Standard Method of Test for

LINEAR CONTRACTION OF MAGNESIUM OXYCHLORIDE CEMENTS[1]

ASTM Designation: C 252 – 52

ADOPTED, 1952.[2]

This Standard of the American Society for Testing Materials is issued under the fixed designation C 252; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

Scope

1. This method of test covers a procedure for the laboratory determination of linear changes occurring in magnesium oxychloride cements prior to the point of maximum contraction.

Apparatus

2. (*a*) *Measuring Apparatus.*—The measuring apparatus (Fig. 1) shall consist essentially of a base on which shall be rigidly mounted a section of angle brass, $1\frac{1}{2}$ in. by $1\frac{1}{2}$ in. in dimensions and approximately 11 in. long, to serve as a cradle for the specimen. A rigidly mounted tail piece at one end of the cradle shall be provided with a bolt for anchoring the test specimen. At the opposite end of the cradle shall be mounted a suitable measuring instrument graduated to permit reading to 0.001 in. and estimating to 0.0001 in. This instrument may be either a micrometer comparator or a dial gage. The tip of the stem of the measuring device shall be hemispherical and shall contact the end of the specimen with a total force of not less than 80 nor more than 120 g. The bolt of the tail piece and the stem of the device shall be horizontal and parallel with the long dimension of the cradle with their centers $\frac{1}{2}$ in. above the apex of the cradle.

(*b*) *Brass Face Plates.*—Pieces of light-gage, but rigid, brass cut in the form of a right triangle with the two adjacent sides each $1\frac{1}{2}$ in. long shall be used to confine the ends of the test specimen. Shim stock approximately 0.010 to 0.020 in. thick is recommended. One face plate shall have soldered to its surface a brass nut of the proper size and thread to engage the bolt of the tail piece of the cradle. The other face plate shall have soldered to its surface a brass washer approximately $\frac{1}{16}$ in. thick with a center opening sufficiently large to make a loose fit over the stem of the measuring device. The centers of the brass nut and washer, respectively, shall be $\frac{7}{16}$ in. from the apex of the face plate and on a line bisecting the right angle. Three $\frac{3}{32}$-in. holes shall be punched in each end plate for keying to the specimen.

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee C-2 on Magnesium Oxychloride and Magnesium Oxysulfate Cements.

[2] Prior to adoption as standard, this method was published as tentative from 1950 to 1952.

Storage and Test Conditions

3. (*a*) The preparation and subsequent testing of the test specimens shall be conducted in an atmosphere maintained at 70 ± 1 F. and at a relative humidity of 50 ± 5 per cent (corresponding to a wet bulb temperature range of 56.5 to 60.5 F.). All materials and apparatus shall be equilibrated to these conditions at time of use.

(*b*) An air circulation velocity of not less than 50 and not more than 100 ft. per min. shall be maintained in the vicinity of the molded specimens for the full duration of the test.

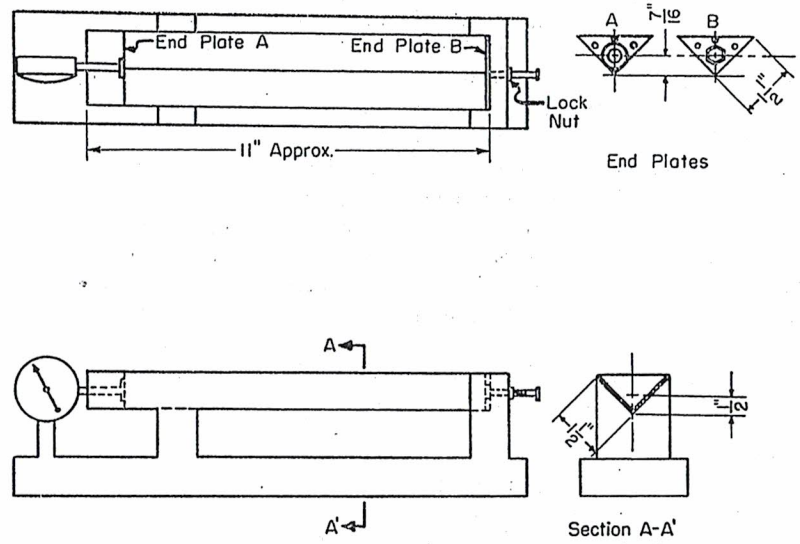

FIG. 1.—Apparatus for Determining Linear Contraction.

