

NOVEMBER 16, 2018
REHABILITATION OF BRIDGE NO. 00196
I-95 OVER US ROUTE 1
FEDERAL AID PROJECT NO. 0952(118)
STATE PROJECT NO. 14-185
TOWN OF BRANFORD

ADDENDUM NO. 2

This Addendum addresses the following questions and answers contained on the “CT DOT QUESTIONS AND ANSWERS WEBSITE FOR ADVERTISED CONSTRUCTION PROJECTS”:

Question and Answer Nos. 13, 14, 17, 20, 24, 25, 26, 27, 28, 29, 35, 38, 41, 50, 56, 57, 59, 61, 62, 63, 64

NEW SPECIAL PROVISIONS

The following Special Provisions are hereby added to the Contract:

- NOTICE TO CONTRACTOR – ARCHITECTURAL AND INDUSTRIAL MAINTENANCE COATINGS
- ITEM NO. 0507495A – MODIFY EXISTING CATCH BASIN
- ITEM NO. 0819002A – PENETRATING SEALER PROTECTIVE COMPOUND
- ITEM NO. 1304066A – REMOVE WATER MAIN
- ITEM NO. 1501500A – REMOVE PIPE

REVISED SPECIAL PROVISION

The Special Provision for the following items is hereby deleted in its entirety and replaced with the attached like-named Special Provision:

- ITEM NO. 0712011A – PERMANENT SOIL NAILS
- ITEM NO. 0712012A – VERIFICATION TEST NAILS
- ITEM NO. 0712013A – STRUCTURE EXCAVATION (SOIL NAIL WALL)
- ITEM NO. 0712014A – SHOTCRETE CONSTRUCTION FACING
- ITEM NO. 0712016A – ABANDON AND BACKFILL DRILL HOLE

CONTRACT ITEMS

NEW CONTRACT ITEMS

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>UNIT</u>	<u>QUANTITY</u>
0305000	PROCESSED AGGREGATE	TON	105 TON
0507069	HEAVY DUTY TYPE “C-L” CATCH BASIN TOP	EA	3 EA
0507495A	MODIFY EXISTING CATCH BASIN	EA	12 EA
0507771	RESET CATCH BASIN	EA	41 EA
0507831	CONVERT CATCH BASIN TO MANHOLE	EA	1 EA
0602053	WELDED WIRE FABRIC	LB	100 LB

0819002A	PENETRATING SEALER PROTECTIVE COMPOUND	SY	500 SY
0921036	RETRO-FIT DETECTABLE WARNING STRIP	EA	2 EA
0921039	DETECTABLE WARNING STRIP	EA	11 EA
0944000	FURNISH AND PLACE TOPSOIL	SY	4,900 SY
1001004	ROCK IN TRENCH EXCAVATION (0'-4' DEEP)	CY	40 CY
1304066A	REMOVE WATER MAIN	LF	130 LF
1501500A	REMOVE PIPE	LF	650 LF

REVISED CONTRACT ITEMS

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>ORIGINAL QUANTITY</u>	<u>REVISED QUANTITY</u>
0202000	EARTH EXCAVATION	8,200 CY	8,310 CY
0202529	CUT BITUMINOUS CONCRETE PAVEMENT	11,950 LF	20,200 LF
0209001	FORMATION OF SUBGRADE	12,000 SY	11,300 SY
0213100	GRANULAR FILL	15 CY	21 CY
0304002	PROCESSED AGGREGATE BASE	1,100 CY	1,010 CY
0406159	PMA S0.5	2,950 TON	2,250 TON
0406160	PMA S1	545 TON	375 TON
0406172	HMA S0.375	2,800 TON	2,100 TON
0406236	MATERIAL FOR TACK COAT	9,200 GAL	7,000 GAL
0406275A	FINE MILLING OF BITUMINOUS CONCRETE (0" TO 4")	31,000 SY	27,500 SY
0406287A	RUMBLE STRIPS-AUTOMATED	23,600 LF	15,000 LF
0406289A	REMOVAL OF RUMBLE STRIPS	16,000 LF	10,000 LF
0507099	HEAVY DUTY TYPE "C" CATCH BASIN TOP	64 EA	14 EA
0815093	BITUMINOUS CONCRETE PARK CURB	825 LF	1,350 LF
0821178	PRECAST CONCRETE BARRIER CURB ("F" SHAPE - DOUBLE FACE)	5,461 LF	3,800 LF
0822001	TEMPORARY PRECAST CONCRETE BARRIER CURB	6,310 LF	5,100 LF
0822002	RELOCATED TEMPORARY PRECAST CONCRETE BARRIER CURB	10,500 LF	9,000 LF
0824052A	REMOVE EXISTING CONCRETE BARRIER CURB	5,340 LF	3,700 LF
0978002	TRAFFIC DRUM	200 EA	160 EA
1400004A	ROCK IN TRENCH EXCAVATION 0'-10' DEEP (SANITARY SEWER)	660 CY	330 CY
1802211.04	RELOCATION OF TEMPORARY SAND BARREL (400 LB.)	6 EA	4 EA
1802211.07	RELOCATION OF TEMPORARY SAND BARREL (700 LB.)	18 EA	12 EA

1802211.14	RELOCATION OF TEMPORARY SAND BARREL (1400 LB.)	24 EA	16 EA
1802211.21	RELOCATION OF TEMPORARY SAND BARREL (2100 LB.)	12 EA	8 EA

DELETED CONTRACT ITEMS

<u>ITEM NO.</u>	<u>DESCRIPTION</u>	<u>ORIGINAL QUANTITY</u>	<u>REVISED QUANTITY</u>
0202502	REMOVAL OF CONCRETE PAVEMENT	3,700 SY	0 SY
0214100	COMPACTED GRANULAR FILL	250 CY	0 CY
0602052	WELDED WIRE FABRIC – EPOXY COATED	670 SY	0 SY

PLANS

NEW PLANS

The following Plan Sheets are hereby added to the Contract:

- 03.17.A2
- 07.19.A2
- 07.20.A2
- 07.21.A2
- 07.22.A2
- 07.23.A2
- 07.24.A2
- 07.25.A2
- 07.26.A2
- 07.27.A2
- 07.28.A2
- 07.29.A2
- 07.30.A2
- 07.31.A2
- 07.32.A2
- 07.33.A2
- 07.34.A2
- 07.35.A2
- 07.36.A2
- 07.37.A2
- 07.38.A2

REVISED PLANS

The following Plan Sheets are hereby deleted and replaced with the like-numbered Plan Sheets:

- 02.01.A2
- 03.02.A2
- 03.05.A2
- 03.06.A2

- 03.07.A2
- 04.26.A2
- 04.29.A2
- 04.33.A2
- 04.35.A2
- 04.39.A2
- 04.40.A2
- 04.41.A2
- 04.42.A2
- 05.05.A2
- 05.06.A2
- 05.07.A2
- 05.08.A2
- 05.09.A2
- 05.10.A2
- 05.11.A2
- 05.12.A2
- 05.13.A2
- 05.14.A2
- 05.15.A2
- 05.18.A2
- 05.19.A2
- 05.20.A2
- 07.09.A2
- 07.10.A2
- 07.11.A2
- 07.12.A2
- 07.13.A2
- 07.14.A2
- 07.15.A2
- 07.16.A2
- 07.17.A2
- 07.18.A2

DELETED PLANS

The following Plan Sheets are hereby deleted in their entirety:

- 05.16
- 05.21

The Detailed Estimate Sheets do not reflect these changes.

The Bid Proposal Form has been revised to reflect these changes.

There will be no change in the number of calendar days due to this Addendum.

The foregoing is hereby made a part of the contract.

NOTICE TO CONTRACTOR – ARCHITECTURAL AND INDUSTRIAL MAINTENANCE COATINGS

This Contract includes the application of materials subject to the Volatile Organic Compounds (VOC) content limits stated in the Regulations of Connecticut State Agencies (RCSA) Sections 22a-174-41 and -41a. All architectural and industrial maintenance (AIM) coatings and applications of such coatings must comply with these regulations.

The Contractor shall submit a Material Safety Data Sheet/Safety Data Sheet or Product Technical Data Sheet developed by the manufacturer of each material that may be subject to the Regulations. The submittal must verify both the type of AIM and its VOC Content. VOC content shall be determined based on the formulation data supplied by the materials manufacturer.

The Contractor may only use AIM coatings that contain VOCs below the respective coating category Phase II limits specified in Table 1 if either:

- a) the coating was manufactured on or after May 1, 2018, **or**
- b) the coating is being applied after April 30, 2021.

The Contractor may use AIM coatings that contain VOCs exceeding the respective coating category Phase II limits specified in Table 1 only if all of the following four conditions are met:

- a) the coating is being applied on or before April 30, 2021,
- b) the coating contains VOCs below the applicable Phase I limits specified in Table 1,
- c) the coating was manufactured prior to May 1, 2018, **and**
- d) the coating container(s) are dated (or date coded) as such.

For any coating that is not categorized within Table 1, the Contractor shall classify the coating as follows and apply corresponding limits in Table 1.

- Registers gloss <15 on an 85-degree meter or <5 on a 60-degree meter) – Flat Coating,
- Registers gloss of ≥ 15 on an 85-degree meter and ≥ 5 on a 60-degree meter) - Nonflat Coating,
- Registers gloss of ≥ 70 on a 60-degree meter - Nonflat-High Gloss Coating.

The Contractor must close all containers of coating and solvent when not in use.

Coating container labels must display the date the coating was manufactured, the manufacturer's recommendation regarding thinning with solvent, and the coating's VOC content in grams per liter (g/L) of coating. Certain coating categories as noted in Table 1 have additional labeling requirements.

The Contractor may add additional solvent to a coating only if such addition does not cause the coating to exceed the applicable VOC limit specified Table 1. The Contractor must adhere to type(s) of solvent and maximum amount of solvent recommended by coating manufacturer. VOC content of a thinned coating shall be the VOC content as listed by the manufacturer after thinning in accordance with its recommendation.

