



Effect of Polymer Slurry Stabilization on Drilled Shaft Side Shear Over Time



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Problem Statement

- ◆ Construction methods affect drilled shaft side shear resistance but are not addressed in design.
- ◆ Bentonite and polymer slurries work differently (e.g. filter cake / no filter cake).
- ◆ Present specifications for bentonite largely do not apply to polymer.



Objectives

- ◆ Quantify the time effects on side shear (if any) from prolonged open excavation where polymer slurry is present and
- ◆ Determine what changes to specifications would be needed.



Clay filter cake formation



No filter cake
Soil bound by polymer
cohesion

Slide 4

LC1

Include Task 3 pictures illustrating the filter cake "versus" polymer adhered in the soil

Lucas Caliarì, 7/11/2016

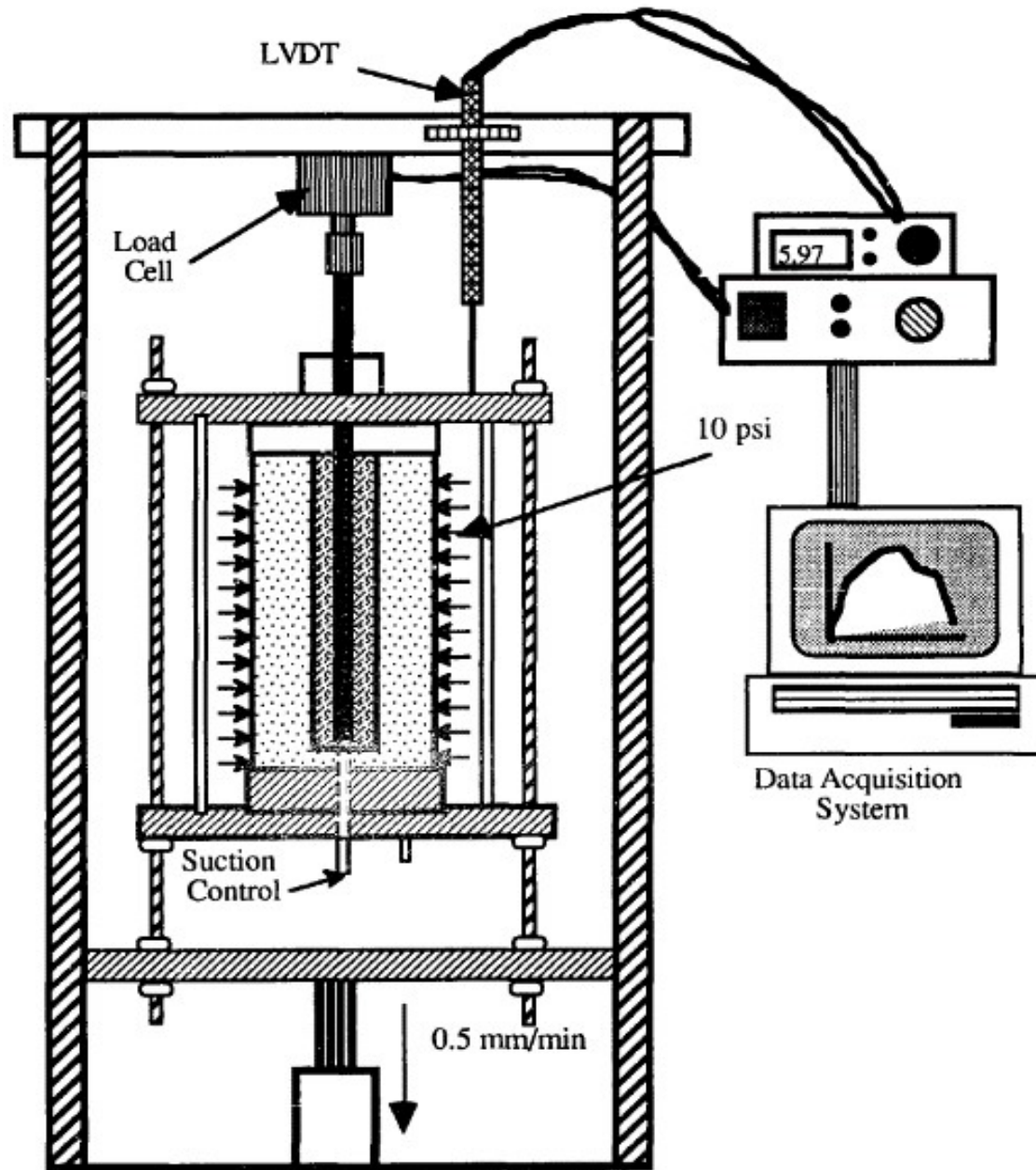
Current Specification

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. . .*

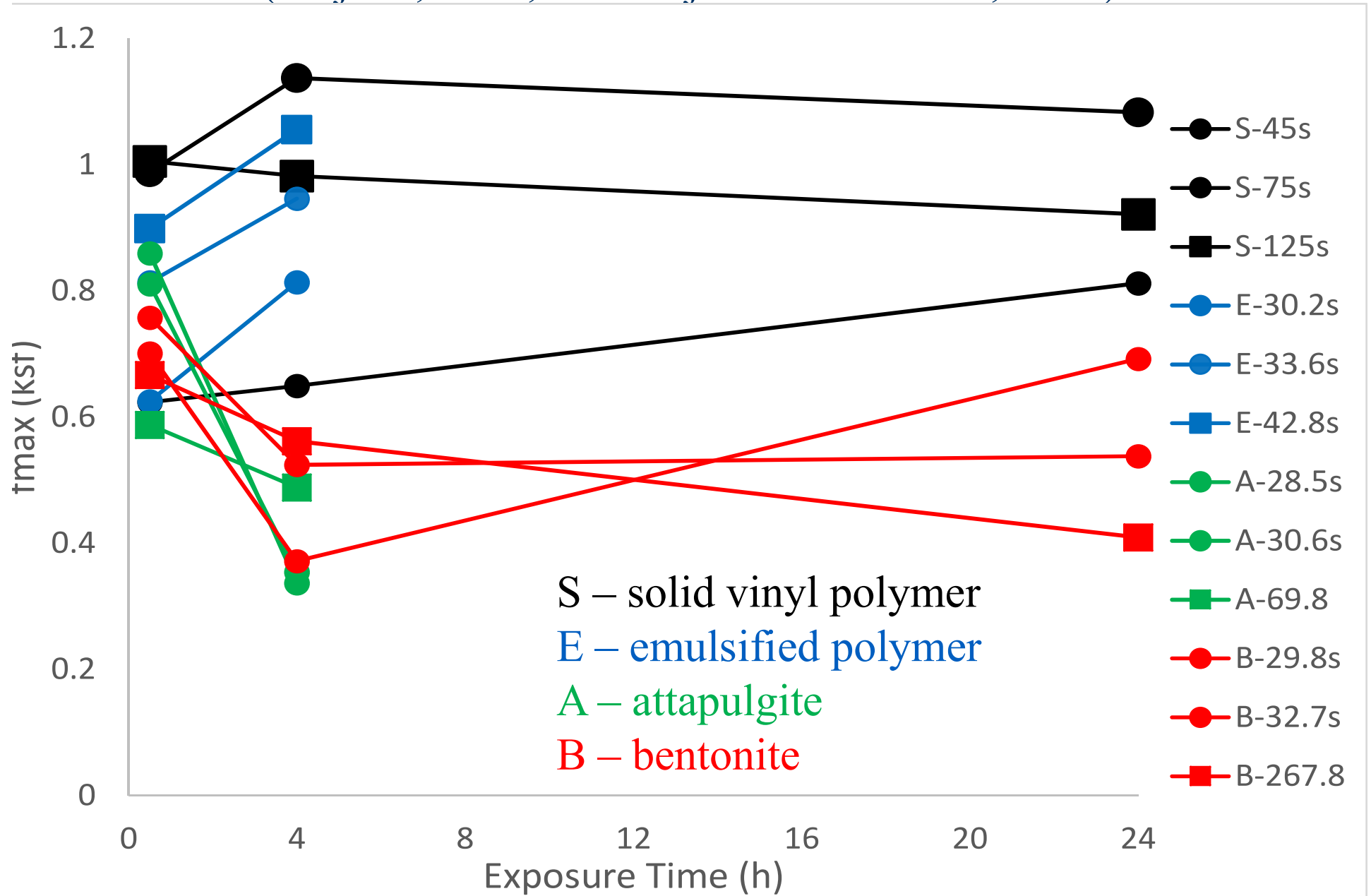
Effects of Exposure Time on Side Shear

(Majano, 1992, and Majano and O'Neill, 1993)



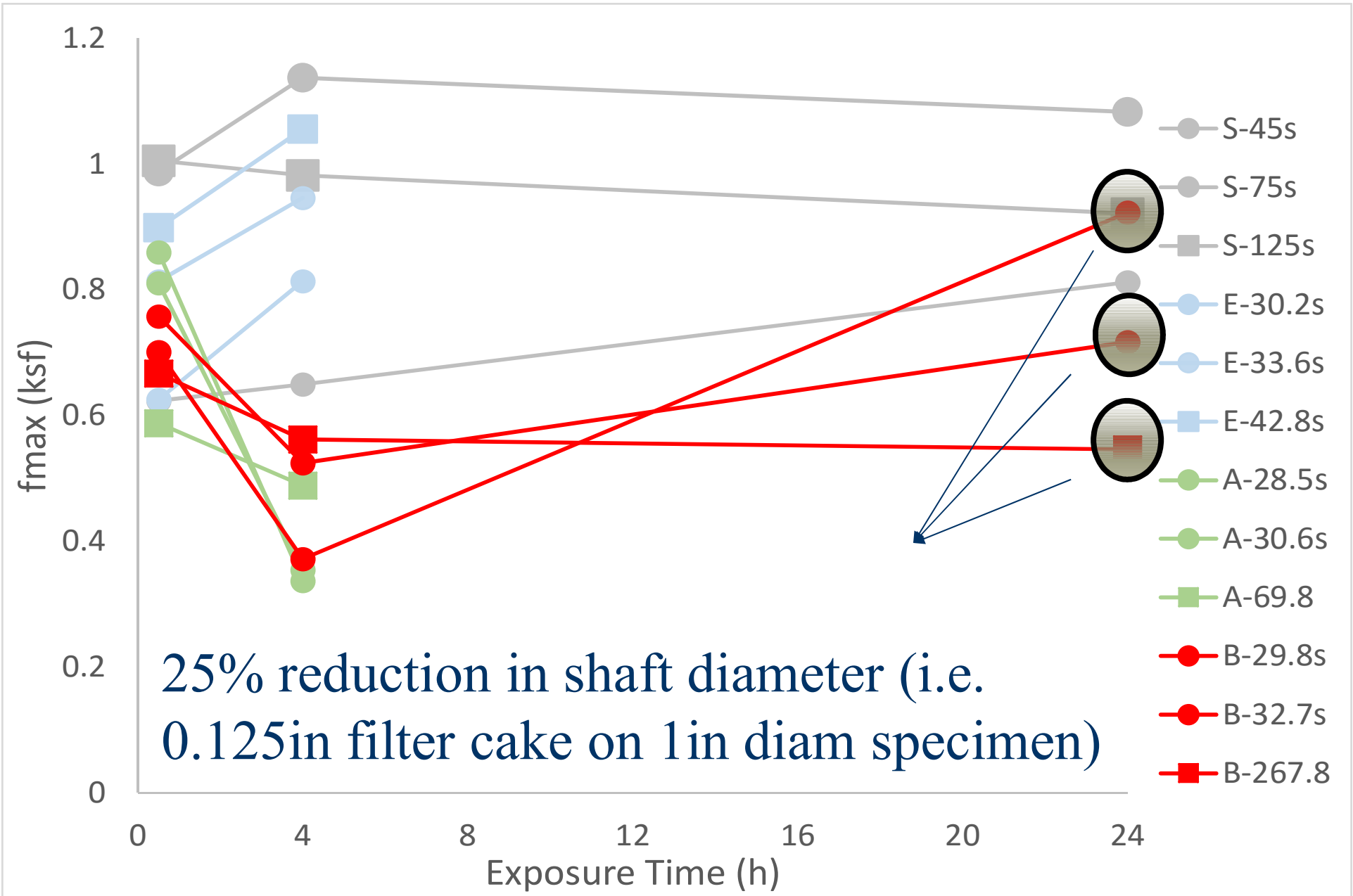
Effects of Exposure Time on Side Shear

(Majano, 1992, and Majano and O'Neill, 1993)



