GENERAL OVERVIEW OF GEOTECHNICAL INPUT TO HIGHWAY PROJECTS

Lesson 1 - Topic 2
GENERAL OVERVIEW OF GEOTECHNICAL INPUT

1. Recognize the Importance of Testing, Theory, and Experience
2. Recall Basic Geotechnical Phases

ACTIVITY: Question-Answer
Geotechnical Participation in Project Phases

*Planning*
- Prepare Terrain Reconnaissance Report
- Perform Site Inspection

*Alternate Design*
- Assess Major Soil Problems
- Implement Subsurface Program
Geotechnical Participation in Project Phases (Cont’d)

- **Advance Detailed Plans**
  - Complete Testing and Analysis
  - Submit Foundation Investigation Report

- **Final Design**
  - Review Final Plans
  - Prepare Pre-bid Geotechnical Package
Geotechnical Participation in Project Phases (Cont’d)

- **Construction**
  - Brief Project Staff
  - Trouble Shoot Geotechnical Problems

- **Post Construction**
  - Monitor Results
  - Participate in Court of Claims Actions
Testing

Theory

Experience
Terrain Reconnaissance
Site Inspection
Subsurface Borings
Soil Profile
Typical Final Soil Profile

Elevation (Ft.)

560

540

520

500

480

460

440

Sand & Gravel (Fill)

Medium Dense Silty Sand

Medium Varved Clay

Very Dense Sand & Gravel

U-1

U-2

U-3

30’

N ≈ 17 (7 to 30) Blows/Ft.

N ≈ 8 (6 to 12) Blows/Ft.

C = 900 PSF

N ≈ 54 (28 to 96) Blows/Ft.
Soil Testing
Coulomb’s Equation

\[ S = C + (\text{Normal Force}) \tan \Phi \]
Geotechnical Analysis
Embankments
Major Design Considerations

- Stability
- Settlement
- Effects on Structure
Design Solutions to Embankment Problems

- Change Alignment
- Lower Grade
- Counterberm
- Excavate and Replace Weak soils
Structural Foundation Topics

- **Shallow Foundations (Spread Footings)**
  - Bearing Capacity
  - Settlement

- **Deep Foundations**
  - Load Capacity
  - Settlement
  - Negative Skin Friction
Shallow Foundation Failure Mode

General Shear Failure:
- Soil undergoes sudden failure as wedge 1 displaces zones 2 and 3
- \( \tan \theta' = \frac{2}{3} \tan \theta \)
- \( C' = \frac{2}{3} C \)

Local Shear Failure:
- Soil undergoes compaction in zones 1, 2 and 3

Diagram:
- Load, \( V \) vs. Settlement, \( S \)
- General shear failure
- Local shear failure
- Bulge

Legend:
- Zone 1
- Zone 2
- Zone 3
Settlement of Footings on Clay

\[ S = \frac{C_{CH}}{1+e_o} \log \frac{P_o + \Delta P}{P_o} \]
Individual Piles

Method of Estimating Load Capacity
- Load Test
- Dynamic Formula
- Static Analysis
The Fundamental Pile Driving Formula

Hammer Energy = Work of Soil Resistance

\[ W \cdot h = R \cdot s \]

\[ R = \frac{W \cdot h}{s} \]
Ultimate Bearing Capacity - Static Formula Method \((Q_u = Q_p + Q_s)\)

- **Embedded Length** = \(D\)
- **Ultimate Bearing Capacity** = \(Q_u\)
- **Unit Frictional Resistance** = \(f\)
- **Shaft Area** = \(A_s\)
- **Unit Bearing Capacity** = \(q_P\)
- **Area of Point** = \(A_P\)

\[ Q_u = Q_p + Q_s \]

\[ Q_p = q_P A_P \]

\[ Q_s = f A_s \]
Constrution Aspects

- Monitoring Construction Operations
- Quality Assurance
Select Material Specifications

- **Specification Item**
  - 6”-8” Lift Thickness
  - Topsize Restriction
  - Gradation Req’mt

- **Reason for Item**
  - Small Compaction Equipment
  - Less than 3/4 Lift Thickness
  - Compactability
*PROJECT SUCCESS*

Cooperation Between
Design & Construction
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