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Liquefaction Potential & Post-Earthquake Stability Assessment

H2J Engineering

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Introduction

- New BRT route in Provo and Orem.
- Geotechnical analysis on University Pkwy. In Provo, between Freedom Blvd. and 550 West.

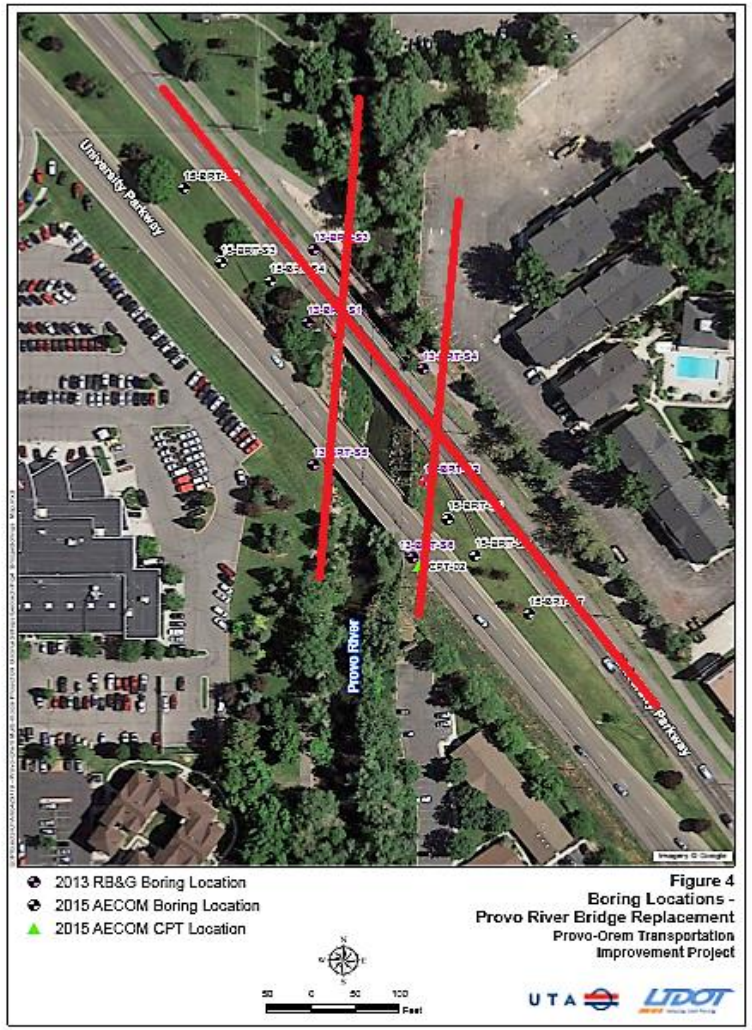
Figure 4
Boring Locations -
Provo River Bridge Replacement
Provo-Orem Transportation
Improvement Project

Background Research

- How to take the data such as the boring logs that were given and provide an accurate prediction of the factor of safety using different earthquake parameters?
- What are the different methods to produce a factor of safety?
- What is liquefaction potential?

