SECTION 03 01 00 - MAINTENANCE OF CONCRETE

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting requirements of this Specification.

This Section includes performance, proprietary, and descriptive specifications. Edit to avoid conflicting requirements.

See Drawing Coordination Considerations for information needed to coordinate this Specification Section with Drawings.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Epoxy adhesive injection materials.
2. Epoxy mortar materials and mixing.
3. Cementitious mortar materials and mixing.
4. Reinforcement materials.

B. Related Sections:

List other Sections directly related to or affecting Work of this Section. Include Sections specifying information expected to be found in this Section as well as Sections required to describe complete system or assembly requirements.

Division 04 - Input required from architectural/structural engineer subconsultant.

1. Section 03 30 00 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frames, slabs on grade, and other concrete components.
2. Section 04 01 00 - Maintenance of Masonry: Restoration of masonry surfaces.
3. Section <_____-_____>: Applied finish to [repaired] concrete surface.

1.2 UNIT PRICE – MEASURE AND PAYMENT

Use this Article only when Work of this Section is performed under unit price payment method. Delete this Article when payment is by Stipulated Sum/Price. Edit basis of payment to meet Project requirements.

A. Section 01 20 00 - Price and Payment Procedures: Contract Sum/Price modification procedures.

B. Surface Repair:

1. Basis of Measurement: By [square foot] <_____> ([square meter] <_____>).

2. Basis of Payment: Includes surface preparation, [reinforcement and] concrete repair, and finishing.

C. Crack Repair:

1. Basis of Measurement: By [linear foot] <_____> ([linear meter] <_____>).

2. Basis of Payment: Includes surface preparation, injection ports, repair materials, and surface finishing.

1.3 REFERENCE STANDARDS

List reference standards included within text of this Section, with designations, numbers, and complete document titles.

LEED requires compliance with specific editions of referenced standards. Section 01 40 00 requires compliance with the latest reference standard edition, except when a specific date is required by code. Consider including publication dates for referenced standards in this Section to ensure the correct standard is used for LEED compliance.

A. American Welding Society:

1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

2. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel.

B. ASTM International:

1. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

2. ASTM A996/A996M - Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.

3. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

4. ASTM C33/C33M - Standard Specification for Concrete Aggregates.

5. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).

6. ASTM C150/C150M - Standard Specification for Portland Cement.

7. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete.

8. ASTM C293/C293M - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam With Center-Point Loading).

9. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.

10. ASTM C882/C882M - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.

11. ASTM C1059/C1059M - Standard Specification for Latex Agents for Bonding Fresh To Hardened Concrete.

12. ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

13. ASTM D695 - Standard Test Method for Compressive Properties of Rigid Plastics.

14. ASTM D790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.4 SUBMITTALS

Only request submittals needed to verify compliance with Project requirements.

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit product standards, physical and chemical characteristics, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material.

Include following Paragraph to submit physical samples to select finish, color, texture, and other properties.

C. Samples: Submit [two] <_____> color samples of patches [exposed to view in finished construction] [and] [required to match existing].

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

E. Welder Certificates: Certify welders and welding procedures employed on Work, verifying AWS qualification within previous 12 months.

Include separate Paragraphs for additional certifications.

Include following Paragraph when Contractor is responsible for designing products or assemblies. List affected products when Section specifies more than one product.

F. Delegated Design Submittals: Submit signed and sealed Shop Drawings with design calculations and assumptions for design reinforcement splices.

G. Manufacturer Instructions: Submit mixing instructions.

H. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

I. Qualifications Statements:

Coordinate following Subparagraphs with requirements specified in QUALIFICATIONS Article.

1. Submit qualifications for Manufacturer, applicator, and licensed professional.

2. Submit Manufacturer's approval of applicator.

3. Welders: Qualify procedures and personnel according to AWS D1.1/D1.1M.

1.5 SUSTAINABLE DESIGN SUBMITTALS

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design submittals.

B. Manufacturer's Certificate: Certify that products meet or exceed specified sustainable design requirements.

Insert material certifications list below to suit products specified in this Section and Project sustainable design requirements. Specific certificate submittal and supporting data requirements are specified in Section 01 81 13.

1. Materials Resources Certificates:

a. Certify source and origin for [salvaged] [and] [reused] products.

b. Certify recycled material content for recycled content products.

c. Certify source for regional materials and distance from Project Site.

C. Product Cost Data:

1. Submit cost of products to verify compliance with Project sustainable design requirements.

2. Exclude cost of labor and equipment to install products.

3. Provide cost data for following products:

Edit list of material cost data below to suit products specified in this Section and Project sustainable design requirements. Specific cost data requirements are specified in Section 01 81 13.

a. Salvaged, refurbished, and reused products.

b. Products with recycled material content.

c. Regional products.

d. <_____>.

1.6 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.

B. Project Record Documents: Record actual locations of structural reinforcement repairs, type of repair, and <_____>.

1.7 QUALITY ASSURANCE

Include this Article to specify compliance with overall reference standards affecting products and installation included in this Section.

A. Welding: Comply with AWS D1.4/D1.4M.

In following Paragraph insert "State of _____ Department of Transportation," "Municipality of _____ Department of Public Works," or other agency as appropriate.

B. Perform Work according to <_____> standards.

Include following Paragraph only when cost of acquiring specified standards is justified.

C. Maintain <_____> [copy] [copies] of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

Coordinate following Paragraphs with requirements specified in SUBMITTALS Article.

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum [three] <_____> years' [documented] experience.

B. Applicator: Company specializing in performing Work of this Section with minimum [three] <_____> years' [documented] experience [and approved by Manufacturer].

C. Welders: AWS qualified within previous 12 months for employed weld types.

D. Licensed Professional: [Professional engineer] <_____> experienced in design of specified Work and licensed [at Project location] [in State of <_____>].

1.9 MOCKUPS

Include this Article for full-size erected assemblies required for review of construction, coordination of Work of several Sections, testing, or observation of operation.

A. Section 01 40 00 - Quality Requirements: Requirements for mockup.

B. Size: Construct mockup panel, <_____> feet (<_____> m) long by <_____> feet (<_____> m) wide, illustrating patching method, color, and texture of repair surface, and <_____>.

C. Prepare [one mockup] [<_____> mockups] for each type of injection and patching procedure.

D. Locate where [directed by Engineer] [indicated on Drawings].

E. Incorporate accepted mockup as part of Work.

******** [OR] ********

F. Remove mockup [when directed by Engineer] <_____>.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept materials on Site in Manufacturer's original packaging and inspect for damage.

C. Store materials according to Manufacturer instructions.

D. Protection:

1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.

2. Provide additional protection according to Manufacturer instructions.

1.11 EXISTING CONDITIONS

A. Field Measurements:

1. Verify field measurements prior to fabrication.

2. Indicate field measurements on Shop Drawings.

PART 2 PRODUCTS

2.1 EPOXY ADHESIVE

A. Manufacturers:

1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

2. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

******** [OR] ********

In following Subparagraph insert "State of _____ Department of Transportation," "Municipality of _____ Department of Public Works," or other agency as appropriate.

3. Furnish materials according to <_____> standards.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

B. Description:

1. Type: Two-part.

2. Solids Content: [100] <_____> percent.

C. Minimum Characteristics:

1. Bond Strength:

a. [2,700] <_____> psi ([18.6] <_____> MPa).

b. Comply with ASTM C882/C882M.

2. Tensile Strength:

a. [6,600] <_____> psi ([45.5] <_____> MPa).

b. Comply with ASTM D638.

3. Elongation:

a. [2] <_____> percent at seven days at 70 deg. F (21 deg. C).

b. Comply with ASTM D638.

4. Flexural Strength:

a. [8,000] <_____> psi ([55.2] <_____> MPa).

2.2 EPOXY MORTAR

A. Manufacturers:

1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

2. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

******** [OR] ********

In following Subparagraph insert "State of _____ Department of Transportation," "Municipality of _____ Department of Public Works," or other agency as appropriate.

3. Furnish materials according to <_____> standards.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

B. Description:

1. Type: Three-part binding resin and aggregate mortar mixture.

C. Binding Resin:

1. Two-part epoxy resin.

2. Solids Content: [100] <_____> percent.

3. Minimum Characteristics:

a. Bond Strength:

1) [2,700] <_____> psi ([18.6] <_____> MPa).

2) Comply with ASTM C882.

b. Tensile Strength:

1) [6,600] <_____> psi ([45.5] <_____> MPa).

2) Comply with ASTM D638.

c. Elongation:

1) [2] <_____> percent at seven days at 70 deg. F (21 deg. C).

2) Comply with ASTM D638.

d. Flexural Strength:

1) [8,000] <_____> psi ([55.2] <_____> MPa).

2) Comply with ASTM D790.

e. Compressive Strength:

1) [6,500] <_____> psi ([44.8] <_____> MPa).

2) Comply with ASTM D695.

D. Aggregate Type: As recommended by Mortar Manufacturer.

2.3 CEMENTITOUS MORTAR

A. Manufacturers:

1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

2. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

******** [OR] ********

In following Subparagraph insert "State of _____ Department of Transportation," "Municipality of _____ Department of Public Works," or other agency as appropriate.

3. Furnish materials according to <_____> standards.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

B. Description: Packaged [latex-modified] [silica-fume enhanced] [portland-cement] [hydraulic-cement] patching mortar.

C. Minimum Characteristics:

1. Compressive Strength:

a. [2,000] <_____> psi ([14] <_____> MPa) after one day and [5,000] <_____> psi ([34] <_____> MPa) after 28 days.

b. Comply with ASTM C109/C109M.

2. Bond Strength:

a. [1,400] [2,500] <_____> psi ([10] [17] <_____> MPa) after 28 days.

b. Comply with ASTM [C882/C882M] [C1059/C1059M].

3. Flexural Strength:

a. [1,500] <_____> psi ([10.3] <_____> MPa) after 28 days.

b. Comply with ASTM C293/C293M.

******** [OR] ********

D. Portland Cement:

1. Type: <_____>.

2. Comply with ASTM C150/C150M.

3. Color: [Gray] [White] [As selected].

E. Sand:

1. Description: Uniformly graded and clean.

2. Comply with ASTM [C33/C33M] [C404].

F. Water: Clean and potable.

G. Air Entrainment Admixture: Comply with ASTM C260/C260M.

H. Calcium Chloride: Not permitted.

I. Bonding Agent:

1. Description:

a. Dispersed in water while mixing and non-coagulant in mix.

b. Water resistant when cured.

2. Emulsion: [Polyvinyl acetate] <_____>.

J. Cleaning Agent:

1. Commercial muriatic acid.

2. [Strength: <_____> percent.]

2.4 REINFORCEMENT MATERIALS

Repair of structural reinforcement typically requires specific Project analysis to determine stress criteria, materials to repair, splicing methods, and special cleanup requirements. Verify existing reinforcement type and requirements prior to editing

following Paragraphs. The most commonly used material is reinforcing steel complying with ASTM A615/A615M with yield strengths of 40 or 60 ksi (276 or 414 MPa).

A. Reinforcing Steel:

1. Description: [Plain] [Deformed] billet bars.

2. Yield Grade: [40] [60] [75] ksi ([276] [414] [517] MPa).

3. Comply with ASTM A615/A615M.

4. Finish: [Galvanized] [Uncoated].

******** [OR] ********

B. Reinforcing Steel:

1. Description: Axle-steel deformed bars.

2. Yield Grade: [40] [60] ksi ([276] [414] MPa).

3. Comply with ASTM A996/A996M.

4. Finish: [Unfinished] [Galvanized].

******** [OR] ********

C. Reinforcing Steel:

1. Description: Rail-steel deformed bars.

2. Yield Grade: [50] [60] ksi ([345] [414] MPa).

3. Comply with ASTM A996/A996M.

4. Finish: [Unfinished] [Galvanized].

D. Stirrup Steel: Comply with [ASTM A1064/A1064M] <_____>.

E. Splicing Sleeves: <_____> type, as manufactured by <_____>.

2.5 SUSTAINABILITY CHARACTERISTICS

Insert sustainable design characteristics in this Article to suit content of this Section and Project sustainable design requirements as specified in Section 01 81 13.

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design compliance.

B. Material and Resource Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content [including:] [.]

Insert list of materials specified in this Section required to have recycled content.

a. <_____>.

2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles (800 km) of Project Site [including:] [.]

Insert list of materials specified in this Section required to be regional materials.

a. <_____>.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application examination.

B. Verify that surfaces are ready to receive Work.

3.2 PREPARATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for application preparation.

B. Cleaning:

1. Clean concrete surfaces of dirt, laitance, corrosion, and other contamination.

2. Scrub with wire brush using [water] [acid].

3. Rinse surface and allow to dry.

4. Flush out cracks and voids with [chemical solvent] [muriatic acid] [water] to remove laitance and dirt.

5. [Chemically neutralize by rinsing with water.]

Consider including following two Paragraphs if specifying injection method.

C. Ports:

1. Provide temporary entry ports spaced to facilitate movement of fluids between ports.

2. Size: Not deeper than depth of crack to be filled, or diameter not greater than thickness of crack.

D. Provide temporary seal at concrete surface to prevent leakage of adhesive.

Consider including following two Paragraphs if specifying epoxy mortar patching method.

E. Remove broken and soft concrete [1/4] <_____> inch ([6] <_____> mm) deep and remove corrosion from steel.

F. Clean surfaces mechanically, wash with [acid] <_____>, and rinse with water.

If specifying maintenance at reinforcement repair areas, indicate cleaning requirements and preparation of structural reinforcing steel prior to welding splices.

G. Reinforcement:

1. [Sandblast] <_____> exposed reinforcement steel surfaces.

2. Mechanically cut away damaged portions of bar.

3.3 MIXES

A. Epoxy Mortar:

1. Mix to consistency for intended purpose.

2. Mix components in clean equipment or containers.

3. Comply with pot life and workability limits.

B. Cementitious Mortar:

1. Mix to consistency required for intended purpose.

2. [Include] [Exclude] bonding agent as additive to mix.

3.4 APPLICATION

Edit following Paragraph to suit specific repair techniques.

A. Repairs:

1. Reinforcement: Weld [new bar reinforcement to existing reinforcement] <_____> with [sleeve splices] <_____>.

2. Strength of Welded [Splices] [and] [Reinforcement]: Exceed original stress values.

3. Exposed Structural, Shrinkage, and Settlement Cracks in Concrete: [As indicated on Drawings] by [epoxy injection] [epoxy application] [bonding agent and cementitious paste] method.

4. [Fill voids flush with surface.]

5. [Apply surface finish.]

B. Epoxy Resin Injection:

1. Inject epoxy-resin adhesive into prepared ports under pressure, using equipment appropriate for particular application.

2. Begin injection at lower entry port and continue until adhesive appears in adjacent entry port, continuing from port to port until entire crack is filled.

3. Remove temporary seal and excess adhesive.

4. Clean surfaces adjacent to repair and blend finish.

C. Epoxy Mortar:

1. Trowel-apply mortar mix to average thickness of <_____> inches (<_____> mm) and tamp into place, filling voids at spalled areas.

2. Patching of Honeycombed Areas:

a. Trowel mortar onto surface, and work mortar into honeycomb to bring surface flush with surrounding area.

b. Finish trowel surface to match surrounding area.

3. Cover exposed steel reinforcement with epoxy mortar and feather edges to flush surface.

D. Cementitious Mortar:

1. Bonding Agent:

a. Apply [sprayed] [brushed] [roller] coating to [dry] [damp] concrete surfaces.

b. Provide full surface coverage.

2. Steel trowel to average thickness of <_____> inches (<_____> mm) and tamp into place, filling voids at spalled areas.

3. Work mix into honeycombed areas.

Cementitious mix with bonding agent as additive does not require damp cure for first 24 hours. Bonding agent as additive may not require supplementary air entrainment in mix for freeze/thaw exposed conditions.

E. Damp cure cementitious mortar for [four] <_____> days.

3.5 FIELD QUALITY CONTROL

Consider including this Article if desired to continue testing concrete for calcium chloride or other chemicals concurrent with progress of Work.

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

******** [OR] ********

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Test concrete for [calcium chloride] <_____> content during execution of the Work.

3.6 ATTACHMENTS

When relying on separate schedules, tables, illustrations, or forms to specify product requirements, include list of each attachment. Include identical list of attachments in Project Manual table of contents.

Consider including schedule if different types of repairs and different repair materials are needed at various locations.

Insert attachments following END OF SECTION. Consider following examples when developing Project schedule.

A. Concrete Maintenance Schedule:

1. North End of Existing Retaining Wall: Epoxy mortar with smooth trowel finish.

2. Cracked East Basement Wall: Epoxy resin injection; roughened surface finish to match adjacent Work.

END OF SECTION

SECTION 03 10 00 - CONCRETE FORMING AND ACCESSORIES

This Section includes form materials, waterstops, and accessories, as required to form cast-in-place concrete and maintain structural integrity until stripping. Accessory devices for concrete control, expansion, and contraction jointing are specified in Section 03 30 00. If architectural form materials are required, they can be edited into this Section.

This Section references American Concrete Institute (ACI) 301 and 318. International Code Council codes require use of ACI 318. Edit references to suit Project conditions.

This Section includes provision for Work performed using unit price payment method when applicable.

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting requirements of this Specification.

This Section includes performance, proprietary, and descriptive specifications. Edit to avoid conflicting requirements.

See Drawing Coordination Considerations for information needed to coordinate this Specification Section with Drawings.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Formwork for cast-in-place concrete.
2. Shoring, bracing, and anchorage.
3. Architectural form liners.
4. Form accessories.
5. Form stripping.

B. Related Sections:

List other Sections directly related to or affecting Work of this Section. Include Sections specifying information expected to be found in this Section as well as Sections required to describe complete system or assembly requirements.

1. Section 03 20 00 - Concrete Reinforcing: Reinforcing steel and required supports for cast-in-place concrete.
2. Section 03 30 00 - Cast-in-Place Concrete: Cast-in-place or in-situ concrete for structural building frame, slabs-on-grade, and other concrete components associated with building.

3. Section 03 38 00 - Post-Tensioned Concrete: On-Site post-tensioning of cast-in-place concrete structural building framing members and slabs.

4. Section 04 20 00 - Unit Masonry:

   a. Positioning of recessed reglets for brick veneer masonry anchors.

   b. Product requirements for masonry accessories for placement by this Section.

5. Section 05 50 00 - Metal Fabrications: Product requirements for metal fabrications for placement by this Section.

List Sections specifying products installed under this Section and indicate specific items.

6. Section <_____-_____>: Specially surfaced concrete.

7. Section <_____-_____>: Execution requirements for shoring and underpinning required by this Section.

8. Section <_____-_____>: Product requirements for masonry accessories for placement by this Section.

9. Section <_____-_____>: Product requirements for mechanical items for placement by this Section.

10. Section <_____-_____>: Product requirements for flashing reglets for placement by this Section.

11. Section <_____-_____>: Product requirements for electrical items for placement by this Section.

1.2 UNIT PRICE – MEASURMENT AND PAYMENT

Use this Article only when Work of this Section is performed under unit price payment method. Delete this Article when payment is by Stipulated Sum/Price. Edit basis of payment to meet Project requirements.

A. Section 01 20 00 - Price and Payment Procedures: Contract Sum/Price modification procedures.

B. Formwork (Vertical Structures):

   1. Basis of Measurement: By square [foot] <_____> ([m] <_____>).

   2. Basis of Payment: Includes form materials, placement, placing accessories, and stripping.

C. Formwork (Horizontal Supported Structures):

   1. Basis of Measurement: By square [foot] <_____> ([m] <_____>).

   2. Basis of Payment: Includes form materials, placement, placing accessories, and stripping.

1.3 REFERENCE STANDARDS

List reference standards included within text of this Section, with designations, numbers, and complete document titles.

A. American Concrete Institute:

1. ACI 117 - Specification for Tolerances for Concrete Construction and Materials.
2. ACI 301 - Specifications for Structural Concrete.
3. ACI 318 - Building Code Requirements for Structural Concrete.
4. ACI 347 - Guide to Formwork for Concrete.

B. American Forest & Paper Association:

1. AF&PA - National Design Specification (NDS) for Wood Construction.

C. American Society of Mechanical Engineers:

1. ASME A17.1 - Safety Code for Elevators and Escalators.

D. APA - The Engineered Wood Association:

1. APA/EWA PS 1 - Voluntary Product Standard - Structural Plywood.

E. ASTM International:

1. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
3. ASTM E96M - Standard Test Methods for Water Vapor Transmission of Materials.

F. West Coast Lumber Inspection Bureau:

1. WCLIB - Standard No. 17 Grading Rules for West Coast Lumber.

1.4 COORDINATION

A. Section 01 30 00 – Administrative Requirements: Requirements for coordination.

Following Paragraph is general statement regarding items to be placed in or attached to formwork. Coordinate type of device with specific affected Section. Location and spacing of components is critical; consider requiring Shop Drawings to specifically indicate component position and dimension.

B. Coordinate Work of this Section with other Sections of Work in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other Work.

1.5 SUBMITTALS

Only request submittals needed to verify compliance with Project requirements.

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data: Submit Manufacturer information on void form materials [and installation requirements].

C. Shop Drawings:

1. Indicate:

a. Formwork, shoring, and reshoring.

b. Pertinent dimensions, openings, methods of construction, types of connections, materials, joint arrangement and details, ties and shores, location of framing, studding, and bracing, and temporary supports.

c. Means of leakage prevention for concrete exposed to view in finished construction.

d. Sequence and timing of erection and stripping, assumed compressive strength at time of stripping, height of lift, and height of drop during placement.

e. Vertical, horizontal, and special loads according to ACI 347, and camber diagrams when applicable.

f. Notes to formwork erector showing size and location of conduits and piping embedded in concrete according to ACI 318.

g. Procedure and schedule for removal of shores and installation and removal of reshores.

D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

Include separate Paragraphs for additional certifications.

Include following Paragraph when Contractor is responsible for designing products or assemblies. List affected products when Section specifies more than one product.

E. Delegated Design Submittals:

1. Submit signed and sealed Shop Drawings with design calculations and assumptions for [formwork] [shoring] [reshores] [and] <_____>.

2. Indicate loads transferred to structure during process of concreting, shoring, and reshoring.

3. Include structural calculations to support design.

F. Field Quality-Control Submittals: Indicate results of Contractor-furnished tests and inspections.

G. Qualifications Statement:

Coordinate following Subparagraph with requirements specified in QUALIFICATIONS Article.

1. Submit qualifications for licensed professional.

1.6 SUSTAINABLE DESIGN SUBMITTALS

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design submittals.

B. Manufacturer's Certificate: Certify that following products meet or exceed specified sustainable design requirements.

Insert material certifications list below to suit products specified in this Section and Project sustainable design requirements. Specific certificate submittal and supporting data requirements are specified in Section 01 81 13.

1. Materials Resources Certificates:

a. Certify recycled material content for recycled content products.

b. Certify source for regional materials and distance from Project Site.

c. Certify that lumber is harvested from FSC-Certified well-managed forest.

C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

1. Provide cost data for following products:

Edit list of material cost data to suit products specified in this Section and Project sustainable design requirements. Specific cost data requirements are specified in Section 01 81 13.

a. Products with recycled material content.

b. Regional products.

c. Certified wood products.

d. <_____>.

1.7 QUALITY ASSURANCE

Include this Article to specify compliance with overall reference standards affecting products and installation included in this Section.

A. Perform Work according to ACI [347] [, 301] [, and] [318].

B. For wood products furnished for Work of this Section, comply with AF&PA.

In following Paragraph insert "State of _____ Department of Transportation," "Municipality of _____ Department of Public Works," or other agency as appropriate.

C. Perform Work according to <_____> standards.

Include following Paragraph only when cost of acquiring specified standards is justified.

D. Maintain <_____> [copy] [copies] of each standard affecting Work of this Section on Site.

1.8 QUALIFICATIONS

Coordinate following Paragraph with requirements specified in SUBMITTALS Article.

A. Licensed Professional: [Professional Engineer] <_____> experienced in design of specified Work and licensed [at Project location] [in State of <_____>].

1.9 MOCKUPS

Include this Article for full-size erected assemblies required for review of construction, coordination of Work of several Sections, testing, or observation of operation.

A. Section 01 40 00 - Quality Requirements: Requirements for mockup.

B. Size: Construct mockup, <_____> by <_____> feet (<_____> by <_____> m), including formwork, form liners, form accessories [, and] <_____>.

C. Locate where [directed by Engineer] [indicated on Drawings].

D. Incorporate accepted mockup as part of Work.

******* [OR] ********

E. Remove mockup [when directed by Engineer] <_____>.

1.10 DELIVERY, STORAGE, AND HANDLING

Include this Article only if void forms are included.

A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Inspection: Accept void forms on Site in Manufacturer's original packaging and inspect for damage.

C. Store materials off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Design, engineer, and construct formwork, shoring, and bracing according to [ACI 318] <_____> to conform to [design and] [applicable] <_____> code requirements to achieve concrete shape, line, and dimension [as indicated on Drawings] <_____>.

ASTM E96 (E96M) permits testing using desiccant and water methods. Samples may be tested with one surface wetted when using water method. Samples may be tested with low humidity on one side and high humidity on opposite side. Single material tested using various conditions will produce different test results.

Select test method and service conditions as necessary to suit application.

B. Vapor Retarder Permeance: Maximum [1 perm] [<_____> perms] ([57] <_____> ng/Pa/s/sq. m) when tested according to ASTM E96 (E96M), [desiccant] [water] method.

2.2 SUSTAINABILITY CHARACTERISTICS

Insert sustainable design characteristics in this Article to suit content of this Section and Project sustainable design requirements as specified in Section 01 81 13.

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content [including:] [.]

Insert list of materials specified in this Section required to have recycled content.

a. <_____>.

2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles (800 km) of Project Site [including:] [.]

Insert list of materials specified in this Section required to be regional materials.

a. <_____>.

3. Certified Wood Materials: Furnish wood materials certified according to FSC standards [including:] [.]

Insert list of materials specified in this Section required to be certified wood.

a. <_____>.

2.3 WOOD FORM MATERIALS

Consider including first following Paragraph if performance specifying and delete subsequent Paragraphs. Select and edit subsequent Paragraphs for prescriptive specifying.

A. Form Materials: At discretion of Contractor.

******** [OR] ********

B. Softwood Plywood: Comply with APA/EWA PS 1, [C] [C Plugged] [D] Grade, Group [2] [3] [4].

******** [OR] ********

C. Plywood:

1. Species: [Douglas fir] [Spruce] <_____>.

2. Grade: [Solid one side] [Select sheathing, tight face] [Select sheathing] [Sheathing] [Medium density, overlaid one side].

3. Edges: Clean and true.

D. Lumber Forms:

1. Applications: Edge forms and unexposed finish concrete.

2. Boards:

a. Description:

1) [Shiplapped] [or] [tongue and groove].

2) Surface boards on four sides.

b. Material: "Standard" grade Douglas fir according to WCLIB Standard No. 17.

c. Width: [6] [8] inches ([150] [200] mm).

E. Plywood Forms:

1. Application: Exposed finish concrete.

2. Description:

a. Comply with APA/EWA PS 1.

b. Panels: Full size, 4 by 8 feet (1 200 by 2 400 mm).

c. Label each panel with grade trademark of APA/EWA.

