Republic of the Philippines
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS
**OFFICE OF THE SECRETARY**
Bonifacio Drive, Port Area Manila

BAGONG PILIPINAS

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**DEPARTMENT ORDER )**
**)**
**NO. 98 )**
**Series of 2024 )**
dt 6/14/2024

**SUBJECT: DPWH Standard Specification for Item 425 – Bridge Repair and Retrofitting Works**

In order to ensure the proper utilization/adoption of bridge repair and retrofitting practices and to facilitate the implementation of bridge rehabilitation projects, the attached **DPWH Standard Specification for Item 425 – Bridge Repair and Retrofitting Works** is hereby prescribed for adoption in Government infrastructure projects.

This Standard Specification shall form part of the DPWH Standard Specifications for Highways, Bridges and Airports, Volume II and is now included in the Project and Contract Management Application (PCMA).

This Order supersedes the following issuances and shall take effect immediately:

1. Department Order No. 106, Series of 2015 – DPWH Standard Specification for Item 740 – Structural Concrete Injection and Crack Repair

2. Memorandum dated May 21, 2018 (Memo 097.7_052118) - Proposed DPWH Standard Specification for Item 628(1), Waterproofing on Deck Slab

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**DPWH Standard Specification for**
**ITEM 425 – BRIDGE REPAIR AND RETROFITTING WORKS**

## 425.1 Description

This Item shall consist of repair and retrofitting works for permanent bridges, including labor, equipment and materials, at locations shown on the Plans and in accordance with this Specification.

## 425.2 Material Requirements

### 425.2.1 Waterproofing on Deck Slab

#### 425.2.1.1 Rubberized Membrane

Rubberized membrane shall conform to the requirements as shown in Table 425.1.

**Table 425.1 Requirements of Rubberized Membrane**

| Property | Requirement | Test Method |
|---|---|---|
| Elongation, Min. | 450 % | ASTM D638 |
| Tensile Strength, Min. | 15 Kgf/cm$^2$ | ASTM D638 |
| Concrete Bond Strength, Min. | 7 Kgf/cm$^2$ | ASTM D882 |

*Notes: ASTM D638 – Standard Test Method for Tensile Properties of Plastics*
*ASTM D882 – Standard Test Method for Tensile Properties of Thin Plastic Sheeting*

#### 425.2.1.2 Asphalt Compound Membrane

Asphalt compound membrane shall conform to the requirements as shown in Table 425.2.

**Table 425.2 Requirements of Asphalt Compound Membrane**

| Property | Requirement | Test Method |
|---|---|---|
| Penetration with Conic Needle | 2 – 5 mm | ASTM D217 |
| Melting Temperature, Min. | 80 °C | ASTM D3461 |
| Elongation, Min. | 3.5 % | ASTM D638 |
| Tensile Strength, Min. | 300 Kgf/cm$^2$ | ASTM D638 |

*Notes: ASTM D217 – Standard Test Methods for Cone Penetration of Lubricating Grease*
*ASTM D3461 – Standard Test Method for Softening Point of Asphalt and Pitch (Mettler Cup-and-Ball Method)*

Silica sand to be used as protection to the waterproofing layer shall conform to the manufacturer's recommendation.

### 425.2.2 Epoxy Coating on Crack

#### 425.2.2.1 Epoxy Sealant

The epoxy sealant for coating on crack shall conform to the requirements in Table 425.3.

**Table 425.3 Requirements of Epoxy Sealant for Coating on Crack**

| Property | Requirement | Test Method |
|---|---|---|
| Viscosity, Max. | 500 mPa-sec | ASTM D445 |
| Bond Strength to Concrete Dry / Wet, Min. | 1.5 MPa | ASTM D7234 |
| Slant Shear Bond Strength, Min. | 15 MPa | ASTM C882 |

*Notes: ASTM D445 – Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity)*
*ASTM D7234 – Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers*
*ASTM C882 – Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear*

### 425.2.3 Epoxy Injection on Crack (Deck Slab and Bridge Superstructure)

#### 425.2.3.1 Epoxy Resin

The epoxy injection material to be used for crack on deck slab and bridge superstructure shall be compatible with the concrete and shall have the properties as shown in Table 425.4.

