

BULLETIN #3: TEST CODES FOR CURING OF TEST CYLINDERS FOR ACCEPTANCE STRENGTH TESTING

Routinely, test specimens are made at the job site that will later be compression tested to determine compliance with the strength specification. When these specimens will be used for this purpose it is imperative that they be properly fabricated and cured in accordance with requirements set forth in the Virginia Uniform Statewide Building Code (USBC). This bulletin addresses test specimens utilized for evaluation and acceptance of the concrete, but not specimens intended for other purposes. Information pertaining to the difference between “laboratory-cured” and “field-cured test specimens” can be found in VRMCA Technical Bulletin #2.

The prescribed conditions related to the fabrication and curing of test specimens used for acceptance purposes are addressed by the Virginia Uniform Statewide Building Code in the following pertinent reference documents:

- IBC – *International Building Code*
- ACI 318 – *Building Code Requirements for Structural Concrete*
- ASTM C 31 – *Standard Practice for Making and Curing Concrete Test Specimens in the Field*

The IBC cites ACI 318 as the governing code document for concrete. ACI 318 prescribes ASTM C 31 as the required method to fabricate and cure test specimens in the field. Although ASTM C 31 is a “Standard Practice,” it becomes a mandatory specification requirement of the USBC by direct reference in the adopted model code and reference standard. As a result, the procedures and requirements stipulated in ASTM C 31 are mandatory (not optional). It is the responsibility of those performing tests under this standard to fully comply with these requirements in accordance with the Virginia USBC.

The issue of initial curing of the test cylinders is often misunderstood or overlooked. However, the importance of proper initial curing cannot be overemphasized. Numerous studies have shown that non-standard or improper initial curing of the test cylinders can result in an artificial reduction in the indicated strength of the concrete. This reduction can range from 5 to 30 percent or more [ref 45]. In accordance with the requirements of ASTM C31, the test specimens must be placed in their initial curing environment IMMEDIATELY following molding and finishing of the cylinders. The temperature in this initial curing environment must remain in the range of 60° to 80° F for the duration of the initial curing period, which is permitted to extend for up to 48 hours. The temperature of the curing environment must be recorded with the maximum and minimum values reported. The initial curing environment must prevent moisture loss from the specimens and be free of vibration. This is often accomplished by using an insulated box with provisions for heating the enclosure in cold weather and cooling it in hot weather. Another convenient method for initial curing is to partially submerge the test cylinders in a water bath. Any suitable watertight container can be used, but experience has shown that a conventional ice chest works well. The water can be heated with a submersible heating element or cooled with ice as needed to maintain the correct temperature. Also the water acts as a buffer to prevent temperature swings when the lid is opened. In addition, the supporting surface that the test specimens will be placed on must be level within ¼ inch per foot. It should also be noted that ASTM C31 requires that the test for slump, air content, and temperature must be conducted on the same sample of concrete from which the test specimens are made.

During transport of the test cylinders to the laboratory they must be properly protected from

jarring, freezing, and moisture loss. Upon arrival at the laboratory the cylinders must be removed from their molds and placed in a moist curing environment at a temperature of 73.5 +/- 3.5 degrees F until the time of compression testing.

Finally, the technician performing the field tests must be properly qualified. ACI 318 requires that a “qualified technician” conduct all tests. The credentials of a “qualified technician” are further defined in ASTM C 1077 *Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation* where it is stipulated that the field technician must be certified by a program that includes both a written and performance examination for the relevant tests. The ACI Field Testing Technician Grade I Certification Program will meet these criteria.

Field testing, in accordance with ASTM C 31, is not completed until the test specimens are placed in the proper initial curing environment. Therefore, under the requirements of the USBC, the field-testing technician is charged with the responsibility to assure that the test specimens are placed in an appropriate curing environment immediately following fabrication of the test specimens. Otherwise the execution of the testing is not in compliance with the USBC and the results of the test specimens cannot be used for the purpose of acceptance of the concrete.

The Technical Committee of the Virginia Ready-Mixed Concrete Association has supplied this information as a service to the concrete construction industry.

References:

- International Building Code 2015, International Code Council, Inc. Falls Church, VA, 2015.
- ACI 318-14 Building Code Requirements for Structural Concrete, American Concrete Institute, Farmington Hills, MI, 2014.
- ASTM C 31-12, Standard Practice for Making and Curing Test Specimens in the Field, ASTM International, West Conshohocken, PA, 2012.
- ASTM C 1077-14 Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation, ASTM International, West Conshohocken, PA, 2014
- Bloem, Delmar. Effect of Curing Condition on Compressive Strength of Concrete Test Specimens, National Ready Mixed Concrete Association, 900 Spring St. Silver Spring, MD, 1969.