

7. TEST METHOD FOR ACCELERATED ARTIFICIAL EXPOSURE OF CONTINUOUS FIBER SHEETS (JSCE-E 547-2000)

1. Scope

This specification describes the method used to perform the accelerated artificial exposure test for the continuous fiber sheets used for upgrading of concrete members.

2. Normative Reference

The following standards, by being referenced herein, form a portion of these specifications. The most recent version of each standard should be used.

- JSCE-E 541 Test method for tensile properties of continuous fiber sheets
- JSCE-E 542 Test method for overlap splice strength of continuous fiber sheets
- JIS A 1415 Methods of exposure to laboratory light sources for polymeric material of buildings
- JIS Z 8401 Guide to the significant digits

3. Definitions

The following are the definitions of the major terms used in this specification in addition to the terms used in the “Recommendations for Upgrading of Concrete Structures with Use of Continuous Fiber Sheets” published by the Japan Society of Civil Engineers, JSCE-E 541 and JSCE-E 542.

- a) Weathering
 - Physical and chemical changes of material properties due to exposure to sunlight, rain, snow and other outdoor natural conditions
- b) Accelerated artificial exposure testing machine
 - A machine that creates reproducible standard test conditions to accelerate weathering artificially

c) Coupon test specimen

A test specimen selected from the same lot that is unexposed and subjected to the tensile strength and overlap splice strength tests

d) Tensile strength retention

The ratio of the tensile strength after accelerated artificial exposure compared with the tensile strength before accelerated artificial exposure, expressed as a percentage of one hundred (%)

e) Overlap splice strength retention

The ratio of the overlap splice strength after accelerated artificial exposure compared with the overlap splice strength before accelerated artificial exposure, expressed as a percentage of one hundred (%)

4. Test specimens

4.1 Accelerated artificial exposure plate

The method of preparing accelerated artificial exposure plates shall conform to the methods in JSCE-E 541 and JSCE-E 542. However, as a rule, the dimensions shall be no less than 300 mm in length nor 70 mm in width, and the plates shall be those that can be mounted to the accelerated artificial exposure test sample holder.

4.2 Number of accelerated artificial exposure plates

As a rule, no fewer than two accelerated artificial exposure plates shall be subjected to accelerated artificial exposure tests simultaneously.

4.3 Types and dimensions

The test specimens shall be cut from the plate that has undergone accelerated artificial exposure, and the method of preparing these test specimens shall conform to either the JSCE-E 541 or the JSCE-E 542. When making test specimens, the edge of the accelerated artificial exposure plate shall be avoided.

4.4 Number of test specimens

A number of test specimens suitable for the test objective shall be determined. It shall be no fewer than five.

5. Testing Machine and Measuring Devices

5.1 Accelerated artificial exposure testing machine

- a) Two types of testing machines are available.
Type WV: Testing machine using an ultraviolet carbon arc lamp
Type WS: Testing machine using a sunshine carbon arc lamp
- b) The configuration of the light source, filter and testing machine is specified in JIS A 1415.
- c) The tensile testing machine is established in JSCE-E 541 and JSCE-E 542.

6. Test Method

6.1 Accelerated artificial exposure test

In addition to JIS A 1415, the following shall be considered in the test.

- a) An appropriate test period shall be established. However, unless otherwise specified, the maximum values shall be 2000 hours for the Type WV testing machine and 1000 hours for the WS testing machine, in accordance with JIS A 1415.

6.2 Tensile strength test and overlap splice strength test

The tensile strength, modulus of elasticity and ultimate strain shall be obtained for the test specimens before and after the accelerated artificial exposure test, in accordance with JSCE-E 541. The overlap splice strength shall be obtained for the test specimens before and after the accelerated artificial exposure test, in accordance with JSCE-E 542.

7. Calculation and Expression of Test Results

7.1 Visual inspection

A visual inspection of the accelerated artificial exposure plate shall be conducted before and after the accelerated artificial exposure test, comparing the color and surface condition. If necessary, the accelerated artificial exposure plate shall be cut and ground and its section observed with a microscope.

7.2 Handling of data

In the tensile strength test, the test data shall be assessed on the basis only of test specimens undergoing failure in the test portion. In cases where tensile fracture or slippage has clearly taken place at the anchorage portion, the data shall be disregarded and additional specimens shall be tested until the number of test specimens fracturing in the test portion exceeds five.