TABLE 1		
Coating Category	Phase I	Phase II
	manufactured prior to May 1, 2018 VOC content limit (g/L)	manufactured on or after May 1, 2018 VOC content limit (g/L)
Aluminum roof coating	--- ¹	450
Antenna coating	530	--- ¹
Antifouling coating	400	--- ¹
Basement specialty coating	--- ¹	400
Bituminous roof coating	300	270
Bituminous roof primer	350	350
Bond breaker	350	350
Calcimine recoater	475	475
Clear wood coating - Clear brushing lacquer²	680	275
Clear wood coating - Lacquer^{2,3}	550	275
Clear wood coating - Sanding sealer^{2,4}	350	275
Clear wood coating - Varnish²	350	275
Concrete curing compound	350	350
Concrete or masonry sealer/ Waterproofing concrete or masonry sealer	400	100
Concrete surface retarder	780	780
Conjugated oil varnish	--- ¹	450
Conversion varnish	725	725
Driveway sealer	--- ¹	50
Dry fog coating	400	150
Faux finishing coating²	350	350
Fire resistive coating	350	350
Fire retardant coating - Clear	650	--- ¹
Fire retardant coating - Opaque	350	--- ¹
Flat coating	100	50
Floor coating	250	100
Flow coating	420	--- ¹
Form-release compound	250	250
Graphic arts coating (sign paint)	500	500
High temperature coating	420	420
Impacted immersion coating	780	780
Industrial maintenance coating²	340	250
Industrial maintenance coating	340	250
Low solids coating	120	120
Magnesite cement coating	450	450
Mastic texture coating	300	100
Metallic pigmented coating	500	500
Multi-color coating	250	250

GENERAL

TABLE 1		
Coating Category	Phase I	Phase II
	manufactured prior to May 1, 2018 VOC content limit (g/L)	manufactured on or after May 1, 2018 VOC content limit (g/L)
Nonflat coating	150	100
Nonflat high gloss coating²	250	150
Nuclear coating	450	450
Pre-treatment wash primer	420	420
Primer, sealer and undercoater	200	100
Quick-dry enamel	250	--- ¹
Quick-dry primer, sealer and undercoater	200	--- ¹
Reactive penetrating carbonate stone sealer²	--- ¹	500
Reactive penetrating sealer²	--- ¹	350
Recycled coating	250	250
Roof coating	250	250
Rust preventive coating²	400	250
Shellac Clear	730	730
Shellac Opaque	550	550
Specialty primer, sealer and undercoater²	350	100
Stain	250	250
Stone consolidant²	--- ¹	450
Swimming pool coating	340	340
Thermoplastic rubber coating and mastic	550	550
Traffic marking coating	150	100
Traffic marking coating	150	100
Tub and tile refinish	--- ¹	420
Waterproofing membrane	--- ¹	250
Waterproofing sealer	250	--- ¹
Wood coating²	--- ¹	275
Wood preservative	350	350
Zinc-rich primer²	--- ¹	340

1 Classify as follows and apply corresponding limits in Table 1.

- Registers gloss <15 on an 85-degree meter or <5 on a 60-degree meter) – Flat Coating,
- Registers gloss of ≥15 on an 85-degree meter and ≥5 on a 60-degree meter) – Nonflat Coating
- Registers gloss of ≥70 on a 60-degree meter – Nonflat-High Gloss Coating

2 Container must be appropriately labeled. See RCSA 22a-174-41a

3 “Clear Wood Coating – Lacquer” includes lacquer sanding sealer

4 “Clear Wood Coating - Sanding Sealer” does not include lacquer sanding sealer

-END-

ITEM #0507495A – MODIFY EXISTING CATCH BASIN

Description: Work shall consist of modifying existing median catch basins and the fabrication, delivery, and installation of new catch basin tops per the details found in the Contract Drawings. Work shall include excavating around the catch basin, removal of the existing catch basin top and concrete barrier section sitting on the catch basin, removal of leveling blocks or bricks, the removal of a section of the catch basin, the installation of a new riser section of the catch basin, the installation of new leveling blocks or bricks to the correct elevations, and the installation of the catch basin top and barrier curb. The work shall also include grouting of any gaps or cracks and grouting between courses of any new risers, blocks or bricks.

Work under this item shall also include plugging any holes, cracks or gaps in the catch basin with grout, replacing and/or repositioning any blocks or bricks that are loose or out of alignment, and sealing any gaps between blocks or bricks with grout.

Materials: The material for this work shall conform to Form 817 and shall include, but not be limited to, any tools necessary, grout, concrete or masonry block, reinforcing bars, mortar and water.

Construction Methods: This work shall be in accordance with Form 817 or as directed by the Engineer.

Care should be taken so that any debris that falls into the catch basin from this work should be kept to a minimum. The Contractor is responsible for cleaning out any debris that falls into the catch basin as a result of this work.

Refer to Section 5.07 in Form 817.

Method of Measurement: This work will be measured for payment by the number of each Modify Existing Catch Basin structure (and not per grate), in place, and acceptable to the Engineer.

Work to raise or lower the catch basin tops shall not be included in this item and shall be measured for payment under the Reset Catch Basin item.

Basis of Payment: This work will be paid for at the contract unit price per each “Modify Existing Catch Basin” completed in place, which price shall include all materials, equipment, tools and labor incidental thereto.

<u>Pay Item</u>	<u>Pay Unit</u>
Modify Existing Catch Basin	Each

ITEM #0819002A – PENETRATING SEALER PROTECTIVE COMPOUND

Description: Work under this item shall consist of cleaning concrete surfaces of dirt, dust and debris, and furnishing and applying a clear, penetrating sealer as noted in this specification and as directed by the Engineer, to provide a hydrophobic barrier against the intrusion of moisture. This work also includes furnishing, installing and removing platforms, scaffolding, ladders and other means of access as well as shields, as required, to protect adjacent areas from overspray. The Contractor shall apply penetrating sealer protective compound to locations noted in the table below or as directed by the engineer. These locations shall include, but not be limited to, all inside and top faces of concrete parapets on: bridges, wingwalls, and retaining walls, as well as vertical faces of abutments, piers and wingwalls subject to roadway salt spray. Other locations include, substructure elements below a deck joint which has potential to leak, such as bridge seats and backwalls for bridges that do not have the slab over backwall detail and pier caps. Penetrating sealer shall be applied to both new, patched, and existing concrete surfaces. Penetrating sealer shall not be applied to concrete surfaces that have been previously treated with coatings or curing compounds that would hinder penetration of the sealer into the concrete. Penetrating sealer will not be required on pre-cast and cast-in-place concrete highway median barrier.

Materials: The penetrating sealer shall be a single component, 100% silane or silane siloxane from the list of materials below. The material shall be selected in anticipation of the expected ambient and surface temperature at the time of installation.

The following products may be used when ambient and surface temperatures are 40°F and above:

SIL-ACT ATS-100 (Silane)
Advanced Chemical Technologies, Inc.
9608 North Robinson Ave.
Oklahoma City, OK 73114
405-843-2585
www.advchemtech.com

Armor SX 5000 EXT-100 or SX 5000 WB (Silane Siloxane)
Foundation Armor, LLC.
472 Amherst St. STE 14
Nashua, NH 03063
866-306-0246
www.foundationarmor.com

Aquinil Plus 100 (Silane)
ChemMasters
300 Edwards Street
Madison, OH 44057
440-428-2105, 800-486-7866
www.chemmasters.net/Aquanil100.php

The following product may be used when ambient and surface temperatures are 20°F and above:

Certi-Vex Penseal 244 100% (Silane)
Vexcon Chemicals
7240 State Road
Philadelphia, PA 19135
888-839-2661
www.Vexcon.com

Construction Methods:

Submittals: The Contractor shall submit to the Engineer Safety Data Sheets (SDS) and product literature for the selected product. The literature shall include written instructions how to apply the product to vertical and horizontal surfaces, and where required, overhead surfaces.

The Contractor shall submit to the Engineer, in accordance with Article 1.05.02, written procedures for cleaning the concrete surfaces. The submittal shall include proposed equipment and materials and shall address how adjacent traffic and other areas shall be protected from dust, debris and overspray during the cleaning and application processes. Where the sealer is to be applied to parapets before pavement is placed, the submittal shall address protecting the deck and curb to which membrane waterproofing will be applied. Should the membrane already be present, the submittal shall address protecting the membrane. It shall also indicate how vegetation shall be protected from overspray. The submittal shall address the conditions under which work may proceed, including wind speed, temperature and precipitation. It shall also include procedures to be followed to protect the work should unfavorable weather conditions occur before the product has been absorbed.

The Contractor shall inspect the surfaces to be sealed to identify surface cleaning needs before submitting the procedures. The Contractor shall identify conditions that need repair or surfaces that may require special attention or cleaning procedures. Such observations shall be addressed in the written procedures.

Locations: The following table provides locations of areas that will require penetrating sealer protective compound:

<u>Project No. 14-185</u>	
Bridge No.	Description of Area to be Sealed
00196	Vertical faces of Proposed Pier Wall and Cap

These locations may be changed based on site conditions, as directed by the Engineer.

Limits of Application: Limits of application for concrete parapets shall be the roadway facing surfaces (inside face), parapet ends and top surfaces. Sealer shall be applied starting at top edge

of waterproofing membrane or top of milled bituminous if deck is not exposed, whichever is lower. Sealer shall not be applied to surfaces that are to receive a waterproofing membrane and these areas shall be adequately masked off if the sealer is applied before the membrane.

Limits for abutments, piers and wingwalls stems shall be vertical surfaces starting at final adjacent grade and continuing full height of the structure. Only vertical surfaces facing traffic or are considered leading and trailing ends are to be coated unless directed otherwise by the Engineer. Additionally, for abutments and piers with deck joints having potential to leak onto bridge seats, horizontal surfaces (abutment seats, top of pier cap, bearing pedestals) shall also be coated, as well as the vertical face of the backwall.

Surface Preparation: Concrete surfaces to which penetrating sealer will be applied shall be dry, clean and free of grease, oil and other surface contaminants. New concrete and newly placed repair concrete shall be allowed to cure for at least 28 days before applying sealer. After rain or water cleaning, allow existing concrete surfaces to dry for at least 8 hours before applying sealer. Dry surfaces may be cleaned by sweeping with brushes or brooms, and blowing clean with oil-free, compressed air. The Contractor shall take care not to damage the concrete surface finish during cleaning operations. Care shall be taken so that cleaning methods do not damage joint sealant or other components of the structure.

Application: Application of the sealer can only begin after the Engineer evaluates the concrete surfaces for cleanliness and moisture, and determines that conditions are appropriate for application.

The sealer shall saturate the concrete surface with a rate of application of 200 square feet per gallon of sealer. The dispersion shall run six to eight inches down a vertical surface from the spray pattern. The maximum run-down is 12 inches. The Contractor shall monitor and record the number of square feet per gallon of sealer used to verify that the required application rate is being met. Additional sealer may be needed if surfaces are porous, rough or textured.

The Engineer will inspect the concrete surface during application and after the sealer has had adequate time to penetrate. As a test, water sprayed from a bottle on the sealed surface shall bead up and not be absorbed. Should water be absorbed into the concrete at a test area, additional areas shall be tested to determine which areas should receive additional application of sealer. The Contractor shall apply additional sealer to the identified areas until absorption of water is prevented.

Method of Measurement: This work will be measured for payment by the actual number of square yards of concrete surface, coated completely and accepted, within the limits designated by the Engineer. The area will be measured once, regardless of the number of applications required. Bevels, rustications and other out of plane surface irregularities will not be directly measured for payment, but shall be coated as part of the work.

Basis of Payment: This work will be paid for at the Contract unit price per square yard for "Penetrating Sealer Protective Compound," complete, which price shall include all equipment

tools, labor and materials, incidental thereto, including the preparation of the concrete surfaces and proper disposal of debris.

Pay Item	Pay Unit
Penetrating Sealer Protective Compound	s.y.

ITEM #1304066A – REMOVE WATER MAIN

ITEM #1501500A – REMOVE PIPE

Description: Work under these items shall include the removal and proper disposal of existing abandoned water mains and gas mains, including all of their associated appurtenances. Both mains will no longer be active, having been removed from service by their respective owner.

The item “Remove Water Main” shall be used for the removal of the existing water main.

The item “Remove Pipe” shall be used for the removal of the existing gas main.

Construction Methods: The Contractor shall not remove either main until he is directed by the Engineer that the main has been abandoned and is safe for removal.

