# Asset Management of MSE Walls: Critical from Design Through Design Life


Robert A. Gladstone
Association for Metallically Stabilized Earth

Scott Anderson and Richard Barrows
Federal Highway Administration

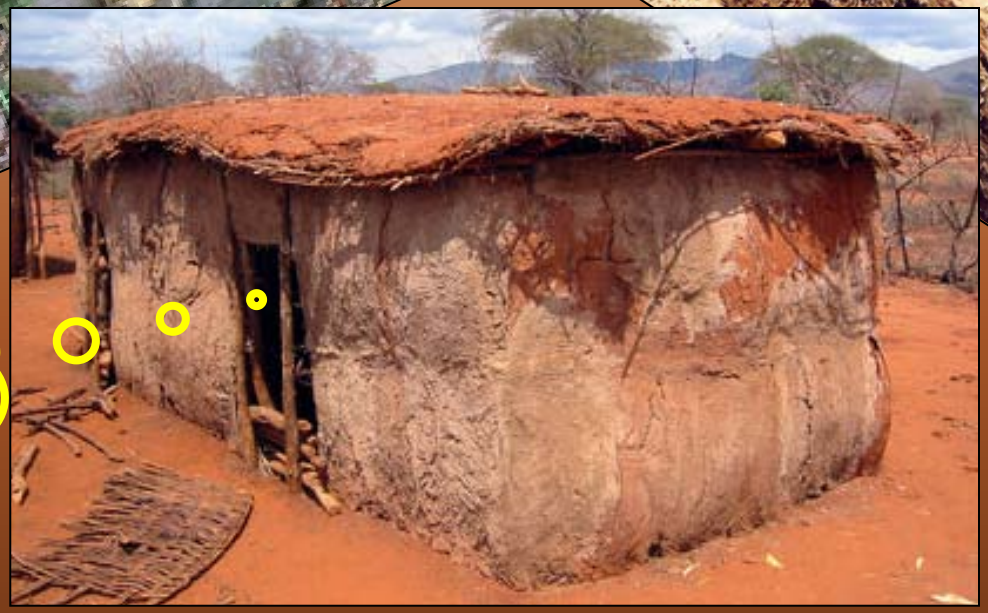

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Early Earth Reinforcement Systems



What's an Asset?

*Build It Right ...*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

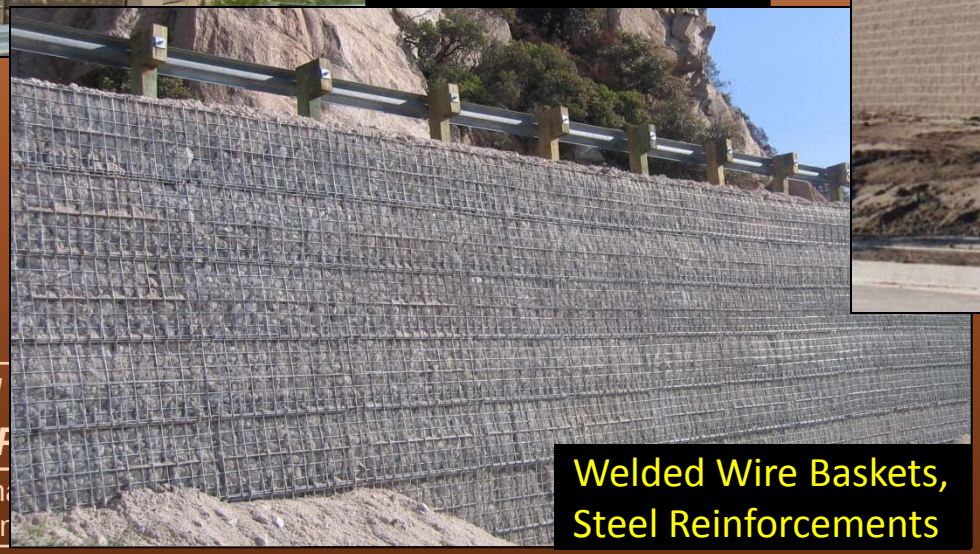
U.S. Department of Transportation
Federal Highway Administration

