

SECTION 03 10 00

CONCRETE FORMWORK

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This Section covers the concrete formwork for construction of all concrete structures set forth on the Drawings and in these Specifications.

1.02 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. ACA: An acronym for Ammoniacal Copper Arsenate, a leach-resistant waterborne wood preservative.
 - 2. CCA: An acronym for Chromated Copper Arsenate, a leach-resistant waterborne wood preservative.
 - 3. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. American Concrete Institute (ACI):
 - 1. ACI 347: Guide to Formwork for Concrete.
 - 2. ACI 350: Code Requirements for Environmental Engineering Concrete Structures and Commentary.
- C. U.S. Department of Commerce Product Standards:
 - 1. PS 1: Construction and Industrial Plywood.
 - 2. PS 20: American Softwood Lumber Standard.
- D. Western Wood Products Association (WWPA):
 - 1. WWPA Product Use Manual.
- E. American Plywood Association (APA):
 - 1. APA Grade - Trademarks.
- F. Southern Pine Inspection Bureau (SPIB):
 - 1. Standard Grading Rules for Southern Pine Lumber.

1.03 SUBMITTALS

- A. Form Coating: Submit manufacturer's descriptive product data and current specification covering named product.
- B. Form Ties: Submit manufacturer's descriptive product data, current specification covering named product and two samples.

1.04 QUALITY ASSURANCE

- A. Formwork Design: Provide formwork designed to ensure the tolerances indicated and to include factors pertinent to safety of personnel during construction.
 - 1. Design formwork in accordance with ACI's Guide to Formwork for Concrete, ACI 347, and in accordance with the following:
 - a. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, temporary construction material, foundation pressures, stresses, lateral stability, and such other factors pertinent to safety of structure during construction.
 - b. Design formwork to be readily removable without impact, shock, or damage to cast-in-place concrete surfaces and adjacent construction.
- B. Allowable Tolerances: Set and maintain concrete forms within tolerance limits stated in American Concrete Institute's Guide to Formwork for Concrete, ACI 347.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection:
 - 1. Protect formwork materials before, during, and after erection to ensure acceptable finished concrete work. Also protect in-place materials and work of other trades in connection with concrete work.
 - 2. In event of damage to erected forms, make necessary repairs or replacements prior to concrete pours. Perform such corrective work at no increase in Contract Price.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Lumber:
 - 1. Form framing, sheathing, struts, braces, and shoring in conformance with WWPA Product Use Manual or SPIB Grading Rules.
 - 2. Rough Structural and Dimension Lumber: Provide lumber of allowable species, surfaced four sides as applicable, and grade stamped with the appropriate WWPA or SPIB stamp indicating product compliance with PS 20.
 - 3. Use lumber free of material defects that would deform the finished concrete product.
- B. Plywood:
 - 1. Form Sheathing and Panels: Not less than 5/8 inch thick Exterior Type B-B Plywood Class I and II EXT-APA conforming to U.S. Product Standard PS 1.
 - 2. Use Class II only on surfaces not exposed to view.
- C. Steel:
 - 1. Metal Forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Drawings, may be used in lieu of wood forms.

D. Form Ties:

1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties conforming to ACI 347 and ACI 350.
2. Use snap-off metal ties with ends that break at least 1½ inches from the face of the wall.
3. Do not use removable ties that leave holes larger than one (1) inch.
4. In construction of liquid-retaining structures and structures designed to exclude groundwater, use ties that are designed to prevent seepage or flow of water along the embedded item.
5. Do not use removable type form ties in construction of liquid-retaining concrete structures.
6. Do not use wire ties, flat bands, or form ties fabricated on the project site.
7. Do not use wood spacers.

- E. Form Coatings: Provide commercial formulation form-coating compounds that will not bond with, stain, nor affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds. On surfaces which will be in contact with potable water, use no material which will add taste, odor, or toxic effects to the water.

PART 3 EXECUTION

3.01 INSPECTION

- A. Prior to placement of concrete, inspect forms for cleanliness and accuracy of alignment.

3.02 PREPARATION

- A. Apply form coatings in accordance with manufacturer's specifications.
- B. Do not allow excess form coating material to accumulate in the forms.
- C. Do not allow form coatings to come in contact with construction joints and reinforcing steel.

3.03 ERECTION

- A. General: Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight, and paste tight where appearance is important.
1. Securely brace and shore forms to prevent displacement, bowing, and pillowing, and to safely support imposed concrete load.
 2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.
 3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.

4. Form intersecting planes to provide true, clean-cut corners with edge grain of plywood not exposed to concrete.
 5. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items, and such other embedded items as indicated on Drawings.
 6. Wet forms sufficiently to prevent joints in wood forms from opening prior to concrete pour.
 7. Do not use stay-in-place metal forms.
- B. Openings: Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete.
1. Securely brace temporary openings and set tightly to forms to prevent the loss of concrete mortar. Locate temporary openings on forms in as inconspicuous a location as possible consistent with the requirements of the work.
 2. Provide openings in concrete formwork of the correct size and in the proper location to accommodate other items and operations of construction work passing through forms. Accurately place and securely support items to be built into forms.
- C. Earth Forms: Earth forms are not permitted.

3.04 CONSTRUCTION

- A. Form Removal
1. Remove forms in accordance with ACI 347 without damage to concrete and in a manner to ensure complete safety and serviceability of the structure.
 - a. Do not cut form ties back from the face of the concrete.
 - b. Concrete surface shall not contain residual form coating that will interfere with other materials or coatings to be applied.
 2. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection. The Engineer's consent to remove forms does not relieve the Contractor of the responsibility for the safety of the work.
 3. When the atmospheric temperature at the site has been continuously above 50 degrees F. from the time of the pour, the forms shall be removed at the earliest practical time within the limits set forth in this paragraph, and wet curing shall continue without delay.
 - a. Forms for walls and other vertical faces may be carefully removed 24 hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form removal, and provided these members are not subjected to loads for a period of 14 days.
 - b. Maintain horizontal forms in place for a minimum of 14 days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3,000 p.s.i.

- c. Carefully remove forms for columns before the falsework is removed from beneath the beams or girders.
- d. When a water-reducing retarder is used in the concrete mix, the normal time periods for removing forms may need to be increased.
4. When the atmospheric temperature at the site drops below 50° F, leave all forms in place for at least five (5) days regardless of the temperature within the protective covering or enclosure.
5. Upon removal of forms, notify the Engineer in order that a review of the newly stripped surfaces may be made before patching.

3.05 RE-USE OF FORMS

- A. Forms for re-use shall meet new form requirements with respect to effect on poured concrete appearance and structural stability.
- B. Do not delay or change the concrete pour schedule as a result of reusing forms compared to the schedule obtainable if all forms were new (in the case of wood forms) or if the total required forms were available (in the case of metal forms).

3.06 SITE QUALITY CONTROL

- A. Inspections:
 1. Notify the engineer at least 10 days prior to scheduled concrete placement operations to allow sufficient time for the Testing and Inspection Agency (Approved Agency) responsible for performing code-required special inspections to schedule an inspection of the concrete formwork.
 2. Prior to placement of concrete, inspect the forms for shape, location, and dimension of the concrete member being formed.
 - a. Provide lumber free of material defects that would unacceptably deform the finished concrete product or cause visible imperfections on surfaces exposed to public view.
 3. Prior to placement of concrete, verify the items to be embedded are properly placed and anchored.
- B. Non-Conforming Work:
 1. If formwork is found to be out of alignment, or requires residual or other detrimental material to be removed from the forms or pour area, realign the forms and/or remove the detrimental material from the formwork before pouring concrete into the form.

3.07 WASTE MANAGEMENT AND DISPOSAL

- A. Do not leave any wood, shavings, sawdust, or similar items on the ground or buried in backfill.
 1. Do not burn scrap on the Work Site.
 - a. Do not burn scraps that have been pressure treated.
 2. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation facilities or “waste-to-energy” facilities.

END OF SECTION

SECTION 03 20 00

CONCRETE REINFORCEMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The work specified in this Section consists of furnishing and installing reinforcement for concrete structures.

1.02 RELATED WORK

- 1. Section 03 30 00: Cast-in-Place Concrete.

1.03 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 315; Details and Detailing of Concrete Reinforcement.
 - 2. ACI 318; Building Code Requirements for Reinforced Concrete.
- B. ASTM International (ASTM):
 - 1. ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 2. ASTM A663: Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
 - 3. ASTM A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
 - 4. ASTM A1064: Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
- C. Concrete Reinforcing Steel Institute (CRSI):
 - 1. Manual of Standard Practice.

1.04 SUBMITTALS

- A. Shop Drawings and Product Data:
 - 1. Prepare shop drawings of concrete reinforcement in accordance with ACI 315.
 - 2. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions and details of bar reinforcing, and accessories.
- B. Test Reports:
 - 1. Submit copies of reports showing the results of tests, conducted in accordance with ASTM Specifications.
 - 2. Test Requirements may be waived based upon certified copies of mill test reports.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage of Materials:

1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
 - a. Store the reinforcement and accessories aboveground on platforms, skids, or other supports.
 - b. Cover reinforcement and accessories.
2. Identify bundles of reinforcing steel with tags wired to steel.
3. Protect reinforcement from deforming, bending, kinking, and other injury.

