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REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
OFFICE OF THE SECRETARY
MANILA

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DEPARTMENT ORDER)
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No. 46)
Series of 2015 03.20. N

SUBJECT : DPWH Standard Specification for Item 404A – Epoxy-Coated Reinforcing Steel Bars

In line with the mandate of the Department in providing effective standard specifications in the implementation of various infrastructure projects and in view of the need of setting a standard specification for protecting the concrete against corrosive conditions that will be exposed to the aggressive elements, the attached **DPWH Standard Specification for Epoxy-Coated Steel Reinforcing Bars, Item 404A** is hereby prescribed, for the guidance and compliance of all concerned.

This specification shall form part of the revised edition of the DPWH Standard Specifications Highways, Bridges and Airports, Volume II.

This Order shall take effect immediately.

ROGELIO L. SINGSON
Secretary

Department of Public Works and Highways
Office of the Secretary
WIN5U01053

5.5.2 FET/JFS

DPWH STANDARD SPECIFICATIONS FOR

ITEM 404A – Epoxy-Coated Reinforcing Steel Bars

404A.1 Description

This Item shall consist of furnishing *deformed and plain reinforcing steel bars applied with* protective epoxy coating by the electrostatic spray method to strengthen the concrete and protect against corrosive conditions that will be exposed to the *aggressive* elements in accordance with this Specification and in conformity with the type, size, shape and grade specified in the Plans, or as directed by the Engineer.

404A.2 Material Requirements

The materials for this item shall conform to ASTM A775/A775M (ASTM Standard Specification for Epoxy-Coated Steel Reinforcing Steel Bars) and AASHTO M284M/M284-09 for steel bars coated in straight condition and then bent, and ASTM A934/A934M (ASTM Standard Specification for Epoxy-Coated Prefabricated Steel Bars) for steel bars that are bent prior to coating.

404A.2.1 Reinforcing Steel Bars

Reinforcing steel bars to be coated shall meet the requirements of the following Specifications:

Subject	Standard Designation	
	ASTM	**AASHTO** Equivalent
Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement	ASTM A 615	AASHTO M 31
Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement	ASTM A 706	
Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcements	ASTM A 996	AASHTO M 322

404A.2.2 Powder Coatings

The powder coating shall be of organic composition except for the pigment which may be inorganic if used.

404A.3 Construction Requirements

404A.3.1 Surface Preparation

The surface of the steel reinforcing bars to be coated shall be cleaned by abrasive blast cleaning to a near white metal. It is recommended that reinforcing steel bars and blast media be checked for contamination by *any foreign materials and oil impurities* prior to use. Blast media found to be salt contaminated should be rejected. *Reinforcing steel bars and blast media found to be contaminated shall be rejected or washed cleaned prior to heating thru the use of methods suitable to remove the contamination.*

Manufacturers shall be permitted to use a chemical wash or blast-cleaned steel reinforcing bar surface, or both, to enhance coating adhesion. This pretreatment shall be applied after abrasive cleaning and before *epoxy* coating, in accordance with the written application instructions specified by the pretreatment manufacturer.

404A.3.2 Heating

Bars are heated to approximately 232°C (450°F), typically using electrical induction heaters, although gas-fired heating is used in some cases.

404A.3.3 Coating Application

If pretreatment is used in the preparation of the surface, the powder coating shall be applied to the cleaned and pretreated steel reinforcing bar surface as soon as possible after surface treatments have been completed, and before visible oxidation of the surface occurs as discernible to a person with normal or corrected vision. In no case shall application of the coating be delayed more than 3 h after cleaning.

The fusion-bonded epoxy powder coating shall be applied in accordance with the written recommendations of the manufacturer of the powder coating for initial surface temperature range and post application curing requirements. During continuous operations, the temperature of the surface immediately prior to coating shall be measured using infrared guns or temperature indicating crayons, or both, at least once every 30 minutes. The powder coating shall be applied by electrostatic spray or other suitable method.

404A.3.4 Curing

Following powder application, the coating is allowed to cure for a short period (approximately 30 seconds) during which time it hardens to a solid. In some plants, the curing is often followed by an air or water quench that quickly reduces the bar temperature to facilitate handling.

404A.3.5 Welding

Welding of epoxy-coated reinforcing steel bars shall conform to American Welding Society, AWS D1.4/D.1M.