The Contractor shall excavate a trench directly over the main that is only of a width that is sufficient to remove the main. Excessively wide trenches will not be allowed, as there are other underground utilities on site. Trench boxes or other means of excavation support may be necessary to minimize the trench width.

The abandoned main may be cut into pieces to facilitate removal. The abandoned water main may contain residual water within it that can be drained into the trench.

All portions of the mains and appurtenances shall be removed from the site and shall be properly disposed of. Portions of existing thrust blocks above the level of subgrade shall be removed.

Method of Measurement: The length of each type of main to be removed will be measured along the crown of the pipe, in place prior to removal, between the limits indicated by the Engineer in the field. The length shall be measured in linear feet and each pipe shall be measured separately so that it can be paid for under the appropriate pay item.

Excavation and backfilling of the trench will not be measured under this item but will be measured for payment under the item “Earth Excavation”.

Basis of Payment: Removal of each main will be paid for at the Contract unit price, per linear foot, for “Remove Water Main” or “Remove Pipe” as the case may be for the type of main being removed. The price shall include all materials, equipment, tools and labor incidental to the removal and proper disposal of the main and appearances.

PAY ITEM

PAY UNIT

Remove Water Main
Remove Pipe

LF
LF

ITEM #1304066A, #1501500A

ITEM #0712011A - PERMANENT SOIL NAILS

ITEM #0712012A - VERIFICATION TEST NAILS

ITEM #0712013A - STRUCTURE EXCAVATION (SOIL NAIL WALL)

ITEM #0712014A - SHOTCRETE CONSTRUCTION FACING

ITEM #0712016A - ABANDON AND BACKFILL DRILL HOLE

DESCRIPTION:

The Work shall consist of designing and constructing permanent soil nail retaining walls as specified herein and shown on the Plans. The Contractor shall furnish all labor, materials and equipment required for completing the Work. The Contractor shall select the method of excavation, drilling method and equipment, final drillhole diameter(s), and grouting procedures to meet the performance requirements specified herein.

Soil nail wall construction requires excavation in staged cuts and excavation in the vicinity of the wall face requires special care and effort compared to general earthwork excavation. The soil nails will be installed under overhead limitations and between existing steel H-piles. The Contractor should be aware that conflicts with existing steel H-piles may require abandoning and filling of a drill hole with flowable fill. The Contractor should consult the wall excavation and abandoning and filling drill hole sections of this specification prior to bidding.

Soil nailing work shall include field locating all utilities and H-Piles, excavating in accordance with the limits of excavation shown in the plans; drilling soil nail drillholes in accordance with the Contractor's soil nail wall design approved by the Engineer; providing, placing and grouting the encapsulated and epoxy coated nail bar tendons into the drillholes; placing drainage elements; placing frost protection barrier; placing shotcrete reinforcement; applying initial shotcrete facing over the reinforcement; attaching bearing plates, bearing plate shear connectors and nuts; performing nail testing; and installing monitoring instrumentation.

Soils to be retained by the soil nail walls are considered chemically aggressive and require double corrosion protection for the soil nails. Required corrosion protection level is Class A encapsulation and Class B epoxy coating.

Soils to be retained by the soil nail walls are considered susceptible to frost. The design and construction of the soil nail wall requires incorporation of frost-induced loads in the soil nail and facing system and/or frost protection measures.

The maximum horizontal and vertical displacement of the soil nail walls is limited to 1/3 inches during construction.

Soil and rock properties, and other criteria are shown on the Plans and in the contract documents. The plans also include the pile layout plan for the existing abutment.

Shotcrete facing, wall drainage and frost protection work consists of furnishing all materials and labor required for placing and securing geocomposite drainage material, connection pipes to the footing drains, applying thermal insulation, reinforcing steel and shotcrete for the initial shotcrete construction facing and nail head bearing plates, shear connectors and nuts for the soil nail walls shown on the plans. The work shall include any preparatory trimming and cleaning of soil/rock surfaces and shotcrete cold joints to receive new shotcrete.

Soil nail wall instrumentation is covered by the “Construction Monitoring” special provision. Cast-in-Place (CIP) concrete facing construction is covered by the Standard Specifications.

Where the imperative mood is used within this Specification for conciseness, “the Contractor shall” is implied.

1 - References.

Codes and Standards

- AASHTO LRFD Bridge Design Specifications (Seventh Edition, 2014)
- FHWA Geotechnical Engineering Circular No. 7, Soil Nail Wall – Reference Manual

Contract Documents

- Connecticut Department of Transportation, Plans for Rehabilitation of Bridge No. 00196, Interstate 95 Over U.S. Route 1, prepared by Ammann & Whitney, dated August 10, 2018
- Connecticut Set Highway Department, Town of Branford, Greenwich-Killingly Expressway Over Relocated Route No. 1 (As-Built), prepared by Seelye, Stevenson, Value & Knecht, dated June 1955

2 - Definitions.

Contractor: The specialty firm who is responsible for performing the soil nail design and the soil nail wall construction.

Design Drawings: Drawings prepared by the Contractor’s Design Engineer and submitted by the Contractor to include the detailed soil nail design.

Design Engineer: The Professional Engineer employed or hired by the contractor who designs the soil nail walls. This person must meet the experience requirements in Section 3.

Engineer: The Connecticut DOT’s project engineer, project manager, or other representative.

Inspector: The Connecticut DOT’s field representative on the project site.

Owner: The Connecticut DOT.

Contract Drawings: Drawings developed by the Engineer and provided by the Owner for bidding purposes.

Project Manager: An employee of the Contractor supervising the work and who has a minimum of three years of experience with soil nail projects of similar size and scope.

3 - Soil Nail and Shotcrete Contractor's Experience Requirements and Submittal.

The Contractor shall submit a project reference list verifying the successful construction completion of at least 3 permanent soil nail retaining wall projects during the past 3 years totaling at least 1200 square yards of wall face area and at least 500 permanent soil nails. A brief description of each project with the Owner's name and current phone number shall be included.

Provide a registered Professional Engineer in the State of Connecticut with experience in the design of permanent soil nail walls for at least 3 completed projects over the past 3 years.

The on-site supervisor and drill rig operators shall have experience installing permanent soil nails on at least 3 projects over the past 3 years. The Contractor shall not use a manufacturer's representatives to satisfy the requirements of this section.

The Contractor's workers installing the shotcrete, including foremen, nozzlemen, and delivery equipment operators, shall be fully experienced to perform the work. All shotcrete nozzlemen on this project shall have experience on at least 3 projects in the past 3 years in soil nail wall shotcrete application work and shall demonstrate ability to satisfactorily place the shotcrete.

Initial qualification of nozzlemen will be based either on previous ACI certification or satisfactory completion of preconstruction test panels. The requirement for nozzlemen to shoot preconstruction qualification test panels will be waived for nozzlemen who can submit documented proof they have been certified in accordance with the ACI 506.3R Guide to Certification of Shotcrete Nozzlemen. The Certification shall have been done by a ACI recognized shotcrete testing lab and/or recognized shotcreting consultant and have covered the type of shotcrete to be used (plain wet-mix, plain dry-mix or steel fiber reinforced). All nozzlemen will be required to periodically shoot production test panels during the course of the work at the frequency specified herein.

Notify the Engineer not less than 2 days prior to the shooting of preconstruction test panels to be used to qualify nozzlemen without previous ACI certification. Use the same shotcrete mix and equipment to make qualification test panels as those to be used for the soil nail wall shotcrete facing. Initial qualification of the nozzlemen will be based on a visual inspection of the shotcrete density and void structure and on achieving the specified 3-day and 28-day compressive strength requirements determined from test specimens extracted from the preconstruction test panels.

Preconstruction and production test panels, core extraction and compressive strength testing shall be conducted in accordance with ACI 506.2 and AASHTO T24/ASTM C42, unless otherwise specified herein. Nozzlemen without ACI Certification will be allowed to begin production shooting based on satisfactory completion of the preconstruction test panels and passing 3-day strength test requirements. Continued qualification will be subject to passing the 28-day strength tests and shooting satisfactory during production test panels.

The Contractor shall submit copies of the completed project reference list and a list identifying the soil nail wall design professional engineer, drill rig operators and on site supervisors assigned to the project, as well as written documentation of the nozzlemen's qualifications, including proof of ACI certification. The personnel list shall contain a summary of each individual's experience and be complete enough for the Engineer to determine whether each individual satisfies the required qualification. These qualifications shall be submitted along with the Shop Drawings and reviewed in accordance to Section 1.05. Work shall not be started nor materials ordered until the Engineer's written approval of the Contractor's qualification is given.

The Engineer may suspend the work if the Contractor uses non-approved personnel. If work is suspended, the Contractor shall be fully liable for all resulting costs and no adjustment in contract time will result from the suspension.

4 - Construction Site Survey.

Before bidding the work, the Contractor shall review the available subsurface information and visit the site to assess the site geometry, equipment access conditions, and location of existing structures and above ground facilities.

The Contractor is responsible for field locating and verifying the location of all utilities. Notify the Engineer of any utility locations different from shown on the Plans that may require nail relocations or wall design modification.

The Contractor is responsible for field locating and verifying the location of existing H-piles that will be within the retained zone of the soil nails. Notify the Engineer of any H-pile locations different from shown on the Design Drawings that may require nail relocations or wall design modification.

Prior to start of any wall construction activity, the Contractor and Engineer shall jointly inspect the site to observe and document the pre-construction condition of the site, existing structures and facilities. During construction, the Contractor shall observe the conditions above the soil nail wall on a daily basis for signs of ground movement in the vicinity of the wall. Immediately notify the Engineer if signs of movements such as new cracks in structures, increased size of old cracks or separation of joints in structures, foundations, streets or paved and unpaved surfaces

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are observed. If the Engineer determines that corrective actions are required, the Contractor shall stop work and take necessary steps to correct the problem. When due to the Contractor's methods or operations or failure to follow the specified/approved construction sequence, as determined by the Engineer, the costs of providing corrective actions will be borne by the Contractor.

5 - Design Submittals.

(A) General

1. At least 30 calendar days before the planned start of the wall construction, the Contractor shall submit complete design calculations and Design Drawings to the Engineer for review and approval. Include all details, dimensions, quantities, ground profiles and cross-sections necessary to conduct the work.
2. Design Drawings and calculations shall be signed and sealed by the Contractor's Design Engineer, previously approved by the Owner's Engineer.
3. Submit 1 set of the Design Drawings with the initial submission. The Design Drawings shall be prepared to the (Owner) standards. The Owner's Engineer will approve or reject the Contractor's submittal within 15 calendar days of the receipt of the complete submission.
4. One set will be returned with any indicated corrections. If revisions are necessary, make the necessary changes and resubmit 1 revised set. When the drawings are approved, furnish set of the approved drawings
5. The Contractor shall not begin the work until the submittal requirements are satisfied and found acceptable by the Engineer.
6. Changes or deviations from the approved submittals must be re-submitted for approval. No adjustments in contract time or delay, or impact claims will be allowed due to incomplete submittals.

(B) Design Calculations

Design calculations shall include, but not be limited to, the following items.

