CEEn-2018CPST-008

Kiewit North Carolina LNG Storage Facility Geotechnical Evaluation

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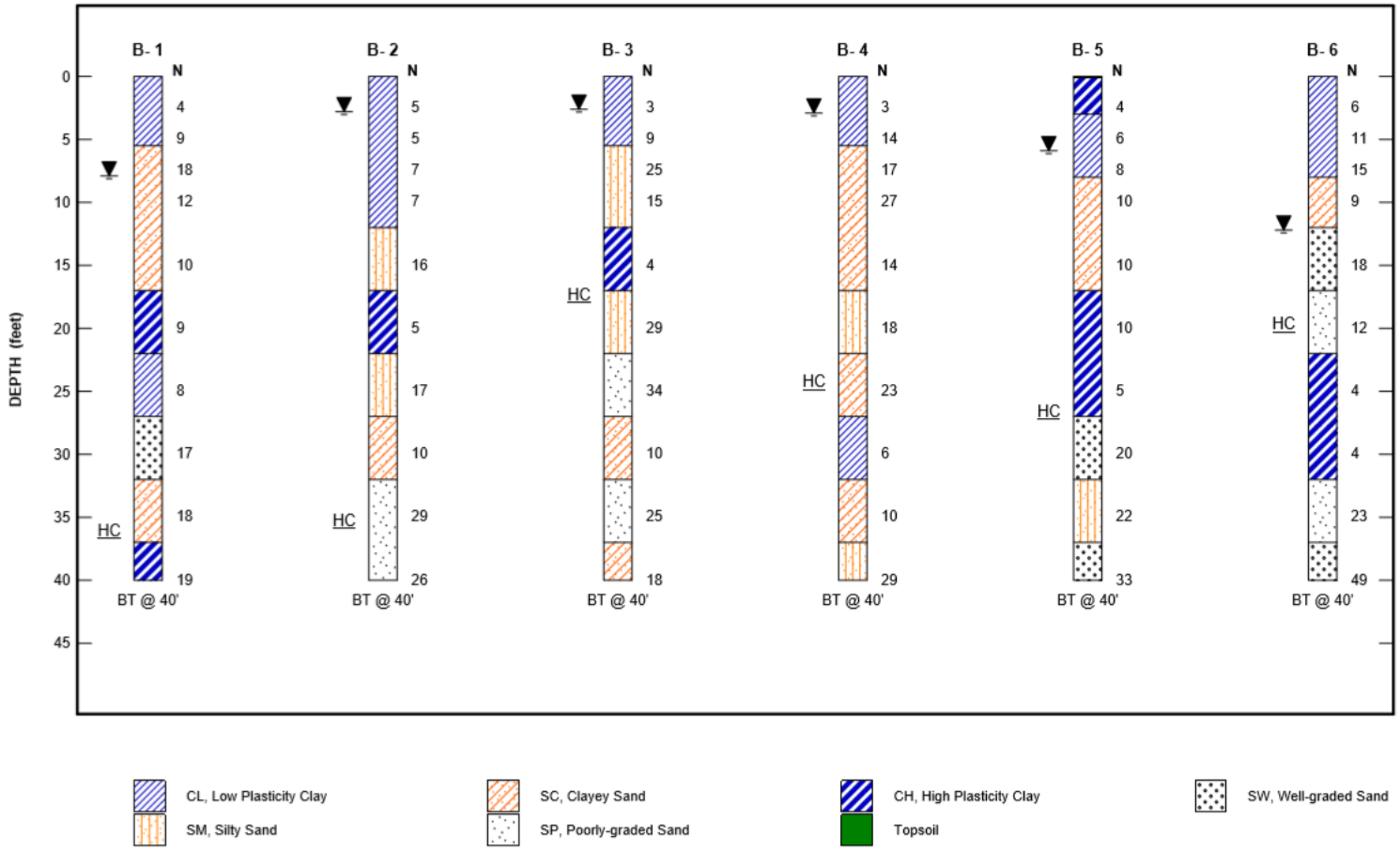
MZM Enterprises

Subsurface Conditions

Provided Boreholes to Evaluate Geotechnical Characteristics



Soil Types

- Low plasticity clay for the first five feet below the surface (with the exception of one borehole)
- The deeper ground largely consists of:
  - Clayey sand
  - Clayey silt
- There are also regions of:
  - Poorly graded sand
  - Well graded sand

