PROJECT SPECIAL PROVISIONS

ROADWAY

CLEARING AND GRUBBING – METHOD III:

(4-6-06) SP2 R02

Perform clearing on this project to the limits established by Method "III" shown on Standard No. 200.03 of the *2006 Roadway Standard Drawings*.

BURNING RESTRICTIONS:

(7-1-95) SP2 R05

Open burning is not permitted on any portion of the right-of-way limits established for this project. Do not burn the clearing, grubbing or demolition debris designated for disposal and generated from the project at locations within the project limits, off the project limits or at any waste or borrow sites in this county. Dispose of the clearing, grubbing and demolition debris by means other than burning, according to state or local rules and regulations.

EMBANKMENT CONSTRUCTION USING DEGRADABLE ROCK:

(1-1-02) SP1

Degradable rock is defined as hard rock material which exhibits high slaking characteristics when exposed to air and water. This type material was encountered on this project and is comprised of Triassic mudstone and siltstone. Place all excavated degradable rock and all mixtures of degradable rock and soil in accordance with these provisions.

Place embankments constructed of degradable rock in 12 inch maximum lifts. Place each lift by blading and dozing in a manner to minimize voids, pockets, and bridging. Use a bulldozer to spread the material that is equivalent to or larger in size than a Caterpillar D-8. Provide each lift with a minimum of three (3) coverages with a static pad foot roller (minimum weight of 45,000 lbs.) and two (2) coverages with a vibratory pad foot roller (minimum centrifugal force per drum of 50,000 lbs.).

If the material is dry, add water to facilitate breakage of the rocks and compaction. Uniformly mix the added water for the entire depth of the lift by blading, disking, or other approved methods. Make sure that the amount of water added is sufficient to achieve optimum moisture of the particle size material.

The Engineer may modify the sequence or the number of coverages with either roller as deemed necessary to insure satisfactory breakage and compaction of the material. Density measurements are not required.

Do not place degradable rock or degradable rock and soil mixture in the top 24 inches of embankment.

Wasting of degradable rock will be permitted provided the provisions and conditions of Article 225-3 of the *Standard Specifications* are met.

No additional compensation will be provided for the procedures outline in this provision. This work is included in the unit price bid for unclassified excavation.

48" WELDED STEEL ENCASEMENT PIPE UNDER THE TRACKS OF CSX TRANSPORTATION AT STATION -Y1- 207+25:

(7-12-07) SPI

The 48" welded steel encasement pipe required under the tracks of CSX Transportation shall conform with Section 330 of the *Standard Specifications*. The thickness of the wall shall be 0.625 inches.

The pipe shall be installed by dry boring and jacking under the tracks as shown in the plans. The pipe shall be carefully dry bored true to the line and grade given. The bore shall be held to a minimum to insure that there will be no settlement. Pipe which has been damaged due to the Contractor's operation shall be removed and replaced at the Contractor's expense. All voids around the outside of the pipe shall be completely filled to the satisfaction of the Engineer.

The Contractor shall notify Mr. Bruce Fowler, Project Engineer, CSX Transportation, Inc., or his duly authorized representative, located at 100 Oakland Avenue, Florence, South Carolina 29501, telephone (843) 664-8210, e-mail address – bruce_fowler@csx.com at least 15 days before any work is begun on the railroad's right of way. This will enable them to have a representative present, if they so desire, while the work is being performed to determine if the work is being performed in accordance with the approved plans and Special Provisions. The railroad will advise the Contractor when the work is to be done between trains and provide a flagman, if required.

The quantity of pipe to be paid for will be the actual number of linear feet of pipe which has been incorporated in the completed and accepted work. Measurement will be made by counting the number of joints used and multiplying by the length of the joint. Where partial joints are used, measurement will be made along the longest length of the partial joint to the nearest 0.1 of a foot.

The quantity of pipe measured as provided for above will be paid for at the contract unit price per linear foot for *48" Welded Steel Pipe, 0.625" Thick, Grade B, (Under RR)*. Such price and payment will be full compensation for all work described herein including dry boring, jacking, tools, materials, labor, workmanship and all other incidentals necessary to complete the work.

The Contractor shall submit two (2) sets of detailed plans and a written description of his proposed method of pipe installation for approval by the Engineer and the Railway Company. Plans should include the size and location of any required jacking pits and- shoring f or support of the railroad roadbed if necessary.

EMBANKMENTS:
(5-16-06) SP2R18

Revise the *2006 Standard Specifications* as follows:

Page 2-22, Article 235-4(B) Embankment Formation, add the following:

(16) Do not place rock or broken pavement in embankment areas where piles or drilled shaft foundations are to be constructed. This shall include but not be limited to piles and foundations for structures, metal signal poles, overhead sign structures, and high mount lighting.

FALSE SUMPS:
(7-1-95) SP2 R40

Construct false sumps in accordance with the details in the plans and at locations shown in the plans or at other locations as directed by the Engineer.

Payment for the work of construction of the false sumps will be made at the contract unit price per cubic yard for *Unclassified Excavation* or *Borrow Excavation* depending on the source of material, or included in *Grading-Lump Sum*.

SHOULDER AND FILL SLOPE MATERIAL:
(5-21-02) SP2 R50

Description

Perform the required shoulder and slope construction for this project in accordance with the applicable requirements of Section 560 and Section 235 of the *2006 Standard Specifications* except as follows:

Construct the top 6 inches of shoulder and fill slopes with soils capable of supporting vegetation.

Provide soil with a P.I. greater than 6 and less than 25 and with a pH ranging from 5.5 to 6.8. Remove stones and other foreign material 2 inches or larger in diameter. All soil is subject to test and acceptance or rejection by the Engineer.

Obtain material from within the project limits or approved borrow source.

Compensation

When the Contractor elects to obtain material from an area located beneath a proposed fill sections which does not require excavation for any reason other than to generate acceptable shoulder and fill slope material, the work of performing the excavation will be considered incidental to the item of *Borrow Excavation* or *Shoulder Borrow*. If there is no pay item for *Borrow* or *Shoulder Excavation* in the contract, this work will be considered incidental to *Unclassified Excavation*. Stockpile the excavated material in a manner to facilitate measurement by the Engineer. Fill the void created by the excavation of the shoulder and fill slope material

with suitable material. Payment for material used from the stockpile will be made at the contract unit price for *Borrow Excavation* or *Shoulder Borrow*. If there is no pay item for *Borrow Excavation* or *Shoulder Borrow*, then the material will be paid for at the contract unit price for *Unclassified Excavation*. The material used to fill the void created by the excavation of the shoulder and fill slope material will be made at the contract unit price for *Unclassified Excavation*, *Borrow Excavation*, or *Shoulder Borrow*, depending on the source of the material.

Material generated from undercut excavation, unclassified excavation or clearing and grubbing operations that is placed directly on shoulders or slope areas, will not be measured separately for payment, as payment for the work requiring the excavation will be considered adequate compensation for depositing and grading the material on the shoulders or slopes.

When undercut excavation is performed at the direction of the Engineer and the material excavated is found to be suitable for use as shoulder and fill slope material, and there is no area on the project currently prepared to receive the material generated by the undercut operation, the Contractor may construct a stockpile for use as borrow at a later date. Payment for the material used from the stockpile will be made at the contract unit price for *Borrow Excavation* or *Shoulder Borrow*.

When shoulder material is obtained from borrow sources or from stockpiled material, payment for the work of shoulder construction will be made at the contract unit price per cubic yard for *Borrow Excavation* or *Shoulder Borrow* in accordance with the applicable provisions of Section 230 or Section 560 of the *2006 Standard Specifications*.

ROCK BLASTING:

(7-11-07) SPI

Description

This project special provision governs fracturing rock for excavation and constructing stable rock cut slopes using controlled, production and trench blasting. Controlled blasting is used to form a certain slope by limiting the effects of blasting with cushion or trim blasting. Another type of controlled blasting known as presplitting is not addressed by this provision. Production blasting is used to fracture rock in manageable sizes for excavation. Trench blasting is used to create trenches in rock for utilities and pipes and construct open ditches. This provision also addresses secondary blasting and blasting adjacent to highway structures in lieu of Article 410-11 of the *Standard Specifications*.

Exercise care when using bulk ammonium nitrate and fuel oil (ANFO) near open water to prevent ANFO from leaching into lakes, streams, creeks and rivers. Control blasting to avoid damaging public and private property. Contain flyrock in the construction limits or perform blasting such that no flyrock occurs if required in the "Project Requirements" section of this provision. When blasting in the vicinity of an open travelway, have equipment standing by to remove material that interferes with traffic flow.

Perform rock blasting, develop blast plans, provide explosive materials, drill, load and stem holes, record drilling, conduct blast surveys, monitor blasts and submit drilling records, surveys

and reports in accordance with the plans, *Standard Specifications* and this provision as directed by the Engineer.

Project Requirements

At a minimum, conduct pre-blast surveys for any building, residence or utility when the maximum charge per delay (W_{max}) and the distance to the subject structure (D) may result in a peak particle velocity (PPV) equal to or greater than 0.4 in/sec using the formulas in the "Peak Particle Velocity and Scaled Distance" section of this provision.

Blasting from Station 211+50 -Y1- to Station 219+50 -Y1- is subject to the following warning levels and not-to-exceed limits.

Variable	Warning Level	Not-to-Exceed Limit
Vibration (PPV) > 40 Hz	0.75 in/sec	1.0 in/sec
Vibration (PPV) < 40 Hz	0.40 in/sec	0.50 in/sec
Air-overpressure (noise)	120 dBL	133 dBL

In addition to the requirements above, conduct a pre-blast survey for the following structures.

Structure	Location
JMC HI TECH METALS, Inc.	Parcel No. 5
Overhead Power Line Towers	211+50 -Y1- to 219+50 -Y1-

In addition to the requirements above, monitor vibration and air-overpressure for the following structures.

Structure	Location
Overhead Power Line Towers	211+50 -Y1- to 219+50 -Y1-

Definitions

Air-Overpressure or Air Blast (Noise) – The pulsating pressure changes above and below ambient air pressure generated by an explosion. Air-overpressure "linear scale" measurements include low frequency noise with a 2 hertz (Hz) response and are expressed in units of decibels-L (dBL).
Blast Pattern – A plan of blast hole locations or an expression of the burden and spacing distance and their relationship to each other.
Burden – The amount of rock broken by an explosive charge measured as the distance between the blast hole and the nearest free face.
Charge per Delay (W) – The sum of all charge weights firing within any 8 milliseconds (ms) time period. For example, if two 10 lb charges fire at 100 ms and one 15 lb charge fires at 105 ms, the charge per delay would be 35 lbs.
Cushion or Trim Blasting – A controlled blasting technique in which a line of blast holes along a rock face are detonated during the last delay period of the blast. The main burden is moved from the face by production blast holes leaving only a small burden to be removed by the line of blast holes at the face. Charges in these holes are lighter than charges in the production blast holes.
Deck Loading (Decking) – A method of loading blast holes in which two or more explosive charges, called decks or deck charges, are loaded in the same hole separated by stemming or an air cushion.

Delay Blasting – The practice of initiating individual explosive decks, blast holes or rows of holes at predetermined time intervals using delays or delay detonators as compared to firing all blast holes simultaneously.
Flyrock – Rocks propelled through the air by the force of an explosion.
Free Face – A rock surface exposed to air or water that provides room for expansion upon fragmentation.
Magazine – Any building, structure or container, approved for storage of explosive materials other than an explosive manufacturing building.
Misfire – An event where all or some charges in a blast fail (do not detonate) when initiated or a term for any portion of explosive materials that fail to detonate as planned.
Peak Particle Velocity (PPV) – The maximum ground vibration velocity measured in the vertical, longitudinal or transverse direction. PPV measurement units are expressed in inches per second (in/sec).
Scaled Distance (Ds) – A calculated value in units of $ft/lb^{0.5}$ describing relative vibration energy based on distance to a structure (D) and charge per delay (W). Ds is equal to D divided by the square root of W, $Ds = D / W^{0.5}$ or $W = (D / Ds)^2$.
Spacing – The distance between blast holes in a row. In production blasting, the distance is measured parallel to the free face and perpendicular to the burden.
Stemming – Crushed stone placed in the unloaded collar area of blast holes for the purpose of confining explosive charges and limiting rock movement and air-overpressure.
Subdrilling – The portion of a blast hole that is drilled below or beyond the desired excavation depth or limit. Subdrilling is generally required to prevent the occurrence of high or tight areas of unfractured rock between blast holes.

