INTERNATIONAL

Designation: ~~C469/C469M – 14~~ C469/C469M – 14$^{\varepsilon 1}$

Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression[1]

This standard is issued under the fixed designation C469/C469M; 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.

ε^1 NOTE—Footnote 3 was editorially updated in February 2021.

1. Scope*

1.1 This test method covers determination of (*1*) chord modulus of elasticity (Young's) and (*2*) Poisson's ratio of molded concrete cylinders and diamond-drilled concrete cores when under longitudinal compressive stress. Chord modulus of elasticity and Poisson's ratio are defined in Terminology E6.

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 non-conformance with the standard.

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~~ safety, health, and ~~health~~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.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field
C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
C174/C174M Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
C617 Practice for Capping Cylindrical Concrete Specimens
E4 Practices for Force Verification of Testing Machines
E6 Terminology Relating to Methods of Mechanical Testing
E83 Practice for Verification and Classification of Extensometer Systems
E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

[1] This test method is under the jurisdiction of ASTM Committee C09 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.61 on Testing for Strength.

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[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.

***A Summary of Changes section appears at the end of this standard**

2.2 *ASTM Adjuncts:*
Compressometers (two drawings) and Extensometers (two drawings)[3]

3. Significance and Use

3.1 This test method provides a stress to strain ratio value and a ratio of lateral to longitudinal strain for hardened concrete at whatever age and curing conditions may be designated.

3.2 The modulus of elasticity and Poisson's ratio values, applicable within the customary working stress range (0 to 40 % of ultimate concrete strength), are used in sizing of reinforced and nonreinforced structural members, establishing the quantity of reinforcement, and computing stress for observed strains.

3.3 The modulus of elasticity values obtained will usually be less than moduli derived under rapid load application (dynamic or seismic rates, for example), and will usually be greater than values under slow load application or extended load duration, given other test conditions being the same.

4. Apparatus

4.1 *Testing Machine*—Use a testing machine capable of imposing a load at the rate and of the magnitude prescribed in 6.4. The machine shall conform to the requirements of Practices E4 (Constant-Rate of-Traverse CRT-Type Testing Machines section). The spherical head and bearing blocks shall conform to the Apparatus Section of Test Method C39/C39M.

4.2 *Compressometer*[3]—For determining the modulus of elasticity use a bonded (Note 1) or unbonded sensing device that measures to the nearest 5 millionths the average deformation of two diametrically opposite gauge lines, each parallel to the axis, and each centered about midheight of the specimen. The effective length of each gauge line shall be not less than three times the maximum size of the aggregate in the concrete nor more than two thirds the height of the specimen; the preferred length of the gauge line is one half the height of the specimen. Either use gauge points embedded in or cemented to the specimen, and read deformation of the two lines independently; or use a compressometer (such as is shown in Fig. 1) consisting of two yokes, one of which (see *B*,Fig. 1) is rigidly attached to the specimen and the other (see *C*,Fig. 1) attached at two diametrically opposite points so that it is free to rotate. At one point on the circumference of the rotating yoke, midway between the two support points, use a pivot rod (see *A*,Fig. 1) to maintain a constant distance between the two yokes. At the opposite point on the circumference of the rotating yoke, the change in distance between the yokes (that is, the gauge reading) is equal to the sum of the displacement due to specimen deformation and the displacement due to rotation of the yoke about the pivot rod (see Fig. 2).

4.2.1 Measure deformation by a dial gauge used directly or with a lever multiplying system, by a wire strain gauge, or by a linear variable differential transformer. If the distances of the pivot rod and the gauge from the vertical plane passing through the support points of the rotating yoke are equal, the deformation of the specimen is equal to one-half the gauge reading. If these distances are not equal, calculate the deformation as follows:

$$d = g e_r/(e_r + e_g) \tag{1}$$

where:

d = total deformation of the specimen throughout the effective gauge length, μm [μin.],
g = gauge reading, μm [μin.],
e_r = the perpendicular distance, measured to the nearest 0.2 mm [0.01 in.] from the pivot rod to the vertical plane passing through the two support points of the rotating yoke, and
e_g = the perpendicular distance, measured to the nearest 0.2 mm [0.01 in.] from the gauge to the vertical plane passing through the two support points of the rotating yoke.