1.06 PROJECT CONDITIONS

- A. Protection: Protect in-place reinforcement from excessive construction traffic and other work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Reinforcing Steel:

1. Reinforcement Bars: ASTM A615, Grade 60, deformed steel, which shall satisfy the exceptions in ACI Building Code, AASHTO, and Federal Specifications.
2. Wire: ASTM A82.
3. Welded Wire Fabric: ASTM A185.
4. Metal Accessories: CRSI Manual of Standard Practice.

- B. Rebar Splicing Coupler: A two-piece splicing system manufactured from ASTM A615 Grade 60 deformed rebar. A dowel bar splicer with integral nailing flange shall be threaded for a threaded down-in rebar such that the completed splice exceeds the tensile requirements of ACI 318.

1. Internal Coupler Protector: Provide coupler manufacturer's plastic internal coupler protector where couplers are provided for anticipated future additions.
2. Bar End Protectors: Plastic solid sleeve for placement over bar ends to protect threading from damage, contamination, and rust.
3. Use Rebar Splicing Coupler only where shown on Drawings or where approved by the Engineer.
4. Acceptable Manufacturers:
 - a. Dayton Superior Corp.
 - b. Or approved equal.

2.02 FABRICATION

- A. General: Fabricate reinforcement to the dimensions indicated on the Drawings and within the tolerances given in ACI 315. Perform bending of steel reinforcement by the cold bending method.
 1. Do not use bars with kinks or bends not indicated on Drawings.

2. Perform bar shape fabrication in a manner that will not injure the material or lessen the member strength.
3. Use a designed bending machine, either hand- or power-operated.
4. Do not field bend bars partially embedded in concrete unless approved by the Engineer.

2.03 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Materials specified in this Section require advance examination or laboratory testing according to the methods referenced herein.
2. The Testing and Inspection Agency (Approved Agency) will perform the source testing specified in this Paragraph, unless the testing is not required as specified.
 - a. The tests specified in Subparagraphs 2.03.A.3 through 2.08.A.7 may be waived if certified copies of mill test reports are submitted showing complete compliance with the specified requirements.
 - b. If the certified mill test reports are not submitted the Testing and Inspection Agency must perform the specified tests.
3. Deformed Steel Reinforcement Tests:
 - a. Test Procedure:
 - 1) The following properties of the deformed steel bar reinforcement will be determined using the methods specified in ASTM A615:
 - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
 - b) The tensile strength, yield strength, and percentage elongation.
 - 2) The bend test will be performed on the deformed steel bar reinforcement using the methods specified in ASTM A615.
 - b. Acceptance Criteria:
 - 1) Deformed steel bar reinforcement that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615, and that pass the bend test for the bar size, as specified in ASTM A615 are acceptable.
4. Steel Welded Wire Reinforcement Tests:
 - a. Test Procedure:
 - 1) The tensile strength, yield strength, and percent reduction of area will be determined, and the bend test for steel welded wire reinforcement will be performed in accordance with the methods specified in ASTM A185.
 - b. Acceptance Criteria:
 - 1) Steel wire used to fabricate the steel welded wire reinforcement that exhibits the tensile strength, yield strength, and percent reduction of area within the ranges specified, and that passes the bend test for the wire size as specified in ASTM A185 are acceptable.
5. Deformed Bar Anchor Tests:
 - a. Test Procedure:

- 1) The tensile strength and yield strength will be determined, and the bend test for steel deformed bar anchors will be performed in accordance with the methods specified in ASTM A496.
 - b. Acceptance Criteria:
 - 1) Deformed bar anchors exhibiting the tensile strength and yield strength within the ranges specified in Subparagraph 2.01.E are acceptable.
6. Rebar Splicing Coupler:
 - a. Test Procedure:
 - 1) The following properties of the dowel bar used to fabricate the rebar splicer components will be determined using the methods specified in ASTM A615:
 - a) The carbon, manganese, phosphorus, and sulfur content of the dowel bar material.
 - b) The tensile strength, yield strength, and percentage elongation.
 - 2) The bend test will be performed on the dowel bar used to fabricate the dowel bar splicer components using the methods specified in ASTM A615.
 - b. Acceptance Criteria:
 - 1) Rebar splicer components that exhibit the chemical composition, tensile strength, yield strength, percent reduction of area, and weight (mass) per unit length within the ranges specified in ASTM A615, and pass the bend test for the bar size as specified in ASTM A615 are acceptable.
7. Non-Conforming Work:
 - a. Do not use concrete reinforcement that fails the testing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Placing:
 1. Place metal reinforcement accurately and securely brace against displacement within permitted tolerances and in accordance with ACI 318 through the use of reinforcing accessories.
 2. Terminate reinforcement two inches from face of expansion joints.
 3. Continue reinforcement across or through construction joints.
 4. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcing around it. Do not bend the reinforcing to clear the obstructions.
 5. Install welded wire fabric as indicated, lapping joints eight inches and wiring securely. Extend welded wire fabric to within two inches of sides and ends of slabs.
 6. Do not lay metal reinforcement on formwork.
 7. Place slab reinforcement supported from the ground on concrete blocks of the correct height and having a compressive strength equal to or greater than the specified compressive strength of concrete being placed. Use concrete blocks not larger than 3 inches by 3 inches with a height equal to required bottom steel cover.

8. Reinforcement supported from formwork for slabs and beams not exposed to weather or to a continuous wet environment may use bar chairs made of plastic or metal. Use stainless steel boosters in areas exposed to a wet environment.
9. Place additional reinforcement around openings in slabs and walls as detailed on the Drawings.

B. Concrete Reinforcement Field Bends:

1. Do not field bend bars partially embedded in concrete.
2. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcement around it.
 - a. Do not bend the reinforcement to clear the obstructions.

C. Shortening Concrete Reinforcement:

1. Shorten (trim) concrete reinforcement, if required, by shearing or sawing.
2. Shortening concrete reinforcement using an acetylene torch may be acceptable, but only if the location of the shortening is approved by the Engineer in writing in advance.

D. Splicing:

1. Splice metal reinforcement as indicated on the Drawings and in accordance with ACI 318.
2. Welding of crossing bars (tack welding) is not permitted.
3. Secure metal reinforcement at intersections with not less than No. 16-gauge annealed wire or appropriate size clips. When bar spacing is less than 12 inches, tie alternate intersections.
4. Make mechanical butt splices in accordance with rebar splicing coupler manufacturer's installation instructions.

- E. Cleaning: Clean or otherwise protect metal reinforcement so that at the time concrete is placed, reinforcement is free from rust, scale, or other coatings that will destroy or reduce bond.

3.02 SITE QUALITY CONTROL

- A. A Testing and Inspection Agency (Approved Agency) shall be engaged by Owner to perform code-required special inspections.

1. Written reports on all tests and inspections shall be provided immediately after work is performed. The reports shall state test specimens either comply with requirements or deviate from them.

B. Inspections:

1. Notify the Engineer at least 10 days prior to scheduled concrete placement operations so the placement of reinforcement can be inspected.
2. Prior to placing concrete, inspect the reinforcement size, location, spacing, clear distance between bars, and to the outside face of the concrete, and the reinforcement will not be displaced during the placement of concrete.

- a. Verify the rebar splicer system is installed at the approved locations, is the correct type, and is installed in accordance with the manufacturer's guidelines.

3.03 PROTECTION

- A. Provide protection for concrete reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Contract Drawings.
- B. Protect in-place reinforcement from excessive construction traffic and other work.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. The work specified in this Section consists of designing mix, furnishing, placing, and curing Portland Cement concrete, reinforced and unreinforced, as indicated.

1.02 RELATED WORK

- A. Section 03 10 00: Concrete Formwork.
- B. Section 03 20 00: Concrete Reinforcement.
- C. Work Provided Under Other Contracts: Items to be embedded in concrete are as specified in the various Sections of this Contract and other Contracts for this Project. The responsibility for coordinating concrete pours with embedded items rests solely with the Contractor.
- D. Work Specified Under Other Sections: Items to be embedded in concrete are as specified in the various Sections of this Contract Specification. The responsibility for coordinating concrete pours with embedded items rests solely with the Contractor.

1.03 REFERENCES

- A. Abbreviations and Acronyms:
 - 1. H.E.S : High Early Strength.
 - 2. VOC: An acronym for volatile organic compounds, generally meant to refer to organic chemical compounds that have high enough vapor pressures under normal conditions to significantly vaporize and enter the atmosphere.
- B. Definitions:
 - 1. Cementitious Material: Mixture of cement and one type of a cement replacement material.
- C. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M 182 Burlap cloth made from Jute or Kenaf and Cotton Mats.
- D. American Concrete Institute (ACI):
 - 1. ACI 117; Specification for Tolerances for Concrete Construction and Materials.
 - 2. ACI 211.1; Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete – Procedures for Mix Design.
 - 3. ACI 211.2; Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
 - 4. ACI 301; Specifications for Structural Concrete.

5. ACI 302.1R; Guide for Concrete Floor and Slab Construction.
6. ACI 304R; Guide for Measuring; Mixing, Transporting, and Placing Concrete.
7. ACI 304.2R; Placing Concrete by Pumping Methods.
8. ACI 305R; Guide to Hot Weather Concreting.
9. ACI 306R; Guide to Cold Weather Concreting.
10. ACI 308; Standard Practice for Curing Concrete.
11. ACI 318; Building Code Requirements.
12. ACI 350; Environmental Engineering Concrete Structures.

