

Method of Test for
TENSILE BOND STRENGTH OF EPOXY RESIN SYSTEMS

DOTD Designation: TR 706-85

METHOD A

(Tensile Bond Strength - Dry Cured Method)

DOTD TR 706-85
Adopted 10/85
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Method A

Scope

1. This method of test is intended to determine the dry-cured tensile bond strength of hardened cement mortar bonded with epoxy to hardened cement mortar. It is also used as a measure of set time properties of Type V epoxy resin systems.

Apparatus

2. (a) *Balance* - A Type I or II, Class D balance conforming to AASHTO M 231.

(b) *Beaker* - A 400 ml (minimum) graduated disposable plastic beaker.

(c) *Mixing Tools* - Stainless steel spatulas or wooden tongue depressors.

(d) *Molds* - Briquette molds conforming to AASHTO T 132.

(e) *Cement Mortar Mixing Apparatus* - Apparatus for mixing portland cement mortar specimens, conforming to AASHTO T 132.

(f) *Saw* - A concrete sawing device that will produce clean and smooth cut faces on briquette halves.

(g) *Testing Machine* - A tensile testing machine with gripping devices that conform to the requirements of AASHTO T 132.

(h) *Thermometer* - A thermometer conforming generally to the requirements for ASTM 1C or 1F thermometers.

(i) *Timer* - A clock or watch capable of measuring minutes and seconds.

(j) *Roughening or Texturing Equipment* - A wire brush or sandblasting equipment capable of producing a lightly rough finish on hardened briquette halves.

Safety Precautions

3. The following precautions should be observed when handling epoxy components and cleaning fluids:

(a) Persons handling these materials should use appropriate protective clothing, including rubber or plastic gloves, and appropriate eye protection such as safety glasses.

(b) If any epoxy or cleaning material should contact the skin, the material should be removed immediately with a dry cloth or paper towel, and the affected area should be washed thoroughly with soap and water.

(c) If any material should come in contact with the eyes, flush immediately with water and contact

a physician.

(d) Adequate ventilation is necessary to prevent excessive inhalation of vapors.

(e) Observe all precautions specified by the manufacturer before handling each material.

Sample Preparation

4. (a) Prepare three cement mortar briquette specimens according to AASHTO T 132.

(b) After a curing period of no less than seven days, saw the three briquettes at the centerline perpendicular to the longitudinal axis.

(c) Lightly sandblast or wirebrush the cut surfaces of the briquettes and use a dry brush to remove the loose surface material.

(d) When testing adhesives having low viscosities, place the briquette halves together, leaving approximately 1/16 in. between both halves. Seal three sides of the area to be bonded with a thin coat of grade C epoxy and/or masking tape.

(e) For Type V epoxy, prior to mixing, condition the individual components and any equipment with which they will come in contact to the test temperature of 77 ± 2 °F by use of a water bath and/or laboratory temperature control.

(f) Thoroughly stir the individual components, for at least one minute, immediately before testing.

(g) Combine and mix sufficient quantities of components A and B, in accordance with the manufacturer's recommendations, such that a minimum sample of 50 ml is obtained. If the manufacturer does not recommend a mixing time, mix the sample for at least 3 minutes. Use separate mixing tools when obtaining and mixing the desired quantities of each component to avoid contamination.

(h) In testing adhesives having medium to high viscosities, apply the adhesive to the faces of the briquette specimens and put the briquette halves together with light pressure. In testing adhesives having low viscosities, pour the adhesive into the sealed briquette specimen as prepared in 4(d).

NOTE: All mixing of epoxy and bonding of briquette halves shall be completed within 10 minutes.

(i) Remove the excess adhesive from the edges of the bonded area.

(j) Allow the bonded briquettes to cure for the

required time (See Table 1), undisturbed in air, at the conditioning temperature in paragraph 4 (e).

TABLE 1

CURE TIME FOR EPOXY RESIN SYSTEMS

| Type | Cure Time |
|----------------|-----------|
| I, II, III | 24 hours |
| V Standard Set | 210 min. |
| V Rapid Set | 40 min. |

Procedure

5. (a) After the elapsed cure period, carefully center each briquette in the gripping devices of the testing machine and apply a continuous load at the rate of 600 ± 25 lbf/min.

(b) Record the maximum load indicated by the testing machine as (L) on the worksheet.

Calculations

6. Calculate the tensile bond strength of each specimen according to the following formula:

$$S = \frac{L}{1 \text{ in.}^2}$$

where:

S = tensile bond strength, psi
 L = load, lbf

Report

7. (a) Report the average tensile bond strength of the bonded briquettes to the nearest 5 psi.

