Designation: ~~C512/C512M – 10~~ C512/C512M – 15

# Standard Test Method for Creep of Concrete in Compression[1]

This standard is issued under the fixed designation C512/C512M; 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 the determination of the creep of molded concrete cylinders subjected to sustained longitudinal compressive load. This test method is limited to concrete in which the maximum aggregate size does not exceed 50 mm [2 in.].

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 and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*[2]

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C125 Terminology Relating to Concrete and Concrete Aggregates
C192/C192M Practice for Making and Curing Concrete Test Specimens in the Laboratory
C470/C470M Specification for Molds for Forming Concrete Test Cylinders Vertically
C617 Practice for Capping Cylindrical Concrete Specimens
C670 Practice for Preparing Precision and Bias Statements for Test Methods for Construction Materials



## 3. Terminology

3.1 For definitions of terms used in this test method refer to Terminology C125.

## 4. Significance and Use



4.1 This test method measures the load-induced time-dependent compressive strain at selected ages for concrete under an arbitrary set of controlled environmental conditions.

4.2 This test method can be used to compare creep potentials of different concretes. A procedure is available, using the developed equation (or graphical plot), for calculating stress from strain data within massive non-reinforced concrete structures. For most specific design applications, the test conditions set forth herein must be modified to more closely simulate the anticipated curing, thermal, exposure, and loading age conditions for the prototype structure. Current theories and effects of material and environmental parameters are presented in ACI ~~SP-9,~~SP-135, Symposium on Creep ~~of Concrete.~~and Shrinkage of Concrete: Effect of Materials and Environment.[3]

4.3 In the absence of a satisfactory hypothesis governing creep phenomena, a number of assumptions have been developed that have been generally substantiated by test and experience.

4.3.1 Creep is proportional to stress from 0 to 40 % of concrete compressive strength.

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[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.

[3] ~~Available~~ SP-135 is currently out of print, however, the individual papers contained in the publication are available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

4.3.2 Creep has been conclusively shown to be directly proportional to paste content throughout the range of paste contents normally used in concrete. Thus, the creep characteristics of concrete mixtures containing aggregate of maximum size greater than 50 mm [2 in.] may be determined from the creep characteristics of the minus 50-mm [minus 2-in.] fraction obtained by wet-sieving. Multiply the value of the characteristic by the ratio of the cement paste content (proportion by volume) in the full concrete mixture to the paste content of the sieved sample.

4.4 The use of the logarithmic expression (Section ~~8~~9) does not imply that the creep strain-time relationship is necessarily an exact logarithmic function; however, for the period of one year, the expression approximates normal creep behavior with sufficient accuracy to make possible the calculation of parameters that are useful for the purpose of comparing concretes.

4.5 There are no data that would support the extrapolation of the results of this test to tension or torsion.

## 5. Apparatus

5.1 *Molds*—Molds shall be cylindrical conforming to the provisions of Practice C192/C192M, or to the provisions of Specification C470/C470M. If required, provisions shall be made for attaching gauge studs and inserts, and for affixing integral bearing plates to the ends of the specimen as it is cast.

5.1.1 Horizontal molds shall conform to the requirements of the section on horizontal molds for creep test cylinders of Practice C192/C192M. A horizontal mold that has proven satisfactory is shown in Fig. 1.

5.2 *Loading Frame,* capable of applying and maintaining the required load on the specimen, despite any change in the dimension of the specimen. In its simplest form the loading frame consists of header plates bearing on the ends of the loaded specimens, a load-maintaining element that is either a spring or a hydraulic capsule or ram, and threaded rods to take the reaction of the loaded system. Bearing surfaces of the header plates shall not depart from a plane by more than 0.025 mm [0.001 in.]. In any loading frame, it is not prohibited to stack several specimens for simultaneous loading. The length between header plates shall not exceed 1780 mm [70 in.]. When a hydraulic load-maintaining element is used, several frames may be loaded simultaneously through a central hydraulic pressure-regulating unit consisting of an accumulator, a regulator, indicating gages, and a source of high pressure, such as a cylinder of nitrogen or a high-pressure pump. Springs such as railroad car springs may be used to maintain the load in frames similar to those described above; the initial compression shall be applied by means of a portable jack or testing machine. When springs are used, care should be taken to provide a spherical head or ball joint, and end plates rigid enough to ensure uniform loading of the cylinders. Fig. 2 shows an acceptable spring-loaded frame. Means shall be provided for measuring the load to the nearest 2 % of total applied load. It is not prohibited to use a permanently installed hydraulic pressure gauge or a hydraulic jack and a load cell inserted in the frame when the load is applied or adjusted.



5.3 *Strain-Measuring Device*—Suitable apparatus shall be provided for the measurement of longitudinal strain in the specimen to the nearest 10 millionths. It is not prohibited for the apparatus to be embedded, attached, or portable. If a portable apparatus is used, gauge points shall be attached to the specimen in a positive manner. Attached gages relying on friction contact are not permissible. If an embedded device is used, it shall be situated so that its strain movement occurs along the longitudinal axis of the cylinder. If external devices are used, strains shall be measured on not less than two gauge lines spaced uniformly around the periphery of the specimen. The gages may be instrumented so that the average strain on all gauge lines can be read directly. The effective gauge length shall be at least three times the maximum size of aggregate in the concrete. The strain-measuring device shall be capable of measuring strains for at least 1 year without change in calibration.

