

Maintenance Guidelines for MSE Walls – TRC2104

Michelle L. Barry, PhD, PE

Associate Professor, Civil Engineering
mlbernha@uark.edu

Richard A. Coffman, PhD, PE, PLS

Associate Professor, Civil Engineering
rick@uark.edu

Ruimin Feng, PhD

Postdoctoral Researcher, Civil Engineering
rf015@uark.edu

Mechanically Stabilized Earth (MSE)

**Reduces Use of
Heavy Equipment**

**Simple & Fast
Construction**

**Various Shapes and
Orientations**



**Reduces Land
Required**

**Less Site Preparation
Required**

**Can Build on Poor
Soils**

Disadvantages of MSE walls

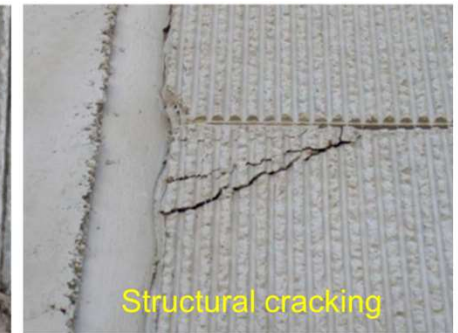
Numerous system designs,
reinforcement types, etc.

Disconnect between design and
construction practices and
specifications

Poor performance can lead to
maintenance headaches

Limited maintenance guidance

Typical Maintenance Concerns



Critical Issue

There is little to no guidance regarding post-construction inspection and the appropriate repairs for given distress signs or performance metrics.

Only 2 of 33 states reported having MSE wall maintenance handbooks

These handbooks had very little information on actual post-construction practices

Very little guidance on repairing versus rebuilding



Research Goals & Objectives

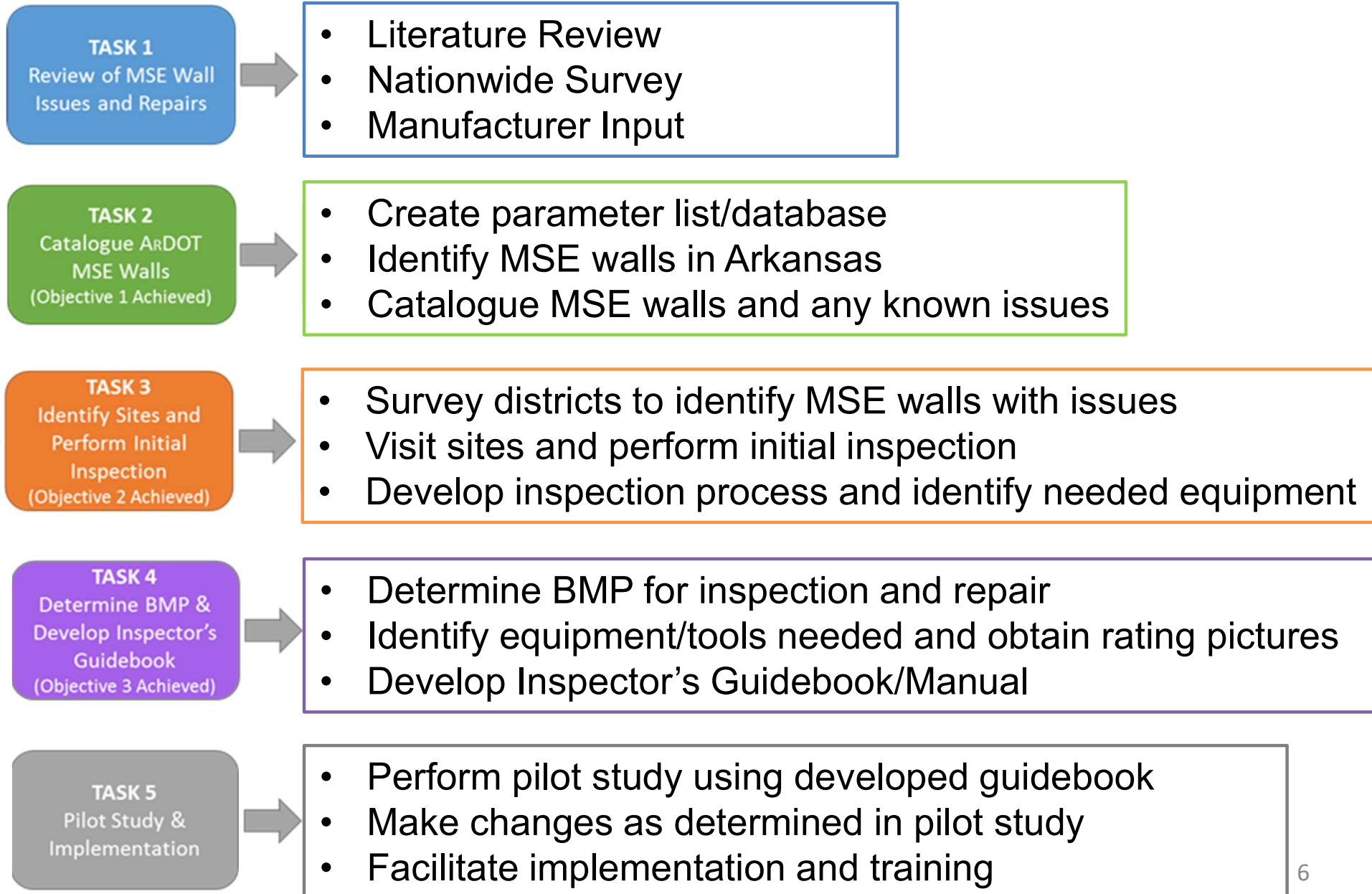
**Determine Best Management Practices (BMP)
for MSE walls**

