Designation: ~~C1579 – 13~~ C1579 – 21

Standard Test Method for Evaluating Plastic Shrinkage Cracking of Restrained Fiber Reinforced Concrete (Using a Steel Form Insert)[1]

This standard is issued under the fixed designation C1579; 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 compares the surface cracking of fiber reinforced concrete panels with the surface cracking of control concrete panels subjected to prescribed conditions of restraint and moisture loss that are severe enough to produce cracking before final setting of the concrete.

1.2 This test method can be used to compare the plastic shrinkage cracking behavior of different concrete mixtures containing fiber reinforcement.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.* (**Warning—**fresh hydraulic cementitious mixtures are caustic and may cause chemical burns to skin and tissue upon prolonged exposure.[2]*)*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

C125 Terminology Relating to Concrete and Concrete Aggregates
C143/C143M Test Method for Slump of Hydraulic-Cement Concrete
C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
C403/C403M Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance
C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials

3. Terminology

3.1 *Definitions:*

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.42 on Fiber-Reinforced Concrete.

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[2] Section on Safety Precautions, Manual of Aggregate and Concrete Testing, *Annual Book of ASTM Standards*, Vol 04.02.

[3] 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.

***A Summary of Changes section appears at the end of this standard**

3.1.1 For definitions of terms used in this test method, refer to Terminology C125.

4. Summary of Test Method

4.1 Panels of control concrete and fiber reinforced concrete are prepared in a prescribed manner and are exposed to controlled drying conditions after finishing. The drying conditions (see Note 1) are intended to be severe enough to induce plastic shrinkage cracking in test panels made of control concrete. The evaporation rate from a free water surface is monitored by pans placed next to the panels in the environmental chamber.

NOTE 1—An important parameter in this method is the rate of evaporative water loss, which is controlled by the atmospheric conditions surrounding the test specimens. Since the concrete specimens will not always have the same rate of water evaporation as the pan of water (due to evaporative and bleeding effects), the rate of evaporation of 1.0 $kg/m^2 \cdot h$ from the pan of water represents the minimum evaporation rate that must be attained for this test (**1**).[4] The moisture loss from the concrete test panels can also be monitored and reported, however, the rate of evaporation from the free surface of the water in the pan is the parameter that should be used to quantify the drying environment.

4.2 The test is terminated at the time of final setting of the concrete determined in accordance with Test Method C403/C403M. At 24 h from initial mixing, the average crack width is determined.

4.3 A cracking reduction ratio (CRR) is computed from the average crack width for the fiber-reinforced concrete panels and the average crack width for the control concrete panels.

5. Significance and Use

5.1 The test method is intended to evaluate the effects of evaporation, settlement, and early autogenous shrinkage on the plastic shrinkage cracking performance of fiber reinforced concrete up to and for some hours beyond the time of final setting (see Terminology C125).

5.2 The measured values obtained from this test may be used to compare the performance of concretes with different mixture proportions, concretes with and without fibers, concretes containing various amounts of different types of fibers, and concretes containing various amounts and types of admixtures. For meaningful comparisons, the evaporative conditions during test shall be sufficient to produce an average crack width of at least 0.5 mm in the control specimens (**2, 3**) (see Note 2). In addition, the evaporation rate from a free surface of water shall be within ± 5 % for each test.

NOTE 2—To achieve evaporation rates that result in a crack of at least 0.5 mm in the control specimens, it may be necessary to use an evaporation rate higher than that discussed in Note 1.

5.3 This method attempts to control atmospheric variables to quantify the relative performance of a given fresh concrete mixture. Since many other variables such as cement fineness, aggregate gradation, aggregate volume, mixing procedures, slump, air content, concrete temperature and surface finish can also influence potential cracking, attention shall be paid to keep these as consistent as possible from mixture to mixture.

6. Apparatus

6.1 *Molds:*

6.1.1 For maximum coarse aggregate size equal to or less than 19 mm, use a mold with a depth of 100 mm ± 5 mm and rectangular dimensions of 355 mm ± 10 mm by 560 mm ± 15 mm (see Fig. 1). The mold can be fabricated from metal, plastic, or plywood.

NOTE 3—If plywood is used for molds, the plywood should have low moisture absorption. The mold should be constructed to be lightweight and stiff. The molds, when properly constructed, should last for approximately 50 uses.

6.1.2 This test method is designed for aggregate less than or equal to 19 mm. For coarse aggregate greater than 19 mm, the depth of the mold shall be at least 65 mm plus at least 2 times the maximum coarse aggregate size.

[4] The boldface numbers in parentheses refer to the list of references at the end of this standard.

