

Hybrid Retaining Wall Conquers a Massive Cut Slope Challenge

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Presentation Outline

- Project Background
- Original Project Plan vs. Hybrid Approach
- Design Methodology
- Load Testing
- Construction – Challenges Encountered
- Successful Completion

Project Information

Design-Build project for expansion of the Birmingham Northern Beltline

- OWNER – Alabama Department of Transportation (ALDOT)
- BUILDER – Russo Corporation
- DESIGNER – Schnabel Engineering

Phase 1: 1.34 miles of the 52-mile, 6-lane corridor

Total cost estimate: \$5.34B

Anticipated completion: 2054

Construction cost of the retaining wall: approximately \$6M

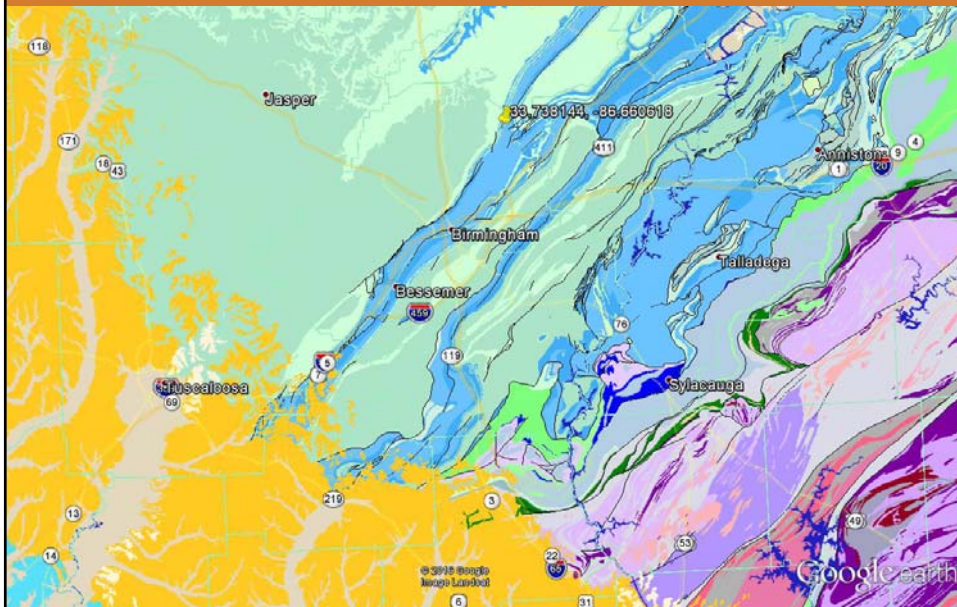
Project Location: Pinson, AL



Project Description



Geology



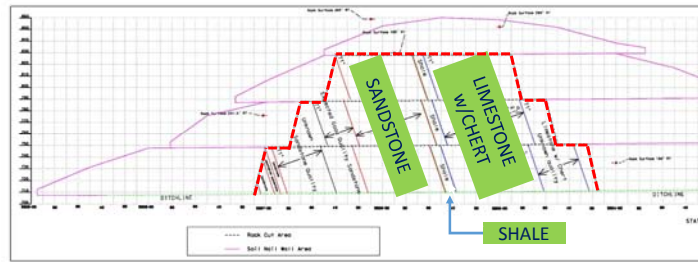
Geology

ROCK INCLUDED:

- Limestone
- Shale
- Sandstone
- Chert

SOILS INCLUDED:

- Transition Zones (weathered soils of the rock masses)
- Silty Sands
- Clayey Sands
- Silts
- Sands
- Lean Clays
- Cherty Clay



