Florida Department of Transportation

JEB BUSH
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

THOMAS F. BARRY, JR.
SECRETARY

November 18, 2002

Mr. Donald Davis
Program Operations Engineer
Federal Highway Administration
227 N. Bronough Street, Suite 2015
Tallahassee, Florida 32301

Re: Office of Design, Specifications
Section 926
Proposed Specification: D9260000 – Epoxy Compounds

Dear Mr. Davis:

We are submitting, for your approval, two copies of a proposed Supplemental Specification for Epoxy Compounds.

This change has been developed by Robert Robertson of the State Structures Office to combat severe corrosion in some post-tensioned structures.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via Email to SP965DB or duane.brautigam@dot.state.fl.us.

If you have any questions relating to this specification change, please call Duane F. Brautigam, State Specifications Engineer at 414-4110.

Sincerely,

Signature on file

Duane F. Brautigam, P.E.
State Specifications Engineer

DFB/sh
Attachment
cc: General Counsel
Florida Transportation Builders' Assoc.
State Construction Engineer

**EPOXY COMPOUNDS.**
**(REV 10-7-02)**

SECTION 926 (Pages 837-844) is deleted and the following substituted:

## SECTION 926
## EPOXY COMPOUNDS

### 926-1 Types of Compounds.

Epoxy resin compounds for application to portland cement concrete, bituminous cement concrete, metals and other type surfaces shall be two-component systems of the applicable of the following types as designated.

Type A - An epoxy resin, for bonding fresh concrete to hardened concrete.

Type B - An epoxy resin adhesive, for bonding hardened concrete to hardened concrete.

Type C - An epoxy resin adhesive, for bonding traffic markers to hardened concrete and to asphaltic concrete.

Type D - A coal-tar, modified epoxy resin for application as a skid-resistant or protective overlay for cement concrete.

Type E - A fluid epoxy for crack injection in the repair of old structures.

Type F - An epoxy for repairing spalled areas on concrete bridge structures with these subtypes:

F-1 - A non sagging gel type for vertical surfaces, and

F-2 - A pourable type for repairs where forms are to be used.

Type G - An epoxy for rebuilding expansion joints and associated wearing surfaces.

Type H - An epoxy for structural bonding where asphalt overlays are to be in contact with the hardened compound.

Type I - An epoxy for filling small holes in concrete such as lifting bolt cut-outs on beams, etc.

Type J - An epoxy for installing rebar and anchor bolts into hardened concrete.

Type K - An epoxy for underwater sealing of the bottom of the jacket of an integral pile jacket system.

Type L - An epoxy for coating the interior of sewage disposal tanks.

Type M - An epoxy for coating steel H piling for fender systems (water immersion).

Type N - An epoxy for preparing mortars and concrete for patching portland cement concrete pavement.

Type O - An epoxy coating system consisting of a penetrant and a surface coating to be used singly or in combination for the protection of concrete surfaces, both new and repaired.

Type P - An epoxy for bonding metals.

*Type Q - An epoxy for use in post tensioning anchorage protection systems.*

### ~~926-2 General Requirements.~~

~~All types of compounds except D, L, M, and O shall contain no volatile solvent.~~

~~All types of compounds except C, F, I, J, L, M, N and O shall be basically pure reactive material with a maximum ash content of 2%.~~

~~All types shall have simple mix ratios of one to one or two to one or shall be supplied in pre-measured containers in which all of the contents of both packages are to be mixed.~~

~~Certain terms used in this specification shall have these meanings:~~

~~low modulus - the stress-strain property for which ultimate tensile strength is attained at over 10% elongation.~~

~~high modulus - the stress-strain property for which ultimate tensile strength is attained at under 6% elongation.~~

~~non-sagging gel - grades of mixed compounds which will not perceptibly flow under their own weight on a vertical surface in the unhardened state.~~

~~pourable - grades of mixed compound sufficiently fluid that they (either neat or filled) can be cast into and will take the shape of a mold.~~

***926-2 Epoxy Design Requirements.***

***926-2.1 General:*** *All types of compounds except D, L, M, and O shall contain no volatile solvent.*

*All types of compounds except C, F, J, L, M, N and O shall be basically pure reactive material with a maximum ash content of 2%.*

*All types shall have simple mix ratios of one to one or two to one or shall be supplied in pre-measured containers in which all of the contents of both packages are to be mixed.*

*Certain terms used in this specification shall have these meanings:*

*low modulus - the stress-strain property for which ultimate tensile strength is attained at over 10% elongation.*

*high modulus - the stress-strain property for which ultimate tensile strength is attained at under 6% elongation.*

*non-sagging gel - grades of mixed compounds which will not perceptibly flow under their own weight on a vertical surface in the unhardened state.*

*pourable - grades of mixed compound sufficiently fluid that they (either neat or filled) can be cast into and will take the shape of a mold.*

***926-2.2 Qualified Products List:*** *All epoxy materials~~, excluding Type Q~~, shall be one of the products listed on the Department's Qualified Products List. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.*

*Products may only be used for applications recommended by the manufacturer.*

***926-2.3 Certification:*** *The Contractor shall provide the Engineer with certification from the manufacturer of the epoxy, confirming that the requirements of this Section are met. The certification shall conform to the requirements of Section 6. Each certification shall cover only one batch of epoxy materials.*

## 926-3 Specific Requirements for Types A and B Compounds.

**926-3.1 Mixing and Application:** Types A and B epoxy compounds (for bonding fresh concrete to hardened concrete or bonding precast concrete parts) shall be mixed, applied, and cured in accordance with the manufacturer's directions, or as might be directed otherwise by the Engineer.

