Dynamic Load Testing of Non-Uniform Piles

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Goble Pile Check

Introduction

* DLT field monitoring using CASE method has been in use in the last 50 years (1970 to date), then iCAP the last 10 years.
* Most piles are uniform piles.
* Engineers used to still rely on CASE method in the field, even on non-uniform piles. Most of time successfully (using judgement on CASE JC).

Question: if typically successful, why there is a need for a more reliable method to evaluate non-uniform piles?

The answer is similar to the one below:

The outdated ENR formula had been used for more than 1 century – successfully.
Why there is a need for Dynamic Load Testing (DLT)?

Fun Fact

ENR:

$$Q_u = WH_{(in)}/(s+c)$$

$$Q_a = 2WH_{(ft)}/(s+c)$$

Introduction

This presentation highlights recent advances in DLT Signal Matching Analysis, coded in N_GAPA.

N_GAPA is to be used in the office, similar to CAPWAP – the gold standard, which is for any types of piles (uniform or non-uniform).

However, N_GAPA is so fast and powerful, that it can be done instantly in real pile driving time, hence, iN_GAPA.

Engineers still have ability to fine tune the analyses in the office N_GAPA

Outline of Presentation:

1)Background of DLT Systems
2)Principles of Real-Time monitoring of Non-Uniform Piles
3)Examples of Non-Uniform Piles
4)Conclusion

1)Background of DLT

Dynamic Load Testing (DLT)
Background

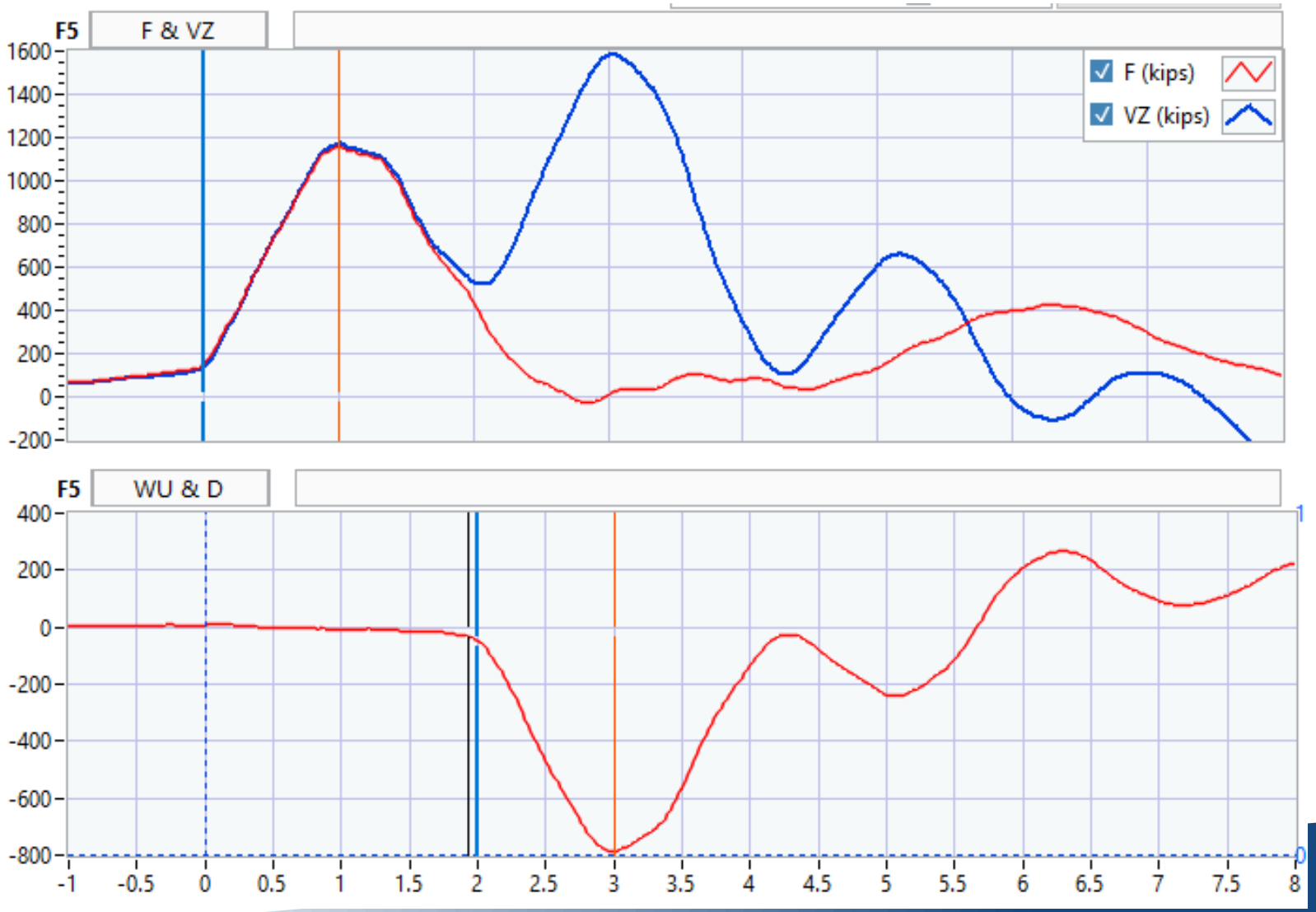
1) **External**
   *Externally mounted
   *Reusable
   *2 to 4 set of gauges
   *1 level only: Top of pile

Video:

Dynamic Load Testing (DLT)
Background

1) External

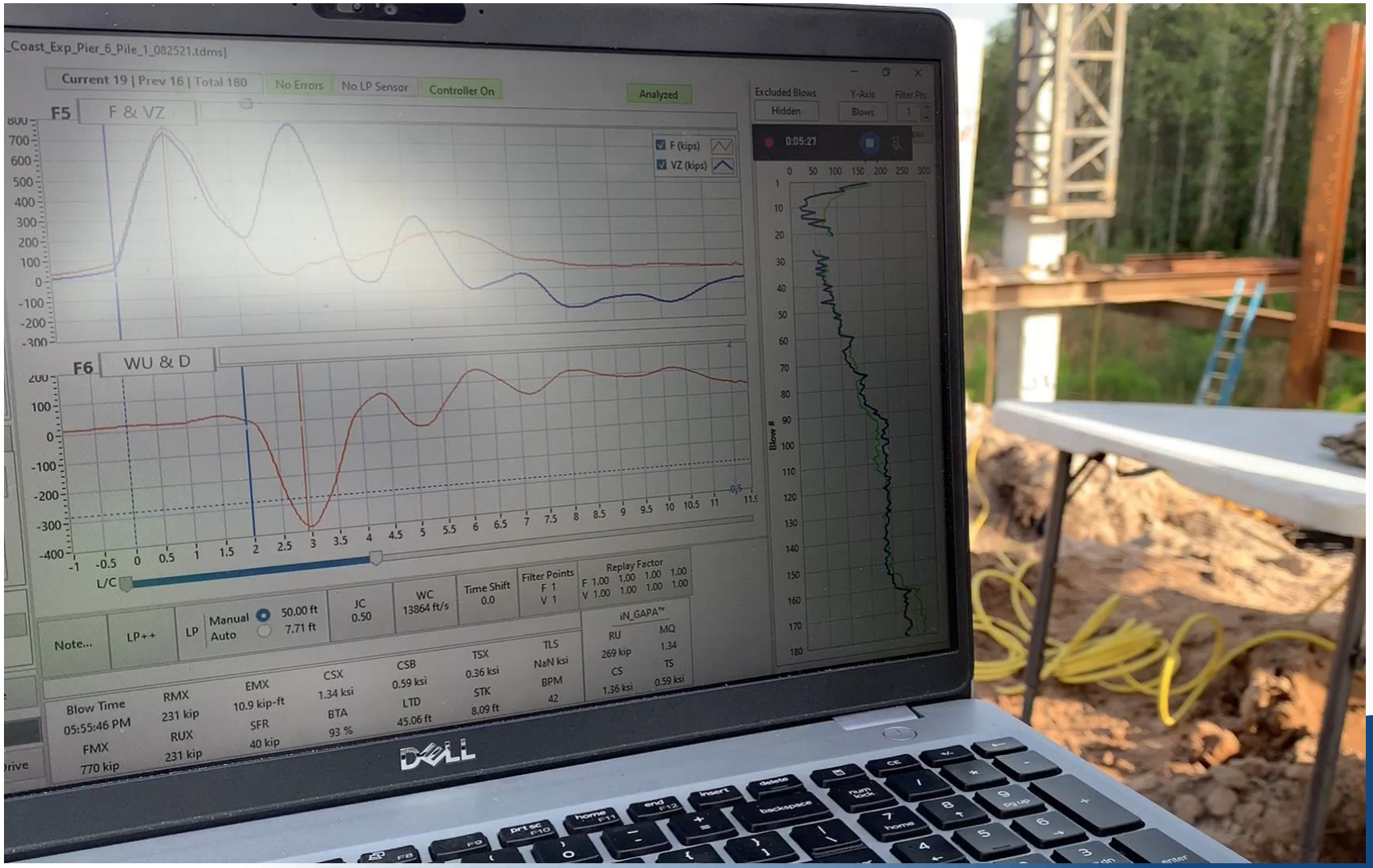
WU



Dynamic Load Testing (DLT)
Background

1) External:

Example video

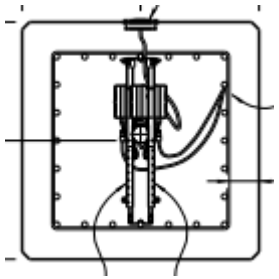


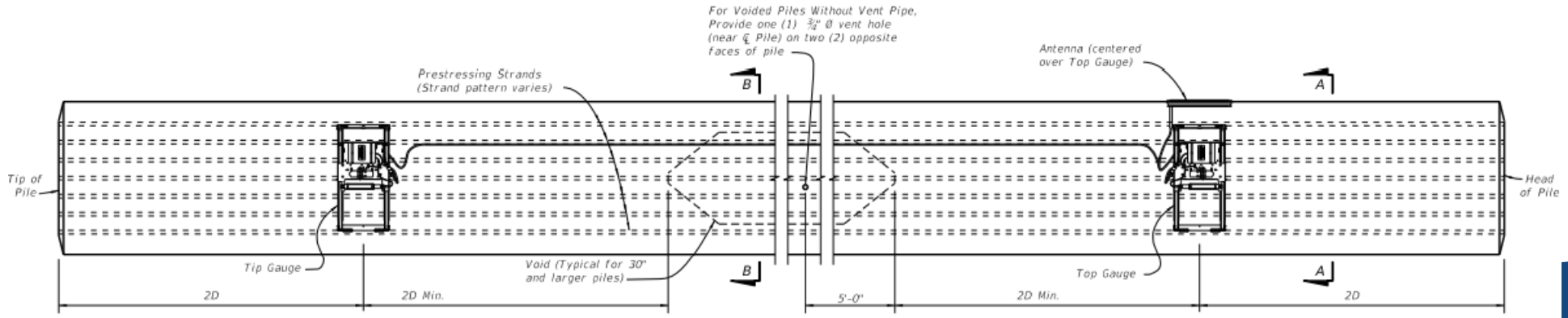
Dynamic Load Testing (DLT) Background

2) EDC (Embedded Data Collector):