Procedures for calibrating strain-measuring devices are given in Practice E83.

NOTE 1—Although bonded strain gauges are satisfactory on dry specimens, they may be difficult, if not impossible, to mount on specimens continually moist-cured until tested.

4.3 *Extensometer*[3]—If Poisson's ratio is desired, the transverse strain shall be determined (*1*) by an unbonded extensometer

[3] Available from ASTM International Headquarters. Order Adjunct No. ~~ADJC0469~~ADJC0469-E-PDF. Adjunct converted to digital format in 2021.

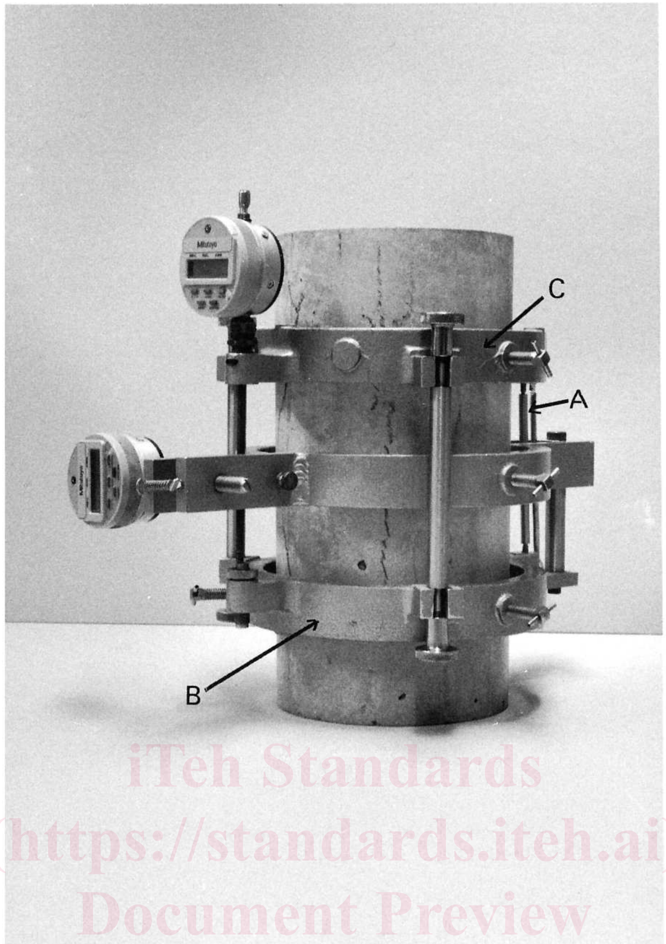
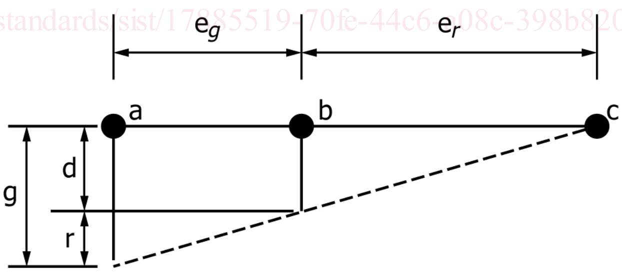


FIG. 1 Suitable Compressometer



d = displacement due to specimen deformation
r = displacement due to rotation of the yoke about the pivot rod
a = location of gauge
b = support point of the rotating yoke
c = location of pivot rod
g = gauge reading

FIG. 2 Diagram of Displacements

capable of measuring to the nearest 0.5 µm [25 µin.] the change in diameter at the midheight of the specimen, or (*2*) by two bonded strain gauges (Note 1) mounted circumferentially at diametrically opposite points at the midheight of the specimen and capable of measuring circumferential strain to the nearest 5 millionths. A combined compressometer and extensometer (Fig. 3) is a convenient unbonded device. This apparatus shall contain a third yoke (consisting of two equal segments) located halfway between the two compressometer yokes and attached to the specimen at two diametrically opposite points. Midway between these points use a short pivot rod (*A*', see Fig. 3), adjacent to the long pivot rod, to maintain a constant distance between the bottom and middle yokes. Hinge the middle yoke at the pivot point to permit rotation of the two segments of the yoke in the horizontal plane. At the