**Develop a maintenance inspector's guidebook to
provide assistance to address potential signs of
distress**

Objectives:

- 1) Expand an ArcGIS database to include an inventory of all MSE walls maintained by ARDOT
- 2) Perform an initial inspection of candidate sites chosen by ARDOT
- 3) Determine BMP and develop MSE maintenance guidebook

Work Plan



Task 1: MSE Wall Survey

Survey sent out to DOT contacts at all 50 states and D.C.

- 47 responses were received, 44 complete responses

Survey comprised of 14 total questions (23 sub-questions) covering 3 categories

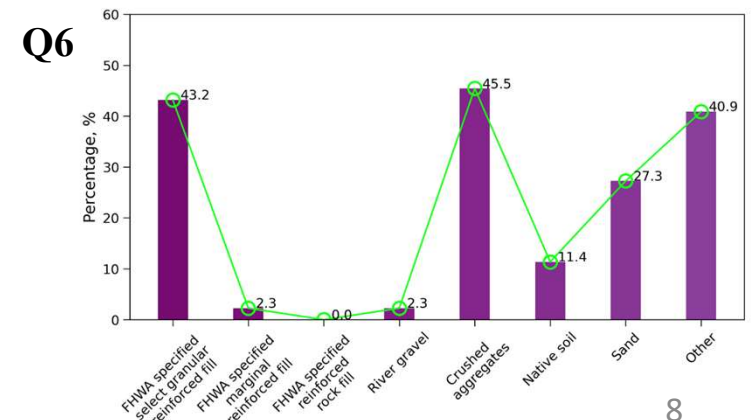
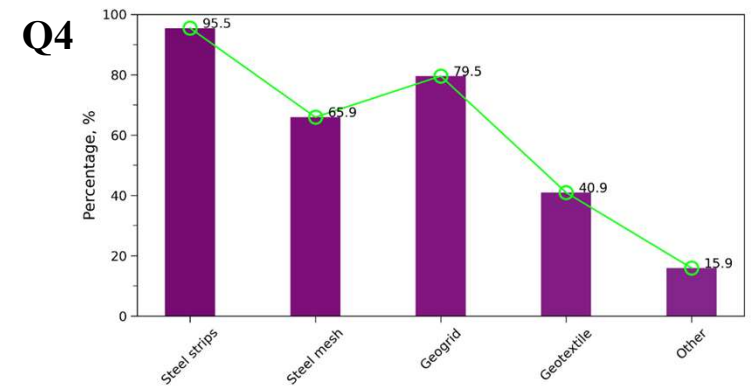
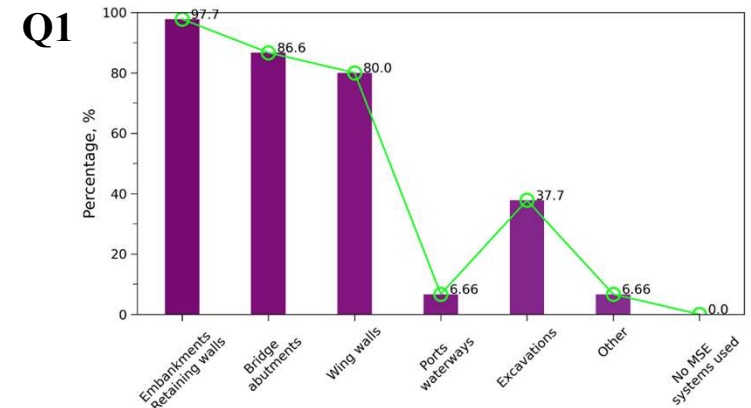
- General system information and usage
- MSE issues encountered
- Inspection, maintenance, repair plans in place