Effects of Exposure Time on Side Shear

Corrected 24h Bentonite





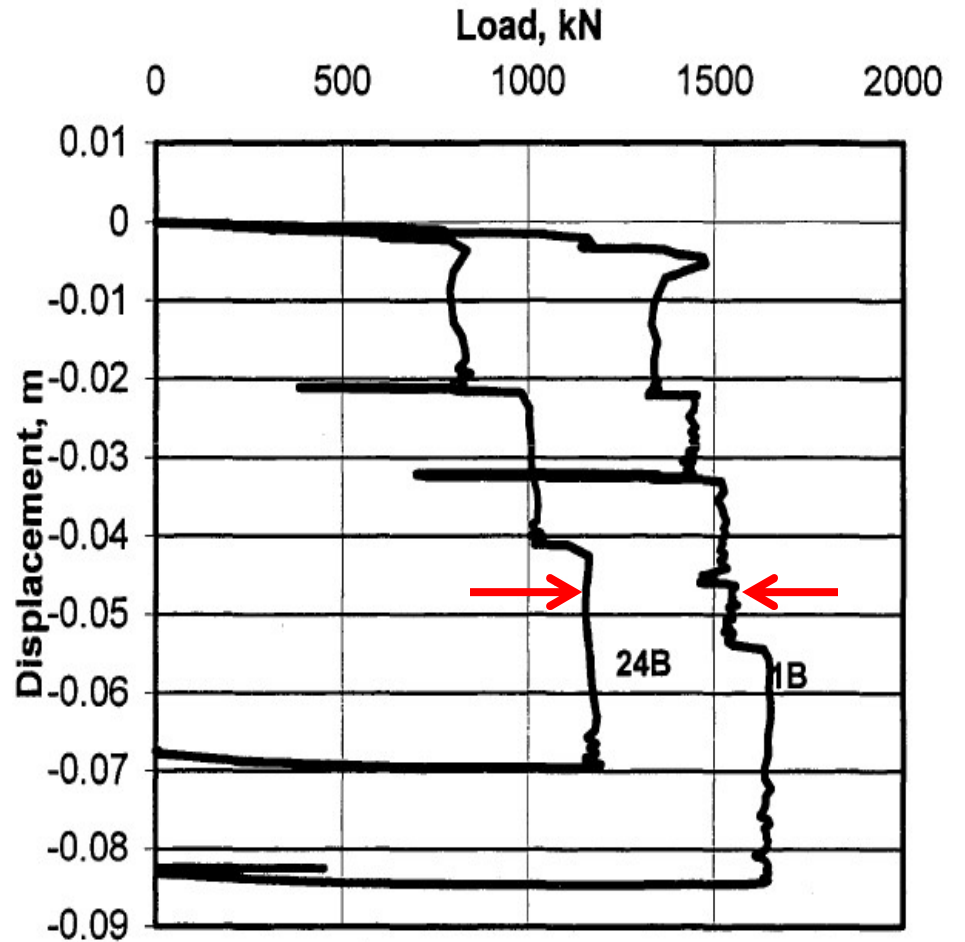
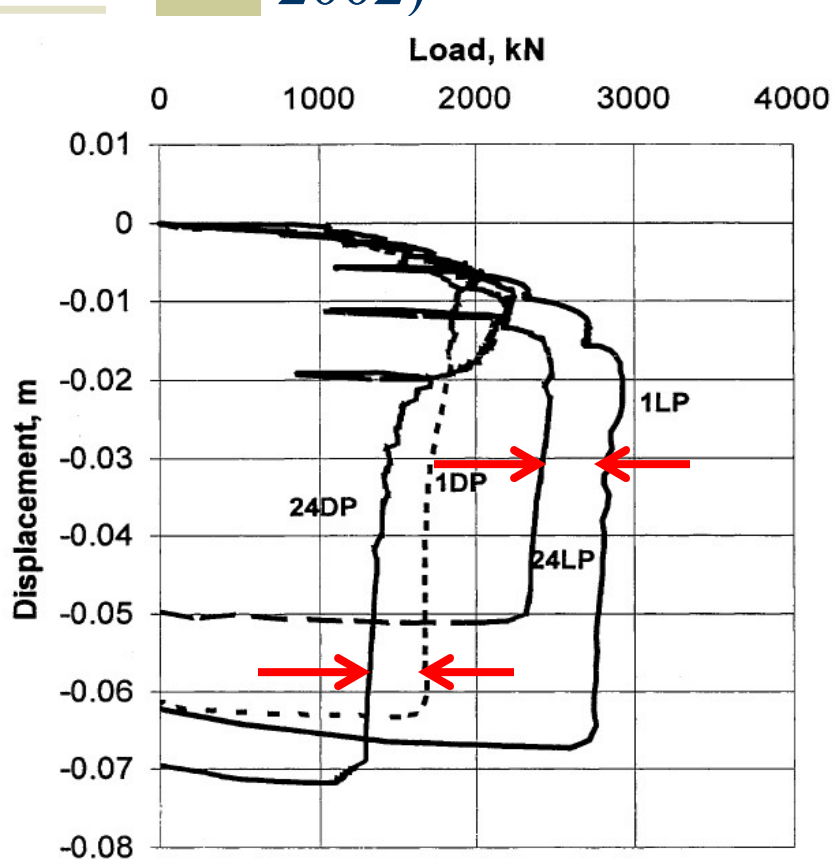
Effects of Exposure Time on Side Shear (Majano, 1992, and Majano and O'Neill, 1993)

*“Although the perimeter shear values yield by some slurries showed an improvement in the load transfer with time (e.g. bentonite) **it is erroneous to assume that longer exposure times produce better drilled shafts.** Visual analysis of the model shafts indicated deterioration in their geometrical dimensions which can be extrapolated to field practice to suggest detrimental effect on structural integrity of the foundation.”*

