SECTION 033020 – CAST-IN-PLACE CONCRETE FOR STEAM UTILITY DISTRIBUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to this section.

1.2 SUMMARY

A. This section includes the furnishing and placement of cast-in-place concrete and accessories.

B. Related sections include the following:

1. Division 03 Section "Concrete Formwork for Steam Utility Distribution."
2. Division 03 Section "Concrete Reinforcement for Steam Utility Distribution."
3. Division 03 Section "Concrete Accessories for Steam Utility Distribution."
4. Division 31 Section "Earthwork."
5. Division 32 Section "Concrete Walks."

1.3 REFERENCES

A. Except as herein specified or as indicated on the Drawings, the work of this section shall comply with the following:

1. ASTM Standards, Specifications, Methods, Test Methods and Classifications:

a. C33 - Specification for Concrete Aggregates.

b. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.

c. C94 - Specification for Ready-Mixed Concrete.

d. C136 - Sieve Analysis of Fine and Coarse Aggregates.

e. C150 - Specification for Portland Cement.

f. C260 - Specification for Air-Entraining Admixtures for Concrete.

g. C309 - Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

h. C494 - Specification for Chemical Admixtures for Concrete.

i. C618 - Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.

j. C939 - Test Method for Flow of Grout for Preplaced - Aggregate Concrete.

k. C1107 - Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).

2. ACI - American Concrete Institute:

a. 117 - Standard Tolerances for Concrete Construction and Materials.

b. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete.

c. 301 - Specifications for Structural Concrete for Buildings.

d. 302.1R - Guide for Concrete Floor and Slab Construction.

e. 304R - Guide for Measuring, Mixing, Transporting and Placing Concrete.

f. 304.2R - Placing Concrete by Pumping Methods.

g. 305R - Hot Weather Concreting.

h. 306R - Cold Weather Concreting.

i. 309R - Guide for Consolidation of Concrete.

j. 318 - Building Code Requirements for Reinforced Concrete.

k. 503.2 - Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive.

3. MDOT - Standard Specifications for Construction.

4. U.S. Army Corps of Engineers: CRD C621 - Grout.

1.4 SUBMITTALS

A. Manufacturer's literature for concrete mix designs to include:

1. General: Allow for 28-day testing of trial mixes in the Project's schedule, if trial mixes are required.

2. Mix design content:

a. Dry weights of cement.
b. Saturated surface - dried weights of fine and course aggregates.
c. Quantities, type and name of all mix design contents.
d. Weight of water.
e. Submit to Engineer and obtain approval prior to placing concrete.

3. Submit product information on all components of mix design.

4. Curing agents: Submit manufacturer's data certifying application rate required for each type of curing agent to be used.

B. Test reports:

1. Submit reports of concrete, compression, yield, air content and slump tests.

2. Furnish copies to Engineer and Contractor.

C. Submit product information on all materials listed in this section which are proposed to be used.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Fabrication and installation personnel:

a. Trained and experienced in the fabrication and installation of the materials and equipment.

b. Knowledgeable of the design and the reviewed Shop Drawings.

B. Testing of concrete:

1. Point of sampling and the method of securing the Samples:

a. Determined by the independent testing laboratory.
b. In accordance with ASTM C 172.

2. Slump tests:

a. Perform slump tests in accordance with ASTM C 143.

b. Perform 1 slump test on the job for each 10 cubic yards of concrete, minimum 1 test per day.

c. Perform more slump tests if deemed necessary by Owner.

3. Perform 1 air-entraining test in accordance with ASTM C 231 or C 173 for each truckload or every 10 yards of concrete placed, whichever is more frequent.