E. American National Standards Institute (ANSI):

1. ANSI/NSF 61: Drinking Water System Components – Health Effects.

F. ASTM International (ASTM):

1. ASTM C31; Standard Practice for Making and Curing Concrete Test Specimens in the Field.
2. ASTM C33; Standard Specification for Concrete Aggregates.
3. ASTM C39; Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
4. ASTM C78; Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
5. ASTM C94; Standard Specification for Ready-Mixed Concrete.
6. ASTM C143; Standard Test Method for Slump of Hydraulic-Cement Concrete.
7. ASTM C150; Standard Specification for Portland Cement.
8. ASTM C171; Standard Specification for Sheet Materials for Curing Concrete.
9. ASTM C172; Standard Practice for Sampling Freshly Mixed Concrete.
10. ASTM C173; Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
11. ASTM C192; Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
12. ASTM C231; Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
13. ASTM C260; Standard Specification for Air-Entraining Admixtures for Concrete.
14. ASTM C309; Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
15. ASTM C494; Standard Specification for Chemical Admixtures for Concrete.
16. ASTM C881; Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
17. ASTM C882; Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
18. ASTM C989; Standard Specification for Slag Cement for Use in Concrete and Mortars.
19. ASTM C1260 – Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
20. ASTM C1567; Standard Test Method for determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
21. ASTM D638; Standard Test Method for Tensile Properties of Plastics.

22. ASTM D695; Standard Test Method for Compressive Properties of Rigid Plastics.
23. ASTM D1751; Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
24. ASTM D1752; Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
25. ASTM E329; Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
26. ASTM C138/C138M; Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
27. ASTM C1077; Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
28. ASTM C1315; Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

- G. Commonwealth of Pennsylvania Department of Transportation (PENNDOT) Specifications *Publication 408*, as supplemented.
1. PENNDOT Section 704 Cement Concrete.
 2. PENNDOT Section 1001 Cement Concrete Structures.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
1. Before concrete is to be placed, give a 10-day advance notice to those performing other construction work related to the concrete pours, such as to those performing work that must be supported by or embedded in concrete, to allow such items to be introduced or furnished before the concrete is placed.
 2. Coordinate with the Independent Quality Assurance Testing and Inspection Agency to insure notification is received sufficiently early to allow them ample time to schedule and perform the required testing and inspection.
- B. Pre-Installation Meetings:
1. Prior to placement of concrete, convene an onsite meeting to establish and coordinate procedures that will enable the Contractor to provide the best possible product under anticipated field conditions.
 2. Required attendees to this meeting include representatives of organizations and material suppliers involved with the design and construction of concrete elements.
- C. Scheduling:
1. A minimum of 30 days prior to placing concrete, submit a schedule showing proposed construction methods, construction joint locations, and the sequence of pouring for approval.

1.05 SUBMITTALS

- A. **Product Data:** Submit manufacturer's descriptive product data and current specifications for the concrete accessories specified herein (admixtures, joint fillers, curing materials, floor hardeners, waterstops, etc.). Include installation instructions.
- B. **Samples:** Submit samples of materials being used when requested by the Engineer including names, sources, and descriptions.
- C. **Aggregate Testing for AAR:** Prior to production of concrete, submit for approval testing as required by Article 2.01.C.2, Aggregate Reactivity.
- D. **Design Mix:** Prior to production of concrete, submit for approval, on form attached at the end of this Section, all mix designs proposed for project. Include with the mix design a standard deviation analysis or trial mixture test data in accordance with ACI 301 Section 4. Use materials in such proposed design mix as specified herein. Make such adjustments in the proposed design mix as directed by the Engineer. Make such adjustments at no increase in contract price.
 - 1. Water shall not be added to concrete mix at the project site unless it is withheld from the mix at the batch mixing plant. Indicate amounts of mix water to be withheld for later addition at project site. If water is added to mix at the Site, perform additional revolutions at the mixing speed to adequately incorporate the additional water into the mixture.
 - 2. For High-Early Strength Concrete, provide an air-entrained mixture that attains a 24-hour compressive strength of 2,500 psi and a three (3) day strength of 3,500 psi. Data shall be provided to demonstrate the ability of the mixture to meet the specification requirements.
- E. **Test Reports:**
 - 1. Submit concrete test reports specified in Part 3, Field Quality Control in this Specification.
- F. **Certificates:**
 - 1. Furnish the Engineer and local authorities requiring same, certificates originated by the batch mixing plant certifying ready mixed concrete, as manufactured and delivered, to be in conformance with ASTM C94.
- G. **Delivery Tickets:** A delivery ticket shall accompany each load of concrete from the batch plant.
 - 1. Tickets must be signed by the Contractor's representative, noted as to time and place of pour, and kept in a record at the site. Make such records available for inspection upon request by the Engineer.
 - 2. Information presented on the ticket to include the tabulation covered by ASTM C94, Section 14, as well as any additional information the local codes may require.
- H. **Schedule:** Submit schedule showing methods, construction joint locations, and sequence of pouring a minimum of 10 days prior to placing concrete.

- I. Testing Agency: Submit name and qualifications of Testing and Inspection Agency to Engineer for approval prior to proceeding with testing.

1.06 QUALITY ASSURANCE

- A. Testing Agency: An agency regularly performing work conforming to ASTM E329.
- B. Source Quality Control:
 - 1. Laboratory Tests: Materials stated herein require advance examination or testing according to methods referenced or as required by the Engineer.
- C. Compression Test Cylinders: For laboratory trial batches, make in accordance with ACI 301. Test to consist of three compression test cylinders for each class of concrete with one broken at seven days and two broken at 28 days; ASTM C192 and ASTM C39.
- D. Flexural Strength Beams: For laboratory trial batches, make in accordance with American Concrete Institute ACI 301. Test to consist of three flexural strength beams (6 x 6 inches) for Class A concrete only, with one broken at seven days and two broken at 28 days; ASTM C192 and ASTM C78. Perform this test for vehicle pavement slabs only.
- E. The use of the High-Early Strength Concrete mix (as defined by requirements in this Section) shall only be installed at locations given prior approval by the Engineer.

1.07 PROJECT CONDITIONS

- A. ACI Compliance: Cast-in-place concrete work shall conform to ACI 301 except as modified by these Specifications or the Drawings.
- B. Concrete Encasement of Pipes: Encase pipes under structures and buildings indicated by the Drawings to be encased in concrete for the full length of the pipe run under the structure.
- C. Concrete Encasement of Conduits: Encase conduit runs as indicated and detailed on the Drawings as work of Division 26 - Electrical Sections.
- D. Equipment Bases: Construct reinforced concrete bases for equipment and piping under this contract at no increase in contract price.

1.08 SEQUENCING

- A. Where other construction work is relative to concrete pours, or must be supported by or embedded in concrete, those performing such related work must be given five days notice to introduce or furnish embedded items before concrete is placed.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Cement:
 - 1. Portland Cement: ASTM C150 of the following Type:
 - a. Type II, Moderate Sulfate Resistance.
 - 2. Only one brand and manufacturer of approved cement shall be used for exposed concrete.
 - 3. Cementitious material is a mixture of cement and ground granulated blast-furnace slag (GGBFS).

- B. Ground Granulated Blast -Furnace Slag (GGBFS): Conform to ASTM C989, Grade 120, NSF approved for contact with potable water.
 - 1. Use GGBFS at the rate of 25% (min) to 40% (max) of the total cementitious material.
 - 2. GGBFS is required in all water containing structures.

- C. Normalweight Concrete Aggregates: Process aggregate meeting requirements of ASTM C33 and subject to the following limitations.
 - 1. Coarse Aggregate Size: Maximum size of coarse aggregate shall not exceed the following requirements but in no case larger than 1½ inches.
 - a. Coarse aggregates be #57 as graded within the limits in ASTM C33 unless otherwise specified.
 - b. One-fifth narrowest dimension between sides of forms within which concrete is to be cast.
 - c. Three-fourths of the minimum clear spacing between reinforcing bars.
 - d. One-third the slab thickness for unreinforced slabs.
 - e. Reduced aggregate concrete containing aggregate with particle size not less than 1/8 inch or more than 1/2 inch in any dimension and a maximum of 5 percent of particles passing a No. 8 sieve (for use in metal pan stairs only).
 - 2. Aggregate Reactivity:
 - a. Each aggregate source shall be tested in accordance with ASTM C 1260. Aggregates tested in accordance with ASTM C 1260 shall be considered potentially reactive if expansion exceeds 0.10% at 16 days after casting the specimens.
 - b. Aggregate sources that are shown to be potentially reactive based on testing in accordance with ASTM C 1260 or aggregate sources that are known to be susceptible to alkali-silica reactivity (ASR) based on field performance or prior testing shall not be used without additional testing in accordance with procedures in ASTM C 1567.
 - c. If necessary, testing in accordance with ASTM C1567 shall be performed using the proposed project materials to assess if slag can be successfully used to mitigate deleterious expansions, and the slag replacement percentage necessary such that expansion is less than 0.10 percent at 16 days after casting the specimens. Regardless of the results of ASTM C 1567 testing, the minimum slag replacement percentages specified above shall be met.