Regulations

Comply with all the latest applicable Federal, State and local codes, laws, rules and regulations as well as professional society standards for the storage, transportation and use of explosives. These include but are not limited to the following:

- The Occupational Safety and Health (OSH) Act of 1970 and the Construction Safety Act (CSA) of 1969, as amended
- Safe Explosives Act, Title XI, Subtitle C of Public Law 107-296; Interim Final Rule
- Title 29, U. S. Code, Section 651 et seq., including safety and health regulations for construction
- Title 27, Code of Federal Regulations (27 CFR), Part 555, U. S. Department of Justice, Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)
- Organized Crime Control Act of 1970, Title XI, Public Law 91-452, as amended
- Title 49, Code of Federal Regulations (49 CFR), Parts 105-177 (DOT RSPA) & Parts 301-399 (DOT FHA)
- Title 29, Code of Federal Regulations (29 CFR), Parts 1910 & 1926, N. C. Department of Labor, Division of Occupational Safety and Health
- The Mining Act of 1971, North Carolina General Statute, Chapter 74, Article 7, as amended
- Fire Code of North Carolina, Section 105.6.15 Explosives

- Administrative Rules, 13 NCAC 06.0521 – 13 NCAC 06.0526, N. C. Department of Labor
- "A Guide to the Safe Storage of Explosive Materials" and "North Carolina Occupational Safety and Health Standards in Construction for Blasting & Use of Explosives", N. C. Department of Labor

Keep a copy of all regulations listed above at the project site.

Non-regulatory Industry Support Organizations:

- Blast Monitoring Equipment Operation Standards (1999), Vibration Subcommittee of the International Society of Explosive Engineers (ISEE)
- Institute of Makers of Explosives (IME) Safety Library Publications (SLPs)

In case of conflict, the more stringent regulation applies.

Submittals

In lieu of a blasting plan in accordance with Article 107-11 of the *Standard Specifications*, the following submittals are required for rock blasting.

- Blasting Contractor Personnel and Experience including Blasting Consultant, if applicable
- General Blast Plan including Blast Monitoring Consultant, if applicable
- Site Specific Blast Plans including Pre-blast Surveys
- Post-blast Reports including Drilling Records, Blast Monitoring Report and Blast Damage Report, when necessary

For the site specific blast plans and post-blast reports, submit two hard copies of each to the Resident Engineer. After completing all blasting for a cut, structure or an excavation, submit electronic copies (pdf or jpg format on CD or DVD) of all site specific blast plans and post-blast reports.

Allow 30 calendar days upon receipt by the Department for the review and acceptance of the Blasting Contractor personnel and experience and general blast plan. Provide these submittals in both electronic and hard copy form in accordance with the following:

Submit one hard copy to the Resident Engineer. At the same time, submit a second hard copy and an electronic copy (pdf or jpg format on CD or DVD) directly to the Geotechnical Engineering Unit at the following addresses:

For projects in Divisions 1-7, use the following Eastern Regional Office address:

Via US mail:
Eastern Regional Geotechnical Manager
North Carolina Department of Transportation
Geotechnical Engineering Unit
Eastern Regional Office
1570 Mail Service Center
Raleigh, NC 27699-1570

Via other delivery service:
Eastern Regional Geotechnical Manager
North Carolina Department of Transportation
Geotechnical Engineering Unit
Eastern Regional Office
3301 Jones Sausage Road, Suite 100
Garner, NC 27529

For projects in Divisions 8-14, use the following Western Regional Office address:

Via US mail:	Via other delivery service:
Western Regional Geotechnical Manager	Western Region Geotechnical Manager
North Carolina Department of Transportation	North Carolina Department of Transportation
Geotechnical Engineering Unit	Geotechnical Engineering Unit
Western Regional Office	Western Regional Office
5253 Z Max Boulevard	5253 Z Max Boulevard
Harrisburg, NC 28075	Harrisburg, NC 28075

The Engineer may suspend blasting operations in accordance with Article 108-7 of the *Standard Specifications* if submittals are illegible, incomplete or not provided.

(A) Blasting Contractor Personnel and Experience

The Engineer may waive this submittal if a Blasting Consultant is not required and the Blasting Contractor and Blaster-in-Charge for this project were previously accepted within the last year for another NCDOT project with subsurface conditions and blasting of a scope and complexity similar to that anticipated for this project.

Obtain acceptance of the Blasting Contractor personnel and experience before submitting a general blast plan.

(1) Blasting Contractor

Use a Blasting Contractor prequalified by the Contractual Services Unit for rock blasting work (work code 070). Submit documentation that the Blasting Contractor has successfully completed at least 5 blasting projects within the last 3 years with subsurface conditions and blasting of a scope and complexity similar to that anticipated for this project. Documentation should include the General Contractor and Owner's name and current contact information with descriptions of each past project.

(2) Blaster-in-Charge

The Blaster-in-Charge has total authority over the handling, use and security of explosives and is responsible for coordinating, planning and supervising explosives use. The Blaster-in-Charge is also responsible for designing blasts and preparing blast plans when a Blasting Consultant is not required and for monitoring blasts when a Blast Monitoring Consultant is not required. Either the Blaster-in-Charge or an alternate Blaster-in-Charge is required to be on-site during blasting.

Submit documentation that the Blaster-in-Charge and any alternate Blasters-in-Charge have a minimum of 5 years experience in blasting with past projects of scope and complexity similar to that anticipated for this project. Documentation should include resumes, references, certifications, project lists, experience descriptions and details, etc.

If there is a change in the Blaster-in-Charge, discontinue explosives use until a new Blaster-in-Charge is submitted and accepted.

(3) Blasting Consultant

When a Blasting Consultant is required in the "Project Requirements" section of this provision, submit the consultant's name with the Blasting Contractor personnel and experience. The Blasting Consultant shall not be an employee of the Contractor or any affiliated companies or product suppliers. Contact the Geotechnical Engineering Unit Contract Administrator for a list of approved Blasting Consultants.

(B) Blast Plans

Blast plans are for quality control and record keeping purposes and shall be signed by the Blaster-in-Charge (and Blasting Consultant, if applicable). Review and acceptance of blast plans does not relieve the Contractor of responsibility for the blast results or liability in accordance with Articles 107-11 and 107-12 of the *Standard Specifications*.

(1) General Blast Plan

Submit a general blast plan before beginning drilling, when revised drilling or blasting methods are proposed or as directed by the Engineer. At a minimum, include the following in the plan:

- Work procedures and safety precautions for the storage, transportation, handling and detonation of explosives
- Explosive products and devices for dry and wet blast holes including explosives, primers and detonators with material safety data sheets
- Drilling equipment and methods for maintaining blast hole alignment
- Typical plan, profile and sectional views for both production and controlled blasting showing hole diameter, depth, inclination and spacing, maximum blast limits, burden, subdrill depth and maximum charge per delay
- Initiation and delay methods and delay times
- Site specific blast plan format
- Blast hole drill log format
- Pre-blast survey criteria and method
- Blast monitoring report format and equipment including calibration information
- Post-blast report format
- Blast Monitoring Consultant if applicable
- Test blast locations when required

Do not deliver explosives to the project site until the general blast plan is reviewed and accepted.

(2) Site Specific Blast Plan

After the general blast plan is accepted, submit a site specific blast plan at least 24 hours in advance of each blast. Site specific blast plans may be waived for non-critical blasts as determined by the Engineer. The following is required for the plan:

- Scaled drawings of the blast area with cross-sections showing the beginning and ending stations, hole diameter, depth, inclination, spacing, burden, subdrill depth and free face location and any joints, bedding planes, weathered zones, voids or other significant rock structure that may influence the blast
- A loading pattern diagram showing the location and amount of each type of explosive including primers and detonators
- The locations and depths of stemming, column heights and maximum charge per delay for each type of loading
- A delay and initiation diagram showing delay pattern, sequence and times
- Pre-blast surveys (once per structure; not required when submitted for a prior blast)
- For site specific blast plans do not exceed the maximum charge per delay accepted in the general blast plan or submit a revised general blast plan to increase the maximum charge per delay allowed.

(C) Pre-blast Surveys and Post-blast Reports

(1) Blast Monitoring Consultant

When a Blast Monitoring Consultant is required in the "Project Requirements" section of this provision, submit the consultant's name with the general blast plan. The Blast Monitoring Consultant shall not be an employee of the Contractor or any affiliated companies or product suppliers. Contact the Geotechnical Engineering Unit Contract Administrator for a list of approved Blast Monitoring Consultants.

(2) Peak Particle Velocity and Scaled Distance

Use the following formulas to determine peak particle velocity (PPV) and scaled distance (Ds).

$PPV = K(Ds)^m$ and $Ds = D / (W_{max})^{0.5}$

where:
PPV = Peak Particle Velocity (in/sec)
K and m = Site specific constants defining initial energy and decay
Ds = Scaled Distance ($ft/lb^{0.5}$)
D = Distance to subject structure (ft)
W_{max} = Maximum charge per delay (lbs)

Typically, a K of 240 and an m of -1.6 may be used for the equations above. However, K and m are site specific and may be determined by performing a regression analysis of

multiple PPV and Ds data pairs. Select K and m based on actual site conditions, rock type and structure, subsurface information and blast monitoring measurements.

(3) Pre-blast Survey

Conduct pre-blast surveys in accordance with the "Project Requirements" section of this provision and the accepted general blast plan. At a minimum, include the following in the survey:

- Summary naming the person who performed the survey and comments about each structure and existing condition
- Sketches of interior and exterior walls and foundations with existing cracks and a written description of the cracks including the length, width, type and angle
- 4 x 6 inch color 35-mm or 5-megapixel digital photographs or miniDV or DVD digital video documenting the existing cracks and condition of each structure

Submit pre-blast surveys with site specific blast plans.

(4) Post-blast Report

Within 3 days after each blast or before the next blast, whichever is sooner, submit a post-blast report signed by the Blaster-in-Charge that includes the following:

- Results and effectiveness of the blast and any proposed changes to subsequent site specific blast plans
- Blast monitoring report
- Blast damage report when necessary
- Drilling records including blast pattern and blast hole drill logs

(a) Blast Monitoring

At a minimum, monitor vibration and air-overpressure (noise) at the nearest building, residence or utility and the nearest building, residence or utility in the direction of the blast in accordance the accepted general blast plan. Furnish seismographs capable of measuring particle velocities in the longitudinal, vertical and horizontal directions. Use monitoring equipment calibrated within one year of the date the data is collected. Interpret the recorded data and submit a blast monitoring report signed by the Blaster-in-Charge (or Blast Monitoring Consultant, if applicable) with the post-blast report that includes the following for each monitoring location:

- Type, identification and specific location of monitoring equipment
- Distance and direction to blast
- PPV in each direction and peak vector sum
- Maximum air-overpressure

If damage occurs from blasting, notify the Engineer immediately. Submit a blast damage report signed by the Blaster-in-Charge (and Blast Monitoring Consultant, if applicable) with the post-blast report that includes the following:

- Property owner's (and injured person's, if any) names, addresses and telephone numbers
- Details and description of property damage (and injury, if any) with photos or video
- Any associated tort claims, complaint letters and other applicable information

(b) Drilling Records

Identify each blast hole with a number on a blast pattern. Log the hole number, total depth, date drilled and the depth and description of significant conditions encountered such as water, voids and weak or jointed seams. Submit the blast pattern and blast hole drill logs signed by the Driller with the post-blast report.

Blast Design Requirements

(A) Vibration and Air-overpressure

Design blasts for the vibration and air-overpressure (noise) warning levels and not-to-exceed limits in the "Project Requirements" section of this provision. If warning levels are exceeded, the Engineer may require additional monitoring and the Contractor should be aware that future blasts could exceed the not-to-exceed limits. If not-to-exceed limits are exceeded, the Engineer may suspend blasting operations in accordance with Article 108-7 of the *Standard Specifications* and require test blasts and a revised general blast plan.

