FINDING COMMON GROUND

DEEP FOUNDATIONS INSTITUTE

DFI®

DFI Augered Cast-in-Place and Drilled Displacement Pile Technical Committee

Augercast Piles for Infrastructure Projects

Presentation to Southeast Geotechnical Engineers' Conference

November 20, 2024

FINDING COMMON GROUND

About the Deep Foundations Institute:

Mission Statement:

"To bring together multidisciplined individuals and organizations to find common ground and create a shared vision and a consensus voice for continual advancement in the deep foundations industry"

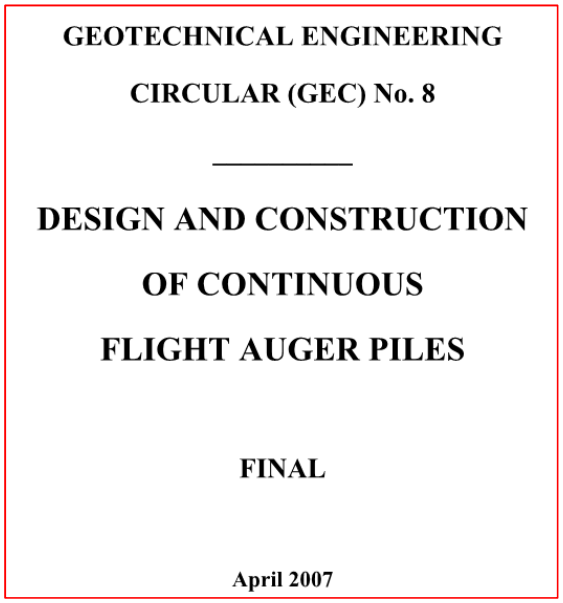
PRESENTATION OUTLINE

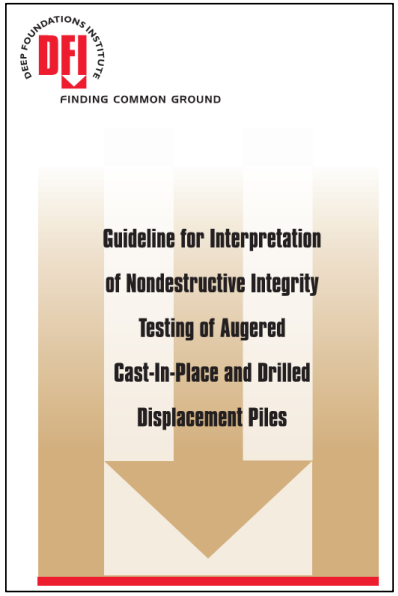
- DFI Augered Cast-in-Place & Drilled Displacement Pile Committee: Who are we and what have we done
- Common Terminology and Pile Components
- Quality Assurance and Quality Control
- Miami Signature Bridge Case Study
- Other ACIP projects

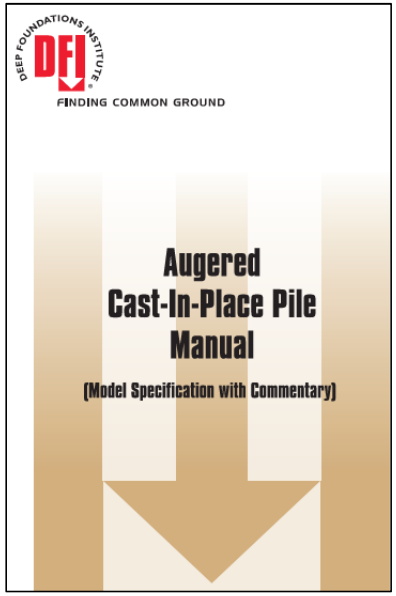
Recent ACIP/DD Pile Committee Activities

- 2016 FDOT ACIP Pile Installation, Monitoring and Testing program report published along with associated Thermal Measurement Recording Report issued by USF to FDOT
- 2017 Research into lateral/pw pressures generated when displacement piles are installed
- 2018 Research into thermal measurement and manually measured pile diameters
- Assisting ACIP Pile Specifications for FDOT, NAVFAC, and AASHTO

DFI TECHNICAL RESOURCES







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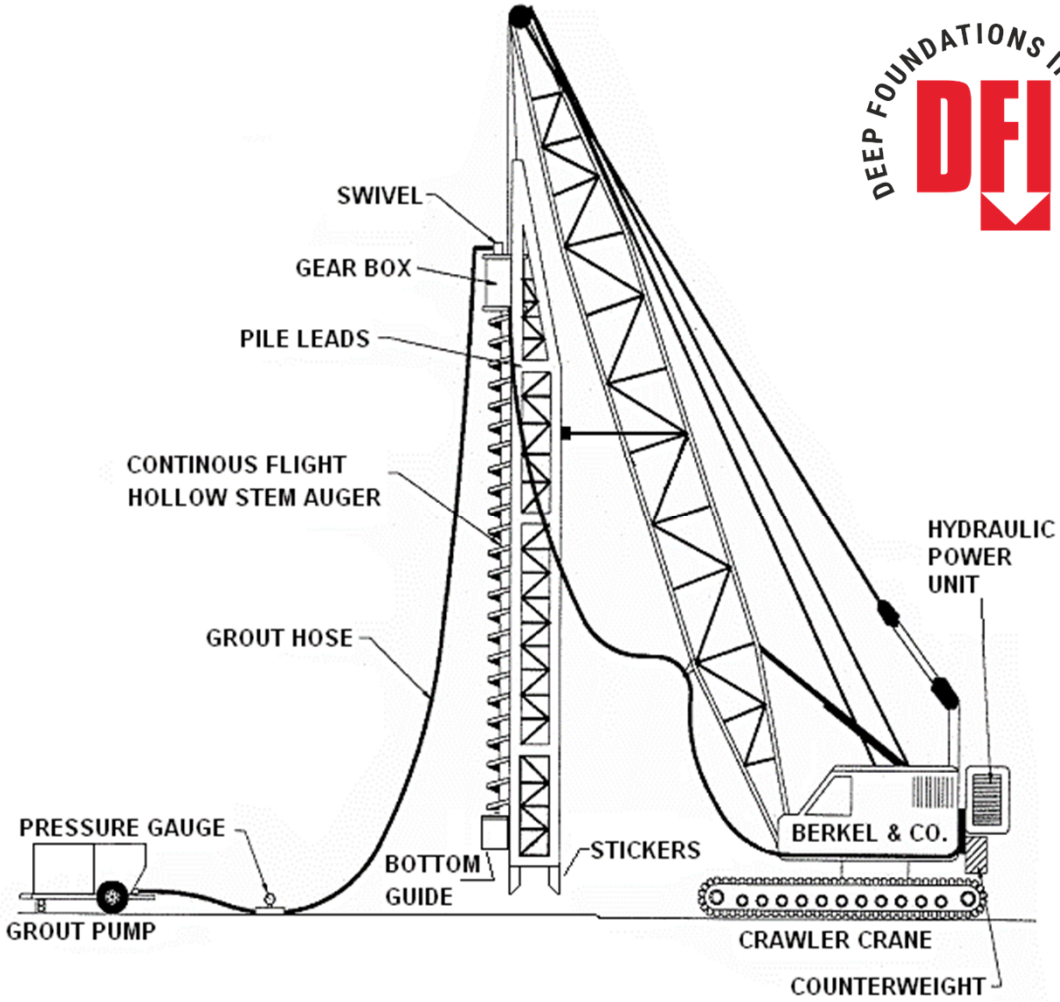
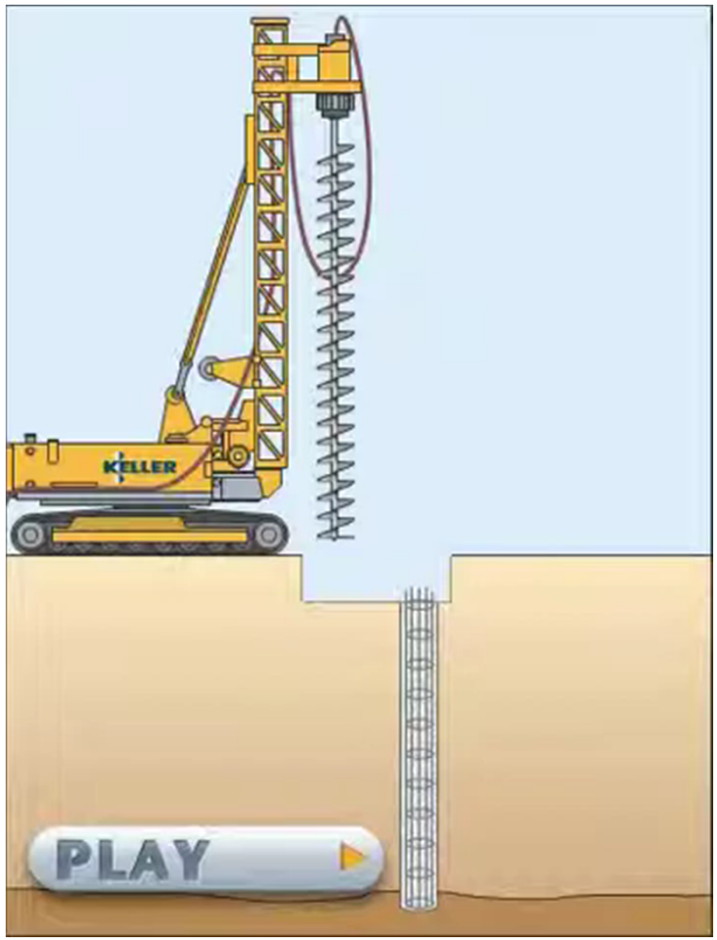
Pile Terminology

