



Designation: D8378/D8378M – 21

# Standard Test Method for Potential Expansion of Steel Slag from Hydration Reactions by Autoclave<sup>1</sup>

This standard is issued under the fixed designation D8378/D8378M; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the determination of potential volume expansion of steel slags that contain components susceptible to hydration and consequent volume increase, such as the free calcium and magnesium oxides.

1.1.1 This method is based upon the Cement Autoclave procedure, Test Method C151/C151M, and the California Bearing Ratio procedure, Test Method D1883. This is an aggressive test that can detect both calcium and magnesium expansion potentials. The procedure is also a rapid method typically completed within 24 h.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

NOTE 1—Sieve size is identified by its standard designation in Specification E11. The alternative designation given in parentheses is for information only and does not represent a different standard sieve size.

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 the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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.*

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.51 on Aggregate Tests.

Current edition approved Jan. 1, 2021. Published January 2021. DOI: 10.1520/D8378\_D8378M-21.

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>2</sup>

C29/C29M Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate

C151/C151M Test Method for Autoclave Expansion of Hydraulic Cement

C702/C702M Practice for Reducing Samples of Aggregate to Testing Size

C1005 Specification for Reference Masses and Devices for Determining Mass and Volume for Use in Physical Testing of Hydraulic Cements

D75/D75M Practice for Sampling Aggregates

D1883 Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils

D4792/D4792M Test Method for Potential Expansion of Aggregates from Hydration Reactions

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

2.2 *Other Standard:*<sup>3</sup>

Indiana Test Method ITM 219 Acceptance Procedures of Steel Furnace Slag for Deleterious Materials

## 3. Summary of Test Method

3.1 This test method consists of measuring the volume expansion of compacted specimens following the autoclave procedures of Test Method C151/C151M. The method utilizes a mold similar to the one used in Test Method D1883, with the exception of it being proportionally smaller in order to fit in the autoclave. This method is severe due to the high temperatures and pressure. This method detects periclase (MgO) hydration reactions that may not appear during some water bath procedures, such as Test Method D4792/D4792M. As a result,

<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

<sup>3</sup> Available from Indiana Department of Transportation, [https://www.in.gov/indot/div/mt/itm/pubs/219\\_testing.pdf](https://www.in.gov/indot/div/mt/itm/pubs/219_testing.pdf).

the numerical results obtained by this method tend to be higher than those obtained by other methods. When used for acceptance/rejection, this method should be correlated to the specified test methods.

#### 4. Significance and Use

4.1 This test method provides a procedure for determining the compliance of steel slags and other materials with specifications or applications that limit permissible expansion of base and subbase aggregates containing components subject to hydration.

4.2 This test method can also be used to evaluate the effectiveness of aging or other treatments for reducing the expansive potential of such materials.

4.3 This test method is utilized for dense graded materials passing a 25.0 mm (1 in.) sieve. If it is desired to investigate materials larger than a 25.0 mm (1 in.) sieve, Indiana Test Method ITM 219 should be considered.

4.4 Test results have not been correlated with field performance, and values obtained do not necessarily indicate expansion that may occur in service conditions. The various methods will provide different numerical results due to differences in severity of the procedures.

#### 5. Apparatus

5.1 *Weighing Devices and Weights*, for determining the mass of materials conforming to the requirements of Specification **C1005**.

5.2 *Molds*, conforming to **Fig. 1**.

5.3 *Flat Trowel*, having a straight-edged steel blade 100 to 150 mm [4 to 6 in.] in length.