Majano, 1992

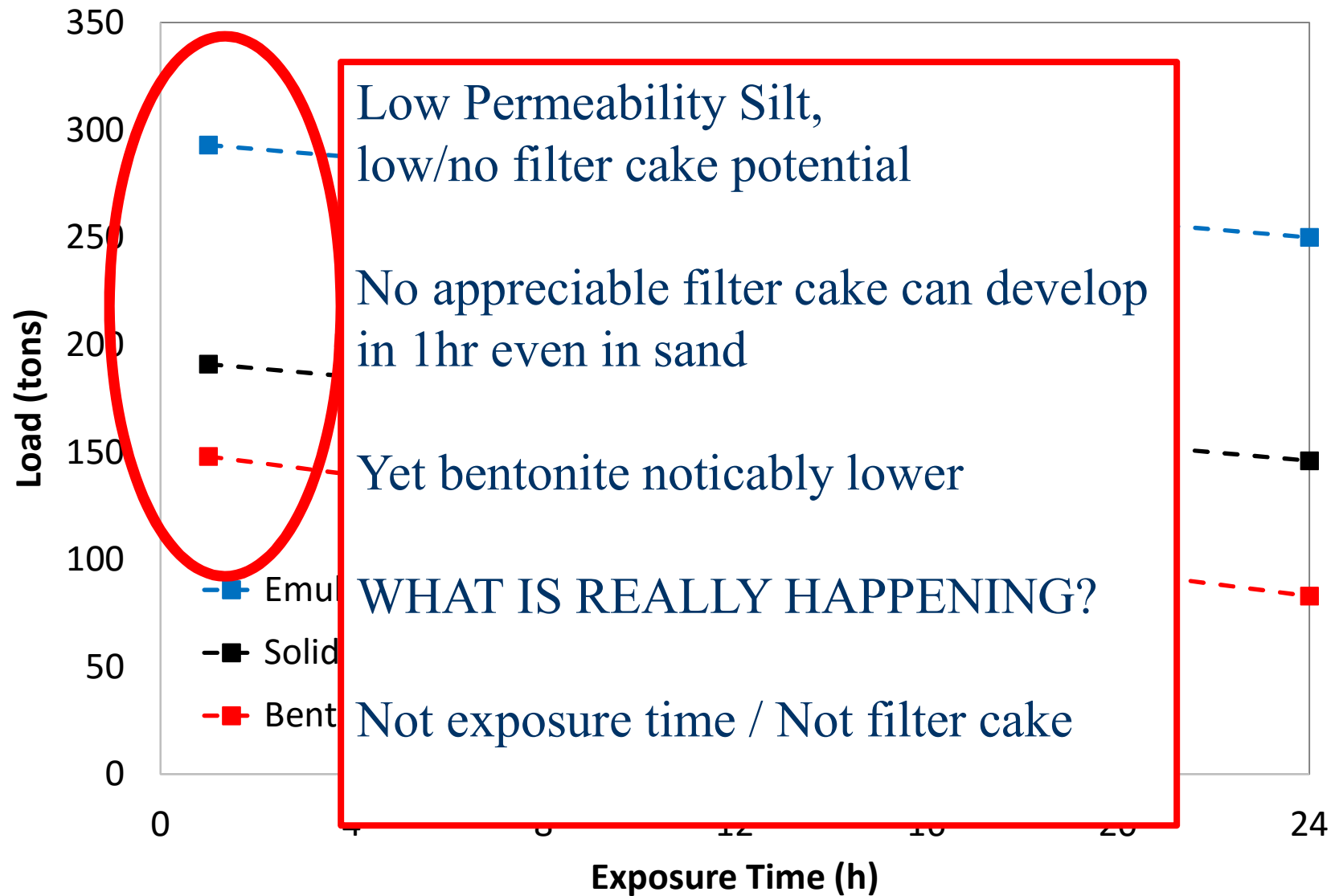
Time Exposure

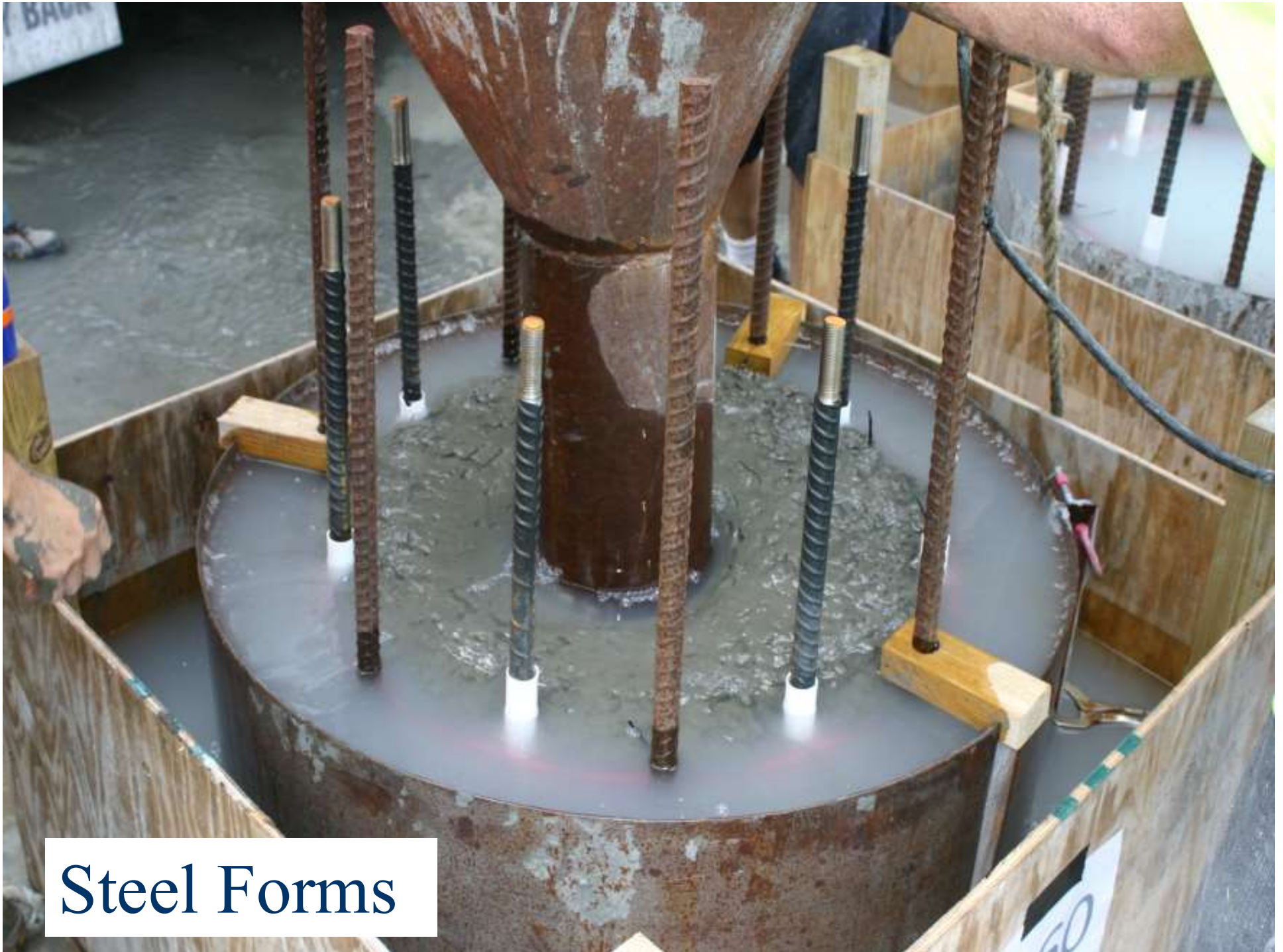
Effects of drilling slurries on Side Resistance (Brown, 2002)



Time Exposure (Brown, 2002)

All slurry types lost same amount of capacity (soil susceptible to stress relaxation or swell?)





Steel Forms

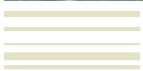






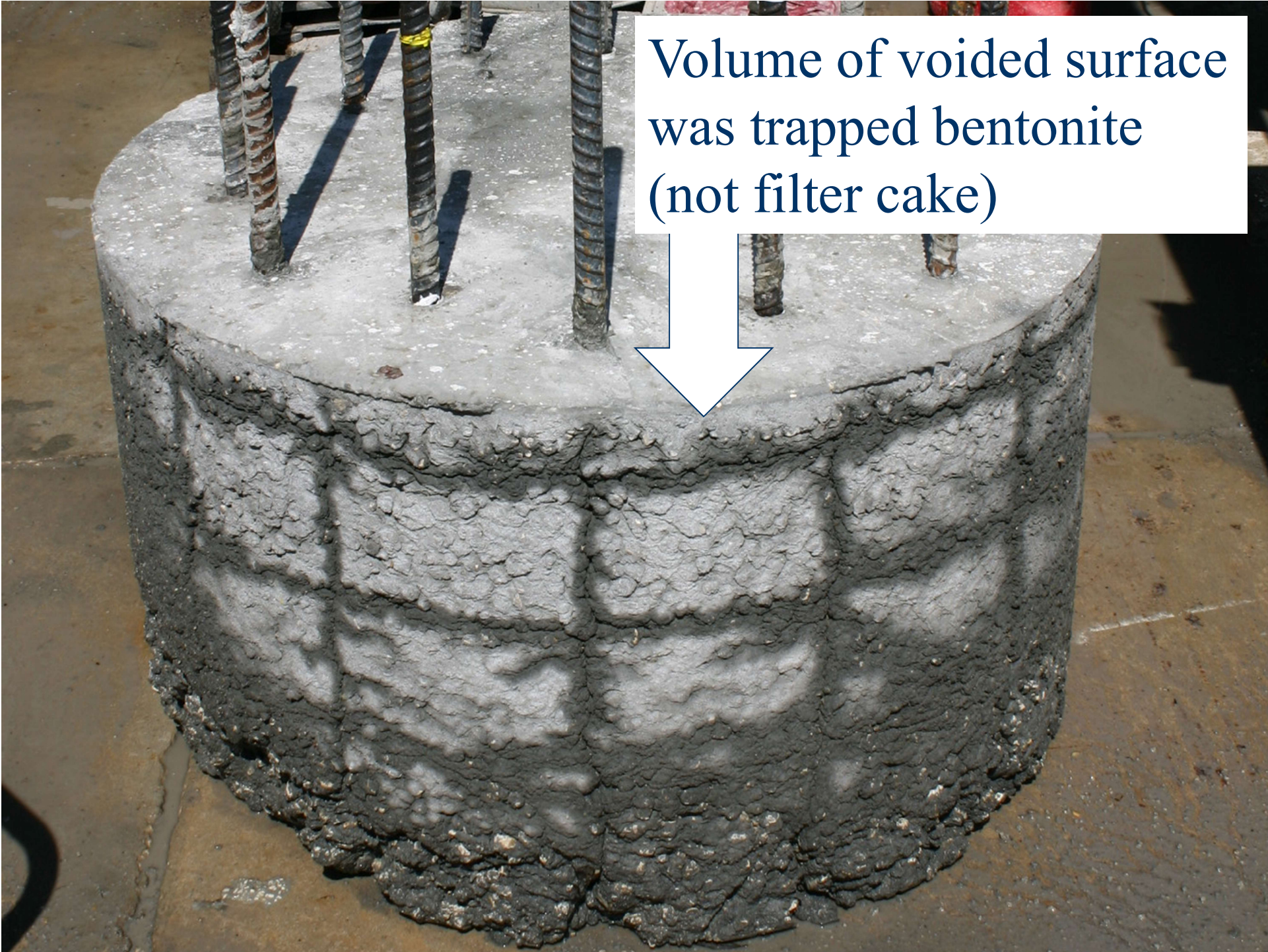












Volume of voided surface
was trapped bentonite
(not filter cake)