- D. Water: Clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or reinforcement.
- E. Crystalline Waterproofing Additive: Add crystalline waterproofing to all concrete used in walls of water containing structures.
1. Concrete waterproofing system shall be of the crystalline type that chemically controls and permanently fixes a non-soluble crystalline structure throughout the capillary voids of the concrete. The system shall cause the concrete to become sealed against the penetration of liquids from any direction and protect the concrete from deterioration due to harsh environmental conditions.
 2. Dosage rate to be 2% (Xypex, Sika WT-215 P) 1% (Penetron Admix) of the total cementitious material content. Dosage rate shall be in accordance with waterproofing admixture manufacturer's recommendations. Add crystalline admixture at the batch plant.
 3. Acceptable Manufacturers:
 - a. Xypex (www.xypex.com)
 - b. ICS Penetron (www.penetron.com)
 - c. Sika WT-215 P
- F. Provide H.E.S. concrete materials conforming to PENNDOT Section 704.
- G. Concrete Admixtures:
1. Prohibited Admixtures: Use only non-corrosive, non-chloride admixtures.
 2. Provide admixtures produced and serviced by established, reputable manufacturers and use in compliance with manufacturer's recommendations.
 3. Admixtures used for areas in contact with potable water shall conform to the requirements of ANSI/NSF 61.
 4. Air-Entraining Admixture:
 - a. Use a product conforming to requirements of ASTM C260.
 - b. Acceptable Manufacturers:
 - 1) AEA-92; The Euclid Chemical Company.
 - 2) Sika Air; Sika Corporation.
 - 3) Micro Air; BASF.
 - 4) Or approved equal.
 5. Water-Reducing Admixture:
 - a. Use a product conforming to requirements of ASTM C494, Type A. (Use this for all concrete except where an admixture listed below is used).
 - b. Acceptable Manufacturers:
 - 1) Eucon WR91; The Euclid Chemical Company.
 - 2) PolyHeed 997; BASF.
 - 3) Or approved equal.
 6. Water-Reducing and Retarding Admixture:
 - a. Use a product conforming to requirements of ASTM C494, Type D.
 - b. Acceptable Manufacturers:
 - 1) Eucon Retarder-75; The Euclid Chemical Company.
 - 2) Plastiment; Sika Corporation.
 - 3) Pozzolith 200N; BASF.

- 4) Or approved equal.
7. High-Range Water-Reducing Admixture:
 - a. Use a product conforming to the requirements of ASTM C494, Types A and F.
 - b. Acceptable Manufacturers:
 - 1) Eucon 37; The Euclid Chemical Company.
 - 2) Sika ViscoCrete 2100; Sika Corporation.
 - 3) Glenium 7700; BASF.
 - 4) Or approved equal.
8. Water-Reducing, and Acceleration Admixture: Use a product conforming to requirements of ASTM C494, Types C or E. Not permitted for use in concrete for water retaining structures.
 - a. Acceptable Manufacturers:
 - 1) Accelguard 80; The Euclid Chemical Company.
 - 2) Pozzutec 20; BASF.
 - 3) Plastocrete 161 FL, Sika Rapid-1, or Sikaset series; Sika Corporation.
 - 4) Or approved equal.
9. Store admixtures in a manner to prevent contamination, evaporation, moisture penetration, or damage. Do not use products which have been stored longer than 6 months.
10. Prior to the mix design review by the Engineer, provide written conformance to the specified requirements of the admixture.

H. Preformed Expansion Joint Fillers:

1. Nonextruding and Resilient Bituminous Types (for exterior use in pavements and sidewalks only): ASTM D1751.
2. Sponge Rubber and Cork Type: ASTM D1752.
3. Self Expanding Cork Type: ASTM D1752.
4. Acceptable Manufacturers:
 - a. W.R Meadows Inc.
 - b. The Euclid Chemical Company/Tamms Industries, Inc.
 - c. Or approved equal.

I. Vinyl Waterstops: Ribbed type manufactured from virgin polyvinyl chloride plastic compound conforming to ASTM C309.

1. 6-inch Waterstop: 6 x 3/8-inch, such as Vinylex Corporation; Cat. No. R6-38.
2. 9-inch Waterstop: 9 x 3/8-inch with center bulb, 1-inch min. to 1.5-inch max. outside diameter; such as Vinylex Corporation; Cat. No. RLB9-38.
3. Acceptable Manufacturers:
 - a. Vinylex Corporation (Catalog Nos. as specified above).
 - b. Greenstreak.
 - c. W. R. Meadows, Inc.
 - d. Or approved equal.
4. Retrofit Waterstop: 6 x 3/8-inch with 3-3/16 inch T leg; such as Greenstreak Product No. 609, or approved equal.

J. Injected Vinylester-Based Resin Waterstop:

- K. Surface Applied Waterstop: A specially formulated joint sealant which swells upon contact with water. Provide waterstop packaged in continuous length coils. Material composition as follows:
1. Chloroprene rubber and chloroprene rubber modified to impart hydrophilic properties.
 2. Waterstop shall have a coating formulated to inhibit initial expansion due to moisture presence in the fresh concrete.
 3. Size: Dual extrusion design; 10 mm by 20 mm.
 4. Waterstop shall be secured to hardened concrete with the waterstop manufacturer's standard adhesive binder.
 5. Acceptable Manufacturers:
 - a. Greenstreak; Hydrotite CJ.
 - b. ADEKA; Ultraseal.
 - c. Or equal.
- L. Curing Materials. Use curing materials that will not stain or affect concrete finish or lessen the concrete strength and comply with the following requirements:
1. Burlap: Materials conforming to AASHTO M 182.
 2. Sheet Materials: Material conforming to ASTM C171.
 3. Liquid Curing Compound for areas in contact with potable water.
 - a. Use curing compounds which are nontoxic and free of taste, odor, and complies with low V.O.C. requirements.
 - b. Where a finish material is to be applied over concrete with architectural finish or coating, provide certification by the product manufacturer stating the curing compound as non-detrimental to the bond of the finish material.
 - c. Acceptable Manufacturers:
 - 1) Atlas Tech Products: Atlas Quantum-Cure NSF.
 - 2) Or approved equal.
 4. Liquid Curing Compound for areas not in contact with potable water.
 - a. Use curing compounds which are nontoxic and free of taste, odor and complies with low V.O.C. requirements.
 - b. Where a finish material is to be applied over concrete with architectural finish, provide certification by the product manufacturer stating the curing compound as non-detrimental to the bond of the finish material.
 - c. Acceptable Manufacturers:
 - 1) Atlas Tech Products: Atlas Quantum-Cure NSF.
 - 2) L&M Cure; L&M Construction Chemicals, Inc. (not NSF 61-certified or approved).
 - 3) Or approved equal.
- M. Chemical Hardener:
1. Chemically reactive solution materials formulated to harden and densify concrete surface.
 - a. Acceptable Manufacturers:
 - 1) Seal Hard; L&M Construction Chemicals, Inc.
 - 2) Or approved equal.

- N. Non-Slip (Dry-Shake) Aggregate Surfer: Aluminum-oxide non-slip aggregate surfer for dry shake application to fresh concrete.
1. Acceptable Manufacturers:
 - a. BASF; Frictex
 - b. Or approved equal.
- O. Epoxy Bonding Compound: A high-modulus, low-viscosity, moisture-insensitive epoxy adhesive having the following properties:
1. Compressive Properties, ASTM D695 at 28 days;
 - a. Compressive Strength: 8,000 psi. min.
 2. Tensile Properties, ASTM D638 at 14 days.
 - a. Tensile Strength: 4,000 psi. min.
 - b. Elongation at Break: One to three percent.
 - c. Modulus of Elasticity: 3×10^5 psi min.
 3. Bond Strength, ASTM C882:
 4. Plastic concrete to hardened concrete at 14 days (moist cure): 1,700 psi. min.
 5. Mixed epoxy resin adhesive shall conform to ASTM C881, Type II, Grade 2, Class C.
 6. Acceptable Manufacturers:
 - a. Sika Corporation; Sikadur 32 Hi-Mod.
 - b. Euclid Chemical Company; Euco Epoxy #452 MV or #620.
 - c. Or approved equal.
- P. Epoxy Adhesive (for grouting dowels): Two-component, high-strength, moisture-tolerant epoxy adhesive:
1. Mixed epoxy resin adhesive shall conform to ASTM C881.
 2. Acceptable Manufacturers:
 - a. Hilti HIT-RE 500 V3, www.hilti.com.
 - b. Simpson XP, www.simpsonanchors.com.
 3. Installation:
 - a. Follow manufacturer's recommendations.

2.02 MIXES

- A. Selection of Proportions of Normalweight Concrete: ACI 211.1.
- B. Proportions of Ingredients: Establish proportions, including water-cement ratio on the basis of either laboratory trial mixture tests or standard deviation analysis, with the materials specified herein.
1. Laboratory Trial Mixture Test: ACI 301, Section 4 and ACI 318, Section 5.
 2. Standard Deviation Analysis: ACI 301, Section 4 and ACI 318, Section 5.
- C. Classes of Concrete:
1. Class A: 4,500 psi minimum compressive strength at 28 days; 564 pounds per cubic yard minimum cementitious material.
 2. Class B: 3,000 psi minimum compressive strength at 28 days; 517 pounds per cubic yard minimum cementitious material.

3. Class C: 2,000 psi minimum compressive strength at 28 days; minimum cementitious material per cubic yard in accordance with current ready-mix plant standard practice.
4. High-Early Strength Concrete: 3500 psi compressive strength at 3 days; 640 pounds per cubic yard minimum cementitious material.

