



# Klamath River Renewal Project

## Daggett Bridge Design Project —Technical Specifications

### IFC Submittal

Revision No. 0



June 2022

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The technical material and data contained in this document were prepared under the supervision and direction of the undersigned, whose seals, as professional engineers licensed to practice as such, are affixed.



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**DAGGETT BRIDGE DESIGN  
TECHNICAL SPECIFICATIONS**

**IFC DESIGN  
TABLE OF CONTENTS**

**Division 01 – General Requirements**

- Section 01 11 00 – Summary of Work
- Section 01 42 10 – Reference Standards

**Division 03 – Concrete**

- Section 03 11 13 – Concrete Formwork
- Section 03 20 00 – Reinforcement Steel
- Section 03 30 00 – CIP Concrete
- Section 03 32 00 – Joints in Concrete
- Section 03 60 00 – Grout
- Section 03 65 00 – Epoxy Resin Adhesive Systems

**Division 05 – Metals**

- Section 05 50 00 – Miscellaneous Metals

**Division 13 – Special Construction**

- Section 13 35 00 – Pre-Engineered Bridge System

**Division 31 – Earthwork**

- Section 31 05 00 – Material for Earthwork\*\*
- Section 31 10 00 – Clearing, Grubbing, and Stripping\*\*
- Section 31 05 19 – Geotextiles
- Section 31 23 00 – Excavation and Fill Placement\*\*
- Section 31 25 00 – Erosion and Sedimentation Control\*\*

**\*\*Knight Piésold 100% Design Specifications**

**Attachments**

- Attachment A -- Klamath River Renewal Project – Geotechnical Data Report

**VOLUME 2: CONTRACT DRAWINGS**

## **SECTION 01 11 00 - SUMMARY OF WORK**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The WORK to be performed under this Contract shall consist of furnishing tools, equipment, materials, supplies, and manufactured articles, and furnishing all labor, transportation, and services, including fuel, power, water, and essential communications, and performing all work or other operations required for the fulfillment of the Contract in strict accordance with the Contract Documents. The WORK shall be complete, and all work, materials, and services not expressly indicated or called for in the Contract Documents which may be necessary for the complete and proper construction of the WORK in good faith shall be provided by the CONTRACTOR as though originally so indicated, at no increase in cost to the OWNER.

#### **1.2 WORK COVERED BY CONTRACT DOCUMENTS**

- A. The WORK of this Contract is comprised of the construction of a new Daggett Road, new Daggett bridge, and supporting a new steel pipeline along the new Daggett Bridge across the Klamath River.
- B. The WORK is located in Siskiyou County northeast of Iron Gate Dam near Hornbrook, California. The Project is located upstream and east of the existing Daggett Road Bridge crossing the Klamath Reservoir near the intersection of Copco Road and Daggett Road.
- C. The Construction Drawings for the Work are titled Klamath River Renewal Corporation Daggett Bridge by McMillen Jacobs Associates.

#### **1.3 WORK SEQUENCE**

- A. The CONTRACTOR's attention is directed to the fact that during the period of construction there shall be no interruption in the City or Yreka's water flow, and the CONTRACTOR shall so schedule its construction operations that no interference with the operation of the water system will occur during this critical period.

#### **1.4 CONTRACTOR USE OF SITE**

- A. The CONTRACTOR's use of the Site shall be limited to its construction operations, including on-Site storage of materials, on-Site fabrication facilities, and field offices.

#### **1.5 OUTAGE PLAN AND REQUESTS**

- A. Unless the Contract Documents indicate otherwise, the CONTRACTOR shall not remove from service, de-energize, or modify settings for any existing operating tank, pipeline, valve, channel, equipment, structure, road, or any other facility without permission from the OWNER.
- B. Where the WORK requires modifications to existing facilities or construction of new facilities and connection of new facilities to existing facilities, the CONTRACTOR shall

submit a detailed outage plan and schedule for the ENGINEER'S approval a minimum of two (2) weeks in advance of the time that such outage is planned.

- C. Construction activities shall be scheduled and sequenced to ensure continuous operation of the existing waterline to the greatest extent possible. The City has stated that they have enough storage capacity to meet City water demands and the waterline can be turned off for up to 20 hours in the summer months (May through October) and up to 60 hours in the winter months (November through April).
- D. A completed System Outage Request form shall accompany each outage plan. The outage plans shall be coordinated with the construction schedule and shall meet the restrictions and conditions of the Contract Documents. The outage plan shall describe the CONTRACTOR's estimated length of time required to complete said operation; any necessary temporary power, controls, instrumentation, or alarms required to maintain control, monitoring, and alarms for the processes; and the manpower and equipment which the CONTRACTOR will furnish. All costs for preparing and implementing the outage plans shall be at no increase in cost to the OWNER.
- E. The ENGINEER shall be notified in writing at least one week in advance of the required outage if the schedule for performing the work has changed or if revisions to the outage plan are required.
- F. The CONTRACTOR shall provide written confirmation of the shutdown date and time two (2) working days prior to the actual shutdown.

## 1.6 PROJECT MEETINGS

### A. **Preconstruction Conference**

1. Prior to the commencement of WORK at the Site, a preconstruction conference will be held at a mutually agreed time and place. The conference shall be attended by the CONTRACTOR'S Project Manager, its superintendent, and its subcontractors as the CONTRACTOR deems appropriate. Other attendees will be:
  - a. ENGINEER and the Resident Project Representative.
  - b. Representatives of OWNER.
  - c. Governmental representatives as appropriate.
  - d. Others as requested by CONTRACTOR, OWNER, or ENGINEER.
2. The CONTRACTOR shall bring the preconstruction conference submittals.
3. The purpose of the conference is to designate responsible personnel and establish a working relationship. Matters requiring coordination will be discussed and procedures for handling such matters established. The complete agenda will be furnished to the CONTRACTOR prior to the meeting date. However, the CONTRACTOR should be prepared to discuss all of the items listed below.
  - a. CONTRACTOR's tentative schedules.

- b. Transmittal, review, and distribution of CONTRACTOR's submittals.
  - c. Maintaining record documents.
  - d. Critical work sequencing.
  - e. Field decisions and Change Orders.
  - f. Use of Site, office and storage areas, security, housekeeping, and OWNER's needs.
  - g. Major equipment deliveries and priorities.
  - h. CONTRACTOR's assignments for safety and first aid.
  - i. Submittal Transmittal Form which the ENGINEER will furnish.
- 4. The ENGINEER will preside at the preconstruction conference and will arrange for keeping and distributing the minutes to all persons in attendance.
  - 5. The CONTRACTOR and its subcontractors should plan on the conference taking no less than one (1) full working day. The meeting will cover the items listed in paragraphs 2 and 3, and reviewing the Drawings and Specifications, in extensive detail, with the ENGINEER and the OWNER.

**PART 2 -- PRODUCTS (NOT USED)**

**PART 3 -- EXECUTION (NOT USED)**

- END OF SECTION -



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## SECTION 01 42 10 - REFERENCE STANDARDS

### PART 1 -- GENERAL

#### 1.1 GENERAL

- A. **Titles of Sections and Paragraphs:** Titles and subtitles accompanying specification sections and paragraphs are for convenience and reference only and do not form a part of the Specifications.
- B. **Applicable Publications:** Whenever in these Specifications references are made to published specifications, codes, standards, or other requirements, it shall be understood that wherever no date is indicated, only the latest specifications, standards, or requirements of the respective issuing agencies which have been published as of the date that the Contract is advertised for Bids shall apply; except to the extent that said standards or requirements may be in conflict with applicable laws, ordinances, or governing codes. No requirements set forth in the Specifications or shown on the Drawings will be waived because of any provision of or omission from said standards or requirements.
- C. **Specialists, Assignments:** In certain instances, specification text requires (or implies) that specific WORK is to be assigned to specialists or expert entities who must be engaged to perform that WORK. Such assignments shall be recognized as special requirements over which the CONTRACTOR has no choice or option. These requirements shall not be interpreted so as to conflict with the enforcement of building codes and similar regulations governing the WORK; also they are not intended to interfere with local union jurisdiction settlements and similar conventions. Such assignments are intended to establish which party or entity involved in a specific unit of WORK is recognized as "expert" for the indicated construction processes or operations. Nevertheless, the final responsibility for fulfillment of the entire set of Contract requirements remains with the CONTRACTOR.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. The CONTRACTOR shall construct the WORK in accordance with the Contract Documents and the referenced portions of those referenced codes, standards, and specifications.
- B. In case of conflict between codes, reference standards, drawings, and the other Contract Documents, the most stringent requirements shall govern. All conflicts shall be brought to the attention of the ENGINEER for clarification and direction prior to ordering or providing any materials or furnishing labor. The CONTRACTOR shall bid for the most stringent requirements.
- C. References to "OSHA Regulations for Construction" shall mean **Title 29, Part 1926, Construction Safety and Health Regulations**, Code of Federal Regulations (OSHA), including all changes and amendments thereto.
- D. References to "OSHA Standards" shall mean **Title 29, Part 1910, Occupational Safety and Health Standards**, Code of Federal Regulations (OSHA), including all changes and amendments thereto.

- E. **Applicable Safety Standards:** References to "Cal-OSHA" shall mean State of California, Department of Industrial Relations, Construction Safety Orders, as amended to date, and all changes and amendments thereto.
- F. **Applicable Project Specifications:** References in the Contract Documents to "Project Specifications" shall mean the Kiewit Infrastructure West Co. Klamath River Renewal Project Technical Specifications prepared by Knight Piésold Consulting for the KRRP. The Project Specifications referenced in the Daggett Bridge Design work include the following specifications:
  - 1. 31 05 00 Materials for Earthwork
  - 2. 31 10 00 Clearing and Grubbing
  - 3. 31 23 00 Excavation and Fill Placement
  - 4. 31 25 00 Erosion and Sediment Control

### 1.3 REGULATIONS RELATED TO HAZARDOUS MATERIALS

- A. The CONTRACTOR shall be responsible that all WORK included in the Contract Documents, regardless if indicated or not, shall comply with all EPA, OSHA, RCRA, NFPA, and any other federal, state, and local regulations governing the storage and conveyance of hazardous materials, including petroleum products.
- B. Where no specific regulations exist and the OWNER has not waived the requirement in writing, chemical, hazardous, and petroleum product piping and storage in underground locations shall be double containment piping and tanks or be installed in separate concrete trenches and vaults with an approved lining that cannot be penetrated by the chemicals.

### PART 2 -- PRODUCTS (NOT USED)

### PART 3 -- EXECUTION (NOT USED)

- END OF SECTION -

## SECTION 03 11 13 - CONCRETE FORMWORK

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall furnish concrete formwork, bracing, shoring, and supports for cast-in-place concrete and shall design and construct falsework, all in accordance with the Contract Documents.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
- B. Manufacturer's information demonstrating compliance with requirements for the following:
  - 1. Form ties and related accessories, including taper tie plugs, if taper ties are used.
  - 2. Form gaskets.
  - 3. Form release agent, including NSF certification if not using mineral oil.
  - 4. Manufacturer's information on formwork, form materials, and locations for use.
  - 5. Form Liners.
- C. **Shop Drawings:** Detailed plans for the fabrication and erection of falsework to be used. Such plans shall be in sufficient detail to indicate the general layout, sizes of members, anticipated stresses, grade of materials to be used in the falsework, means of protecting existing construction which supports falsework, and typical soil conditions. Include a list of form materials and locations for use.

#### 1.3 QUALITY CONTROL

- A. **Tolerances:** The variation from required lines or grade shall not exceed 1/4-inch in 10-feet, non-cumulative, and there shall be no offsets or visible waviness in the finished surface. Other tolerances shall be within the tolerances of ACI 117 - Standard Tolerances for Concrete Construction and Materials

### PART 2 -- PRODUCTS

#### 2.1 GENERAL

- A. Except as otherwise expressly accepted by the ENGINEER, lumber brought on the Site for use as forms, shoring, or bracing shall be new material. Forms shall be smooth surface forms and shall be of the following materials:

Bridge Abutment/Walls	Steel, fiberglass, or plywood panel
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All other WORK	Steel panels, fiberglass, plywood or tongue and groove lumber
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- B. **NSF-61 Compliance.** Form materials that may remain or leave residues on or in the concrete shall be certified as compliant with NSF Standard 61 – Drinking Water System Components.

## 2.2 FORM AND FALSEWORK MATERIALS

- A. **Materials.** Materials for concrete forms, formwork, and falsework shall conform to the following requirements:
1. Lumber shall be Douglas Fir or Southern Yellow Pine, construction grade or better, in conformance with U.S. Product Standard PS 20 - American Softwood Lumber Standard
  2. Plywood for concrete formwork shall be new, waterproof, synthetic resin bonded, exterior type Douglas Fir or Southern Yellow Pine plywood manufactured especially for concrete formwork, shall conform to the requirements of PS 1 – Construction and Industrial Plywood, for Concrete Forms, Class I, and shall be edge sealed.
  3. Form materials shall be metal, wood, plywood, or other material that will not adversely affect the concrete and will facilitate placement of concrete to the shape, form, line, and grade indicated. Metal forms shall accomplish such results. Wood forms for surfaces to be painted shall be Medium Density Overlaid plywood, MDO Ext. Grade.
  4. Steel leave in place forms shall not be used.
- B. **Chamfer Edges.** Unless otherwise indicated, exterior corners in concrete members shall be provided with 3/4-inch chamfers or be tooled to 0.5-inch radius. Re-entrant corners in concrete members shall not have fillets unless otherwise indicated.
- C. **Load Criteria.** Forms and falsework to support the roof and floor slabs shall be designed for the total dead load, plus a live load of 50-psf minimum. The minimum design load for combined dead and live loads shall be 100-psf.

## 2.3 FORM TIES

- A. Form ties shall be provided with a plastic cone or other suitable means for forming a conical hole to ensure that the form tie may be broken off back of the face of the concrete. The maximum diameter of removable cones for rod ties or other removable form tie fasteners having a circular cross-section shall not exceed 1.5 inches; and all such fasteners shall be such as to leave holes of regular shape for reaming. Form ties for water-retaining structures shall have integral waterstops that tightly fit the form tie so that they cannot be moved from mid-point of the tie. Form ties shall be **ST Snap Ties** by **MeadowBurke**; **A3 Snap Ties** by **Dayton Superior**, or approved equal.
- B. Removable taper ties may be used when approved by the ENGINEER. A preformed neoprene or polyurethane tapered plug sized to seat at the center of the wall shall be

inserted in the hole left by the removal of the taper tie. Use **Taper Ties** by **MeadowBurke, D9 Taper Ties** by **Dayton Superior**, or approved equal.

## **PART 3 -- EXECUTION**

### **3.1 GENERAL**

- A. **Design Responsibility.** Forms to confine the concrete and shape it to the required lines shall be used wherever necessary. The CONTRACTOR shall assume full responsibility for the adequate design of forms, and any forms that are unsafe or inadequate in any respect shall promptly be removed from the WORK and replaced.
1. A sufficient number of forms of each kind shall be available to permit the required rate of progress to be maintained.
  2. Provide worker protection from protruding reinforcement bars in accordance with applicable safety codes.
  3. The design and inspection of concrete forms, falsework, and shoring shall comply with applicable local, state, and Federal regulations.
  4. Plumb and string lines shall be installed before concrete placement and shall be maintained during placement. Such lines shall be used by CONTRACTOR's personnel and by the ENGINEER and shall be in sufficient number and properly installed. During concrete placement, the CONTRACTOR shall continually monitor plumb and string line form positions and immediately correct deficiencies.
- B. **Quality Control & Bracing.** Concrete forms shall conform to the shape, lines, and dimensions of members required, and shall be substantial, free from surface defects, and sufficiently tight to prevent leakage. Forms shall be properly braced or tied together to maintain their position and shape under a load of freshly-placed concrete. If adequate foundation for shores cannot be secured, trussed supports shall be provided.
- C. All forms shall be removed, after the appropriate curing times have been obtained, unless approved otherwise by the ENGINEER.

### **3.2 FORM DESIGN**

- A. Forms shall be true in every respect to the required shape and size, shall conform to the established alignment and grade, and shall be of sufficient strength and rigidity to maintain their position and shape under the loads and operations incident to placing and vibrating the concrete. Suitable and effective means shall be provided on forms for holding adjacent edges and ends of panels and sections tightly together and in accurate alignment so as to prevent the formation of ridges, fins, offsets, or similar surface defects in the finished concrete.
1. Plywood, 5/8-inch and greater in thickness, may be fastened directly to studding if the studs are spaced close enough to prevent visible deflection marks in the concrete.

2. The forms shall be tight so as to prevent the loss of water, cement, and fines during placing and vibrating of the concrete. Specifically, the bottom of wall forms that rest on concrete footings or slabs shall be provided with a gasket to prevent loss of fines and paste during placement and vibration of concrete. Such gasket may be a 1.0- to 1.5-inch diameter polyethylene rod held in position to the underside of the wall form.
3. Adequate clean-out holes shall be provided at the bottom of each lift of forms. The size, number, and location of such clean-outs shall be as acceptable to the ENGINEER.
4. Whenever concrete cannot be placed from the top of a wall form in a manner that meets the requirements of the Contract Documents, form windows shall be provided in the size and spacing needed to allow placement of concrete to the requirements of Section 03 30 00 - Cast-in-Place Concrete. The size, number, and location of such form windows shall be as acceptable to the ENGINEER.