- Internally mounted
- Sacrificial
- 1 set of gauge at 1 level.
- Typically 2 levels: Top of pile and Bottom of pile:

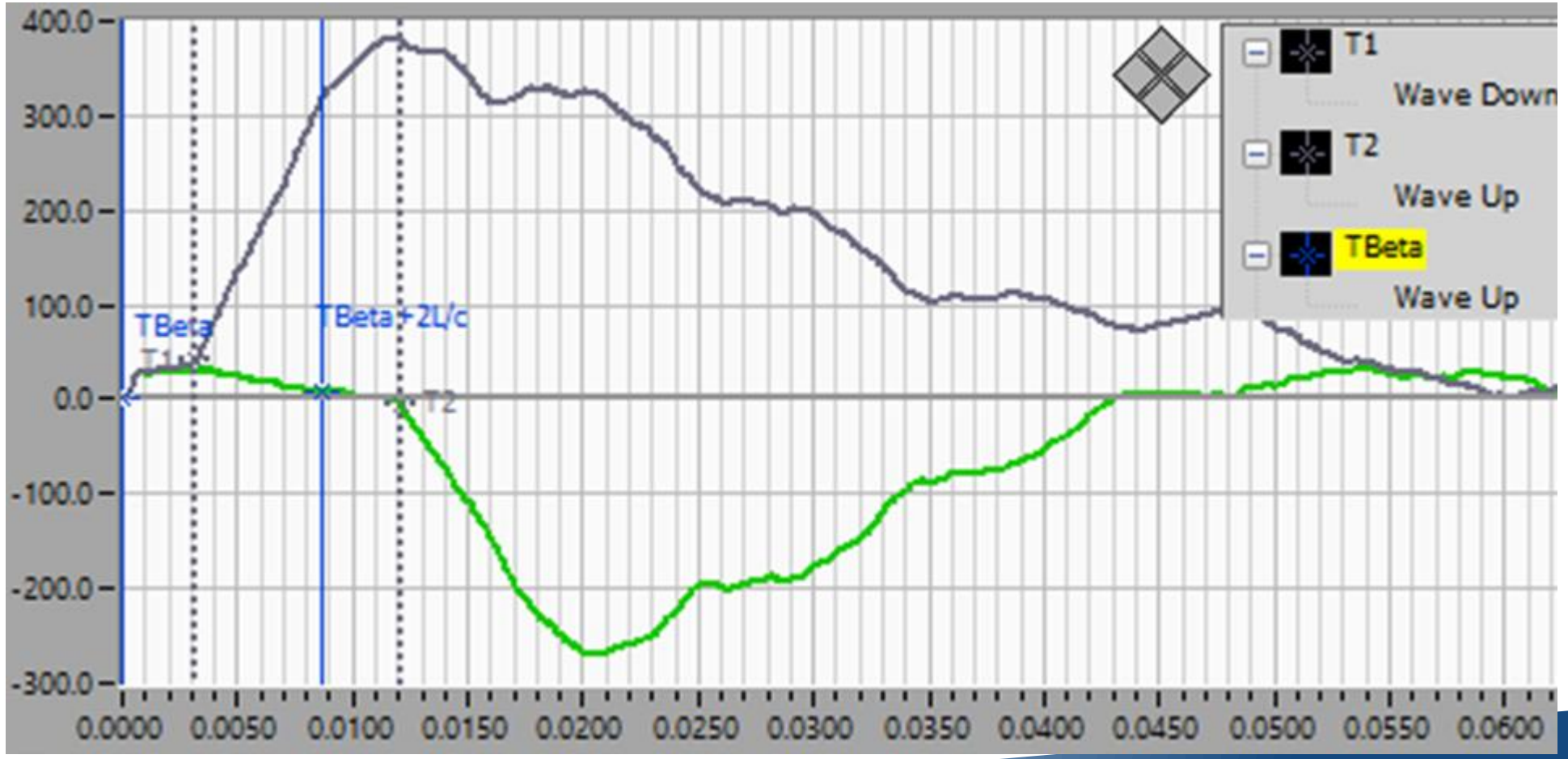
  ⇒ WC automatically calculated based on wave time travelling from Top to Bottom gauges





Dynamic Load Testing (DLT) Background

2) EDC (Embedded Data Collector):



2) Principles of Real-Time monitoring of Non-Uniform Piles

- Signal Match Analyses have been used for decades:

  e.g., CAPWAP – the gold standard, iCAP

  AllWave-DLT

  IMPACT

  Pile configurations (i.e., non-uniform properties) are entered after data collection.