1. A narrative describing the overall soil nail design.
2. Applicable code requirements and references.
3. Basis of design, including soil/rock shear strength parameters (friction angle and cohesion), unit weights, pullout resistances, steel resistances, and shotcrete resistance values. Any additional subsurface borings, laboratory work, or other subsurface data collected for the design shall also be included.
4. Soil nail critical cross-section(s) including soil/rock strata, piezometric levels,

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- and location, magnitude, and direction of applied loads.
5. Values and associated load factors used in design for pullout resistance, surcharges, soil/rock unit weights, nail head strengths, and strengths of steel, shotcrete and concrete materials.
 6. Global stability calculations of the soil nail wall and bridge abutment system including soil resistance/load factors used in LRFD verifications.
 7. Seismic design coefficient and other seismic design criteria applicable for the geographic area of the project.
 8. Horizontal and vertical deflection calculations.
 9. Design calculation sheets with the project number, structure location, designation, date of preparation, initials of designer and checker, and page number at the top of each page. Provide an index page with the design calculations.
 10. Design notes including an explanation of symbols and computer programs used in design.
 11. Structural design calculations for the initial shotcrete wall facing and nail head/facing connections including consideration of facing flexural and punching shear strength, headed stud tensile strength, upper cantilever, minimum reinforcement ratio, cover, and splice requirements.
 12. Other design calculations such as frost-induced loading and drainage evaluations.

(C) Design Drawings

Design Drawings shall include all information required for the construction and quality control of the work. Design Drawings shall include, but not be limited to, the following items unless provided in the Contract Drawings:

1. A plan view of the structure(s) identifying:
 - a. A reference baseline and elevation datum.
 - b. The offset from the construction centerline or baseline to the face of the wall at its base and at all changes in horizontal alignment.
 - c. Beginning and end station of wall.
 - d. Soil nail locations.
 - e. Right-of-way and permanent or temporary construction easement limits, location of all known active and abandoned existing utilities, adjacent structure or other potential interfaces. The centerline of any drainage structure or drainage pipe behind, passing through, or passing under the wall.
 - f. Subsurface exploration locations shown on a plan view of the proposed

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wall alignment with appropriate reference base lines to fix the locations of the explorations relative to the structure(s).

- g. Limit of longest nails.
- 2. An elevation view of the structure(s) identifying:
 - a. The elevation at the top of the wall, at all horizontal and vertical break points, and at least every 50 feet along the wall.
 - b. Elevations at the base of the wall and the top of the leveling pads for casting CIP facing.
 - c. Soil nail elevations, vertical and horizontal spacing and location of wall drain elements, frost protection elements, and final facing expansion/contraction joints along the wall length.
 - d. Existing and finished grade profiles both behind and in front of the wall.
- 3. All necessary cross-section(s) to construct the wall.
- 4. General notes for constructing the soil nails including construction sequencing or other special construction requirements.
- 5. Design parameters and applicable codes.
- 6. Horizontal and vertical curve data affecting the wall and control points, including match lines or other details to relate to wall stationing to centerline stationing.
- 7. A listing of the summary or quantities on the elevation drawing of each wall showing the estimated surface area and other pay items.
- 8. Nail wall typical sections including staged excavation cut elevations, wall and excavation face batter, nail spacing and inclination, size of nail bars (also referred to as tendons), drainage details, frost protection details, and corrosion protection details.
- 9. Typical details of production and test nails defining the location, nail length, minimum drill hole diameter, inclination, and test nail bonded and unbonded test lengths.
- 10. Details, dimensions, and schedules for all nails, reinforcing steel, wire mesh, bearing plates, headed studs, etc. and/or attachment devices for shotcrete and cast-in-place facing.
- 11. Dimensions and schedules for all reinforcing steel including reinforcing bar bending details.
- 12. Details and dimensions for wall appurtenances such as barrier, coping, drainage gutters, fences, etc.
- 13. Details for constructing walls around drainage facilities.
- 14. Details for terminating walls and adjacent slope construction.
- 15. Facing finishes, color and architectural treatment requirements for final wall facing elements.

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6 - Construction Submittals.

(A) Soil Nails

The Contractor shall submit copies of the following information, in writing, to the Engineer for review and approval. This information shall be submitted along with the Shop Drawings and reviewed in accordance with Section 1.05 of the Standard Specifications.

1. The proposed start date and proposed detailed wall construction sequence including:
 - a. Plan describing how surface water will be diverted, controlled and disposed of.
 - b. Proposed methods and equipment for locating the existing H-piles behind the proposed soil nail walls
 - c. Proposed methods and equipment for excavating the soil and/or rock within the excavation limits indicated in the Plans, including the proposed grade elevations for each excavation cut shown on a wall elevation view.
 - d. Information on space requirements for installation equipment
 - e. Proposed nail drilling methods and equipment including drill hole diameter proposed to achieve the pullout resistance used for design and any variation of these along the wall alignment

2. Nail grout mix design including:
 - a. Type of Portland cement.
 - b. Aggregate source and gradation.
 - c. Proportions of mix by weight and water-cement ratio.
 - d. Manufacturer, brand name and technical literature for proposed admixtures.
 - e. Compressive strength test results (per AASHTO T106/ASTM C109) supplied by qualified independent testing lab verifying the specified minimum 3 and 28-day grout compressive strengths. Previous test results for the proposed grout mix completed within one year of the start of grouting may be submitted for initial verification and acceptance of the required compressive strengths and start of production work.

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3. Proposed nail grout placement procedures and equipment.
4. Proposed nail testing methods and equipment setup including:
 - a. Details of the jacking frame and appurtenant bracing, with design calculations performed and sealed by a Professional Engineer licensed in the State of Connecticut.
 - b. Details showing methods of isolating verification and proof test nails during shotcrete application (i.e., methods to prevent bonding of the soil nail bar and the shotcrete facing during testing.
 - c. Details showing methods of providing the temporary unbonded length of verification and proof test nails and grouting the temporary unbonded length of proof test nails after completion of testing.
 - d. Equipment list.
5. Identification number and certified calibration records for each test jack and pressure gauge and load cell to be used. Jack and pressure gauge shall be calibrated as a unit. Calibration records shall include the date tested, device identification number, and the calibration test results and shall be certified for an accuracy of at least 2 percent of the applied certification loads by a qualified independent testing laboratory within 90 days prior to submittal.
6. Material Certificates for the soil nail centralizers and Certified Test Reports for the epoxy coating and encapsulation in accordance with Section 1.06.07 of the Standard Specifications.

The Contractor will not be allowed to begin wall construction or incorporate materials into the work until the submittal requirements are satisfied and found acceptable to the Engineer. Changes or deviations from the approved submittals must be re-submitted for approval.

Upon delivery of nails to the project site, provide Certified Test Reports for nail specifying the ultimate strength, yield strength, elongation and composition in accordance with Section 1.06.07 of the Standard Specifications.

(B) Shotcrete

The Contractor shall submit copies of the following information, in writing, to the Engineer. This information shall be submitted along with the Shop Drawings and reviewed in accordance with

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Section 1.05 of the Standard Specifications.

1. Proposed methods of shotcrete placement and of controlling and maintaining facing alignment and location and shotcrete thickness.
2. Shotcrete mix design including:
 - a. Type of Portland cement.
 - b. Aggregate source and gradation.
 - c. Proportions of mix by weight and water-cement ratio.
 - d. Proposed admixtures, manufacturer, dosage, technical literature.
 - e. Previous strength test results for the proposed shotcrete mix completed within one year of the start of shotcreting may be submitted for initial verification of the required compressive strengths at start of production work.
3. Material Certificates, manufacturers' engineering data and installation instructions for the drainage geotextile, geocomposite drain strip, and accessories in accordance with Section 1.06.07 of the Standard Specifications.
4. Material Certificates, manufacturer's engineering data and installation instructions for the thermal insulation (if applicable), and accessories in accordance with Section 1.06.07 of the Standard Specifications.
5. Material Certificates for bearing plates, nuts, and PVC drain piping in accordance with Section 1.06.07 of the Standard Specifications.

The Contractor will not be allowed to begin wall construction or incorporate materials into the work until the submittal requirements are satisfied and found acceptable to the Engineer. Changes or deviations from the approved submittals must be re-submitted for approval.

Upon delivery to the project site, provide Certified Test Report for all reinforcing steel specifying the minimum ultimate strength, yield strength, elongation and chemical composition in accordance with Section 1.06.07 of the Standard Specifications.

(C) Monitoring Program

At least 30 calendar days before starting the soil nail work, the Contractor shall submit a Construction Monitoring Program to the Owner's Engineer for approval. The Owner's Engineer shall review the Contractor's Construction Monitoring Program within 14 calendar days of receipt of the submission.

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Monitoring during wall construction should be performed to obtain data on the overall wall performance and to monitor any potential adverse effects on the existing bridge abutment and wingwall structures. At a minimum, the performance-monitoring program should include measurement of the following quantities:

1. Vertical and horizontal movements of the existing abutment stem walls, pile caps, and wingwalls using deformation monitoring points (DMPs) with optical surveying methods. The number, locations and frequency of monitoring for the DMPs shall be in accordance with the “Construction Monitoring” special provisions. The Contractor should perform a minimum of 3 independent rounds of surveying readings for the DMPs to establish a single initial elevation or plan location and standard deviation for measurement. Address methods to achieve required accuracy of 0.01-foot and repeat measurements if error at 1 standard deviation exceeds 0.01-foot vertical or 0.01-foot horizontal for initialization rounds. Locate surface markers within a horizontal accuracy of plus or minus 0.01 feet, and elevation accuracy of plus or minus 0.01 feet at 1 standard deviation.
2. Horizontal movement of the soil nail wall face using DMPs on the initial and final facing with optical surveying methods. Surface markers should be spaced at maximum horizontal 20 foot intervals along the soil nail wall face and the adjacent abutment pile caps. The number, locations and frequency of monitoring for the DMPs shall be in accordance with the “Construction Monitoring” special provisions.
3. Ground cracks and other signs of disturbance in the ground surface behind the top of wall, through daily visual inspection during construction and, if necessary, installation of crack gauges across the cracks.
4. Cracks on the concrete faces of the existing abutments, through daily visual inspection during construction and, if necessary, installation of crack gauges across the cracks.
5. Local movements and/or deterioration of the facing using visual inspections and instruments such as crack gauges.
6. Drainage behavior of the structure, especially if groundwater is observed during construction, by visual observation of outflow points or through standpipe piezometers installed behind the facing.

The monitoring program must indicate type and location of instruments, frequency of measurements and visual observations, and frequency of reporting. Monitoring data reporting will be submitted to the Engineer and are required to be submitted in accordance with the schedules specified in the

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“Construction Monitoring” special provision.

7 - Pre-Construction Meeting.

A pre-construction meeting will be scheduled by the Engineer and held prior to the start of wall construction. The Engineer, Contractor, and all Subcontractors involved in the construction of the soil nail wall shall attend the meeting. Attendance is mandatory. The pre-construction meeting will be conducted to clarify the construction requirements for the work, to coordinate the construction schedule and activities, and to identify contractual relationships and delineation of responsibilities amongst the Contractor and the various Subcontractors - particularly those pertaining to wall excavation, nail installation and testing, excavation and wall alignment survey control, shotcrete, and CIP facing construction.

MATERIALS:

Furnish materials new and without defects. Remove defective materials from the job site at no additional cost. Materials for soil nail structures shall consist of the following:

1 - Solid Bar Nail Tendons: AASHTO M31/ASTM A615, Grade 60. The deformed bar shall be continuous without splices or welds, new, straight, undamaged, epoxy coated and/or encapsulated as shown on the Plans. Threading shall be continuous spiral deformed ribbing provided by the bar deformations (e.g. continuous threadbars).