For steel bars conforming to ASTM A706, the bars can be welded without preheating. Steel bars conforming to ASTM A615 shall be preheated to 260 degrees celsius.

After completion of welding on epoxy-coated bars, the damaged areas shall be repaired using patch materials conforming to ASTM A47.

404A.3.6 Requirements for Coated Reinforcing Steel Bars

404A.3.6.1 Coating Thickness

404A.3.6.1.1 For acceptance purpose, at least 90 % of all recorded thickness measurements of the coating after curing shall be 175 to 300 μm (7 to 12 mils). Thickness measurements below 125 μm (5 mils) shall be considered cause for rejection. The upper thickness limit does not apply to repaired areas of damaged coating.

404A.3.6.1.2 A single recorded coated reinforcing steel bar thickness measurement is the average of three (3) individual gauge readings obtained between four (4) consecutive deformations. A minimum of five (5) recorded measurements shall be obtained approximately evenly spaced along each side of the test bar (a minimum of ten recorded measurements per bar).

404A.3.6.1.3 The coating thickness shall be measured on the body of a straight length of reinforcing steel bar between the deformations.

404A.3.6.2 Coating Continuity

404A.3.6.2.1 Holiday checks to determine the acceptability of the reinforcing steel bars prior to shipment shall be made at the manufacturers plant with a 67.5 V, 80,000 Ω, wet-sponge type direct-current holiday detector or equivalent method.

404A.3.6.2.2 On average, there shall not be more than 3 holidays per meter on a coated steel reinforcing bar. The average applies to the full production length of a bar.

404A.3.6.2.3 A wetting agent shall be used as per applicable requirements of Test Method of ASTM G 62 in the inspection for holidays on the coated steel reinforcing bars.

404A.3.6.3 Coating Flexibility

404A.3.6.3.1 The coating flexibility shall be evaluated by bending production coated reinforcing steel bars at a uniform rate around a mandrel of specified size within a maximum specified time period as prescribed in the applicable requirements of bend test requirements of ASTM A775/A775M. The two longitudinal ribs shall be placed in a plane perpendicular to the mandrel radius. The test specimen shall be between 20 and 30°C.

404A.3.6.3.2 No cracking or disbonding of the coating shall be visible to the unaided eye on the outside radius of the bent bar. Except as specified in 404A.3.7.2, evidence of cracking or disbanding of the coating shall be considered cause for rejection of the coated reinforcing steel bars represented by the bend test sample.

404A.3.6.3.3 Fracture or partial failure of the reinforcing steel bar, or cracking or disbonding caused by imperfections in the bar surface visible after performing the bend test shall not be considered a flexibility failure of the coating, but shall require testing two additional specimens. These two specimens shall then meet the requirements of 404A.3.6.3.2.

404A.3.6.3.4 The requirements for coated reinforcing steel bars shall be met at the manufacturers plant prior to shipment.

404A.3.7 Quality Test

404A.3.7.1 Number of Test

The coated reinforcing steel bar shall conform to the requirements for the number and frequency of test for coating thickness, continuity, flexibility and adhesion as follows:

1. *Test for coating thickness shall be made on a minimum of two bars of each size every two production hours.*

2. *Bend test for coating flexibility shall be conducted on at least one bar of each size every four production hours.*

3. *Random tests shall be made for coating continuity.*

4. *Coating adhesion as measured by cathodic disbondment testing shall be conducted on at least one bar every eight production hours.*

404A.3.7.2 Retests

If the specimen for coating thickness or flexibility fails to meet the specified requirements, two retest on random samples shall be conducted for each failed test. If the results of both retests meet the specified requirements, the coated reinforcing steel bars represented by the samples shall be accepted.

404A.3.7.3 Permissible Amount of Damaged Coating and Repair of Damaged Coating

The maximum amount of repaired damaged coating shall not exceed 1% of the total surface area in each 0.3 meter of the bar. This limit on repaired damaged coating shall not include sheared or cut ends that are coated with patching material.

All coating damage due to fabrication or handling (to the point of shipment) shall be repaired with patching material.

Repaired areas shall have a minimum coating thickness of 175 um (7 mils).

When coated bars are sheared, saw-cut, or cut by other means during the fabrication process, the cut ends shall be coated with the same patching material that is used for the repair of damaged coating.

