

DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
Transportation Laboratory
5900 Folsom Blvd.
Sacramento, California 95819-4612



METHOD OF TEST FOR CHORD MODULUS OF ELASTICITY OF CONCRETE (Compressometer Method)

A. SCOPE

This test method describes the procedure used in determining the modulus of elasticity of concrete by means of a compressometer is described in this test method. Alternate methods using a dial gauge capable of reading to 0.0001 in. or an electronic recorder for plotting a stress-strain curve are described.

B. REFERENCES

ASTM E 4 - Force Verification of Testing Machines
ASTM C 39/C 39M - Compressive Strength of Cylindrical Concrete Specimens
ASTM C 192/C 192M - Making and Curing Concrete Test Specimens in the Laboratory
California Test 540 - Making, Handling, and Storing Concrete Compressive Test Specimens in the Field

C. APPARATUS

The apparatus shall consist of the following:

1. Testing Machine:

Any type of testing machine capable of imposing a load at a constant rate of 35 psi \pm 5 psi per second if hydraulically operated. If a screw-type machine is used, the moving head shall travel at a rate of 0.05 in./min, when the machine is running idle. The machine shall conform to Section 15 of ASTM E 4. The spherical head and bearing blocks shall conform to Sections 2 and 5 of ASTM C 39/C 39M.

2. Compressometer:

The compressometer shall be capable of reading deformations to 0.0001 in. by means of a dial gauge, or by use of a linear variable differential transformer (LVDT) directly connected to a plotting recorder, or to a computer for graphics program processing and file storage.

D. TEST RECORD FORM

Record the concrete test data and the deformation readings from a dial compressometer on a suitable form. If either an LVDT and chart recorder are used, or a computer for graphics generation, then attach the plots to a form containing the concrete test data for the files.

E. TEST SPECIMENS

Mold and cap the test cylinders in accordance with the requirements for compression test specimens in ASTM C 192/C 192M, or in accordance with California Test 540. Subject the test cylinders to a specified curing condition and test at the age for which the elastic deformation

information is desired. Test the cylinders in a moist condition after being removed from the curing room, unless another condition is specified.

F. TEST PROCEDURE

1. Maintain the ambient temperature and humidity as constant as possible throughout the test. Record any unusual fluctuation in temperature or humidity in the report.
2. If companion specimens are available, determine the compressive strength in accordance with ASTM C 39/C 39M prior to the test for modulus of elasticity.
3. Place the specimen, with the strain measuring equipment attached, on the lower platen or bearing block of the testing machine. Carefully align the axis of the specimen with the center of thrust of the spherically seated upper bearing block. Note the reading on the strain indicators. As the spherically seated block is brought slowly to bear upon the specimen, rotate the moveable portion of the block gently by hand so that uniform seating is obtained.
4. Pre-load the specimen to a stress at least equal to that to be used during the test, but not to exceed 75 % of the ultimate strength of the specimen. Do not record any data during this pre-loading as the pre-loading is primarily for the seating of the gauges, etc., but merely observe the performance of the gauges and correct any unusual behavior prior to the second loading. If excessive correction is necessary, pre-load the specimen again prior to obtaining the deformation readings. At least two subsequent loadings during which the deformations are recorded are recommended so that the repeatability of the test may be noted.
5. Observe each set of readings as follows: Apply the load continuously and without shock. Apply the load at the rate specified in B-1. Record, without interruption of loading, the applied load and the longitudinal strain at pre-designated intervals. Position these intervals to obtain readings at sufficient points to permit plotting a stress strain curve if desired. Include in these readings (1) the applied load when the longitudinal strain is 50 $\mu\text{in./in.}$ and (2) the longitudinal strain when the applied load is equal to 40 % of the ultimate. The longitudinal strain is defined as the total longitudinal deformation divided by the effective gauge length.
6. If a dial indicator is used, plot the results of each test with the longitudinal strain as the abscissa and the compressive stress as the ordinate.
7. If a linear variable differential transformer (LVDT) and chart recorder or computer graphics generation program are used in lieu of the dial gauge, check to be sure the correct amplification of the recorder drive or computer program setting is used to correspond with the testing range used on the testing machine. (Consult the instructions for proper operation of the recording device or computer graphics software program.)

G. CALCULATIONS

1. Calculate the chord modulus of elasticity, to the nearest 15,000 psi, as follows:

$$E = \frac{(S_2 - S_1)}{(C - 0.00005)}$$

Where:

- E = Chord modulus of elasticity in psi.
- S_2 = Stress corresponding to 40 % of ultimate load.
- S_1 = Stress corresponding to a longitudinal strain of 50 $\mu\text{in./in.}$, in psi.
- C = Longitudinal strain produced by stress S_2 .

H. PRECAUTIONS

1. The dial indicator on some compressometers indicates two times the actual deformation.
2. Strain recorder must be operated at the correct amplification of the recorder drive for the testing range being used for the testing machine in order to obtain a correct chart plot for the stress-strain relationship of the specimen.
3. Operation of the strain recorder should be checked before starting a modulus determination.

I. HEALTH AND SAFETY

It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Prior to handling, testing or disposing of any materials, testers must be knowledgeable about safe laboratory practices, hazards, and exposure, chemical procurement and storage, and personal protective apparel and equipment.

Caltrans Laboratory Safety Manual is available at:

http://www.dot.ca.gov/hq/esc/ctms/pdf/lab_safety_manual.pdf

End of Text
(California Test 522 contains 3 pages)