(B) Production Blasts

Design production blasts in accordance with the following unless otherwise approved:

- Maintain a minimum 6 ft clearance between the production blast holes and final cut slope face
- Diameter of production blast holes may not exceed 6"
- Do not drill production blast holes below the bottom of adjacent controlled blast holes
- Use delay blasting to detonate production blast holes towards a free face

(C) Controlled Blasts

Controlled blasts are required for final cut slopes steeper than 2:1 (H:V) when the height of the rock face exceeds 15 ft.

(1) Cushion Blasts

Cushion blasts refer to either trim or cushion blasting. Design cushion blasts in accordance with the following unless otherwise approved:

- Diameter of cushion blast holes may not exceed 6"
- Minimize subdrilling to only that required for excavation of the final cut slopes
- Do not subdrill below final grade
- Bench height or lift thickness may not exceed 25 ft

- Use a maximum of half the charge density and burden of the production blast holes for the cushion blast holes
- Do not use bulk ANFO or any other bulk loaded products
- Fire cushion blast holes after production blast holes with a minimum 25 ms delay

(D) Trench Blasts

Design trench blasts in accordance with the following unless otherwise approved:

- Diameter of trench blast holes may not exceed 3"
- Do not use bulk ANFO or any other bulk loaded products
- Use cartridge explosives or other types of explosives specifically designed for trench blasting
- Use a charge diameter ½ to ¾ inch less than the diameter of the trench blast holes

Test Blasts

A test blast is defined as drilling, blasting and excavation of a test section before beginning or restarting full scale blasting. When a test blast is required in the "Project Requirements" section of this provision or as directed by the Engineer, perform one or more test blasts for both production and controlled blasting (cushion or trim blasting) or trench blasting before beginning full scale blasting. Submit proposed test blast locations with the general blast plan. Also, if the Engineer suspends blasting operations after full scale blasting has begun, one or more test blasts may be required before resuming blasting. When this occurs, inform the Engineer of the test blast locations before submitting any site specific blast plans.

Perform test blasts in accordance with the submittal, blast design and construction requirements except submit site specific blast plans for test blasts 72 hours before beginning drilling. Full scale blasting may not begin or resume until the test blasts are acceptable to the Engineer. The Engineer will not consider whether a test blast is acceptable until the rock face is exposed and the post-blast report is submitted. Examples of results that may be unacceptable include excessive vibration, air-overpressure or flyrock, overbreakage, damage to the final cut slope face and overhangs.

Construction Methods

Conduct a pre-blast meeting with the Blaster-in-Charge, Blasting Consultant and Blast Monitoring Consultant, if required, the Resident Engineer, the Roadway Construction Engineer and the Geotechnical Operations Engineer to discuss the blasting and associated activities. This meeting should occur after the general blast plan is accepted and before submitting the site specific blast plan for the first blast on the project.

Drill and blast in accordance with site specific blast plans, the general blast plan, and this provision as directed by the Engineer. Use explosives in accordance with all applicable government regulations, professional society standards and manufacturer guidelines and recommendations.

Remove all overburden material along the top of the excavation for a minimum of 30 ft beyond the blast holes or the end of the cut unless approved otherwise by the Engineer. Inspect the free face to ensure there is adequate burden.

Drill blast holes within 3" of plan location and control drilling to maintain the final cut slope angle. Accurately determine the angle at which the drill steel enters the rock. Cover all blast holes after drilling to prevent unwanted backfill and identify and mark each hole with hole number and depth. Blast holes shall be free of obstructions the entire depth. Load holes without dislodging material or caving in the blast hole wall. Use standard size nos. 67 and 78M in accordance with Section 1005 of the *Standard Specifications* for stemming. Stem blast holes with diameters of 5" (250 mm) or greater with no. 67 coarse aggregate and blast holes with diameters less than 5" (250 mm) with no. 78M coarse aggregate. Do not stem blast holes with drill cuttings. Matting is required when blasting in close proximity to buildings, residences, utilities, traffic and populated areas. Soil cover may be used in lieu of matting if allowed by the Engineer.

Notify all occupants of residences, businesses and structures in the surrounding area and the Engineer at least 24 hours before blasting. Check for misfires immediately after each blast before signaling all clear. Remove any loose, hanging or potentially dangerous conditions by hand or machine scaling methods. Resume drilling only after scaling is complete.

When the height of a cut requires multiple lifts or benches, offset the controlled blast holes for each subsequent lift the minimum distance necessary to allow for drill equipment clearances. Adjust the alignment of controlled blast holes to account for this offset as well as any drift that occurred in the preceding lift.

The Engineer may suspend blasting operations in accordance with Article 108-7 of the *Standard Specifications* when vibration, air-overpressure or flyrock limits are exceeded, unsatisfactory rock cut slopes are produced or other reasons.

Remove all loose material from final rock faces by scaling. The Contractor is responsible for the final rock face. If blasting damages the final rock face, stabilize the slope at no additional cost to the Department with a method proposed by the Contractor and accepted by the Department.

Secondary Blasting

Secondary blasting is used to reduce the size of naturally occurring boulders or those resulting from initial blasting. Secondary blasting methods include block holing or boulder busting. Block holing or boulder busting is the breaking of boulders by loading and firing small explosive charges in small diameter blast holes. Submit a combined general and site specific blast plan for secondary blasting. The Engineer may waive the pre-blast surveys, blast monitoring and post-blast reports at their discretion.

Mud capping, which is defined as placing an unconfined explosive charge in contact with a rock surface without the use of a blast hole and covering it with mud, is not allowed.

Blasting Adjacent to Highway Structures

Do not blast adjacent to highway structures until the concrete strength reaches 2400 psi. When blasting adjacent to highway structures, limit PPV to 4 in/sec measured at a location on the structure nearest the blast. Perform blasting adjacent to highway structures in accordance with the submittal, blast design and construction requirements in this provision.

When blasting for foundation excavation, submit a combined general and site specific blast plan and the Engineer may waive the pre-blast surveys, blast monitoring and post-blast reports at their discretion.

Measurement and Payment

Payment for rock blasting for roadway excavation will be considered incidental to *Unclassified Exacavation* in accordance with Section 225 of the *Standard Specifications*. No separate payment will be made for any scaling. Payment for scaling will be considered incidental to *Unclassified Excavation.*

Rock blasting for pipe and utility installation will be considered excavation and payment will be made in accordance with Sections 300 and 1505, respectively, of the *Standard Specifications*.

Payment for rock blasting for foundation excavation will be considered incidental to *Foundation Excavation, Foundation Excavation for Bent No._____ at Station _____* or *Foundation Excavation for End Bent No. _____ at Station _____* in accordance with Section 410 of the *Standard Specifications*.

No additional payment will be made or extension of contract time allowed when the Engineer suspends blasting operations and requires test blasts, additional monitoring or submittals in accordance with this provision.

FLOWABLE FILL:
(9-17-02) (Rev 8-21-07) SP3 R30

Description

This work consists of all work necessary to place flowable fill in accordance with these provisions, the plans, and as directed.

Materials

Provide flowable fill material in accordance with Article 340-2 of the *2006 Standard Specifications.*

Construction Methods

Discharge flowable fill material directly from the truck into the space to be filled, or by other approved methods. The mix may be placed full depth or in lifts as site conditions dictate. The Contractor shall provide a method to plug the ends of the existing pipe in order to contain the flowable fill.

Measurement and Payment

At locations where flowable fill is called for on the plans and a pay item for flowable fill is included in the contract, *flowable fill* will be measured in cubic yards and paid for as the actual number of cubic yards that have been satisfactorily placed and accepted. Such price and payment will be full compensation for all work covered by this provision including but not limited to the mix design, furnishing, hauling, placing and containing the flowable fill.

Payment will be made under:

Pay Item	Pay Unit
Flowable Fill	Cubic Yard

PIPE TESTING:

4-17-07 SP3R33

Revise the *2006 Standard Specifications* as follows:

Page 3-3, Article 300-6, add the following:

The Department reserves the right to perform forensic testing on any installed pipe.

PIPE ALTERNATES:

(7-18-06) (Rev 4-17-07) SP3 R36

Description

The Contractor may substitute Aluminized Corrugated Steel Pipe, Type IR or HDPE Pipe, Type S or Type D up to 48 inches in diameter in lieu of concrete pipe in accordance with the following requirements.

Material

Item	Section
HDPE Pipe, Type S or D	1032-10
Aluminized Corrugated Steel Pipe, Type IR	1032-3(A)(7)

Aluminized Corrugated Steel Pipe will not be permitted in counties listed in Article 310-2 of the *2006 Standard Specifications*.

Construction Methods

Aluminized Corrugated Steel Pipe Culverts and HDPE Pipe Culverts shall be installed in accordance with the requirements of Section 300 of the *2006 Standard Specifications* for Method A, except that the minimum cover shall be at least 12 inches. Aluminized Corrugated Steel Pipe

Culvert and HDPE Pipe Culvert will not be permitted for use under travelways, including curb and gutter.

Measurement and Payment

____ "*Aluminized Corrugated Steel Pipe Culvert* to be paid for will be the actual number of linear feet installed and accepted. Measurement will be in accordance with Section 310-6 of the *2006 Standard Specifications*.

_____ "*HDPE Pipe Culvert* to be paid for will be the actual number of linear feet installed and accepted. Measurement will be in accordance with Section 310-6 of the *2006 Standard Specifications*.

Payment will be made under:

Pay Item	**Pay Unit**
___" Aluminized Corrugated Steel Pipe Culverts, ___" Thick	Linear Foot
___" HDPE Pipe Culverts	Linear Foot

AGGREGATE BASE COURSE:
12-19-06 SP5 R03

Revise the *2006 Standard Specifications* as follows:

Page 5-11, Article 520-5 Hauling and Placing Aggregate Base Material, 6th paragraph, replace the first sentence with the following:

Base course that is in place on November 15 shall have been covered with a subsequent layer of pavement structure or with a sand seal. Base course that has been placed between November 16 and March 15 inclusive shall be covered within 7 calendar days with a subsequent layer of pavement structure or with a sand seal.

ASPHALT PAVEMENTS - SUPERPAVE:
(7-18-06) (Rev 9-19-06) SP6 R01

Revise the *2006 Standard Specifications* as follows:

Page 6-2, Article 600-9 Measurement and Payment

Delete the second paragraph.

Page 6-12, 609-5(C)2(c) add after (AASHTO T 209):

or ASTM D 2041

Page 6-13, last line on page & Page 6-14, Subarticle 609-5(C)(2)(e), delete and substitute the following:

(e) Retained Tensile Strength (TSR) - (AASHTO T 283 Modified), add subarticle (1) Option 1 before the first paragraph.

(1) Option 1

Add subarticle (2) Option 2 and the following sentence as the first sentence of the second paragraph:

(2) Option 2

Mix sampled from truck at plant with one set of specimens prepared by the Contractor and then tested jointly by QA and QC at a mutually agreed upon lab site within the first 7 calendar days after beginning production of each new mix design.

Page 6-28, 610-3(A) Mix Design-General, third sentence of the fourth paragraph:

Substitute 20% for 15%

First, second and third sentences of the fifth paragraph:

Substitute 20% for 15%

Page 6-44, 610-8, third full paragraph, replace the first sentence with the following:

Use the 30 foot minimum length mobile grade reference system or the non-contacting laser or sonar type ski *with at least four referencing stations mounted on the paver at a minimum length of 24 feet* to control the longitudinal profile when placing the initial lanes and all adjacent lanes of all layers, including resurfacing and asphalt in-lays, unless otherwise specified or approved.

Page 6-54, Article 620-4, add the following pay item:

Pay Item	**Pay Unit**
Asphalt Binder for Plant Mix, Grade PG 70-28	Ton

Page 6-69, Table 660-1 **Material Application Rates and Temperatures**, add the following:

Type of Coat	**Grade of Asphalt**	**Asphalt Rate gal/yd^2**	**Application Temperature °F**	**Aggregate Size**	**Aggregate Rate lb./sq. yd. Total**
Sand Seal	CRS-2 or CRS-2P	0.22-0.30	150-175	Blotting Sand	12-15

Page 6-75, 660-9(B), add the following as sub-item (5)

(5) Sand Seal

Place the fully required amount of asphalt material in one application and immediately cover with the seal coat aggregate. Uniformly spread the fully required amount of aggregate in one application and correct all non-uniform areas prior to rolling.