# Modern Earth Reinforcement Systems

**Asset Management is *HIGHLY APPROPRIATE!***

Precast Panels, Steel Reinforcements

Segmental Blocks, Geosynthetic Reinforcements



Welded Wire Baskets, Steel Reinforcements

***Build***
***Care F***

9th Nationa
Transportatior

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

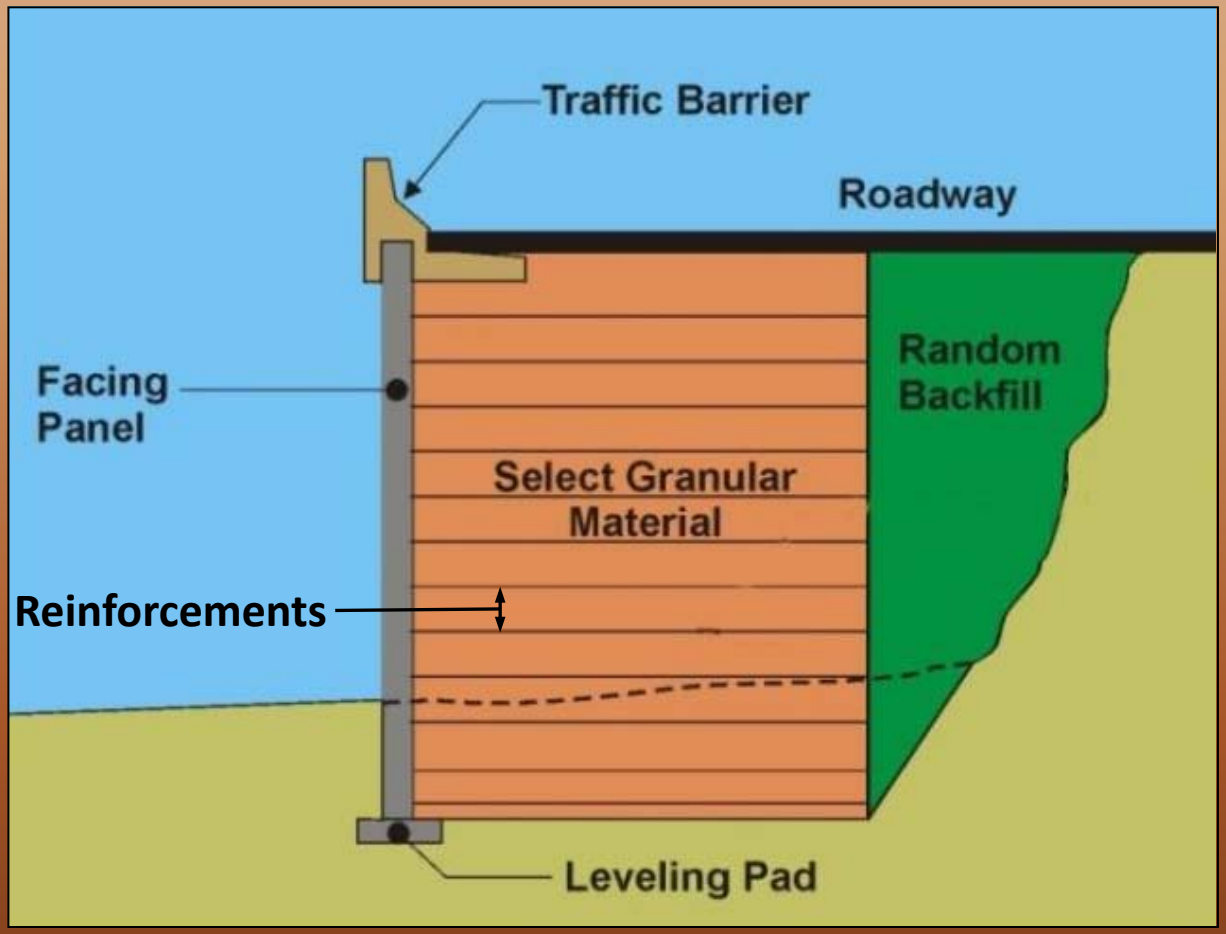
# Walls: Out of Sight, Out of Mind

Driving here?

# Walls: Out of Sight, Out of Mind

Can't see down here!

