



RESPONSIBILITY FOR THE CARE OF TEST SPECIMENS FOR ACCEPTANCE OF CONCRETE—TechNote

Keywords: contractor; engineer of record (EOR); initial curing; responsibilities; test specimens; testing agency.

Introduction

This TechNote discusses the implications of improper procedures for curing test specimens at the jobsite that result in strength test results that are not reliable for acceptance of concrete.

Question

What are the responsibilities for the requirements for fabricating, curing, transporting, and testing concrete test specimens for acceptance of concrete?

Response

Responsibilities for providing facilities for initial curing and care of test specimens used for acceptance testing to comply with standards should be defined in the construction documents. Contractual and cost details among project entities should be established and confirmed at a preconstruction meeting to include logistics and assigned responsibility of resources and tasks.

Discussion

In accordance with [ACI 318](#), compressive strength tests are used to evaluate if the concrete supplied to a project complies with the strength-acceptance criteria. As required by ACI 318, cylindrical test specimens, standard cured in accordance with [ASTM C31/C31M](#), are used for this evaluation. Additionally, ACI 318 references specific ASTM standards that must be followed.

The engineer of record (EOR) and the building official use compressive strength test results to determine if ready mixed concrete supplied to a project complies with the strength requirements stated in the specification. The EOR, as used herein, is the same as licensed design professional or architect/engineer used in other ACI documents.

Procedures for obtaining representative samples, molding specimens, storage and initial curing at the jobsite, transportation to the laboratory, final curing at the laboratory, preparing the test specimens, and testing the specimens at the test age impact the reliability of strength test results. Standardized procedures are outlined in [ASTM C172/C172M](#), [ASTM C31/C31M](#), and [ASTM C39/C39M](#). Conforming to these standardized procedures assures the reliability of the test results. Certification programs for field and laboratory testing technicians also cover these standards to ensure their knowledge and competency in performing these procedures.

Any deviation from these standardized procedures may result in lower measured strength test results. When compressive strength test results fail the acceptance criteria, the process of evaluation and resolution will delay the progress of the project and may financially impact stakeholders. Concrete producers are required to establish concrete mixtures to achieve an average strength that exceeds the specified strength by a sufficient margin to minimize the probability of tests that fail the acceptance criteria. Increasing the average strength of concrete beyond this level increases cost, works against project sustainability goals, and can result in unintended performance problems. Among these potential problems are difficulty in placement and finishing, increased temperature rise, and increased potential for early- and later-age cracking. Concrete producers often increase the strength level of concrete mixtures to avoid problems associated with acceptance testing.

One of the more critical and often violated testing requirements impacting compressive strength test results is the initial curing of test specimens at the jobsite. ASTM C31/C31M requires that, after molding, test specimens should be maintained in a curing environment that prevents the loss of moisture and in a temperature range of 60 to 80°F (16 to 27°C). For concrete with a specified strength exceeding 6000 psi (40 MPa), the temperature limits are 68 to 78°F (20 to 26°C). This requires a well-maintained curing environment that will be undisturbed and can maintain a temperature within the required range for the 24- to 48-hour duration of initial curing at the project location. This often requires a source of power and clean water at the project location, as well as jobsite security. The testing agency requires access to retrieve the specimens after the initial curing period to transport them to the laboratory for subsequent curing and storage. Transportation time to the laboratory is required to be within 4 hours. Access to the jobsite can raise an issue when the project location is secured during weekends or holidays. [Oblate et al. \(2018\)](#) discuss the consequences of typical practices for the initial curing of test specimens and suggest recommendations for improvement.

ACI standards—ACI standards address details on acceptance testing of concrete. The following excerpt from **ACI 318** defines the requirements for strength tests used for acceptance of concrete, qualification of the testing agency and technicians, and the distribution of test reports.

26.12—Evaluation and acceptance of hardened concrete

Ref: ACI 318-19

26.12.1.1 Compliance requirements:

(a) Evaluation of hardened concrete shall be based on strength tests. A strength test is the average of the compressive strengths of at least two 6 x 12 in. cylinders or at least three 4 x 8 in. cylinders made from the same sample of concrete taken in accordance with ASTM C172 at the point of delivery, handled and standard-cured in accordance with ASTM C31, and tested in accordance with ASTM C39 at 28 days or at test age designated for f'_c .

...

(c) The testing agency performing acceptance testing shall comply with ASTM C1077.

(d) Certified field-testing technicians shall perform tests on fresh concrete at the job site, prepare specimens for standard curing, prepare specimens for field curing, if required, and record the temperature of the fresh concrete when preparing specimens for strength tests.

(e) Certified laboratory technicians shall perform required laboratory tests.

(f) All reports of acceptance tests shall be provided to the licensed design professional, contractor, concrete producer, and, if requested, to the owner and the building official.

ACI 301 is a reference specification directed to the contractor. It recognizes that the contractor maintains control over the project site and includes these requirements.

1.7—Testing and inspection

Ref: ACI 301-20

1.7.2 *Quality control: Duties and responsibilities of Contractor*

1.7.2.2(a) Provide Owner's testing agency with access to project site or to source of materials to perform testing and inspection activities and assist Owner's testing agency in obtaining and handling samples at project site or at source of materials. Provide Owner's testing agency with requested documentation.

...

1.7.2.2(c) Provide secure location and sources of water and electrical power on project site acceptable to Owner's testing agency for initial curing of concrete strength test specimens as required by ASTM C31/C31M.

ACI 301 cannot direct mandatory information to the Owner or representatives (the Owner's testing agency) but states the responsibilities in nonmandatory language and is consistent with those stated in ACI 318:

1.7.3 *Quality assurance: Duties and responsibilities of Owner's testing agency*

Ref: ACI 301-20

1.7.3.3(d) For each concrete mixture cast in 1 day, obtain samples of fresh concrete in accordance with ASTM C172/C172M. ...

Sampled concrete used to mold strength test specimens (ASTM C31/C31M) will be tested for slump (ASTM C143/C143M) or slump flow (ASTM C1611/C1611M), air content (ASTM C231/C231M or ASTM C173/C173M), temperature (ASTM C1064/C1064M), and density (ASTM C138/C138M).

1.7.3.3(e) Owner's testing agency will conduct concrete strength tests by making and standard curing test specimens in accordance with ASTM C31/C31M and testing them according to ASTM C39/C39M. Unless otherwise specified, concrete strength test specimens for acceptance will be tested at 28 days.

ACI 311.6 can be used as the basis of a contract between the Owner and the testing agency. These are excerpts from this specification related to the initial curing of specimens at the jobsite and information that should be included in the test reports.