Creating Value …

… Delivering Solutions

Innovative Geotechnical Solutions for Replacement of the Milton-Madison Bridge

Bart Asher, P.E., P.L.S.
Kentucky Transportation Cabinet

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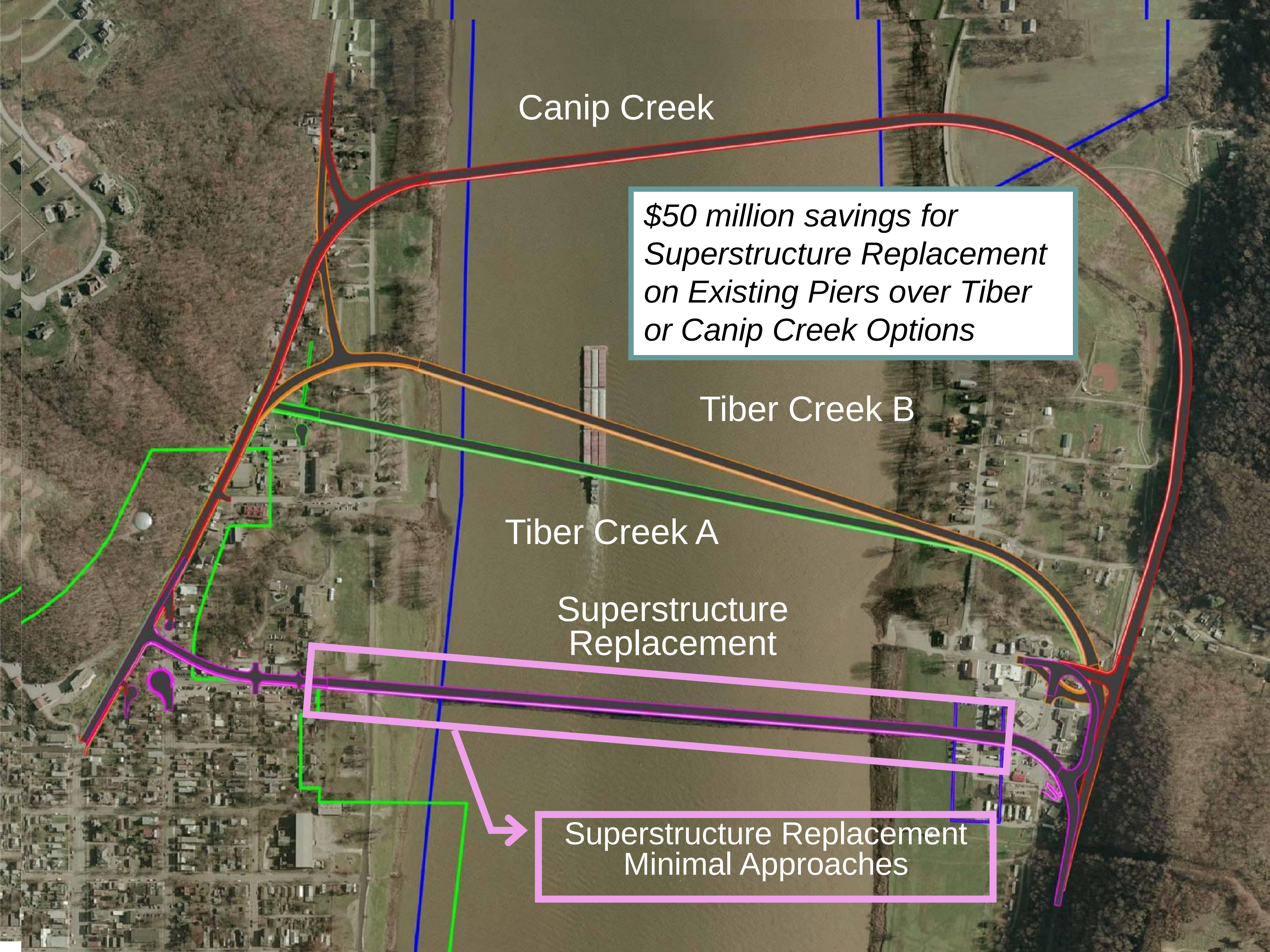
Michael Baker Jr., Inc.

KENTUCKY TRANSPORTATION CABINET

Baker

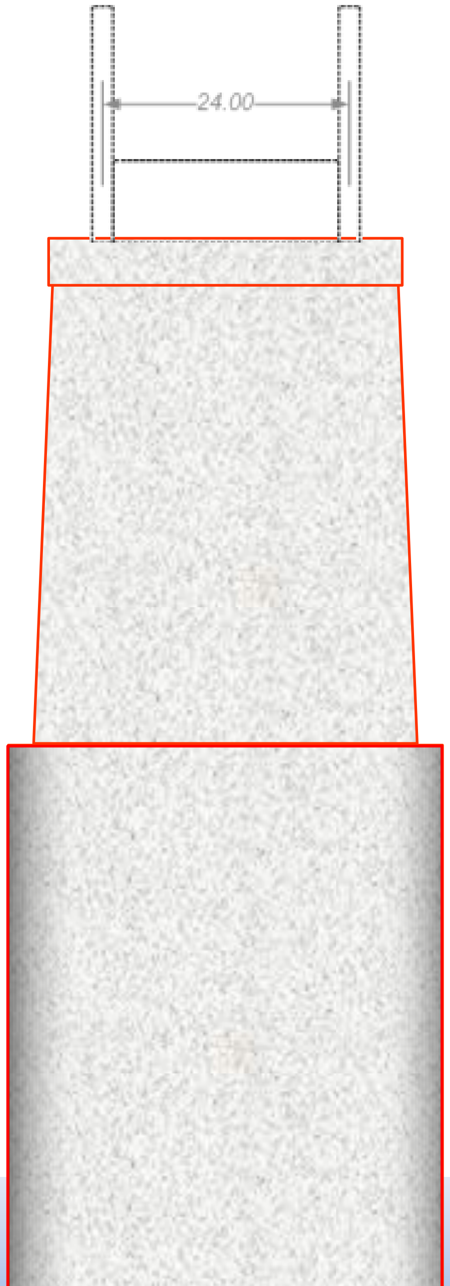
Project Location


Canip Creek
$50 million savings for Superstructure Replacement on Existing Piers over Tiber or Canip Creek Options
Tiber Creek B
Tiber Creek A
Superstructure Replacement
Superstructure Replacement Minimal Approaches

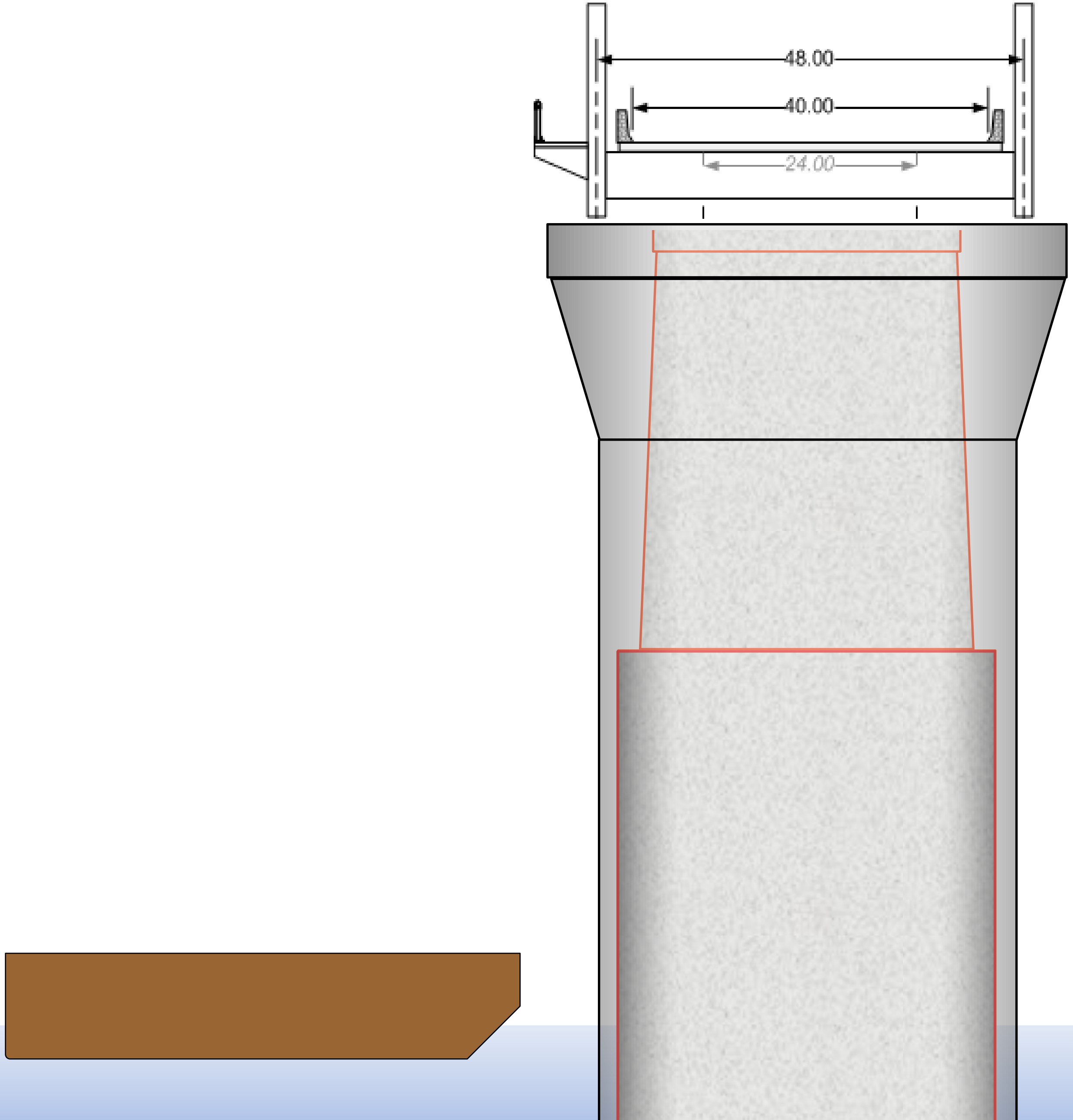
Existing Bridge

Proposed Bridge

Pier Cap Widening



Pier Cap Widening



Subsurface Investigation

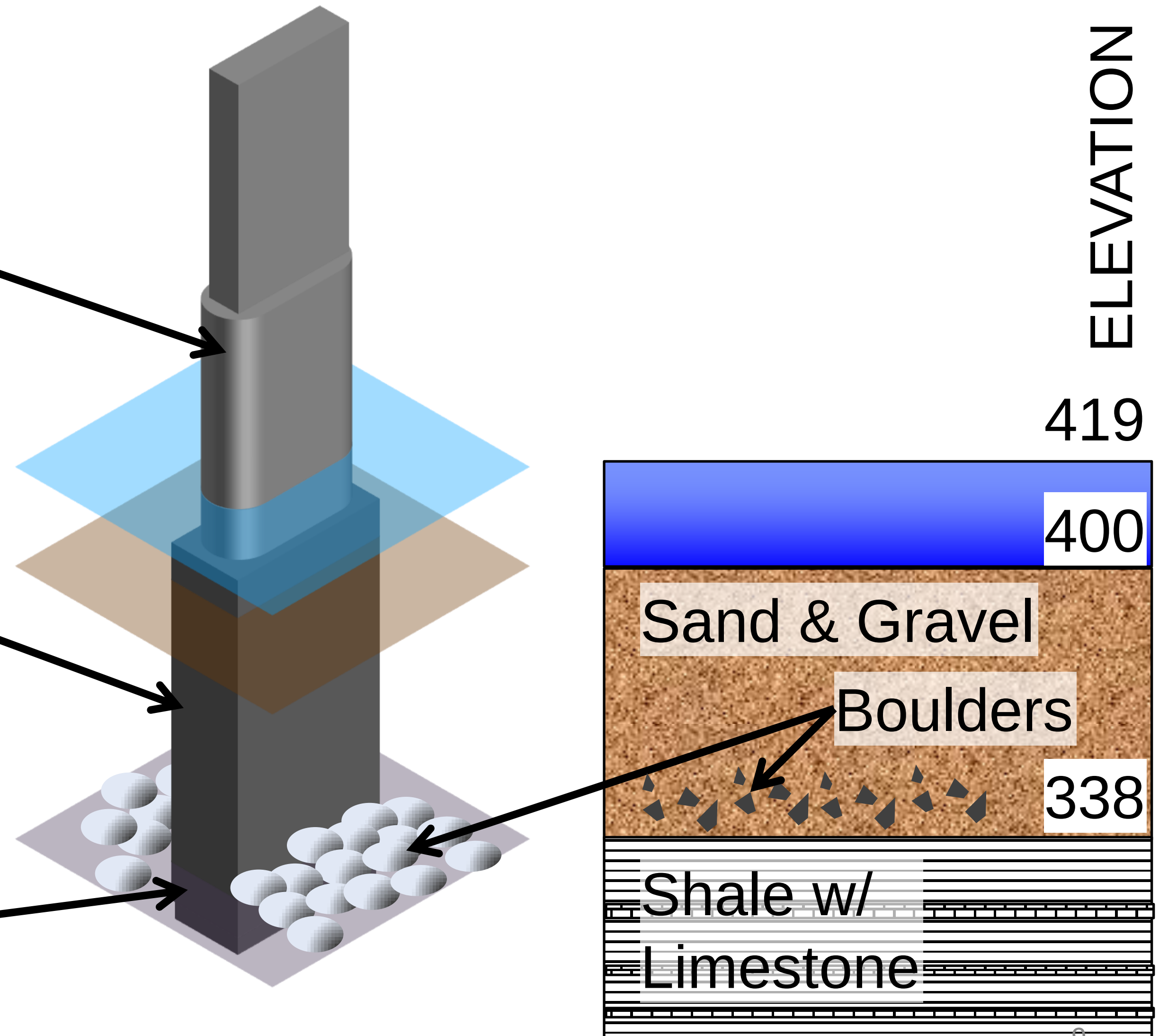
← Drilling Through Existing Pier

Typical Existing River Piers

Reinforced Pier Stem dowelled 12’ into caisson

Un-reinforced Caisson

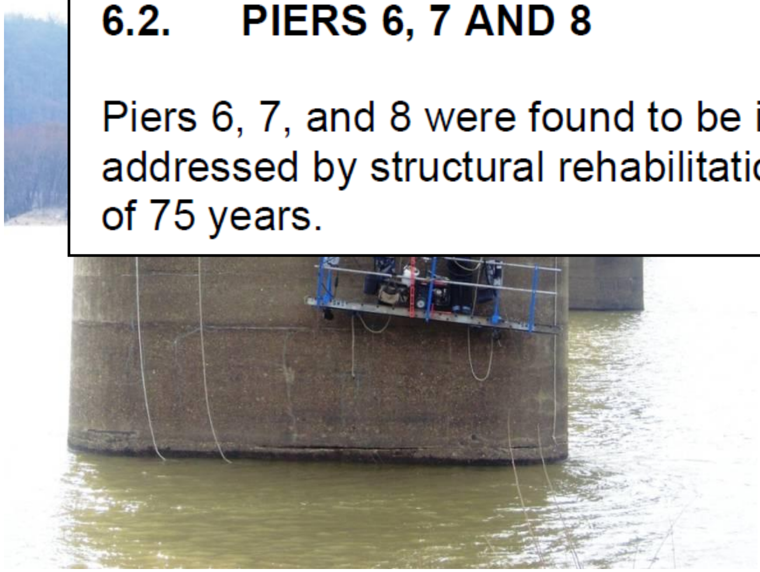
Un-reinforced Rock Socket 1.7’-6.7’ deep

