

SPECIAL PROVISION  
SECTION 636  
SHOTCRETE FACING FOR SOIL NAIL WALL

636.01 Description This work includes the design and construction of shotcrete facing for soil nail walls as described on the Plans and specified herein. Shotcrete may be applied directly against soil or rock faces or may be applied to the face of existing retaining structures requiring reinforcement. Refer to Special Provision Section 675 for SOIL NAIL WALL. Shotcrete may be wet or dry mix.

636.02 Design The Contractor shall prepare the design of the shotcrete facing consistent with the parameters and depictions of the required wall shown on the Plans. Design of the wall shall be guided by and generally conform to the document FHWA-NHI-14-007, FHWA GEC 007, February 2015, "Soil Nail Walls Reference Manual" and the AASHTO LRFD Bridge Design Specifications, 10<sup>th</sup> Edition, 2024. A digital copy of FHWA-NHI-14-007, GEC 007, 2015, referred to subsequently as the "Manual" is provided on the MaineDOT webpage where bidding documents are provided. AASHTO LRFD Bridge Design Specifications, 10<sup>th</sup> Edition 2024 is subsequently referred to as "AASHTO LRFD BDS."

Design documents shall define required construction joint locations and details to allow for the practical limits of applied shotcrete areas for a typical work period.

Approved submittal documents shall become the basis for and guide the construction. These will be referred to herein, along with the Contract Documents, as the Design.

636.03 Qualifications The shotcrete facing designer (Designer) shall provide evidence of the design of at least five (5) shotcrete applications during the past three years. The Contractor shall provide evidence of the successful completion of at least five (5) shotcrete projects of a permanent nature during the last three years. The Contractor's superintendent shall have a minimum of three (3) years' experience supervising shotcrete application. Soil nail crews shall be experienced in the installation of soil nails, soil nail wall drainage elements, soil nail wall shotcrete applications along with any associated forming, concrete reinforcing placement and securing and other associated work. All shotcreters, concrete equipment operators and on-site foremen shall have a minimum of one (1) year experience installing shotcrete facing and American Concrete Institute (ACI) Shotcreter certified.

636.04 Submittals The Contractor shall submit the following for review.

1. Design calculations (see Subsection 636.02, above)
2. Design drawings.
3. Experience evidence for Designer
4. Experience evidence for Contractor and Shotcrete Crew
5. Shotcrete mix designs (specify proposed air entrainment).
6. Concrete reinforcing.
7. Certified mill test reports for rebars.
8. Submit description of method and materials cut sheets for cold weather protection if the Contractor intends to continue shotcrete placement when ambient temperatures drop below 40°F, conforming to ACI 306R-16.

636.05 Materials

1. Welded wire fabric shall conform to ASTM A1064, grade 65, and galvanized in conformance with Standard Specification part 503.053.