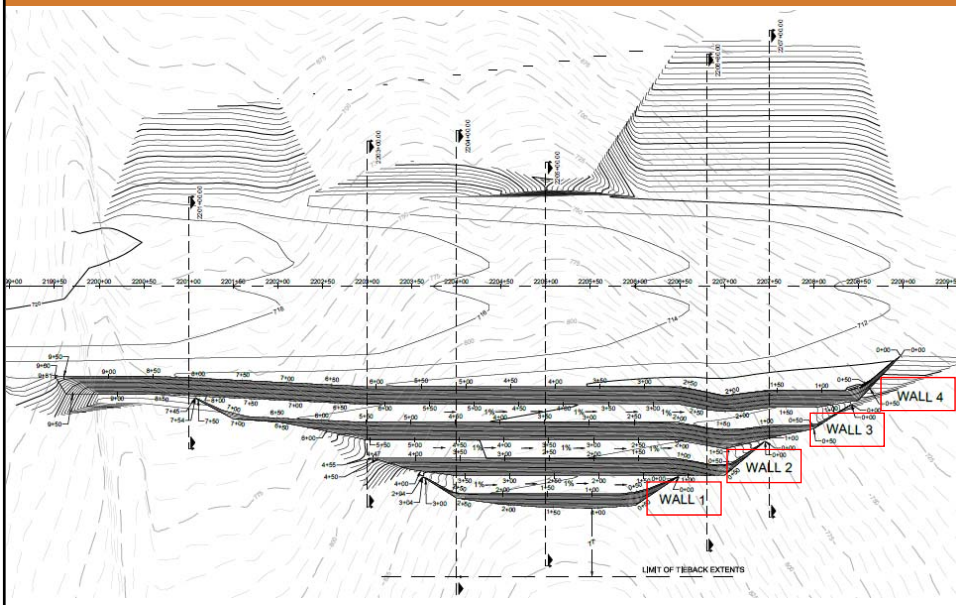
Geology—Vertical Bedding



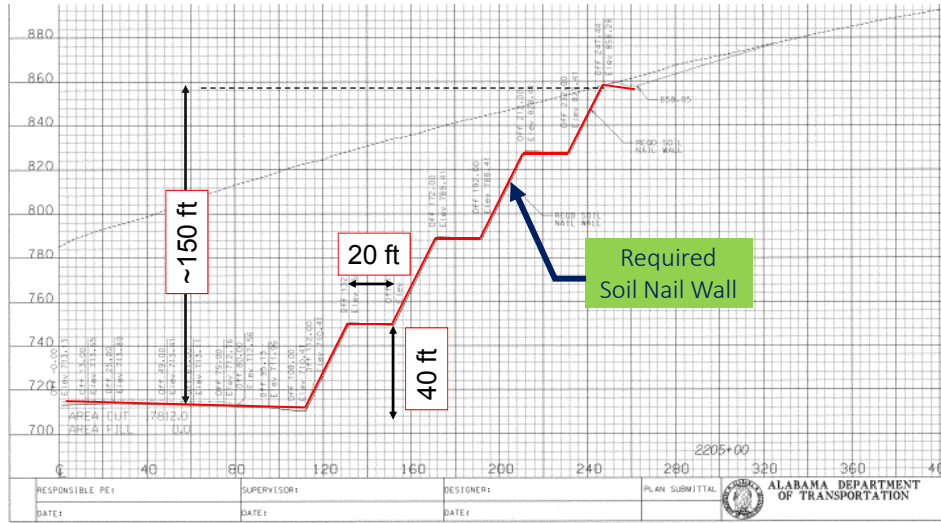
Geology



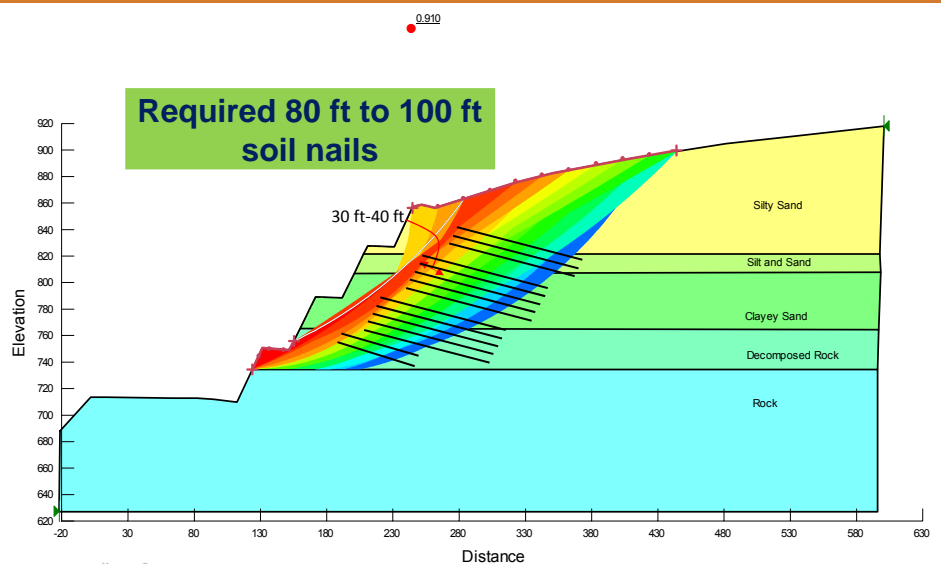
Project Plan



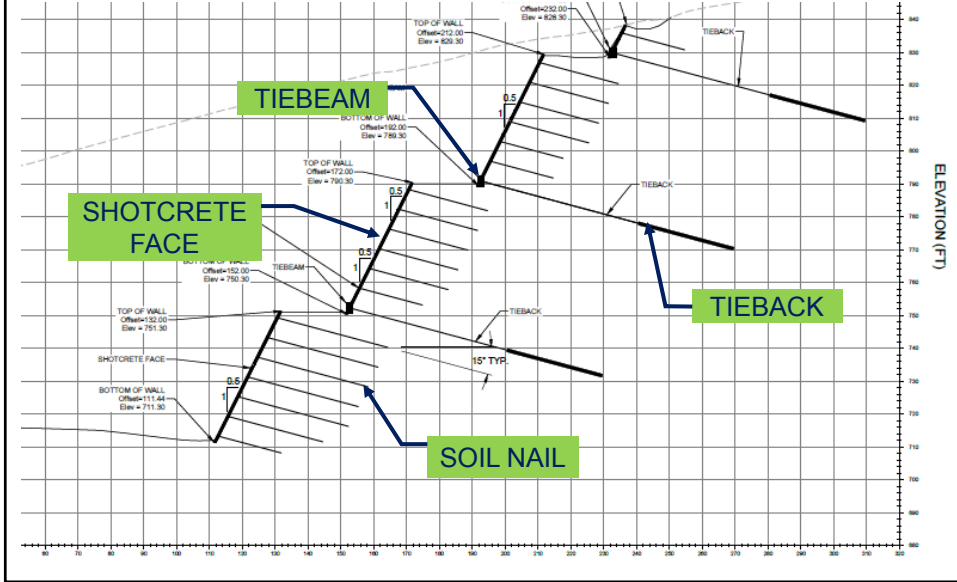
Original Project Intent



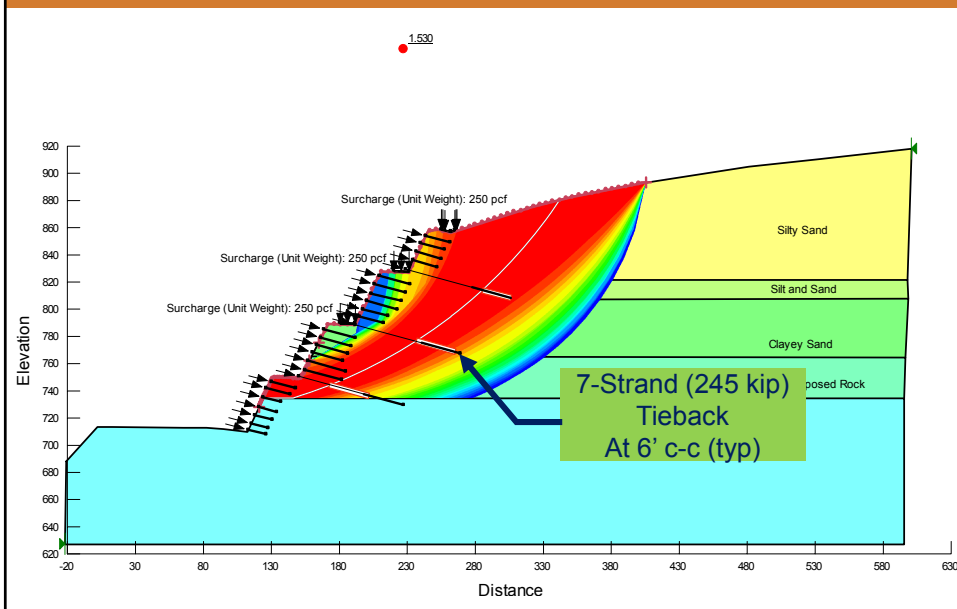
Original Project Intent

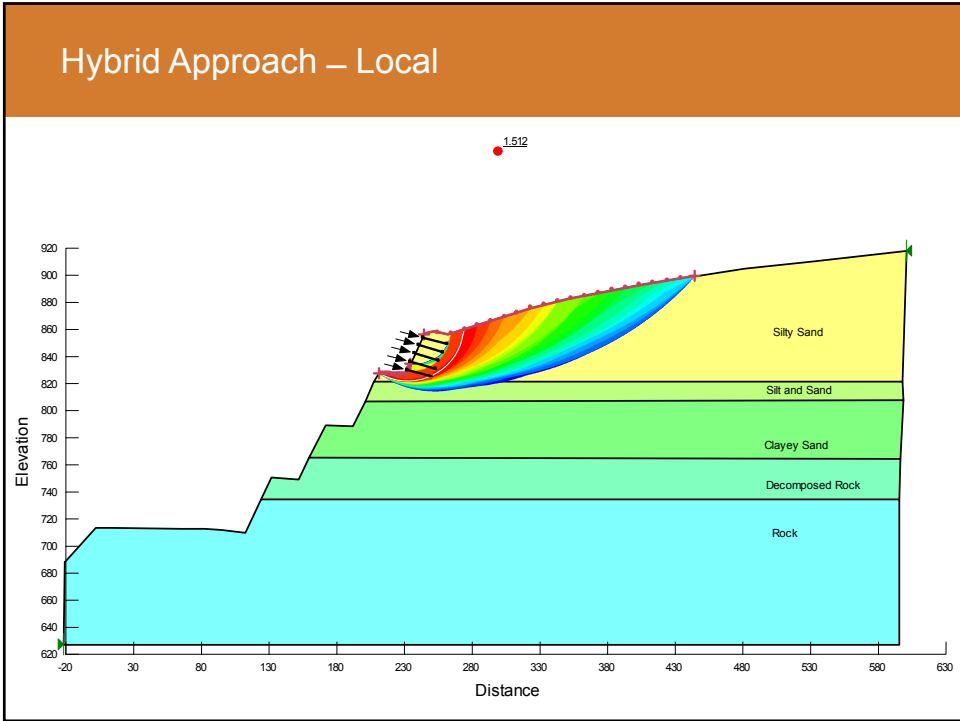


Hybrid Approach



Hybrid Approach – Global





Hybrid Wall Components

Soil Nails

- 6V:6H Spacing
- #11 Bars