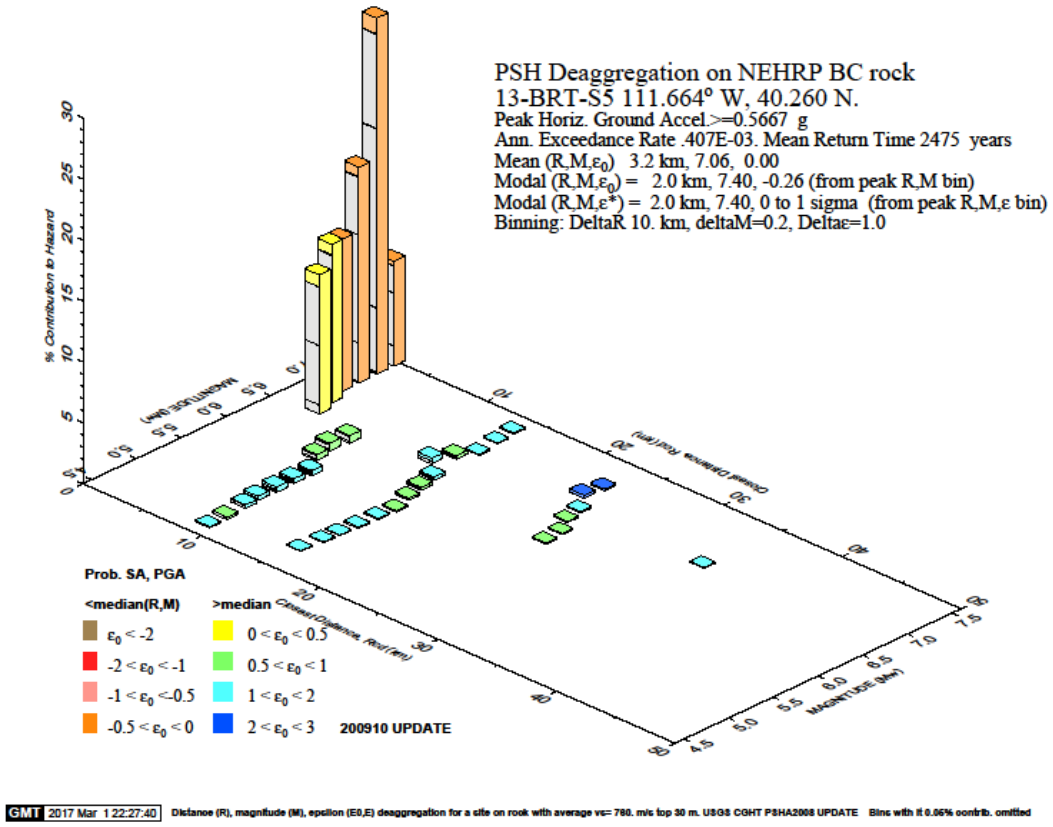
Plan

- AutoCad cross sections of boring logs
- Estimate factors of safety of the different layers in the boring logs using Idriss and Boulanger
- Make graphs corresponding to depth to factor of safety
- Point out where potential surface displacements might result



Design, Analysis & Results

- **Idriss & Boulanger method**



$$FS_{Liq} = \frac{CRR_{M,\sigma'_v}}{CSR} = \frac{CRR \cdot MSF \cdot K_\sigma \cdot K_\alpha}{0.65 \frac{a_{\max}}{g} \frac{\sigma_v}{\sigma'_v} (r_d)}$$