Epoxy compounds shall be used only under conditions which are compatible with the material being applied in accordance with the specific directions of the manufacturer.

**926-3.2 Performance Tests:**

(a) For Epoxy Bonding Compounds: The performance test, upon which the acceptance of epoxy bonding compounds is based, is described below. Test specimens shall be cured at a temperature of 73 ± 3°F [23 ± 2°C]. The epoxy compounds shall be tested for composite cylinder shear (diagonal shear) as specified below.

The test specimen of concrete shall be prepared in a 3 by 6 inch [76 by 152 mm] mold. The first portion of the test specimen may be formed by sawing a full size 3 by 6 inch [76 by 152 mm] cylinder on a 45-degree slope from the vertical, giving a maximum height of 4 1/4 inches [108 mm] to a minimum height of 1 1/4 inches [32 mm], or through the use of an elliptical insert of the same dimensions. The concrete shall be cast as described in AASHTO T 23, using Class III Concrete (Florida DOT designation) with Type III Cement. The specimens shall be cured in the standard manner, and for at least four days. At the end of this period the half cylinder on which the epoxy resin is to be applied shall be prepared for bonding by removal of all loose particles and oil film and then coated with a thick coat of the epoxy compound under test. The portion of the cylinder shall then be replaced in the mold and plastic concrete of the same mix as before added to the mold to form the 3 by 6 inch [76 by 152 mm] cylinder. Reference test cylinders are prepared with each batch of concrete.

After the composite test cylinder has cured for a 3-day period in a moist cabinet, the compressive-strength is determined. This strength is compared to the strength of the weaker of the two concretes from which the test cylinder was made. If the ratio of the compressive strength of the composite cylinder to the compressive strength of the weaker concrete is less than 0.90, the epoxy compound is rejected.

(b) For Epoxy Mortars: Epoxy mortar shall be prepared for testing using two parts of standard concrete sand and one part of mixed epoxy compound. Three 2 inches [50 mm] cubes shall be cast from the epoxy mortar and cured for three days prior to testing. The cubes shall be tested in direct compression. The average compressive strength of the three test specimens shall be at least 5,000 psi [35 MPa].

The molds for epoxy mortar test specimens and compressive loading shall be in accordance with AASHTO T 106.

## 926-4 Specific Requirements for Type C Compounds.

Epoxy adhesives for pavement markers will be approved on the basis of satisfactory performance in field tests. If, during a one year period, more than 2% of the markers in a test site are displaced due to failure of the adhesive, the adhesive will not be considered acceptable.

## 926-5 Specific Requirements for Type D Compounds.

These compounds shall meet the requirements of AASHTO M 200.

## 926-6 Specific Requirements for Type E Compounds.

Epoxies for crack injection shall meet the Specification for Type B compound with these additional requirements:

| | | |
|---|---|---|
| Viscosity five minutes after mixing | 300 to 600 cps at 77°F by ASTM D 2393 | [0.3 to 0.6 Pa≅s at 25°C by ASTM D 2393] |
| Wet bond strength to concrete, minimum | 250 psi at seven days by Florida Method FM 5-518 | [1.7 MPa at seven days by Florida Method FM 5-518] |

## 926-7 Specific Requirements for Type F Compounds.

Epoxies for repairing spalled areas shall meet these requirements:

Subtype F-1 for repairing vertical and other surfaces shall be a trowelable low modulus, non-sagging gel epoxy compound capable of bonding to wet surfaces with these properties:

| | |
|---|---|
| Color | Shall match gray color No. 36622 of Federal Standard No. 595a |
| Viscosity | Gel |

| | |
|---|---|
| Color | Shall match gray color No. 36622 of Federal Standard No. 595a |
| Maximum sand loading | 2.25 parts sand to one part mixed epoxy by volume |
| Elongation in tension minimum | 10% by ASTM D 638, seven day cure |
| Wet bond to Steel and Concrete minimum | 250 psi [1.7 MPa] by Florida Test Method FM 5-23 |