Immediately after the aggregate has been uniformly spread, perform rolling.

When directed, broom excess aggregate material from the surface of the seal coat.

When the sand seal is to be constructed for temporary sealing purposes only and will not be used by traffic, other grades of asphalt material meeting the requirements of Articles 1020-6 and 1020-7 may be used in lieu of the grade of asphalt required by Table 660-1 when approved.

Page 10-41, Table 1012-1, add the following:

Mix Type	Course Aggregate Angularity [(b)] ASTM D5821	Fine Aggregate Angularity % Minimum AASHTO T304 Method A	Sand Equivalent % Minimum AASHTO T176	Flat & Elongated 5:1 Ratio % Maximum ASTM D4791 Section 8.4
S 9.5 D	100/100	45	50	10

Page 10-45, Replace Table 1012-2 with the following:

TABLE 1012-2
NEW SOURCE RAP GRADATION and BINDER TOLERANCES
(Apply Tolerances to Mix Design Data)

Mix Type	**0-20% RAP**			**21-25% RAP**			**26%+ RAP**		
Sieve (mm)	**Base**	**Inter.**	**Surf.**	**Base**	**Inter.**	**Surf.**	**Base**	**Inter.**	**Surf.**
P_b, %		± 0.7%			± 0.4%			± 0.3%	
1 1/2" (37.5)	±10	-	-	±7	-	-	±5	-	-
3/4" (19.0)	±10	±10	-	±7	±7	-	±5	±5	-
1/2" (12.5)	-	±10	±6	-	±7	±3	-	±5	±2
3/8" (9.5)	-	-	±8	-	-	±5	-	-	±4
No. 4 (4.75)	±10	-	±10	±7	-	±7	±5	-	±5
No. 8 (2.36)	±8	±8	±8	±5	±5	±5	±4	±4	±4
No.16 (1.18)	±8	±8	±8	±5	±5	±5	±4	±4	±4
No. 30 (0.600)	±8	±8	±8	±5	±5	±5	±4	±4	±4
No. 50 (0.300)	-	-	±8	-	-	±5	-	-	±4
No. 200 (0.075)	±4	±4	±4	±2	±2	±2	±1.5	±1.5	±1.5

ASPHALT BINDER CONTENT OF ASPHALT PLANT MIXES:
(11-21-00) SP6 R15

The approximate asphalt binder content of the asphalt concrete plant mixtures used on this project will be as follows:

Asphalt Concrete Base Course	Type B 25.0__	4.3%
Asphalt Concrete Intermediate Course	Type I 19.0__	4.7%

Asphalt Concrete Surface Course	Type S 4.75A	7.0%
Asphalt Concrete Surface Course	Type SF 9.5A	6.5%
Asphalt Concrete Surface Course	Type S 9.5__	6.0%
Asphalt Concrete Surface Course	Type S 12.5__	5.5%

The actual asphalt binder content will be established during construction by the Engineer within the limits established in the *2006 Standard Specifications.*

PRICE ADJUSTMENT - ASPHALT BINDER FOR PLANT MIX:
(11-21-00) SP6 R25

Price adjustments for asphalt binder for plant mix will be made in accordance with Section 620 of the *2006 Standard Specifications.*

The base price index for asphalt binder for plant mix is **$317.86** per ton.

This base price index represents an average of F.O.B. selling prices of asphalt binder at supplier's terminals on **July 1, 2007**.

GUARDRAIL ANCHOR UNITS, TYPE 350:
(4-20-04) SP8 R65

Description

Furnish and install guardrail anchor units in accordance with the details in the plans, the applicable requirements of Section 862 of the *2006 Standard Specifications*, and at locations shown in the plans.

Materials

The Contractor may at his option, furnish any one of the guardrail anchor units.

Guardrail anchor unit (ET-2000) as manufactured by:

Trinity Industries, Inc.
2525 N. Stemmons Freeway
Dallas, Texas 75207
Telephone: 800-644-7976

The guardrail anchor unit (SKT 350) as manufactured by:

Road Systems, Inc.
3616 Old Howard County Airport
Big Spring, Texas 79720
Telephone: 915-263-2435

Prior to installation the Contractor shall submit to the Engineer:

(A) FHWA acceptance letter for each guardrail anchor unit certifying it meets the requirements of NCHRP Report 350, Test Level 3, in accordance with Section 106-2 of the *2006 Standard Specifications*.

(B) Certified working drawings and assembling instructions from the manufacturer for each guardrail anchor unit in accordance with Section 105-2 of the *2006 Standard Specifications*.

No modifications shall be made to the guardrail anchor unit without the express written permission from the manufacturer. Perform installation in accordance with the details in the plans, and details and assembling instructions furnished by the manufacturer.

Construction Methods

Guardrail end delineation is required on all approach and trailing end sections for both temporary and permanent installations. Guardrail end delineation consists of yellow reflective sheeting applied to the entire end section of the guardrail in accordance with Section 1088-3 of the *2006 Standard Specifications* and is incidental to the cost of the guardrail anchor unit.

Measurement and Payment

Measurement and payment will be made in accordance with Articles 862-6 of the *2006 Standard Specifications*.

Payment will be made under:

Pay Item	Pay Unit
Guardrail Anchor Units, Type 350	Each

STEEL U-CHANNEL POSTS:
(7-18-06) SP9 R02

Revise the *2006 Standard Specifications* as follows:

Page 9-15 Subarticle 903-3(D) first paragraph, last sentence, delete the last sentence and add the following:

Use posts of sufficient length to permit the appropriate sign mounting height. Spliced posts are not permitted on new construction.

AGGREGATE PRODUCTION:
(11-20-01) SP10 R05

Provide aggregate from a producer who uses the current Aggregate Quality Control/Quality Assurance Program that is in effect at the time of shipment.

No price adjustment is allowed to contractors or producers who use the program. Participation in the program does not relieve the producer of the responsibility of complying with all requirements of the *2006 Standard Specifications*. Copies of this procedure are available upon request from the Materials and Test Unit.

CONCRETE BRICK AND BLOCK PRODUCTION:
(11-20-01) SP10 R10

Provide concrete brick and block from a producer who uses the current Solid Concrete Masonry Brick/Unit Quality Control/Quality Assurance Program that is in effect on the date that material is received on the project.

No price adjustment is allowed to contractors or producers who use the program. Participation in the program does not relieve the producer of the responsibility of complying with all requirements of the *2006 Standard Specifications*. Copies of this procedure are available upon request from the Materials and Test Unit.

PORTLAND CEMENT CONCRETE (Alkali-Silica Reaction):
2-20-07 SP10 R16

Revise the *2006 Standard Specifications* as follows:

Article 1024-1(A), replace the 2nd paragraph with the following:

Certain combinations of cement and aggregate exhibit an adverse alkali-silica reaction. The alkalinity of any cement, expressed as sodium-oxide equivalent, shall not exceed 1.0 percent. For mix designs that contain non-reactive aggregates and cement with an alkali content less than 0.6%, straight cement or a combination of cement and fly ash, cement and ground granulated blast furnace slag or cement and microsilica may be used. The pozzolan quantity shall not exceed the amount shown in Table 1024-1. For mixes that contain cement with an alkali content between 0.6% and 1.0%, and for mixes that contain a reactive aggregate documented by the Department, regardless of the alkali content of the cement, use a pozzolan in the amount shown in Table 1024-1.

Obtain the list of reactive aggregates documented by the Department at:http://www.ncdot.org/doh/operations/materials/pdf/quarryasrprob.pdf

Table 1024-1
Pozzolans for Use in Portland Cement Concrete

Pozzolan	*Rate*
Class F Fly Ash	20% by weight of required cement content, with 1.2 lbs Class F fly ash per lb of cement replaced
Ground Granulated Blast Furnace Slag	35%-50% by weight of required cement content with 1 lb slag per lb of cement replaced
Microsilica	4%-8% by weight of required cement content, with 1 lb microsilica per lb of cement replaced

GLASS BEADS:
(7-18-06) SP10 R35

Revise the *2006 Standard Specifications* as follows:

Page 10-223, 1087-4(C) Gradation & Roundness

Replace the second sentence of the first paragraph with the following:

All Drop-On and Intermixed Glass Beads shall be tested in accordance with ASTM D1155.

Delete the last paragraph.

ENGINEERING FABRICS TABLE 1056-1:
(7-18-06) SP10 R40

Revise the *2006 Standard Specifications* as follows:

Page 10-100, Table 1056-1, replace the values for Trapezoidal Tear Strength with the following:

Physical Property	ASTM Test Method	Type 1	Type 2	Type 3		Type 4
				Class A	Class B	
Typical Applications		Shoulder Drain	Under Riprap	Temporary Silt Fence		Soil Stabilization
Trapezoidal Tear Strength	D4533	*45* lb	*75* lb	--	--	*75* lb

CHANGEABLE MESSAGE SIGNS
(11-21-06) SP11 R11

Revise the *2006 Standard Specifications* as follows:

Page 11-9, Article 1120-3, Replace the 3rd sentence with the following:

Sign operator will adjust flash rate so that no more than two messages will be displayed and be legible to a driver when approaching the sign at the posted speed.

PAVEMENT MARKING LINES MEASUREMENT AND PAYMENT:
(11-21-06) SP 12 R01

Revise the *2006 Standard Specifications* as follows:

Page 12-14, Subarticle 1205-10, delete the first sentence of the first paragraph and replace with the following:

Pavement Marking Lines will be measured and paid for as the actual number of linear feet of pavement marking lines per application that has been satisfactorily placed and accepted by the Engineer.

PERMANENT SEEDING AND MULCHING:

(7-1-95) SP16 R01

The Department desires that permanent seeding and mulching be established on this project as soon as practical after slopes or portions of slopes have been graded. As an incentive to obtain an early stand of vegetation on this project, the Contractor's attention is called to the following:

For all permanent seeding and mulching that is satisfactorily completed in accordance with the requirements of Section 1660, Seeding and Mulching, and within the following percentages of elapsed contract times, an additional payment will be made to the Contractor as an incentive additive. The incentive additive will be determined by multiplying the number of acres of seeding and mulching satisfactorily completed times the contract unit bid price per acre for Seeding and Mulching times the appropriate percentage additive.

Percentage of Elapsed Contract Time	Percentage Additive
0% - 30%	30%
30.01% - 50%	15%

Percentage of elapsed contract time is defined as the number of calendar days from the date of availability of the contract to the date the permanent seeding and mulching is acceptably completed divided by the total original contract time.

SOIL NAIL RETAINING WALLS

(7-11-07) SPI

1.0 General

The work under this section consists of design, plan preparation and construction of soil nail retaining walls to the lines and grades shown in the plans and in accordance with these specifications.

Soil nailing consists of excavating in lifts, drilling holes into the ground, placing and grouting the nail tendons in the holes, placing geocomposite drain strips and installing weep holes, applying temporary shotcrete facing, installing the nail head anchorage assembly and constructing the permanent cast-in-place concrete facing.

The term "Soil Nail" as used in this special provision is intended as a generic term and refers to a reinforcing bar grouted into a drilled hole installed in any type of ground including soil, weathered rock and hard rock.

The Contractor is advised to review all available subsurface information and conduct additional investigations, as needed, to determine subsurface conditions such as high groundwater, unstable soil, hard rock, etc. that would adversely affect the cost of construction.

Submit 5 copies of plans and calculations to the Engineer for review and approval and allow 40 calendar days from the date they are received until the Engineer returns them.

A pre-construction meeting is required prior to the start of the work and will be attended by representatives of the Contractor, Resident Engineer and the Geotechnical Engineering Unit. Soil nailing requires organized coordination of each of these parties. Conduct the pre-construction meeting to clarify the construction requirements, provide appropriate scheduling of the construction activities and identify contractual relationships and responsibilities. Review of all submittals should be complete prior to scheduling the pre-construction meeting.

Value engineering proposals for other wall types will not be considered.

2.0 Prequalification Requirements

The Soil Nail Wall Subcontractor is responsible for the installation, monitoring and testing of the soil nail wall. Use a Soil Nail Wall Subcontractor prequalified by the Contractual Services Unit of the Department for Retaining Walls (Anchored) [work code 3020].