# For Asset Management, Design Matters




*Build It Right …*
*Care For It Right*

9th National Conference on Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# A Typical MSE Wall Cross Section

# Foundations – The First Look

# Foundations – Site Preparation

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Foundations – Important Wall Details

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Construction Practice – Panel Facing

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Construction Practice – Connecting Steel Reinforcements

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Construction Practice – Block Facing

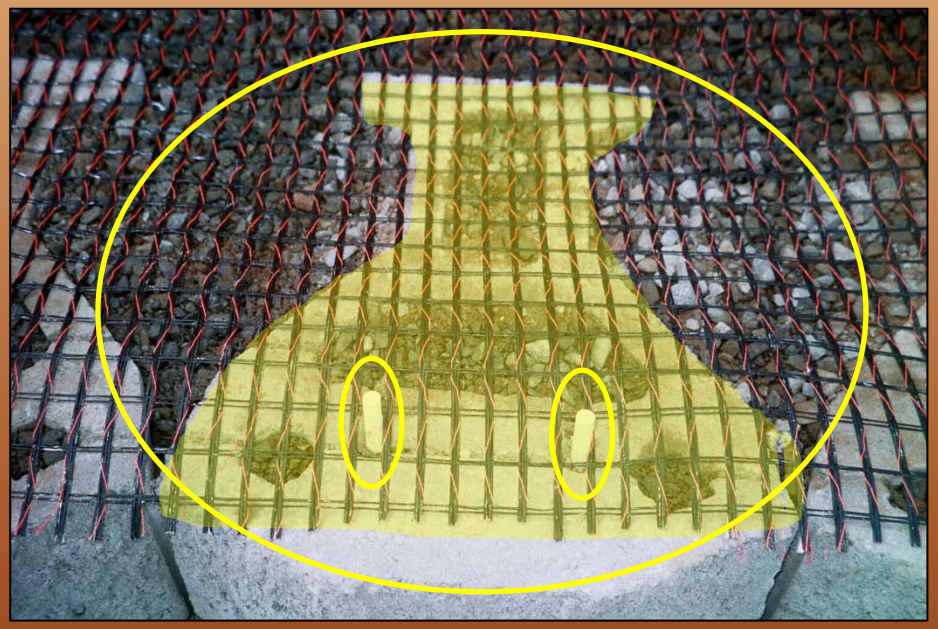

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

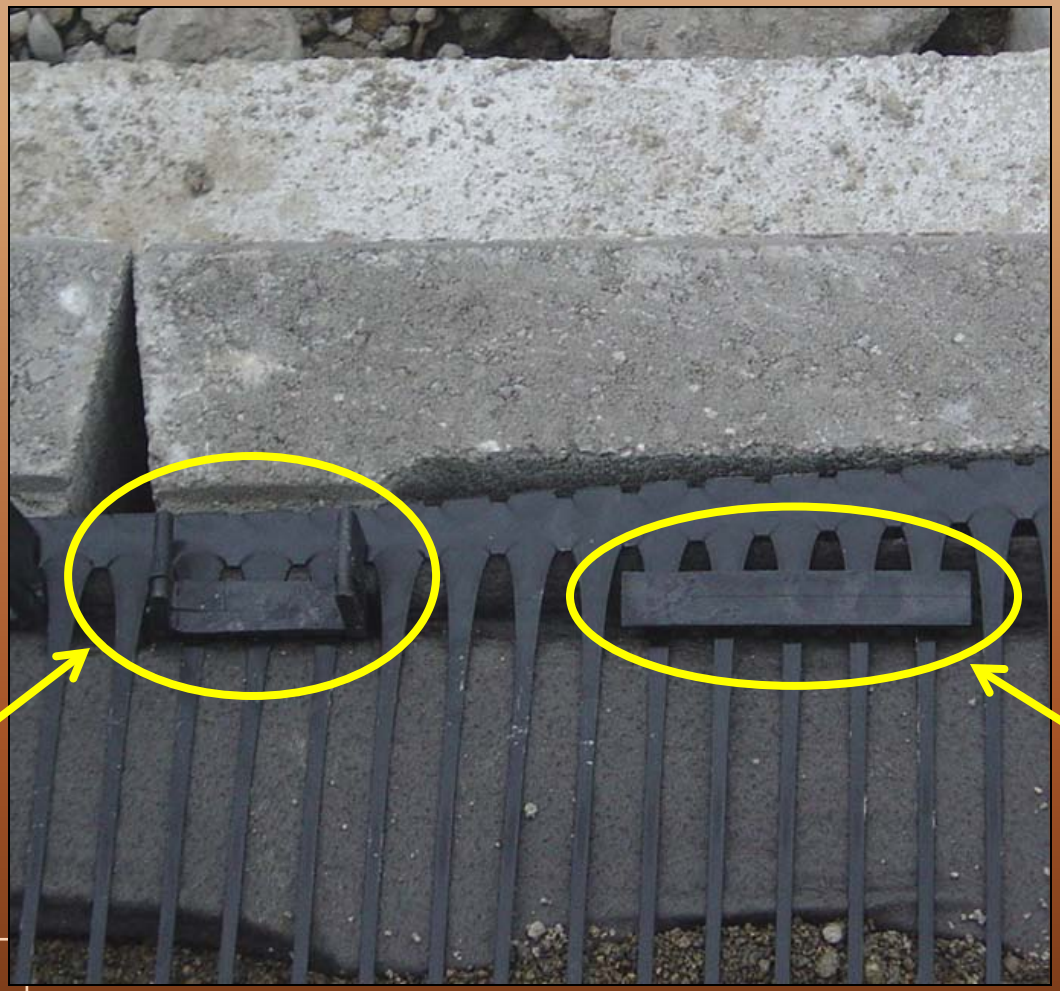
AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Construction Practice – Connecting Geosynthetic Reinforcements



