SECTION 1070
REINFORCING STEEL

1070-1 GENERAL

Store steel reinforcement on blocking at least 12" above the ground; protect the steel at all times from damage; and when placing in the work, ensure it is free from dirt, dust, loose mill scale, loose rust, paint, oil or other foreign materials.

1070-2 DEFORMED STEEL BAR REINFORCEMENT FOR STRUCTURES

Supply deformed steel bar reinforcement conforming to ASTM A615 for Grade 60. Bend and cut during fabrication with tolerances in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute. Bend the bars cold to the details shown in the plans.

Weld steel bar reinforcement only where shown in the plans or approved by the Engineer. When welding steel bar reinforcement use bars conforming to ASTM A706.

1070-3 COLD DRAWN STEEL WIRE AND WIRE REINFORCEMENT

Provide cold drawn steel wire for use as spirals or in fabricated form for the reinforcement of concrete meeting AASHTO M 32. Epoxy coat all spacers on spirals when the spirals are epoxy coated.

Use smooth welded wire reinforcement conforming to AASHTO M 55.

Use deformed welded wire reinforcement conforming to AASHTO M 221.

1070-4 REINFORCING STEEL BAR SUPPORTS

Make all wire bar supports of smooth cold drawn industrial quality basic wire having a minimum tensile strength of 65,000 psi. When the legs of the bar supports are in contact with the forms, ensure that the entire leg of the bar support is stainless steel wire or a minimum thickness of 1/4" stainless steel at points of contact with the forms. Use stainless steel wire meeting ASTM A493 except having a minimum chromium content of 16% and a minimum tensile strength of 95,000 psi. Ensure that wire sizes, height tolerance, and leg spacing for wire bar supports are in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute.

As an option to the stainless steel wire for the legs of bar supports at points of contact with the forms, provide legs of cold drawn steel wire plastic protected in accordance with the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute, except provide plastic protection by dipping or by premolded plastic tips. Do not use plastic legs molded to the top wire.

Use plastic bar supports meeting the requirements listed in the *Manual of Standard Practice* published by the Concrete Reinforcing Steel Institute only when approved by the Engineer.

1070-5 PRESTRESSING STRAND

Use prestressing strands for use in prestressed concrete consisting of 7 wire strands, stress relieved after manufacture to remove internal stresses. Use the size and the grade of the strand as shown in the plans. Use strands conforming to AASHTO M 203 except provide a specimen for test purposes, if required, from each reel of cable instead of each 20 ton production lot.

For precast prestressed deck panels, use 3/8” round seven-wire stress-relieved Grades 250 or 270 prestressing strands meeting AASHTO M 203.

Mark the outer layer of each reel pack of strand with a wide color band as follows: white for Grade 270 stress relieved strand, green for low relaxation strand, and a double marking of green and red for special low relaxation strand. In addition, attach a metal tag to each reel pack labeled in accordance with AASHTO M 203.

1070-6 DOWELS AND TIE BARS FOR PORTLAND CEMENT CONCRETE PAVEMENT

Use smooth plain round steel dowel bars conforming to AASHTO M 31 Grade 60. Do not use dowel bars with burred ends. A tolerance of ± 1/4" is permitted from the dowel length required by the plans. A straightness tolerance of 0.075" from a straight line is permitted.

Epoxy coat all dowel bars in accordance with AASHTO M 284 and these provisions, with a coating thickness of 7 to 13 mils after curing. Coated bars will be taken by the Engineer from the production run on a random basis at the point of coating application for testing and evaluation. The Engineer determines the sampling and testing schedule for the number and frequency of tests for thickness of coating, adhesion of coating and holidays. At least one bar for each 20 coated is tested for holidays and coating thickness. Perform at least 2 bend tests for each 8 hours of production coating or any fraction thereof for determining that adhesion and flexibility of the coating meets specification requirements. Payment is not made by the Department for coated bars selected for testing and evaluation purposes at the point of coating application. All coated bars are inspected at both the coating and fabrication shops. Furnish a Type 1 material certification in accordance with Article 106-3 and attach it to a completed Reinforcing Steel Certification, M&T Form 913, for all coated reinforcing bars before cleaning and coating operations, of the time and location where the work is performed. A blank Reinforcing Steel Certification, M&T Form 913, may be obtained from the Materials and Tests Unit.