Subtype F-2 for filling larger spalls where a form is required to build back to the original surface shall be a pourable low modulus type compound capable of bonding to wet surfaces with these properties:

| | |
|---|---|
| Color | Shall match gray color No. 36622 of Federal Standard No. 595a |
| Maximum sand loading | 2.25 parts sand to one part mixed epoxy by volume |
| Elongation in tension, minimum | 10% by ASTM D 638, seven day cure |
| Exotherm | 110°F [43°C] by ASTM D 2471, 415 mL sample |
| Wet bond strength | 250 psi [1.7 MPa] at seven days by Florida Method FM 5-518 |

**926-8 Specific Requirements for Type G Compounds.**

Epoxies for rebuilding expansion joints shall be pourable types which may be mixed with sand and with these requirements for the mix:

| Compressive strength | |
|---|---|
| at 24 hours, minimum | 4,500 psi [30 Mpa] |
| at seven days, minimum by the method of 926-3.2(b) | 7,500 psi [50 Mpa] |
| Bond to wet concrete at seven days by Florida Method FM 5-518 | 250 psi [1.7 Mpa] |
| Maximum sand loading | 2.25 parts to one part mixed epoxy by volume |
| Elongation in tension at seven days, ASTM D 638, minimum | 2% |
| Color | Natural |
| Exotherm, maximum by test method ASTM D 2471, 1 pint [415 mL] sample size | 110°F [43°C] |

**926-9 Specific Requirements for Type H Compounds.**

Epoxies for structural bonding where bituminous pavement overlays will come in contact with the hardened compound shall meet the requirements for Types A and B compounds above and the manufacturer shall provide test data showing that cutback and emulsified asphalts, asphalt cement, and bituminous mixes shall bond to but not soften or otherwise damage the epoxy after a curing period of four days.

**926-10 Specific Requirements for Type I Compounds.**

Epoxies for cosmetic patching of small areas on new concrete structures and components shall be of any non-sagging grade which has a gray color matching that of Shade 36622 of the Federal Standards and which has been demonstrated to the Engineer to bond satisfactorily to the concrete.

**926-11 Specific Requirements for Type J Compounds.**

Epoxies for installing rebar and anchor bolts into the hardened concrete shall meet the requirements of Section 937 and be installed in accordance with Section 416. When the Contract Documents call for the use of Type J, Class I, II, III, IV, epoxy or a Class IV Adhesive Anchor

System, use materials meeting the requirements of Section 937, constructed in accordance with Section 416. Use materials meeting Section 937 to construct doweled splices for prestressed concrete piles.

## 926-12 Specific Requirements for Type K Compounds.

Epoxies for sealing the bottom of integral pile jackets in the repair of concrete piles shall be a type which will harden underwater with these requirements for the sand-epoxy mix:

| | |
|---|---|
| Compressive strength at seven days, minimum by the method described in 926-3.2(b) | 4,500 psi [30 Mpa] |
| Bond | |
| to wet concrete, minimum | 250 psi [1.7 Mpa] |
| to wet pile jacket, minimum (by Florida Method FM 5-518) | 150 psi [1.0 Mpa] |
| Maximum sand loading | 2.25 parts to one part mixed epoxy by volume |
| Viscosity of mixed epoxy component at 77°F [25°C], five minutes by ASTM D 2393 | 1,000-2,000 cps [1 to 2 *Pa*·s] |

The epoxy sand mix shall be capable of flowing through water in the void area of the jacket so as to provide a water tight seal of the depth indicated on the plans or approved shop drawings and to maintain this seal during subsequent construction steps.

## 926-13 Specific Requirements for Type L Compounds.

Epoxies for coating the interior of sewage disposal system tanks shall be of an approved type. Manufacturers shall submit data and a record of previous usage showing satisfactory performance in the protection of concrete from the aggressive effect of sewage for a five year minimum to the Office of Materials and Research.

## 926-14 Specific Requirements for Type M Compounds.

Epoxy coatings for steel H piling used in fender systems shall comply with the requirements of Corps of Engineers Specification C-200. Products not meeting these requirements may be approved by the Office of Materials and Research on the basis of data furnished by the manufacturer documenting equal or superior performance.

Application shall be according to the manufacturers published recommendations with the additional requirements that application shall be in two coats of approximate equal thickness and the total dry film thickness measured by a magnetic gauge shall be not less than 16 mils [400 µm].

## 926-15 Specific Requirements for Type N Compounds.

Epoxy adhesives for making epoxy mortar or concrete for patching portland cement concrete pavement shall be any of approved products listed at the time of the work. Mix designs for mortar and concrete shall be submitted to the Engineer at the time of the preconstruction conference. Approval shall be by a field demonstration made by the Contractor using the criteria of bond to the pavement, matching color, durability, and absence of excessive surface slicking under traffic flow for acceptance.

The basic approval of new adhesives shall be made by the Office of Materials and Research using a six months road test with mortar-concrete mix designs recommended by the epoxy manufacturer.

**926-16 Specific Requirements for Type O Compounds.**

These compounds shall be fluid penetrants or surface coatings to be used singly or in combination for the protection of concrete surfaces.

