



Designation: C 469 – 02

Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression¹

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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/C 31M Practice for Making and Curing Concrete Test Specimens in the Field²

C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens²

C 42/C 42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete²

C 174/C 174M Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores²

C 192/C 192M Practice for Making and Curing Concrete Test Specimens in the Laboratory²

C 617 Practice for Capping Cylindrical Concrete Specimens²

E 4 Practices for Force Verification of Testing Machines³

E 6 Terminology Relating to Methods of Mechanical Testing³

E 83 Practice for Verification and Classification of Extensometer³

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods⁴

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 Annual Book of ASTM Standards, Vol 04.02.

³ Annual Book of ASTM Standards, Vol 03.01.

⁴ Annual Book of ASTM Standards, Vol 14.02.

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 E 4 (Constant-Rate-of-Traversal CRT-Type Testing Machines section). The spherical head and bearing blocks shall conform to the Apparatus Section of Test Method C 39/C 39M.

4.2 *Compressometer*⁵—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 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. Either use gage 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.

⁵ Copies of working drawings of strain measuring apparatus are available from ASTM International Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428. Request adjunct No. ADJC0469.

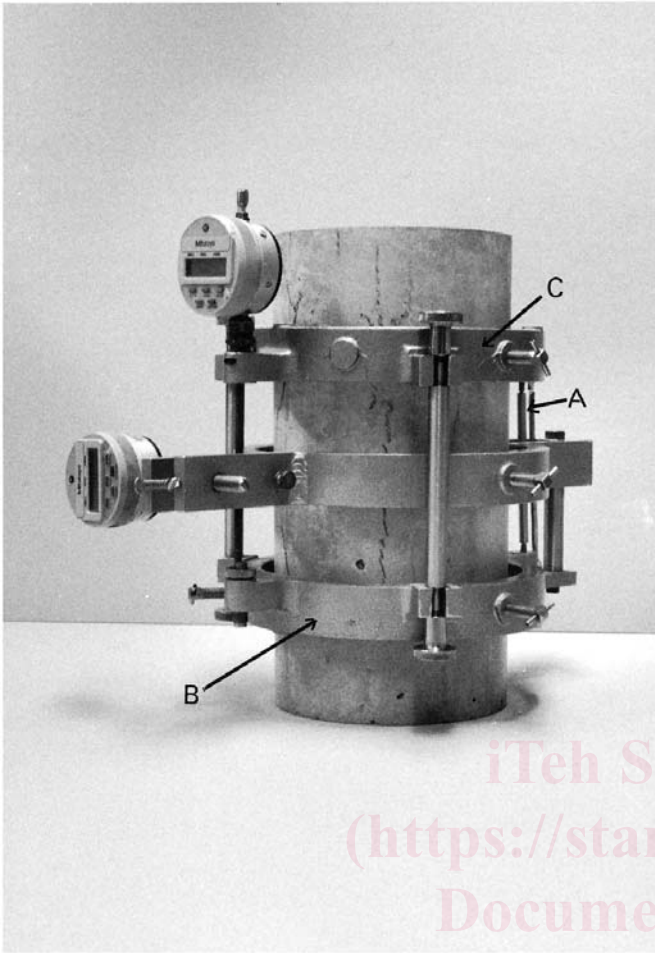
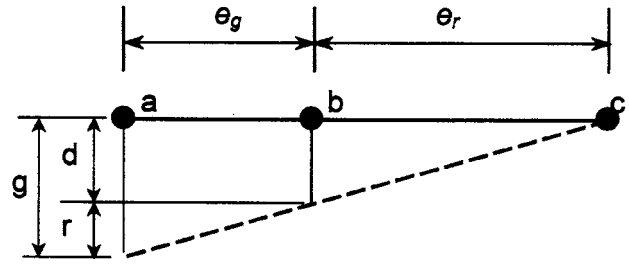


FIG. 1 Suitable Compressometer

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 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 Measure deformation 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, calculate the deformation as follows:

$$d = g e_r / (e_r + e_g) \quad (1)$$



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

where:

- d = total deformation of the specimen throughout the effective gage length, $\mu\text{in.}$ (μm),
- g = gage reading, $\mu\text{in.}$ (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*⁵—If Poisson's ratio is desired, the transverse strain shall be determined (1) by an unbonded extensometer capable of measuring to the nearest 25 $\mu\text{in.}$ (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 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