NCDOT Geotechnical Engineering Unit
Procedures and Specifications for Soil Laboratory Testing

Utilize current AASHTO or ASTM Standard for each test below or referenced.

With the exception of Rock Core Laboratory Testing, all testing shall be performed in a NCDOT Certified Laboratory by a NCDOT Certified Laboratory Technician. Contact the Materials and Tests Unit for Laboratory or Technician certification. Results shall bear the certification and signature of the Laboratory Technician who performed the testing.

Tier I Tests

Classification of Soils and Soil-Aggregate Mixtures (AASHTO M 145)

This test shall include performance of the following Standard Methods and any others referenced in the AASHTO Standard Specification. Applicable tests shall be performed as modified by the NCDOT Materials & Tests Unit (NCMod).

AASHTO R 58 NCMod (Dry Preparation of Disturbed Soil and Soil-Aggregate Samples)
T 88 NCMod (Particle Size Analysis of Soils)
T 89 NCMod (Determining the Liquid Limit of Soils)
T 90 (Determining the Plastic Limit and Plasticity Index of Soils)
T 265 (Determination of Moisture Content of Soils)

The appropriate US standard size sieve stack for NCDOT work shall consist of:

Sieve Number	Sieve Opening (mm)
4	4.75
10	2.00
40	0.425
60	0.250
200	0.075
270	0.053

The following information shall be supplied in the reports for each sample tested for classification:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index
6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Moisture content to the nearest 0.1 percent (optional for A-1 and A-3 materials)

Materials Finer Than 75-μm (No. 200) Sieve by Washing (AASHTO T 11)

This test shall include performance of any Standard Methods referenced in the AASHTO Standard Method.

Procedure A – Washing with plain water shall be utilized for performance of this test.

The appropriate US standard size sieve stack for AASHTO T 11 shall consist of:

Sieve Number	Sieve Opening (mm)
Range No. 8 to No. 16	2.36 to 1.18
No. 200	0.075

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Percent of material finer than the No. 200 sieve to the nearest whole number

Sieve Analysis of Fine and Coarse Aggregates (AASHTO T 27)

This test shall include performance of the following Standard Method and any others referenced in the AASHTO Standard Method.

AASHTO T 11 (Material Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing)

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Total percent of material passing each sieve to the nearest whole number

Moisture Content of Soils (AASHTO T 265)

This test shall include performance of any Standard Methods referenced in the AASHTO Standard Method.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Moisture content to the nearest 0.1 percent

Organic Content by Loss on Ignition (AASHTO T 267)

This test shall include performance of any Standard Methods referenced in the AASHTO Standard Method.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Percent of organic content to the nearest 0.1 percent

pH of Soil (AASHTO T 289)

This test shall include performance of any Standard Methods referenced in the AASHTO Standard Method.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Report the pH value to the nearest tenth of a whole number

Tier II Tests

California Bearing Ratio (AASHTO T 193)

This test shall include performance of the following Standard Methods and any others referenced in the AASHTO Standard Method. Applicable tests shall be performed as modified by the NCDOT Materials & Tests Unit (NCMod).

AASHTO T 99 (Moisture-Density Relations of Soils using a 5.5 lb Rammer and a 12-in. Drop), or
T 180 NCMod (Moisture-Density Relations of Soils using a 10 lb Rammer and a 18-in. Drop)
M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 100 (Specific Gravity of Soils)

All specimens shall be soaked for performance of this test.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index
6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Moisture content before and after soaking to the nearest 0.1 percent
12) Specific gravity of soil
13) Dry density before and after soaking
14) Graph of dry density vs. water content
15) CBR at 0.1 and 0.2-inch penetration
16) T 99 or T 180 Compaction (Standard or Modified Compaction Effort)
17) Percent swell

Moisture-Density Relations of Soils using a 5.5 lb Rammer and a 12-in. Drop / Standard Proctor Compaction Test (AASHTO T 99)

This test shall include performance of the following Standard Methods and any others referenced in the AASHTO Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 100 (Specific Gravity of Soils)

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index
6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) Method used (A, B, C, or D)
13) 4 points to define the moisture-density relationship
14) Graph of dry density vs. water content

Moisture-Density Relations of Soils using a 10 lb Rammer and a 18 in. Drop / Modified Proctor Compaction Test (AASHTO T 180 NCMod)

This test shall include performance of the following Standard Methods and any others referenced in the AASHTO Standard Method. This test shall be performed as modified by NCDOT Materials & Tests Unit (NCMod).

