Nevada DOT’s Experience with MSE Wall Corrosion

Presented By

J. Mark Salazar, P.E.
Chief Geotechnical Engineer
Nevada Department of Transportation

Contributing Engineers:
Abbas Bafghi, P.E., NDOT Senior Geotechnical Engineer
Todd Stefonowicz, P.E., NDOT Asst. Chief Bridge Engineer
Craig Smart, P.E., HDR Consulting Engineer
John Thornley, P.E., Consulting Engineer for Hattenburg Dilley & Linnell
Background

- 1974 ~ NDOT’s first MSE Wall
- Over 150 MSE Walls built since 1974
- Steel reinforcements are required
- 2004 ~ Extensive corrosion discovered accidently at MSEW I-515 at Flamingo
Flamingo Interchange

Wall Location

N

Flamingo Rd.

I-515
Example of Discovered Corrosion
Background

• NDOT/FHWA does preliminary MSEW evaluation & condition assessment
  – Barry Berkovitz, P.E., FHWA

• Results:
  – MSE Walls are near end of service lives
  – Rehabilitation is necessary
  – NDOT lets emergency contract to repair tallest wall
  – McMahon & Mann Consulting Engineers (MMCE) hired for expert corrosion evaluation
Drilling Operations – Track Mounted
Finished Tieback Wall and Soundwall
MMCE’s In-depth Corrosion Evaluation

- 11 test pits exposing top 3 bar mats
- 43 backfill samples
- 37 bar mat samples
- 2800 wire diameter measurements
- PR monitoring on 45 bar mats and 36 steel coupons
Exhumed Reinforcement Sample
Observations & Testing Results

- Maximum section loss observed at least 2 ft behind face of wall.
- Moisture content of MSE backfill 1%-13% (6% median); 25%-40% degree of saturation.
- Drainage structures influenced the rate.
- On average, reinforcements have lost more than 60% of their capacity.
Observations & Testing Results

- Reinforcement at condition expected at 50 years...not 20 years.
- Actual corrosion rate estimated to be 5-29 μm/yr (12 μm/yr ~ FHWA design manual).
- No material anomalies were identified in the nongalvanized steel reinforcements.
Corrosion Study Conclusions

- Aggressive very corrosive backfill and moisture intrusion were primary causes of accelerated corrosion.
- All three walls were found to be in similar condition and were close to the end of their service life.
- The PR measurements compare well with direct physical site observations.
Corrosion Study Recommendations

- Retrofit walls or remove from service.
- Conduct further studies at other Las Vegas MSEW locations to identify problem and extent.
- Continue PR corrosion monitoring of I-515 Flamingo MSE Walls.
- Conduct laboratory studies to better understand corrosion mechanisms and contributing factors.
NDOT Research Project

• 2007~ NDOT/UNR initiate investigation of corrosion of MSE Walls in Nevada.

• Phase 1 Tasks
  – Develop NDOT MSEW inventory
  – Synthesize available field inspection database on the behavior of NDOT MSEWs
  – Review McMahon Report to identify most significant factors responsible for I-515 Flamingo MSEW corrosion
NDOT Research Project

Phase 1 Tasks (cont)

– Identify and synthesize data on important factors that affect corrosion of NDOT’s MSE Walls

– Assemble data on MSE Wall performance, corrosion history, and specifications from other states

– Select MSE Wall candidates for Phase 2 Investigations
Phase 1 Project
Findings & Conclusions

NDOT’s source approval process has not effectively predicted the corrosive nature of backfill actually used in MSEW construction.
# Historical Corrosion Limits

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<tbody>
<tr>
<td>pH</td>
<td>6.4 to 9.5</td>
<td>5 to 10</td>
<td>5 to 10</td>
<td>5 to 10</td>
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<tr>
<td>Resistivity (ohm-cm)</td>
<td>1,000 min.</td>
<td>3,000 min.</td>
<td>3,000 min.</td>
<td>3,000 min.</td>
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<tr>
<td>Chlorides (ppm)</td>
<td>500 max.</td>
<td>200 max.</td>
<td>50 max.</td>
<td>100 max.</td>
</tr>
<tr>
<td>Sulfates (ppm)</td>
<td>2,000 max.</td>
<td>1,000 max.</td>
<td>500 max.</td>
<td>200 max.</td>
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**Statistical Analysis of MSE Backfill**

Data from the 2005 investigation by MMCE was compared to original data from backfill approval in 1985. The data was converted to test method AASHTO T 288 equivalent soil resistivity.