### 3.3 CONSTRUCTION

- A. **Vertical Surfaces:** Vertical surfaces of concrete members shall be formed, except where placement of the concrete against the ground is indicated. Not less than 1-inch of concrete shall be added to the indicated thickness of a concrete member where concrete is permitted to be placed against trimmed ground in lieu of forms. Permission to do this on other concrete members will be granted only for members of comparatively limited height and where the character of the ground is such that it can be trimmed to the required lines and will stand securely without caving or sloughing until the concrete has been placed.
- B. **Construction Joints:** Concrete construction joints will not be permitted at locations other than those indicated, except as may be acceptable to the ENGINEER. When a second lift is placed on hardened concrete, special precautions shall be taken in the way of the number, location, and tightening of ties at the top of the old lift and bottom of the new to prevent any unsatisfactory effect whatsoever on the concrete. Pipe stubs and anchor bolts shall be set in the forms where required.

### 3.4

#### A. Form Ties

1. **Embedded Ties:** Holes left by the removal of form tie cones shall be reamed with suitable toothed reamers so as to leave the surface of the holes clean and rough before being filled with mortar. Wire ties for holding forms will not be permitted. No form-tying device or part thereof, other than metal, shall be left embedded in the concrete. Ties shall not be removed in such manner as to leave a hole extending through the interior of the concrete members. The use of snap-ties that cause spalling of the concrete upon form stripping or tie removal will not be permitted. If steel panel forms are used, rubber grommets shall be provided where the ties pass through the form in order to prevent loss of cement paste. Where metal rods extending through the concrete are used to support or to strengthen forms, the rods shall remain embedded and shall terminate not less than 1-inch back from the formed face or faces of the concrete.

2. **Removable Ties:** Where taper ties are approved for use, the larger end of the taper tie shall be on the wet side of walls in water retaining structures. After the taper tie is removed, the hole shall be thoroughly cleaned and roughened for bond. A precast neoprene or polyurethane tapered plug shall be located at the wall centerline. The hole shall be completely filled with non-shrink grout for water bearing and below-grade walls. The hole shall be completely filled with non-shrink or regular cement grout for above-grade walls that are dry on both sides. Exposed faces of walls shall have the outer 2-inches of the exposed face filled with a cement grout that shall match the color and texture of the surrounding wall surface.

### 3.5 REUSE OF FORMS

- A. Forms may be reused only if in good condition and only if acceptable to the ENGINEER. Light sanding between uses will be required wherever necessary to obtain uniform surface texture on exposed concrete surfaces. Exposed concrete surfaces are defined as surfaces which are permanently exposed to view. In the case of forms for the inside wall surfaces of hydraulic/water retaining structures, unused tie rod holes in forms shall be covered with metal caps or shall be filled by other methods acceptable to the ENGINEER.

### 3.6 REMOVAL OF FORMS

- A. Careful procedures for the removal of forms shall be strictly followed, and this WORK shall be done with care so as to avoid injury to the concrete. No heavy loading on green concrete will be permitted.
  1. Forms shall remain in place until test cylinders for the bridge abutment concrete attain a minimum compressive strength of 75 percent of the 28 Day strength in Section 03 30 00 - Cast-in-Place Concrete. No forms shall be disturbed or removed under an individual panel or unit before the concrete in the adjacent panel or unit has attained 75 percent of the 28 Day strength and has been in place for a minimum of 7 Days. The time required to establish said strength shall be as determined by the ENGINEER. If the time so determined is more than the 7 Day minimum, then that time shall be used as the minimum length of time.
  2. For parts of the WORK not specifically mentioned herein, forms shall remain in place for periods of time as recommended in ACI 347 - Guide to Formwork for Concrete.

### 3.7 MAINTENANCE OF FORMS

- A. **General Condition.** Forms shall be maintained in good condition, particularly as to size, shape, strength, rigidity, tightness, and smoothness of surface. Before concrete is placed, the forms shall be thoroughly cleaned.
- B. **Form Oil.** The form surfaces shall be treated with a non-staining mineral oil or other lubricant acceptable to the ENGINEER. Any excess lubricant shall be satisfactorily removed before placing the concrete. Where field oiling of forms is required, the CONTRACTOR shall perform the oiling at least 2 weeks in advance of their use. Care shall be exercised to keep oil off the surfaces of steel reinforcement and other metal items to be embedded in concrete.



- END OF SECTION -

## **SECTION 03 20 00 - REINFORCEMENT STEEL**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide reinforcement steel and appurtenant WORK, complete and in place, in accordance with the Contract Documents.

#### **1.2 CONTRACTOR SUBMITTALS**

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.

#### **B. Shop Drawings**

1. Shop bending diagrams, placing lists, and drawings of reinforcement steel prior to fabrication. The shop bending diagrams shall show the actual lengths of bars to the nearest inch measured to the intersection of the extensions (tangents for bars of circular cross section) of the outside surface. Include bar placement diagrams that clearly indicate the dimensions of each bar splice.
2. Details of the concrete reinforcement steel and concrete inserts shall be submitted at the earliest possible date after receipt by the CONTRACTOR of the Notice to Proceed. Said details of reinforcement steel for fabrication and erection shall conform to ACI 315 - Details and Detailing of Concrete Reinforcement and the requirements herein.
3. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, the CONTRACTOR shall submit manufacturer's literature which contains instructions and recommendations for installation for each type of coupler used; certified test reports that verify the load capacity of each type and size of coupler used; and Shop Drawings that show the location of each coupler with details of how they are to be installed in the formwork.
4. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit mill test reports containing the information necessary for determination of the carbon equivalent per AWS D1.4 - Structural Steel Welding Code - Reinforcing Steel. The CONTRACTOR shall submit a written welding procedure for each type of weld for each size of bar which is to be spliced by welding; merely a statement that AWS procedures will be followed is not acceptable.
5. If reinforcement steel is spliced by welding at any location, the CONTRACTOR shall submit certifications of procedure qualifications for each welding procedure and certification of welder qualifications, for each welding procedure and for each welder performing on the WORK.

#### **1.3 QUALITY CONTROL**

- A. If requested by the ENGINEER, the CONTRACTOR shall furnish samples from each heat of reinforcement steel in a quantity adequate for testing. Costs of initial tests will be

paid by the OWNER. Costs of additional tests if material fails initial tests shall be the CONTRACTOR's responsibility.

- B. Welder qualifications and procedure qualifications shall be as specified in AWS D1.4.
- C. If requested by the ENGINEER, the CONTRACTOR shall furnish samples of each type of welded splice in a quantity and of dimensions adequate for testing. At the discretion of the ENGINEER, radiographic testing of direct butt-welded splices will be performed. The CONTRACTOR shall provide assistance necessary to facilitate testing. The CONTRACTOR shall repair any weld that fails to meet AWS D1.4. The costs of testing will be paid by the OWNER, but the costs of tests that show failure to meet requirements shall be the CONTRACTOR's responsibility.

## **PART 2 -- PRODUCTS**

### **2.1 MATERIAL REQUIREMENTS**

- A. Materials that may remain or leave residues on or within the concrete shall be certified as compliant with NSF Standard 61- Drinking Water System Components.

### **2.2 REINFORCEMENT STEEL**

- A. **Reinforcement Steel ASTM Standards.** Reinforcement steel for cast-in-place reinforced concrete construction shall conform to the following requirements:

1. Bar and spiral reinforcement shall conform to ASTM A 615 - Deformed and Plain Billet - Steel Bars, for Grade 60 reinforcement unless otherwise indicated.
2. Bar and spiral reinforcement that is welded shall conform to ASTM A 706 - Low Alloy Steel Deformed and Plain Bars for Concrete Reinforcement, for Grade 60 reinforcement unless otherwise indicated. In addition, the carbon equivalent in reinforcing that is welded shall not exceed 0.55 percent.

- B. **Accessories**

1. Accessories shall include necessary chairs, slab bolsters, concrete blocks, tie wires, dips, supports, spacers, and other devices to position reinforcement during concrete placement. Bar supports shall meet the requirements of the CRSI Manual of Standard Practice, including special requirements for supporting epoxy-coated reinforcing bars. Wire bar supports shall be CRSI Class 1 for maximum protection with a 1/8-inch minimum thickness of plastic coating that extends at least 0.5-inch from the concrete surface. Plastic shall be gray in color.
2. Concrete blocks (i.e. dobies) used to support and position reinforcement steel shall have the same or higher compressive strength as required for the concrete in which they are located. Wire ties shall be embedded in concrete block bar supports.

## 2.3 MECHANICAL COUPLERS

- A. Mechanical couplers shall be provided where indicated and where approved by the ENGINEER. The couplers shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars being spliced at each splice.
- B. Where the type of coupler used is composed of more than one component, components required for a complete splice shall be provided. This shall apply to mechanical splices, including those splices intended for future connections.
- C. The reinforcement steel and coupler used shall be compatible for obtaining the required strength of the connection. Straight threaded type couplers shall require the use of the next larger size reinforcing bar or shall be used with reinforcing bars with specially forged ends which provide upset threads which do not decrease the basic cross section of the bar.
- D. Couplers shall be **Lenton Form Saver** by **nVent**, **Taper-Lock Rebar Splices** by **Dayton Superior**, or equal.

## 2.4 WELDED SPLICES

- A. Welded splices shall be provided where indicated and where approved by the ENGINEER. Welded splices of reinforcement steel shall develop a tensile strength that exceeds 125 percent of the yield strength of the reinforcement bars that are connected.
- B. Materials required to conform the welded splices to AWS D1.4 shall be provided.

## 2.5 EPOXY GROUT

- A. Epoxy for grouting reinforcing bars shall be specifically formulated for such application, for the moisture condition, application temperature, and orientation of the hole to be filled. Epoxy grout shall meet the requirements of Section 03 60 00 - Grout.

# PART 3 -- EXECUTION

## 3.1 GENERAL

- A. Reinforcement steel, welded wire fabric, couplers, and other appurtenances shall be fabricated, and placed in accordance with the Building Code and the supplementary requirements herein.

## 3.2 FABRICATION

### A. General

- 1. Reinforcement steel shall be accurately formed to the dimensions and shapes indicated, and the fabricating details shall be prepared in accordance with ACI 315 and ACI 318 - Building Code Requirements for Structural Concrete, except as modified by the Drawings. Bars shall be bent cold. Bars shall be bent per ACI 318.

2. The CONTRACTOR shall fabricate reinforcement bars for structures in accordance with bending diagrams, placing lists, and placing drawings.

B. **Fabricating Tolerances:** Bars used for concrete reinforcement shall satisfy the following fabricating tolerances:

1. Sheared length: plus and minus 1-inch
2. Depth of truss bars: plus zero, minus 0.5-inch
3. Stirrups, ties, and spirals: plus and minus 0.5-inch
4. Other bends: plus and minus 1-inch

### 3.3 PLACING

A. Reinforcement steel shall be accurately positioned as indicated and shall be supported and wired together to prevent displacement, using annealed iron wire ties or suitable clips at intersections. Reinforcement steel shall be supported by concrete, plastic or metal support spacers, or metal hangers that are strong and rigid enough to prevent any displacement of the reinforcement steel. Where concrete is to be placed on the ground, supporting concrete blocks (or dobies) shall be used in sufficient numbers to support the bars without settlement, but in no case shall such support be continuous. Concrete blocks used to support reinforcement steel shall be tied to the steel with wire ties that are embedded in the blocks. For concrete over formwork, the CONTRACTOR shall provide concrete, metal, plastic, or other acceptable bar chairs and spacers.

B. Limitations on the use of bar support materials shall be as follows.

1. Concrete Dobies

- a. Permitted at any location except where architectural finish is required.

2. Wire Bar Supports: permitted only at slabs over dry areas, interior dry wall surfaces, and exterior wall surfaces.

3. Plastic Bar Supports: permitted at every location except on grade.

C. Tie wires shall be bent away from the forms in order to provide the required concrete coverage.

D. Bars additional to those indicated that may be found necessary or desirable by the CONTRACTOR for the purpose of securing reinforcement in position shall be provided by the CONTRACTOR at its own expense.

E. Unless otherwise indicated, reinforcement placing tolerances shall be within the limits in Section 7.5 of ACI 318 except where in conflict with the Building Code.

F. Bars may be moved as necessary to avoid interference with other reinforcement steel, conduits, or embedded items. If bars are moved more than one bar diameter or enough to exceed the above tolerances, the resulting arrangement of bars shall be as reviewed and accepted by the ENGINEER.

- G. Accessories supporting reinforcing bars shall be spaced such that there is no deflection of the accessory from the weight of the supported bars. When used to space the reinforcing bars from wall forms, the forms and bars shall be located so that there is no deflection of the accessory when the forms are tightened into position.

### 3.4 SPACING OF BARS

- A. The clear distance between parallel bars (except in columns and between multiple layers of bars in beams) shall be not less than the nominal diameter of the bars, nor less than 1-1/3 times the maximum size of the coarse aggregate, nor less than one inch.
- B. Where reinforcement in the bridge abutment is placed in 2 or more layers, the clear distance between layers shall be not less than one inch.
- C. The clear distance between bars shall also apply to the distance between a contact splice and adjacent splices or bars.

### 3.5 SPLICING

#### A. **General**

- 1. Reinforcement bar splices shall only be used at locations indicated. When it is necessary to splice reinforcement at points other than where indicated, the character of the splice shall be as reviewed and accepted by the ENGINEER.
- 2. Unless otherwise indicated, dowels shall match the size and spacing of the spliced bar.

#### B. **Splices of Reinforcement**

- 1. The length of lap for reinforcement bars, unless otherwise indicated, shall be in accordance with ACI 318, Section 12.15.1 for a Class B splice.

- C. **Bending or Straightening:** Reinforcement shall not be straightened or rebent in a manner which will injure the material. Bars shall be bent or straight as indicated. Do not use bends different from the bends indicated. Bars shall be bent cold, unless otherwise permitted by the ENGINEER. No bars partially embedded in concrete shall be field-bent except as indicated or specifically permitted by the ENGINEER.

- D. **Couplers.** Couplers that are located at a joint face shall be a type that can be set either flush or recessed from the face as indicated. The couplers shall be sealed during concrete placement to completely eliminate concrete or cement paste from entering.

- 1. Couplers intended for future connections shall be recessed a minimum of 1/2-inch from the concrete surface.
- 2. After the concrete is placed, the coupler shall be plugged with plastic plugs which have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials.
- 3. Threaded couplers shall be plugged.

4. Unless indicated otherwise, mechanical coupler spacing and capacity shall match the spacing and capacity of the reinforcing indicated for the adjacent section.

### 3.6 CLEANING AND PROTECTION

- A. Reinforcement steel shall always be protected from conditions conducive to corrosion until concrete is placed around it.
- B. The surfaces of reinforcement steel and other metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed. Where there is delay in depositing concrete, reinforcement shall be reinspected and, if necessary, recleaned.

### 3.7 EMBEDMENT OF DRILLED REINFORCING STEEL DOWELS

#### A. **Hole Preparation**

1. The hole diameter shall be as recommended by the epoxy manufacturer but shall be no larger than 1/4-inch greater than the diameter of the outer surface of the reinforcing bar deformations.
2. The depth of the hole shall be as recommended by the epoxy manufacturer to fully develop the bar but shall not be less than 12 bar diameters, unless indicated otherwise.
3. The hole shall be drilled by methods that do not interfere with the proper bonding of epoxy.
4. Existing reinforcing steel in the vicinity of proposed holes shall be located prior to drilling. The location of holes shall be adjusted to avoid drilling through or nicking any existing reinforcing bars.
5. The hole shall be blown clean with clean, dry compressed air to remove dust and loose particles.

#### B. **Embedment**

1. Epoxy shall be injected into the hole through a tube placed to the bottom of the hole. The tube shall be withdrawn as epoxy is placed but kept immersed to prevent formation of air pockets. The hole shall be filled to a depth that ensures excess material will be expelled from the hole during dowel placement.
2. Dowels shall be twisted during insertion into the partially filled hole so as to guarantee full wetting of the bar surface with epoxy. The bar shall be inserted slowly enough to avoid developing air pockets.

- END OF SECTION -

## SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide cast-in-place concrete in accordance with the Contract Documents.
- B. The term "hydraulic structure" used in these Specifications means environmental engineering concrete structures for the containment, treatment, or transmission of water, wastewater, other fluids, or gases.
- C. The following types of concrete are covered in this Section:
  - 1. **Structural Concrete**
    - a. Regular Mix: Walls and other concrete items not indicated otherwise in the Contract Documents.
    - b. Thick Section Mix: For 12-inch and thicker walls and abutment pours. This type of concrete may be used at the indicated locations at the CONTRACTOR's option if the ENGINEER agrees.
    - c. Mass Concrete: For 36-inches and thicker walls, slabs on grade and footings.

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01300 – Contractor Submittals.
- B. **Mix Designs:** Prior to beginning the WORK and within 14 Days of the Notice to Proceed, submit preliminary concrete mix designs which shall show the proportions and gradations of materials proposed for each class and type of concrete. Mix designs shall be checked through trial batch and laboratory testing by an independent testing laboratory acceptable to the ENGINEER. Costs related to trial batch and related laboratory testing shall be CONTRACTOR's responsibility as part of the WORK. Since laboratory trial batches require 35 calendar days to complete, the CONTRACTOR shall test a minimum of 2 mix designs for each class of concrete.
- C. **Delivery Tickets:** Where ready-mix concrete is used, the CONTRACTOR shall furnish delivery tickets at the time of delivery of each load of concrete. Each ticket shall show the state-certified equipment used for measuring and the total quantities, by weight, of cement, sand, each class of aggregate, admixtures, the amount of water in the aggregate added at the batching plant, and the amount allowed to be added at the Site for the specific design mix. In addition, each ticket shall state the mix number, total yield in cubic yards, and the time of day, to the nearest minute, corresponding to the times when the batch was dispatched, when it left the plant, when it arrived at the Site, when unloading began, and when unloading was finished.