AASHTO T 27 (Sieve Analysis of Fine and Coarse Aggregates)
T 100 (Specific Gravity of Soils) **and**
T 85 (Specific Gravity and Absorption of Coarse Aggregate)

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment

c. Northing
d. Easting
e. Depth interval of sample

3) Percent passing 1-1/2-inch sieve
4) Percent passing 1-inch sieve
5) Percent passing 1/2-inch sieve
6) Percent passing No. 4 sieve
7) Percent passing No. 10 sieve
8) Percent passing No. 40 sieve
9) Percent passing No. 200 sieve
10) Specific gravity of material tested
11) Method used (A, B, C, or D)
12) 4 points to define the moisture-density relationship
13) Graph of dry density vs. water content

Specific Gravity of Soils (AASHTO T 100)

This test shall include performance of any Standard Methods referenced in the AASHTO Standard Method.

Perform this test using minus 2.00 mm (No. 10 Sieve) fraction.

The following information shall be supplied in the report for the test data:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Specific gravity of soil

Compressive Strength of Molded Soil-Cement Cylinders (ASTM D1633)

This test shall include performance of the following Standard Specification and Methods as well as any other Standard Methods referenced in the ASTM Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 100 (Specific Gravity of Soils)
T 134 (Moisture-Density Relations of Soil-Cement Mixtures)

This procedure is intended for testing anticipated subgrade soils during preconstruction/ project design phase. Requirements and procedures for quality control and quality assurance testing of treated subgrade soils during construction may vary.

Cement is typically used with soils that meet the following criteria:

- Percent passing No. 200 sieve $\leq$ 35
- Liquid Limit 40 maximum
- Plasticity Index 10 maximum

Moisture-density relations should be determined for molding the specimens utilizing 10 percent cement by weight for the sample and following AASHTO T 134 Moisture-Density Relations for Soil-Cement Mixtures.

Two specimens shall be molded for each percentage of cement added to the soil by weight. Specimens should be molded at optimum moisture content using a quantity of cement in the range of 5 to 10 percent. Typically, 8 and 10 percent cement added by weight is used. The laboratory performing the testing may adjust the rates of cement added based on the site-specific conditions and experience. The specimens should be molded to 95 percent of the maximum dry density obtained by following AASHTO T 134.

Specimens shall be cured for 7 days in a moist room maintained at a temperature of 73°F ± 2.7° and a humidity of 100 percent. At the end of the curing period, immerse the specimens in water for 4 hours. After immersion, test the cured specimens in unconfined compression in accordance with ASTM D1633.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index
6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) T 134 Method used (A or B)
13) 4 points to define the moisture-density relationship of mixture
14) Graph of dry density vs. water content for the mixture
15) Specimen dimensions
16) Percent cement
17) Unit weight of specimen
18) Compressive strength
19) Moisture content to the nearest 0.1 percent

Unconfined Compressive Strength of Compacted Soil-Lime Mixtures (ASTM D5102)

This test shall include performance of the following Standard Specification and Methods as well as any other Standard Methods referenced in the ASTM Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 99 (Moisture-Density Relations of Soils using a 5.5 lb Rammer and a 12 in. Drop)
T 100 (Specific Gravity of Soils)
T 208 (Unconfined Compressive Strength of Cohesive Soils)

This procedure is intended for testing anticipated subgrade soils during preconstruction/ project design phase. Requirements and procedures for quality control and quality assurance testing of treated subgrade soils during construction may vary.

