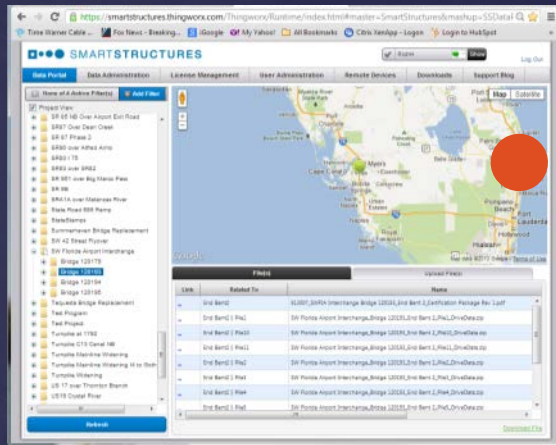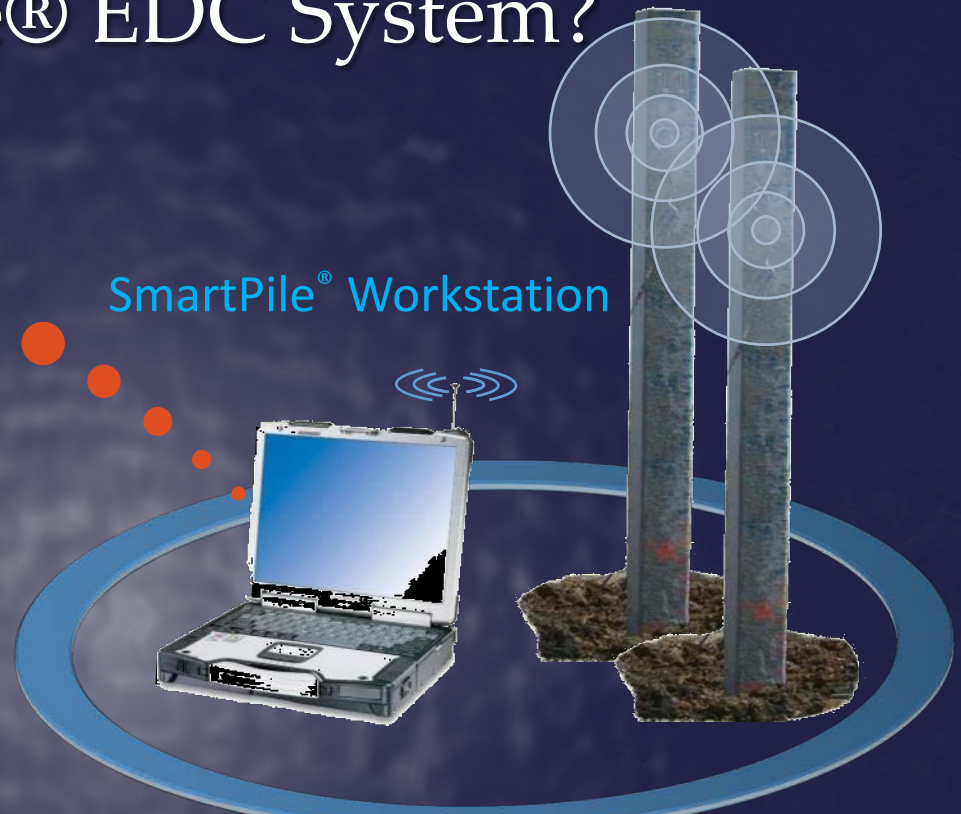# SMARTSTRUCTURES

