

Tip-Grouted Drilled Shaft Foundations for the Audubon Bridge

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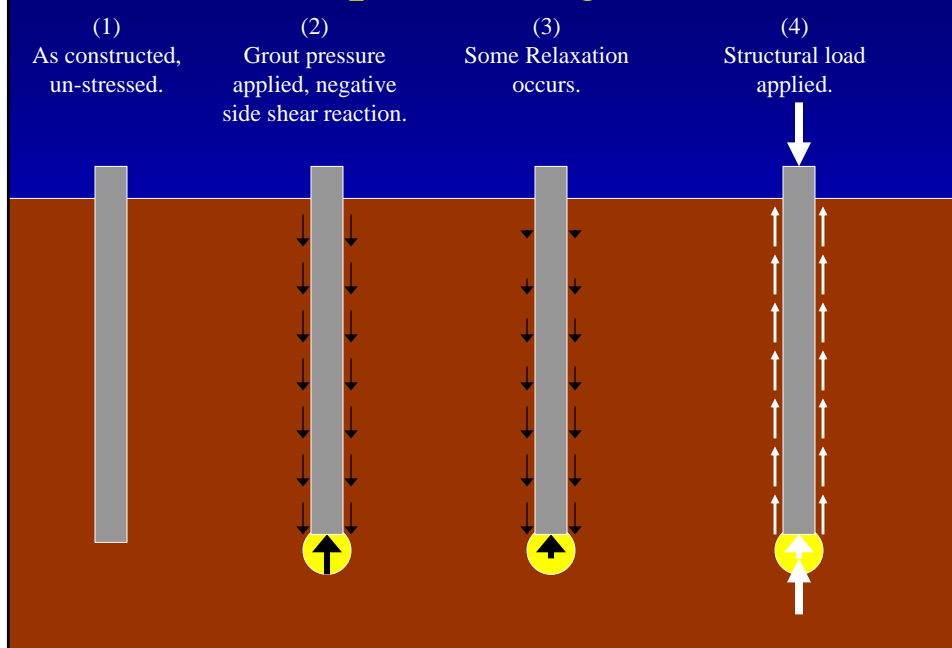
Acknowledgements

- Tip grouting used worldwide for more than 3 decades.
- Six years of research at USF, funded by the FDOT, has produced a rational design procedure.
- Gaining wide acceptance within the US.

Outline

- The Tip Grouting Process
- The Benefits of Tip Grouting
- Experiences: U.S. and Abroad
- John James Audubon Bridge