- 20 ft, 25ft and 35 ft long
- 8 inch Nominal Diameter

Tiebacks

- 6 ft c-c Spacing
- 7 Strands (245 kip)
- 80 ft long
- 6 inch Nominal Diameter

Permanent Facing

- Shotcrete
- 10 inch thick
- Two Layers of W5 x W5 WWM
- **No Shear Studs!!**

Other Components

- Tie-Beam (12#8; 4 ft high)
- Sub-horizontal Drains – 20 ft long
- Drainage Strips – every 12 ft

Verification Test Program – Load Transfer Ratio



Load Testing:

- Tiebacks
(bonded deep into rock or disintegrated rock)
Design LTR (Allowable) = 8.4 kips/ft
- Soil Nails
(bonded near surface)
Design LTR (Allowable) = 8.4 kips/ft

Performed Tests:

- 5 Verification Test Nails in Rock
- 3 Verification Test Nails in Soil
- 2 Verification Test Tiebacks
- 5% Nail Proof Test (random)
- All tiebacks Proof Tested
- 6 Tieback Performance Tests

Design Assumptions

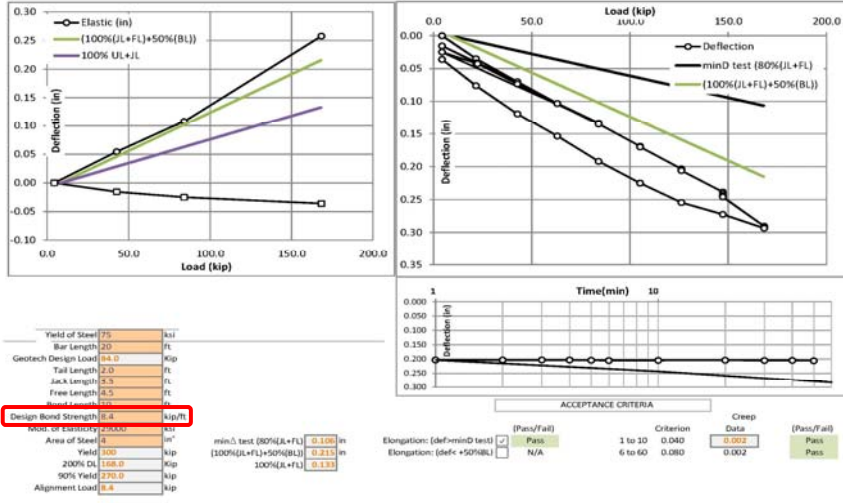
Contractor could achieve a design load transfer ratio (LTR) of 8.4 kips/ft.
Based on Local Experience