- Continuous Flight Auger (CFA)
- Auger Cast-in-Place (ACIP)
- Auger Pressure Grouted (APG)

All refer to single-pass, cast-in-place foundation systems with steel reinforcement.





What is an ACIP pile?

- Spoils removed by rotating flights
- Auger withdrawn with grout under fluid head pressure
- Reinforcing steel inserted into fluid grout

RIG- AND CRANE-MOUNTED ACIP

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Application of ACIP Piles in Transportation Market

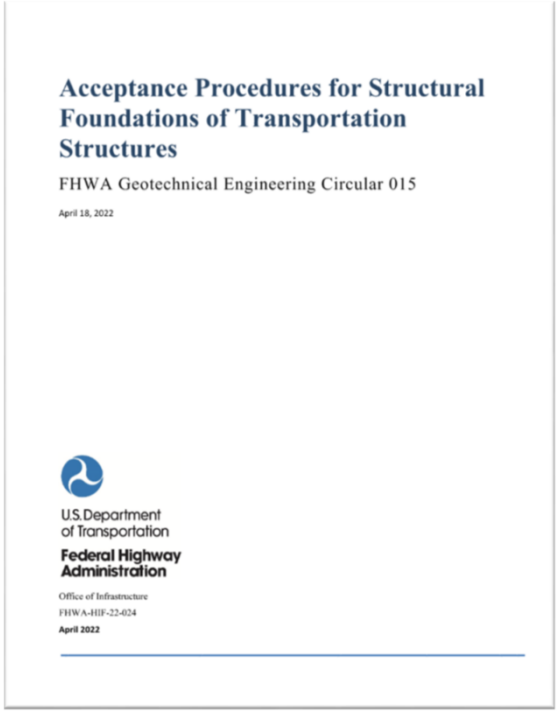
- Soundwalls in numerous states
- Excavation Support (as secant piles)
- ~20 state DOTs and FHWA have approved ACIP piles on project specified (VE) basis
- Selected Bridge Support to Date:
  - MetroRail in Miami, FL
  - Bridge / Retaining Wall Tiebacks in Canton, OH
  - I-135 in Salina, KS and Wichita, KS
  - 153rd St Bridge in Seattle, WA
  - SR-97 in Roy, UT

APPLICATION OF ACIP PILES IN TRANSPORTATION MARKET

Geotechnical Engineering Circular No. 15

Acceptance Procedures for Structural Foundations of Transportation Structures

Chapter 7: Assessment and Acceptance of Continuous Flight Auger Pile Foundations



ACIP Pile Design

- ACIP Piles are designed like drilled shafts
  - Structural design is the same, considers nominal auger dia. for shaft dia.
  - Geotechnical design can use similar drilled shaft methods or calibrated to contractor's local experience
- Design methodology outlined in FHWA GEC No. 8 "Design and Construction of Continuous Flight Auger Piles"

REINFORCING STEEL

- Can be single center bar or full cage. Partial length cage plus full-length center bar is common. All reinforcement should be fitted with centralizers to properly position within pile **as the steel is placed into the fluid grout**.
- The configuration of the reinforcing steel cage can greatly impact the successful insertion of pile reinforcement into the grout. Total steel surface area has a **significant impact on placement**.
- High static pressures in the fresh grout column **may force water from the grout into permeable soils**, potentially making steel placement difficult.

