99 th Purdue Road School
March 6, 2013
Mechanically Stabilized Earth
Project Coordination

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All The Mistakes in MSE Wall Design and Construction Have Been Made But Not By Everyone
The Reason For Repetitive Mistakes is Simple

No One Talks About Mistakes or Acknowledges Mistakes; Hence They Are Repeated
Introduction of MSE Was Slow In Indiana And In Most places For Two Reasons

2. MSE Is A Mix Of Geotechnical Engineering and Structural Engineering
INDOT MSE History
Has Evolved From Sole Source Bids Of Two Jobs

Indot (2) Jobs Mid 80’s
Encouraged By FHWA
Lafayette Railroad Relocation
Followed Setting new INDOT Standards For MSE Competing With CIP Walls in Same Plans
Lafayette Railroad Relocation

Bridges (2) Over Wabash

Allowed CIP to Compete with MSE As Alternates

MSE Was Selected (‘88)

Later MSE Was Permitted to Be Base Bid By Consultants On Other Jobs.
Case Study # 5

- Railroad Relocation
- Lafayette, Indiana

- Budget restraints by City limited geotech report.
- Prime Consultant would not use MSE because MSE was not mentioned in geotech report.
- $63 Dollar Geotechnical report was accepted as addendum and MSE was allowed as option in bid.
1986 AASHTO Was First To Include MSE

My Supervisor As A 1964 INDOT Summer Intern Wrote The First INDOT MSE SPEC In 1987 With My Input As Requested.
INDOT Has List Of Approved MSE Systems and Suppliers

That List Was Shortened By Two MSE Firms In 2012

Two Firms Altered Their Approved MSE System Without Notifying INDOT
There Are No Patented Design Methods or Secret Formulas For MSE

INDOT 731 Specification Governs MSE Steel Used Not Manufacture’s Preferences; MSE Steel May Be Only Preapproved System Components
Spec 731 Calls For Submittal of Drawings and Calcs

Review Should Not Be Casual But Complete to Show Compliance With 731

Compliance Can Not Be Assumed
INDOT Bid Plans Set MSE
Steel design length

0.7H is Default Value From AASHTO Unless Bid plans Change the Length for Bearing Capacity Or Global Stability
It Is Easier to Change The Problem Than to Find An Innovative Solution

Lamberson’s Law
INDOT 731 Sets Aggregate Phi Angle Maximum That May Be used in MSE Design Calcs Regardless Of Actual Test Results
34 degrees Is used In MSE Steel Design For All Structures. No Changes Are Permitted By Any MSE Supplier
SHOP DRAWING REVIEW

Review is for general conformance with the design concept and contract documents. Markings or comments shall not be construed as relieving the Contractor from compliance with the project plans and specifications. The Contractor remains solely responsible for means and methods, quantities and dimensions, for selecting fabrication processes, for techniques of assembly, and for performing the work in a safe manner.

URS

☐ Reviewed, No exceptions taken
☐ Reviewed, See Comments
☒ Revise and Resubmit
☐ Rejected
☐ No Action Required

BY: [Signature]  Date: 7-27-07
Applied vs Allowable Bearing Stress

1. $H_{max} = 4.352 \text{ m} \quad (14.28 \text{ ft})$
   $B = 3.048 \text{ m} \quad (10.00 \text{ ft})$
   $F.P. = 2.83 \text{ ksf}$
   ROWS 1-3: W9.5xW11.0, 9"x6"
   ROWS 4-6: W12.5xW11.0, 9"x12"

3. $H_{max} = 3.353 \text{ m} \quad (11.00 \text{ ft})$
   $B = 3.048 \text{ m} \quad (10.00 \text{ ft})$
   $F.P. = 3.88 \text{ ksf}$
   ROW 1-6: W12.5xW11.0, 9"x12"

*MAT ROW DESIGNATIONS START FROM TOP OF WALL.
Case Study

- I-94 Borman Expressway
- Hammond, Indiana

- MSE walls set to bid without geotech parameters..
- Consultants Geotech assumed MSE designer was responsible for external stability including bearing..
- Addendum set bearing allowable less than gravity
- Addendum correcting addendum was issued directing contractor to conclude geotech report and set recommendations after contract award…
- Post bid dispute on payment followed report…

Panels and MSE Steel were All On Site When INDOT Withdrew Approval of MSE Engineering Due To No Foundation Engineering Being Provided By Wall Supplier
US 24 Railroad Bridge Adjacent to Minnow Creek Had Major Flaw Also.