The basic approval of these compounds is through an accelerated electrolysis test, Florida Method FM 5-518. Acceptable products shall meet the minimum resistivity requirements at the end of 10 or 50 days test as described in Florida DOT Research Report 79/207. Manufacturers wishing to qualify products shall obtain the special concrete test cylinders from the Corrosion Section, Office of Materials and Research, apply their coating according to their Specifications, and return the cured specimens for test along with technical literature which shall include the dry film thickness specified.

Materials other than epoxy may be qualified under this type.

***926-17 Specific Requirements for Type Q Compounds*.**

*These epoxy materials are to be used to protect the anchorages of post-tensioning tendons or bars and other uses indicated in the plans. The material shall produce a low exotherm reaction and have flow and fill characteristics suitable for machine base plate applications. The material will be extended with the aggregate supplied by the manufacturer. Mix with the full aggregate loading unless the use of less aggregate is approved by the Engineer.*

*The material shall be factory pre-proportioned including factory supplied aggregate. Deliver products in original containers with manufacturer's name, date of manufacture, product identification label and batch numbers. Materials must be within the manufacturer's recommended shelf life. Store and condition the product in full compliance with manufacturer's recommendations.*

*The epoxy grout plus aggregate mix shall meet or exceed the specified physical properties stated herein as determined by the following standard ASTM test methods.*

| *Property* | *Test Value* | *Test Method* |
|---|---|---|
| *Compressive Strength Cubes 7 day Cure @ 77°F (25°C)* | *> 10,000 psi (68.9 MPa)* | *ASTM C 579B* |
| *Tensile Strength @ 7 day* | *> 2100 psi (14.5 MPa)* | *ASTM C 307* |
| *Flexural Strength @ 7day Cure @ 77°F (25°C)* | *> 3600 psi (24.8 MPa)* | *ASTM C 580* |
| *Modulus of Elasticity 7 day Cure @ 77°F (25°C)* | *< 2,100,000 psi (14.5 GPa)* | *ASTM C 580* |
| *Coefficient of Thermal Expansion @ 74 to 210°F (23 to 99°C)* | *< 20 x $10^{-6}$ in/in/°F (11.1 x $10^{-6}$ mm/mm/°C)* | *ASTM C 531* |

| | | |
|---|---|---|
| *Peak Exotherm, Specimen 12 x 12 x 3 in. (305 x 305 x 76 mm)* | *< 150°F (66°C)* | *ASTM D 2471* |
| *Slant Shear @ 7 days (Bond Strength to Concrete)* | *> 3000 psi (20.7 MPa)* | *ASTM C 882* |
| *Thermal Compatibility* | *5 Cycles Passed* | *ASTM C 884* |
| *Linear Shrinkage @ 7 days* | *0.025%* | *ASTM C 531* |
| *Flowability and Bearing Area* | *90% Contact area* | *ASTM C 1339* |
| *Gel Time, Specimen 12 x 12 x 3 in.* | *< 4:00 (hr.)* | *ASTM D 2471* |

| | | |
|---|---|---|
| *(305 x 305 x 76 mm)* | | |

**926-~~17~~ *18* Packaging, Labeling, and Safety.**

All containers shall be identified as Component A - contains epoxy resin or Component B - contains hardener, and shall show the type, mixing directions, batch numbers, manufacturer's name, date of packaging, shelf life expiration date and quantity in pounds or gallons [kilograms or liters]. Mix ratios shall be prominently shown on labels. Potential hazards shall be stated on each package in accordance with the Federal Hazardous Products Labeling Act. ~~including this minimum warning:~~

~~Caution~~

~~Epoxies will cause dermatitis if proper precautions are not followed. Avoid contact with skin and eyes, use gloves and protective creams on hands. Goggles should be used to protect the eyes; however, in the event of eye contact, flush with water for ten minutes and secure immediate medical attention.~~

**926-~~18~~ *19* Storage.**

Epoxy materials, which have been in storage for more than 12 months, will not be accepted for use.

~~926-19 Certification Required.~~

~~The manufacturer of the epoxy compound shall certify that the product supplied meets the requirements of the Specification for that type. Each certification shall cover only one type. Due to the wide range of application of the products within some types, the manufacturer shall additionally certify that he has examined the particular application and that his product is recommended for that stated use for that specific project.~~

~~926-20 Qualified Products Lists.~~

~~The epoxy compound used for any of the applications described in 926-1 shall be a product included in the approved list.~~

~~Samples of epoxy materials will be taken in accordance with the Department's Sampling, Testing and Reporting Guide Schedule and on a random basis at the discretion of the Engineer. If the results of tests performed on these samples indicate failure to comply with any specific requirement of this Specification or significant inconsistencies in material properties, new qualification tests including strength, bond, exothermic and elongation values, as appropriate for the particular material, and a comparison with original infrared spectrophotometry values will be required.~~

~~Any marked variation from the original test values for a material or evidence of inadequate field performance of a material will be considered to be sufficient evidence that the properties of the material have changed and the material will be removed from the approved list.~~

**926-~~21~~ *20* Fillers.**

Fillers for mixing mortars and grouts may be as recommended by the manufacturer of the particular epoxy compound and may be supplied as packages accompanying the epoxy or premixed in accordance with approved properties.

