greater than 10% of the joints show fabric exposed to sunlight.

❖3 - Fewer than 5% of joints show fabric exposed to sunlight.

❖6 - No fabric is currently exposed at joints, but some joints appear to be increasing in width, which may allow fabric behind to become visible.

❖9 - Joints appear to be stable; no fabric is currently exposed.

Loss of Backfill

The material shown above is select backfill which has moved from behind the wall, through panel joints, to accumulate in front of the wall.

Definition:

Backfill moving from its original location down the wall's back slope or outward through wall joints.

Loss of Backfill

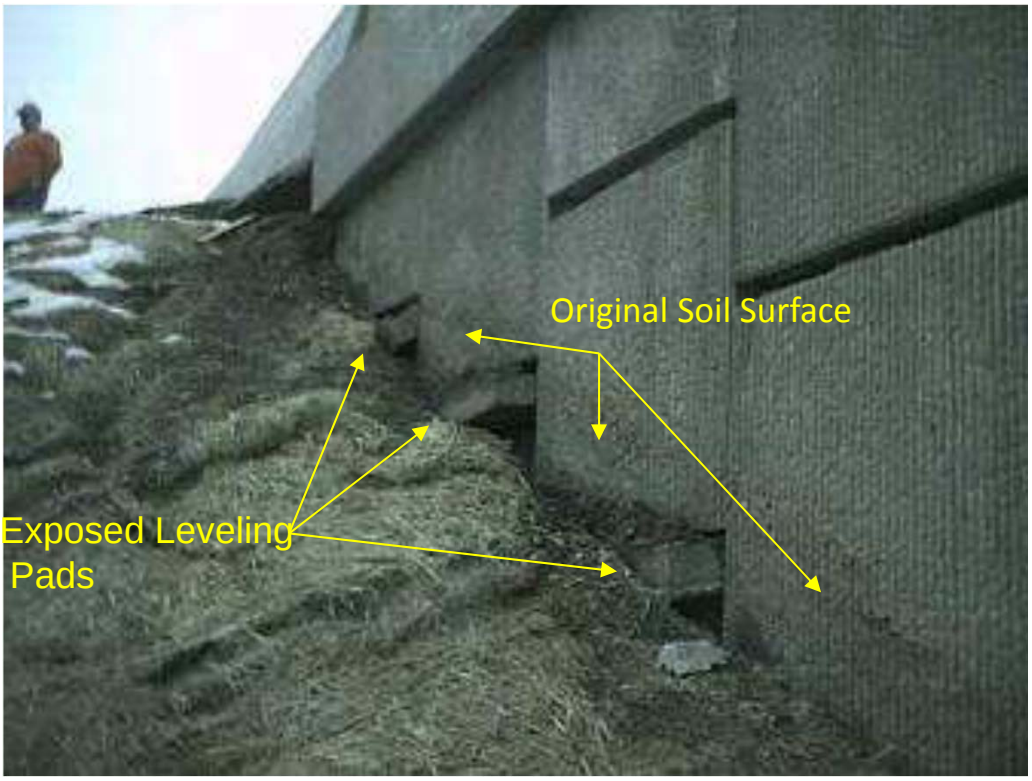
❖0 - Backfill loss has resulted in significant settlement of the v-ditch or roadway or has affected wall inclination or alignment.

❖3 – Significant areas/quantities of backfill loss are visible.

❖6 – Backfill loss is occurring, but only minor areas/quantities of backfill loss are visible.

❖9 - No visible evidence of backfill loss.

Erosion- Front of Wall



The soil surface along this wall is being eroded, which exposed the leveling pads.

Definition:

Materials covering the leveling pad are being actively eroded. Uncorrected erosion results in exposure of the leveling pad (subsurface panel face or concrete footing) and, if not brought under control, can remove material from beneath the wall.

Erosion- Front of Wall

- NA – Area in front of the wall is paved.
- 0 - Erosion has exposed more than 50% of the wall base.
- 3 - Erosion has exposed more than 25% of the wall base.
- 5 – Erosion has exposed less than 25% of the wall base.
- 7 – Erosion is occurring but the wall base remains covered.
- 9- No evidence of erosion in front of the wall.

