Designation: C860 – 15

Standard Test Method for Determining the Consistency of Refractory Castable Using the Ball-In-Hand Test[1]

This standard is issued under the fixed designation C860; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 This test method covers the procedures for determining the consistency of a castable using the Ball-in-Hand Test. The amount of water used in a castable has a significant influence on its performance.

1.2 This test method applies to castable refractories that are described in Classification C401. It also applies to such castables containing metal fibers.

1.3 This test method is not intended to determine the proper consistency for gunning, pumping, or self flow applications.

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 this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* (See 6.2.3 for a specific safety warning.)

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C401 Classification of Alumina and Alumina-Silicate Castable Refractories

3. Significance and Use

3.1 This test method is used to determine if a freshly mixed refractory castable is of the proper consistency to provide optimum performance. There are times when the manufacturer's specified water content and consistency will purposely not lead to the correct ball in hand but should be used to provide optimum performance. Contact the manufacturer when in doubt. This test method can also be used to estimate the correct water addition rate of a castable when either the manufacturer's specified water content is not available or when unique circumstances have rendered that recommendation unusable.

3.2 The correct water content is an important factor that must be controlled to obtain optimum castable performance. Excess water can reduce strength, increase volume shrinkage, and promote segregation of the castable ingredients. Insufficient water can produce "honeycombs" (air voids) in the castable because of the insufficient mobility during placement and in extreme cases can prevent the complete hydration of the cement (if used).

3.3 The Ball-in-Hand test is subjective and somewhat depends on the skill of the operator. However, it is a universally accessible method due to the simplicity of the equipment required, and it is readily used in the field.

3.4 The total wet mixing time of a castable influences the rheological and final properties and therefore should be monitored.

3.5 This test method can be performed in a laboratory or on a job site.

4. Apparatus

4.1 *Castable Mixer*—Either a manually or electrically operated mechanical mixer (see Fig. 1) may be used to prepare batches for consistency determination in a laboratory. Wet castable may also be obtained while in the field from the mixer being used for installation.

4.2 *Heavy Rubber Gloves,* for castables containing metal fibers.

4.3 *Clock or Watch,* with a readability of 1 s.

5. Sampling

5.1 A representative handful of freshly mixed castable should be drawn from the center of the mixer while the mixer is not running.

[1] This test method is under the jurisdiction of ASTM Committee C08 on Refractories and is the direct responsibility of Subcommittee C08.09 on Monolithics.

Current edition approved Oct. 1, 2015. Published December 2015. Originally approved in 1977. Last previous edition approved in 2010 as C860 – 10. DOI: 10.1520/C0860-15.

[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.

FIG. 1 Example of a Five-Quart Mechanical Mixer

6. Procedure

6.1 *Preparation of Castable:*

6.1.1 Load the mixer with dry castable to an appropriate level so as to allow proper mixing action by the mixer but not so much as to cause dry or wet castable to splash out of the mixer.

6.1.1.1 The amount of water required to reach the consistency specified in 6.2 increases as the dry volume loading of a mixer drops below 40 % of its capacity. This occurs because the percentage of the total water required to wet the mixer surfaces increases with decreased volume loading.

6.1.2 Dry mix the castable for the manufacturer's recommended dry mixing time or until the castable appears to be fully mixed.

6.1.3 Start the mixer and note the time. Add 90 % of the estimated water requirement over a period of 30 s. If a water content specified by the manufacturer is available, it should be used to calculate this amount. Then add additional water in small amounts and continue mixing until the batch appears to have the desired ball-in-hand consistency specified in 6.2. Some castables require a minimum amount of mixing time to wet out. Do not add additional water until sufficient time for wet out has occurred. Follow the manufacturer's recommendations for minimum mixing time.

6.1.3.1 The moisture content of lightweight, porous aggregates can affect the water demand of a castable. Dry aggregates can change the consistency of a castable after mixing is completed by absorbing the mixing water into its pores. This can cause premature stiffening and poor consolidation of the castable.

6.1.4 The total mixing time, including water additions, shall be in accordance with the manufacturer's recommendations. If no recommendations are given, use the following guidelines: 3 min for dense castables, 5 min for insulating castables, 4 to 6 min for mixes needing heavy vibration, and at least 5 min for castables containing deflocculating admixtures (to allow for wet-out), such as low cement castables (LCC) or ultra-low cement castables (ULCC).

6.2 *Ball-in-Hand Test:*

6.2.1 Prepare the castable in accordance with 6.1.

6.2.2 While the mixer is off, remove a handful of castable from the center of the mixer.

6.2.3 Form a fist-sized compact ball of the mix with the hands (see Figs. 2-4). Toss it upward about 1 ft (300 mm), and catch it in one hand with the fingers spread slightly apart. The proper consistency and variations are illustrated in Figs. 2-4. (**Warning—** If the castable contains metal fibers, the operator must wear a heavy rubber glove to prevent the needles from cutting or otherwise injuring his hand.)

7. Report

7.1 Report the following information:

7.1.1 The type of mixer used to prepare the test batch,

7.1.2 Environmental conditions such as ambient temperature and water quality,

7.1.3 The total mixing time, and

7.1.4 The consistency of the castable as observed by the Ball-in-Hand test.

8. Precision and Bias

8.1 *Precision*—No justifiable statement of precision is possible since the results of this test method are word descriptions rather than numerical values.

8.2 *Bias*—No justifiable statement of accuracy is possible since a true value of consistency cannot be established by an accepted reference sample.

9. Keywords

9.1 ball-in-hand; castable; consistency; mixing; refractory; water demand; wet-out

NOTE 1—This figure shows a castable containing excess water. The ball will be greatly deformed and nearly flat with castable flowing between the fingers.

FIG. 2 Range in Consistency of Castable Mixes as Shown by Ball-in-Hand Tests

NOTE 1—This figure shows a castable containing insufficient water. The ball may be slightly deformed with no castable flowing between the fingers

FIG. 3 Range in Consistency of Castable Mixes as Shown by Ball-in-Hand Tests

NOTE 1—This figure shows a castable having proper consistency. The ball will be somewhat deformed with castable slightly flowing between the fingers.

FIG. 4 Range in Consistency of Castable Mixes as Shown by Ball-in-Hand Tests