The survey results and literature review were then discussed with 3 MSE wall manufacturers and industry representatives.

Nationwide MSE Wall Survey

General System Questions

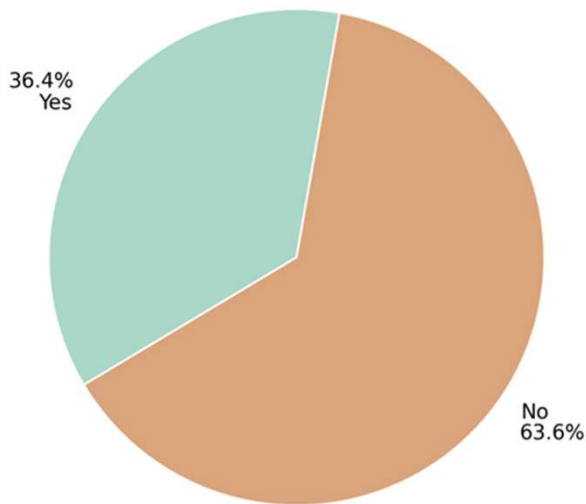
1. Which types of structures have MSE systems been used for in your state?
2. Do you have a list of approved MSE manufacturers and/or products?
3. Do you know which specific systems/products have been constructed?
4. What types of soil reinforcement have been used in your state?
5. If steel reinforcement was used, have there been any other types of coatings used other than galvanization?
6. What type of backfill materials have been used in your state?
7. What is the maximum height (in ft) allowed for MSE walls in your state?
8. MSE walls are allowed to be built on which of the following in your state: Native soil/rock, Improved ground, Other
9. If MSE walls are used as bridge abutments, the bridge footing is bearing on which of the following: Deep foundations, MSE reinforced fill, Other



Nationwide MSE Wall Survey

Inspection & Maintenance Questions

11. Have there been any MSE wall failures in your state?



Failure type	No. of States																Sum of the states having such a failure	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	16	17		
Vertical deviation on facing panels							√	√			√	√					√	5
Cracking on facing panels															√			1
Settlement of Backfill		√		√								√		√	√	√		6
Hit by vehicle												√					√	2
Loss of Backfill		√	√	√				√				√	√		√	√		8
Problematic drainage		√		√				√	√			√			√			6
Other (specify)	√		√	√	√	√		√	√	√	√			√				10
How many failures	1	2-3	1	<10	1	N/A	1	10	1	2	1	~5	1	N/A	N/A	√		

