
Standard Practice for

Estimating the Cracking Tendency of Concrete

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1. SCOPE

- 1.1. This method covers the determination of the cracking tendency of restrained concrete specimens. The procedure determines the effects of variations in the properties of concrete as related to the time-to-cracking of concrete when restrained. The procedure is comparative and not intended to determine the time of initial cracking of concrete cast in a specific type of structure.
- 1.2. *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this procedure to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 210, Use of Apparatus for the Determination of Length Change of Hardened Cement Paste, Mortar, and Concrete
 - R 39, Making and Curing Concrete Test Specimens in the Laboratory
 - T 160, Length Change of Hardened Hydraulic Cement Mortar and Concrete
- 2.2. *ASTM Standards:*
- A 53/A 53M, Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded, and Seamless
 - A 501, Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

3. SIGNIFICANCE AND USE

- 3.1. This test can determine the effects of concrete variations on cracking tendency. These variations might include aggregate source, aggregate gradation, aggregate-paste bond, cement type, cement content, water content, mineral admixtures, silica fume admixtures, fiber reinforcement, or chemical admixtures.
- 3.2. Actual cracking in service depends on many variables including bridge type, degree of restraint, hydration effects, construction and curing methods, and environmental factors. The method is useful for determining the relative likelihood of early concrete cracking and for aiding in the selection of concrete mixtures that are less likely to crack. The test method may also be modified to evaluate other factors that may affect cracking such as curing time, curing method, evaporation rate, or temperatures.

- 3.3. The test method measures the strain in a steel ring as a surrounding concrete ring shrinks. The time-to-cracking of the concrete ring is measured as the time when an abrupt drop in strain is seen in the steel ring. Simple visual monitoring of the time-to-first-cracking may also be useful, but it is less accurate and more time-consuming than monitoring strains, and large errors may result with visual monitoring. The test can also evaluate environmental and construction factors by modifying the test environment or curing procedures.
- 3.4. Other concrete tests that may be related to cracking tendency are unrestrained free-shrinkage according to T 160, compressive strength, tensile strength, elastic modulus, Poisson's ratio, and creep.

4. APPARATUS

- 4.1. *Steel Ring*—The standard steel ring shall have a wall thickness of 12.7 mm $\pm$ 0.4 mm ($\frac{1}{2}$ in. $\pm$ $\frac{1}{64}$ in.), an outside diameter of 305 mm (12 in.), and a height of 152 mm (6 in.). As shown in Figure 1, the inner and outer faces shall be machined smooth, round and true, and polished.
- Note 1**—Theoretical elastic analysis indicates that decreasing the steel thickness increases stresses in the steel significantly but only slightly affects concrete stresses. Bond strain gauges at four equidistant midheight locations on the interior of the steel ring.
- Note 2**—Structural steel pipe conforming to ASTM A 501 or A 53M/A 53 12-in. extra-strong pipe with an outside diameter of 324 mm ($12\frac{3}{4}$ in.) and wall thickness of 13 mm ($\frac{1}{2}$ in.) may be substituted, if its inner and outer faces are machined to a smooth, polished surface.
- 4.2. *Data Acquisition*—The data acquisition unit shall be compatible with the strain instrumentation and automatically record each strain gauge independently.
- Note 3**—Often when cracking occurs, only one or two gauges indicate significant strain relief.
- 4.3. *Forms*—The forms shall be nonabsorbent. Fabricate the base forms of resin-coated or polyethylene-coated plywood to minimize friction restraint of the concrete. Thin 3-mm ($\frac{1}{8}$ -in.) polyethylene sheeting works well as the outside radius form.
- 4.4. *Curing*—Wet cure the top surface, using prewetted burlap covered with plastic.
- 4.5. *Curing and Test Room*—After wet curing, store the samples in a controlled-environment room with a constant air temperature of 21°C $\pm$ 1.7°C (73.4°F $\pm$ 3°F) and a relative humidity of 50 $\pm$ 4 percent. Note and record the evaporation rate near the ring surfaces as described in T 160.

5. SPECIMEN FABRICATION

- 5.1. Secure the steel ring to the base with a central hold-down device during casting.
- 5.2. Coat the steel ring surface in contact with the concrete with a release agent such as paraffin wax dissolved in solvent or other suitable form-release agent. Do not use form-release agents on the outside radius form.
- 5.3. Make and cure the test ring specimens following the applicable requirements of M 210 and R 39.
- 5.4. Cast at least two concrete rings, using the apparatus shown in Figures 1a and 1b, for each batch. Rod the concrete into the molds in three equal lifts, using a 16-mm ($\frac{5}{8}$ -in.) diameter round-nosed