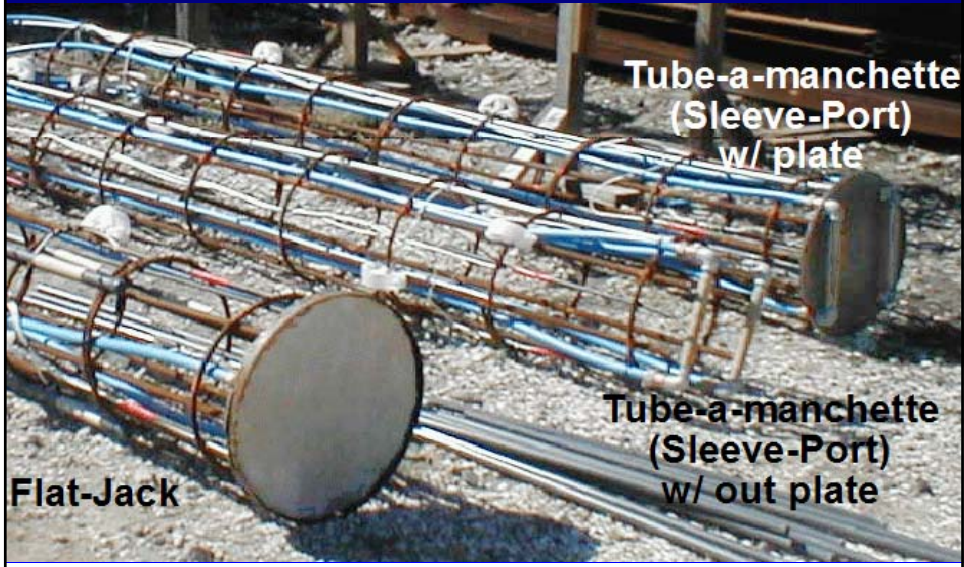
The Tip Grouting Process



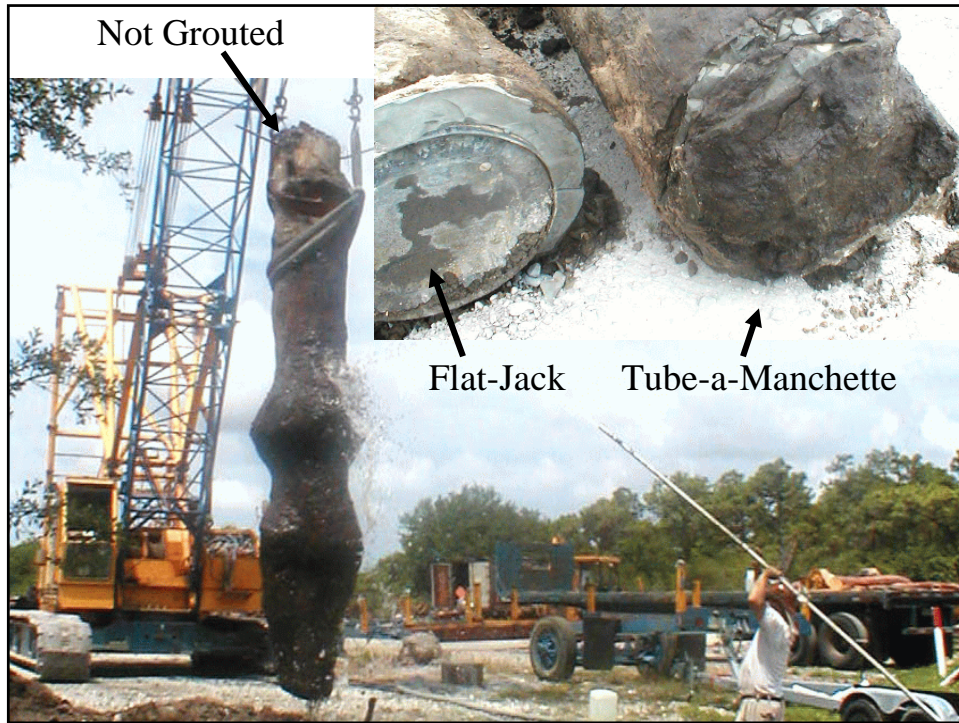
Tip Grouting Process



Grouting Injection Mechanisms



Stem or Orifice (Not Shown): Consider as a Remediation Option Only.



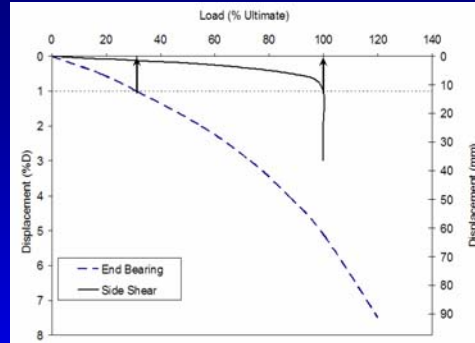
Benefits of Tip Grouting

- Increases the ultimate tip capacity.
- Tip component able to contribute to the “useful” capacity (i.e., within tolerable displacements).
- Provides a proof load of capacity for every grouted shafts on the site.

Benefit with Soil Type

Cohesionless Soils:

- Significant improvement as well as proof's the load.
- Most improvement seen in loose to medium dense sands.



Cohesive Soils:

- Little improvement, but proofs the load.