Polymer slurry not trapped

Polymer does not create
compromised soil interface at
time of concreting

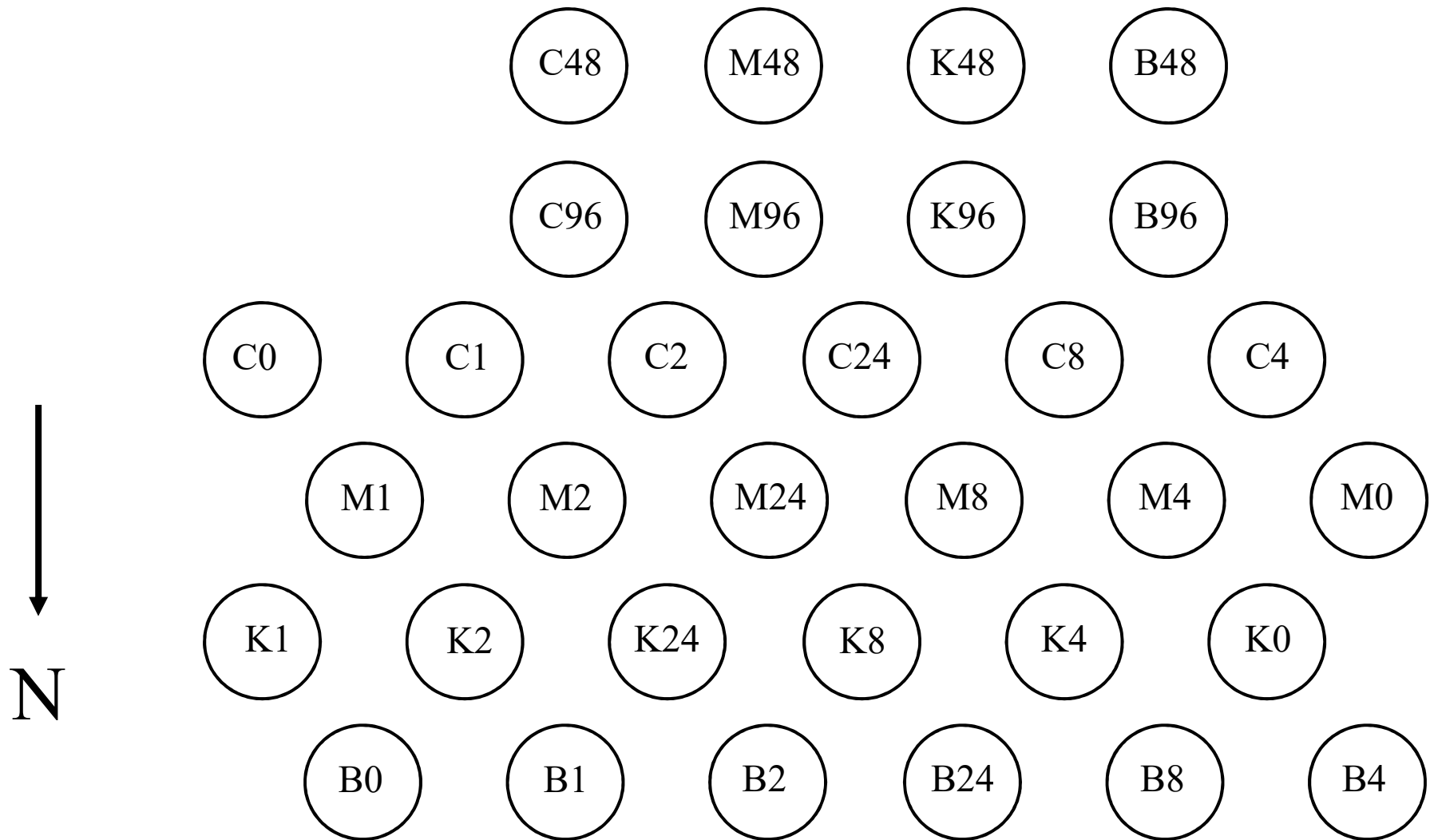


Research Approach

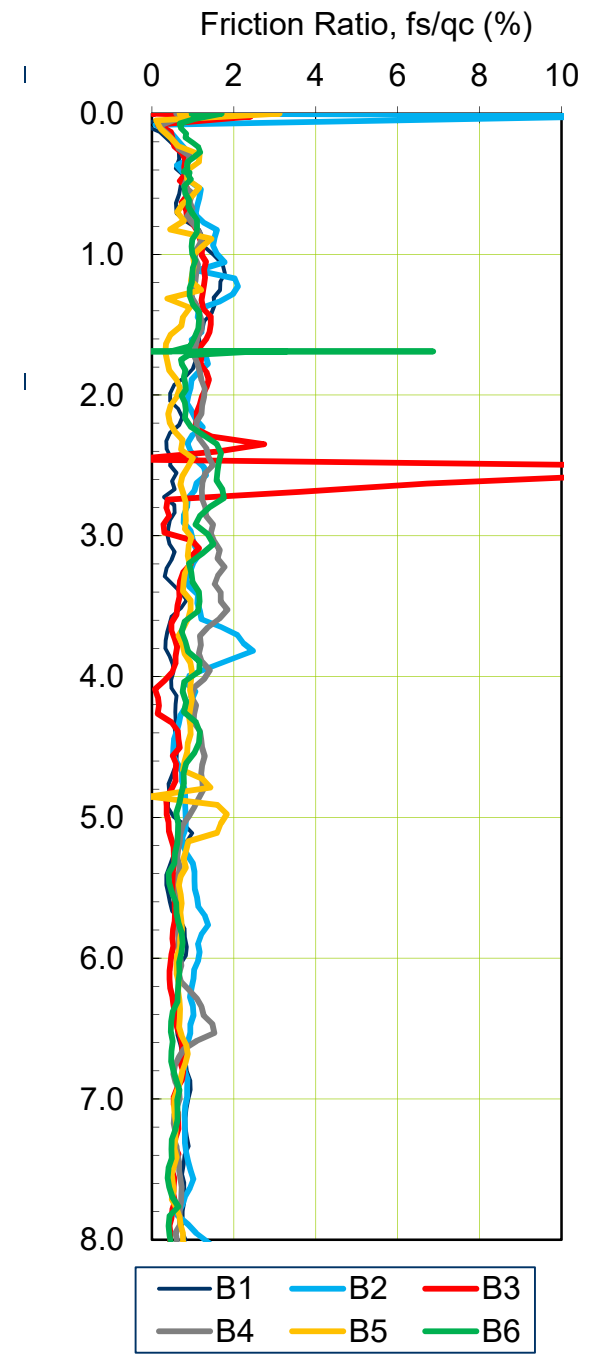
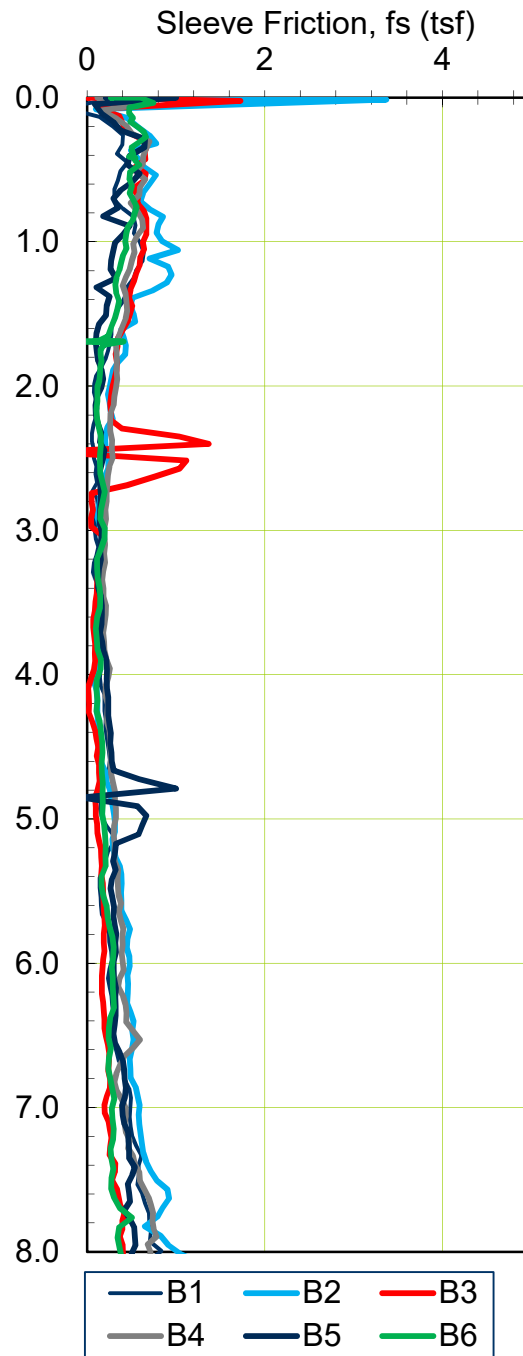
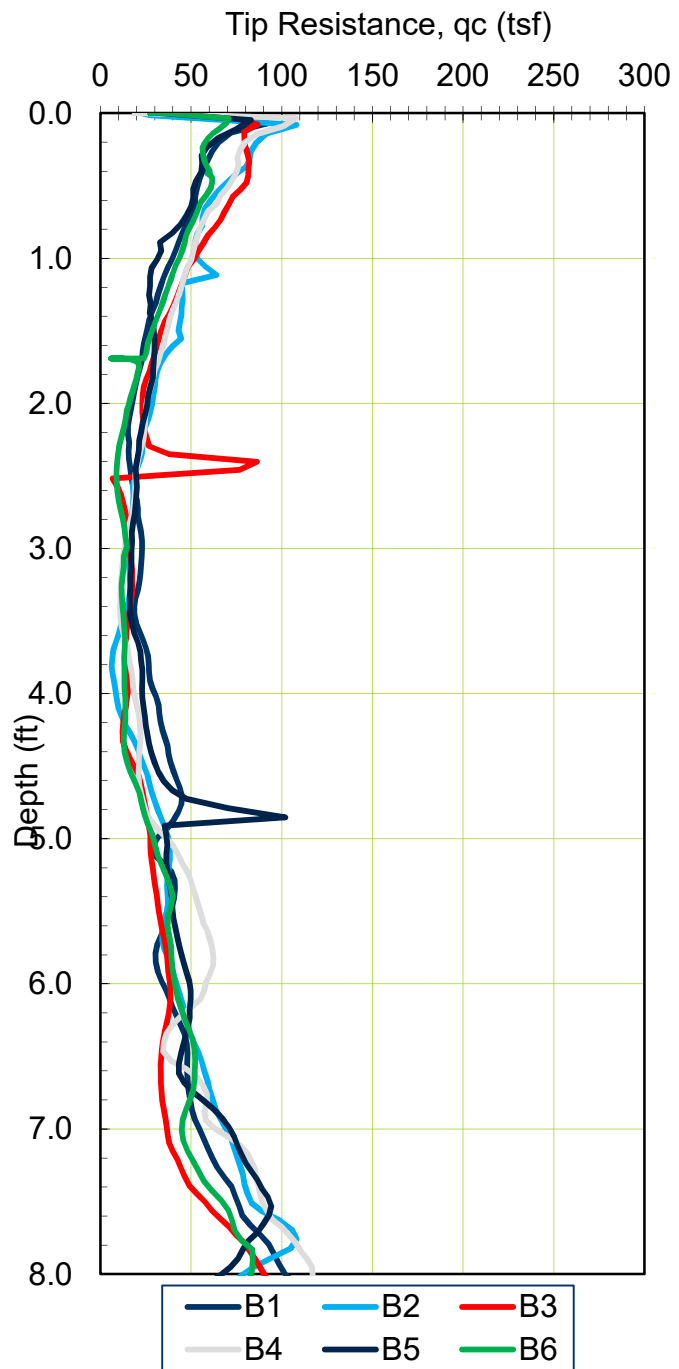


- ◆ 32 - 1/10th scale shafts
- ◆ 4in diam., 7ft to 8ft long
- ◆ Sand / silty sand (high flow rates)
- ◆ 0, 1, 2, 4, 8, 24, 48 and 96h exposure times
- ◆ 3 different polymer types
- ◆ 1 pure bentonite (control)

Small Scale Test Shaft Program



Not to Scale



Materials & Equipment



Sleeved Anchor Rods



Tremie



Temporary Surface
Casing and Slurry Pan



Excavation





Mixing Concrete



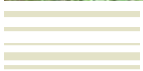
No coarse aggregate

Concreting







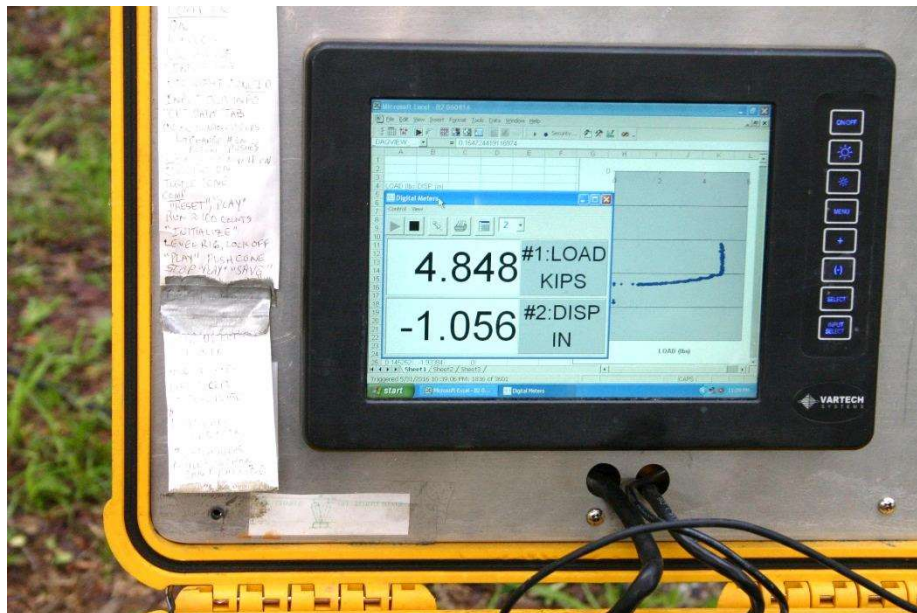






Static Load Test

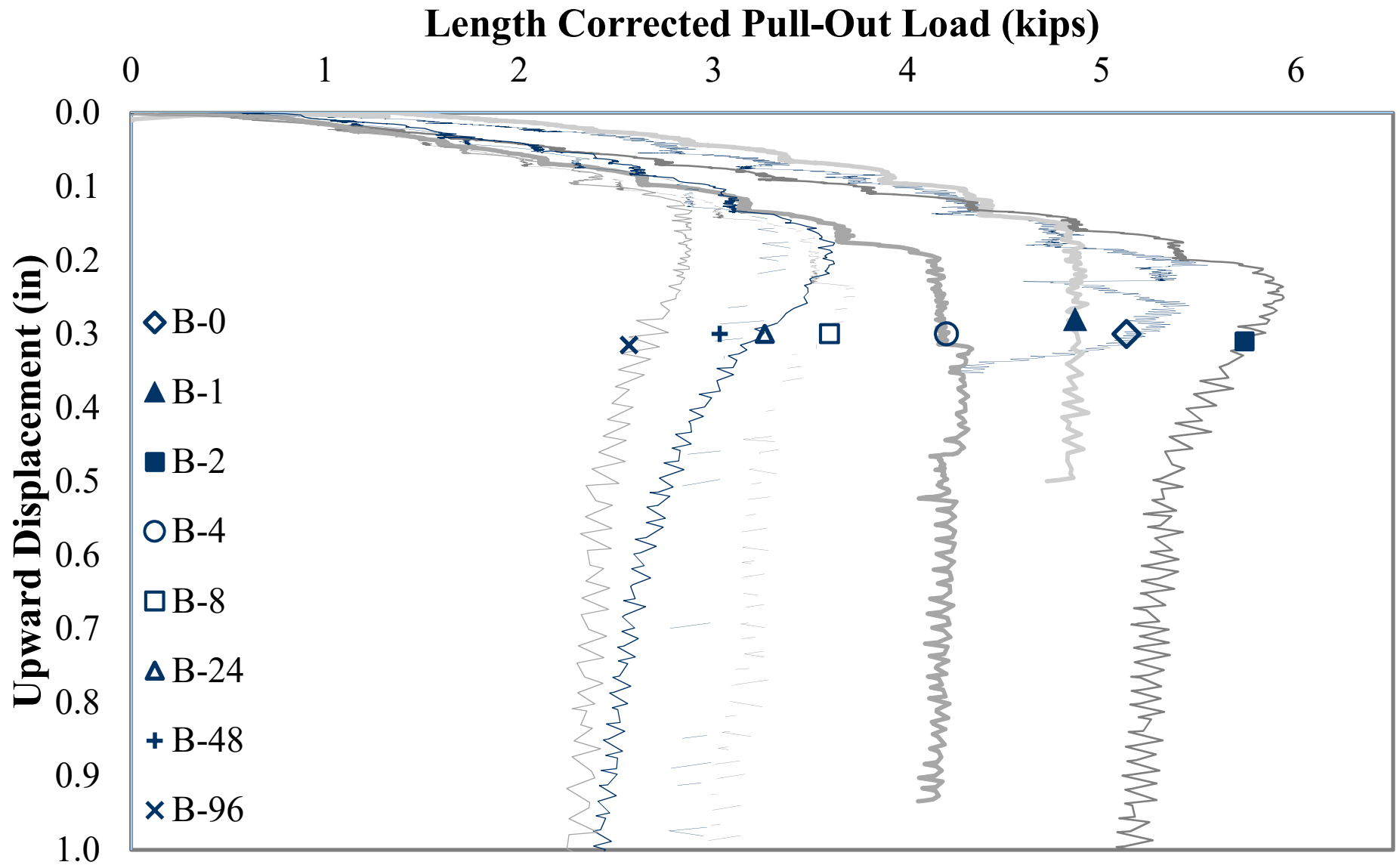
- ◆ Modified Quick Test
- ◆ Load Increments of 500lbs
- ◆ Max. Displacement of 4in