*advanced sensing and monitoring technology that enables our clients to optimize the design, construction and operation of the nation's transportation infrastructure.*
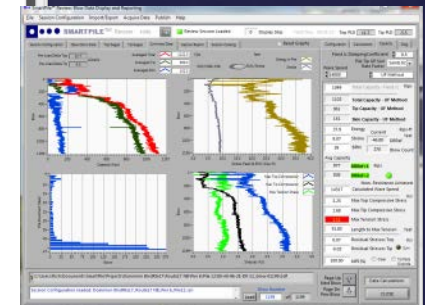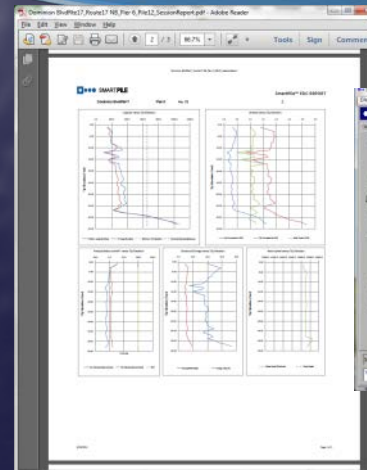
# What is the **SmartPile® EDC System?**



SmartPile® Workstation

- Electronics/Sensors embedded in the pile core at both pile ends

- Wireless communication and data transmission from the pile

- Ruggedized Workstation to collect sensor data in Real Time

- Software to Analyze, Present, and Report

- Data Portal to organize and share results

# Benefits

✓ Owner Confidence – *Measuring* vs. Estimates/Assumptions

✓ *Job Site Safety* – Wireless, Operation Transparent

✓ **Saves money –** *Improves Quality*

# Benefits
## Unique Advanced Damage Detection (early detection saves $$)

Collision Avoidance    – vs. –    Costly Recovery/Replacement

IS-Kanazawa 2012

18 - 20 September, 2012, Kanazawa, Japan

The 9th International Conference on
Testing and Design Methods
for Deep Foundations

Re-evaluation of the method to determine pile damage
using the Beta Method

Verbeek, G.E.H.
*VMS, USA*

Goble, G.
*Goble Pile Test, USA*

"The theoretical review of the method showed clearly that the Beta Method cannot be a reliable indicator of pile toe damage… …the Beta method should not be used to protect against pile toe damage."

 Verbeek, G.E.H. / Goble, G.

It's not about damage being detected, but rather *real damage going undetected!*

# Pile Integrity

- Limitations of damage detection measured at pile top only well documented
- MPI – change in static pre-stress tracking aids in pile damage detection
  - Numerous pile extractions have confirmed results
- Measured wave speed w/o pile end location assumptions – detect onset of / monitor material fatigue during driving
  - Ability to confirm wave speed used for key calculations at the end of drive – **Sensitivity on ultimate capacity results!**
- Ability to assess proper load transfer at pile toe in cases of damage detection – confirm vs. assume performance

# Composite Capacity Realization
## (tip and skin)

- Understanding driving resistance contribution by ***direct measurement*** (%tip vs. %skin)
  - Need to know in two places? Measure in two places!
- Measured static tip resistance - EOID
- Soil Freeze - understanding true skin contribution (only) during restrike – knowing through confirming un-mobilized pile tip (*total capacity = skin capacity with un-mobilized pile tip*)
- Improves quality by preventing potentially damaging and unnecessary overdriving of piles