- D. **Additional Submittals.** Test data relating to the cement, aggregate, and admixtures shall be less than 6 months old. Furnish the following submittals in accordance with ACI 301 – Structural Concrete:

1. Mill tests for cement.
2. Admixture certification. Chloride ion content shall be included.
3. Aggregate gradation test results and certification.
4. Materials and methods for curing.

### 1.3 QUALITY CONTROL

#### A. General

1. Tests on component materials and for compressive strength and shrinkage of concrete shall be performed as indicated. Tests for determining slump shall be in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete.
2. Testing for aggregate shall include sand equivalence, reactivity, organic impurities, abrasion resistance, and soundness, according to ASTM C 33 – Concrete Aggregates.
3. The cost of trial batch laboratory tests on cement, aggregates, and concrete shall be the CONTRACTOR's responsibility. The cost of laboratory tests on field-placed cement, aggregates, and concrete will be the OWNER'S responsibility. However, the CONTRACTOR shall be responsible for the cost of any tests and investigations of WORK that is determined to be Defective WORK. The laboratory shall meet or exceed ASTM C 1077 – Practice for Laboratories Testing Concrete and Concrete Aggregates for use in Construction and Criteria for Laboratory Evaluation.
4. Concrete for testing shall be furnished by the CONTRACTOR, and the CONTRACTOR shall assist the ENGINEER in obtaining samples and disposal and cleanup of excess material.

#### B. Field Compression Tests

1. Each set of specimens shall be a minimum of 5 cylinders.
2. Compression test specimens for concrete shall be made in accordance with Section 9.2 of ASTM C 31 – Practices for Making and Curing Concrete Test Specimens in the Field. Specimens shall be 6-inches diameter by 12-inches tall cylinders.
3. Frequency of Testing
  - 1) Sampling frequency and testing for each class of concrete shall be in accordance with ACI 350 section 5.5 as follows:
    - a) Not less than once a day for each class of concrete placed, nor less than:

- b) Once for each 100 yd<sup>3</sup> of each class of concrete placed each day, nor less than:
  - c) Once for each 5,000 ft<sup>2</sup> of slab or wall surface area placed each day.
  - d) If total volume of concrete is such that frequency of testing would provide less than five strength tests for a given class of concrete, tests shall be made from at least five randomly selected batches or from each batch if fewer than five batches are used.
- 2) Frequency of testing may be changed at the discretion of the ENGINEER.
4. Compression tests shall be performed in accordance with ASTM C 39 – Test Method for Compressive Strength of Cylindrical Concrete Specimens. One test cylinder will be tested at 7 Days and 2 at 28 Days. The remaining cylinders will be held to verify test results, if needed.

#### **C. Evaluation and Acceptance of Concrete**

- 1. Evaluation and acceptance of the compressive strength of concrete will be according to ACI 318 – Building Code Requirements for Structural Concrete, Chapter 26 "Construction Documents and Inspection," and as indicated.
- 2. A statistical analysis of compression test results will be performed according to ACI 214 – Recommended Practice for Evaluation of Strength Test Methods. The standard deviation of the test results shall not exceed 640 psi, when ordered at equivalent water content as estimated by slump.
- 3. If any concrete fails to meet these requirements, immediate corrective action shall be taken to increase the compressive strength for subsequent batches of the type of concrete affected.
- 4. When the standard deviation of the test results exceeds 640 psi, the average strength for which the mix is designed shall be increased by an amount necessary to satisfy the statistical requirement that the probability of any test being more than 500 psi below or the average of any 3 consecutive tests being below the required compressive strength is 1 in 100. The required average strength shall be calculated by Criterion No. 3 of ACI 214 using the actual standard deviation.
- 5. Concrete that fails to meet the ACI requirements and these Specifications is subject to removal and replacement.

#### **D. Shrinkage Tests**

- 1. Drying shrinkage tests shall be performed for the trial batches indicated in the Article below entitled "Trial Batch and Laboratory Tests, for the first placement of each class of structural concrete, and during placement to determine continued compliance.
- 2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gauge length of 10-inches; fabricated, cured, dried, and measured in accordance with ASTM C 157 – Test Method for Length Change of Hardened Hydraulic Cement Mortar and Concrete, modified as follows: Specimens shall be removed from molds at an age of 23 hours plus or minus 1 hour after batching, shall

be placed immediately in water at 70 degrees F plus or minus 3 degrees F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then be submerged in saturated lime water at 73 degrees F plus or minus 3 degrees F. Measurement to determine expansion expressed as a percentage of original length shall be made at age 7 Days. This length at age 7 Days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73 degrees F plus or minus 3 degrees F and 50 percent plus or minus 4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 Days of drying after 7 Days of moist curing.

3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001 inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations are indicated in Part 2 below.

E. **Aggregate Testing:** Aggregate testing shall be performed within 12 months of the start of construction and every 12 months during construction to determine continued compliance.

F. **Construction Tolerances:** The CONTRACTOR shall set and maintain concrete forms and perform finishing operations to ensure that the completed WORK is within tolerances. Surface defects and irregularities are defined as finishes and are different from tolerances. Tolerance is the permissible variation from lines, grades, or dimensions indicated on the Drawings. Where tolerances are not stated in the Specifications, permissible deviations will be in accordance with ACI 117 – Standard Tolerance for Concrete Construction and Materials.

1. The following non-cumulative construction tolerances apply to finished walls and slabs unless otherwise indicated:

Item	Tolerance
Variation of the constructed linear outline from the established position in plan.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from the level or from the grades indicated.	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation from plumb	In 10-feet: 1/4-inch; In 20-feet or more: 1/2-inch
Variation in the thickness of slabs and walls.	Minus 1/4-inch; Plus 1/2-inch

Variation in the locations and sizes of slabs and wall openings	Plus or minus 1/4-inch
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## PART 2 -- PRODUCTS

### 2.1 CONCRETE MATERIALS

#### A. General

1. Materials shall be classified as acceptable for potable water use according to NSF Standard 61.
2. Ready-mix concrete shall conform to the requirements of ASTM C 94 – Ready Mixed Concrete.
3. Cement for concrete that will contact potable water shall not be obtained from kilns that burn metal rich hazardous waste fuel.
4. Materials shall be delivered, stored, and handled so as to prevent damage by water or breakage. Cement reclaimed from cleaning bags or leaking containers shall not be used. Cement shall be used in the sequence of receipt of shipments.

B. Storage of materials shall comply with ACI 301, as applicable.

C. **Materials.** Materials for concrete shall comply with ACI 301 and shall conform to the following requirements:

1. **Cement.** Cement shall be standard brand Portland cement conforming to ASTM C 150 –Portland Cement, for Type I/II or Type V, including Table 2 optional requirements. A minimum of 85 percent of cement by weight shall pass a 325 screen. A single brand of cement shall be used throughout the WORK, and prior to its use, the brand shall be accepted by the ENGINEER. The cement shall be suitably protected from exposure to moisture until used. Cement that has become lumpy shall not be used. Sacked cement shall be stored in such a manner so as to permit access for inspection and sampling. Certified mill test reports, including fineness, for each shipment of cement to be used shall be submitted to the ENGINEER, if requested, regarding compliance with the Specifications.
  - 1) Cement for the **Mass Concrete Mix** shall be standard brand Portland cement conforming to ASTM C 150 – Portland Cement, for Type II (MH - low heat).
2. **Water.** Water for mixing and curing shall be potable, clean, and free from objectionable quantities of silty organic matter, alkali, salts, and other impurities. The water shall be considered potable, for the purposes of this Section only, if it meets the requirements of the local governmental agencies. Agricultural water with high total dissolved solids (greater than 1000 mg/l TDS) shall not be used.
3. **Aggregates.** Aggregates shall be obtained from pits acceptable to the ENGINEER, shall be non-reactive, and shall conform to ASTM C 33 – Concrete Aggregates.

Maximum size of coarse aggregate shall be as indicated. Substituting lightweight sand for fine aggregate will not be permitted.

a. Coarse aggregates shall consist of clean, hard, durable gravel, crushed gravel, crushed rock, or a combination thereof. The coarse aggregates shall be prepared and handled in 2 or more size groups for combined aggregates with a maximum size greater than 3/4-inch. When the aggregates are proportioned for each batch of concrete, the 2 size groups shall be combined.

b. Fine aggregates shall be natural sand or a combination of natural and manufactured sand that is hard and durable. When tested in accordance with ASTM D 2419 – Test Methods for Sand Equivalent Value of Soils and Fine Aggregate, the sand equivalency shall not be less than 75 percent for an average of 3 samples, nor less than 70 percent for an individual test. Gradation of fine aggregate shall conform to ASTM C 33 when tested in accordance with ASTM C 136 for the fineness modulus of the sand used, including the optional grading in Section 6.2. The fineness modulus of sand used shall not be over 3.1.

c. Combined aggregates shall be well graded from coarse to fine sizes and shall be uniformly graded between screen sizes to produce concrete that has optimum workability and consolidation characteristics. Where a trial batch is required for a mix design, the final combined aggregate gradations will be established during the trial batch process.

d. When tested in accordance with ASTM C 33, the ratio of silica released to reduction in alkalinity shall not exceed 1.0.

e. When tested in accordance with ASTM C 33, the fine aggregate shall produce a color in the supernatant liquid no darker than the reference standard color solution.

f. When tested in accordance with ASTM C 33, the coarse aggregate shall show a loss not exceeding 42 percent after 500 revolutions or 10.5 percent after 100 revolutions.

g. When tested in accordance with ASTM C 33, the loss resulting after 5 cycles of the soundness test shall not exceed 10 percent for fine aggregate and 12 percent for coarse aggregate when using sodium sulfate.

4. **Flyash.** If used, flyash shall be Class F and meet ASTM C618.

5. **Admixtures.** Admixtures shall be compatible and be furnished by a single manufacturer capable of providing qualified field service representation. Admixtures shall be used in accordance with manufacturer's recommendations. If the use of an admixture is producing an inferior end result, the CONTRACTOR shall discontinue use of the admixture. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic after 30 days.

a. **Air-entraining agents:** Agents shall meet the requirements of ASTM C 260 – Air Entraining Admixtures for Concrete shall be used. Concrete floors to receive a dry-shake floor hardener shall have an air content not to exceed 7 percent. The OWNER reserves the right, at any time, to sample and test the air-entraining agent. The air-entraining agent shall be added to the batch in a portion of the mixing water. The solution shall be batched by means of a mechanical batcher capable of accurate measurement. Air content shall be tested at the point of placement. Air-entraining admixture shall be approved by the ENGINEER prior to use.

b. **Set controlling and water reducing admixtures:** Admixtures may be added at the CONTRACTOR's option, subject to the ENGINEER's approval, to control the set, effect water reduction, and increase workability. The cost of adding an admixture shall be the CONTRACTOR's responsibility. Concrete containing an admixture shall be first placed at a location determined by the ENGINEER. Admixtures shall conform to ASTM C 494 – Chemical Admixtures for Concrete. The required quantity of cement shall be used in the mix regardless of whether or not an admixture is used.

- 1) Concrete shall not contain more than one water reducing admixture.
- 2) Set controlling admixture may be either with or without water-reducing properties. Admixture shall be appropriate for the air temperature at time of placement. Set controlling admixture shall be approved by the ENGINEER prior to use.
- 3) Normal range water reducer shall conform to ASTM C 494, Type A. The quantity of admixture used and the method of mixing shall be in accordance with the manufacturer's instructions and recommendations. Normal range water reducing admixtures shall be approved by the ENGINEER prior to use.
- 4) High range water reducer shall conform to ASTM C 494, Type F or G. High range water reducer shall be added to the concrete after all other ingredients have been mixed and initial slump has been verified. No more than 14 ounces of water reducer per sack of cement shall be used. Water reducer shall be considered as part of the mixing water when calculating the water/cement ratio. High range water reducing admixtures shall be approved by the ENGINEER prior to use.
- 5) If the high range water reducer is added to the concrete at the Site, it may be used in conjunction with the same water reducer added at the batch plant. Concrete shall have a slump of 3-inches plus or minus 1/2-inch prior to adding the high range water reducing admixture at the Site. The high range water reducing admixture shall be accurately measured and pressure injected into the mixer as a single dose by an experienced technician. A standby system shall be provided and tested prior to each day's operation of the primary system.

- 6) Concrete shall be mixed at mixing speed for a minimum of 70 mixer revolutions or 5 minutes after the addition of the high range water reducer, unless recommended otherwise by the manufacturer.
6. **Lithium Additives:** Lithium additives shall not be used in concrete mix design for water bearing structures.
7. **Anti-washout Admixture for Underwater Concrete:** Anti-Washout Admixture shall be in accordance with US Army Corps of Engineers CRD-C 61. Contractor shall use **MasterMatrix UW 450 anti-washout admixture** by **BASF** or approved equal.
  - a. Anti-washout Admixture shall be added at the batch plant or at the job site after all other concrete ingredients have been batched and thoroughly mixed as recommended by the manufacturer.
  - b. Anti-washout Admixtures shall be added with a water reducing admixture as recommended by the manufacturer.
- D. **Alkali-Silica Reactivity (ASR) of Aggregates.** All aggregates used in the concrete mix designs shall generally be considered non-reactive (innocuous) aggregate according to the requirements of ASTM C1260 or ASTM 1567 and tested according to the requirements listed below.
  1. Fine and coarse aggregates to be used in all concrete shall be evaluated individually and tested for alkali-aggregate reactivity, according to ASTM C1260. The average expansion of the mortar bars for the fine aggregate test according to ASTM C1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution. Likewise, the average expansion of the mortar bars for the coarse aggregate test according to ASTM C1260 shall not exceed 0.10% at 16-days of immersion in a 1N NaOH solution.
  2. If either of the aggregates do not pass the ASTM C1260 test requirements as described above, CONTRACTOR shall provide information to the CONTRACTOR that the proposed fine and coarse aggregate is the best (i.e. least reactive) locally available material within [[50]] [[100]]-miles of the project site. In addition, the CONTRACTOR shall provide additional testing of the proposed aggregates (fine and coarse) along with approved mitigating additives (i.e. fly ash, class N pozzolan, GGBF slag, silica fume or other approved additives) to the concrete mix design, according to the requirements of ASTM C1567 and the following requirements:
    - a. The concrete mix design parameters used in the ASTM C1567 expansion test shall be within the allowable ranges of mix design parameters as specified under Part 2.5.D of this Section. After 16-days of immersion in a 1N NaOH solution, the average expansion of the three mortar bars shall not exceed 0.10% as measured according to ASTM C1567 standards and protocol.
    - b. ASR test on both the fine and coarse aggregate and concrete mix additives (i.e. flyash, pozzolan, or other approved additives), sample bar preparation, testing and all analytical methods shall meet the ASTM C1567 testing procedural requirements.
    - c. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.

- d. Results of the ASR test show that expansion of the concrete sample is less than 0.10% at 16-days after the start of the expansion test procedure.
  - e. Test results shall be reported to the CONTRACTOR and Design Engineer at 7-days, 11-days, and 16-days.
  - f. The Concrete Supplier is still actively mining and using aggregate from the same representative portion of the aggregate pit from which the aggregate samples were taken for testing.
3. In lieu of the ASR testing above the aggregate may be tested in accordance with the requirements of ASTM C1293.
- a. The concrete mix design parameters used in the ASTM C1293 expansion test shall be within the allowable ranges of mix design parameters as specified under Part 2.5.D of this Section.
  - b. Alkali content of the cement in the proposed concrete mix design shall not be greater than the alkali content of the cement used in the test samples.
  - c. Results of the test, in accordance with ASTM C33, shall indicate less than 0.04% expansion at 1-year for cement aggregate combinations to demonstrate aggregates to be non-reactive.
  - d. Results of the test, in accordance with ASTM C33, shall indicate less than 0.04% expansion at 2-years for cement aggregate combinations with pozzolan or slag to demonstrate aggregates to be non-reactive

## 2.2 CURING MATERIALS

- A. Curing compounds shall be resin-based and compliant with local VOC requirements.
  - 1. Regular curing compounds shall be white pigmented and conform to ASTM C 309 - Liquid Membrane-Forming Compounds for Curing Concrete, Type 2, Class B. Sodium silicate compounds shall not be allowed. Concrete curing compound shall be approved by the ENGINEER prior to use.
  - 2. When curing compound must be removed for finishes or grouting, compounds shall be a dissipating type meeting ASTM C 309, type 1 or 2, Class B. Concrete curing compound shall be approved by the ENGINEER prior to use.
- B. Polyethylene sheet for use as concrete curing blanket shall be white and shall have a nominal thickness of 6-mils. The loss of moisture when determined in accordance with ASTM C 156 – Test Method for Water Retention by Concrete Curing Materials, shall not exceed 0.055 grams per square centimeter of surface.
- C. Polyethylene-coated waterproof paper sheeting for use as concrete curing blanket shall consist of white polyethylene sheeting free of visible defects, uniform in appearance, have a nominal thickness of 2-mils, and be permanently bonded to waterproof paper conforming to the requirements of Federal Specification UU-B-790A – Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellant and Fire Resistant). The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 gram per square centimeter of surface.