Soil Classifications

Physical Soil Type (Top 10' of boring)	Average Blow Count	Number of Values Averaged	Unconfined Compressive Strength	OSHA Soil Classification
Clayey Sand	7	5	>1.5 tsf	A
Low Plasticity Clay	6	16	0.5-1.5 tsf	B
High Plasticity Clay	4	1	< 0.5 tsf	B

Constructability Considerations

Considered Factors that may Determine Cost:

- Reuse of excavated soil:
  - Cost of excavation
  - Cost of replacement and compaction
  - Cost of labor
- Use of new structural fill:
  - Cost of excavation
  - Cost to bring in new material
  - Cost of compaction
  - Cost of labor

Considered Pros and Cons:

- **Reuse of excavated soil:**
  - **Pros:**
    - No need to purchase fill
  - **Cons:**
    - Higher compaction cost
- **Use of new structural fill:**
  - **Pros:**
    - High stability
    - Lower compaction costs; lower labor costs
  - **Cons:**
    - Cost of new fill

Potential Geotechnical Risks:

- Flooding
- Settlement
- Expansive Soil
- Slope Stability
- High Water Table

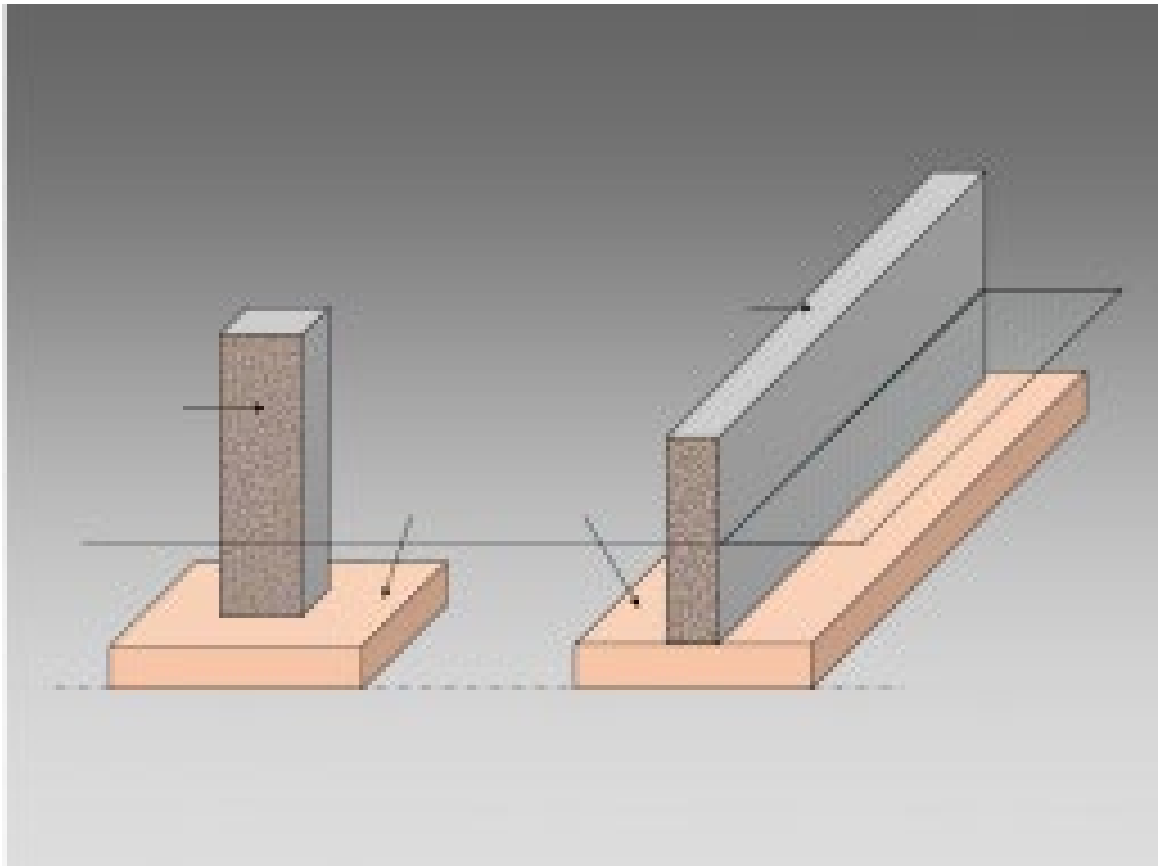
- NCBC assigns this project a risk category of IV because of storage of toxic material.

