

## **GEOTECHNICAL GUIDELINES FOR DESIGN-BUILD PROJECTS    June 2009**

The Design-Build Team shall be responsible for, but not limited to, addressing, and incorporating, if necessary, the following items for the roadway and structure foundation design of the project. Include all design calculations and supporting documentation in the geotechnical design submittals for the NCDOT Geotechnical Engineering Unit's review and acceptance.

1. Analyze the stability of embankments and utilize recognized geotechnical engineering designs and construction methods accepted by the NCDOT to ensure embankment stability.
2. Analyze embankment settlement and if necessary, recommend and incorporate mitigation through the use of undercut or soil improvement methods such as surcharges, waiting periods, wick drains, column supported embankments, etc.
3. Address, and incorporate if needed, the following regarding embankment problems:
  - a. The feasibility of using geo-textiles to achieve stability, reduce excavation of soft soils and reduce the effect of settlement on the roadway.
  - b. The need for settlement gauges, slope inclinometers and other embankment monitoring devices and their placement and location.
4. Determine the feasibility, recommend and incorporate types of retaining walls and / or shoring for permanent and / or temporary situations. Design all retaining walls in accordance with the most recent edition of the AASHTO *LRFD Bridge Design Specifications* and applicable FHWA manuals. If the AASHTO *LRFD Bridge Design Specifications* do not provide applicable load and / or resistance factors for certain retaining wall types, then design these walls in accordance with the latest AASHTO *Standard Specification for Highway Bridges* allowable strength design methods.
5. Determine amount of, recommend and incorporate methods to mitigate any differential settlement problems at locations of culverts and utilities.
6. Analyze the stability of cut sections. Utilize recognized geotechnical engineering designs and construction methods to ensure cut slope stability.
7. Analyze the stability of roadway approaches (to the distance from the bridge that affects the stability and design of the bridge foundations) and particularly the end slopes under the bridge, utilizing recognized geotechnical engineering designs and construction methods to ensure stability.
8. Recommend pile, drilled pier or spread footing foundations for structures with regard to bearing capacity, lateral stability, buckling analysis for piles, scour, settlement and constructability.
9. Recommend maximum bearing pressure for spread footings considering both strength limit and service limit states, and effects of adjacent foundations, water table, scour, etc. The scour critical elevation for a spread footing shall be at the bottom of footing elevation.

10. Address the following regarding pile and / or drilled pier foundations:
  - a. Method of support – skin friction, tip bearing or combination of both
  - b. Tip elevations and estimated pile lengths
  - c. Ultimate axial load
  - d. Settlement
  - e. Number and location of test piles or piers and dynamic and / or static load testing
  - f. Wave equation analyses using an appropriately chosen pile hammer and cushion material
  - g. Necessity of using steel pile tips for concrete piles or pile points for steel piles
  - h. Effects of vibration on adjacent construction or existing structures
  - i. Corrosion effects of various soils and water (Reference NCDOT *Structure Design Unit's Policy Manual*)
  - j. Downdrag on piles or piers
  - k. Lateral stability and horizontal deflections
  - l. Design scour and scour critical elevations. The scour critical elevation for drilled piers and pile foundations shall be the 500-year design scour elevation.
  - m. Point of fixity
  - n. Lateral squeeze for piles
11. Include in the geotechnical recommendations report a summary table of the bridge foundation recommendations including the following:
  - a. WBS project number, TIP number, county, description and bridge station
  - b. Bent (work point) stations, types of foundations, allowable loads, bottom of cap or footing elevations, estimated pile lengths and tip elevations
12. Address the following items, when applicable, as notes on plans or comments and attach to the summary table:
  - a. All appropriate notes on plans (Reference NCDOT Structure Design Unit's Standard Foundation Notes on Plans)
  - b. End slope and extent of slope protection
  - c. Waiting periods for approach slab construction or end bent construction
  - d. Battered piles
  - e. Point of fixity elevations
  - f. Design and scour critical elevations
  - g. Tip elevations
  - h. Steel pile points for steel piles or steel pile tips for concrete piles
  - i. Number and location of test piles or piers, load tests, dynamic and / or static testing
  - j. Required rock socket for drilled piers
  - k. Need for permanent steel casing including casing tip elevations, SPT, SID Inspection, CSL and slurry use in accordance with the current NCDOT *Drilled Piers Special Provision*
  - l. Range of estimated hammer energies for concrete and pipe piles

Address any other items affecting the foundation design on the summary sheets and include all final recommendations on the summary sheets.