ADSC RESEARCH PROJECT UPDATE: ROCK SOCKETS IN THE SOUTHEASTERN U.S.

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Introduction

- Research project sponsored by ADSC SE Chapter
- Rock-socketed drilled shafts
- Aim to improve:
  - Design methods
  - Cost-efficiency
- Involve designers, contractors, owners (DOTs)

Current Practice in Southeast

- Allowable Unit Base Resistance of 60 to 120ksf (maybe up to 200ksf)
- Design for base resistance only
- Inspected by probe hole drilled in base of socket
- If seams found, excavation continues until inspector satisfied "sound rock" is below shaft
- Lawrenceville – Rock defined as Rock Auger Refusal = 2in/5min with LLDH rig

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Test Program

- Two sites tested to date
- Nashville, Tennessee
  - Hard Limestone (sometimes solutioned)
  - Birmingham, Knoxville, Chattanooga
- Lawrenceville, Georgia (Metro Atlanta)
  - Metamorphic rock (Gneiss, Schist, etc.)
  - Piedmont Formation – Georgia to Virginia

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Test Program

- Thorough Subsurface Explorations
- Two test shafts at each site
- O-Cell testing device
- Inspected by local geotechs
- Conducted field day with local ASCE/G-I Technical Group

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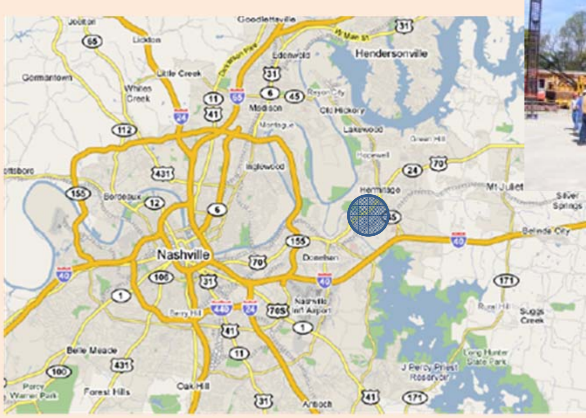
Nashville Site



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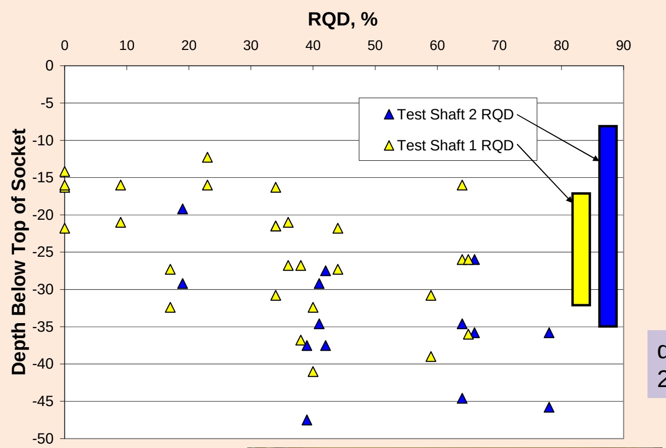
Rock Core RQD - Nashville



qu = 5,000 to 20,000 psi

Construction - Nashville

- 48in core barrel to excavate limestone sockets (16ft)
- Mechanical cleaning only
- Inspectors consensus:
  - TS 1 had 3in to 4in soil seam 19in below base
    - Shaft should have been extended
  - TS 2 no significant seams
    - Typical conditions sought
  - Both shafts needed additional cleaning
- Significant concrete overrun in TS 2

Unit Side Resistance - Nashville

- Test Shaft 1 best for side resistance
  - Fully mobilized side resistance vs Test Shaft 2
  - No overrun on concrete to complicate interpretation
- Fully mobilized at small displacement: 1 % of dia. (~0.2in)

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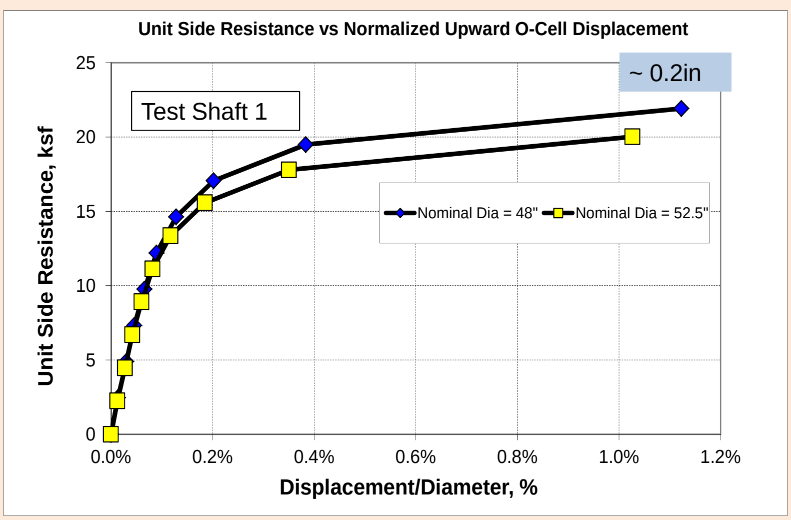
Unit Side Resistance - Nashville