Lime is typically used with soils that meet the following criteria:

- Percent passing No. 200 sieve > 36
- Liquid Limit 41 minimum
- Plasticity Index 25 minimum

Moisture-density relations should be determined for molding the specimens utilizing 4 percent lime by weight for the sample and following AASHTO T 99 Moisture-Density Relations of Soils using a 5.5 lb Rammer and a 12 in. Drop.

Allow the soil-water-lime mixture to mellow in an airtight, moisture proof container that does not contain aluminum or zinc for a minimum of 24 hours before compacting specimens.

Two specimens shall be molded for each percentage of lime added to the soil by weight. Specimens should be molded at optimum moisture content using a quantity of lime in the range of 3 to 6 percent. Typically, 3 and 5 percent lime added by weight is used. The laboratory performing the testing may adjust the rates of lime added based on the site-specific conditions and experience. The specimens should be molded to 95 percent of the maximum dry density obtained by following AASHTO T 99 with 4 percent lime added to the soil by weight.

Specimens shall be cured in airtight, moisture proof containers at a temperature of 73°F ± 4° for 7 days. The container for curing the specimen should not contain aluminum or zinc due to the potential for these metals to react with the lime. **Do not immerse molded soil-lime specimens in water at the end of the curing period.** Test the cured specimens in unconfined compression in accordance with AASHTO T 208.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index

6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) T 99 Method used (A, B, C, or D)
13) 4 points to define the moisture-density relationship of mixture
14) Graph of dry density vs. water content for the mixture
15) Specimen dimensions
16) Percent lime
17) Unit weight of specimen
18) Compressive strength
19) Moisture content to the nearest 0.1 percent

Tier III Tests

One-Dimensional Consolidation Properties of Soils (AASHTO T 216)

This test shall include performance of the following Standard Specification and Method as well as any other Standard Methods referenced in the AASHTO Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 100 (Specific Gravity of Soils)

Test Method B requiring time-deformation readings on all load increments and applying successive load increments after 100 percent primary consolidation is reached shall be utilized for this test.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index

6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) Initial and final moisture content of specimen
13) Initial and final dry weight of specimen
14) Initial and final void ratio of specimen
15) Initial and final degree of saturation of specimen
16) List of dial readings for each load
17) Typical load increments are 0, 0.250, 0.500, 1.000, 2.000, 4.000, 8.000, 16.000 TSF, these recommended increments should be adjusted as necessary by the Engineer requesting the testing based on the soil and proposed construction.
18) Graph of percent change in height vs. log of pressure
    a. Graph should include a rebound curve starting at one load past the estimated pre-consolidation pressure
    b. Rebound curve should contain 3 unloading points and 3 reloading points
19) Graph of load vs. coefficient of consolidation

Unconsolidated Undrained Compressive Strength of Cohesive Soil in Triaxial Compression (AASHTO T 296)

This test shall include performance of the following Standard Specification and Method as well as any other Standard Methods referenced in the AASHTO Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 100 (Specific Gravity of Soils)

Unconsolidated, undrained with back pressure saturation on 2.5 or 2.8-inch undisturbed samples (3 points). Run test to failure at maximum deviator stress or 20 percent strain.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index

6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) Initial and final water content
13) Initial and final void ratio
14) Initial and final dry unit weight
15) Degree of saturation
16) Initial and final height of specimen
17) Initial and final diameter of specimen
18) Total back pressure
    a. Without pore pressure measurements (to be determined at project scope)
    b. With pore pressure at the end of saturation (to be determined at project scope)
19) Effective consolidated stress (to be determined at project scope)
20) Time to 50 percent primary consolidation (to be determined at project scope)
21) Failure criterion used
22) All incremental stress ratio data
23) Failure sketches or photographs for each sample

Graphs:
(a) Deviator Stress vs. Percent Strain
(b) Pore Pressure vs. Percent Strain