2 - Fusion Bonded Epoxy Coating: ASTM A775. Minimum 12 mils thickness electrostatically applied. Bend test requirements are waived. Coating at the wall anchorage end of epoxy coated bars may be omitted over the length provided for threading the nut against the bearing plate.

3 - Encapsulation: Minimum 40 mils thick corrugated HDPE tube conforming to AASHTO M252 or corrugated PVC tube conforming to ASTM D1784, Class 13464-B. Encapsulation shall provide at least 0.2 inch of grout cover over the nail bar and be resistant to ultra violet light degradation, normal handling stresses, and grouting pressures. Factory fabrication of the encapsulation is preferred. Upon the Engineers approval, the encapsulation may be field fabricated if done in strict accordance with the manufacturer's recommendations.

4 - Centralizers: Manufactured from Schedule 40 PVC pipe or tube, steel or other material not detrimental to the nail steel (wood shall not be used); securely attached to the nail bar; sized to position the nail bar within 1 inch of the center of the drillhole; sized to allow tremie pipe insertion to the bottom of the drillhole; and sized to allow grout to freely flow up the drillhole.

5 - Nail Grout: Neat cement or sand/cement mixture with a minimum 3-day compressive strength of

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1500 psi and a minimum 28-day compressive strength of 3000 psi per AASHTO T106/ASTM C109.

6 - Admixtures for Nail Grout: AASHTO M194/ASTM C494. Admixtures which control bleed, improve flowability, reduce water content and retard set may be used in the grout subject to review and acceptance by the Engineer. Accelerators are not permitted. Expansive admixtures may only be used in grout used for filling sealed encapsulations. Admixtures shall be compatible with the grout and mixed in accordance with the manufacturer's recommendations.

7 - Cement for Nail Grout: AASHTO M85/ASTM C150, Type I, II, III or V.

8 - Fine Aggregate for Nail Grout: AASHTO M6/ASTM C33.

9 - Film Protection: Polyethylene film per AASHTO M171.

10 - Shotcrete: All materials for shotcrete shall conform to the following requirements:

- | | |
|---------------------------------------|--|
| A) Cement | AASHTO M85/ ASTM C150, Type I, II, III or V. |
| B) Fine Aggregate | AASHTO M6/ASTM C33 clean, natural. |
| C) Coarse Aggregate | AASHTO M80, Class B for quality |
| D) Water | Clean and Potable. AASHTO M157/ASTM C94 |
| E) Chemical Admixtures | |
| 1. Accelerator | Fluid type, applied at nozzle, meeting requirements of AASHTO M194/ASTM C494/ASTM C1141. |
| 2. Water-reducer and Superplasticizer | AASHTO M194/ASTM C494 Type A, C, D, E, F, or G |
| 3. Retarders | AASHTO M194/ ASTM C494 Type B or D. |
| F) Mineral Admixtures | |
| 1. Fly Ash | AASHTO M295/ASTM C618 Type F or C, cement |
| 2. Silica Fume | ASTM C1240, 90 percent minimum silicon dioxide solids |

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content, not to exceed 12 percent by weight of cement.

G) Welded Wire Fabric	AASHTO M55/ASTM A185 or A497.
H) Reinforcing Bars for Shotcrete Facing	AASHTO M31/ASTM A615, Grade 60, deformed.
I) Bearing Plates	AASHTO M183/ASTM A36.
J) Bearing Plate Shear Connectors	ASTM A108
K) Nuts	AASHTO M291, grade B, hexagonal, fitted with beveled washer or spherical seat to provide uniform bearing.
L) Prepackaged Shotcrete	ASTM C928.

10.1 - Shotcrete Mix Design. The Contractor must receive notification from the Engineer that the proposed mix design and method of placement are acceptable before shotcrete placement can begin.

10.2 - Aggregate. Aggregate for shotcrete shall meet the strength and durability requirements of AASHTO M6/M80 and the following gradation requirements:

<u>Sieve Size</u>	<u>Percent Passing by Weight</u>
1/2"	100
3/8"	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

10.3 - Proportioning and Use of Admixtures. Proportion the shotcrete to be pumpable with the concrete pump furnished for the work, with a cementing materials content of at least 25 pounds per cubic foot and water/cement ratio not greater than 0.50. Do not use admixtures unless approved by the Engineer. Thoroughly mix admixtures into the shotcrete at the rate specified by the manufacturer. Accelerators (if used) shall be compatible with the cement used, be non-corrosive to steel and not promote other detrimental effects such as cracking or excessive shrinkage. The

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

10.4 - Air Entrainment. Air entrainment is not required for temporary shotcrete construction facings.

10.5 - Strength Requirements. Provide a shotcrete mix capable of attaining 2000 psi compressive strength in 3 days and 4000 psi in 28 days. The average compressive strength of each set of three test cores extracted from test panels or wall face must equal or exceed 85 percent of the specified compressive strength, with no individual core less than 75 percent of the specified compressive strength, in accordance with ACI 506.2.

10.6 - Mixing and Batching. Aggregate and cement may be batched by weight or by volume in accordance with the requirements of ASTM C94 or AASHTO M241/ASTM C685. Mixing equipment shall thoroughly blend the materials in sufficient quantity to maintain placing continuity. Ready mix shotcrete shall comply with AASHTO M157. Shotcrete shall be batched, delivered, and placed within 90 minutes of mixing. The use of retarding admixtures may extend application time beyond 90 minutes if approved by the Engineer.

Premixed and packaged shotcrete mix may be provided for on-site mixing. The packages shall contain materials conforming to the Materials section of this specification. Placing time limit after mixing shall be per the manufacturer's recommendations.

10.7 - Field Quality Control. Both preconstruction test panels (for nozzlemen without previous ACI certification) and production test panels or test cores from the wall facing are required. Shotcreting and coring of test panels shall be performed by qualified personnel in the presence of the Engineer. The Contractor shall provide equipment, materials, and personnel as necessary to obtain shotcrete cores for testing including construction of test panel boxes, field curing requirements and coring. Compressive strength testing will be performed by the Engineer. Shotcrete final acceptance will be based on the 28-day strength.

Shotcrete production work may commence upon initial approval of the design mix and nozzlemen and continue if the specified strengths are obtained. The shotcrete work by a crew will be suspended if the test results for their work does not satisfy the strength requirements. The Contractor shall change all or some of the following: the mix, the crew, the equipment, or the procedures. Before resuming work, the crew must shoot additional test panels and demonstrate that the shotcrete in the panels satisfies the specified strength requirements. The cost of all work required to obtain satisfactory strength tests will be borne by the Contractor.

10.8 - Preconstruction Test Panels. Each nozzleman without previous ACI certification shall

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furnish at least one preconstruction test panel for each proposed mixture being considered and for each shooting position to be encountered on the job. Preconstruction test panels shall be made prior to the commencement of production work using the same equipment, materials, mixture proportions and procedures proposed for the job.

Make preconstruction test panels with minimum dimensions of 30in.x30in. square and at least 4 inches thick. Slope the sides of preconstruction and production test panels at 45 degrees over the full panel thickness to release rebound.

10.9 - Production Test Panels . Furnish at least one production test panel or, in lieu of production test panels, six 3 inch diameter cores taken from the shotcrete facing, during the first production application of shotcrete and henceforth for every 600 square yards of shotcrete placed. Cores for testing must be taken from the nozzle and may not be taken from the mixer. Construct the production test panels simultaneously with the shotcrete facing installation at times designated by the Engineer. Make production test panels with minimum dimensions of 18in.x18in. square and at least 4 inches thick.

10.10 - Test Panel Curing, Test Specimen Extraction and Testing. Immediately after shooting, field moist cures the test panels by covering and tightly wrapping with a sheet of polyethelene film (material meeting the requirements of ASTM C171) until they are delivered to the testing lab or test specimens are extracted. Do not immerse the test panels in water. Do not further disturb test panels for the first 24 hours after shooting. Provide at least six 3 inch diameter core samples cut from each preconstruction test panel and production test panel. Contractor has the option of extracting test specimens from test panels in the field or transporting to another location for extraction. Keep panels in their forms when transported. Do not take cores from the outer 6 inches of test panels measured in from the top outside edges of the panel form. Trim the ends of the cores to provide test cylinders at least 3 inches long. If the Contractor chooses to take cores from the wall face in lieu of making production test panels, locations will be designated by the Engineer. Clearly mark the cores and container to identify the core locations and whether they are for preconstruction or production testing. If for production testing, mark the section of the wall represented by the cores on the cores and container. Immediately wrap cores in wet burlap or material meeting requirements of ASTM C171 and seal in a plastic bag. Deliver cores to the Engineer within 48 hours of shooting the panels. The remainder of the panels will become the property of the Contractor. Compressive strength testing will be performed by the Engineer. Upon delivery to the testing lab, samples will be placed in the moist room until the time of test. When the test length of a core is less than twice the diameter, the correction factors given in AASHTO T24/ASTM C42 will be applied to obtain the compressive strength of individual cores. Three cores will be tested at 3 days and three cores will be tested at 28 days in accordance with AASHTO T24/ASTM C42.

Fill core holes in the wall by dry-packing with non-shrink patching mortar after the holes are

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cleaned and dampened. Do not fill core holes with shotcrete.

11 - Backwall Drainage: All materials for backwall drainage shall conform to the following requirements:

A) Drainage Geotextile For Drain Strip AASHTO M288 Class 3, Permittivity min. 0.2 per second; AOS 0.25 mm max.

B) Geocomposite Drain Strip Miradrain 6000, Amerdrain 500 or approved equal.

C) PVC Connector and Drain Pipes:

- | | |
|-------------------|--|
| 1. Pipe | ASTM 1785 Schedule 40 PVC, solid and perforated wall, cell classification 12454-B or 12354-C, wall thickness SDR 35, with solvent weld or elastomeric gasket joints. |
| 2. Fittings | ASTM D3034, cell classification 12454-B or 12454-C, thickness SDR35, with solvent weld or elastomeric gasket joints. |
| 3. Solvent Cement | ASTM D2564 |
| 4. Primer | ASTM F656 |
- wall

12 - Film Protection Polyethylene films per AASHTO M-171.

13 – Frost Protection Extruded Polystyrene (XPS) foam insulation panels per AASHTO M-230

14 – Flowable Fill. The material for Flowable Fill shall conform to the requirements of Article M.03.01. Flowable Fill shall be a mixture of Portland Cement, Fly Ash (optional), Fine Aggregates, Air Entraining Agent, and Water. The Contractor shall be responsible for producing a Flowable Fill mixture and adjusting their mixture design as called for by the circumstances or as directed by the Engineer. There shall be a minimum air content of 8% in the Flowable Fill. Flowable Fill material shall be proportioned to produce a 28-day compressive strength between 50 - 100 psi.

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Materials Handling And Storage: Store soil nail cement to prevent moisture degradation and partial hydration. Do not use cement that has become caked or lumpy. Store aggregates so that segregation and inclusion of foreign materials are prevented. Do not use the bottom 6 inches of aggregate piles in contact with the ground.