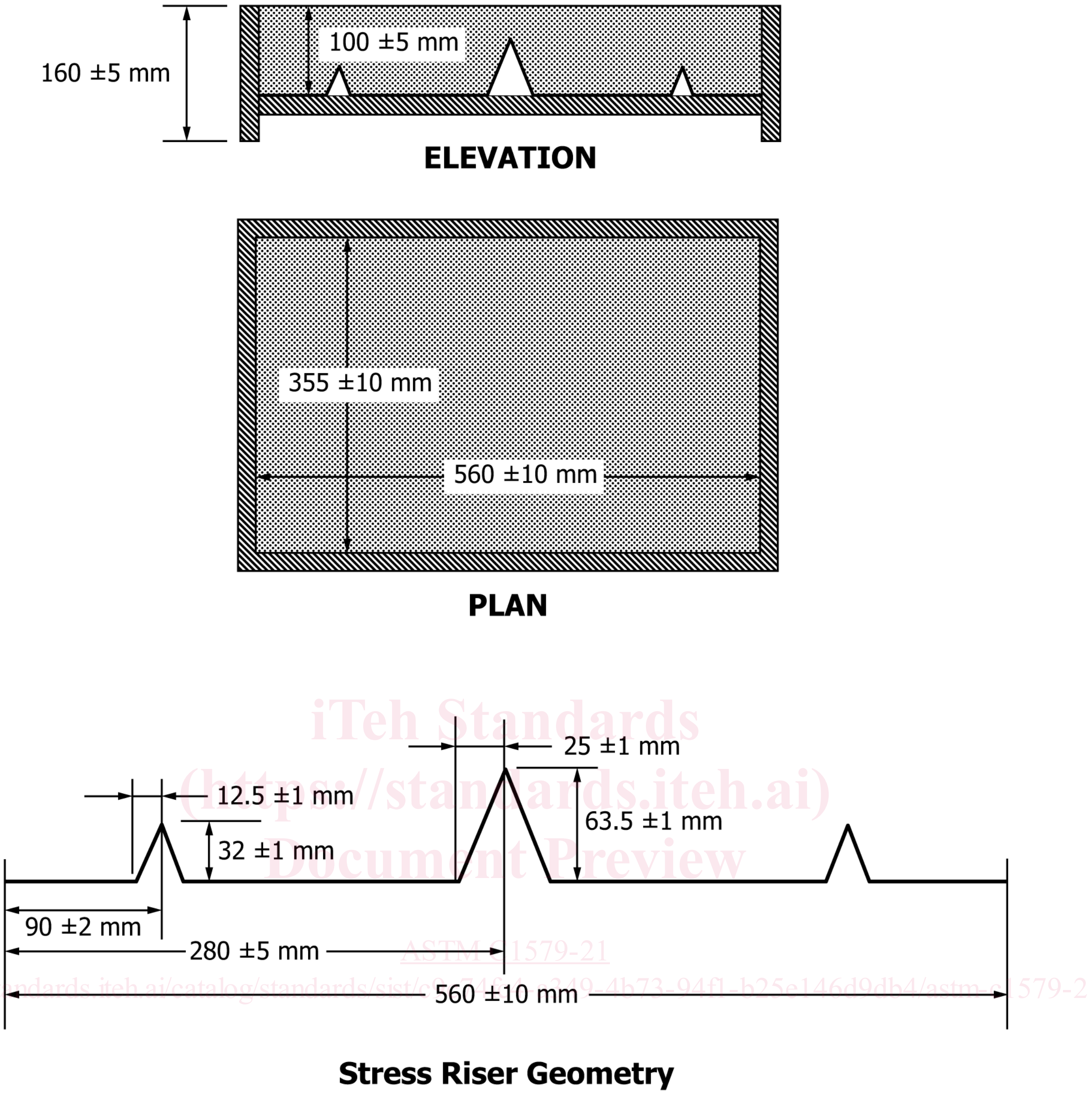


FIG. 1 Specimen and Stress Riser Geometry (4, 3)

6.2 *Stress Riser and Internal Restraints*—The internal restraints and stress riser shall be bent from one piece of sheet metal, as illustrated in Fig. 1, or made from a solid piece of steel. The sheet metal shall have a thickness of 1.2 mm ± 0.05 mm (18 gauge) (see Fig. 1 and Ref **2**). Two 32 mm ± 1 mm high restraints are placed 90 mm ± 2 mm inward from each end of the mold. The central stress riser is 64 mm ± 2 mm high and serves as an initiation point for cracking. This sheet metal stress riser with internal restraints shall fit at the bottom of the mold.

6.2.1 Use form release oil to coat the metal insert and mold sides to reduce bond with concrete. The insert and mold are considered to be properly oiled when the entire surface is coated and excess oil has been removed with a clean, dry rag.

6.3 *Variable Speed Fan(s)*—The fan(s) used shall be capable of achieving a wind speed of more than 4.7 m/s over the entire test panel surface area.

