# DEPARTMENT OF TRANSPORTATION
# STATE OF GEORGIA

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# GEOTECHNICAL ENGINEERING BUREAU
# FOUNDATION DRILLING AND SAMPLING GUIDELINES

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## Bridge Foundation Investigations - Drilling and Sampling

### A. Drilling Criteria

1. **Number of Borings**: As a general rule, one boring should be made at each bent of the new or widened bridge (Refer to Section B-2 for CPT soundings and DPT testing). Also, bridges that are 60 feet wide or more should have 2 borings per bent.

    a. Piedmont and Valley and Ridge Regions:

        1. Bridges in the Piedmont or Valley and Ridge Regions may require two borings at each bent if erratic foundation conditions are found between bents. Discuss this with the geotechnical engineer in charge of the project.

    b. Coastal Plain:

        1. For bridges with short spans (approximately 40 feet or less) in the Coastal Plain Region, begin by drilling every other intermediate bent, and if the subsurface conditions between borings are very similar, the bents that were skipped may not need to be drilled. This decision should have prior approval from the geotechnical engineer in charge of the project, however. Coastal Plain bridges with short spans with more than 25 spans may be drilled every third bent.

        2. This guideline may not apply for bridges in southwest Georgia where limerock is encountered.

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**2. Boring Location:**

a. Borings should be drilled as closely as possible to the location of the proposed bent. Borings should be offset only when site or traffic conditions prevent this. Maintain a maximum of 10 feet offset unless obstacles prohibit drilling at the boring location. Offset along the bent line if possible; otherwise, the offset may be perpendicular to the bent line.

b. If a lane or shoulder closure is required to perform borings, prior approval must be obtained from the District Engineer's office. All lane or shoulder closures must be set up in accordance with MUTCD standards, and within the hours set by the District Engineer's office.

3. **Boring Depths**:

a. Piedmont and Valley and Ridge Regions:

i. Grade Separation Bridges:

1. End Bents: Drill borings at the end bents to refusal on rock. If no rock is found within 75 feet of the ground surface, continue drilling until the following minimum strata thickness/SPT criteria is met:

| Thickness of Strata | SPT N60 Value Greater Than |
|---|---|
| 15 feet | 50 blows ≤ 6 inches |
| 20 feet | 50 blows > 6 inches |
| 25 feet | 40 blows |
| 30 feet | 35 blows |
| 35 feet | 30 blows |
| 45 feet | 25 blows |
| 50 feet | 20 blows |

Note: These are minimum guidelines and the geotechnical engineer in charge of the project should make the final decision on boring termination.

2. If rock is not encountered and the SPT criteria above has not been met within 100 feet, contact the geotechnical engineer in charge of the project for instruction. If rock is encountered

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within 75 feet, refer to rock coring requirements below.

3. Intermediate Bents: Borings at the intermediate bents should be drilled to refusal on rock. However, if no rock is found within approximately 75 feet of the ground surface, follow the SPT Criteria above for termination depth. If rock is encountered within 75 feet of the ground surface, rock should be cored. Refer to rock coring requirements below.

ii. Stream Crossings:

1. Borings should be drilled in the same manner as for grade separation bridges. At the intermediate bents the depth of borings will also be dependent on the theoretical scour line shown on the bridge layout. The boring must extend 15 feet below the 500 year theoretical scour line.

iii. Rock Coring:

1. If relatively shallow rock (less than 15' deep) is found, then rock cores should be taken to confirm rock consistency and continuity.

2. If the project is in karst or other erratic geological conditions commonly found in the Valley & Ridge region (northwest Georgia), rock cores should be taken to confirm the absence or presence of a void.

3. In general, rock should be cored (with 10-foot runs) until the percent recovery is at least 75% and RQD is at least 60% to confirm the presence of competent rock. If 60% RQD has not been achieved after 30 feet, contact the geotechnical engineer in charge of the project for termination criteria.

   Note: At the discretion of the geotechnical engineer in charge of the project, coring may go deeper than 30 feet prior to achieving the above recovery and RQD requirements. This decision will depend on the soil and rock conditions encountered in the boring and their ability to provide sufficient bearing resistance for spread footings, driving resistance for piles, or side resistance/ end bearing for drilled caissons.

4. Refer to Section B-3 for additional rock coring requirements.

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b. Coastal Plain Region:

i. General:

The following minimum strata thickness/SPT criteria should be used in determining the minimum boring termination depth:

| Thickness of Strata | SPT N60 Value Greater Than |
|---|---|
| 15 feet | 50 blows |
| 20 feet | 40 blows |
| 25 feet | 35 blows |
| 30 feet | 30 blows |
| 35 feet | 25 blows |
| 45 feet | 20 blows |

Note: These are minimum guidelines and the geotechnical engineer in charge of the project should make the final decision on boring termination. If the coastal geology mimics the piedmont, the SPT termination criteria in A.3.a.i.1 may be used in lieu of the criteria in this section.

ii. Grade Separation Bridges:

Use the SPT criteria as a guideline to terminate the borings. Also use the SPT criteria for borings at the end bents once the boring is drilled below the original ground surface. If none of the minimum strata thickness/SPT sampling criteria have been met by 100 foot depth, contact the geotechnical engineer in charge of the project for instructions.

iii. Stream Crossings: Borings should be drilled in the same manner as for grade separation bridges. At the intermediate bents the depth of borings will also be dependent on the theoretical scour line shown on the bridge layout. The minimum strata thickness/SPT criteria should be used once the boring is drilled below the scour line. The boring must extend 15 feet below the 500 year theoretical scour line.