Differential Settlement
in Soils Associated
with End Bearing

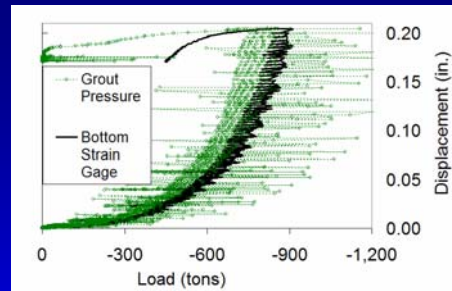
Rock Socket:

- May be used to remediate soft toes in deep excavations (long construction times) where thorough clean-out can not be achieved/assured.

Grouting Procedures / Criteria



Sustained Grout Pressure:
Develops and proves the increase in “useful” tip resistance.



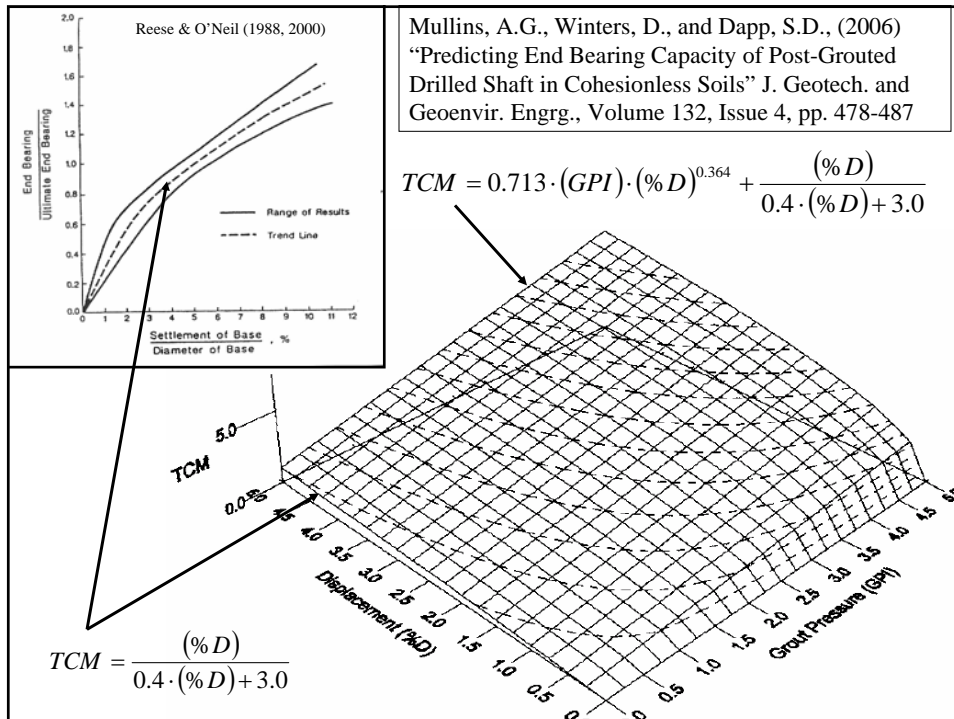
Excessive Grout Volume (without achieving grout pressure):
Stop, flush lines, and try staged grouting technique later.