The Soil Nail Wall Subcontractor's Project Engineer and Superintendent must have successfully completed at least 10,000 square feet of wall face area with a minimum of 500 soil nails within the last three years.

All nozzlemen are required to have at least one year of continuous experience in similar shotcrete application work and must demonstrate ability to satisfactorily place the material in accordance with the recommendations of ACI 506.3R Guide to Certification of Shotcrete Nozzlemen. Evidence that the proposed nozzelman have been certified to the requirements of ACI 506.3R within the last five years is required.

Work cannot be started nor materials ordered until the Contractor's personnel qualifications have been approved by the Engineer. The Engineer may suspend the work if the Contractor substitutes non-approved personnel for approved personnel. The Contractor will be fully liable for costs resulting from the suspension of work and no adjustments in the contract time resulting from the work suspension will be allowed.

3.0 Design Criteria and Plan Requirements

Design and construct soil nail retaining walls in accordance with the Service Load Design (SLD) procedures contained in the FHWA "Manual for Design and Construction Monitoring of Soil Nail Walls", Report No. FHWA-SA-96-069R, the Soil Nailing Field Inspectors Manual, Publication No. FHWA-SA-93-068, and FHWA-IF-03-017 (GEC 7). The required partial safety factors, allowable strength factors and minimum global stability soil factors of safety must be in accordance with the FHWA manual, unless specified otherwise. Estimated soil/rock design shear strength parameters, slope and external surcharge loads, type of wall facing and facing architectural requirements, soil nail corrosion protection requirements, known utility locations, easements and right-of-ways will be as shown on the "Layout Drawings" or specified herein. Structural design of any individual wall elements not covered in the FHWA manual will be by

the service load design methods in conformance with Article 3.22 and other appropriate articles of the latest Edition of the *AASHTO Standard Specifications for Highway Bridges* including current interim specifications.

Prior to beginning wall construction the Contractor is required to perform a survey to verify the wall limits.

Use the soil parameters shown on the plans for design of the wall. Design all components of the wall for 100-year design life.

Include calculations and details for the cast-in-place concrete facing in the soil nail retaining wall design. The cast-in-place concrete facing must be a minimum 8 inches in thickness. A minimum 6 inch thick by 1 foot wide unreinforced concrete leveling pad is required for the cast-in-place facing.

Temporary shotcrete facing is required and must be a minimum of 4 inches in thickness and reinforced with welded wire and #4 bars running horizontally above and below the nails and behind the bearing plates.

Geocomposite drainage mats at minimum 10 foot centers are required.

A minimum nail inclination of 12 degrees is required. The nail holes must be a minimum of 6 inches and a maximum of 10 inches in diameter with a minimum center to center spacing of 3 feet. A minimum clearance from end of soil nail to bottom of nail hole of 6 inches is required. Corrosion protection consisting of epoxy coated bars is required.

Embed the wall to the top of the leveling pad a minimum of 2 feet below the proposed finished bottom of wall grade.

Do not extend nails beyond the Right of Way or easement line.

The submitted plans should include but will not be limited to the following:

- Elevation views showing all nail locations, proposed ground line elevations and stations, proposed leveling pad elevations and construction joint locations.
- Plan views.
- Section views showing shotcrete and concrete reinforcement, vertical nail locations, nail inclinations, drainage details, etc.
- Details of nail head anchorage assemblies, nail holes, drainage mats, etc.
- Verification test nail locations and required design adhesion values.
- Construction sequence.

A professional engineer registered in the state of North Carolina must seal all plans and calculations.

4.0 Construction Submittals

Provide the following submittals for the Engineer's review and approval. Changes or deviations from the approved submittals must be re-submitted for approval by the Engineer. The Contractor will not be allowed to begin wall construction until all submittal requirements are satisfied and found acceptable to the Engineer. No adjustments in contract time will be allowed due to incomplete submittals. Items listed below that have been included on the contractor prepared plans need not be resubmitted.

At least 30 days prior to initiating the work, submit to the Engineer:

1. Proposed schedule and detailed construction sequences.

2. Methods of excavation to the staged lifts indicated in the plans and excavation equipment types.

3. Drilling methods and equipment.

4. Nail grout mix design including:
- Brand and type of Portland cement.
- Source, gradation and quality of all aggregates.
- Proportions of mix by weight.
- Compressive strength test results (per AASHTO T106) verifying the required minimum seven day grout compressive strengths or previous test results completed within one year of the start of the work may be submitted for verification of the required compressive strength.

5. Nail grout placement procedures and equipment.

6. Soil nail testing methods and equipment including:
- Details of the jacking frame and appurtenant bracing.
- Details showing methods of isolating test nails during shotcrete application (i.e., methods to prevent bonding of the soil nail bar and the shotcrete).
- Details showing methods of grouting the unbounded length of test nails after completion of testing.
- Equipment list.

7. Identification number and certified calibration records for each load cell, test jack pressure gauge and jack master pressure gauge to be used. Calibration records must include the date tested, device identification number and the calibration test results and be certified for an accuracy of at least two percent of the applied certification loads by a qualified independent testing laboratory within 30 days prior to submittal.

8. Certified mill test results for nail bars together with properly marked samples from each heat specifying the ultimate strength, yield strength, elongation and composition.

9. Certifications of compliance for bearing plates and nuts.

10. A detailed construction dewatering plan addressing all elements necessary to divert, control and dispose of surface water.

11. Certified concrete and shotcrete mix designs including:
- Brand and type of Portland cement used.
- Source, gradation and quality of aggregates as specified herein.
- Proportions of mix by weight.
- Proposed admixture, manufacturer, dosage, technical literature if allowed.
- Compressive strength test results verifying the 3-day and 28-day compressive strengths.

12. Certified mill tests for all reinforcing steel together with properly marked samples from each heat specifying the minimum ultimate strength, yield strength, elongation and composition.

13. Complete engineering data for the drainage geotextile and geocomposite drain strip including a 1 ft square sample, manufacturers' certificate of compliance and installation instructions.

14. Certifications of Compliance for weep hole drainage pipes and curing compounds (if used).

15. Specification and data for review on equipment proposed for the project including shotcreting and compressed air equipment, proposed access arrangements and capacities.

5.0 Materials

All materials must conform to the requirements of the applicable sections of the *Standard Specifications for Roads and Bridges of the North Carolina Department of Transportation* and the following provisions:

Centralizers	PVC pipe or tube, steel or other material not detrimental to the nail steel (wood must not be used); securely attached to the nail bar; sized to position the nail bar within 1 inch of the center of the drill hole; sized to allow tremie pipe insertion to the bottom of the drill hole; and sized to allow grout to freely flow up the drill hole.
Nail Grout	Neat grout is to be used with a minimum seven day compressive strength of 3000 psi per AASHTO T106 and a minimum cement of nine sacks per cubic yard.
Cement	Portland Cement conforming to AASHTO M85 Type I, II or III.
Fine Aggregate	Clean, natural sand, AASHTO M6. Artificial or manufactured sand will not be accepted.

Coarse Aggregate	AASHTO M-80, Class B for quality.
Water	Potable, clean and free from substances deleterious to concrete and steel or elements that would cause staining.
Chemical Admixtures	ASTM C1141 and the following:
Accelerator	Fluid type, applied at nozzle, meeting requirements of ASTM D98, C494 Types C or E and C266.
Water-reducer and Superplastisizer	AASHTO M-194, Type A, D, F or G.
Air-Entraining Agent	AASHTO M-194.
Plasticizers	AASHTO M-194, Type A, D, F or G.
Mineral Admixtures:	
Fly Ash	AASHTO M-295, Type F or C.
Silica Fume	ASTM C1240, 90 percent minimum silicon dioxide solids content, not to exceed 12 percent by weight of cement.
Reinforcing Bars	AASHTO M-31, Grade 60 or 75, deformed. See Section 1070 of the *Standard Specifications* .
Welded Wire	AASHTO M55/ASTM A185 or A497.
Curing Compounds	AASHTO M-148, Type ID of Type 2.
Prepackaged Concrete	ASTM C928.
Excavation Protection	AASHTO M-171 or Polyethylene film.
Solid Bar Nails	AASHTO M31, Grade 60 or 75 (420 or 520) (or Grade 150, 1035 for testing only), threaded steel bars without splices or welds. All bars must be new, straight, undamaged and epoxy coated.
Epoxy Coating	AASHTO M284. Minimum 12 mils electrostatically applied. Bend test requirements will be waived.
Bearing Plates	AASHTO M183 steel plates bearing plates must be furnished by the nail bar manufacturer.

Nuts	AASHTO M291, Grade B, hexagonal fitted with beveled washer or spherical seat to provide uniform bearing. Nuts must be furnished by the nail bar manufacture.
Washer	AASHTO M291 steel.
Joint Filler & Sealant	Section 1028 of the *Standard Specifications*.
Geocomposite Drain	Miradrain 6200 or Equal.
Weep Hole	ASTM 1785 Schedule 40 PVC, solid and perforated wall.
Drainage Pipe	Cell classification 12454-B or 12354-C, wall thickness SDR 35, with solvent weld or elastomeric gasket joints.
Fittings	ASTM D3034, cell classification 12454-B or 12454-C, wall thickness SDR 35, with solvent weld or elastomeric gasket joints.

6.0 Handling and Storage

Carefully handle and store all steel reinforcement items and nail steel on supports to prevent contact with the ground. Damage to the nail steel as a result of abrasion, cuts or nicks, welds and weld spatter will be cause for rejection. Grounding of welding leads to the nail steel will not be allowed. Protect nail steel from dirt, rust and other deleterious substances at all times. Corrosion or pitting of the nails will be cause for rejection. Any epoxy coated nails that are damaged or defective in a manner that adversely affects the strength or serviceability of the unit must be repaired to the satisfaction of the Engineer or rejected and removed from the site by the Contractor at no additional cost to the Department. Repair epoxy coating using an epoxy field repair kit approved by the epoxy manufacturer.

Handle encapsulated nails in a manner that does not crack or otherwise damage the grout inside the sheath.

Provide drainage geotextile and geocomposite drains in rolls wrapped with a protective covering and store in a manner that protects the fabric from mud, dust, dirt, debris and shotcrete rebound. Do not remove protective wrapping until the geotextile or drain strip is installed. Avoid extended exposure to ultra-violet light. Label each roll of geotextile or drain strip in the shipment to identify that production run.

Adequately store cement to prevent moisture degradation and partial hydration. Do not use cement that is caked or lumpy.

7.0 Dewatering and Damage Control

Localized areas of perched water may be encountered at the interface of geologic units. Contact the Engineer if groundwater problems persist at the excavation face.

Provide all labor, equipment and materials required to maintain the work area in a sufficiently dry condition such that adverse water related effects do not occur during the construction period. Provide positive control and discharge of all surface water and perched ground water, if encountered, to the extent necessary to prevent adverse conditions as determined by the Engineer.

Damage caused by failure of the construction dewatering and drainage control plan to existing structures, soils or structures included in the work will be repaired by the Contractor to the Engineer's satisfaction at no additional cost to the Department.

The Contractor will be responsible for the condition of any pipe or conduit which may be used for temporary construction dewatering and all such pipes or conduits must be maintained clean and free of sediment during construction. Upon substantial completion of the work, remove construction dewatering conduits from the site. Alternatively, construction dewatering conduits can be fully grouted (abandoned) or left in a manner that protects the structure and all adjacent facilities from migration of fines through the conduit and potential ground loss.

All dewatering and drainage control costs will be considered incidental to the cost of the soil nail retaining wall.

8.0 Excavation

A. Mass Grading

Overexcavating the original ground beyond the final wall face will not be allowed. In the event that overexcavation beyond the final wall face occurs as a result of the Contractor's operations, restore such overexcavation using a method approved by the Engineer and at no additional cost to the Department.