2. Deformed steel bar for concrete reinforcing shall conform to ASTM A615, Grade 60, uncoated.
3. Concrete for shotcrete shall conform to the following.
  - a. Conform to ACI 506.2 Specifications for Materials, Proportioning, and Application of Shotcrete” and ACI 506R-90 A Guide to Shotcrete.
  - b. Shotcrete shall be both “pumpable” and “shootable” to provide a durable, reasonably uniform concrete wall.
  - c. Shotcrete shall contain air entraining admixtures to protect against freeze-thaw action of the northern climate.
  - d. Strength measured at 28 days shall be greater than that assumed for design but not less than 3,000 psi. The strength measured at 3 days shall be half of the design 28-day strength.
  - e. Maximum water/cement ratio 0.45.
  - f. Cement shall conform to ASTM C150, Type I, II, or I/II.
  - g. Admixtures: Provide admixtures conforming to ASTM C494 requirement as well as the following additional requirements:
    - i. Do not use admixtures that contain water-soluble chlorides or materials corrosive to steel or known to cause other detrimental effects such as cracking or spalling.
    - ii. Do not use admixtures that reduce the sulphate resistance of shotcrete such as aluminum salts, chlorides, or nitrates.
    - iii. Provide documentation that the proposed admixture has demonstrated satisfactory performance in a shotcrete mix of similar proportions.
    - iv. The use of a particular brand or type of admixture is subject to the approval of the RE.
    - v. Limit hose runs to less than 150 feet.
    - vi. Do not use more than 6 percent accelerator by cement weight unless approved by the RE. Proportioning of rapid-set alkali-free accelerator shall be determined by preconstruction testing to confirm set time and strength gain desired.
  - h. Water: Provide water clean and free of oil, salt, acid, alkali, sugar, plant material, or other deleterious substance that may impact the finished product.
  - i. Fiber Reinforcement: Include steel or fibrillated polypropylene fibers in the shotcrete as necessary to achieve the desired toughness, strength, and durability and complying with ASTM C1116 Standard Specification for Fiber-Reinforced Concrete. Provide steel fibers that are at least 1.5 inches long and 0.01 to 0.03 inches in diameter at a minimum weight of 20 pounds per cubic yard with deformed ends at both ends. Mix and use steel fibers in accordance with the manufacturer’s specifications. Fibrillated polypropylene Macro-fiber reinforcement, if used, the length should be 1-2.75 in, and at a minimum 5 pounds per cubic yard, or per supplier’s recommendations. Micro-synthetic polypropylene fibers are not permitted for fiber reinforcement. Submit details of the proposed type of fibers to the Resident for approval prior to shotcrete.
  - j. Add silica fume or approved equal to the mixture at a rate of 3 to 5 percent of cementitious content. Submit the silica fume product data sheet and manufacturer’s instructions for use and handling. Ensure the silica fume meets the requirements of ASTM C1240. Incorporate silica fume uniformly into the mix. Provide documentation verifying the dosage.
  - k. Aggregates shall conform to the following requirements:
    - i. Fine Aggregate – AASHTO M-6, ASTM C33 clean, natural
    - ii. Coarse Aggregate – AASHTO M-80, Class B for quality

- Aggregate for shotcrete shall meet the following gradation requirements. Alternative gradation requirements may be submitted by the Contractor for approval by the Resident.

Gradation Requirements

Sieve Size	% Passing by Weight
3/8 in	100
No. 4	95 - 100
No. 8	80 - 100
No. 16	50 - 85
No. 30	25 - 60
No. 50	10 - 30
No. 100	2 - 10
No. 200	0 - 5
Fineness Modulus*	2.3 to 3.1

\* Fineness modulus as defined by ASTM C33 and ASTM C136.

- Protective coating for concrete surfaces shall meet the requirements of Type 1c penetrating silane concrete sealers, and be listed on the Department Qualified Products List (QPL), conforming to Standard Specification Section 515.

All materials shall be carefully handled and stored according to the recommendations of the manufacturer. Improper storage or damage to any shotcrete facing materials shall be repaired or replaced at the discretion of the Resident.

636.06 Tolerances Construction tolerances for the shotcrete facing from Design location and Design dimensions shall meet the following tolerances:

Item	Tolerance
Horizontal location of welded wire mesh, reinforcing bars, and headed studs	3/8 in.
Location of headed-studs on bearing plate	1/4 in.
Spacing between reinforcing bars	1 in.
Reinforcing lap	1 in.
Thickness of shotcrete, if left as shot	1-1/8 in.
Planeness of finish face surface, gap under 10-ft straightedge, if troweled or screeded	9/16 in.
Planeness of finish face surface, gap under 10-ft straightedge, if left as shot	1-1/8 in.
Nail head bearing plate deviation from parallel to wall face	10 degrees

The Contractor shall be responsible for providing the necessary survey and alignment control for locating drill holes and verifying limits of soil nail wall installation.

636.07 Testing Production test panels will be required for each day of shotcrete application for the purpose of quality testing of shotcrete materials.

