Effects of Construction on Shaft Performance

Part I: Polymer Slurry Exposure

GRIP 2015

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Civil & Environmental Engineering

Design Considerations

- Ground Material
  - Clay
  - Sand
  - Rock
- Shaft Dimensions
  - Diameter
  - Length
  - Percent Steel
- Resistance Factor
  - Load testing type
  - Load testing frequency
- Rock Quality
  - UCS
  - Recovery, RQD

Construction Effects
(not addressed by design)

- Excavation Equipment
- Reinforcement Bar Size and Cage Spacing
- Concrete properties
- Cased or Slurry Supported
- Vibrated or Oscillated Casing
- Slurry Type
- Slurry Exposure
- Temporary or Permanent Casing

Structure of this Presentation

- **Part I:**
  - Effect of Polymer Slurry Stabilization on Drilled Shaft Side Shear over Time (BDV25-977-19)
- **Part II:**
  - Evaluating the Effect of Temporary Casing on Drilled Shaft Rock Socket Friction (BDV25 TWO 977-18)

Part I: Problem Statement

- Construction methods affect drilled shaft side shear resistance which is not fully addressed by design.

- The primary objective of this study is to quantify the time effects on side shear (if any) from prolonged open excavation where polymer slurry is present.

Problem Statement

- Bentonite and polymer slurries work differently (e.g. filter cake / no filter cake).
- Present specifications for bentonite largely do not apply to polymer.

Research Approach

- Task 1 Literature Review
- Task 2 Evaluation of Past Studies
- Task 3 Laboratory Side Shear Testing
- Task 4 Full Scale Field Testing
- Task 5 Draft Final and Final Report

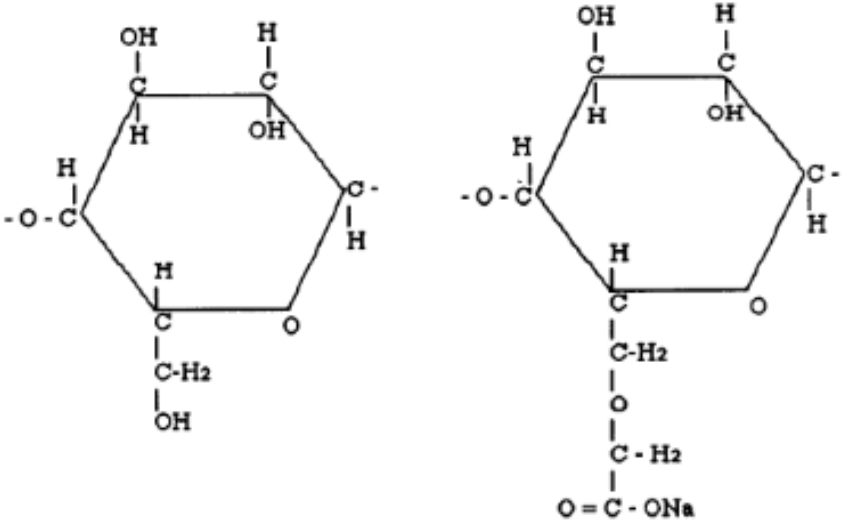
Current Specification

FDOT 2014 455-15.11.5 specifications state:

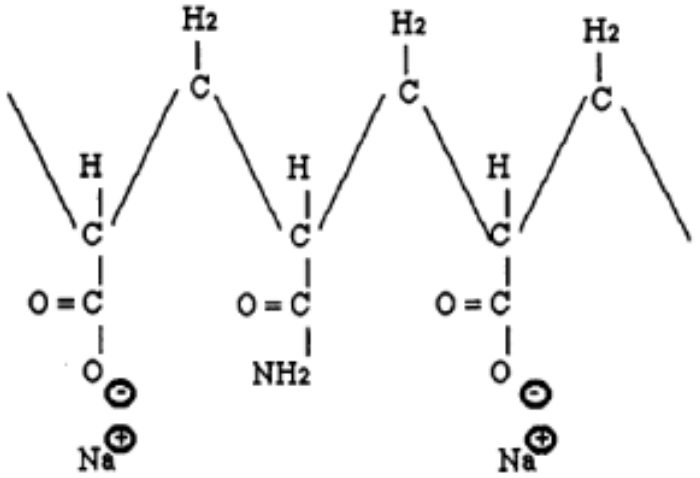
Any unclassified excavation work lasting ***more than 36 hours*** *(measured from the beginning of excavation for all methods except the Permanent Casing Method, which begins at the time excavation begins below the casing) before placement of the concrete requires* ***overreaming the sidewalls*** *to the depth of softening or* ***removing*** *excessive* ***slurry cake buildup****. Ensure that the minimum depth of overreaming the shaft sidewall is 1/2inches and the maximum depth is 3 inches. . .*