Store steel reinforcement on supports to keep the steel from contacting the ground. Damage to the nail steel as a result of abrasion, cuts, nicks, welds, and weld splatter shall be cause for rejection. Do not ground welding leads to nail bars. Protect nail steel from dirt, rust, and other deleterious substances prior to installation. Place protective wrap over anchorage end of nail bar to which bearing plate and nut will be attached to protect during handling, installation, grouting and shotcreting.

Do not move or transport encapsulated nails until the encapsulation grout has reached sufficient strength to resist damage during handling. Handle encapsulated nails in a manner that will prevent large deflections, distortions or damage. Repair encapsulated nails that are damaged or defective in accordance with the manufacturer's recommendations or remove them from the site.

Handle and store epoxy coated bars in a way that will prevent them from being damaged beyond what is permitted by ASTM 3963. Repair damaged epoxy coating in accordance with ASTM A775 and the coater's recommendations using an epoxy field repair kit approved by the epoxy manufacturer. Repaired areas shall have a minimum 12 mils coating thickness.

Materials for shotcrete shall be delivered, stored and handled to prevent contamination, segregation, corrosion or damage. Store liquid admixtures to prevent evaporation and freezing.

Drainage geotextile and geocomposite drain strips shall be provided in rolls wrapped with a protective covering and stored in a manner which protects the fabric from mud, dirt, dust, debris, and shotcrete rebound. Protective wrapping shall not be removed until immediately before the geotextile or drain strip is installed. Extended exposure to ultra-violet light shall be avoided. Each roll of geotextile or drain strip in the shipment shall be labelled to identify the production run.

CONSTRUCTION REQUIREMENTS:

1 – Location of Existing H-Piles

The Contractor shall determine the methods and equipment necessary to locate the existing H-Piles that will be behind the retained zone behind the soil nail wall. According to available historic bridge documents, the abutment foundation consists of two rows of H-Piles. The front row consists of battered piles spaced at 5 feet and the back row consists of vertical piles spaced at 8 feet. Test pits

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and/or a combination of test pits and probing through the existing embankment could be used to locate the H-Piles. The cost associated with labor, materials and equipment required to locate the existing H-piles will be paid for by the unit price for “Verification Test Nails”.

2 – Additional Subsurface Exploration

Should the Contractor determine that additional soil borings, test pits, and laboratory testing are required to supplement the available geotechnical information for the design of the soil nail walls, the cost associated with such exploration will be paid for by the unit price for “Verification Test Nails”.

3 - Site Drainage Control.

Provide positive control and discharge of all surface water that will affect construction of the soil nail retaining wall. Maintain all pipes or conduits used to control surface water during construction. Repair damage caused by surface water at no additional cost. Upon substantial completion of the wall, remove surface water control pipes or conduits from the site. Alternatively, with the approval of the Engineer, pipes or conduits that are left in place, may be fully grouted and abandoned or left in a way that protects the structure and all adjacent facilities from migration of fines through the pipe or conduit and potential ground loss.

The regional groundwater table is anticipated to be below the level of the wall excavation based on the results of the geotechnical site investigation.

4 - Excavation.

Coordinate the work and the excavation so the soil nail wall is safely constructed. Perform the wall construction and excavation sequence in accordance with the approved Design Drawings and approved submittals. No excavations steeper than those shown on the approved Design Drawings will be made above or below the soil nail wall without written approval of the Engineer. The Contractor shall progress the excavation in a manner that will not adversely affect the stability of the excavated face. The excavation sequence shall ensure sufficient stand-up time for the period of time required for soil nail installation, grouting and construction of the initial shotcrete face along the extent of the excavation cut.

4.1 - Excavation and Wall Alignment Survey Control

The Contractor will be responsible for providing the necessary survey and alignment control during excavation of each lift, locating and drilling each drillhole within the allowable tolerances. The Contractor will be responsible for performing the wall excavation and nail installation in a manner

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which will allow for construction of the shotcrete facing to the design minimum thickness and such that the finish CIP structural facing can be constructed to the specified minimum thickness and to the line and grade indicated in the Plans. Where the as-built location of the front face of the shotcrete exceeds the allowable tolerance from the wall control line shown on the Plans, the Contractor will be responsible for determining and bearing the cost of remedial measures necessary to provide proper attachment of nail head bearing plate connections and satisfactory placement of the final facing, as called for on the Plans.

4.2 - General Roadway Excavation.

Complete clearing, grubbing, grading and excavation above and behind the wall before commencing wall excavation. Do not over-excavate the original ground behind the wall or at the ends of the wall, beyond the limits shown on the Contract Drawings. Do not perform general roadway excavation that will affect the soil nail wall until wall construction starts. Roadway excavation shall be coordinated with the soil nailing work and the excavation shall proceed from the top down in a horizontal staged excavation lift sequence with the ground level for each lift excavated as illustrated on the approved Design Drawings. Do not excavate the full wall height to the final wall alignment as shown on the Plans but maintain a working bench of native material to serve as a platform for the drilling equipment. The bench shall be wide enough to provide a safe working area for the drill equipment and workers.

4.3 - Soil Nail Wall Structure Excavation.

Structure excavation in the vicinity of the existing abutment wall face will require special care and effort compared to general earthwork excavation. The structure excavation pay limits are shown on the Contract Drawings.

Excavate to the final wall face using procedures that: (1) prevent over excavation; (2) prevent ground loss, swelling, air slaking, or loosening; (3) prevent loss of support for completed portions of the wall; (4) prevent loss of soil moisture at the face; and (5) and prevent ground freezing. Costs associated with additional thickness of shotcrete or concrete or other remedial measures required due to irregularities in the cut face, excavation overbreak or inadvertent over excavation, shall be borne by the Contractor.

The exposed unsupported final excavation face cut height shall not exceed the vertical nail spacing plus the required reinforcing lap or the short-term stand-up height of the ground, whichever is less. It would be preferable for the Contractor to complete excavation to the final wall excavation line and application of the shotcrete in the same work shift. Application of the shotcrete may be delayed up to 24 hours if the Contractor can show that the delay will not adversely affect the excavation face stability. A polyethylene film over the face of the excavation may reduce degradation of the cut face

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caused by changes in moisture. Damage to existing structures or structures included in the work shall be repaired by the Contractor at no cost to the State where approval is granted for the extended face exposure period.

Excavation to the next lift shall not proceed until nail installation, reinforced shotcrete placement, attachment of bearing plates and nuts and nail testing has been completed and accepted in the current lift. Nail grout and shotcrete shall have cured for at least 72 hours before excavating the next underlying lift.

Notify the Engineer immediately if raveling or local instability of the final wall face excavation occurs. Unstable areas shall be temporarily stabilized by means of buttressing the exposed face with an earth berm or other methods. Suspend work in unstable areas until remedial measures are developed.

4.4 - Wall Discontinuities.

The Contractor shall not be permitted to construct the wall in a discontinuous manner. Each row of nails shall be completed and shotcreted before the Contractor may excavate for the next lower row of nails.

4.5 - Excavation Face Protrusions, Voids or Obstructions.

Remove all or portions of cobbles, boulders, rubble or other subsurface obstructions encountered at the wall final excavation face which will protrude into the design shotcrete facing. Determine method of removal of face protrusions, including method to safely secure remnant pieces left behind the excavation face and for promptly backfilling voids resulting from removal of protrusions extending behind the excavation face. Notify the Engineer of the proposed method(s) for removal of face protrusions at least 24 hours prior to beginning removal. Voids overbreak or over-excavation beyond the plan wall excavation line resulting from the removal of face protrusions or excavation operations shall be backfilled with shotcrete, or other material as approved by the Engineer. Removal of face protrusions and backfilling of voids or over-excavation is considered incidental to the work.

The Contractor shall immediately notify the Engineer when a possible conflict with an existing H-pile has been encountered. The Engineer shall review the plans and inspect the drill hole to determine if an H-pile is in conflict with the soil nail. The Contractor shall provide access and equipment as necessary for the Engineer to inspect the drill hole. Should the Engineer determine that the obstruction is not an H-pile, the Contractor shall remove the obstruction as previously noted. Should the Engineer determine that an H-pile is in conflict with the soil nail, the Contractor shall

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abandon the hole and backfill the hole with Flowable Fill. Flowable Fill shall be produced and delivered using concrete construction equipment. Placing Flowable Fill shall be by chute, pumping, or other method approved by the Engineer. The Flowable Fill shall be placed so as to fill the entire abandoned drill hole. The Engineer in consultation with the Design Engineer will determine where to relocate the soil nail. The Contractor shall wait a minimum 24 hours after placement of the Flowable Fill before drilling the relocated soil nail. Cost of drilling and backfilling drillholes abandoned due to unanticipated obstructions with H-piles will be paid for by the linear foot at the unit price for “Abandon and Fill Drill Hole”

5 - Nail Installation.

Determine the required drillhole diameter(s), drilling method, grout composition and installation method necessary to achieve the nail pullout resistance(s) used for design, in accordance with the nail testing acceptance criteria in the Nail Testing section.

No drilling or installation of production nails will be permitted until successful pre-production verification testing of nails is completed in that unit and approved by the Engineer. Install verification test nails using the same equipment, methods, nail inclination and drillhole diameter as planned for the production nails. Perform pre-production verification tests in accordance with the Verification Testing Section prior to starting wall excavation and prior to installation of production nails. The number and location of the verification tests will be as indicated on the approved Design Drawings. Verification test nails shall be installed at the verification test nail locations designated on the approved Design Drawings. Install the production soil nails before the application of the reinforced shotcrete facing.

Where necessary for stability of the excavation face, the Contractor shall have the option of placing a sealing layer (flashcoat) of unreinforced shotcrete or steel fiber reinforced shotcrete or of drilling and grouting of nails through a temporary stabilizing berm of native soil to protect and stabilize the face of the excavation per Section 4.3 of the Construction Requirements portion of this specification. Cost shall be incidental to the work.

The Engineer in consultation with the Design Engineer may add, eliminate, or relocate nails to accommodate actual field conditions. Cost adjustments associated with these modifications shall be made in accordance with Section 2.5 of the Construction Method portion of this specification and the General Provisions of the Contract. The cost of any redesign, additional material, or installation modifications resulting from actions of the Contractor shall be borne by the Contractor.

5.1 - Drilling.

The drill holes for the soil nails shall be made at the locations, orientations, and lengths shown on

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the approved Design Drawings or as directed by the Engineer. Select drilling equipment and methods suitable for the ground conditions described in the geotechnical report and shown in the boring logs. Select drillhole diameter(s) required to develop the pullout resistance used for design. It is the Contractor's responsibility to determine the final drillhole diameter(s) required to provide the design pullout resistance. Use of drilling muds such as bentonite slurry to assist in drill cutting removal is not allowed but air may be used. With the Engineer's approval, the Contractor may be allowed to use water or foam flushing upon successful demonstration, at the Contractor's cost, that the installation method still provides adequate nail pullout resistance. If caving ground is encountered, use cased drilling methods to support the sides of the drillholes. Where hard drilling conditions such as rock, cobbles, boulders, or obstructions are described elsewhere in the contract documents or project Geotechnical Report, percussion or other suitable drilling equipment capable of drilling and maintaining stable drillholes through such materials, will be used.