If a manufacturer recommends only the gradation of filler, it must be a silica sand commercially available in Florida and shall be a gradation listed in Table I or a specified blend of these gradations.

The silica sands specified in Table I shall be clean, kiln dried, packaged in strong moisture proof bags, contain no more than 0.2% organic trash, and be chloride free.

Fillers shall not be used with these compounds: Types C, E, J, L, M, and O.

When the fillers specified in Table I are used, the maximum amount shall be 2.25 volumes to one volume of mixed compound.

TABLE I
GRADATION REQUIREMENTS FOR FILLERS FOR USE WITH EPOXY COMPOUNDS

| | GRADE | | | |
|---|---|---|---|---|
| | A | B | C* | D** |
| Sieve Opening Size | | Required % Passing | | |
| No. 4 [4.75 mm] | | | 95-100 | 95-100 |
| No. 6 [3.35 mm] | | 90-100 | | |
| No. 8 [2.36 mm] | | | 0-15 | 85-100 |
| No. 16 [1.18 mm] | | | | 65-97 |
| No. 20 [850 µm] | 80-100 | 0-20 | | |
| No. 30 [600 µm] | 0-40 | | | 25-70 |
| No. 50 [300 µm] | 0-10 | | | 5-35 |
| No. 100 [150 µm] | | | | 0-7 |

*For use only in sections 1 1/2 inches [38 mm] or greater in thickness.
**Same as quartz sand fine aggregate for cement concrete (902-1.3.1).

**EPOXY COMPOUNDS.**
**(REV 10-7-02)**

SECTION 926 (Pages 837-844) is deleted and the following substituted:

## SECTION 926
## EPOXY COMPOUNDS

### 926-1 Types of Compounds.

Epoxy resin compounds for application to portland cement concrete, bituminous cement concrete, metals and other type surfaces shall be two-component systems of the applicable of the following types as designated.

Type A - An epoxy resin, for bonding fresh concrete to hardened concrete.

Type B - An epoxy resin adhesive, for bonding hardened concrete to hardened concrete.

Type C - An epoxy resin adhesive, for bonding traffic markers to hardened concrete and to asphaltic concrete.

Type D - A coal-tar, modified epoxy resin for application as a skid-resistant or protective overlay for cement concrete.

Type E - A fluid epoxy for crack injection in the repair of old structures.

Type F - An epoxy for repairing spalled areas on concrete bridge structures with these subtypes:

F-1 - A non sagging gel type for vertical surfaces, and

F-2 - A pourable type for repairs where forms are to be used.

Type G - An epoxy for rebuilding expansion joints and associated wearing surfaces.

Type H - An epoxy for structural bonding where asphalt overlays are to be in contact with the hardened compound.

Type I - An epoxy for filling small holes in concrete such as lifting bolt cut-outs on beams, etc.

Type J - An epoxy for installing rebar and anchor bolts into hardened concrete.

Type K - An epoxy for underwater sealing of the bottom of the jacket of an integral pile jacket system.

Type L - An epoxy for coating the interior of sewage disposal tanks.

Type M - An epoxy for coating steel H piling for fender systems (water immersion).

Type N - An epoxy for preparing mortars and concrete for patching portland cement concrete pavement.

Type O - An epoxy coating system consisting of a penetrant and a surface coating to be used singly or in combination for the protection of concrete surfaces, both new and repaired.

Type P - An epoxy for bonding metals.

Type Q - An epoxy for use in post tensioning anchorage protection systems.

### 926-2 Epoxy Design Requirements.

**926-2.1 General:** All types of compounds except D, L, M, and O shall contain no volatile solvent.

All types of compounds except C, F, J, L, M, N and O shall be basically pure reactive material with a maximum ash content of 2%.

All types shall have simple mix ratios of one to one or two to one or shall be supplied in pre-measured containers in which all of the contents of both packages are to be mixed.

Certain terms used in this specification shall have these meanings:

low modulus - the stress-strain property for which ultimate tensile strength is attained at over 10% elongation.

high modulus - the stress-strain property for which ultimate tensile strength is attained at under 6% elongation.

non-sagging gel - grades of mixed compounds which will not perceptibly flow under their own weight on a vertical surface in the unhardened state.

pourable - grades of mixed compound sufficiently fluid that they (either neat or filled) can be cast into and will take the shape of a mold.

**926-2.2 Qualified Products List:** All epoxy materials shall be one of the products listed on the Department's Qualified Products List. Manufacturers seeking evaluation of their product shall submit an application in accordance with Section 6.

Products may only be used for applications recommended by the manufacturer.