# Construction Practice – Connecting Geosynthetic Reinforcements



# Drainage – MSE

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Drainage – Roadway

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

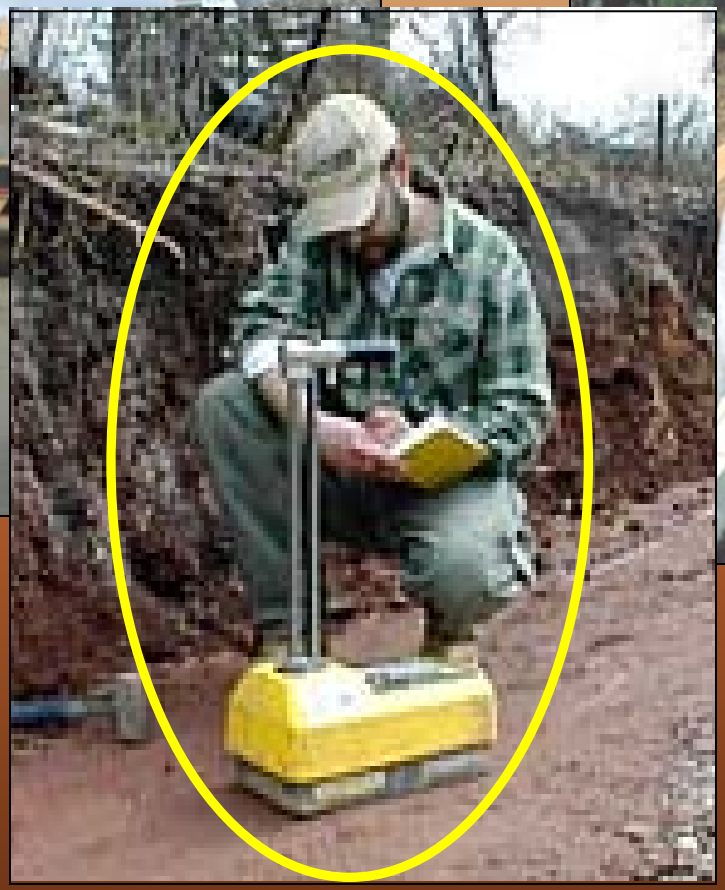
U.S. Department of Transportation
Federal Highway Administration

# Backfill Selection is Critical

Sheepsfoot roller. Clay backfill = poor friction and drainage

Good friction and drainage come from *granular backf ill*

# Excellent Compaction for Long Life

*Build It Right …*
*Care For It Right*

9th National Conference on
Transportation Asset Management

AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# Construction Inspection – for *Long-Lasting Results*

- Control of materials
  - Panels, reinforcements, joint materials
  - Backfill – grain size, moisture, electrochemistry
- Control of processes
  - Wall erection – plumbness, alignment, finish details
  - Backfill placement and compaction
  - Drainage systems/runoff control
  - Barrier/coping
- Record-keeping – enables monitoring

