The Spirit of Innovation.
Challenge Your Thinking. Challenge Yourself.

Role of the Geotechnical Consultant in Design–Build Projects
a General Contractors Geotechnical Engineer’s Perspective

Steven R. Saye
Kiewit Engineering Group, Inc.
Design Build Geotechnical Goal

- All parties want to build more infrastructure on time at less cost with less risk
- Often the geotechnical Conditions drive the risks, schedule, and cost of Design Build Projects
- Especially Large Projects
The Geotechnical Engineer Can

- Work for the Owner or the Owner’s Design Consultant

- Work for the DB Contractor or the DB Contractors Consultant

- Each role can require a different approach by the Geotechnical Engineer
Key Concepts

- The key cost / risk reductions begin with the Proposal and Bid
- These cost / risk reductions are related to means and methods decisions that often occur early in the proposal process
- Final Design and the initiation of construction is driven by schedule and significant design changes occur rarely
- If it is not in the General Contractor’s proposal / bid it likely will not be done in final design
Key Concepts

- A comprehensive geotechnical investigation pre-bid will help Everyone
- Everyone’s interest is served by having the DB Team focus on how to deal with the geotechnical issues rather than spending significant time and effort first defining the geotechnical issues
- The Owner’s Geotechnical Engineer can materially impact this issue, but it takes time and money
What’s Important

► The Owner’s Geotechnical Engineer Should:
► Define the important geotechnical factors that will significantly impact the cost and schedule for the DB Project
► See that sufficient information is provided for development of competitive proposals including a clear definition of the ground conditions
► Provide the basis to confirm implementation of the geotechnical design
► Focus on site characterization
Pre-bid geotechnical data

- Forms the basis of the D-B Team’s design, schedule and cost
- May be < 30% of the quantity of information required for final geotechnical design
- The Owners Geotechnical Engineer assembles these data
- D-B Team must address the limitations in the provided information at bid time
What’s not important

- The Owners foundation and ground improvement designs
- The Design Build team will make their designs based on the provided data. The geotechnical data needed to make these assessments and calculations are what is important
Defining the Geotechnical Conditions for Proposal and Bid

- Ground conditions can be visualized
- Soil and rock layers are defined
- Focus on dealing with the ground conditions not defining them
- Example from Hawaii GBR
Pre-bid geotechnical data

- Quality and timeliness of basic information is critical
  - Stratigraphy and coverage
  - Emphasis on basic soil and rock material properties
  - Develop sufficient information for the pre-bid design
  - Limitations of pre-bid foundation tests
Stratigraphy and coverage

- Need thorough program of borings or soundings for pre-bid estimating
  - More routine borings with cpt soundings preferred over few borings with sophisticated testing
  - Provide surveyed information for 3D modeling
  - Televiewer data with rock coreholes
  - Provide core samples for examination by bidders
Need basic material properties

- SPT hammer energy measurements
- Groundwater levels
- Pavement section data
- Electronic files for CPTu, or GINT logs
- Borings to sufficient depth
- Lab tests on “Undisturbed” samples
- Follow Agency’s Geotechnical Manual
Timing of pre-bid geotechnical data

- The Pre-bid geotechnical design is essentially complete halfway through the bid period
- Data received after this time has limited usefulness in significantly impacting the means, methods and cost of the geotechnical issues
If The Owner wants something - say so in the contract documents

- Honolulu LRT Job Example
- Owners Geotechnical Engineer wanted extensive UU triax tests, but did not communicate the need
- SPT’s were specified for at least 50% of the sample locations
- Kiewit budgeted SPT’s for 90% of the sample locations
- In Final Design disagreement occurred
Importance of high-quality pre-bid geotechnical data

Typical Problems:

- No SPT hammer energy measurements
- No reliable groundwater level data
- No pavement section data
- Geotechnical data input into Gint format but electronic files not provided to D-B Teams
- CPTu electronic files not provided
- Investigation does not extend deep enough
- Limited information to guide construction dewatering
Making Quality Geotechnical Investigations

- State DOT Manual for Geotechnical Instruction
Soft Ground Issues

- Settlement and Stability can be significant cost schedule and performance issues.
  - Obtain sufficient samples and geotechnical tests to permit a proper design pre-bid
    - Preconsolidation Stress
    - Compression Ratio
    - Rate of primary and secondary compression
  - SPT tests are likely inadequate
  - CPTu tests beneficial
Performance based specifications