Crash Wall Was Left Off The Bid Plans... Beams Were Already Cast When Detected. My CIP Solution Encased Piles and Backed Up MSE Panels.
INDOT 731 Allows either 5’x5’
Or 5’x10’ Standard Panels

Special Panels With sloped Tops
May Be taller To Meet Wall Bid
Plan Envelopes
MSE Business Has Changed
MSE Walls or Wall Types Can’t Cause, Alter or Prevent Settlement

MSE Supplier Designs with ¾” Joints Around each Panel.... This Accommodates Differential Settlement
Don’t Do this!
Case Study

- I-43
- Milwaukee, Wisconsin

- Worker fell off MSE wall 2 months after built.
- $16 million sought by (at fault) injured worker
- Sub and Prime Contactor settled out of court
- To recoup payment to worker Sub charged MSE supplier alleging unsafe wall design was at fault.
- MSE supplier/ designer found innocent in court.
I-43 AT SILVER SPRINGS AVE.
MILWAUKEE, WISCONSIN
MSE Use in Water Is Misunderstood But Viable

#8 Stone Is Mandated To Q 100 Water Level

Job 731 Spec Correction Needed
Spec 731  Paragraph 210
Is Generally Overlooked

If Unsuitable Material Is
Encountered it Shall Be Removed
And Replaced With B Borrow…….
The plans do not show a fish ladder but I am sure we can work out something.
Case History

- Bid Documents Did not Show Coping
- Reviewer Held up Approval Of MSE Submittal For Absence Of Coping
- INDOT Intervened And Said Coping Only By Change Order.
- City Declined To Offer Change Order
INDOT Spec 731 Does Not Address Special Conditions

Special Or Composite Structures Such As
Rail Road Crash Walls Require Special Provision Supplement
Placing Slope Top Bottom Row Panel
Erected Wall And Railroad Crashwall
Placing Precast Coping
Cast in Place and Precast Coping
Slope Top Panels Ideal For Precast Coping
ODOT Failed To Execute Drainage Plan

Nearly Full Abutment Washed Out
Contractor Rebuilt With Flow-able Fill And Was Fully Compensated
WISDOT Self Destructs

Failed To Perform Borings
MSE Wall Built on 10 ft of Peat
Contractor Rebuilt 35 Ft Wall and
Was Fully Compensated
MSE Walls Are 3 Dimensional
NOT Pencil Width Lines

Make sure There Is Room For Steel
To Connect to the Panels. Bid
Plans Having 2 Things in Same
Space Don’t Work
Non- Constructible Plan detail
Wing Wall Shortened To Work
Pile Cap Extends Thru Wing Wall
Much of the MSE Drainage Specified MSE INDOT Walls Can Not And Will Not Work

The INDIANA Water Is Not Smart Enough To Jump Up And Into Elevated Drainage Pipe
The Following Two Slides Complied With INDOT MSE Drainage At Time of Design. Design Standards Have Now Changed As INDOT Found That The Details Failed To Work For MSE Embankments
The MSE Supplier Shall Provide An Adequate Drainage System......

The Costs Of This Shall be Included In The Cost Of Face panels
MSE wall project at Rte 25
Over Rte 25 In Cass County
As Part of Hoosier Heartland

contained MSE walls and
Railroad Crash Wall
This Is Not The End

But It Is A New beginning

For MSE
Case Study

- Davison Freeway
- Detroit, Michigan

- Design-build performance spec allowed MSE; Spec. mandated approval before ordering MSE.
- Consultant did not review MSE…did not approve as review not in contract..
- Early finish bonus lost and late penalties applied.
- 10 years later MDOT paid major claims........
ODOT Spec 840

- States Wall Designer performs Internal Stability Design.
- Does Not Stipulate Wall designer Must increase Minimum Length Stated in Bid Documents For Bearing pressure
ODOT 840 Spec

Stipulates That Bid plans show Minimum Length Steel for Foundation Conditions.