D. Specified Flexural Strength at 28 Days:

1. Class A: 603 psi

E. Water-Cementitious Material Ratio:

1. Class A Concrete shall have a maximum water- cementitious material ratio of 0.42.
2. Class B Concrete shall have a maximum water- cementitious material ratio of 0.55.
3. Proportion Class C Concrete to meet the strength requirement.

F. Slump:

1. Concrete, at the point of delivery, shall have a slump of 4 inches (± 1 inch) as determined by ASTM C143; slump value may be increased 1 inch for methods of consolidation other than vibration.
2. Pumped concrete shall have a maximum slump of 5 inches measured prior to pumping.
3. Concrete containing high-range water-reducing admixture shall have an 8-inch maximum slump after admixture is added to concrete with a 2- to 4-inch slump.

2.03 ADMIXTURES

- A. Air Entraining: Provide air-entrained concrete for each concrete pour except where indicated otherwise on the Drawings or specified herein. Total air content required as follows:

1. Maximum-size coarse aggregate, inches:	Air content
	percent by volume:
1½	5 \pm 1
¾ or 1	6 \pm 1

- B. Water-Reducing Admixture: Unless high temperatures occur or placing conditions dictate a change, use concrete containing a water-reducing admixture.
- C. Water-Reducing and Retarding Admixture: When high temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) may be replaced with a water-reducing and retarding admixture (Type D). Notify the Engineer of such change and submit product data prior to placement of concrete.
- D. Water-Reducing and Accelerating Admixture: When low temperatures occur or placing conditions dictate, the water-reducing admixture (Type A) can be replaced with a water-reducing and accelerating admixture. Notify the Engineer of such change and submit product data prior to placement of concrete. Water-reducing and

accelerating admixture (Type C and E) will not be permitted in concrete for water retaining structures.

2.04 SOURCE QUALITY CONTROL

- A. General Requirements: Provide only Class A concrete in the project except for those cases where indicated otherwise on the Drawings or specified otherwise.
 - 1. Where in-ground encasement of piping is required, provide Class B concrete.
 - 2. Where in-ground encasement of conduit runs is required, provide Class B concrete.
- B. Use H.E.S. concrete for reaction backings, concrete cradle, and encasement. Provide H.E.S. concrete air entrained with a minimum mix design compressive strength of 3,000 psi at 3 days, and minimum compressive strength of 3,750 psi at 28 days.

PART 3 EXECUTION

3.01 INSPECTION

- A. Inspect work to receive cast-in-place concrete for deficiencies which would prevent proper execution of the finished work. Do not proceed with placing until such deficiencies are corrected to the satisfaction of the Engineer.

3.02 PREPARATION

- A. Joints:
 - 1. Construction Joints: Only the locations of critical joints throughout the structures are indicated on the Drawings. Select additional joint locations in walls, slabs, and beams subject to the Engineer's approval and meeting the following conditions:
 - a. Locate such joints to least impair the strength of the structure and near the middle of the span of structural slabs or beams.
 - b. The horizontal length between wall joints shall not exceed 30 feet in a continuous wall. At corners or other intersections of two or more walls, provide a joint in each wall at a distance less than 15 to 20 feet from the intersection point in all directions.
 - c. Space construction joints in structural slabs not greater than 30 feet in each direction, although some adjustments, as approved by the Engineer, may be permitted due to column spacing and details.
 - d. If a beam intersects another beam at a proposed construction joint, offset the joint in the beam a distance equal to twice the width of the beam and provide adequate shear reinforcement as determined by the Engineer.
 - e. Maximum joint spacing for slabs-on-grade shall not be greater than 20 feet.
 - f. Provide waterstops in construction joints where such joints are exposed to liquids, in contact with earth, or subject to weather exposure.
 - g. Place walls and slabs in alternate sections allowing at least two days elapsed time for slabs and five days elapsed time for walls before concrete is placed against an adjacent joint.

- h. Submit requests for approval of joint locations ten days prior to scheduled concrete pours. Do not make concrete pours unless joint locations have been approved by the Engineer.
 - i. No exceptions permitted to the above requirements unless written approval is given by the Engineer.
2. Expansion Joints and Contraction Joints:
 - a. Install where indicated on the Contract Drawings.
 - b. Do not extend reinforcing or other embedded metal items through expansion and contraction joints except where indicated otherwise on Contract Drawings.
 - c. Sawcutting contraction joints will not be permitted.
 - d. Provide waterstops in joints exposed to liquids, in contact with earth, or subject to weather exposure.
 3. Bonding to New Concrete: Bond fresh concrete with hardened previously poured new concrete in accordance with the following:
 - a. Roughen and clean hardened concrete of foreign matter and laitance and dampen with water.
 - b. Other bonding methods must be approved by Engineer prior to use.
 4. Bonding to Existing Concrete: Roughen existing concrete in the area of bonding to produce exposed aggregate and an absolutely uncontaminated concrete surface.
 - a. Apply Epoxy Bonding Compound over existing prepared concrete in accordance with manufacturer's instructions.
 5. When concreting is to be discontinued for more than forty-five (45) minutes and if the construction plane is to be horizontal, install keyways, waterstops and embed dowels in the concrete before initial hardening. Use keyways and dowels in vertical concrete construction only when indicated or directed by the Engineer. Use waterstops for water retaining structures or structures below grade. Horizontal joints are not permitted in slabs or footings.
 - a. Extend dowels placed in joint one splice length into wall and one splice length into next concrete pour.

B. Embedded Items:

1. PVC
2. Waterstops:
 - a. Install in all joints where watertightness is required.
 - 1) Vinyl Waterstops:
 - a) Use ribbed-type waterstops of the following dimensions except as otherwise indicated on the Contract Drawings.
 - (1) Expansion joints in new construction: 9 inches wide by 3/8 inch thick, with center bulb.
 - (2) Contraction and construction joints: 6 inches wide by 3/8 inch thick; no center bulb.
 - b. Use continuous lengths without splices where possible.
 - c. Provide factory-formed and tested waterstop corners and intersections leaving only straight butt joint splice in the field.
 - d. Connect all adjoining waterstops including vertical and horizontal runs to provide a continuous water barrier.

- e. Splices:
 - 1) Strength: Not less than 50% of the mechanical strength of the parent section.
 - 2) Watertightness: Make equal to that of continuous material.
 - 3) Heat seal adjacent surfaces in accordance with manufacturer's recommendations using a thermostatically controlled electric source of heat that provides sufficient heat to melt but not to char the material.
 - f. Adequately support waterstops to prevent displacement and deformity of the waterstops during concrete pours. Maintain two inch minimum clearance between waterstop and reinforcing steel.
 - g. Center waterstop on joint with one-half of waterstop width to be embedded in concrete on each side of joint. At expansion joints, keep center bulb unembedded.
 - h. In substructures and other structures required to be watertight, install waterstops if concreting is discontinued for a sufficient length of time which, in the opinion of the Engineer, may result in seepage cracks in concrete.
 - 3. Surface Applied Waterstop Installation: Install surface applied waterstop at such location where indicated on the Drawings.
 - a. Install the waterstop in strict accordance with the manufacturer's installation instructions and with respect to the environmental requirements specified therein and substrate preparation.
 - 4. Embedded Pipes and Conduits: Material not harmful to concrete may be permitted to be embedded in concrete upon approval by the Engineer. Items embedded shall satisfy the following:
 - a. Maximum outside dimension not greater than one-third the overall thickness of the member in which it is embedded.
 - b. Minimum spacing between items not less than 3 widths on center nor 3 inches clear between items.
 - c. Item shall not impair strength of member.
 - d. Provide 2 inch minimum clearance to face of slab.
- C. Anchoring Reinforcement Dowels into Existing Concrete:
- 1. Drill holes for each dowel to the size and depth indicated on the Drawings with carbide tip bit or star bit. Core drilling will not be permitted. Do not drill into or cut or otherwise damage existing reinforcement bars. If existing reinforcement bars are encountered during the drilling operation, relocate the hole to clear the existing reinforcement as directed by the Engineer.
 - 2. Blow clean each finished hole with an oil free air jet and then flush with a jet of clean water.
 - 3. Immediately prior to the grouting operation, remove all water from the hole and from the walls of the hole.
 - 4. Pump dispensing gun for proper mixture. Insert nozzle and pump epoxy adhesive into the hole and insert reinforcement dowels. Do not retemper grout that has begun to stiffen; discard such grout.

3.03 CONSTRUCTION

- A. Construction of Concrete Elements:
 - 1. Construct the concrete elements indicated on the Contract Drawings or in the specifications; including but not limited to beams, columns, slabs, foundations, in-ground encasement of piping and conduit, reaction backings for piping, concrete backfill, and the reinforced concrete bases for equipment and piping provided under this contract.
 - 2. Provide only Class A concrete in the project except for those cases where indicated otherwise on the Drawings or specified otherwise.
 - a. Where in-ground encasement of piping is required, provide Class B concrete
 - 1) Encase pipes under structures and buildings or where indicated on the Contract Drawings; encase in concrete for the full length of the pipe run under the structure and as indicated.
 - b. Where in-ground encasement of conduit runs is required, provide Class B concrete.
 - 1) Encase conduit runs indicated on the Contract Drawings.
 - c. Provide Class B concrete for backfilling of overexcavated foundation area, foundation voids, and cavities.
- B. Production of Concrete
 - 1. Ready-Mixed Concrete:
 - a. Batched, mixed and transported in accordance with ASTM C94.
 - b. Add admixtures to the mix in accordance with ACI 301.
 - c. Plant equipment and facilities conforming to the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.
- C. Mix, place, and cure H.E.S. concrete as specified in PENNDOT Section 704 and PENNDOT Section 1001.
- D. Placing
 - 1. General: Conduct placement work in accordance with ACI 304R and such additional requirements as specified herein.
 - a. Complete discharge of the concrete within 1½ hours or before the mixing drum has revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates.
 - 2. Preparation:
 - a. Prepare formwork in advance and remove snow, ice, water, and debris from within forms.
 - b. Pre-position reinforcement in advance of concrete pours.
 - c. Pre-position waterstops, expansion joint materials, anchors, and embedded items in advance of concrete pours.
 - d. Sprinkle subgrades sufficiently to eliminate water loss from concrete in accordance with ACI 301 Chapter 11.
 - e. Do not place concrete on frozen surfaces.

