11th Annual Technical Forum
GEOHAZARDS IMPACTING TRANSPORTATION IN THE APPALACHIAN REGION

GEO-DESIGN APPLICATIONS IN KARST ENVIRONMENTS

William D. Spencer, P.G.,
Jaye Richardson, and Chris Ramsey, P.E.
AMEC, Nashville TN
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KARST CAN OCCUR ANYTIME AND ANYWHERE
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NSC Mainline Track at MP 96.1A
Morristown, Tennessee
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### SUMMARY OF DEEP FOUNDATION OPTIONS

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th>PERCEIVED ADVANTAGES</th>
<th>PERCEIVED DISADVANTAGES</th>
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<tr>
<td>Driven Piles (H-Piles)</td>
<td>Low cost</td>
<td>Impossible to assess bearing strata</td>
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<tr>
<td>Drilled Piers (Caissons)</td>
<td>High load capacity; low long term risk</td>
<td>High cost; potentially large voids in bedrock might take large quantities of concrete to fill.</td>
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<tr>
<td>Small Diameter Drilled Pipe Piles (Micro Piles)</td>
<td>Low long-term risk; easy to make adjustments</td>
<td>Moderate to high cost; smaller than “normal” pile size for bridge bents; requires real-time field engineering during construction to adjust.</td>
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NSC Mainline Track at MP 96.1A
Morristown, Tennessee

BEFORE
Karst engulfing the soil and ballast

AFTER
Micro pile and structural land bridge REMOVES the karst from play and provides for surface drainage under the track.
Mack Hatcher Parkway
Franklin, Tennessee
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SO HOW DO WE BUILD A BRIDGE FOUNDATION ON EXTREMELY KARSTIC AND VARIABLY BEDROCK??

BY A COMBINATION OF INTEGRAL ABUTMENTS, SPREAD FOOTINGS, WHERE POSSIBLE, AND MICROPILES
Mack Hatcher Parkway
Franklin, Tennessee

WHY?

CAISSONS ARE DIFFICULT TO INSTALL IN IRREGULAR BEDROCK CONDITIONS

THEY ARE COSTLY $$

HOW MUCH ADDITIONAL CONCRETE WILL BE USED TO FILL THE OPEN CAVITIES?

HOW MUCH DOES IT COST TO USE PERMANENT CASING IN THE GROUND TO CONTROL CONCRETE PLACEMENT?
Mack Hatcher Parkway
Franklin, Tennessee

How close is that end bearing H-PILE to the weathered rock or open cavity?

We don’t know
Micro-piles as a SOLUTION
RECENT LOAD TESTING ON INSTALLED MICRO-PILES

DESIGN LOADS WERE 300 KIPS COMPRESSION AND 180 KIPS TENSION

COMPRESSSION LOADING EXCEEDED 200% OR 600 KIPS

TENSION LOADING FAILED AT 200% OR 360 KIPS DUE TO FOLIATION OF WEATHERED ROCK

FOLLOW-UP LOAD TESTING EXCEEDED 200% OF DESIGN FOR TENSION AND COMPRESSION
QUESTIONS??
THANK-YOU