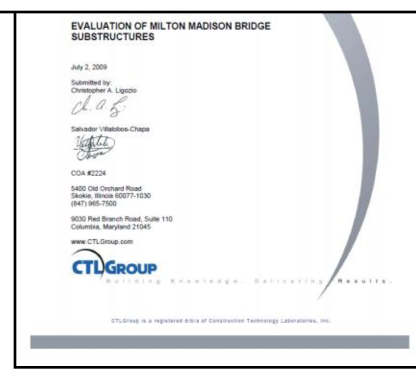


Existing Pier Evaluation

6.2. PIERS 6, 7 AND 8

Piers 6, 7, and 8 were found to be in generally good condition. All noted vulnerabilities will be addressed by structural rehabilitation necessary, resulting in a remaining service life in excess of 75 years.





EVALUATION OF MILTON MADISON BRIDGE SUBSTRUCTURES

July 2, 2009

Submitted by:
Christopher A. Ligozio

Salvador Villalobos-Chapa

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SERVICE LIFE EVALUATION OF MILTON MADISON BRIDGE RIVER PIERS

December 18, 2009

Submitted by:
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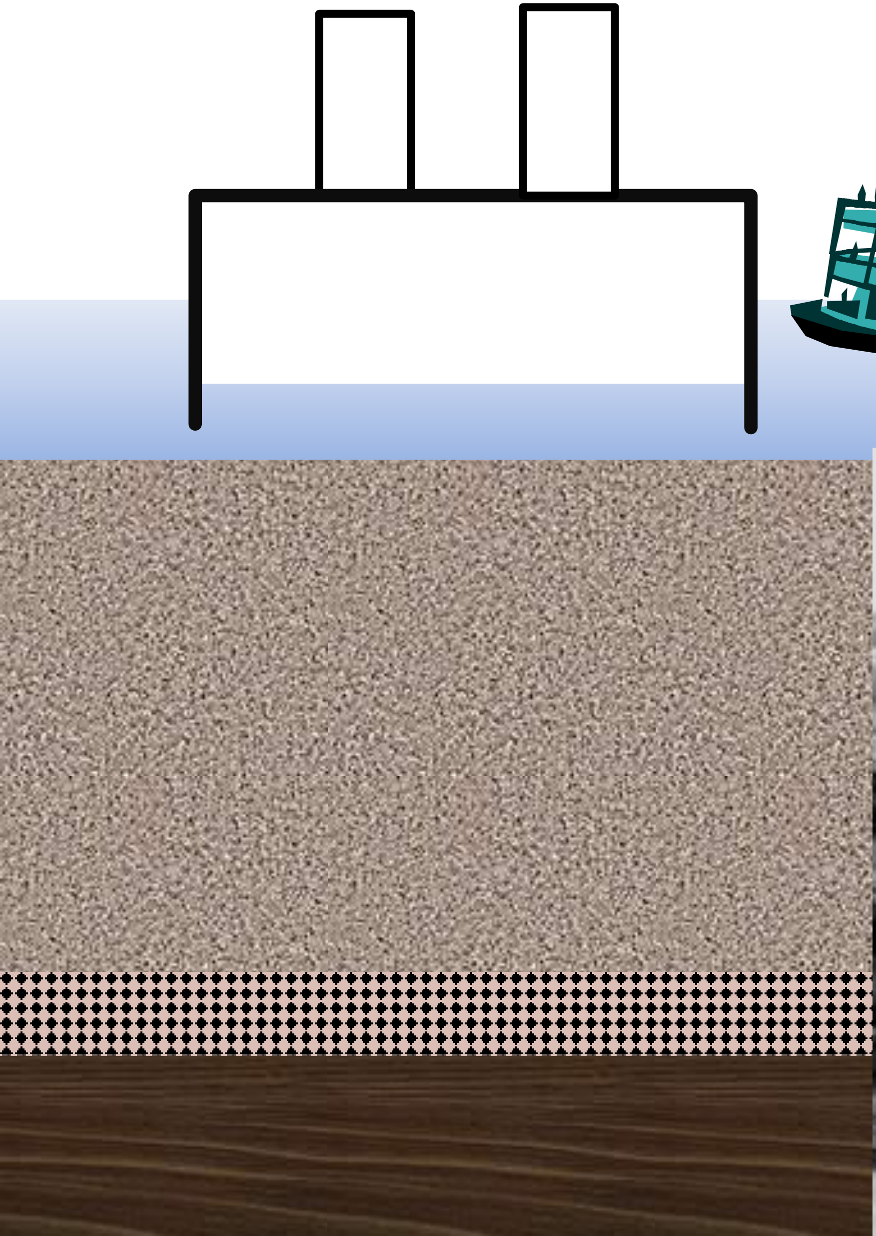
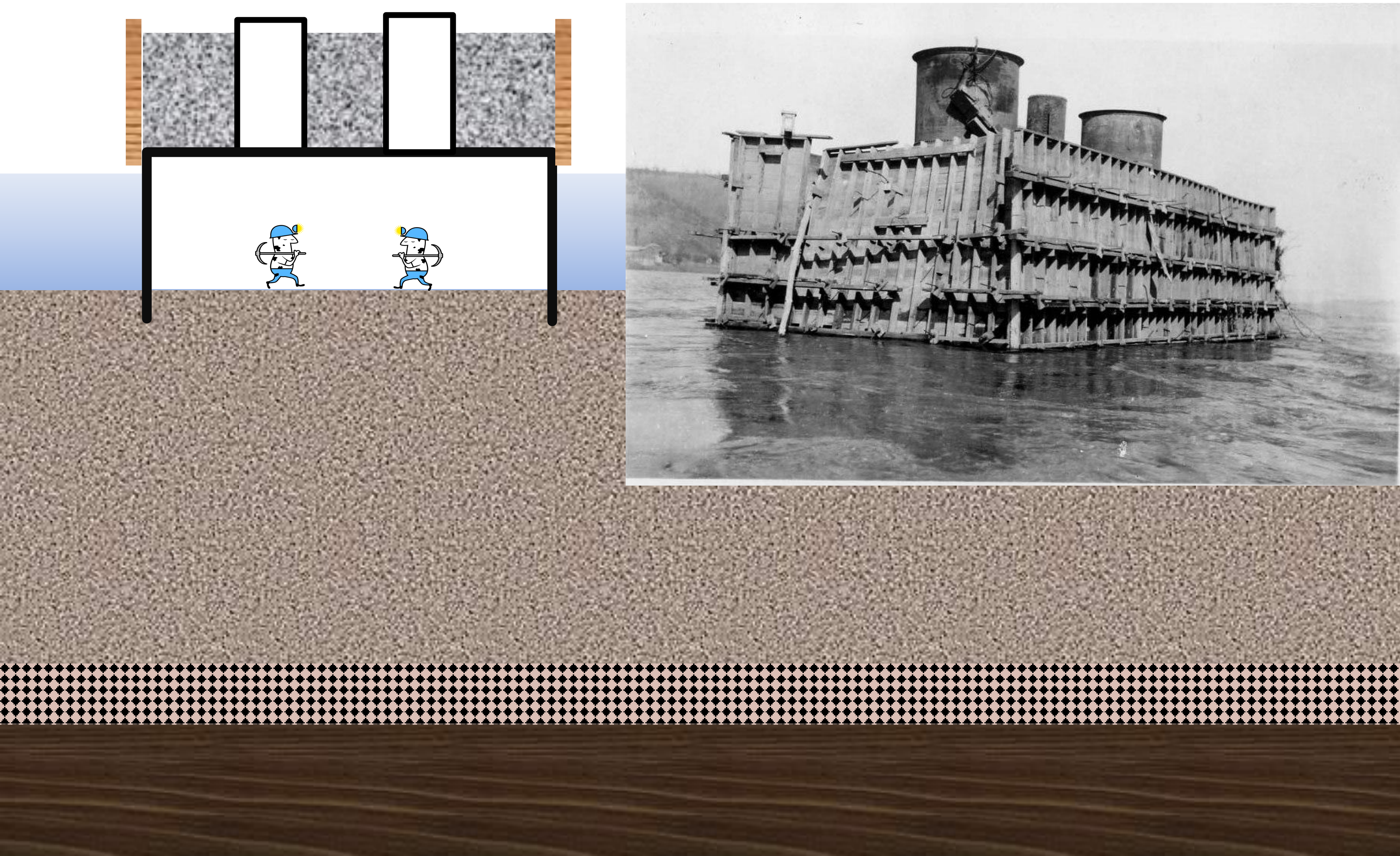
REVIEW DRAFT