- (b) Note the mode of failure as being either:
- (1) in the mortar
 - (2) in the adhesive
 - (3) in the mortar/adhesive interface

NOTE: Should any of the bonded test specimens fail in the mortar at a strength less than that required, a retest shall be conducted for that specimen.

Normal testing time is 2 days.

Method of Test for
TENSILE BOND STRENGTH OF EPOXY RESIN SYSTEMS
DOTD Designation: TR 706-85
METHOD B
(Tensile Bond Strength - Moist Cured Method)

Scope

1. This method of test is intended to indicate the moisture sensitivity characteristics of an epoxy by measuring the moist-cured tensile bond strength of hardened cement mortar bonded with epoxy to plastic cement mortar.

Apparatus

2. (a) *Balance* - A Type I or II, Class D balance conforming to AASHTO M 231.

(b) *Beaker* - A 400 ml (minimum) graduated disposable plastic beaker.

(c) *Mixing Tools* - Stainless steel spatulas or wooden tongue depressors.

(d) *Molds* - Briquette molds conforming to AASHTO T 132.

(e) *Cement Mortar Mixing Apparatus* - Apparatus for mixing portland cement mortar specimens conforming to AASHTO T 132.

(f) *Saw* - A concrete sawing device that will produce clean and smooth cut faces on briquette halves.

(g) *Testing Machine* - A tensile testing machine with gripping devices that conform to the requirements of AASHTO T 132.

(h) *Thermometer* - A thermometer conforming generally to the requirements for ASTM 1C or 1F thermometers.

(i) *Timer* - A clock or watch capable of measuring minutes and seconds.

(j) *Roughening or Texturing Equipment* - A wire brush or sandblasting equipment capable of producing a lightly rough finish on hardened briquette halves.

(k) *Moist Cabinet* - A moist cabinet conforming to AASHTO M 201.

Safety Precautions

3. The following precautions should be observed when handling epoxy components and cleaning fluids:

(a) Persons handling these materials should use appropriate protective clothing, including rubber or plastic gloves, and appropriate eye protection such as safety glasses.

(b) If any epoxy or cleaning material should contact the skin, the material should be removed immediately with a dry cloth or paper towel, and the affected area should be washed thoroughly with soap and water.

(c) If any material should come in contact with

the eyes, flush immediately with water and contact a physician.

(d) Adequate ventilation is necessary to prevent excessive inhalation of vapors.

(e) Observe all precautions specified by the manufacturer before handling each material.

Sample Preparation

4. (a) Prepare three cement mortar briquette specimens in accordance with Method A, paragraphs 4(a) through 4(c).

(b) Place three half-sections of the cured briquette specimens inside three molds so that the remaining halves of the molds can be filled with fresh portland cement mortar.

(c) Prior to mixing, condition the individual components and any equipment with which they will come in contact to the test temperature of 77 ± 2 °F by use of a water bath and/or laboratory temperature control.

(d) Thoroughly stir the individual components for at least one minute, immediately before testing.

(e) Combine and mix sufficient quantities of components A and B, in accordance with the manufacturer's recommendations, such that a minimum sample of 50 ml is obtained. If the manufacturer does not recommend a mixing time, mix the sample for at least 3 minutes. Use separate mixing tools when obtaining and mixing the desired quantities of each component to avoid contamination.

(f) Apply the mixed adhesive to the ends of each hardened half section and allow the adhesive to set until a tacky state is attained.

NOTE: In no case shall this setting period exceed the specified gel time, as determined by DOTD Designation: TR 703.

(g) Fill the remaining halves of the molds with fresh portland cement mortar prepared in accordance with Method A, paragraph 4(a).

(h) Allow the specimens to cure for 24 hours in the moist cabinet at a relative humidity of not less than 95% and at a temperature of 73.4 ± 3 °F. Remove from molds and place the bonded specimens in a moist cabinet for an additional two days of moist curing.

Procedure

5. (a) After the elapsed cure period, carefully center each briquette in the gripping devices of the testing

machine and apply a continuous load at the rate of 600 ± 25 lbf/min.

(b) Record the maximum load indicated by the testing machine as (L) on the worksheet.

Calculations

6. Calculate the tensile bond strength of each specimen according to the following formula:

$$S = \frac{L}{1 \text{ in.}^2}$$

where:

S = tensile bond strength, psi

L = load, lbf

Report

7. (a) Report the average tensile bond strength of the bonded briquettes to the nearest 5 psi.

(b) Note the mode of failure as being either:

(1) in the mortar

(2) in the adhesive

(3) in the mortar/adhesive interface

NOTE: Should any of the bonded test specimens fail in the mortar at a strength less than that required, a retest shall be conducted for that specimen.

Normal testing time is 5 days.