Mohr's Circles:
(a) Effective Stress @ Maximum Deviator Stress[1]
(b) Total Stress @ Maximum Deviator Stress[1]
(c) Effective Stress @ Maximum Effective Stress Ratio[2]
(d) Total Stress @ Maximum Effective Stress Ratio[2]
(e) Effective p'-q diagram - (q vs. p') Stress Path Diagram

Variable Descriptions:
[1] $\Rightarrow (\sigma_1-\sigma_3)$ max
[2] $\Rightarrow (\sigma_1/\sigma_3)$ max
$p' = (\sigma_1'+\sigma_3')/2$
$q = (\sigma_1-\sigma_3)/2$

Remolded Unconsolidated Undrained Compressive Strength of Cohesive Soils in Triaxial Compression (AASHTO T 296)

This test shall include performance of the following Standard Specification and Methods as well as any other Standard Methods referenced in the AASHTO Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 99 (Moisture-Density Relations of Soils using a 5.5 lb Rammer and a 12-in. Drop)
T 100 (Specific Gravity of Soils)

Unconsolidated, undrained with back pressure saturation on 2.5 or 2.8-inch samples remolded at near optimum moisture and approximately 95 percent maximum density (3 points) based on the

moisture-density relation of the soil determined using 5.5 lb rammer and a 12-inch drop. Run test to failure at maximum deviator stress or 20 percent strain.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index
6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) Initial and final moisture content
13) Initial and final void ratio
14) Initial and final dry unit weight
15) Degree of saturation
16) Initial and final height of specimen
17) Initial and final diameter of specimen
18) Total back pressure
    a. Without pore pressure measurements (to be determined at project scope)
    b. With pore pressure at the end of saturation (to be determined at project scope)
19) Effective consolidated stress (to be determined at project scope)
20) Time to 50 percent primary consolidation (to be determined at project scope)
21) Failure criterion used
22) All incremental stress ratio data
24) Failure sketches or photographs for each sample

Graphs:
(c) Deviator Stress vs. Percent Strain
(d) Pore Pressure vs. Percent Strain

Mohr's Circles:
(f) Effective Stress @ Maximum Deviator Stress[1]
(g) Total Stress @ Maximum Deviator Stress[1]
(h) Effective Stress @ Maximum Effective Stress Ratio[2]
(i) Total Stress @ Maximum Effective Stress Ratio[2]
(j) Effective p'-q diagram - (q vs. p') Stress Path Diagram

Variable Descriptions:	[1] $\Rightarrow (\sigma_1-\sigma_3)$ max
	[2] $\Rightarrow (\sigma_1/\sigma_3)$ max
	$p' = (\sigma_1'+\sigma_3')/2$
	$q = (\sigma_1-\sigma_3)/2$

Consolidated Undrained Triaxial Compression Test for Cohesive Soils (ASTM D4767)

AASHTO T 297 has been discontinued and now refers the reader to ASTM D4767. This test shall include performance of the following AASHTO Standard Specification and AASHTO Methods as well as any other Standard Methods referenced in the ASTM Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 100 (Specific Gravity of Soils)

Consolidated, undrained with back pressure saturation and pore pressure measurements on 2.5 or 2.8-inch undisturbed samples (3 point). Run test to failure at maximum deviator stress or 20 percent strain.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index
6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) Initial and final moisture content
13) Initial and final void ratio
14) Initial and final dry unit weight
15) Degree of saturation
16) Initial and final height of specimen
17) Total back pressure
18) Pore pressure at the end of saturation
19) Effective consolidated stress
20) Time to 50 percent primary consolidation
21) Failure criterion used

22) All incremental stress data
25) Failure sketches or photographs for each sample

Graphs:	(e) Deviator Stress vs. Percent Strain (f) Pore Pressure vs. Percent Strain
Mohr's Circles:	(k) Effective Stress @ Maximum Deviator Stress[1] (l) Total Stress @ Maximum Deviator Stress[1] (m) Effective Stress @ Maximum Effective Stress Ratio[2] (n) Total Stress @ Maximum Effective Stress Ratio[2] (o) Effective p'-q diagram - (q vs. p') Stress Path Diagram
Variable Descriptions:	[1] $\Rightarrow (\sigma_1-\sigma_3)$ max [2] $\Rightarrow (\sigma_1/\sigma_3)$ max $p' = (\sigma_1'+\sigma_3')/2$ $q = (\sigma_1-\sigma_3)/2$