**Table 425.4 Requirements of Epoxy Resin for Epoxy Injection on Crack**

| Property | Requirement | Test Method |
|---|---|---|
| Viscosity, Max. | 1000 mPa-sec | ASTM D445 |
| Specific Gravity | 1.15 ± 0.1 | ASTM D792 |
| Compressive Strength, Min. | 50 MPa | ASTM D695 |
| Flexural Strength, Min. | 40 MPa | ASTM D790 |
| Tensile Shear Bond Strength, Min. | 10 MPa | ASTM D1002 |
| Slant Shear Bond Strength to Concrete, Min. [A] | 15 MPa | ASTM C882 |
| Bond Strength to Concrete (Dry / Wet), Min. | 1.5 CF MPa | ASTM D7234 |

*Notes: CF=Concrete Failure*
*[A] Requirement shall only apply to Bridge Superstructure*
*All other requirements shall apply to Deck Slab and Bridge Superstructure*
*ASTM D695 – Standard Test Method for Compressive Properties of Rigid Plastics*
*ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics And Electrical Insulating Materials*
*ASTM D792 – Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement*
*ASTM D1002 – Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading (Metal-to-Metal)*

### 425.2.3.2 Sealant

The epoxy-based sealant material to be used for crack on deck slab and bridge superstructure shall be compatible with the injection material and shall have the properties as shown in Table 425.5.

**Table 425.5 Requirements of Sealant for Epoxy Injection on Crack**

| Property | Requirement | Test Method |
|---|---|---|
| Specific Gravity | 1.50 ± 0.30 | ASTM D792 |
| Compressive Strength, Min. | 50 MPa | ASTM D695 |
| Flexural Strength, Min. | 15 MPa | ASTM D790 |
| Tensile Shear Bond Strength, Min. | 10 MPa | ASTM D1002 |
| Bond Strength to Concrete (Dry / Wet), Min. | 1.5 CF MPa | ASTM D7234 |

*Note: All requirements shall apply to Deck Slab and Bridge Superstructure*

### 425.2.4 Replacement of Expansion Joint

### 425.2.4.1 New Expansion Joint

The expansion joint to be installed shall conform to the requirements of Item 413, Expansion Joint Systems.

### 425.2.4.2 Expansion Joint Rubber Seal

The expansion joint rubber seal shall comply with the following requirements:

**Table 425.6 Requirements of Expansion Joint Rubber Seal**

| Property | Requirement | Test Method |
|---|---|---|
| Tensile Strength, Min. | 0.98 MPa | ASTM D412 |
| Elongation at break, Min. | 100 % | ASTM D412 |

*Note: ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers—Tension*

### 425.2.5 Caulking

### 425.2.5.1 Epoxy Grout

The epoxy grout for caulking shall be compatible with the concrete and shall have the properties as shown in Tables 425.7 and 425.8.

**Table 425.7 Requirements of Epoxy-Based Injection Material for Caulking of Deck Slab and Girder**

| Property | Requirement | Test Method |
|---|---|---|
| Viscosity, Max. | 1000 mPa-sec | ASTM D445 |
| Specific Gravity | 1.15±0.10 | ASTM D792 |

| Property | Requirement | Test Method |
|---|---|---|
| Compressive Strength, Min. | 50 MPa | ASTM D695 |
| Modulus of Elasticity, Min. | 1000 Mpa | ASTM D695 |
| Flexural Strength, Min. | 40 Mpa | ASTM D790 |
| Tensile Shear Bond Strength, Min. | 10 Mpa | ASTM D1002 |
| Bond Strength to Concrete (Dry/Wet), Min. | 1.5 CF Mpa | ASTM D7234 |

**Table 425.8 Requirements of Epoxy-Based Injection Material for Caulking of Substructure**

| Property | Requirement | Test Method |
|---|---|---|
| Specific Gravity | 1.1±0.1 | ASTM D792 |
| Viscosity, Max. | 2000 mPa-sec | ASTM D445 |
| Consistency | Liquid | ASTM C881 |
| Elongation, Min. | 50% | ASTM D638 |
| Bond Strength to Concrete (Dry/Wet), Min. | 3.0 MPa | ASTM C882 |

*Note: ASTM C881 - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete*

### 425.2.5.2 Sealant

The epoxy based sealant shall be compatible with the injection material and shall have the properties as shown in Tables 425.9 and 425.10.

