CO US 36 Wall Foundation Failure and Use of Geofoam to Reopen the Roadway in 6 weeks

44th Annual Southwest Geotechnical Engineering Conference
June 23, 2021

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Background

- On or about July 12, 2019, what is known as the "Boulder Turnpike" (US 36) between Boulder and Denver began to show rigid pavement distress.
- The average traffic is approximately 90,000 vehicles a day.
- The roadway section was supported by an approximate 35-foot-high MSE wall on a clay soil foundation.
- By July 13, 2019, the Eastbound Section of the highway was closed, and emergency repair operations began……..

Presentation and Publication

The paper discusses observations by RJ Engineering from July 13, 2019 forward.

The paper does not discuss:

- Causation or parties involved.
- Forensic investigation.
- Geotechnical investigations either prior to are after the wall failure.
- Discussion of pros and cons of various direct shear laboratory testing methods.
- Geologic history and breakdown of geologic events in the past.

July 13, 2019

July 13, 2019

July 14, 2019

July 14, 2019

July 14, 2019

July 14, 2019

July 16, 2019

July 15, 2019

July 16, 2019

July 16, 2019

July 18, 2019

July 18, 2019

July 18, 2019

July 18, 2019

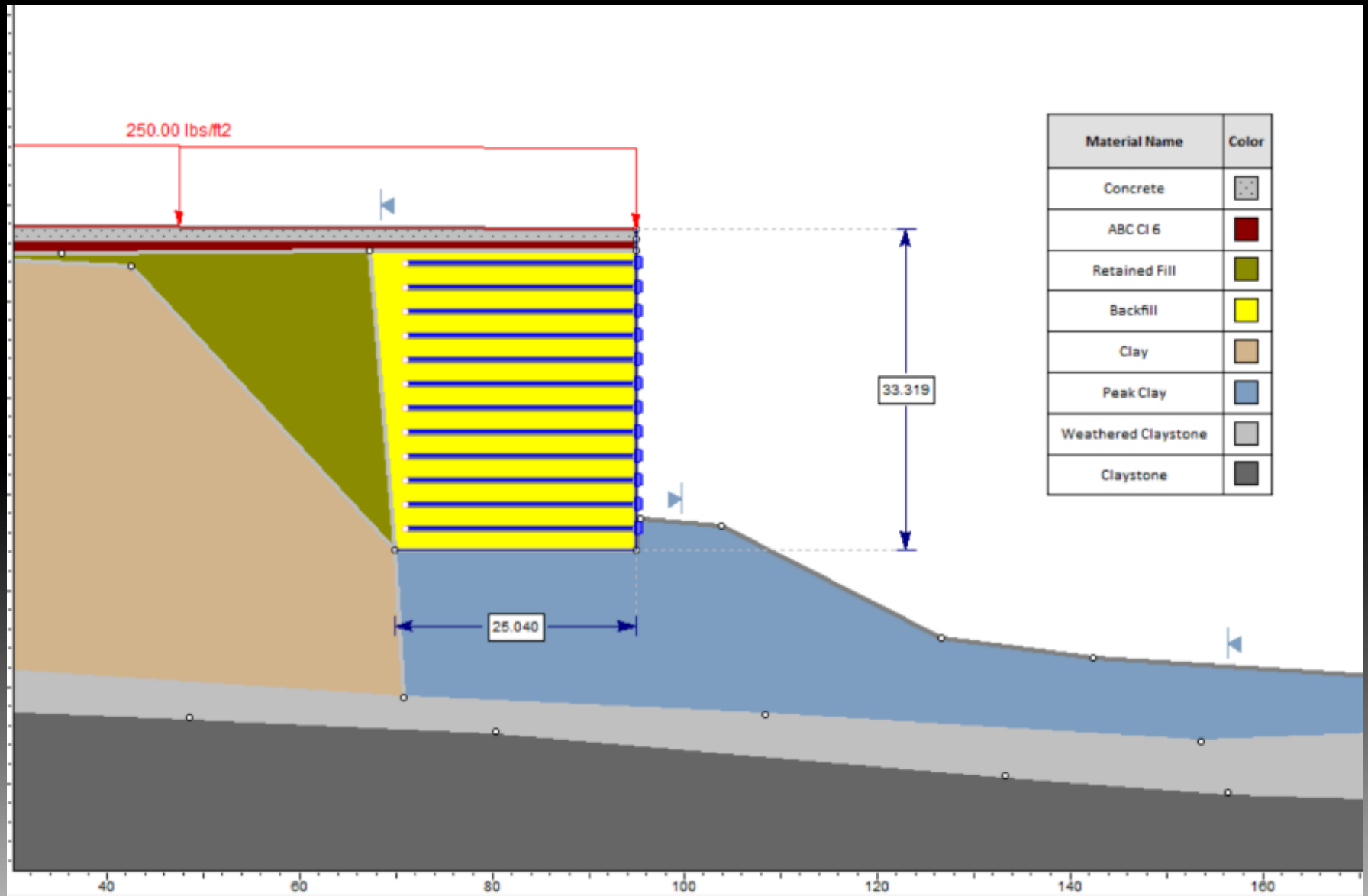
July 22, 2019

July 22, 2019

Notable Topics

- CDOT Chief Engineer asked design team (RJ Engineering and David Evans and Associates, Inc) to get the roadway open ASAP.
- Global Stability Controls Design.
- Based on my previous experience suggested GEOFOAM.
- GEOFOAM replaces 130 pcf with 1.5 pcf material.
- Lightweight GEOFOAM reduces driving forces of Global Stability.
- Considerations / Lessons Learned using GEOFOAM for this project.