3. Conveying:
 - a. Handle concrete from mixer to final deposit rapidly by methods which will prevent segregation or loss of ingredients to maintain required quality of concrete.
 - b. Do not convey concrete through aluminum or aluminum alloy.
 - c. Do not place concrete by pumps or other similar devices without prior written approval of the Engineer.
 - d. Placing concrete by pumping methods shall conform to the applicable requirements of ACI 304R, Chapter 9, and ACI 304.2R.
4. Depositing:
 - a. Do not drop concrete freely where reinforcing will cause segregation, nor more than four (4) feet.
 - b. Deposit concrete in approximately horizontal layers of 12 to 18 inches.
 - c. Do not allow concrete to flow laterally more than three feet.
 - d. Place concrete at such a rate that concrete which is being integrated with fresh concrete is still plastic.
 - e. Do not deposit concrete on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within sections.
 - f. Do not use concrete which has partially hardened or has been contaminated by foreign materials.
 - g. Do not subject concrete to procedures which will cause segregation.
 - h. Do not place concrete in forms containing standing water.
 - i. Make placement within sections continuously to produce monolithic unit.
 - j. Do not begin placement of concrete in beams or slabs until concrete previously placed in walls or columns have attained initial set.
 - k. Do not bend reinforcement out of position when placing concrete.
5. Consolidation:
 - a. Consolidate concrete by vibration, spading, rodding, or other manual methods. Work concrete around reinforcement, embedded items and into corners; eliminate all air or stone pockets and other causes of honeycombing, pitting, or planes of weakness.
 - b. Use vibration equipment of internal type and not the type attached to forms and reinforcement.
 - c. Use vibrators capable of transmitting vibration to concrete in frequencies sufficient to provide satisfactory consolidation.
 - d. Do not leave vibrators in one spot long enough to cause segregation. Remove concrete segregated by vibrator operation.
 - e. Do not use vibrators to spread concrete.
 - f. Have sufficient reserve vibration equipment to guard against shutdown of work occasioned by failure of equipment in operation.
6. Cold Weather Concreting: Perform cold weather concrete work in accordance with ACI 306R and the following additional requirements.
 - a. Provide concrete delivered at the job-site in accordance with the following temperature limitations:

Air Temperature	Minimum Concrete
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Deg. F	Temperature, deg F	
	For sections with least dimension less than 12 in.	For sections with least dimension 12 in or greater
30 to 45	60	55
0 to 30	65	60

- b. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather.
 - c. Maintain concrete at temperatures listed in Table 5.1 of ACI 306R as follows, after the concrete has developed a compressive strength of 500 psi:
 - 1) slab-on-grade: 2 days.
 - 2) walls and supported slabs: 3 days.
 - d. If the strength is not achieved, maintain the minimum temperature an additional 24 hours or until the 500 psi strength is reached.
 - e. Make additional concrete cylinders to verify strength achievement of 500 psi; however, additional cylinders are not required for every pour, provided concrete temperatures are maintained fairly uniform. Once two sets of cylinders have been broken and a strength of 500 psi is achieved, additional cylinders will not be required, except for random testing as determined by the Engineer.
 - f. Remove temperature protection after 500 psi is achieved, but in a manner so thermal shock does not occur to the exposed concrete. The removal criteria shall be as stated in ACI 306R.
 - g. Leave housing, covering, or other protection used in curing intact at least 24 hours after artificial heating is discontinued.
 - h. Surfaces with which the concrete is to come in contact must be free of frost, snow and ice. Subgrade shall be free of frost. Do not place concrete around any embedment which has a temperature below freezing.
 - i. If water or aggregate is heated above 100 degrees F, combine water with aggregate in the mixer before cement is added. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 100 degrees F.
 - j. Provide equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather. Do not use foreign materials or materials containing snow or ice.
 - k. Surfaces with which the concrete is to come in contact with must be free of frost, snow to and ice.
7. Hot Weather Concreting: Perform hot weather concrete work in accordance with ACI 305R and the following additional requirements.
- a. Temperature of concrete delivered at the job-site shall not exceed 90 degrees F.
 - b. Cool ingredients before mixing to prevent temperature in excess of 90 degrees F.
 - c. Make provisions for windbreaks, shading, fog spraying, sprinkling or wet cover when necessary.

E. Finishing:

1. General: Finish concrete in the various specified manners either to remain as natural concrete or to receive an additional applied finish or material.
 - a. Concrete containing ground granulated blast furnace slag material may have longer time of set compared to 100 percent Portland Cement concrete.
2. Formed Surfaces: Provide one or more of the following finishes to the surfaces of the concrete after removal of forms. The locations where these finishes are required are listed herein or specified on the Drawings. Allowable surface irregularities are designed as either "abrupt" or "gradual." Check gradual irregularities using 10 foot straightedges per ACI 117 Specification for Tolerances for Concrete Construction and Materials and Commentary.
 - a. "Rough Form" finish: Surface may include roughness and irregularities not to exceed ½ inch, but tie holes and defects shall be patched.
 - b. "Ordinary Wall" finish: Surface that is true and uniform without any conspicuous offsets or bulges. Gradual irregularities not to exceed ½ inch and abrupt irregularities not to exceed 1/4 inch.
 - c. "Plywood" finish: Similar to the ordinary wall finish. Construct the surface of the forms using 5/8-inch plywood or boards lined with tempered hardboard not less than 3/16 inch thick. Place the plywood or liner sheets in an orderly and symmetrical arrangement using sheets as large as practicable. Do not use sheets showing torn grain, worn edges, patches of holes from previous use, or other defects which will impair the texture of the concrete surfaces. Remove gradual irregularities exceeding ½ inch and abrupt irregularities exceeding 1/8 inch. Completely remove all fins on the surface. Rub all surfaces which cannot meet these requirements.
 - d. "Rubbed" finish: Apply to a freshly hardened "plywood" finish. Complete rubbing within one day of removal of forms. Wet surfaces and rub with a carborundum brick or other abrasive until all form marks, projections, and irregularities have been removed and a smooth uniform surface, texture, and color are produced. Wash the surface clean after rubbing.
3. Unformed Surfaces: In concrete having unformed surfaces, use just sufficient mortar to avoid the necessity for excessive floating. Slope exposed unformed surfaces to provide quick, positive drainage and to avoid puddles in low spots. Unless otherwise noted, set floor drains 1/2 inch below the normal floor elevation and slope floor toward the drain. Slope all surfaces exposed to weather 1/4 inch per foot for drainage unless noted otherwise on Drawings.
 - a. "Floated" Finish: After concrete has been placed, consolidated, struck off, and leveled, do not work further until ready for floating. Begin floating when water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after first floating, check planeness of surface with a ten foot straightedge applied at not less than two different angles. Cut down high spots and fill low spots during this procedure to produce a surface with true planes within 1/4 inch in ten feet as determined by a ten foot straightedge placed anywhere on the slab in any direction. Following straightedge checking, refloat slab immediately to a uniform sandy texture.

- b. "Steel Trowel" Finish: Obtained by working a floated finish with a steel trowel. First troweling shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Perform additional trowelings by hand after the surface has hardened sufficiently. Perform final troweling when a ringing sound is produced as the trowel is moved over the surface. Thoroughly consolidate surface by hand trowel operations. Produce finished surface essentially free of trowel marks, uniform in texture and appearance, with true planes within 1/4 inch in ten feet, as determined by a ten foot straightedge placed anywhere on the slab in any direction.
 - c. "Broom or Belt" Finish: Immediately after concrete has received a floated finish, give surface a coarse transverse scored texture by drawing a broom or burlap across the surface.
 - d. "Nonslip" Finish: The surfaces shall be given a "dry shake" application of non-slip aggregate surfacer. The rate of application of such material not to be less than 25 pounds per 100 square feet. Apply in accordance with manufacturer's recommendations.
4. Special Finishes:
- a. Weirs and Overflow Surfaces: Provide "hard steel trowel" finish to surfaces to produce a hard, dense, smooth, surface free of irregularities. Obtain finish by troweling a regular steel trowel finish after the surface has nearly hardened. The hard surface will have a somewhat glossy appearance. The elevation of the weir crest shall be constant along its entire length.
 - b. Flumes and Troughs: Provide a "hard steel trowel" finish to the top of bottom slab. Use "plywood" formed finish on side walls, and an "ordinary wall" finish on overhead surfaces. Provide a "rubbed" finish on all surfaces which will not be in contact with water.
 - c. Deck Finish: Power or single hand troweling of slab surface followed by a light hair broom drawn across the slab to produce fine shallow scored texture.
 - d. Architectural Finishes. Special finishes such as Vinyl Composition Tile, Quarry Tile, Ceramic Tile, or other, when used, shall be as specified herein or on the Drawings.
5. Application for Finishes: Except where the type of finish is indicated on the drawings or under "Special Finish," all concrete surfaces shall be finished as indicated below.
- a. "Rough Form" Finish:
 - 1) All surfaces to be covered by earth and not exposed to view.
 - b. "Ordinary Wall" Finish:
 - 1) Interior and exterior wall and slab surfaces not exposed to view.
 - 2) Inside vertical surfaces of tank type structures below an elevation which is 18 inches below normal water surface.
 - c. "Plywood" Finish:
 - 1) All surfaces to be painted.
 - d. "Rubbed" Finish:
 - 1) All interior and exterior surfaces exposed to view which are not to be painted.