**Table 425.9 Requirements of Epoxy-Based Sealant for Caulking of Deck Slab and Girder**

| Property | Requirement | Test Method |
|---|---|---|
| Specific Gravity | 1.50 ± 0.30 | ASTM D792 |
| Compressive Strength, Min. | 50 MPa | ASTM D695 |
| Flexural Strength, Min. | 15 MPa | ASTM D790 |
| Tensile Shear Bond Strength, Min. | 10 MPa | ASTM D1002 |
| Bond Strength to Concrete (Dry/Wet), Min. | 1.5 CF MPa | ASTM D7234 |

**Table 425.10 Requirements of Epoxy-Based Sealant for Caulking of Substructure**

| Property | Requirement | Test Method |
|---|---|---|
| Specific Gravity | 1.50 ± 0.30 | ASTM D792 |
| Consistency | Paste-like | ASTM C881 |
| Elongation, Min. | 50% | ASTM D638 |

| Property | Requirement | Test Method |
|---|---|---|
| Bond Strength to Concrete, Min. | 3.0 MPa | ASTM C882 |

### 425.2.6 Patching

#### 425.2.6.1 Portland Cement Mortar

Portland Cement Mortar shall conform to the requirements of Item 405, Structural Concrete. Strength test for Portland cement mortar shall conform to ASTM C780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.

#### 425.2.6.2 Polymer Cement Mortar

Polymer Cement Mortar (PCM) shall conform to the following requirements:

**Table 425.11 Requirements for Polymer Cement Mortar**

| Property | Requirement | Test Method |
|---|---|---|
| Compressive Strength at 28 days, Min. | 25 MPa | ASTM C39 |
| Bonding Strength to Concrete, Min. | 1.5 MPa | ASTM D7234 |
| Bleeding Rate | 0% | ASTM C39 |

*Notes: All requirements shall apply to routine maintenance, repair of deck slab, superstructure, and substructure*
*ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*

#### 425.2.6.3 Protective Coating for Rebar

Protective coating for rebar shall conform to the following requirements:

**Table 425.12 Requirements for Protective Coating for Rebar**

| Property | Requirement | Test Method |
|---|---|---|
| Compressive Strength, Min. | 75 MPa | ASTM D695 |
| Flexural Strength, Min. | 40 MPa | ASTM D790 |
| Tensile Strength, Min. | 30 MPa | ASTM D638 |
| Tensile Shear Bond to Steel, Min. | 10 MPa | ASTM D1002 |
| Slant Shear Bond to Mortar, Min. | 15 MPa | ASTM C882 |

*Note: All requirements shall only apply to repair of deck slab*

#### 425.2.6.4 Epoxy Bonding Agent

Epoxy Bonding Agent shall conform to the following requirements:

**Table 425.13 Requirements for Epoxy Bonding Agent for Routine Maintenance Repair**

| Property | Requirement | Test Method |
|---|---|---|
| Compressive Strength, Min. | 70 MPa | ASTM D695 |
| Flexural Strength, Min. | 40 MPa | ASTM D790 |
| Tensile Strength, Min. | 30 MPa | ASTM D638 |
| Tensile Shear Bond to Steel, Min. | 15 MPa | ASTM D1002 |
| Slant Shear Bond to Mortar, Min. | 15 MPa | ASTM C882 |
| Bond Strength of Cured Concrete to Fresh Concrete, Min. | 15 MPa | ASTM D7234 |

**Table 425.14 Requirements for Epoxy Bonding Agent for Major Maintenance Repair**

| Property | Requirement | Test Method |
|---|---|---|
| Compressive Strength, Min. | 75 MPa | ASTM D695 |
| Flexural Strength, Min. | 40 MPa | ASTM D790 |
| Tensile Strength, Min. | 30 MPa | ASTM D638 |
| Tensile Shear Bond to Steel, Min. | 10 MPa | ASTM D1002 |
| Slant Shear Bond to Mortar, Min. | 15 MPa | ASTM C882 |

*Note: All requirements shall only apply to repair of superstructure and substructure*

### 425.2.6.5 Zinc-Rich Primer for Rebar

Zinc-Rich Primer shall conform to the following requirements:

**Table 425.15 Specifications of Zinc-Rich Primer for Rebar**

| Property | Requirement | Test Method |
|---|---|---|
| Gloss at 60° Angle | Flat | ASTM D523 |
| Adhesion, Min. | 3A | ASTM D3359 |
| Salt Spray Resistance | Excellent | ASTM B117 |
| % Zinc (By weight in Dried Film Test) | 87.5±2% | ASTM D6580 |