Procedure

4. (*a*) Cut four pieces of thin, non-sticky, waxed paper (kitchen type) to approximately 4 by 11 in. and fold in half lengthwise. Line the cradle with these folded papers without wrinkling and install the fixed end plate at the tail piece. Insert the other end plate at its approximate location near the opposite end of the cradle. Fill the resulting trough with the plastic cement prepared in accordance with the Standard Method for Mixing Magnesium Oxychloride Cement Compositions with Gauging Solution (ASTM Designation: C 251).[3] The cement shall not have aged more than 10 min. from the time of completion of the mixing. Remove the entrapped air by a cutting motion with the spatula and extrude a small amount of cement through the holes in and around the edges of the end plates. Strike off the excess cement and engage the end plate and stem of the indicating device. Adjust the end plate so that it is vertical and does not bind on the sides of the mold, and so that the test specimen is 10 ± 0.05 in. in length. The test specimen shall remain undis-

[3] Appears in this publication, see Contents in Numeric Sequence of ASTM Designations at front of book.

turbed in the apparatus until the completion of the determination.

(*b*) Exactly 30 min. after starting to add the gauging solution to the dry ingredients in the mixing procedure, record the reading of the indicating device to the nearest 0.0001 in. No adjustment of the end plate or the specimen length shall have been made within 5 min. prior to this base-point readng. Record the length of the test specimen at ½-hr. intervals until maximum contraction is reached. Maximum contraction is the point of minimum length of the test specimen after which two consecutive measurements at ½-hr. intervals show either a decrease in length of not more than 0.0001 in. or an actual expansion.

(*c*) Concurrently with the linear contraction determination, determine the setting time of the oxychloride cement in accordance with the Standard Method of Test for Setting Time of Magnesium Oxychloride Cements (ASTM Designation: C 254),[3] using test specimens prepared from the same batch of cement.

Calculations

5. (*a*) Plot the linear change measurements, expressed as percentage change from the base-point, against time on suitable coordinates in order to make it possible to interpolate linear change values corresponding to the independently measured setting times.

(*b*) Calculate *nonplastic contraction* as the percentage change in length of the test specimen between the time of final set and the time at which maximum contraction occurs.

(*c*) Calculate *net contraction* as the percentage decrease in length of the test specimen between the initial base-point (at ½-hr. age) and the point of maximum contraction. With some types of mixes expansion may occur prior to maximum contraction and the test specimen may increase in length beyond the length recorded at the initial base-point. In such cases the contraction shall be considered as the difference between the maximum length and the length at maximum contraction, and shall be reported as percentage *gross contraction.*

(*d*) Round off final calculated values to the nearest 0.001 per cent in accordance with the rounding-off method given in Section 3 (*d*) to (*h*) of the Recommended Practices for Designating Significant Places in Specified Limiting Values (ASTM Designation: E 29).[3]

Report

6. The report shall include the following:

(*1*) Percentage of nonplastic contraction, and

(*2*) Percentage of net contraction, or percentage of gross contraction.

3, p. 323 (C 253 – 52).

Make the following editorial changes in Standard Methods C 253 – 52:

Section 7 (*a*) (*2*).—Change lines 9 through 15 to read: "graduated to at least 0.001 in. The graduations shall be such that length changes of 0.0001 in. may be estimated. When tested at any point throughout its range, the error shall not be greater than ±0.002 in. The difference between repeated measurements shall not be greater than 0.0001 in."

Section 9 (*a*).—Change dimension at left of center drawing from "¾ in." to "⅜ in."

Section 12.—In Item (*2*) of the Note change "0.*xyz* per cent" to read "±, as the case may be, 0.*xyz* per cent."