B. Wall Face Excavation

Excavate from the top down in a staged horizontal lift sequence as shown in the approved submittals. The excavated surface ("neat line") must be within 1 inch of the location shown on the approved submittals. Do not excavate the ground level in front of the wall face more than 3 feet below the level of the row of nails to be installed in that lift. Do not excavate a lift until nail installation, reinforced shotcrete placement and nail testing for the preceding lift are complete and acceptable to the Engineer. Prior to advancing the excavation, allow shotcrete and nail grout on the preceding lift to cure for a minimum one day and three days, respectively. After a lift is excavated, clean the cut surface of all loose materials, mud, rebound and other foreign material that could prevent or reduce shotcrete bond. The excavated vertical wall face cannot be exposed for more than 24 hours for any reason.

Take all necessary measures to ensure that installed nails are not damaged during excavation. Repair or replace to the satisfaction of the Engineer and at no cost to the Department nails that are damaged or disturbed during excavation. Remove hardened nail grout protruding from the final wall excavation more than 2 inches in a manner that prevents fracturing the grout at the nail head. Sledge hammer removal of the grout is not allowed. The use of hand held rock chippers is acceptable provided their use does not damage or disturb the remaining grout at the nail head, the nail bar or the surrounding exposed ground.

Complete the excavation to the final wall face ("neat line") and application of the shotcrete in the same work shift unless otherwise approved by the Engineer. Extensions of the excavation face exposure period must be approved by the engineer. The Contractor must demonstrate for each material type at his own expense that the unsupported final excavation face will be stable over the proposed extension of the exposure period. Extensions to the face exposure period will be periodically reviewed and may be revoked by the Engineer at his discretion. Risk of damage to existing structures or structures included in this work will be borne by the Contractor where approval for extended face exposure period is granted by the Engineer. Where extension of the face exposure period is allowed, provide and install polyethylene sheets (properly anchored to the top and bottom of the excavation) to reduce degradation of the cut face caused by changes in soil moisture, unless otherwise approved by the Engineer.

C. Wall Discontinuities

Where the Contractor's excavation and installation methods result in a discontinuous wall along any continuous nail row, the ends of the wall at the points of discontinuity must be constructed to prevent sloughing or failure of the temporary slopes. Submit a plan for wall discontinuity construction sequencing and shoring to the Engineer for review and approval at least 30 days prior to starting work on the affected wall sections.

D. Protrusions and Voids

Remove all cobbles, boulders, rubble or debris which are encountered at the soil face during excavation and which protrude from the soil face more than 2 inches into the design shotcrete thickness shown on the plans. Backfill any overexcavations with shotcrete. Any shotcrete used to fill voids created by the removal of cobbles and boulders or other obstructions will be considered incidental to the shotcrete wall facing and no additional payment will be made. Generally, rocky ground such as colluvium, hard rock, fill with boulders and weathered rock will be difficult to excavate on a neat line without leaving pockets and voids. The Contractor is recommended to evaluate the subsurface conditions in order to anticipate the total volume of shotcrete needed.

E. Excavation Face Instability

Raveling or local instability of the final wall face excavation due to the presence of groundwater, problematic soil conditions, equipment vibrations or other causes must be brought to the immediate attention of the Engineer.

Temporarily stabilize unstable areas by means of buttressing the exposed face with an earth berm or other methods acceptable to the Engineer. Suspend work in unstable areas until remedial measures submitted by the Contractor and approved by the Engineer have successfully stopped facial instability.

Timber backing or lagging behind soil nail walls that is to remain in place and is greater than 1 inch total thickness must be pressure treated with wood preservative for soil and fresh water use in accordance with AWPB LP-22 to a minimum retention 4 pounds per cubic foot. Use one of the following wood preservatives: Creosote, Creosote-Coal tar solution, Penta Chlorophenol, Copper Naphthenate, ammonia copper arsenate, ammoniacal, copper zinc arsenate, acid copper chromate or chromated copper arsenate.

F. Access

If temporary work benches are required to install the nails, locate these benches behind any traffic barriers placed for protection of existing traffic. Payment for temporary work benches including the placement and removal of fill and any temporary shoring required will be considered incidental to the cost of the temporary soil nail wall. Equipment and nails may hang over the existing lanes; however, implement lane closures in accordance with the Traffic Control Plans such that equipment and nails do not hang over or into traffic.

9.0 Installation

A. Classification of Materials

No classification of drilled materials will be made except for identification purposes. Nail installation will include the removal and subsequent handling of all materials encountered in drilling the holes to the required lengths.

B. Equipment

Use drilling equipment that can drill straight and clean holes and has the size and capability to install nails as specified herein. This will include drill rigs with the capability of nail installation and grout placement through the drill casing or hollow-stem auger where drill hole stability cannot be maintained in open holes. Provide sufficient casing/auger lengths on site to maintain uninterrupted installation of soil nails. Where hard drilling conditions such as rock, cobbles, boulders or obstructions are encountered, a down-hole, pneumatic hammer drill bit may be required to advance the nail holes.

C. Drilling

Drill each nail hole at the locations and to the lengths and minimum diameters indicated in the approved submittals unless otherwise approved by the Engineer. Remove cuttings from the holes using compressed air or by mechanical auger flights. Compressed air may not be used where raveling or erodible conditions cause significant disturbance or voids to develop or where facial instability is induced. Water, drilling muds or other fluids

used to assist in cutting removal will not be allowed. At final penetration depth, thoroughly clean and make ready the nail hole for examination by the Engineer before nail bar installation or placement of grout. No portion of the nail hole may be left open for more than 60 minutes prior to grouting unless otherwise approved by the Engineer.

D. Nail Hole Support

Provide positive support of the hole during drilling as required to prevent excessive groundwater infiltration or sloughing and caving of the hole prior to nail insertion and/or grouting. Where caving and sloughing occurs, no further drilling will be allowed until the Contractor selects a method which prevents ground movement. Holes must be continuously supported by casing or alternate methods approved by the Engineer. Drilling fluids such as bentonite or water will not be allowed as a means of hole support. All installation material and other costs due to casing holes will be at no additional expense to the Department.

Provide casing made of steel construction and of ample strength to withstand handling and installation stresses, grout pressure, surrounding earth and groundwater pressures. Remove casings as the grout is placed. The casing extraction may be facilitated by the use of a vibratory extractor, if required. During removal, continually align the casing with the hole.

E. Optional Nail Installation Methods

Optional nail installation methods will require the approval of the Engineer. At the Contractor's option, a thin shotcrete layer may be installed prior to drilling nail holes provided that this construction sequence has been documented and approved by the Engineer. Include in the Contractor's documentation calculations demonstrating the bearing plates are adequate to service the design loads and transfer the stress to the wall by neglecting the bearing area beneath the plate encompassed by the drill hole or block out.

F. Production Nails

No drilling or bar placement for production nails will be allowed without prior written approval by the Engineer of the proposed drilling, installation and grouting methods. Only installation methods that have been successfully verification tested will be approved for production nail installation. Methods which fail to meet the verification and proof test acceptance criteria will be rejected. Methods that differ from those used during installation of verification nails will require additional verification nails prior to approval at no additional cost to the Department.

Provide bar sizes and grades for each nail hole as indicated in the approved submittals. Fit the bar with centralizers as shown in the plans and insert into the drill hole to the required depth without difficulty and in such a manner as to prevent damage to the drill hole and corrosion protection. Where the bar cannot be completely inserted, remove the bar and clean or redrill the hole to permit unobstructed installation. Partially installed bars may not be driven or forced into the drill hole and will be rejected. When using

open-hole drilling methods are being used, hole cleaning tools suitable for cleaning drill holes along their full length just prior to bar insertion and/or grouting are required.

G. Grouting

Grout the drill hole after installation of the nail bar. Grouting prior to insertion of the nail bar may be allowed provided neat grout without sand is used and the nail bar is immediately inserted through the grout to the specified design length without difficulty. Nails inserted in the grout that has taken set will be rejected and must be replaced at no additional cost to the Department. No portion of the nail hole may be left open for more than 60 minutes prior to grouting unless otherwise approved by the Engineer. Inject grout at the lowest point of each drill hole through a grouting conduit and fill the hole in one continuous operation. Gravity flow of grout into the nail hole from the excavation face will not be allowed. Cold joints in the grout placement will not be allowed, except for proof test nails. Pump the grout through a grout tremie pipe, casing, hollow-stem auger or drill rods. Maintain the conduit delivering the grout at least 5 feet (1.5 m) below the surface of the grout as the conduit is withdrawn. Withdraw the grouting conduit at a slow and even rate as the nail hole is filled in a manner that prevents the creation of voids. A sufficient quantity of grout to fill the entire nail hole must be available in delivery trucks or grout mixing/pumping plants when the first grout is placed in each nail hole. Record the quantity of grout and the grouting pressures.

If the grouting of any nail is suspended for more than 30 minutes before grouting is complete or if the quality of the grout placement results in a nail that does not satisfy any of the requirements specified herein, then remove and dispose of the steel and grout and install fresh grout and undamaged steel at no additional cost to the Department.

1. Grout Testing

Provide nail grout that has a minimum compressive strength of 3000 psi in seven days. Test the nail grout in accordance with AASHTO T106 at a frequency no less than every 50 cubic yards of grout placed or once per week, which ever comes first.

2. Grouting Equipment

Provide grouting equipment that produces a uniformly mixed grout free of lumpy and undispersed cement. A positive displacement grout pump is required. Use a pump with a pressure gauge which can measure at least twice but no more than three times the intended grout pressure and a stroke counter (for piston-type grout pumps). Grout pumps without the specified pressure gauge and piston-type grout pumps without a stroke counter may not be used. Size the grouting equipment to be able to grout the entire nail in one continuous operation. A mixer that is capable of continuously agitating the grout during usage is required.

H. Attachment of Bearing Plate and Nut

Attach the bearing plate and nut as shown in the approved submittals. Seat the plate by hand wrench tightening the nut such that uniform contact with the shotcrete is achieved while the shotcrete is still plastic and prior to its initial set. Where uniform contact

between the plate and the shotcrete cannot be provided, seat the plate on a mortar pad to provide uniform support. Once the mortar pad has attained strength (minimum one day), hand tighten the nut with a wrench.

Replace bearing plates that are damaged or defective as determined by the Engineer at no additional cost to the Department.

I. Test Nail Unbonded Length

Isolation of the nail bar tendon for production proof test nails is required to prevent bonding of the shotcrete to the nail bar. Isolation through the shotcrete facing must be made in a manner which maintains the tolerances of reinforcing steel behind the bearing plate. Blockouts in the shotcrete that result in no reinforcing below the nail head will not be allowed. Details of the method of test nail isolation through the shotcrete facing and the method by which the unbonded length of production proof test nails will be maintained during testing and grouted back after testing must be submitted to the Engineer for approval.

10.0 Shotcreting

Furnish all materials, equipment, tools and labor required for placing and securing geocomposite drainage material, weep holes and reinforced shotcrete. If necessary, trim and clean the soil/rock surfaces and shotcrete cold joints prior to shotcreting.

Shotcrete must comply with the requirements of ACI 506R, "Specification for Shotcrete", except as otherwise specified. Shotcrete consists of an application of one or more layers of mortar or concrete conveyed through a hose and pneumatically projected at a high velocity against a prepared surface.

Shotcrete may be produced by either a dry-mix or a wet-mix process. The wet-mix process consists of thoroughly mixing all the ingredients except accelerating admixtures but including the mixing water, introducing the mixture into the delivery equipment and delivering it, by positive displacement, to the nozzle. The wet-mix shotcrete may then be air jetted from the nozzle at high velocity onto the surface. Dry-mix process is shotcrete without mixing water which is conveyed through the hose pneumatically and the mixing water is introduced at the nozzle.

A. Mix Design

No shotcrete admixture may be used without the Engineer's approval. Thoroughly mix at the rate specified by the manufacturer any admixtures used to entrain air, reduce water-cement ratio, retard or accelerate setting time or accelerate the development of strength. Accelerating additives must be compatible with the cement used, be non-corrosive to steel and not promote other detrimental effects such as cracking and excessive shrinkage.

The maximum allowable chloride ion content of all ingredients may not exceed 0.10% when tested to AASHTO T260.

