

CRD-C 231-63

**METHOD OF TEST FOR
VOLUME CHANGES IN NEAT CEMENT BARS****Scope**

1. This test method covers procedures for determining the volume changes in neat cement bars produced by prolonged saturation followed by prolonged drying, and alternate saturation and drying. The procedures simulate some of the conditions in nature that cause stress and consequent volume change. Volume change will be measured and expressed as an increase or decrease in the original axial gage length of the test specimen.

Apparatus

2. Apparatus for the tests shall consist of the following:

(a) Molds.- 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. There shall be sufficient material in the sides of the molds 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 1/4 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 5/8 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 molds, 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 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 and shall be frequently checked with this reference bar. The comparator and reference bar are shown in Fig. 1.



Fig. 1. Length comparator
with 11-1/2-in. reference bar

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Test Specimens

3. The test specimens shall be 1-in. by 1-in. by 11-1/4-in. bars, with stainless steel reference points at each end of the longitudinal axis, providing an effective initial gage length of exactly 10 in. The preparation of the specimens shall be as follows:

(a) Preparation of Molds.- Molds shall be thinly covered with mineral oil; after this operation the stainless steel or noncorroding metal reference points shall be set, care being taken to keep them clean and free of oil.

(b) Mixing Cement Paste.- The standard batch shall consist of 500 g of cement with sufficient water to give a paste of normal consistency, and shall be mixed in accordance with the procedure described in CRD-C 220.

(c) Molding Specimens.- Immediately following completion of mixing, the test specimen shall be molded in one or two layers, each layer being compacted with the thumbs or forefingers by pressing the paste into the corners, around the reference inserts, and along the surfaces of the molds until a homogeneous specimen is obtained. After the top layer has been compacted, the paste shall be cut off flush with the top of the mold and the surface smoothed with a few strokes of the trowel. During the operations of mixing and molding, the hands shall be protected by rubber gloves.

Storage

4. Immediately after molding, the specimens shall be placed in the moist room, which shall be maintained at a relative humidity of at least 90 percent and at a temperature of $73.4\text{ F} \pm 2\text{ F}$. At the end of $24\text{ hr} \pm 2\text{ hr}$, the specimens shall be removed from the molds and placed in clean water at a temperature of $73.4\text{ F} \pm 2\text{ F}$ for a curing period of 28 days or as otherwise required.

Measuring Procedure

5. The length change measurements shall be made in accordance with the requirements of CRD-C 25. There should be no change in the temperature and the humidity conditions surrounding the test specimens and instrument during length measurements. The measuring apparatus shall be kept in the room in which the specimens are stored. All measurements shall be made as quickly as accuracy will permit. The reference bar shall be measured after specimen measurements have been made as well as before.

Procedure

6. (a) Prolonged Saturation.- The lengths of the bars shall be measured immediately after the specimens are removed from the molds. The bars shall then be immersed in water at the specified temperature. The bars shall be removed from the water and measured every 2 days to 14 days, then every 14 days to 90 days.

(b) Prolonged Drying.- At the end of 90 days, the bars shall be removed to air and dried at $73.4\text{ F} \pm 2\text{ F}$ and a relative humidity of 50 ± 5 percent for 90 days (or longer if constant length has not been reached at that age). The length of the bars shall be measured every 2 days to 14 days, then every 14 days to 90 days. The exact temperature of the specimens shall be recorded at each reading. Adjustments for temperature irregularities shall be applied after coefficients of thermal expansion for the individual cements have been determined. A continuous graph of the length changes observed shall be plotted.

(c) Continued Saturation.- Bars remaining in water longer than 90 days shall be measured every 28 days until completion of the period determined for the test.

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(d) Alternate Saturation and Drying.- At the end of the 28-day curing period, the lengths of the bars shall be measured and the temperature recorded. The bars shall then be exposed to air at 73.4 ± 2 F with a relative humidity of 50 ± 5 percent for 28 days, measured again, and the temperature recorded. The bars shall then be immersed in water at 73.4 ± 2 F for 28 days, removed, measured, and the temperature recorded. The bars shall be alternately immersed 28 days and air-dried 28 days for the desired number of reversals. The length change shall be computed, and a graph plotted of the alternate expansion and contraction.