3. Plywood for Surfaces to Receive Membrane Waterproofing:

a. Minimum Thickness: 5/8 inch (16 mm).

b. Grade: APA/EWA "B-B Plyform Structural I Exterior."

4. Plywood with "Smooth Finish" Indicated on Drawings:

a. Minimum Thickness: 3/4 inch (19 mm).

b. Grade: APA/EWA "HD Overlay Plyform Structural I Exterior."

2.4 PREFABRICATED FORMS

A. Manufacturers:

1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

2. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

******** [OR] ********

In following Subparagraph insert "State of _____ Department of Transportation," "Municipality of _____ Department of Public Works," or other agency as appropriate.

3. Furnish materials according to <_____> standards.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

B. Preformed Steel Forms:

1. Description: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

2. Minimum Thickness: [16] <_____> gauge ([1.5] <_____> mm).

C. FRP Forms: Matched, tightly fitted, and stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished concrete surfaces.

D. Pan:

1. Material: [Steel] [Glass fiber] <_____>.

2. Configuration: Size and profile as required.

E. Tubular Column:

1. Description: Round [spirally wound laminated fiber] [wood] [glass fiber].

2. Surface Treatment: Release agent, non-reusable.

3. Sizes: [As indicated on Drawings] <_____>.

4. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

Void forms are used primarily when adjacent to expansive soils.

F. Void Forms:

1. Moisture-resistant treated paper faces; biodegradable.

2. Structurally sufficient to support weight of wet concrete mix until initial set.

3. Thickness: [2] [4] <_____> inches ([50] [100] <_____> mm).

4. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

G. Steel Forms:

1. Description: Sheet steel, suitably reinforced.

2. Design: For particular use as indicated on Drawings.

H. Form Liners: Smooth, durable, grainless, and non-staining hardboard unless otherwise indicated on Drawings.

I. Framing, Studding, and Bracing: [Stud] [or] [No. 3 structural light-framing grade].

2.5 ARCHITECTURAL FORM LINERS

A. Manufacturers:

1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

2. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

******** [OR] ********

In following Subparagraph insert "State of _____ Department of Transportation," "Municipality of _____ Department of Public Works," or other agency as appropriate.

3. Furnish materials according to <_____> standards.

Insert descriptive specifications below to identify Project requirements and to eliminate conflicts with products specified above.

Polystyrene form liners are generally single-use type. Acrylonitrile butadiene styrene (ABS) form liners are reusable type with up to 40 reuses depending on pattern. Polyurethane form liners are reusable type with up to 100 reuses. ABS form liners are generally available in sizes 4 by 10 feet (1 200 by 3 000 mm); polyurethane liners are available in larger custom sizes.

Check Manufacturer's literature for standard patterns and custom pattern capabilities.

B. Architectural Form Liners:

1. Material: [Polystyrene] [Acrylonitrile butadiene styrene (ABS)] [Polyurethane] <_____>.

2. Type: [Single use] [Reusable].

3. Pattern: <_____> [As indicated on Drawings] [As selected by Engineer].

2.6 COATINGS

A. Coatings for Aluminum:

1. Polyamide epoxy finish coat with paint manufacturer's recommended primer for aluminum substrate.

2. One coat primer and one coat finish.

3. Minimum Total Dry Film Thickness: <_____> mils (<_____> mm).

4. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

2.7 FORMWORK ACCESSORIES

Form ties are usually concealed from view when used in structural concrete. If exposed to view, select appropriate type, and indicate tie locations by dimensional spacing or indicate required pattern on Drawings.

A. Form Ties:

1. Type: [Removable] [Snap off] [; cone].

2. Material: [Galvanized] <_____>.

3. Length: [Fixed] [Adjustable].

4. [Furnish waterproofing washer.]

5. [Back Break Dimension: <_____> inches (<_____> mm).]

6. Free of defects capable of leaving holes larger than [1] [1-1/4] <_____> inch ([25] [32] <_____> mm) in concrete surface.

7. Manufacturers:

   a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

   b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

B. Spreaders:

1. Description: Standard, non-corrosive metal-form clamp assembly, of type acting as spreaders and leaving no metal within 1 inch (25 mm) of concrete face.

2. Wire ties, wood spreaders, or through bolts are not permitted.

Some form release agents adhere to concrete and discourage bonding of surface aggregate, finishes, or other coatings. Coordinate proper selection of release agent.

C. Form Release Agent:

1. Description: Colorless mineral oil that will not stain concrete or absorb moisture [or impair natural bonding or color characteristics of coating intended for use on concrete].

2. Manufacturers:

   a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

   b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

Preformed corner devices are typically used if structural members are exposed to view.

D. Corners:

1. Type: [Fillet] [Chamfer], [rigid plastic] [wood strip] <_____>.

2. Size: <_____> by <_____> inches (<_____> by <_____> mm).

3. Lengths: Maximum possible.

4. Manufacturers:

   a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

   b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

Consider including one or both of following two Paragraphs if items are not provided by other Sections.

E. Dovetail Anchor Slot:

1. Material: Galvanized steel.

2. Thickness: [22] <_____> gauge ([0.8] <_____> mm).

3. Filling: [Foam] [None].

4. Fasten slot to concrete formwork according to Manufacturer instructions and insert foam filler to prevent concrete from entering slot during pour.

5. Manufacturers:

   a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

   b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

F. Flashing Reglets:

1. Material: [Galvanized steel] [Rigid PVC].

2. Thickness: [22] <_____> gauge ([0.8] <_____> mm).

3. Lengths: Maximum possible.

4. Furnish alignment splines for joints.

5. Filling: [Foam] [None].

6. Fasten flashing reglet to concrete formwork according to Manufacturer instructions and insert foam to prevent concrete from entering reglet during pour.

7. Manufacturers:

   a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

   b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

G. Vapor Retarder:

1. Description: Polyethylene sheet.

2. Thickness: 8 mils (0.2 mm).

H. Bituminous Joint Filler: Comply with ASTM D1751.

I. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Size, strength, and character to maintain formwork in place while placing concrete.

Waterstops are typically used in conjunction with formwork to compartmentalize concrete for placing and to provide a water dam at resultant joints. These devices do not provide waterproof stops but function as a passive moisture stop.

J. Waterstop:

1. Material: [Rubber] [PVC].

2. Tensile Strength: Minimum [1,750] <_____> psi ([12] <_____> MPa).

3. Working Temperature Range: Minus 50 to plus 175 degrees F (minus 46 to plus 79 degrees C).

4. Width: <_____> inches (<_____> mm).

5. Lengths: Maximum possible.

6. Profile: Ribbed.

7. Corner Sections: Preformed.

8. Jointing: Heat welded.

9. Manufacturers:

   a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

   b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

******** [OR] ********

K. Waterstop:

1. Material: Copper.

2. Minimum Thickness: [<_____> oz.] [<_____> mils] (<_____> mm).

3. Temper: <_____>.

4. Lengths: Maximum possible.

******** [OR] ********

Caution: Obtain warranty for bentonite waterproofing systems.

L. Waterstop:

1. Description: Flexible strip of bentonite waterproofing compound in coil form for joints in concrete construction.

2. Manufacturers:

   a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

   b. Substitutions: [As specified in Section 01 60 00 - Product Requirements] [Not permitted].

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for installation examination.

B. Verify lines, levels, and centers before proceeding with formwork.

C. Verify that dimensions agree with [**Drawings**] [**Shop Drawings**].

D. If formwork is placed after reinforcement resulting in insufficient concrete cover over reinforcement, request instructions from Engineer before proceeding.

3.2 INSTALLATION

A. Earth Forms: Not permitted.

******** [OR] ********

B. Earth Forms:

1. Trench earth forms neatly, accurately, and at least 2 inches (50 mm) wider than footing widths indicated on Drawings.

2. Trim sides and bottom of earth forms.

3. Construct wood edge strips at top of each side of trench to secure reinforcing and to prevent trench from sloughing.

4. Form sides of footings where earth sloughs.

5. Tamp earth forms firm and clear them of debris and loose material before depositing concrete.

C. Formwork:

1. Provide top form for sloped surfaces steeper than 1.5 horizontal to 1 vertical to hold shape of concrete during placement, unless it can be demonstrated that top forms can be omitted.

2. Construct forms to correct shape and dimensions, mortar-tight, braced, and of sufficient strength to maintain shape and position under imposed loads from construction operations.

3. Camber forms where necessary to produce level finished soffits unless indicated otherwise on Drawings.

4. Positioning:

a. Carefully verify horizontal and vertical positions of forms.

b. Correct misaligned or misplaced forms before placing concrete.

5. Complete wedging and bracing before placing concrete.

6. Erect formwork, shoring, and bracing to achieve design requirements according to ACI [301] [318].

7. Stripping:

   a. Arrange and assemble formwork to permit dismantling and stripping.

   b. Do not damage concrete during stripping.

   c. Permit removal of remaining principal shores.

8. Obtain approval of Engineer before framing openings in structural members not indicated on Drawings.

9. Install [fillet] [and] [chamfer] strips on external corners of [beams] [, joists] [, columns] [, and] <_____>.

10. Install void forms according to Manufacturer instructions.

11. Do not reuse [wood] <_____> formwork more than <_____> times for [concrete surfaces to be exposed to view] <_____>.

12. Do not patch formwork.

13. Leave forms in place for minimum number of days according to ACI 347.

D. Form Removal:

1. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads, and removal has been approved by Engineer.

2. Loosen forms carefully; do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.

3. Store removed forms in manner that surfaces to be in contact with fresh concrete will not be damaged.

4. Discard damaged forms.

5. Form Release Agent:

   a. Apply according to Manufacturer instructions.

   b. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

   c. Do not apply form release agent if concrete surfaces are indicated to receive [special finishes] [or] [applied coverings] that may be affected by agent.

   d. Soak inside surfaces of untreated forms with clean water, and keep surfaces coated prior to placement of concrete.

6. Form Cleaning:

   a. Clean forms as erection proceeds to remove foreign matter within forms.

   b. Clean formed cavities of debris prior to placing concrete.

   c. Flush with water or use compressed air to remove remaining foreign matter.

   d. Ensure that water and debris drain to exterior through cleanout ports.

   Consider including following Subparagraph if formwork will be erected during cold weather.

   e. Cold Weather:

      1) During cold weather, remove ice and snow from within forms.

      2) Do not use de-icing salts.

      3) Do not use water to clean out forms unless formwork and concrete construction proceed within heated enclosure; use compressed air or other dry method to remove foreign matter.

7. Reuse and Coating of Forms:

   a. Thoroughly clean forms and reapply form coating before each reuse.

   b. For exposed Work, do not reuse forms with damaged faces or edges.

   c. Apply form coating to forms according to Manufacturer instructions.

   d. Do not coat forms for concrete indicated to receive "scored finish."

   e. Apply form coatings before placing reinforcing steel.

E. Forms for Smooth Finish Concrete:

1. Use steel, plywood, or lined-board forms.

2. Use clean and smooth plywood and form liners, uniform in size, and free from surface and edge damage capable of affecting resulting concrete finish.

3. Install form lining with close-fitting square joints between separate sheets without springing into place.

4. Use full-sized sheets of form liners and plywood wherever possible.

5. Tape joints to prevent protrusions in concrete.

6. Apply forming and strip wood forms in a manner to protect corners and edges.

7. Level and continue horizontal joints.

8. Keep wood forms wet until stripped.

F. Architectural Form Liners:

1. Erect architectural side of formwork first.
2. Attach form liner to forms before installing form ties.
3. Install form liners square, with joints and pattern aligned.
4. Seal form liner joints to prevent grout leaks.
5. Dress joints and edges to match form liner pattern and texture.

G. Forms for Surfaces to Receive Membrane Waterproofing:

1. Use plywood or steel forms.
2. After erection of forms, tape form joints to prevent protrusions in concrete.

H. Framing, Studding, and Bracing:

1. Maximum Spacing of Studs:
   a. Boards: Maximum 16 inches (400 mm) o.c.
   b. Plywood: 12 inches (300 mm) o.c.
2. Size framing, bracing, centering, and supporting members for sufficient strength to maintain shape and position under imposed loads from construction operations.
3. Construct beam soffits of material minimum 2 inches (50 mm) thick.
4. Distribute bracing loads over base area on which bracing is erected.
5. When placed on ground, protect against undermining, settlement, and accidental impact.

I. Form Anchors and Hangers:

1. Do not use anchors and hangers leaving exposed metal at concrete surface.
2. Symmetrically arrange hangers supporting forms from structural-steel members to minimize twisting or rotation of member.
3. Penetration of structural-steel members is not permitted.

J. Inserts, Embedded Parts, and Openings:

1. Install formed openings for items to be embedded in or passing through concrete Work.
2. Locate and set in place items required to be cast directly into concrete.

Following Subparagraph is example for specific or special items requiring placement in forms. Add Subparagraphs for other items for Project conditions.

3. Position recessed reglets for brick veneer masonry anchors according to spacing and intervals as [specified in Section 04 20 00 - Unit Masonry] [specified in Section <_____-_____>] [indicated on Drawings].

4. Install accessories straight, level, and plumb, and ensure that items are not disturbed during concrete placement.

5. Joints:

   a. Install waterstops continuous without displacing reinforcement.

   b. [Heat-seal joints watertight.]

6. Openings:

   a. Provide temporary ports or openings in formwork as required to facilitate cleaning and inspection.

   b. Locate openings at bottom of forms to allow flushing water to drain.

7. Close temporary openings with tight-fitting panels, flush with inside face of forms, and neatly fitted such that joints will not be apparent in exposed concrete surfaces.

K. Form Ties:

1. Provide sufficient strength and quantity to prevent spreading of forms.

2. Place ties at least 1 inch (25 mm) away from finished surface of concrete.

3. Leave inner rods in concrete when forms are stripped.

4. Space form ties equidistant, symmetrical, and aligned vertically and horizontally unless indicated otherwise on Drawings.

L. Arrange formwork to allow proper erection sequence and to permit form removal without damage to concrete.

M. Construction Joints:

1. Install surfaced pouring strip where construction joints intersect on exposed surfaces to provide straight line at joints.

2. Just prior to subsequent concrete placement, remove strip and tighten forms to conceal shrinkage.

3. Appearance:

   a. Show no overlapping of construction joints.

   b. Construct joints to present same appearance as butted plywood joints.

4. Arrange joints in continuous line straight, true, and sharp.

N. Embedded Items:

1. Make provisions for pipes, sleeves, anchors, inserts, reglets, anchor slots, nailers, waterstops, and other features.

2. Do not embed wood or uncoated aluminum in concrete.

3. Obtain installation and setting information for embedded items furnished under other Sections.

4. Securely anchor embedded items in correct location and alignment prior to placing concrete.

5. Ensure that conduits and pipes, including those made of coated aluminum, meet requirements of ACI 318 regarding size and location limitations.

O. Openings for Items Passing through Concrete:

1. Frame openings in concrete where indicated on Drawings.

2. Establish exact locations, sizes, and other conditions required for openings and attachment of Work specified under other Sections.

3. Coordinate Work to avoid cutting and patching of concrete after placement.

4. Perform cutting and repairing of concrete required as result of failure to provide required openings.

P. Screeds:

1. Set screeds and establish levels for tops of and finish on concrete slabs.

2. Slope slabs to drain where required or as indicated on Drawings.

3. Before depositing concrete, remove debris from space to be occupied by concrete and thoroughly wet forms; remove freestanding water.

Q. Screed Supports:

1. For concrete over waterproof membranes and vapor retarder membranes, use cradle-, pad-, or base-type screed supports that will not puncture membrane.

2. Staking through membrane is not permitted.

R. Cleanouts and Access Panels:

1. Provide removable cleanout sections or access panels at bottoms of forms to permit inspection and effective cleaning of loose dirt, debris, and waste material.

2. Clean forms and surfaces against which concrete is to be placed.

3. Remove chips, sawdust, and other debris.

4. Thoroughly blow out forms with compressed air just before concrete is placed.

3.3 TOLERANCES

Refer to ACI 301 and ACI 318 for tolerance references. If tolerances are not appropriate, include supplementary statements in this Article.

A. Construct formwork to maintain tolerances according to ACI [301] [318].

******** [OR] ********

B. Tolerances: Construct formwork to produce completed concrete surfaces within construction tolerances according to ACI 117.

Refer to ASME A17.1 for elevator shaft hoistway plumb alignment requirements.

C. [Construct and align formwork for elevator hoistway according to ASME A17.1.]

D. Camber:

1. Slabs and Beams: [1/4] <_____> inch per 10 feet ([2] <_____> mm/m).

******** [OR] ********

E. Camber:

1. According to ACI [301] [318].

3.4 FIELD QUALITY CONTROL

A. Section 01 40 00 - Quality Requirements: Requirements for inspecting and testing.

******** [OR] ********

B. Section 01 70 00 - Execution and Closeout Requirements: Requirements for testing, adjusting, and balancing.

C. Inspection:

1. Inspect erected formwork, shoring, and bracing to ensure that Work complies with formwork design and that supports, fastenings, wedges, ties, and items are secure.

2. Notify Engineer after placement of reinforcing steel in forms but prior to placing concrete.

3. Schedule concrete placement to permit formwork inspection before placing concrete.

3.5 ATTACHMENTS

When relying on separate schedules, tables, illustrations, or forms to specify product requirements, include list of each attachment. Include identical list of attachments in Project Manual table of contents.

Consider including schedule if differing form types are intended for Work at various locations.

Insert attachments following END OF SECTION. Consider following examples when developing Project schedule.

A. Basement Walls Not Exposed to View: Site-fabricated plywood coated with form oil.

B. Basement Walls Exposed to View: Site-fabricated rough-sawn lumber.

C. Supported Floor Slabs: Prefabricated glass-fiber pan forms, treated for exposed-to-view finish.

END OF SECTION

SECTION 03 11 00 - CONCRETE WORK

For general projects, including pump stations or projects with minor quantities of concrete work, this Section acts as a standalone concrete/reinforcing specification. This version was created October 5, 2015, as provided by PSE (a structural engineering subconsultant). Coordinate review & update this Section with the Project structural engineer for Project specific needs.

Note for prestressed concrete reservoirs, (or other projects with major concrete work) use Section 03 33 00, Cast-In-Place Concrete and Section 03 21 00, Reinforcing Steel in lieu of this Section.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. The extent of concrete work is shown on the Drawings.

B. Work includes providing formwork and shoring for cast-in-place concrete and installation into formwork of items such as reinforcing steel bar (rebar), anchor bolts, setting plates, bearing plates, anchorages, inserts, reveals, frames, nosings, sleeves and other items to be embedded in concrete.

1.2 QUALITY ASSURANCE

A. Codes and Standards

Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified here:

ACI 301 "Specifications for Structural Concrete for Buildings"

ACI 311 "Recommended Practice for Concrete Inspection"

ACI 318 "Building Code Requirements for Reinforced Concrete"

ACI 347 "Recommended Practice for Concrete Formwork"

ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete"

Concrete Reinforcing Steel Institute, "Manual of Standard Practice"

Comply with building code requirements which are more stringent than the above and all Occupational Safety and Health Administration (OSHA) requirements.

B. ASTM International (ASTM)

1. C31, Making and Curing Concrete Test Specimens in the Field

2. C33, Specification for Concrete Aggregate
3. C39, Compressive Strength of Cylindrical Concrete Specimens
4. C40, Organic Impurities in Fine Aggregate for Concrete
5. C85, Cement Content of Hardened Portland Cement Concrete
6. C88, Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate
7. C94, Standard Specifications for Ready-Mixed Concrete
8. C131, Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
9. C136, Method for Sieve Analysis to Fine and Coarse Aggregate
10. C143, Slump of Portland Cement Concrete
11. C150, Standard Specification for Portland Cement
12. C156, Water Retention by Concrete Curing Materials
13. C173, Air Content of Freshly Mixed Concrete by the Volumetric Method
14. C231, Air Content of Freshly Mixed Concrete by the Pressure Method
15. C233, Standard Method of Testing Air-Entraining Admixtures for Concrete
16. C260, Standard Specifications for Air-Entraining Admixtures for Concrete
17. C289, Standard Test Method for Potential Reactivity of Aggregates (Chemical Method)
18. C441, Standard Test Method for Effectiveness of Mineral Admixtures in Preventing Excessive Expansion of Concrete Due to the Alkali-Aggregate Reaction
19. C457, Microscopical Determination of Air-Void Content and Parameters of the Air-Void System in Hardened Concrete
20. C494, Standard Specifications for Chemical Admixtures for Concrete
21. C670, Preparing Precision Statements for Test Methods for Construction Materials
22. C803, Penetration Resistance of Hardened Concrete

C. Workmanship

The Contractor is responsible for correction of concrete work that does not conform to the specified requirements, including strength, tolerances, and finishes. Correct deficient concrete as directed by the Engineer. The Contractor shall also be responsible for the cost of corrections to any other work affected by or resulting from corrections to the concrete work.

Verify with the Owner if they will provide their own special inspector and/or testing laboratory. We recommend the Owner provides and hires the special inspector/testing laboratory.

Paragraphs below should be coordinated to reflect who will be providing the testing.

D. Concrete Testing Service

The Owner or a representative of the Owner will engage a special inspector/testing laboratory to perform material evaluation tests and to design concrete mixes. See detailed requirements in Part 3.14 "Quality Control Testing during Construction". Per the Owner or Engineer's requirements the Contractor shall notify the designated representative to schedule the special inspections and materials testing required by the Project documents.

E. Testing Requirements

Materials and installed work may require testing and retesting, as directed by the Engineer, at any time during the progress of the work. Allow free access to material stockpiles and facilities at all times. All testing, including the retesting of rejected materials and installed work shall be done at the Contractor's expense.

F. Tests for Concrete Materials

1. Test aggregates by the methods of sampling and testing of ASTM C33.

2. For Portland cement, sample the cement and determine the properties by the methods of test of ASTM C150.

3. Submit written reports to the Engineer, for each material sampled and tested prior to the start of work. Provide the Project identification name and number, date of report, name of Contractor, name of concrete testing service, source of concrete aggregates, Material Manufacturer and brand name for manufactured materials, values specified in the referenced specification for each material, and test results. Indicate whether or not material is acceptable for intended use.

4. Certificates of material properties and compliance with specified requirements may be submitted in lieu of testing. The materials producer and the Contractor must sign certificates of compliance.

G. Allowable Tolerances:

1. Construct formwork to provide completed cast-in-place concrete surfaces complying with the tolerances specified in ACI 347, and as follows:

   a. Variation from plumb in lines and surfaces of columns, piers, walls and rises; 1/4-inch per 10 feet, but not more than 1-inch. For exposed corner columns, control joint grooves, and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum; 1/2-inch maximum in 40 feet or more.

   b. Variation from level or grade in slab soffits, ceilings, beam soffits, and rises 1/4-inch in 10 feet, 3/8-inch in any bay or 20 feet maximum, and 3/4-inch in 40 feet or more. For

exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, 1/4-inch in any bay or 20 feet maximum and 1/2-inch in 40 feet or more.

c. Variation from position of the linear lines and related columns, walls, and partitions, 1/2-inch in any bay or 20 feet maximum, and 1-inch in 40 feet or more.

d. Variation in sizes and locations of sleeves, floor openings, and wall openings, 1/4-inch.

e. Variation in cross-sectional dimensions of columns and beams and thickness of slabs and walls, minus 1/4-inch and plus 1/2-inch.

f. Variations in footing plan dimensions, minus 1/2-inch and plus 2 inches; misplacement or eccentricity, 2 percent of the footing width in direction of misplacement but not more than 2 inches; thickness reduction, minus 5 percent.

g. Variation in steps - In a flight of stairs, 1/8-inch for rise and 1/4-inch for treads; in consecutive steps, 1/16-inch for rise and 1/8-inch for treads.

h. Circular structures shall be constructed in a true circular form, with maximum variation of 1/4-inch from the dimensions shown on the plans.

2. Before concrete placement check the lines and levels of erected formwork. Make corrections and adjustments to ensure proper size and location of concrete members and stability of forming systems.

3. During concrete placement check formwork and related supports to ensure that forms are not displaced, and that completed work will be within specified tolerances.

H. Quality Control Testing During Construction

See Section 3 - Execution.

1.3 SUBMITTALS

A. For information only, submit six copies of Manufacturer's data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, water stops, joint systems, chemical floor hardeners, dry-shake finish materials, and others. Bind and submit in one submittal.

B. Submit shop drawings for fabrication, bending and placement of concrete reinforcement. Comply with the ACE 315 "Manual of Standard Practice for Detailing Reinforced Concrete Structures" showing bar schedules, stirrup spacing, diagrams of bent bars, and arrangements of concrete reinforcement. Include special reinforcement required at openings through concrete structures.

C. Submit shop drawings for fabrication and erection of specific finished concrete surfaces as shown or specified. Show the general construction of forms including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items which affect the exposed concrete visually. Submit form drawings for building columns, walls, fascias, and intersections, and concrete pan and joist system. Submit for typical sections only. Engineer's

review is for general architectural applications and features only. Design of formwork for structural stability and efficiency is the Contractor's responsibility.

D. Submit six copies of laboratory test reports for concrete materials and mix design tests as specified.

E. Material Certificates may be provided in lieu of materials laboratory test reports. The Material Manufacturer and the Contractor, certifying that each material item complies with, or exceeds, the specified requirements shall sign material certificates.

1.4 CONCRETE MIX DESIGNS

A. All concrete materials shall be proportioned so as to produce a workable mixture in which the water content will not exceed the maximum specified.

Coordinate who will arrange and pay for testing with other paragraphs in this Section.

B. If the concrete mix designs specified herein have not been used previously by the ready-mix supplier or if directed by the Engineer, mix proportions and concrete strength curves for regular cylinder tests, based on the relationship of 7-, 14- and 28-day strengths versus slump values of 2, 4, and 6 inches, all conforming to these Specifications, shall be established by an approved ready-mix supplier or an independent testing laboratory. A laboratory, independent of the ready-mix supplier, shall be required to prepare and test all concrete cylinders. The costs for preparation of mix designs (if required by the Owner to be performed by an independent testing laboratory) and testing of concrete and materials shall be borne by the Owner, except when materials do not meet specified requirements, in which case such costs shall be borne by the Contractor.

C. The exact proportions by weight of all materials entering into the concrete delivered to the jobsite shall conform to the approved mix design unless specifically so directed by the Engineer or Laboratory for improved specified strength or desired density, uniformity and workability.

D. The proportions of such mix design shall be based on a full cubic yard of hardened concrete.

E. Ready-mix companies or jobsite batch plants shall furnish delivery tickets, signed by a Certified Weighmaster, on which each shall state the weight of aggregates, sand, cement, admixtures and water, and the number of cubic yards of concrete furnished, which will be compared against the approved mix design.

F. There shall be no variation in the weights and proportions of materials from the approved mix design.

G. There shall be no variation in the quality and source of materials once they have been approved for the specific mix design.

1.5 READY-MIXED CONCRETE

Ready-mixed concrete shall conform to the requirements of ACI 301 and ASTM C 94. In case of conflict, ACI 301 shall govern.

