

Caltrans Augmentation / Revisions to ICBO-AC58
"Acceptance Criteria for Adhesive Anchors in Concrete and Masonry Elements"

Subject No. AC-58-R4-05/2010

In order for chemical adhesives to be used on Caltrans contracts, the conditions specified in ICBO Acceptance Criteria 58 (AC58) shall be met together with the following clarifications and amendments:

Notes:

1. Hybrid bonding materials may require tests that are different from those listed in ICBO-AC58, or in this augmentation package. At this time, Caltrans will not approve the use of polyester resins (styrene based) as reports and evidence of saponification problems associated with this type of adhesives have been received.
2. The creep test (Section 5.3.3) shall be conducted in accordance with ASTM 1512 as a restrained test. This is required to ensure that all load tests are conducted under similar conditions, and facilitates evaluation and comparison of different test results with uniformity by Caltrans. In addition, this method of testing measures the creep response of the epoxy material more reliably.

Section 3.2.6

The first four tests identified below shall be conducted in accordance with ICBO-AC58 (Section 3.2.6), with corresponding modifications as shown, to establish a fingerprint. The remaining five tests, which are not discussed in ICBO-AC58, shall be conducted in accordance with the corresponding ASTM test or California Test (CT). These tests are required to clearly fingerprint the adhesive as well as establish conformance to minimum performance criteria.

1) QUALITATIVE INFRARED ANALYSIS: ASTM E 1252

An infrared scan shall be conducted on each component.

2) BOND STRENGTH - SLANT SHEAR: ASTM C 882

Prior to installation, all individual components and materials used in the tests shall be conditioned at $21^{\circ}\pm 2.8^{\circ}\text{C}$ for 1 hour minimum. After installation, the samples shall be cured for 7 days prior to loading to determine the bond strength. Curing and loading shall be performed at $21^{\circ}\pm 2.8^{\circ}\text{C}$.

3) DENSITY OF ADHESIVES: ASTM D 1875

The density of each component of the unreacted adhesive shall be determined.

4) GEL TIME: ASTM C 881

Prior to installation, all individual components and materials used in the tests shall be conditioned at $21^{\circ}\pm 2.8^{\circ}\text{C}$ for 1 hour minimum. The components shall then be mixed and samples tested at this temperature. For fast setting adhesives, the tests may commence earlier than the "8 minutes after the beginning of mixing" that is specified.

5) VISCOSITY OF ADHESIVES: ASTM D 2556

Prior to installation, all individual components and materials used in the tests shall be conditioned at $21^{\circ}\pm 2.8^{\circ}\text{C}$ for 1 hour minimum. The samples shall then be prepared and tested at this temperature to determine the apparent viscosity and thixotropic index.

6) DEFLECTION TEMPERATURE: ASTM D 648

Prior to installation, all individual components and materials used in the tests shall be conditioned at $21^{\circ}\pm 2.8^{\circ}\text{C}$ for 1 hour minimum. The samples shall then be prepared and cured at these conditions for 7 days prior to testing. Test specimens may be cast in molds of proper dimensions prior to curing or be machined to proper dimensions after curing.

7) FILLER CONTENT: ASTM C 881

The test determines the filler content of each component.

8) RHEOLOGICAL PROPERTIES: CT 438

The test determines several properties of the cured adhesive. The power factor determined in Part 1B-3 shall be greater than or equal to 0.020.

9) GLASS TRANSITION TEMPERATURE: CT 438

Prepare three aged slices as described in Sample Preparation. Soak the slices in deionized water for one week at $25^{\circ} + 2^{\circ}\text{C}$. After the soaking period has been completed, towel dry a sample and install it in the rheometer. Run frequency sweeps in 10°C increments beginning at 25°C , sufficient to construct shear modulus and phase angle master curves. Determine the glass transition temperature (T_g) from the phase angle master curve. The mean T_g shall be greater than or equal to 55°C .

Additional Performance Test for Sag:

The sag test determines the tendency of an adhesive to flow out of an overhead hole. The test shall be conducted at 4°C and 43°C . Prior to mixing/installation, all the components and materials used in the tests shall be conditioned for a minimum of 1 hour at the test temperature. Testing shall be done in accordance with the following procedure:

1. Fill an 18 mm x 150 mm test tube with the adhesive using the manufacturer's standard dispensing equipment, so that there are no air pockets in the tube. If the components are designed to be mixed by the rotating action of the anchor, separate the components so that they can be mixed in a cup using a spatula. After mixing, immediately transfer the adhesive to the test tube.
2. Immediately after filling, strike off any excess adhesive flush with the top of the test tube and place the filled tube upside down in an environmental chamber at the test temperature. Check the flow after the manufacturer's published set time for the test temperature.
3. To be acceptable, the adhesive shall not flow out of the test tube by more than 1 mm.
4. If the flow is greater than 1 mm, retest the adhesive incorporating the use of a 9.5 x 200 mm threaded rod with a beveled end.
5. After filling the test tube (at least 60%) with the adhesive, twist the threaded rod through the center of the adhesive, to within 10 mm of the bottom of the tube. Strike off any excess adhesive flush with the top of the test tube.

6. Immediately place the assembly upside down in the environmental chamber with the rod contacting a horizontal surface. Check the flow after the manufacturer's published set time for the test temperature.
7. To be acceptable, the adhesive shall not flow out of the test tube by more than 1 mm.