4. Test the concrete unit weight in accordance with ASTM C 138 or C 567, as applicable.

5. Test the air content of each set of concrete cylinders.

6. Concrete cylinder testing:

a. In accordance with ASTM C 31 and C 39.
b. Take concrete cylinder Samples as follows:
1) Once each day a given class of concrete is placed, nor less than

2) Once for each 150 cubic yards (or fraction thereof) of each class of concrete placed each day, nor less than

3) Once for each 5000 square feet of slab or wall surface area placed each day.

c. Concrete cylinder Sample shall consist of 6 standard 6-inch cylinders.

d. Handle cylinders carefully.

e. Onsite storage:

1) 12 hours, minimum, 48 hours maximum.

2) At a temperature range of 60 to 80 degrees F and in a moist environment.

3) Shielded from direct sunlight and radiant heat.

4) Contractor shall construct heated enclosure if conditions require.

f. Laboratory curing: For duration of curing after onsite storage.

g. Test 2 of the cylinders at 7 days, 2 of the cylinders at 14 days, and 2 of the cylinders at 28 days.

h. Acceptance and evaluation of the concrete shall be based on ACI 301.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:

1. Portland cement, ASTM C150, Type I.

2. Do not use different types of cement, different manufacturers of cement, or different degrees of fineness.

B. High early cement: Portland cement, ASTM C150, Type III, at Contractor's option.

C. Fly ash:

1. ASTM C618, Type F.

2. At Contractor’s option.

3. Allowable amount: 25% of total cementitious materials, by weight, maximum, unless specified otherwise in Article 2.2.

D. Ground-Granulated Blast Furnace (GGBF) Slag:

1. ASTM C989, Grade 120.

2. Use at Contractor's option, at a substitution rate of up to 25% of the total cementitious products content of the mix design; however, maintain a minimum of 330 pounds of Portland cement in concretes which may be subjected to freeze thaw cycles.

E. Aggregates:

1. Grade aggregates according to procedures of ASTM C136.
2. Coarse aggregate: ASTM C33-5S, Number 67 (3/4-inch) or MDOT 17A.
3. Fine aggregate: ASTM C33 or MDOT 2NS.

F. Water: Clean, fresh, and potable.

G. Admixtures:

1. Chlorides:

a. No admixture shall contain more than 0.1% water soluble chloride ions by mass of cementitious material.

b. No admixture shall contain calcium chloride.

2. Air-entraining:

a. Comply with ASTM C260.

b. Daravair series or Darex series, by W.R. Grace & Company; Micro Air, by Master Builders; or equal.

3. Mid-range water reducer:

a. Comply with ASTM C494, Type A.

b. Daracem 55 or Daracem 65, by W.R. Grace & Company; Polyheed Series by Master Builders; or equal.

4. Water reducing and retarding:

a. At Contractor's option, when included in reviewed mix designs.

b. Comply with ASTM C494, Type D.

c. Daratard 17 or WRDA35 by W.R. Grace & Company; Pozzolith 100-XR by Master Builders; or equal.

5. Water reducing and accelerating:

a. At Contractor's option, when included in reviewed mix designs.

b. Comply with ASTM C494, Type E.

c. Daracel by W.R. Grace & Company; Pozzutec 20 by Master Builders; or equal.

H. Curing agents:

1. Curing agents shall comply with ASTM C309.

2. Provide approved products by Symons Corporation, W.R. Meadows, L & M Chemical, Master Builders, or Dayton-Superior.

3. Manufacturer shall guarantee that Manufacturer's material is compatible with the intended application.

4. Maximum V.O.C. limit: 350 gm/l.

5. No wax based compounds allowed.

6. Compounds:

a. Curing:
1) 1100 Clear by W.R. Meadows.
2) Rez Cure (J-11-W) by Dayton Superior.
3) Resi-Chem Clear Cure by Symons.
4) Masterkure by Master Builders.
5) L & M Cure by L & M Chemical.

I. Epoxy bonding agent: Concressive Standard Liquid or Standard Paste, as applicable, Master Builders; or equal.

2.2 MIXES

A. General proportioning:

1. Proportions of materials for concrete shall be in accordance with ACI 211.1, in order to produce concrete with the specified compressive strength, good placability and durability, and other specified properties.