- D. Polyethylene-coated burlap for use as concrete curing blanket shall be 4-mils thick with white opaque polyethylene film impregnated or extruded into one side of the burlap. Burlap shall weigh not less than 9 ounces per square yard. The loss of moisture, when determined in accordance with ASTM C 156, shall not exceed 0.055 grams per square centimeter of surface.
- E. Curing mats for use in Curing Method 6 below shall be heavy shag rugs or carpets or cotton mats quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.
- F. Evaporation retardant shall be a material such as **MasterKure ER 50** by **BASF**, **Eucobar** by **Euclid Chemical Company**, **L&M E-CON** by **Laticrete**, or equal.

## 2.3 NON-WATERSTOP JOINT MATERIALS

- A. Materials for non-waterstop joints in concrete shall conform to the following requirements:
  - 1. Preformed joint filler shall be a non-extruding neoprene sponge or polyurethane type conforming to Section 03290 - Joints in Concrete.
  - 2. Elastomeric joint sealer shall conform to Section 07920 - Sealants and Caulking.
  - 3. Mastic joint sealer shall be a material that does not contain evaporating solvents; that will tenaciously adhere to concrete surfaces; that will remain permanently resilient and pliable; that will not be affected by continuous presence of water and will not in any way contaminate potable water; and that will effectively seal the joints against moisture infiltration even when the joints are subject to movement from expansion and contraction. The sealer shall be composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance containing no volatile oils or lubricants and shall be capable of meeting the test requirements set forth below, if testing is required by the ENGINEER.

## 2.4 MISCELLANEOUS MATERIALS

- A. **Bonding Agents.** Bonding agents shall be epoxy adhesives conforming to the following:
  - 1. For bonding freshly-mixed, plastic concrete to hardened concrete, **Sikadur 32 Hi-Mod Epoxy Adhesive** by **Sika Corporation**, **MasterEmaco ADH 326** by **BASF**, **Sure Bond J58** by **Dayton Superior**, or equal.
  - 2. For bonding hardened concrete or masonry to steel, **Sikadur 31 Hi-Mod Gel** by **Sika Corporation**, **MasterEmaco ADH 327** by **BASF**, or equal.

## 2.5 CONCRETE DESIGN REQUIREMENTS

- A. **General:** Concrete shall be composed of cement, admixtures, aggregates, and water of the qualities indicated. In general, the mix shall be designed to produce a concrete capable of being deposited so as to obtain maximum density and minimum shrinkage, and where deposited in forms, to have good consolidation properties and maximum smoothness of surface. The aggregate gradations shall be formulated to provide fresh concrete that will not promote rock pockets around reinforcing steel or embedded items.

The proportions shall be changed whenever necessary or desirable to meet the required results. Changes shall be subject to review by the ENGINEER.

- B. **Fine Aggregate Composition:** In mix designs for structural concrete, the percentage of fine aggregate in total aggregate by weight shall be as indicated in the following table.

FINE AGGREGATE	
Fineness Modulus	Maximum Percent
2.7 or less	41
2.7 to 2.8	42
2.8 to 2.9	43
2.9 to 3.1	44

1. For other concrete, the maximum percentage of fine aggregate of total aggregate by weight shall not exceed 50.
- C. Duct bank concrete shall contain an integral red-oxide coloring pigment. Concrete shall be dyed red throughout. Surface treatment to color duct banks will not be acceptable.
- D. **Water/Cement Ratio W/C:** The water/cement ratio indicated is for saturated-surface dry condition of aggregate. Every Day, throughout the day, the batch water added shall be adjusted for the total free water in the aggregates.
1. Total free moisture of aggregates shall be determined by:
    - a. Starting with the total moisture content of all aggregate, calculated by ASTM C 566 -Test Method for Total Moisture Content of Aggregate by Drying
    - b. Subtracting the moisture absorbed by the coarse aggregate, calculated by ASTM C 127 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Coarse Aggregate
    - c. Subtracting the moisture absorbed by the fine aggregate, calculated by ASTM C 128 – Standard Test Method for Density, Relative Density (Specific Gravity) and Absorption of Fine Aggregate.

## E. Concrete Property Tables

<b>Structural Concrete</b>			
<b>Type of WORK</b>	<b>Regular Mix</b> (Walls, pavements, slabs on grade, footings and other concrete items not categorized elsewhere)	<b>Thick Section Mix</b> (12-inches and thicker walls, slabs on grade, pavements, and footings)	<b>Mass Concrete Mix</b> (12-inches and thicker walls, slabs on grade, pavements, and footings)
<b>Min 28 Day Compressive Strength, psi</b>	4,500	4,500	4,500 (90-Day)
<b>Max Aggregate Size, in</b>	1	1 1/2	1 1/2
<b>Cement Content, lbs /cubic yard,</b>	564 to 600	564 to 600	564 to 600
<b>Max Allowable Fly Ash Content (FA); lbs/cubic yard</b>	15% max of cement content	15% max of cement content	25% max of cement content
<b>Max W/C Ratio by weight</b>	0.42	0.42	0.45
<b>Total Air Content, percent</b>	5.0 to 7.0	5.0 to 7.0	5.0 to 7.0
<b>Slump, in</b>	3-in +/- 1-in	3-in +/- 1-in	3-in +/- 1-in
	with high range water reducer	with high range water reducer	with high range water reducer
	7-in +/- 2-in	7-in +/- 2-in	7-in +/- 2-in

NOTE: The CONTRACTOR is cautioned that the limiting parameters above are not a mix design. Admixtures may be required to achieve workability required by the CONTRACTOR's construction methods and aggregates. The CONTRACTOR is responsible for providing concrete with the required workability and strength.

F. **Adjustments to Mix Design:** The CONTRACTOR may elect to decrease the water/cement ratio to achieve the strength and shrinkage requirements and/or add water reducers, as required to achieve workability. The mixes shall be changed whenever such change is necessary or desirable to secure the required strength, density, workability, and surface finish, and the CONTRACTOR shall be entitled to no additional

compensation because of such changes. Any changes to the accepted concrete mix design shall be submitted to the ENGINEER for review and shall be tested again in accordance with these Specifications.

## 2.6 CONSISTENCY

- A. The quantity of water in a batch of concrete shall be just sufficient, with a normal mixing period, to produce a concrete that can be worked properly into place without segregation and which can be compacted by vibratory methods to give the desired density, impermeability, and smoothness of surface. The quantity of water shall be changed as necessary, with variations in the nature or moisture content of the aggregates, to maintain uniform production of a desired consistency. The consistency of the concrete in successive batches shall be determined by slump tests in accordance with ASTM C 143 – Test Method for Slump of Hydraulic Cement Concrete. The slumps shall be as indicated with the concrete properties.

## 2.7 TRIAL BATCH AND LABORATORY TESTS

- A. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch testing requirements or approved historical concrete testing results as specified below.
  - 1. **Trial Batch Concrete Testing.** Before placing any concrete, a testing laboratory selected by the ENGINEER shall prepare a trial batch of each class of structural concrete, based on the preliminary concrete mixes submitted by the CONTRACTOR. During the trial batch the aggregate proportions may be adjusted by the testing laboratory using the two coarse aggregate size ranges to obtain the required properties. If one size range produces an acceptable mix, a second size range need not be used. Such adjustments will be considered refinements to the mix design and will not be the basis for extra compensation to the CONTRACTOR. Concrete shall conform to the requirements of this Section whether the aggregate proportions are from the CONTRACTOR's preliminary mix design or whether the proportions have been adjusted during the trial batch process. The trial batch shall be prepared using the aggregates, cement, and admixture proposed for the project. The trial batch materials shall be of a quantity such that the testing laboratory can obtain 3 drying shrinkage, and 6 compression test specimens from each batch.
  - 2. **Historical Concrete Testing.** For shrinkage testing, as well as ASR expansion testing requirements, the CONTRACTOR may propose the use of historical test results on these tests provided that all of the following conditions are met:
    - a. The test results are no more than 6-months old from the project Notice-to-Proceed date.
    - b. The mix design used in the proposed historical tests has the same characteristics, as described below, as the mix design proposed for use on the project:
      - 1) The type and quantity of cement used in the historical tested mix, is the same as that of the proposed mix design.
      - 2) The quantity and source location of the coarse and fine aggregate used in the historical tested mix is the same as that of the proposed mix design.

In addition, the aggregate used in the historical tests must be screened to the same gradations as that proposed for the project mix design.

- 3) The type and quantity of cementations substitutes (fly ash or slag or other approved substitute) used in the historical tested mix, is the same as that of the proposed mix design.
- 4) The water to cement ratio of the historical tested mix is within +/- 5% of the proposed water to cement ratio.
- 5) The air content of the historical tested mix is within 1% of the proposed air content (for example: for a proposed air content of 6% in the proposed mix design, the historical air content must be in the range of 5 to 7%.)
- 6) The same additives, including water reducing additives, that were used in the historical batch test results are being proposed for the new concrete mix design, and the proportions of those additives used in the historical mix design are within +/- 5% of that of the proposed project mix design.

B. **Compressive Strength Testing.** The determination of compressive strength will be made by testing 6-inch diameter by 12-inch high cylinders; made, cured, and tested in accordance with ASTM C 192 - Practice for Making and Curing Concrete Test Specimens in the Laboratory and ASTM C 39. Three compression test cylinders will be tested at 7 Days and 3 at 28 Days. The average compressive strength for the 3 cylinders tested at 28 Days for any given trial batch shall not be less than 125 percent of the indicated compressive strength.

C. **Sieve Analyses.** A sieve analysis of the combined aggregate for each trial batch shall be performed according to the requirements of ASTM C 136 – Method for Sieve Analysis of Fine and Coarse Aggregates. Values shall be given for percent passing each sieve.

## 2.8 SHRINKAGE LIMITATION FOR STRUCTURAL CONCRETE

- A. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 28 Day drying age shall be 0.042 percent. Standard deviation will not be considered. The CONTRACTOR shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to structural concrete.
- B. The maximum concrete shrinkage for specimens cast in the field shall not exceed the trial batch maximum shrinkage requirement by more than 25 percent.
- C. If the required shrinkage limitation is not met during construction, the CONTRACTOR shall take any or all of the following actions to reestablish compliance. These actions may include changing the source of aggregates, cement and/or admixtures; reducing water/cement ratio; washing of coarse and/or fine aggregate to reduce fines; increasing the number of construction joints; modifying the curing requirements; or other actions to minimize shrinkage or the effects of shrinkage.

## 2.9 MEASUREMENT OF CEMENT AND AGGREGATE

- A. The amount of cement and of each separate size of aggregate entering into each batch of concrete shall be determined by direct weighing equipment furnished by the

CONTRACTOR and acceptable to the ENGINEER. Weighing tolerances for the materials shall be a maximum of that given below.

Material	Percent of Total Weight
Cement	1
Aggregates	3
Admixtures	3

## 2.10 MEASUREMENT OF WATER

- A. The quantity of water entering the mixer shall be measured by a suitable water meter or other measuring device of a type acceptable to the ENGINEER and capable of measuring the water in variable amounts within a tolerance of one percent. The water feed control mechanism shall be capable of being locked in position so as to deliver constantly any required amount of water to each batch of concrete. A positive quick-acting valve shall be used for a cut-off in the water line to the mixer. The operating mechanism shall prevent leakage when the valves are closed.

## 2.11 READY-MIXED CONCRETE

- A. At the CONTRACTOR'S option, ready-mixed concrete may be used if it meets the requirements as to materials, batching, mixing, transporting, and placing indicated herein and is in accordance with ASTM C 94, including the following supplementary requirements.
- B. Ready-mixed concrete shall be delivered to the WORK, and discharge shall be completed within one hour after the addition of the cement to the aggregates or before the drum has been revolved 250 revolutions, whichever occurs first.
- C. Truck mixers shall be equipped with electrically-actuated counters by which the number of revolutions of the drum or blades may be readily verified. The counter shall be the resettable, recording type and shall be mounted in the driver's cab. The counters shall be actuated at the time of starting mixers at mixing speeds.
- D. Each batch of concrete shall be mixed in a truck mixer for not less than 70 revolutions of the drum or blades at the rate of rotation designated by the manufacturer of equipment. Additional mixing, if any, shall be at the speed designated by the manufacturer of the equipment as agitating speed. Materials including mixing water shall be in the mixer drum before actuating the revolution counter for determining the number of revolutions of mixing.
- E. Truck mixers and their operation shall be such that the concrete throughout the mixed batch as discharged is within acceptable limits of uniformity with respect to consistency, mix, and grading. If slump tests taken at approximately the 1/4 and 3/4 points of the load during discharge give slumps differing by more than one-inch when the required slump is 3-inches or less, or if they differ by more than 2-inches when the required slump is more than 3-inches, the mixer shall not be used on the WORK unless the causative condition is corrected and satisfactory performance is verified by additional slump tests. Mechanical details of the mixer, such as water measuring and discharge apparatus, condition of the blades, speed of rotation, general mechanical condition of the unit, and

clearance of the drum, shall be checked before a further attempt to use the unit will be permitted.

- F. Each batch of ready-mixed concrete delivered to the Site shall be accompanied by a delivery ticket that is furnished to the ENGINEER in accordance with the Paragraph above entitled "Delivery Tickets."
- G. The use of non-agitating equipment for transporting ready-mixed concrete will not be permitted. Combination truck and trailer equipment for transporting ready-mixed concrete will not be permitted. The quality and quantity of materials used in ready-mixed concrete and in batch aggregates shall be subject to continuous inspection at the batching plant by the ENGINEER.

## **PART 3 -- EXECUTION**

### **3.1 PROPORTIONING AND MIXING**

- A. **Proportioning:** Proportioning of the mix shall conform to ACI 301.
- B. **Mixing:** Mixing shall conform to ACI 301.
- C. **Slump:** Slumps shall be as indicated.
- D. **Retempering:** Retempering of concrete or mortar that has partially hardened shall not be permitted.

### **3.2 PREPARATION OF SURFACES FOR CONCRETING**

- A. **General:** Earth surfaces shall be thoroughly wetted by sprinkling prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.
- B. **Joints in Concrete:** Construction joints are defined as concrete surfaces upon which or against which concrete is to be placed but placement of concrete has been stopped or interrupted and the ENGINEER has determined that the new concrete cannot be incorporated integrally with the concrete previously placed. The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. Pools of water shall be removed from the surface of construction joints before the new concrete is placed.
- C. **Placing Interruptions:** When placing of concrete is to be interrupted long enough for the concrete to take a set, the working face shall be given a shape by the use of forms or other means that will secure proper union with subsequent WORK; provided that construction joints shall be made only where acceptable to the ENGINEER.
- D. **Embedded Items:** No concrete shall be placed until formwork, installation of parts to be embedded, reinforcement steel, and preparation of surfaces involved in the placing have been completed and accepted by the ENGINEER at least 4 hours before placement of

concrete. Surfaces of forms and embedded items that have become encrusted with dried grout from previous usage shall be cleaned before the surrounding or adjacent concrete is placed.

- E. Inserts or other embedded items shall conform to the requirements herein.
- F. Reinforcement, anchor bolts, sleeves, inserts, and similar items shall be set and secured in the forms at locations indicated on the Drawings or shown by Shop Drawings and shall be acceptable to the ENGINEER before any concrete is placed. Accuracy of placement is the responsibility of the CONTRACTOR.
- G. **Casting New Concrete Against Old:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the ENGINEER.
- H. No concrete shall be placed in any structure until water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes or other means, and carried out of the forms, clear of the WORK. No concrete shall be deposited underwater nor shall the CONTRACTOR allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, shall be subject to review by the ENGINEER.
- I. **Corrosion Protection:** Pipe, conduit, dowels, and other ferrous items required to be embedded in concrete construction shall be so positioned and supported prior to placement of concrete that there will be a minimum of 2-inches clearance between said items and any part of the concrete reinforcement. Securing such items in position by wiring or welding them to the reinforcement will not be permitted.
- J. Openings for pipes, inserts for pipe hangers and brackets, and anchors shall, where practicable, be provided during the placing of concrete.
- K. Anchor bolts shall be accurately set and shall be maintained in position by templates while embedded in concrete.
- L. **Cleaning:** The surfaces of metalwork to be in contact with concrete shall be thoroughly cleaned of dirt, grease, loose scale and rust, grout, mortar, and other foreign substances immediately before the concrete is placed.

### 3.3 MASS CONCRETE PLACEMENT

- A. When placing mass concrete, lifts shall not exceed 8 feet in height. Mass concrete is any concrete section with a least dimension greater than 3-feet.
- B. The maximum peak curing temperature of all mass concrete elements shall not exceed 158 degrees Fahrenheit for mass concrete placements, a minimum cure time of 7-days is required for mass concrete.
- C. It is the Contractor's responsibility to produce a structure free of cracks, which would result from heat of hydration during the curing of large concrete cross-sections.