# Plan for Monitoring (instead of retrofitting)

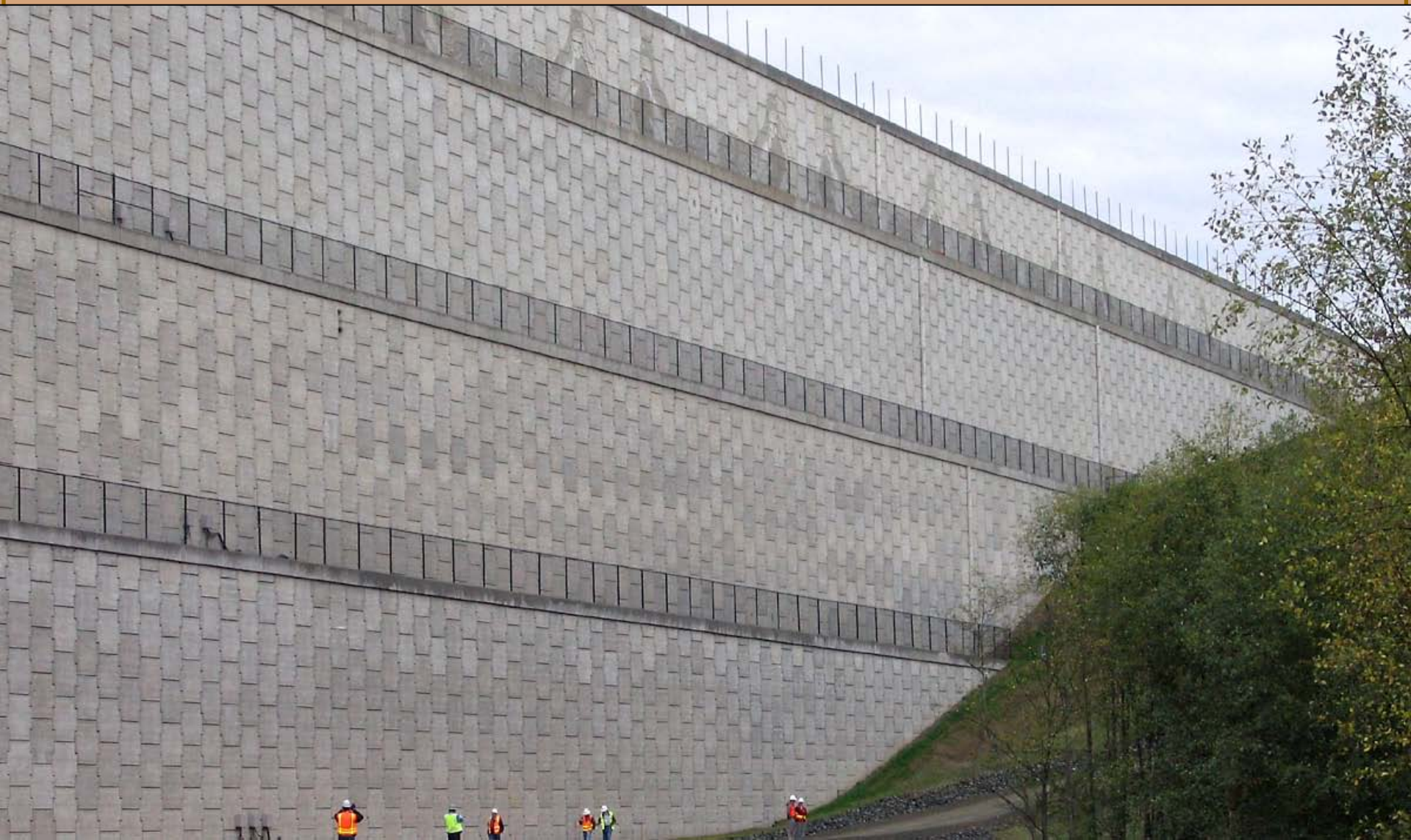
# Key Elements of The MSE Wall Asset (From Cradle On)

- **Design** Cradle - By FHWA GEC11 and AASHTO
  - Bearing Capacity, Settlement, Sliding, Overturning, Over All Stability
  - Reinforcement Strength and Connection Strength
  - **Reinforcement and Facing Durability**
  - **Drainage and Storm Water**
- **Appropriate Specifications**
- **QA/QC For Conformance to Specifications** (Construction Inspection)