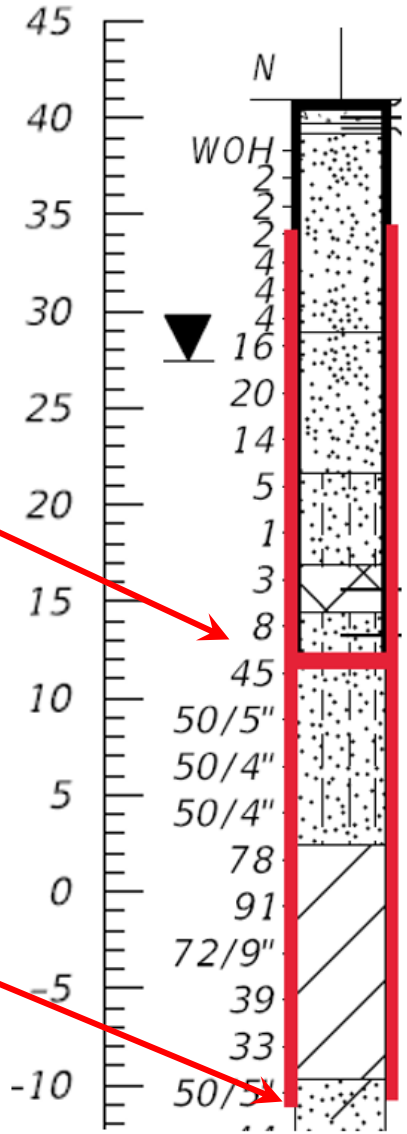
  Therefore, instant (real-time) is not available for non-uniform piles.

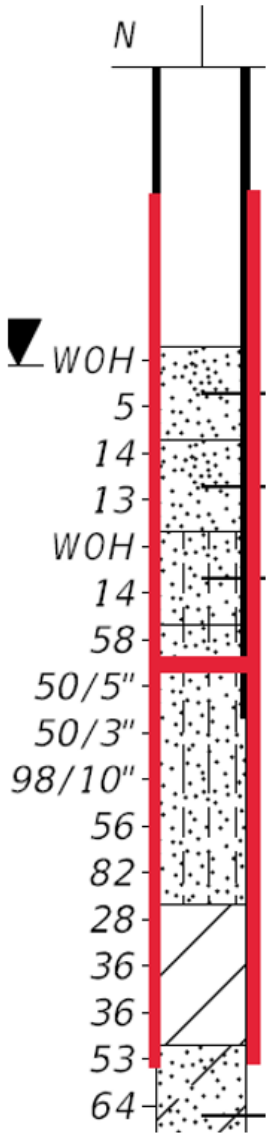
- New Signal Match program (N_GAPA): Pile configurations (i.e., non-uniform properties) are entered prior to data collection, allowing each blow to be **analyzed instantly** for non-uniform piles. N_GAPA and iN_GAPA are the same. Users can manually improve signal match analysis using N_GAPA.

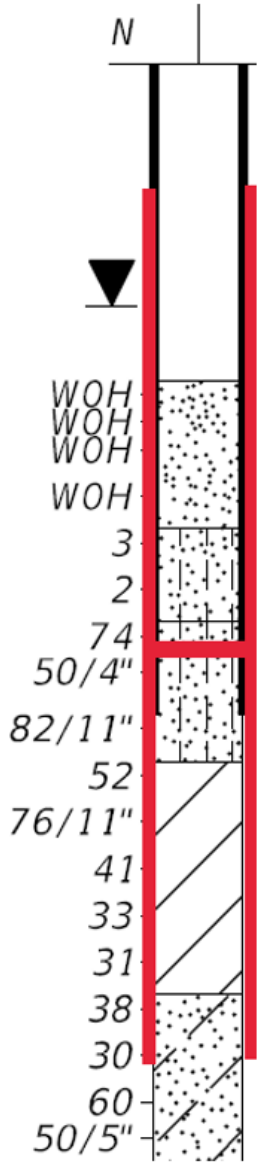
3) Non-Uniform Pile Examples

Examples of Non-Uniform Piles - 1. Steel Pipe Piles

- To have higher bearing capacity due to the additional end bearing at the “restrictor plate”
- To achieve minimum tip elevation at the open toe (which not possible to drive a closed-end piles that deep).