- D. This work consists of temperature control of mass concrete for the purpose of minimizing potential cracking as a result of excessive temperature differentials due to the heat of hydration in the curing phase of large concrete cross-sections and for limiting the maximum temperature of concrete during the curing process.
- E. Temperature control of these structures shall be provided in accordance with ACI 207.1R-05, "Guide to Mass Concrete," ACI 207.2R-95 "Effect of Restraint, Volume Change, and Reinforcement on Cracking of Mass Concrete," and ACI 207.4R-05 "Cooling and Insulating Systems for Mass Concrete.
- F. The maximum temperature differential between the interior and a point 2 inches inside of the exterior surface, and the maximum peak concrete curing temperature shall be limited to 35 degrees.
- G. These temperature conditions shall be maintained from time of concrete placement until all interior concrete temperatures are decreasing.
- H. Surface mounted temperature sensors will not be used to measure differential temperatures.
- I. Temperature Control: The Contractor shall control the maximum temperature and interior and exterior temperature differential in the mass concrete in accordance with the following:
  - 1. Submittals - At least 30 calendar days prior to scheduled concrete casting for mass concrete elements, the CONTRACTOR shall submit a heat generation and dissipation analysis to the ENGINEER for approval indicating how temperature controls are to be achieved together with proposed concrete design mix, casting procedures and material information. The submittal shall include, but not be limited to, the following:
    - a) Heat generation and dissipation analysis in accordance with ACI 207.1R-05 for the geometry of each mass concrete element. The analysis shall determine the predicted concrete temperature at the center and 2 inches inside of the exterior surface exposed to air for a time period until all temperatures are decreasing.
    - b) Analyses shall be performed for the anticipated mean weekly ambient air temperatures for the period of the proposed placement, and for temperatures plus, and minus, 10 degrees Fahrenheit of the mean weekly ambient air temperature.
    - c) Anticipated concrete placement temperatures measured at discharge into the forms for the mean weekly ambient air temperatures, and temperatures plus, and minus, 10 degrees Fahrenheit of the mean weekly ambient air temperature
    - d) The method(s) that are intended to be used for maintaining a maximum temperature differential between the interior and 2 inches inside of the exterior surface of the designated mass concrete elements, and a maximum peak curing temperature, at the anticipated mean weekly ambient air temperatures in which the element is intended to be cast.

#### J. TEMPERATURE MONITORING:

1. The CONTRACTOR shall provide temperature monitoring devices to record temperature development between the interior and 2 inches inside the exterior surface of each element at points approved by the ENGINEER.
2. A minimum of two independent sets of interior and exterior points shall be monitored for each element to provide redundancy in case of monitoring device failure.
3. Both sets of monitoring points shall be located along the shortest line from the geometric center to the nearest exterior exposed surface of the structure as such: 1) one sensor at the geometric center of the structure and one sensor at 2 inches from the nearest exposed exterior surface.
4. The minimum number of sensors for each pour shall be two sets of two, or a total of 4 sensors
5. The temperatures shall be recorded automatically by an approved strip-chart recorder furnished by the CONTRACTOR.
6. The monitoring devices shall be read by the CONTRACTOR, beginning when casting is complete and continuing until the maximum concrete temperature has decreased for a period of not less than thirty-six (36) hours. Furnish temperature-monitoring records to the ENGINEER daily.
7. If monitoring indicates the maximum temperature differential or the maximum curing temperature will, in the determination of the ENGINEER, or has, exceeded the maximums the CONTRACTOR shall take immediate action to retard further growth in the differential or maximum temperatures.
8. Additionally, the CONTRACTOR shall make the necessary revisions to the approved plan to not exceed the maximum differential and maximum curing temperatures on any remaining placements. Revisions to the approved plan must be approved by the ENGINEER prior to implementation.

#### 3.4 HANDLING, TRANSPORTING, AND PLACING

- A. **General:** Placing of concrete shall conform to the applicable portions of ACI 301 and the requirements of this Section. No aluminum materials shall be used in conveying any concrete.
- B. **Non-Conforming WORK or Materials:** Concrete which during or before placing is found not to conform to the requirements indicated herein shall be rejected and immediately removed from the WORK. Concrete that is not placed in accordance with these requirements or which is of inferior quality shall be removed and replaced.
- C. **Unauthorized Placement:** No concrete shall be placed except in the presence of a duly authorized representative of the ENGINEER. The CONTRACTOR shall notify the ENGINEER in writing at least 24 hours in advance of placement of any concrete.
- D. **Placement in Wall and Column Forms:** Concrete shall not be dropped through reinforcement steel or into any deep form, nor shall concrete be placed in any form in such a manner as to leave accumulation of mortar on the form surfaces above the placed concrete. In such cases, means such as hoppers and, if necessary, vertical

ducts of canvas, rubber, or metal shall be used for placing concrete in the forms in a manner that it may reach the place of final deposit without separation. In no case shall the free fall of concrete below the ends of ducts, chutes, or buggies exceed 4-feet in walls and 8-feet in columns. Concrete shall be uniformly distributed during the process of depositing and in no case after depositing shall any portion be displaced in the forms more than 6-feet in horizontal direction. Concrete in wall forms shall be deposited in uniform horizontal layers not deeper than 2-feet; and care shall be taken to avoid inclined layers or inclined construction joints except where such are required for sloping members. Each layer shall be placed while the previous layer is still soft. The rate of placing concrete in wall forms shall not exceed 5-feet of vertical rise per hour. Sufficient illumination shall be provided in the interior of forms so that the concrete at the places of deposit is visible from the deck or runway.

E. **Placement in Slabs:** Concrete placement in sloping slabs shall proceed uniformly from the bottom of the slab to the top for the full width of the placement. As the WORK progresses, the concrete shall be vibrated and carefully worked around the slab reinforcement, and the surface of the slab shall be screeded in an up-slope direction.

F. **Temperature of Concrete:** The temperature of concrete when it is being placed shall be not more than 90 degrees F nor less than 50 degrees F. For sections less than 12-inches thick the temperature of concrete when placed shall be not less than 55 degrees.

1. If required by ENGINEER, CONTRACTOR shall submit detailed procedures for production, transportation, placement, protection, curing, and temperature monitoring of concrete during hot or cold weather. The submittal shall include procedures to be implemented upon abrupt changes in weather conditions or equipment failures.
2. CONTRACTOR shall not be entitled to additional compensation for satisfying the hot weather placement or the cold weather placement requirements below.

G. **Hot Weather Placement**

1. If the temperature of the concrete is 85 degrees F or greater, the time between introducing the cement into the aggregates and discharge shall not exceed 45 minutes.
2. If concrete is placed when the weather is such that the temperature of the concrete would exceed 90 degrees F, CONTRACTOR shall employ effective means such as precooling of aggregates and using ice as mixing water or placing at night as necessary to maintain the temperature of the concrete below 90 degrees F as it is placed.
3. During the curing period, the maximum temperature decrease measured at the surface of the concrete shall not exceed 50 degrees F in 24 hours nor 5 degrees F in one hour.

H. **Cold Weather Placement**

1. Placement of concrete shall conform to ACI 306.1 - Cold Weather Concreting, and the following.
2. Remove snow, ice, and frost from the surfaces, including reinforcement, against which concrete is to be placed. Before beginning concrete placement, thaw the

subgrade to a minimum depth of 6-inches. Reinforcement and embedded items shall be warmed to above 32 degrees F prior to concrete placement.

3. Maintain the concrete temperature above 50 degrees F for at least 72 hours after placement.
4. Concrete ingredients shall not be heated more than necessary to prevent the temperature of the mixed concrete, as placed, from falling below the minimum temperature criterion.

### 3.5 PUMPING OF CONCRETE

- A. **General:** If the pumped concrete does not produce satisfactory end results, the CONTRACTOR shall discontinue the pumping operation and proceed with the placing of concrete using conventional methods.
- B. **Pumping Equipment:** The pumping equipment shall have 2 cylinders and be designed to operate with one cylinder in case the other one is not functioning. In lieu of this requirement, the CONTRACTOR may have a standby pump on the Site during pumping.
- C. The minimum diameter of the hose conduits shall be in accordance with ACI 304.2R – Placing Concrete by Pumping Methods.
- D. Pumping equipment and hose conduits that are not functioning properly shall be replaced.
- E. Aluminum conduits for conveying the concrete shall not be permitted.
- F. **Field Control:** Concrete samples for slump, air content, and test cylinders will be taken at the placement end of the hose.

### 3.6 ORDER OF PLACING CONCRETE

- A. The order of placing concrete in the WORK shall be acceptable to the ENGINEER. To minimize the effects of shrinkage, the concrete shall be placed in units as bounded by construction joints at the indicated locations. The placing of units shall be done by placing alternate units in a manner such that each unit placed shall have cured at least 5 Days for hydraulic structures and 2 Days for all other structures before the contiguous unit or units are placed, except that the corner sections of vertical walls shall not be placed until the 2 adjacent wall panels have cured at least 10 Days for hydraulic structures and 4 Days for all other structures.
- B. The surface of the concrete shall be level whenever a run of concrete is stopped. For a level, straight joint on the exposed surface of walls, a wood strip at least 3/4-inch thick shall be tacked to the forms on these surfaces. The concrete shall be carried about 1/2-inch above the underside of the strip. About one hour after the concrete is placed, the strip shall be removed and any irregularities in the edge formed by the strip shall be leveled with a trowel and laitance shall be removed.

### 3.7 TAMPING AND VIBRATING

- A. As concrete is placed in the forms or in excavations, it shall be thoroughly settled and compacted throughout the entire depth of the layer which is being consolidated into a dense, homogeneous mass, filling all corners and angles, thoroughly embedding the

reinforcement, eliminating rock pockets, and bringing only a slight excess of water to the exposed surface of concrete. Vibrators shall be Group 3 per ACI 309 – Consolidation of Concrete, high speed power vibrators (8000 to 12,000 rpm) of an immersion type in sufficient number and with at least one standby unit as required. Group 2 vibrators may be used only at specific locations when accepted by the ENGINEER.

- B. Care shall be used in placing concrete around waterstops. The concrete shall be carefully worked by rodding and vibrating to make sure that air and rock pockets have been eliminated. Where flat-strip type waterstops are placed horizontally, the concrete shall be worked under the waterstops by hand, making sure that air and rock pockets have been eliminated. Concrete surrounding the waterstops shall be given additional vibration over and above that used for adjacent concrete placement to assure complete embedment of the waterstops in the concrete.
- C. Concrete in walls shall be internally vibrated and at the same time rammed, stirred, or worked with suitable appliances, tamping bars, shovels, or forked tools until it completely fills the forms or excavations and closes snugly against each surface. Subsequent layers of concrete shall not be placed until the layers previously placed have been worked thoroughly. Vibrators shall be provided in sufficient numbers, with standby units as required, to accomplish the required results within 15 minutes after concrete of the prescribed consistency is placed in the forms. The vibrating head shall not contact the surfaces of the forms. Care shall be taken not to vibrate concrete excessively or to work it in any manner that causes segregation of its constituents.

### 3.8 FINISHING CONCRETE SURFACES

- A. **General:** Surfaces shall be free from fins, bulges, ridges, offsets, honeycombing, or roughness of any kind, and shall present a finished, smooth, continuous hard surface. Allowable deviations from plumb or level and from the alignment, profiles, and dimensions indicated are defined as tolerances and are indicated above. These tolerances are to be distinguished from irregularities in finish as described herein. Aluminum finishing tools shall not be used.
- B. **Formed Surfaces:** No treatment is required after form removal except for curing, repair of Defective concrete, and treatment of surface defects. Where architectural finish is required, it shall be as indicated.
  - 1. Surface holes larger than 1/2-inch in diameter or deeper than 1/4-inch are defined as surface defects in basins and exposed walls.

### 3.9 CURING AND DAMPPROOFING

- A. **General:** Concrete shall be cured for not less than 7 Days after placing, in accordance with the methods indicated below for the different parts of the WORK.

Surface to be Cured or Dampproofed	Method
Unstripped forms	1
Wall, Bridge Abutment sections with forms removed	6

Construction joints between footings and walls, and between floor slab and columns	2
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- B. **Method 1:** Wooden forms shall be wetted immediately after concrete has been placed and shall be kept wet with water until removal. If steel forms are used the exposed concrete surfaces shall be kept continuously wet until the forms are removed. If forms are removed within 7 Days of placing the concrete, curing shall be continued in accordance with Method 6 below.
- C. **Method 2:** The surface shall be covered with burlap mats which shall be kept wet with water for the duration of the curing period, until the concrete in the walls has been placed. No curing compound shall be applied to surfaces cured under Method 2.
- D. **Method 3:** The surface shall be covered with moist earth not less than 4 hours nor more than 24 hours after the concrete is placed. Earthwork operations that may damage the concrete shall not begin until at least 7 Days after placement of concrete.
- E. **Method 4:** The surface shall be sprayed with a liquid curing compound.
1. Compound shall be applied in accordance with the manufacturer's printed instructions at a maximum coverage rate of 200 square feet per gallon and in such a manner as to cover the surface with a uniform film that will seal thoroughly.
  2. Where the curing compound method is used, care shall be exercised to avoid damage to the seal during the 7 Day curing period. If the seal is damaged or broken before expiration of the curing period, the break shall be repaired immediately by the application of additional curing compound over the damaged portion.
  3. Wherever curing compound has been applied by mistake to surfaces against which concrete subsequently is to be placed and to which it is to adhere, compound shall be entirely removed by wet sandblasting just prior to the placing of new concrete.
  4. Curing compound shall be applied as soon as the concrete has hardened enough to prevent marring on unformed surfaces and within 2 hours after removal of forms. Repairs to formed surfaces shall be made within the 2 hour period; provided, however, that any such repairs which cannot be made within the said 2 hour period shall be delayed until after the curing compound has been applied. When repairs are to be made to an area on which curing compound has been applied, the area involved shall first be wet-sandblasted to remove the curing compound.
  5. At locations where concrete is placed adjacent to a panel which has been coated with curing compound, the panel shall have curing compound reapplied to an area within 6-feet of the joint and to any other location where the curing membrane has been disturbed.
  6. Prior to final acceptance of the WORK, visible traces of curing compound shall be removed in such a manner that does not damage the surface finish.
- F. **Method 5:**
1. Until the concrete surface is covered with curing compound, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the

surface is not marred or washed. The concrete shall be given a coat of curing compound in accordance with Method 4 above. Not less than one hour nor more than 4 hours after the curing compound has been applied, the surface shall be wetted with water delivered through a fog nozzle, and concrete-curing blankets shall be placed on the slabs. The curing blankets shall be polyethylene sheet, polyethylene-coated waterproof paper sheeting, or polyethylene-coated burlap. The blankets shall be laid with the edges butted together and with the joints between strips sealed with 2-inch wide strips of sealing tape or with edges lapped not less than 3-inches and fastened together with a waterproof cement to form a continuous watertight joint.

2. The curing blankets shall be left in place during the 7 Day curing period and shall not be removed until after concrete for adjacent WORK has been placed. If the curing blankets become torn or otherwise ineffective, the CONTRACTOR shall replace damaged sections. During the first 3 Days of the curing period, no traffic of any nature and no depositing, temporary or otherwise, of any materials shall be permitted on the curing blankets. During the remainder of the curing period, foot traffic and temporary depositing of materials that impose light pressure will be permitted only on top of plywood sheets 5/8-inch minimum thickness, laid over the curing blanket. The CONTRACTOR shall add water under the curing blanket as often as necessary to maintain concrete surfaces damp.

**G. Method 6:** This method applies to both walls and slabs.

1. The concrete shall be kept continuously wet by the application of water for a minimum period of at least 7 Days beginning immediately after the concrete has reached final set or forms have been removed.
2. Until the concrete surface is covered with the curing medium, the entire surface shall be kept damp by applying water using nozzles that atomize the flow so that the surface is not marred or washed.
3. Heavy curing mats shall be used as a curing medium to retain the moisture during the curing period. The curing medium shall be weighted or otherwise held substantially in contact with the concrete surface to prevent dislodging by wind or any other causes. Edges shall be continuously held in place.
4. The curing blankets and concrete shall be kept continuously wet by the use of sprinklers or other means both during and after normal working hours.
5. Immediately after the application of water has terminated at the end of the curing period, the curing medium shall be removed, the entire concrete surface shall be wetted, and curing compound shall be immediately applied to the entire surface in accordance with Method 4 above.
6. The CONTRACTOR shall dispose of excess water from the curing operation to avoid damage to the WORK.

### 3.10 PROTECTION

- A. The CONTRACTOR shall protect concrete against injury until final acceptance.

- B. Fresh concrete shall be protected from damage due to rain, hail, sleet, or snow. The CONTRACTOR shall provide such protection while the concrete is still plastic and whenever precipitation is imminent or occurring.

### 3.11 CURING IN COLD WEATHER

- A. Water curing of concrete may be reduced to 6 Days during periods when the mean daily temperature in the vicinity of the Site is less than 40 degrees F; provided that during the prescribed period of water curing, when temperatures are such that concrete surfaces may freeze, water curing is temporarily discontinued.
- B. Concrete cured by an application of curing compound will require no additional protection from freezing if the protection at 50 degrees F for 72 hours is obtained by means of approved insulation in contact with the forms or concrete surfaces; otherwise the concrete shall be protected against freezing temperatures for 72 hours immediately following 72 hours protection at 50 degrees F. Concrete cured by water shall be protected against freezing temperatures for 72 hours immediately following the 72 hours of protection at 50 degrees F.
- C. Discontinuance of protection against freezing temperatures shall be such that the drop in temperature of any portion of the concrete will be gradual and will not exceed 40 degrees F in 24 hours. In the spring, when the mean daily temperature rises above 40 degrees F for more than 3 successive Days, the required 72-hour protection at a temperature not lower than 50 degrees F may be discontinued for as long as the mean daily temperature remains above 40 degrees F; provided, that the concrete shall be protected against freezing temperatures for not less than 48 hours after placement.
- D. Where artificial heat is employed, special care shall be taken to prevent the concrete from drying. Use of unvented heaters will be permitted only when unformed surfaces of concrete adjacent to the heaters are protected for the first 24 hours from an excessive carbon dioxide atmosphere by application of curing compound; provided, that the use of curing compound for such surfaces is otherwise permitted.