- 2) All exterior surfaces to a point 6 inches below finished ground.
- 3) Inside vertical surfaces of tank type structures above an elevation which is 18 inches below normal water surface.
- 4) Equipment pads, pipe supports, etc.
- e. "Floated" Finish:
 - 1) All unformed surfaces unless otherwise specified.
- f. "Steel Trowel" Finish:
 - 1) Interior floors of structures except where Architectural Finish is to be applied.
 - 2) Interior stair treads.
 - 3) Tops of exposed walls.
- g. "Broom or Belt" Finish:
 - 1) Sidewalks, exterior ramps and platforms.
 - 2) Unloading dock platform.
 - 3) Walkways on the process tanks.
- h. "Nonslip" Finish:
 - 1) Exterior stair treads and landings.
- i. Architectural Finishes:
 - 1) As specifically called for in these Specifications or on the Drawings.
- 6. Application of Chemical Hardener: Apply to floor surfaces as scheduled on Drawings. Concrete must be a minimum of twenty-eight (28) days old and cured by water or sheet material curing methods.
 - a. Concrete surfaces must be clean, dry, and free of residues, oil, wax, sealers, curing compounds, laitance, or other contaminants in order to promote maximum penetration of hardener.
 - b. Apply hardener in two applications in accordance with hardener manufacturer's instructions and by such methods as stated in instructions.
 - c. Application: Mechanical scrubbers, equipped with brushes, are the preferred method of application for the first coat.
 - d. Pour chemical hardener directly from the container onto the surface to be treated, maintaining an application rate of 200 ft.² per gallon. Scrub chemical hardener into the surface for 15-20 minutes, working all areas evenly.
 - e. Apply second coat using sprayers or rollers in accordance with manufacturer's instructions.

3.04 CURING AND PROTECTION

- A. General: Immediately after placement and finishing, protect concrete from premature drying, excessive hot or cold temperatures and mechanical injury. Perform curing by water curing, sheet form curing, or liquid membrane forming methods in accordance with ACI 308. Cure concrete continuously for a minimum of seven days at ambient temperatures above 40° F.
- B. Hot Weather Curing: See Hot Weather Concreting this Section.
- C. Cold Weather Curing: See Cold Weather Concreting this Section.

D. Application of Liquid Curing Compound:

1. Finishing operations must be completed prior to application. Apply compound as soon as the free water on the surface disappears and no water sheen is visible. Surface shall be capable of taking walking workmen without being marred. Apply compound in two (2) applications.
2. Do not apply curing compound to construction joint surfaces. Protect exposed reinforcement during application of curing compound. Water cure those areas not coated with compound.
3. Do not use liquid curing compound when the ambient air temperature during placement and for 24 hours after placement is or will fall below 35 degrees F.
4. Do not use liquid curing compounds on concrete surfaces which will receive later treatments, such as hardeners, special finishes, protective coating, dampproofing, waterproofing, future grout, grout fill, or coatings.

E. Finished surfaces and slabs shall be protected from the direct rays of the sun to prevent checking and crazing.

3.05 FIELD QUALITY CONTROL

A. Testing and Inspection:

1. During the period when concrete is being placed, the Approved Agency must perform routine and other testing of materials.
 - a. Advise the Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of concrete test cylinders on the Work Site for the sole use of the Approved Agency.
 - c. Strength testing requirements are based on using 6-inch by 12-inch size cylinders.
 - d. Provide containers for transporting concrete test cylinders to the testing laboratory.
 - e. The Approved Agency will perform additional materials testing due to changed in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements.
 - f. Failure of the Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered.
2. The Independent Testing Laboratory shall:
 - a. Obtain composite samples in accordance with ASTM C172.
 - b. Mold and cure minimum of three test specimens for each strength test in accordance with ASTM C31 and as follows:
 - 1) Concrete compression test: Use standard 6 inch x 12 inch cylinders.
 - 2) Concrete flexural strength: Use 6 inch x 6 inch x 12 inch beams.
 - 3) Identify each test by number, mix, amount of admixture, origin of sample in the structure, the date the test specimen was made, the date the test specimen was tested, the amount of slump determined, and the compressive and flexural strength test results.

- 4) Test Methods:
 - a) Compressive strength test: ASTM C39.
 - b) Flexural strength test: ASTM C78 ((Required only for slabs-on-grade subject to wheel loads)).
 - c) Test one specimen at 7 days for information and test two specimens at 28 days for acceptance. A strength test is the average of the strengths of the two cylinders tested at 28 days.
 - d) Perform one strength test for each 50 cubic yards of concrete poured, unless waived by the Engineer, but not less than one test for each structure.
- c. Make slump tests for each truck load upon truck arrival at the job-site and whenever consistency of concrete appears to vary in accordance with ASTM C143.
- d. Make air content tests for each truck load upon truck arrival at the job-site in accordance with ASTM C231 or ASTM C173.
- e. Prepare and submit all reports required in the various standards and specifications referenced herein.
 - 1) Distribution of reports shall be:
 - a) Two copies to the Engineer.
 - b) One or more copies, as required, to the Contractor.
- f. Immediately notify the Contractor and the Engineer of any test results which do not conform to the Specification requirements.

B. Evaluation and Acceptance:

1. The strength level of the concrete will be considered satisfactory if the averages of all sets of three consecutive strength tests equal or exceed specified strength and no individual strength test result is below specified strength by more than 500 psi.
2. If the concrete fails to meet the specified strength requirements the Engineer may require one or both of the following:
 - a. The Engineer shall have the right to order a change in the mix proportions for the remaining concrete being poured.
 - b. The Engineer may order tests on the in-place concrete. Testing shall be in accordance with ACI 301 at no increase in contract price.

3.06 REPAIR OF DEFECTIVE CONCRETE

A. Defective Concrete

1. Porous areas, open or porous construction joints, and honeycombed concrete will be considered to indicate that the requirements for mixing, placing and handling have not been complied with and will be sufficient cause for rejection of the members of the structure thus affected.
2. Defective work exposed upon removal of forms shall be entirely removed or repaired within forty-eight hours after forms have been removed.
3. Repaired areas will not be accepted if:
 - a. The structural requirements have been impaired by reducing the net section of compression members.

- b. The bond between the steel and concrete has been reduced.
 - c. The area is not finished to conform in every respect to the texture, contour, and color of the surrounding concrete.
 4. If the above requirements are not satisfied or if there are excessive honeycombs or other defects, the Engineer may require that the members of unit involved be entirely removed and satisfactorily replaced at no additional expense to the Owner.
 5. The Engineer will determine the extent and manner of action to be taken for the correction of defective concrete as may be revealed by surface defects or otherwise.
 - a. Prior to repair of structural defects or defects which impair watertightness (shrinkage cracks, etc.), submit proposed material and repair methods to the Engineer for approval.
 6. As soon as the forms have been stripped and the concrete surfaces exposed, remove fins and other projections, fill recesses left by the removal of form ties, and repair surface defects which do not impair structural strength. Clean all exposed concrete surfaces and adjoining work stained by leakage of concrete to the satisfaction of the Engineer.
 7. Hammer pack tie holes and other small cavities with a stiff mortar of the same material, but somewhat leaner than that in the concrete. Clean the cavity and the area wetted before mortar is placed.
 8. Repair and patch defective areas with cement mortar of mix proportions and materials identical to those used in the surrounding concrete. Produce a finish on the patch that is indistinguishable from the surrounding concrete.
 9. Where the honeycomb or voids are not excessive and repairs are authorized by the Engineer, chip out the defective areas in a square shape to sound solid concrete with a depth not less than 2 inches. Make edges of cuts perpendicular to concrete surface or slightly undercut to provide a key at the edge of the patch. Before placing cement mortar, thoroughly clean, dampen, and brush coat area to be patched with neat cement grout. Other patching materials may be used if accepted by Engineer in writing prior to start of repair work. The patch should be kept damp for seven days at a temperature above 50°F.

3.07 CLEANING

- A. At the end of each day, clean and remove waste sandblasting material from the Work area.

3.08 ATTACHMENTS

- A. The following attachments are appended to this Section following the “END OF SECTION” marker:
 1. Final Concrete Mix Design Submittal Form.
 2. Test Results Submittal Form.