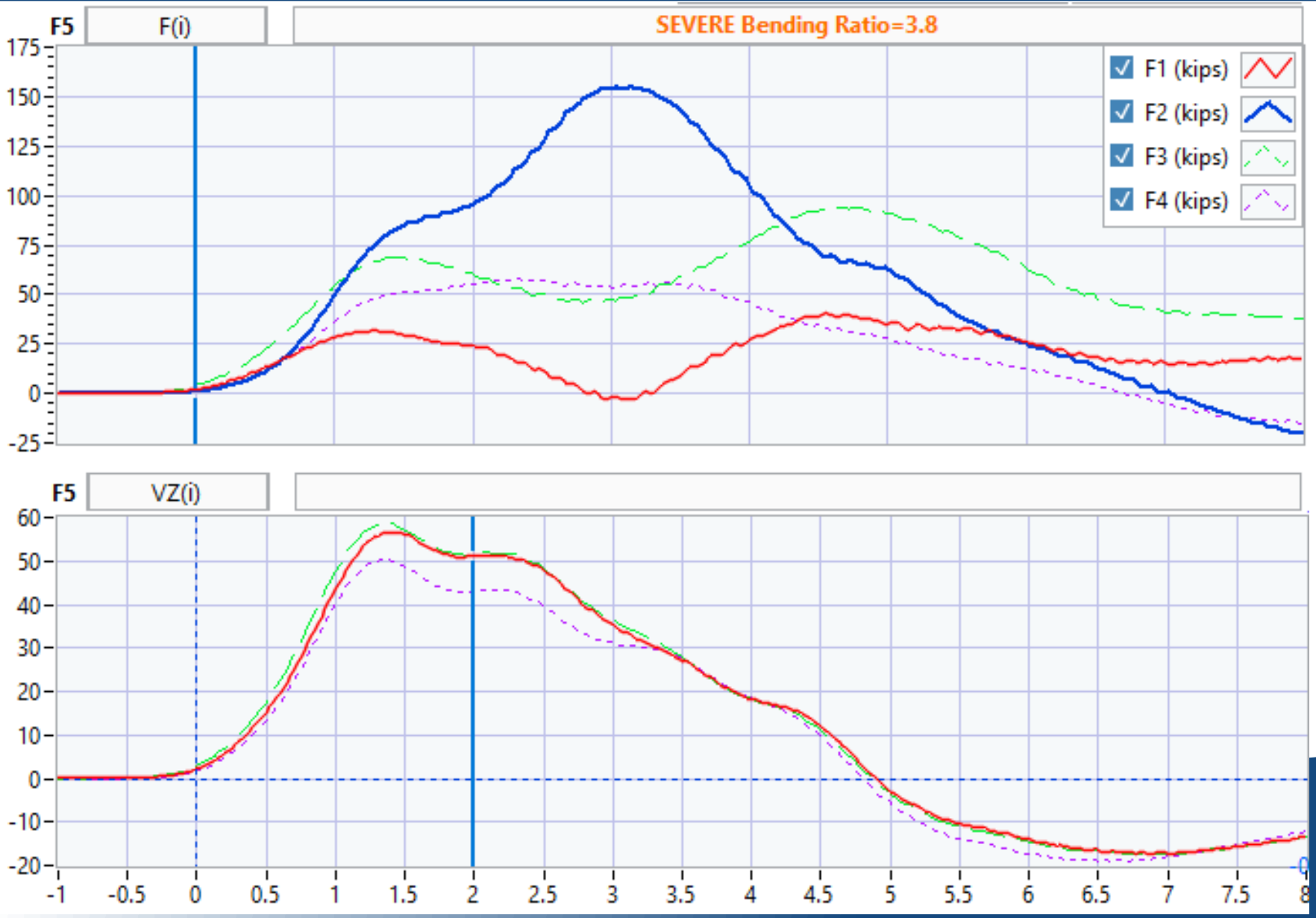


Examples of Non-Uniform Piles - 2. Timber Piles (video)

- Tapper diameter (head/butt is typically 2 to 6 inches larger than toe
- Pile is of heterogeneous property (i.e., grain of the timber not uniform) which may require 4 strain gauges instead of 2.

Examples of Non-Uniform Piles - 2. Timber Piles

4 strain gauges indicate very different individual forces (due to heterogeneous load transfer along the timber grains)