Use dowel assemblies for supporting dowel bars of rigid construction capable of holding the dowel bars in proper position during placing of concrete, and of such design to permit unrestricted movement of the pavement slab. Use wire for dowel assemblies meeting AASHTO M 32. Use a dowel assembly that holds the dowels in the required position within a tolerance of ± 1/4" in vertical and horizontal planes. Obtain written approval for the dowel assembly before use.

Coat dowel bars and the entire dowel assembly with an approved wax base coating. Apply the coating by dipping or spraying such that the wax coating on the dowel bars is of uniform thickness sufficient to allow pulling of the dowel from the concrete as provided in AASHTO T 253 and M254. Furnish to the Department for testing one dowel basket assembly for each 200 assemblies incorporated into the project.

Use deformed tie bars conforming to AASHTO M 31 for Grade 40 or Grade 60.

1070-7 EPOXY COATED REINFORCING STEEL

(A) General

Coaters of epoxy coated reinforcing steel shall establish proof of their competency and responsibility in accordance with the Concrete Reinforcing Steel Institute's Fusion Bonded Epoxy Coating Applicator Plant Certification Program. Registration and certification of the plant or shop under the CRSI Program and submission of the valid annual certificate to the State Materials Engineer is required before beginning any coating. The same requirement applies to coaters subcontracting work from the coater directly employed by the contractor.

Obtain approval of each coater and/or fabricator of epoxy coated reinforcing steel before coating or fabricating bars. Approval is based upon the following:

(1) The coating applicator and/or fabricator establishing and maintaining an effective quality control program and

(2) The coating applicator having equipment for cleaning, coating and/or fabricating that produces coated material conforming to these *Standard Specifications*.

Include in requests for approval a well defined quality control program and direct the requests to the State Materials Engineer. Before Department approval is issued, the condition of equipment for blast cleaning, coating and/or fabricating material is evaluated by the Engineer for determining the equipment capability of producing a coated product conforming to the *Standard Specifications*. Lists of Department approved epoxy coating and fabricating companies are available from the State Materials Engineer.

(B) Coating Materials

Obtain approval for the epoxy resin powder before use. A list of prequalified powder sources is available from the State Materials Engineer.

Submit prequalified products other than those now approved for use to the State Materials Engineer for approval. Requalify each product every 5 years and any time a change is made in the manufacturing process or chemical composition of the epoxy resin.

Use powdered resin of any color that provides contrast to the corroded or uncorroded surface of the steel. Provide material of the same quality as that used for prequalification tests and as represented by test reports forwarded to the State Materials Engineer.

Ensure the manufacturer of the epoxy resin supplies to the coating applier information on the resin that is essential to the proper use and performance of the resin as a coating. Ensure the manufacturer of the resin furnish the coating applier a written certification signed by a responsible officer of the company that the material furnished for coating the reinforced steel is the same formulation as that for which test reports were previously submitted to the State Materials Engineer.

With each batch of coating material, furnish a written certification by the coating applier to the Engineer which properly identifies the batch number, material, quantity represented, date of manufacture, name and address of manufacturer and includes a statement that the supplied coating material is the same composition as that prequalified.

(C) Patching Material

Ensure the epoxy resin manufacturer supplies a prequalified and approved patching or repair material that is compatible with the coating and inert in concrete. Ensure that the material is suitable for making repairs with a minimum dry film thickness of 6 mils from 2 coats on damaged areas of the coating. Ensure that each coater, fabricator and contractor has a copy of the manufacturer's written instructions for application of the patching material and the instructions are closely followed during coating damage repairs.

Apply 2 coats of patch material where needed with the second coat applied only after the first coat dries to the touch. Do not apply any patch material when the surface temperature of the steel or the air temperature is below 40°F. Do not ship or place steel until the patch material is dry to the touch.

(D) Reinforcing Steel

Use coated steel reinforcing bars meeting AASHTO M 31, Grade 60 and free of contaminants such as oil, grease and paint. Use bars free of surface irregularities that produce holidays in the coating. Ensure the coater visually inspects the bars to avoid coating bars containing such surface irregularities. If the coater fails to detect surface irregularities that produce holidays in the coating, patch the holidays with 6 mils of patching material as specified in Subarticle 1070-7(C) to avoid rejection of the bars.

