047.13 DPWH
02-02-05

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

FEB 02 2005

DEPARTMENT ORDER)
No. 30)
Series of 2005)
x-x-x-x-x-x-x-x-x-x-x-x 02-02-05

SUBJECT : **DPWH Standard Specifications of Epoxy-Resin-Base Bonding Systems for Concrete**

For the guidance and compliance of all concerned, the new standard specifications of Epoxy-Resin-Base Bonding Systems for Concrete are hereby prescribed which shall form part of the DPWH Standard Specifications, Volume II- Highways, Bridges and Airports.

This supersedes all existing specifications and related issuances issued contrary hereto.

This order shall take effect immediately.

FLORANTE SORIQUEZ
Acting Secretary

DPWH STANDARD SPECIFICATION OF EPOXY–RESIN–BASE BONDING SYSTEMS FOR CONCRETE

1.0 Description

1.1 Scope

This item shall consist of furnishing and placing two-component, epoxy-resin bonding systems for application to portland cement concrete, which are able to cure under humid conditions and bond to damp surfaces in accordance with this specification and in conformity with the types, grades, classes and color specified in the Plans, or as directed by the Engineer.

1.2 Classes and Uses of Epoxy-Resin

1.2.1 Classification

1.2.1.1 This specification shall provide for classification of epoxy-resin bonding systems by type, grade, class, and color.

1.2.2 Types and Uses of Systems

Seven types of systems are provided for in this specification namely: Type I, II, III, IV, V, VI, and VII. Each type shall be used for bonding concrete and other materials as called for on the approved Plans.

The type of systems will generally be used as follows:

Type I – For use in non-load bearing application for bonding hardened concrete to hardened concrete and other materials, and as a binder in epoxy mortars or epoxy concretes.
Type II – For use in non-load bearing applications for bonding freshly mixed concrete to hardened concrete.
Type III – For use in bonding skid-resistant materials to hardened concrete and as a binder in epoxy mortars or epoxy concretes used on traffic bearing surfaces (or surfaces subject to thermal or mechanical movements).
Type IV – For use in load bearing applications for bonding hardened concrete to hardened concrete and other materials and as a binder for epoxy mortars and concretes.
Type V – For use in load bearing applications for bonding freshly mixed concrete to hardened concrete.
Type VI – For bonding and sealing segmental pre-cast elements with internal tendons and for span-by-span erection when temporary post tensioning is applied.
Type VII – For use as a non-stress carrying sealer for segmental pre-cast elements when temporary post tensioning is not applied as in span-by-span erection.

1.2.3 Grades of Systems

Three grades of systems defined according to their flow characteristics and are provided in this specification according to Grade 1, 2, and 3.

Grade 1 – Low viscosity.
Grade 2 – Medium viscosity.
Grade 3 – Non-sagging consistency.

1.2.4 Classes of Systems

This specification provides six classes of systems and are defined in accordance with the range of temperatures for which they are suitable, namely: Classes A, B, and C are defined for Types I through V, and Classes D, E, and F are defined for Types VI and VII. However, the temperature of the surface of the hardened concrete to which the bonding system is to be applied may be considerably different from that of the air. Where unusual curing rates are desired it is possible to use a class of bonding agent at a temperature other than that for which it is normally intended.

Class A – For use below 40°F (4.0°C) the lowest allowable temperature to be defined by the manufacturer of the product.
Class B – For use between 40°F and 60°F (4.0°C and 15.0°C).
Class C – For use above 60°F (15.0°C) the highest allowable temperature to be defined by the manufacturer of the product.
Class D – For use between 40°F and 65°F (4.0°C and 18.0°C).
Class E – For use between 60°F and 80°F (15.0°C and 30.0°C).
Class F – For use between 75°F and 90°F (25.0°C and 30.0°C).

1.2.5 Color

Epoxy resin systems are normally unpigmented, but they can be colored or darkened depending upon the desire of the end user.

2.0 Material Requirements

2.1 General

The systems covered by this specification shall be furnished in two components for combining immediately prior to use in accordance with the written instructions of the agency responsible for preparing the separate components and for recommending the proportions to be used in preparing the final bonding system.

Component A is most often the portion containing the epoxy resin with or without reactive diluents.

Component B is its hardener system containing one or more curing agents, which on mixing with Component A shall cause the mixture to harden.