1.6 SAMPLE

Contractor shall pour and finish one 2-foot square exposed aggregate concrete sample for Engineer's approval prior to construction if exposed aggregate is included on job.

1.7 JOB CONDITIONS

Maintain continuous traffic control and access for vehicular and pedestrian traffic as required for other construction activities as well as to adjoining facilities for regular operation. Utilize flagmen, barricades, warning signs and warning lights as required, to maintain a safe entrance and passage on all roads or drives abutting the Project.

PART 2 PRODUCTS

2.1 WALL FORMS

A. Full Height Pours: The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete.

B. Wall Form Ties

1. Form ties which remain in the wall of a subgrade water-retaining structure shall have waterstops and a 1-inch minimum break back or cone depth.

2. Snap ties, if used, shall not be broken until the concrete has reached the design concrete strength. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used. The use of tie wires as form ties will not be permitted. Fully threaded stub bolts may be used in lieu of smooth ties with waterstops.

3. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess. Plugs shall be [A-58 SURE PLUG as manufactured by DAYTON SUPERIOR, Santa Fe Springs, CA; phone: (714) 522-3442].

4. Ties shall positively secure the wall to the required dimension and hold the wall to that dimension prior to and during concrete placement.

C. Wall Form Stiffeners

1. Horizontal walers shall consist of structural steel channels, angles, or tubing of adequate size to retain the concrete without deflecting.

2. The walers shall be rolled or welded to the proper radii or offset brackets shall be used for shaping the wall to the dimensions shown on the Drawings and shall be used both for inside and outside wall forms in direct contact with the wall panels and at vertical spacings of no more than 96 inches on center.

3. There shall be at least one such waler within 24 inches of the top and bottom of the wall.

4. The largest dimension of the steel waler shall be in the radial direction.

5. Vertical structural steel or wood members shall be used at a minimum horizontal spacing of 74 inches and shall have sufficient rigidity and strength to insure the proper vertical alignments with the aid of braces under all predictable stress conditions.

6. In lieu of the above, a different system and spacings may be used if it is satisfactorily demonstrated to the Engineer that it will be equally effective.

2.2 FORMS FOR EXPOSED FINISH CONCRETE

Unless otherwise shown or specified, construct all formwork for exposed concrete surfaces with plywood, metal, metal-framed plywood-faced or other acceptable panel-type materials, to provide continuous, straight, smooth, exposed surfaces. Finish in largest practicable sizes to minimize number of joints and to conform to joint system shown on drawings. Provide form material with sufficient thickness to withstand pressure of newly placed concrete without bow or deflection. Use overlaid plywood complying with U.S. Product Standard PS-1 "B-B High Density Overlaid Concrete Form", Class I. Use flexible spring steel forms or laminated boards free of distortion and defects to form radius bends as required.

2.3 FORMS FOR UNEXPOSED FINISH CONCRETE

A. Form concrete surfaces which will be unexposed in finished structure with plywood, lumber, metal, or other acceptable material. Provide lumber dressed on at least two edges and one side for tight fit.

2.4 FORM MATERIALS

A. Form Coatings

Provide commercial formulation form-coating compounds that will not bond with, stain nor adversely affect concrete surfaces, and will not impair subsequent treatments of concrete surfaces requiring bond or adhesion, nor impede wetting of surfaces to be cured with water or curing compound. Petroleum based coatings shall not be used for structures in creeks and waterways. Biodegradable coatings shall be used which will not contaminate the creeks/waterways or an alternate method for stripping the form shall be proposed.

B. Chamfers, Reveals, Drips

Provide preformed PVC or shaped wood or metal of size and profile as shown on drawings.

C. Cylindrical Columns and Supports

Form round-section members with paper or fiber tubes, constructed of laminated plies using water-resistant type adhesive with wax-impregnated exterior for weather and moisture protection. Provide units with sufficient wall thickness to resist loads imposed by wet concrete without deformation. Provide units having "seamless" interior to minimize spiral gaps or seams.

D. Pan Forms

Provide forms for concrete pan-type construction complete with covers and end enclosures to form a true, clean, smooth concrete surface. Design units for easy removal without damaging placed concrete. Block adjoining pan units if required to avoid lateral deflection of formwork during concrete placement and compaction. Provide standard or tapered end forms, as shown.

If required, factory-fabricate pan form units to required sizes and shapes of the following:

1. Steel – 16-gauge minimum, free of dents, irregularities, sag, and rust, or

2. Glass-Fiber Reinforced Plastic - Molded under pressure with matched dies, 0.11 inches minimum wall thickness.

E. Inserts

Provide metal inserts for anchorage of materials or equipment to concrete construction, not supplied by other trades and as required for the work. Provide "Parabolt" by the Molly Company, "Phillips Red-Head", or "Burke" products. The Contractor is responsible for ensuring that all required anchorage not specified in the Project documents is installed per current building code and applicable ICC report requirements.

2.5 REINFORCING MATERIALS

A. Reinforcing Bar (rebar): ASTM A615 and as follows below>

Stirrups and Ties	Grade 60 (Grade 40 may be used for #3 and smaller)
All other Uses	Grade 60

B. Steel Wire: ASTM A82, plain, cold-drawn, steel.

C. Welded Wire Fabric (WWF): ASTM A185, welded steel wire fabric.

D. Supports for Reinforcement

Provide supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing bars, and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations, unless otherwise specified. Wood, brick, concrete blocks, and other devices will not be acceptable. For slabs-on-grade, use supports with sand plates or horizontal runners where wetted base materials will not support chair legs. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with legs that are hot-dip galvanized, after fabrication, or plastic protected or stainless steel protected.

E. Fiber Reinforcement – Collated polypropylene fiber, 3/4-inch, manufactured from 100 percent virgin homopolymer polypropylene, hydrophobic, in compliance with ASTM C116.

2.6 CONCRETE MATERIALS

A. Portland Cement

ASTM C150, Type II, unless otherwise acceptable to Engineer. Use only one brand of cement throughout the Project, unless otherwise acceptable to the Engineer. The use of ground granulated blast furnace slag is not allowed.

B. Aggregates

ASTM C33 and as herein specified. Provide aggregates from a single source for all exposed concrete.

Local aggregates not complying with ASTM C33, but which have shown by special test or actual service to produce concrete of adequate strength and durability, may be used when acceptable to the Engineer.

1. Fine Aggregate - Clean, sharp, natural sand free from loam, clay, lumps, or other deleterious substances. Dune sand, bank-run sand and manufactured sand are not acceptable.

2. Coarse Aggregate - Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:

   a. Crushed stone processed from natural rock or stone.

   b. Washed gravel, either natural or crushed. Use of pit or bank run gravel is not permitted.

   c. Maximum Aggregate Size - Not larger than one-fifth of the narrowest dimensions between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear space between individual reinforcing bars or bundles of bars.

3. These limitations may be waived if, in the judgment of the Engineer, workability and methods of consolidation are such that concrete can be placed without honeycomb or voids.

4. In general, it is desired that normal commercial mixes using 1-1/2-inch or 3/4-inch maximum aggregate size be used.

5. Aggregate for exposed aggregate concrete shall consist of selected aggregate of washed clean river gravel in color range of medium to dark in browns and grays; material uniformly sized 5/8-inch to 3/4-inch.

C. Water: Clean, fresh, drinkable.

D. Air Entraining Admixture: ASTM C260.

E. Water-Reducing Admixture: ASTM C494, Type A.

F. Set-Control Admixtures: ASTM C494, as follows:

1. Type B, Retarding

2. Type C, Accelerating

3. Type D, Water-reducing and Retarding

4. Type E, Water-reducing and Accelerating

Calcium chloride will not be permitted in concrete, unless otherwise authorized in writing by the Engineer.

2.7 RELATED MATERIALS

A. Waterstops

Provide flat, dumbbell type, or centerbulb type waterstops at construction joints and other joints as shown. Size to suit joints or as shown. Provide PVC waterstops complying with Corps of Engineer's CRD-C 572. Waterstops to be Greenstreak 701 or equal. Split face waterstops will not be acceptable under any circumstances.

B. Bituminous and Fiber Joint Filler

Provide resilient and non-extruding type pre-molded bituminous impregnated fiberboard units complying with ASTM D1751, FS HH-F-341, Type 1 and AASHTO M 213. Provide one of the following products:

1. Elastite; Philip Carey/Celotex

2. Flexcell; Celotex Corp.

3. Crane Fiber 1390; W.R. Grace & Co.

4. Fibre; W.R. Meadows, Inc.

5. Tex-Lite; J & P Petroleum Prod. Inc.

6. Sonoflex; Sonneborn/Contech, Inc.

C. Joint Sealing Compound: See Section 07 92 00, Sealants and Caulking

D. Moisture Barrier

Provide moisture barrier cover over all prepared base material. Use only materials that are resistant to decay when tested in accordance with ASTM E154. The moisture barrier consists of heavy Kraft papers laminated together with glass fiber reinforcement and overcoated with black polyethylene on each side. Provide Moistop, St. Regis, or equal.

E. Form Ties (for forms other than wall forms)

Factory-fabricated, adjustable-length, removable or snap off metal form ties, designed to prevent form deflection, and to prevent spalling concrete surfaces upon removal. Unless otherwise shown, provide ties so portion remaining within concrete after removal is at least 1-1/2 inches inside concrete. Unless otherwise shown, provide form ties, which will not leave holes larger than 1-inch in diameter in concrete surface.

F. Concrete Curing Materials

Acrylic curing and sealing compound - Water emulsion acrylic curing and sealing compound formulated of acrylic polymers of water-based carrier. W.R. Meadows, Inc. VOCOMP-20 or equal.

G. Epoxy Adhesive

Provide Sikadur Hi-Mod (Sikastik 370) or Sikadur Hi-Mod Gel (Sikastix 390) for application to wire-brushed and prepared existing concrete to be mated to new concrete. Apply per Manufacturer's recommendations.

H. Chemical-Hardener Finish: Provide Hornolith from Tamms Industries or equal.

I. Non-slip Aggregate Finish

Provide fused aluminum oxide grits, or crushed emery, as abrasive aggregate for non-slip finish with emery aggregate containing not less than 40 percent aluminum oxide and not less than 25 percent ferric oxide. Use material that is factory-graded, packaged, rustproof and non-glazing, and is unaffected by freezing, moisture and cleaning materials.

J. Non-shrink Grout: See Section 03 60 00, Grouting.

2.8 PROPORTIONING NORMAL CONCRETE

A. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for each class of concrete required, complying with ACI 211.1. All measurements shall be by weight. All concrete admixtures will either be by the same supplier to insure compatibility. If different suppliers are used, a memorandum from EACH admixture supplier will be provided stating the compatibility of their product with the other supplier's products.

B. The slump shall be between 2 inches and 4 inches when tested in accordance with ASTM Specifications C 143. Variations in the slump range may be allowed by the Engineer if admixtures, such as water reducers or superplasticizers, are utilized in the concrete mix. Regardless of the measured slump, the maximum allowable water-cement ratios as specified here-in, shall be strictly adhered to.

C. Compressive Strength, Water and Cement Content

Notwithstanding what has been stated here-before, and unless shown otherwise on the Drawings, the concrete shall meet the following requirements. All concrete except as noted otherwise on the drawings shall have 4,000 pounds per square inch (psi) 28-day compressive strength. The maximum water content per 94-pound sack of cement is 4.5 gallons. The minimum cement content for the 4,000-psi mix is 6.0 sacks (94-pound sack of cement per cubic yard of concrete). Up to a maximum of 15 percent of cementatious material may be fly ash in accordance with ASTM C618. The use ground granulated blast furnace slag is not allowed.

D. Retarding Densifiers

1. All concrete (as defined in 2.9 below) used for wall construction shall also contain DARATARD-17, as manufactured by Grace Const. Products, Cambridge, MA or MBL-82, as manufactured by Master Builders, Cleveland, OH in the amounts recommended by the

Additive Manufacturer whenever the air temperature during the pour exceeds 85 degrees Fahrenheit (F).

2. To be considered as equal, any alternate product offered for consideration shall contain no calcium chloride and shall be compatible with air-entrained cements and air-entraining admixtures conforming to the applicable ASTM, AASHTO, ANSI and Federal specifications.

3. Contractor shall certify that admixtures do not contain calcium chlorides or other corrosive materials.

E. Air-Entraining Agents

1. All concrete that that is specified to be air entrained or that may be exposed to freeze/thaw action either during construction or the service life of the structure must be air entrained. Sufficient air-entraining agent shall be used to provide total air content of 5 percent, +/- 1 percent.

2. Air-entraining agents shall meet ASTM C 260, ASTM C 233 and ASTM C 457.

3. The maximum total volumetric air content of the concrete before placement shall be 6 percent plus or minus one percent as determined by ASTM C 173 or ASTM 231.

4. Subject to these Specifications, consideration will be given to the following products: PROTEX "AES," GRACE "DAREX AEA," MASTER BUILDERS "MB-AE10," or SIKA CHEMICAL "AER."

F. Water Reducing Admixtures

1. In addition to air-entrainment, approved water reducing additives, which do not affect the ultimate performance of any steel in any way, may be added to maintain the maximum water content below that specified herein. Water reducing additives shall conform to ASTM C 494, Type A or D.

2. The use of water reducing additives shall not permit a reduction in the minimum specified cement content or in the specified amount of air-entrainment.

3. Admixtures shall contain no calcium chloride, tri-ethanolamine or fly ash. All admixtures shall be from the same manufacturer.

4. Superplasticizers, if allowed by the Engineer, shall conform to ASTM C 494, Type F or G, batch plant added using second or third generation only.

5. Set control admixtures if allowed by the Engineer, shall conform to ASTM C 494, Type B (retarding) or Type C (accelerating).

G. Fiber reinforcement admixture shall be included in the ready-mix concrete design used for filling and channeling the wet well chambers. Fibers shall be used in strict accordance with the Manufacturer's directions.

2.9 CONCRETE MIXING

Ready-Mix Concrete - Comply with the requirements of ASTM C94, and as herein specified. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C94 may be required. When the air temperature is between 85 degrees F and 90 degrees F, reduce the mixing and delivery time from 1-1/2 hours to 75 minutes, and when the air temperature is above 90 degrees F, reduce the mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.1 FORMS

A. Design, erect, support, brace, and maintain formwork to support vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. Construct formworks so concrete members and structures are of correct size, shape, alignment, elevation, and position.

B. Design formworks to be readily removable without impact shock, or damage to cast-in-place concrete surfaces and adjacent materials.

C. Construct forms complying with ACI 347, to sizes, shapes, lines and dimensions shown, and to obtain accurate alignment, location, grades, level, and plumb work in finished structures. Provide for openings, offsets, sinkages, keyways, recesses, moldings, rustications, reglets, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and other features required in work. Use selected materials to obtain required finishes. Solidly butt joints and provide backup at joints to prevent leakage of cement paste.

D. Fabricate forms for easy removal without hammering or prying against the concrete surfaces. Provide crush plates or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces where slope is too steep to place concrete with bottom forms only. Kerf wood inserts for forming keyways, reglets, recesses, and the like, to prevent swelling and for easy removal.

E. Erect falsework and support; brace and maintain it to safely support vertical, lateral, and asymmetrical loads applied until such loads can be supported by in-place concrete structures.

Provide shores and struts with positive means of adjustment capable of taking up formwork settlement during concrete placing operations, using wedges or jacks or a combination thereof. Provide trussed supports when adequate foundations for shores and struts cannot be secured.

Support form facing materials by structural members spaced sufficiently close to prevent deflection. Fit forms placed in successive units for continuous surfaces to accurate alignment, free from irregularities and within allowable tolerances.

F. Forms for Exposed Concrete

Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes. Do not splinter forms by driving ties through improperly prepared holes. Do not use metal cover plates for patching holes or defects in forms. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square

intersections. Use extra studs, walers, and bracing to prevent bowing of forms between studs and to avoid bowed appearance in concrete. Do not use narrow strips of form material, which will produce bow. Assemble forms so they may be readily removed without damage to exposed concrete surfaces. Form molding shapes, recesses and projections with smooth-finish materials, and install in forms with sealed joints to prevent displacement.

Corner Treatment - Form exposed corners of beams and columns to produce square, smooth, solid, unbroken lines, except as otherwise indicated.

G. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings of forms at inconspicuous locations.

H. Chamfer exposed corners and edges, reveals and drips as shown using wood, metal, PVC or rubber strips fabricated to produce uniform smooth lines and tight edge joints.

I. Provisions for Other Trades - Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses and chases from trades providing such ties. Accurately place and securely support items built into forms.

J. Cleaning and Tightening - Thoroughly clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, or other debris just before concrete is placed. Retighten forms after concrete placement if required to eliminate mortar leaks.

3.2 PLACING REINFORCEMENT

Detail and place according to ACI Manual SP-66. Unless otherwise noted, minimum cover shall be 1-1/2 inches for No. 5 and smaller bars, 2 inches for No. 6 and larger bars and 3 inches when poured against earth. Unless otherwise noted, bend all horizontals reinforcing a minimum of 2 feet at corners and wall intersections.

A. Clean reinforcement of loose rust and mill scale, earth, ice and other materials which reduce or destroy bond with concrete.

B. Accurately position, support and secure reinforcement against displacement by formwork, construction, or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers, and hangers, as required.

C. Place reinforcement to obtain at least the minimum coverages for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces. Do not place reinforcing bars more than 2 inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

D. Install welded wire fabric in as long lengths as practicable. Lap adjoining pieces at least one full mesh plus 2 inches, and lace splices with wire. Offset end laps in adjacent widths to prevent continuous laps in either direction.

3.3 JOINTS

A. Construction Joints - Locate and install construction joints, which are not shown on the drawings, so as not to impair the strength and appearance of the structure, as acceptable to the Engineer.

B. Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints. Unless otherwise specified, reinforcement shall be lapped in accordance with ACI Standards.

C. Waterstops - Provide waterstops in construction joints as shown on the drawings. Install waterstops to form a continuous diaphragm in each joint. Make provisions to support and protect waterstops during the progress of the work. Fabricate field joints in waterstops in accordance with Manufacturer's printed instructions. Protect waterstop material from damage where it protrudes from any joint.

D. Isolation Joints in Slabs-on-Ground - Construct isolation joints in slabs-on-ground at all points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

E. Control Joints in Slabs-on-Ground - Construct control joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4-inch wide by one-fifth to one-fourth of the slab depth, unless otherwise shown.

1. Form control joints by inserting a pre-molded hardboard or fiberboard strip into the fresh concrete until the top surface of the strip is flush with the slab surface. After the concrete has cured, remove inserts and clean groove of loose debris.

2. Joint sealant material shall be as specified above.

3.4 INSTALLATION OF EMBEDDED ITEMS

A. General - Set and build into the work anchorage devices and other embedded items required for other work that is attached to, or supported by, cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of the items to be attached thereto.

B. Edge Forms and Screed Strips for Slabs - Set edge forms or bulkheads and intermediate screed strips for slabs to obtain the required elevations and contours in the finished slab surface. Provide and secure units sufficiently strong to support the types of screed strips by the use of strike-off templates or accepted compacting type screeds.

C. Cast in Place Reglets - Place in straight and continuous lines as detailed to enable flashing to be applied continuously without deviation at reglet joints more than 1/8-inch. Miter corners for continuous reglet joint where outside corners occur. At inside corners extend one section 1-inch past corner. Adequately anchor or secure reglets per Manufacturer's instructions prior to pouring and during construction to insure dimensional tolerances and alignment. Vibrate concrete to insure concrete cover adjacent to and around reglet. Visually inspect after pour and patch as required.

3.5 PREPARATION OF FORM SURFACES

Coat the contact surfaces of forms with a form-coating compound before reinforcement is placed. Thin formcoating compounds only with thinning agent of type, and in amount, and under conditions of the Form-coating Compound Manufacturer's directions. Use dissipating-type form oil at surfaces to receive cement plaster finish. Do not allow excess form-coating material to accumulate in the forms or to come into contact with concrete surfaces against which fresh concrete will be placed. Apply in compliance with Manufacturer's instructions. Coat steel forms with a non-staining, rust-preventative form oil or otherwise protect against rusting. Rust-stained steel formwork is not acceptable.

3.6 CONCRETE PLACEMENT

A. Pre-Placement Inspection

1. Before placing concrete, inspect and complete the formwork installation, reinforcing steel, and items to be embedded or cast in. Notify other crafts involved in ample time to permit the installation of their work; cooperate with other trades in setting such work as required. Notify Engineer in time for inspection prior to pouring.

2. Thoroughly wet wood forms immediately before placing concrete, as required where form coatings are not used.

3. Coordinate the installation of joint materials and moisture barriers with placement of forms and reinforcing steel.

4. Concrete Curbs and Paving - Do not place concrete until subbase is completed and approved by the Engineer as required to provide uniform dampened condition at the time concrete is placed. Moisten subbase as required to provide uniform dampened condition at the time concrete is placed.

B. Place concrete in compliance with the practices and recommendations of ACI 304 and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as herein specified. Perform concrete placing at such a rate that concrete, which is being integrated, with fresh concrete is still plastic. Deposit concrete as nearly as practicable to its final location to avoid segregation due to re-handling or flowing. Do not subject concrete to any procedure, which will cause segregation.

2. Screed concrete which is to receive other construction to the proper level to avoid excessive skimming or grouting.

3. Do not use concrete which becomes non-plastic and unworkable or does not meet the required quality control limits or which has been contaminated by foreign materials. Do not use re-tempered concrete. Remove rejected concrete from the Project Site and dispose of in an acceptable location. Do not use concrete whose allowable mixing time has been exceeded.

C. Concrete Conveying

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practicable by methods, which will prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice, and other deleterious materials.

3. The Contractor shall provide traffic control on the narrow access roads to the work sites.

4. The Contractor shall not wash concrete trucks/chutes/equipment off at the Project Site unless plastic tarps and hay bales are employed to contain the concrete. The Contractor will be required to haul off-site all concrete contaminated soil.

D. Placing Concrete into Forms

1. Deposit concrete in forms in horizontal layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.

2. Do not interrupt successive placement; do not permit cold joints to occur.

3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete in accordance with the recommended practices of ACI 309, to suit the type of concrete and Project conditions. Vibration of forms and reinforcing will not be permitted.

5. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete at least 6 inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.

6. Do not place concrete in supporting elements until the concrete previously placed in columns and walls is no longer plastic.

E. Placing Concrete Slabs

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.

2. Consolidate concrete during placing operations using mechanical vibrating equipment so the concrete is thoroughly worked around reinforcement and other embedded items and into corners.

3. Consolidate concrete placed in beams and girders of supported slabs and against bulkheads of slabs on ground, as specified for formed concrete structures. Consolidate concrete in the remainder of slabs by vibrating bridge screeds, roller pipe screeds, or other acceptable methods. Limit the time of vibrating consolidation to prevent bringing an excess of fine aggregate to the surface.

4. Bring slab surfaces to the correct level with a straight edge and strike off. Use bull floats or darbies to smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.

5. Maintain reinforcing steel in the proper position continuously during concrete placement operations.

F. Bonding

1. Roughen surfaces of set concrete at all joints except where bonding is obtained by use of concrete bonding agent, and clean surfaces of laitance, coatings, loose particles and foreign matter. Roughen surfaces in a manner to expose bonded aggregate uniformly and not to leave laitance, loose particles of aggregate or damaged concrete at the surface.

2. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:

   a. At joints between footings and walls or columns, and between walls or columns and beams or slabs they support, and elsewhere unless otherwise specified herein, dampen, but do not saturate, the roughened and cleaned surface of set concrete immediately before placing fresh concrete.

   b. At joints in exposed work; at vertical joints in walls; at joints in girders, beams, supported slabs and other structural members; and at joints designed to contain liquids; dampen, but do not saturate the roughened and cleaned surface of set concrete and apply a liberal coating of neat cement grout.

   c. Use neat cement grout consisting of equal parts Portland cement and fine aggregate by weight and not more than 6 gallons of water per sack of cement. Apply with a stiff broom or brush to a minimum thickness of 1/16-inch. Deposit fresh concrete before cement grout has attained its initial set.

   d. In lieu of neat cement grout, bonding grout may be a commercial bonding agent. Apply to cleaned concrete surfaces in accordance with the printed instructions of the Bonding Material Manufacturer.

3. Prepare for bonding of fresh concrete to fully cured hardened concrete or existing concrete by using an epoxy-resin-bonding agent as follows:

a. Handle and store epoxy-resin adhesive binder in compliance with the Manufacturer's printed instructions, including safety precautions.

b. Mix the epoxy-resin adhesive binder in the proportions recommended by the Manufacturer, carefully following directions for safety of personnel.

c. Before depositing fresh concrete, thoroughly roughen and clean hardened concrete surfaces and coat with epoxy-resin grout not less than 1/16-inch thick. Place fresh concrete while the epoxy-resin material is still tacky, without removing the in-place grout coat, and as directed by the Epoxy-resin Manufacturer.

G. Cold Weather Placing

1. Protect all concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.

2. When the air temperature has fallen to or is expected to fall below 40 degrees F, provide adequate means to maintain the temperature in the area where concrete is being placed at either 70 degrees F for 3 days or 50 degrees F for 5 days after placing. Provide temporary housing or coverings including tarpaulins or plastic film. Keep protections in place and intact at least 24 hours after artificial heat is discontinued. Keep concrete moist. Avoid rapid dry-out of concrete due to over-heating and avoid thermal shock due to sudden cooling or heating.

3. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50 degrees F, and not more than 80 degrees F, at point of placement.

4. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.

5. Do not use calcium chloride, salt and other materials containing antifreeze agents or chemical accelerators unless otherwise accepted in mix designs.

H. Hot Weather Placing

1. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.

2. Cool ingredients before mixing to maintain concrete temperature at time of placement below 90 degrees F. Mixing water may be chilled or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated to the total amount of mixing water.

3. Cover reinforcing steel with water-soaked burlap if it becomes too hot so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.

4. Wet forms thoroughly before placing concrete.

5. Do not use retarding admixtures unless otherwise accepted in mix designs.

3.7 FINISH OF FORMED SURFACES

A. Rough Form Finish

For formed concrete surfaces not exposed to view in the finish work or covered by other construction, unless otherwise shown or specified. This is the concrete surface having the texture imparted by the form facing material used, with tie holes and defective areas repaired and patched and fins and other projections exceeding 1/4-inch in height rubbed down or chipped off.

B. Smooth Form Finish

Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view. Or that are to be covered with a coating material applied directly to the concrete, or a covering material bonded to the concrete such as waterproofing, damp proofing, painting or other similar system.

Produce smooth form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed.

C. Curb Finishes

Curbs shall be screeded off accurately to true lines and planes or warped surfaces as indicated or directed. Finish smooth. Arises shall be true and straight or properly eased where curved and neatly rounded with approved tool. Smooth trowel finish with corners rounded to 3/4-inch radius.

D. Grout Cleaned Finish (Sacked)

Provide grout cleaned finish to scheduled concrete surfaces which have received smooth form finish treatment, and to all exposed to view interior and exterior building surfaces, typical.

Combine one part Portland cement to 1-1/2 parts fine sand by volume and mix with water to the consistency of thick paint. Blend standard Portland cement and white Portland cement, amounts determined by trial patches, so that final color of dry grout will closely match adjacent surfaces.