### 3.12 TREATMENT OF SURFACE DEFECTS

- A. As soon as forms are removed, exposed surfaces shall be carefully examined and any irregularities shall be immediately rubbed or ground in a satisfactory manner in order to secure a smooth, uniform, and continuous surface. Plastering or coating of surfaces to be smoothed will not be permitted. No repairs shall be made until after inspection by the ENGINEER. In no case will extensive patching of honeycombed concrete be permitted. Concrete containing minor voids, holes, honeycombing, or similar depression defects shall be repaired as indicated below. Concrete containing extensive voids, holes, honeycombing, or similar depression defects shall be completely removed and replaced. Repairs and replacements shall be performed promptly.
- B. Defective surfaces to be repaired shall be cut back from trueline a minimum depth of 1/2-inch over the entire area. Feathered edges will not be permitted. Where chipping or cutting tools are not required in order to deepen the area properly, the surface shall be prepared for bonding by the removal of laitance and soft material, plus not less than 1/32-inch depth of the surface film from hard portions by means of an efficient sandblast. After cutting and sandblasting, the surface shall be wetted sufficiently in advance of shooting with shotcrete or with cement mortar so that while the repair material is being applied, the surfaces underneath will remain moist but not so wet as to overcome the



suction upon which a good bond depends. The material used for repair shall consist of a mixture of one sack of cement to 3 cubic feet of sand. For exposed walls, the cement shall contain such a proportion of white portland cement as is required to make the color of the patch match the color of the surrounding concrete.

- C. Holes left by tie-rod cones shall be reamed with suitable toothed reamers so as to leave the surfaces of the holes clean and rough. Holes then shall be repaired in an approved manner with dry-packed cement grout. Holes left by form-tying devices having a rectangular cross section and other imperfections having a depth greater than their least surface dimension shall not be reamed but shall be repaired in an approved manner with dry-packed cement grout.
- D. Repairs shall be built up and shaped in such a manner that the completed WORK will conform to the requirements of this Section, as applicable, using approved methods which will not disturb the bond, cause sagging, or cause horizontal fractures. Surfaces of repairs shall receive the same kind and amount of curing treatment as required for the concrete in the repaired section.

### 3.13 PATCHING HOLES IN CONCRETE

#### A. Patching Small Holes

- 1. Holes that are less than 12-inches in the least dimension and extend completely through concrete members shall be filled.
- 2. Small holes in members that are water-bearing or in contact with soil or other fill material shall be filled with non-shrink grout. Where a face of the member is exposed to view, the non-shrink grout shall be held back 2-inches from the finished surface. The remaining 2-inches shall then be patched according to the Article above entitled "Treatment of Surface Defects."
- 3. Small holes through other concrete members shall be filled with non-shrink grout, with exposed faces treated as above.

#### B. Patching Large Holes

- 1. Holes which are larger than 12-inches in the least dimension shall have a keyway chipped into the edge around the opening, unless a formed keyway exists. The holes shall then be filled with concrete as indicated herein.
- 2. Holes which are larger than 24-inches in the least dimension and which do not have reinforcing steel extending from the existing concrete, shall have reinforcing steel set in grout in drilled holes. The reinforcing added shall match the reinforcing in the existing wall unless indicated otherwise.

### 3.14 CARE AND REPAIR OF CONCRETE

- A. The CONTRACTOR shall protect concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance. Particular care shall be taken to prevent the drying of concrete and to avoid roughening or otherwise damaging the surface. Any concrete found to be damaged, or which may have been originally defective, or which becomes defective at any time prior to the final acceptance of the completed WORK, or which departs from the established line or grade, or which, for any other reason, does not conform to the requirements of the

Contract Documents, shall be satisfactorily repaired or removed and replaced with acceptable concrete.

- END OF SECTION -

## SECTION 03 32 00 - JOINTS IN CONCRETE

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide joints in concrete, complete and in place, in accordance with the Contract Documents.
- B. Joints in concrete structures shall be the types defined below and will be permitted only where indicated, unless specifically accepted by the ENGINEER.

#### 1.2 TYPES OF JOINTS

##### A. **Construction Joints (CJ)**

- 1. These joints are typically identified / abbreviated as "CJ" on the Contract Drawings.
- 2. The purpose of a construction joint is to bond concrete from an earlier pour to that of a later pour, and if in a water-bearing member, prevent water seepage at the joint location.
- 3. When fresh concrete is placed against a hardened concrete surface, the joint between the pours shall be defined as a construction joint.
- 4. Reinforcement typical to the slab exists across the joint.
- 5. Unless otherwise indicated, joints in water-bearing members shall be provided with a waterstop and/or joint sealant groove of the shape indicated.

#### 1.3 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

##### B. **Shop Drawings**

- 1. Furnish placement drawings showing the location and types of joints for each structure.

##### C. **Manufacturer's Information and Certificates**

- 1. Furnish manufacturer's information demonstrating compliance of the following with the indicated requirements:
  - a. preformed joint filler
  - b. backing rod
  - c. bearing pad

- d. slip dowels
- 2. Furnish written certification from the manufacturer, as an integral part of the shipping form, that the material shipped to the Site meets or exceeds the indicated physical property requirements.
- 3. Supplier certificates will not be accepted.

**D. Samples**

- 1. Prior to production of the material required under this Section, submit qualification samples of waterstops which accurately represent the material being provided.
- 2. Such samples shall be extruded or molded sections of each size or shape to be installed.
- 3. The balance of the material to be used shall not be produced until after the ENGINEER has reviewed the qualification samples.

**E. Welding Certification**

- 1. Furnish copies of the waterstop welding certification by manufacturer or authorized agent of the manufacturer.
- 2. Every person who is to be involved with waterstop installation shall be required to have individual certification on file with the ENGINEER, stating that the named individual is certified and trained to install waterstop in accordance with the manufacturer's recommendations and specifications.

**1.4 QUALITY CONTROL**

**A. Joint Sealant**

**1. Test specimens.**

- a. The CONTRACTOR shall prepare adhesion and cohesion test specimens at intervals of 5 Days while joint sealants are being installed.
- b. The joint sealant material shall show no signs of adhesive or cohesive failure when tested in accordance with the following procedure in laboratory and field tests:
  - 1) Joint sealant specimen shall be prepared between 2 concrete blocks (1-inch by 2-inch by 3-inch).
  - 2) Spacing between the blocks shall be one inch.
  - 3) Coated spacers (2-inch by 1-1/2-inch by 1/2-inch) shall be used to set and hold joint sealant cross-sections of 1/2-inch by 2-inch with a width of one inch.

- 4) The joint sealant shall be cast and cured in accordance with the manufacturer's recommendations, except that the curing period shall be not less than 24 hours.
- 5) Following the curing period, the gap between the blocks shall be widened to 1-1/2 inches, and spacers shall be used to maintain this gap for 24 hours prior to inspection for failure.

## 1.5 CORRECTION OF DEFECTS

- A. **Joint Sealant.** The CONTRACTOR shall furnish a 5-year written warranty of the entire joint sealant installation against faulty and/or incompatible materials and workmanship, together with a statement that the CONTRACTOR agrees to repair or replace, to the satisfaction of the OWNER, any defective areas which become evident within the 5-year period.

## PART 2 -- PRODUCTS

### 2.1 GENERAL

- A. Fish Friendly Sealant: Sealants that are required on surfaces that come into contact with fish shall be Tremco Vulkem 921 polyurethane sealant; or approved equal.

### 2.2 JOINT SEALANT FOR WATER-BEARING JOINTS

- A. The joint sealant shall be a polyurethane polymer designed for bonding to concrete which is continuously submerged in water.
- B. No material will be accepted which has an unsatisfactory history as to bond or durability when used in the joints of water-retaining structures.
- C. Joint sealant material shall meet the following requirements (73 degrees F and 5 percent R.H.):

Work Life, minutes	45 - 180
Time to Reach 20 Shore A Hardness (at 77 degrees F, 200 gram quantity), max	24 hours
Ultimate Hardness (ASTM D 2240, Shore A)	20 - 45
Tensile Strength (ASTM D 412), min	175 psi
Ultimate Elongation (ASTM D 412), minimum	400 percent
Tear Resistance (Die C, ASTM D 624), pounds per inch of thickness, min	75
Color	Light Gray

D. Polyurethane joint sealants for waterstop joints in concrete shall conform to the following requirements:

1. Joint sealant shall be 2-part polyurethane with the physical properties of the cured joint sealant conforming to or exceeding the requirements of ASTM C 920 – Elastomeric Joint Sealant, or Federal Specification TT-S-0227 E(3) - Sealing Compound, Elastomeric Type, Multicomponent, for Caulking, Sealing, and Glazing Buildings and Other Structures, for 2-part material, as applicable.
2. For vertical joints and overhead horizontal joints, only "non-sag" compounds shall be used, conforming to the requirements of ASTM C 920, Class 25, Grade NS, or Federal Specification TT-S-0227 E(3), Type II, Class A.
3. For plane horizontal joints, use the self-leveling compounds meeting the requirements of ASTM C 920 Class 25, Grade P, or Federal Specification TT-S-0227 E(3), Type I.
4. For joints subject to either pedestrian or vehicular traffic, a compound providing non-tracking characteristics and having a Shore A hardness range of 35 to 45 shall be used.
5. Primer materials, if recommended by the joint sealant manufacturer, shall conform to the printed recommendations of the manufacturer.

E. Joint Sealant Manufacturers

1. Joint sealants shall be **Sikaflex 2C NS EZ Mix**, as manufactured by **Sika Corporation**, or equal.

## 2.3 JOINT SEALER FOR NON-WATER-BEARING JOINTS

A. Joint sealer for non-waterstop joints in concrete shall be a material that is composed of special asphalts or similar materials blended with lubricating and plasticizing agents to form a tough, durable mastic substance that shall:

1. Not contain evaporating solvents, or volatile oils/lubricants;
2. Strongly adhere to concrete surfaces;
3. Remain permanently resilient and pliable;
4. Not be affected by continuous presence of water;
5. Not in any way contaminate potable water;
6. Effectively seal the joints against moisture infiltration even when the joints are subjected to movement from expansion and contraction.

## 2.4 JOINT FILLER

- A. Joint filler for expansion joints in waterholding structures shall be neoprene conforming to ASTM D 1056, Type 2C5-E1.
- B. Joint filler material in other locations shall be of the preformed non-extruding type, constructed of cellular neoprene sponge rubber or polyurethane of firm texture.
- C. Bituminous fiber type will not be accepted.
- D. Non-extruding and resilient-type preformed expansion joint fillers shall conform to the requirements and tests set forth in ASTM D 1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction, for Type I, except as otherwise indicated.
- E. **Neoprene Sponge.** The sponge shall be neoprene, closed-cell, expanded, conforming to ASTM D 1056 - Flexible Cellular Materials - Sponge or Expanded Rubber, Type 2C5-E1.

## 2.5 BACKING ROD

- A. The backing rod shall be an extruded closed-cell, polyethylene foam rod.
- B. The rod material shall be compatible with the joint sealant material, and shall have a tensile strength of not less than 40 psi and a compression deflection of approximately 25 percent at 8 psi.
- C. 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.

## 2.6 BEARING PAD

- A. The bearing pad shall be neoprene conforming to ASTM D 2000 - Standard Classification System for Rubber Products in Automotive Applications, BC 420, 40 durometer hardness, unless otherwise indicated.

## 2.7 SLIP DOWELS

- A. Slip dowels in joints shall be smooth epoxy-coated bars conforming to ASTM A 775 - Epoxy Coated Reinforcing Steel Bars.

## 2.8 PVC TUBING

- A. PVC tubing in joints shall be SDR 13.5, conforming to ASTM D 2241 - Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

# PART 3 -- EXECUTION

## 3.1 JOINT CONSTRUCTION

### A. **Joint Location**

1. Construction joints and other types of joints shall be provided where indicated.
2. If not indicated, construction joints shall be provided at a 25-foot maximum spacing.
3. Where joints are indicated to be spaced greater than 40 feet apart, additional joints shall be provided to maintain the 25-foot maximum spacing.
4. The location of joints, regardless of type, shall be submitted for acceptance by the ENGINEER.

**B. Joint Preparation**

1. **Construction Joints:** The surfaces of horizontal joints shall be given a compacted, roughened surface for good bonding. Except where the Drawings call for joint surfaces to be coated, the joint surfaces shall be cleaned of laitance, loose or defective concrete, foreign material, and be roughened to a minimum of 1/4-inch amplitude. Such cleaning and roughening shall be accomplished by hydroblasting or sandblasting (exposing aggregate) followed by thorough washing. Pools of water shall be removed from the surface of construction joints before the new concrete is placed. The following is also required:
  - a. Special care shall be used in preparing concrete surfaces at joints where bonding between 2 sections of concrete is required.
  - b. Unless otherwise indicated, such bonding shall be required at every horizontal joint in walls.
2. **Old Concrete:** Where concrete is to be cast against old concrete (defined as any concrete which is greater than 60 Days old), the surface of the old concrete shall be thoroughly cleaned and roughened by hydroblasting or sandblasting to expose aggregate. The joint surface shall be coated with an epoxy bonding agent unless determined otherwise by the OWNER. This provision shall not apply to joints where waterstop is provided.

- END OF SECTION -



## SECTION 03 60 00 – GROUT

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide grout, complete and in place, in accordance with the Contract Documents
- B. **Grout Types.** The following types of grout are covered in this Section:
  - 1. Cement Grout
  - 2. Non-Shrink Grout - Class I (cement-based)

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
  - 1. Certified testing lab reports for tests indicated herein.
  - 2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.
  - 3. Certification that grouts used on the project contain no chlorides or other chemicals that cause corrosion.
  - 4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of grout used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor grout for adhesive anchors.
  - 5. Manufacturer's certification that its non-shrink grout does not contain aluminum, zinc, or magnesium powders as a method of expansion.
  - 6. Submit manufacturer's written warranty as indicated herein.
  - 7. Name and telephone number of grout manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated grouts.

#### 1.3 QUALITY CONTROL

##### A. **Field Tests**

- 1. Compression test specimens will be taken from the first placement of each type of grout, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.
- 2. Compression tests and fabrication of specimens for cement grout and cement based non-shrink grout will be performed in accordance with ASTM C 1107 -

Packaged Dry, Hydraulic-Cement Grout (Nonshrink), at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days, 28 Days, and each additional time period as appropriate.

3. Compression tests and fabrication of specimens for topping grout and concrete/grout fill will be performed in accordance with Section 03 30 00 - Cast-in-Place Concrete, at intervals during construction selected by the ENGINEER.
  4. The cost of laboratory tests on grout will be paid by the OWNER except where test results show the grout to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.
  5. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.
- B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03 30 00 - Cast-in-Place Concrete, unless indicated otherwise.

C. **Pre-Installation Demonstration and Training**

1. **Cement Based Non-Shrink Grouts**

- a. The grout manufacturer shall give a demonstration and training session for the cement based non-shrink and epoxy grouts to be used on the project, before any installation of grout is allowed.
- b. Training session shall use a minimum of 5 bags of cement-based non-shrink class I grout mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining grout shall be placed, and curing may be initiated on actual project placements such as baseplates and tie holes to provide on-the-job training for the CONTRACTOR and ENGINEER. The CONTRACTOR employees who will be doing the grouting shall participate in this training and demonstration session. The training session shall include methods for curing the grout.
- c. The manufacturer shall mix enough cement-based non-shrink class II grout for a minimum of 15 tie holes and shall train the CONTRACTOR'S employees in how to perform the WORK and cure the grout. The CONTRACTOR shall have the employees assisting in the mixing and sealing of the tie holes.
- d. If the project includes patching, throughbolt holes, epoxy anchors, and/or blockouts, the manufacturer shall also train the CONTRACTOR'S employees in the mixing and curing of the epoxy grouts for each of these applications.
- e. The CONTRACTOR shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the ENGINEER.

#### 1.4 SPECIAL CORRECTION OF DEFECTS PROVISIONS

##### A. **Manufacturer's Warranty**

1. Furnish one year warranty for WORK provided under this section.
2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

### **PART 2 -- PRODUCTS**

#### 2.1 APPLICATION

- A. Unless indicated otherwise, grouts shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Grout
Anchor bolts and reinforcing steel required to be set in grout at Bridge Abutment	Non-Shrink - Class I

#### 2.2 CEMENT GROUT

- A. Cement grout shall be composed of one part cement, 3 parts sand, and the minimum amount of water necessary to obtain the desired consistency. Where needed to match the color of adjacent concrete, white Portland cement shall be blended with regular cement as needed. The minimum compressive strength at 28 Days shall be 4,000 psi.
- B. Cement grout materials shall be as indicated in Section 03 30 00 - Cast-in-Place Concrete.

#### 2.3 NON-SHRINK GROUTS (Cement-based)

##### A. **General**

1. Cement-based non-shrink grout shall be a prepackaged, inorganic, fluid, non-gas liberating, non-metallic, cement type grout requiring only the addition of water. Cement from kilns burning metal-rich hazardous waste fuel shall not be used.
2. Manufacturer's instructions shall be printed on each bag or other container in which the materials are packaged. The specific formulation for each class of non-shrink grout shall be as recommended by the manufacturer for the particular application.
3. Grout shall not contain chlorides or additives that may contribute to corrosion.
4. Grout shall be formulated to be used at any consistency from fluid to plastic.
5. Cement-based non-shrink grout shall have the following minimum properties when tested at a fluid consistency, at 28 Days:

- a. Minimum tensile splitting strength of 500 psi per ASTM C 496 - Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
- b. Minimum flexural strength of 1,000 psi per ASTM C 580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes.
- c. Minimum bond strength (concrete to grout) of 1,900 psi per modified ASTM C 882 - Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

**B. Class I Non-Shrink Grout**

1. Class I non-shrink grout shall have a minimum 28 Day compressive strength of 5,000 psi when mixed at a fluid consistency.
2. Class I non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C, when mixed to fluid, flowable, and plastic consistencies.
3. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827 – Test Method for Early Volume Change of Cementitious Mixtures. The grout when tested shall not bleed or segregate at maximum allowed water.
4. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090 - Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
5. Furnish certification that the non-shrink property of grout is not based on gas production or gypsum expansion.
6. Class I Non-Shrink Grout shall be **MasterFlow 713** by **BASF**, **Five Star Grout** by **Five Star Products**, **SikagROUT 212** by **Sika Corporation**, **L&M CRYSTEX** by **Laticrete**; **Hi-Flow Grout** by **Euclid Chemical Company**, or approved equal.