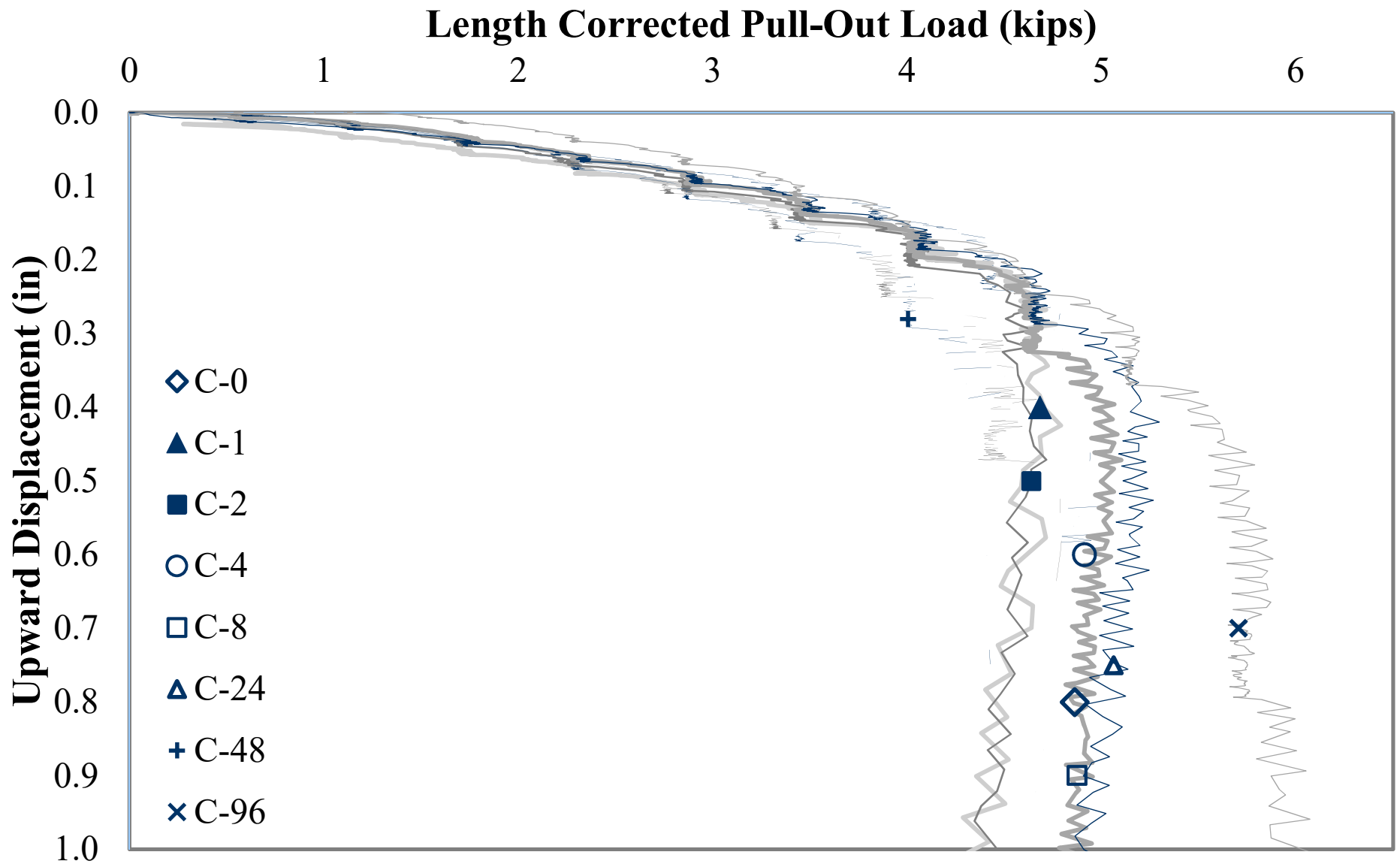
Load Testing



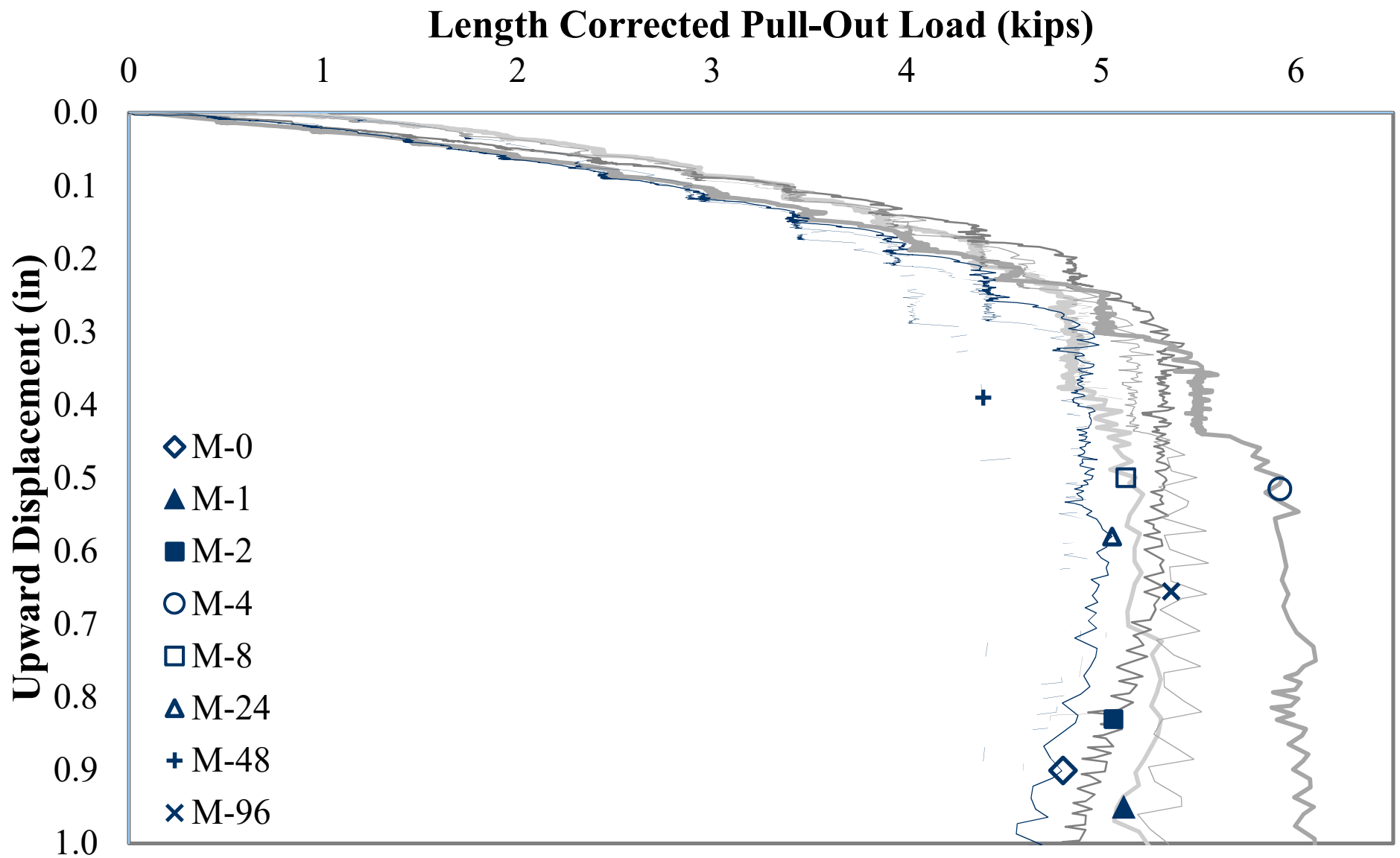
Bentonite Load Tests



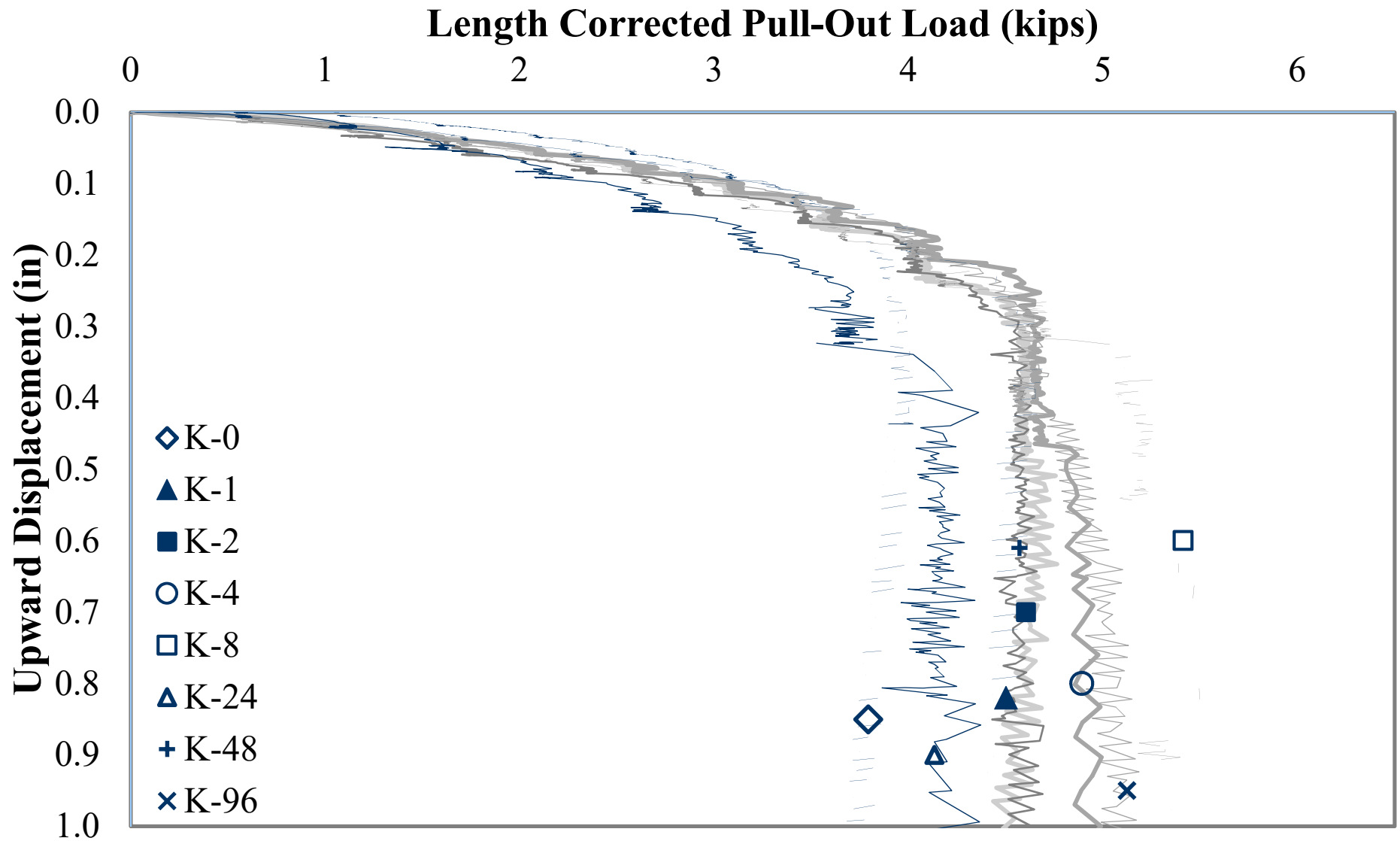
Cetco Polymer Load Tests