Typical Cross Section 07/13/19
Modeled with LE and FE



Consideration for Stability Modeling

As stated by George Box, a British statistician:

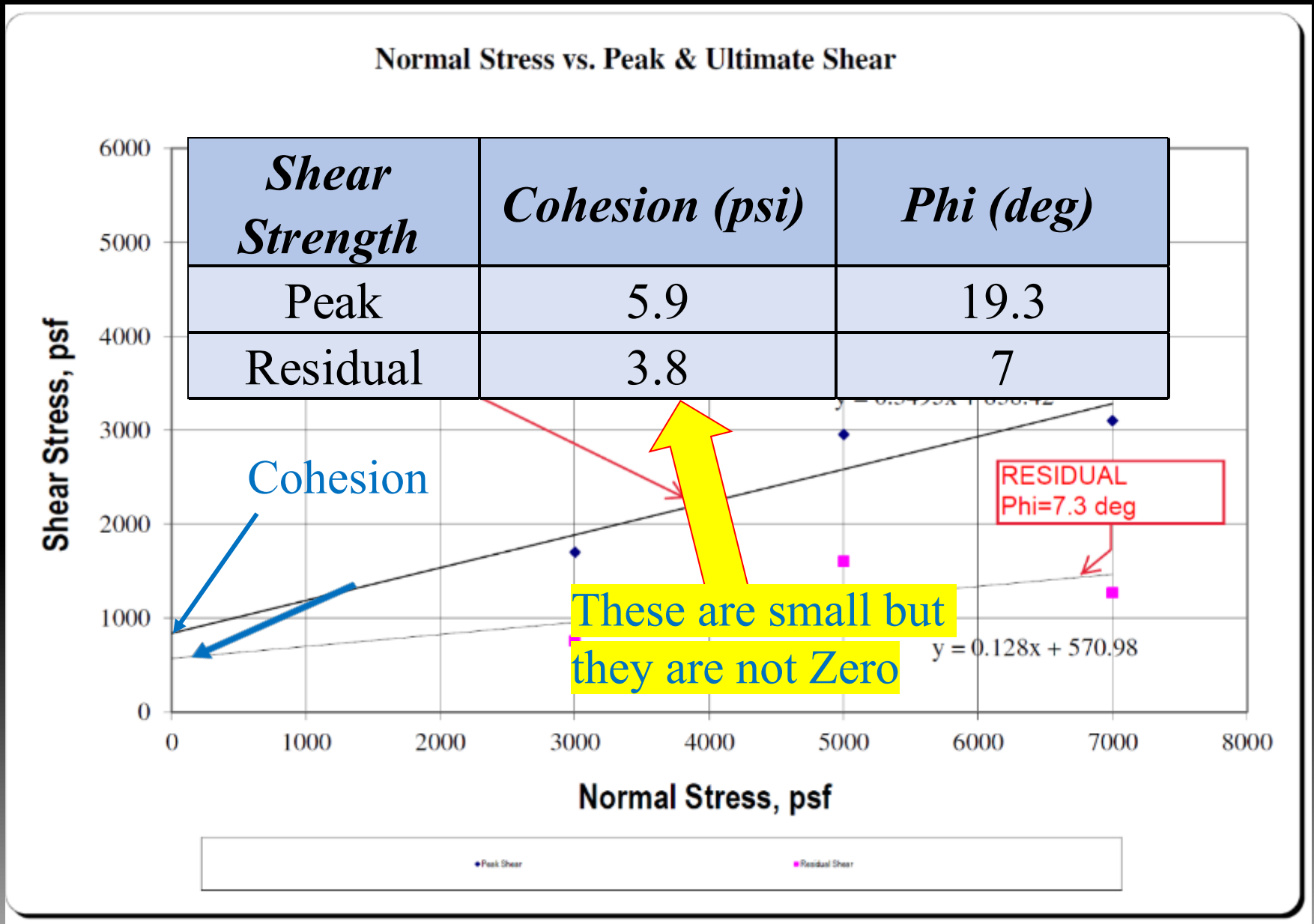
"…all models are approximations. Essentially, all models are wrong, but some are useful. However, the approximate nature of the model must always be borne in mind."