*Notes: All requirements shall only apply to repair of deck slab, superstructure, and substructure*
*ASTM D523 – Standard Test Method for Specular Gloss*
*ASTM D3359 – Standard Test Methods for Rating Adhesion by Tape Test*
*ASTM D117 – Standard Guide for Sampling, Test Methods, and Specifications for Electrical Insulating Liquids*
*ASTM D6580 – Standard Test Method for the Determination of Metallic Zinc Content in Both Zinc Dust Pigment and in Cured Films of Zinc-Rich Coatings*

### 425.2.7 Partial Deck Slab Replacement

#### 425.2.7.1 Portland Cement

This material shall conform to the applicable requirements of Item 405, Structural Concrete.

#### 425.2.7.2 Reinforcing Steel

This material shall conform to the applicable requirements of Item 404, Reinforcing Steel

#### 425.2.7.3 Epoxy Resin

This material shall conform to the requirements of Subsection 425.2.6.4, Epoxy Bonding Agent.

#### 425.2.7.4 Zinc-Rich Primer

This material shall conform to the requirements of Subsection 425.2.6.5, Zinc-Rich Primer for Rebar.

### 425.2.8 Special Anti-Corrosion Paint

Special Anti-Corrosion Paint shall conform to the following requirements:

**Table 425.16 Requirements for Special Anti-Corrosion Paint**

| Property | Requirement | Test Method |
|---|---|---|
| Adhesive Test, Min. | 1.0 MPa at 7days<br>1.5 MPa at 28 days | ASTM D7234 |
| Elongation, Min. | 0.40% at 7 days<br>0.40% at 28 days | ASTM C190 |
| Saltwater Test | No defection | ASTM D6943 |

*Notes: ASTM D7234 – Standard Test Method for Pull-Off Adhesion Strength of Coatings on Concrete Using Portable Pull-Off Adhesion Testers*
*ASTM C190 – Standard Test Method for Tensile Strength of Hydraulic Cement Mortars*
*ASTM D6943 – Standard Practice for Immersion Testing of Industrial Protective Coatings and Linings*

### 425.2.9 Dismantling and Reinstallation of Existing Signs

The dismantling and reinstallation of existing signs shall conform to the applicable material requirements of Item 602, Monuments, Markers, and Guide Posts and Item 605, Road Signs.

All damaged materials subject for replacement shall be furnished as new.

### 425.2.10 Protective Coating for Concrete Structures

Acryl Urethane Protective Coating shall conform to the requirements as shown in Table 425.17.

**Table 425.17 Specifications of Protective Coating**

| Property | Requirement | Test Method |
|---|---|---|
| Bond Strength, Min. | 1.5 MPa | ASTM D3359/ ASTM D7234 |
| Tap Water Resistance | No Change | ASTM D6943 |
| Acid Resistance (5%$H_2SO_4$) | No Change | ASTM D6943 |
| Alkali Resistance (5%NaOH) | No Change | ASTM D6943 |

*Notes: All requirements shall apply to repair of deck slab, superstructure, and substructure.*
*ASTM D3359 - Standard Test Methods for Rating Adhesion by Tape Test*
*ASTM D6943 - Standard Practice for Immersion Testing of Industrial Protective Coatings*

### 425.2.11 Bridge Seat Extension

#### 425.2.11.1 Concrete

Concrete shall conform to the requirements as shown in Table 425.11.

The actual mix portion shall be determined during a field mixture test and shall be approved by the Engineer.

#### 425.2.11.2 Anchor Bar

Anchor bar shall conform to the applicable requirements of Item 710, Reinforcing Steel and Wire Rope.

#### 425.2.11.3 Epoxy Bonding Primer

The epoxy bonding primer to concrete shall conform to the requirements as shown in Table 425.14.

#### 425.2.11.4 Zinc-Rich Primer

The zinc-rich primer to rebar shall conform to the requirements as shown in Table 425.15.

### 425.3 Construction Requirements

The application criteria and work sequence for Waterproofing on Deck Slab, Epoxy Coating on Crack, Epoxy Injection on Crack, Replacement of Expansion Joint, Caulking, Patching, Partial Deck Replacement, Bridge Seat Extension, Application of Special Anti-Corrosion Paint and Protective Coating for Concrete Structures shall conform to the DPWH Bridge Repair Manual.