- Panels shall be at least 24 inch x 24 inch x 6 inches thick, created during the application of

- the shotcrete for the wall. Incorporate the same admixtures, color, and fiber reinforcement into the test panels as used for field shotcrete production. Ensure all staff, materials, equipment, and processes closely replicate actual field production conditions.
2. Panels shall be moist cured (not immersed in water), protected during initial set from disturbance, and prepared for subsequent materials testing.
  3. Obtain core cylinders from the test panels in accordance with ASTM C1140, Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels. At least six, 3-inch diameter core samples shall be extracted from the test panel after 24 hours and within 48 hours of creating the test panel with curing of the cores continuing. If the test panel is transported prior to extracting the cores, the test panel shall remain in the forms during transport.
  4. Strength testing per AASHTO T 24/ASTM C 42 will be performed on three cores at 3 days and 3 cores at 28 days. Results shall be provided to the Resident immediately in writing.
  5. Air entrainment tests of fresh shotcrete shall be taken for each day's production and reported to the Resident. Conform to ASTM C231. Perform one test for every 10 cubic yards. Account for the reduction in entrained air during shotcrete application in the mix design.

#### 636.08 Construction Requirements

1. Place concrete reinforcing to the lines and dimensions developed by the Designer and defined on the approved submittal documents.
2. Pressure-wash the Bin wall steel face prior to applying shotcrete.
3. Shotcrete shall be continuously applied to avoid cold joints not anticipated in the approved submittal documents.
4. Wall construction shall be consistent with recommended practices as described in the Manual.
5. All shotcrete which lacks uniformity, exhibits segregation, sagging, honeycombing, or lamination, or which contains any voids or sand pockets shall be removed and replaced with fresh shotcrete by the Contractor to the satisfaction of the Resident with no additional compensation.
6. Shotcrete shall not be placed in cold weather unless adequately protected when the ambient temperature is below 40°F. Once deposited, cold weather protection shall maintain the shotcrete temperature at no less than 55°F and no more than 75°F. Cold weather protection shall be maintained until the strength of the in-place shotcrete is greater than 500 psi. Cold weather protection shall include heating under tents, blankets or other means acceptable to the Resident.
7. Shotcrete shall not be placed on frozen ground or bin walls below 32°F. Heat the surface as necessary prior to shotcrete placement.
8. Shotcrete application shall also be suspended during high winds and heavy rain when in the opinion of the Resident the quality of the application is not acceptable. Freshly placed shotcrete shall be protected from any weather that will adversely affect the concrete quality.
9. Apply penetrating silane concrete sealer in conformance with Standard Specification 515 to exposed shotcrete faces.

Cutting of soils over 6 inches beyond the plan shotcrete limits shall not be performed without prior approval by the Resident.

#### 636.09 Field Quality Control

1. The Resident will sound shotcrete with a hammer to locate hollow sounding areas which may potentially have a lack of bond or void. Cut out and replace defective areas identified by the

- Resident.
2. During shotcreting, frequently probe the fresh shotcrete for thickness and to detect voids using a thin rod with clearly distinguishable depth marking that can easily penetrate fresh shotcrete.
  3. If the shotcreting system selected by the Contractor fails to provide satisfactory in-place shotcrete in accordance with these specifications as determined by the Resident, change to another shotcreting system.
  4. Shotcrete that in the Resident's opinion is damaged, fails to meet the minimum strength requirements as specified herein, lacks uniformity, exhibits segregating, honeycombing, laminations, cracks, or is hollow sounding, is considered defective. The Resident may order defective shotcrete be removed and replaced with acceptable shotcrete or other remedial measures at no additional cost to the Department.
  5. Add fibers for wet-mix shotcrete at the concrete plant.
  6. If lab testing of shotcrete fails to meet the specified requirements, the Contractor may perform field verification using, Windsor probe, shotcrete coring, or other approved methods. If the Contractor elects not to perform additional testing or if the verification fails, remove and replace the nonconforming shotcrete at no additional cost to the Department. Submit all test results and documentation for review and approval.

#### 636.10 Measurement and Payment

Measurement and payment are defined by Special Provision Section 675 – Soil Nail Wall.