Thoroughly wet concrete surfaces and apply grout immediately to coat surfaces and fill small holes. Remove excess grout by scraping and rubbing with clean burlap. Keep damp by fog spray for at least 36 hours after rubbing.

E. Related Unformed Surfaces

At tops of walls, horizontal offsets and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.8 MONOLITHIC SLAB FINISHES

A. Float Finish

1. Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing or sand bed terrazzo, and as otherwise shown on drawings or in schedules.

2. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance not exceeding 1/4-inch in 10 feet when tested with a 10-foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill at low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

B. Trowel Finish

1. Apply trowel finish to monolithic slab surfaces that are to be exposed to view, unless otherwise shown, and slab surfaces that are to be covered with resilient flooring, paint, or other thin-film finish coating system.

2. After floating, begin the first trowel finish operation using a power-driven trowel. Begin final troweling when the surface produces a ringing sound as the trowel is moved over the surface.

3. Consolidate the concrete surface by the final hand troweling operation, free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in 10 feet when tested with a 10-foot straightedge. Grind smooth surface defects which would telegraph through applied floor covering system.

C. Exposed Aggregate Finish

1. Screed to true plane, bullfloat surfaces, provide uniform double troweled finish. After troweling, let set until hard enough to wash without disturbing coarse aggregates. Simultaneously brush and spray with water to expose large aggregate and produce texture to match approved sample. Water cure or keep wet for 25 hours.

2. Scrub surface after 24 hours with a 1-part muriatic acid to 10-part water solution. Rinse thoroughly.

D. Broom Finish (Non-Slip)

1. Apply non-slip, broom finish to exterior concrete platforms, steps and ramps and elsewhere as shown on the drawings or in schedules.

2. Immediately after trowel finish, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route or in the direction of water flow. Use fiber-

bristle broom unless otherwise directed. Coordinate the required final finish with the Engineer before application.

E. Chemical-Hardener Finish

1. Apply chemical curing-hardening compound or chemical-hardener to all interior concrete floors which will not receive applied finish materials. Mask adjacent work and surfaces to avoid over spray. Apply liquid chemical-hardener after complete curing and drying of the concrete surface.

2. Dilute the liquid hardener with water and apply in accordance with the Manufacturer's printed directions. Evenly apply each coat and allow for drying between coats in accordance with Manufacturer's printed directions.

3. After the final coat of chemical-hardener solution is applied and dried, remove surplus hardener by scrubbing and mopping with water.

F. Non-slip Aggregate Finish

Apply non-slip aggregate finish to concrete stair treads, platforms, ramps, and elsewhere as shown on the drawings or in schedules.

After completion of float finishing and before starting trowel finish, uniformly spread 25 pounds of dampened non-slip aggregate per 100 square feet of surface. Tamp aggregate flush with surface using steel trowel, but do not force the non-slip aggregate particles below surface. After broadcasting and tamping, apply trowel finish as herein specified. After curing, lightly work the surface with a steel wire brush, or an abrasive stone, and water to expose the non-slip aggregate.

3.9 SCHEDULE OF CONCRETE SURFACE FINISHES

Also see Section 09 90 00, Painting and Coating for protective coating requirements.

	Surface Description	Type	Finish Requirement
A.	Interior Horizontal Slabs	Slab	Trowel Finish
B.	Exterior Horizontal Slabs	Slab	Broom Finish (Non-Slip)
C.	Stair Treads, Platforms and Ramps	Slab	Non-Slip Aggregate
D.	Interior Vertical Surfaces (including Wet Well)	Formed	Smooth Form
E.	Exterior Vertical Surfaces Exposed to View	Formed	Smooth Form

3.10 CONCRETE CURING AND PROTECTION

A. General

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.

2. Start initial curing as soon as free moisture has disappeared from the concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than 72 hours.

3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures. Avoid rapid drying at the end of the final curing period.

B. Curing Methods

Perform curing of concrete by moist curing, by moisture-retaining cover curing, by membrane curing, or by combinations thereof, as herein specified. Provide the curing methods indicated as follows:

1. For concrete floor slabs provide moisture curing, moisture cover curing, or liquid membrane/chemical curing-hardening curing. If liquid membrane curing is used, it must be compatible with concrete hardening compounds to be applied later.

2. For other concrete work, provide moisture curing or moisture cover curing. Do not use liquid membrane or chemical curing-hardening curing on any concrete work to receive any applied finishes.

3. For curing, use only water that is free of impurities, which could etch or discolor exposed, natural concrete surfaces.

4. Provide moisture curing by any of the following methods:

   a. Keeping the surface of the concrete continuously wet by covering with water.

   b. Continuous water-fog spray.

   c. Covering the concrete surface with the specified absorptive cover thoroughly saturated with water and keeping the absorptive cover continuously wet. Place absorptive cover so as to provide coverage of the concrete surfaces and edges with a 4-inch lap over adjacent absorptive covers.

5. Provide moisture-cover curing as follows - Cover the concrete surfaces with the specified moisture-retaining cover for curing concrete placed in the widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.

6. Provide liquid membrane curing as follows:

   a. Apply the specified membrane-forming curing compound to damp concrete surfaces as soon as the water film has disappeared. Apply uniformly in a coat continuous

operation by power spray equipment in accordance with the Manufacturer's directions. Recoat areas, which are subjected to heavy rainfall within 3 hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.

b. Do not use membrane-curing compounds on surfaces, which are to be covered with a coating material applied directly to the concrete or with a covering material bonded to the concrete. Such as other concrete, liquid floor hardener, waterproofing, dampproofing, membrane roofing, flooring, painting, and other coatings and finish materials, unless otherwise acceptable to the Engineer.

7. Curing Formed Surfaces - Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs, and other similar surfaces by moist curing with the forms in place for the full curing period or until forms are removed. If forms are removed, continue curing by methods specified above, as applicable.

8. Curing Unformed Surfaces

a. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by moist curing, whenever possible.

b. Final cure unformed surfaces, unless otherwise specified, by any of the methods specified above, as applicable.

c. Final cure concrete surfaces to receive liquid floor hardener or finish flooring by use of moisture-retaining cover, unless otherwise acceptable to the Engineer.

9. Provide liquid curing-hardening compound as follows:

a. Apply to horizontal surfaces when concrete is dry to touch by means of power spray, hand spray or hair broom in accordance with Manufacturer's directions.

C. Temperature of Concrete during Curing

1. When the atmospheric temperature is 40 degrees F and below, maintain the concrete temperature between 50 degrees F and 70 degrees F continuously throughout the curing period. When necessary, make arrangements before concrete placing for heating, covering, insulation, or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protections complying with the requirements of ACI 306.

2. When the atmospheric temperature is 80 degrees F, and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation wind breaks or shading, and for fog spraying, wet sprinkling, or moisture-retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protections complying with the requirements of ACI 305.

3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete, which exceed 5 degrees F in any 1-hour and 50 degrees Ft in any 24-hour period.

D. Protection from Mechanical Injury - During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.11 MISCELLANEOUS CONCRETE ITEMS

A. Filling-In - Fill-in holes and openings in concrete structures for the passage of work by other trades, unless otherwise shown or directed, after the work of other trades is in place. Mix, place, and cure concrete as herein specified, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the work.

B. Curbs - Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

C. Equipment Bases and Foundations - Provide machine and equipment bases and foundations as shown on the drawings. Set anchor bolts for machines and equipment to template at correct elevations, complying with certified diagrams or templates of the Manufacturer furnishing the machines and equipment.

3.12 REMOVAL OF SHORES AND FORMS

A. Remove shores and re-shore in a planned sequence to avoid damage to partially cured concrete. Locate and provide adequate re-shoring to safely support the work without excessive stress or deflection.

Keep re-shores in place a minimum of 15 days after placing upper tier, and longer if required, until the concrete has attained its required 28-day strength and heavy loads due to construction operations have been removed.

B. Formwork not supporting weight of concrete, such as sides of beams, walls, columns, and similar parts of the work, may be removed after cumulative curing at not less than 50 degrees F for 24 hours after placing concrete. Providing the concrete is sufficiently hard to not be damaged by form removal operations and provided curing and protection operations are maintained.

C. Formwork supporting weight of concrete, such as beam soffits, joints, slabs, and other structural elements, may not be removed in less than 14 days and until concrete has attained design minimum compressive strength at 28 days. Determine potential compressive strength of in place concrete by testing field-cured specimens representative of concrete location or members.

D. Form facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form facing material without loosening or disturbing shores and supports.

E. Re-Use of Forms

Clean and repair surfaces of forms to be re-used in the work. Split, frayed, delaminated, or otherwise damaged form facing material will not be acceptable. Apply new form coating compound material to concrete contact surfaces as specified for new formwork.

When forms are extended for successive concrete placement, thoroughly clean surfaces, remove fins and laitance, and tighten forms to close all joints. Align and secure joints to avoid offsets. Do not use "patched" forms for exposed concrete surfaces, except as acceptable to the Architect.

No forming material will be allowed to be built permanently into exposed visible surfaces.

3.13 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas

1. Repair and patch defective areas with cement mortar immediately after removal of forms but only when directed by the Engineer.

2. Cut out honeycomb, rock pockets, voids over 1/2-inch diameter, and holes left by tie rods and bolts down to solid concrete but, in no case, to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water and brush-coat the area to be patched with neat cement grout. Proprietary patching compounds may be used when acceptable to the Engineer.

3. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

4. Fill holes extending through concrete by means of a plunger type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure complete filling.

B. Repair of Formed Surfaces

1. Repair exposed-to-view formed concrete surfaces that contain defects, which adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolt; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.

2. Repair concealed formed concrete surfaces that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01-inch wide, cracks or any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corners.

C. Repair of Unformed Surfaces

1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.

2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.

3. Repair finished unformed surfaces that contain defects, which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, pop outs, honeycomb, rock pockets, and other objectionable conditions.

4. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so those repairs can be made without damage to adjacent areas.

5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the Engineer.

6. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with a neat cement grout coating or use concrete bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same material to provide concrete of the same type or class as the original adjacent concrete. Place, compact, and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

7. Repair isolated random cracks and single holes not over 1-inch in diameter by the dry-pack method. Groove the top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and brush with a neat cement grout coating. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.

8. For repair of existing unformed surfaces, mechanically remove all lose concrete as required to expose sound aggregate. Clean concrete surfaces to achieve a contaminate free, open textured surface. Square cut or undercut perimeter to minimum depth as specified by the Repair Mortar Manufacturer. Remove all loose concrete around the exposed steel and hand tool or blast clean all portions of rebar with visible rust to near white metal finish. If half of the diameter of the reinforcing steel is exposed, chip out behind the reinforcing to a 1/2-inch minimum depth. Splice new reinforcing steel to existing where corrosion has depleted the cross-section area by 25 percent. Apply a corrosion inhibitor/primer/bonding

agent to all exposed rebar and other steel components and to concrete surfaces to be repaired per Manufacturer's requirements, such as Sika Armatec 110. Apply a polymer-modified, cement-based, repair mortar, trowel applied as specified by the Manufacturer, such as Sika MonoTop 615.

9. Repair methods not specified above may be used subject to the acceptance of the Engineer.

3.14 QUALITY CONTROL TESTING DURING CONSTRUCTION

A. The Owner or a representative of the Owner will engage a special inspector/testing laboratory to perform all tests and to submit test reports to the Engineer and the Contractor.

B. Concrete shall be sampled and tested for quality control during the placement of concrete, as follows:

1. Sampling Fresh Concrete - ASTM C172, except modified for slump to comply with ASTM C94.

2. Slump - ASTM 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.

3. Air Content - ASTM C231, pressure method; one for each set of compressive strength test specimens.

4. Compression Test Specimen - ASTM C31; one set of four standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

5. Concrete Temperature - Test hourly when air temperature is 40 degrees F and below, and when 80 degrees F and above; and each time a set of compression test specimens is made.

6. Compressive Strength Tests - ASTM C39; one set for each 100 cubic yards or fraction thereof, of each concrete class placed in any 1 day or for each 5,000 square feet of surface area placed; one specimen tested at 7 days, two specimens tested at 28 days, and one specimen retained in reserve for later testing if required.

a. When the frequency of testing will provide less than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

b. When the total quantity of a given class of concrete is less than 50 cubic yards, the strength tests may be waived by the Engineer if, in the Engineer's judgment, adequate evidence of satisfactory strength is provided.

c. If required by the building official, perform strength tests of cylinders cured under field conditions. Field cured cylinders shall be taken and molded at the same time and from the same samples as the laboratory cured test cylinders. When the strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.

C. Report test results in writing to the Engineer and the Contractor on the same day that tests are made. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of Contractor, name of concrete supplier and truck number, name of concrete testing service, concrete type and class, location of concrete batch in the structure, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-day tests and 28-day tests.

D. Additional tests - The testing service will make additional tests of in-place concrete when test results indicate the specified concrete strengths and other characteristics have not been attained in the structure, as directed by the Engineer. The testing service shall conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42, or by other methods as directed. Contractor shall pay for such tests conducted, and any other additional testing as may be required, when unacceptable concrete is verified.

END OF SECTION

SECTION 03 15 10 - EXPANSION AND CONSTRUCTION JOINTS

For all prestressed concrete reservoirs. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project. Coordinate review & update of this Section with PSE for Project needs.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all work necessary to furnish, install, and complete the tank expansion and construction joints.

B. Section includes:

1. Waterstops
2. Joint sealers
3. Joint fillers
4. Backing rods
5. Bond breakers

C. Related Sections

1. Section 03 30 00 - Cast-In-Place Concrete
2. Section 03 21 00 - Reinforcing Steel
3. Section 03 15 12 - Tank Wall Base and Top Joint
4. Section 33 16 31 – Ground-Level Prestressed Concrete Water Utility Storage Reservoir

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Mill Certificates: Furnish certified mill certificates showing that the material meets all of the requirements specified herein. The Engineer, at their option, may take samples of any materials and have them tested by an independent testing laboratory to verify their compliance with these Specifications. All such costs shall be borne by the Owner. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.

1.3 OBSTRUCTIONS

Contractor shall pay particular attention to removing all obstructions such as concrete, nails, etc., from joints when movements of floor, wall, and roof sections can be expected under prestressing, temperature, and other conditions.

PART 2 PRODUCTS

2.1 WATERSTOPS

A. Waterstops shall be of an approved type, supplied by an approved manufacturer and shall be plastic made of virgin polyvinyl chloride (PVC) compound, shall be ribbed, uniform in dimensions, dense, homogeneous, free from porosity, and as detailed on the Drawings.

B. No reclaimed PVC shall be used in the compound.

C. The finished waterstop material shall meet the following minimum requirements:

1. Tensile strength 2,000 psi (ASTM D412)
2. Ultimate elongation 350 percent (ASTM D412)
3. Shore hardness 75 ±5 (ASTM D2240)
4. Specific gravity 1.3 (ASTM D792)
5. Stiffness in flexure 600 psi (ASTM D747)
6. Cold brittleness -35 degrees Fahrenheit (ASTM D746)
7. Water absorption: 48 hours 0.320 percent max. (ASTM D570)
8. Tear resistance 290 pounds per inch (ASTM D624)

D. VINYLEX CORPORATION and GREENSTREAK PLASTIC PRODUCTS are two of several suppliers who can furnish waterstops meeting these requirements. Approved equal materials may also be used.

2.2 JOINT SEALERS

A. Joints, not requiring waterstops or when so indicated on the Drawings, shall be sealed with a mastic joint sealer material of uniform, stiff consistency that does not contain solvents.

B. The mastic shall tenaciously adhere to primed concrete surfaces, shall remain permanently mastic and shall not contaminate potable water.

C. The material shall be of a type that will effectively and permanently seal joints subject to movements in concrete.

D. The mastic joint sealer shall be an acceptable two-part, self-leveling (or gun grade), non-staining, polyurethane elastomeric sealant which cures at ambient temperature. Acceptable sealants shall conform to ASTM C920 or Federal Specification TT-S-00227E.

E. For sloping joints, vertical joints, and overhead horizontal joints, only "non-sag" compounds shall be used; all such compounds shall conform to the requirements of ANSI/ASTM C920 Class 12-1/2, or Federal Specification TT-S-0027 E(3), Type II.

F. For plane horizontal joints, the self-leveling compounds which meet the requirements of ANSI/ASTM C920 Class 25, or Federal Specification TT-S-0027 E(3), Type I shall be used. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics, and having a Shore "A" hardness range of 25 to 35, shall be used.

G. Primer materials, if recommended by the Sealant Manufacturer, shall conform to the printed recommendations of the Sealant Manufacturer.

H. Acceptable polyurethane materials are PSI-270 RESERVOIR SEALANT, as manufactured by POLYMERIC SYSTEMS, INC., SIKAFLEX/2C POLYURETHANE ELASTOMERIC SEALANT, as manufactured by SIKA CHEMICAL CORP., and SELECT SEAL U-227 RESERVOIR GRADE, as manufactured by SPC, or equal.

2.3 PREFORMED JOINT FILLER

Preformed joint filler material shall be of the preformed non-extruding type joint filler constructed of cellular neoprene sponge rubber or polyurethane of firm texture. Bituminous fiber type will not be permitted. All non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D1752 for Type I, except as otherwise specified herein.

2.4 BACKING ROD

Backing rod shall be an extruded closed-cell, polyethylene foam rod. The material shall be compatible with the joint sealant material used and shall have a tensile strength of not less than 40 pounds per square inch (psi) and a compression deflection of approximately 25 percent at 8 psi. The rod shall be 1/8-inch larger in diameter than the joint width except that a one-inch diameter rod shall be used for a 3/4-inch wide joint.

2.5 BOND BREAKER

Bond breaker shall be SUPER BOND BREAKER WATER BASE as manufactured by Burke Company, SELECT EMULSION CURE 309, as distributed by Select Products Co., (clear or white pigmented) or equivalent. Fugitive dye may be used in bond breakers if recommended by Manufacturer.

PART 3 EXECUTION

3.1 INSTALLATION OF WATERSTOPS

A. The waterstop shall be correctly positioned in the forms so that the center of the waterstop is centered on the joint.

B. In cases where preformed expansion joint material is used in conjunction with the waterstop, allowance shall be made for equal waterstop embedment on each side in the concrete.

C. Waterstop shall be held in place in the forms by use of a split form or other approved method that will positively hold the waterstop in the correct position and to the correct alignment.

D. Horizontal waterstops shall be bent up during placing of concrete until the concrete has been brought to the level of the waterstop; additional concrete shall then be placed over the waterstop, after which the concrete shall be thoroughly vibrated.

E. All horizontal and vertical waterstops, which are not accessible during pouring, shall be tied off in two directions every 12 inches in such a manner that bending over one way, or another is prevented.

F. A hog-ring or nail may be driven through both ends of the waterstop to facilitate placing and tying of waterstops to reinforcing steel forms or form-ties.

G. All waterstops shall be properly spliced and joints shall be checked for strength and pinholes after splicing.

H. Splices shall be strong enough to develop a pulling force of 75 percent of the strength of the waterstop and shall be watertight.

I. Connect the ends of the radial waterstop in the wall footing joints to the circumferential waterstop in the wall to wall-footing joint and to the circumferential waterstops in the floor to wall-footing joints if they should exist.

3.2 JOINT SEALERS

A. Joint sealed areas shall be sandblasted or roughened and blown clean of dust and sand with compressed air before the material may be applied.

B. Joints shall be primed (if required) and the sealant shall be applied in accordance with the Manufacturer's recommendations.

3.3 CONSTRUCTION JOINTS

A. Construction Joints - Locate and install construction joints, which are not shown on the drawings, so as not to impair the strength and appearance of the structure, as acceptable to the Engineer.

B. Place construction joints perpendicular to the main reinforcement. Continue all reinforcement across construction joints.

C. Isolation Joints in Slabs-on-Ground - Construct isolation joints where shown on plans in slabs-on-ground at all points of contact between slabs on ground and vertical surfaces, such as column pedestals, foundation walls, grade beams, and elsewhere as indicated.

D. Control Joints in Slab-on-Ground - Construct control joints in slabs-on-ground to form panels of patterns as shown. Use inserts 1/4-inch wide by one-fifth to one-fourth of the slab depth, unless otherwise shown. Form control joints by inserting a pre-molded hardboard or fiberboard strip into the fresh concrete until the top surface of the strip is flush with the slab surface. After the concrete has cured, remove inserts and clean groove of loose debris.

END OF SECTION

SECTION 03 15 12 - TANK WALL BASE AND TOP JOINT

For all prestressed concrete reservoirs. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers the work necessary to furnish, install, and complete the tank wall base and top joint (if shown on the Drawings).

B. Section includes:

1. Waterstops
2. Bearing pads
3. Closed cell bearing pads
4. Soft mastic

C. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete
2. Section 03 21 00 - Reinforcing Steel
3. Section 03 15 20 - Earthquake Cables
4. Section 33 16 31 – Ground-Level Prestressed Concrete Water Utility Storage Reservoir

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Sample: Provide 2-foot minimum length of each of the closed cell neoprene pads and the neoprene bearing pads in order that the Engineer can test the pads for compliance with this Section.

C. Mill Certificates: Furnish certified mill certificates showing that the material meets all of the requirements specified herein. At the Engineer's option, samples of any materials may be taken to be tested by an independent testing laboratory to verify their compliance with this Section. All such costs shall be borne by the Owner. If any materials should fail to meet these Specifications, all costs for further testing of the replacement material shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 PVC WATERSTOPS

Conform to requirements in Section 03 15 10, Expansion and Construction Joints. The size and location of the waterstop shall be as shown.

2.2 NEOPRENE BEARING PADS

A. Neoprene pads shall be of dimensions and hardness shown on the Drawings and shall be made by an approved manufacturer.

B. The material for 40 durometer neoprene pads shall conform to ASTM D2000 M2BC414A14C12F17 and the material for 30 durometer neoprene pads shall conform to ASTM D2000 M2BC310A14C12F17.

C. Unless otherwise specified on the Drawings, neoprene pads shall be of 40 durometer.

D. KIRKHILL RUBBER CO. and WEST AMERICAN RUBBER COMPANY, INC. are two of several suppliers who can furnish neoprene pads meeting these requirements. Approved equal materials may be used.

2.3 CLOSED CELL NEOPRENE PADS

A. Closed cell neoprene pads, shall be used as a filler material in the flexible joints between the wall and wall-footing and between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads and waterstops.

B. The materials shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D1056 and as further specified here-in and on the Drawings.

1. Compression deflection	9-13 PSI
2. Shore 00 durometer	60 (±5) PCF
3. Density	9 (±2) PCF
4. Water absorption by weight	< 10%
5. Temperature range:	
▪ low (flex without cracking)	-40° F
▪ high continuous	200° F
▪ high intermittent	250° F
6. Heat aging (7 days @ 158° F)	
▪ Flexibility (180° Bend)	PASS
▪ Appearance change	NONE
▪ Change in Compression Deflection	±30%
7. Tensile strength	100 PSI min.
8. Elongation	125% min.
9. Resilience	20%
10. Armacell Monarch #5013 (Black), or equal, are acceptable materials.	

2.4 SOFT MASTIC

A. Soft mastic shall be installed in all voids and cavities around bearing pads, waterstops and seismic cable sleeves. Such material shall be installed with a consistency that will not adversely affect the quality of PVC and neoprene materials.

B. SIKAFLEX 1A, as manufactured by Sika Corporation or SELECT SEAL U-230, as manufactured by Select Products Company, or equal, are acceptable materials.

PART 3 EXECUTION

3.1 INSTALLATION OF PVC WATERSTOP

PVC waterstops shall be continuous and shall be installed where shown. The method of installation shall be as specified in Section 03 15 10, Expansion and Construction Joints.

3.2 BEARING AND FILLER PADS

A. Bearing and filler pads shall be installed as indicated on the Drawings.

B. Bearing and filler pads shall be glued to the concrete with an approved rubber cement material to prevent uplift of the pads during concrete pouring.

C. In addition, all pads shall be held down with approved plastic shim plates placed under the reinforcing steel.

D. Nailing down pads will not be permitted

E. All voids and cavities between bearing and filler pads, waterstop, and seismic cable sleeves, irrespective of whether these voids are large or small, shall be filled with a soft mastic in accordance with the requirements of Section 03255-2.4.

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F. Closed-cell neoprene shall be ordered at least 1/4-inch wider than theoretically required to facilitate placing and to reduce development of voids between filler pads, bearing pads and waterstops.

G. Contractor's workmanship shall be such that no cement grout or concrete seepage will occur through the bearing and filler pad area resulting in a restraint of radial wall-movements.

H. A continuous neoprene pad and one or more sponge filler pads are required between the top of the wall and the underside of the roof. Any void areas between such pads shall be caulked and sealed to prevent any mortar from the roof pour to come in contact with the wall top.

END OF SECTION

SECTION 03 15 20 - EARTHQUAKE CABLES

For all prestressed concrete reservoirs. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all work necessary to furnish, install and complete the tank earthquake cables.

B. Section includes:

1. Earthquake cables
2. Cable sleeves
3. Reinforcing steel

C. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete
2. Section 03 21 00 - Reinforcing Steel
3. Section 03 15 12 - Tank Wall Base and Top Joint
4. Section 33 16 31 – Ground-Level Prestressed Concrete Water Utility Storage Reservoir

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Product Data:

1. Submit five copies of the quantity, location, and details for the Engineer's approval before the earthquake cables are fabricated.

PART 2 PRODUCTS

2.1 EARTHQUAKE CABLES

A. Where called for on the Drawings, earthquake cables consisting of seven wire galvanized strands, meeting the minimum strength requirements on the Drawings and these Specifications, shall be installed to connect wall and wall footing.

B. If no strength requirements are shown on the Drawings, the minimum ultimate strength for 3/8-inch, 1/2-inch and 0.6-inch strand shall be 21,400 pounds, 38,200 pounds, and 53,750 pounds, respectively.

C. The strands shall be hot-dipped galvanized before stranding with a minimum zinc coating of 0.85-ounce per foot squared.

D. Galvanized strands for earthquake cables shall meet the quantity and spacing outlined on the Drawings.

2.2 CLOSED CELL NEOPRENE SEISMIC CABLE SLEEVES

A. Closed cell neoprene pads shall be used as a filler material in the flexible joints between the wall and wall-footing and between the wall and roof connection in the areas not taken up by the solid neoprene bearing pads and waterstops.

B. The material shall be medium grade closed cell neoprene conforming to 2A3 of ASTM D1056 and as further specified herein and on the Drawings.

1. Compression deflection:	9-13 PSI
2. Shore 00 durometer:	60 (±5) PCF
3. Density	9 (±2) PCF
4. Water absorption by weight	< 10%
5. Temperature range:	
▪ low (flex without cracking) ▪ high continuous ▪ high intermittent	-40° F 200° F 250° F
6. Heat aging (7 days @ 158° F):	
▪ Flexibility (180° Bend) ▪ Appearance change	PASS NONE
▪ Change in Compression Deflection	±30%
7. Tensile strength	100 PSI min.
8. Elongation	125% min.
9. Resilience (Bayshore-% rebound average:	
1/2" thickness @ 72° F)	20%
10. Armacell Monarch #5013 (Black), or equal, are acceptable materials.	