3) Stinger Piles

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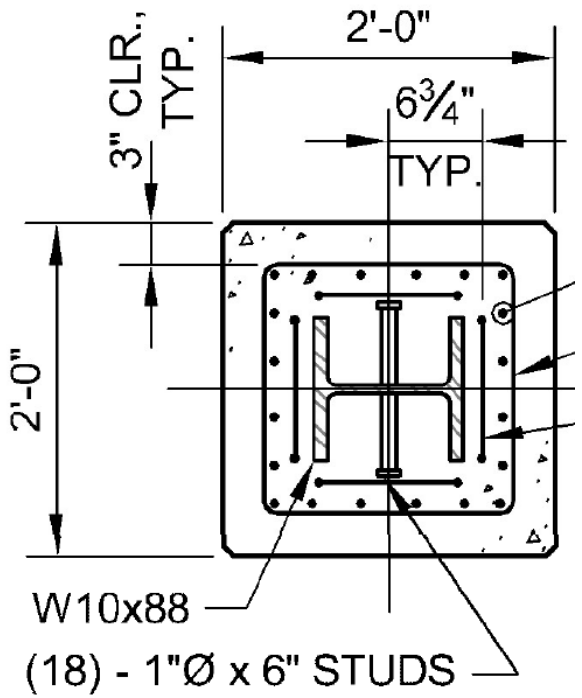
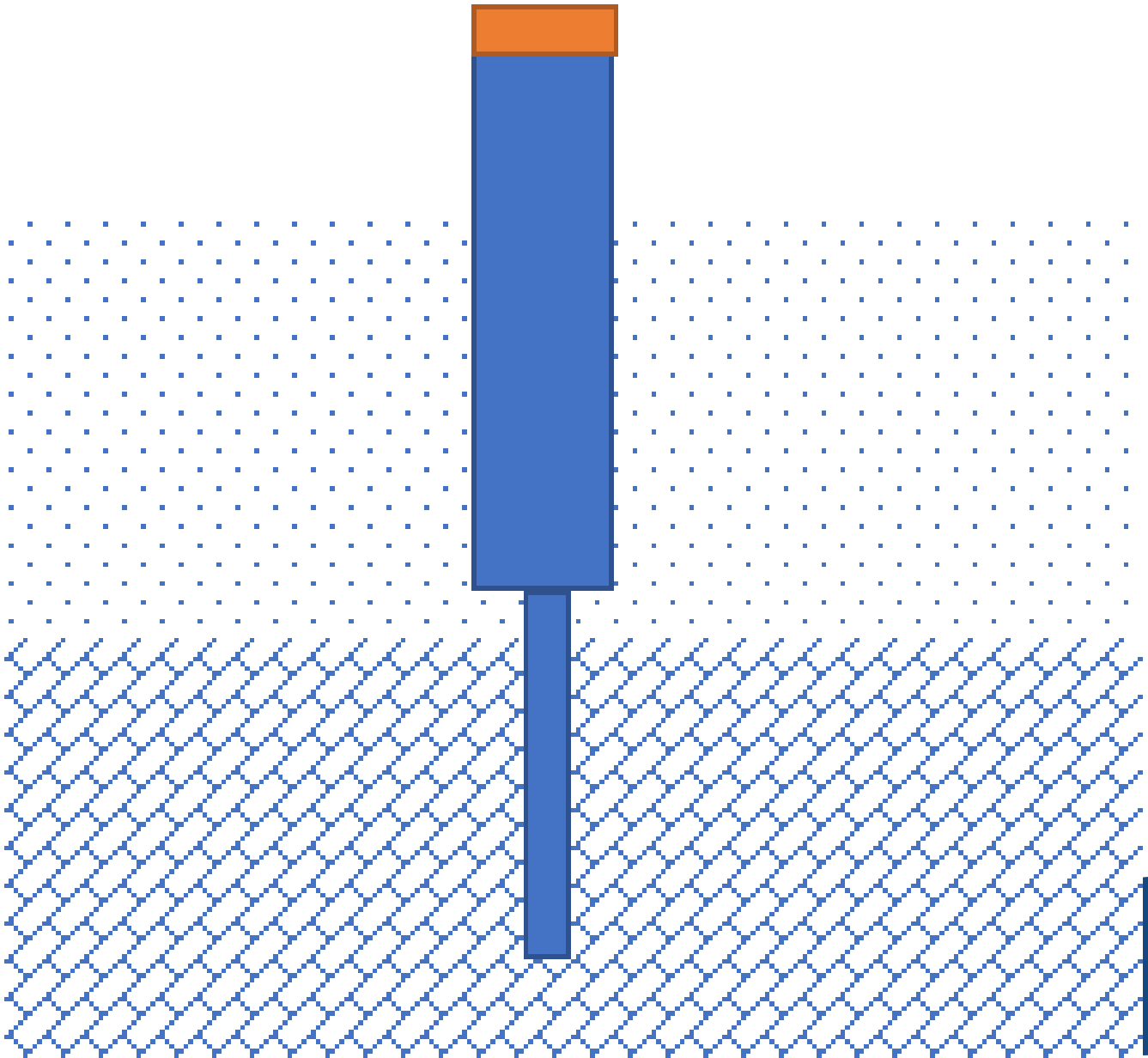
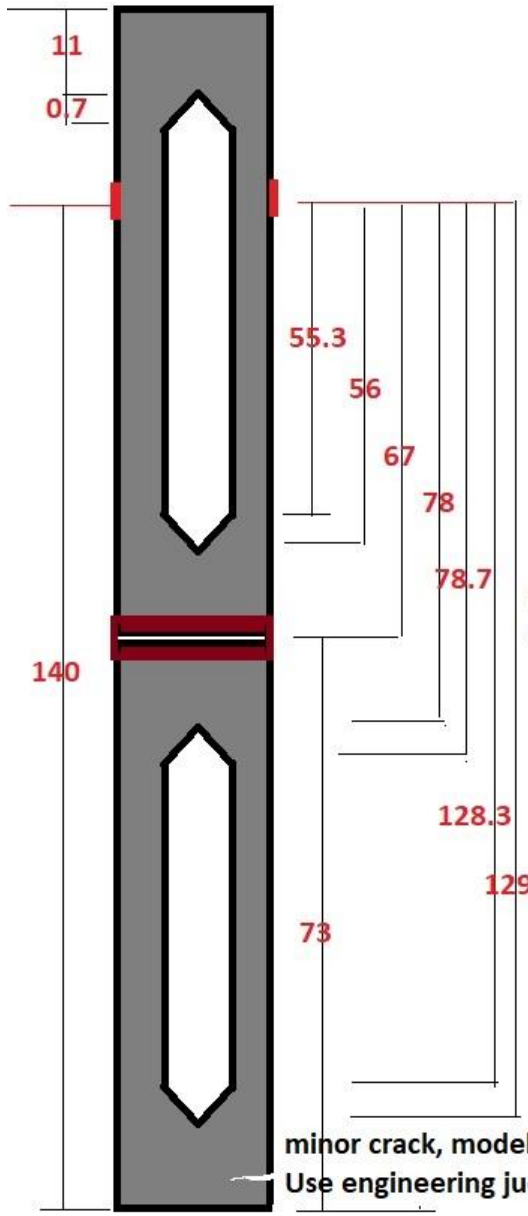