(E) Surface Preparation of Bars

Subject coated reinforcing steel surfaces to a very thorough blast (near white) cleaning, before coating. Ensure that the appearance of the surface after cleaning corresponds to ASTM D2200 and the pictorial standards of SSPC-VIS 1, degree of cleaning SSPC-SP 10. Produce a suitable anchor pattern profile by the cleaning media. A target profile depth of 1/3 of the coating thickness is considered a suitable anchor pattern.

Apply the coating to the cleaned surface as soon as possible after cleaning. Remove any formation of rust blooms on the cleaned bars by blast cleaning before application of the coating. However, never delay the coating more than 8 hours after cleaning unless otherwise permitted. Provide surface characteristics of the steel as described above at the time of coating.

After blast cleaning, and before application of the coating, remove all visible traces of grit and dust from the bars.

(F) Application of Coating

Apply the coating as an electrostatically charged dry powder sprayed into the grounded steel bar using an electrostatic spray gun. Apply the powder to either a hot or cold bar. Give the coated bar a thermal treatment as specified by the manufacturer of the epoxy resin that provides a fully cured and bonded finish coating. Control temperature as recommended by the manufacturer of the coating material to ensure a workmanlike finish without blistering or other defects. Completely coat all bars, including bar ends, with epoxy resin powder to the minimum thickness specified in Subarticle 1070-7(G).

Run the production line at such a speed as to provide proper cure time before quench by air or water.

(G) Quality Control Requirements

For acceptance purposes, ensure that each recorded film thickness measurement is in the range of 7 to 12 mils after cure, with the entire area of a bar having a minimum coating thickness of 7 mils.

A single recorded coated reinforcing bar thickness measurement is the average of 3 individual readings obtained from 3 adjacent areas on the body of the bar (3 adjacent areas between deformations). Obtain at least 5 recorded measurements approximately evenly spaced along each side of the test bar (at least 10 recorded measurements per bar).

Ensure the coating applier visually inspects each coated bar after cure for continuity of coating and to ensure that the coating is free of holes, voids, contamination, cracks and damaged areas discernible to the unaided eye. In addition, no more than an average of 2 holidays per linear foot of bar are permitted providing the total quantity of holidays does not exceed 5 in any linear foot. Bars that contain no more than 5 holidays in any linear foot of bar are acceptable provided any holidays in excess of 2 per linear foot are coated with 6 mils of patching material specified in Subarticle 1070-7(C). Retest the bars after patching to confirm that no more than 2 holidays exist in any linear foot of bar.

Ensure the coating applier evaluates the adhesion of the coating on a representative number of bars selected by the Engineer from each proposed shipment as specified in Subarticle 1070-7(L). No visible cracks or disbonding of the coating are allowed when tested in accordance with Subarticle 1070-7(H).

(H) Test Methods Required of the Coater

The thickness of the coating is measured on the body of the bar between the deformations or ribs. Conduct non-destructive coating thickness measurements using magnetic gauges in accordance with ASTM G12, with the following additions applicable to commercially available pull-off gauges, and to fixed probe gauges with a magnetic field of vision not exceeding 0.015" of steel depth; 0.015" is the minimum thickness of smooth steel to which adding more material does not change the zero reading.

Perform gauge calibration with shims on a smooth, clean low-carbon steel plate with minimum dimensions of 3" x 3 1/2", rather than on a cleaned reinforcing bar.

Determine a correction factor defining the effect of the bar preparation process as the difference between (a) the average of 10 gauge readings on a cleaned, but uncoated reinforcing bar of the size and lot coated, and (b) the average of 5 gauge readings on a smooth mild steel plate. This correction factor is then subtracted from all subsequent gauge readings on coated bars.

TABLE 1070-1
BEND TEST REQUIREMENTS

Bar No.	Mandrel Diameter, inch
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
14	17
18	23

Fixed probe gauges are checked to ensure that the force generated by the springloaded probe housing is sufficient to ensure intimate contact between the probe tip and the coatings of the curved bar surface. If intimate contact does not result, remove the probe housing and use hand pressure to obtain valid indicated thickness readings.

As an option, use thumbwheel pulloff gauges to provide valid thickness measurements on coated reinforcing bars with a deformation spacing which is less than the maximum outer dimensions of the probe housing. Position the base of the probe housing against the top of 2 adjacent deformations and extend the probe through the air gap to the body of the bar. Hold the gauge very steady and apply continuous light downward pressure to the housing during the measurement.