If voids or other erratic foundation conditions are encountered, notify the engineer

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in charge of the project as soon as possible for additional instructions.

## B. Sampling Guidelines

1. **SPT Testing**: At bridge end bents, perform SPT tests at 2.5-foot intervals to a depth of 10 feet below grade. Beginning at a depth of 10 feet, perform SPT tests at 5-foot intervals to boring termination. Save all samples in a clean sample jar, and mark all jar boxes with the project number and county, boring number, bridge location and date. Sample jars must be a minimum of 16 oz (500 ml) in size. Fill up the jar so the lab has sufficient material for testing.

2. **CPT (Cone Penetration Test) and DMT (Flat-Plate Dilatometer Test)**: are acceptable however they must be accompanied by SPT tests so soil samples are collected and tested in the lab.

    a. SPTs should comprise of no less than 50% of the drilling plan when CPT and/or DMT are being considered.

    b. If refusal is encountered within 75 feet with CPT or DMT, SPT should be conducted somewhere along the same bent and rock should be cored (if encountered within 100 feet. See section B-3 for additional rock coring requirements.

    c. Note that DMT should not be used for bearing capacity analysis for deep foundations.

3. **Rock Coring**:

    a. When coring rock as noted in Item A-3 or Item B-2 above:

        i. Note the time spent on coring each run.

        ii. Save all core runs and label the boxes with the project number and county, boring number, depths and date.

        iii. Label the top and bottom of the core runs with the beginning and ending depths. It is strongly recommended not to break core runs to fit into boxes. However, if long boxes are not readily available and cores must be broken to fit into shorter boxes, note the locations of the breaks on the cores and on the drilling logs.

        iv. A 24 hour groundwater reading will be required in each location a rock core was obtained.

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4. Note the type of drill rig, augers, casing, and bit(s) used throughout the boring. When drilling hard rock layers or boulders, also note the time to drill through these materials.

5. **24-hour Groundwater Readings**: Obtain 24-hour groundwater elevations on at least two of the borings at grade separation bridges.

6. **Shelby Tubes**: If soft layers of clay or plastic silt are found at the end bent borings, push at least two 3 inch diameter Shelby tubes at or near the center of any soft layer(s) ($N<10$) so that consolidation tests can be performed on the samples. Mark the tube with the project number and county, the boring number, the depth of the sample, and the date.

## C. Special Notes

1. Obtain the ground elevations at each boring by using the benchmark shown on the preliminary layout. If there is no benchmark shown, obtain a survey control package from the GDOT Statewide Location Bureau in the Office of Design Policy and Support. If that is not available, have a Georgia registered land surveyor create a benchmark from which you can determine ground elevations at each boring.

2. In addition to all drilling and sampling data, each boring log should contain the project number and county, the date, the bridge location, the driller's name, the type of drill used (i.e. truck-mounted Failing 250, CME 550 on ATV, etc.), the drilling method used (auger, rotary, etc.), the groundwater elevation and all other notes relevant to the subsurface conditions. The driller should also include energy rating data for the hammer. **Note:** SPT hammers must be calibrated once every 2 years and calibration data must be submitted as part of the deliverables on every project.

3. After groundwater checks are made, all boring holes should be filled in (and patched if made in a travel lane or paved shoulder) and the site left in good condition. Holes through bridge decks must be patched with non-shrink grout. Drill cuttings and all other spoils should be cleaned off any paved areas.

4. If the existing bridge has spread footings, contact the engineer to see if wash boring(s) to locate the top of footings will be required.

5. Note any other additional information or problems, such as old foundations, rock outcrops, erosion problems, stream channel migration, etc. that would be helpful in the foundation design or construction of the bridge.

6. Remember that these guidelines may be modified based on the site conditions and the engineer's requirements.

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## D. Laboratory Testing

1. Laboratory testing for most soil samples for BFI's normally consists of a Unified classification test, which includes an Atterberg limits test, moisture content test, and sieve analysis.

2. The sieve sizes used for the sieve analysis are Nos. 4, 10, 40, 60 and 200, which is one more than the minimum required by AASHTO or ASTM standards.

3. Laboratory testing for rock samples normally consists of unconfined compressive strength tests, and on occasion, split tensile tests.

4. Undisturbed tests such as Triaxial - Consolidated Undrained (CU) (other types of triaxial tests (CD or UU) may be run in addition to the CU test based on the discretion of the geotechnical engineer in charge of the project) and Consolidation should be run if Shelby tube samples are collected.

5. The latest editions of the following ASTMs should be followed for any lab tests performed:

| Test | ASTM Designation |
|---|---|
| Unified Soil Classification System (USCS) | D2487 |
| Moisture Content | D2216 |
| Atterberg Limits | D4318 |
| Unconfined Compressive Strength of Rock | D7012 |
| Split Tensile Strength of Rock | D3967 |
| Triaxial - Consolidated Undrained (CU) | D4767 |
| Triaxial – Consolidated Drained (CD) | D7181 |
| Triaxial – Unconsolidated Undrained (UU) | D2850 |
| Consolidation | D2435 |

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