August 9, 2019
Failure Surface Exposed

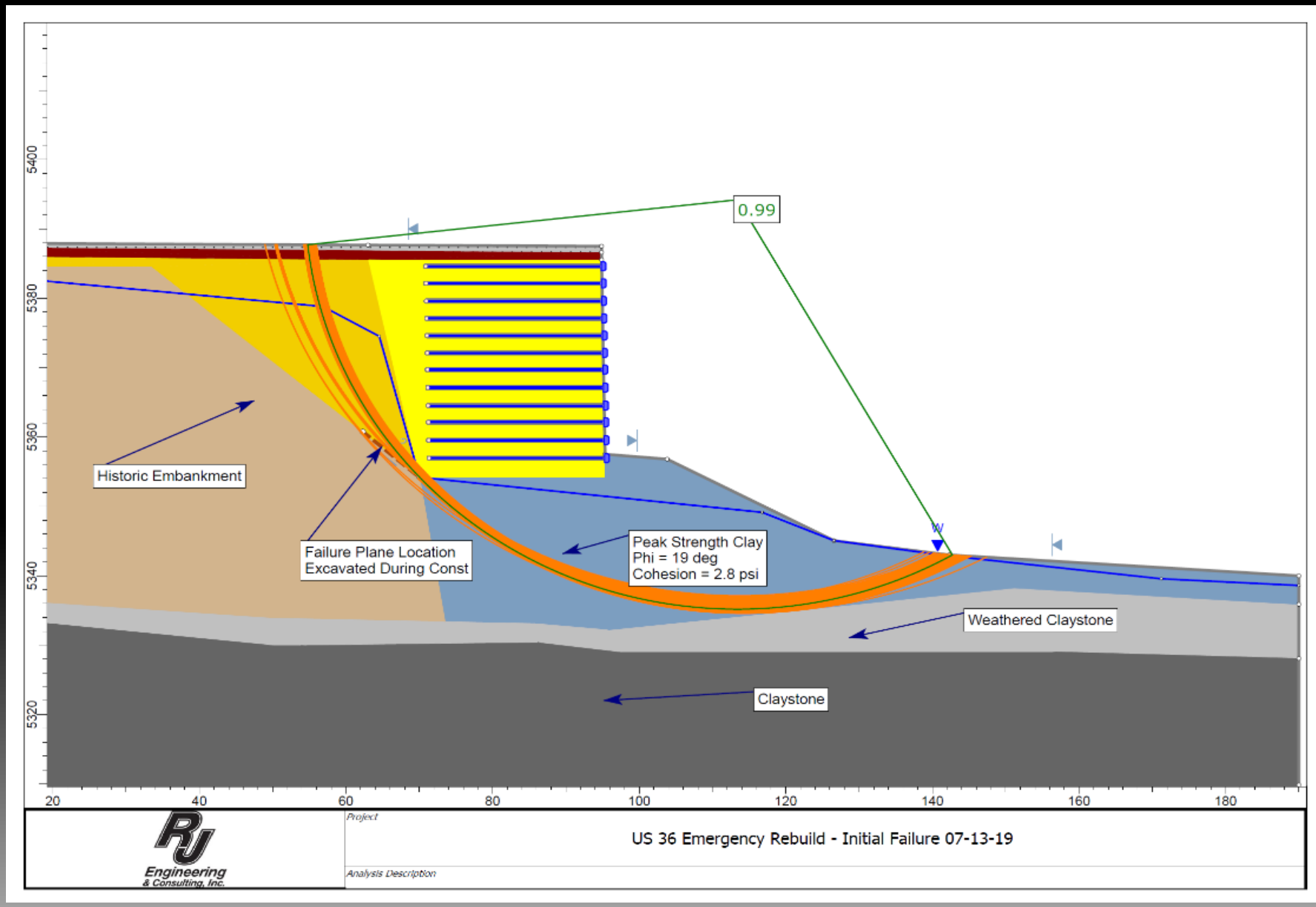
California Sampler

Slickensided Surface

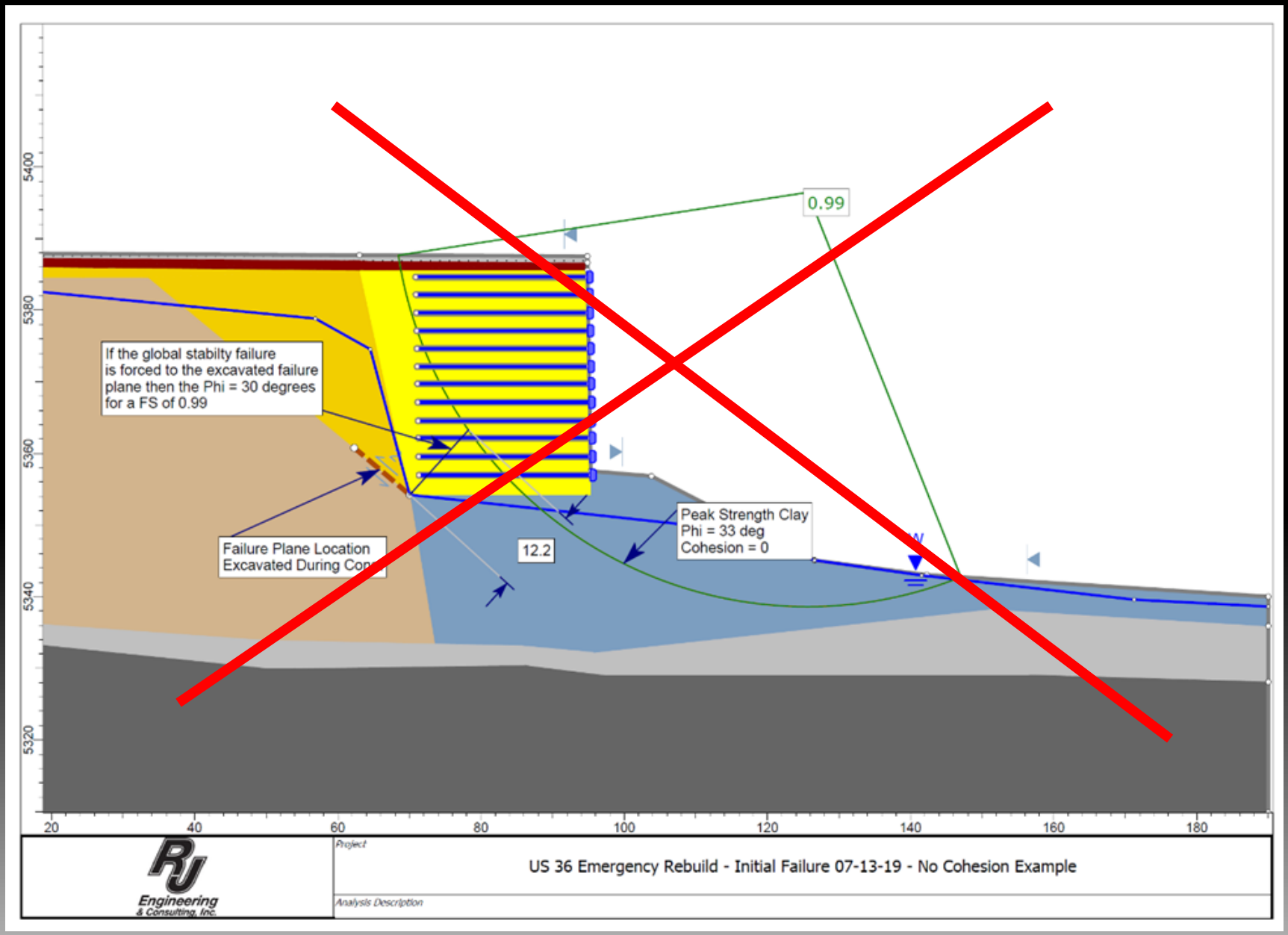
