Scour, Water, and a few Ideas on Repair

Jeffrey Hill, PE
National Association of County Engineers, Cincinnati
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www.HaywardBaker.com
All accidents are preventable

No repeat occurrences

Safety Standards

Goal: Zero Injuries

Job site Daily Task Analysis Meeting to review safety issues related to the day’s tasks.

All Incidents investigated, corrective actions implemented and shared in the Weekly Safety Update for awareness.

Safety Standards Document
Presentation Outline

- Introduction to ground improvement
- Water and loss of ground
- Alternative techniques
- Cost Savings Solutions
Projects completed for Highway Bridges

Wide Variety of solutions, geographically diverse!

- Compaction Grouting
- Cement or Chemical
- Jet Grouting
- Water Proofing
- Soil Mixing
- Earth Retention
- Piling/Piers
- Vibro Systems
- Micropiles
- Wick Drains
Grouting

- Compaction Grouting
- Permeation Grouting, Cement or Chemical
- Fracture Grouting
- Jet Grouting
- Urethane Grouting
Structural Support

- Micropiles, Drilled
- Micropiles, Pushed
- Driven Piling
- Drilled Shaft
- Auger Cast Piling
Ground Improvement

- Dynamic Compaction and Replacement
- Wet Soil Mixing
- Dry Soil Mixing
- Injection for Expansive/Collapsible Soils
- Wick and Earthquake Drains
Ground Improvement – Vibro Systems

- Vibro Replacement
- Vibro Compaction
- Vibro Concrete Columns / Rigid Inclusions
- VibroPiers
### Water – And it’s effect on roadways

<table>
<thead>
<tr>
<th>Washouts/sloughing of embankments</th>
<th>Nails and ERS</th>
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<tr>
<td>Washouts and settlement of culverts</td>
<td>Micropiles and Compaction grouting</td>
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<tr>
<td>Settlement and/ or lateral movement of bridges</td>
<td>Anchors, Micropiles, Grouting</td>
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<td>Debris and mud flows</td>
<td>Anchor Blocks, Beam and Lagging walls</td>
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A few examples but no two are the same
We’ve all seen water problems, are their alternatives to remove and replace?
Your embankment sloughed off, now your road is closed. Access is tough.
How can you regain lost ground and reopen the road?
Installation of the soil nails
And the shotcrete
And finally the completed wall
Scour – not always a bridge foundation issue

Loss of land or retaining wall
Scour – not always a bridge foundation issue

What damage results from the loss of the structure
Install Bar, flash coat with fiber reinforced shotcrete
Final coat of shotcrete
Imagine your bridge has 12” plus of settlement

Bridge settlement from the ’60s
Not monitored or noted
Repair or replace structure?
Compaction Grouting, improvement by displacement

- No Vibration
- No connection needed
- Ability to lift
- Quick mobilization
- Low cost
Micropiles, the structural solution

- No Vibration
- High Capacity
- Tight access
- Low Headroom
- Obstructions and difficult ground conditions
When Scour and Karst Co Exist

Underpinning and Grouting
Construction boring to “top of rock”

- False Refusal
- Cemented gravel not sandstone
- Kastic Gypsum below
- Settlement of 12” common
Original construction

- Tremie seal
- Spread footings
- No treatment of karst
Remember local knowledge

- Mining in the area in 1900’s
- Karst noted in the mine and local knowledge
- No treatment of karst
Construction Sequence For Composite Rock Socket Micropile
Enlarge Footing or Pile Cap

Reinforced concrete and dowels
Structural Connections

Edge Connection

Standard Steel
(encased in concrete or corrosion protected)
Any money saved during design more than consumed......

36 Borings Now, 3 Initial
Potential causes of settlement……

- Scour of soil below tremie
- Softening of shale due to water
- Collapse of voids in Gypsum
- Piping of fines into voids in rock
And the repair....

- Compaction grouting for water piers
- Micropiles on land based piers
- Successful program
The Micropiles for the land piers, a bit more challenging due to utilities

MP are ideal for missing utilities and obstructions
The Micropiles for the land piers, a bit more challenging due to utilities

MP are ideal for missing utilities and obstructions
Now let's use micropiles for tough access earth retention

Existing bridge does not provide adequate width
Micropile earth retention system installed to allow replacement of structure
E 80 Surcharge requires ground anchors
Installation of the micropiles
System designed for full RR Surcharge
The System is wedged into the existing conditions
For new structures – support of embankments in poor ground conditions
Vibro-Compaction uses vibratory energy to increase density of clean granular soil

Performed in-situ up to 120 feet deep
Can achieve 70-85% relative density
Is effective above and below water table
Basic soil mechanics – shake loose sand
Selection of Ground Improvement Techniques

Soil Type Typically Governs the Ground Improvement Technique

[Graph showing different ground improvement techniques based on soil type]
Vibro-Replacement or Stone Columns: reinforce with aggregate

Also performed in-situ up to 120 feet deep

Also effective above and below the water table

Performed using wet top-feed method or dry bottom-feed method

Commonly used for seismic response improvement

Vibro Systems

1 Vibrocompaction

2 Vibro-Replacement Stone Columns

3 VibroPiers / Aggregate Piers
Vibro-Replacement or Stone Column–Bottom feed Process: vibrate down, feed stone, & densify

Similar to Vibro Compaction – only now stone is added to reinforce
Dry Bottom Feed Method–stone conveyed to the bottom of the vibrator

Hopper and pressure chamber

Tube adjacent to vibrator
Case Study 1: InDOT I-69, White River to CSX Railroad

5 mile stretch of new highway alignment

18 new bridges

Liquefiable “marl” at depths ranging from 20 to 70 feet below ground surface

Vibro Replacement Columns installed using dry bottom feed methods

Stone columns installed around new bridge piers and end bents to increase factor of safety against liquefaction
Vibro Piers™ -- columns of dense aggregate installed as foundation support elements

1 Vibro-Compaction

2 Vibro-Replacement Stone Columns

3 VibroPiers / Aggregate Piers

Designed to support light to medium loads, (often referred to as intermediate foundation system)

Typically sized to 24-42 in. in diameter and 10 to 30 ft. deep

Installed in both cohesive and cohesionless soil

Installed above and BELOW the water table
Ground improvement to support a grade separation
Drilling and Filling of Vibro Piers
Work near existing tracks
Ongoing work with two rigs and UP Locomotive in background
THINK SAFE  WORK SAFE  GO HOME SAFE
Conclusions

- HBI can offer the right solution – saving cost, schedule, and risk
- Experience with a wide variety of techniques on a wide variety of projects
- Use the solution that fits the project
- Consider design build for difficult, emergency work