### 425.3.1 Dismantling and Reinstallation of Existing Signs

Dismantling of existing signs and support shall be handled with care to avoid unnecessary damage. Concrete foundations of disassembled signs shall be removed 610 mm below finish

grade. Backfilling of holes and removal of all salvable materials shall conform to the applicable requirements of Item 101, Removal of Structures and Obstructions.

Damaged surfaces shall be restored to good as new condition.

Signs to be reinstalled or relocated shall include new foundations and shall conform to the applicable requirements of Item 605, Road Signs. Supports shall be reused and adjusted to the required length as approved by the Engineer.

Upon reinstallation of signs, dirt, grease, oil smears, and other foreign materials shall be removed by any cleaning methods approved by the Engineer.

## 425.4 Acceptance Requirements

Acceptance shall conform to the requirements for each repair works of the Bridge Repair Manual.

## 425.5 Method of Measurement

### 425.5.1 Waterproofing on Deck Slab

The quantities to be paid for waterproofing on deck slab shall be measured based on the actual area in square meters ($m^2$) of bridge deck material applied and accepted by the Engineer. Application on curb faces and overlaps shall not be included.

### 425.5.2 Epoxy Coating and Epoxy Injection on Crack

The quantities to be paid for epoxy coating and injection on crack shall be based on the total length of crack in linear meters as identified by the Engineer.

### 425.5.3 Replacement on Expansion Joint

The quantities to be paid for shall be measured by the actual length of joint defined by the Engineer in linear meters.

### 425.5.4 Caulking

The quantities to be paid for shall be measured based on the total length of the cracks in linear meters, as identified by the Engineer.

### 425.5.5 Patching

The quantities to be paid for shall be measured by the actual area in square meters ($m^2$) of unsound or delaminated concrete marked and verified by the Engineer. Measurement shall be made after the removal of identified area.

### 425.5.6 Partial Deck Slab Replacement

The quantities to be paid for shall be measured by the actual volume of the replaced concrete in cubic meters ($m^3$) accepted by the Engineer.

### 425.5.7 Special Anti-corrosion Paint

The quantities to be paid for shall be measured by square meters ($m^2$) of steel surfaces cleaned, painted, and accepted by the Engineer.

### 425.5.8 Dismantling and Reinstallation of Existing Signs

This Item shall be measured for each sign dismantled, reinstalled and accepted.

### 425.5.9 Protective Coating for Concrete Structures

The quantities to be paid for shall be measured by the total area of applied protective coating in square meters ($m^2$).

### 425.5.10 Bridge Seat Extension

The quantities to be paid for shall be measured in cubic meters ($m^3$) as verified with the Engineer.

## 425.6 Basis of Payment

The quantities, as determined in Section 425.5, shall be paid for at the Contract Unit Price respectively, for each of the particular Pay Items listed below that is shown on the Bid Schedule, which price and payment shall be full compensation for furnishing and placing all materials and labor, equipment, tools and incidentals necessary to complete the Item.

Payment shall be made under:

| Pay Item Number | Description | Unit of Measurement |
|---|---|---|
| 425 (1) | Waterproofing on Deck Slab, Liquid Applied | Square Meter |
| 425 (2) | Epoxy Coating on Crack | Linear Meter |
| 425 (3) | Epoxy Injection on Crack | Linear Meter |
| 425 (4) | Replacement of Expansion Joint | Linear Meter |
| 425 (5) | Caulking | Linear Meter |
| 425 (6) | Patching | Square Meter |
| 425 (7) | Partial Deck Slab Replacement | Cubic Meter |
| 425 (8) | Special Anti-Corrosion Paint | Square Meter |
| 425 (9) | Dismantling and Reinstallation of Existing Signs | Each |

| Pay Item Number | Description | Unit of Measurement |
|---|---|---|
| 425 (10) | Protective Coating for Concrete Structures | Square Meter |
| 425 (11) | Bridge Seat Extension | Cubic Meter |

*References:*

1. *DPWH and Japan International Cooperation Agency. (2014). Bridge Repair Manual, (2nd Ed.)*
2. *Texas Department of Transportation. (2004). Item 649, Removing or Relocating Roadside Sign Assemblies*