Immediately suspend or modify drilling operations if ground subsidence is observed, if the soil nail wall is adversely affected, or if adjacent structures are damaged from the drilling operation. Immediately stabilize the adverse conditions at no additional cost to the State.

5.2 - Nail Bar Installation.

Provide nail bars in accordance with the schedules included in the approved Design Drawings. Provide centralizers sized to position the bar within 1 inch of the center of the drillhole. Position centralizers so their maximum center-to-center spacing does not exceed 10 feet. Also locate centralizers within 1.5 feet from the top and bottom of the drillhole. Securely attach centralizers to the bar so they will not shift during handling or insertion into the drill hole yet will still allow grout tremie pipe insertion to the bottom of drillhole and allow grout to flow freely up the hole.

Inspect each nail bar before installation and repair or replace damaged bars or corrosion protection. Check uncased drillholes for cleanliness prior to insertion of the soil nail bar. Insert nail bars with centralizers into the drill hole to the required length without difficulty and in a way that prevents damage to the drill hole, bar, or corrosion protection. Do not drive or force partially inserted soil nails into the hole. Remove nails which cannot be fully inserted to the design depth and clean the drill hole to allow unobstructed installation.

5.3 - Nail Installation Tolerances.

Nails shall not extend beyond the right-of-way or easement limits shown on the Plans. Nail location and orientation tolerances are:

- Nail head location, deviation from design location; 6 inches any direction.
- Nail inclination, deviation from design; + or - 3 degrees.

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- Center nail bars within 1 inch of the center of the drillhole.
- Clearance from H-Piles, drillhole perimeter; minimum 6 inches from outer limit of H-Piles.
- Location tolerances are applicable to only one nail and not accumulative over large wall areas.

Soil nails which do not satisfy the specified tolerances, due to the Contractor's installation methods, will be replaced at no additional cost. Backfill abandoned nail drill holes with Flowable Fill. Nails which encounter unanticipated obstructions during drilling shall be relocated, as approved by the Engineer, in accordance with section 4.5 of the Construction Requirement portion of this specification.

6 - Grouting

6.1 - Grout Mix Design.

Use a neat cement grout or a sand-cement grout. Submit the proposed nail grout mix design to the Engineer for review and approval in accordance with the submittal section. The design mix submittal shall include compressive strength test results verifying that the proposed mix will have a minimum 3-day compressive strength of 1500 psi and minimum 28-day compressive strength of 3000 psi.

6.2 - Grout Testing.

Previous test results for the proposed grout mix completed within one year of the start of work may be submitted for initial verification of the required compressive strengths for installation of pre-production verification test nails and initial production nails. During production, nail grout shall be tested by the Engineer in accordance with AASHTO T106/ASTM C109 at a frequency of no less than one test for every 10 cubic yards of grout placed.

6.3 - Grouting Equipment.

Grout equipment shall produce a uniformly mixed grout free of lumps and undispersed cement, and be capable of continuously agitating the mix. Use a positive displacement grout pump equipped with a pressure gauge which can measure at least twice but no more than three times the intended grout pressure. Size the grouting equipment to enable the entire nail to be grouted in one continuous operation. Neat cement grout takes may be high due to the potential for open voided coarse material. Alternative grouting methods including low slump/high viscosity sand-cement grout mixtures or neat cement grout contained in a geotextile sock encapsulation of the nail may be used, provided the specified nail pullout resistance is still successfully provided. Alternative proposed grouting methods shall be submitted to the Engineer for approval. Place the grout within 60 minutes after mixing or within the time recommended by the admixture manufacturer, if admixtures are used. Grout not placed in the allowed time limit will be rejected.

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6.4 - Grouting Methods.

Grout the drillhole after installation of the nail bar. Each drillhole will be grouted within 2 hours of completion of drilling, unless otherwise approved by the Engineer. Inject the grout at the lowest point of each drill hole through a grout tube, casing, hollow-stem auger, or drill rods. Keep the outlet end of the conduit delivering the grout below the surface of the grout as the conduit is withdrawn to prevent the creation of voids. Completely fill the drillhole in one continuous operation. Cold joints in the grout column are not allowed except at the top of the test bond length of proof tested production nails. At the Contractor's option, the grout tube may remain in the hole provided it is filled with grout.

During casing removal for drillholes advanced by either cased or hollow-stem auger methods, maintain sufficient grout level within the casing to offset the external groundwater/soil pressure and prevent hole caving. Maintain grout head or grout pressures sufficient to ensure that the drillhole will be completely filled with grout and to prevent unstable soil or groundwater from contaminating or diluting the grout. Record the grout pressures for soil nails installed using pressure grouting techniques. Control grout pressures to prevent excessive ground heave or fracturing.

Remove the grout and nail if grouting is suspended for more than 30 minutes or does not satisfy the requirements of this specification or the Plans, and replace with fresh grout and undamaged nail bar at no additional cost.

7 -Soil Nail Testing.

Perform both verification and proof testing of designated test nails. The Contractor shall perform pre-production verification test on sacrificial test nails at the locations shown on the approved Design Drawings. The Contractor shall perform proof tests on production nails at locations shown on the approved Design Drawings. Both the Contractor and the Engineer shall record required nail test data. Do not perform nail testing until the nail grout and shotcrete facing have cured for at least 72 hours and attained at least their specified 3-day compressive strength. The Contractor shall not apply loads greater than 80 percent of the minimum guaranteed ultimate tensile strength of the tendon for Grade 50 bars or 90 percent of the minimum guaranteed ultimate tensile strength of the tendon for Grade 60 or 75 bars. Preliminary results shall be submitted to the Owner and/or Owner's Engineer within 24 hours of the test completion. A full report containing load test results shall be submitted to the Owner and/or Owner's Engineer within 5 working days of test completion.

Refer to the latest publication of the FHWA Geotechnical Circular No. 7 "Soil Nail Walls," Chapter 9, for detailed guidance on soil nail testing.

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7.1 Verification Testing.

The Contractor shall perform a number of verification tests on sacrificial soil nails as established in the Design Drawings. Verification testing shall be conducted prior to installation of production soil nails on sacrificial soil nails to confirm the appropriateness of the Contractor's drilling and installation methods, and verify the require nail pullout resistance. The verification tests shall be carried to pullout failure. The verification tests must be well planned such that their locations do not interfere with the location of production nails.

The maximum test load in verification tests (VTL) shall be calculated based on as-built bonded lengths per the latest publication of the FHWA Geotechnical Circular No. 7 "Soil Nail Walls" Chapter 9. The Load Schedule for Verification Testing shall comply with the latest publication of the FHWA Geotechnical Circular No. 7 "Soil Nail Walls" Chapter 9.

The Contractor shall perform a minimum of two (2) verification tests per soil nail wall. The verification test nails shall provide sufficient bond length to verify the bond strength in any combination of strata that the production nails will engage. The verification tests shall be performed in accordance with the final number and location of test nails shown on the approved Design Drawings. If the Contractor makes substantive changes in the drilling or soil nail installation operation as shown on the approved Design Drawings, or if significant variability of the ground conditions are observed, additional verification tests may be required at no additional cost.

The verification test nails shall be installed and tested in the area where the permanent wall will be constructed so the results are representative of the actual conditions; i.e., through the H-piles and bonded to the soils that will provide the pullout resistance as per the approved design. The verifications tests will be performed by installing the test nail and placing the loading assembly and reaction block against a limited excavated area whit temporary reinforced shotcrete face installed to provide sufficient bearing resistance at the nail head. This will be a limited excavated area just for testing purposes. The test nail is a sacrificial nail and it shall be abandoned in place after the test completion to avoid unnecessary soil disturbance. The sacrificial test nail head shall be cut at a minimum distance of 3 inches from the initial shotcrete face.

7.2 Proof Testing

Successful proof testing shall be demonstrated on at least 5 percent of production soil nails in each nail row. The Contractor shall determine the locations and number of proof tests prior to nail installation in each row and shall be in accordance with the approved Design Drawings. Verification tests shall not be counted towards the minimum 5 percent of production nails.

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The maximum test load in proof tests (PTL) shall be calculated based on as-built bonded lengths per the latest publication of the FHWA Geotechnical Circular No. 7 “Soil Nail Walls” Chapter 9. The Load Schedule for Proof Testing shall comply with the latest publication of the FHWA Geotechnical Circular No. 7 “Soil Nail Walls” Chapter 9.

7.3 Test Nail Acceptance Criteria.

7.3.1 Verification Tests

Considering that pullout is defined as the load at which attempts to further increase the test load increments simply result in continued movement of the tested nail, a test nail shall be considered acceptable when all of the following criteria are met:

1. The total creep movement is less than 0.08 in. between the 6- and 60-minute readings, and the creep rate is linear or decreasing throughout the creep test hold period.
2. The total movement (Δ VTL) measured at VTL exceeds 80 percent of the theoretical elastic elongation of the unbonded length of the test nail, as defined in the latest publication of the FHWA Geotechnical Circular No. 7 “Soil Nail Walls” Chapter 9.
3. Pullout does not occur before achieving 1.0 x VTL.

7.3.2 Proof Tests

1. The creep movement between the 1- and the 10-minute readings is less than 0.04 in.
2. In cases when the creep movement between the 1- and the 10-minute readings is greater than 0.04 in., the creep movement between the 6- and the 60-minute readings is less than 0.08 in., and the creep rate is linear or decreasing throughout the creep test load hold period.
3. The total soil nail movement (Δ PTL) measured at PTL exceeds 80 percent of the theoretical elastic elongation of the unbonded length, as defined in the latest publication of the FHWA Geotechnical Circular No. 7 “Soil Nail Walls” Chapter 9.
4. Pullout does not occur before the test load is 1.0 x PTL.
5. The temporary unbonded test length in proof tests is successfully maintained for

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subsequent satisfactory grouting. If the unbonded test length of production proof test nails cannot be satisfactorily grouted after testing, the proof test nail shall become sacrificial and shall be replaced with an additional production nail installed at no additional cost to the Owner.

8 Test Nail Rejection

If a test nail does not satisfy the acceptance criterion, the Contractor shall provide corrective measures as necessary to provide nail(s) that achieves the acceptance criteria.

8.1 Verification Test Nail.

The Contractor shall prepare a report summarizing the results of the verification test within 3 days upon completion of the test. The Engineer will evaluate the results of each verification test. Installation methods which do not satisfy the nail testing requirements shall be rejected. The Contractor shall propose alternative methods and install replacement verification test nails. Replacement test nails shall be installed and tested at no additional cost.

8.2 Proof Test Nails.

The Contractor shall prepare a report summarizing the results of the proof test before proceeding with additional nail drilling. The Engineer may require the Contractor to replace some or all of the installed production nails between a failed proof test nail and the adjacent passing proof test nail. Alternatively, the Engineer may require the installation and testing of additional proof test nails to verify that adjacent previously installed production nails have sufficient load carrying capacity. Contractor modifications may include, but are not limited to; the installation of additional proof test nails; increasing the drillhole diameter to provide increased capacity; modifying the installation or grouting methods; reducing the production nail spacing from that shown on the approved Design Drawings and installing more production nails at a reduced capacity; or installing longer production nails if sufficient right-of way is available and the pullout capacity behind the failure surface controls the allowable nail design capacity. The nails may not be lengthened beyond the temporary construction easements or the permanent right-of-way shown on the Contract Drawings. Installation and testing of additional proof test nails or installation of additional or modified nails as a result of proof test nail failure(s) will be at no additional cost.