Nail Verification Test

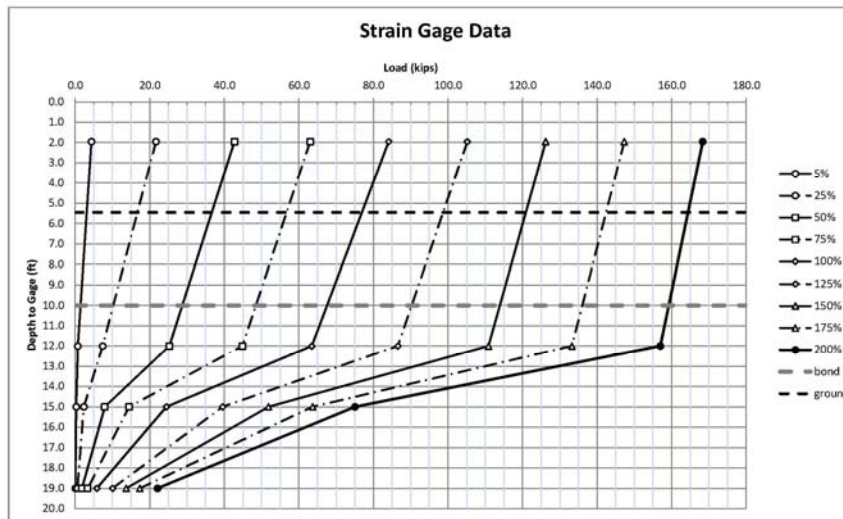


- Nails instrumented with 3 strain gauges along bond zone
- Unbonded zone – PVC
- Nail head deflection – measured with 2 dial gauges
- Applied load confirmed by load cell

Soil Nail Verification Load Testing



Soil Nail Verification Load Testing



Nail Verification Test Results

Nail	Design Maximum Test Load (kip)	Maximum Load Achieved (kip)	Design LTR (kip/ft)	Achieved Allowable LTR (kip/ft)	Soil in Bond Zone
VT1	168	168	8.4	13.7	Chert
VT2	168	168	8.4	13.3	Weathered Shale
VT3	168	210	8.4	12.8	Weathered Shale
VT4	168	126	8.4	6.3	Cherty Clay/Weathered
VT5	168	115	8.4	5.75	Chert with Clay
VT6	200	270	13.5	13.5	Weathered Sandstone
VT7	270	270	13.5	13.5	Chert

Oh, No!

**Nail spacing was changed from 6 ft c-c to 4 ft c-c.
~35% increase in nails**

Construction Begins



Hybrid Wall Construction



Hybrid Wall Construction



Hybrid Wall Construction



Hybrid Wall Construction



Hybrid Wall Construction



Element Quantities



Soil Nails

- 325 - 20 ft long nails
- 552- 25 ft long nails
- 676 - 35 ft long nails
- **Total Soil Nails = 1552**