Reinforcing Cage Centralizers

Reinforcing Cage Placement

Reinforcing Cage Centralizers

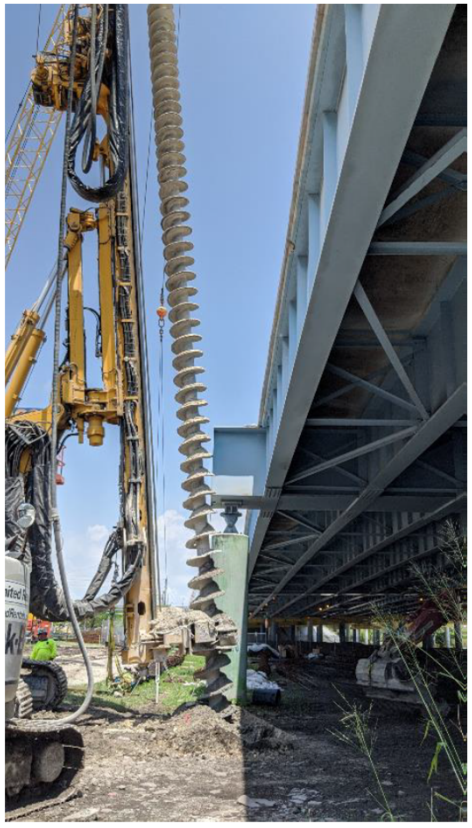
GROUT

- Needs to be fluid in order to:
  - Pump through auger flight to pile tip
  - Develop pressure head to maintain open excavation
  - Allow reinforcing steel placement
- Typically pumped to 110% to 150% of theoretical volume (measured diameter exceeds nominal auger/design diameter)
- Typical f'c strengths are 5 to 7 ksi, in some markets up to 10 to 11 ksi
- Needs proper admixtures to maintain fluidity and retain water

Battered piles

Between overhead bridges (17-ft opening)

- (108) 30” Diameter CFA
- 80’ Depth
- 1:8 Max inclination
- Required for constructability



Low headroom piles

- 40 ft. headroom
- (36) 30” Diameter CFA
- Max 85’ Depth

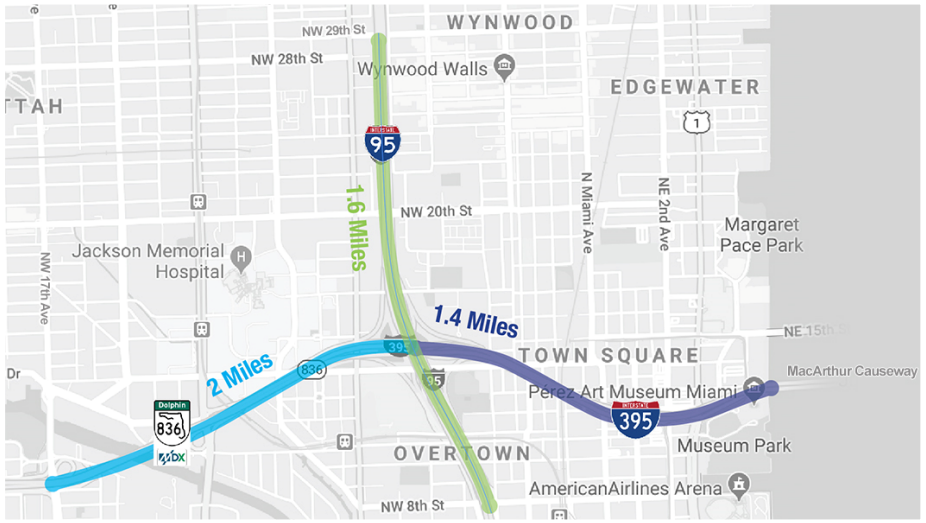
Case History: FDOT I-395/SR-836 Signature Bridge

- Client: Florida Department of Transportation (FDOT)

- Multiple phases: ~5-year schedule
- ~1000 x 30” dia. piles up to 90’ deep for connecting and ancillary structures
    - Some battered and low headroom piles
- ~800 x 36” dia. piles 115-140’ deep for main Signature Bridge structure

- General Contractor: Archer Western de Moya JV
- Deep Foundation Contractor: Keller North America
- Geotech: Universal Engineering Services (UES)
- Testing Agencies:
    - Load Test Consulting (LTC) / GRL Engineers Inc.
    - Applied Foundation Testing (AFT) / Radise International.

I-395/SR-836



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I-395/SR-836

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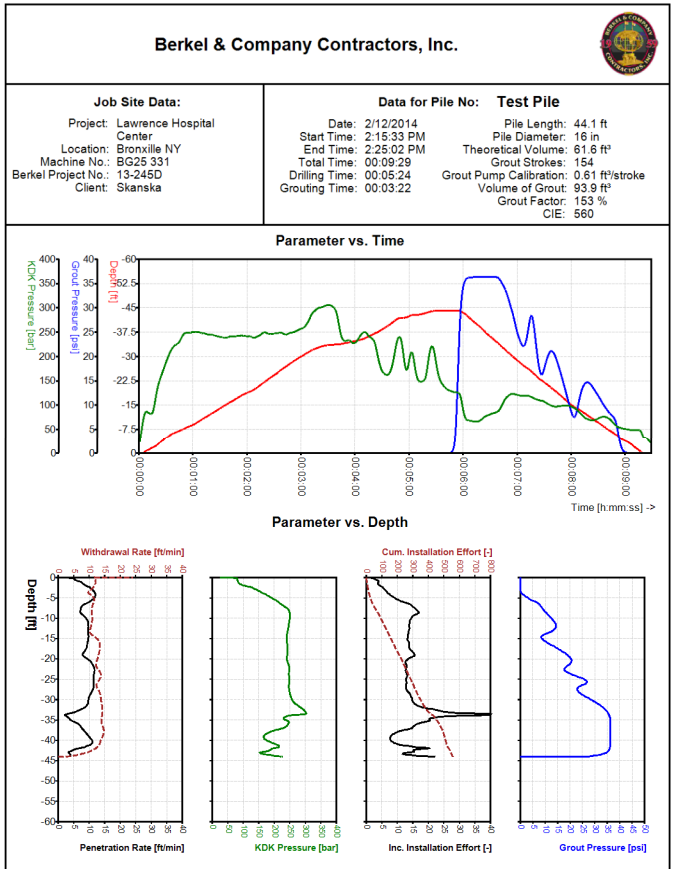
Signature Bridge Deep Foundation Selection

- Driven Piles did not achieve needed capacity in pre-design testing program
- Drilled Shafts are problematic in South Florida geology – only used for in-water piers
- Auger Cast-in-Place piles were selected by FDOT as the preferred deep foundation solution

ACIP Pile Quality Assurance - During Construction

- Observe auger insertion.
- Monitor the cuttings
- Count pump strokes.
- Observe rate of auger withdrawal.
- Log depth of grout return.
- Use Automated Measurement Equipment (AME).