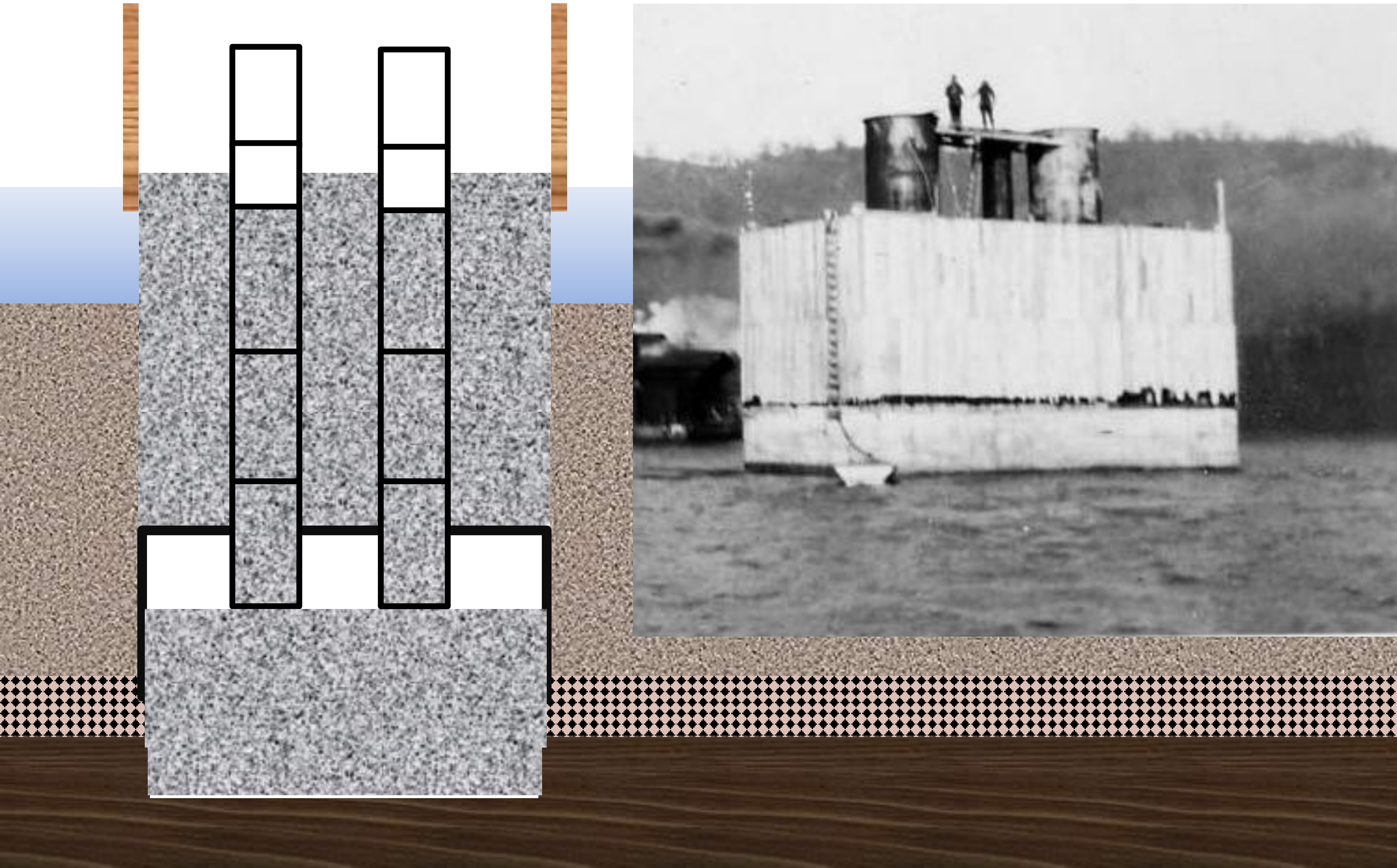
Pier Construction Methods



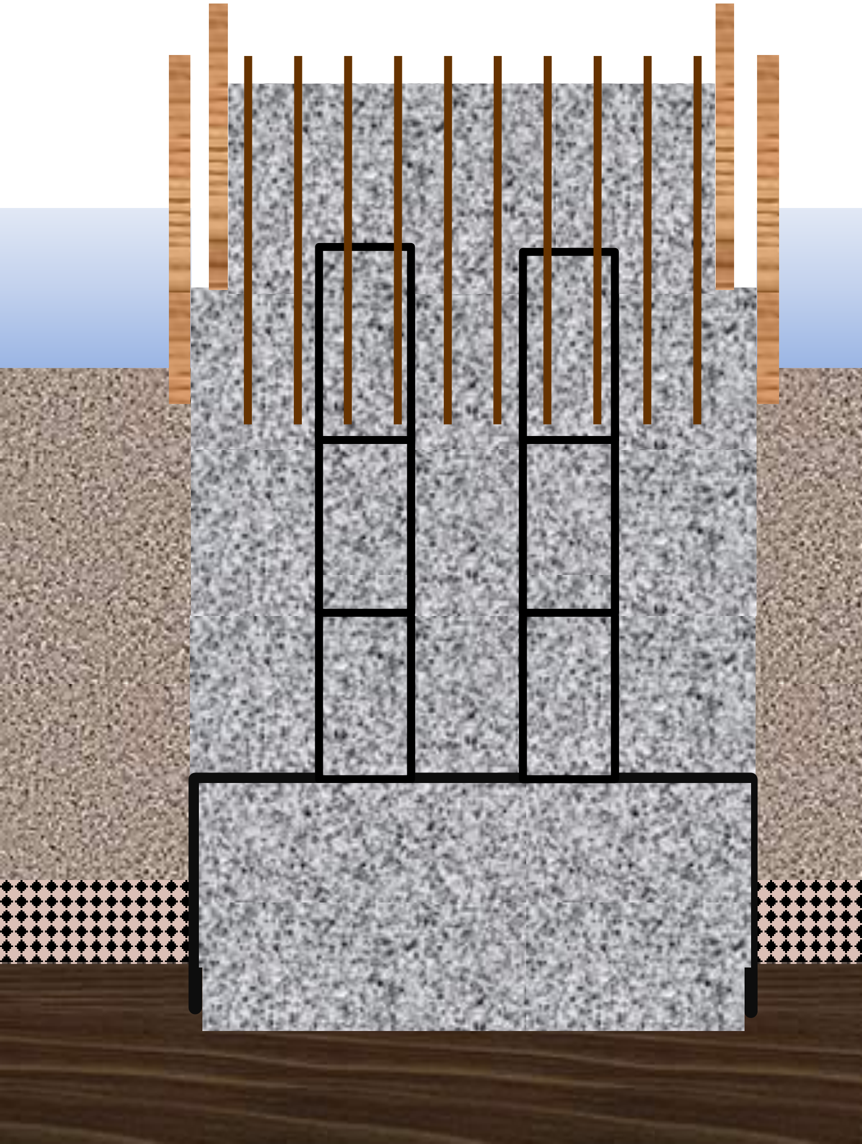
Pier Construction Methods

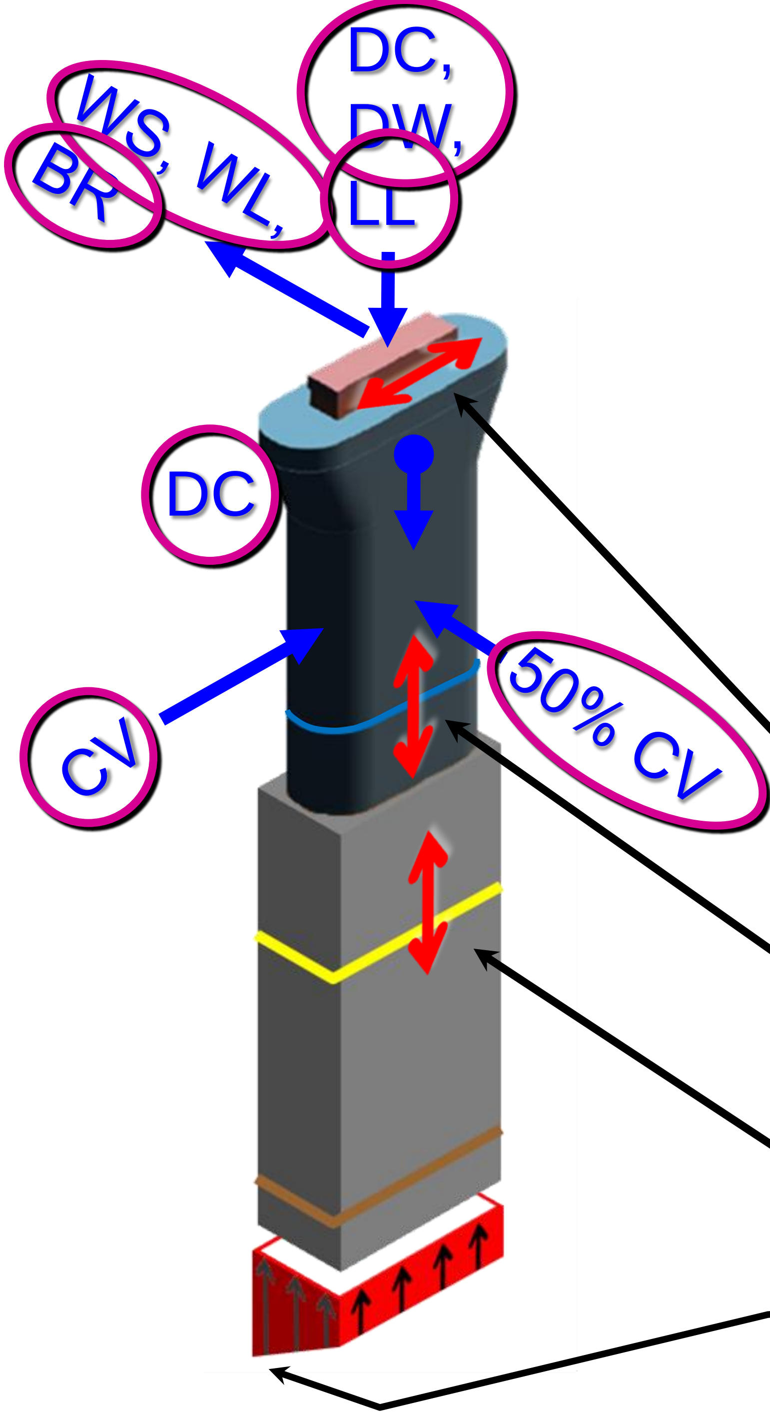


Pier Construction Methods



Pier Construction Methods





Pier Demand Concerns

Heavier truss
Increased wind loading
Larger live loads
Increased pier weight
Increased vessel collision