Peak and Residual Strength Parameters



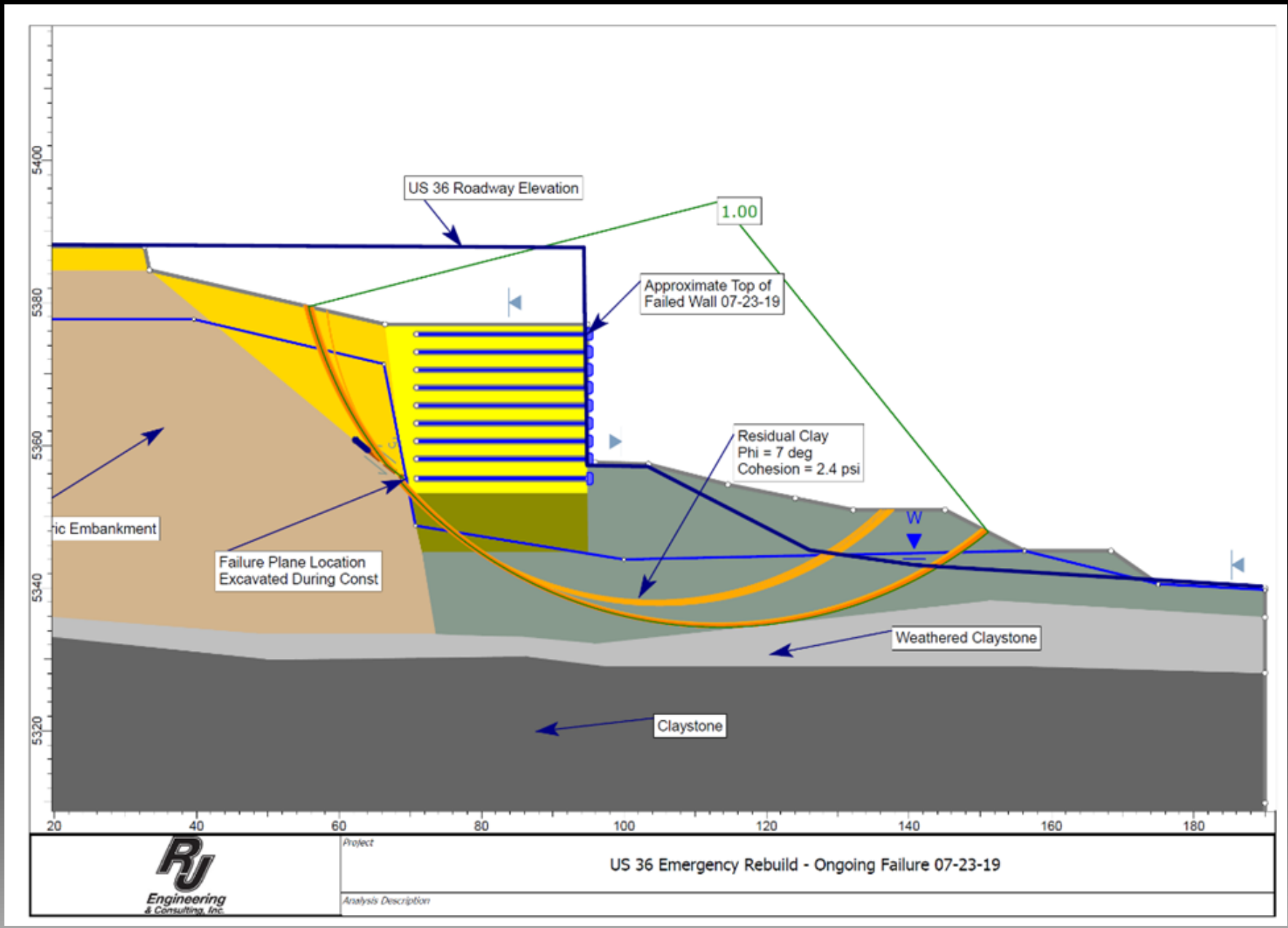
Peak Strength LE Model with Cohesion



