ARTICLE 5

REINFORCEMENT FOR STRUCTURAL CONCRETE

5.1 GENERAL

5.1.1 DESCRIPTION

The work under this section includes the furnishing of all labor and materials necessary for the construction (placement) of the reinforcement for structural concrete according to the plans and these specifications. Structural concrete shall be defined as mass concrete with reinforcement exceeding 0.3% of the concrete cross-sectional area.

5.2 MATERIALS

5.2.1 SUBMITTALS

(a) Engineered shop drawings and schedules shall require original Colorado engineer's or architect's stamp, for all reinforcement.

(b) The submittals shall be made in ample time to be reviewed, and to permit corrected drawings to be delivered to the Engineer a minimum of seven days prior to work.

(c) These drawings shall show the size, number, exact position and spacing of reinforcement and the exact location of all openings, framing, or special conditions affecting the work.

(d) Detailing of reinforcement shall conform to ACI 315.

5.2.2 REINFORCEMENT

The reinforcing bars shall be in conformity with ASTM A-615 SI Grade 40 and Grade 60 and the general notes on the structural drawings. Dowels, conforming to the requirements of ASTM A-15, shall be intermediate grade plain bars rolled from billet stock. Glass Fiber Reinforced Polymer (GFRP) and Carbon Fiber Reinforced Polymer (CFRP) reinforcing bars may be used with prior approval of the Engineer.

(a) Welded Wire Fabric shall not be permitted for use with structures within the City right-of-way.

(b) Fiber-Reinforced Concrete shall not be permitted for use with structures within the City right-of-way.

(c) Reinforcing Bars, #3 to #18, shall conform to AASHTO M31 Grade 60 (ties and stirrups may be Grade 40). Epoxy coated reinforcing shall conform to AASHTO M284.

(d) The usage of GFRP and CFRP shall conform to ACI 440.1R-06 *Guide for the Design and Construction of Structural Concrete Reinforced with FRP Bars (or most current version)*. Do not use CFRP reinforcing bars in contact with steel reinforcing, metal lifting devices or other embedded metal items. Use the nominal diameters, nominal cross-sectional areas, and the

mechanical properties of Fiber Reinforced Polymer (FRP) reinforcing bars in accordance with CDOT Specifications for the design of structural concrete.

5.2.3 CLEANING

Reinforcement, prior to placement of concrete, shall be free from rust, scale, oil, ice, or other coatings that will destroy or reduce the bond, including mortar from previous concrete pours.

5.2.4 MATERIALS FOR ACCESSORIES

Where the concrete surface will be exposed to the weather in the finished structure, the portions of all accessories in contact with the formwork shall be galvanized or shall be made of plastic. Where the concrete surface will be exposed to plant water, all accessories in contact with formwork shall be stainless steel or plastic.

5.2.5 EXPANSION DOWELS

Smooth steel dowels conforming to AASHTO M183 with gage metal or PVC sleeves. Size, number and spacing as noted on the drawings.

5.2.6 CONCRETE

Conform to the requirements of *ARTICLE 4 - CONCRETE*. Calcium chloride shall not be used in reinforced concrete.

5.3 CONSTRUCTION REQUIREMENTS

5.3.1 GENERAL

See *Article 4 – CONCRETE* for construction requirements for the concrete portion of structural concrete.

5.3.2 REBAR PREPARATION

5.3.2.1 Tie Bars, Bar Supports and Wire Ties

Place reinforcement to maintain minimum coverage as indicated for concrete protection. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.

5.3.2.2 Bending

Reinforcement shall be bent cold. **The use of heat in bending bars shall not be permitted.** Bars shall be full length required and accurately bent to details. All bent bars shall be manufactured in accordance with the recommendations of the Concrete Reinforcing Steel Institute (CSRI). No bars partially embedded in concrete shall be field bent except as shown on the drawings or specifically permitted by the Engineer.

5.3.2.3 Placing

For details and reinforcement placement and supports comply with Concrete Reinforcing Steel Institute's (CRSI's) recommended practice for "Placing Reinforcing Bars," for details and reinforcement placement and supports, and as specified. Reinforcement shall be accurately located in forms and firmly held in place before and during the depositing of concrete by means of metallic supports, metal chairs, spacer bars, tie wire or other devices adequate to ensure against displacement during construction.

Exposed reinforcing bars intended for bonding with future extensions shall be protected from corrosion by adequate covering.

5.3.2.4 Preventing Displacement

All reinforcing bars shall be positioned, supported, secured and wired together to prevent displacement by construction loads or the placing of concrete. On the ground, and where necessary, supporting concrete blocks shall be used. Over formwork, bar chairs, metal chairs, runners, bolsters, spacers, and hangers shall be furnished, as approved by the Engineer.

5.3.2.5 Offsetting Bars

Vertical bars in columns shall be offset to permit the bars to be adjacent and in contact at all splices.

5.3.2.6 Splicing

Wherever it is necessary to splice reinforcement other than as shown on the drawings, the character of the splice shall be approved by the Engineer on the basis of allowable bond stress in the reinforcement at the splice. Splicing shall not be made at points of maximum stress nor shall adjacent bars be spliced at the same point. Laps in tension splices shall be 36-bar diameters or 30bar diameters in compression, or as specified.

5.3.2.7 Cover

The minimum clear cover for reinforcing steel shall be as specified in ACI 301, Section 5.5, and as shown below, unless otherwise shown on the plans.

Table 5.1. Minimum clear cover

Location	Minimum Cover
Bottom bars on soil bearing foundation and slabs	3″
Bars adjacent to surfaces exposed to weather on earth backfill:	
Bars more than 3/4″ diameter	2″
Bars 3/4″ or less in diameter	1-1/2″
Interior Surfaces: Slabs, walls, joints with 1-3/8″ diameter or smaller bars	3/4″

5.4 METHOD OF MEASUREMENT

The contract quantities to be paid for under this item shall be according to *Article 4 – CONCRETE Section 4.4 METHOD OF MEASUREMENT.*

5.5 BASIS OF PAYMENT

The basis of payment shall be according to *Article 4 – CONCRETE Section 4.5 BASIS OF PAYMENT.*