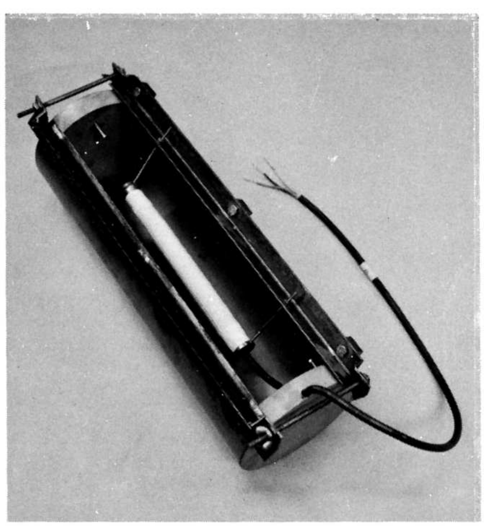

**FIG. 1 Horizontal Mold for Creep Specimens**

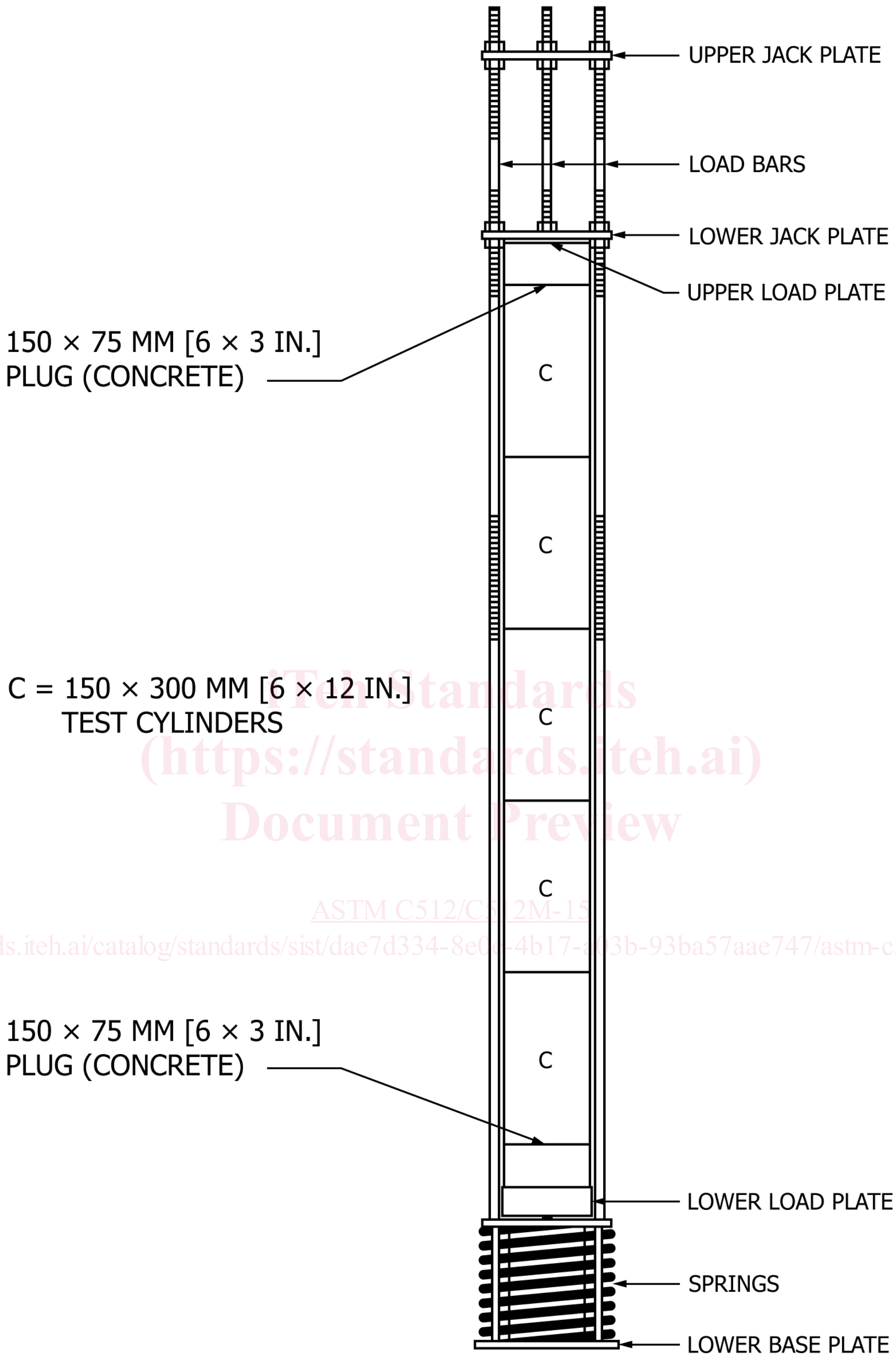


**FIG. 2 Spring-Loaded Creep Frame**



NOTE 1—Systems in which the varying strains are compared with a constant-length standard bar are considered most reliable, but unbonded electrical strain gages are satisfactory.

## 6. Test Specimens

6.1 *Specimen Size*—The diameter of each specimen shall be 150 ± 1.5 mm [6 ± 0.6 in.], and the length shall be at least 290 mm [11.5 in.]. When the ends of the specimen are in contact with steel bearing plates, the specimen length shall be at least equal to the gauge length of the strain-measuring apparatus plus the diameter of the specimen. When the ends of the specimen are in