Working within Multi-Lane Highways
Required use of Truck/Trailer-Mounted Attenuator (TAM)

- When working on a multi-lane highway (45 mph or above) in a closed lane or shoulder without portable or permanent traffic barriers separating the work area from the travel lanes.

- Any situation on a multi-lane highway (45 mph or above) where a TMA is depicted or labeled as required or optional on a shadow vehicle in the OMUTCD.

Do NOT use a TAM in place of the arrow board as the beginning of a merge taper, or as a substitute in location where other positive protection methods are required.

Purchased a Kessler Sapper Auto DCP Unit
Large Diameter Culverts

July 2019 SGE Update

For large diameter culverts - >20 ft. - treat as a bridge. 
Exploration should follow SGE 303.7.1 Bridges. 
Test for scour if an open bottomed structure.
Positional Data of Boring Locations

➢ Boring Logs should report the **As-Drilled** locations

If borings are moved from staked locations, need to collect new positional data.

➢ Historical Data

When utilizing historical data make sure reporting current coordinates. Convert NGVD 29 coordinates to NGVD 88 coordinates

[https://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl](https://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl)
Subsurface Investigation Qualification
FHWA-NHI-132079
Min. 20 Participants

https://www.nhi.fhwa.dot.gov/course-search?tab=0&key=132079&course_no=132079&res=1

NO LONGER OFFERED BY NATIONAL DRILLING ASSOCIATION

OGE has requested this class - NOV. 5-7, 2019
and planning again in late Winter 2020.
Will be offered through LTAP - Notice sent through LTAP email listserv
Visual Classification Course for Geotechnical Logging of Soil and Rock Stratum

Being offered twice a year through LTAP.

➢ If problems enrolling employees please let me know.

http://www.dot.state.oh.us/Divisions/Planning/LocalPrograms/LTAP/Pages/default.aspx
FHWA - A-GAME

FHWA Center for Accelerating Innovation

- Advanced Geotechnical Methods in Exploration (A-GaME) EDC-5

https://www.fhwa.dot.gov/innovation/everydaycounts/edc_5/

- Geophysical Surveys
  - CPT
  - Measurement While Drilling (MWD)
  - Televiewers
Geophysical Surveys

- NCHRP Synthesis 357: Use of Geophysics for Transportation Projects

http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_357.pdf

- Currently being updated
Geophysical Surveys

- Seismic Reflection
- Seismic Refraction
- Seismic Tomography
- Shear Wave
- Surface Wave (SASW, MASW, passive)
- Frequency-Domain EM
- Time-Domain EM
- Electrical Resistivity
- Induced Polarization
- Gravity
- Magnetics
- Ground Penetrating Radar
FHWA - A-GAME

Cone Penetration Test (CPT)


- NCHRP Synthesis 368 Cone Penetration Testing

Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

❖ Background:

➢ AKA - Diagraphy Drilling, Instrumented Drilling, Use of Drilling Parameters

➢ Predominately used with rotary-percussive, air rotary and rotary-wash drilling

➢ ACIP Piles - Use many of the same drilling measurements

➢ Often used in conjunction with Logging While Drilling (LWD), down-hole geophysics, in the Oil/Gas/Mining Industries
Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

❖ Background (continued):
Measured and Recorded while drilling:
➢ Fluid Pressure
➢ Torque
➢ Rotation Speed
➢ Thrust-on-bit (i.e. down-thrust, down pressure, crowd)
   ➢ Hold-back
➢ Penetration Depth
   ➢ Time
➢ Drilling-Speed (reciprocal of time)
Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

❖ Background (continued):

• Gui, Soga, Bolton, and Hamelin - 2002
  “Instrumented Borehole Drilling for Subsurface Investigation”

• Laudanski, Reiffsteck, and Benoit, - 2013
  “Experimental Study of Drilling Parameters Using a Test Embankment”

• Florida DOT and UF: David Horhota (PM), Mike McVay (PI) - 2016
  “Drilled Shaft Resistance Based on Diameter, Torque and Crowd”
Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

Typical Measurements and Records recorded
From: Gui et al. 200
From Gui et al. 2002

\[ \Gamma_v = \frac{V_d}{(\omega_d D)} \]

\[ \Gamma_f = \frac{W'}{(T_q / D)} \]

\[ \Gamma_{\text{easy}} = -\sqrt{\Gamma_v / \Gamma_f} \]

\[ \Gamma_{\text{hard}} = \frac{1}{\Gamma_{\text{easy}}} \]

\[ E = \log\Gamma_v / \log\Gamma_f \]
Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

From: Laudanski et al. 2013
Evaluated following:
• Multiple bit types and CFA
• Rotary and Rotopercussion
• Test Embankment with Multiple Materials
• Compound Parameters
• Comparison with some in-situ tests

Table 1. Compound parameters.