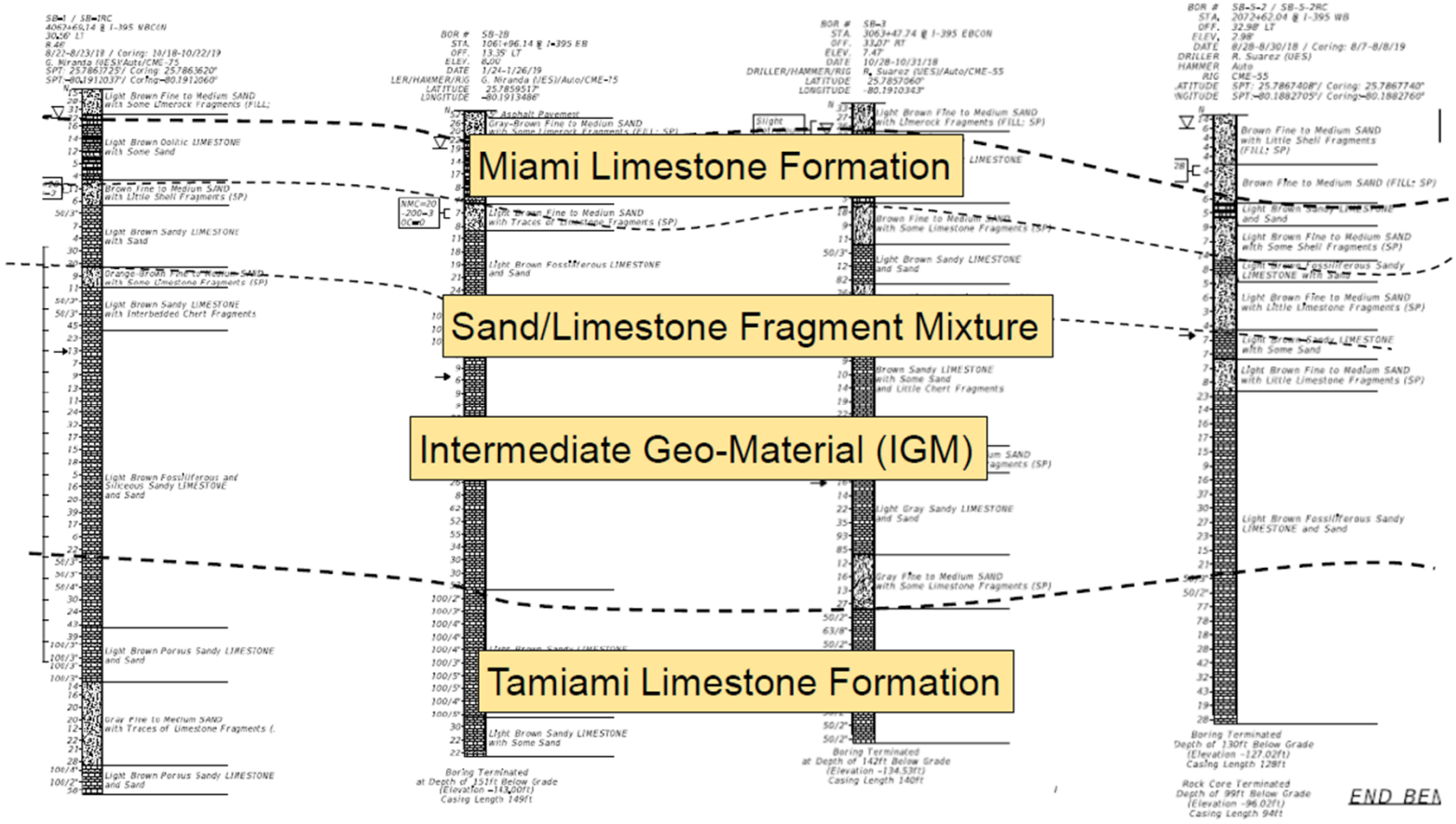
AUTOMATIC MONITORING EQUIPMENT (AME)



Primary Drilling Parameters:

- Time: Recorded by an internal counter and referenced to the initial date and time input by the operator at the beginning of the project.
- Depth: From proximity switch that measures rotation of the main winch supporting the drilling turntable and drilling tools.
- Hydraulic Fluid Pressure driving turntable (i.e. KDK Pressure): From in-line pressure transducer.
- Rotation of auger: From proximity switch on turntable.

SIGNATURE BRIDGE STRATIGRAPHY



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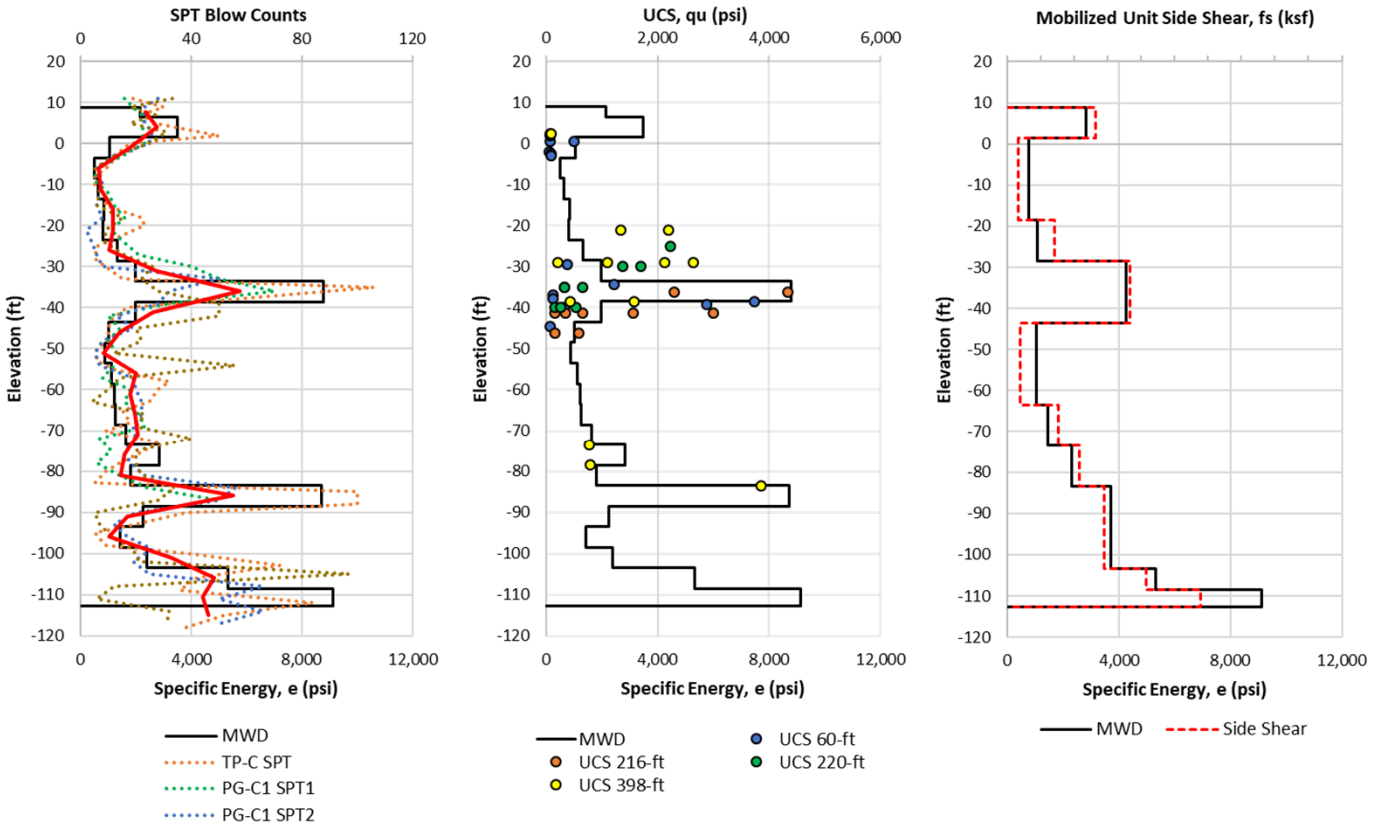
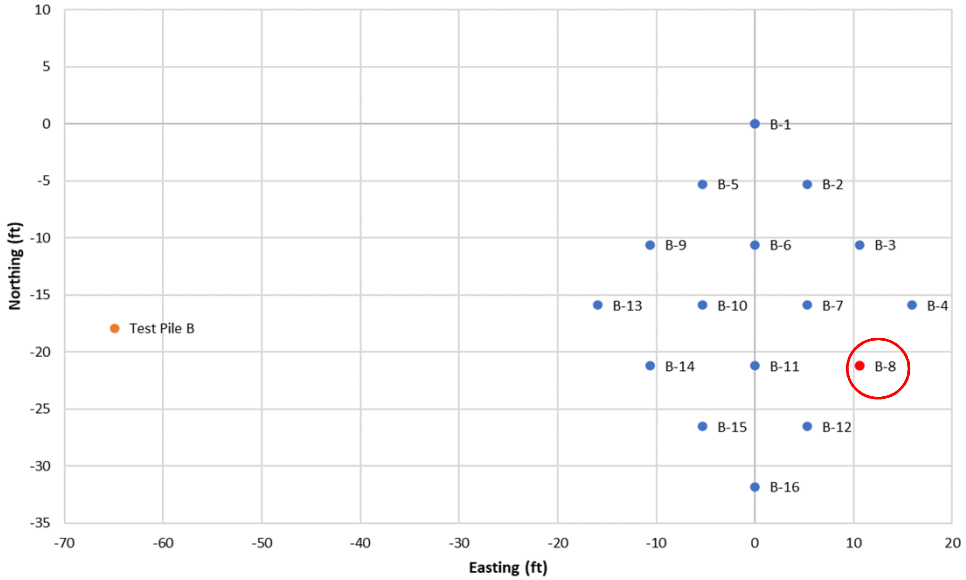
MEASURING WHILE DRILLING (MWD)