Pier Response Concerns

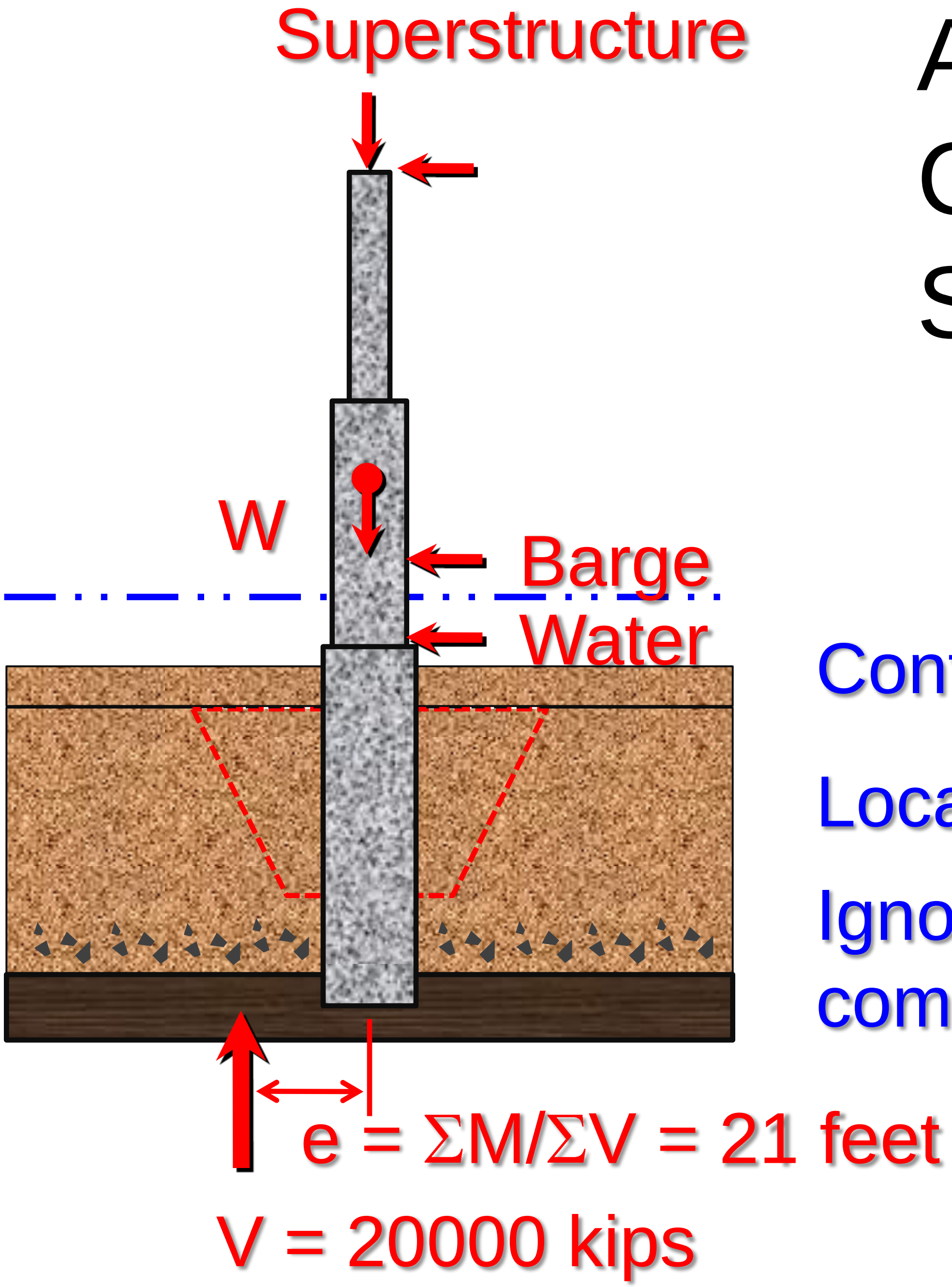
Pier cap tie in to existing pier

Tension in stem and at interface between stem and unreinforced caisson

Tension in unreinforced caisson

Foundation/ Geotechnical Design

Analysis as a Conventional Spread Footing

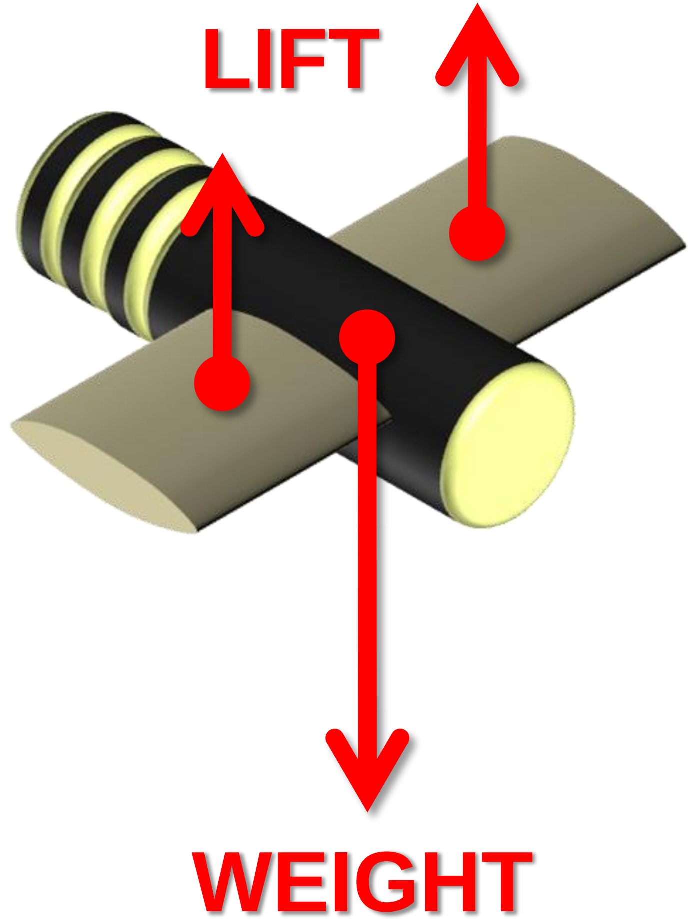


Contraction scour

Local pier scour

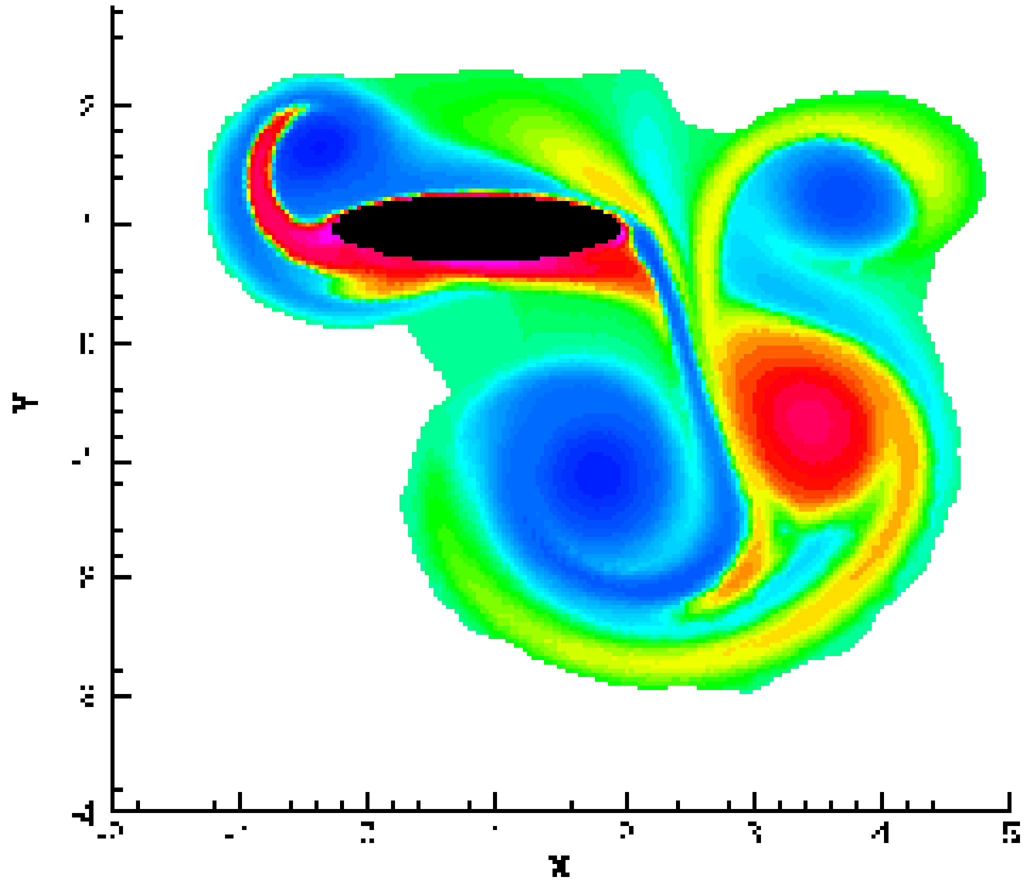
Ignore softer soil response compared to rock

The Bumble Bee Myth

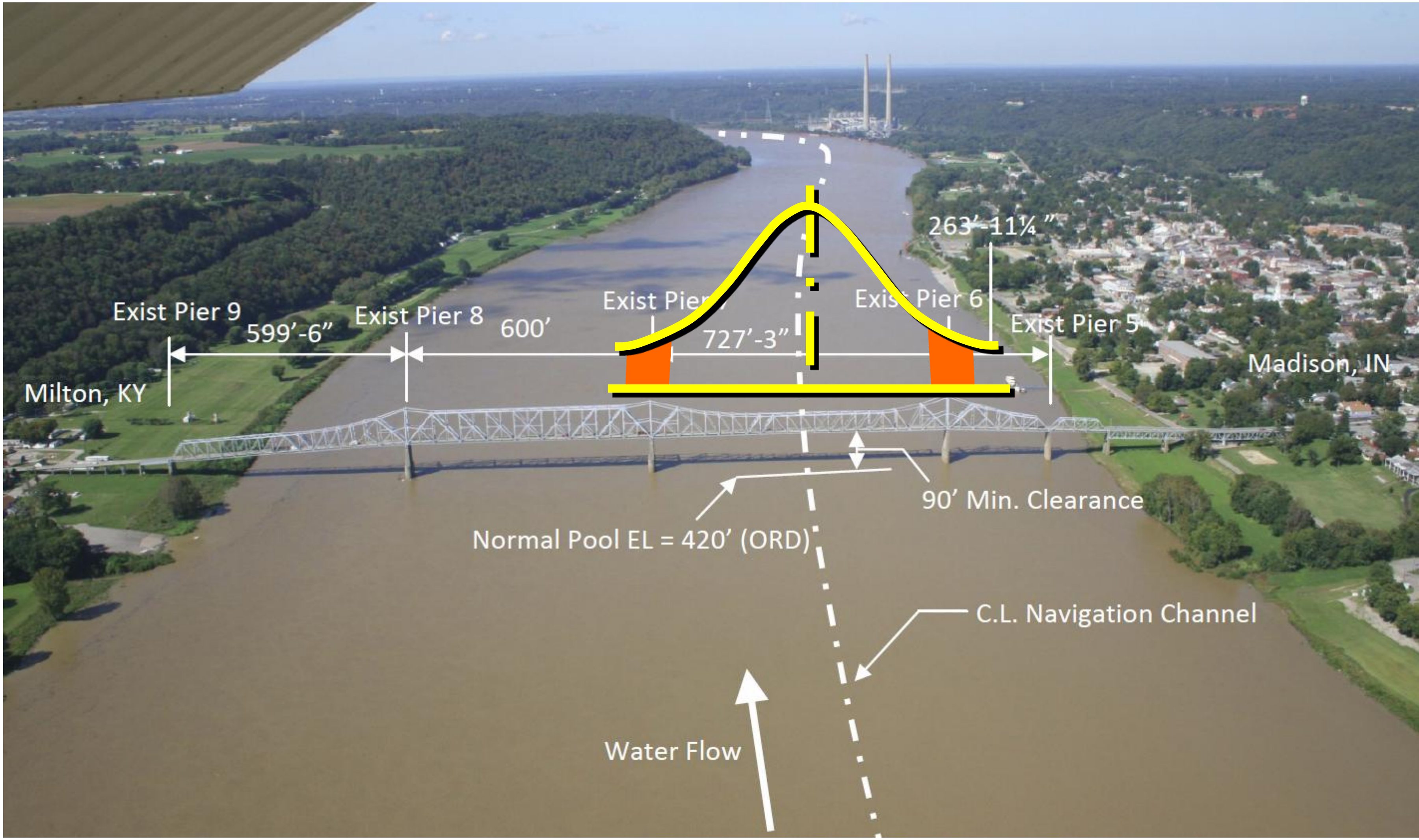


Improved Analysis

“Told bumble bee he couldn’t fly”