2. Concrete mixes as noted below shall receive a mid range water-reducing admixture added at the ready mix plant.

3. To ensure concrete of adequate strength, concrete proportions shall be selected and documented in accordance with ACI-318. This will determine the required average compressive strength (f'cr) of the concrete as supplied by the concrete production facility. The procedure is described below:

a. The required average compressive strength (f'cr) of the concrete shall exceed the specified compressive strength (f'c). The amount by which the required average compressive strength (f'cr) must exceed the specified compressive strength (f'c) shall be determined by 1 of the following:

1) Where the concrete production facility has 15 or more consecutive tests for concrete composed of similar materials and with specified strengths within 1,000 psi of that specified for proposed works, a standard deviation shall be calculated. This standard deviation is a measure of the variability of strength produced by the production facility for concrete of similar proportions. The required average compressive strength (f'cr) shall be calculated using this standard deviation along with appropriate formulas as given in ACI-318.

2) Where the concrete production facility does not have test records meeting the required criteria, the required average compressive strength (f'cr) must exceed specified compressive strength (f'c) by a minimum of 1,200 psi.

b. Documentation that the proposed concrete proportions will produce an average compressive strength equal to or greater than the required average compressive strength (f'cr) shall consist of 1 of the following

1) Where the concrete production facility has 10 or more field strength tests for concrete produced with similar materials and under similar conditions, these tests may be used to demonstrate that the proposed concrete proportions will produce the required average compressive strength (f'cr).

2) Where the concrete production facility does not have test records meeting the Mix Design Criteria, concrete proportions shall be established based on trial mixtures in accordance with ACI 318, Paragraph 5.3.3.2.

c. Provide mix design, test records, calculations and other documentation to Engineer at least 14 days prior to placement. Also state type of mixing to be used as listed in Item 10, ASTM C94.

d. Should trial mixes be required, no concrete shall be placed until results from the 28-day tests have been reviewed and approved by Engineer.

B. Fly ash:

1. If Contractor chooses to use fly ash in concrete mixes:

a. Proposed mix design shall specifically identify amount and type of fly ash.

b. Field strength test data submitted with proposed design shall be for concrete mixes that included similar amount and types of fly ash.

C. Mix Design Criteria:

1. Ratio of weight of fine aggregate to weight of coarse aggregate shall not be less than 0.50.

2. Mid range water-reducing admixture (MRWR): Approximately 3 to 12 ounces per 100 pounds of cement, to achieve specified slump.

3. Refer to table below for specific proportioning.

Mix Design	Use	Minimum* Cementitious Content (94 lb. sack) (1)	Fly Ash Content	Entrained Air (percent)	Maximum w/c (2) Ratio	Specified Maximum Coarse Agg.	Compress Strength (PSI)	Slump (Inches) Before Adding Water Reducer	Slump (Inches) After Adding Water Reducer	Water Reducing Admixture Type
1	Structural Concrete	6	Optional	6 ± 1-1/2	0.45	3/4"	4,000	1-4	4-6	Optional MRWR

Notes:

(1) Use a higher cement content if required to achieve the required w/c ratio and strengths.
(2) w/c - Water to cementitious products ratio. All fly ash plus GGBF slag plus all cement shall be included in w/c ratio calculation.
(3) Slabs which slop more than 1/4-inch per foot shall have a slump after adding water reducer of 2 to 5 inches.
(4) The compressive strength specified here and on the Drawings is the actual required specified compressive design strength (f'_c) at 28 days (unless noted otherwise) for the concrete structures on this Project, and is not be considered the target strength (f'_{cr}) which the concrete Supplier is required to achieve.
(5) Ratio of weight of fine aggregate to weight of coarse aggregate shall not be less than 0.50.
(6) The amount of mid range water-reducing admixture (MRWR) added shall be approximately 3 to 12 ounces per 100 pounds of cement, to achieve specified slump.