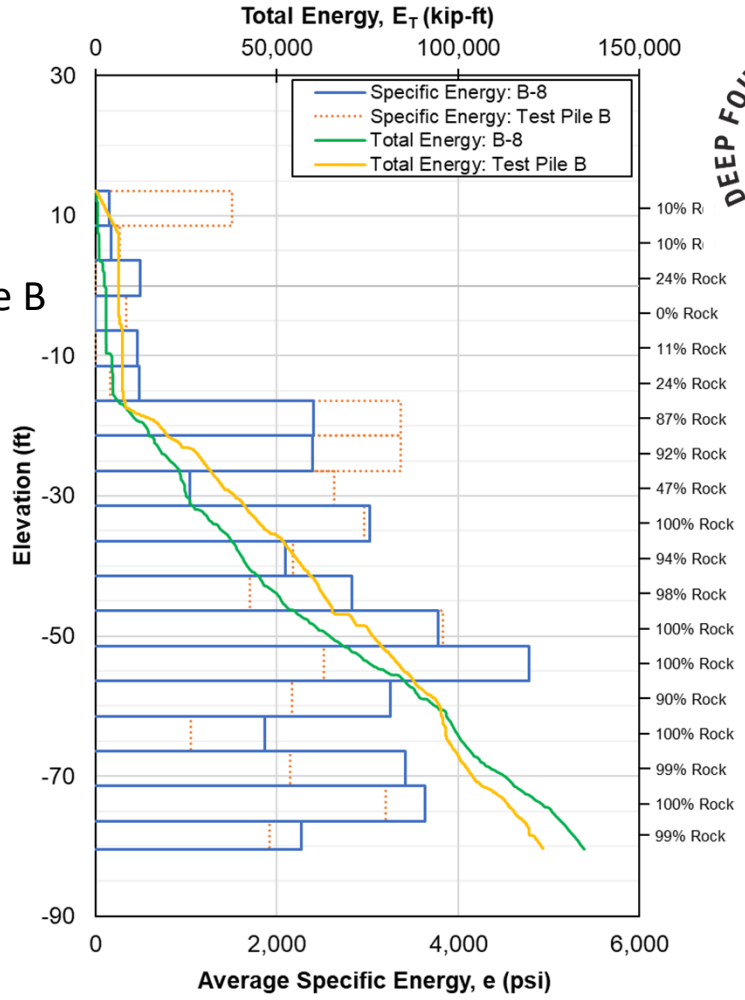


ACIP Pile MWD QA/QC

-Specific Energy & Total Energy-

- Compare production pile to local test pile specific energy
- Production pile B-8 strength profile is compared to Test Pile B strength profile, indicating more total energy than the test pile location