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Unit Base Resistance - Nashville

- **Displacements about 1% of loaded area**
  (B = 39in for TS 1; B = 29in for TS 2)
- **Inspections indicated soil seam 19in below TS 1**
  (10% of B approx. 0.5B below shaft base)
- **Maximum unit base resistance**
  - **TS 1 = 500 ksf**
  - **TS 2 = 1250 ksf**

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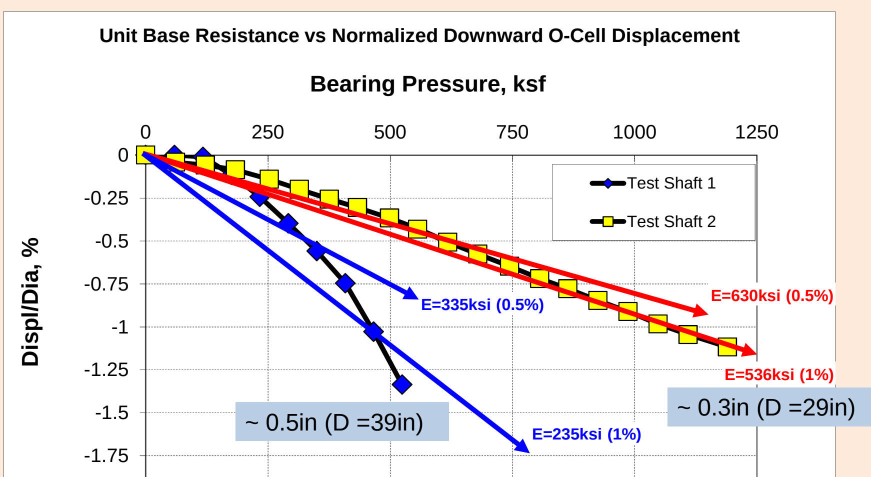
Unit Base Resistance - Nashville



$$\rho_s = 0.79 \cdot \frac{qB\left(1-\nu^2\right)}{E}$$

Soil seam beneath TS 1?

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Implications - Nashville

- "Sound Rock": conditions similar to Test Shaft 2
  - 1 or 2 small seams < ½ inch thick
  - Allowable unit base resistance = 500ksf
- "Fair Rock": conditions similar to Test Shaft 1
  - soil-filled seams up to 10%B, at depths > ½ B
  - Allowable unit base resistance = 200 ksf
- Displacement approx. 0.5%B
  (1/4 to 3/8 inch for B = 4 to 6 ft)

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Implications - Nashville

- Side resistance not factor in "Sound Rock" for typical designs (when socket not needed for lateral)
- Utilizing side resistance in "Fair Rock" conditions may be prudent
  - When socket > 10ft to "find" base resistance
  - Use lower base resistance + side resistance

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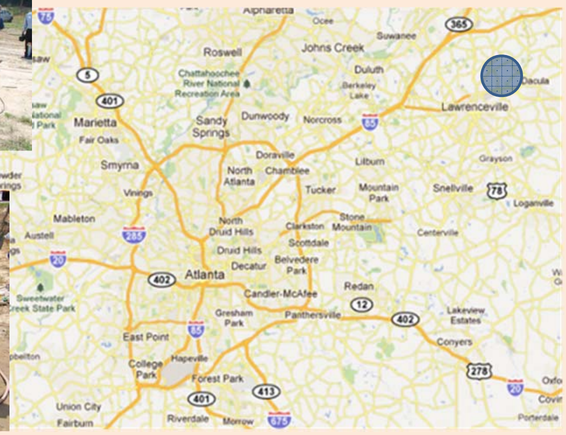
Lawrenceville Site



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Construction - Lawrenceville

- **TS 1 – Test side and base resistance of 40.5in rock socket**
  - **Started with core barrel, completed with rock auger**
  - **Penetration = 4 to 6.5in/min – not "Rock Auger Refusal"**
- **TS 2 – Test base resistance at "Rock Auger Refusal" with 66in socket and 19in O-cell**
  - **Drilled with rock auger**
  - **Two distinct zones of PWR**
  - **Penetration = 3in/5min – not "Rock Auger Refusal"**

