Designation: C 469 – 94

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 C 469; 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.

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 E 6.

1.2 The values stated in inch-pound units are to be regarded as 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 31 Practice for Making and Curing Concrete Test Specimens in the Field[2]
C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens[2]
C 42 Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete[2]
C 174 Test Method for Measuring Length of Drilled Concrete Cores[2]
C 192 Practice for Making and Curing Concrete Test Specimens in the Laboratory[2]
C 617 Practice for Capping Cylindrical Concrete Specimens[2]
E 4 Practices for Load Verification of Testing Machines[2]
E 6 Terminology Relating to Methods of Mechanical Testing[3]
E 83 Practice for Verification and Classification of Extensometers[3]
E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods[2]

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), may be 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, other test conditions being the same.

4. Apparatus

4.1 *Testing Machine*—Any type of testing machine capable of imposing a load at the rate and of the magnitude prescribed in 6.4 may be used. The machine shall conform to the requirements of Practices E 4 (Constant-Rate of-Traverse CRT-Type Testing Machines section). The spherical head and bearing blocks shall conform to the Apparatus Section of Test Method C 39.

4.2 *Compressometer*[4]—For determining the modulus of elasticity a bonded (Note 1) or unbonded sensing device shall be provided for measuring to the nearest 5 millionths the average deformation of two diametrically opposite gage lines, each parallel to the axis, and each centered about midheight of the specimen. The effective length of each gage 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 gage line is one half the height of the specimen. Gage points may be embedded in or cemented to the specimen, and deformation of the two lines read independently; or a compressometer (such as is shown in Fig. 1) may be used 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

[1] This test method is under the jurisdiction of ASTM Committee C-9 on Concrete and Concrete Aggregates and is the direct responsibility of Subcommittee C09.70 on Elastic and Inelastic.

Current edition approved March 15, 1994. Published July 1994. Originally published as C469 – 61. Last previous edition C469 – 87a.

[2] *Annual Book of ASTM Standards*, Vol 04.02.

[3] *Annual Book of ASTM Standards*, Vol 03.01.

[4] Copies of working drawings of strain measuring apparatus are available from the American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428. Request adjunct No. 12-304690-00.

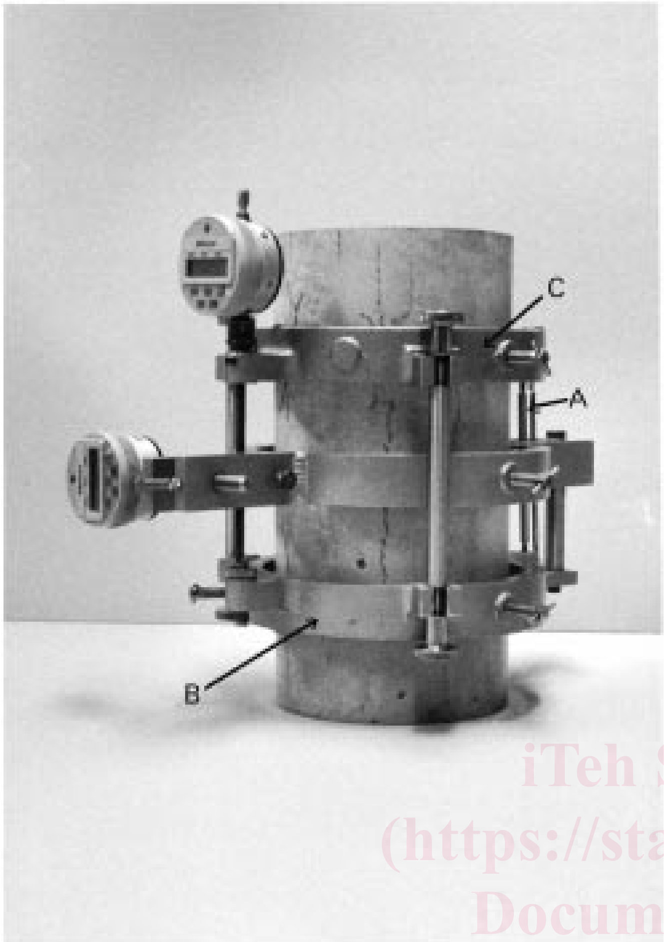
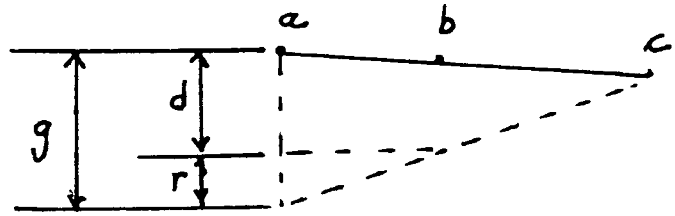


FIG. 1 Suitable Compressometer



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

FIG. 2 Diagram of Displacements

it is free to rotate. At one point on the circumference of the rotating yoke, midway between the two support points, a pivot rod (see *A*, Fig. 1) shall be used 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 gage 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 Deformation may be measured by a dial gage used directly or with a lever multiplying system, by a wire strain gage, or by a linear variable differential transformer. If the distances of the pivot rod and the gage 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 gage reading. If these distances are not equal, the deformation shall be calculated as follows:

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

where:

d = total deformation of the specimen throughout the effec- tive gage length, µin. (µm),
g = gage reading, µin. (µm),
e_r = the perpendicular distance, measured in inches (millimetres) to the nearest 0.01 in. (0.254 mm) 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 in inches (millimetres) to the nearest 0.01 in. (0.254 mm) from the gage to the vertical plane passing through the two support points of the rotating yoke.

Procedures for calibrating strain-measuring devices are given in Practice E 83.

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

4.3 *Extensometer*[4]—If Poisson's ratio is desired, the transverse strain shall be determined (*1*) by an unbonded extensometer capable of measuring to the nearest 25 µin. (0.635 µm) the change in diameter at the midheight of the specimen or (*2*) by two bonded strain gages (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 a short pivot rod (*A′*, see Fig. 3), adjacent to the long pivot rod, shall be used to maintain a constant distance between the bottom and middle yokes. The middle yoke shall be hinged at the pivot point to permit rotation of the two segments of the yoke in the horizontal plane. At the opposite point on the circumference, the two segments shall be connected through a dial gage or other sensing device capable of measuring transverse deformation to the nearest 50 µin. (1.27 µm). If the distances of the hinge and the gage from the