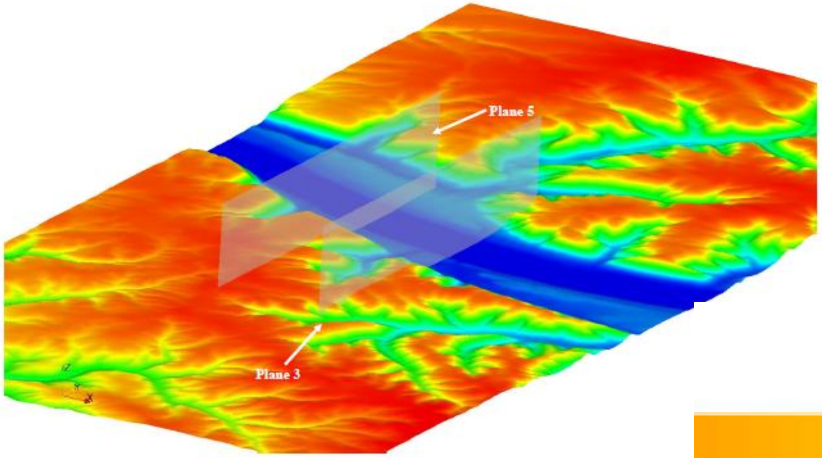


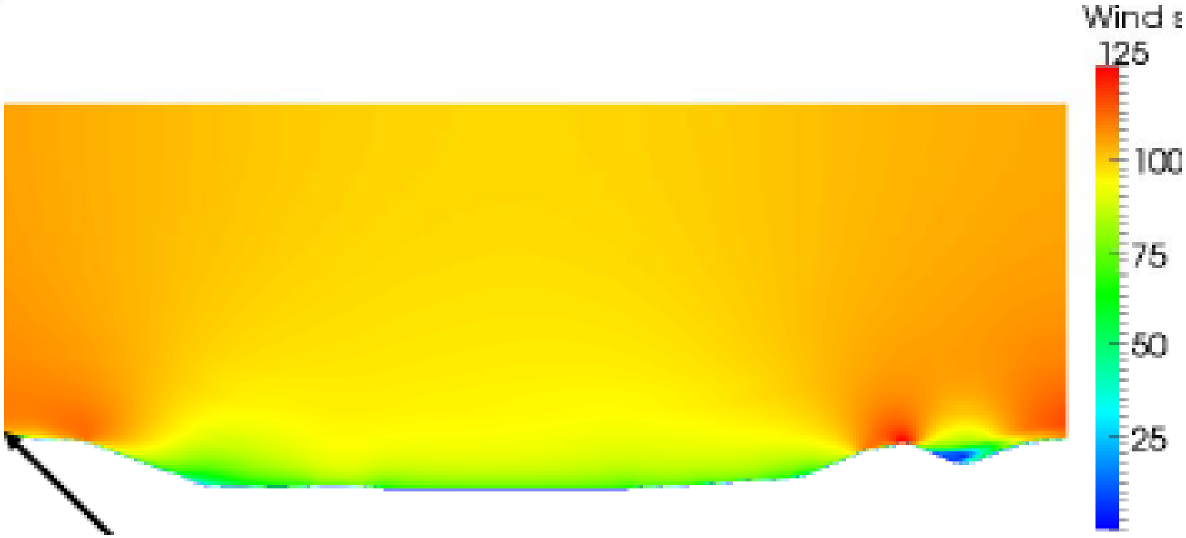
“Improve” the Loads



Barge Impact

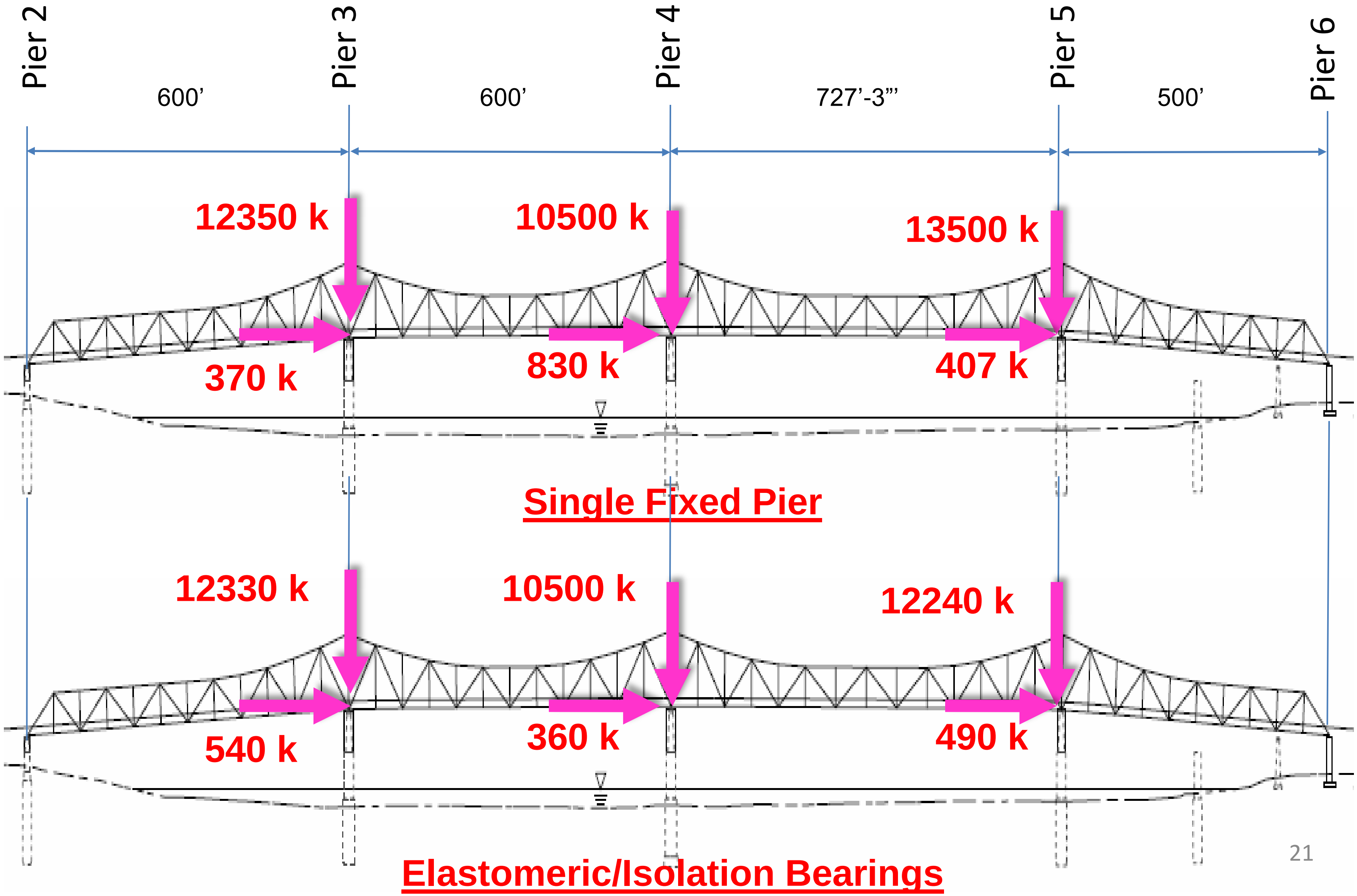
“Improve” the Loads





Wind

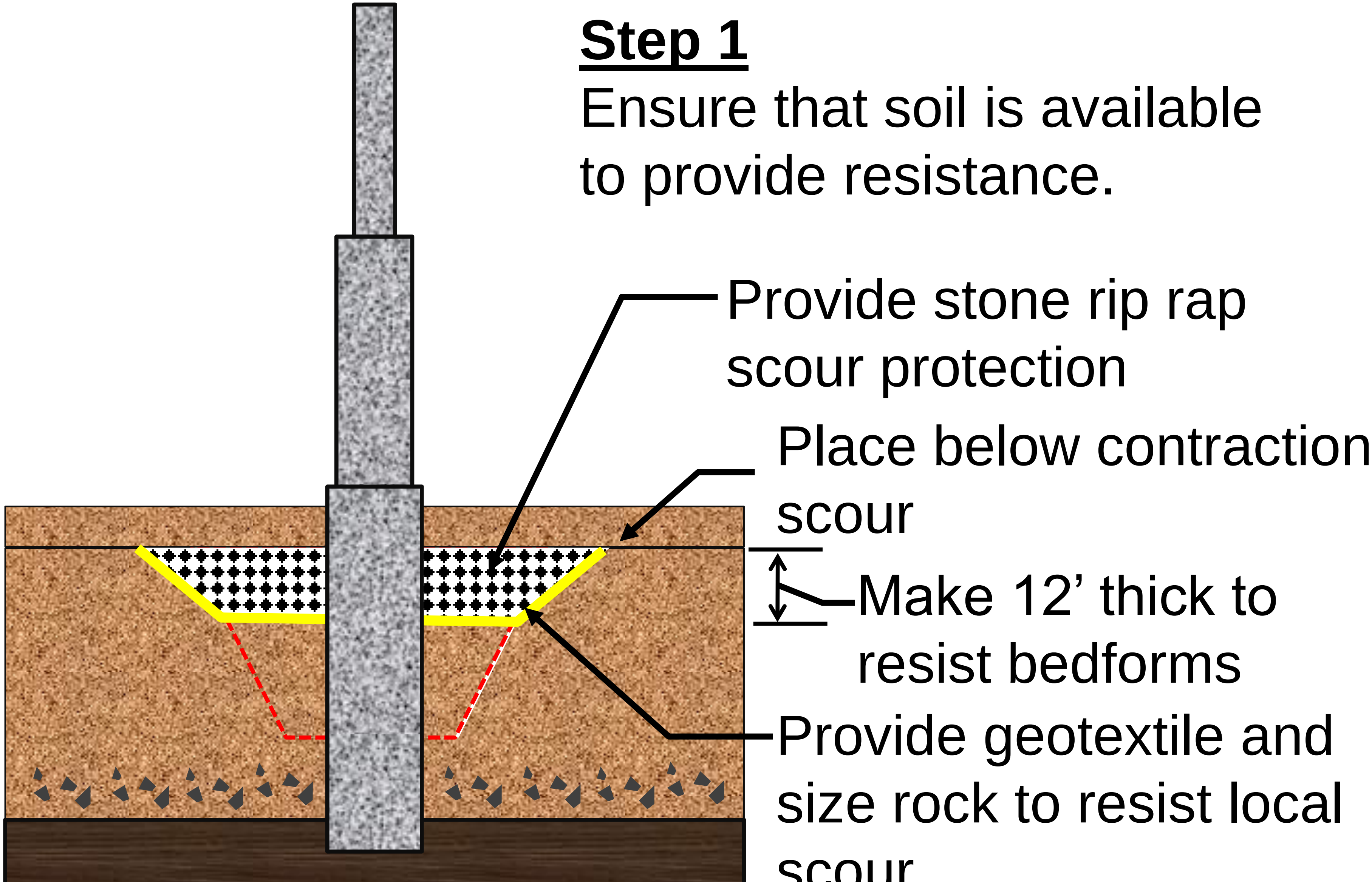
"Improve" the Loads



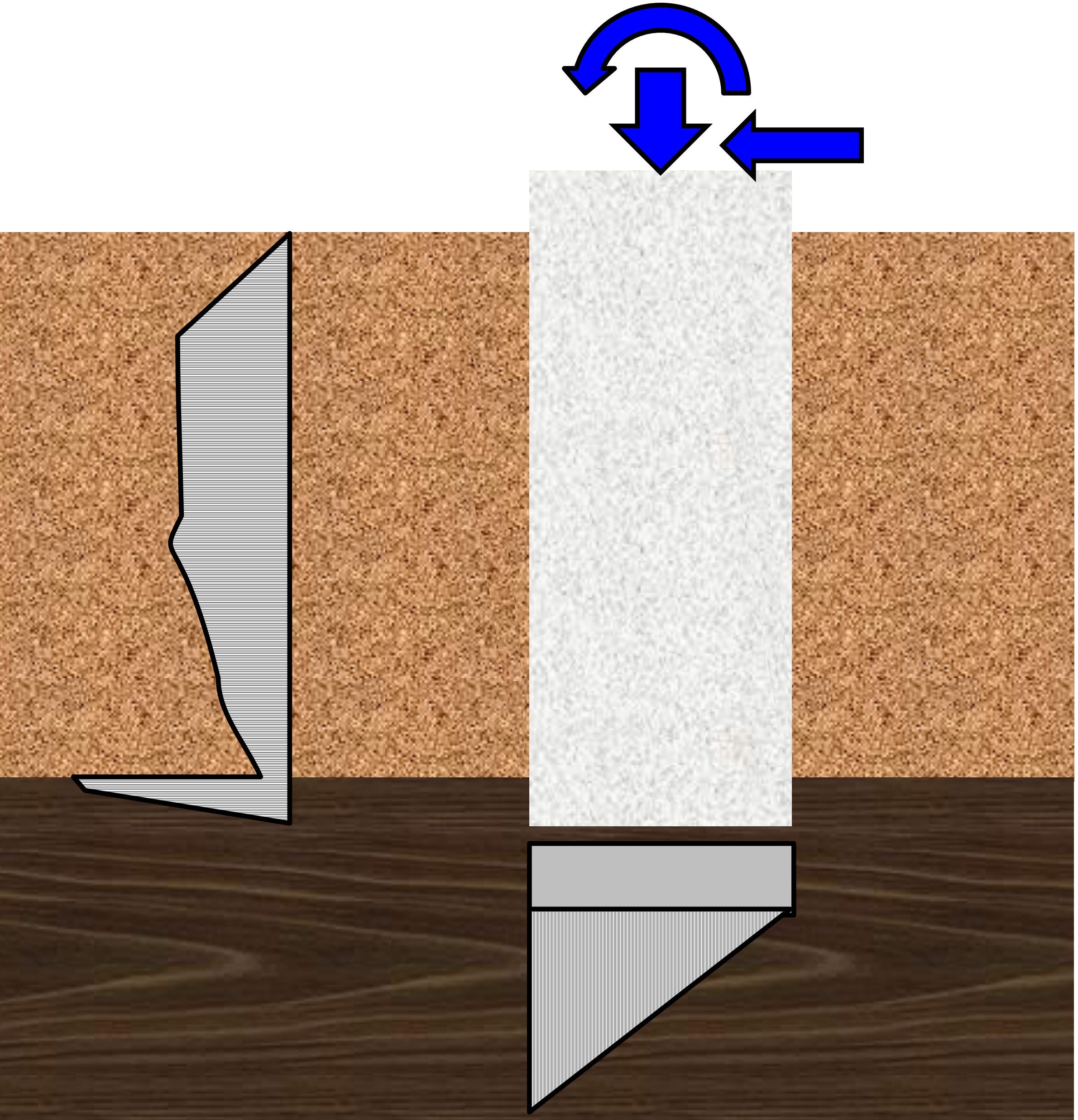
Improve Foundation Resistance

Step 1

Ensure that soil is available to provide resistance.



Improve Foundation Resistance

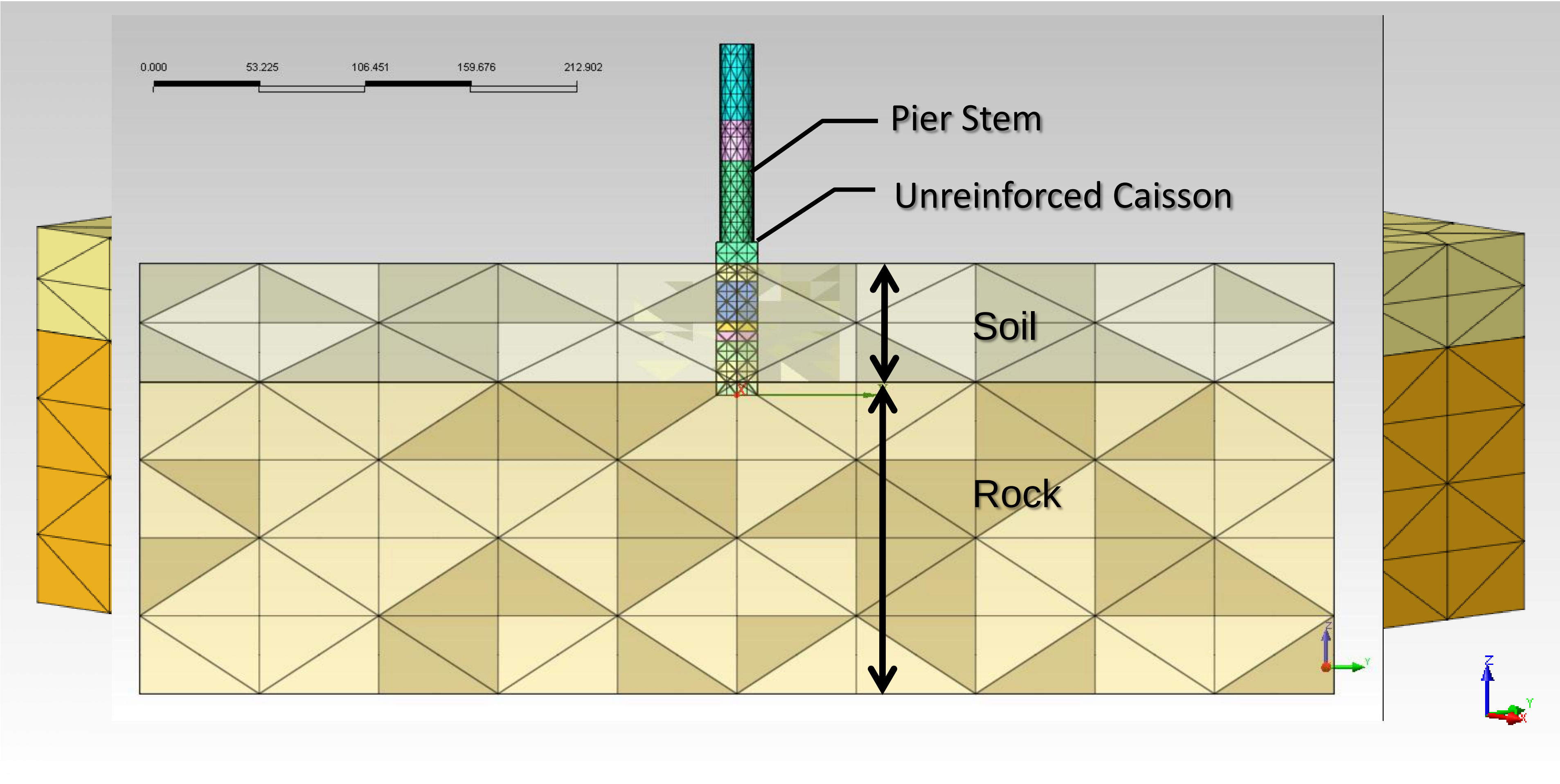


Step 2

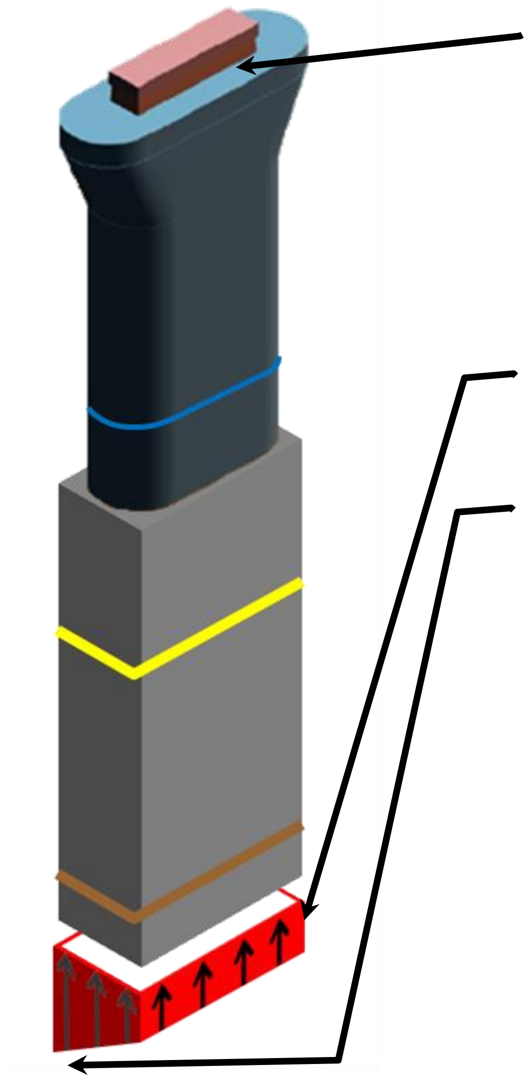
Account for difference in response between softer soil and harder rock.