6.4 *Environmental Chamber*—The use of a fan box in an environmental chamber is a method for producing a uniform airflow over the panel surface (see Fig. 2). A clear cover over the panels will aid in obtaining uniform airflow and allow for observation of cracking. Another method of producing uniform airflow is to use a specifically designed environmental chamber as shown in Fig. 3. A commercially available heater, humidifier, and dehumidifier can be used to maintain the specified environmental condition.

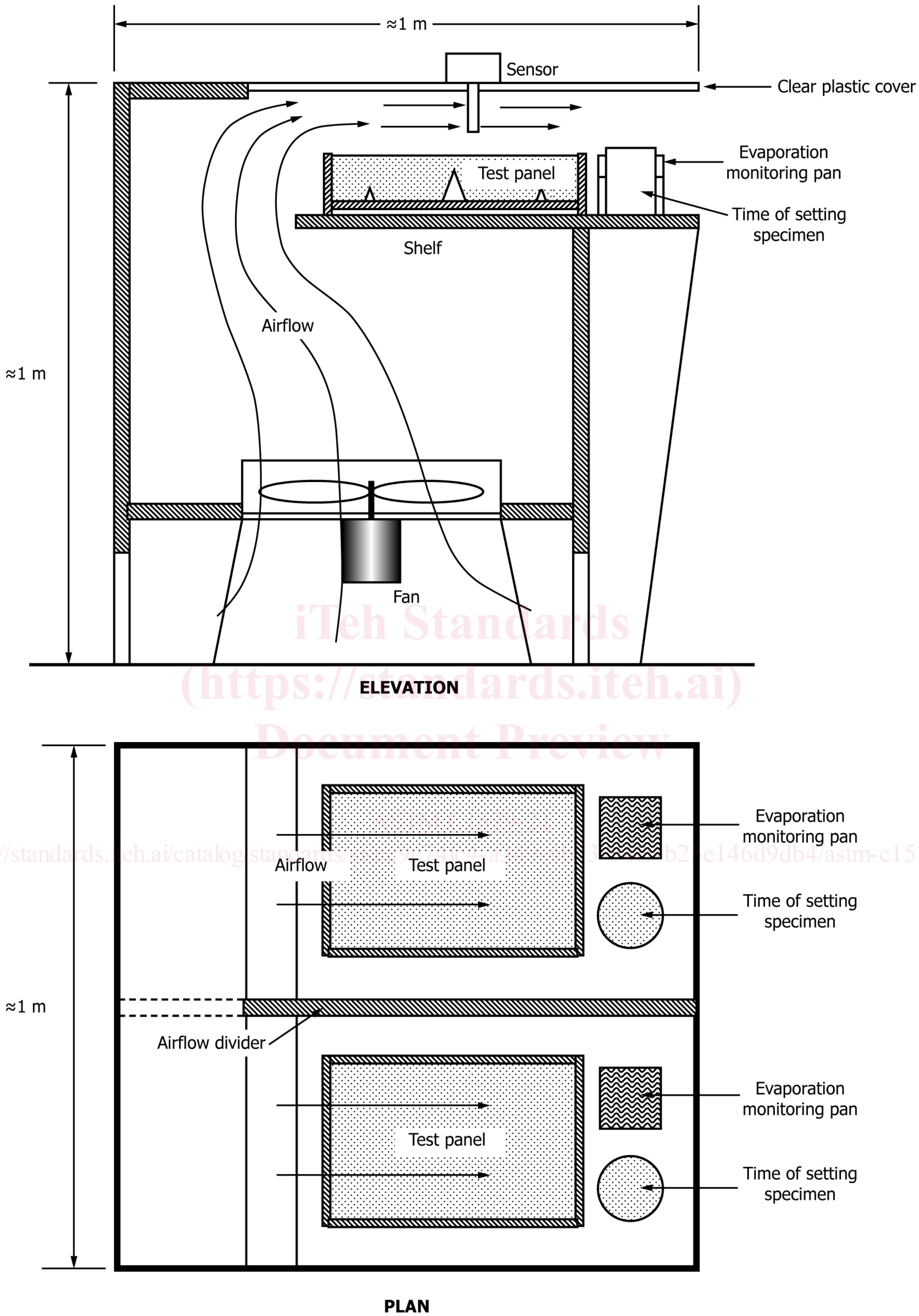
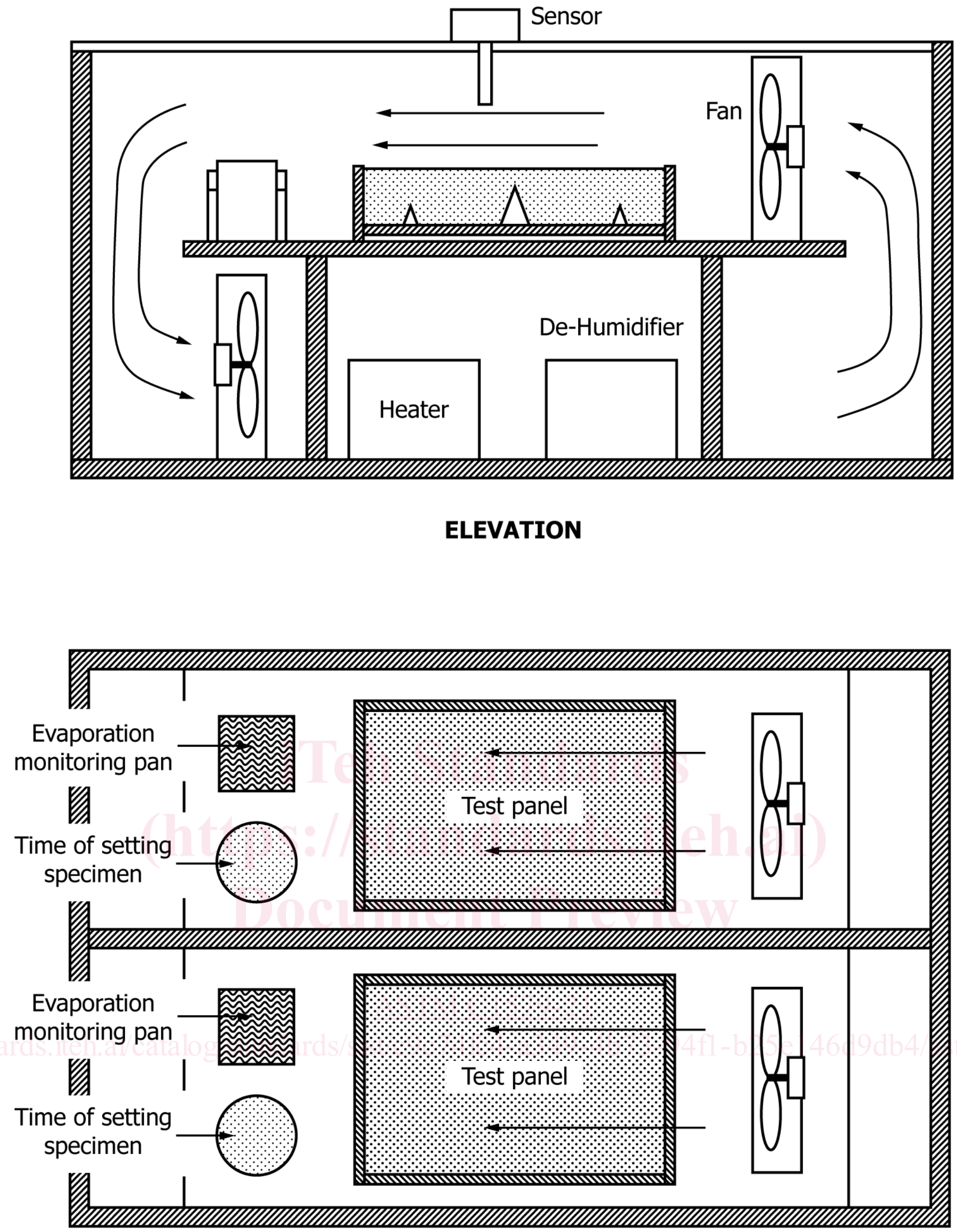