$$A_{pile} = 576 \text{ in}^2$$

$$A_{stinger} = 26 \text{ in}^2$$

Examples of Non-Uniform Piles - 4) 30-in Concrete Pile



When WU encounters impedance increase at 56', the WU will rise up

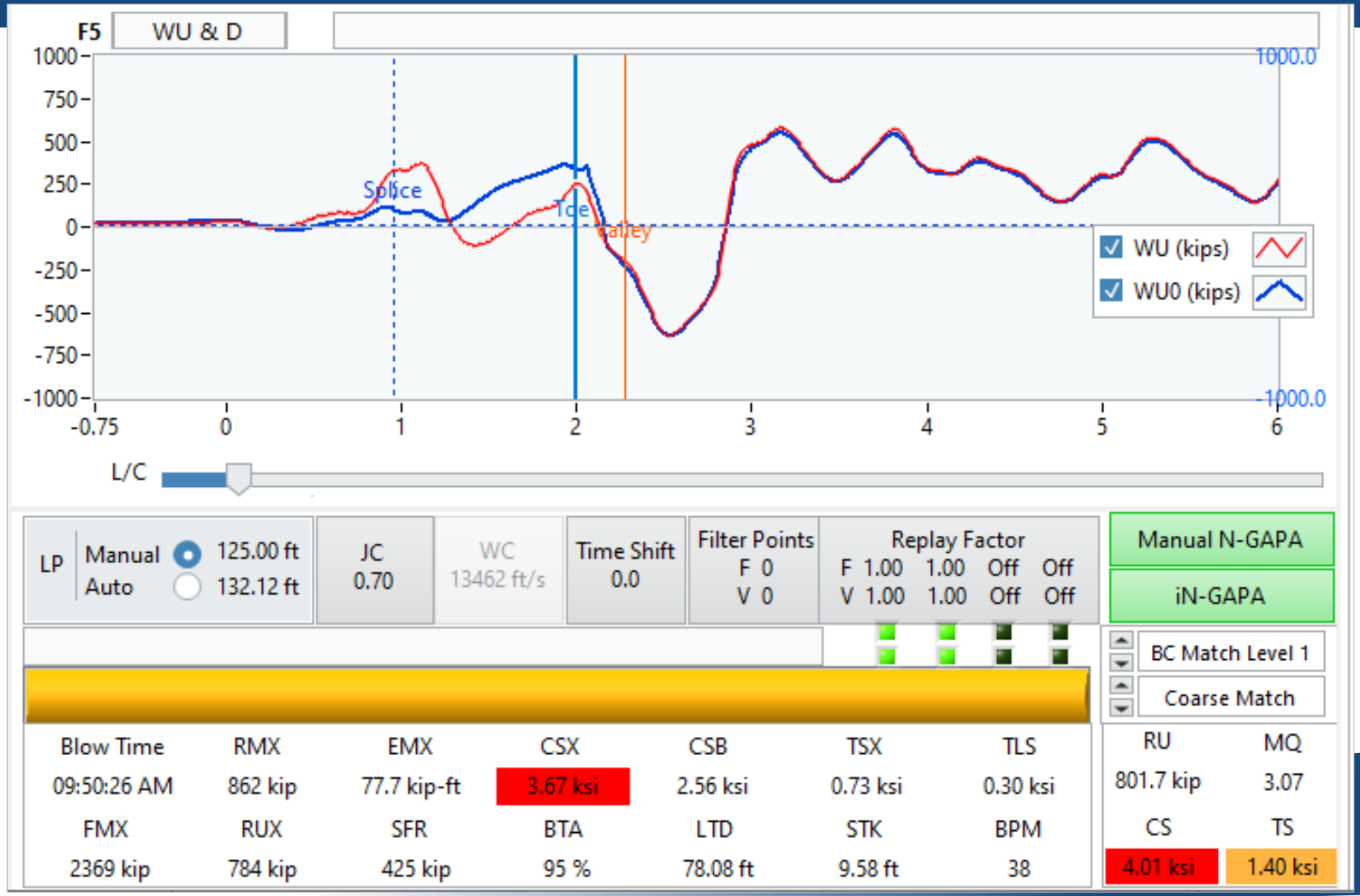
When WU encounters both impedance increase (steel block of the SureLock or KieLock mechanical splice) and impedance decrease (splice gap), it is extremely difficult to model.

WU then drops down when encountering the void

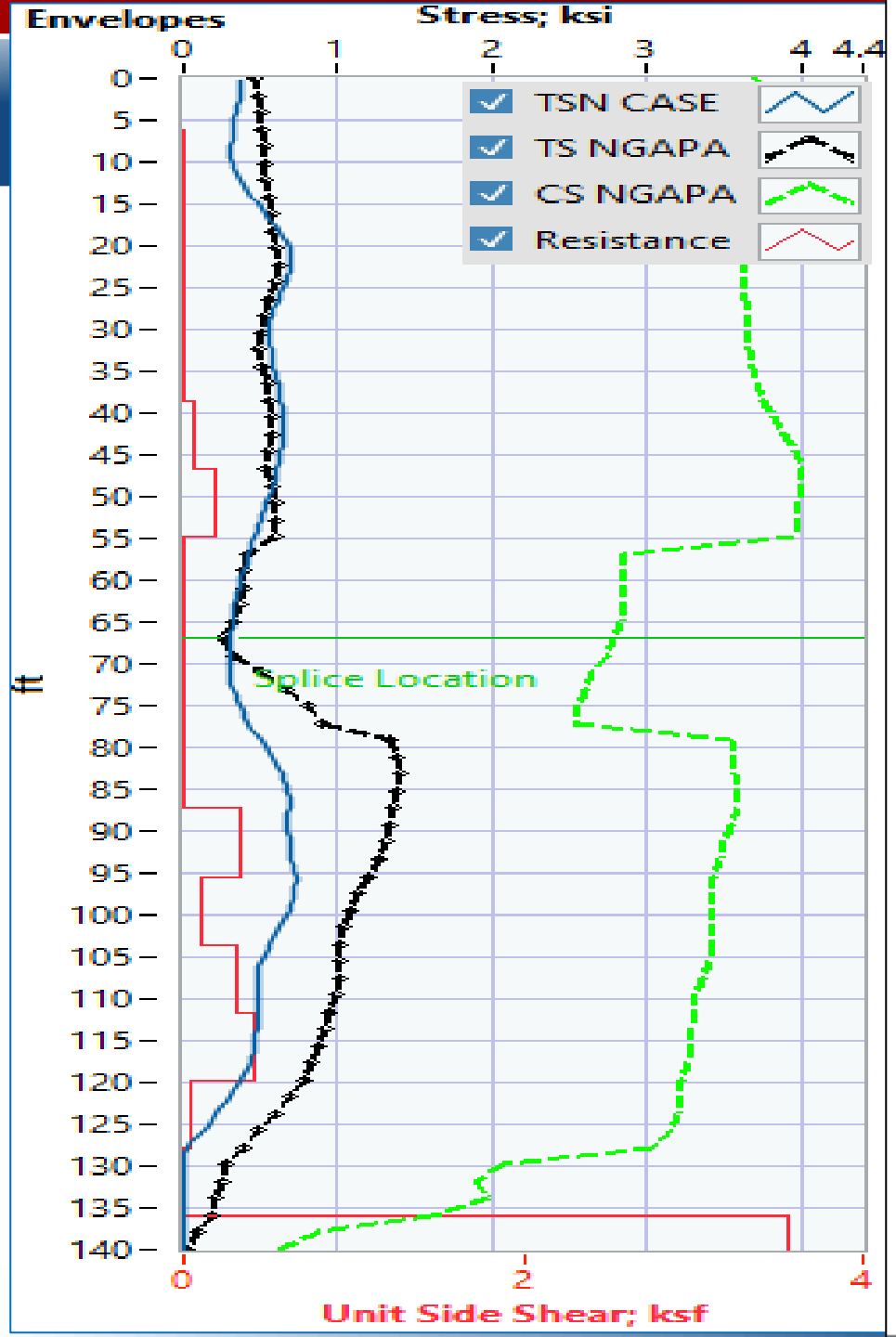
and rise up when going from the voided section to the solid section