Repair of damaged coating shall be done in accordance with the patching material manufacturer's written recommendations.

404A.3.8 Protection of Materials

The powder coating shall be stored in a temperature-controlled environment following the written recommendations of the powder coating manufacturer until ready for use. At that point, if the storage temperature is below the plant ambient temperature, the powder coating shall be given sufficient time to reach approximate plant ambient temperature. The powder coating shall be used within the powder coating manufacturer's written recommended shelf life.

404A.3.9 Delivery, Storage and Handling

a. Epoxy coated steel stored at the site shall be placed on timber sills suitably spaced so that no steel shall be laid upon or come in contact with the ground and elevated sufficiently to prevent sags in the bundles and from workers walking on the steel.

b. If rainy or exceptionally humid weather occurs or is anticipated, bars shall be stored under cover immediately upon delivery to site. Epoxy bars shall be covered with polyethylene or other materials to prevent exposure to direct sunlight.

c. Reinforcement steel bars shall be handled and stored in manner to prevent damage to bars or the epoxy coating.

d. Coated reinforcing steel bars, whether individual bars or bundles of bars, or both, shall be covered with opaque polyethylene sheeting or other suitable opaque protective material. For stacked bundles, the protective covering shall be draped around the perimeter of the stack. The covering shall be secured adequately, and allow for air circulation around the bars to minimize condensation under the covering.

e. Bars or epoxy coating damaged in handling or other operations shall be satisfactorily repaired at no additional cost to the government. Repair (touch-up) kits and instructions for their use *should be affixed/attached when coated bars are delivered.*

f. All systems for handling the epoxy coated bars shall have padded contact areas to eliminate damage.

g. All bundling bands shall be padded or suitable banding shall be used to prevent damage to the coating. All bundles of coated reinforcing steel bars shall be lifted with a strong back, spreader bar, multiple supports, or a platform bridge to prevent bar to bar abrasion from sags in the bundles of coated reinforcing steel bars.

h. *To reduce or eliminate in-place coating repairs, the bar or bundles shall not be dropped or dragged.*

i. Before the *reinforcing* steel bars are lowered into place and prior to placement of the concrete, the coated bars *shall* be inspected by the Engineer *to check* for damage to the epoxy coating. Where damage *to the coating* exists, *the same* should be repaired with patching material *that would conform to the* specification.

404A.3.10 Inspection and Rejection

The reinforcing steel bars should be inspected for their suitability for coating. Bars with sharp edges on the deformations, rolled-in slivers, or other surface imperfections are difficult to coat properly and should not be coated. The coating will

flow away from the sharp edges and may result in inadequate coating thickness at these points.

If the bar has more than *two percent* (2 %) of its area damaged in any given 0.30 *meter* of coated reinforcement the bar *should* be rejected. Care should be taken during patching if the total bar surface area covered by *the* patching materials exceeds *five percent* (5 %) in any given 0.30 meter section of coated reinforcement, *as*

damage when so occurring shall render the bar as reject. Both of these limits do not include sheared or cut ends.

404A.4 Method of Measurement

The quantity of reinforcing steel to be paid for will be the final quantity placed and accepted in the completed structure.

404A.5 Basis of Payment

The accepted quantity, measured as prescribed in Section 404A.4, shall be paid for at the contract unit price for Epoxy-Coated Steel Reinforcing Bars which price and payment shall be full compensation for furnishing and placing all materials, including all labor, equipment, tools and incidentals necessary to complete the work prescribed in this Item.

Payment will be made under:

Pay Item Number	Description	Unit of Measurement
404A	Epoxy-Coated Reinforcing Steel Bar	Kilogram

References:

1. DPWH Standard Specifications for Highways, Bridges and Airport, Volume II, 2013 Edition
2. American Society for Testing and Materials (ASTM)
3. American Association of State Highway and Transportation Officials (AASHTO)
4. American Concrete Institute (ACI)
5. http://astm.org/Standards/A934.htm
6. http://www.concreteconstruction.net/concrete-articles/epoxy-coated-reinforcing-bars
7. http://www.ehow.com/list_7618105_advantages-epoxy-coated-steel-bars.html
8. http://crsi.org/index.cfm/certification/plant
9. http://wxlvhuan.b2bage.com/product-steel-rebars/942588/fusion-bonded-epoxy-coated
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