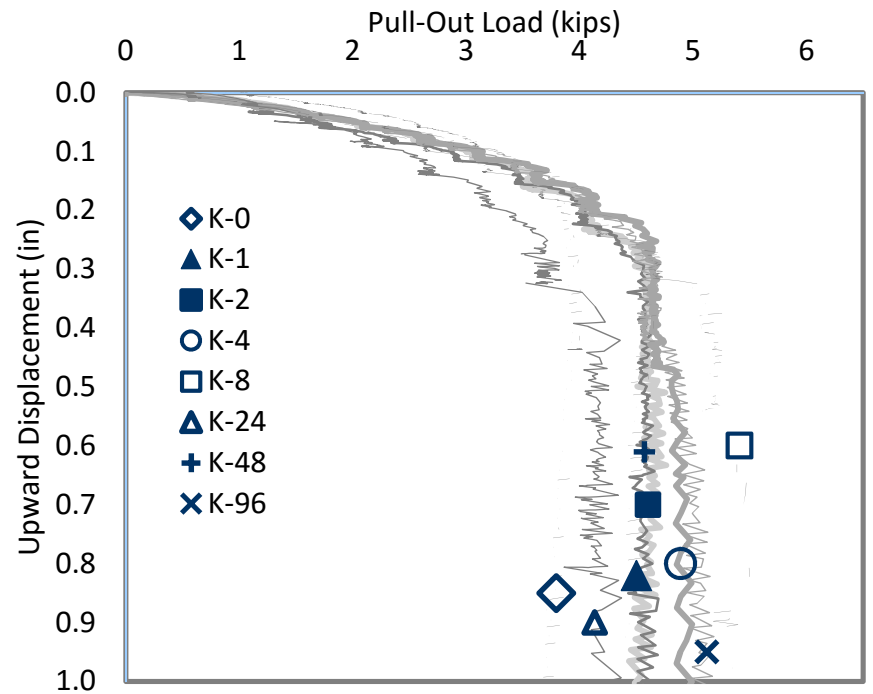
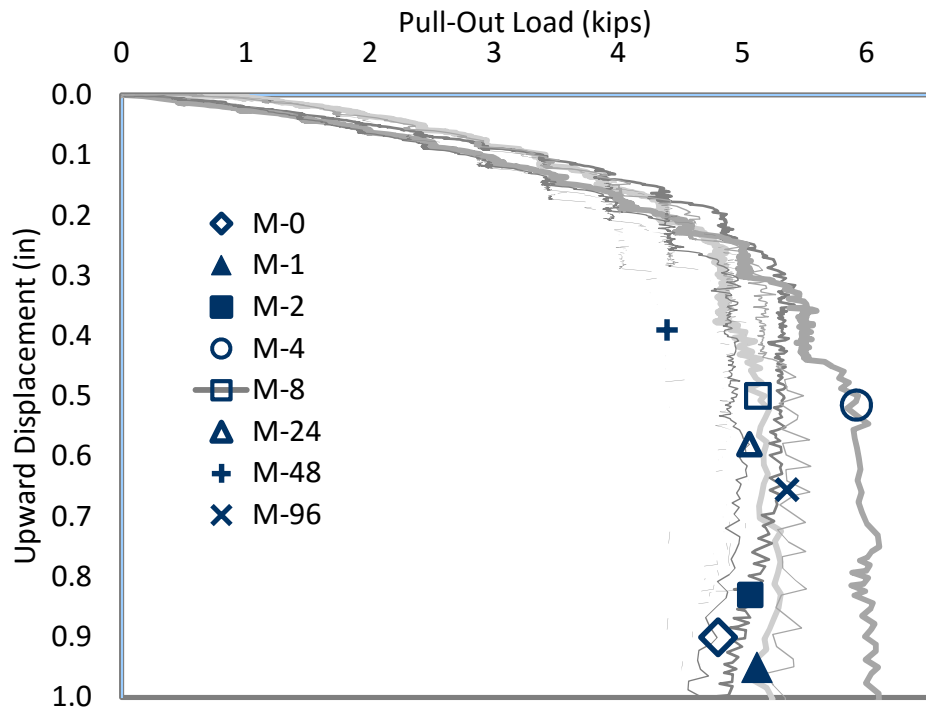
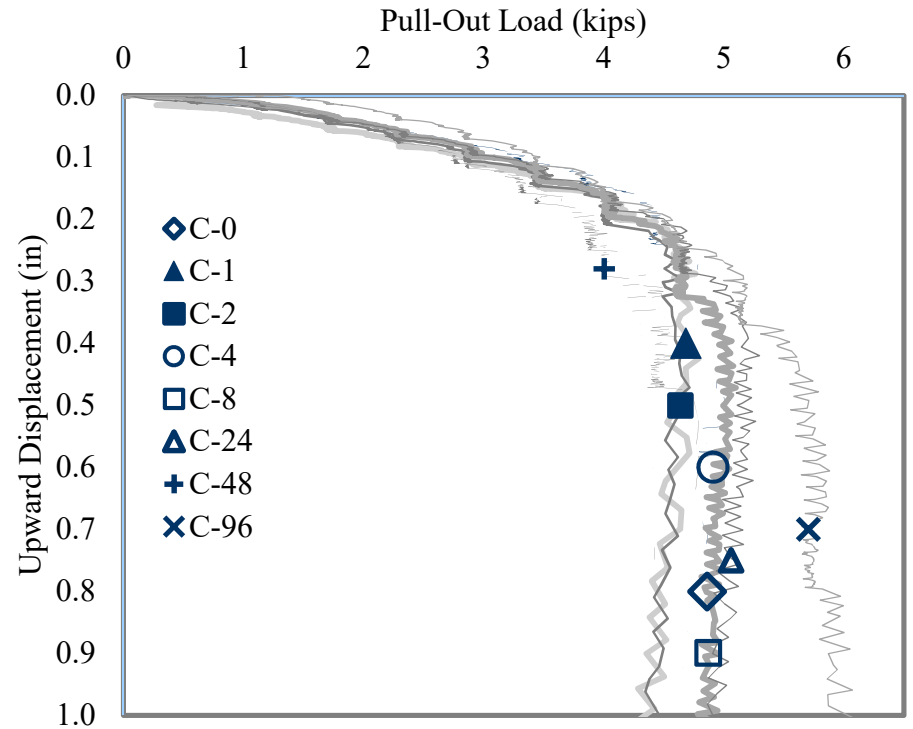
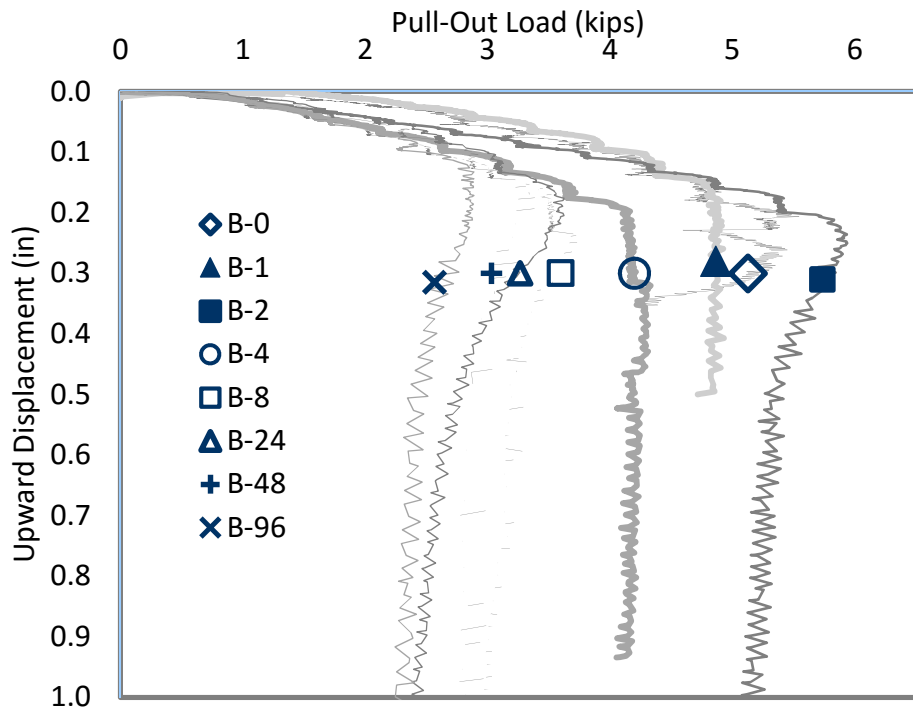