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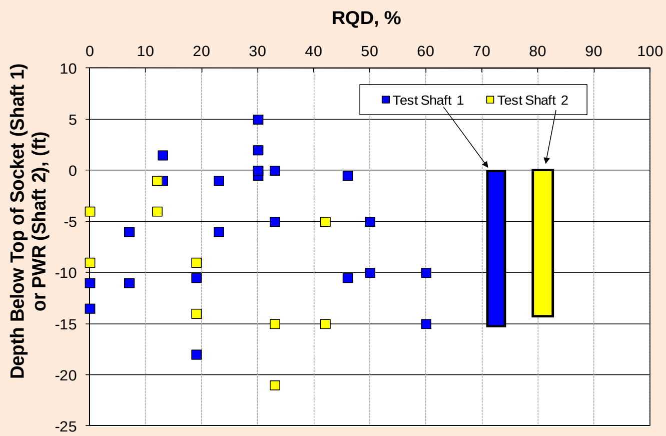
Rock Core RQD - Lawrenceville



qu = 7,000 to 11,000 psi

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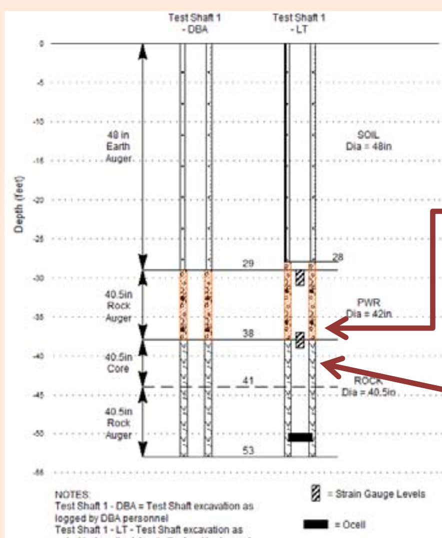
Test Shaft 1 - Lawrenceville



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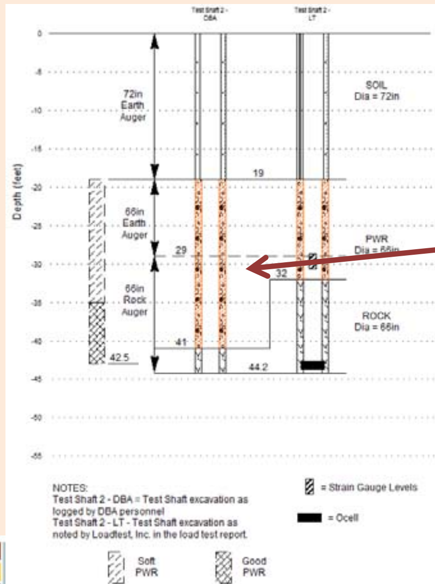
Test Shaft 2 - Lawrenceville



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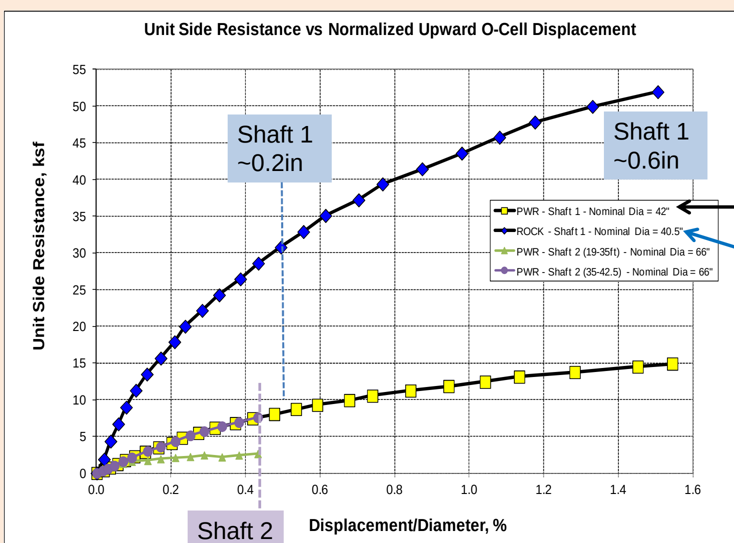
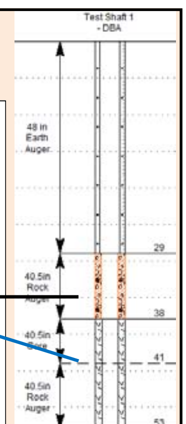
Unit Side Resistance - Lawrenceville