7.3 Tensile strength retention

The tensile strength retention shall be calculated using Eq. (1) and rounded off to three significant digits in accordance with JIS Z 8401.

$$R_{ett} = \frac{\bar{f}_{fu1}}{\bar{f}_{fu0}} \times 100 \dots\dots\dots(1)$$

where

- R_{ett} : Tensile strength retention (%)
- \bar{f}_{fu0} : Average value for tensile strength before accelerated artificial exposure (N/mm²)
- \bar{f}_{fu1} : Average value for tensile strength after accelerated artificial exposure (N/mm²)

7.4 Overlap splice strength retention

The overlap splice strength retention shall be calculated using Eq. (1) and rounded off to three significant digits in accordance with JIS Z 8401.

$$R_{ets} = \frac{\bar{f}_{fus1}}{\bar{f}_{fus0}} \times 100 \dots\dots\dots(2)$$

where

- R_{ets} : Overlap splice strength retention (%)
- \bar{f}_{fus0} : Average value for overlap splice strength before accelerated artificial exposure (N/mm²)

\bar{f}_{fust} : Average value for overlap splice strength after accelerated artificial exposure (N/mm²)

8. Report

The report shall include the following items:

- a) Common items
 - (1) Name of continuous fiber sheet
 - (2) Type of continuous fiber sheet and impregnation resin
 - (3) Fiber mass per unit area and density of continuous fiber sheet
 - (4) Identification of test specimen
- b) Items relating to accelerated artificial exposure test
 - (1) Type and model of testing machine and test conditions (black panel temperature, spray cycle, with or without humidity control unit, test period, location of test specimens, conditions for changing of test specimens, filter use conditions)
 - (2) Date that accelerated artificial exposure test starts and ends
 - (3) Observation records for appearance inspection
- c) Items relating to tensile strength test
 - (1) Fabrication date, fabrication method and curing period for test specimens
 - (2) Temperature, humidity and duration of test specimen conditioning
 - (3) Test date, test temperature and loading rate
 - (4) Shape, dimensions and calculated cross-sectional area for each test specimen
 - (5) Tensile capacity of each test specimen and average for these values
 - (6) Maximum tensile strength of each test specimen and average for these values
 - (7) Young's modulus of each test specimen and average for these values
 - (8) Ultimate strain of each test specimen and average for these values
 - (9) Load-strain curve for each test specimen
 - (10) Tensile strength retention
- d) Items relating to overlap splice strength test
 - (1) Fabrication date, fabrication method and curing period for test specimens
 - (2) Temperature, humidity and duration of test specimen conditioning

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- (3) Test date, test temperature and loading rate
- (4) Shape, dimensions and calculated cross-sectional area for each test specimen
- (5) Tensile capacity of each test specimen and average for these values
- (6) Maximum tensile strength of each test specimen and average for these values
- (7) Mode of failure for each test specimen
- (8) Overlap splice strength retention

COMMENTARY ON TEST METHOD FOR ACCELERATED ARTIFICIAL EXPOSURE OF CONTINUOUS FIBER SHEETS

Introduction

The use of continuous fiber sheets to upgrade concrete structures is based on the premise that these structures are used for a long time, and that the effects of upgrading must be lasting and the materials used must be durable.

Accelerated artificial exposure tests are generally used as a means of predicting the durability of materials, and they are also thought to be an effective means of estimating the durability of continuous fiber sheets used as upgrading materials.

This test method evaluates the durability of continuous fiber sheets by determining changes in their mechanical properties through measurement of the tensile strength and overlap splice strength of continuous fiber sheets following accelerated artificial exposure tests.

1. Scope

This method applies to the tensile strength tests and overlap splice strength test for continuous fiber sheets during and after the period in which they are subjected to accelerated artificial exposure tests. This method may also be applicable as to "bond strength," which is an important factor affecting the durability of concrete structures upgraded using continuous fiber sheets. However, when concrete is involved in test specimens, the test would become more complex in terms of devising a way to attach the test specimen to the sample holder and devising the sample holder itself. Accordingly, the bond strength test is not included within the scope of this test method.

2. Normative Reference

3. Definitions

4. Test specimens

4.1

The dimensions of the accelerated artificial exposure plate are determined through consideration of the shape and dimensions of the sample holders in general use and the specifications in JSCE-E 541 and JSCE-E 542. The width of 70 mm means that five Type A test specimens measuring 12.5 mm in width may be sampled.

5. Testing Machine and Measuring Devices

6. Test Method

6.1

Details of the accelerated artificial exposure test method are noted in JIS A 1415. The test period necessary to determine durability is generally longer for continuous fiber sheets than for plastic materials. Therefore, a longer time than the maximum value specified in JIS A 1415 may be used.

7. Calculation and Expression of Test Results

8. Report