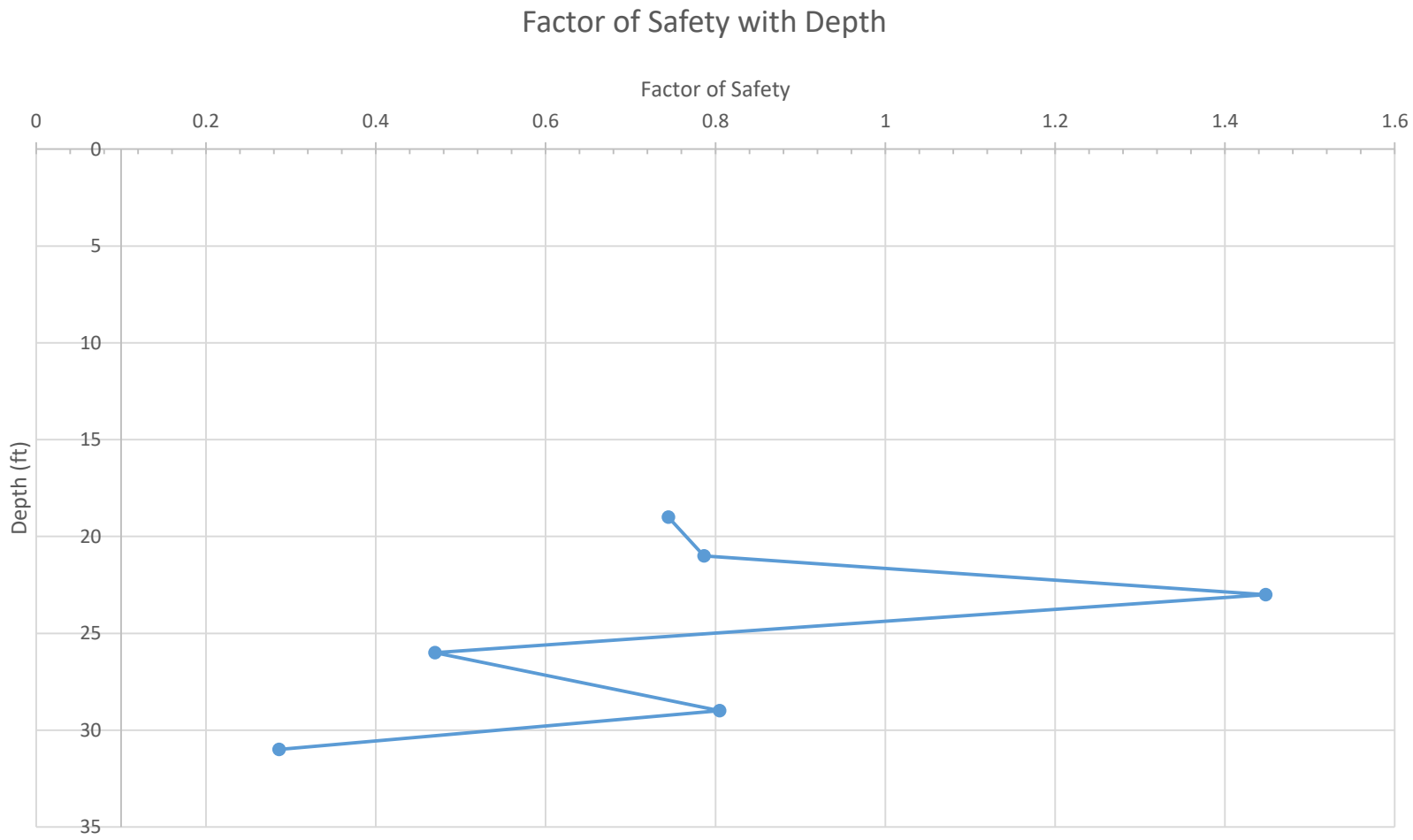
Idriss and Boulanger Table

Material	Depth (ft)	FC	$(N_1)_{60}$	$(N_1)_{60cs}$	CRR	D_r	ρ	C_σ	K_σ	σ_v	$\sigma_{v'}$	FS
Gravel	4		24.7	24.7	0.283	64.161	129	0.161	1.10	516	516	8.4
SP(Sand)	6		43.2	43.2	13.7	84.853	104	0.300	1.10	749	749	269.5
Gravel	9		36.6	36.6	1.59	78.102	103	0.288	1.10	1060	1060	20.8
Gravel	11		47.4	47.4	113.16	88.882	128	0.300	1.10	1291	1291	1216.5
Gravel	14		57.1	57.1	373543.65	97.553	132	-2.71	0.14	1681	1543	377820.1
Boulders	16		100	100	2.7332E+73	129.099	1	-0.152	0.97	1945	1682	1.53E+74
Sandy Silt	19		15.6	15.6	0.161	50.990	88	0.113	1.02	2275	1825	0.7
Sandy Silt	21	62.8	13.7	19.2955	0.198	47.784	86	0.130	1.02	2449	1874	0.8
Silty Sand	23	16.1	25.1	28.7051	0.415	64.679	100	0.191	1.02	2635	1936	1.4
Silt	26	36.5	10.2	15.7332	0.162	41.231	85	0.114	1.00	2912	2026	0.5
Silt	29	31.1	21.0	26.4039	0.328	59.161	91	0.173	1.00	3176	2103	0.8
Silt	31	17.5	7.5	11.475	0.129	35.355	84	0.097	1.00	3351	2153	0.3
Silt	34	28	38.5	43.7705	17.52	80.104	94	0.300	0.98	3618	2233	33.6

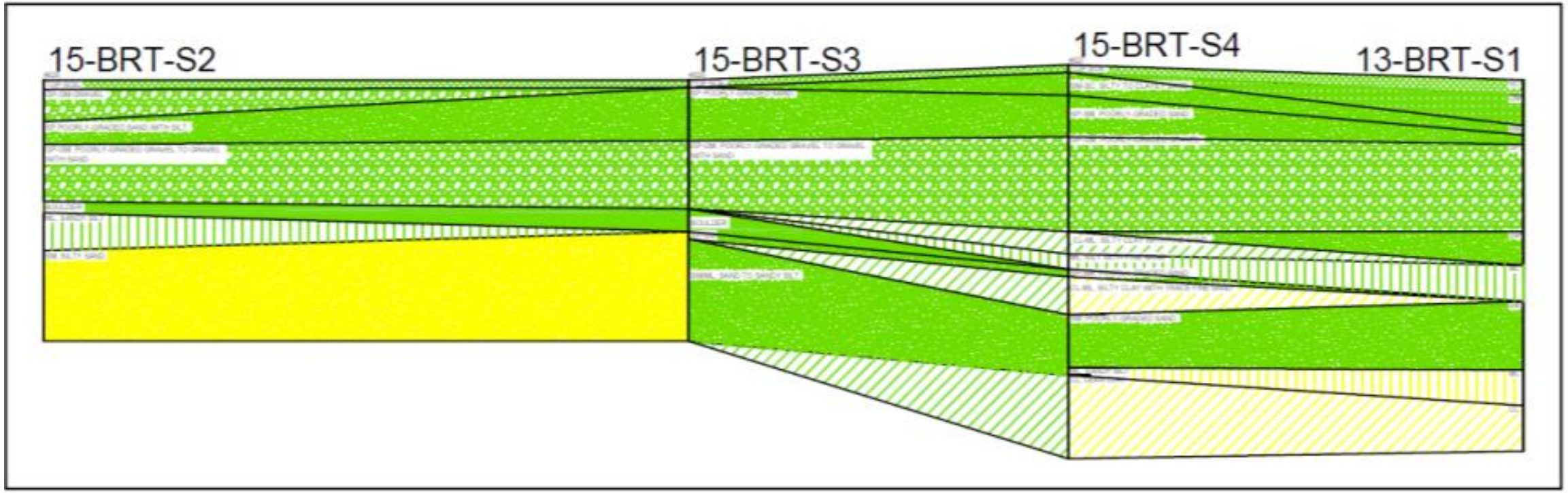
- **Calculations for 15-BRT-S2**
- **Parameters used:**
  - **2% 50 yr, Return period 2475**
  - **PGA 0.5567**