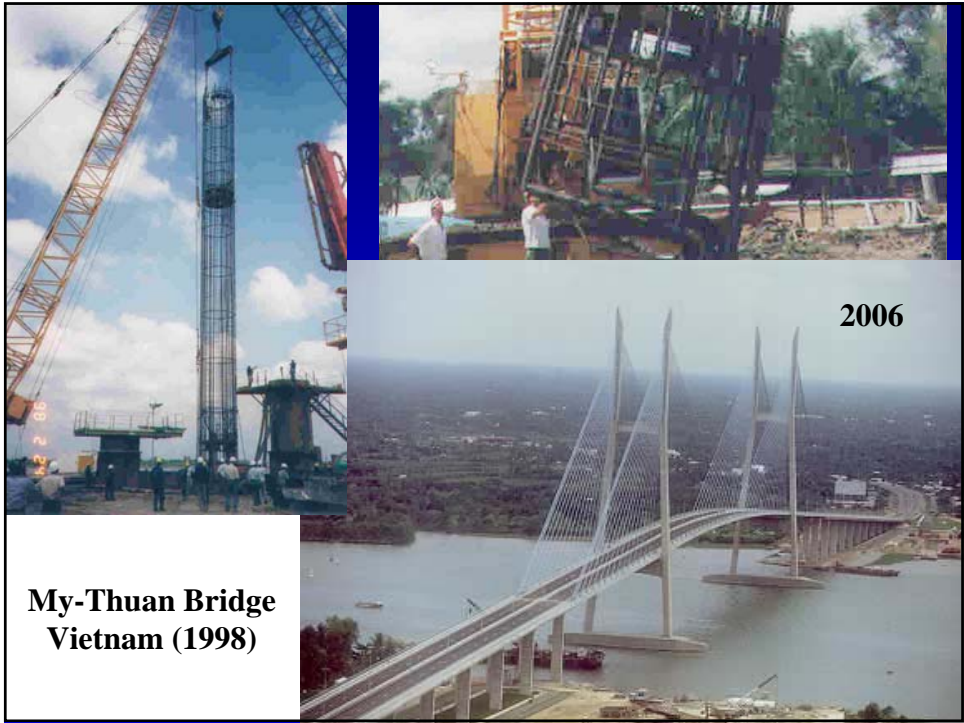


Shaft Uplift (without achieving grout pressure):
Side shear is not as great as anticipated, and is inadequate to provide reaction for grout pressure.

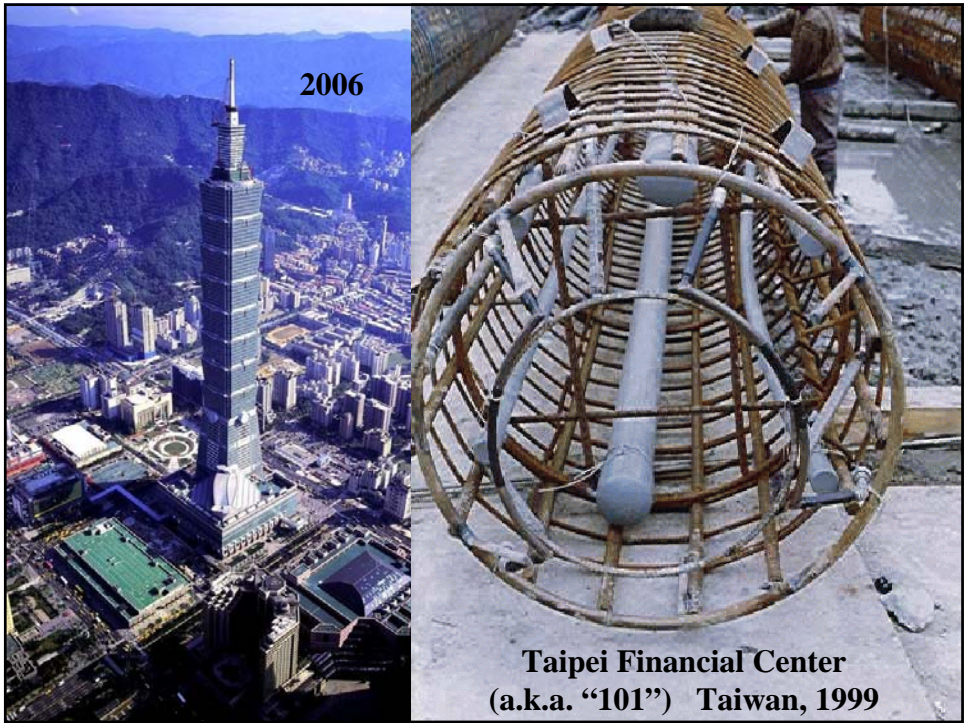
When to Consider Tip Grouting

- Sandy bearing stratum
- Shaft tip cleanliness is difficult to achieve and/or maintain.
- Increase reliability by proof loading every shaft.





**My-Thuan Bridge
Vietnam (1998)**



**Taipei Financial Center
(a.k.a. "101") Taiwan, 1999**

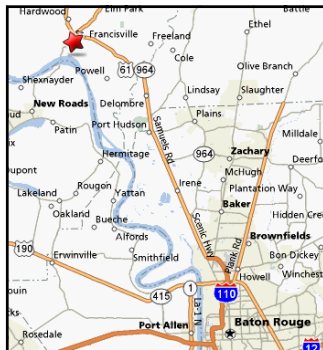
Experience with Tip Grouting in the U.S.