Use a 67.5V holiday detector equipped with a holiday marker in accordance with the detector manufacturer's instructions. Maintain the detector in perfect working condition at all times during the bar coating process. Immediately after coating, route each bar through the detector for holiday detection. Bars containing more than five holidays in a linear foot of bar or averaging more than 2 holidays per foot of bar are either rejected or cleaned, recoated, and retested for holidays. A coating holiday for the purpose of this specification is defined as a discontinuity in the applied coating that occurs during the coating process that is detected either visually or electromechanically.

The adhesion of the coating is evaluated by bending production coated bars 120° (after rebound) around a mandrel of specified size as prescribed in Table 1070-1. Conduct the bend test at a uniform rate and take up to 90 seconds to complete. Place the 2 longitudinal deformations in a plane perpendicular to the mandrel radius, and maintain the test specimen at thermal equilibrium between 68°F and 85°F. If the specimen for the adhesion of coating shows evidence of cracking or debonding of the coating, conduct 2 retests on random samples. If the results of both retests meet the specified requirements, the coated bars represented by the samples are acceptable.

The fracture or partial failure of the steel-reinforcing bar in the bend test for adhesion of coating is not considered as an adhesion failure of the coating. If failure of the bar occurs, test 2 check samples without bar failure.

Condition test bars at a temperature range of 68°F to 85°F. In cases of dispute, conduct tests at 73°F and 50% relative humidity in accordance with recommended practices in ASTM D3451.

(I) Handling and Identification

Provide padded contact areas for all systems for handling coated bars at the coating plant, fabricator and project. Pad or suitably band all bundling bands to prevent damage to the coating. Lift all bundles of coated bars with a strong back, spreader bar, multiple supports or a platform bridge to prevent bar-to-bar abrasion from sag in the bundles of coated bars.

(J) Fabrication of Steel-Reinforcing Bars After Coating

Protect drive rolls and automatic kick-off levers on shear beds, and drive pins, center pins and back-up barrels on benders with a suitable covering to minimize damage during the fabrication process. Note that these *Standard Specifications* permit no more than 5% of the surface area of a bar to contain patching material. This includes patching due to damage to the coating by the coater, fabricator, transporter and contractor.

Store coated bars as required by Subarticle 1070-7(M).

Ensure the fabricator maintains the identification of the coated bars and that the coated, fabricated bars are identified with proper tags for final shipment to the job site.

Perform coating repairs as described in Subarticle 1070-7(K) with material specified in Subarticle 1070-7(C).

Flame cutting of coated bars to the required dimensions is not permitted. Maintain any mechanical device used for cutting the coated bars to required length in good working order to minimize damaging the coating in the vicinity of the cut ends. Repair coating damage in these areas as described in Subarticle 1070-7(K) with material specified in Subarticle 1070-7(C).

(K) Procedures for Repair of Coating

Repair all coating damage of the reinforcing bars with material described in Subarticle 1070-7(C) when coating bond loss and damage exist, including crushed coating and hairline cracking if bare metal is evident. When repair is required, clean and repair all damage. Remove crushed coating and loose or deleterious material. In areas where rust is present, remove it by wire brushing with a power tool to the surface finish specified in Subarticle 1070-7(E) before repair.

(L) Inspection by the Department

Coated bars are inspected at both the coating and fabrication shops unless otherwise approved. The coater and/or fabricator shall furnish Type 3 material certification in accordance with Article 106-3, attached to a completed Reinforcing Steel Certification, M&T Form 913, for all coated reinforcing bars. Include a completed Epoxy Coated Reinforcing Bar Inspection Report, Form 310, with each shipment. These certification forms are available from the State Materials Engineer. Do not epoxy coat, fabricate or ship reinforcing steel to the project site without the approval of the Engineer.

Provide free entry to the plant and facilities of the coater and/or fabricator for the inspection of all manufacturing processes including, but not limited to, the cleaning, coating and fabrication of the ordered bars.

On a random basis, lengths of coated bars or fabricated bars are taken from the production run at the point of coating application for testing and evaluation.

All bar tests are made at the coating applicator and/or fabricator's plant, before shipment, unless otherwise approved. Ensure the coating applier and/or fabricator notify the State Materials Engineer 5 working days before the time the material is coated or fabricated. Do not ship bars until they are inspected and tagged by the Department.