D. Climatic conditions: Concrete mix design shall be adjusted for climatic conditions.

2.3 SOURCE QUALITY CONTROL

A. Production and delivery:

1. Ready mixed concrete shall be batched, mixed and transported in accordance with ASTM C94.

2. Ready-mix delivery tickets:

a. Furnish with each batch of concrete before unloading at the site, a delivery ticket on which is printed, stamped or written the following information:

1) Name of ready-mix batch plant.
2) Serial number of ticket.
3) Date and truck number.
4) Name of Contractor.
5) Job name and location.
6) Specific class or designation of concrete.
7) Amount of concrete (cubic yards).
8) Time loaded or of first mixing of cement and aggregates.
9) Type, name and amount of admixture.
10) Type, brand and amount of cement.
11) Total water content by producer (or water-cement ratio).
12) Maximum size of aggregate.
13) Weights of fine and course aggregates.

3. Concrete delivered in an outdoor temperature lower than 40 degrees F shall arrive at the site of the Work having a temperature of not less than 60 degrees F and not greater than 90 degrees F unless otherwise specified or permitted by the Engineer.

4. Discharge of the concrete shall be completed within 1-1/2 hours after introduction of mixing water to the cement or 1 hour after arriving at the Site, whichever is sooner.

PART 3 - EXECUTION

3.1 PLACEMENT

A. General: Place concrete in accordance with ACI 304R and ACI 304.2R.

B. Preplacement inspection:

1. Before placing concrete, inspect and complete the formwork installation, reinforcing steel and items to be embedded or cast-in.

2. Notify other trades to permit the installation of their work; cooperate with other trades in setting such work, as required.

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

4. Notify Engineer 24 hours in advance of placing.

C. Handling:

1. Handle concrete from mixer to place of final deposit in carts, buggies, conveyors, pumps or crane buckets.

2. Do not deliver concrete by a method with a free fall of more than 3 feet.

3. Crane buckets shall have a reinforced rubber chute which shall extend into formwork to minimize free fall of concrete and to eliminate separation of materials.

4. Take every possible precaution to prevent separation or loss of ingredients while transporting concrete.

D. Method and rate:

1. Deposit concrete in horizontal layers in walls to avoid flowing along the forms.

2. Horizontal layers shall not exceed 18 inches in thickness and placed in a manner to avoid inclined construction joints.

3. Carry on placement at such a rate that concrete surfaces not yet to grade shall not have reached their initial set before additional concrete is placed.

E. Compaction:

1. Mechanically vibrate concrete to thoroughly embed reinforcement and fixtures.

2. Apply mechanical vibration directly to concrete.

3. Apply vibration at point of deposit and in area of freshly placed concrete.

4. Vibrations shall be of sufficient duration to accomplish thorough compaction and complete embedment of reinforcement and fixtures, but shall not be long enough to cause segregation of mix.

5. Withdraw vibrator at the rate of 1-1/2 inches per second.

6. Use vibrators designed to operate with vibratory element submerged in concrete, maintaining a speed of not less than 6,000 impulses per minute.

7. Comply with ACI 309R.

8. Do not use vibrators to transport concrete inside of forms.

9. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine.

10. Avoid inserting vibrators into lower layers of concrete that have begun to set by scheduling placement of concrete layers and concrete delivery.

F. Retempering:

1. Do not add water to the concrete once it has left the redimix plant.

2. Concrete which has stood for 60 minutes is unacceptable and shall be immediately removed from the premises.

G. Site redosing with water reducer:

1. One redosing of batched concrete at the Project site may be permitted only under the following conditions:

a. Redosing has been approved in advance by Engineer.

b. Equipment is on-site to permit accurate measurable dispensing.

c. Adequate supply of water reducer in on-site.

d. Engineer or independent testing laboratory witnesses the addition of water reducer, verifies the quantity, and witnesses the proper truck mixing of the redosed concrete.