- 10 projects since 2003
 - 6 were DOT bridges (Florida, Mississippi, Texas and South Carolina).
 - 4 were commercial High Rise (Florida).
- Nearly 600 tip grouted drilled shafts, with 17 full scale load tests.



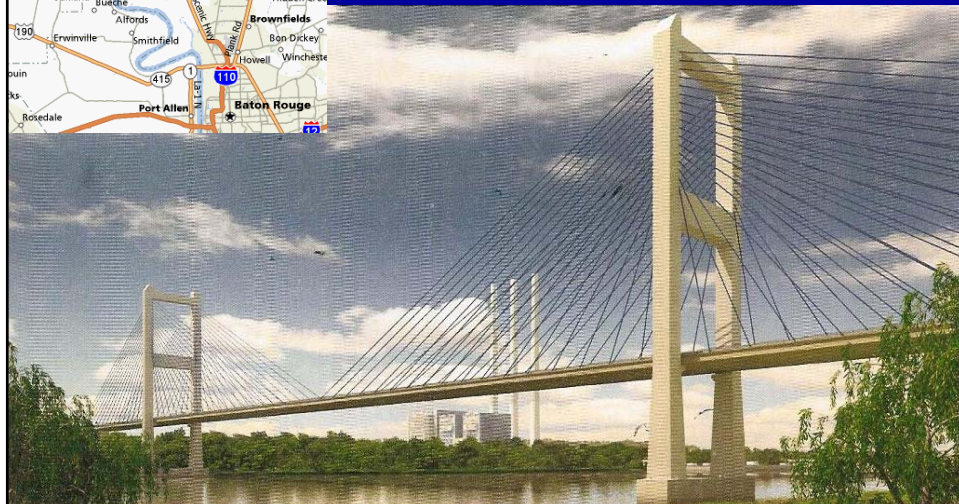
Dapp, S.D., Muchard, M., Brown, D.A., 2006.