1. Aggregate

Provide aggregate for shotcrete that meets the strength and durability requirement of AASHTO M-80 and M-43 and the following gradation requirements:

Sieve Size	% Passing by Weight
1/2 inch	100
3/8 inch	90-100
No. 4	70-85
No. 8	50-70
No. 16	35-55
No. 30	20-35
No. 50	8-20
No. 100	2-10

2. Proportioning

Proportion and deliver shotcrete with a minimum cement content of 658 pounds per cubic yard. Aggregate cement ratio may not be more than 4.5 by weight and water/cement ratio may not be more than 0.45. For wet-mix shotcrete the air content at delivery to the pump should be in the range of 7 to 10 percent when tested in accordance with ASTM C231.

3. Strength Requirements

Produce a shotcrete mix capable of attaining 2000 psi compressive strength in three days and 4000 psi in 28 days. The average compressive strength of each set of three cores should be equal to or exceed 85 percent with no individual core less than 75 percent of the specified compressive strength.

4. Mixing and Batching

Aggregate and cement may be batched by weight or by volume in accordance with the requirements of ASTM C91 and ASTM C685, respectively. Provide mixing equipment that is capable of thoroughly mixing the materials in sufficient quantity to maintain continuity during placement. Ready mix shotcrete must comply with AASHTO M-157. Batch, deliver and place ready mix shotcrete within 90 minutes of mixing.

B. Field Quality Control

Both preconstruction and production shotcrete test panels are required. Do not disturb test panels within the first 24 hours. Field cure the test panels under conditions similar to those anticipated for the work.

Perform field control tests in the presence of the Engineer. Provide equipment, materials and the services of one or more employees as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring. The Department will perform compressive strength testing in accordance with ACI 506R. The frequency specified for test panels is approximate. The Engineer may require a greater or lesser number of panels.

Preconstruction and production test panels must be 18 x 18 inches and a minimum of 4 inches thick.

Test reports that indicate unsatisfactory compressive shotcrete properties will result in suspension of the crew responsible for the unsatisfactory specimens until they have demonstrated that they are capable of producing acceptable work or until additional specimens have been submitted, tested and proven satisfactory. Cost associated with field quality control testing including additional testing and lost production due to tests failing to meet the specifications will be borne by the Contractor.

1. Preconstruction Test Panels

   Furnish at least two preconstruction test panels for each proposed mixture being considered and for each shooting position to be encountered on the job, made by each application crew. Preconstruction test panels must be made by each application crew using the equipment, materials, mixture proportions and procedures proposed for the job prior to the commencement of work.

   Preconstruction test panels for plain shotcrete must be in accordance with ACI 506.2 and the following:

   a. Provide one preconstruction test panel with the maximum shotcrete thickness and the maximum anticipated reinforcing congestion. Cores extracted from the test panel must demonstrate adequate cover of the reinforcement and must be equal to core grade two or better in accordance with ACI 506.2.

   b. Provide one preconstruction test panel at least 4 inches thick without reinforcement for compressive strength testing.

   c. Slope the sides of the test panels at 45 degrees.

2. Production Test Panels

   Furnish at least one production test panel or, in lieu of production test panels, six 3 inch diameter cores from the shotcrete face for every 5000 square feet or 50 cubic yards of shotcrete placed, whichever is less. Construct the production test panels simultaneously with the shotcrete facing installation at times designated by the Engineer.

3. Core Testing

Cut at least six core samples from each pre-construction test panel and production test panel at the frequency specified herein. Soak cores in water for at least 40 hours in accordance with AASHTO T24. Cores should be at least 3 inches in diameter and have a minimum length to diameter ratio of one. When the length of a core is less than twice the diameter, apply correction factors given in ASTM C42 to obtain the compressive strength of individual cores. Test three cores at 3-days and three more cores at 28-days for compressive strength testing.

Fill core holes in the wall with patching mortar or shotcrete after cleaning and thoroughly dampening.

4. Visual Observation

A clearly defined pattern of continuous horizontal or vertical ridges or depressions at the reinforcing elements after they are covered will be considered an indication of insufficient cover of reinforcement or poor application and probable voids. In this case the application of shotcrete will be immediately suspended and the work carefully inspected by the Engineer. Implement and complete corrective measures prior to resuming the shotcrete operations.

The shotcrete procedure may be corrected by adjusting the nozzle distance and orientation perpendicular to the surface, adjusting the water content of the shotcrete mix or other means acceptable to the Engineer. If necessary, broom and roughen the shotcreted surface to ensure proper bond of subsequent layers.

C. Shotcrete Alignment Control

Provide alignment wires and/or thickness control pins to establish shotcrete thickness and maintain a plain surface. The maximum distance between the wires on any surface should be equal to the vertical nail spacing. Ensure that the alignment wires are tight, true to line and placed to allow further tightening.

D. Surface Preparation

Prior to shotcreting the "birds beak" (ungrouted zone of the nail drill hole near the face), remove all loose materials from the surface of the grout and prepare the joint in accordance with all requirements for joint construction specified herein.

Remove all loose materials and loose dried shotcrete from all receiving surfaces by methods acceptable to the Engineer. Accomplish the removal in such a manner as not to loosen, crack or shatter the surfaces to receive the shotcrete. Any surface material which, in the opinion of the Engineer, is so loosened or damaged must be removed to a sufficient depth to provide a base that is suitable to receive shotcrete. Remove material that loosens as the shotcrete is applied. Do not place shotcrete on frozen surfaces.

E. Delivery and Application

Maintain a clean, dry, oil-free supply of compressed air sufficient for providing adequate nozzle velocity for all parts of the work at all times. Use equipment that is capable of delivering the premixed material accurately, uniformly and continuously through the delivery hose. Control thicknesses, methods of support, air pressure and rate of placement of shotcrete to prevent sagging or sloughing of freshly-applied shotcrete.

Apply the shotcrete from the lower part of the area upwards to prevent accumulation of rebound on uncovered surfaces. Where shotcrete is used to complete the "birds beak" (ungrouted zone of the nail drill hole near the face), the nozzle must be positioned into the mouth of the drill hole to completely fill the void. Do not use or salvage rebound shotcrete. Remove rebound which does not fall clear of the working area. Hold the nozzle at a distance and an angle approximately perpendicular to the working face so that rebound will be minimal and compaction will be maximized. Rotate the nozzle steadily in a small circular pattern.

F. Defective Shotcrete

Repair surface defects as soon as possible after initial placement of the shotcrete. Remove all shotcrete which lacks uniformity, exhibits segregation, honeycombing or lamination or contains any voids or sand pockets and replace with fresh shotcrete to the satisfaction of the Engineer.

G. Construction Joints

Uniformly taper construction joints toward the excavation face over a minimum distance equal to the thickness of the shotcrete layer. Clean and prepare the surface of the nail grout at the face of the wall to receive shotcrete in a manner equal to all other construction joints.

H. Finish

Shotcrete finish should be either an undisturbed gun finish as applied from the nozzle or a screened finish. Remove shotcrete extending into the cast-in-place section beyond the tolerances specified.

I. Climate

Do not place shotcrete in cold weather when the ambient temperature is below 40°F and the shotcrete is likely to be subjected to freezing temperatures before gaining sufficient strength to avoid damage. Maintain cold weather protection until the strength of the in-place shotcrete is greater then 750 psi. Cold weather protection may include heating under tents, blankets or other means acceptable to the Engineer. Materials may be heated in order that the temperature of the shotcrete, when deposited, is not less than 50°F or more than 90°F.

Suspend shotcrete application during high winds and heavy rains when in the opinion of the Engineer the quality of the application is not acceptable. Remove and replace shotcrete that is exposed to rain and washes out cement or otherwise makes the shotcrete unacceptable to the Engineer. Provide polyethylene sheeting or equivalent when adverse exposure to weathering is anticipated. Secure polyethylene film to the top and bottom of the excavation.

11.0 CIP Concrete Facing

Construction of the concrete facing must conform to the requirements of Section 420 of the *Standard Specifications*, unless otherwise specified herein. Form the exposed face of the concrete facing with an acceptable forming system. A properly designed form bracing system to resist the lateral concrete pressure is required to keep the finished wall in good alignment. Submit formwork and falsework system to be approved by the Engineer before the beginning of any formwork.

The vertical face of the wall must be plumb or have a back-batter no greater than two percent (2%) for the total height of the wall. No forward leaning of the wall in any magnitude is allowed.

Deliver the concrete to the formed area by means of tremie or drop chute to prevent the formation of honeycomb. Concrete must be placed in maximum three foot lifts and vibration may not be used to move the concrete horizontally.

Use internal vibrations only. No external vibrations are allowed. Vibrate one lift at a time and extend the vibrator to 6 to 12 inches into the preceding lift. After a momentary pause, withdraw the vibrator slowly, at a rate of one to two inches per second. Insert the vibrator at an interval of 12 to 18 inches and adjust the interval as necessary to insure the affected area of vibrator overlap by a sufficient amount. Maintain a constant time lag from the time of concrete placement to the time of vibration application through the entire wall.

Accomplish patching as needed with epoxy mortars or specially mixed grouts for patching. Do not use concrete from subsequent placements for patching. Patch may be recessed slightly and smearing fill material on the surrounding finished surface is not allowed. Use light sand blasting to improve the appearance of the finished surface of the wall as directed by the Engineer.

After stripping and patching, apply the finished wall surface as soon as possible with one coat of cure and seal compound. The cure and seal compound should be compatible with the form release compound.

12.0 Wall Drainage Network

The drainage network consists of installing prefabricated geocomposite drainage strips and weep hole drain pipes as shown in the approved submittals or as directed by the Engineer. Install all elements of the drainage network prior to shotcreting.

A. Geocomposite Drainage Strips

Install geocomposite drain strips as shown in the approved submittals. Place drain strips at construction joints such that the joint is aligned as close as practical along the middle of the longitudinal axis of the drain strip.

Use geocomposite drain strips at least 12 inches wide and secure to the cut face with the geotextile side against the ground before shotcreting. Use securing pins at least 8 inches long with a 1.5 inch diameter head on a minimum grid pattern of 24 inches on center. Discontinuous drain strips are not allowed. If splices are needed, overlap a minimum of 12 inches.

When the drain strips cannot be secured tight against the excavation face, place polyethylene film over the drain edges to prevent excess shotcrete from entering the sides of the drain. Alternatively, the drains may be installed in 16 inch wide strips and the film omitted.

B. Weep Hole Drainage Pipes

Install weep hole drainage pipes at locations shown in the approved submittals or as directed by the Engineer. The distance between each weep hole may not be more than 10 feet. Install pipes of solid PVC pipe to direct water from the geocomposite drain strips to the outside of the facing. Connect the pipes to the drain strips by installing prefabricated drain grates in accordance with the drain strip manufacturer's recommendations. Seal the joint between the drain grate and the drain strip and the drainage pipe to prevent shotcrete intrusion. Damage of the geocomposite drainage board which, in the opinion of the Engineer, may cause interruption in flow will require installation of additional weep holes, at the Contractor's expense.

13.0 Nail Testing

Both verification and proof testing of the nails are required. Supply all material, equipment and labor to perform the tests. The Engineer will collect all required data with the assistance of the Contractor. Testing of nails may not be performed within three days of nail grout placement or shotcrete application, whichever occurs last.

Where temporary casing of the unbonded test length of test nails is provided, place the casing in a manner which precludes causing any reaction between the casing and the grouted zone of the nail and/or the stressing apparatus during nail testing.

A. Testing Equipment

Two dial or vernier gauges, a dial gauge support, jack and pressure gauge, master pressure gauge and a reaction frame are required for testing.

Use a minimum of two dial or vernier gauges capable of measuring to 0.001 inch to measure the nail movement. The dial gauges should have a minimum stroke of 3 inches.

Align the dial gauges within five degrees from the axis of the nail and support the dial gauges independently of the jacking set-up and the wall. Apply the test load with a hydraulic jack and a pump.

The jack and pressure gauge must be calibrated by an independent testing laboratory as a unit. Provide a pressure gauge that is graduated in 1000 psi increments or less and has a range not exceeding twice the anticipated maximum pressure during testing unless otherwise approved by the Engineer. Use the pressure gauge to measure the applied load. The minimum ram travel of the jack may not be less than 4 inches. The jack should be capable of applying each load in less than one minute.