# Comprehending Composite Capacity (EOD/BOR)
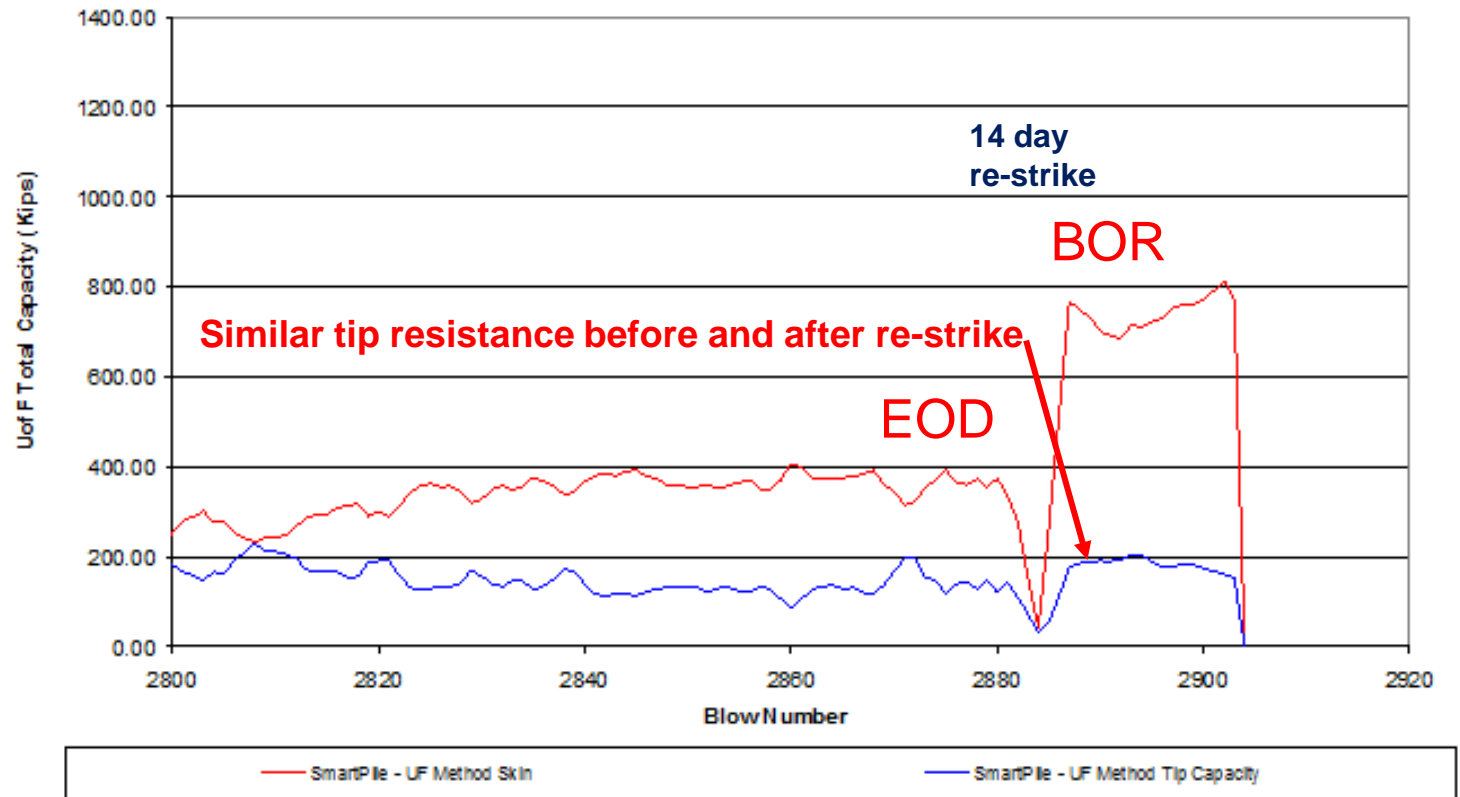
# Beyond Sensors ... Advanced Software Modeling and Analysis Environment



- **Fully Integrated**
- **Common / electronically portable file formats**
- **Closed loop system provides for checks and balances during analysis**
- **Validated Signal Matching (using tip data)**
- **Driving Criteria for Test Piles**

# Validated Signal Matching

- Eliminates estimates, assumptions, and subjective interpretation – measured data driven!

- Signal match performed at pile top, and results validated using pile tip data
    - Validated solution for given pile top and pile tip boundaries
    - Soil model provides initial conditions
    - Results used to better understand and characterize soil properties and behavior
    - *No other approach provides for tip validated results*

- Provides ability to audit capacity results derived from the UF Method

# Conclusion

- A new approach to dynamic testing enabling all structural elements to be efficiently tested during installation
- Owner Advantages over "Top Only" Dynamic Testing:
  - Ability to ***confirm correct wave speed at the end of drive***!
  - Best-in-class damage detection/prevention - It's not about damage being detected, but ***real damage going undetected!***
  - Skin capacity = Total Capacity (with a measured as un-mobilized pile tip)
  - ***Signal Matching results validated using pile tip data!***
  - Estimates, assumptions, and subjective interpretation replaced with measured data!
- It's not about more data, but more reliable data, *providing for checks and balances*, to improve owner confidence