Graphs of Factor of Safety

- Graph for 15-BRT-S2
- Parameters used:
  - 2% 50 yr, Return period 2474
  - PGA 0.5567
- Only Factors of safety between 0-2



Cross Section of 15 BRT S2 Color Coated



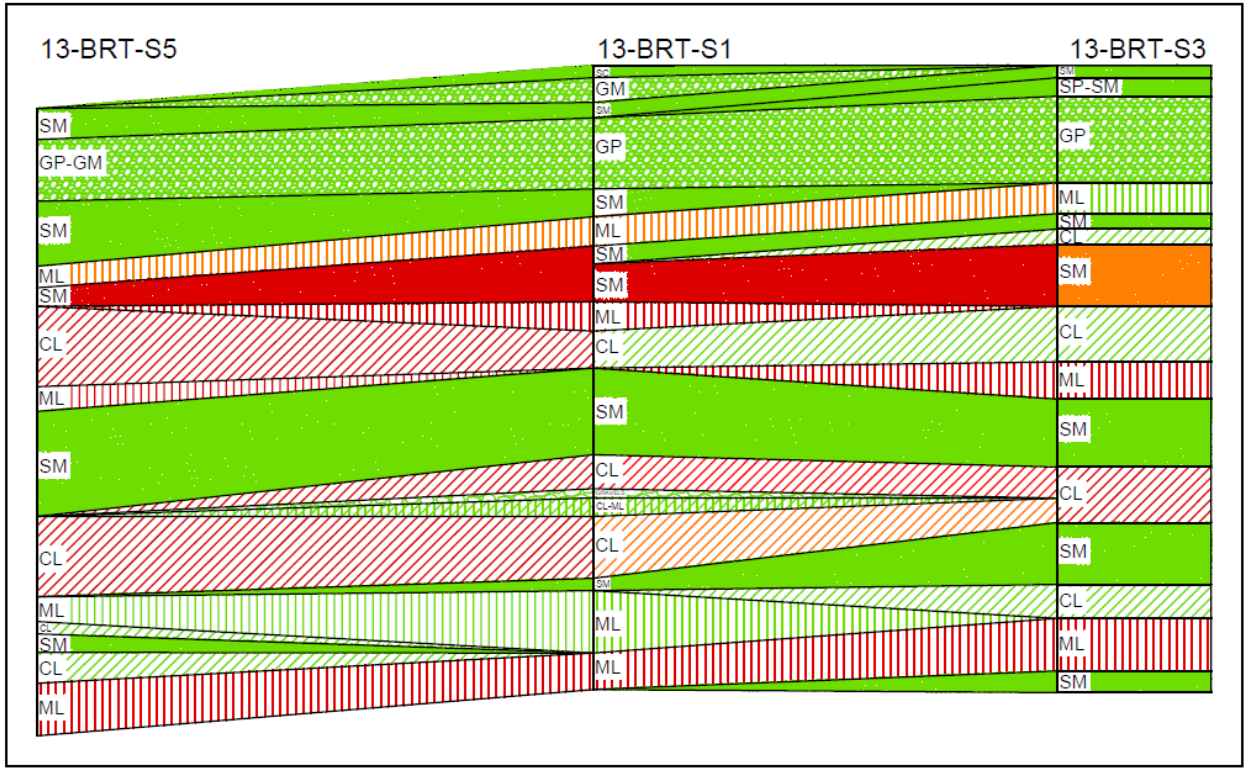
Analysis

The deterministic analysis used was limited and does not provide a range of data but still is able to provide how the soil will react to a single set of earthquake conditions.

Any layer that gave a factor of safety higher than 2 were concluded to be safe against liquefaction. The higher values were taken out of the graphs so that it would be easier to compare.

For a PGA of almost 5 ft/s for a 7.5 earthquake would cause significant damage

Conclusions & Recommendations



- There is a potential for liquefaction at new bridge location.

Conclusions

- The deterministic analysis that was performed is limited and does not provide a range of data, yet still gives an idea to engineers of how the soil will react under a set of earthquake conditions.
- Perhaps use a wider range of loadings and conditions to comparision.
- Many locations for potential
- With depth the amount of potential increases. Expected due to known water table.

Any Questions