Challenges During a Top Down Design and Construction Approach of Foothills Parkway Bridge No. 8

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Geohazards Impacting Transportation in Appalachia
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OUTLINE

- Introduction
- Project Location
- Foothills Parkway History
- General Geologic Conditions
- Design & Construction Constraints
- Bridge Foundation Design Changes
- Foundation Construction
- Bridge Construction

Challenges?
INTRODUCTION

- Foothills Bridge No. 8 is One of 10 Proposed Bridges Along “Missing Link”
- The “Missing Link” section of the Parkway is 1.65-mile long
- Bridge No. 9 and 10 were completed in 2001
- Bridge No. 1 was Replaced by a Geogrid Reinforced Limestone Shot rock Embankment
- Bridge 2 Was Completed in 2013
- Remaining Bridges are Under Construction

90 ft High Reinforced Geogrid Limestone Shot rock Embankment
PROJECT LOCATION
The Parkway was Authorized by Congress in 1944
- Structural Fill and Retaining Walls Failures and Acid Drainage Occurred During Construction in The 1980s
- All Projects Were Suspended and The Uncompleted Section Was Referred to as “Missing Link”
- FHWA Began Developing New Alignment in the 1990s
- The New Alignment Included Bridges, Cut Slopes, Retaining Walls and Embankments to Mitigate Environmental Impact (Source: NPS)
The Project is Located in The Foothills of The Great Smoky Mountains in Eastern Tennessee.

Project Area Appears to be Underlain by Precambrian Rock from The Ocoee Series. (USGS, Philip King, 1964)

Principal Formations are The Shields and Possibly The Licklog From The Walden Creek Group

The Shields Formation Consists of Coarse Conglomerate of Quartz and Pebbles and Cobbles and Coarse Grained Pebbly Sandstone Interbedded With Laminated Sandstone

Project Rock Cores Indicate Conglomerate and Sandstone Predominated at Project Site
The Design and Construction of Bridge No. 8 Has to Work With A Number of Constraints: Hence Was “Top-Down Construction Concept”

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<tr>
<th>Constraint</th>
<th>Consequence</th>
<th>Result</th>
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<td>Limit Ground Disturbance</td>
<td>Select a Foundation type That Requires Minimum Excavation and Equipment</td>
<td>Drilled Shafts Foundation Was Eliminated Due To Equipment Access Need</td>
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<td>Avoid Cutting Trees and Vegetation Removal</td>
<td>Had to Use Alternative Systems to Access Substructure Locations</td>
<td>A Platform Was Built to Substructure Locations to Minimize Cutting Trees And Vegetation</td>
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<td>Difficult Access</td>
<td>Restriction on Ground Disturbance Severely Limited Establishment of Access Roads</td>
<td>Use Small Equipment That Can Be Air Lifted or Driven on Temporary Platform To Substructure Location.</td>
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<td>Steep Train</td>
<td>Design Considerations for Stability. Construction Difficult Access</td>
<td>Foundation Design Was Modified for Added Safety. Smaller Equipment Was Used for Access</td>
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<tr>
<td>Prepare A Plan for Detecting and Treating Pyretic (Acid) Rock</td>
<td>Need to Carefully Plan Excavation, Treatment and Disposal</td>
<td>Testing and Monitoring Plans Treatment Plan (Encapsulation) if Encountered, Disposal As Needed</td>
</tr>
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</table>
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DESIGN AND CONSTRUCTION CONSTRAINS (Pyritic (Acid) Rock)

- Acid Rock Plan
  - Encapsulation
  - Treatment With Lime
  - Disposal

Pyritic backfill material placed in 600 mm lifts, treated with agriculture limestone at the rate of 25 km/m².
The 1997 Consultant’s Geotechnical Report Considered Spread footings and Micropiles.

Design Accounted for Slope angles Varying from 38° to 40° at Substructure Locations.

Depth to Bedrock Varied from 0 to 0.2 m (0 to 1 foot).
RQDs at depths 0 to 5 m Varied From 70% to 100%.

RQD & RC below 5 m is 100% at All Substructure Locations.

Allowable Bearing Capacities of 1.0 to 1.95 Mpa (10 to 20 tsf) were Recommended By Consultant Based on Competent Rock Conditions.
Brige Foundation Design Changes (EFLHD, 2005)

- **Abutment Footings** were stepped up to avoid deep excavations into competent rock (~9 m (30-ft)).
- Structural engineers used a vaulted abutment design for added stability.
- The vaulted abutments consisted of breast, back, and side walls.
- One of the many advantages is providing additional lateral stability on a steep slope.
Piers 1 & 2 Foundations Embedment Depth Into Bedrock Was Modified for Additional Lateral Stability

Foundations Embedment Depth Was Extended to 5 (16.5 ft) Meters Below Ground Low Point Into 100% RC & RQD Competent Rock

The New Design is Similar To A Socketed Shaft That Can be Constructed Using Small Equipment

Drilled Shafts Were Not Selected Due To Equipment Access Requirements
BRIDGE FOUNDATION DESIGN

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BRIDGE PIERS FOUNDATION CONSTRUCTION

- Contractor Had Difficulty at The Beginning Excavating Foundations.
- Contractor Was Successful After Attempting Different Methods
  - Jack Hammer
  - Chemical Disintegration Of Bedrock
  - Drill and Blast
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Bridge Construction Progressed Successfully After Resolving Initial Problems

Coordination and Communication Between Design and Construction Assisted in Quickly Resolving Problems

Construction Was Completed Successfully Using A Top-Down Process With Minimum Impact on Environment
Bridge 8 Construction

- Bridge 8 Was Completed Successfully After Resolving Initial Problems
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- Construction Was Completed Successfully Using A Top-Down Process With Minimum Impact on Environment
Bridge 8 was completed successfully after resolving initial problems. Coordination and communication between design and construction assisted in quickly resolving problems. Construction was completed successfully using a top-down process with minimum impact on environment.
BRIDGE 8 Design & CONSTRUCTION

Thank You!

Questions?