2.3 MILD STEEL REINFORCING BARS

The mild steel reinforcing bars for the support of the earthquake cable anchors shall conform to the requirements of Section 03 21 00, Reinforcing Steel.

PART 3 EXECUTION

3.1 EARTHQUAKE CABLES

A. The cables may be cut to length with a burning torch.

B. Where necessary, the strands shall be pre-bent before placing the units in wall and wall footings, as called for on the Drawings.

C. The strands shall be tied to circumferential reinforcing as required and as shown on the Drawings.

D. In the footing, the strands shall be tied to the radial footing bars.

END OF SECTION

SECTION 03 21 00 - REINFORCING STEEL

For all prestressed concrete reservoirs. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all the work necessary to furnish, install, and complete the reinforcing steel.

B. Section includes:

1. Reinforcing steel
2. Cable sleeves
3. Reinforcing steel

C. Related sections

1. Section 03 30 00 - Cast-In-Place Concrete
2. Section 33 16 10 – Ground-Level Prestressed Concrete Water Utility Storage Reservoir

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.

B. Shop Drawings: Submit shop drawings of detailed placing and bending lists for the Engineer's approval before the reinforcement is fabricated.

C. Mill Certificates: Mill test certificates shall be submitted to the Engineer to certify that the reinforcing steel meets the specified requirements. Mill test certificates shall be furnished and paid for by the Contractor.

1.3 QUALITY CONTROL

A. The Engineer may require that test samples be taken, and test certificates be furnished by a reputable material testing laboratory at the Owner's expense.

PART 2 PRODUCTS

2.1 DEFORMED REINFORCING BARS

A. Unless otherwise specified, reinforcing steel shall be Grade 60 billet steel conforming to ASTM A615.

B. Varying grades shall not be used interchangeably in structures.

C. All such reinforcing shall be deformed steel bars with deformations conforming to the requirements set forth in ASTM A615.

D. Steel bending processes shall conform to the requirements of ACI 318.

E. Bending or straightening shall be accomplished so that the steel will not be damaged.

F. Kinked bars shall not be used.

G. Spiral reinforcement and steel wire shall be cold-drawn steel wire conforming to the requirements of ASTM A82 unless shown otherwise on the Drawings.

2.2 PLAIN REINFORCING BARS

Spiral reinforcement shall be cold-drawn steel wire conforming to the requirements of ASTM A82 unless shown otherwise on the Drawings.

2.3 SUPPORTS

A. Bar supports shall conform to ACI 315.

B. Bar supports shall consist of approved high density "adobes", stainless steel chairs, plastic spacers or plastic shim plates.

1. Brick, broken concrete masonry units, spalls, rocks or similar materials shall not be used for support of reinforcing steel.

2. Steel chairs shall be furnished with plastic tips when incorporated into concrete exposed to view, such as in the roof slab.

3. Plastic spacers shall be PRECO BARSPAN WHEELS, as manufactured by the PRECO CORPORATION or equal.

4. Plastic shim plates may be used to support the plastic spacers and shall be used to support the vertical reinforcing in the corewall, unless shown otherwise on the Drawings.

C. Hot-dipped Galvanized Reinforcing Bars

When reinforcing bars are indicated on the Drawings to be hot-dipped galvanized, they shall be galvanized in accordance with ASTM A767 and ASTM A143. The grade of reinforcing bars shall be as specified under Section 03 21 00-2.1. The bars shall be galvanized in conformance with a Class 1 coating and shall be galvanized after fabrication and shearing.

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D. Welded Wire Fabric Reinforcement

If specified on the Drawings, welded wire fabric shall be manufactured in accordance with ASTM A185. It shall be of new stock and free from rust when placed in the work.

E. Steel Tie Wire: Annealed steel tie wire shall be used to fasten the reinforcing steel in place.

PART 3 EXECUTION

3.1 REINFORCING BARS

Comply with the specified codes and standards and Concrete Reinforcing Steel Institutes recommended practice for "placing reinforcing bars," for details and methods of reinforcement placement and supports, and as herein specified.

A. General

1. Mild steel reinforcing bars shall be furnished, cut, bent, and placed as indicated on the Drawings.

2. At the time of placing concrete, all reinforcement shall be free from loose mill scale, rust, grease, or other coating which might destroy or reduce its bond with concrete.

3. Steel reinforcement which is to be placed in the work shall be stored under cover to prevent rusting and shall be placed on blocking such that no steel touches any ground surface.

4. All reinforcing steel placed in the work shall be tied together and supported in such a manner that displacement during placing of concrete and shotcrete will not occur.

5. When there is a delay in depositing concrete, reinforcement shall be re-inspected and cleaned when necessary.

B. Cutting and Bending

1. Steel reinforcement shall be cut and bent in accordance with ACI 318 and with approved practices and machine methods, either at the shop or in the field.

2. Reinforcement shall be accurately formed to the dimensions indicated on the Drawings and on the bending schedule.

3. Bends for hooks on bars shall be made around a pin having a diameter not less than six times the minimum thickness of the bar.

4. All bars shall be bent cold.

C. Minimum Bar Spacing

The clear distance between parallel bars shall not be less than one and one-half times the diameter of the bars and, unless specifically authorized, shall in no case be less than 1-inch, nor less than the maximum size of coarse aggregate specified.

D. Concrete Cover (Minimum)

1. On all formed surfaces which will be exposed to water, ground, or the elements, there shall be a nominal cover over the steel of 2 inches for bars number 6 through number 18 and 1-1/2 inches for bars number 5 and smaller, with an installation tolerance of + 1/4-inch. When crossing bars of different diameter are encountered in one face, one shall consider

the bar size and location that will provide the largest cover over the nearest steel to the outside surface.

2. Unless otherwise specified in these specifications or shown on the Drawings, all reinforcing steel facing subgrades in footing and floors for concrete construction of the tank shall be given a nominal protective cover of 3.0-inch minimum. The largest cover shall be used when different size bars are encountered in one face.

3. The minimum cover over reinforcing steel for concrete construction of other facilities shall be as shown on the Drawings.

4. No "bury" or "carrier" bars will be allowed unless specifically approved by the Engineer.

E. Splicing

1. Except as shown or specified on the Drawings, reinforcing steel shall not be spliced at any location without specific approval by the Engineer. Splices in adjacent bars shall be staggered.

2. Where permitted or required, splices in reinforcing steel shall have sufficient lap to transfer full strength of the bar by bond and shear. Unless specified or shown otherwise on the Drawings, the bars at a lap splice shall be in contact with each other. In no event shall the lap be less than 40 diameters of the spliced bars.

3. Unless specified or shown otherwise on the Drawings, bars shall be lap spliced in accordance with ACI 318 and shall be fastened together with steel tie wire.

4. Unless shown otherwise on the Drawings, where bars are to be lapped spliced at joints in the concrete, all bars shall project from the concrete first placed, a minimum length equal to the lap splice length indicated on the Drawings. All concrete or other deleterious coating shall be removed from dowels and other projecting bars by wire brushing or sandblasting before the bars are embedded in a subsequent concrete placement.

F. Supports

1. All reinforcement shall be retained in place, true to indicated lines and grades, by the use of approved bar supports. The Contractor shall submit for Engineer's approval, samples of all bar supports the Contractor proposes to use along with a written description of where each bar support will be used.

2. The supports shall be of sufficient quantity, strength, and stability to maintain the reinforcement in place throughout the concreting operations. Bar supports shall be placed no further than 4 feet apart in each direction. Supports must be completely concealed in the concrete and shall not discolor or otherwise mar the surface of the concrete. The Contractor shall be held responsible for providing the appropriate quantity and type of bar supports.

3. Do not place reinforcing bars more than 2 inches beyond the last leg on continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

G. Bar Tying

1. Bars shall be tied sufficiently often to prevent shifting. There shall be at least three ties in each bar length (this shall not apply to dowel laps or to bars shorter than 4 feet, unless necessary for rigidity).

2. Slab bars shall be tied at every intersection around the periphery of the slab. Wall bars and slab bar intersections shall be tied at not less than every fourth intersection, but at not greater than the following maximum spacings:

	Slab Bars (inches)	Wall Bars (inches)
Bars No. 5 and smaller	60	48
Bars No. 6 through No. 9	96	60
Bars No. 10 through No. 11	120	96

H. Reinforcement Around Openings -- Where reinforcing steel has to be cut to permit passage of pipe or to create openings, and should no detail be shown for extra reinforcing in such areas, the area of steel removed by the creation of the opening must be replaced by placing at least double the area of steel removed by the opening equally around the openings. The steel shall be placed such that it extends 5 feet beyond the opening on each side to provide for sufficient bond.

3.2 WELDED WIRE FABRIC REINFORCEMENT

A. General

1. All necessary tie wiring, spacing chairs, or supports shall be installed to keep the welded wire fabric in place while concrete is being placed.

2. The welded wire fabric shall be bent as shown or required on the Drawings to fit the work. Welded wire fabric shall be rolled or otherwise straightened to make a perfectly flat sheet before placing in the Work.

B. Splicing

1. Welded wire fabric shall be lap spliced as indicated on the Drawings. If the lap splice length is not indicated on the Drawings, the welded wire fabric shall be spliced in accordance with ACI 318 and no less than a minimum of 40 wire diameters of the lapped wire, or 12 inches, whichever is greater.

2. Offset end laps in adjacent widths to prevent continuous laps in either direction.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

This section is based on a prestressed concrete reservoir project.

This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. The extent of concrete work is shown on the Drawings.

B. This Section covers cast-in-place concrete including framework, shoring for concrete, and installation into formwork of items such as anchor bolts, setting plates, bearing plates, anchorages, inserts, reveals, frames, nosings, sleeves, and other items to be embedded in concrete.

C. Section includes:

1. Concrete
2. Portland cement
3. Aggregates
4. Water
5. Admixtures
6. Wall forms
7. Roof forms
8. Form oil
9. Epoxy adhesive
10. Curing compounds

D. Related Sections:

1. Section 03 21 00 - Reinforcing Steel
2. Section 33 16 10 – Ground-Level Prestressed Concrete Water Utility Storage Reservoir

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals

B. Shop Drawings:

1. Reinforcement:

a. Comply with the ACI 315 “Details and Detailing of Concrete Reinforcement,” showing bar schedules, stirrup spacing, diagrams of bent bars and arrangements of concrete reinforcement.

b. Show complete details and arrangement and bending of reinforcing and embedded items.

c. Include special reinforcement required and openings through concrete structures.

2. Formwork:

a. Submit shop drawings for fabrication and erection of specific finished concrete surfaces as shown or specified.

b. Show the general construction of forms including jointing, special formed joints or reveals, location and pattern of form tie placement, and other items which affect the exposed concrete visually.

C. Certifications: Certification of aggregate compliance with these Contract Documents, and source of supply and location of all materials and cement.

D. A sufficient quantity of the proposed aggregate, sand, air-entraining admixtures, cement and water for testing of materials, and concrete mix designs referred to herein.

1.3 PRE-CONCRETE PLACEMENT MEETING

A. Schedule and attend a Concrete Placement meeting at least 1 week prior to placing concrete.

B. The meeting shall be attended by the Owner, Engineer, Contractor, Testing Laboratory Representative, and the Concrete Supplier.

C. The following shall be discussed at the meeting: Safety, Batching and Delivery, Adjustments to Mix; Site Dosing, Placement Rates and Anticipated Schedule of Placing and Finishing, Site Layout –Holding Area; Pump Truck Location; Truck Wash-out Area; Parking area, Equipment – Pumps and Appurtenances; Vibrators; Spare Equipment, Concrete Testing Procedures, and Curing.

1.4 QUALITY ASSURANCE

A. Codes and Standards - Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified.

1. ASTM International (ASTM)

a. C31, “Standard Practice for Making and Curing Concrete Test Specimens in the Field”

b. C33, “Standard Specification for Concrete Aggregate”

c. C39, “Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens”

d. C40, “Standard Test Method for Organic Impurities in Fine Aggregate for Concrete”

e. C1084, “Standard Test Method for Portland-Cement Content of Hardened Hydraulic-Cement Concrete”

f. C88, “Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate”

g. C94, “Standard Specification for Ready-Mixed Concrete”

h. C131, “Standard Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine”

i. C136, “Standard Test Method for Sieve Analysis to Fine and Coarse Aggregate”

j. C143, “Standard Test Method for Slump of Hydraulic Cement Concrete”

k. C150, “Standard Specification for Portland Cement”

l. C156, “Standard Test Method for Water Loss Through Liquid Membrane Forming Curing Compounds for Concrete”

m. C173, “Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method”

n. C231, “Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method”

o. C233, “Standard Test Method for Air-Entraining Admixtures for Concrete”

p. C260, “Standard Specifications for Air-Entraining Admixtures for Concrete”

q. C289, “Standard Test Method for Potential Alkali Silica Reactivity of Aggregates (Chemical Method)”

r. C441, “Standard Test Method for Effectiveness of Pozzolans or Ground Blast-Furnace Slag in Preventing Excessive Expansion of Concrete Due to the Alkali-Silica Reaction”

s. C457, “Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete”

t. C494, “Standard Specification for Chemical Admixtures for Concrete”

u. C670, “Standard Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials”

v. C803, “Standard Test Method for Penetration Resistance of Hardened Concrete”

2. American Concrete Institute (ACI)

a. "Specifications for Structural Concrete," ACI 301 as supplemented and modified herein.

b. "Standard Practice for Selecting Proportions for Normal Heavyweight, and Mass Concrete," ACI 211.1.

B. Forming

1. Forming, shoring, and bracing designs for footings, walls, and roofs shall be designed by the Contractor to meet all requirements specified here-in.

2. If requested by the Engineer, drawings and calculations shall be submitted verifying the selection of form ties, horizontal and vertical stiff-backs or braces for wall panels, forming and form openings, shoring of roof forms, or any other part of forming, shoring, or bracing which may be considered critical by the Engineer.

3. All falsework and forming requirements for roof support systems must be designed by an Engineer registered in the same state as the reservoir will be built in. The drawings, with supporting calculations, must each be signed and sealed by the designer. No work shall be started until the roof support and form design has been reviewed by the Engineer. The falsework design Engineer must visit the site and approve the erection of all shoring prior to the placement of any concrete.

4. The Contractor shall be solely responsible for the adequacy of the forming, shoring and bracing design.

5. The turn-around time of the Engineer's review will be 2 weeks from date of receipt of each written submittal.

6. Any formwork installed by Contractor shall be solely at Contractor's risk. The Engineer's review will not lessen or diminish the Contractor's liability.

1.5 CONCRETE MIX DESIGNS

A. All concrete materials shall be proportioned so as to produce a workable mixture in which the water content will not exceed the maximum specified.

B. If the concrete mix designs specified herein have not been used previously by the ready-mix supplier or if directed by the Engineer, mix proportions and concrete strength curves for regular cylinder tests, based on the relationship of 7-, 14- and 28-day strengths versus slump values of 2, 4, and 6 inches, all conforming to these Specifications, shall be established by an approved ready-mix supplier or an independent testing laboratory. A laboratory, independent of the ready-mix supplier, shall be required to prepare and test all concrete cylinders.

C. The costs for preparation of mix designs (if required by the Owner to be performed by an independent testing laboratory) and testing of concrete and materials shall be borne by the Owner, except when materials do not meet specified requirements, in which case such costs shall be borne by the Contractor.

D. The exact proportions by weight of all materials entering into the concrete delivered to the jobsite shall conform to the approved mix design unless specifically so directed by the Engineer or Laboratory for improved specified strength or desired density, uniformity and workability.

E. The proportions of such mix design shall be based on a full cubic yard of hardened concrete.

F. Ready-mix companies or jobsite batch plants shall furnish delivery tickets, signed by a Certified Weighmaster, on which each shall state the weight of aggregates, sand, cement, admixtures and water and the number of cubic yards of concrete furnished, which will be compared against the approved mix design.

G. There shall be no variation in the weights and proportions of materials from the approved mix design.

H. There shall be no variation in the quality and source of materials once they have been approved for the specific mix design.

1.6 READY-MIXED CONCRETE

Ready-mixed concrete shall conform to the requirements of ACI 301 and ASTM C94. In case of conflict, ACI 301 shall govern.

PART 2 PRODUCTS

2.1 CONCRETE COMPOSITION

Concrete shall be composed of Portland cement, fine aggregate, coarse aggregate, water, and specified additives so proportioned and mixed as to produce a plastic workable mixture in accordance with requirements of this section of the specification and suitable to the specific conditions of placement.

2.2 PORTLAND CEMENT

A. Portland cement shall be from an approved source and shall conform to the requirements of the current ASTM C150, for Type II cement. Only one brand of cement from one manufacturing plant may be used. The use of ground granulated blast furnace slag is not allowed.

B. Cement may be delivered in paper sacks or in bulk.

C. If cement is delivered in sacks, each sack shall contain not less than 94 pounds of cement, and if delivered in bulk, one barrel of cement shall be considered to weigh 376 pounds.

D. In order that the cement may not become unduly aged after delivery, the Contractor shall use cement that has been stored on the jobsite before using cement direct from freighting, hauling, or transporting operations.

E. Storage bins for bulk cement shall be watertight and constructed so that there will be no dead storage.

F. If there is reason to believe that dead storage exists, the bins shall be emptied completely at least once every four months.

G. Cement bins at the mixing plant, and cement storage silos shall be provided with effective dust collectors at the vent to prevent loss of cement.

H. The Contractor shall designate the source and quantity of cement required for the Contractor's needs at least 30 days prior to its use, so that appropriate tests, inspection, and certification can be made.

I. Certified mill certificates shall be furnished by the cement company with every shipment, giving proof that the above requirements have been met.

J. In addition, the Owner may conduct, at its own expense, any tests it considers necessary, to ensure that the cement furnished meets the specified requirements.

K. Any cement not meeting the Specifications will be rejected.

L. The Owner may direct the use of Portland cement of a type other than that above specified, in which case it will pay the additional cost, if any, for the cement required over the cost of that specified or shall receive appropriate credit for any cement required of a lesser cost than specified.

2.3 FINE AND COARSE AGGREGATES

A. Aggregates shall conform to ASTM C33 and as herein specified. Provide aggregates from a single source for all exposed concrete.

B. Fine aggregates shall be clean, sharp, natural sand free from loam, clay, lumps, or other deleterious substances and consisting of hard, strong, durable, and uncoated particles.

C. Material removable by decantation from fine aggregate shall not exceed 5 percent by weight.

D. The moisture content of fine aggregate shall not exceed 8 percent by weight at the time the aggregate is used for the concrete.

E. Fine aggregate shall be subjected to careful, thorough analysis to determine conformity with all requirements of these specifications.

F. Mortar specimens made with the fine aggregate shall have a compressive strength after 7 days of at least 90 percent of the strength of similar specimens made with Ottowa sand having a fineness modulus of 2.40 ± 0.10.

G. Coarse aggregate shall be washed gravel or crushed stone consisting of hard, tough, durable particles free from adherent coating. Use of pit or bankrun gravel is not permitted.

H. It shall contain no vegetable matter of soft, friable, thin, flat, or elongated particles in quantities considered deleterious.

I. A thin, flat, or elongated particle is defined as a particle having a maximum dimension in excess of five times its minimum dimension.

J. Aggregate which has disintegrated or weathered badly under exposure conditions similar to those which will be encountered in the work under consideration shall not be used.

K. When crushed stone is used, the crusher shall be equipped with a screening system which will entirely separate the dust from the stone and convey it to a separate bin.

L. The substances designated shall not be present in excess of the following amounts:

1. Soft fragments	5 percent
2. Clay lumps	1.4 percent
3. Material removed by decantation	1 percent

M. When the material removed by decantation consists essentially of crushed dirt, the maximum amount permitted may be raised to 1-1/2 percent.

N. Coarse aggregate shall be subjected to a careful, thorough analysis to determine conformity with all requirements of these Specifications.

O. The maximum size aggregate shall be 1-1/2-inch and the aggregate shall be uniformly well graded from coarse through fine in accordance with the following schedule.

Sieve Size	Percent Passing
1	90 - 100
3/4	70 - 90
3/8	45 - 65
N0. 4	31 - 47
No. 8	23 - 40
No. 16	17 - 35
No. 30	10 - 23
No. 50	2 - 10
No 100	0 - 3
No. 200	0 - 2

P. Corrective measures to remedy deficiencies in aggregate grading may be used only with the written approval of the Engineer.

Q. The Contractor shall furnish satisfactory evidence to the Engineer that all aggregate used in the work meets the requirements specified herein. Tests shall be performed by a reputable independent testing laboratory and the cost of testing be borne by the Contractor.

R. If the Engineer deems that additional testing of aggregate is necessary, the Engineer may select samples from any of the aggregate delivered to the ready-mix plant or jobsite and have them tested by a laboratory of the Engineer's choice. Such material shall not be used in the work until test reports are available. If in such tests the material fails to meet the specified requirements, the aggregate will be rejected, and the expense of testing shall be borne by the Contractor. If such tests show the aggregate to be satisfactory, the cost of additional testing will be paid by the Owner, but the Contractor shall have no claim for costs due to delays caused by testing.

S. When tested in accordance with "Standard Test Method for Organic Impurities in Fine Aggregate for Concrete," (ASTM C40), the fine aggregate shall provide a color in the supernatant liquid no darker than the reference standard color solution.

T. When tested in accordance with “Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate,” (ASTM C88), the loss resulting after five cycles shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

U. When tested in accordance with ““Standard Test Method for Resistance to Abrasion of Small Size Coarse Aggregate by use of the Los Angeles Machine,” (ASTM C131), the coarse aggregate shall show a loss not exceeding 50 percent after 500 revolutions or 10 percent after 100 revolutions.

V. When tested in accordance with “Standard Test Method for Potential Alkali Silica Reactivity of Aggregates (Chemical Method),” (ASTM C289), the aggregates should be represented by points lying to the left side of the solid line of Figure 2 therein.

2.4 WATER

Water for mixing shall be clean, fresh, and free from injurious amounts of oil, acid, chlorides, sulfates, alkali, or organic matter. Water shall conform to ACI 301.

2.5 ADMIXTURES - GENERAL

All admixtures used in any mix design shall be manufactured and supplied by the same admixtures company to insure compatibility.

2.6 RETARDING DENSIFIERS

A. All Class “A” concrete (as defined in Section 03 30 00-2.9) used for wall construction shall also contain DARATARD-17, as manufactured by Grace Construction Products, or equal in the amounts recommended by the Additive Manufacturer whenever the air temperature during the pour exceeds 85degrees Fahrenheit (F).

B. To be considered as equal, any alternate product offered for consideration shall contain no calcium chloride and shall be compatible with air-entrained cements and air-entraining admixtures conforming to the applicable ASTM, AASHTO, ANSI and Federal specifications.

C. Contractor shall certify that admixtures do not contain calcium chlorides or other corrosive materials.

2.7 AIR-ENTRAINING AGENTS

A. Unless specifically required by Owner, Class “A” concrete shall not be air entrained. Unless otherwise specified, all other concrete may be air-entrained at the option of the Contractor.

B. Air-entraining agents shall meet ASTM C260, ASTM C233 and ASTM C457.

C. The maximum total volumetric air content of the concrete before placement shall be 6 percent plus or minus 1 percent as determined by ASTM C173 or ASTM 231.

D. Subject to these Specifications, consideration will be given to the following products: PROTEX “AES,” GRACE “DAREX AEA,” MASTER BUILDERS “MB-AE90,” or SIKA CHEMICAL “AER.”

2.8 WATER REDUCING ADMIXTURES

A. In addition to air-entrainment, approved water reducing additives, which do not affect the ultimate performance of any steel in any way, may be added to maintain the maximum water content below that specified herein. Water reducing additives shall conform to ASTM C494, Type A or D.

B. The use of water reducing additives shall not permit a reduction in the minimum specified cement content or in the specified amount of air-entrainment.

C. Admixtures shall contain no calcium chloride, tri-ethanolamine or fly ash. All admixtures shall be from the same manufacturer.

D. Superplasticizers, if allowed by the Engineer, shall conform to ASTM C494, Type F or G, batch plant added using second or third generation only.

E. Set control admixtures if allowed by the Engineer, shall conform to ASTM C494, Type B (retarding) or Type C (accelerating).

2.9 PROPORTIONING NORMAL CONCRETE

Unless indicated otherwise on the Drawings, concrete shall be of the following classes, each meeting the mix and compressive strength requirements as specified hereafter, and shall be used as follows:

Confirm all classes of concrete strength needed on the Project are included in below.

Edit definitions as needed.

1. Class "A" Prestressed concrete reservoir walls.

2. Class "B" Roof slabs and drop panels, floor slabs, wall footings. Pump station floor slabs and footings

3. Class "C" Pipe blocks and appurtenances, columns, and column footings

At the Contractor's option, Class "A" concrete may be substituted for Class "B" and "C" concrete. Likewise, Class "B" concrete may be used in lieu of Class "C" concrete. If Class "A" concrete is substituted for Class "B" or Class "C" concrete, such concrete shall be air-entrained if the Class "B" or "C" concrete is required to be air-entrained.

2.10 MEASUREMENT

A. All measurements shall be by weight. However, Contractor, at the Contractor's own expense, may increase the cement content at a corresponding reduction in weight of aggregate and sand, whenever the Contractor is concerned that the minimum strength and mix ratio requirements under these specifications cannot be met. The amount of water to be used shall be the amount necessary to produce a plastic mixture of the specified slump.

B. The slump shall be between 2 inches and 4 inches when tested in accordance with ASTM C143. Variations in the slump range may be allowed by the Engineer if admixtures, such as water reducers or superplasticizers, are utilized in the concrete mix. Regardless of the measured

slump, the maximum allowable water-cement ratios as specified here-in, shall be strictly adhered to.

2.11 COMPRESSIVE STRENGTH, WATER AND CEMENT CONTENT

A. Notwithstanding what has been stated here-before, and unless shown otherwise on the Drawings, the concrete shall meet the following requirements:

Confirm all classes of concrete strength needed on the Project are included in the table below.

	Class A	Class B	Class C
1. Min. Compressive Strength	5,000 psi	4,000 psi	3,500 psi
2. Max. Water Content (gallon per 94 lb. sack of cement)	4.5 gal.	4.5 gal.	4.5 gal.
3. Min. Cement Content (94 lb. sack of cement per cubic yard of solid concrete)	7.0 sacks	5.5 sacks	6.0 sacks
4. The cement content is required irrespective of strength. Up to a maximum of 15% of cementatious material may be fly ash in accordance with ASTM C618. The use ground granulated blast furnace slag is not allowed.			
5. The total chloride ion content of hardened concrete shall be less than 0.06 percent by weight of cement.			

2.12 WALL FORMS

A. Full Height Pours: The wall form design shall be such that wall sections can be poured full height without creating horizontal cold joints and without causing snapping of form ties which shall be of sufficient strength and number to prevent spreading of the forms during the placement of concrete and which shall permit ready removal of the forms without spalling or damaging the concrete. A plastic shotcrete reglet shall be incorporated into the top of the reservoir corewall as shown on the Drawings.

B. Ties

1. Form ties which remain in the corewall of water-retaining structures shall have waterstops and a 1-inch minimum breakback or cone depth.