Remolded Consolidated Undrained Triaxial Compression Test on Cohesive Soils (ASTM D4767)

AASHTO T 297 has been discontinued and now refers the reader to ASTM D 4767. This test shall include performance of the following AASHTO Standard Specification and AASHTO Methods as well as any other Standard Methods referenced in the ASTM Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 99 (Moisture-Density Relations of Soils using a 5.5 lb Rammer and a 12-in. Drop)
T 100 (Specific Gravity of Soils)

Consolidated, undrained with back pressure saturation and pore pressure measurement on 2.5 or 2.8-inch samples remolded at near optimum moisture and approximately 95 percent maximum density (3 points) based on the moisture-density relation of the soil determined using 5.5 lb rammer and a 12-inch drop. Run test to failure at maximum deviator stress or 20 percent strain.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index
6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve

9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) Initial and final moisture content
13) Initial and final void ratio
14) Initial and final dry unit weight
15) Degree of saturation
16) Initial and final height of specimen
17) Initial and final diameter of specimen
18) Total back pressure
19) Pore pressure at the end of saturation
20) Effective consolidated stress
21) Time to 50 percent primary consolidation
22) Failure criterion used
23) All incremental stress ratio data
26) Failure sketches or photographs for each sample

Graphs:	(g) Deviator Stress vs. Percent Strain (h) Pore Pressure vs. Percent Strain
Mohr's Circles:	(p) Effective Stress @ Maximum Deviator Stress[1] (q) Total Stress @ Maximum Deviator Stress[1] (r) Effective Stress @ Maximum Effective Stress Ratio[2] (s) Total Stress @ Maximum Effective Stress Ratio[2] (t) Effective p'-q diagram - (q vs. p') Stress Path Diagram
Variable Descriptions:	[1] $\Rightarrow (\sigma_1-\sigma_3)$ max [2] $\Rightarrow (\sigma_1/\sigma_3)$ max $p' = (\sigma_1'+\sigma_3')/2$ $q = (\sigma_1-\sigma_3)/2$

Unconfined Compressive Strength of Cohesive Soil (AASHTO T 208)

This test shall include performance of the following Standard Specification and Method as well as any other Standard Methods referenced in the AASHTO Standard Method.

AASHTO M 145 (Classification of Soils and Soil-Aggregate Mixtures)
T 100 (Specific Gravity of Soils)

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) AASHTO classification with Group Index
4) Liquid Limit
5) Plasticity Index

6) Minus 2.00 mm (No. 10 Sieve) Fraction (Soil Mortar)

Soil Mortar = 100 percent by weight (as defined by NCDOT)		
Coarse Sand Retained	-	No. 60 sieve
Fine Sand Retained	-	No. 270 sieve
Silt	-	0.05 to 0.005 mm
Clay	-	< 0.005 mm

7) Percent retained No. 4 sieve
8) Percent passing No. 10 sieve
9) Percent passing No. 40 sieve
10) Percent passing No. 200 sieve
11) Specific gravity of soil
12) Initial and final moisture content
13) Initial and final dry unit weight
14) Initial and final water content
15) Degree of saturation
16) Average height and diameter of specimen
17) Failure sketch or photograph of sample
18) Graph of load vs. strain

Permeability of Granular Soils (Constant Head) (AASHTO T 215)

This test will include the following procedures and any others listed in the description for the test in the ASTM Standard Specifications Manual. Applicable tests shall be performed as modified by the NCDOT Materials & Tests Unit (NCMod).