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<tbody>
<tr>
<td>Soil Resistivity (ohm-cm)*</td>
<td>3470</td>
<td>1301</td>
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<tr>
<td>Chlorides (ppm)</td>
<td>124</td>
<td>48</td>
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<tr>
<td>Sulfates (ppm)</td>
<td>62</td>
<td>2435</td>
<td>Yes</td>
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Phase 1 Project
Findings & Conclusions

Nevada DOT’s T235B “Method for the Determination of Minimum Resistivity of Soil” test method substantially under-predicts material corrosivity as compared to the AASHTO T 288 standard test method.
Soil Resistivity Test Methods

• Nevada T235B
  – Conductivity of water from saturated soil is measured

• AASHTO T 288
  – Soil resistivity is measured in a 2-pin soil box
Nevada T235B
AASHTO T 288
Correlation Between Two Resistivity Testing Procedures (NDOT Study Data)

- **AASHTO Resistivity Test Results (ohm-cm)**
- **NDOT Resistivity Test Results (ohm-cm)**

114 tests included from NDOT test data.

- Current AASHTO Resistivity Specification
- Current NDOT Resistivity Specification

Equation: $y = 0.859x^{0.963}$

$R^2 = 0.925$
Resistivity of Approved NDOT MSE Backfills (1982 to 2008)

118 Tests are included. The current resistivity requirements are a minimum of 3,000 ohm-cm (NDOT test method).

Resistivity (Nevada T235 Test Method, ohm-cm)
There is significant potential that NDOT has more MSE Walls experiencing high rates of corrosion due to unintentional use of aggressive backfill!
AASHTO Correlated Resistivity’s for Constructed MSE Walls in Nevada District 1 (1982 to 2008)

Data included from post construction investigation
Phase 1 Project
Findings & Conclusions

Surprise!
A 10 year old MSE Wall at Cheyenne and I-15 with significant corrosion was discovered accidentally in 2008 during Phase 1 Study.
I-15 at Cheyenne MSEW Corrosion
I-15 at Cheyenne MSEW Corrosion
Phase 1 Recommendations

• Existing MSE Walls
  – Conduct further studies at other MSEW locations that have been identified as having potential corrosion problems.

• Future MSE Walls
  – Modify NDOT backfill approval practice.
    • Use AASHTO T 288 instead of NevadaT235B
    • Require source and production testing
    • Begin corrosion monitoring program
NDOT Policy Changes

• Feb 2010 NDOT converts to AASHTO T 288 test method

• Source and production testing of MSEW backfill now required for all projects

• New specifications for geogrid reinforced MSEW developed for Standard Specs
NDOT Policy Changes

• Geosynthetic reinforced MSE Walls are now being considered to support roadways

• Approved Tensar ARES Wall System to NDOT MSEW QPL (project specific basis)

• Developing standard NDOT MSEW QPL submittal procedure guidelines
Phase 2 Study Objectives

– Develop understanding of mechanisms and extent of elevated corrosion of NDOT’s MSE Walls

– Develop guidelines/procedures to evaluate consequences of corrosion problems and remaining MSE Wall service live

– Develop suggestions to remediate problems found during Phase 2
Phase 2 Study Tasks

– Site specific corrosivity studies of top 8 problematic MSE Walls identified in Phase 1

– Install steel coupons for future corrosion evaluation by inspection and PR method

– Develop procedure to estimate remaining service life of walls
Phase 2 Study Tasks

– Refine correlation of AASHTO and NDOT resistivity test methods

– Revisit original Phase 1 MSEW prioritization procedure and prepare new priority list

– Develop more suggestions, if needed, to remediate NDOT MSEW corrosion problems depending on results of Phase 2 Study
References


2. A draft of UNR’s Nov 2009 “Investigation of Corrosion of MSE Walls in Nevada” is available at the above link. The draft will be replaced with the finalized version soon.
Questions?