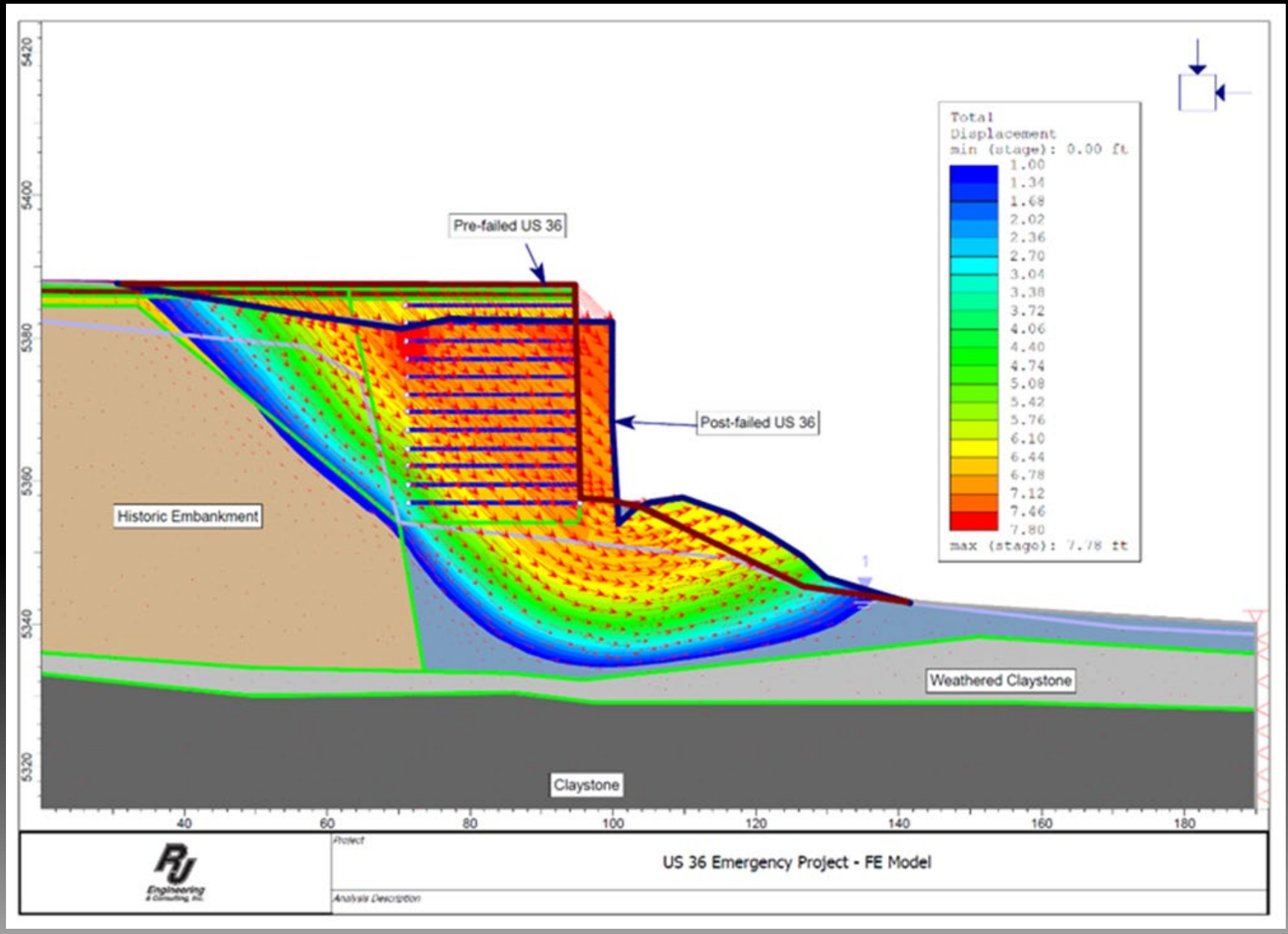
Peak Strength LE Model without Cohesion



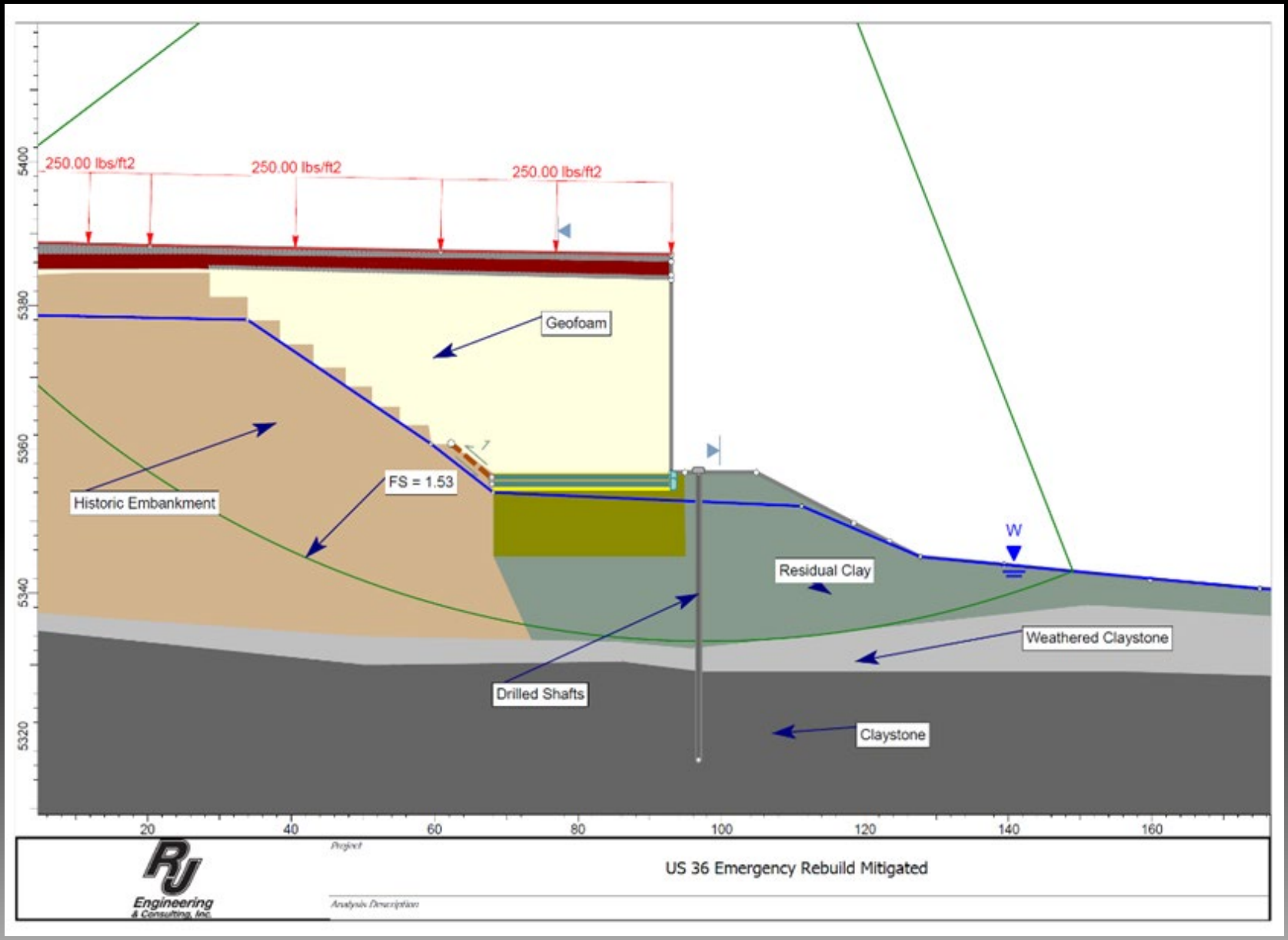
Residual Strength LE Model with Cohesion



