Designation: C1560 – 03 (Reapproved 2016)

Standard Test Method for Hot Water Accelerated Aging of Glass-Fiber Reinforced Cement-Based Composites[1]

This standard is issued under the fixed designation C1560; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method provides a way of accelerating the aging of glass fiber reinforced cementitious composites in order to develop data that will indicate real-life natural weathering performance.

1.2 The coupons prepared for this test method will be tested using Test Method C947.

1.3 This test method can be used to age coupons for other test methods.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C947 Test Method for Flexural Properties of Thin-Section Glass-Fiber-Reinforced Concrete (Using Simple Beam With Third-Point Loading)

C1228 Practice for Preparing Coupons for Flexural and Washout Tests on Glass Fiber Reinforced Concrete

3. Significance and Use

3.1 The basis for this test as an indicator of the long term behavior of fiber reinforced composites is that elevated temperature and moisture content accelerate the formation of the products of hydration of the cement in the matrix, particularly calcium hydroxide.

3.1.1 It is known that the interaction of these products of hydration, particularly calcium hydroxide, with the fibers can have a major effect on the long-term properties of the composites.

3.1.2 The principal mechanism that occurs is that the calcium hydroxide forms within the bundles of filaments that form the glass fiber strand. This gradually bonds the filaments together, which reduces filament pull-out. This causes a reduction in the strain capacity of the composite, thereby reducing the strength of the composite and changing the composite from a ductile material to an increasingly brittle material.

3.1.3 Accelerating the formation of the hydration products accelerates their interaction with the fibers, hence accelerating the aging of the composite.

3.2 The data developed from this test are used by researchers and manufacturers to evaluate the long-term performance of different mixtures, reinforcements, mixture components, and to provide data for the development of design procedures for products made from these composites.

3.2.1 The recorded data also provides screening information as new matrices and reinforcements are developed.

3.3 The usefulness of the test as an indicator of long term composite performance is valid if the only reactions that are accelerated are those that occur more slowly under natural weathering, hot water can induce effects in some composites, for instance those containing acrylic polymer, that may not occur in natural weathering. This test method may not be a valid indicator of long-term performance of such composites.

4. Apparatus

4.1 *Aging Tanks*—Tank material can be but not limited to, plastic, insulated to maintain a stable temperature. Insulation should cover all exterior surfaces including the cover. Insulation can be a foam product as used in building construction.

4.1.1 The size of the tank is typically 12 in. deep (300 mm), 18 in. wide (450 mm), and 20 to 36 in. (600 to 900 mm), in length. Size is determined by the amount of coupons to be processed and the ability to maintain stable temperatures.

[1] This test method is under the jurisdiction of ASTM Committee C27 on Precast Concrete Products and is the direct responsibility of Subcommittee C27.40 on Glass Fiber Reinforced Concrete.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

Water temperature in several medium sized tanks is easier to control than one large tank.

4.2 *Heating Unit*—An immersion unit with rheostat for controlling temperature, such as those used for aquariums, has been found to be satisfactory.

4.3 *Thermometer*—A standard immersion, laboratory thermometer is used to monitor temperature. More sophisticated recorders can also be used.

4.4 *Immersion Rack*—A rack built from a non-contaminating material, such as wood or plastic, should be used to maintain coupon separation. Space should be at least 1 in. (25 mm) between coupons and coupons should be totally immersed. The design of the rack is left up to the testing facility.

4.5 It is recommended that about 50 $in.^3$ (820 cc) of water be used per coupon.

4.6 The tank should be sealed to prevent loss of water through evaporation.

5. Procedure

5.1 Coupons are prepared according to Practice C1228, or cut from actual product, and coded for identification. Coupons are first cured for 28 days and tested using Test Method C947. A random sampling of test coupons is tested to establish unaged or beginning properties. Sufficient coupons should be produced to allow the testing of a minimum of six coupons per interval.

5.1.1 Coupons cut from actual product should have a product history if possible.

5.2 Coupons are totally immersed in the tank filled with preheated water. The type of water, for example. distilled, lime-saturated, etc., must be chosen to minimize contamination of the coupons and to minimize the possibility of the water dissolving constituents of the composite that could affect the aging process.

5.2.1 Different matrices should be aged in separate tanks.

5.2.2 It is important that the water not be changed during the duration of the test. Also topping up should be minimal.

5.3 Test intervals after immersion are: 0, 5, 10, 20, 30, 40, 50, 60, 70, 80, 90 or more days. Aging can be considered as complete when the doubling of the aging period shows less than a 5 % decrease in the flexural ultimate and/or a decrease of strain capacity of less than 10 %.

5.4 Water temperature can be 122°F (50°C) up to 176°F (80°C) but must be stable at the chosen temperature. Aging will be faster at higher temperatures. Temperature should be maintained at the required level ± 3°F (2°C) and measured and recorded at twelve hour intervals. Manual checks with a laboratory thermometer is satisfactory, however the use of a continuous recorder is preferred. If the temperature increases or decreases more than 3°F (2°C) from the chosen value and is constant for over five hours the test should be discontinued. If there is any question regarding the stability of the temperature the test should be discontinued.

5.5 At each test interval, aged coupons should be selected at random from the remaining coupons in the tank and tested.

6. Calculation or Interpretation of Results

6.1 Modulus of Rupture is calculated in accordance with Test Method C947.

6.2 Strain to failure is measured analogously using the measured deflection at failure.

7. Report

7.1 The report shall include the following:

7.1.1 Identification of coupon,

7.1.2 Description of coupon,

7.1.3 Temperature of water,

7.1.4 Number of hours immersed,

7.1.5 Date and time of test,

7.1.6 Type of test performed,

7.1.7 Flexural yield strength and flexural ultimate strength as per Test Method C947,

7.1.8 Measured deflection at failure,

7.1.9 Appearance of coupon at rupture point,

7.1.10 Description of reinforcement,

7.1.11 Description of mix proportions including fiber content,

7.1.12 Type of aging medium, for example, distilled water, lime saturated water, etc., and

7.1.13 Source of coupons.

8. Precision and Bias

8.1 The precision and bias criteria are being developed and tests are being conducted.

9. Keywords

9.1 accelerated aging; GFRC; glass fiber; glass fiber reinforced concrete