**926-2.3 Certification:** The Contractor shall provide the Engineer with certification from the manufacturer of the epoxy, confirming that the requirements of this Section are met. The certification shall conform to the requirements of Section 6. Each certification shall cover only one batch of epoxy materials.

## 926-3 Specific Requirements for Types A and B Compounds.

**926-3.1 Mixing and Application:** Types A and B epoxy compounds (for bonding fresh concrete to hardened concrete or bonding precast concrete parts) shall be mixed, applied, and cured in accordance with the manufacturer's directions, or as might be directed otherwise by the Engineer.

Epoxy compounds shall be used only under conditions which are compatible with the material being applied in accordance with the specific directions of the manufacturer.

**926-3.2 Performance Tests:**

(a) For Epoxy Bonding Compounds: The performance test, upon which the acceptance of epoxy bonding compounds is based, is described below. Test specimens shall be cured at a temperature of 73 ± 3°F [23 ± 2°C]. The epoxy compounds shall be tested for composite cylinder shear (diagonal shear) as specified below.

The test specimen of concrete shall be prepared in a 3 by 6 inch [76 by 152 mm] mold. The first portion of the test specimen may be formed by sawing a full size 3 by 6 inch [76 by 152 mm] cylinder on a 45-degree slope from the vertical, giving a maximum height of 4 1/4 inches [108 mm] to a minimum height of 1 1/4 inches [32 mm], or through the use of an elliptical insert of the same dimensions. The concrete shall be cast as described in AASHTO T 23, using Class III Concrete (Florida DOT designation) with Type III Cement. The specimens shall be cured in the standard manner, and for at least four days. At the end of this period the half cylinder on which the epoxy resin is to be applied shall be prepared for bonding by removal of all loose particles and oil film and then coated with a thick coat of the epoxy compound under test. The portion of the cylinder shall then be replaced in the mold and plastic concrete of the same mix as before added to the mold to form the 3 by 6 inch [76 by 152 mm] cylinder. Reference test cylinders are prepared with each batch of concrete.

After the composite test cylinder has cured for a 3-day period in a moist cabinet, the compressive-strength is determined. This strength is compared to the strength of the weaker of the two concretes from which the test cylinder was made. If the ratio of the compressive strength of the composite cylinder to the compressive strength of the weaker concrete is less than 0.90, the epoxy compound is rejected.

(b) For Epoxy Mortars: Epoxy mortar shall be prepared for testing using two parts of standard concrete sand and one part of mixed epoxy compound. Three 2 inches [50 mm] cubes shall be cast from the epoxy mortar and cured for three days prior to testing. The cubes shall be tested in direct compression. The average compressive strength of the three test specimens shall be at least 5,000 psi [35 MPa].

The molds for epoxy mortar test specimens and compressive loading shall be in accordance with AASHTO T 106.

## 926-4 Specific Requirements for Type C Compounds.

Epoxy adhesives for pavement markers will be approved on the basis of satisfactory performance in field tests. If, during a one year period, more than 2% of the markers in a test site are displaced due to failure of the adhesive, the adhesive will not be considered acceptable.

## 926-5 Specific Requirements for Type D Compounds.

These compounds shall meet the requirements of AASHTO M 200.

## 926-6 Specific Requirements for Type E Compounds.

Epoxies for crack injection shall meet the Specification for Type B compound with these additional requirements:

| | | |
|---|---|---|
| Viscosity five minutes after mixing | 300 to 600 cps at 77°F by ASTM D 2393 | [0.3 to 0.6 Pa≅s at 25°C by ASTM D 2393] |
| Wet bond strength to concrete, minimum | 250 psi at seven days by Florida Method FM 5-518 | [1.7 MPa at seven days by Florida Method FM 5-518] |

## 926-7 Specific Requirements for Type F Compounds.

Epoxies for repairing spalled areas shall meet these requirements:

Subtype F-1 for repairing vertical and other surfaces shall be a trowelable low modulus, non-sagging gel epoxy compound capable of bonding to wet surfaces with these properties:

| | |
|---|---|
| Color | Shall match gray color No. 36622 of Federal Standard No. 595a |
| Viscosity | Gel |
| Maximum sand loading | 2.25 parts sand to one part mixed epoxy by volume |
| Elongation in tension minimum | 10% by ASTM D 638, seven day cure |
| Wet bond to Steel and Concrete minimum | 250 psi [1.7 MPa] by Florida Test Method FM 5-23 |

Subtype F-2 for filling larger spalls where a form is required to build back to the original surface shall be a pourable low modulus type compound capable of bonding to wet surfaces with these properties:

| | |
|---|---|
| Color | Shall match gray color No. 36622 of Federal Standard No. 595a |
| Maximum sand loading | 2.25 parts sand to one part mixed epoxy by volume |
| Elongation in tension, minimum | 10% by ASTM D 638, seven day cure |
| Exotherm | 110°F [43°C] by ASTM D 2471, 415 mL sample |
| Wet bond strength | 250 psi [1.7 MPa] at seven days by Florida Method FM 5-518 |

