
Standard Method of Test for

**Evaluating Stress Development
and Cracking Potential due to
Restrained Volume Change
Using a Dual Ring Test**

AASHTO Designation: T 363-22¹

Technically Revised: 2022

Technical Subcommittee: 3c, Hardened Concrete



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1. SCOPE

- 1.1. This test method covers the evaluation of stress development and cracking potential in concrete when volume changes caused by shrinkage and temperature changes are restrained. The procedure is comparative for the degree of restraint of the ring and is not intended to determine the time of initial cracking of a concrete cast in any specific type of structure.
- 1.2. The values stated in SI units are to be regarded as the standard.
- 1.3. *This standard does not purport to address all of the safety problems, 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.*
- 1.4. *The quality of the results produced by this standard are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of R 18 are generally considered capable of competent and objective testing/sampling/inspection/etc. Users of this standard are cautioned that compliance with R 18 alone does not completely assure reliable results. Reliable results depend on many factors; following the suggestions of R 18 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.*

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- M 339M/M 339, Thermometers Used in the Testing of Construction Materials
 - R 18, Establishing and Implementing a Quality Management System for Construction Materials Testing Laboratories
 - R 39, Making and Curing Concrete Test Specimens in the Laboratory
- 2.2. *ASTM Standards:*
- C305, Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency
 - C403/C403M, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance

- < C1581/C1581M, Standard Test Method for Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage
- < C1698, Standard Test Method for Autogenous Strain of Cement Paste and Mortar
- < E1, Standard Specification for ASTM Liquid-in-Glass Thermometers
- < E230/E230M, Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples
- < E879, Standard Specification for Thermistor Sensors for General Purpose and Laboratory Temperature Measurements
- < E1137/E1137M, Standard Specification for Industrial Platinum Resistance Thermometers
- < F1684, Standard Specification for Iron-Nickel and Iron-Nickel-Cobalt Alloys for Low Thermal Expansion Applications

2.3. *International Electrotechnical Commission Standards:*

- < IEC 60584-1:2013, Thermocouples - Part 1: EMF Specifications and Tolerances
- < IEC 60751:2008, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors

2.4. *Other Document:*

- < Schlitter, J. L., A. H. Senter, D. P. Bentz, T. Nantung, and W. J. Weiss. A Dual Concentric Ring Test for Evaluating Residual Stress Development due to Restrained Volume Change. *Journal of ASTM International*, Vol. 7, No. 9, ASTM, West Conshohocken, PA, 2010.

3. SUMMARY OF TEST METHOD

- 3.1. This test method measures the strains developed in two concentric metal rings providing restraint to a concrete specimen undergoing volume change. The measured strains in the restraining rings are used to calculate the stress development in the concrete specimen. This enables the stress that develops due to restraint to be quantified along with an assessment of the cracking potential of the concrete mixture.
- 3.2. This test method utilizes restraining rings made of a low thermal expansion iron-nickel alloy (Invar), allowing for the temperature of the test to be varied, while the rings remain nominally volumetrically stable. The test equipment is enclosed in an insulated chamber, with the temperature being controlled throughout the entirety of the test. The methodology set forth in this standard is to utilize the thermal capabilities of the dual ring test to assess the potential for cracking at 2, 4, and 7 days of age. The temperature of the test specimen is held at a constant $23 \pm 2^\circ\text{C}$ until the appropriate age, at which time the temperature is reduced at a rate of 2°C/h until cracking is induced. This temperature drop approach yields the remaining stress capacity of the concrete specimens at early ages, quantifying the potential for cracking in the specimen at the given ages.

4. SIGNIFICANCE AND USE

- 4.1. This test method is suitable for evaluating the effects of material variations on the cracking potential of restrained mortar elements. These variations may include aggregate source, aggregate gradation, aggregate absorption, aggregate-paste bond, cement type, cement content, water content, supplementary cementitious materials, fiber reinforcement, or chemical admixtures.
- 4.2. Actual cracking during service or construction is dependent upon many variables including degree of restraint, hydration effects of the cement, curing methods, and environmental factors. This method is useful for comparing the relative likelihood of early age cracking and for aiding in the