FE Model with Cohesion



As-Built LE Model with Cohesion



August 16, 2019

August 16, 2019

August 26, 2019

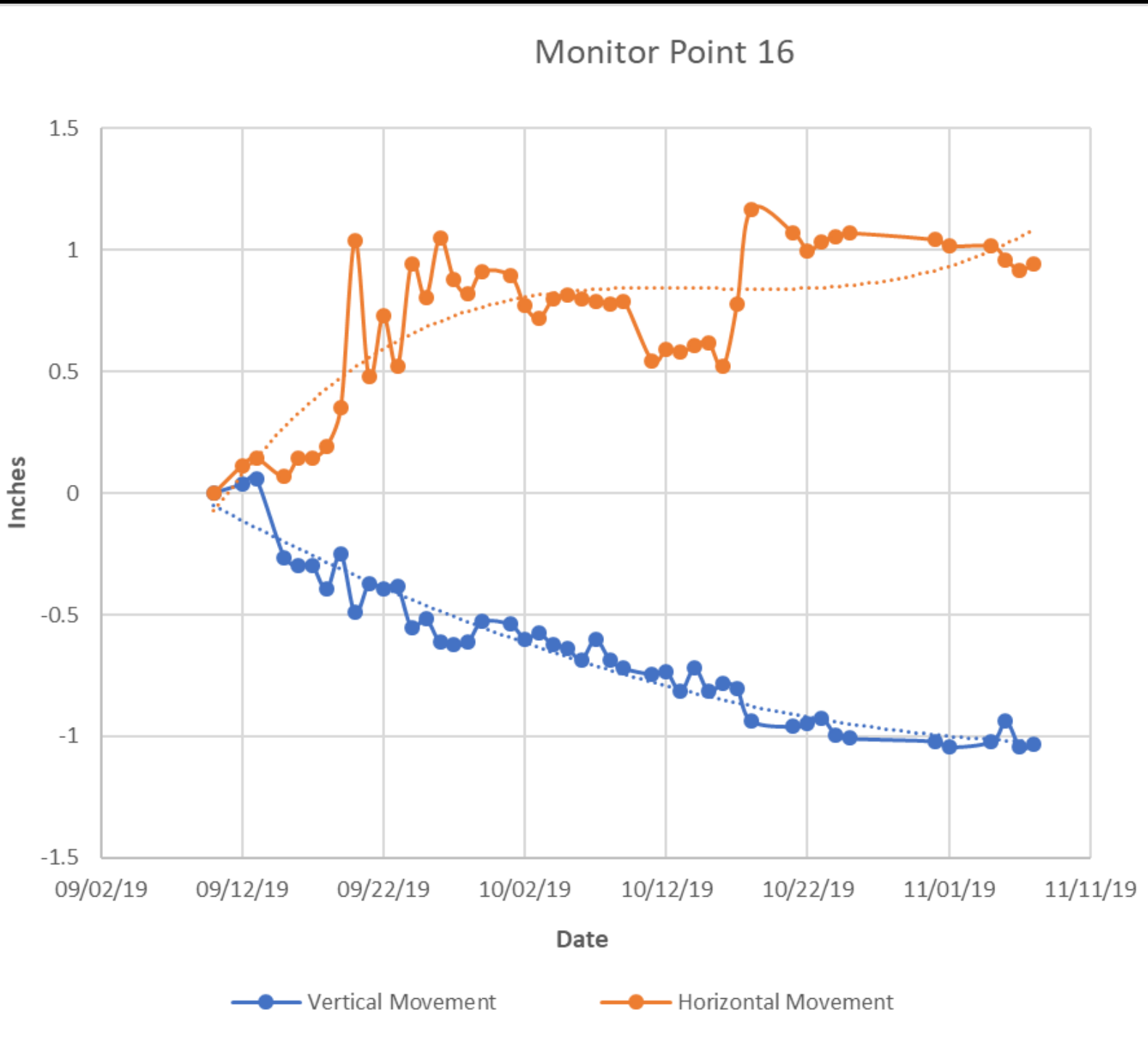
September 13, 2019