Analysis Methodology

- Finite Element Method Required
- Using Midas GTS



Pier Response Concerns



<u>Foundation/ Geotechnical design</u>

Pier top deflection at service limit state

Sliding at strength limit states
V/H > 10 so not a problem

Eccentricity < 3/8 B at all limit states

Peak foundation bearing pressure
Strength limit state
= 0.45(75 ksf) = 33.75 ksf
Extreme limit state
= 1.0 (75 ksf) = 75 ksf

Summary of results for Pier 5 w/ Elastomeric Bearings*

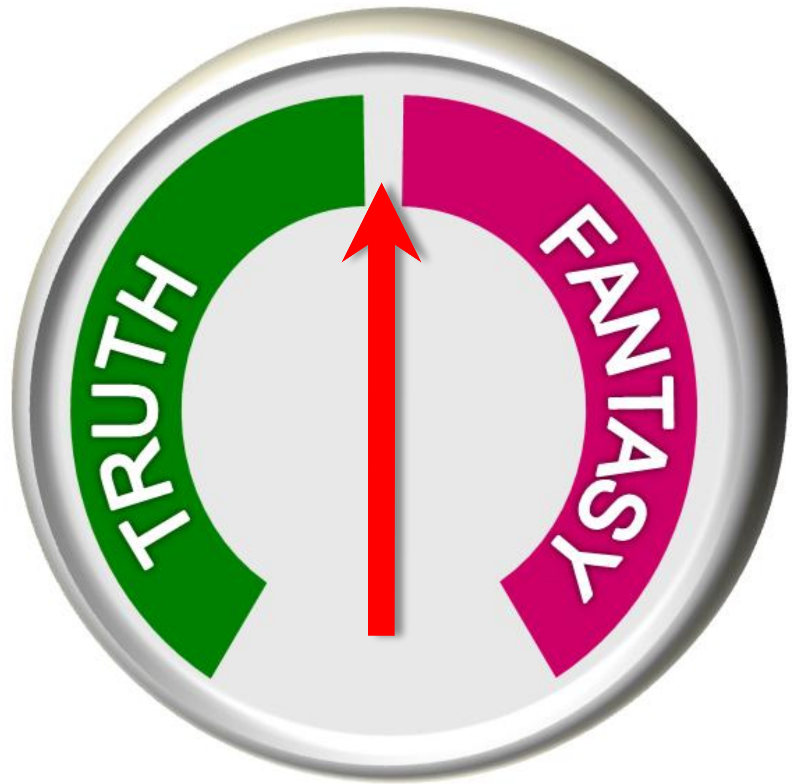
Case	Min Bearing Stress (ksf)	Max Bearing Stress (ksf)	Factored Resistance (ksf)	Performance Ratio Capacity / Demand	Deflection at top of pier (in)
EXT II	5.1	18.0	75.0	4.2	Y=3.47 X=0.13
STR III Max	6.2	29.7	33.8	1.1	Y=1.66 X=2.85
STR III min	4.4	21.7	33.8	1.6	Y=1.51 X=2.34
SER I	6.8	17.2	N/A	N/A	Y=0.88 X=0.57

* k = 200 k/ft

Bogosity

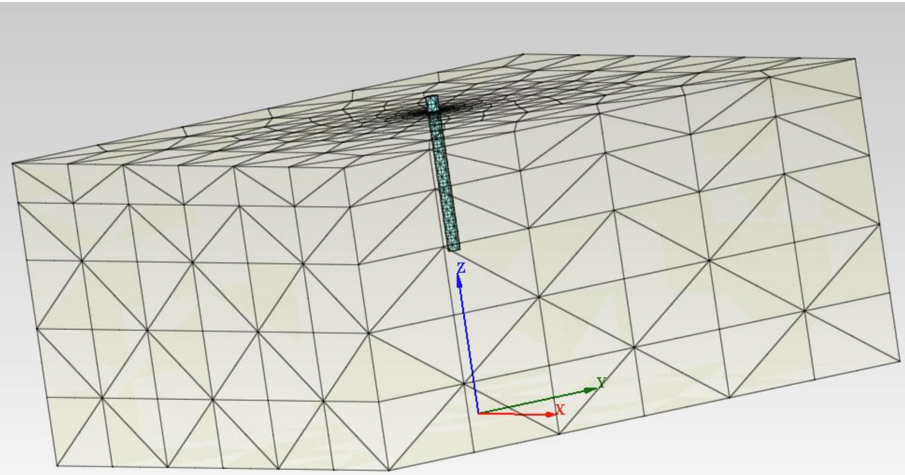
<u>From: "Bogus"</u>

The extent to which an engineering analysis has the potential to misrepresent reality

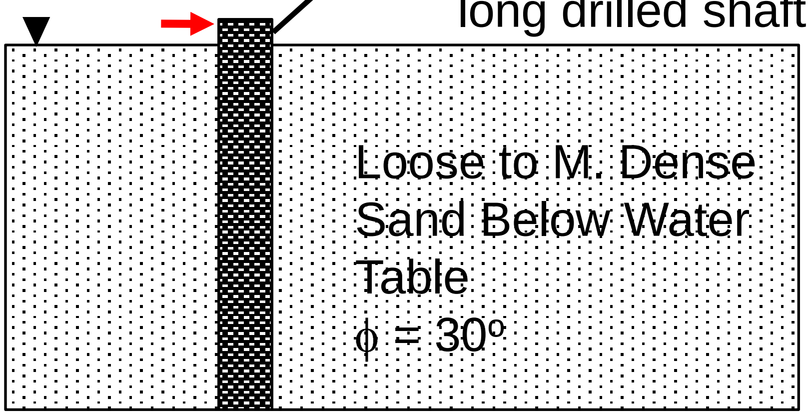


Bogometer

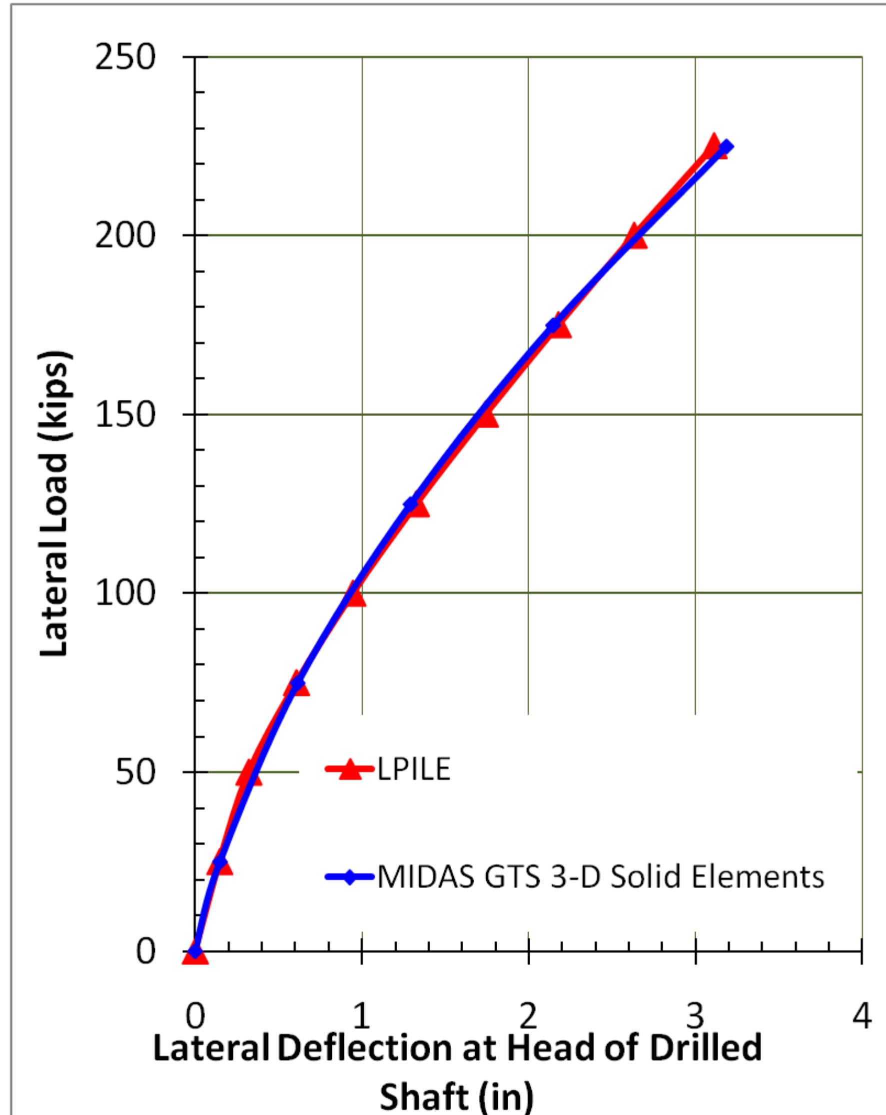
Validation (De-Bogification)



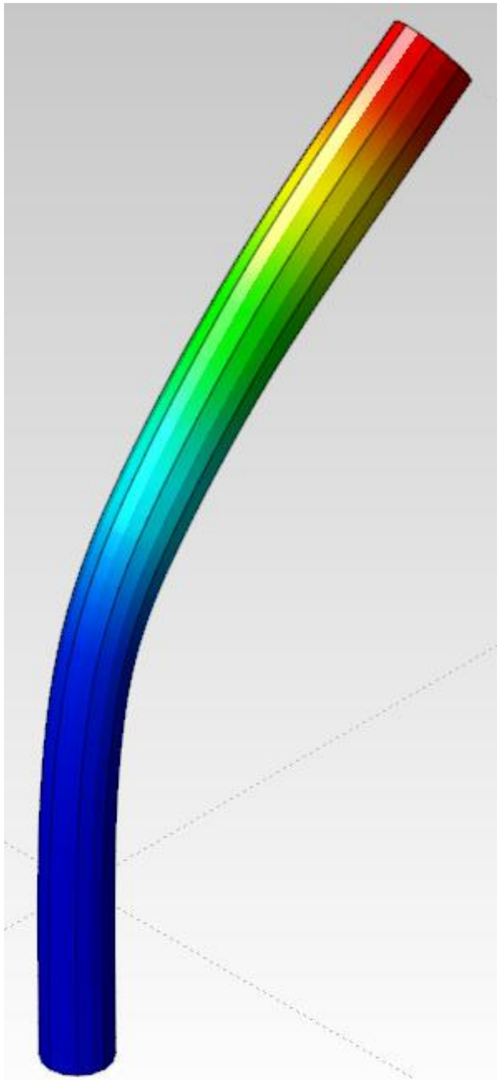
MIDAS GTS Analysis

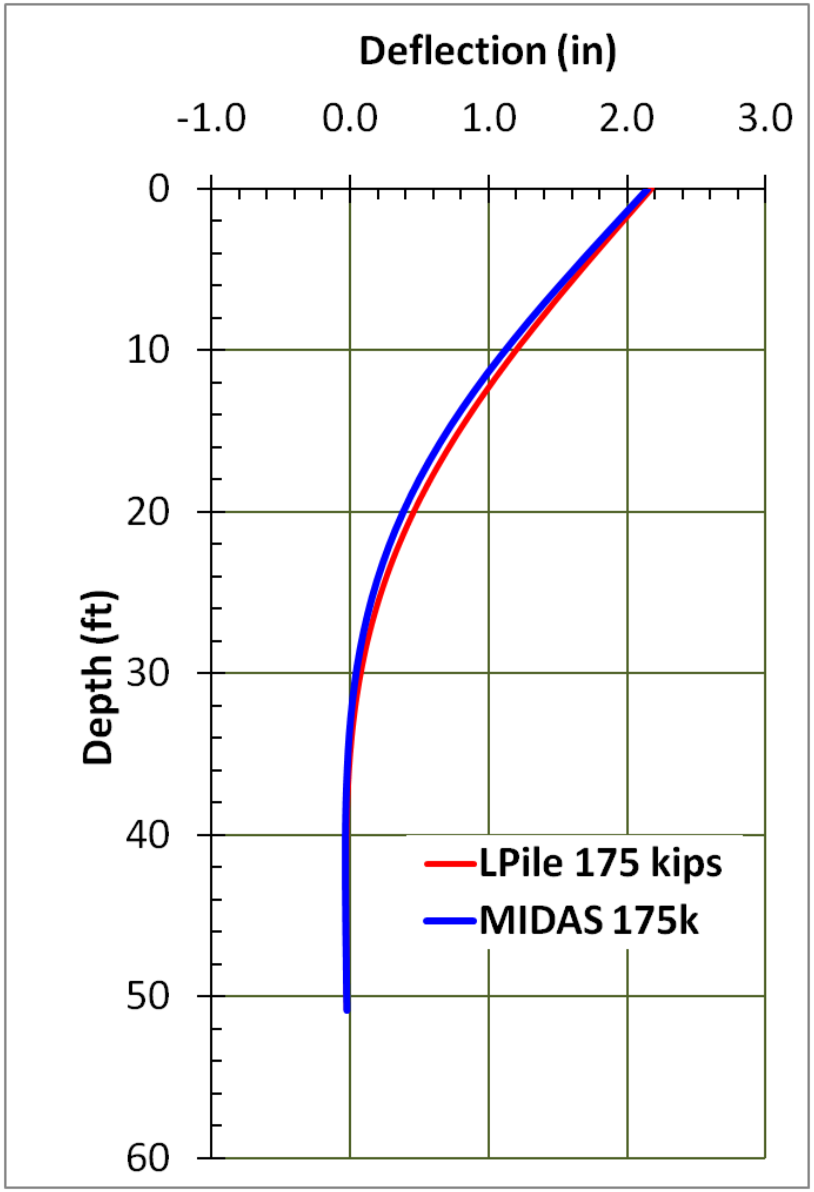


LPile Analysis

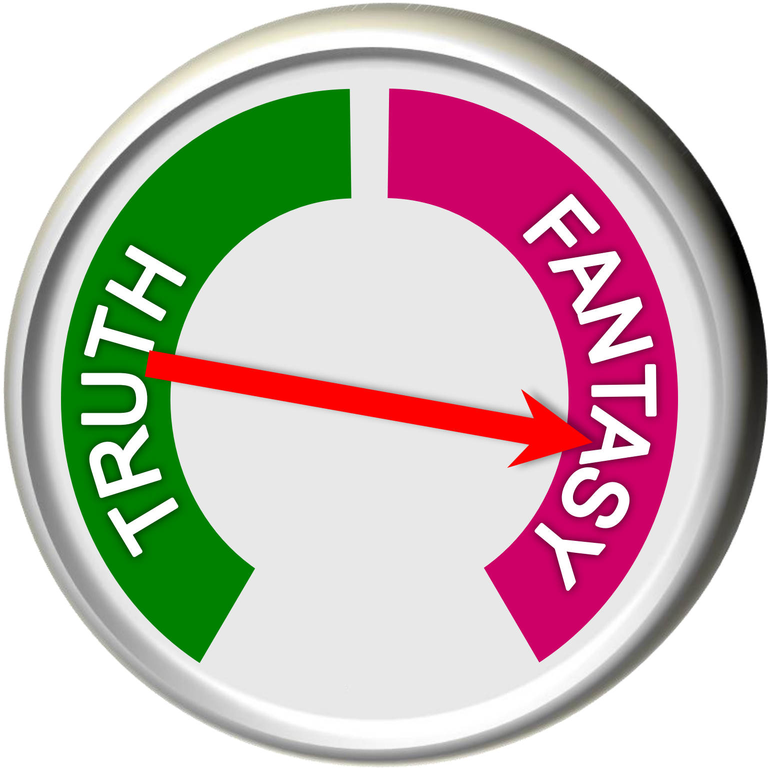


Validation (De-Bogification)