**C. Class II Non-Shrink Grout**

1. Class II non-shrink grout shall be a high precision, fluid, extended working time grout. The minimum 28-Day compressive strength shall be 7,500 psi, when mixed at a fluid consistency.
2. Grout shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827.
3. Grout shall have no shrinkage (0.0 percent) and a maximum of 0.3 percent expansion in the hardened state when tested in accordance with ASTM C 1090.
4. Class II non-shrink grout shall have an extended working time of 30 minutes minimum when mixed to a fluid consistency as defined in ASTM C 827 at temperature extremes of 45 to 90 degrees F in accordance with ASTM C 1107.

5. Class II non-shrink grout shall meet the requirements of ASTM C 1107, Grade B or C when tested using the amount of water needed to achieve fluid consistency per ASTM C 939.
6. The grout when tested shall not bleed or segregate at maximum allowed water content.
7. Provide certification that its non-shrink property is not based on gas production or gypsum expansion.
8. Class II non-shrink grout shall be **MasterFlow 928** by **BASF**, **Five Star Fluid Grout 100** by **Five Star Products**, **L&M CRYSTEX** by **Laticrete**, or approved equal.

## 2.4 CURING MATERIALS

- A. Curing materials shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete and as recommended by the manufacturer of prepackaged grouts.

## 2.5 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 defined 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 indicated herein for the particular application.
- B. The slump for topping grout and concrete/grout fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

## 2.6 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement grout shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged grouts shall have ingredients measured by means recommended by the manufacturer.

# PART 3 -- EXECUTION

## 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Grout shall be stored in accordance with manufacturer's recommendations.

## 3.2 GENERAL

- A. CONTRACTOR shall arrange for the manufacturer of prepackaged grouts to provide on-Site technical assistance within 72 hours of request, as part of the WORK.
- B. Grout shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.

- C. When cementitious grouts are used on concrete surfaces, the concrete surface shall be saturated with water for 24 hours prior to placement. Upon completion of the saturation period, excess water shall be removed with clean, oil free compressed air prior to grouting. Concrete substrate shall not be wet prior to placement of epoxy grouts.
- D. Surface preparation, curing, and protection of cement grout shall be in accordance with Section 03 30 00 - Cast-in-Place Concrete. The finish of the grout surface shall match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with grout shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after grouting.
- G. Contact the grout manufacturer's representative for assistance on hot and cold weather grouting techniques and precautions if applicable.

### 3.3 GROUTING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged grouts shall be done according to the instructions and recommendations of the manufacturer.
- B. **Equipment, Tank, and Pipe Supports.** Structural, equipment, tank, and piping support bases shall be grouted, unless indicated otherwise.
  - 1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of grout or other thickness if indicated.
  - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type grout through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for grout shall be tight against retaining surfaces, and joints shall be sealed as recommended by the grout manufacturer to be liquid-tight. Forms shall be coated as recommended by the grout manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate grouting methods shall be submitted for acceptance by the ENGINEER.
  - 3. Concrete equipment pads for equipment bases that will be epoxy-grouted shall be sized so that, when the equipment base is fully grouted, the epoxy grout is stopped not less than 4-inches from the edge of the pad.

#### C. **Drilled Anchors and Reinforcing Bars**

- 1. General
  - a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a

power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the grout has reached its indicated strength in accordance with the manufacturer's instructions.

- b. The CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.

## 2. Cement Based Non-Shrink Grout

- a. In places of high temperature or fire hazard, anchor bolts shall be grouted in using cement based non-shrink grout, Class I.
- b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 16 diameters for threaded rod or 24 diameters for reinforcing or smooth bars.
- c. When the bolt diameter is one-inch or less, the hole diameter should be a minimum of 2-inches. When the bolt diameter is greater than one-inch, the hole diameter should be at least twice the bolt diameter.
- d. Drilled holes shall be saturated with water for not less than 24 hours before installation of anchor/rod/rebar.
- e. The non-shrink grout should be placed in the holes in a non-sag (trowelable) consistency. The grout should be placed in the holes before the anchor and then the anchor inserted and vibrated to ensure proper coverage.

## 3.4 CONSOLIDATION

- A. Grout shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be grouted is completely filled.

## 3.5 CURING

- A. Cement based grouts shall be cured per Section 03 30 00 - Cast-in-Place Concrete and per the manufacturer's recommendations.

- END OF SECTION -

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## SECTION 03 65 00 – EPOXY RESIN ADHESIVE SYSTEMS

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide epoxy resin adhesives, complete and in place, in accordance with the Contract Documents
- B. **Epoxy Resin Adhesives Types.** The following types of epoxy resin adhesives are covered in this Section:
  - 1. Non-Shrink Epoxy Resin Adhesives
  - 2. Epoxy Anchor Resins for Adhesive Anchors

#### 1.2 CONTRACTOR SUBMITTALS

- A. Furnish submittals in accordance with Section 01 33 00 - Contractor Submittals.
  - 1. Certified testing lab reports for tests indicated herein.
  - 2. Test results and service report from the field tests and the demonstration and training session verifying the requirements indicated herein.
  - 3. Certification that resins used on the project contain no chlorides or other chemicals that cause corrosion.
  - 4. Manufacturer's literature containing instructions and recommendations on the mixing, handling, placement, curing, and appropriate uses for each type of resin used in the WORK, and location of use. ICBO/ES report shall be submitted for epoxy anchor resin for adhesive anchors.
  - 5. Manufacturer's certification that its non-shrink resin does not contain aluminum, zinc, or magnesium powders as a method of expansion.
  - 6. Submit manufacturer's written warranty as indicated herein.
  - 7. Name and telephone number of resin manufacturer's representative who will give on-Site service. The representative shall have at least one year of experience with the indicated resins.

#### 1.3 QUALITY CONTROL

##### A. **Field Tests**

- 1. Compression test specimens will be taken from the first placement of each type of resin, and at intervals thereafter selected by the ENGINEER. The specimens will be made by the ENGINEER or its representative.

2. Compression tests and fabrication of specimens for epoxy resins will be performed in accordance with ASTM C 579 - Test Methods for Compressive Strength of Chemical-Resistant Mortars and Monolithic Surfacing and Polymer Concretes, Method B, at intervals during construction selected by the ENGINEER. A set of 3 specimens will be made for testing at 7 Days and each earlier time period as appropriate.
  3. The cost of laboratory tests on resin will be paid by the OWNER except where test results show the resin to be defective. In such case, the CONTRACTOR shall pay for the tests, removal and replacement of Defective Work, and re-testing, all as part of the WORK.
  4. The CONTRACTOR shall assist the ENGINEER in obtaining specimens for testing and shall furnish materials necessary for fabricating the test specimens.
- B. **Construction Tolerances:** Construction tolerances shall be as indicated in Section 03 33 00 - Cast-in-Place Concrete, unless indicated otherwise.
- C. **Pre-Installation Demonstration and Training**
1. **Epoxy-Based Non-Shrink Resins**
    - a. The resin manufacturer shall give a demonstration and training session for the epoxy non-shrink resins to be used on the project, before any installation of resin is allowed.
    - b. Training session shall use a minimum of 2 bags of epoxy-based non-shrink resin mixed to fluid consistency. Tests shall be conducted for flow cone and bleed tests. Six cubes for testing at 1, 3, and 28 Days shall be made. The remaining resin shall be placed, and curing may be initiated on actual project placements such as baseplates and tie holes to provide on-the-job training for the CONTRACTOR and ENGINEER. The CONTRACTOR employees who will be doing the resining shall participate in this training and demonstration session. The training session shall include methods for curing the resin.
    - c. The manufacturer shall mix enough epoxy-based non-shrink resin for a minimum of 8 tie holes and shall train the CONTRACTOR'S employees in how to perform the WORK and cure the resin. The CONTRACTOR shall have the employees assisting in the mixing and sealing of the tie holes.
    - d. If the project includes patching, throughbolt holes, epoxy anchors, and/or blockouts, the manufacturer shall also train the CONTRACTOR'S employees in the mixing and curing of the epoxy resins for each of these applications.
    - e. The CONTRACTOR shall transport the test cubes to an independent test laboratory, obtain the test reports, and report these demonstration and training test cube strengths to the ENGINEER.
  2. **Epoxy Anchor Resins for Adhesive Anchors**

- a. Special inspection as recommended by the ICBO/ES report or as required by the building department shall be required for adhesive anchor installations. Cost of special inspection of adhesive anchors will be paid by the OWNER.
- b. Before installing adhesive anchors in the WORK, adhesive anchor installers shall be trained and qualified at the Site by the manufacturer's representative. Training and qualification for each installer shall include at least:
  - 1) Hole drilling procedure, hole preparation and cleaning techniques, adhesive injection technique and dispenser training/maintenance, rebar dowel preparation and installation, and proof loading/torquing.
  - 2) Anchors installed in both the vertical and horizontal positions in a mock-up concrete panel of adequate size and thickness. Anchors shall be tested in tension and shear loading. A minimum of 3 anchors shall be tested for each installation position.
  - 3) Anchors shall be tested at 2 times the published allowable load in tension and in shear as indicated in the ICBO/ES report.
  - 4) If any of the 3 test bolts in any installation position fail to reach the test loads, the installer shall be re-tested with the same procedure. Re-testing is required only for the failed installation position.
  - 5) An installer who has 3 consecutive successful bolt tests in the first or second trial is considered qualified for adhesive anchor installation for this project. The manufacturer's representative shall issue a certificate to the qualified installer, and a copy of the certificate shall be filed with the CONTRACTOR and be submitted to the ENGINEER.
  - 6) The test anchor size shall be the largest size adhesive anchor used on the project. The embedment length shall be long enough to develop the allowable steel strength per AISC Manual of Steel Construction.
  - 7) Each installer shall be re-qualified every 6 months for the duration of the project by the same qualifying procedure.
  - 8) The certification of each qualified installer shall be available for verification at the Special Inspector's request.
  - 9) Defective anchors noted by the Special Inspector shall be replaced and re-installed by the CONTRACTOR without any additional compensation.

#### 1.4 SPECIAL CORRECTION OF DEFECTS PROVISIONS

##### A. **Manufacturer's Warranty**

1. Furnish one-year warranty for WORK provided under this section.
2. Manufacturer's warranty shall not contain a disclaimer limiting responsibility to the purchase price of products or materials.

## PART 2 -- PRODUCTS

### 2.1 APPLICATION

- A. Unless indicated otherwise, epoxy adhesive resins shall be provided as listed below whether indicated on the Drawings or not.

Application	Type of Epoxy Resins
Anchor bolts and reinforcing steel required to be set in resin that is not in high temperature or high fire risk areas.	Epoxy Anchor Resin

### 2.2 NON-SHRINK EPOXY RESIN

- A. Non-shrink epoxy adhesives shall be a flowable, non-shrink, 100 percent solids system. The epoxy resin system shall have 3 components: resin, hardener, and specially blended aggregate, each premeasured and prepackaged. The resin component shall not contain any non-reactive diluents. Resins containing butyl glycidyl ether (BGE) or other highly volatile and hazardous reactive diluents are not acceptable. Variation of component ratios is not permitted unless specifically recommended by the manufacturer. Manufacturer's instructions shall be printed on each container in which the materials are packaged.
- B. Epoxy resin shall have a maximum early age height change of 4.0 percent expansion, and shall have no shrinkage (0.0 percent) in accordance with ASTM C 827, (modified for epoxy resins by using an indicator ball with a specific gravity between 0.9 and 1.1).
- C. Epoxy resin shall have a negligible (less than 0.0006 in/in) length change after hardening, and a coefficient of thermal expansion less than 0.00003 in/in F when tested according to ASTM C 531 - Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Resins, and Monolithic Surfacing.
- D. The epoxy resin shall develop a minimum compressive strength of 9000 psi in 24 hours and 13,000 psi in seven days when tested in accordance with ASTM C 579, method B.
- E. The mixed epoxy resin shall have a minimum working life of 90 to 120 minutes at 70 degrees F.
- F. The effective bearing area shall be a minimum of 95 percent EBA in accordance with ASTM C 1339 – Standard Test Method for Flowability and Bearing Area of Chemical-Resistant Polymer Machinery Resins, for bearing area and flow.
- G. The chemical formulation of the epoxy resin shall be that recommended by the manufacturer for the particular application. Do not reduce aggregate loading or add solvents to increase flowability.
- H. Non-shrink epoxy resin shall have the following minimum properties when tested at 7 Days:

1. Minimum bond strength to concrete of 3000 psi per ASTM C 882 modified.
  2. Minimum bond strength to steel of 1700 psi per ASTM C 882 modified.
  3. Minimum flexural strength of 2500 psi per ASTM C 580.
  4. Minimum tensile strength of 2000 psi per ASTM C 307 -- Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Resins, and Monolithic Surfacing.
- I. Non-shrink epoxy resin shall be **Five Star DP Epoxy Grout** by **Five Star Products, Inc.**, **Masterflow 648** by **BASF**, **Sikadur 42 Grout-Pak** by **Sika Corporation**, or approved equal.

## 2.3 EPOXY ANCHOR RESIN

Class A - For use above 60 degrees F

- A. Epoxy anchor resin shall conform to ASTM C 881 - Epoxy-Resin-Base Bonding Systems for Concrete, Type IV, Class A, Grade 3 with the exception of gel time.
- B. Heat deflection temperature per ASTM D 648 -- Test Method for Deflection Temperature of Plastics Under Flexural Load shall be a minimum 120 degrees F.
- C. Manufacturer shall certify that the epoxy anchor resin will maintain 90 percent of its strength up to a temperature of 125 degrees F.
- D. Resin shall come in a 2 chambered cartridge with a metering system that provides the proper ratio of hardener and resin. The resin shall also come with a static mixer nozzle to thoroughly mix the hardener and resin together.
- E. Epoxy anchor resin shall be capable of being used in submersed applications once cured.
- F. Compressive strength per ASTM D 695 - Test Method for Compressive Properties of Rigid Plastics shall be 10,000 psi minimum.
- G. Whenever possible, overhead anchors subject to vibration, anchors in fire-resistive construction or high fire risk areas, and anchors subject to working or operating temperatures above 100 degrees F shall be cast-in-place anchors. Whenever cast-in-place anchors cannot be used in these applications, use cement based non-shrink resin and oversized holes.
- H. Embedment of adhesive anchors/rebar shall be deep enough to develop the anchor/rebar. Embedment shall not exceed 67 percent of the member depth.
- I. Epoxy anchor resin shall be **HIT-RE 500 V3** by **Hilti**, or approved equal.

## 2.4 CURING MATERIALS

- A. Curing materials shall be in accordance with recommendations by the manufacturer of prepackaged resins.

## 2.5 CONSISTENCY

- A. The consistency of resins shall be that necessary to completely fill the space to be resined for the particular application. Dry pack consistency is defined such that the resin is plastic and moldable but will not flow. Where "dry pack" is called for in the Contract Documents, it shall mean a resin of that consistency; the type of resin to be used shall be as indicated herein for the particular application.
- B. The slump for topping resin and concrete/resin fill shall be adjusted to match placement and finishing conditions but shall not exceed 4-inches.

## 2.6 MEASUREMENT OF INGREDIENTS

- A. Measurements for cement resin shall be made accurately by volume using containers. Shovel measurements shall not be allowed.
- B. Prepackaged resins shall have ingredients measured by means recommended by the manufacturer.

# PART 3 -- EXECUTION

## 3.1 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Resin shall be stored in accordance with manufacturer's recommendations.

## 3.2 GENERAL

- A. CONTRACTOR shall arrange for the manufacturer of prepackaged resins to provide on-Site technical assistance within 72 hours of request, as part of the WORK.
- B. Resin shall not be placed until base concrete or masonry has attained its design strength, unless authorized otherwise by the ENGINEER.
- C. Concrete substrate shall not be wet prior to placement of epoxy resins.
- D. The finish of the resin surface shall match that of the adjacent concrete unless otherwise indicated.
- E. Surfaces that will be in contact with resin shall be free of dirt, loose rust, oil, wax, grease, curing compounds, laitance, loose concrete, and other deleterious materials.
- F. Shade the WORK from sunlight for at least 24 hours before and 48 hours after resining.
- G. Contact the resin manufacturer's representative for assistance on hot and cold weather resining techniques and precautions if applicable.