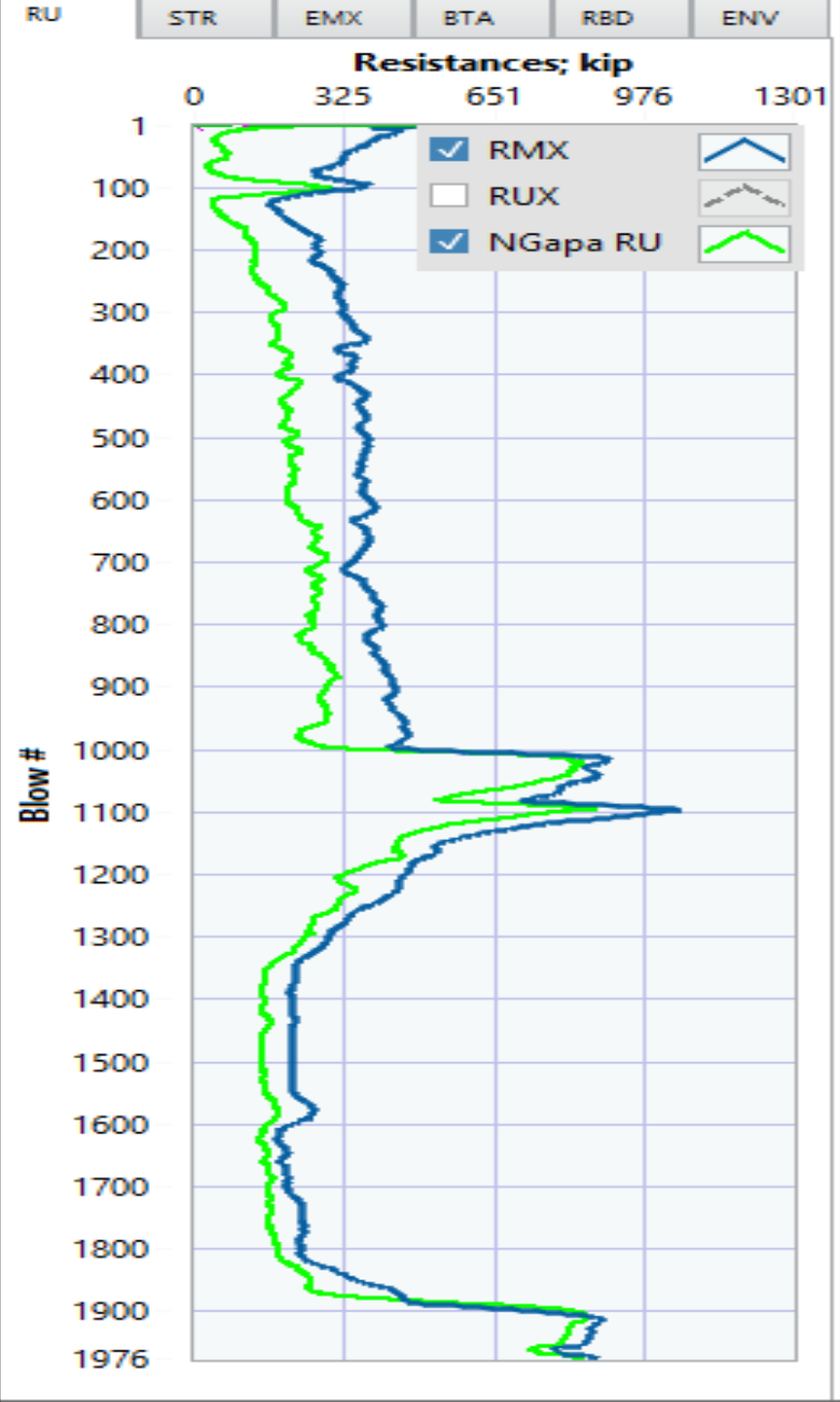
minor crack, modelled by compression slack. User should not use full RU reported by Signal Match. Use engineering judgement to reduce the availability capacity.

Examples of Non-Uniform Piles - 3) 30-in Concrete Pile



3) 30-in Concrete Pile





Summary

1. Use of 8-channel system (i.e., 4 strain gauges) when needed
2. Enter non-uniform pile configuration before pile driving
3. Real-time monitoring of stresses/ capacities is now possible on non-uniform piles

Thank you !

Questions ?