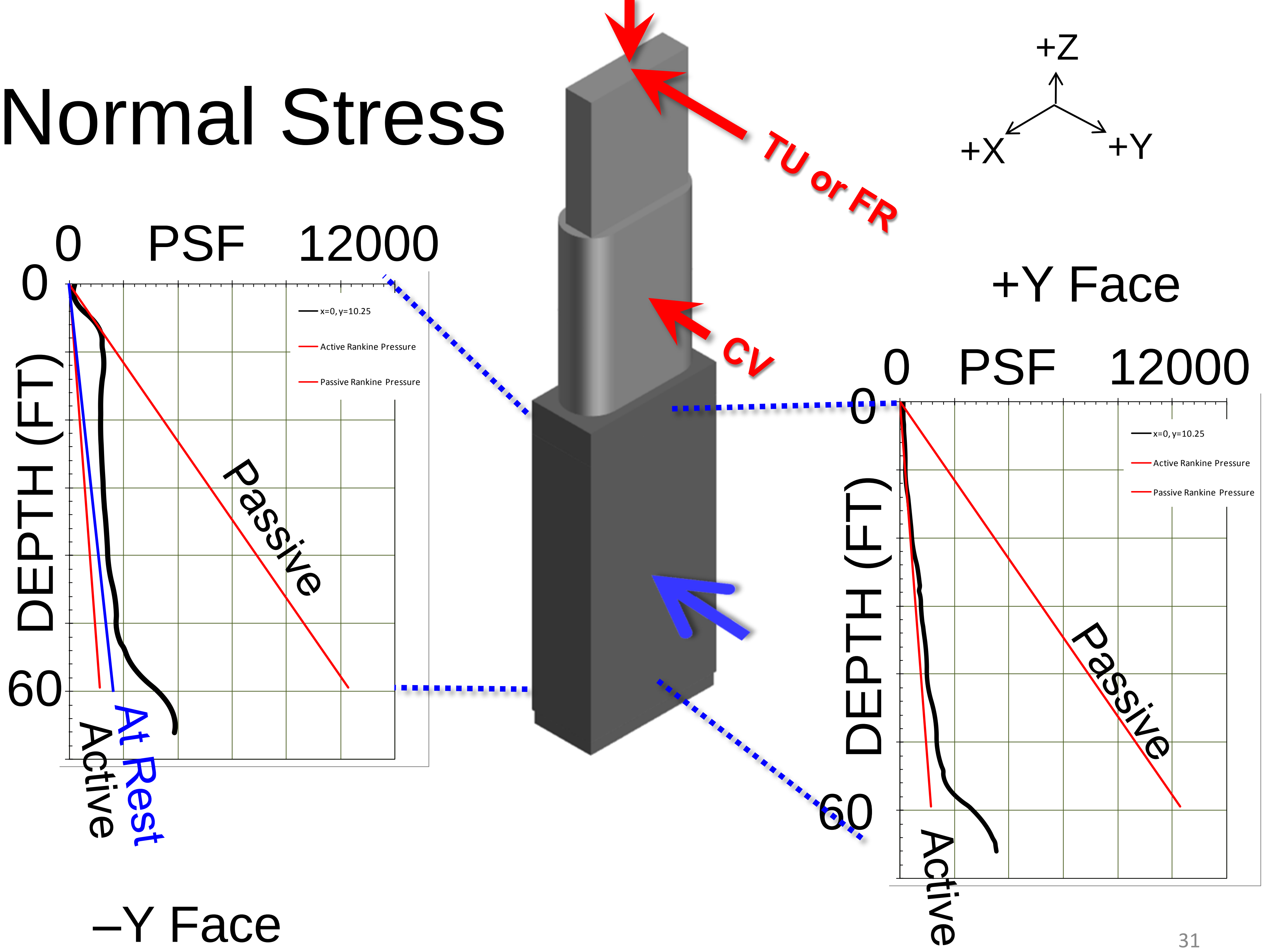


Bogosity

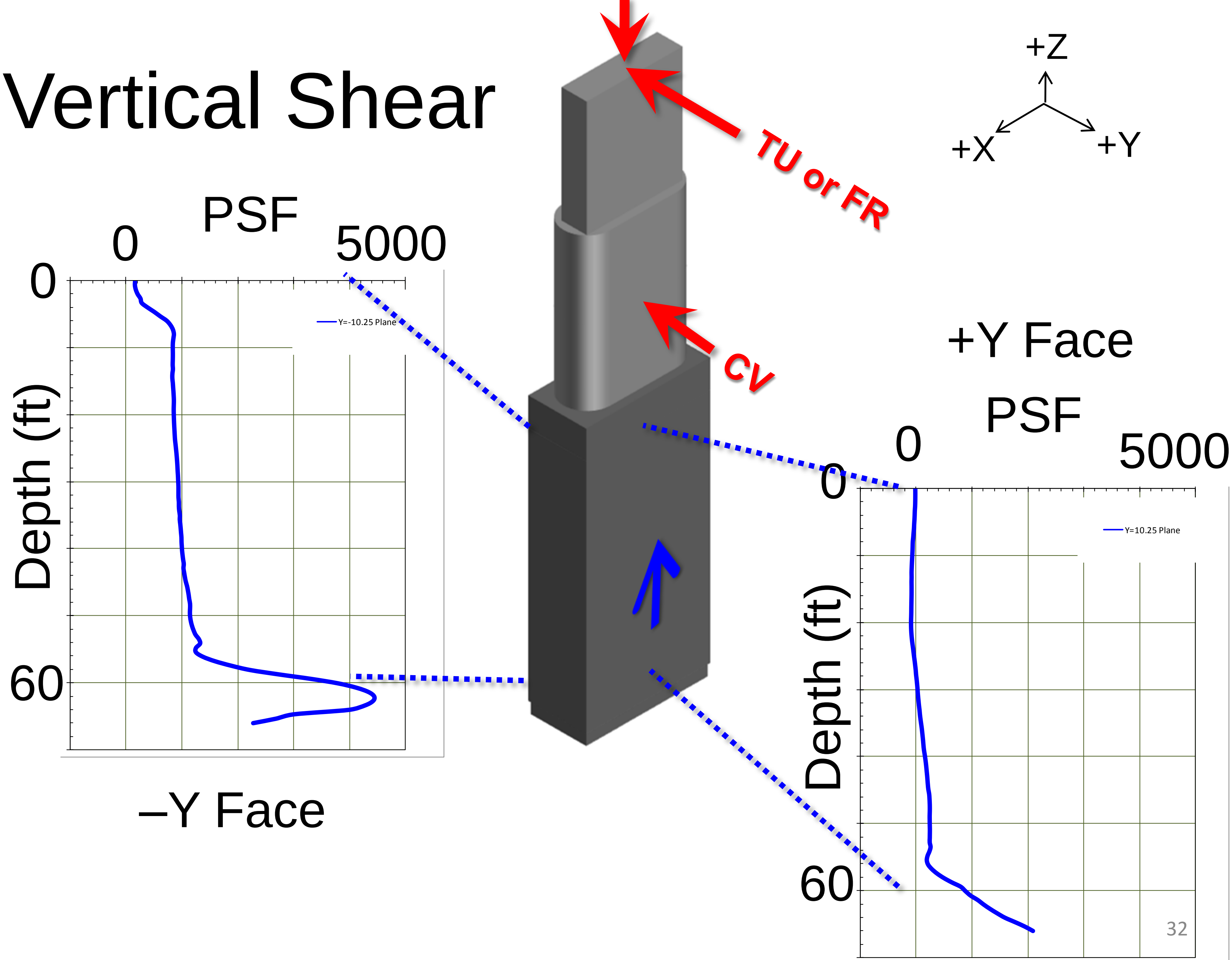


Bogometer

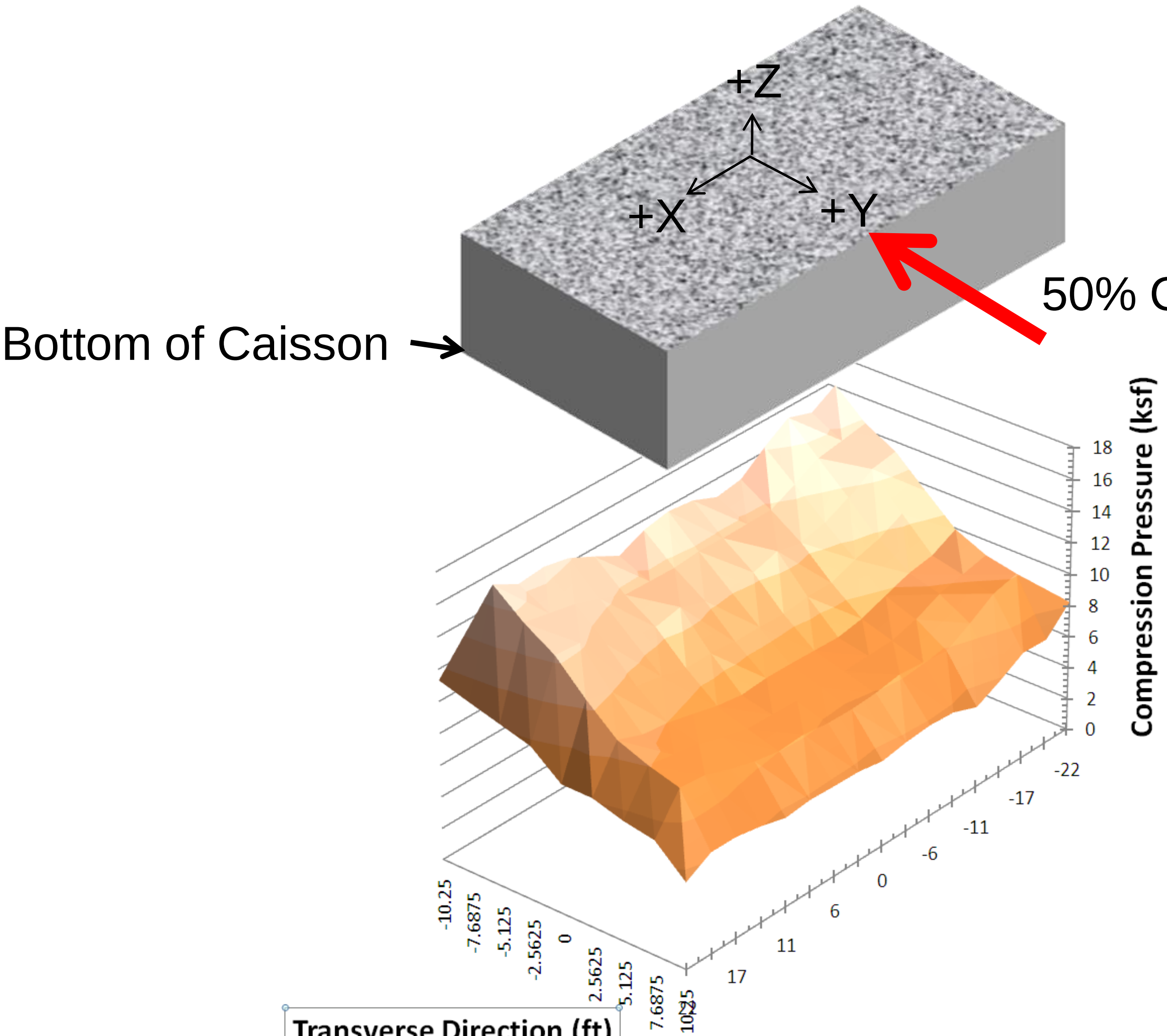
Normal Stress



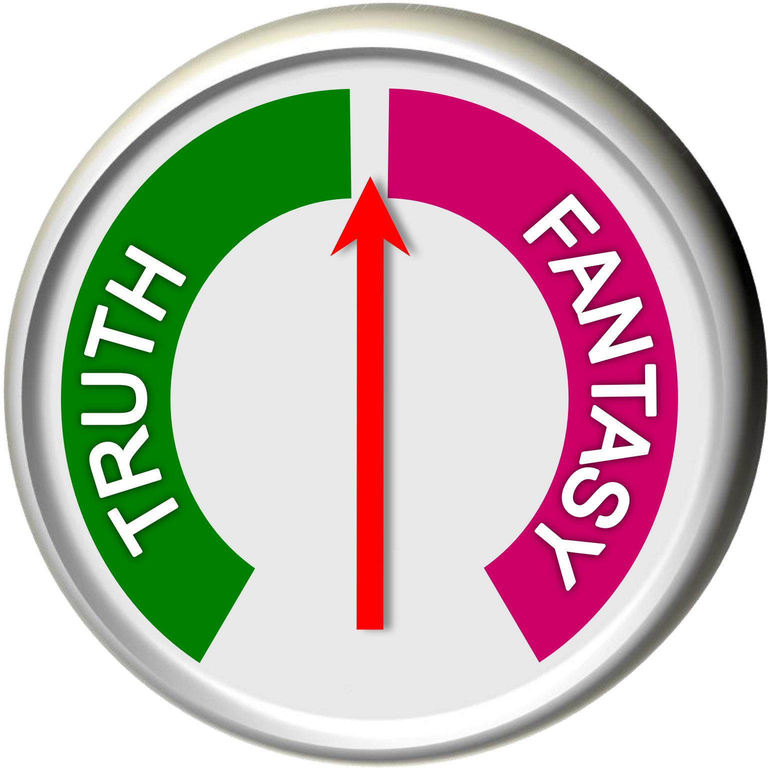
Vertical Shear



Bearing Pressure (EXT II)