Allowable Bearing pressure must be set at an achievable magnitude before bid.

Consultant Checks Applied Pressure via Meyerhof Equation before bid.
Facts About MSE Length

- All MSE Systems can work at 0.7H Length

- Internal design specified in 840 Spec should be undertaken at 0.7H

If Bearing capacity or stability dictate more than 0.7H need be used, then bid plans need to show that need.
The truth about MSE Walls Design

- MSE walls are Structures with Geotechnical Input just like CIP retaining walls.
- All MSE wall systems are to be designed to the same standard and are not designed with Proprietary Methods schemes or ideas.
- MSE design submittals frequently uncover Bid plan errors or omissions or concepts that are non-constructible or have two things in the same place.
MSE Drawing and Calc Issues

- MSE calculations are not checkable if only submitted in computer output format.
- The length of MSE steel has very little to do with the applied bearing pressure.
- The MSE company has 2 choices:
  - The size of Panel and type of Steel
Case Study

- Tywkenham Blvd.
- Lafayette, Indiana

- City bid documents were for lump sum bid.
- INDOT # 731 MSE spec only referenced by note.
- Allowable bearing pressure requested.
- Allowable bearing pressure set at less than gravity
- Under-cut added by addendum...
Applied Pressure Depends On:

- Design Height of Wall
- Backfill Weight. And Phi Angle
- Method of Analysis (Meyerhof)
- Length of MSE Steel
Where have we been?

- The firm or person that finds an error in the bid set is not responsible for that error.

- Neither MSE wall supplier nor Contractor are responsible economically for fixing bid plan errors or for other economic impact.
MSE Bid Document Issues

- MSE Structures are three Dimensional.
- Bid Drawings show two dimensional wall envelopes and details.
- MSE design and Detailing often expose Omissions and Conflicts
Bid Plan Issues

- Two things cannot occupy the same space.
- The firm or person that finds an error in the bid set is not responsible for that error.
- Neither MSE wall supplier nor Contractor are responsible economically for fixing the errors or the economic impact on the project.
ODOT 840 Specification

- MSE Supplier/Designer:
  Responsible for Structural design of MSE components above leveling pad using design parameters set in bid documents.

- Consultant and Geotech:
  Responsible for determining if the site is suitable for the construction intended and for setting design parameters.
Issues in Liability Discussions

- Consultants and Geotech’s don’t Communicate well with each other and clients except by contract.
- Scopes of work are often not compatible and the cause of disputes later on.
- Plans and specs are often not compatible.
- The costs of stopping the job are ignored.
- Many plans are not complete or constructible.
- There is enough liability to go around and there are too many lawyers available.....
The Truth About Mistakes

- Everyone makes mistakes but it is what you do about them that makes a difference.
- The firm or person who makes the mistake does not always have to pay for them and often someone else does.
- The golden rule:
  
  He who has the gold rules..... initially
Case Study

- Main Street
- Monticello, Indiana

- Bid set mandated lump sum wall bid not unit price.
- Geotech was not advised as to need to follow INDOT standards because of origin of funding.
- Without #731 undercut provisions not present.....
- Scope of work by Geotech not understood by prime consultant as per INDOT requirements......
Case Study # 7

- I-94
- Port Huron, Michigan

- 24” of settlement projected in geotechnical report.
- MDOT called that settlement failure when it began.
- MDOT requested MSE supplier inform them as to how much the settlement was to be and when it would stop. Geotech was not asked to respond.
INDOT Spec Allows Only Galvanized Wire Mesh or Strips Of Steel

Design Using AASHTO Formulas

Results in Steel Density and Length Behind Wall Panels