2. Snap ties, if used, shall not be broken until the concrete has reached the design concrete strength. Snap ties, designed so that the ends must be broken off before the forms can be removed, shall not be used. The use of tie wires as form ties will not be permitted. Fully threaded stub bolts may be used in lieu of smooth ties with waterstops.

3. Taper ties with plastic or rubber plugs of an approved and proven design may also be used. The plugs must be driven into the hole with a steel rod, placed in a cylindrical recess made therefore in the plug. At no time shall plugs be driven on the flat area outside the cylindrical recess. Plugs shall be A-58 SURE PLUG as manufactured by DAYTON SUPERIOR.

4. Ties shall positively secure the wall to the required dimension and hold the wall to that dimension prior to and during concrete placement.

C. Form Size

1. BURKE, ECONOMY, SYMONS, ALUMA, and overlaid plywood complying with U.S. Product Standard PS-1 "B-B High Density Overlaid Concrete Form," Class 1, forms may be used for forming of circular walls, as long as there are no straight sections longer than 36 inches at any place around the outside circumference of such walls.

2. The height of such wall panels shall not exceed 8 feet unless built-in pouring openings are incorporated in such walls.

D. Form Stiffeners

1. Horizontal walers shall consist of structural steel channels, angles, or tubing of adequate size to retain the concrete without deflecting.

2. The walers shall be rolled or welded to the proper radii or offset brackets shall be used for shaping the wall to the dimensions shown on the Drawings and shall be used both for inside and outside wall forms in direct contact with the wall panels and at vertical spacings of no more than 96 inches on center.

3. There shall be at least one such waler within 24 inches of the top and bottom of the wall.

4. The largest dimension of the steel waler shall be in the radial direction.

5. Vertical structural steel or wood members shall be used at a minimum horizontal spacing of 74 inches and shall have sufficient rigidity and strength to insure the proper vertical alignments with the aid of braces under all predictable stress conditions.

6. In lieu of the above, a different system and spacings may be used if it is satisfactorily demonstrated to the Engineer that it will be equally effective.

2.13 ROOF FORMS

A. Forms and falsework supports for the roof shall be sufficiently rigid and strong to support the wet concrete and the men and equipment necessary for its placement without appreciable deflections. A minimum of 40 pounds per square foot (psf) for live-load shall be allowed in the design.

B. Allowable deflections and required form camber in roof forms shall be regulated per ACI 347.

C. Forms shall be sloped equal to the prescribed roof slope to avoid exceeding the design roof slab thickness.

2.14 FORM OIL

Form oil compounds shall be NSF-61 approved for use in potable water and shall be provided which will not adversely affect finished concrete surfaces by bonding or staining. Selected form coating shall not adversely affect application of curing compounds or future application of bonding or adhesive products.

2.15 EPOXY ADHESIVE

An approved non-sag epoxy adhesive shall be applied over all dry-packed holes on the inside surface of the corewall. An acceptable material is SELECT BOND GP-3000, as manufactured by SELECT PRODUCTS CO. or LV EPOXY as manufactured by SIKA CORPORATION. Approved equal materials may be used.

2.16 CURING COMPOUND

A. All horizontal, screeded and floated surfaces, exposed to drying winds and sunlight, shall be sprayed with ATLAS QUANTUM-CURE as manufactured by Atlas Construction Supply, Inc. (application rate: 200 square foot per gallon (sf/gallon)). Application of the curing compound shall conform to the requirements of Section 03 30 00-3.11.

B. Alternate curing compounds will be accepted if they are pigmented or colored, such as white, at the time of application and are non-toxic to potable water. Regardless of the type of curing compound used, Contractor shall assume complete responsibility for its adequacy.

PART 3 EXECUTION

3.1 CONCRETE QUALITY

A. Concrete shall conform to the requirements specified herein. The required proportions shall be assembled, well mixed, transported, placed, consolidated, finished, and cured as here-in-after specified. Concrete shall be uniformly dense and sound, free from faults, cracks, voids, honeycomb, and other imperfections.

B. If not called for specifically, and unless specified otherwise hereunder, concrete requirements shall follow ACI 301 where applicable.

3.2 MIXING

A. Concrete shall be batched in fully automatic or semi-automatic stationary plants or approved portable batch type plants, and mixed in stationary or truck mixers. Mixing equipment and mixing procedures shall be subject to the approval of the Engineer.

B. Site-Mixed Concrete

1. Conform to ACI 304 except as modified by these Specifications.

2. Use a batch type mixer capable of combining the aggregates, cement, and water within the specified time into a thoroughly mixed and uniform mass and discharging the mixture without segregation.

3. Use supporting equipment that can accurately proportion the cement, the coarse and fine aggregates, the admixtures, and the water which enters the mixing drum. Proportion the cement and aggregate by weight.

4. Discharge each entire batch before recharging. Do not allow the volume of the mixed materials per batch to exceed the Manufacturer's rate capacity of the mixer.

5. Mixing time shall be as follows:

   a. For mixer of capacity of 1-cubic yard or less, 1-1/2 minutes after batching is completed.

   b. For mixers of capacities larger than 1-cubic yard, 1-1/2 minutes plus 1/2-minute for each additional 1/2-cubic yard capacity or fraction thereof in excess of 1-cubic yard.

   c. The mixer shall revolve at a uniform rate as specified by the Manufacturer for the mixing equipment.

C. Ready-mixed Concrete

1. Provide central-mixed concrete conforming to ASTM C94 except as modified by these Specifications.

2. Limit the haul time of central-mixed concrete so that the specified slump is attained without the onsite addition of water which will cause the mix design water-cement ratio to be exceeded. In no event shall the time exceed 90 minutes from the batch plant to the completion of the pour, unless specifically approved by the Engineer.

3. Use truck-transported, dry-batched concrete or mix on the jobsite when haul time is excessive. Do not re-temper partially hardened concrete.

3.3 PROTECTION FROM ABRASION OR FIRE

A. Every reasonable precaution shall be taken to protect finished surfaces from abrasion or other damage. Concrete surfaces or edges likely to be injured during the construction period shall be protected by leaving the forms in place or by erecting satisfactory covers. No fire shall be permitted in direct contact with concrete at any time.

3.4 PLACEMENT OF CONCRETE

A. Placement shall conform to ACI 304 except as modified by these Specifications.

B. Notify the Engineer of readiness, not just intention, to place concrete in any portion of the work. This notification shall be made a minimum of 48 normal working day hours prior to proposed concrete placing. All forms, steel, anchors, ties, inserts, and other embedded items shall be in place before the Contractor's notification of readiness is given to the Engineer.

C. Schedule sufficient equipment for continuous concrete placing, program backup equipment, and the actions to be taken in case of an interruption in placing. Provide extra concrete vibrators. Test the concrete vibrators the day before placing concrete.

D. Concrete in walls shall not be placed in layers thicker than 24 inches (vertical dimension) at any one time except that the bottom layer shall be no thicker than 12 inches.

E. Concrete in circular spirally tied columns, having no horizontal reinforcement crossing into the region bounded by the vertical reinforcement, may be deposited from the top of the column form at Contractor's option such that no separation of the coarse aggregate from the mortar takes place. All concrete shall be vibrated as required here-in. The final quality of the poured concrete column shall be the responsibility of the Contractor. If the quality of the column is

found to be unacceptable, the Engineer, at the Contractor's expense, may require the complete removal of the column and may require that an alternate placement method by used.

F. Each layer of concrete in walls and columns shall be vibrated thoroughly before the next layer may be placed thereon. Vibrators shall be taken through the top layer down through the full layer thickness below to ensure proper integration of the concrete and to avoid the development of cold joints and honeycomb between the layers. In other words, each layer of concrete shall be vibrated at least twice.

G. Each wall footing, wall section, column footing (if any) and column pour (if any) shall immediately be preceded with a cement/sand slurry mix consisting of equal parts cement and sand in combination with 4-1/2 gallons of water per sack of cement. The thickness of the slurry shall be 1-inch average for the wall and columns and 1/2-inch average for the wall and column footings.

H. Unforeseen cold joints in walls shall be roughened and then covered with a pure mixture of cement and water of approximately 1-inch thickness, before the pour may be continued.

I. Horizontal waterstops in floor and roof decks, if shown on the Drawings, shall be lifted up, then the concrete shall be placed under the waterstop, the waterstop shall then be laid down on that concrete, additional concrete shall be placed on top of that waterstop to the approximate finish level of the concrete, where upon the concrete shall be thoroughly vibrated in one continuous motion from one end of the waterstop to the other end without skipping any areas. Visual observation shall be performed by the Contractor to certify that voids under waterstops do not exist.

J. Cold joints in floor, roof slabs, and in wall-footings shall be avoided at all costs. Joints shall be continuously covered with new concrete, and shall be thoroughly integrated through vibration, even if it means that horizontal passes of only 6 inches in width be made until additional concrete and equipment becomes available to permit wider passes in concrete placement.

K. The following minimum equipment, which must be in excellent working condition, shall be available on the site for every concrete placement operation on floor, wall and roof:

1. Conveying: Two pumps, or two cranes, or one pump and one crane (for floor and roof decks only).

2. Vibrating: Three vibrators of 14,000 vibrations per minute (minimum).

3. Trowelling: Two power-operated trowelling machines (for floor and roof decks only).

The Engineer shall be the sole judge as to the acceptability of the equipment and as to its condition and capacity. The Contractor shall assume complete responsibility for having adequate equipment.

L. Use mechanical vibration in placing concrete to eliminate rock pockets and voids, to consolidate each layer with that previously placed, to completely embed reinforcing bars and fixtures, and to bring just enough fine material to exposed surfaces to produce a smooth, dense, and even texture. Vibrators shall be of the high-frequency internal type, and the number in use shall be ample to consolidate the incoming concrete to a proper degree within 15 minutes after it is deposited in the forms. In all cases, at least three operable vibrators shall be

available at the site. Use external vibrators for consolidating concrete when the concrete is otherwise inaccessible for adequate consolidating, provided the forms are constructed rigidly enough to resist displacement or damage from external vibration.

M. Not used.

N. If avoidable, do not place concrete during rainstorms. Protect concrete placed immediately before rain to prevent rainwater from coming in contact with it. Keep sufficient protective covering on hand at all times for this purpose.

O. Concrete placed for encasement shall not be backfilled until the concrete has reached at least 50 percent of its 28-day compressive strength confirmed by concrete cylinder tests. The Contractor may mold and cure additional concrete cylinders as specified here-in to verify that the 50 percent strength has been achieved, prior to the required 7-day test. The Contractor shall keep the trench dewatered until that time. The Contractor may use type III cement (High Early Strength) in lieu of type II cement in the same batch quantities as specified, but there will be no additional reimbursement to the Contractor for costs incurred using such concrete.

3.5 PUMPING CONCRETE

A. Base pump size on the rate of concrete placement, length of delivery pipe or hose, aggregate size, mix proportions, vertical lifts, and slump of concrete. The minimum inside diameter of pipe or hose shall be based on the maximum aggregate size as follows:

- 1-1/2-inch maximum aggregate: 4 inches minimum I.D.
- 1-inch maximum aggregate: 3 inches minimum I.D.

B. Do not use aluminum pipes for delivery of concrete to forms.

C. Before pumping is started, prime the delivery pipe or hose by pumping mortar through the line using 5 gallons of mortar for each 50 feet of delivery line. Do not deposit mortar in the forms.

3.6 GENERAL FORMING

A. Purpose

1. Forms shall be used, whenever necessary, to confine the concrete, to shape the concrete to the required lines and grades, and to obtain a thoroughly compacted dense concrete through proper vibrating. Construct forms complying with ACI 347.

2. The forms shall have sufficient strength and rigidity to hold the concrete and to withstand the necessary pressure, tamping and vibration, without deflection from the prescribed lines.

B. Design

1. The surfaces of all forms in contact with the concrete shall be clean, rigid, tight, and smooth.

2. Openings sufficient in size and number to permit convenient access to properly clean, inspect and place concrete within the forms shall be provided.

3. Exposed sharp edges shall be eliminated from finished concrete work by means of 3/4-inch triangular fillets or chamfer strips placed in the forms.

C. Removal

1. All forms shall be removed before backfilling is placed.

2. Forms shall be so constructed that they can be removed without hammering on, or prying against, the concrete and shall be removed in such a manner as to prevent damage to the concrete and to ensure the complete safety of all parts of the structure.

D. Form-Ties and Seepage

1. Form-ties may be loosened temporarily to permit the removal of bulkheads.

2. All forms, whether prefabricated or custom made, shall be assembled, and connected in such a manner that only minor mortar seepage through the joints will occur during vibration of the concrete, which shall be small enough that no honeycomb areas will develop.

E. Clean and Oil

1. All dirt, chips, sawdust, mud, water, and other foreign matter shall be removed from within the forms or within the excavated areas before any concrete is deposited therein.

2. Forms previously used shall be thoroughly cleaned of all dirt, mortar, and foreign matter before being reused.

3. Before concrete is deposited within the forms, all inside surfaces of steel and plywood form surfaces shall be thoroughly, but not excessively, coated with an approved non-staining bond releasing form oil.

3.7 WALL, WALL FOOTING, AND COLUMN FOOTING FORMS

A. All vertical wall and column footing sides shall be formed by methods acceptable to the Engineer and to the correct elevations and location shown on the Drawings.

B. Pouring Openings

1. Pouring of walls may be done only through pouring openings on one of the wall sides, and may not be pumped or poured from the top through the use of "elephant trunks" or tremies.

2. Contractor shall either erect the complete form on one side of the wall and then erect the form panels on the other side of the wall while the concrete pour is in progress or remove form panels from either the inside or outside form assembly before concrete pouring starts.

3. The horizontal centerline distance between such openings shall not exceed 96 inches nor shall the distance between the nearest opening and the bulkhead for the vertical joint exceed 36 inches.

4. The vertical centerline distance between horizontal rows of openings shall not exceed 96 inches.

5. The minimum pouring opening size shall be 18-inch by 18-inch.

6. The bottom of the lower openings shall be no more than 48 inches from the top of the wall-footing.

7. Under no circumstances shall forming be such that the drop of concrete in the forms will exceed 8 feet in any one place.

C. Blockouts

There shall be no blockouts or other types of wall-openings other than those shown on the Drawings.

D. Remove Wood Splinters

1. Contractor shall remove all wood splinters on concrete surfaces after stripping of wood forms.

2. Such work shall be completed before sandblasting of exterior wall surfaces may be started.

E. Bulkheads

1. Bulkheads to form vertical wall joints shall be strong enough to withstand concrete pressures during pouring and vibrating and shall be properly placed between the forms and against the waterstop to avoid mortar seepage.

2. Holes shall be provided in the bulkheads to permit passage of horizontal mild steel reinforcing where required by the Drawings.

3. Unless these are specifically called for on the Drawings, no chamfer strips shall be placed in the corners of vertical construction joints of reservoir walls.

F. Form Removal

1. Forms may be removed as soon as the concrete has developed sufficient strength to prevent sagging, excess deflection, misalignment, spalling, cracking, breaking of edges and surfaces, and any other damage to the concrete.

2. Removal of wall and column forms shall not be started any sooner than 12 hours of accumulated time with the ambient air temperature above 50 degrees F after completion of the wall or column pour, respectively.

3. Hammering or prying against concrete surfaces to remove forms is prohibited.

G. Alignment and Tolerances

1. Every precaution shall be taken to see that all forms are in the proper alignment, plumb, placed to correct radius, and that all form supports are secure and tight.

2. Form sills shall be used to contain or hold down neoprene pads and facilitate proper alignment of forms. The maximum permissible variation in the horizontal and vertical location of the waterstops, neoprene pads and seismic cables (if required) is plus or minus 1/4-inch.

3. The maximum permissible variation in reservoir radius, as measured from the center of the reservoir to the inside wall surface at the bottom, is plus or minus 3/8-inch.

4. The out-of-round tolerance is: 3/4-inch in 50 feet, 3/8-inch in 10 feet, and 3/16-inch in 24 inches from the true curvature specified at any point on the wall.

5. The maximum permissible variation in the vertical alignment, from the bottom to the top of the wall, is plus or minus 3/8-inch.

6. The allowable tolerance in the average wall thickness for poured walls shall not vary more than 1/8-inch either way. All transitions from plus to minus shall be gradual, even and smooth, and without abrupt changes in the surfaces.

7. Adequate time and cooperation shall be provided to the Inspector to verify the compliance of these requirements prior to closing up the forms or pouring concrete.

H. Slipform

The use of slipform construction on liquid-retaining walls will not be permitted on any part of the reservoir.

I. Gaps between Wall and Wrapped Wire

Irrespective of what has been stated elsewhere in this section, the forming and bracing method shall be such that no gaps between the wrapped wire and the corewall will develop which exceed 3/8-inch at any place on the wall.

3.8 ROOF FORMS

A. Form Finish and Alignment

The finished form surface shall be smooth, true to elevation and alignment and all joints between boards, plywood sheets or form panels shall be mortar-tight or be made mortar-tight by taping or other means as the situation calls for, before any concrete pour may be started.

B. Form Removal

1. Removal of the forms will be permitted only when the concrete has attained 90 percent of its design strength (verified by cylinder tests) and no sooner than 7 days (168 hours) of cumulative time above 50 degrees F after concrete installation.

2. As soon as the forms have been removed, the Contractor will carefully examine the top and bottom surface of the concrete for any defects in the concrete or irregularities in the surface which shall be repaired as required.

3. Hammering or prying against concrete surfaces to remove forms is prohibited.

C. Form Adjust and Release

The Contractor shall provide either wedges under timber posts, screw jacks under shoring, or provide other means to adjust the forms and relieve the load.

D. Tolerance

1. Unless stated otherwise on the Drawings, the permissible tolerance at any point for flat or dome-roof form-surfaces shall not exceed plus or minus 1/4-inch from the specified elevation or thickness. The finished roof surface shall be capable of completely draining. Contractor shall camber or provide necessary forming supports to prevent low spots and to ensure drainage. If low spots should occur, Contractor shall submit a corrective procedure to the Engineer for approval.

2. Any transition between high and low points shall be gradual, smooth, and even, and shall be to the satisfaction of the Engineer.

3.9 BULKHEADS AND SCREEDS FOR FLOORS AND ROOFS

A. Unless free-spanning vibrating and finishing screeds are used, sufficient floor and roof screeds shall be installed to ensure that the finished concrete surface will conform to the slopes, elevations, and tolerances specified in these documents.

B. Screeds and bulkheads shall be set to specified alignment and elevations permitting a maximum tolerance of 1/4-inch plus or minus.

C. All transitions between high and low points shall be gradual, smooth, and even, and shall be to the satisfaction of the Engineer.

3.10 SURFACE FINISHES

A. Smooth Form Finish

1. Provide as-cast smooth form finish for formed concrete surfaces that are to be exposed to view, or that are to be covered with a coating material applied directly to the concrete, or a covering material bonded to the concrete such as waterproofing, dampproofing, painting or other similar system.

2. Produce smooth form finish by selecting form material to impart a smooth, hard, uniform texture and arranging them orderly and symmetrically with a minimum of seams. Repair and patch defective areas with all fins or other projections completely removed and smoothed.

3. Curb finishes: Curbs shall be screeded off accurately to true lines and planes or warped surfaces as indicated or directed. Finish smooth. Arises shall be true and straight or properly eased where curved and neatly rounded with approved tool. Smooth trowel finish with corners rounded to 3/4-inch radius.

B. Wood-Float Finish

1. This requires an integral finish by wood-float after screeding, to compact the surface evenly.

2. Any excess surface water shall be removed before floating and no mortar shall be used for leveling.

3. Apply float finish to monolithic slab surfaces that are to receive trowel finish and other finishes as hereinafter specified, and slab surfaces which are to be covered with membrane or elastic waterproofing, membrane or elastic roofing or sand bed terrazzo, and as otherwise shown on drawings or in schedules.

4. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently to permit the operation of a power-driven float, or both. Consolidate the surface with power-driven floats, or by hand-floating if area is small or inaccessible to power units. Check and level the surface plane to a tolerance not exceeding 1/4-inch in 10 feet when tested with a 10-foot straightedge placed on surface at not less than two different angles. Cut down high spots and fill at low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.

C. Steel Trowel Finish

1. This shall be an integral finish obtained by trowelling with a steel trowel after the surface has been floated and allowed to stand until all water-sheen has disappeared.

2. Final trowelling shall be done after the concrete has hardened sufficiently to prevent drawing moisture and fine materials to the surface and when the concrete is sufficiently hard that no mortar accumulates on the trowel.

3. Cement, or mixture of cement and sand, shall not be spread on surfaces to absorb excess water or to stiffen the concrete.

4. Trowelling shall produce a dense, smooth, impervious surface free from defects and blemishes.

5. All finished top surfaces of wall and wall-corbel (if required), column-footings (if required), and floors shall receive a smooth, even, level, and hard (so called "burnt") steel trowel finish. The entire wall footing surface, particularly along each side of the circumferential waterstop in the area to receive neoprene pads, shall also receive a hard steel trowel finish.

D. Non-Slip Broom Finish:

1. Apply non-slip broom finish to exterior and interior concrete platforms, steps and ramps and elsewhere as shown on the drawings or in schedules.

2. Immediately after trowel finish, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fiber-bristle broom unless otherwise directed. Coordinate the required final finish with the Engineer before application.

E. Unformed Surfaces

1. Unformed surfaces which will not be exposed in the completed work shall be brought to required finished elevations and left true and regular.

F. Screeds

1. Sufficient screeds, unaffected by form deflections under concrete loads, shall be installed to ensure an even concrete surface, true to grade and elevation, without unacceptable local depressions of any sort.

2. Screeds shall be set to the required levels and be approved by the Engineer before any concrete may be placed.

G. Form Tie Holes

1. Tie holes shall be thoroughly sandblasted or roughened. After the taper tie holes have been cleaned, plugs, as specified in Section 03 30 00-2.12.B.3, shall be installed in the middle third of the corewall. The tie holes shall then be coated with a water insensitive epoxy or an acceptable bonding agent and properly filled through damp-packing with a mortar of dry consistency and a mix of one part of cement to one part sand. The amount of water to be added to the cement-sand mix shall be such that the mortar can be driven into the voids and will compact properly. The outside of the tie hole shall be drypacked no sooner than 7 days after the inside has been drypacked.

2. Embeco or other fast-setting cements/additives shall not be used for damp-packing such cavities.

3. Interior reservoir wall surfaces which have been damp-packed shall be covered with an approved 10-mil thick water insensitive non-sag epoxy coating, which shall conform to the requirements specified herein. Finished surfaces shall be free from sand streaks or other voids.

H. Abrasive Blasting

1. The exterior surface of poured concrete wall areas, which will receive wire-wrapped prestressing/shotcrete or paint, if any, shall be abrasive blasted, regardless of the forming method used, by a mechanical etching or shot blast system combined with a vacuum recovery system, or a self-contained waterblasting system.

2. The surface shall be blasted sufficiently to remove all laitance, form oil or other type coatings.

3. The surface shall be cut sufficiently to provide a good mechanical bond between the shotcrete covercoat and the concrete wall. The surface shall be cut to a minimum CSP5 profile, was established by the International Concrete Repair Institute (ICRI), over a minimum 90 percent of the area as measured over any one-foot square area.

4. Systems that have not been used in the past to prepare circular tank wall surfaces for shotcreting and strandwrapping or systems which rely on sandblasting or steel shot without a vacuum system will not be allowed.

5. All abrasive blasting shall be done to the satisfaction of the Engineer, and this work shall not be started before the completion date of the curing period or before all the tie-holes have been drypacked.

I. Honeycombed areas

1. Unless the removal of one or more defective panels is required by the Engineer, defective surfaces, such as honeycomb, shall be cut out entirely until homogeneous concrete is met, even if it means going through the entire wall, floor, or roof slab. Removal of defective areas must be performed in a way as to avoid damage to all embedded items such as reinforcing steel, vertical threadbars, waterstops, or any other items.

2. Such areas shall be coated with an approved epoxy or adhesive bonding material, which shall be applied in accordance with the Manufacturer's instructions, before damp-packing the area with a mix consisting of one part of Portland cement and two parts of sand and fine gravel, epoxy and sand mix, or any combination of materials and mixes as the situation dictates in the opinion of the Engineer.

3. The water content of the damp-pack material shall be such that a ball of the mix may be squeezed in the hand without bringing free water to the surface.

4. Damp-pack material shall be tamped into place and finished to match adjacent concrete surfaces.

5. Particular care shall be taken that no sagging of the material will occur.

6. The bond between any two layers of damp-pack shall be improved through the use of an approved epoxy bonding agent.

7. Surfaces which have been damp-packed shall be kept continuously damp during, and for a period of not less than 7 days after completing the damp-pack operation, by the curing procedure described below in Section 03 30 00-3.11.

8. Under no circumstances shall Contractor apply a plaster coat over the honeycomb areas to conceal the existence of the honeycomb in the concrete.

9. Neither Embeco, calcium chloride, nor fast-setting cements/additives shall be used for filling honeycomb areas, nor shall they be mixed with damppack material. Contractor shall provide certification that any material placed on or in the corewall shall be free of chlorides and other materials corrosive to prestressing steel.

10. Determination of defective areas is at the discretion of the Engineer.

J. Miscellaneous Surfaces

1. Miscellaneous surfaces that are not covered herein and not specifically designated on the Drawings shall be finished as directed by the Engineer.

K. Schedule of Finishes

Consider other finishes needed for the Project, i.e., Sidewalk, curb, gutter, building floors, etc.

Surface Description	Finish Required
Reservoir:	

Reservoir Floor	Steel Trowel Finish
Top of Footings	Steel Trowel Finish
Interior of Wall	Smooth Form Finish
Exterior of Wall	Sandblasted
Underside of Roof	Smooth Form Finish
Surface of Roof	Non-Slip Broom Finish
Columns	Smooth Form Finish

Vault:

Interior Floor	Steel Trowel Finish
Interior of Wall	Smooth Form Finish
Exterior of Wall	Smooth Form Finish
Underside of Roof	Smooth Form Finish
Surface of Roof	Steel Trowel Finish

3.11 CURING

A. The Contractor shall begin curing immediately after initial concrete set has occurred. Exposed concrete surfaces shall be kept moist during finishing operations prior to initiating specified curing procedures.

B. Curing of the roof and floor slabs shall be made by covering the slab with curing blankets, which incorporate a water containing felt or burlap element and a white plastic cover and kept continuously wet for a period of no less than 7 days (168 hours). After removal of curing blankets, the slab shall be sprayed with a curing compound as specified in Section 03 30 00-2.16.

C. All other horizontal, screeded, and floated surfaces, exposed to drying winds and sunlight, shall be sprayed with a curing compound as specified in Section 03 30 00-2.16 at an application rate of 200 sf/gallon or more as recommended by the Manufacturer.

D. Water for curing shall be generally clean and free from any elements which might cause staining or discoloration of the concrete.

E. All formed concrete surfaces shall be sprayed with a concrete curing compound as specified in Section 03 30 00-2.16 at an application rate of 200 sf/gallon, or as recommended by the Product Manufacturer, whichever provides the most coverage. This requirement will be waived if the forms have been left in place for at least 7 days.