Polymer Slurries

Examples of general chemical composition



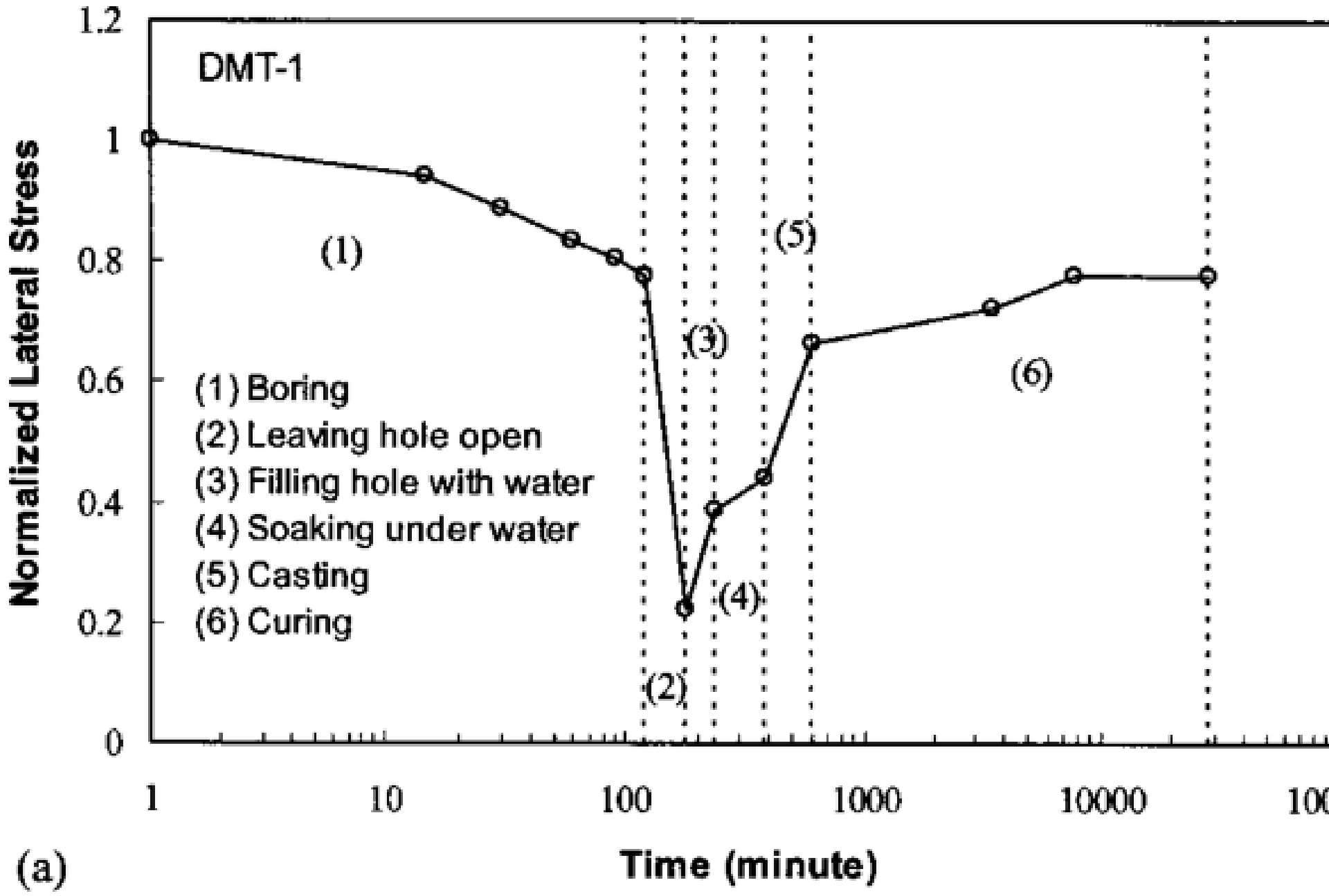
Cellulose based monomers



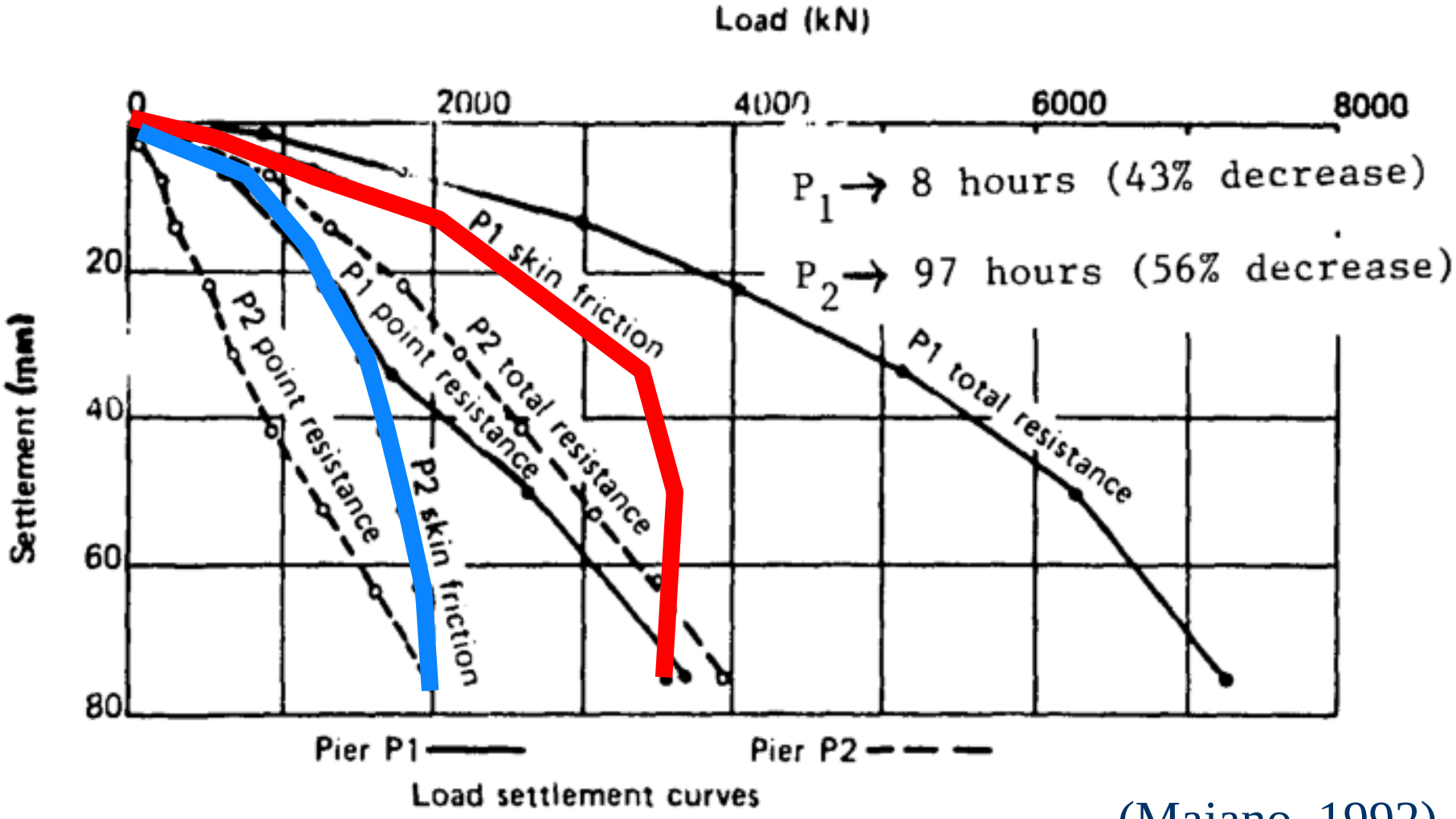
Acrylamide-sodium acrylate

(Majano, 1992)

Stress Relaxation – (Chang and Zhu, 2004)



Time Exposure to Bentonite Slurry
Effects on Side Resistance



(Majano, 1992)

Time Exposure to Bentonite Slurry

Effects on Side Resistance (Caliari de Lima, 2008)