<table>
<thead>
<tr>
<th>Name</th>
<th>Formula</th>
<th>Units</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penetration resistance</td>
<td>( R_p = \left(1 - \frac{V_E}{V_A}\right)^{1/2} )</td>
<td>( s/0.2 ) m</td>
<td>Möller et al. 2004</td>
</tr>
<tr>
<td>Somerton index</td>
<td>( S_d \approx P_E \cdot \left(\frac{V_R}{V_A}\right)^{1/2} )</td>
<td>kPa</td>
<td>Somerton 1959</td>
</tr>
<tr>
<td>Drilling specific energy</td>
<td>( SDE = \frac{P_O}{S_0} + 2 \cdot \pi \cdot \left(\frac{V_R \cdot C_R}{V_A}\right) )</td>
<td>kJ/m³</td>
<td>Teale 1965</td>
</tr>
<tr>
<td>Specific energy</td>
<td>( E_S = \frac{C_R \cdot V_R}{V_A} )</td>
<td>N \cdot m/m</td>
<td>Pfister 1985, Teale 1965</td>
</tr>
<tr>
<td>Normalized energy</td>
<td>( E_N = \frac{\alpha \cdot P_O \cdot V_A + \beta \cdot C_R \cdot 2\pi \cdot V_R}{\frac{V_A}{V_m}} + \gamma \cdot P_M \cdot f )</td>
<td>N \cdot m/m</td>
<td>Nishi et al. 1998</td>
</tr>
<tr>
<td>Alteration index</td>
<td>( I = 1 + k_0 \cdot \left(\frac{P_0}{P_{max}} - k_1 \cdot \frac{V_A}{V_{max}}\right) )</td>
<td>none</td>
<td>Pfister 1985</td>
</tr>
<tr>
<td>Entropy of S</td>
<td>( L(z) = \sum_{z_0}^z</td>
<td>S(z + dz) - S(z)</td>
<td>)</td>
</tr>
</tbody>
</table>
Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

From: Laudanski et al. 2013

Comparison of normalized energy $En$ with different tools

![Graph showing Comparison of normalized energy En with different tools](image-url)
Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

From: Laudanski et al. 2013

Comparison of normalized energy $E_n$ with different tools
Measurement While Drilling (MWD)
From Ben Rivers, P.E. - FHWA - Resource Center

From: Karasawa 2002 and Teale 1965

Related Drillability Strength, $D_s$ and Specific Energy to Unconfined Compressive Strength

$$D_s = 64NT^2/Fud^3$$

- $N$ - Rotational Speed
- $T$ - Torque
- $F$ - Crowd
- $u$ - Penetration Rate
- $d$ - Bit Diameter
Televiwers - Optical and Acoustic
From GEOVision

- **Optical Teviewer**: Uses visible light optics provides continuous, detailed and oriented 360° true color imaging of a borehole wall. Develops feature analysis which includes dip, stike, frequency and fracture aperture.

- **Acoustic Teviewer**: Using a fixed acoustic transducer and a rotating acoustic mirror developed a high-resolution, oriented images of the borehole wall. Developes a “psudo-color” borehole image.
Harper Road Bridge Widening

FRA-70-7.94 L over Harper Rd, Columbus Ohio

Project Information:

- Geotechnical Exploration completed in 1967
- Current three-span structure constructed in 1973
  - Existing structure support:
    - Abutments: H-pile founded on bedrock
    - Piers: spread footing bearing on bedrock
- Columbus Limestone supporting structure
- Widening planned with construction beginning 2019
- Limited geotechnical exploration; plan to utilize historical information for design along with B-001-0-17 at rear pier and B-002-0-17 at forward abutment
OGE PROJECT - HARPER RD

FRA-70-7.94 L over Harper Rd, Columbus Ohio

Exploration:

• Borings completed early summer 2017
  • B-001-0-17 encountered top of rock 41 ft. DEEPER than anticipated
  • B-002-0-18 encountered top of rock 13.5 ft. DEEPER than anticipated

➢ Columbus Limestone = Paleokarst?
➢ Remember: Pier on spread footing

Additional Exploration:

• ER lines along both piers
• Potential for clay filled voids
• Limited space restricted ability to run ER lines
  • B-001-1-17 completed at rear pier
• B-001-1-17 encountered boulders within clay and several clay filled voids within bedrock

➢ New Design, All substructures supported by H-piles founded on bedrock
FRA-70-7.94 L over Harper Rd, Columbus Ohio

Construction:

- High variability in bedrock surface along the pier caps
- Rear Abutment: Piles drove 137% to 220% of plan length
  - Rear Pier: Piles drove 38% to 200%* of plan length
  - Forward Pier: Piles drove 0%** to 80% of plan length
- Forward Abutment: Piles drove 34% to 126% of plan length

* Pile drove to 100 ft. without encountering bedrock
** Eliminated 6 piles and replaced with spread footing
FRA-70-7.94 L over Harper Rd, Columbus Ohio

Lessons Learned:

➢ Historical Data is good, but not always the answer
➢ Geophysics indicated potential problems in construction
➢ Should have run multiple methods to better define the problem
➢ Work around restrictions, if possible, to obtain the data needed to answer the question fully
➢ Reasonable exploration can not always provide a full solution
➢ Construction Issues may always occur