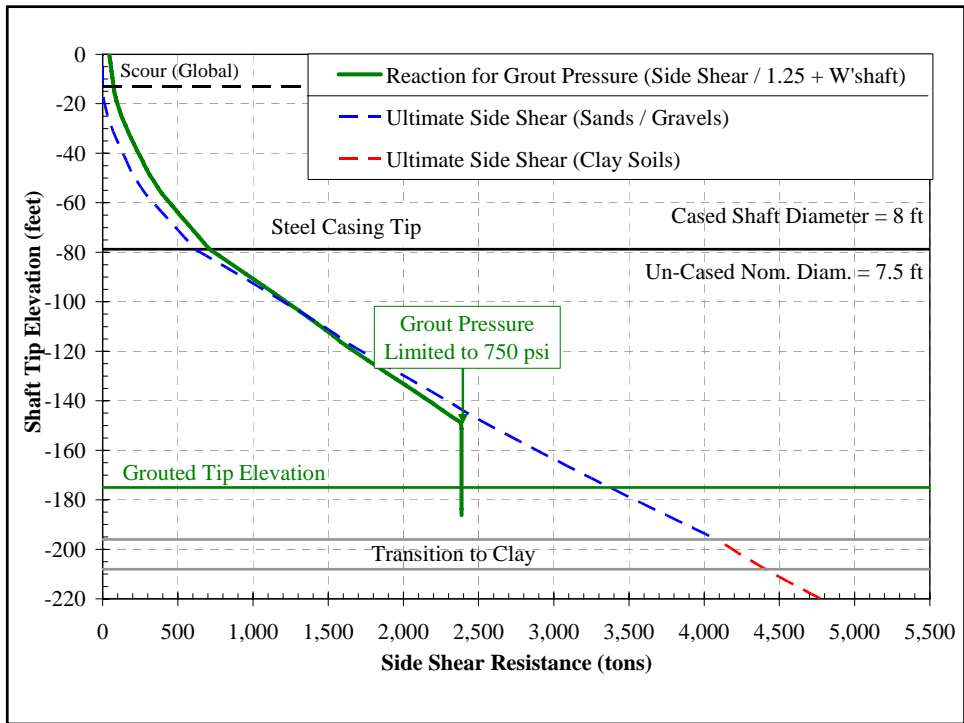
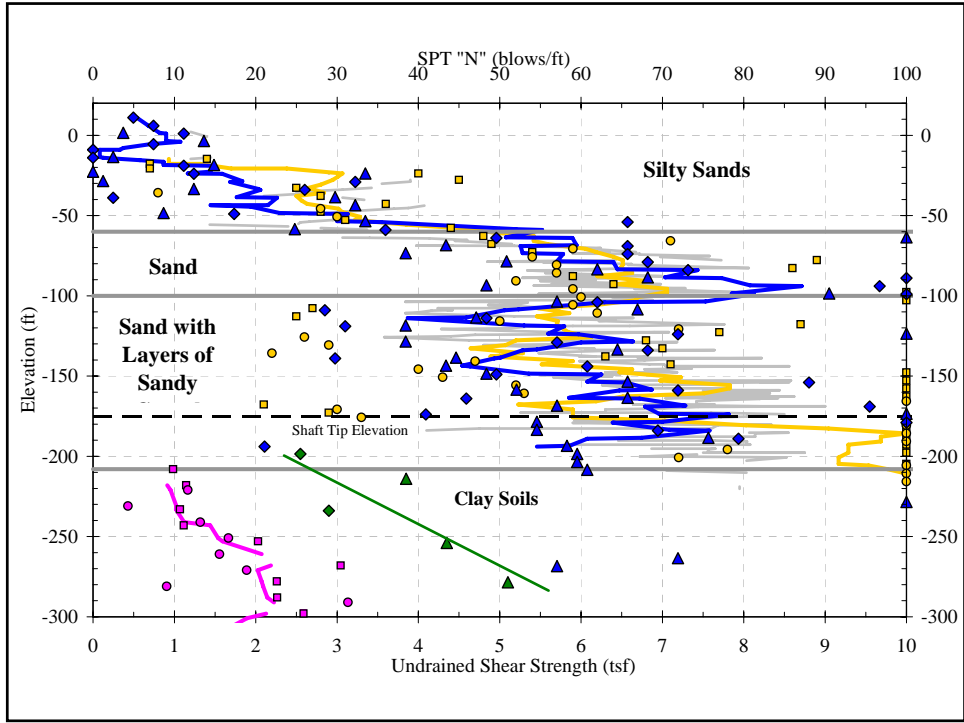
Experiences with Base Grouted Drilled Shafts in the Southeastern United States.
DFI 10th International Conference on Piling Foundations, Ghent, Belgium.