# Key Elements of The MSE Wall Asset (continued)

- **The "On"…… Part**
- Condition Assessments (post construction inspection)
- Ability to address unforeseen circumstances or events (guidance to be developed in IBRD Study
- IBRD Study: **Reinforced Mechanically Stabilized Earth Wall Rehabilitation Solutions and Performance Monitoring Methods**

# Build It Right … Care For It Right



# Key Elements: Settlement, Bearing Capacity, Overall Stability

# Key MSE Wall Element – Drainage and Storm Water

***Build It Right … Care For It Right***

9th National Conference on Transportation Asset Management

# MSE Wall Design Elements with Respect to Durability

- Corrosion and Chemical Degradation Potential
- Installation Damage
- Freeze Thaw Cycles
- Ultraviolet Light

# MSE Durability – Reinforcement Installation Damage

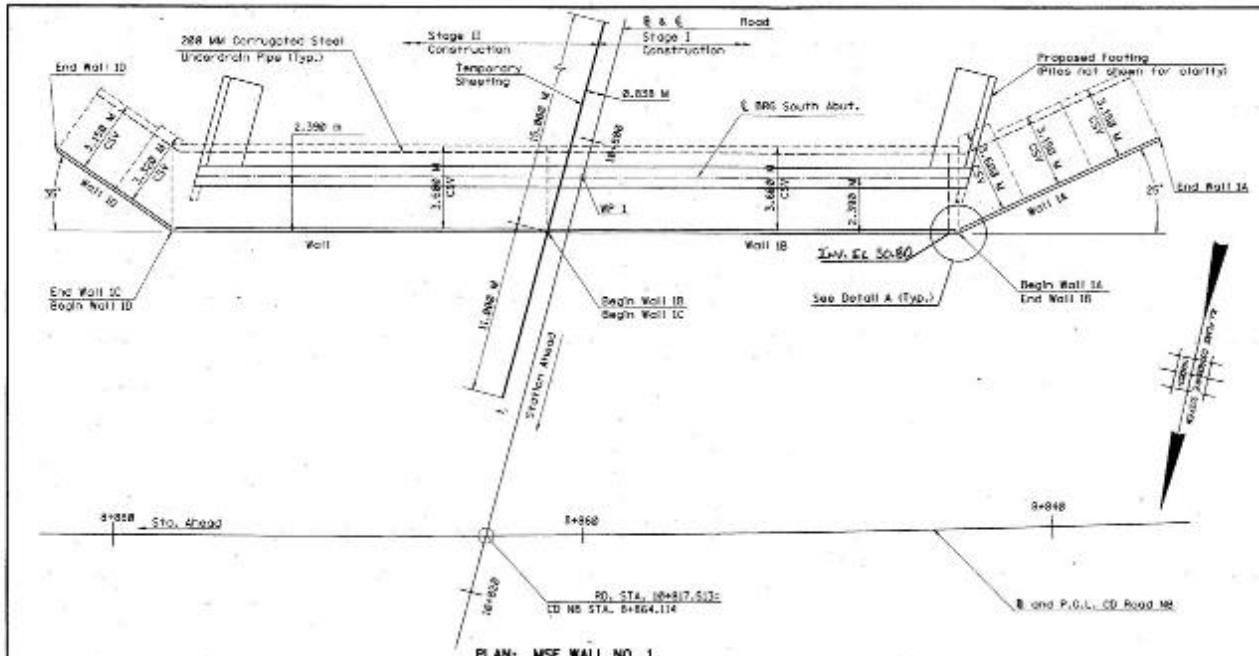
# MSE Durability – Reinforcement Corrosion

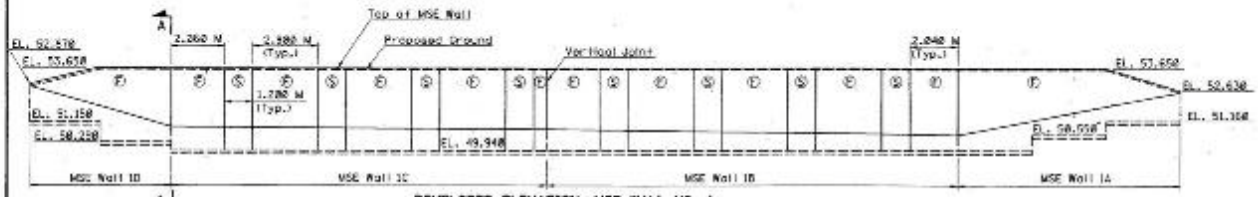
# MSE Durability – Facing

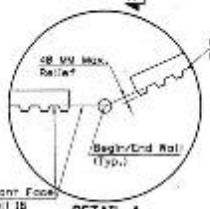
# MSE Wall Specifications and Plans

- High quality plans and specs are needed to construct a high quality asset.