Suitable inert filler may be uniformly incorporated in one or both components. The filler shall be either non-settling or readily dispersible in any component in which it is incorporated. Almost without exception, epoxy systems must be formulated to make them suitable for specific end uses. All systems shall cure under humid conditions, and bond to damp surfaces.

Epoxy resin systems will adhere to a wide variety of materials, including wood, metals, masonry, and most plastics. Polyethylene, TFE-fluorocarbon, cellophane, and greased or waxed surfaces are among the few materials to which these systems will not adhere.

2.2 Physical Requirements

A mixture of Component A and B shall conform to the Physical Requirements of Bonding Systems specified in Table 1 of ASTM C881/AASHTO M235.

2.3 Chemical Requirements

The epoxy resin constituent of Component A shall have an epoxy equivalent of 155 to 275 g/g mol.

3.0 Construction Requirements

3.1 Preparation of Surface

All bonding surfaces shall be clean and free of all dirt, dust, oil, grease, old coatings, laitance, or any other materials, which would prevent bonding. If it is necessary to have chipping or scarifying to achieve clean and sound substrate surface. Chemical cleaning is recommended to remove salts, laitance and penetrating contaminants and it should be followed with thorough rinsing with clean water.

3.2 Mixing and Application

3.2.1 Mixing

Mixing proportions and procedures, as well as mixing time, shall be in accordance with the manufacturers' recommendations or as prescribed by the Engineer.

Prior to mixing, each component shall be thoroughly mixed with a paddle. Separate paddles shall be used to stir each component.

3.2.2 Application

The applicator should be assured that the epoxy to be applied has the proper rate of hardening and viscosity for the job. Both are affected by the temperature at which the epoxy is applied, and both can affect the ultimate thickness of the epoxy layer. The amount of sag and thickness that will be achieved in the adhesive layer also depends partly on whether it is applied to a vertical surface, to the top of a horizontal surface or the bottom and whether the surface is flat or irregular.

Highly porous concretes or concrete made of very absorptive aggregate may absorb enough epoxy to starve the glue line. Such concrete should be given a first seal coat of the same epoxy adhesive to penetrate into the absorptive aggregate. Allow the seal to become tack free and then apply the second coat. To assure adhesion most epoxy manufacturers recommend that subsequent coats be applied within 24 hours. If a longer time is required before recoating, sandblast the last coat to remove the gloss and immediately apply the next coat.

The resin shall be fully cured within 24 hours after application.

Epoxy protective coating shall be applied using brush or roller.

3.3 Safety Requirements

Epoxy resins contain irritants, especially to the skin, eyes, and respiratory system. Persons handling these materials shall use appropriate protective clothing, including rubber or plastic gloves. If an epoxy resin should contact the skin, it shall be removed immediately with a dry cloth or paper towel, and the area of contact washed thoroughly with soap and water. Solvents shall not be used, because they carry the irritant into the skin. Cured epoxy resins are harmless.

3.4 Sampling

Take a representative sample of each of the two components from a well-blended lot prior to packaging or by withdrawing samples from no fewer than 5 percent of the containers comprising the lot or shipment. Unless the samples of the same component taken from containers show visual evidence of variability, they may be combined into a single composite sample. In place of the foregoing, packaged materials may be sampled by a random selection of containers of each component from each lot, provided such a procedure is acceptable to the purchaser.

3.5 Testing

Epoxy resins shall be tested in accordance with ASTM C881 or AASHTO M235.

3.6 Acceptance, Rejection and Rehearing

3.6.1 Material that fails to conform to the requirements of this specification shall be rejected. Rejection shall be reported to the supplier promptly and in writing. In case of dissatisfaction with the results of the test, the supplier has the right to a rehearing.

3.6.2 If all requirements of this specification are met, except those pertaining to bond strength, the bond tests shall be repeated. If the sample again fails to meet the bond strength requirements, the entire lot shall be rejected.

3.6.3 *Retest* – Lots of material that have been rejected shall be reworked by the supplier to correct the defects and resubmitted for test provided specific approval of the purchaser has been obtained for such resubmission. Before resubmission of the material, full particulars concerning the action taken to correct the defects in the original material shall be made available to the purchaser.