Nationwide MSE Wall Survey

Inspection & Maintenance Questions

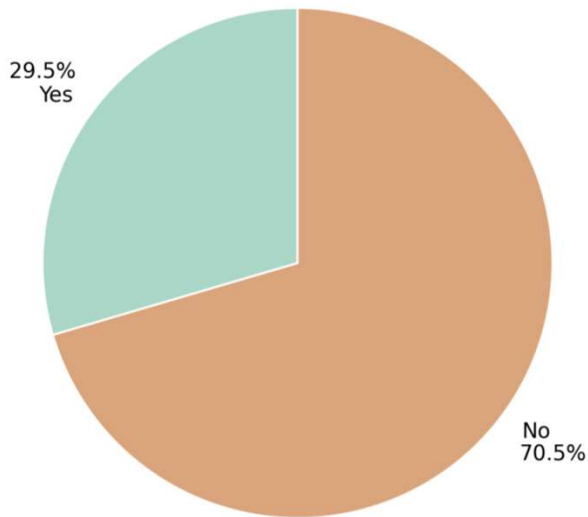
12. Are there any MSE inspector handbooks specifically written or used for maintenance activities in your state?

States	Link or sources
FL	https://www.fdot.gov/docs/default-source/construction/CONSTADM/Guidelist/InspectGuidelist/FY1213/MSE-Wall-Inspectors-Handbook.pdf
OH	https://www.transportation.ohio.gov/working/engineering/structural/mbi
NY	https://www.dot.ny.gov/divisions/engineering/technical-services/technical-services-repository/GEM-16.pdf
PA	Publication 238 addresses MSE wall inspection. See Chapter 2. https://www.dot.state.pa.us/public/PubsForms/Publications/PUB%20238.pdf
WI	Wisconsin Structures Inspection Manual: https://wisconsin.dot.gov/dtsdManuals/strct/inspection/insp-fm-pt4ch4.pdf Updates to inspection and maintenance guidance are currently ongoing.

Nationwide MSE Wall Survey

Inspection & Maintenance Questions

13. Is there a periodic inspection, maintenance plan, or inventory in place for MSE walls in your state?



States	a. How often	b. rating system	c. link or reference
AK	Not set interval		
CO	5		
DE	Unknown		
IN	Not set interval	√	
KS	Not set interval		
ME	Inspected at the frequency of bridge inspection	√	√
NE	2	√	√
NY	5	√	√
OH	10		
PA	5 years routine 10/15-year in-depth inspections	√	√
VT	2		
MO	unknown – typically tracked with bridges where applicable		
WI	6	√	√

Nationwide MSE Wall Survey

Inspection & Maintenance Questions

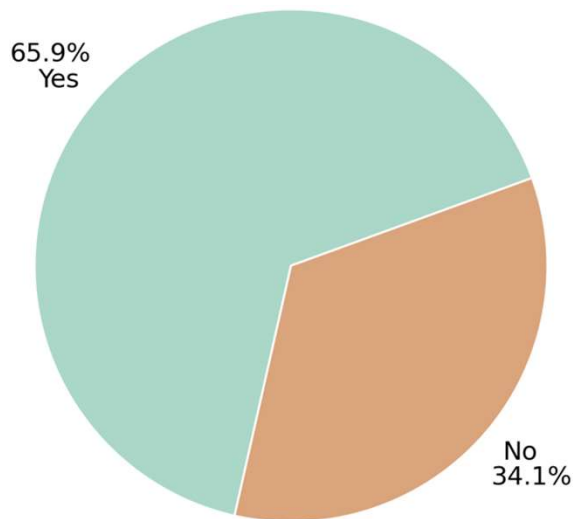
14. Have there been any maintenance issues with MSE walls in your state? Maintenance issues are defined here as events that do not result in the replacement or reconstruction of the wall but require repair.