3.12 CONCRETE SURFACE REPAIRS

A. Patching Defective Areas

1. Repair and patch defective areas with cement mortar immediately after removal of forms but only when directed by the Engineer.

2. Cut out honeycomb, rock pockets, voids over 1/2-inch diameter and holes left by tie rods and bolts down to solid concrete but, in no case, to a depth of less than 1-inch. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean, dampen with water and brush-coat the area to be patched with neat

cement grout. Proprietary patching compounds may be used when acceptable to the Engineer.

3. For exposed-to-view surfaces, blend white Portland cement and standard Portland cement so that, when dry, the patching mortar will match the color of the surrounding concrete. Provide test areas at inconspicuous location to verify mixture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

4. Fill holes extending through concrete by means of a plunger type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure complete filling.

B. Repair of Formed Surfaces

1. Repair exposed-to-view formed concrete surfaces that contain defects, which adversely affect the appearance of the finish. Remove and replace the concrete having defective surfaces if the defects cannot be repaired to the satisfaction of the Engineer. Surface defects, as such, include color and texture irregularities, cracks, spalls, air bubbles, honeycomb, rock pockets, and holes left by the rods and bolt; fins and other projections on the surface; and stains and other discolorations that cannot be removed by cleaning.

2. Repair concealed formed concrete surfaces that contain defects that adversely affect the durability of the concrete. If defects cannot be repaired, remove, and replace the concrete having defective surfaces. Surface defects, as such, include cracks in excess of 0.01-inch wide, cracks or any width and other surface deficiencies which penetrate to the reinforcement or completely through non-reinforced sections, honeycomb, rock pockets, holes left by tie rods and bolts, and spalls except minor breakage at corners.

C. Repair of Unformed Surfaces

1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.

2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.

3. Repair finished unformed surfaces that contain defects, which adversely affect the durability of the concrete. Surface defects, as such, include crazing, cracks in excess of 0.01-inch wide or which penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.

4. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so those repairs can be made without damage to adjacent areas.

5. Correct low areas in unformed surfaces during or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Proprietary patching compounds may be used when acceptable to the Engineer.

6. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. Dampen all concrete surfaces in contact with patching concrete and brush with a neat cement grout coating or use concrete bonding agent. Place patching concrete before grout takes its initial set. Mix patching concrete of the same material to provide concrete of the same type or class as the original adjacent concrete. Place, compact, and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.

7. Repair isolated random cracks and single holes not over 1-inch in diameter by the dry-pack method. Groove the top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen all cleaned concrete surfaces and brush with a neat cement grout coating. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of 1-part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.

8. Repair methods not specified above may be used subject to the acceptance of the Engineer. Alternate repair methods must be submitted and approved by the Engineer prior to installation.

3.13 CONCRETE TESTS

A. Compression tests shall conform to ASTM C39, ASTM C670 and ASTM C803.

B. Proportioning (or chemical analysis) tests shall conform to ASTM C1084.

C. Air content: ASTM C231, pressure method; one for each set of compressive strength test specimens. If air content is found to be out of conformance during site concrete testing, air content will be checked for every 9-cubic yard truck delivered to the site until three consecutive trucks are found to have air content meeting the specification. Testing will then return to rate outlined in 03 30 00-3.13.E.

D. Slump Test: ASTM 143; one test for each concrete load at point of discharge; and one for each set of compressive test specimens.

E. At least one slump test and five test cylinders shall be made, under the supervision of the Engineer, by an approved testing lab for every 40 cubic yards of ready-mixed concrete delivered to the jobsite. Each cylinder shall be coded to identify the date of delivery, the truck number, the location where the concrete has been used and the slump measured upon discharge. For each reservoir wall section, two sets of five cylinders shall be made. When the frequency of testing will provide less than five strength tests for a given class of concrete, conduct testing from at least five randomly selected batches or from each batch if fewer than five are used.

F. The specimens shall be standard test cylinders, 6 inches in diameter, 12 inches in length, and they shall be prepared in accordance with ASTM C31.

G. Molds for the standard test cylinders shall be furnished by the independent testing laboratory contracted by the Owner at the expense of the Owner.

H. All costs for making and testing of concrete and materials, by an approved recognized reputable testing laboratory, will be borne by the Owner.

I. Making and testing of cylinders shall be performed by an approved testing laboratory that normally engages in the preparation of concrete mix designs and testing of concrete materials.

J. A compression test may be made on one cylinder from each group of five after 7 and/or 14 days, at the Engineer's option. A strength test shall be made using two cylinders from each group of five at 28 days for use in evaluating the concrete strength in accordance with the current editions of the IBC and ACI 318.

K. As requested by the Engineer, proportioning tests for each class of concrete delivered to the jobsite, shall be made from test cylinders designated by the Engineer.

L. In addition to the test cylinders referred to in Section 03 30 00-3.13.E, an additional three test cylinders shall be made for each day's pour, or for every 4,000 square feet of wall and roof surface, whichever provides the largest number of cylinders.

They shall be cured in the same manner, and in the same location of the concrete area to be investigated. Before walls may be prestressed, or before roof-forms may be stripped, at least one cylinder, of each batch of three cylinders, must be tested to verify whether the in-place concrete strength meets the minimum specified design strength.

M. The method of determining the standard deviation of compressive concrete strengths from previously utilized mix designs having previously recorded test results and the minimum allowable average compressive strengths of mix designs not having any previously recorded test results shall comply with the requirements of the code and commentary sections in the current edition of ACI 318.

N. The compressive test results of the cylinders referred to in Section 03 30 00-3.13.J above will be compared against the strength-versus-slump relationship curves referred to in Section 03 30 00-1.4 B. Proportioning tests may then be made, at the discretion of the Engineer, on those groups of cylinders which have shown low readings.

O. Any concrete not meeting the minimum specified design strength and any concrete showing a cement content less than the ratio by weight established in the original mix design will be subjected to further testing of concrete cores complying with ASTM C42 taken from the concrete in question. Should these tests confirm that the specified requirements have not been met, the extra costs involved in such testing shall be borne by Contractor; and the concrete, at the Engineer's option, and at Contractor's sole expense, may be rejected and must then be removed from the site or may be strengthened with additional shotcrete or concrete as the situation warrants it. Should the core tests indicate that the strength requirement has been met or if the low strength concrete is deemed acceptable to the Engineer, the extra costs involved in such testing shall still be borne by the Contractor.

END OF SECTION

SECTION 03 30 10 - COLD WEATHER CONCRETING PROCEDURES

For all prestressed concrete reservoirs. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers requirements for placement and preparation for cast-in-place concrete and appurtenances under cold weather conditions.

1.2 RELATED SECTIONS

A. Section 03 30 00 - Cast-In-Place Concrete

B. Section 33 16 10 – Ground-Level Prestressed Concrete Water Utility Storage Reservoir

1.3 DEFINITIONS

A. Cold Weather Conditions: Any period when for more than three successive days the mean daily temperature falls below 40 degrees Fahrenheit (F), or any day when the temperature is expected to fall or falls below freezing.

1.4 SUBMITTALS

A. Not less than 30 days prior to expected placement of concrete under cold weather conditions, a complete procedure shall be submitted for review covering all aspects of protection of concrete and its ingredients from the detrimental effects of cold weather.

B. Concrete placement during cold weather shall not commence prior to return of the procedure marked "Reviewed".

1.5 PRODUCT DELIVERY, HANDLING, AND STORAGE

The concrete temperature, during placement in cold weather, shall not be less than 50 degrees F. Temperature measurements of the concrete as delivered to the jobsite shall confirm this requirement.

PART 2 PRODUCTS

2.1 MATERIALS

Water and aggregates may be preheated for cold weather placement; however, their temperature shall not exceed 150 degrees F. All methods and equipment for heating of water and aggregate shall be subject to the approval of the Engineer and shall conform to ACI 306.

PART 3 EXECUTION

3.1 CONCRETE PLACEMENT

A. No concrete shall be placed on frozen ground.

B. The ground, against which concrete is to be poured, must be protected against freezing after its preparation, or the concrete placement shall be delayed until the ground has fully thawed out.

C. When temperatures are expected to be below 32 degrees F the night before the concrete is placed, then all reinforcing steel, forms and the ground shall be preheated, for a minimum of 12 hours, under a minimum temperature of 50 degrees F.

D. When temperatures are expected to be below 40 degrees F any time before the concrete has reached a strength of 1,000 pounds per square inch (psi), the concrete must be adequately protected against frost damage by heating blankets, straw, or insulation materials for a minimum of 7 days or until at least 1,000 psi concrete strength has been reached. Provide adequate means to maintain the temperature in the area where concrete is being placed at either 70 degrees F for 3 days or 50 degrees F for 5 days after placing. Keep protections in place and intact at least 24 hours after artificial heat is discontinued. The concrete temperature shall at no time fall below 40 degrees F based on recording temperature monitors placed at a maximum of 50 feet on centers, each way, and around the circumference of the floor, wall, roof slab, and wall-footing. Contractor shall provide heat as required to keep the concrete temperature as specified throughout the entire curing period of 7 days.

E. Weather prediction made by the nearest NOAA station, and corrected for the local elevation and environmental conditions, may be used to determine whether cold weather protection shall be required. Thermometers will be used by the Engineer and these readings shall determine whether cold weather protection shall be required and whether cold weather protection is adequate.

F. When combustion type heaters are used to maintain concrete temperatures within an enclosure, the exhaust gases shall be vented from the heater to the outside atmosphere so that the concrete is not exposed to the products of combustion.

G. Protect all concrete work from physical damage or reduced strength which could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.

H. When air temperature has fallen to or is expected to fall below 40 degrees F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 50 degrees F, and not more than 80 degrees F, at point of placement.

I. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel and adjacent concrete surfaces are entirely free of frost, snow, and ice before placing concrete.

END OF SECTION

SECTION 03 30 20 - HOT WEATHER CONCRETING PROCEDURES

For all prestressed concrete reservoirs. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section covers requirements for placement and preparation for cast-in-place concrete and appurtenances under hot weather conditions.

B. During hot weather conditions, any or all the methods specified herein for temperature control of concrete shall be used as required to maintain the concrete temperature below the limits specified.

C. Related Sections

1. Section 03 30 00 - Cast-In-Place Concrete

2. Section 33 16 10 – Ground-Level Prestressed Concrete Water Utility Storage Reservoir

1.2 DEFINITIONS

A. Hot Weather Conditions: Any combination of high air temperature, low relative humidity and wind velocity tending to impair the quality of fresh or hardened concrete or otherwise resulting in abnormal concrete properties.

1.3 SUBMITTALS

A. Not less than 30 days prior to expected placement of concrete under hot weather conditions, a complete procedure shall be submitted for review covering the aspects of protection of concrete and its ingredients from the detrimental effects of hot weather.

B. Concrete placement during hot weather shall not commence prior to the return of the procedure marked "Reviewed".

1.4 PRODUCT DELIVERY, HANDLING, AND STORAGE

A. Aggregate piles, cement bins, and batch plant bins shall be shaded from the direct rays of the sun.

B. Aggregate piles shall be cooled by wetting and evaporation. Aggregate wetting shall be performed in such a manner that it will not cause wide variations in moisture content impairing slump uniformity.

1.5 QUALITY ASSURANCE

Comply with the provisions of the following codes, specifications, and standards, except as otherwise shown or specified.

A. American Concrete Institute - ACI 305

PART 2 PRODUCTS

2.1 MATERIALS

A. Batching and Mixing

1. Concrete mix water shall be refrigerated, or ice shall be added to the mix up to 100 percent of the water requirement. Ice, when introduced into the mixer, shall be in such form that it will be completely melted and dispersed throughout the mix at the completion of the mixing time. Ice may be used provided the water equivalent of the ice is calculated to the total amount of mixing water. The mixing time shall be held to the minimum practicable consistent with producing concrete meeting the specified requirements.

2. All methods and equipment for cooling of water and aggregate shall be subject to the approval of the Engineer and shall conform to ACI 305.

PART 3 EXECUTION

3.1 TEMPERATURE CONTROL OF CONCRETE

A. General Practices and Measures

The following list of practices and measures, as described in ACI 305, may be used to reduce, or avoid the potential problems of hot weather concreting:

1. Use concrete materials and proportions with satisfactory records in field use under hot weather conditions.

2. Use cool concrete.

3. Use a concrete consistency that permits rapid placement and effective consolidation.

4. Transport, place, consolidate, and finish the concrete with least delay.

5. Plan the job to avoid adverse exposure of the concrete to the environment; schedule placing operations during times of the day or night when weather conditions are favorable.

6. Protect the concrete against moisture loss at all times during placing and during its curing period.

B. Concrete Temperature

The temperature of concrete, as delivered at the time and location of placement, shall not exceed 90 degrees Fahrenheit under any conditions. The temperature of concrete as delivered

at the time and location of placement under the following combined ambient conditions, except concrete that will be deposited within wall or column forms, shall not exceed the following temperatures:

Relative humidity		Ambient temperature		Maximum concrete temperature
less than:	80%	greater than:	90°F	100°F
	70%		90°F	95°F
	60%		90°F	90°F
	50%		90°F	85°F
	40%		90°F	80°F
	30%		80°F	75°F
	20%		75°F	70°F

3.2 DELIVERY

Concrete shall be placed in the Construction within 90 minutes after the completion of mixing.

3.3 PREPARATION FOR PLACING

A. Elevated forms and reinforcing steel for beams and similar members shall be cooled by fog spraying and evaporation immediately prior to placing concrete. Forms shall be free of standing water when concrete is placed herein.

B. Cover reinforcing with water-soaked burlap such that the steel temperature does not exceed the ambient air temperature immediately before embedment in concrete.

C. Wet form thoroughly before placing concrete.

3.4 PLACING

A. Concrete shall be placed in shallower layers than under normal weather conditions, if necessary, to assure coverage of the previous layer while it will respond readily to vibration.

B. Do not use retarding admixtures unless otherwise accepted in mix design. Wet forms thoroughly before placing concrete.

3.5 FINISHING

Fog spray shall be used during finishing operations whenever necessary to avoid surface plastic-shrinkage cracking. Fog spray shall also be used after finishing and before the specified curing is commenced to avoid surface plastic-shrinkage cracking.

3.6 PROTECTION AND CURING

Forms shall be kept covered and continuously moist. Once forms are loosened and during form removal, concrete surfaces shall be protected from drying and shall be kept continuously wet by fog spraying or other approved means.

END OF SECTION

SECTION 03 39 00 - CONCRETE CURING

This Section includes procedures for curing horizontal and vertical concrete surfaces. Coordinate text of this section with Section 03 30 00 and Section 03 35 00.

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting the requirements of this specification.

This Section includes performance, proprietary, and descriptive type specifications. Edit to avoid conflicting requirements.

See the Drawing Coordination Considerations for information needed to coordinate this specification Section with the Drawings.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. Section includes initial and final curing of horizontal and vertical concrete surfaces.

B. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete.
2. Section 03 35 00 - Concrete Finishing.

1.2 REFERENCES

List reference standards included within text of this section. Edit the following for Project conditions.

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 302.1 - Guide for Concrete Floor and Slab Construction.
3. ACI 308.1 - Standard Specification for Curing Concrete.
4. ACI 318 - Building Code Requirements for Structural Concrete.

B. ASTM International:

1. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.
2. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
3. ASTM C1315 - Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.

4. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting.

1.3 SUBMITTALS

Only request submittals needed to verify compliance with Project requirements.

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Product Data: Submit data on [curing compounds,] [mats,] [paper,] [film,] compatibilities, and limitations.

1.4 SUSTAINABLE DESIGN SUBMITTALS

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design submittals.

B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

Edit material certifications list to suit products specified in this section and Project sustainable design requirements. Specific certificate submittal and supporting data requirements are specified in Section 01 81 13.

1. Materials Resources Certificates:

a. Certify recycled material content for recycled content products.

b. Certify source for regional materials and distance from Project Site.

C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

1. Provide cost data for the following products:

Edit list of material cost data to suit products specified in this section and Project sustainable design requirements. Specific cost data requirements are specified in Section 01 81 13.

a. Products with recycled material content.

b. Regional products.

c. <_____.>

1.5 QUALITY ASSURANCE

Use this article to specify compliance with overall reference standards affecting all products and installation included in this section.

A. Perform Work in accordance with [ACI 301] [ACI 302.1] [ACI 318].

B. Perform Work in accordance with [[State] [Municipality] of <_____> [Highways] [Public Work's] standard.]

Include the following paragraph only when cost of acquiring specified standards is justified.

C. Maintain [one copy] [<_____> copies] of [each] document on site.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Deliver curing materials in Manufacturer's packaging including application instructions.

PART 2 PRODUCTS

2.1 SUSTAINABILITY CHARACTERISTICS

Edit sustainable design requirements to suit content of this section and Project sustainable design requirements specified in Section 01 81 13.

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content [including:] [.]

List materials specified in this section required to have recycled content.

a. <_____.>

2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles (800 km) of Project Site [including:] [.]

List materials specified in this section required to be regional materials.

a. <_____.>

2.2 MATERIALS

In the following paragraph, select curing compound based on functional use of floor surface, compatibility with finish materials, and longevity of wear expected. Select one

or more of the following materials; when more than one is required, schedule types and applications at end of section.

ASTM C309 Type and Class are as follows:

- Type 1 - Clear or transparent without dye.

- Type 1-D - Clear or transparent with fugitive dye.

- Type 2 - White pigmented.

- Class A - No restrictions on vehicle solids material.

- Class B - Vehicle solids restricted to all resin material.

A. Membrane Curing Compound [Type [A]]: ASTM C309, Type [1] [1D] [2], Class [A] [B].

1. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [Section 01 60 00 - Product Requirements] [Not Permitted].

******** [OR] ********

ASTM C1315 Type and Class are as follows:

- Type I - Clear or translucent.

- Type II - White pigmented.

- Class A - Non-yellowing.

- Class B - Moderate yellowing.

- Class C - Unrestricted color change permitted.

B. Membrane Curing Compound: ASTM C1315 Type [I] [II], Class [A] [B] [C].

1. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [Section 01 60 00 - Product Requirements] [Not Permitted].

******** [OR] ********

C. Non-Membrane Forming Curing Compound [Type [B] <_____>]: Liquid, penetrating siliconate based type; combination curing, hardening, and dustproofing compound.

1. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [Section 01 60 00 - Product Requirements] [Not Permitted].

******** [OR] ********

D. Absorptive Mats [Type [C] <_____>]: [ASTM C171,] [burlap-polyethylene, minimum 9 oz/sq yd (305 grams/sq m) bonded to prevent separation during handling and placing] <_____>.

1. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [Section 01 60 00 - Product Requirements] [Not Permitted].

******** [OR] ********

Caution is required when one of the following two paragraphs are used; their use restricts ability of floor surface material to breathe and hydrate properly.

E. Waterproof Paper [Type [D] <_____>]: [ASTM C171,] curing paper treated to prevent separation during handling and placing, [regular] [white color].

1. Manufacturers:

a. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

b. Substitutions: [Section 01 60 00 - Product Requirements] [Not Permitted].

******** [OR] ********

F. Polyethylene Film [Type [E] <_____>]: [ASTM C171,] [ASTM D2103,] [4] [6] <_____> mil ([0.1] [0.15] <_____> mm) thick, [clear.] [white opaque color.]

Caution with the following paragraph, water is not used with all materials above.

G. Water: Potable, not detrimental to concrete.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and Project conditions.

B. Verify substrate surfaces are ready to be cured.

3.2 INSTALLATION – HORIZONTAL SURFACES

ACI 308.1 includes curing requirements for various methods.

A. Cure concrete in accordance with ACI 308.1 using <_____> method.

Select and edit the following concrete curing methods to suit Project requirements.

B. Ponding: Maintain 100 percent coverage of water over floor slab areas, continuously for [4] <_____> days.

******** [OR] ********

C. Spraying: Spray water over floor slab areas and maintain wet for [7] <_____> days.

******** [OR] ********

D. Absorptive Mat: Spread [cotton fabric] <_____> over floor slab areas. Spray with water until mats are saturated and maintain in saturated condition for [7] <_____> days.

******** [OR] ********

E. Absorptive Mat: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place for [7] <_____> days.

******** [OR] ********

F. Membrane Curing Compound: Apply curing compound in [one coat.] [two coats with second coat applied at right angles to first.]

******** [OR] ********

G. Non-Membrane Forming Curing Compound: Apply curing compound in one coat [Scrub compound into surface.] Maintain surface wet with curing compound, without ponding for time recommended by Manufacturer.

******** [OR] ********

H. Polyethylene Film: Spread over floor slab areas, lap edges and sides, seal with pressure sensitive tape [and cover with plywood]; maintain in place for [7] <_____> days.

3.3 INSTALLATION – VERTICAL SURFACES

ACI 308.1 includes curing requirements for various methods.

A. Cure concrete in accordance with ACI 308.1 using <_____> method.

Select and edit the following concrete curing methods to suit Project requirements.

B. Spraying: Spray water over surfaces and maintain wet for [7] <_____> days.

******** [OR] ********

C. Membrane Curing Compound: Apply compound in [one coat.] [two coats with second coat applied at right angles to first.]

******** [OR] ********

D. Non-Membrane Forming Curing Compound: Apply curing compound in one coat [Scrub compound into surface.] Maintain surface wet with curing compound, without ponding for time recommended by Manufacturer.

3.4 PROTECTION OF FINISHED WORK

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting finished Work.

B. Do not permit traffic over unprotected floor surface.

3.5 SCHEDULES

Include schedule when differing concrete curing materials are required for the Project. Consider the following examples when developing Project schedule.

A. Storage Area Slabs: Absorptive mats, burlap-polyethylene type.

B. Retaining Walls: Membrane curing compound, acrylic type, clear color.

C. Concrete Pavement: Membrane curing compound, opaque color.

D. Other Floor Areas: Membrane curing compound, acrylic type, translucent color.

END OF SECTION

SECTION 03 45 00 - PRECAST ARCHITECTURAL CONCRETE

This Section includes plant cast architecturally finished concrete wall panels; this Section can be edited to include decorative units and horizontal pavers. Units are usually non-load bearing, with supports, anchors, and attachments.

Sealant joint treatment is included in this Section by reference to SpecText Section 07 90 00. Integral insulation is included by generic description in this Section and by reference to SpecText Section 07 21 13.

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting the requirements of this specification.

This Section includes performance, proprietary, and descriptive type specifications. Edit to avoid conflicting requirements.

See the Drawing Coordination Considerations for information needed to coordinate this specification Section with the Drawings.

PART 1 GENERAL

1.1 SUMMARY

A. Section includes architectural precast concrete for:

Edit the following list for Project conditions.

1. Wall panels [with integral insulation].
2. Pavers [and paver pedestals].
3. Sills.
4. Planters.
5. <_____>.
6. Supports, anchors, and attachments.
7. Perimeter joint seals.
8. Intermediate joint seals.
9. Grouting under panels.

1.2 RELATED SECTIONS:

A. Section 03 30 00 - Cast-In-Place Concrete: Building structural frame.

******** [OR] ********

B. Section 03 38 00 - Post-Tensioned Concrete: Building structural frame.

******** [OR] ********

C. Section 03 41 00 - Precast Structural Concrete: Building structural frame.

******** [OR] ********

D. Section 03 41 13 - Precast Concrete Hollow Core Planks: Building structural floor system.

******** [OR] ********

E. Section 03 47 13 - Tilt-Up Concrete: Building structural frame.

F. Section 05 12 00 - Structural Steel Framing: Building structural frame.

G. Section 07 84 00 - Firestopping: [[Fire] [Smoke] barrier] [Air] seal between precast unit and edge of floor slab.

Include the following paragraph when perimeter joint seals are described in related section.

H. Section 07 90 00 - Joint Protection: Perimeter joints with sealant and backing.

I. Section <_____-_____>: Surface reglets and metal flashings attached to precast units.

J. Section <_____-_____>: Substrate surface to receive pavers.

K. Section <_____-_____>: Supporting masonry.

L. Section <_____-_____>: Metal flashings to fit recessed reglets in precast units.

M. Section <_____-_____>: Windows [and glass] site installed in precast units.

List sections specifying installation of products included in this section and indicate specific items.

N. Section <_____-_____>: Placement of anchors for [embedding into] [placing in] [welding to] building structural components.

List sections specifying products installed in this section and indicate specific items.

O. Section <_____-_____>: Supply of window units [and glass] for placement by this Section.

P. Section <_____-_____>: Supply of flashing reglets for placement by this Section.

1.3 REFERENCES

List reference standards included within text of this section. Edit the following for Project conditions.

A. American Concrete Institute:

1. ACI 301 - Specifications for Structural Concrete.

2. ACI 318 - Building Code Requirements for Structural Concrete.

B. ASTM International:

1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.

2. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

4. A185/A185M-07 Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.

5. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

6. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.

7. ASTM A325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric).

8. ASTM A416/A416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

9. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.

10. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

11. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.

12. ASTM A775/A775M - Standard Specification for Epoxy-Coated Steel Reinforcing Bars.

13. ASTM C31/C31M - Standard Practice for Making and Curing Concrete Test Specimens in the Field.

14. ASTM C33 - Standard Specification for Concrete Aggregates.

15. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.

16. ASTM C150 - Standard Specification for Portland Cement.

17. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.

18. ASTM C330 - Standard Specification for Lightweight Aggregates for Structural Concrete.

19. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

C. American Welding Society:

1. AWS D1.1 - Structural Welding Code - Steel.

2. AWS D1.4 - Structural Welding Code - Reinforcing Steel.

D. Precast/Prestressed Concrete Institute:

1. PCI MNL-117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.

2. PCI MNL-120 - PCI Design Handbook - Precast and Prestressed Concrete.

3. PCI MNL-122 - Architectural Precast Concrete.

4. PCI MNL-123 - Design and Typical Details of Connections for Precast and Prestressed Concrete.

1.4 DESIGN REQUIREMENTS

Use this article carefully; restrict statements to identify system design requirements only.

Select one of the following two paragraphs depending on Project requirements.

A. Design units to withstand design loads [as calculated in accordance with <_____> code,] and erection forces. Calculate structural properties of units in accordance with ACI 318.

********* [OR] *********

B. Design units to withstand actual loads including wind, suction, deflection, and thermal movement loads.

C. [Design and size components to withstand seismic loads and sway displacement as calculated in accordance with <_____> code.]

D. Design units to accommodate construction tolerances, deflection of building structural members, and clearances of intended openings.

E. Design component connections to accommodate building movement and thermal movement. Provide adjustment to accommodate misalignment of structure without unit distortion or damage.

Include the following paragraph to indicate insulation value for complete unit. When insulation material is specified by thickness or R (RSI) value, delete this paragraph.

F. [Insulated precast concrete units to achieve R of <_____> (RSI of <_____>) insulation value.]

1.5 SUBMITTALS

Only request submittals to verify compliance with Project requirements.

A. Section 01 33 00 - Submittal Procedures: Submittals procedures.

B. Shop Drawings: Indicate layout, unit locations, configuration, [unit identification marks,] [reinforcement,] connection details, support items, [location of lifting devices,] dimensions, openings, and relationship to adjacent materials. [Submit erection drawings.]

C. Design Data: Submit design data reports indicating calculations for loadings and stresses of fabricated, designed framing and connections.