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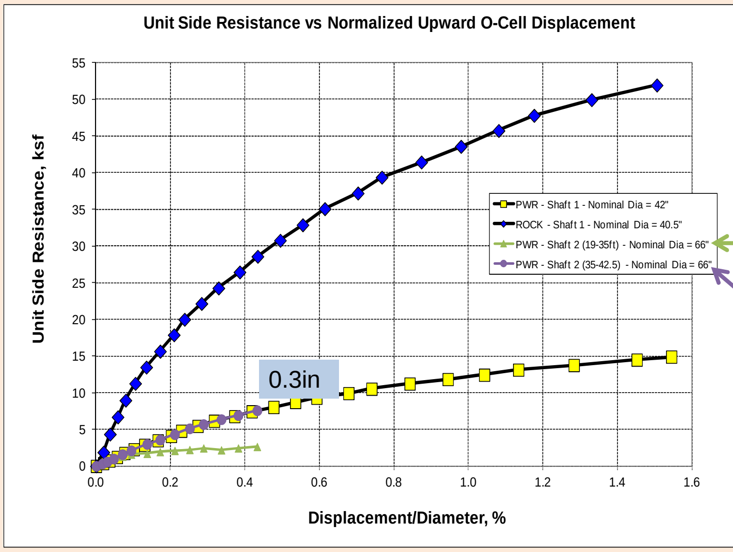
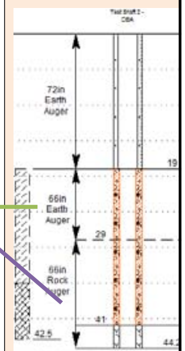
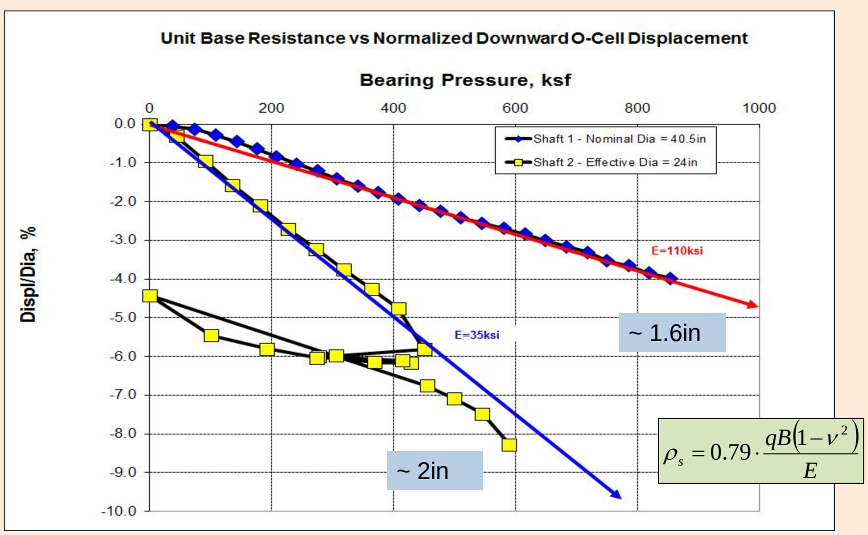
Unit Side Resistance - Lawrenceville





Unit Base Resistance - Lawrenceville



TS 2 in softer rock

Implications - Lawrenceville

- Terminated in material that did not meet local criteria for rock: “rock auger refusal”.
- Nominal/ultimate unit base resistance significantly greater than current design limits.
- High nominal/ultimate unit side resistance can be achieved.

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Implications - Lawrenceville

- Formed committee
  - Atlanta area practitioners, ADSC Southeast Chapter, and the researchers
- Reviewed results, local practice
- Identified key considerations for applying results
- Developed recommended design values
- Developed specific criteria to be met
  - RQD, penetration rate, inspection criteria

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Conclusion

- Tests demonstrated:
  - High nominal base and side resistance
  - Higher design values than have historically been used can easily be achieved
  - Less than "perfect" conditions exceed current design values
- Design guidelines are suggested to provide more economical use of drilled shaft foundations in the two markets.

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Conclusion

- Site-specific criteria are provided to apply test results.
- ALWAYS have a thorough site investigation
- Inspection program to confirm the findings of the site investigation.

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Conclusion

- **Reports available:**
  - **Expo Proceedings**
  - **http://danbrownandassociates.com/publications**

- **Many thanks go out to:**
  - **ADSC Member Firms and Suppliers**
  - **Participating Geotechnical Firms**
  - **Loadtest, Inc.**
  - **Individuals**

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Questions?

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