3.7 Packaging and Package Marking

3.7.1 Packaging

The two components furnished under this specification shall be supplied in separate containers that are non-reactive with the contents. They are usually supplied in amounts such that the recommended proportions of the final mixture can be obtained by combining one container of Component A with one container of Component B.

3.7.2 Marking

Containers shall be identified as "Component A – Contains Epoxy Resin" and "Component B – Contains Curing Agent" and shall show the type, grade, class, and color. Each container shall be marked with the name of the formulator, the lot number, the date of packaging, the quantity contained therein, and the recommended mixing ratio, by both weight and volume. The materials shall be delivered on site in sealed container.

3.7.3 Ordering Information

3.7.3.1 The purchaser shall specify the type, grade, class, and color of bonding system desired and the size of units in which the components shall be furnished. Special requirements regarding filling of either the components or the final bonding system should be stated. The product furnished under this specification is intended to be resistant to moisture after proper curing, and therefore should be suitable for either indoor or outdoor exposure.

3.7.3.2 The purchaser may specify a minimum gel time of 5 minutes for Types I and IV when automatic proportioning, mixing, and dispensing equipment are used.

3.8 Storage

Both components shall be stored for a year in their original containers and shall be kept under dry and cool conditions.

4.0 Measurement and Payment

Epoxy-resin-base bonding system shall not be measured and paid for separately, but the cost thereof shall be considered as included in the contract unit price of the items where called for.

References

1. **ASTM C 881/C 881 M** *Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete*
2. **AASHTO M 235** *Epoxy Resin Adhesives*
3. **Manufacturers' Standards**
    a. Chemserve Incorporated
    b. Construction Chemicals Technologies, Inc.
    c. Weltanchaung Corporation

TABLE 1 Physical Requirements of Bonding Systems

Property	Type						
	I	II	III	IV	V	VI	VII
Viscosity, P [Pa-s]:							
Grade 1, max	20 [2.0]	20 [2.0]	20 [2.0]	20 [2.0]	20 [2.0]	...	...
Grade 2, min	20 [2.0]	20 [2.0]	20 [2.0]	20 [2.0]	20 [2.0]	...	...
max	100 [10]	100 [10]	100 [10]	100 [10]	100 [10]	...	...
Consistency, in [mm]:							
Grade 3, Types I, II, III, IV, V, VI, VII, max	¼ [6.0]	¼ [6.0]	¼ [6.0]	¼ [6.0]	¼ [6.0]	¼ [6.0]	¼ [6.0]
Gel time, minutes, min	30	30	30	30	30	30	30
Bond strength, min, psi [MPa]:							
2 days (moist cure)	1000 [7.0]	...	...	1000 [7.0]	...	1000 [7.0]	...
14 days (moist cure)	1500 [10.0]	1500 [10.0]	1500 [10.0]	1500 [10.0]	1500 [10.0]	...	1000 [7.0]
Absorption, 24 h max, %	1	1	1	1	1	...	...
Heat Deflection Temperature, min, °F [°C]:							
7 days	...	...	...	120 [50]	120 [50]	...	...
14 days	...	...	...	...	...	120 [50]	120 [50]
Thermal compatibility	...	...	passes test	...	...	...	...
Linear coefficient of shrinkage on cure, max	0.005	0.005	...	0.005	0.005	...	...
Compressive Yield Strength, min, psi [MPa]:							
24 h	...	...	...	...	...	2000 [14.0]	...
36 h	...	...	...	...	...	...	1000 [7.0]
48 h	...	...	...	...	...	6000 [40.0]	...
72 h	...	...	...	...	...	...	2000 [14.0]
7 days	8000 [55.0]	5000 [35.0]	...	10 000 [70.0]	8000 [55.0]	...	...
Compressive Modulus, psi [MPa]:							
Min	150 000 [1000]	90 000 [600]	...	200 000 [1400]	150 000 [1000]	...	...
Max	...	...	130 000 [896]	...	...	...	...
Tensile Strength, 7 days min, psi [Mpa][A]	5000 [35.0]	2000 [14.0]	...	7000 [50.0]	6000 [40.0]	...	...
Elongation at Break, %, min	1	1	30	1	1	...	...
Contact Strength, psi [Mpa] min							
2 days	...	...	...	...	...	1000 [7.0]	...
14 days	...	...	...	...	...	...	1000 [7.0]

[A] Not required for Viscosity Grade 3 Systems.