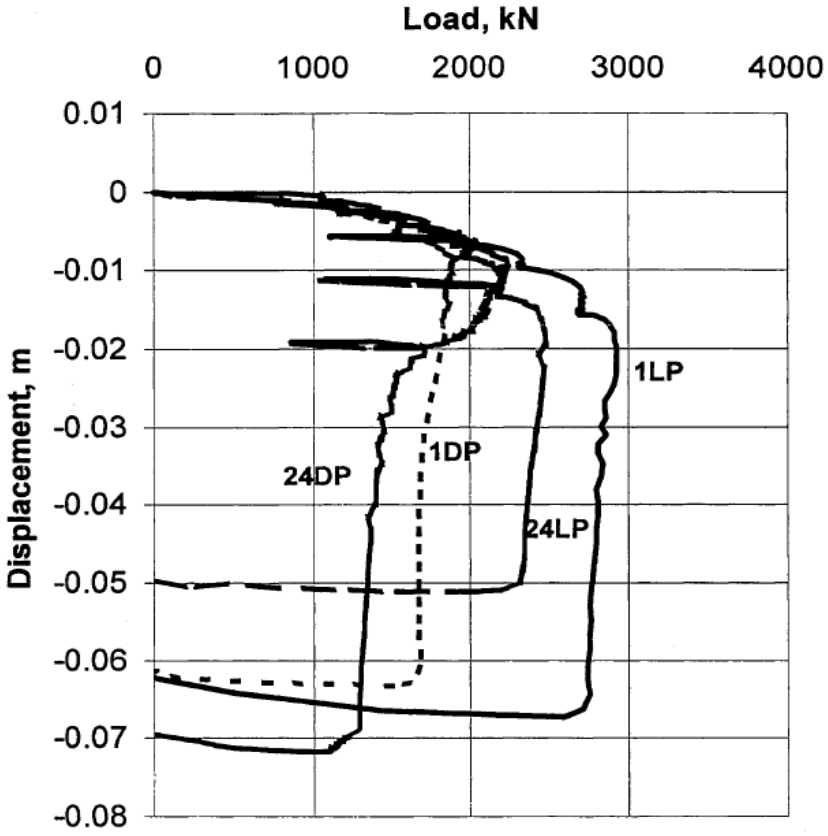
$$Q_{su} = 30\left(\frac{SPT(N)}{3} + 1\right)A_s$$ For immediate casting

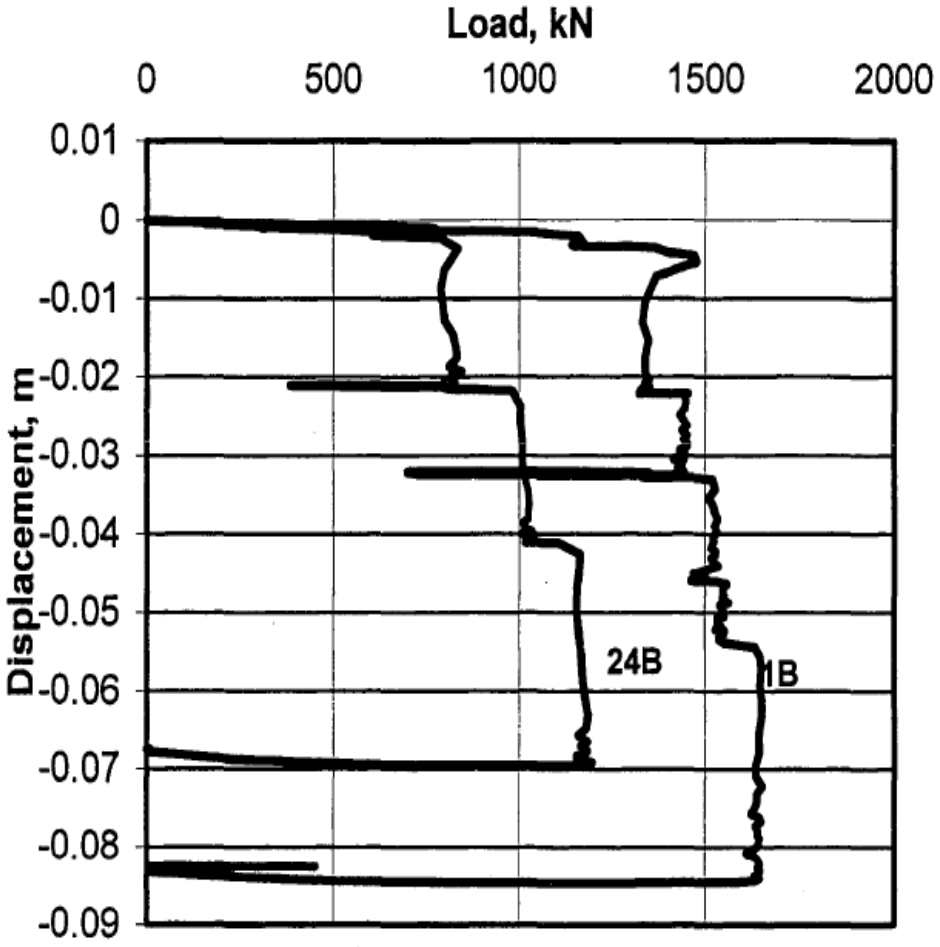
$$Q_{su} = 8.0\left(\frac{SPT(N)}{3} + 1\right)A_s$$ 16h: 70% reduction