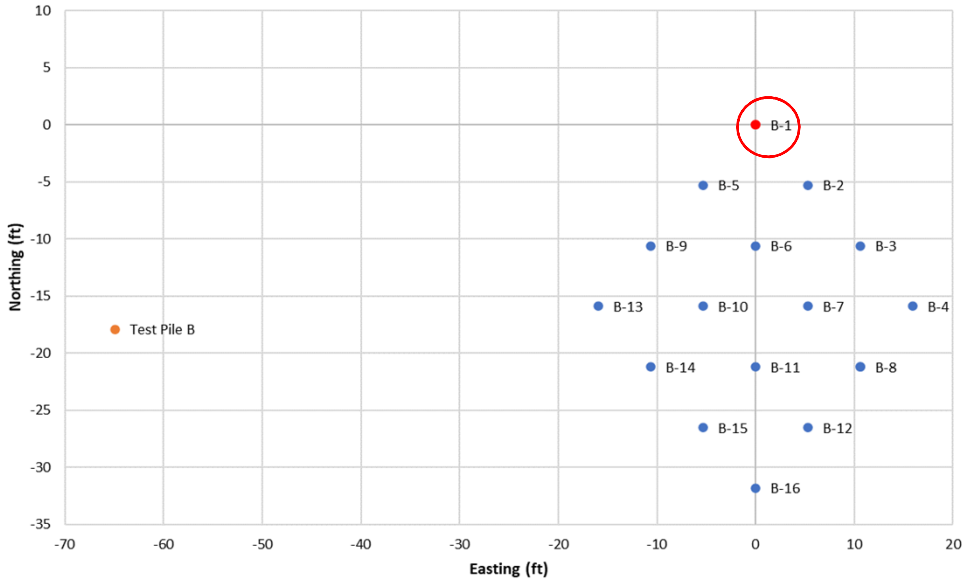


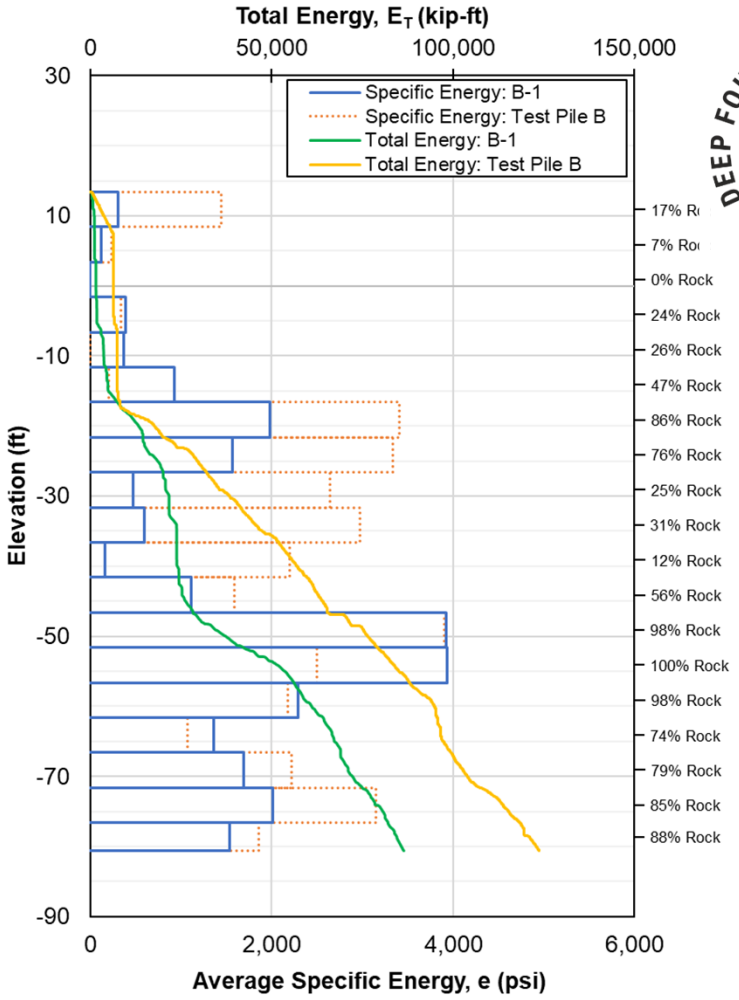


ACIP Pile MWD QA/QC

-Specific Energy & Total Energy-

- Production pile B-1 indicates less total energy than the test pile location
  - UF/FDOT developed and ACIP MWD analysis tool that was useful to quickly evaluate a pile group and determine which pile was selected for verification testing, which was part of the specification language

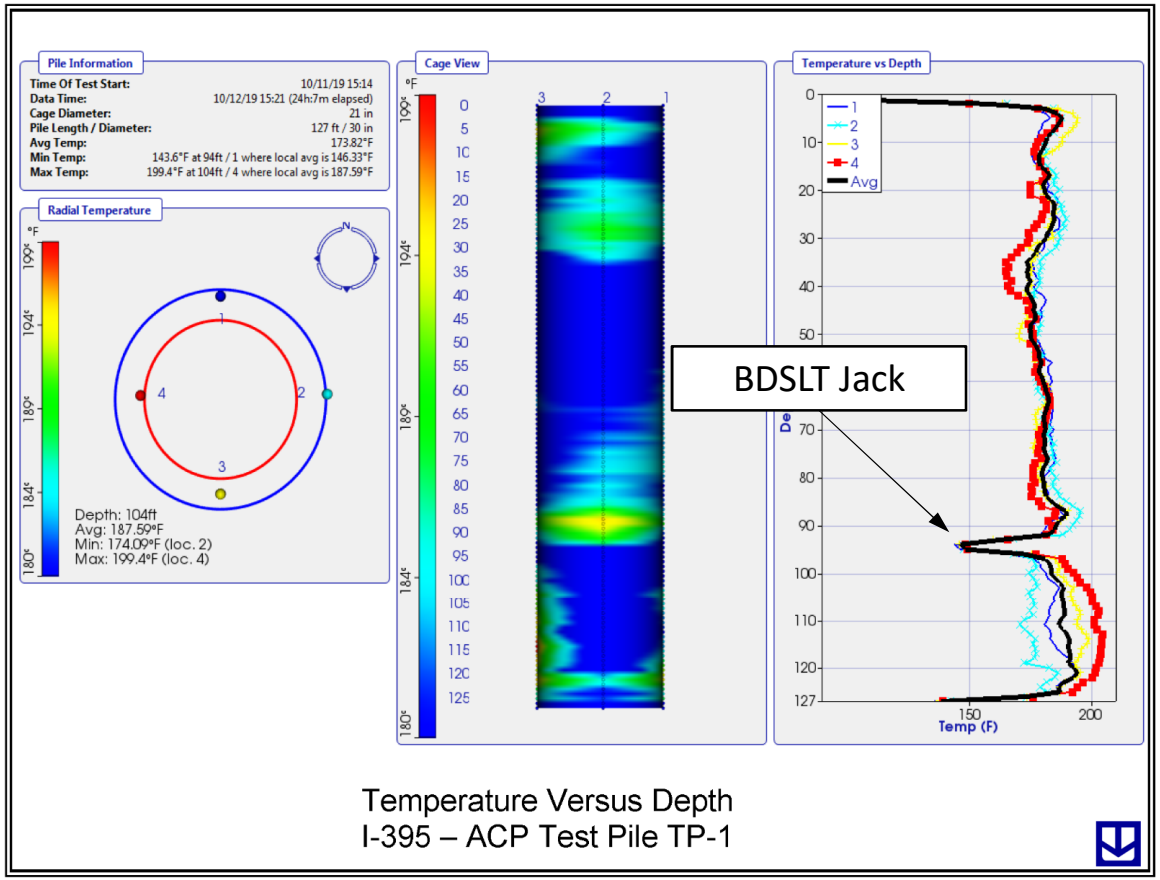




ACIP Pile Testing & Quality Control - Post Construction

- Nondestructive Integrity Test (NDT) Options
  - Low-strain Pile Integrity Test (ASTM D5882)
  - Crosshole Sonic Logging (ASTM D6760)
  - Thermal Integrity Profiling (ASTM D7949)
- Axial Load Testing Options
  - Static Load Test (ASTM D1143 Compressive, D3689 Tensile, D8169 Bi-directional)
  - Rapid Load Test (ASTM D7383 “Statnamic”)
  - High-strain Dynamic Test (ASTM D4945 PDA)