Seismic Site Class: D

- Site Classification D (NCBC 16)
- Risk Category IV
- Seismic Spectral Response Acceleration (Chapter 16):
  - 1-second acceleration, S_1, determined from Figure 1613.3.1(4) = 0.11
  - 0.2-second acceleration, S_S, determined from Figure 1613.3.1(3) = 0.30

Shallow Foundations

Recommended: Strip Footings



Max Bearing Capacity: 1500 psf

If 1.253 = d/B

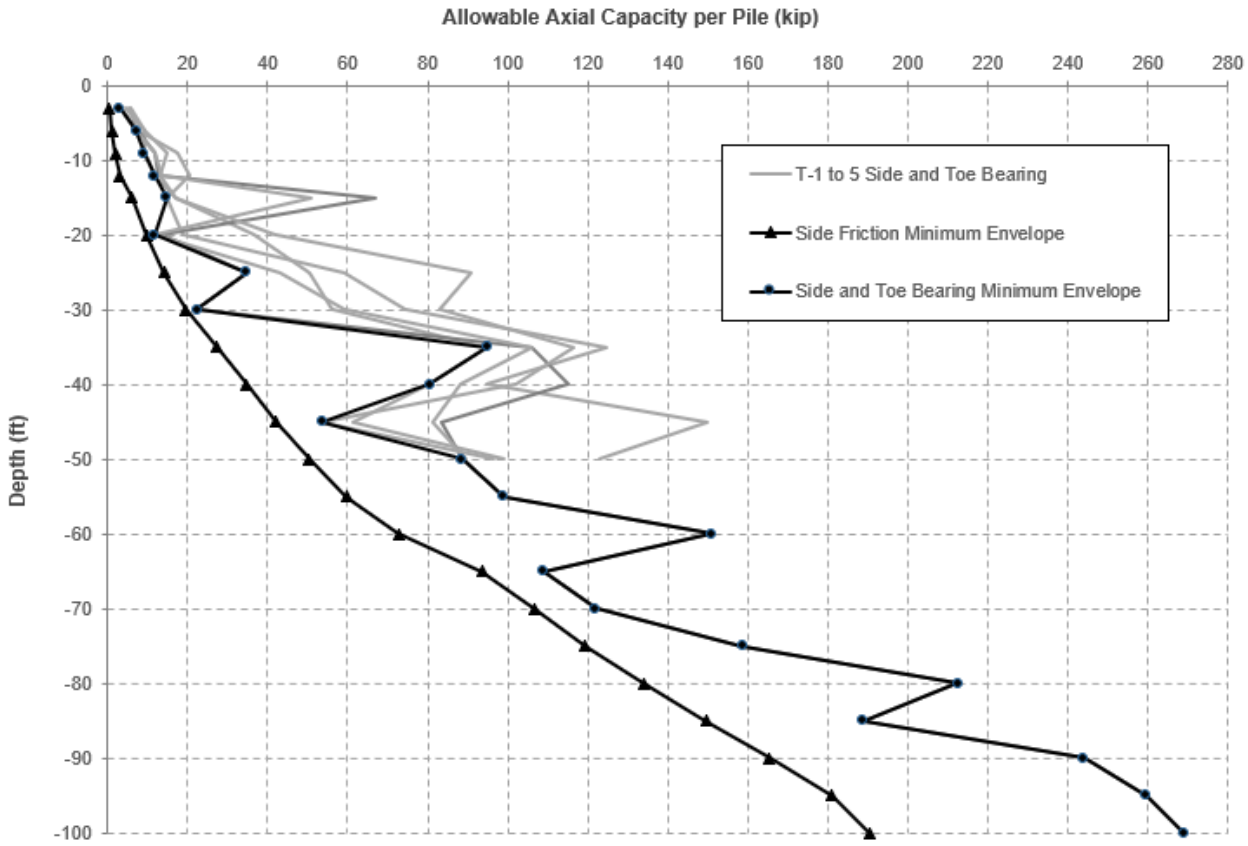
Where d is foundation depth and B is footing width

(Meyerhof and Hanna)

Deep Foundations

Individual Pile Capacity against Depth

- Assumed 12” diameter driven steel pipe pile
- Used API Alpha method for cohesive soils and Fellenius Beta method for cohesionless soils
- Followed Berezantsev’s curve for toe bearing coefficient