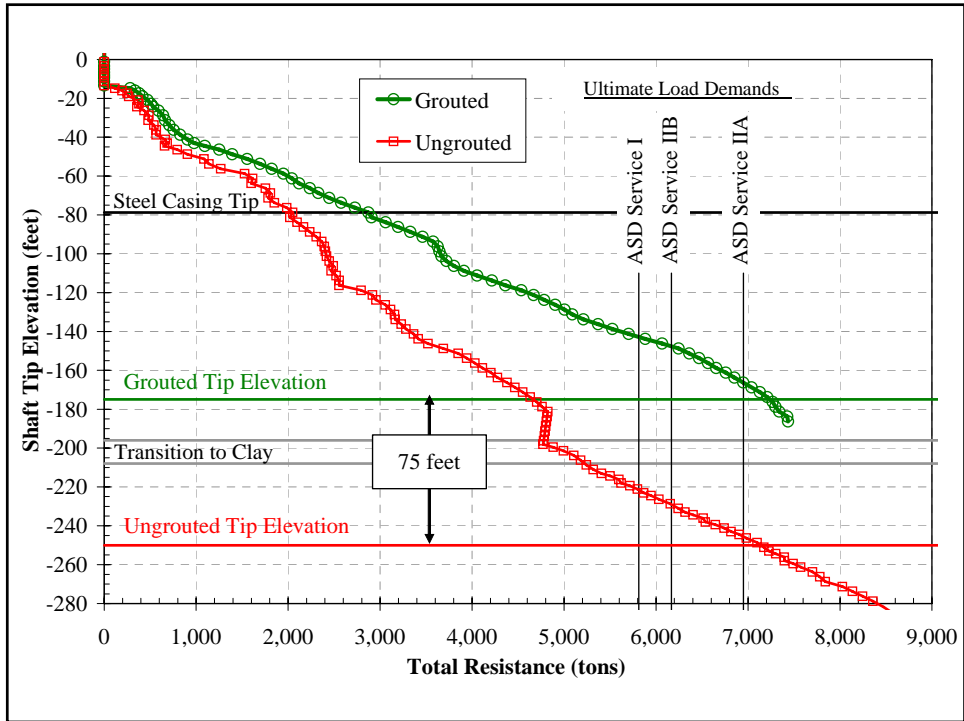
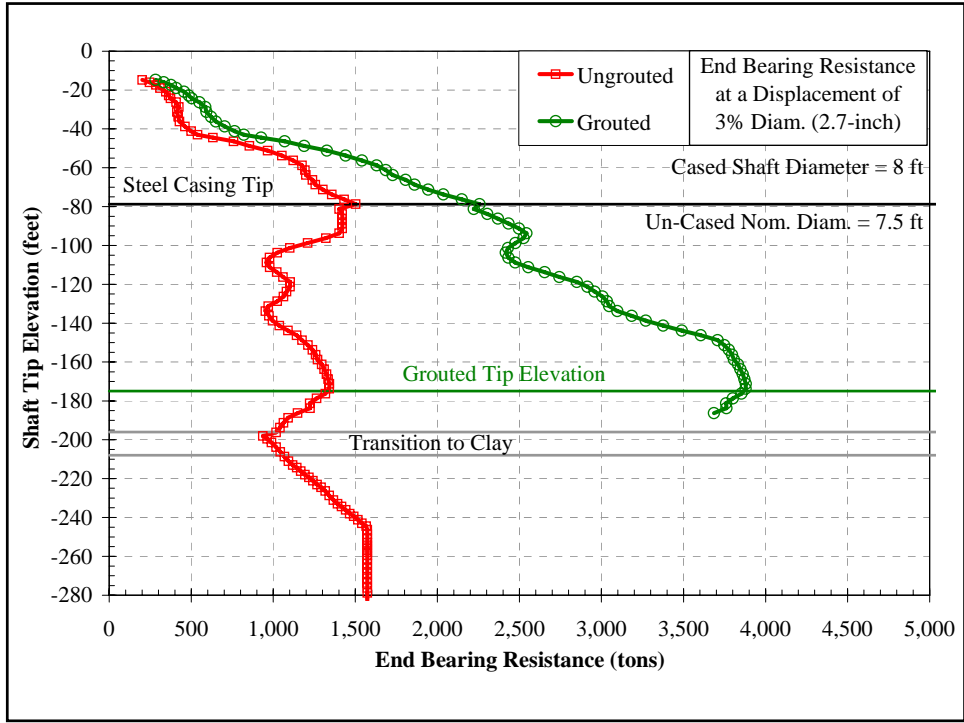


John James Audubon Bridge

- SR10 over the Mississippi River
- 1,583 ft Cable Stayed Span, Longest in North America
- \$347 million, Design-Build Project







Summary

- Increase the “Useful” End Bearing Resistance
 - Greater Ultimate Resistance
 - End Bearing Develops within service limit displacement
 - Reduce Differential Settlement in Some Cases.
- Allows for Greater Reliability
 - Providing a “Proof Load” of Every Production Shaft
 - can use lower SF’s for ASD, or greater Φ factors for LRFD?
- Identify Unforeseen Construction and/or Soil Problems, and Provide the Means of Remediation.