5.4 *Autoclave*—Conforming to the requirements of Test Method **C151/C151M**. Consisting of a high-pressure steam vessel provided with a thermometer well. The autoclave shall be equipped with an automatic pressure control and a rupture disk with a bursting pressure of 2.4 MPa [350 psi]  $\pm$  5 %. In locations where the use of a rupture disk is not permitted, the autoclave shall be equipped with a safety valve. In addition, the autoclave shall be equipped with a vent valve to allow the escape of air during the early part of the heating period and to release any steam pressure remaining at the end of the cooling period. The pressure gauge shall have a nominal capacity of 4.0 MPa [600 psi], a dial with a nominal diameter of 115 mm [4.5 in.], and shall be graduated from 0 to 4.0 MPa [0 to 600 psi] with scale divisions not exceeding 0.03 MPa [5 psi]. The error in the gauge shall not exceed  $\pm$ 0.02 MPa [ $\pm$ 3 psi] at the operating pressure of 2 MPa [295 psi]. The capacity of the heating unit shall be such that, with maximum load (water plus specimens), the pressure of the saturated steam in the autoclave may be raised to a gauge pressure of 2 MPa [295 psi] in 45 to 75 min from the time the heat is turned on. The automatic pressure control shall be capable of maintaining the gauge pressure at  $2 \pm 0.07$  MPa [ $295 \pm 10$  psi] for at least 3 h. A gauge pressure of  $2 \pm 0.07$  MPa [ $295 \pm 10$  psi] corresponds to a temperature of  $216 \pm 2$  °C [ $420 \pm 3$  °F]. The autoclave shall be designed to permit the gauge pressure to drop from 2 MPa

[295 psi] to less than 0.07 MPa [10 psi] in 1.5 h after the heat supply has been shut off.

5.5 *Rupture Disk*—The rupture disk shall be made of a material having a tensile strength that is relatively insensitive to temperatures in the range 20 to 216 °C [68 to 420 °F] and that is electrochemically compatible with the pipe leading to it and to its holder.

#### 6. Safety Precautions

6.1 The pressure gauge shall have a capacity of 4.0 MPa [600 psi]. A gauge with too small or too large a capacity may be a hazard, since for pressure above the specified maximum working pressure, with a smaller capacity gauge, the pressure may be off scale; and with a larger capacity gauge, the arc of movement may be too small to invite attention. The operator shall be sure the gauge hand has not passed the maximum graduation on the scale.

6.2 Test the pressure gauge for proper operation. Always use a thermometer together with the pressure gauge, to provide a means of detecting any failure of the pressure gauge to operate properly and to indicate any unusual condition.

6.3 Maintain the automatic control in proper working order at all times.

6.4 Set the safety valve to relieve the pressure at about 6 to 10 % above the maximum of 2.1 MPa [305 psi] specified in this test method, that is, at about 2.3 MPa [330 psi]. Unless the manufacturer has given specific instructions as to maintenance of the safety valve, test the valve twice each year. Test with a gauge testing device or by adjusting the automatic controls to allow the autoclave to reach a pressure of about 2.3 MPa [330 psi], at which pressure the safety valve will either open or be adjusted to open. Direct the safety valve discharge away from the operator (**Note 2**).