$$Q_{su} = 5.6\left(\frac{SPT(N)}{3} + 1\right)A_s$$ 48h: 80% reduction

Time Exposure

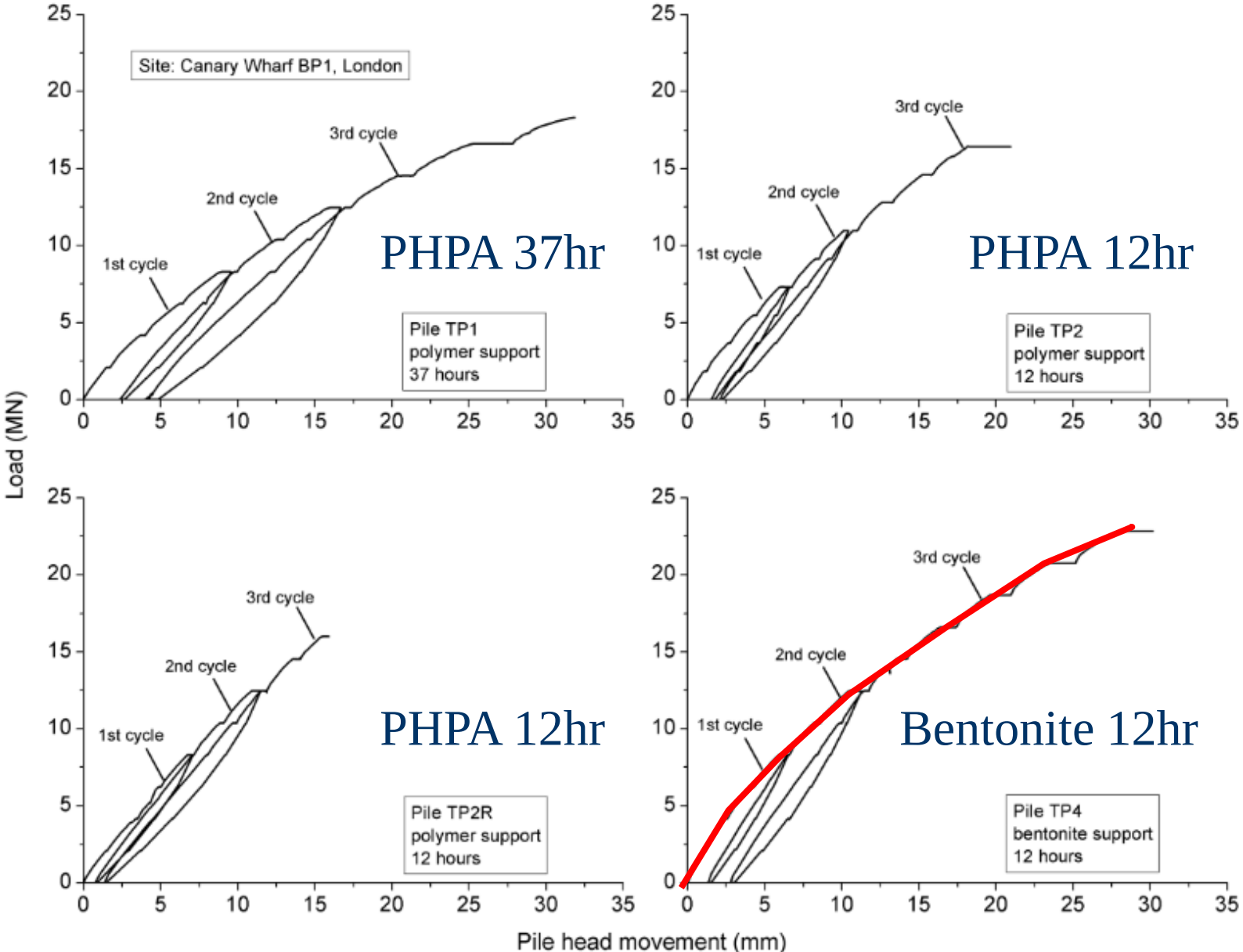
Effects of drilling slurries on Side Resistance (Brown, 2002)