THERMAL INTEGRITY PROFILING



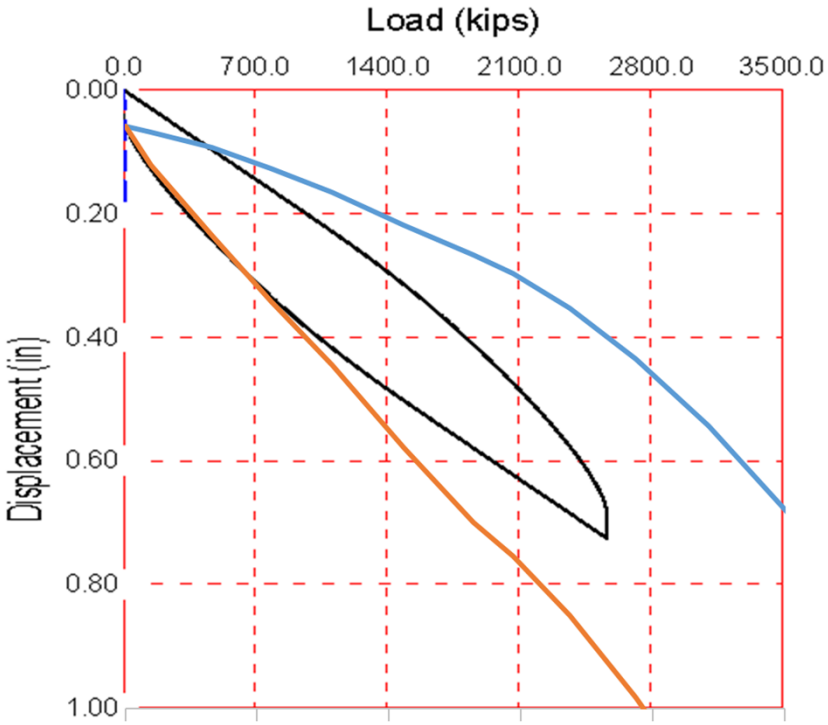
Temperature Versus Depth
I-395 – ACP Test Pile TP-1

Signature Bridge - BDSLT

Signature Bridge – BDSLT Testing

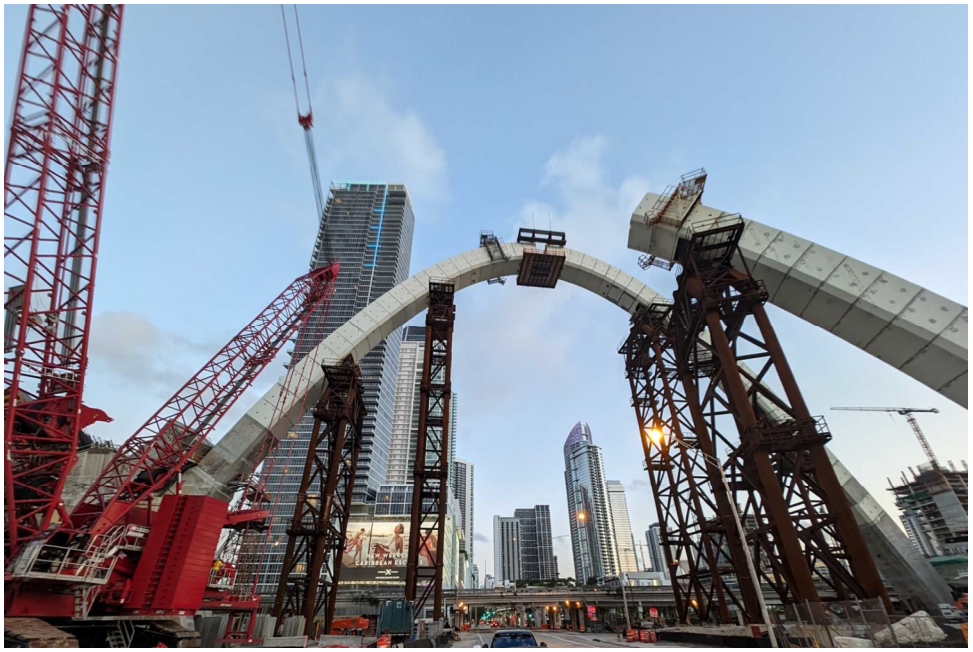
SIGNATURE BRIDGE – LOAD TESTING

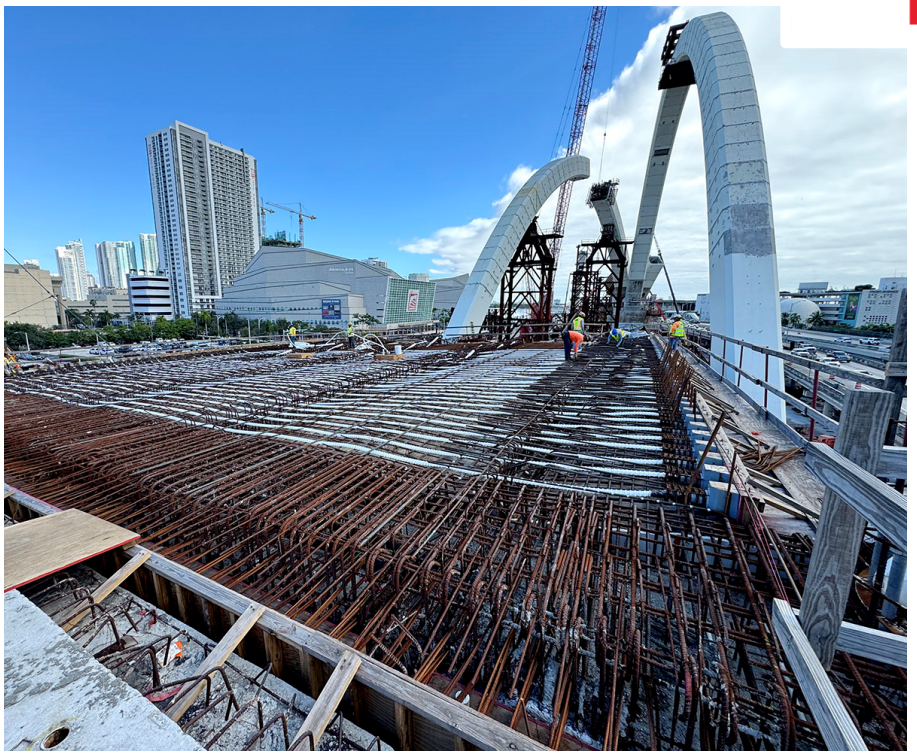
ASTM D7383-19



ASTM D8169-18

Signature Bridge – Current Progress





OTHER PROJECTS

Miami MetroRail – ca. 1979

Other Projects

SR-97 in Roy, UT (UDOT) – Test Program

ASTM D4945-17 Testing

SUSTAINABILITY AND ACIP TECHNOLOGY

- IIJA/Bipartisan Infrastructure Law requires development of a carbon reduction strategy
  - "Facilitate approaches to the construction of transportation assets that result in lower transportation emissions as compared to existing approaches." [§ 11403; 23 U.S.C. 175(d)(2)(B)]
- Carbon reduction strategies: higher strength concrete with longer and more slender shafts can result in carbon savings

SUSTAINABILITY AND ACIP TECHNOLOGY

- Case Study in Carbon Emissions Reduction (Keller project in Florida):
  - High rise residential building founded on sand underlain by limestone