No.	Distress sign or issue	Repair or maintenance activity
1	Vertical deviation of the facing panels	
2	Cracking on facing panels	
3	Vegetation growth in panels	
4	Settlement of backfill	
5	Loss of backfill	
6	Problematic drainage	
7	Vehicle impact	
8	Animal burrows or clogging of drainpipes	
9	Other	

Nationwide MSE Wall Survey

Inspection & Maintenance Questions

14. Have there been any maintenance issues with MSE walls in your state? Maintenance issues are defined here as events that do not result in the replacement or reconstruction of the wall but require repair.



No. of Walls	Number of States	Types of Issues	Recurrence
1-5	10	Vehicle impact, backfill loss, erosion, panel spalling, cracking, vegetation, detail issues, construction defects, isolated and varied issues	Mixed
6-10	2	Backfill, panel issues	New
11-20	2	Structural issues and maintenance issues	Mixed
21-30	1	Multiple issues	Recurring
31-50	1	Various structural and maintenance issues	Recurring
50+	1	Older walls with multiple issues; vehicle impact	Recurring
Unknown	9	Vehicle impact, construction defects, and unspecified issues	Mixed

Nationwide MSE Wall Survey

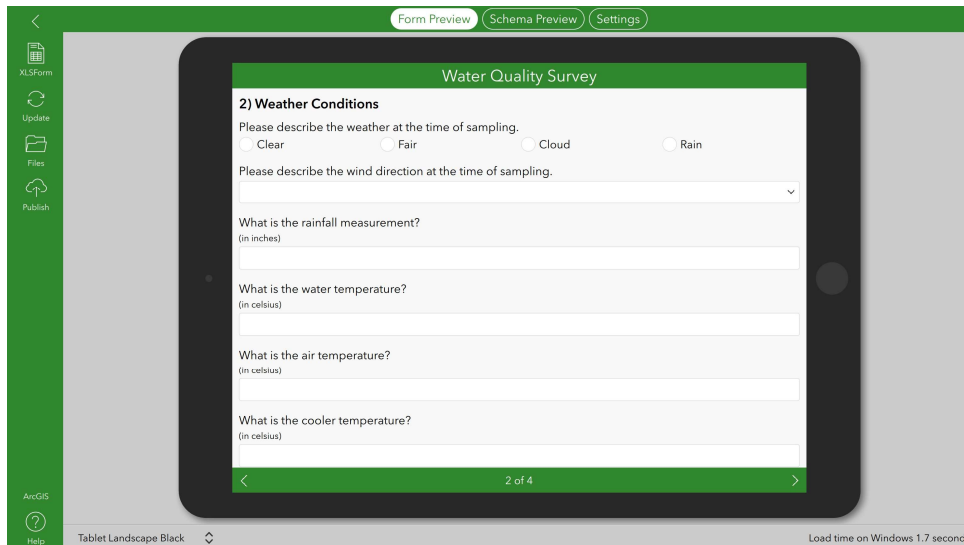
Inspection & Maintenance Questions

Table 20. Maintenance or Repair Activity Used to Address Loss of Backfill

States	Loss of Backfill
AZ	Fill gaps in facing panels
AR	√
FL	Fill voids with polyurethane foam
GA	Most of <u>our</u> backfill loss situations have been due to the undermining of the wall <u>face</u> . If we catch it early enough, slope repair and the addition of flowable fill have provided a long-term fix.
IN	Maintenance
IA	Small amounts of sand leaking through joints
KS	Flowable fill, polyurethane grouting
LA	Wall was buried behind a new embankment
MN	We are currently investigating this issue in several areas.
MS	√
MO	We have experienced material migration through the panel joints even using geosynthetic strips at joints. This issue has been observed where sand is used as backfill, and we are considering eliminating sand from the Select Granular Backfill specification (See Section 1010 of our Specs linked earlier in this survey).
NE	Same as above
OH	Backfill of voids with flowable cementitious fill
OK	Placed grout behind MSE panels
OR	A concrete panel-faced MSE wall along a slough had a void behind the facing. The void was filled with controlled low-strength material.
TN	Sand migrated from the panel. The resulting action was to allow only graded stone and no longer permit sand.
TX	Backfill with fines, plus surface drainage issues, often results in channel voids behind the wall face. If the voids are very small and the reinforcement is intact, they can often be addressed with flowable fill; otherwise, this requires local panel/reinforcement removal and replacement.
WI	-Monitor retaining wall - Add foam backer rod and consider filling voids with foam - Add filter fabric to weep holes