**926-8 Specific Requirements for Type G Compounds.**

Epoxies for rebuilding expansion joints shall be pourable types which may be mixed with sand and with these requirements for the mix:

| Compressive strength | |
|---|---|
| at 24 hours, minimum | 4,500 psi [30 Mpa] |
| at seven days, minimum by the method of 926-3.2(b) | 7,500 psi [50 Mpa] |
| Bond to wet concrete at seven days by Florida Method FM 5-518 | 250 psi [1.7 Mpa] |
| Maximum sand loading | 2.25 parts to one part mixed epoxy by volume |
| Elongation in tension at seven days, ASTM D 638, minimum | 2% |
| Color | Natural |
| Exotherm, maximum by test method ASTM D 2471, 1 pint [415 mL] sample size | 110°F [43°C] |

**926-9 Specific Requirements for Type H Compounds.**

Epoxies for structural bonding where bituminous pavement overlays will come in contact with the hardened compound shall meet the requirements for Types A and B compounds above and the manufacturer shall provide test data showing that cutback and emulsified asphalts, asphalt cement, and bituminous mixes shall bond to but not soften or otherwise damage the epoxy after a curing period of four days.

**926-10 Specific Requirements for Type I Compounds.**

Epoxies for cosmetic patching of small areas on new concrete structures and components shall be of any non-sagging grade which has a gray color matching that of Shade 36622 of the Federal Standards and which has been demonstrated to the Engineer to bond satisfactorily to the concrete.

**926-11 Specific Requirements for Type J Compounds.**

Epoxies for installing rebar and anchor bolts into the hardened concrete shall meet the requirements of Section 937 and be installed in accordance with Section 416. When the Contract Documents call for the use of Type J, Class I, II, III, IV, epoxy or a Class IV Adhesive Anchor System, use materials meeting the requirements of Section 937, constructed in accordance with Section 416. Use materials meeting Section 937 to construct doweled splices for prestressed concrete piles.

**926-12 Specific Requirements for Type K Compounds.**

Epoxies for sealing the bottom of integral pile jackets in the repair of concrete piles shall be a type which will harden underwater with these requirements for the sand-epoxy mix:

| Compressive strength at seven days, minimum by the method described in 926-3.2(b) | 4,500 psi [30 Mpa] |
|---|---|
| Bond | |
| to wet concrete, minimum | 250 psi [1.7 Mpa] |
| to wet pile jacket, minimum (by Florida Method FM 5-518) | 150 psi [1.0 Mpa] |
| Maximum sand loading | 2.25 parts to one part mixed epoxy by volume |

| | |
|---|---|
| Compressive strength at seven days, minimum by the method described in 926-3.2(b) | 4,500 psi [30 Mpa] |
| Viscosity of mixed epoxy component at 77°F [25°C], five minutes by ASTM D 2393 | 1,000-2,000 cps [1 to 2 Pa·s] |

The epoxy sand mix shall be capable of flowing through water in the void area of the jacket so as to provide a water tight seal of the depth indicated on the plans or approved shop drawings and to maintain this seal during subsequent construction steps.

**926-13 Specific Requirements for Type L Compounds.**

Epoxies for coating the interior of sewage disposal system tanks shall be of an approved type. Manufacturers shall submit data and a record of previous usage showing satisfactory performance in the protection of concrete from the aggressive effect of sewage for a five year minimum to the Office of Materials and Research.

**926-14 Specific Requirements for Type M Compounds.**

Epoxy coatings for steel H piling used in fender systems shall comply with the requirements of Corps of Engineers Specification C-200. Products not meeting these requirements may be approved by the Office of Materials and Research on the basis of data furnished by the manufacturer documenting equal or superior performance.

Application shall be according to the manufacturers published recommendations with the additional requirements that application shall be in two coats of approximate equal thickness and the total dry film thickness measured by a magnetic gauge shall be not less than 16 mils [400 μm].

**926-15 Specific Requirements for Type N Compounds.**

Epoxy adhesives for making epoxy mortar or concrete for patching portland cement concrete pavement shall be any of approved products listed at the time of the work. Mix designs for mortar and concrete shall be submitted to the Engineer at the time of the preconstruction conference. Approval shall be by a field demonstration made by the Contractor using the criteria of bond to the pavement, matching color, durability, and absence of excessive surface slicking under traffic flow for acceptance.

The basic approval of new adhesives shall be made by the Office of Materials and Research using a six months road test with mortar-concrete mix designs recommended by the epoxy manufacturer.

**926-16 Specific Requirements for Type O Compounds.**

These compounds shall be fluid penetrants or surface coatings to be used singly or in combination for the protection of concrete surfaces.