H. Cold-weather concrete operations:

1. Comply with the recommendations of ACI 306R.

2. Recommended protective measures:

a. Heating materials.
b. Providing insulating blankets and windbreaks.
c. Use heated enclosures.

3. Advise Engineer of planned protective measures.

4. Straw or similar materials shall not be allowed.

5. Do not use frozen materials or materials containing ice or snow.

6. Do not place concrete on frozen subgrade.

I. Hot-weather concrete operations:

1. Comply with the recommendations of ACI 305R.

2. Recommended protective measures:

   a. Cooling materials.

   b. Concrete placement during cooler hours of the day.

   c. Providing shading and windbreaks.

3. Advise Engineer of planned protective measures.

3.2 SURFACE TREATMENT

A. Wall finishes: Refer to Division 03 Section "Concrete Formwork for Steam Utility Distribution" for formwork facing materials and required finishes.

B. Patching:

1. Patch poor joints, voids greater than 1/4-inch, honeycomb, defective areas and tie holes immediately after stripping forms.

2. The finished patch shall be acceptable to Engineer and reasonably match the adjacent wall construction or the defective wall shall be replaced.

3. Suggested concrete mix mortar patching method:

   a. Patch material shall consist of mortar with the same proportions as the concrete to be patched except omit coarse aggregate.

   b. Mix different proportions of gray and white cement until exact color of concrete is obtained.

   c. Bond patch material to concrete with epoxy bonding agent in accordance with manufacturer's instructions and recommendations.

   d. The use of an epoxy bonding agent for bonding plastic concrete to hardened concrete shall conform to all requirements of ACI 503.2, except as modified by the requirements of this project specification.

   e. Remove all latence and foreign materials from areas to be patched by means of sandblasting.

C. Troweling floors:

1. Provide monolithic troweled finish.

2. Vibratory screeding is required on concrete slabs.

3. Use highway straight edge to eliminate high and low spots.

4. After screeding and as soon as concrete has set sufficiently, float surface with compactor power floats, then steel trowel surface, burnishing to smooth, hard, dense finish free from trowel marks, blemishes and irregularities.

D. Floor finish tolerances:

1. In accordance with ACI 117 and 302.1R.

2. Interior building floors shall have a maximum sag of 1/8-inch under a 10-foot straight edge.

3. No "bird bath" allowed on sloping floor slabs.

E. Curing agents:

1. Curing agents shall be immediately applied to walls and slabs.

2. Compound shall be rolled or sprayed on in accordance with manufacturer's instruction. Each application shall be applied at the rate in gallons per square foot and number of coats required to meet ASTM C309.

3.3 PROTECTION

A. Keep freshly placed concrete from damage due to low temperatures when the mean daily temperature is below 40 degrees F (4.5 degrees C) in accordance with ACI 306R.

3.4 JOINTS AND EMBEDDED ITEMS

A. Comply with ACI 318-6.3, 6.4 and ACI 301 Section 6.

B. Avoid horizontal construction joints in walls.

C. Tunnel joints:

1. Tunnels shall have construction joints as indicated on the Drawings. Where no specific indication is given, limit joints to 25 feet spacing.

2. Vaults shall have construction joints only as indicated on the Drawings.

D. Construct a keyway at construction joints in concrete. In reinforced concrete, provide lap of reinforcing steel at construction joints.

E. Contractor shall be responsible for controlling the proper placing of embedded pipe, conduit and other fixtures. ACI 318, Section 6.3, shall apply to cases of embedded fixtures.

F. Anchor rods shall be clean and free of oil, grease and dirt prior to installation.

3.5 MISCELLANEOUS

A. Chamfer: Chamfer exposed concrete edges 3/4-inch x 3/4-inch unless otherwise indicated on the Drawings.

B. Miscellaneous items: Perform concrete work for mechanical and electrical trades including but not limited to vaults, valve and meter pits, light pole bases and machine bases.

END OF SECTION 033020