Task 2: ARDOT GIS Database

Catalogue MSE walls in Arkansas and provide up to date information for maintenance personnel



The screenshot shows a mobile application interface for a "Water Quality Survey" form. The form is displayed on a tablet within a desktop environment. The form has a green header with the title "Water Quality Survey" and three tabs: "Form Preview", "Schema Preview", and "Settings". The main content area is titled "2) Weather Conditions" and contains several questions with input fields and radio buttons. The questions are: "Please describe the weather at the time of sampling." with radio buttons for "Clear", "Fair", "Cloud", and "Rain"; "Please describe the wind direction at the time of sampling." with a dropdown menu; "What is the rainfall measurement? (in inches)" with a text input field; "What is the water temperature? (in celsius)" with a text input field; "What is the air temperature? (in celsius)" with a text input field; and "What is the cooler temperature? (in celsius)" with a text input field. The form is displayed on a tablet with a black bezel. The desktop environment shows a green sidebar with icons for "XLSForm", "Update", "Files", "Publish", "ArcGIS", and "Help". The status bar at the bottom indicates "Tablet Landscape Black" and "Load time on Windows 1.7 seconds".

Parameters in database:

- Location, identifier (bridge or wall ID), type and year of build
- System and details (Soil reinforcement type, panel type, etc.)
- Backfill material
- Facing panel
- Foundation
- Dimension/height of the wall
- Sign of distress
- Performance of any structure supported by the reinforced soil
- Inspection history/Maintenance history
- Maintenance issue(s) encountered

Task 3: Initial Field Inspection

Example signs of distress in MSE walls in Arkansas



Wall face tilting



Bowing of the wall



Structural cracking



Facial deterioration



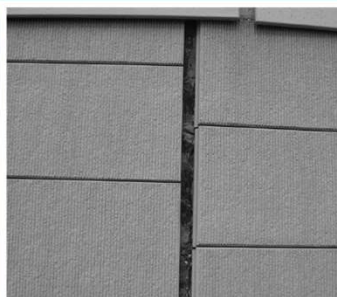
Exposure of fabric



Loss of backfill



Erosion



Joint spacing



Coping deterioration

Task 4: MSE Manufacturer Guidance



Maintenance issues, measurement thresholds, and suggested repairs were discussed to help develop the best practices for the inspection process and associated guidebook

Key Takeaways

- Importance of initial “as built” measurements and information
- Importance of rate of change versus absolute measurement in some cases
- Tools and best measurement practices for the various issues
- How to determine cosmetic damage versus something more serious
- What severity ratings can accurately capture the various issues
- Importance of working to identify the root of the cause versus the symptoms
- When to get an engineer or manufacturer representative involved

Task 4/5: MSE Inspector's Guidebook



INSPECTOR'S GUIDEBOOK FOR MECHANICALLY STABILIZED EARTH (MSE) WALLS

By

Michelle L. Barry, PhD, PE
Richard Coffman, PhD, PE, PLS
Ruimin Feng, PhD

Department of Civil Engineering,
University of Arkansas, Fayetteville

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Implementation Report

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TRC2104 Subcommittee
Lauren Baker
Kim Romano
Manuel Regalado
Raymond Leung

Kris Rutherford
Deric Wyatt
Rochelle Blue
Daniel DeVore
Paul Tinsley
John Borgeson



David Hutchinson



Willie Liew
Robert Johnson



Robert Gladstone

Michelle L. Barry, PhD, PE
Associate Professor, Civil Engineering
mlbernha@uark.edu

Richard A. Coffman, PhD, PE, PLS
Associate Professor, Civil
Engineering
rick@uark.edu

Ruimin Feng, PhD
Postdoctoral Researcher, Civil Engineering
rf015@uark.edu