Section 3.3 Change the last sentence in 3.3, ICBO-AC58 to read as follows:

"The zinc coating on threaded rods shall either be hot-dip galvanized in accordance with ASTM A 153 with a Class C coating weight, or mechanically deposited in accordance with ASTM B 695 with a Class 50 coating."

Section 5.1.8 Add the following to Section 5.1, ICBO-AC58:

"If the adhesive is to be used with coated steel anchorage rods (either threaded rods or reinforcing bars), then sufficient tests shall be performed to determine the effects of the coatings on anchor performance. The tests on coated bars/rods shall be conducted on all tests required as per Table 3 as well as on those tests that are required by Caltrans. Coating type may include, but is not limited to, zinc or other sacrificial metal, epoxy paint, or any other approved coating applied to the surface of the bar/rod. The actual coating type and thickness applied to the steel bars/rods used for testing shall be clearly documented. The thickness of coating shall be representative of the actual thickness as applied on typical bars/rods. In no case shall the actual thickness of the coating be less than the minimum thickness of coating specified by the user. When a maximum coating thickness is specified by the user, coating samples shall be prepared and used for testing that has at least the maximum coating thickness allowed".

Section 5.3.3.1 The third sentence in Section 5.3.3.1, ICBO-AC58 is modified as follows:

"The tests must be conducted in accordance with Section 7.1.2 of ASTM E 1512 as a restrained test."

Section 5.3.3.1.3 The third sentence in Section 5.3.3.1.3, ICBO-AC58 is modified as follows:

"After the anchor curing period, the temperature of the specimens shall be increased until the temperature, as determined from the thermocouples, is stabilized for no more than 24 hours at the minimum elevated temperature of $110^{\circ}\text{F} \pm 3^{\circ}\text{F}$ ($43.33^{\circ}\text{C} \pm 1.67^{\circ}\text{C}$) before initiating the loading procedure."

Section 5.3.4 This section in ICBO-AC58 is modified as follows:

5.3.4.1 Procedure: Temperature effects are evaluated according to ASTM E 1512, Sections 7.1 and 7.6. One of the tension tests shall be conducted at 43°C . In addition; the test specifications of Section 7.6.5.1 and 7.6.5.2 in ASTM 1512 are modified as shown in the following Sections 5.3.4.1.1 and 5.3.4.1.2, respectively:

5.3.4.1.1 Test at least three anchors at the minimum installation temperature specified by the manufacturer (hereafter referred to as the minimum installation temperature). Cool the structural member sufficiently long to ensure that the entire sample is at the minimum installation temperature. Install the chemical anchor system at the minimum installation temperature and cure the specimens at this same temperature. The minimum installation temperature shall be maintained for the duration of the minimum cure time specified by the manufacturer for this temperature. Minimum cure time is the time from the installation of the chemical anchor system

to the time when full design load may be applied. Tension test the anchors to failure at the minimum installation temperature.

Conduct another set of tests in accordance with the procedures enunciated in the preceding paragraph, but with the conditioning of the specimens, installation, curing and testing conducted at 43°C.

5.3.4.1.2 Install additional anchors at the minimum installation temperature in the structural members that are cooled to the specified temperature sufficiently long to ensure that the entire sample is at the minimum installation temperature. Cure the samples for a duration equal to the minimum cure time specified for the minimum installation temperature. Test the anchors in accordance with Sections 7.6.1 through 7.6.4 of ASTM E 1512. Conduct one of the tests at 43°C. Compare the ultimate loads, load displacement curves and the load-temperature charts to those of Section 7.6.4 of ASTM E 1512.

The following optional tests shown in ICBO-AC58 are required by Caltrans:

5.3.3 Creep

5.3.5 Dampness

5.3.6 Freezing and Thawing

5.3.7 Seismic

Section 5.3.3.2 (Conditions of Acceptance are modified as follows).

The average total displacement at 600 days, of the creep test series described in Section 5.3.3.1.3 of AC58, shall be less than the average displacement at ultimate load determined from Section 5.3.3.1.2 of AC58 or less than 0.060 inch (1.52 mm), whichever is less.

Section 5.3.7.2.1 (Procedure is modified as follows).

The frequency of loading shall be within the range of 1 to 2 Hz.

Section 5.3.7.2.4 (Conditions of Acceptance are modified as follows).

Δ_{ult} = Average ultimate displacement measured in the determination of T_{ref} described in Section 5.3.7.2.1.

The following optional test is required by Caltrans only if fire is a concern for a particular job/application:

Section 5.3.2 Fire Resistance

Test Reports

In addition to the requirements in Section 7 of ICBO-AC58, each test report shall include a detailed summary of test conditions, number of samples tested and the corresponding results. Results and test data for all tests performed (including data from tests that did not meet ICBO/Caltrans requirements) shall be submitted along with the following:

1. A report of the cure-time and the set-time at the following temperatures: 0°C, 21°C and 43°C. Set time is defined as the minimum time after installation when anchors are to be

undisturbed during the setting process. Cure time is defined as the minimum time from the installation of the chemical anchor system to the time when full design load may be applied.

2. A report of the method used in 5.3.4 to determine that the test members have been conditioned adequately at the temperatures other than ambient.
3. The test results shall include the following information: Sample and concrete temperature immediately around the adhesive at a) installation b) during curing, and c) while testing.