# Contract Drawing




**QUANTITIES**

| PAY ITEM NO. | STANDARD ITEM NO. | DESCRIPTION | UNIT | CONTRACT QUANTITY |
|---|---|---|---|---|
| 578 | SM21C | TEMPORARY SHEETING | S.M. | 162 |
| 388 | MSTBI | MECHANICALLY STABILIZED EARTH WALL, LOCATION NUMBER 1 | S.M. | 133 |

**WORK ITEMS** - (Price to be included in Wall Pay Item)

| DESCRIPTION | UNIT | APPROXIMATE QUANTITY |
|---|---|---|
| FOUNDATION EXCAVATION | C.M. | 556 |
| CONCRETE LEVELING PAD | L.M. | 48 |
| CONCRETE IN SUPERSTRUCTURES, COPING | L.M. | 68 |
| POROUS FILL I-9 | C.M. | 79 |
| 200 MM CORRUGATED STEEL UNDERDRAIN PIPE | L.M. | 93 |

**MSE RETAINING WALL STATION AND OFFSET CONTROL**

| BEGIN/END WALL | CD-NB & STA. | OFFSET (M)* | WALL LENGTH |
|---|---|---|---|
| BEGIN WALL 1A | 8+843.715 | 12.647 | 0.580 m |
| END WALL 1A | 8+834.088 | 16.453 | |
| BEGIN WALL 1B | 8+861.413 | 12.944 | 17.580 m |
| END WALL 1B | 8+843.715 | 12.647 | |
| BEGIN WALL 1C | 8+861.413 | 12.944 | 16.088 m |
| END WALL 1C | 8+877.599 | 12.975 | |
| BEGIN WALL 1D | 8+877.599 | 12.935 | 6.888 m |
| END WALL 1D | 8+882.684 | 16.388 | |

* All Offsets are to the Front Face of the MSE Wall, as defined in Detail A.