Include the following paragraph for submission of physical samples for selection of finish, color, texture, and other properties.

D. Samples: Submit [two] <_____> panels, <____>x<____> inch (<____>x<____> mm) in size illustrating surface finish, color, and texture.

1.6 SUSTAINABLE DESIGN SUBMITTALS

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design submittals.

B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.

Edit material certifications list to suit products specified in this section and Project sustainable design requirements. Specific certificate submittal and supporting data requirements are specified in Section 01 81 13.

1. Materials Resources Certificates:

a. Certify recycled material content for recycled content products.

b. Certify source for regional materials and distance from Project site.

C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.

1. Provide cost data for the following products:

Edit list of material cost data to suit products specified in this section and Project sustainable design requirements. Specific cost data requirements are specified in Section 01 81 13.

a. Products with recycled material content.

b. Regional products.

c. <_____.>

1.7 CLOSEOUT SUBMITTALS

A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.

B. Operation and Maintenance Data: Procedures for Project closeout submittals. Indicate [surface cleaning] <_____> instructions.

1.8 QUALITY ASSURANCE

Use this article to specify compliance with overall reference standards affecting all products and installation included in this section.

A. Perform Work in accordance with [PCI MNL-117,] [PCI MNL-120,] [PCI MNL-122,] [PCI MNL-123,] [ACI 318] [and] <_____>.

B. Welding: AWS D1.1 and AWS D1.4.

C. Surface Burning Characteristics:

1. Foam Insulation: Maximum 75/450 flame spread/smoke developed index when tested in accordance with ASTM E84.

D. Apply label from agency approved by authority having jurisdiction to identify each foam plastic insulation board.

E. Perform Work in accordance with [[State] [Municipality] of <_____> [Highways] [Public Work's] standard.]

Include the following paragraph only when cost of acquiring specified standards is justified.

F. Maintain [one copy] [<_____> copies] of [each] document on site.

1.9 QUALIFICATIONS

A. Fabricator: Company specializing in performing Work of this section with minimum <_____> years [documented] experience.

******** [OR] ********

B. Precast Manufacturer and Erectors: Qualified in accordance with PCI MNL-117 Group A1 - Architectural Concrete.

C. Design units under direct supervision of Professional Engineer experienced in design of this Work and licensed [at Project location.] [in State of <_____>.]

D. Welder: Qualified within previous [12] <_____> months in accordance with AWS D1.1 and AWS D1.4.

1.10 MOCK-UP

Use this article for full sized erected assemblies required for review of construction, coordination of work of several sections, testing, or observation of operation.

Mock-ups may also be used for assessing field applied finishes and for assessing aesthetics of field finishes.

A. Section 01 40 00 - Quality Requirements: Requirements for mockup.

B. Construct mockup panel, <_____> feet (<_____> m) long by <_____> feet (<_____> m) wide, with lifting device, and attachment points, and finish in accordance with approved sample.

******** [OR] ********

C. Fabricate and erect [**at site**] [**in plant**], [**one**] <_____> full size panel, illustrating shape, lifting device, and attachment points, and finish in accordance with approved sample.

D. Include mock-up panel with [**typical window,**] [**fully glazed,**] [**insulated panel,**] [**sealants,**] [**and**] <_____>.

E. Locate [**where directed by Engineer.**] [**where indicated on Drawings.**]

F. Incorporate accepted mockup as part of Work.

******* [OR] ********

G. Remove mockup [**when directed by Engineer.**] <_____.>

1.11 PRE-INSTALLATION MEETINGS

A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

B. Convene minimum [**one**] <_____> week prior to commencing work of this section.

1.12 DELIVERY, STORAGE, AND HANDLING

A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.

B. Handle precast units to position, consistent with their shape and design. Lift and support only from support points.

C. Blocking and Lateral Support During Transport and Storage: Clean, non-staining, without causing harm to exposed surfaces. Provide temporary lateral support to prevent bowing and warping.

D. Protect units to prevent staining, chipping, or spalling of concrete.

E. Mark units with date of production in location not visible to view when in final position in structure.

PART 2 PRODUCTS

2.1 SUSTAINABILITY CHARACTERISTICS

Edit sustainable design requirements to suit content of this section and Project sustainable design requirements specified in Section 01 81 13.

A. Section 01 81 13 - Sustainable Design Requirements: Requirements for sustainable design compliance.

B. Materials and Resources Characteristics:

1. Recycled Content Materials: Furnish materials with maximum available recycled content [including:] [.]

List materials specified in this section required to have recycled content.

a. <_____.>

2. Regional Materials: Furnish materials extracted, processed, and manufactured within 500 miles (800 km) of Project site [including:] [.]

List materials specified in this section required to be regional materials.

a. <_____.>

2.2 MANUFACTURERS

In this article, list manufacturers acceptable for this Project.

A. Manufacturers:

1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

2. Substitutions: [Section 01 60 00 - Product Requirements] [Not Permitted].

******** [OR] ********

B. Furnish materials in accordance with [[State] [Municipality] of <_____> [Highways] [Public Work's] standards.]

Edit the following descriptive specifications to identify project requirements and to eliminate conflicts with manufacturers' products specified above.

2.3 MATERIALS

Use sulfate resisting cement type when sulfate soil backfill is placed against precast units.

A. Cement: ASTM C150, [Type I - Normal] [Type IA - Air Entraining] [Type III - High Early Strength] <_____> Portland type; [white] [gray] [buff] <_____> color for facing mix.

B. Concrete Materials: [ASTM C33] [ASTM C330]; water and sand.

C. Reinforcement: [ASTM A615/A615M, Grade [40] [60], deformed steel bars] [ASTM A185/A185M, welded steel wire fabric] [ASTM A416/A416M, pre-stressing strand]; [galvanized to ASTM A767/A767M Class [II] <_____>,] [epoxy finish to ASTM A775/A775M,] [unfinished,] strength and size commensurate with precast unit design.

D. Air Entrainment Admixture: ASTM C260.

E. Admixtures: [Air entrainment] [and] <_____> as specified in Section 03 30 00.

An infinite variety of finish aggregate types and sizes are available; edit the following paragraph accordingly.

F. Surface Finish Aggregate: Clean, [washed,] [angular] [smooth] <_____> natural [gravel] [quartz] [granite] [limestone] [marble] <_____>; <_____> inch (<_____> mm) size, <_____> color, from single source throughout [conforming to ASTM C33].

******** [OR] ********

G. Surface Finish Aggregate: Conforming to sample [in office of Engineer.] <_____.>

Evaluate fading or streaking characteristics of pigments or coloring agents and their effects upon concrete strength before making final selection. Determine potential for uniformity of pigment when reviewing sample. Consider use of naturally colored fine aggregate in lieu of pigments.

H. [Pigment] [Coloring Agent]: <_____> type, <_____> color resistant to alkalis; <_____> manufactured by <_____>.

I. Surface Retarder: <_____> manufactured by <_____>.

Grout can be used for load bearing units; edit one of the following paragraphs accordingly.

J. Grout: [Non-shrink,] [Non-metallic,] [Normal,] minimum [10,000] <_____> psi ([70] <_____> MPa), 28-day strength.

******** [OR] ********

K. Grout: Thermo-setting epoxy.

2.4 FORM LINERS

A. Manufacturers:

1. <Click link above to find, evaluate, and insert list of manufacturers from SpecAgent>.

2. Substitutions: [Section 01 60 00 - Product Requirements] [Not Permitted].

B. Material: [Glass fiber reinforced polyester.] [Acrylonitrile butadiene styrene.] [Polyvinyl chloride.] [Polyurethane.] <_____.>

C. Configuration: <_____>.

2.5 SUPPORT DEVICES

A. Connecting and Support Devices: [ASTM A36/A36M [weldable] [general construction] steel.] [ASTM A666, Grade <_____>Type [304] [316] stainless steel.]

B. Bolts, Nuts, and Washers: [ASTM A307 Grade A] [ASTM A325 (ASTM A325M)], [high strength steel] [high strength alloy steel] [chromium nickel steel alloy].

C. Primer: [Zinc rich type.] <_____.>

2.6 ACCESORIES

The following paragraph includes insulation intended to be cast into panel. Exposed plastic insulation may cause fire hazard during field welding. Indicate insulation by thickness or R (RSI) value only when DESIGN REQUIREMENTS article does not indicate overall panel R (RSI) value.

A. Integral Insulation: Rigid [extruded polystyrene] [expanded polystyrene] [polyurethane] <_____> insulation, [<_____> thick] [value R of <_____> (RSI of <_____>)]; <_____> manufactured by <_____>.

******** [OR] ********

B. Integral Insulation: Rigid [extruded polystyrene] [expanded polystyrene] [polyurethane] <_____> insulation, specified in Section [07 21 13.] <_____.>

C. Bearing Pads: [High density plastic,] [Steel,] [Vulcanized elastomeric compound molded to size,] [Neoprene (Chloroprene),] [Tetrafluoroethylene (TFE),] [1/8] <_____> inch ([3] <_____> mm) thick, smooth both sides.

Include the following paragraph when recessed reglets are to be specified in this section.

D. Recessed Reglets: [Galvanized steel] [Stainless steel] [Plastic], shaped and flanged to remain in place once cast, [foam plastic filled] [taped closed] to eliminate wet concrete intrusion.

E. Paver Pedestals: <_____> manufactured by <_____>.

F. Sealant: <_____> type specified in Section 07 90 00.

2.7 MIX

This section is normally performance or criteria section not involving requirements for mix design. When minimum strength requirement is preferred, edit the following paragraph. When "face" mix and "back-up" mix are required, edit subsequent paragraph accordingly.

A. Concrete: Minimum [5,000] <_____> psi ([34] <_____> MPa), 28-day strength, air entrained to [5 to 7] <_____> percent [in accordance with [ACI 301] [ACI 318]].

********* [OR] *********

B. Separate face mix and backup mix:

1. Face mix: Minimum [5,000] <_____> psi ([34] <_____> MPa), 28-day strength, air entrained to [5 to 7] <_____> percent [in accordance with [ACI 301] [ACI 318]].

2. Backup mix: Same aggregate-cement ratio as face mix; achieve 28-day compressive strength of <_____> psi (<_____> MPa).

2.8 FABRICATION

A. Fabricate in conformance with PCI MNL-117 and [ACI 318] [[applicable] <_____> code].

B. Maintain plant records and quality control program during production of precast units. Make records available upon request.

C. Use rigid molds, constructed to maintain precast unit uniform in shape, size, and finish.

D. [Utilize form liners.]

E. Maintain consistent quality during manufacture.

F. Fabricate connecting devices, plates, angles, [items fit to steel framing members,] inserts, bolts, and accessories. Fabricate to permit initial placement and final attachment.

G. Weld steel fabrications in accordance with AWS D1.1. Weld reinforcing steel in accordance with AWS D1.4. Do not tack weld reinforcing.

H. Embed reinforcing steel, anchors, inserts plates, angles, and other cast-in items.

Window units are sometimes shop installed in precast panels. Use the following paragraph as appropriate.

I. Install [window units] <_____> in place while fabricating precast units. Protect assembly from damage.

Delete the following paragraph when not applicable.

J. Cast rigid insulation into units. [Cut drainage channels in exterior face of insulation to route moisture to exterior. Position weep drains to suit. Maintain drainage channels clear.]

Include the following paragraph whether reglets are provided by another section or by this section.

K. Place recessed flashing reglets continuous and straight.

L. Locate hoisting devices to permit removal after erection.

M. Cure units to develop concrete quality, and to minimize appearance blemishes including non-uniformity, staining, or surface cracking.

N. [Minor patching in plant is acceptable, providing structural adequacy and appearance of units is not impaired.]

2.9 FINISH – PRECAST UNITS

When it is intended to have adjacent cast-in-place concrete work with same finish as precast work, coordinate to ensure similar specification requirements.

A. Finish Type [A] <_____>: Ensure exposed-to-view finish surfaces of precast units are uniform in color and appearance.

Include the following paragraph when using surface retarder to achieve exposed aggregate finish.

B. Finish Type [B] <_____>: Remove cement mortar from areas affected by aggregate retarder.

Include the following paragraph when sandblasting is to be used to produce exposed aggregate finish. Specify degree of aggregate exposure in concert with size of aggregate being exposed.

C. Finish Type [C] <_____>: Sand blast exposed-to-view precast unit surfaces to [<_____> percent of unit aggregate surface.] [[light] [medium] [heavy] exposure.] Protect adjacent surfaces.

2.10 FINISH – SUPPORT DEVICES

Include finish treatment for carbon steel devices as appropriate.

A. Clean surfaces of rust, scale, grease, and foreign matter.

B. Prime paint in [one coat] [two coats], except surfaces in direct contact with concrete or requiring field welding.

ASTM A123/A123M includes minimum coating thickness grade based on type of material and steel thickness of component.

C. Galvanizing for Structural Steel Members: ASTM A123/A123M; galvanize after fabrication.

D. Galvanizing for Fasteners, Connectors, and Anchors:

1. Hot-Dipped Galvanizing: ASTM A153/A153M.

2. Mechanical Galvanizing: ASTM B695; Class 50 minimum.

2.11 FABRICATION TOLERANCES

Select and edit first paragraph or subsequent paragraphs.

A. Conform to [PCI MNL-117] <_____>.

******** [OR] ********

B. Maximum Out of Square: [1/8] <_____> inch in 10 feet ([1] <_____> mm/m), non-cumulative.

C. Variation From Dimensions Indicated on [Shop] Drawings: Plus or minus [1/8] <_____> inch ([3] <_____> mm).

D. Maximum Misalignment of Anchors, Inserts, Openings: [1/8] <_____> inch ([3] <_____> mm).

E. Maximum Bowing of Units: Length of bow/ [360] <_____>.

F. Location of Reglets: [1/4] <_____> inch ([6] <_____> mm) from indicated position.

2.12 SOURCE QUALITY CONTROL AND TESTS

A. Section 01 40 00 - Quality Requirements: Testing, inspection, and analysis requirements.

B. Test and analyze concrete in accordance with [PCI MNL-117] [ACI 318].

C. Take <_____> concrete test cylinders for every <_____> cu yds (<_____> cu m) of concrete placed in accordance with ASTM C31/C31M.

D. Take <_____> slump tests for every set of test cylinders in accordance with ASTM C143/C143M.

E. Take [one] <_____> air entrainment test for each set of exterior concrete test cylinders taken.

F. [Take water absorption test in accordance with PCI MNL-117.]

Include the following paragraph when reliance on fabricator's approved quality control program is sufficient for Project requirements.

G. When fabricator is approved by authority having jurisdiction, submit certificate of compliance indicating Work performed at fabricator's facility conforms to Contract Documents.

PART 3 EXECUTION

3.1 EXAMINATION

A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

B. Verify building structure, anchors, devices, and openings are ready to receive work of this Section.

3.2 PREPARATION

A. Provide for erection procedures and induced loads during erection. Maintain temporary bracing in place until final support is provided.

3.3 ERECTION

A. Erect units without damage to shape or finish. Replace or repair damaged panels.

B. Erect units level and plumb within allowable tolerances.

C. Align and maintain uniform horizontal and vertical joints as erection progresses.

D. When units require adjustment beyond design or tolerance criteria, discontinue affected work; advise Engineer.

E. [Fasten] [and] [Weld] units in place. [Perform welding in accordance with AWS D1.1.]

F. Touch-up [field welds and] scratched or damaged [primed painted] [galvanized] surfaces.

G. Weld reinforcing steel in accordance with AWS D1.4. Do not tack weld reinforcing.

Grout packing is normally used under load bearing precast units after unit has been placed.

H. Set vertical units dry, without grout, attaining joint dimension with lead or plastic spacers. [Pack grout to base of unit.]

Panel joint dimensions can be indicated on Drawings or specified in the following paragraph.

I. Exposed Joint Dimension: [1/2] <_____> inch ([12] <_____> mm).

Edit the following paragraph to suit joint sealing technique and whether reference is required to Section 07 90 00.

J. Seal [perimeter and] intermediate joints in accordance with Section [07 90 00] <_____> with <_____> type sealant.

3.4 ERECTION TOLERANCES

A. Section 01 40 00 - Quality Requirements: Tolerances.

B. Maximum Variation from Plane of Location: [1/4] <_____> inch in 10 feet and [3/8] <_____> inch in 100 feet ([2] mm in 3 m and [3] <_____> mm in 30 m), non-cumulative.

C. Maximum Offset from Indicated Alignment Between Two Connecting Units: [1/4] <_____> inch ([6] <_____> mm).

D. Joint Tolerance: Plus or minus [1/4] <_____> inch ([6] <_____> mm).

3.5 FIELD QUALITY CONTROL

A. Welding: Inspect welds in accordance with AWS D1.1.

3.6 ADJUSTING

A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.

B. Adjust units so joint dimensions are within tolerances.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.

B. Use non-combustible shields during welding operations to protect adjacent Work.

3.8 SCHEDULES

Include schedule when several differing member shapes, sizes, or finishes are required.

Consider the following examples when developing Project schedule.

A. Main Entry / Vestibule Panels: Finish Type X, buff cement color, 30 percent exposure of aggregate, flat panel with 4-inch (101 mm) nominal thickness, integral insulation to achieve panel R-Value of 5 (RSI value of 0.88).

B. Exterior Wall Spandrel Panels: Finish Type Y, white cement color, 20 percent exposure of aggregate, configured shape as detailed.

END OF SECTION

SECTION 03 60 00 - GROUTING

For all concrete projects. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all work necessary to form, mix, place, cure, repair, finish, and do all other work as required to produce finished grout, in accordance with the requirements of the Contract Documents.

B. Work covered in this Section includes:

1. Grouting
2. Removal of loose and spalling grout and concrete
3. Anchoring, patching, grouting, and sealing

C. Related Sections:

1. Section 03 30 00 - Cast-In-Place Concrete

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

A. Specifications, codes, and standards shall be as specified in Section 03 30 00, Cast-In-Place Concrete and as referred to herein.

B. Commercial Standards:

1. CRD-C 621, Corps of Engineers Specification for Non-Shrink Grout
2. ASTM C109, "Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens)"
3. ASTM C531, "Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes"
4. ASTM C579, "Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes"
5. ASTM C827, "Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures"

1.3 SUBMITTALS

A. Certified Test Results: Verifying the compressive strength, shrinkage, and expansion requirements specified herein.

B. Manufacturer's Literature: Containing instructions and recommendations on the mixing, handling, placement, and appropriate uses for each type of non-shrink and epoxy grout used in the work.

1.4 QUALITY ASSURANCE

Field Tests

A. Compression test specimens will be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the Engineer to ensure continued compliance with these specifications. The specimens will be made by the Engineer or its representative.

B. Compression tests and fabrication of specimens for cement grout and non-shrink grout will be performed as specified in ASTM C 109 at intervals during construction as selected by the Engineer. A set of three specimens will be made for testing at 7 days, 28 days, and each additional time period as appropriate.

C. All grout, already placed, which fails to meet the requirements of these specifications, is subject to removal and replacement at the cost of the Contractor.

D. The cost of all laboratory tests on grout shall be borne by the Contractor and the Contractor shall obtain the specimens for testing. The Contractor shall also be charged for the cost of any additional tests and investigation on work performed which does not meet the specifications. The Contractor shall supply all materials necessary for fabricating the test specimens.

PART 2 PRODUCTS

2.1 PREPACKAGED GROUTS

A. Non-shrink grout: This type of grout is to be used wherever grout is required in the Contract Documents unless another type is specifically referenced.

B. Non-shrink grout shall be a prepackaged, inorganic, non-gas-liberating, non-metallic, non-corrosive, non-chloride, cement-based grout requiring only the addition of water. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation of each class of non-shrink grout specified herein shall be that recommended by the Manufacturer for the particular application.

C. Class A non-shrink grouts shall have minimum 28-day compressive strength of 5,000 pounds per square inch (psi); shall have no shrinkage (0.0 percent) and a maximum 4.0 percent expansion in the plastic state when tested in accordance with ASTM C827; and shall have no shrinkage (0.0 percent) and a maximum of 0.2 percent expansion in the hardened state when tested in accordance with CRDC 621.

D. Class B non-shrink grouts shall have minimum 28-day compressive strength of 5,000 psi and shall meet the requirements of CRD C621.

E. Application

1. Class A non-shrink grout shall be used for the repair of all holes and defects in concrete members which are water bearing or in contact with soil or other fill material, grouting under all equipment base plates, and at all locations where grout is specified in the contract documents; except, for those applications for Class B non-shrink grout specified herein. Class A non-shrink grout may be used in place of Class B non-shrink grout for all applications.

2. Class B non-shrink grout shall be used or the repair of all holes and defects in concrete members which are not water-bearing and not in contact with soil or other fill material, grouting under all base plates for structural steel members, and grouting railing posts in place.

2.2 CONSISTENCY

A. The consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that the grout is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a grout of that consistency; the type of grout to be used shall be as specified herein for the particular application.

B. The slump for topping grout and concrete fill shall be adjusted to match placement and finishing conditions but shall not exceed 4 inches.

2.3 MEASUREMENT OF INGREDIENTS

A. Measurements for cement grout shall be made accurately by volume using containers approved by the Engineer. Shovel measurement shall not be allowed.

B. Prepackaged grouts shall have ingredients measured by means recommended by the Manufacturer.

PART 3 EXECUTION

3.1 GENERAL

A. All surface preparation, curing, and protection of cement grout shall be as specified by the Manufacturer. The finish of the grout surface shall match that of the adjacent concrete.

B. The Manufacturer of Class A non-shrink grout shall provide on-site technical assistance upon request.

C. Base concrete or masonry must have attained its design strength before grout is placed, unless authorized by the Engineer.

3.2 GROUTING PROCEDURES

Prepackage Grouts: All mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution of prepackaged grouts shall be done according to the instructions and recommendations of the Manufacturer.

END OF SECTION

SECTION 03 64 23 - EPOXY ADHESIVE INJECTION

For all prestressed concrete reservoirs. This version is the most current as of September 2015, City of West Linn's Bolton Reservoir Replacement Project.

Some of the paragraphs may be deleted. When deleting, do not renumber all the paragraphs. Simply leave the section number and title as is, delete the text, and add the words "Not Used".

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes all work necessary to furnish all materials, tools, equipment, appliances, transportation, labor, and supervision required to repair cracks by the injection of an epoxy resin adhesive.

B. Section includes:

1. Epoxy resin adhesive for injection
2. Surfacing sealing
3. Equipment for epoxy injecting

1.2 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Requirements for submittals

B. Product Data: Submit data on materials to be used

1.3 QUALIFICATIONS

A. Epoxy injection shall be performed by a certified applicator.

B. Contractor's/Subcontractor's Operator engaged in the epoxy injection process shall have satisfactory operator experience in the methods of restoring concrete structures utilizing the specific epoxy injection process indicated. Operator's experience shall include previous repairs of cracked or damaged concrete structures, the technical knowledge of correct material selection and use, and the operation, maintenance, and troubleshooting of equipment.

PART 2 MATERIALS AND EQUIPMENT

2.1 EPOXY RESIN ADHESIVE FOR INJECTION

Epoxy adhesive grout shall be a 100 percent solids two-part water insensitive low-viscosity epoxy resin system. Epoxy shall be suitable for grouting both dry and damp cracks. Epoxy shall develop a minimum tensile strength (ASTM D695) of 6,000 pounds per square inch (psi) and a minimum compressive strength of 8,000 psi. Epoxy shall be SELECT BOND GP-4440, as manufactured by SPC, or equivalent.

2.2 SURFACE SEAL

A. The surface seal material is that material used to confine the injection adhesive in the fissure during injection and cure.

B. The surface seal material shall have adequate strength to hold injection fittings firmly in place and to resist injection pressures adequately to prevent leakage during injection.

2.3 EQUIPMENT FOR INJECTION

A. The equipment used to meter and mix the two injection adhesive components and inject the mixed adhesive into the crack shall be portable, positive displacement type pumps with interlock to provide positive ratio control of exact proportions of the two components at the nozzle. The pumps shall be electric, or air powered and shall provide in-line metering and mixing.

B. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi plus or minus 5 psi and shall be equipped with a manual pressure control override.

C. The injection equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the Manufacturer of the adhesive within a tolerance of plus or minus 5 percent by volume at any discharge pressure up to 200 psi.

PART 3 EXECUTION

3.1 PREPARATION

A. Surface adjacent to cracks or other areas of application shall be cleaned of dirt, dust, grease, oil, efflorescence, or other foreign matter which may be detrimental to the integrity of the bond between the epoxy and the injection surface. Acids and corrosives shall not be permitted.

B. Entry ports shall be provided along the crack at intervals of not less than the thickness of the concrete at that location.

C. Surface seal material shall be applied to the face of the crack between the entry ports. For through cracks, surface seal shall be applied to both faces.

D. Enough time for the surface seal material to gain adequate strength shall pass before proceeding with the injection.

3.2 EPOXY INJECTION

A. Injection of epoxy adhesive shall begin at lower entry port and continue until there is an appearance of epoxy adhesive at the next entry port adjacent to the entry port being pumped.

B. When epoxy adhesive travel is indicated by appearance at the next adjacent port, injection shall be discontinued on the entry port being pumped, and epoxy injection shall be transferred to the next adjacent port where epoxy adhesive has appeared.

C. Epoxy adhesive injection shall be performed continuously until cracks are completely filled.

D. If port to port travel of epoxy adhesive is not indicated, the work shall immediately be stopped, and the Engineer notified.

3.3 FINISHING

A. When cracks are completely filled, epoxy adhesive shall be cured to sufficient time to allow removal of surface seal without any draining or runback of epoxy material from cracks.

B. Surface seal material and injection adhesive runs, or spills, shall be removed from concrete surfaces.

C. The face of the crack shall be finished flush to the adjacent concrete showing no indentations or protrusions caused by the placement of entry ports.

3.4 PRESSURE TEST

A. The mixing head of the injection equipment shall be connected, and the equipment run until clear uniformly mixed material flows into the purge pail. The Operator shall engage the equipment shut-off nozzle valve and subsequently bump the on-off switch while monitoring pressure on psi gauge until the pressure reaches 200 psi. Pressure gauge shall be monitored for 1-minute. If pressure is maintained between 190-200 psi, check valves shall be considered functioning properly and the injection may proceed. If pressure drops below 190 psi, Contractor shall be required to have new seals installed on the check valves and the equipment shall be subsequently retested.

B. The pressure test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.

C. The adequacy and accuracy of the equipment shall be solely the responsibility of the Contractor.

3.5 RATIO TEST

A. The epoxy mixture ratio shall be monitored continuously while injecting by placing a strip of masking tape on the sides of the A & B reservoirs full height. After filling reservoirs, the A and B levels shall be marked and monitored while running injection machine into purge pail for a period of one minute.

B. The ratio test shall be run for each injection unit at the beginning and after meal break of every shift that the unit is used in the work of crack repair.

3.6 PROOF OF RATIO AND PRESSURE TEST

A. At all times during the work the Contractor shall keep complete and accurate records available to the Engineer of the pressure and ratio tests specified above.

B. In addition, the Engineer at any time without prior notification of the Contractor, may request the Contractor to conduct the tests specified above in the presence of the Engineer.

END OF SECTION