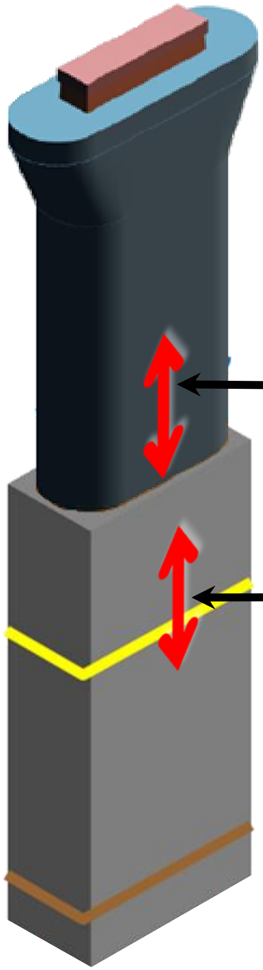


Bogosity



Bogometer

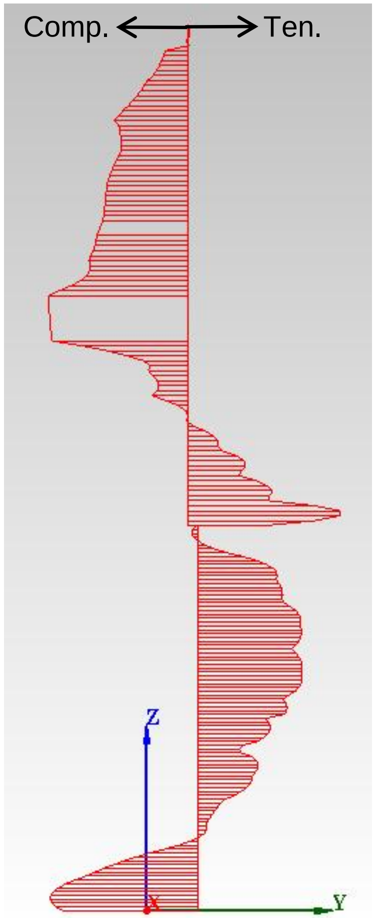
Pier Response Concerns

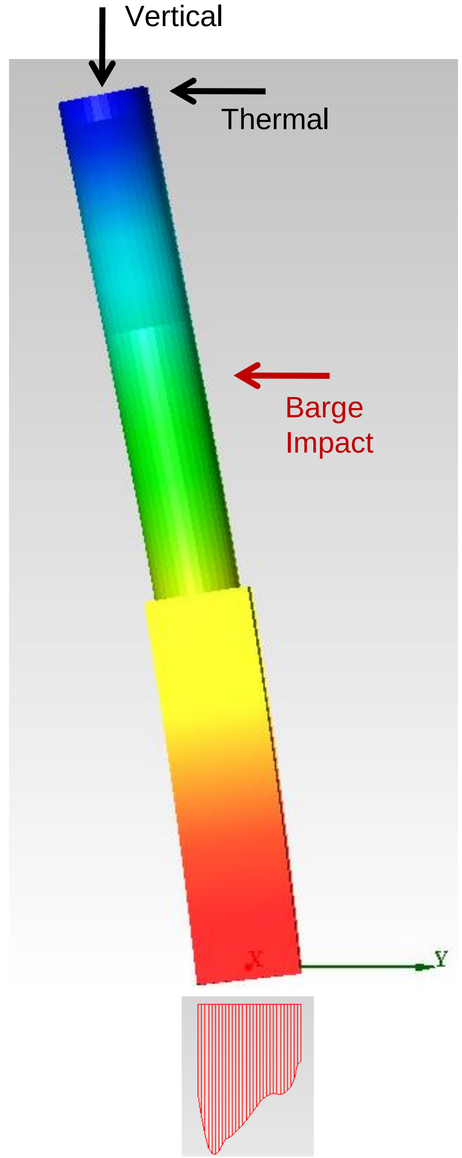


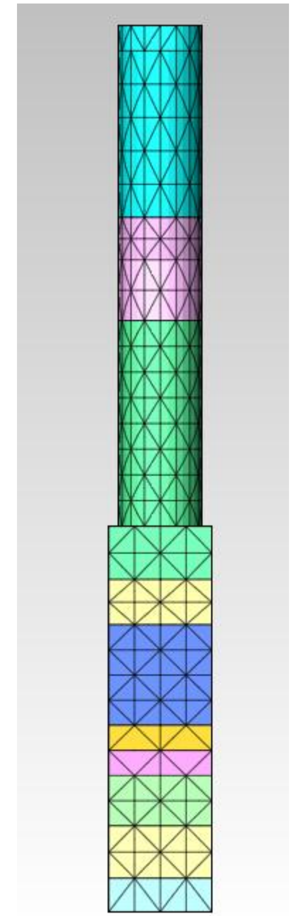
Tension in stem and at interface between stem and unreinforced caisson

Tension in unreinforced caisson

EXT-II: Barge Impact







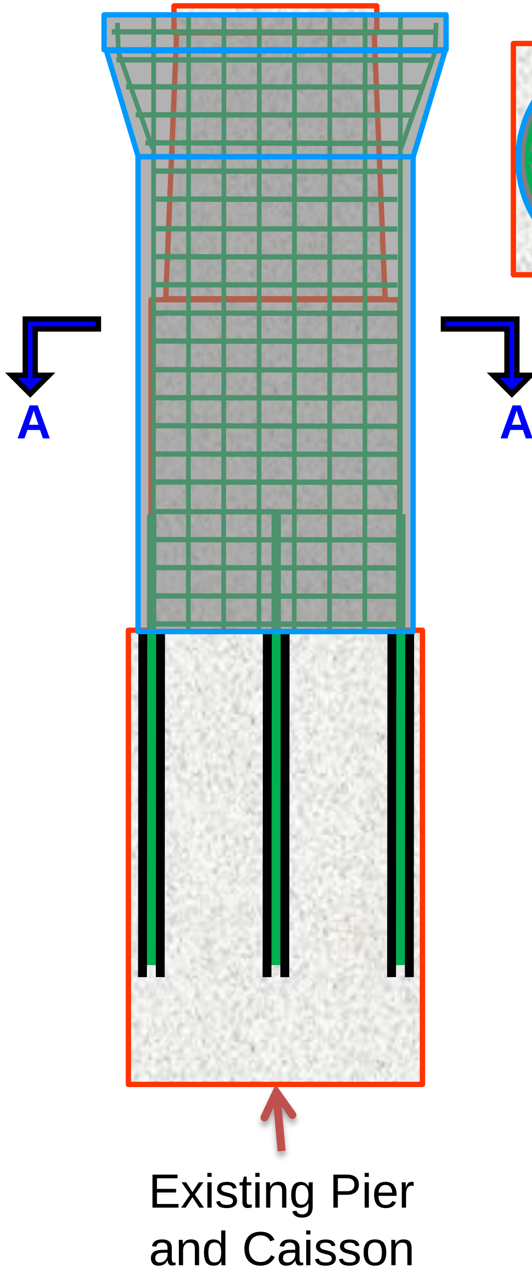
Proposed Pier Strengthening

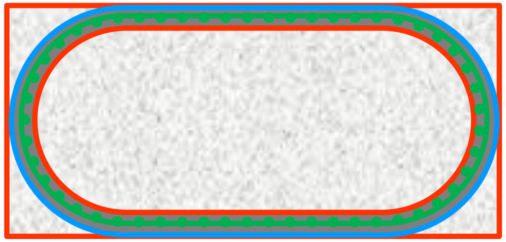
1) Drill holes into existing unreinforced caisson

2) Grout dowels into holes and extend above top of caisson

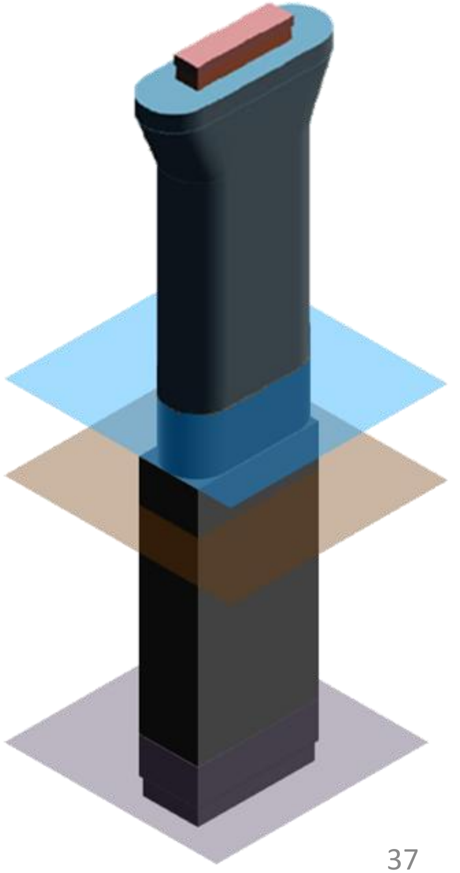
3) Add stem reinforcement

4) Form and cast collar and new cap



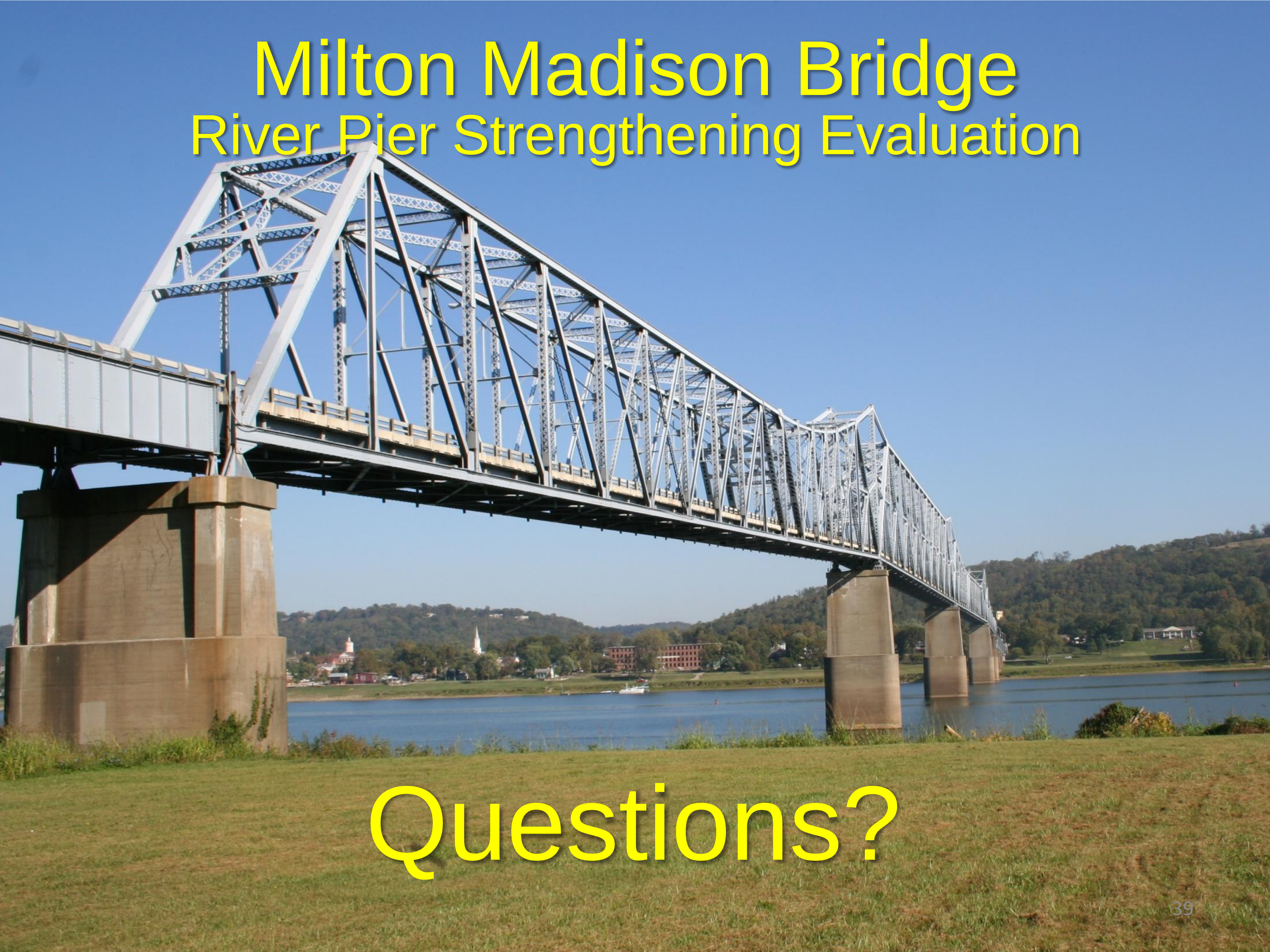


SECTION A-A



Conclusions

- The existing river piers can be reused to support the new truss.
- A refined analysis considering soil response is required during design.
- Scour mitigation is required to ensure soil response.
- The pier must be strengthened.
- Include these requirements in the design build documents.


Milton Madison Bridge
River Pier Strengthening Evaluation
Questions?