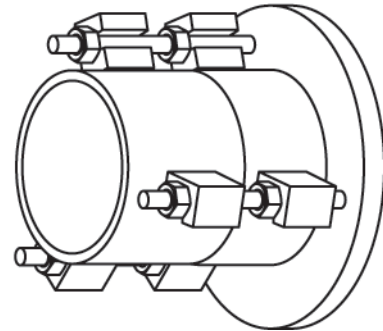
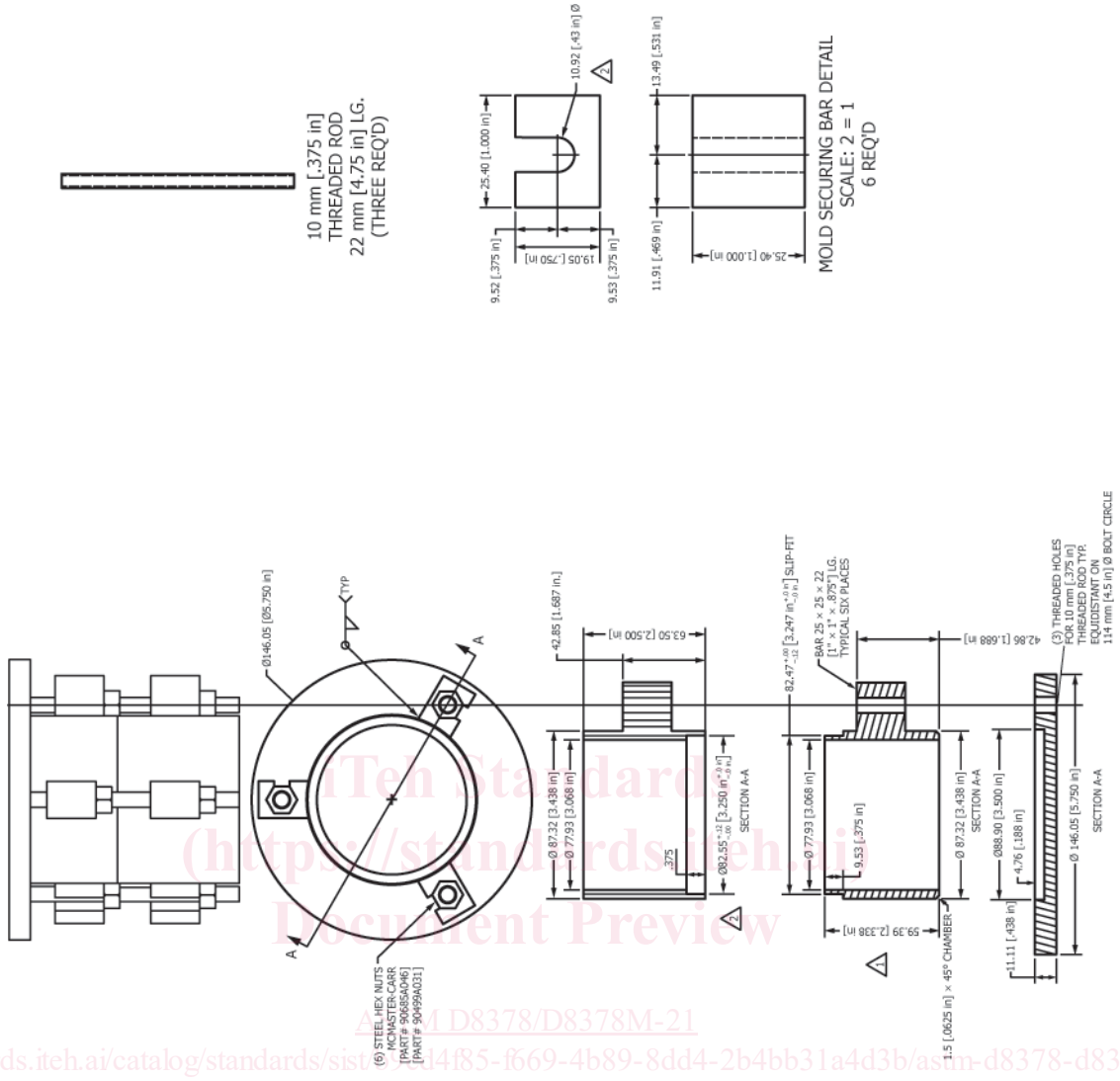
**NOTE 2**—Unexpected combinations of conditions may occur. For example, in one case the automatic control had failed, the safety valve had become stuck, and the gauge hand, which at first glance appeared to be at about zero, had passed the maximum graduation and had come to stop of the wrong side of the pin. This condition of the gauge was finally detected and the pressure, then of an unknown magnitude, was released before failure could occur in the apparatus.

6.5 Wear work gloves, heavy leather, to prevent burning of the hands when removing the top of the autoclave at the end of the test. Direct the vent valve away from the operator. When removing the autoclave lid, tilt it so that any steam escaping from beneath the lid will be discharged away from the operator. Care shall be taken to avoid scalding by any liquid that may have been used in the autoclave well.

6.6 The operator shall be made aware that, for many autoclave pressure gauges, the return of the gauge hand to the initial rest or starting point does not necessarily indicate zero pressure within the autoclave; there may then still remain an appreciable dangerous pressure.

#### 7. Sample Preparation

7.1 The test sample shall be obtained following the guidelines of Practices **C702/C702M** and **D75/D75M**. The sample shall consist of aggregate that has 100 % of the particles



MATERIAL: STEEL  
EST. TOTAL WT: 3.2 KG [7 LBS]

FIG. 1 Equipment Diagrams—Mold