END OF SECTION

FINAL CONCRETE MIX DESIGN SUBMITTAL FORM
(One for each required mix design)

PROJECT: _____ Location: _____
 General Contractor: _____
 Mix design no.: _____ Design strength: _____

USE (Describe *): _____
 Mix Design Preparation: Based on Standard Deviation Analysis: _____
 (check one) or Based on Trial Mixture Test Data: _____

MATERIALS:

Aggregates: (Provide size, type, source, specification)

Coarse: _

Fine: _____

Cement Type/Source: _____

Admixtures: (Provide product, manufacturer)

Water Reducer: _

Air Entraining: _

Accelerator: _____

Other: _

CONCRETE PROPERTIES

Water/Cementitious Material Ratio: _

Slump: _____ inches

Entrained Air: _____ %

Density _____ pcf

SPECIFIC GRAVITIES

Fine Aggregate _____

Coarse Aggregate: _____

ADMIXTURES

Accelerator _____ oz. per 100# cement

W. R. _____ oz. per 100# cement

A. E. _____ oz. per 100# cement

Other _____ oz. per 100# cement

MIX PROPORTIONS

Weight
 Absolute Volume
 (lbs)
 (cubic feet)

Cementitious Material: _____

Fine **
 Aggregate: _____

Coarse **
 Aggregate: _____

Water: _____

Entrained
 Air: _____

Other: _____

 TOTAL: _____

TEST RESULTS SUBMITTAL FORM

METHOD 1 - STANDARD DEVIATION ANALYSIS (ACI 318 Chapter 5):

Number of Test Cylinders Evaluated: _ Standard Deviation: _____

(Attach Copy of All Test Results)

Mix Designs Proportioned to Achieve Both of the Following:

$$f'_{cr} = f'_c + 1.34s = \text{_____} \text{ psi}$$

$$f'_{cr} = f'_c + 2.33s - 500 = \text{_____} \text{ psi}$$

$$\text{Actual } f'_c = \text{_____} \text{ psi } (\leq f'_{cr})$$

$$\text{Slump} = \text{_____} \text{ in.}$$

$$\text{Air Content} = \text{_____} \%$$

METHOD 2 - TRIAL MIXTURE TEST DATA (ACI 318 Chapter 5):

Age (days)	Mix 1 (comp. str.)	Mix 2 (comp. str.)	Mix 3 (comp. str.)
7	_____	_____	_____
28	_____	_____	_____
28	=====	=====	=====
28 day avg.	_____	_____	_____

Mix Design Proportioned to Achieve the Following:

$$f'_{cr} = f'_c + 1200 \text{ psi} \quad (\text{for } f'_c \leq 5000 \text{ psi})$$

$$\text{or } f'_{cr} = 1.1f'_c + 700 \text{ psi} \quad (\text{for } f'_c > 5000 \text{ psi})$$

$$\text{Slump} = \text{_____} \text{ in.}$$

$$\text{Air Content} = \text{_____} \%$$

REMARKS: _____

Note: Fill in all blank spaces. Use -0- (zero) or N.A. (not applicable). See Design and Control of Concrete Mixtures, Portland Cement Association, for assistance in filling out this form.

SUBMITTED BY:

Ready-Mix Supplier: Name _____

Address: _____

Phone Number: _____

SECTION 03 60 00

GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. This section covers the furnishing and placing of grout as specified on the drawings and in various other sections of these specifications.

1.02 RELATED SECTIONS

- A. Section 03 30 00: Cast-in-Place Concrete.

1.03 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M6: Standard Specification for Fine Aggregate for Hydraulic Cement Concrete.
- B. American Concrete Institute (ACI):
 - 1. ACI 305R: Guide to Hot Weather Concreting.
 - 2. ACI 306R: Guide to Cold Weather Concreting.
 - 3. ACI 306.1: Standard Specification for Cold Weather Concreting.
 - 4. ACI 308: Standard Practice for Curing Concrete.
 - 5. ACI 351.1R: Grouting between Foundations and Bases for Support of Equipment and Machinery.
- C. ASTM International (ASTM):
 - 1. ASTM C33: Standard Specification for Concrete Aggregates.
 - 2. ASTM C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. [50-mm] Cube Specimens).
 - 3. ASTM C150: Standard Specification for Portland Cement.
 - 4. ASTM C827: Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
 - 5. ASTM C1090: Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
 - 6. ASTM C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.04 SUBMITTALS

- A. Action Submittals:
 - 1. Submit the following for approval:
 - a. Product Data:
 - 1) Non-shrink non-metallic grout.
 - b. Certificates:

1) Grout manufacturer non-shrink certification.

B. Informational Submittals:

1. Submit the following for information:
 - a. Manufacturer's Instructions:
 - 1) Manufacturer's placing instructions.

1.05 QUALITY REQUIREMENTS

- A. Non-Shrink Grout Performance Qualifications: Furnish the grout manufacturer's current independent laboratory test results indicating the grout conforms to the following:
1. Early height change of 0.0% to 4.0%, according to ASTM C827.
 2. Hardened height change of 0.0% to 0.3% according to ASTM C1090.
 3. Compressive strength of 4,000 psi strength developed with a trowelable mix within 24 hours when tested in accordance with the requirements of ASTM C109 modified in accordance with the requirements of ASTM C1107.
 4. Placement time based on initial set of not less than 60 minutes at 70° F.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide protective covering over materials to prevent moisture damage and contamination of grout materials.
- B. Store and pre-condition grout and grout materials in accordance with the grout manufacturer's requirements. Provide air-conditioned storage if required.
- C. Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.07 PROJECT CONDITIONS

- A. Environmental Requirements: Protect against high and low temperatures and unfavorable environmental conditions in accordance with American Concrete Institute standards for placement of concrete (ACI 305R, 306R, and 306.1).

PART 2 PRODUCTS

2.01 MATERIALS

- A. Water: Potable quality, free from deleterious amounts of acids, alkalis, and organic substances.
- B. Non-Shrink Non-Metallic Grout:
1. A factory-premixed material containing no corrosive irons, aluminums, chemicals, or gypsums meeting ASTM C1107 Grades A, B, and C.
 - a. Provide a ready-mix type of grout requiring only the addition of water.
 - b. Do not add other materials to the grout.

- c. For grout applications not in contact with sewage, provide grout manufactured using Type I (Normal) cement as specified in Subparagraph 2.01C this specification.
 - d. For grout applications in contact with sewage, provide grout manufactured using Type II (Sulfate Resistant) cement as specified in Subparagraph 2.01C this specification.
2. Acceptable manufacturers for non-shrink non-metallic grout include the following:
- a. Five Star Products, Inc.
 - b. Euclid Chemical Company.
 - c. Or approved equal.
- C. Portland Cement:
- 1. Portland Cement conforming to the requirements of ASTM C150 Type I or Type II as specified.
 - a. Provide Type II (sulfate resistant) cement for applications in contact with sewage.
- D. Aggregates:
- 1. Fine aggregate conforming to the material quality requirements of ASTM C33.

2.02 MIXES

- A. Non-Shrink Grout: Use ready-mix type requiring only the addition of water. Do not add other materials. Water requirement proportions shall conform to manufacturer's specifications for the desired mix consistency.

PART 3 EXECUTION

3.01 PREPARATION

- A. Preparation of Surface:
 - 1. Non-Shrink Grout: Prepare in accordance with manufacturer's printed instructions.
- B. Forming:
 - 1. Use forming procedures that allow proper and complete placement of grout.
 - 2. Anchor support elements so no movement is possible.
 - 3. Remove supports only after grout has hardened.
 - 4. Pre-treat wood forms that may absorb moisture with forming oils.
- C. Grout Mixing: Use power-operated mechanical mixer of sufficient capacity to carry out batch mixing without interruption.
 - 1. Mix Non-Shrink Grout in accordance with manufacturer's instructions.

3.02 INSTALLATION

- A. Non-Shrink Non-Metallic Grout: Perform grout placement in accordance with the recommendations of ACI and the manufacturer's published specification for mixing and placing. Place non-shrink non-metallic grout only where indicated on Drawings.

3.03 SITE QUALITY CONTROL

A. Site Tests and Inspections:

1. During the period when grout is being placed, the Testing and Inspection Agency (Approved Agency) must perform routine and other testing of materials.
 - a. Advise the Approved Agency sufficiently in advance of operations to allow testing personnel to be assigned and to provide sufficient time for quality tests to be performed and completed.
 - b. Provide and maintain adequate and separate facilities for safe storage and proper curing of grout test samples on the Work Site for the sole use of the Approved Agency.
 - c. Provide containers for transporting grout test samples to the testing laboratory.
 - d. The Approved Agency will perform additional materials testing due to changes in materials or proportions requested by the Contractor or testing required due to failure of material to meet specified requirements
 - e. Failure of the Approved Agency to detect defective work will not prevent its rejection later when the defect is discovered; neither does it obligate the Engineer or Owner to grant final acceptance of the Work.
2. Compressive Strength Test:
 - a. Test Procedure:
 - 1) A test sample will be obtained from the first placement of the day and for every 3 cubic yards of grout placed each day.
 - 2) The grout will be tested in accordance with the requirements of ASTM C109 modified in accordance with the requirements of ASTM C1107.
 - b. Acceptance Criteria:
 - 1) Grout meeting the requirements specified in Subparagraph 1.05 will be acceptable.
3. Inspections:
 - a. All grout placement will be visually inspected to verify if proper placement procedures are being followed.

B. Non-Conforming Work

1. Remove under-strength grout, and replace the removed grout with grout meeting the specified requirements.

END OF SECTION