- Embankment settlements
  - UDOT example: 4 inches allowable settlement in 5 years (after project completion) w/ < ¼ inch differential within 12 ft horizontal distance
Key Issue Deep Foundation Design

- Transportation Infrastructure LRFD Design Code uses deep foundation load tests to select more favorable resistance factors.
- Economic benefit can be obtained by implementing static load tests but the AASHTO Code does not specify the number of tests needed to attain the higher design resistance factor.
- Best to define the number of load tests needed to use the higher resistance factor for the bid.
DB Geotechnical Engineer – Proposal Development

- Validate that the key geotechnical issues are addressed
- Determine if additional exploration is needed for the Proposal / Bid
- Develop the key geotechnical concepts that must be successful for the project to be successful
D-B Final Geotechnical Design

- Subsurface investigation to fill in the gaps
- Detailed Design
- Deep Foundation load testing
- Construction Quality Control
- Instrumentation and Monitoring
Performance based specifications for geotechnical investigations

- Set the minimum requirements for extent of exploration
- All the D-B Team to determine the type of investigation (borings, in situ tests, laboratory study)
- Reference the State Manual of Instruction
Selected case history – Geotechnical Baseline Report Application

- Honolulu High-Capacity Transit, Hawaii
Honolulu Transit Project

[Map showing the Honolulu Transit Project including the Kamehameha Highway Design-Build Contract and various other routes and locations]
Geotechnical Baseline Report perspective

► Context of Two Honolulu, Hawaii High-Capacity Transit Corridor Projects - $800 million value

► Key Feature: Elevated Guideway supported on mono-shaft foundations spaced at 125 foot intervals for 16 miles
Geotechnical Baseline Report perspective

► GBR prepared by Parsons Brinkerhoff
► Key Project Benefits of the GBR:
  ▪ Developed a common understanding of the subsurface conditions and key factors impacting the foundation design and construction at bid time.
  ▪ Provided a framework for the subsequent final design investigation.
Basalt Characteristics
Cobbles & Boulders in Alluvium
GBR for Honolulu Transit

Owner’s defined purpose “to help define the contractual ground rules of the bidding process in regards to allocation and definition of geotechnical risks”

“baselines are developed which will serve as a contractual basis for comparison with actual conditions encountered during foundation construction”

“The Contractor may rely on these baselines in preparing his Price Proposal”
Honolulu Transit

Key components to the baseline report

- Geologic setting
- Site and subsurface conditions
- Previous construction experience
- Baselines for stratigraphy and ground characterization
- Design considerations
- Construction considerations
Design-Build Team Perspective

- Ground conditions can be visualized.
- Soil and Rock layers defined.
- Focus on dealing with the ground conditions not defining them.
Design-Builder Risks and Responsibilities

- A baseline report does not compensate for poor quality data or inadequate data.
  - Hollow-stem auger borings below the groundwater table provided, but
  - In situ testing with careful sampling and laboratory testing to characterize the strength and compressibility of the ground was needed.
  - Design-Builder needs to be pleased with the presented information as the basis of a bid.
Risks and Responsibilities of the Design-Build Team

- Actual ground conditions can get better or worse than depicted.
- Foundation Performance was the D-B Teams’ Responsibility.
Risks and Responsibilities of the Design-Build Team

- Actual ground conditions can get better or worse than depicted.
- Foundation Performance was the D-B Teams’ Responsibility.
Oscillator Drilling Equipment

Base Grouting Operations
Summary

- Design Build Project cost, schedule, risk can be improved with high quality, timely pre-bid geotechnical data

- The Pre-bid studies should focus on site characterization to define the geotechnical conditions as a basis of the bid

- Geotechnical Baseline Reports can add significant value
Extended Reading

- Geotechnical Baseline Reports for Construction
  *Suggested Guidelines* ASCE Randall Essex Editor
NCHRP 429 – Geotechnical Information Practices in Design-Build

Describes effective practices in geotechnical procurement, design, and quality management

► Qualifications & experience of D-B geotechnical team is key to quality

► Weight geotechnical factors appropriately to the importance for project success
Extended Reading: NCHRP Synthesis 484

Influence of Geotechnical Investigation and Subsurface Conditions on Claims, Change Orders, and Overruns A Synthesis of Highway Practice