Standard Methods of Test for

LINEAR CHANGE OF MAGNESIUM OXYCHLORIDE CEMENTS[1]

ASTM Designation: C 253 – 52

ADOPTED, 1952.[2]

This Standard of the American Society for Testing Materials is issued under the fixed designation C 253; the final number indicates the year of original adoption as standard or, in the case of revision, the year of last revision.

Scope

1. (*a*) These methods of test cover procedures for the laboratory determination of linear changes occurring in magnesium oxychloride cements subsequent to final set.

(*b*) Two types of apparatus and procedures are covered. In Method A, use is made of molds and a length comparator conforming to the Standard Method of Test for Autoclave Expansion of Portland Cement (ASTM Designation: C 151).[3] Method B covers the apparatus and procedure currently in use by the oxychloride cement industry.[4]

METHOD A

Apparatus

2. (*a*) *Molds.*—The test specimen molds shall provide for 1 by 1-in. test specimens of 10-in. effective gage length. The effective gage length shall be considered as that length between the innermost points of the metal inserts used as reference points. The parts of the molds shall be tight fitting and firmly held together when assembled. The molds shall be made of steel or hard metal not readily attacked by the cement paste. The sides of the molds shall be sufficiently rigid to prevent spreading or warping. Each end plate of the molds shall be equipped to hold properly in place, during the setting period, a stainless steel or noncorroding metal reference point having a diameter of ¼ in. The reference points shall be set so that their principal axes coincide with the principal axis of the test specimen, and shall extend into the specimen ⅝ in. The distance between the inner ends of the reference points shall be 10 ± 0.1 in. The distance between opposite faces of the molds shall be 1 ± 0.03 in. The height of the mold measured separately for each specimen compartment, shall be 1 ± 0.03 in both for new molds and for molds in use

(*b*) *Length Comparator.*—Changes in length of the test specimen shall be measured by a dial gage or micrometer comparator having a range of at least

[1] Under the standardization procedure of the Society, this method is under the jurisdiction of the ASTM Committee C-2 on Magnesium Oxychloride and Magnesium Oxysulfate Cements.

[2] Prior to adoption as standard, these methods were published as tentative from 1950 to 1952.

[3] Appears in this publication, see Contents in Numeric Sequence of ASTM Designations at front of book.

[4] It is anticipated that further experience with the two different types of equipment and procedures may result in the selection of one method as standard.

0.3 in. The instrument shall be graduated to at least 0.001 in., and when tested at any point throughout its range, the error shall not be greater than plus or minus 0.002 in. The difference between repeated measurements shall not be greater than 0.001 in. The comparator shall be equipped with a steel reference bar having an insulating grip and shall be frequently checked with this reference bar.

Storage and Test Conditions

3. (*a*) The preparation and subsequent testing of the test specimens shall be conducted in an atmosphere maintained at a temperature of 70 ± 1 F. and at a relative humidity of 50 ± 5 per cent (corresponding to a wet bulb temperature range of 56.5 to 60.5 F.). All materials and apparatus shall be equilibrated to these conditions at time of use.

(*b*) The temperature of the storage cabinet or storage room shall be maintained at 70 ± 1 F. and the relative humidity at 50 ± 5 per cent. An air circulation velocity of not less than 20 and not more than 500 ft. per min. shall be maintained in the vicinity of the specimens during the entire period of curing and storage.

Preparation of Test Specimens

4. (*a*) *Preparation of Molds.*—Coat the test specimen molds with a saturated solution of stearic acid in trichloroethylene sufficiently in advance of molding of the specimens to permit complete evaporation of the solvent. When the solvent has evaporated, set the stainless steel or noncorroding metal reference points, taking care to keep them free of the parting compound.

(*b*) *Molding Specimens.*—Fill the mold with the plastic cement prepared in accordance with the Standard Method for Mixing Magnesium Oxychloride Cement Compositions with Gauging Solution (ASTM Designation: C 251).[3] The cement shall not have aged more than 20 min. from completion of the mixing. Remove entrapped air and completely fill the corners of the mold by applying a spatula with a cutting motion. Strike off the excess cement flush with the top of the mold.