FIG. 2 Example of Fan Box to Maintain Environmental Conditions (2) (Not to Scale)



PLAN

FIG. 3 Example of Chamber to Maintain Environmental Conditions (4)

This test is conducted using either apparatus shown in Fig. 2 or Fig. 3 by exposing the panels to an evaporation rate of at least 1.0 kg/m^2·h (see Note 1). For the standard test, the temperature must be maintained at ~~36~~36 °C ± ~~3°C,~~3 °C, the relative humidity must be 30 ± 10 %, and the wind velocity must be sufficient to maintain the minimum evaporation rate during the test.

NOTE 4—Before casting the concrete panels, atmospheric variables in the environmental facility should be checked to determine that the necessary evaporative conditions can be achieved. A wind velocity of 4.7 m/s should be sufficient to achieve the minimum specified evaporation rate, but a higher wind velocity may be needed to obtain sufficient average crack width in some control panels.

6.5 *Sensors*—Use temperature, humidity, and wind velocity sensors to measure ambient air and concrete surface temperature to the nearest ~~0.5°C,~~0.5 °C, relative humidity to the nearest 1 %, and air speed to the nearest 0.1 m/s.

6.6 *Vibrating Platform*—Any device that can fully consolidate the test panel that meets minimum frequency requirements as stated in Practice C192/C192M for an external vibrator is suitable.