Independently support and center the jack over the nail so that the nail does not carry the weight of the jack. Calibrate the master pressure gauge with the test jack and pressure gauge as a unit. Monitor the loads on the nails during the verification tests with both the master pressure gauge and electric load cell. The load cell will be used to maintain constant load hold throughout the creep test. Provide recent calibration curves. Place the stressing equipment over the nail in such a manner that the jack, bearing plates, load cell and stressing anchorage are in alignment. Position the jack at the beginning of the test such that unloading and repositioning of the jack during the test is not required.

Provide a reaction frame that is sufficiently rigid and of adequate dimension such that excessive deformation of the test apparatus requiring repositioning of any components does not occur. Where the reaction frame bears directly on the shotcrete, the reaction frame must be designed to prevent fracture of the shotcrete. No part of the reaction frame may bear within 6 inches of the edge of the test nail blockout unless otherwise approved by the Engineer.

B. Verification Testing

Perform verification testing horizontally prior to procuring materials for or installation of production nails to verify the Contractor's installation methods, soil conditions, nail capacity and design assumptions. Verification tests must be performed within the limits of the work area. A minimum of two verification tests or one verification test for each set of assumed soil parameters, which ever is greater, are required at locations approved by the Engineer. Additional verification tests are required where ground conditions differ from those anticipated or shown on the approved submittals.

Submit details of the verification testing arrangement including the method of distributing test load pressures to the excavation surface (reaction frame), test nail bar size and grade, grouted hole diameter and reaction plate dimensioning to the Engineer for approval. All verification nail testing must be performed using the same equipment, methods and hole diameter as planned for the production nails. Changes in the drilling or installation method may require additional verification testing as determined by the Engineer at no additional cost to the Department. The nails used for the verification tests are sacrificial and may not be incorporated into the production nail schedule.

Test nails will have both bonded and unbonded lengths. Prior to testing only the bonded length of the test nail may be grouted. The unbonded length of the test nail must be at least 5 feet unless otherwise approved by the Engineer. The bonded length of the test nail will be based on the bar grade and size such that the allowable bar load is not exceeded, but may not be less than 10 feet unless otherwise approved by the Engineer. The allowable bar load during testing may not exceed 80 percent of the ultimate strength of the steel for Grade 150 bars or 90 percent of the yield strength for Grade 60 and 75 bars. The minimum bond length of 10 feet may require larger or higher grade bars than the production nails in order to achieve 200% of the design load without overstressing the bar. Provide higher capacity bars instead of shortening the bond length too less than the minimum.

The verification test bonded length L_{BV} may not exceed the test allowable bar load divided by two times the design adhesion value. Use the following equation for sizing the test nail bond length to avoid overstressing the verification nail bar:

$$L_{BV} \leq \frac{Cf_yA_s}{2A_D}$$

Where: L_{BV} = Maximum Verification Test Nail Bond Length (ft)
f_y = Bar Yield Stress (ksi)
A_s = Bar Area (in^2 or m^2)
A_D = Design Adhesion (kips/ft)
C = 0.8 for Grade 150 Bar and 0.9 for Grade 60 and 75 Bars

Determine the design load during testing by the following equation:

$$DTL = L_B \times A_D$$

Where: DTL = Design Test Load
L_B = As-Built Bonded Test Length (ft)
A_D = Design Adhesion (kips/ft)

Load and unload verification test nails to twice the design test load (DTL) in accordance with the following schedule.

LOADING		UNLOADING	
LOAD	HOLD TIME	LOAD	HOLD TIME
AL	1 minute	1.75DTL	Until Stable
0.25DTL	10 minutes	1.50DTL	Until Stable
0.50DTL	10 minutes	1.25DTL	Until Stable
0.75DTL	10 minutes	1.00DTL	Until Stable
1.00DTL	10 minutes	0.75DTL	Until Stable
1.25DTL	10 minutes	0.50DTL	Until Stable
1.50DTL	60 minutes	.25DTL	Until Stable
1.75DTL	10 minutes	AL	Until Stable
2.00DTL	10 minutes		

Hold each load increment for at least ten minutes. Monitor the verification test nail for creep at the 1.50 DTL load increment. Measure and record nail movements during the creep portion of the test at 1, 2, 3, 5, 6, 10, 20, 30, 50 and 60 minutes. Extended creep measurements may be required as determined by the Engineer. Maintain all load increments within five percent of the intended load during the creep test using the load cell. Unload the nail in increments of 25 percent with deflection measurements recorded at each unload increment. Each unload increment may be held only for a sufficient time to allow stabilization of the movement reading.

The alignment load (AL) is the minimum load required to align the testing apparatus and may not exceed five percent of the design test load. "Zero" dial gauges after the alignment load has been applied.

C. Proof Testing

Proof testing is required on at least five percent of the production nails in each shotcrete lift to verify the Contractor's methods and the design nail capacity. The Engineer will determine the specific locations and number of these tests.

Proof test nails will have both bonded and unbonded lengths. Prior to testing only the bonded length of the test nail may be grouted. The unbonded length of the test nail must be at least 5 ft) unless approved otherwise by the Engineer. The bonded length of the test nail will be such that the allowable bar load is not exceeded but may not be less than 10 feet unless otherwise approved by the Engineer. The allowable bar load may not exceed 80 percent of the ultimate steel strength for Grade 150 bars and 90 percent of the yield strength for Grade 60 and 75 bars.

The proof test bonded length L_{BP} may not exceed the test allowable bar load divided by 1.5 times the design adhesion value. Use the following equation for sizing the test nail bond length to avoid overstressing the production bar:

$$L_{BP} \leq \frac{C f_y A_s}{1.5 A_D}$$

Where: L_{BP} = Maximum Proof Test Nail Bond Length (ft)
f_y = Bar Yield Stress (ksi)
A_s = Bar Stress Area (in^2)
A_D = Design Adhesion (kips/ft)
C = 0.8 for Grade 150 (1035) Bar and 0.9 for Grade 60 and 75 (420 and 520) Bars

Perform proof tests by incrementally loading the nail to 1.5 times the design test load. Determine the design test load by the equation shown for the verification test nails. Measure and record nail movements at each load in the same manner as for verification test nails. Monitor the load with a pressure gauge with a sensitivity and range meeting

the requirements of pressure gauges used for verification test nails. Load proof test nails in accordance with the following schedule.

LOADING

LOAD	HOLD TIME
AL	Until Stable
0.25DTL	Until Stable
0.50DTL	Until Stable
0.75DTL	Until Stable
1.00DTL	Until Stable
1.25DTL	Until Stable
1.50DTL	10 or 60 minutes

The alignment load (AL) should be the minimum load required to align the testing apparatus and may not exceed five percent of the design load (DTL). "Zero" dial gauges after the alignment load has been applied.

Maintain all load increments within five percent of the intended load. Depending on performance, either 10 minute or 60 minute creep tests are required at the maximum test load (1.50 DTL). The creep period will start as soon as the maximum test load is applied. Measure and record nail movements at 1, 2, 3, 5, 6 and 10 minutes. Where nail movement between one minute and 10 minutes exceeds 0.04 inch, maintain the maximum test load an additional 50 minutes and record movements at 20, 30, 50 and 60 minutes.

D. Test Nail Acceptance

A test nail will be considered acceptable when:

1. For verification tests, a creep rate less than 0.08 inches per log cycle of time between the six and 60 minute readings is observed during creep testing and the rate is linear or decreasing throughout the creep test load hold period.

2. For proof tests: (a) a total creep less than 0.04 inches is observed between the one and 10 minute readings creep test or a creep rate less than 0.08 inches per log cycle of time is observed during the 60 minute creep test between six and 60 minute readings and; (b) the creep rate is linear or decreasing throughout the creep test load hold period.

3. The total movement at the maximum test load exceeds 80 percent of the theoretical elastic elongation of the test nail unbonded length.

4. A pullout failure does not occur at the maximum test load. Pullout failure load is defined as the load at which attempts to increase the test load simply result in continued excessive pullout movement of the test nail. Record the pullout failure load as part of the test data.

Proof test nails may be incorporated into the production nail schedule provided that (1) the unbonded test length of the nail hole has not collapsed during testing, (2) the minimum required hole diameter has been maintained and (3) the test nail length is equal to or greater than the scheduled production nail length. Complete test nails meeting these requirements by satisfactorily grouting the unbonded test length. If the unbonded test length of production proof test nails cannot be grouted subsequent to testing due to caving conditions or other reasons, replace the test nail with a similar production nail to the satisfaction of the Engineer at no additional cost to the Department.

E. Test Nail Results

1. Verification Test Nails

The Engineer will evaluate the results of each verification test. Installation methods that do not satisfy the nail testing requirements will be rejected. Where the design adhesion is not attainable by reasonable means, revise the production nail schedule. Incorporate any increases in the quantity, the lengths or the diameters of nails as required by the designer. Reasonable means will be considered to include gravity grouted nails installed as specified herein to the minimum diameter required or to a maximum diameter of 10 inches.

2. Proof Test Nails

The Engineer may require that the Contractor replace some or all of the installed production nails between the failed proof test nail and the adjacent passing proof test nail. Abandon nails which fail in proof test and replace them with new proof test nails. Also, the Engineer may require that additional proof testing be conducted to verify that adjacent nails have sufficient load carrying capacity. Modifications may be required which include installing additional test or production nails, installing longer production nails, increasing the drill hole diameter or modifying the installation methods.

14.0 Tolerances

A. Soil Nails

Center the bars within 1 inch of the center of the hole. Individual nails must be positioned plus or minus 6 inches from the design locations shown in the approved submittals unless otherwise directed by the Engineer. Location tolerances will be considered applicable to only one nail and not accumulative over large wall areas. The nail inclination should be plus or minus two degrees of that shown in the plans. Use a magnetic angle-indicator tool to align the drill inclination prior to drilling each nail installation hole. Relocate nails which encounter unanticipated obstructions during drilling as directed by the Engineer. Replace soil nails which do not satisfy the specified tolerances due to the Contractor's installation to the Engineer's satisfaction at no additional cost to the Department.

B. Bearing Plates

The location of the bearing plate may not vary from its proposed location within the concrete facing vertical plane by more than ¾".

15.0 Records

Record the following information:

1. Contractor's and drill rig operator's names
2. Design and as-built, nail locations and elevations
3. Deviations from specified tolerances
4. Design and as-built, hole lengths and diameters
5. Design and as-built, bar lengths and sizes
6. Groundwater conditions
7. Caving or sloughing of excavation
8. Casing requirements
9. Drilling difficulties
10. Date and time of start and finish of drilling
11. Date, time and method grout was placed including grout pressure
12. Total daily quantity of grout placed and quantity per hole
13. Design changes

Upon completion of the work, submit a complete record of the construction activities including the information listed above to the Engineer.

16.0 Measurement and Payment

Soil nail retaining walls will be measured and paid for as the actual number of square feet of exposed face area incorporated into the completed and accepted wall. The wall height is measured as the difference between the top and bottom of the wall. The bottom of wall is defined as the point where the finished grade intersects the front of the wall. The top of the wall is defined as the top elevation of the completed cast in place face.

The price and payment will be full compensation for all items required to provide the soil nail retaining walls including but not limited to those items contained in this special provision.

Payment will be made under:

Pay Item	**Pay Unit**
Soil Nail Retaining Wall	Square Foot

TEMPORARY RAILROAD GRADE CROSSINGS:

The Department of Transportation has made arrangements for a Temporary Grade Crossing. The Temporary Grade Crossing will be in the same location as the proposed permanent grade crossing. The Contractor will need to have a railroad flagman on site during any use of the crossing and the crossing must be physically barricaded at each approach during such times that it is not required for use. The Railroad Crossing will be constructed and removed by CSX Railroad. When all drainage and approach work is completed, the contractor shall provide CSX Railroad a thirty-day notice and request cooperation in determining an installation schedule of said crossing as to not adversely affect project timelines. Contact information is Mr. J. D. Kirkland, 100 Center Street Apex, N.C. 27502, Office (919) 362-9402 Cell (843) 250-0264. The Contractor shall construct the road and approaches such that it does not interrupt existing drainage patterns and to the satisfaction of the Railroad. Flagman must be on site for construction and removal of the crossing. Where applicable, the Contractor shall restore the property including any drainage ditches. The Contractor's attention is called to the fact that he will not be required to bear the cost of the flagging services required by the Railroad Company or provide any additional railroad insurance except that required by the Insurance Special Provision.