Storage and Measurement of Test Specimens

5. (*a*) After filling the test specimen mold, place it immediately in the curing cabinet. At 30 ± 5 min. after final set of the cement, as determined in accordance with the Standard Method of Test for Setting Time of Magnesium Oxychloride Cements (ASTM Designation: C 254),[3] carefully remove the specimen from the mold and measure its length to the nearest 0.0001 in. Then place the specimen on a rack or grating in the storage area in such a position that the standard atmosphere (Section 3 (*b*)) will have access to all faces at all times.

(*b*) Repeat the measurement of the length of the specimen at ½-hr. intervals until maximum contraction is reached. Maximum contraction is the point of minimum length of the specimen after which two consecutive measurements at ½-hr. intervals show either a decrease in length of not more than 0.0001 in. or an actual expansion. With some types of magnesium oxychloride cement mixes the test specimens will not contract after removal from the mold. In this event, the fact shall be noted in the record of measurements of the specimen. Finally, measure the length of the specimen at the age of 24 hr. after starting to add the gauging solution to the dry ingredients in the mixing procedure, and at subsequent ages as prescribed in the specifications for the material being tested.

NOTE.—In determining linear change, a suitable initial reference point, in terms of age or history of the specimen, to which subsequent changes are referred, must be selected. The difference between the length of the specimen at the initial reference point and its length at any specified subsequent point provides the basis for calculation of the percentage of linear change. The initial and final reference points to be selected are designated in the specifications for the material under test. Customary initial reference points are: (*1*) point of maximum contraction, or (*2*) point at age of 1 day (24 hr.) after starting to add the gauging solution to the dry ingredients in the mixing procedure. Final reference points may be at ages of 1, 3, 7, or 28 days.

Calculations

6. (*a*) Calculate the percentage of linear change by multiplying by ten the difference between the length, in inches, of the test specimen at the initial reference point and its length at the specified final reference point (Note, Section 5). If the test specimen increases in length between the initial and final reference points, the change shall be reported as expansion (this expansion may be indicated by a plus sign); if it decreases in length the change shall be reported as contraction (may be indicated by a minus sign).

(*b*) Final calculated values shall be rounded off to the nearest 0.001 per cent in accordance with the rounding-off method given in Section 3 (*d*) to (*h*) of the Recommended Practices for Designating Significant Places in Specified Limiting Values (ASTM Designation: E 29).[3]

METHOD B

Apparatus

7. (*a*) *Measuring Apparatus:*

(*1*) A cradle similar to that illustrated in Fig. 1, suitable for holding the test specimen at an angle of 45 deg. to the vertical, shall be provided.

(*2*) *Length Comparator.*—Changes in length of the test specimen shall be measured by a dial gage or a micrometer comparator with ratchet stop. The measuring instrument shall be fitted to the cradle (Item (*1*)), as indicated in Fig. 1. It shall have a range of at least 1.0 in. The instrument shall be graduated to at least 0.0002 in., and, when tested at any point throughout its range, the error shall not be greater than plus or minus 0.002 in. The difference between repeated measurements shall not be greater than 0.001 in. The calibrations of the dial gage or micrometer shall be such that length changes of 0.0001 in. may be estimated. A standard invar reference bar

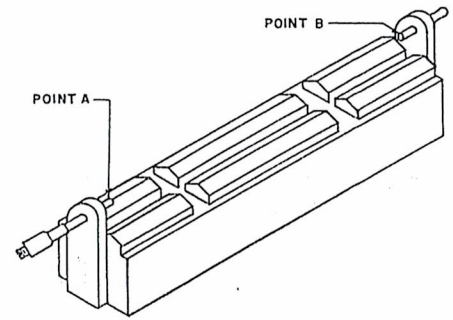

FIG. 1.—Micrometer Cradle.
NOTE.—Distance between points *A* and *B* is variable.

10 ± 0.1 in. long shall be provided and the instrument shall be checked frequently with this reference bar.

(*b*) *Mold.*—A collapsible brass mold with internal dimensions of 1 by 1 by 10 in., suitable for forming the test specimen with its longitudinal axis in the horizontal position, shall be provided. A suitable mold is shown in Fig. 2.