September 13, 2019

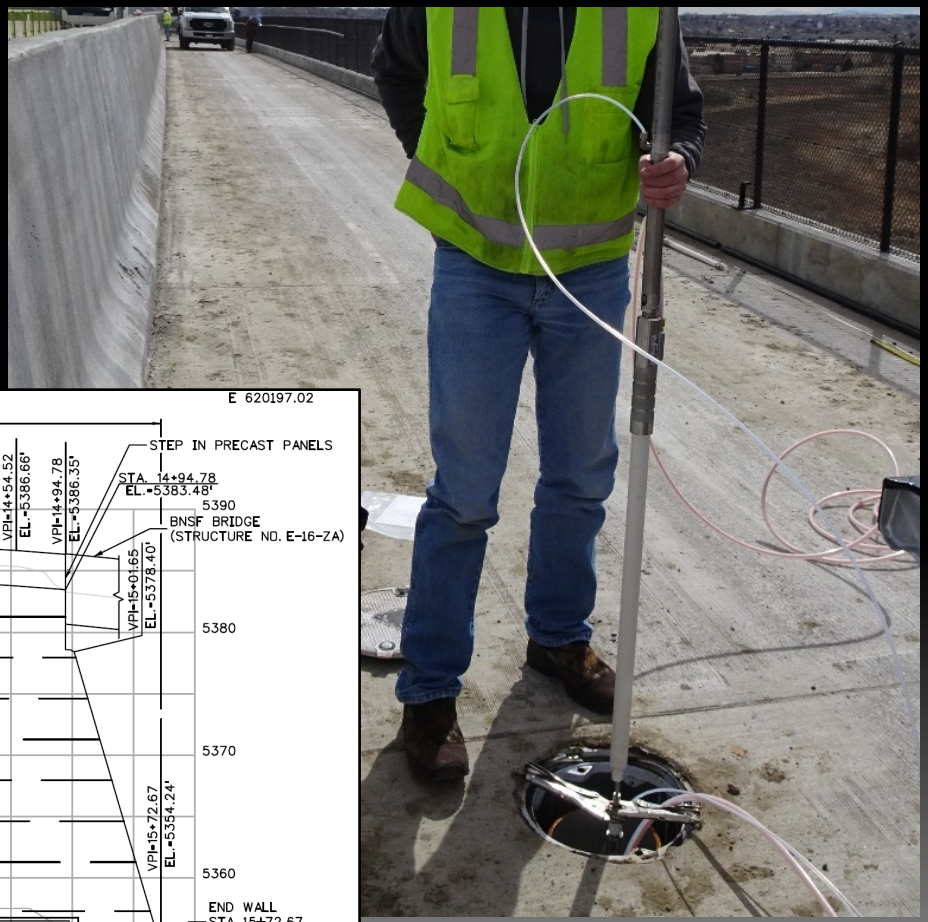
October 4, 2019

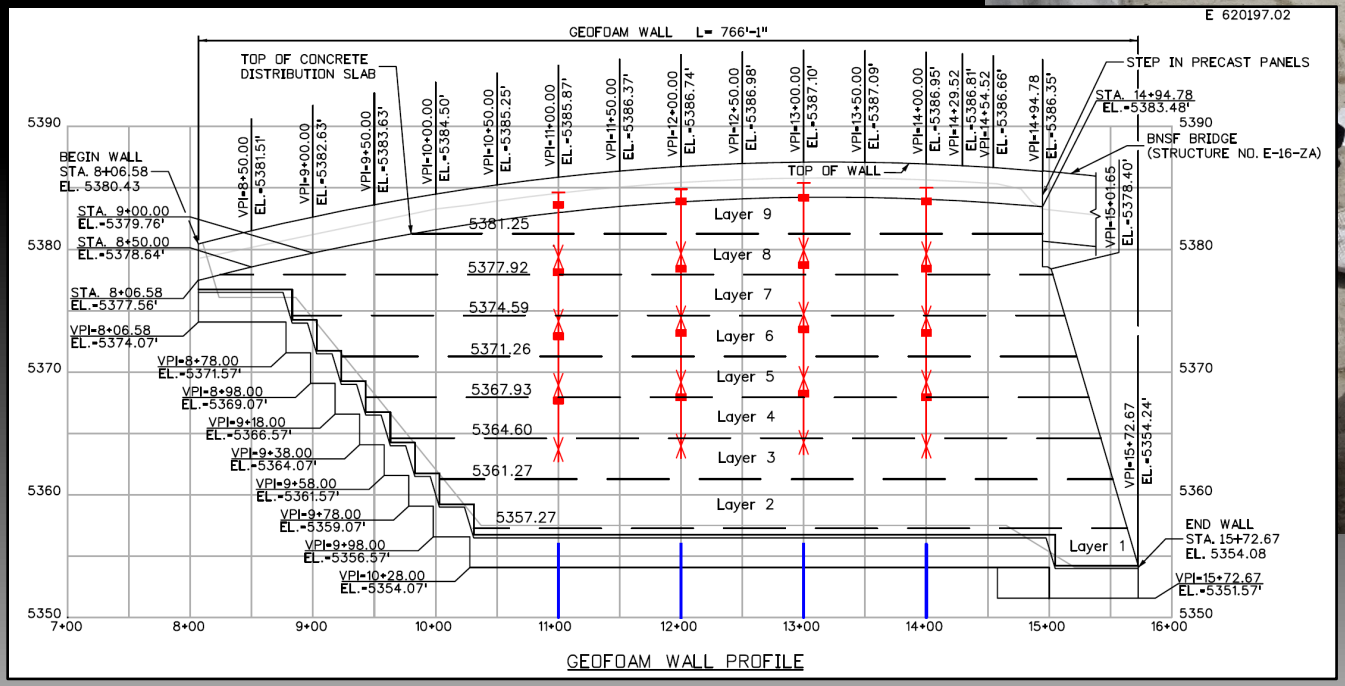
Lessons Learned with Project with Respect to Stability Analysis