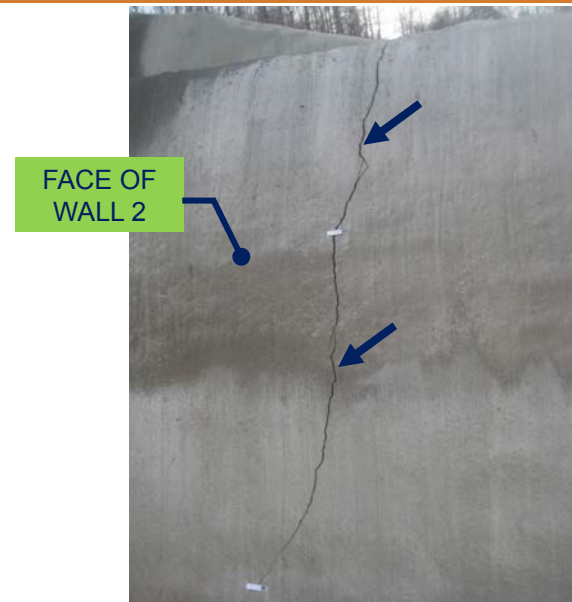
Tiebacks

- 136 - 80 ft long tiebacks

Cracking Observed



Cracking Observed



Cracking Observed



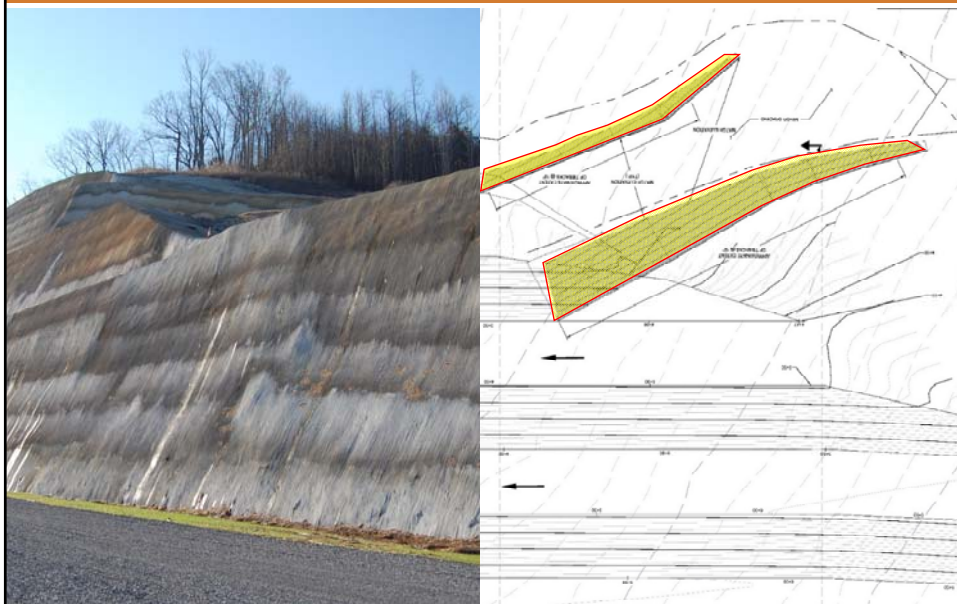
Critical Lines of Communication

- Owner and Contractor observed cracking
- Contacted Designer
- Monitoring program established
- Designer provides recommendations for continuing work
- Cracks monitored while installation continues
- Designer performs additional analyses
- Designer and Contractor submit mitigation plan to Owner

As Constructed



Mitigation Plan



Successful Completion



Successful Completion

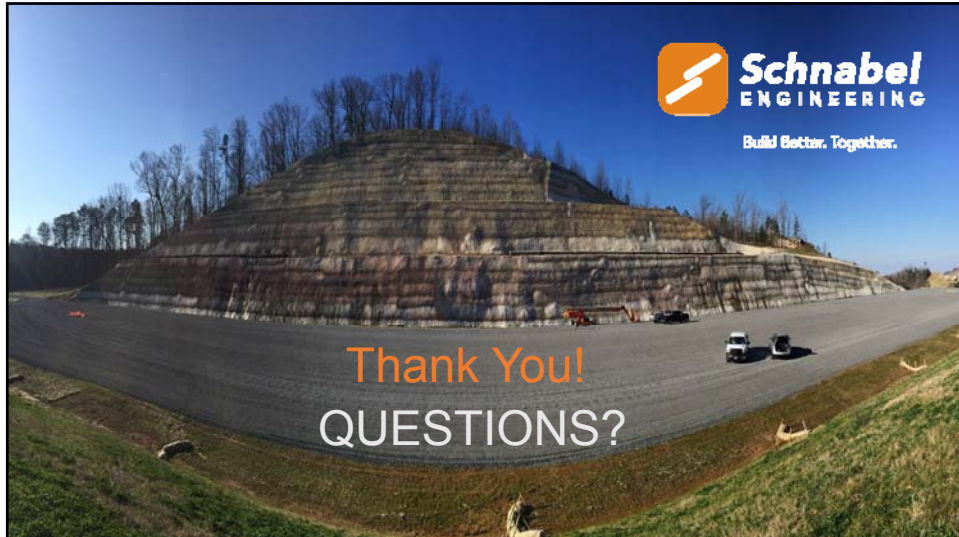


Successful Completion



Successful Completion






Schnabel
ENGINEERING

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Thank You!
QUESTIONS?

Acknowledgements



Russo Corporation
• Lance Kitchens (Engineer)
• Parker Allen (Project Manager)