



Standard Practice for Determining the Consistency of Refractory Castable Using the Ball-in-Hand Test¹

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1. Scope

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

1.2 This practice applies to regular weight castable refractories and insulating castable refractories which are described in Classification C 401. It also applies to such castables containing metal fibers.

1.3 *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 6.2.3.1.*

2. Referenced Documents

2.1 ASTM Standards:

C 401 Classification of Alumina and Alumina-Silicate Castable Refractories²

3. Significance and Use

3.1 This practice is used primarily to determine if a freshly mixed refractory castable is of the proper consistency and therefore would most likely provide optimum performance. It 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 practice can be performed in a laboratory or on a job site.

3.6 This practice is not intended to determine the proper consistency for gunning applications, although it may provide information of value for interpretation by a skilled operator.

4. Apparatus

4.1 *Castable Mixer*—Either a manually or electrically operated (see Fig. 1) mechanical mixer³ 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 second hand.

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.

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

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² *Annual Book of ASTM Standards*, Vol 15.01.

³ Mixers having various capacities are available from the Hobart Manufacturing Co., Troy, OH and have been found to be suitable for this purpose.



FIG. 1 Five-Quart Hobart Mixer

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.

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 actual wet mixing time, including water additions, should be $3 \text{ min} \pm 10 \text{ s}$ for dense castables, $5 \text{ min} \pm 10 \text{ s}$ 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). These recommendations do not override any specified by the manufacturer.

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 Fig. 2, Fig. 3, and Fig. 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.

6.2.3.1 **Precaution:** 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. Keywords

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



NOTE 1—This test shows a mix containing excess water.

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



NOTE 1—This test shows a mix containing insufficient water.

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



NOTE 1—This test shows a mix having proper consistency.

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

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