Mix Data

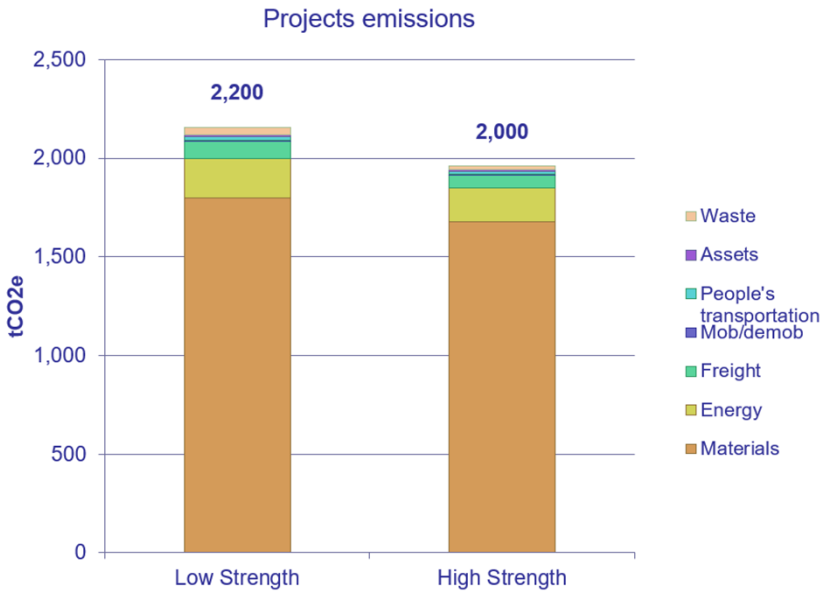
Lab. No.	7262	7263	7264
Cement lbs/cy	475	571	721
Fly Ash lbs/cy	119	143	180
Sand (ssd) lbs/cy	1397	1279	1096
#57 Rock (ssd) lbs/cy	1459	1470	1487
Water Red./Retarder oz/cwt	5	5	5
W/C Ratio	0.50	0.43	0.37
28 Day Avg (psi)	5333	6923	8307

SUSTAINABILITY AND ACIP TECHNOLOGY

- Case Study in Carbon Emissions Reduction (Keller project in Florida):
  - High rise residential building founded on sand underlain by limestone

  - **10% reduction in carbon emissions**
  - 11 days schedule savings
  - 20% cost savings

  - Decreased diameter
  - Increased length
  - Increased concrete strength



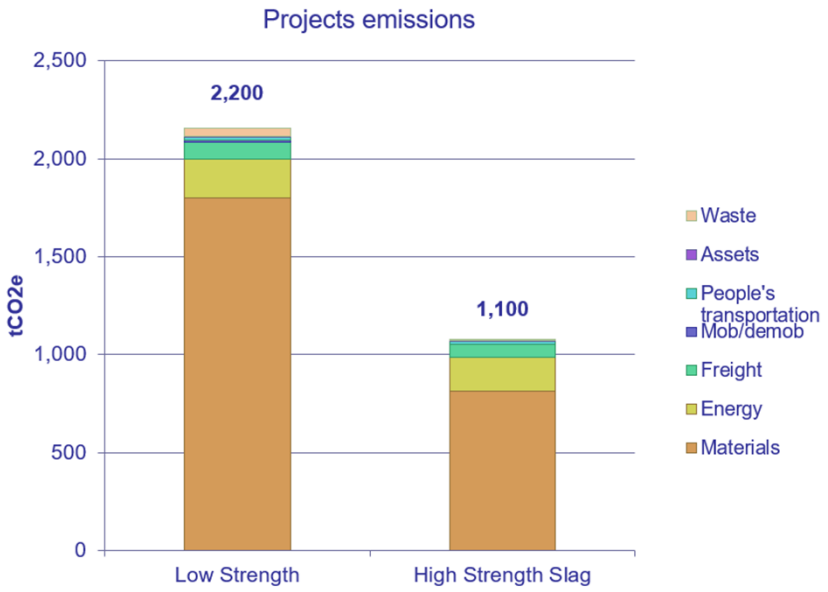
SUSTAINABILITY AND ACIP TECHNOLOGY

- Case Study in Carbon Emissions Reduction (Keller project in Florida):
  - High rise residential building founded on sand underlain by limestone

Explore Slag Cement Substitution

Limestone cement
Slag cement 25%
Slag cement 75%

Slag substitution decreased carbon emissions from materials by 1,000 tons



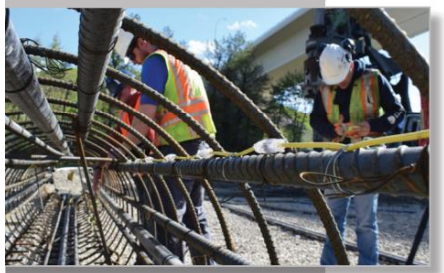
DFI Research Project Call for Data

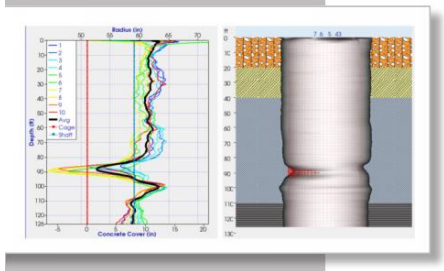
- Collecting Thermal Integrity Profiling (TIP) data
- Data logger and wires provided for free
- Need TIP data, soil boring, and **direct measurements of pile circumference at 4 feet bgs** (measured at multiple points)
- http://bit.ly/ACIP-Request-Form
- http://bit.ly/ACIP-Submission-Form

AUGERED CAST-IN-PLACE AND DRILLED DISPLACEMENT PILE COMMITTEE

Exciting project alert!

We Need Your Help!





DFI's Augered Cast-in-Place and Drilled Displacement Pile Committee is collecting data to evaluate the in-situ grout temperature during pile curing versus pile diameter at specific depths using thermal profiling. The target is to gather enough data from different sites to perform a statistical analysis that would meet the sample number requirement considered necessary for a normal distribution. Sensors are provided at no cost!

We need your help to gather more data!

- Anyone can request a set of wires and a data logger to be used on a test pile. You can request to test as many piles as you'd like at: **https://bit.ly/ACIP-Request-Form**
- Regardless of if you requested wires/data logger, anyone can submit data with the corresponding information:
  - Total pile length
  - Pile circumference measured at several points down to 4 feet below grade
  - AME and/or manual inspection records
  - Local boring/geotechnical data for site
  - Photos of excavated piles
  - Data submission form: **https://bit.ly/ACIP-Submission-Form**

CONTRIBUTORS

- Hannah Iezzoni, P.E. – Keller NA, DFI ACIP/DD Committee Chair
- Jon Sinnreich , P.E. – GRL Engineers (formerly LTC)
- Morgan NeSmith, P.E. – Berkel and Company Contractors, Inc., past Chair