**MSE WALL NOTES:**

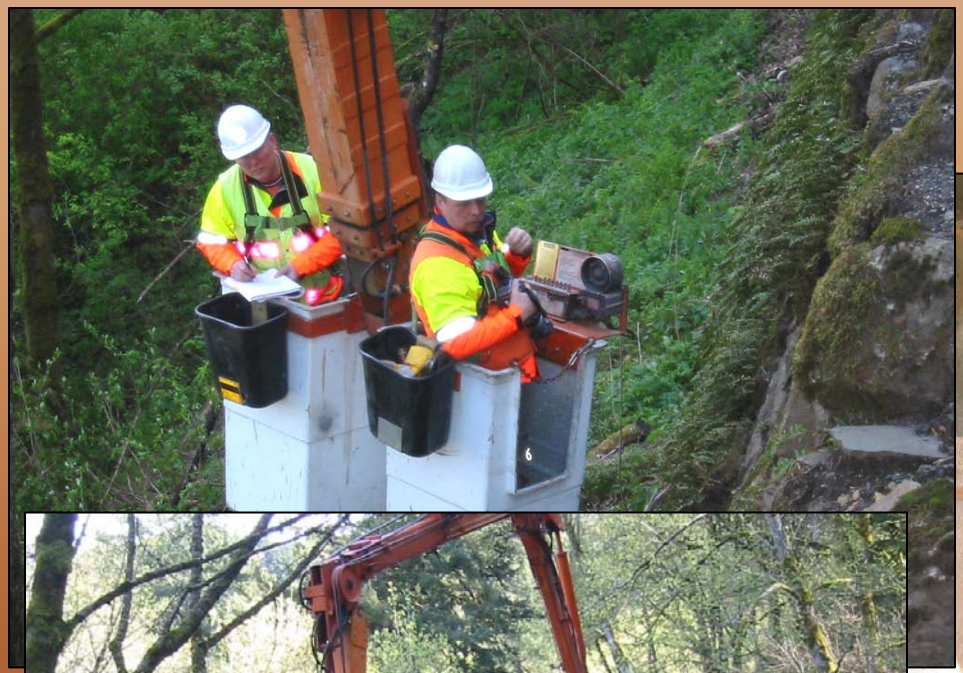
1. Mechanically Stabilized Earth (MSE) Retaining Walls will be paid for under Item. Mechanically Stabilized Earth Wall, Location No. and Item. Mechanically Stabilized Earth Wall, location No. . Any projections beyond the limits indicated to accommodate precast face unit spacing and coursing will be considered incidental to this Item.
2. Wall lengths are measured along the front face of the walls. Lengths of walls are defined at the intersection of the front faces of adjacent walls. For further information, see Detail A.
3. MSE Walls shall also be designed assuming the select backfill material property has a unit weight of 19 KN/m³ and an angle of friction of 34° with an allowable bearing pressure of 250 KN/m². Walls within 3.58 meters of the front row of piles shall be designed to accomodate an additional uniform thrust pressure of 28.68 KPa as specified in and Geotechnical Report.
4. Piles shall be placed prior to MSE wall construction. The Contractor shall be responsible for this coordination. If the pile layout interfers with the placement of the soil reinforcing elements, the Contractor may place the reinforcing elements along a skew within the Manufacturer's allowable limits. In the event that the required skew of a reinforcing element is beyond the Manufacturer's allowable limit, the Contractor shall submit to the Engineer for approval, alternate reinforcing element layout details, which eliminate the pile conflict with the reinforcing element. Any modifications to the placement of the reinforcing elements or connections shall meet the requirements of the MSE wall Manufacturer and be approved by the Engineer.
5. MSE Panels designated with a (F) shall have a Fracture Fin Finish corresponding to the Fracture Fin Section Detail on Sheet No. 811. MSE Panels designated with a (S) shall have a smooth flat surface. The MSE Panels with the Fracture Fin Finish shall be created with a form liner at the time of precasting each panel. The relief shall be approximately 40mm and shall be in addition to the standard panel thickness. Precast panel joints shall be coincident with the fractured fin finish/smooth pattern jointing. The Contractor shall submit samples of the Fracture Fin finish to the Engineer for approval.
6. Actual wall lengths provided may vary slightly to account for Manufacturer's panel lengths. The location and width of the smooth (S) panels shall coincide with the location and width shown in the Developed Elevation on this drawing and drawing 818.
7. Coping along top of wall is not shown for clarity.
8. The Contractor may nominally increase the length of wall at no additional cost to the State.
9. MSE Wall No. 1 and MSE Wall No. 2 shall contain color additives at the time of precasting each panel. The color of the additive shall match color #37138 in accordance with the Federal Standard 595B color chart. The integrally colored concrete shall comply with ASTM C979. In addition to the color additive at the time of precasting, the MSE Walls shall also be stained in accordance with Section 522 of the NJDOT 1998 Supplemental Specifications to the 1996 Standard Specifications for Road and Bridge Construction. The color of the stain shall also match color #37138 as previously described. The cost of the color additives as well as the cost of the MSE Wall staining shall be included in the MSE Wall Items.
10. For Section A-A and Details, See Sheet No. 811.
11. For Temporary Sheeting notes and details, see sheet 836.

Figure 5.1.5 Typical Contract Drawing for MSE Wall Abutment

# Construction Inspection

- Trained inspectors who understand MSE walls and what's Important
- Experienced
- Cooperative
- On site

# MSE Wall Long-term Condition Assessments



AMSE
Association for Metallically Stabilized Earth

U.S. Department of Transportation
Federal Highway Administration

# MSE Wall Asset Preservation


Photo by: www.ncsconsultants.com

# Wall Was Hit Hard


Photo by: www.ncsconsultants.com

# Repaired Wall

# MSE Wall Asset Preservation

# Spiral Nails

# Repaired Wall

# Landslide Over MSE Wall

# Wall Face Damage

# Wall Repaired – Slide Still Moving

# Asset Management – Not Just MSE

# Summary

- Many components make up an MSE wall; most are buried.
- Managing the MSE wall asset starts with the design (cradle).
- There are key MSE wall design, material, inspection, and construction elements to consider.
- The MSE wall asset lends its self to NDT monitoring, condition assessment, in-place repair.

***Build it Right … Care For It Right!***