Time Exposure (interbedded sand clay layers)

Effects of bentonite and polymer slurries on Side Resistance (2.5ft) (Lam and Jefferis, 2015)



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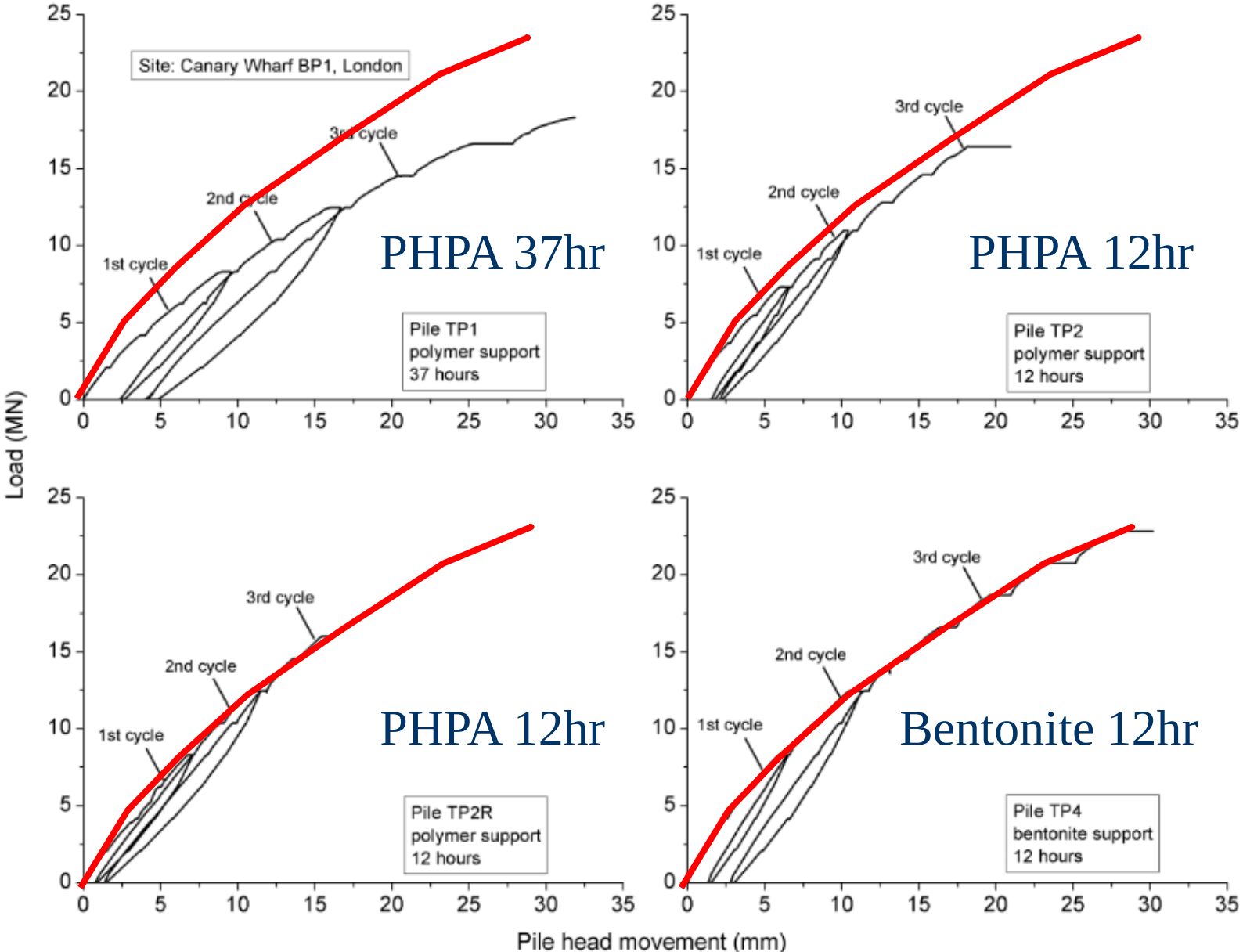
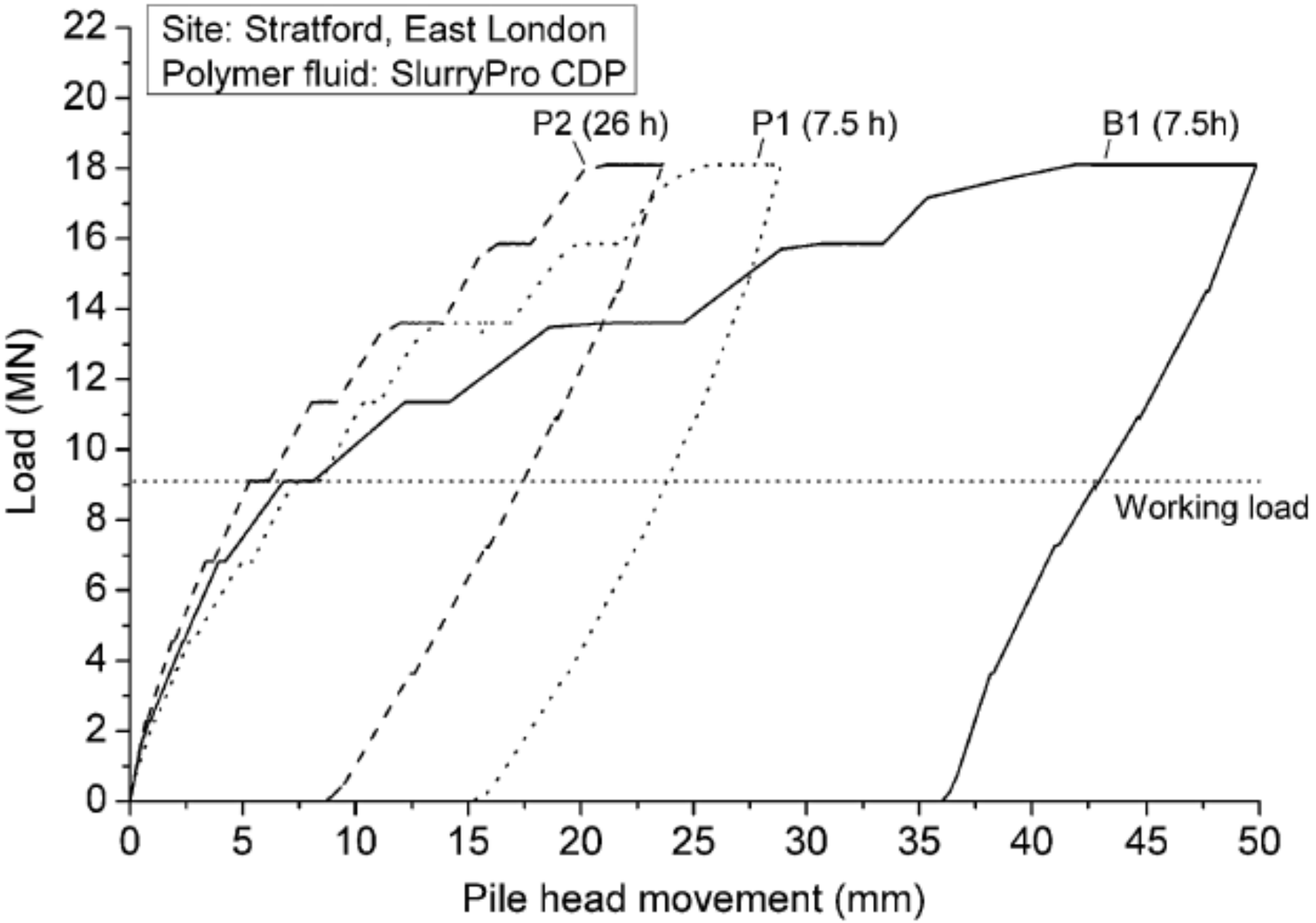


Time Exposure (dense sand)

Effects of bentonite and polymer slurries on Side Resistance (4ft shafts) (Lam and Jefferis, 2015)



Next Steps for Part I

- **Task 1 Literature Review**
- Task 2 Evaluation of Past Studies
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Questions for Part I?