1. Cohesion is very important in Modeling Effort. We should consider not simply use "zero" for cohesion.
2. Actual Cohesion is a very small number (i.e., 5 psi) but has significant impacts on the analysis.
3. Where do we sample? Incredibly difficult to get a sample in the actual failure plane.
4. Quick Geofoam Charateristic – Deformation is vertical and horizontal.

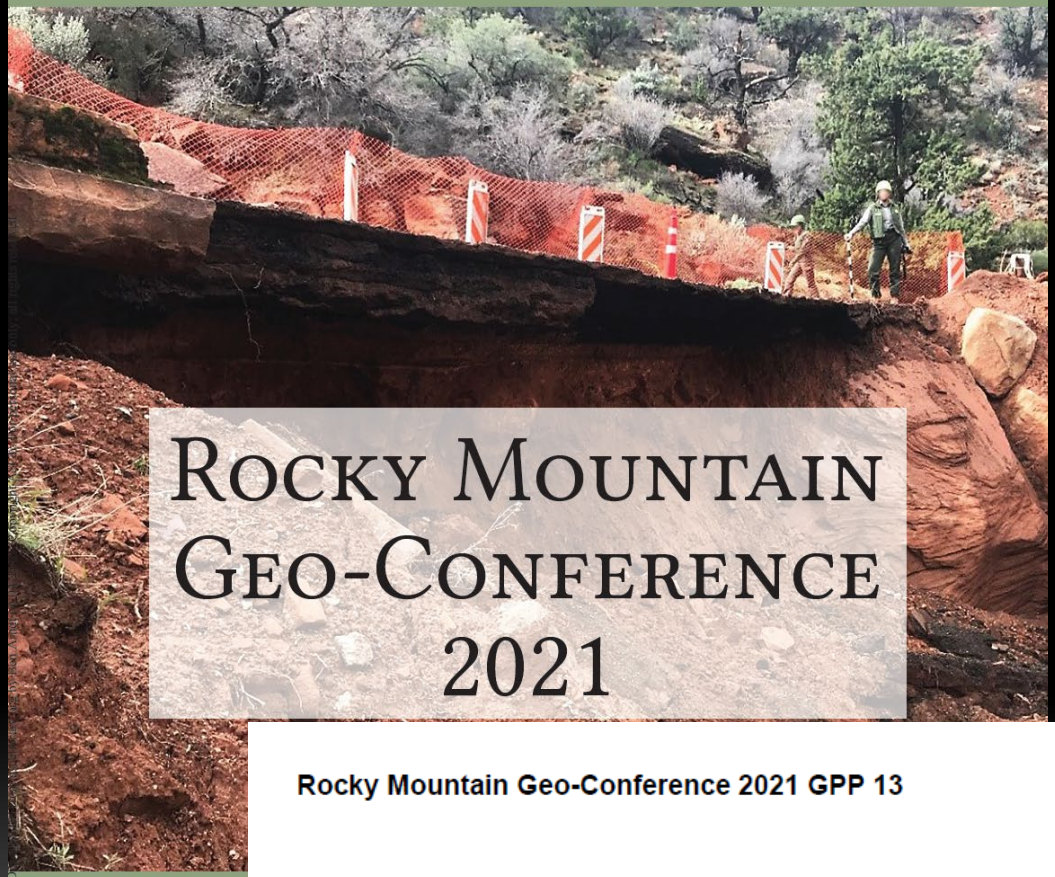

Monitor Point 16
1.5
1
0.5
0
-0.5
-1
-1.5
Inches
09/02/19
09/12/19
09/22/19
10/02/19
10/12/19
10/22/19
11/01/19
11/11/19
Date
Vertical Movement
Horizontal Movement

Installation of Extensometer Instrumentation





GEOTECHNICAL PRACTICE PUBLICATION NO. 13



Rocky Mountain Geo-Conference 2021

U.S. 36 Emergency Project—Geofoam Fill to Support Urban Roadway Traffic

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