(*c*) *Ground Glass Inserts.*—Pieces of glass microscope slides that have been roughened on one side with carborundum until they are translucent, and of the proper size to fit into the ends of the mold, shall be provided.

Storage and Test Conditions

8. The storage and test conditions shall be as prescribed in Section 3.

Preparation of Test Specimens

9. (*a*) *Preparation of Molds.*—Coat the test specimen mold with a saturated solution of stearic acid in trichloroethylene

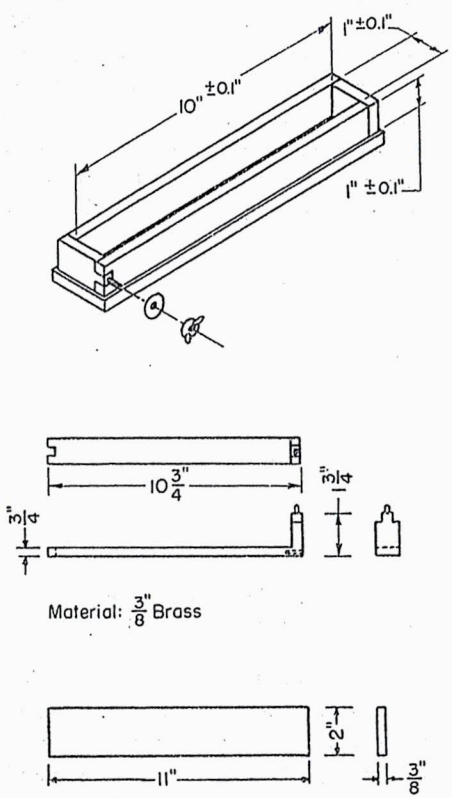

FIG. 2.—Linear Change Specimen Mold.

sufficiently in advance of molding the specimen to permit complete evaporation of the solvent. Place the ground-glass inserts at each end of the mold so that their smooth surfaces are next to the mold.

(*b*) *Molding Specimens.*—Fill the mold with the plastic cement prepared in accordance with the Standard Method for Mixing Magnesium Oxychloride Cement Compositions with Gauging Solution (ASTM Designation: C 251).[3] The cement shall not have aged more than 20 min. from completion of mixing. Remove entrapped air and completely fill the corners of the mold by applying a spatula with a cutting motion. Strike off the excess cement flush with the top of the mold. At 30 ± 5 min. after final set of the cement, as determined in accordance with the Standard Method of Test for Setting Time of Magnesium Oxychloride Cements (ASTM Designation: C 254),[3] carefully remove the test specimen from the mold. Clean the exposed faces of the ground glass inserts so that they are free of cement and stearic acid and proceed with the specified measurements as described in Section 10. After removal from the mold, place the test specimen on a rack or grating so that the standard atmosphere will have access to all four sides at all times.

Storage and Measurement of Test Specimens

10. (*a*) Place the specimen, immediately upon removal from the mold, in the cradle (Fig. 1) so that the faces of the anvil and spindle of the micrometer or dial gage will touch only the faces of the glass inserts in the ends of the specimen. Measure and record the length of the specimen to the nearest 0.0001 in. If, in a series of measurements, it is necessary to remove the specimen from the cradle, make all subsequent readings with the specimen in exactly the same position relative to the micrometer as when the original measurement was made. At least once each day, preferably just prior to or after measuring the specimen, check the micrometer dial gage against the standard reference bar (Section 6 (*b*)(*2*)) and correct the measurement of the specimen accordingly if deviations greater than plus or minus 0.0001 in. from the length of the standard reference bar are noted.

(*b*) Continue in accordance with Section 5 (*b*).

Calculations

11. Calculate the percentage of linear change in accordance with Section 6.

REPORT

Report

12. The report shall include the following:

(*1*) Method used—Method A or Method B,

(*2*) Initial and final reference points, and

(*3*) Percentage expansion or contraction (Note).

NOTE.—Typical forms for reporting linear change are:

(*1*) Expansion, 1 to 7 days = 0.*xyz* per cent, or

(*2*) Linear change, 1 to 7 days = 0.*xyz* per cent.