Erosion- Back of Wall

Washout (showing wall reinforcement exposed).

Definition:

Loss of backfill material through erosion behind the wall face. Severe erosion of backfill is indicated by significant washouts and exposure of wall reinforcement.

Erosion- Back of Wall

❖0 - Wall reinforcement is visible in several locations.

❖3 - Wall reinforcement is being exposed at two or more locations.

❖5 - Effects of erosion are visible but no wall reinforcement has been exposed.

❖7 - Minor effects of erosion are visible; plant roots may be exposed or higher original soil levels on concrete structures may be indicative of erosion.

❖9 - There is no visual evidence that erosion is occurring behind the wall.

Joint Spacing

Two adjacent sections of this wall are bowing outward,
causing excessive joint spacing between two adjacent panels.

Definition:

Even spacing between panels or blocks is desirable for wall function and for esthetic considerations. Vertical and horizontal joints should be consistent and of uniform size across the entire wall face.

Joint Spacing

❖NA – Wall is not a panel wall; wall has no joints.

❖0 – Joint width appears almost totally irregular and random.

❖3 - Joint width varies widely across the wall face.

❖5 - Joint width appears marginally regular, but considerable variation exists in different areas or at different heights along the wall.

❖7 – Joint width appears generally uniform with the exception of some discrepancies in localized areas.

❖9 - Joint width appears generally uniform across the entire wall.

Condition of V-Ditch

Loss of backfill has caused a complete break along the V-Ditch as well as its separation from the wall.

Definition:

The V-Ditch is a continuous structure that intercepts runoff and transports it away from the wall. Where the V-Ditch has failed, runoff may cascade downward over the wall's face or drain downward through the wall along its back face.

Condition of V-Ditch

❖NA – The wall has no V-Ditch.

❖0 - The V-Ditch is nonfunctional due to backfill movement, cracking, etc.

❖3 - The V-Ditch has separated from the wall face; extensive cracking or breakup of the V-Ditch has rendered it almost nonfunctional.

❖5 - The V-Ditch is still attached to wall, but large cracks are developing in the V-ditch at several locations. The V-Ditch can transport less water than intended.

❖7 - The V-Ditch is still attached to the wall, but minor cracks are developing; ability of V-Ditch to transport water has not been affected.

❖9 - No cracks in the V-Ditch; no separation of the V-Ditch from the wall. The V-Ditch is functioning as intended.

Coping Deterioration

The coping covering the top of this wall is in excellent condition.

Definition:

Coping is the cap (often concrete) that covers the top panels along a wall face. Coping should not be confused with railing, which serves as a safety mechanism for vehicles.

Coping Deterioration

❖NA – This wall has no coping.

❖0 - More than 25% of the coping shows signs of severe cracking, has become detached or is spalling.

❖5 – Less than 25% of the coping shows signs of severe cracking, has become detached or is spalling.

❖9 – There are no signs of coping deterioration.

Drainage Runoff

Improper drainage runoff from the roadway caused undermining of this road and displacement of the flume.

Definition:

Drainage pathways should move runoff from the upper road surface away from the wall without adversely affecting the wall function or traffic movement. Indicators of problems include and are not limited to: misalignment on tilting of guardrails, erosion beneath guardrails or erosion along the sides of the road in either direction.

Drainage Runoff

❖NA- No structure above wall to cause drainage runoff.

❖0 - Erosion runoff is actively moving significant quantities of backfill material from its original location.

❖3 - Indications of erosion runoff are present; quantity of backfill material being moved appears significant.

❖6 - Indications of erosion runoff are present but there is no indication that the quantity of backfill material being moved is significant.

❖9 - No signs of erosion due to drainage runoff.

Drainage at the Front of the Wall

Problematic drainage is causing ponding at the front of this wall.

Definition:

Drainage along the front of the wall should remove water without allowing inundation of the structure's base or adjacent traffic paths.

Drainage at the Front of the Wall

❖0 – Signs of water ponding consistently in front of the wall (Cattails growing, stain lines left from standing water on the wall, etc.).

❖ 5 – Water ponds in front of the wall infrequently or only during periods of intense precipitation.

❖ 9 - Front of the wall is well drained; no ponding occurs.