### 3.3 RESINING PROCEDURES

- A. **General:** Mixing, surface preparation, handling, placing, consolidation, curing, and other means of execution for prepackaged resins shall be done according to the instructions and recommendations of the manufacturer.
- B. **Equipment, Tank, and Pipe Supports.** Structural, equipment, tank, and piping support bases shall be resined, unless indicated otherwise.
  - 1. The original concrete shall be blocked out or finished off a sufficient distance below the plate to provide for a minimum one-inch thickness of resin or other thickness if indicated.
  - 2. After the base plate has been set in position at the proper elevation by steel wedges or double nuts on the anchor bolts, the space between the bottom of the plate and the original pour of concrete shall be filled with non-shrink-type resin through a headbox of appropriate size. The mixture shall be of a fluid consistency and poured continuously into the space between the plate and the base concrete. Forms for resin shall be tight against retaining surfaces, and joints shall be sealed as recommended by the resin manufacturer to be liquid-tight. Forms shall be coated as recommended by the resin manufacturer for easy form release. Where this method of placement is not practical or where required by the ENGINEER, alternate resining methods shall be submitted for acceptance by the ENGINEER.
  - 3. Concrete equipment pads for equipment bases that will be epoxy-resined shall be sized so that, when the equipment base is fully resined, the epoxy resin is stopped not less than 4-inches from the edge of the pad.
- C. **Drilled Anchors and Reinforcing Bars**
  - 1. General
    - a. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions. Holes shall be roughened with a brush on a power drill, and cleaned. Drilled anchors shall not be installed until the concrete has reached the required 28 Day compressive strength. Anchors shall not be loaded until the resin has reached its indicated strength in accordance with the manufacturer's instructions.
    - b. The CONTRACTOR shall identify position of reinforcing steel and other embedded items prior to drilling holes. Care shall be exercised in coring and drilling to avoid damaging existing reinforcing or embedded items. Notify the ENGINEER if reinforcing steel or other embedded items are encountered during drilling. Take precautions as necessary to avoid damaging prestressing tendons, electrical and communications conduit, and piping.
  - 2. Epoxy Adhesive Anchors
    - a. Resin shall be proportioned and mixed with automatic equipment.

- b. Unless otherwise indicated, embedment shall be sufficient to develop the ultimate tensile strength of the anchor or reinforcing bar per the manufacturer's ICBO/ES report, but shall not be less than 8 diameters for threaded rod or 12 diameters for reinforcing or smooth bars.
- c. Holes shall be dry.

#### 3.4 CONSOLIDATION

- A. Resin shall be placed in such a manner, for the consistency necessary for each application, to assure that the space to be resined is completely filled.

#### 3.5 CURING

- A. Cement based resins shall be cured per Section 03300 - Cast-in-Place Concrete and per the manufacturer's recommendations.

- END OF SECTION -



## SECTION 05 50 00 - MISCELLANEOUS METALWORK

### PART 1 -- GENERAL

#### 1.1 SUMMARY

- A. The CONTRACTOR shall provide miscellaneous metalwork and appurtenances, complete and in place, as indicated in accordance with the Contract Documents.

#### 1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

##### A. Federal Specifications

MIL-G-18015 A (3) (Ships) Aluminum Planks. (6063-T6)

MIL-A-907E Antiseize Thread Compound, High Temperature

##### B. Codes

OSHA 1927.10 Fixed Ladders

##### C. Commercial Standards

AA-M32C22A41 Aluminum Assn.

AASHTO HS-20 Truck Loading

AISC Manual of Steel Construction

AISI Design of Light Gauge, Cold-Formed Steel Structural Members

ANSI / AWS D1.1 Structural Welding Code - Steel

ANSI / AWS D1.2 Structural Welding Code - Aluminum

ANSI / AWS QC1 Qualification and Certification of Welding Inspectors

ASTM A 36 Carbon Structural Steel

ASTM A 48 Gray Iron Castings

ASTM A 53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

ASTM A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM A 193 Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service

ASTM A 194	Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service
ASTM A 307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A 325	Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A 500	Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A 992	Steel for Structural Shapes for Use in Building Framing

### 1.3 CONTRACTOR SUBMITTALS

A. Furnish submittals in accordance with the requirements of Section 01 33 00 – Contractor Submittals.

#### B. **Shop Drawings**

1. Shop Drawings shall conform to AISC recommendations and specifications, and shall show holes, and the like, as may be required for other parts of the WORK.
2. Shop Drawings shall include complete details of members and connections, anchor bolt layouts, schedules for fabrication procedures, and diagrams for the sequence of erection.
3. Grating
  - a. Submit layout drawings for grating, showing the direction of span, type and depth of grating, size and shape of grating panels, support seat angle and ledger details, and details of grating hold down fasteners.
  - b. Submit load and deflection tables for each style and depth of grating used.
4. Anchors
  - a. Submit an ICBO report listing the ultimate load capacity in tension and shear for each size and type of concrete anchor.
  - b. Submit manufacturer's recommended installation instructions and procedures for adhesive anchors.
  - c. Upon review by the ENGINEER, these instructions shall be followed specifically.
  - d. No substitution for the indicated adhesive anchors will be considered unless accompanied with ICBO report verifying strength and material equivalency, including temperature at which load capacity is reduced to 90 percent of that determined at 75 degrees F.

## 1.4 QUALITY CONTROL

- A. Weld procedures and welder qualifications shall be available in the CONTRACTOR's field office for review.
- B. Welding shall be inspected by a CONTRACTOR-furnished inspector qualified in accordance with AWS requirements and approved by the ENGINEER.

## PART 2 -- PRODUCTS

### 2.1 GENERAL REQUIREMENTS

#### A. Steel

Wide Flange Shapes	ASTM A 992
Shapes, Plates, Bars	ASTM A 36
HSS	ASTM A 500 Grade B

- B. **Loads.** Covers and grates with matching frames shall be designed to support the following loadings:
  - 1. Where located within a structure, the design loading shall match that required for the adjacent floor area, or, if no floor loading is indicated, a minimum of 300 pounds per square foot.
  - 2. Exterior covers and grates shall be designed for AASHTO HL-93 loading unless indicated otherwise.

### 2.2 BOLTS AND ANCHORS

#### A. Standard Service (Non-Corrosive Application)

- 1. Unless otherwise indicated, bolts, anchor bolts, washers, and nuts shall be fabricated from carbon steel as indicated, and hot dip galvanized after fabrication.
- 2. Threads on galvanized bolts and nuts shall be formed with suitable taps and dies such that they retain their normal clearance after hot-dip galvanizing.
- 3. Except as otherwise indicated, steel for bolt material, anchor bolts, and cap screws shall be in accordance with the following requirements:
  - a. Structural Connections: ASTM A 307, Grade A or B, hot-dip galvanized
  - b. Anchor Bolts: ASTM A 307, Grade A or B, or ASTM A 36, hot-dip galvanized
  - c. High-Strength Bolts, where indicated: ASTM A 325

- d. Pipe and Equipment Flange Bolts: ASTM A 193, Grade B-7

## **B. Bolt Requirements**

1. The bolt and nut material shall be free-cutting steel.
2. The nuts shall be capable of developing the full strength of the bolts.
3. Threads shall be Coarse Thread Series conforming to the requirements of the American Standard for Screw Threads.
4. Bolts and cap screws shall have hexagon heads and nuts shall be Heavy Hexagon Series.
5. Bolts and nuts shall be installed with washers fabricated from material matching the base material of bolts, except that hardened washers for high-strength bolts shall conform to the requirements of the AISC Specification.
6. Lock washers fabricated from material matching the bolts shall be installed where indicated.
7. The length of each bolt shall be such that the bolt extends at least 1/8-inch beyond the outside face of the nut before tightening, except for anchor bolts which shall be flush with the face of the nut before tightening.

## **PART 3 -- EXECUTION**

### **3.1 FABRICATION AND INSTALLATION REQUIREMENTS**

#### **A. Fabrication and Erection**

1. Except as otherwise indicated, the fabrication and erection of structural steel shall conform to the requirements of the American Institute of Steel Construction "Manual of Steel Construction."

### **3.2 WELDING**

#### **A. Methods & Qualifications**

1. Welding shall be performed by the metal-arc method or gas-shielded arc method as described in the American Welding Society "Welding Handbook" as supplemented by other pertinent standards of the AWS.
2. The qualification of the welders shall be in accordance with the AWS Standards.

#### **B. Quality**

1. In assembly and during welding, the component parts shall be adequately clamped, supported, and restrained in order to minimize distortion and for control of dimensions.

2. Weld reinforcement shall be as indicated by the AWS Code.
3. Upon completion of welding, remove weld splatter, flux, slag, and burrs left by attachments.
4. Welds shall be repaired in order to produce a workmanlike appearance, with uniform weld contours and dimensions.
5. Sharp corners of material that is to be painted or coated shall be ground to a minimum of 1/32-inch on the flat.

### 3.3 GALVANIZING

- A. Structural steel plates, shapes, bars, and fabricated assemblies required to be galvanized shall, after the steel has been thoroughly cleaned of rust and scale, be galvanized in accordance with the requirements of ASTM A 123.
- B. Any galvanized part that becomes warped during the galvanizing operation shall be straightened.
- C. Bolts, anchor bolts, nuts, and similar threaded fasteners, after being properly cleaned, shall be galvanized in accordance with the requirements of ASTM A153.

#### D. **Field Repairs**

1. Field repairs to damaged galvanizing shall be performed by preparing the surface and applying a coating.
2. Surface preparation shall consist of removing oil, grease, soil, and soluble material by cleaning with water and detergent (SSPC SP1) followed by brush-off blast cleaning (SSPC SP7) over an area extending at least 4 inches into the undamaged area.
3. The coating shall be applied to at least 3 mils dry film thickness, and shall be **Zinc-Clad XI** by **Sherwin-Williams**, **Galvax** by **Alvin Products**, **Galvilite** by **ZRC Worldwide**, or equal.

### 3.4 DRILLED ANCHORS

- A. Drilled anchors and reinforcing bars shall be installed in strict accordance with the manufacturer's instructions.
- B. Holes shall be roughened with a brush on a power drill, and then cleaned and dried.
- C. Drilled anchors shall not be installed until the concrete has reached the required 28-day compressive strength.
- D. Adhesive anchors shall not be loaded until the adhesive has reached its indicated strength in accordance with the manufacturer's instructions.

- END OF SECTION -

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## **SECTION 13 35 00 – PRE-ENGINEERED BRIDGE SYSTEM**

### **PART 1 -- GENERAL**

#### **1.1 SUMMARY**

- A. The CONTRACTOR shall provide a fully engineered simple span bridge of modular galvanized steel construction. The bridge is new construction using standard bridge elements.
- B. This specification is based on the 700XS DSR2 Acrow Panel Bridge as manufactured by ACROW Bridge, City of Milton, Pennsylvania.

#### **1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS**

##### **A. COMMERCIAL STANDARDS:**

- 1. American Association of State Highway and Transportation Officials Bridge Design Code (ASD or LRFD).
- 2. AASHTO M111 - American Association of State Highway and Transportation Officials M111, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
- 3. AASHTO M223 American Association of State Highway and Transportation Officials M223, Standard Specification for High-Strength Low-Alloy columbium-vanadium structural steel.
- 4. AASHTO M183 American Association of State Highway and Transportation Officials M183, Standard Specification Carbon Structural Steel.
- 5. AASHTO - M164 American Association of State Highway and Transportation Officials M164, Standard Specification High-Strength Bolts for Structural Steel Joints.
- 6. AISC - American Institute of Steel Construction, Certified Bridge Fabrication.
- 7. ASTM A 193 - Specification for Alloy-Steel and Stainless-Steel Bolting, Grade B7.
- 8. AWS D.1.5 - American Welding Society Bridge Welding Code.

#### **1.3 CONTRACTOR SUBMITTALS**

- A. General arrangement drawings shall be submitted for review by the ENGINEER a minimum of 30 days prior to manufacturing of the bridge.
  - 1. Drawings showing each phase of a launching sequence shall be for the bridge installation process stamped by a qualified professional engineer registered in the State of California.

2. Completed installation drawings shall be provided stamped by a qualified professional engineer registered in the State of California.
3. Complete calculations demonstrating adequacy of the design to meet all temporary and final loading conditions stamped by a qualified professional engineer registered in the State of California.

## **PART 2 -- PRODUCTS**

### **2.1 METAL BRIDGE SYSTEM**

#### **A. Bridge Dimensions:**

1. Bridge length shall be 260-foot clear span.
2. Bridge width shall provide a 24-foot clear driving lane.
3. Work areas, including actual work sites, materials processing and stockpiling areas, access corridors, disposal areas, and staging areas.
4. Any work completed by other contractors at the Site that will be connected to or otherwise affected by the WORK.

#### **B. Design Requirements**

1. Truck live load shall be HL-93 minimum.
2. Maximum loading requirements shall be determined by CONTRACTOR if construction equipment loading exceeds HL-93 or construction/maintenance loading of a 175 ton rough terrain crane with 15 ton load.
3. Design Standard shall be the AASHTO Bridge Design Code (ASD or LRFD) and all interim amendments
4. Live load deflection shall not exceed the ratio of  $L/800$
5. Design Life: Live load fatigue shall be analyzed in accordance with the AASHTO design code for 500,000 cycles (or other appropriate number of cycles) using Category E for the trusses. Fatigue tests shall not be acceptable.
6. The bridge shall be assembled by the rolling/launching method (or lift in by crane).
7. Engineering analyses shall be submitted with each bridge demonstrating the bridge live load capabilities and the launching stresses and loads at each phase of an assembly launch.
8. Wind loads shall be applied in accordance with the AASHTO standard and shall at a minimum meet the design wind loads shown in the CONTRACT DRAWINGS.
9. An Operators' Manual or Technical Handbook shall be supplied with each bridge



### C. Bridge Sub-Systems

1. **TRUSSES (PANELS):** The upper and lower chords of a panel shall be fabricated from hot-rolled steel channels, and the verticals and diagonals are fabricated from rectangular hollow sections, channels, or flat bar. The material specifications are those listed in Paragraph 6 of the Technical Specifications. Truss panels are 10 feet long from center of pinhole to center of pinhole and 7' 6" tall (overall). The overall width of a truss panel does not exceed 6.5 inches. Male forgings used for pin connections shall be solid and of one-piece construction. The minimum metal thickness is ¼ inch.
2. **TRANSOMS/FLOORBEAMS:** The transoms shall be fabricated from wide flanged sections, and utilize material listed in Paragraph 6 of the Technical Specifications. Vertical cross-bracing shall be incorporated between floorbeams in every other bay. This bracing shall be at each end of the floorbeams and prevent horizontal loads from being transferred from the floorbeam into the truss members. Weight of transom is dependent on the chosen width.
3. **ORTHOTROPIC STEEL DECKS:** The deck system is comprised of orthotropic units. Each unit is 9.9 feet long and has a steel deck plate welded to longitudinal stringers. The driving surface of the deck plate has a factory applied anti – skid aggregate and epoxy surface (alternate driving surfaces are available including galvanized finish to be overlaid with asphalt). Curbs shall be 6" tall and shall be shop welded to a deck unit. Transversely in a deck unit are 4 round tube diaphragms of 3" diameter that distribute wheel loads. Material is listed in Paragraph 6 of the Technical Specifications.

### D. Materials

1. **Trusses / Panels – Part No. AB701 (comprised of chords, diagonals and verticals), Reinforcing Chords**
  - a. AASHTO M223 Grade 65 (ASTM A572 Gd 65)
  - b. Ultimate tensile strength 80,000/100,000 p.s.i. (551/690 N/mm<sup>2</sup>)
  - c. Yield 65,000 p.s.i. (448N/mm<sup>2</sup>)
  - d. Elongation 17% of 203mm Gauge Length
2. **Deck Stringers, Floorbeams, Truss Braces, Swaybraces, Raker Braces, verticals and diagonals in heavy truss units Parts AB702 and AB708.**
  - a. AASHTO M223 Grade 50 (ASTM A572 Gd 50)
  - b. Ultimate tensile strength 70,000/90,000 p.s.i. (483/620 N/mm<sup>2</sup>)
  - c. Yield 50,000 p.s.i. (345 N/mm<sup>2</sup>)
  - d. Elongation 18% of 203 mm Gauge Length

3. All other parts
  - a. AASHTO M183 Grade 36 (ASTM A36/50)
  - b. Ultimate tensile strength 63,000/75,000 p.s.i. (434/517 N/mm<sup>2</sup>)
  - c. Yield 36,000 p.s.i. (248N/mm<sup>2</sup>)
  - d. Elongation 20% of 203mm Gauge Length
4. Panel Connecting Pins
  - a. ASTM A193 Grade B7
  - b. Ultimate tensile strength (minimum) 125,000 p.s.i. (862 N/mm<sup>2</sup>)
5. Bolts - AASHTO M164 (ASTM A325) The following diameters are minimum acceptable diameters.
  - a. Chord bolt - 32mm
  - b. Deck bolt - 19mm
  - c. All other bolts - 25mm

## **PART 3 -- FINISHING**

### **3.1 GALVANIZING**

- A. All major components shall be hot-dipped galvanized to AASHTO M111 and ASTM A123 specification or equivalent. This coating provides a minimum of 610 gm/m<sup>2</sup> of coverage for steel of 6.5 mm thick and greater.
- B. The interior circumference of the pin holes of the trusses/panels shall be coated with hot dip galvanizing.
- C. All bolts, pins, etc., are galvanized or spun galvanized.

## **PART 4 -- FABRICATION**

### **4.1 Quality Standards**

- A. Workmanship, fabrication, Quality Assurance Systems, and shop connections are in accordance with the AISC (American Society of Steel Construction) for Certified Bridge Fabrication – Advanced (Major), AWS (American Welding Society) D.1.5. Bridge welding codes, AASHTO (American Association of State and Highway Transportation Officials Bridge Design Code), and ISO9001.
- B. Welding is performed by properly certified operators.

- END OF SECTION -