AASHTO T 88 NCMod (Particle Size Analysis of Soils)
T 265 (Moisture Content of Soils)

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Graph of grain size curve
4) Curve of velocity vs. hydraulic gradient

Minimum Laboratory Soil Resistivity: AASHTO T 288

This test shall include performance of any Standard Methods referenced in the AASHTO Standard Method.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing

d. Easting
e. Depth interval of sample

3) Minimum soil resistivity value

Tier IV Tests

Compressive Strength of Cylindrical Concrete Specimens (AASHTO T 22)

This test shall include performance of the following Standard Practices and any others referenced in the AASHTO Standard Method.

AASHTO R 100 (Making and Curing Concrete Test Specimens in the Field)
R 39 (Making and Curing Concrete Test Specimens in the Laboratory)

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of placement represented by sample, if applicable
3) Delivery ticket number, if applicable
4) Average measured diameter
5) Cross sectional area
6) Maximum load
7) Compressive strength
8) Average compressive strength rounded to the nearest 10 psi if two or more companion cylinders are tested at the same age
9) Type of fracture
10) Defects in either specimen or caps
11) Age of specimen at time of testing
    a. Report age in days for ages 3 days or greater
    b. Report age in hours if the age is less than 3 days
12) When determined, report the unit weight to the nearest lb/ft^3

Compressive Strength of Hydraulic Cement Mortar (using 50-mm or 2-in. cube specimens) (AASHTO T 106)

This test shall include performance of any Standard Methods referenced in the AASHTO Standard Method.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of placement represented by sample, if applicable
3) Delivery ticket number, if applicable
4) Flow to the nearest 1 percent
5) Water usage to the nearest 0.1 percent
6) Average compressive strength of all specimens from the same sample reported to the nearest 10 psi

NCDOT Geotechnical Engineering Unit
Procedures and Specifications for Rock Laboratory Testing

Utilize current ASTM Standard for each test below or referenced

Compressive Strength and Elastic Moduli of Intact Rock Core Specimens Under Varying States of Stress and Temperatures (ASTM D7012)

Method A:
Triaxial Compressive Strength of Undrained Rock Core Specimens Without Pore Pressure Measurements.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Specimen diameter and height
4) Failure sketch or photograph of specimen
5) Rate of loading or deformation rate
6) Unit weight
7) Confining stress levels at which triaxial test was performed
8) Plot of Mohr stress circles
9) Triaxial compressive strength

Method B:
Elastic Moduli of Undrained Rock Core Specimens in Triaxial Compression Without Pore Pressure Measurements.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Specimen diameter and height
4) Failure sketch or photograph of specimen
5) Graph of stress vs. strain
6) Poisson's ratio
7) Unit weight
8) Rate of loading or deformation rate

Method C:
Uniaxial Compressive Strength of Intact Rock Core Specimens

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Specimen diameter and height
4) Failure sketch or photograph of specimen
5) Temperature at which test was performed if other than room temperature
6) Time to failure
7) Loading, stress, or strain rate
8) Uniaxial compressive strength

Method D:
Elastic Moduli of Intact Rock Core Specimens in Uniaxial Compression

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number
2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Specimen diameter and height
4) Failure sketch or photograph of specimen
5) Temperature at which test was performed if other than room temperature
6) Time to failure
7) Loading, stress, or strain rate
8) Plot of the stress vs. strain curves
9) Poisson's radio at stress levels determined
10) Rate of loading or deformation rate

Splitting Tensile Strength of Intact Rock Core Specimens (ASTM D3967)

This test shall include performance of any Standard Methods referenced in the ASTM Standard Method.

Indicate if the specimen is being tested perpendicular or parallel to foliation.

The following information shall be supplied in the reports for each sample tested utilizing this method:

1) Sample number

2) Location of sample
    a. Boring identification
    b. Alignment
    c. Northing
    d. Easting
    e. Depth interval of sample
3) Specimen diameter and length
4) Rate of loading
5) Failure sketch or photograph of specimen
6) Splitting tensile strength as calculated to nearest 0.01 percent
7) Unit weight