The basic approval of these compounds is through an accelerated electrolysis test, Florida Method FM 5-518. Acceptable products shall meet the minimum resistivity requirements at the end of 10 or 50 days test as described in Florida DOT Research Report 79/207. Manufacturers wishing to qualify products shall obtain the special concrete test cylinders from the Corrosion Section, Office of Materials and Research, apply their coating according to their Specifications, and return the cured specimens for test along with technical literature which shall include the dry film thickness specified.

Materials other than epoxy may be qualified under this type.

**926-17 Specific Requirements for Type Q Compounds.**

These epoxy materials are to be used to protect the anchorages of post-tensioning tendons or bars and other uses indicated in the plans. The material shall produce a low exotherm reaction and have flow and fill characteristics suitable for machine base plate applications. The material will be extended with the aggregate supplied by the manufacturer. Mix with the full aggregate loading unless the use of less aggregate is approved by the Engineer.

The material shall be factory pre-proportioned including factory supplied aggregate. Deliver products in original containers with manufacturer's name, date of manufacture, product identification label and batch numbers. Materials must be within the manufacturer's recommended shelf life. Store and condition the product in full compliance with manufacturer's recommendations.

The epoxy grout plus aggregate mix shall meet or exceed the specified physical properties stated herein as determined by the following standard ASTM test methods.

| Property | Test Value | Test Method |
|---|---|---|
| Compressive Strength Cubes 7 day Cure @ 77°F (25°C) | > 10,000 psi (68.9 MPa) | ASTM C 579B |
| Tensile Strength @ 7 day | > 2100 psi (14.5 MPa) | ASTM C 307 |
| Flexural Strength @ 7day Cure @ 77ºF (25ºC) | > 3600 psi (24.8 MPa) | ASTM C 580 |
| Modulus of Elasticity 7 day Cure @ 77ºF (25ºC) | < 2,100,000 psi (14.5 GPa) | ASTM C 580 |
| Coefficient of Thermal Expansion @ 74 to 210°F (23 to 99°C) | < 20 x $10^{-6}$ in/in/ºF (11.1 x $10^{-6}$ mm/mm/°C) | ASTM C 531 |
| Peak Exotherm, Specimen 12 x 12 x 3 in. (305 x 305 x 76 mm) | < 150ºF (66ºC) | ASTM D 2471 |
| Slant Shear @ 7 days (Bond Strength to Concrete) | > 3000 psi (20.7 MPa) | ASTM C 882 |
| Thermal Compatibility | 5 Cycles Passed | ASTM C 884 |
| Linear Shrinkage @ 7 days | 0.025% | ASTM C 531 |
| Flowability and Bearing Area | 90% Contact area | ASTM C 1339 |
| Gel Time, Specimen 12 x 12 x 3 in. (305 x 305 x 76 mm) | < 4:00 (hr.) | ASTM D 2471 |

## 926-18 Packaging, Labeling, and Safety.

All containers shall be identified as Component A - contains epoxy resin or Component B - contains hardener, and shall show the type, mixing directions, batch numbers, manufacturer's name, date of packaging, shelf life expiration date and quantity in pounds or gallons [kilograms or liters]. Mix ratios shall be prominently shown on labels. Potential hazards shall be stated on each package in accordance with the Federal Hazardous Products Labeling Act.

## 926-19 Storage.

Epoxy materials, which have been in storage for more than 12 months, will not be accepted for use.

## 926-20 Fillers.

Fillers for mixing mortars and grouts may be as recommended by the manufacturer of the particular epoxy compound and may be supplied as packages accompanying the epoxy or premixed in accordance with approved properties.

If a manufacturer recommends only the gradation of filler, it must be a silica sand commercially available in Florida and shall be a gradation listed in Table I or a specified blend of these gradations.

The silica sands specified in Table I shall be clean, kiln dried, packaged in strong moisture proof bags, contain no more than 0.2% organic trash, and be chloride free.

Fillers shall not be used with these compounds: Types C, E, J, L, M, and O.

When the fillers specified in Table I are used, the maximum amount shall be 2.25 volumes to one volume of mixed compound.

TABLE I
GRADATION REQUIREMENTS FOR FILLERS FOR USE WITH EPOXY COMPOUNDS

| | GRADE | | | |
|---|---|---|---|---|
| | A | B | C* | D** |
| Sieve Opening Size | | Required % Passing | | |
| No. 4 [4.75 mm] | | | 95-100 | 95-100 |
| No. 6 [3.35 mm] | | 90-100 | | |
| No. 8 [2.36 mm] | | | 0-15 | 85-100 |
| No. 16 [1.18 mm] | | | | 65-97 |
| No. 20 [850 µm] | 80-100 | 0-20 | | |
| No. 30 [600 µm] | 0-40 | | | 25-70 |
| No. 50 [300 µm] | 0-10 | | | 5-35 |
| No. 100 [150 µm] | | | | 0-7 |

*For use only in sections 1 1/2 inches [38 mm] or greater in thickness.
**Same as quartz sand fine aggregate for cement concrete (902-1.3.1).