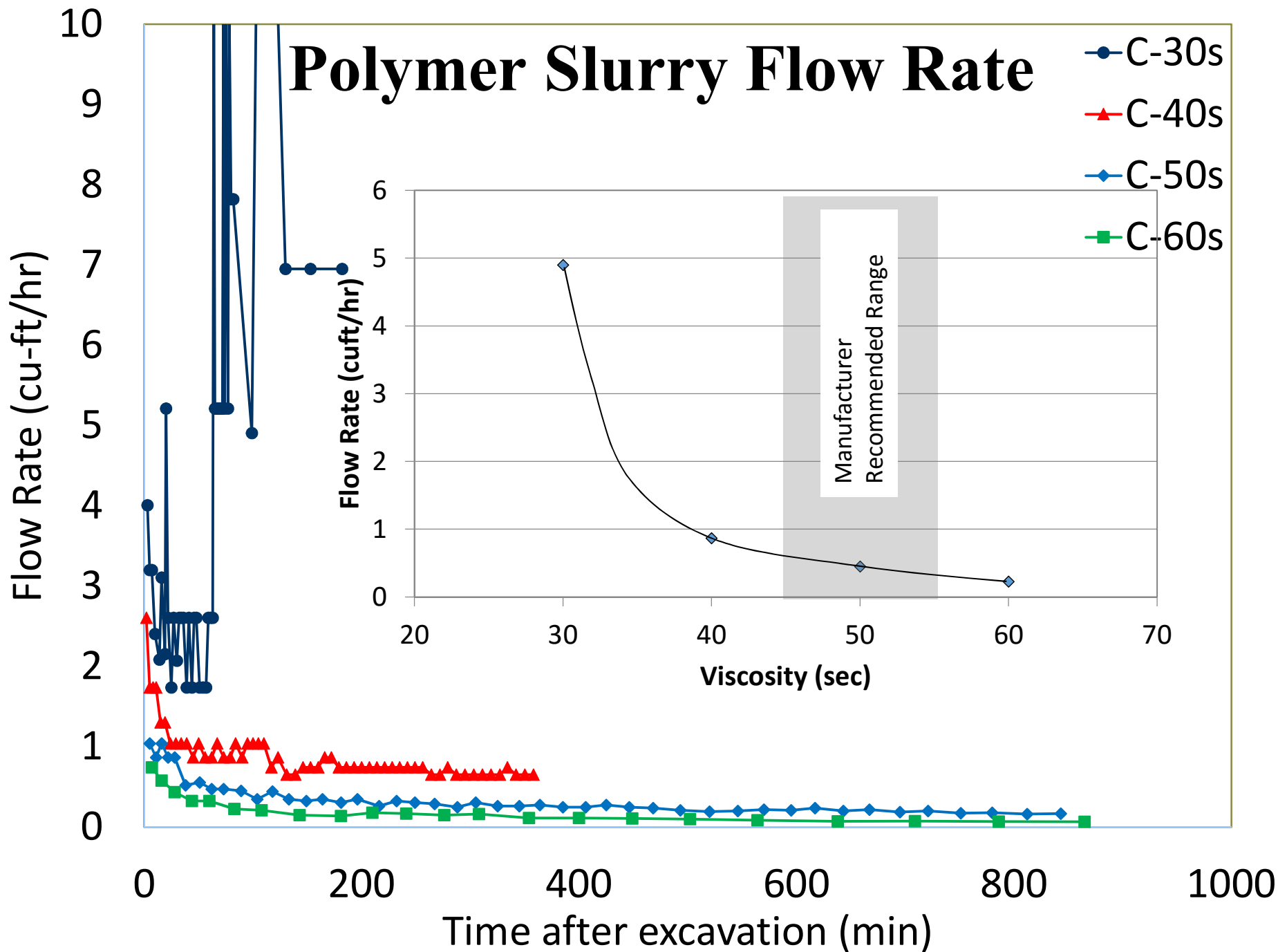
Matrix Polymer Load Tests



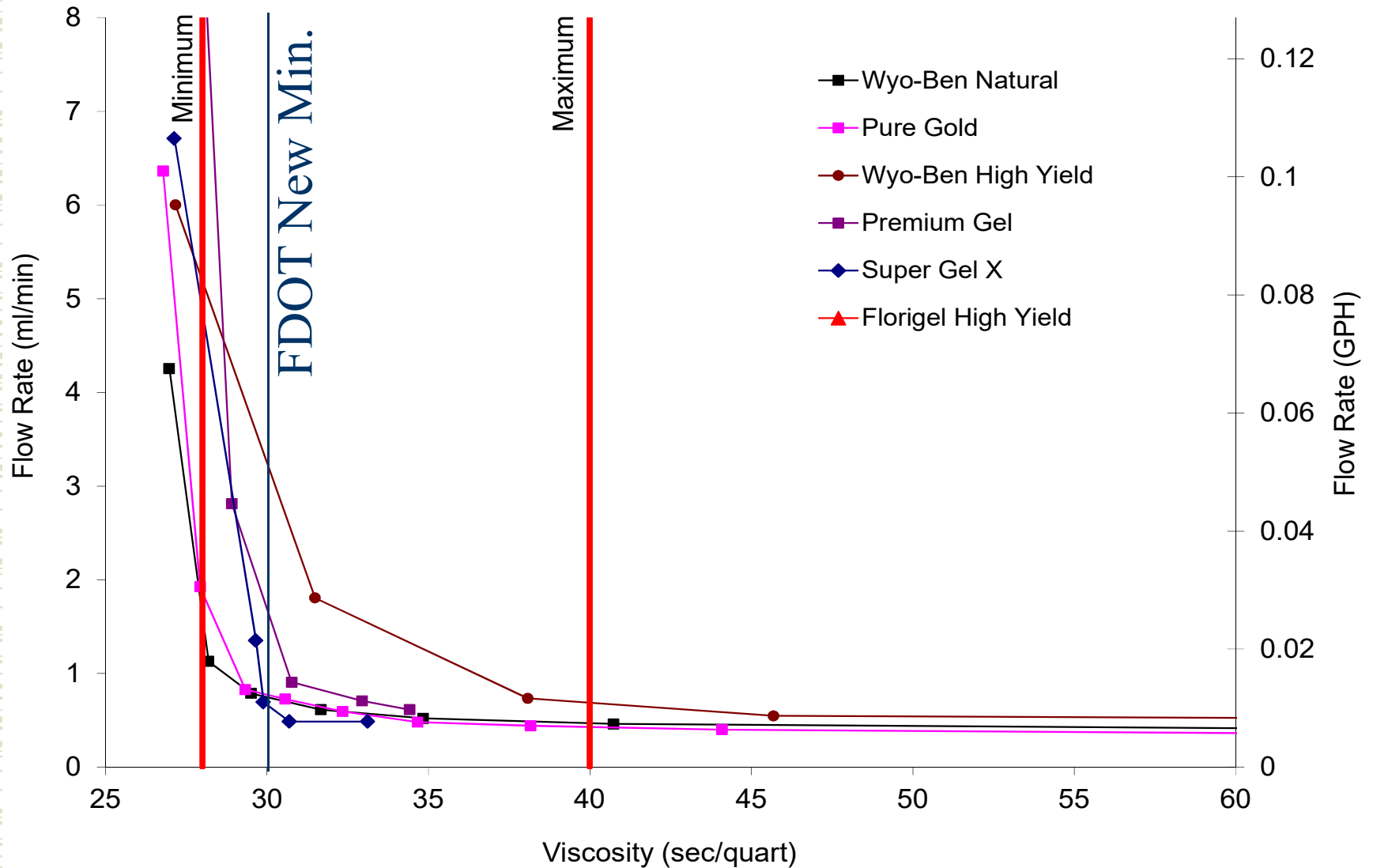
KBI Polymer Load Tests







Polymer Slurry Flow Rate



Shaft Extraction







Cutting and Cross Section



Bentonite



0h



24h

Polymer



0h



24h

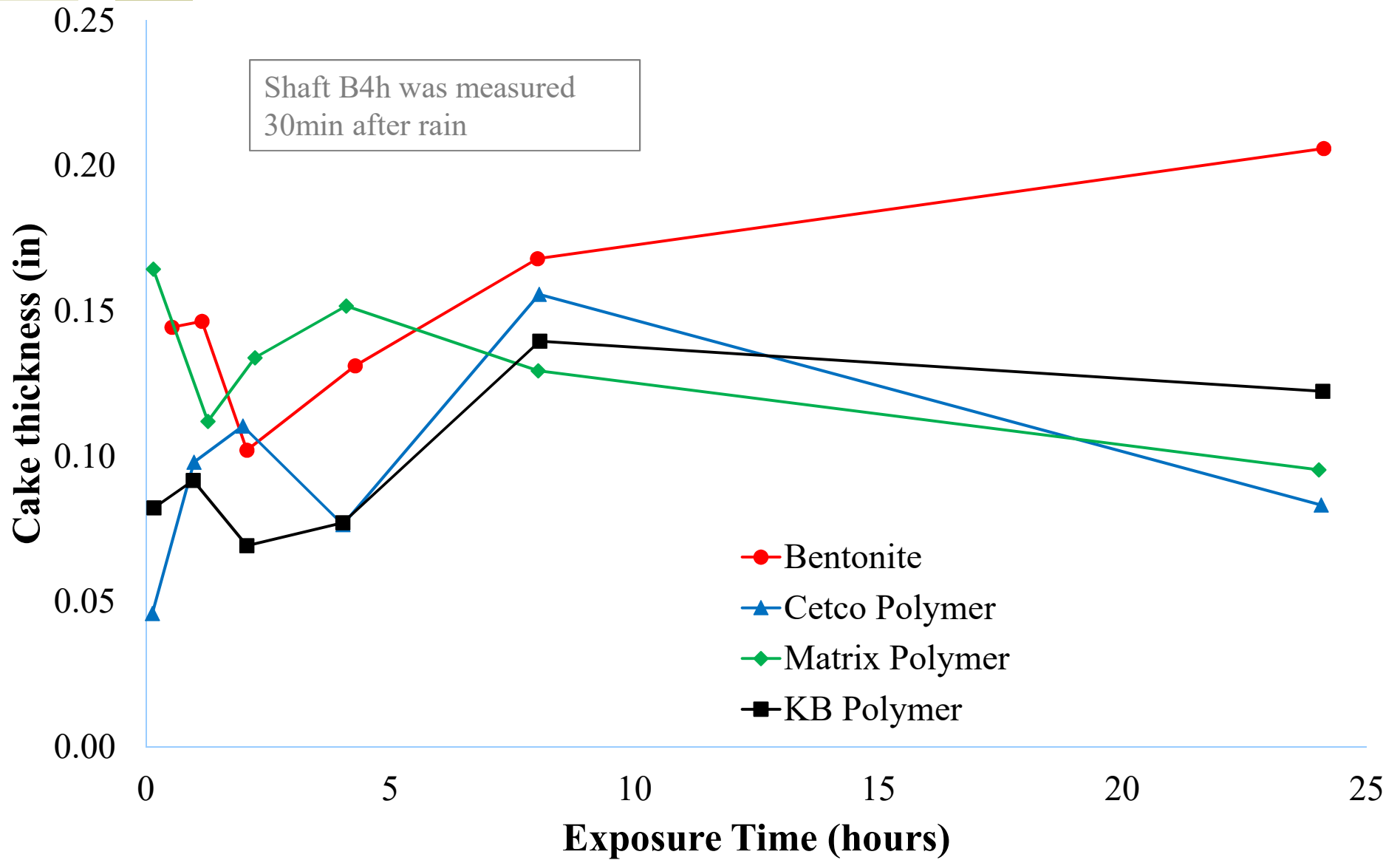


0h

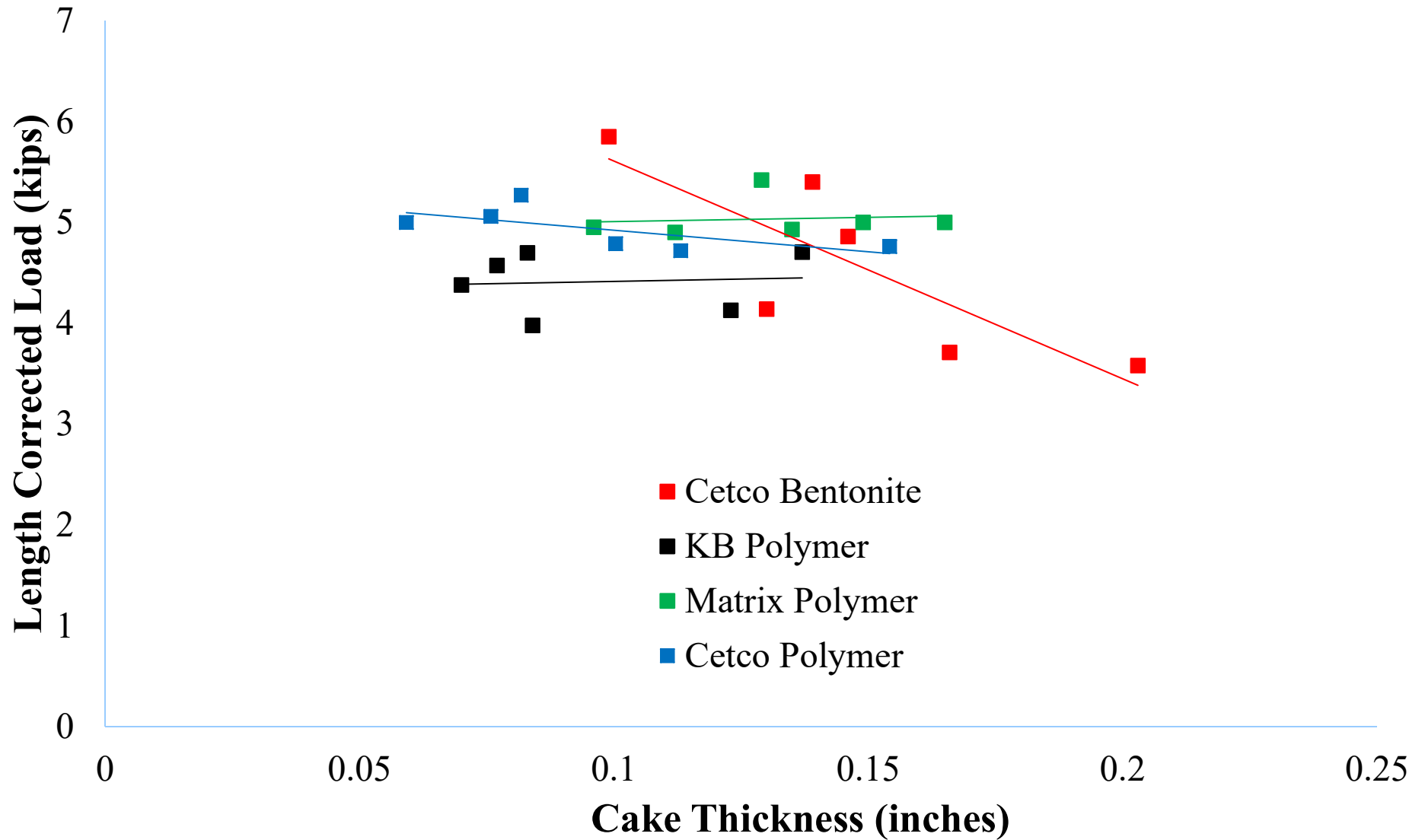
24h



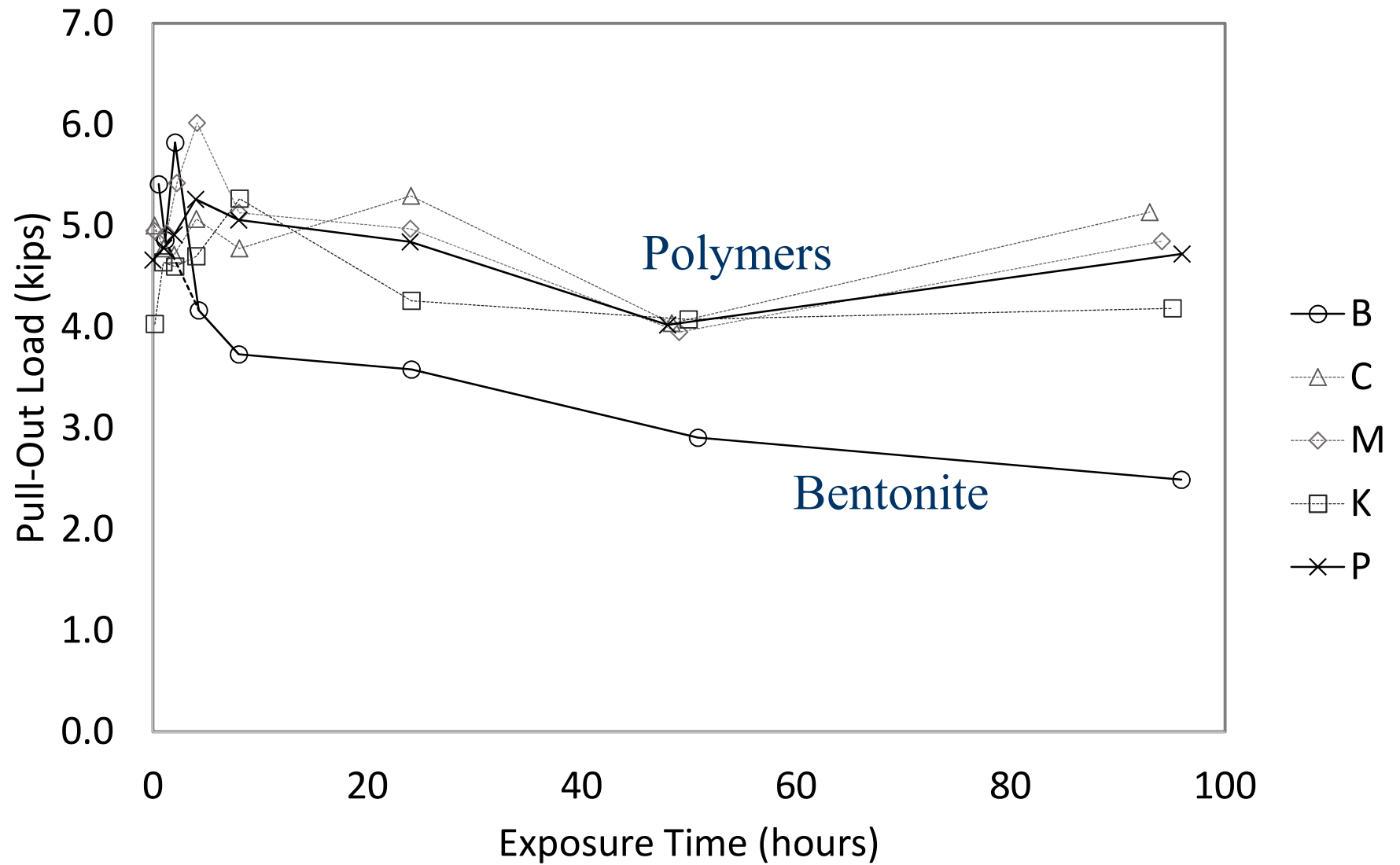
“Filter / Soil Cake”



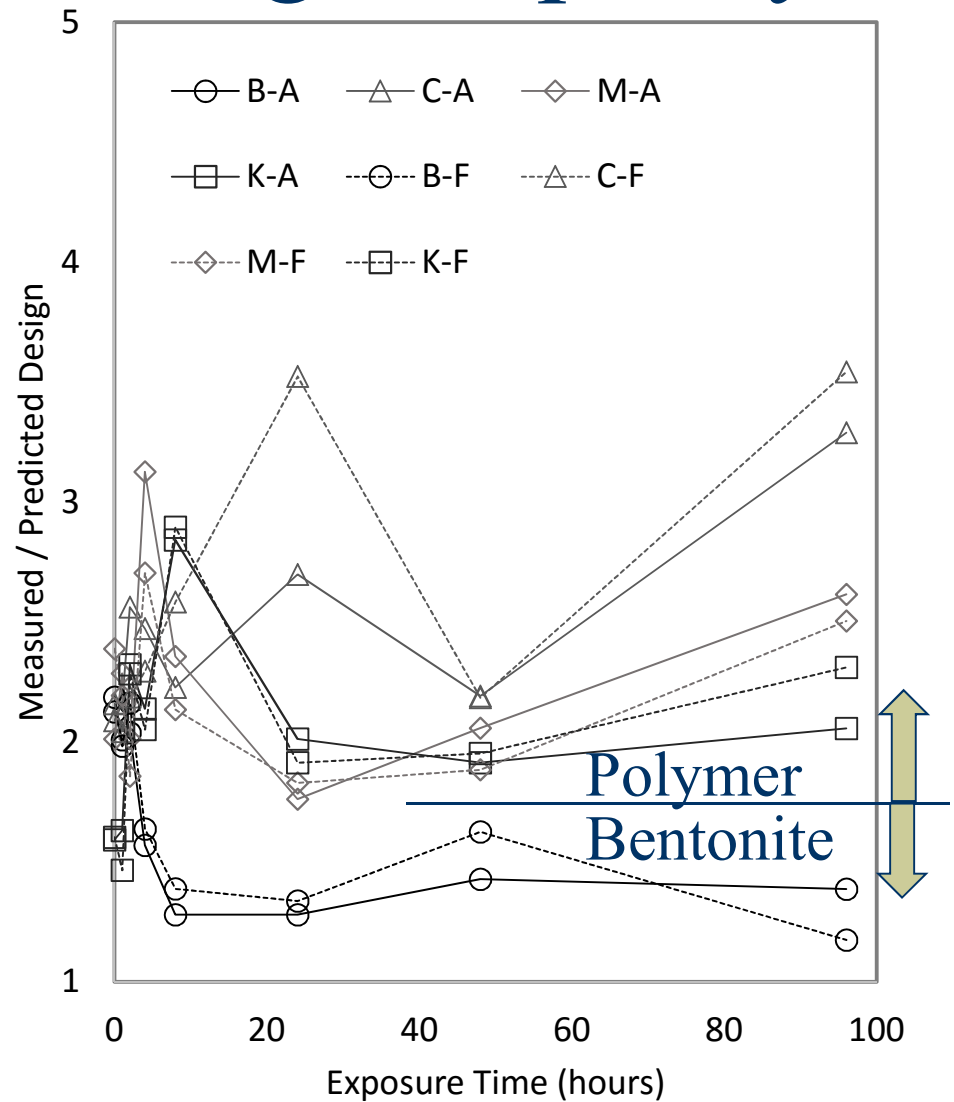
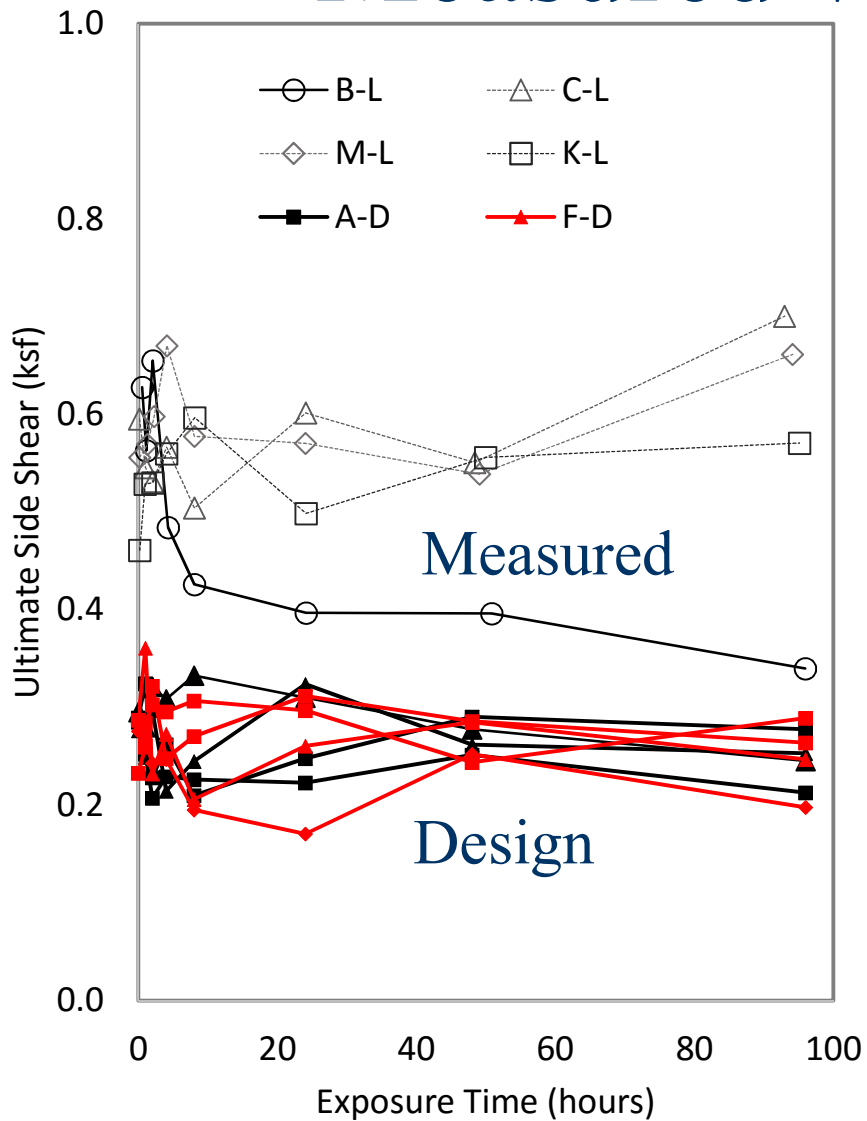
“Filter Cake”



Exposure Effects



Measured vs. Design Capacity





Summary

- ◆ Bentonite capacity reduction occurs within 8hrs
- ◆ Polymer showed no capacity reduction with time
- ◆ Polymer capacity was 1.5 to 2.5 times higher than bentonite
- ◆ Study considers purely the effect of slurry type and time (not concrete flow)
- ◆ Effects from entrapped bentonite from radial concrete flow thru cage not addressed; however, Polymer slurry does not exhibit entrapment.
- ◆ Updated polymer slurry specs are being considered

Questions