9 Nail Installation Records.

Records documenting the soil nail wall construction will be maintained by the Engineer, unless specified otherwise. The Contractor shall provide the Engineer with as-built drawings showing as-built nail locations and as-built shotcrete facing line and grade within 5 days after completion of the

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shotcrete facing and as-built CIP facing line and grade within 5 days after completion of the CIP facing.

10 Wall Drainage Network.

Install and secure all elements of the wall drainage network as shown on the Plans, specified herein, or as required by the Engineer to suit the site conditions. The drainage network shall consist of installing geocomposite drain strips and PVC connection pipes as shown on the Plans or as directed by the Engineer. All elements of the drainage network shall be installed prior to shotcreting.

10.1 Geocomposite Drain Strips.

Install geocomposite drain strips centered between the columns of nails as shown on the Plans. The drain strips shall be at least 1 foot wide and placed with the geotextile side against the ground. Secure the strips to the excavation face and prevent shotcrete from contaminating the ground side of the geotextile. Drain strips will be continuous. Splices shall be made with a 1 foot minimum overlap such that the flow of water is not impeded. Repair damage to the geocomposite drain strip, which may interrupt the flow of water.

10.2 Connection Pipes and Weepholes.

Install connection pipes as shown on the Plans. Connection pipes are lengths of solid PVC pipe installed to direct water from the geocomposite drain strips into a footing drain or to the exposed face of the wall. Connect the connection pipes to the drain strips using either prefabricated drain grates as shown on the Plans or using the alternate connection method described below. Install the drain grate per the manufacturer's recommendations. The joint between the drain grate and the drain strip and the discharge end of the connector pipe shall be sealed to prevent shotcrete intrusion. Connection pipes that end at the footing drain shall be extended to the edge of the drain. Do not puncture the drainage fabric around the footing drain.

The alternative acceptable method for connection of the connector pipe to the drain strip involves cutting a hole slightly larger than the diameter of the pipe into the strip plastic core but not through the geotextile. Wrap both ends of the connection pipe in geotextile in a manner that prevents migration of fines through the pipe. Tape or seal the inlet end of the pipe where it penetrates the drain strip and the discharge end of the connector pipe in a manner that prevents penetration of shotcrete into the drain strip or pipe. To assure passage of groundwater from the drain strip into the connector pipe, slot the inlet end of the connector pipe at every 45 degrees around the perimeter of the pipe to a depth of ¼ inch.

11 Frost Protection Measures

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Frost protection measures are required due to potential frost-induced loading from the frost-susceptible soils retained by the wall. Additionally to adopting appropriate bar sizes of tendons, thermal insulation such as extruded polystyrene (XPS) foam panels or equivalent can be installed to provide frost protection along the vertical face of the soil nail wall and at the ground surface behind the top of the wall.

12 Shotcrete Construction Facing

12.1 Shotcrete Alignment and Thickness Control.

Ensure that the thickness of shotcrete satisfies the minimum requirements shown on the Plans using shooting wires, thickness control pins, or other devices acceptable to the Engineer. Install thickness control devices normal to the surface such that they protrude the required shotcrete thickness outside the surface. Ensure that the front face of the shotcrete does not extend beyond the limits shown on the Plans.

12.2 Surface Preparation.

Clean the face of the excavation and other surfaces to be shotcreted of loose materials, mud, rebound, overspray or other foreign matter that could prevent or reduce shotcrete bond. Protect adjacent surfaces from overspray during shooting. Avoid loosening, cracking, or shattering the ground during excavation and cleaning. Remove any surface material which is so loosened or damaged, to a sufficient depth to provide a base that is suitable to receive the shotcrete. Remove material that loosens as the shotcrete is applied. Cost of additional shotcrete is incidental to the work. Divert water flow and remove standing water so that shotcrete placement will not be detrimentally affected by standing water. Do not place shotcrete on frozen surfaces.

12.3 Delivery and Application.

Maintain a clean, dry, oil-free supply of compressed air sufficient for maintaining adequate nozzle velocity at all times. The equipment shall be capable of delivering the premixed material accurately, uniformly, and continuously through the delivery hose. Control shotcrete application thickness, nozzle technique, air pressure, and rate of shotcrete placement 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. Orient nozzle at a distance and approximately perpendicular to the working face so that rebound will be minimal and compaction will be maximized. Pay special attention to encapsulating reinforcement.

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Do not work rebound back into the construction. Where shotcrete is used to complete the top ungrouted zone of the nail drill hole near the face, position the nozzle into the mouth of the drillhole to completely fill the void.

A clearly defined pattern of continuous horizontal or vertical ridges or depressions at the reinforcing elements after they are covered with shotcrete will be considered an indication of insufficient reinforcement cover or poor nozzle techniques. In this case the application of shotcrete shall be immediately suspended and the Contractor shall implement corrective measures before resuming the shotcrete operations. The shotcreting procedure may be corrected by adjusting the nozzle distance and orientation, by insuring adequate cover over the reinforcement, by adjusting the water content of the shotcrete mix or other means. Adjustment in water content of wet-mix will require requalifying the shotcrete mix.

12.4 Defective Shotcrete.

Repair shotcrete surface defects as soon as possible after placement. Remove and replace shotcrete which exhibits segregation, honeycombing, lamination, voids, or sand pockets. In-place shotcrete determined not to meet the specified strength requirement will be subject to remediation as determined by the Engineer. Possible remediation options include placement of additional shotcrete thickness or removal and replacement, at the Contractor's cost.

12.5 Construction Joints. Taper construction joints uniformly toward the excavation face over a minimum distance equal to the thickness of the shotcrete layer. Provide a minimum reinforcement overlap at reinforcement splice joints as shown on the Plans. Clean and wet the surface of a joint before adjacent shotcrete is applied. Where shotcrete is used to complete the top ungrouted zone of the nail drill hole near the face, to the maximum extent practical, clean and dampen the upper grout surface to receive shotcrete, similar to a construction joint.

12.6 Finish. Shotcrete finish shall be either an undisturbed gun finish as applied from the nozzle or a rough screeded finish. Remove shotcrete extending into the CIP finish face section beyond the tolerances shown on the Plans or specified herein.

12.7 Attachment of Nail Head Bearing Plate and Nut. Attach a bearing plate, bearing plate shear connectors and nut to each nail head as shown on the Plans. While the shotcrete is still plastic and before its initial set, uniformly seat the plate on the shotcrete by hand wrench tightening the nut. Where uniform contact between the plate and the shotcrete cannot be provided, set the plate in a bed of grout. After grout has set for 24 hours, hand wrench tighten the nut. Ensure bearing plates with headed studs are in intimate contact with the construction facing and the studs are located within the tolerances shown on the Plans or specified herein.

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12.8 Weather Limitations. No shotcrete shall be placed when the air temperature is below 40°F or against a surface containing frost. The temperature of the shotcrete mix, when deposited, shall be not less than 50°F or more than 95°F.

Suspend shotcrete application during high winds and heavy rains unless suitable protective covers, enclosures or wind breaks are installed. Remove and replace newly placed shotcrete exposed to rain that washes out cement or otherwise makes the shotcrete unacceptable. Provide a polyethylene film or equivalent to protect the work from exposure to adverse weather.

12.9 Curing. Curing is not required for shotcrete construction facings.

12.10 Construction Facing Tolerances. Construction tolerances for the temporary shotcrete construction facing are as follows:

Horizontal Location of Wire Mesh; Rebar; Headed Studs on Bearing Plates,
from Plan location; + or - ½ inch

Headed studs location on bearing plate, from plan location: ¼ inch

Spacing between reinforcing bars, from plan dimension; 1 inch

Reinforcing lap, from specified dimension: - 1 inch

Thickness of shotcrete; - ½ inch

Nail head bearing plate, deviation from parallel to wall face: 10 degrees

METHOD OF MEASUREMENT:

The unit of measurement for Permanent Soil Nails will be per linear foot. The length to be paid will be the length measured along the bar centerline from the back face of shotcrete to the bottom tip end of nail bar as shown on the Plans. No separate measurement will be made for proof test nails, which shall be considered incidental to production nail installation.

Verification test nails will be measured on a unit basis for each verification test successfully completed. This unit price shall include the cost for materials, equipment, and labor required for the construction of the verification soil nail. Failed verification test nails or additional verification test nails installed to verify alternative nail installation methods proposed by the Contractor will not be

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measured. Verification test nail unit price shall include the cost associated with labor, materials, and equipment required to locate the existing H-Piles behind the soil nail wall. Verification test nail unit price shall also include the cost associated with any supplemental subsurface exploration the Contractor determines to be necessary.

Structure Excavation (Soil Nail Wall) will be measured as the theoretical plan volume in cubic yards within the structure excavation pay limits shown on the Plans. This will be the excavation volume within the zone measured from top to bottom of shotcrete wall facing and extending 6 feet – 6 inches horizontally in front of the plan wall final excavation line. Additional excavation beyond the plan wall final excavation line resulting from irregularities in the cut face, excavation overbreak or inadvertent excavation, will not be measured. Removal of face protrusions and backfilling of voids or over-excavation is considered incidental to the work.

General roadway excavation will not be a separate wall pay item but will be measured and paid as part of the general roadway excavation.

The unit of measurement for Abandon and Fill Drill Holes will be per linear foot. The length to be paid will be the length measured along the hole centerline from the back face of shotcrete to the bottom tip of the hole where the steel H-pile is encountered.

The shotcrete construction facing will be measured in square yards of the shotcrete area completed and accepted in the final work. As shown on the approved Design Drawings or as directed by the Engineer. No measurement or payment will be made for additional shotcrete or CIP concrete needed to fill voids created by irregularities in the cut face, excavation overbreak or inadvertent excavation beyond the plan final wall face excavation line, or failure to construct the facing to the specified line and grade and tolerances. The final pay quantity shall include all structural shotcrete, admixtures, reinforcement, welded wire mesh, wire holding devices, wall drainage materials, bearing plates, bearing plate shear connectors and nuts, test panels and all sampling, testing and reporting required by the Plans and this Specification.

BASIS OF PAYMENT:

This work will be paid for at the contract unit price for “Permanent Soil Nails”, “Verification Test Nails”, “Structure Excavation (Soil Nail Wall)”, “Abandon and Backfill Drill Hole”, and “Shotcrete Construction Facing”, complete in place, which price shall included all work shown within the pay limits shown on the contract drawings for the soil nail wall including but not limited to all labor, equipment, materials, material tests, field tests and incidentals necessary to acceptably fabricate and construct the soil nails and perform the structure excavation in accordance with all requirements of the contract, including the excavation and wall alignment survey control for the soil nail wall and work required to provide the proper shotcrete facing alignment and thickness control. All wall

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drainage materials and frost protection including geocomposite drain strips, connection pipes, drain grates, thermal insulation, and accessories are considered incidental to the shotcrete construction facing and will not be paid separately.

<u>Pay Item</u>	<u>Pay Unit</u>
Permanent Soil Nails	L.F
Verification Test Nails	EA.
Structure Excavation (Soil Nail Wall)	C.Y.
Abandon and Backfill Drill Hole	L.F.
Shotcrete Construction Facing	S.Y.

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