Pavement Design

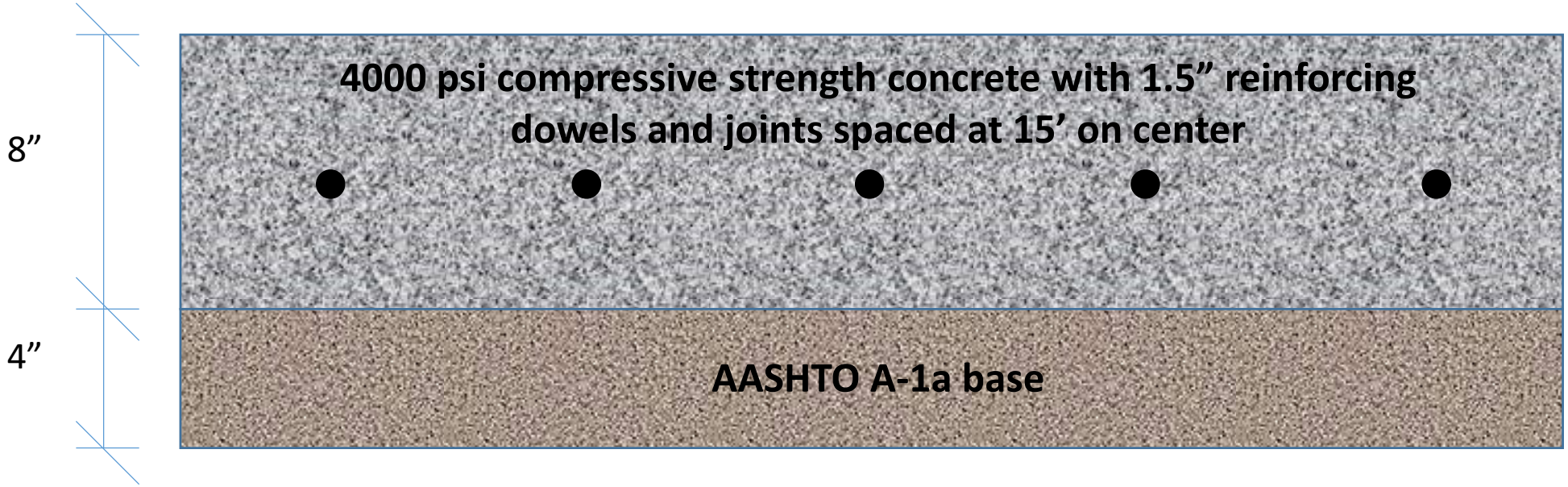
Classifications & Recommendations:

- Road class: Industrial
- Concrete modulus of rupture: 600 psi
  - About 4000 psi compressive strength
- Concrete pavement thickness: 8”
- AASHTO A-1a subbase thickness: 4”
- Use 1.5” reinforcing dowels
- Transverse joints 2.5” deep and spaced 15’ apart

Propagation Goal Seek of ADTT			
Growth rate per year			14.7%
Year	ADTT	Year	ADTT
1	22	16	172.1369
2	25.234	17	197.441
3	28.9434	18	226.4648
4	33.19808	19	259.7552
5	38.07819	20	297.9392
6	43.67569	21	341.7362
7	50.09602	22	391.9715
8	57.46013	23	449.5913
9	65.90677	24	515.6812
10	75.59506	25	591.4863
11	86.70754	26	678.4348
12	99.45355	27	778.1647
13	114.0732	28	892.555
14	130.842	29	1023.761
15	150.0758	30	1174.253
	Design ADTT		300

AASHTO Vehicle Class	Estimated Total Weight (kip)	Passes per Week
3	7	200
5	25	50
8	48	50
10	80	50

Pavement Profile



References

- 2018 North Carolina Building Code (NCBC)
- American Association of State Highway and Transportation Officials (AASHTO)
- American Concrete Pavement Association (ACPA)
  - IS184-P
- Occupational Safety and Health Administration (OSHA)
- *Soil Mechanics in Engineering Practice,* Terzaghi & Peck
- Meyerhof and Hanna
- "Load Bearing Capacity and Deformation of Piled Foundations," Berezantsev
- *Basics of Foundation Design*, Fellenius, B.H.
- American Petroleum Institute (1986). "API Recommended Practice for Planning, Designing, and Constructing Fixed Offshore Platforms," Report RP-2A
- *Soil Mechanics Design Manual 7.01,* Naval Facilities Engineering Command (1986)
- *Concrete*, Second Edition, Sidney Mindess, J. Francis Young, David Darwin