The Engineer randomly selects 3 coated bars of each size from each proposed shipment to test for holidays, damage and coating thickness. If any bar fails to conform to these Specification requirements, 6 samples are selected and tested. If these tests reveal that the coating conforms to Specification requirements the shipment is acceptable. If any of the second set of samples fail to conform to these Specifications the coater is required to test all bars of that size that are included in the shipment and re-submit the shipment to the Department for inspection. The Engineer selects from each proposed shipment 2 samples of each size bar for bend tests by the coater for determining that the adhesion and flexibility of the coating conforms to Subarticle 1070-7(H).

(M) Repairs to Coating Due to Loading, Transporting and Handling

Transport the bundled bars from the coater or fabricator to the project site with padding, such as carpet padding or used carpet, placed over each bundle of steel upon which another bundle of steel is placed unless wooden spacers are placed between each bundle to prevent contact.

Load all bundles of bars horizontally for transporting. Transport the bars on a flatbed trailer. Do not allow the length of bars extending beyond the trailer bed to exceed 8 ft.

Repair coating damage due to handling and transporting or other causes with material specified in Subarticle 1070-7(C) and in accordance with Subarticle 1070-7(K).

(N) Rejection

Coated bars that do not meet the *Standard Specifications* are rejected. At the Contractor's option, replace coated bars containing defects beyond the limits of the *Standard Specifications*. Alternatively, strip the bars of coating, reclean and recoat in accordance with the *Standard Specifications*.

1070-8 SPIRAL COLUMN REINFORCING STEEL

Furnish spiral column reinforcing steel with the following areas and weights as required in Table 1070-2 and in the plans.

TABLE 1070-2 SPIRAL COLUMN REINFORCEMENT STEEL PROPERTIES			
Material	**Size**	**Area, sq.in.**	**Weight, lb/ft**
Plain Cold Drawn Wire	W 20	0.20	0.668
	W 31	0.31	1.043
Deformed Cold Drawn Wire	D-20	0.20	0.680
	D-31	0.31	1.054
Plain or Deformed Bar	#4	0.20	0.668
	#5	0.31	1.043

Use cold drawn wire conforming to AASHTO M 32. Use plain or deformed bars conforming to AASHTO M 31 for Grade 60. Use deformed cold drawn wire conforming to AASHTO M 225.

The diameter of the spiral reinforcing steel is the outside to outside measurement of the bars or wire, with an allowance of 1/2" more or 1/2" less than the specified diameter as shown in the plans.

Furnish spirals with 1.5 extra turns at top and at bottom of the completed spiral cage. Where splicing of the spirals is necessary other than those shown in the plans, provide a minimum lap splice of 3 ft.

Do not weld on the spiral reinforcing steel.

When required by the plans, use epoxy coated spiral column reinforcing steel including spacers in accordance with Article 1070-7.

Use the minimum number of spiral spacers as shown in the plans. Ensure a minimum section modulus per spiral spacer of 0.030 cu.in.

1070-9 MECHANICAL BUTT SPLICES

When called for by the contract or when directed by the Engineer, use a mechanical butt reinforcing steel splice from an approved source. Use a standard metal filled sleeve, cement mortar filled sleeve, threaded steel couplings, forged steel sleeve or cold-forged sleeve. An exothermic process whereby molten filler metal, contained by a high strength steel sleeve of larger inside diameter than the bars, is introduced into the annular space between the bars and the sleeve and between the ends of the bars may be used. Provide a splice that is capable of transferring at least 125% of the yield strength of the bars from one bar to the other by the mechanical strength of the splice components.

For splices not on the approved list, before use and as a condition of approval, assemble 3 test splices in the presence of the Engineer for each size of bar which is proposed for use on the project. Forward the test splices to the Materials and Tests Unit in Raleigh, NC for testing and approval.

SECTION 1072
STRUCTURAL STEEL

1072-1 GENERAL

Furnish and fabricate all structural steel and related incidental materials including sign supports and high mount lighting standards and use materials in accordance with this section.

(A) Fabricator Qualification

Use steel fabricators on the Department's Approved Structural Steel Fabricators List for the type work being performed. The list is available from the Materials and Tests Unit or on the Department's website.