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Standard Test Methods for Strength of Anchors in Concrete Elements[1]

This standard is issued under the fixed designation E488/E488M; 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.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope

1.1 These test methods address the tensile and shear strengths of post-installed and cast-in-place anchors in test members made of cracked or uncracked concrete. Loadings include quasi-static, seismic, fatigue and shock. Environmental exposures include freezing and thawing, moisture, decreased and elevated temperatures and corrosion. These test methods provide basic testing procedures for use with product-specific evaluation and acceptance standards and are intended to be performed in a testing laboratory. Product-specific evaluation and acceptance standards may add specific details and appropriate parameters as needed to accomplish the testing. Only those tests required by the specifying authority need to be performed.

1.2 These test methods are intended for use with post-installed and cast-in-place anchors designed for installation perpendicular to a plane surface of a test member.

1.3 This standard prescribes separate procedures for static, seismic, fatigue and shock testing. Nothing in this standard, however, shall preclude combined tests incorporating two or more of these types of loading (such as seismic, fatigue and shock tests in series).

1.4 Both inch-pound and SI units are provided in this standard. The testing may be performed in either system and reported in that system, and the results converted to the other. However, anchor diameters, threads, and related testing equipment shall be in accordance with either inch-pound or SI provisions.

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

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field

C33/C33M Specification for Concrete Aggregates

C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens

C42/C42M Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete

C150/C150M Specification for Portland Cement

C330/C330M Specification for Lightweight Aggregates for Structural Concrete

E4 Practices for Force Calibration and Verification of Testing Machines

E8/E8M Test Methods for Tension Testing of Metallic Materials

E468 Practice for Presentation of Constant Amplitude Fatigue Test Results for Metallic Materials

E575 Practice for Reporting Data from Structural Tests of Building Constructions, Elements, Connections, and Assemblies

E631 Terminology of Building Constructions

E2265 Terminology for Anchors and Fasteners in Concrete and Masonry

F606/F606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, Direct Tension Indicators, and Rivets

F1624 Test Method for Measurement of Hydrogen Embrittlement Threshold in Steel by the Incremental Step Loading Technique

G5 Reference Test Method for Making Potentiodynamic Anodic Polarization Measurements

[1] These test methods are under the jurisdiction of ASTM Committee E06 on Performance of Buildings and are the direct responsibility of Subcommittee E06.13 on Structural Performance of Connections in Building Construction.

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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.

2.2 *ANSI Standard:*[3]

B212.15 American National Standard for Cutting Tools—Carbide-Tipped Masonry Drills and Blanks for Carbide-Tipped Masonry Drills

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms related to building construction used in this standard, refer to Terminology E631, and for definitions of terms related to anchoring, refer to Terminology E2265.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *load-controlled undercut anchor, n*—a post-installed anchor that derives its tensile holding strength by the mechanical interlock provided by installing the anchor by tensioning, which causes the sleeve to expand into the predrilled undercut.

3.2.2 *post-installed anchor, n*—an anchor that is installed after the placement and hardening of concrete.

3.2.3 *run-out, n*—a condition in which failure does not occur within the specified number of load cycles in a fatigue test.

3.2.4 *standard temperature, n*—73 °F [23 °C] ± 8 °F [6 °C].

3.2.5 *test member, n*—the base material in which the anchor is installed and which resists forces from the anchor.

3.3 *Symbols:*

c_a = distance from the center of an anchor shaft to the edge of test member, in. [mm].

c_{min} = minimum distance from the center of an anchor shaft to the edge of test member, determined from tests, in. [mm].

d = nominal diameter of anchor to be tested, in. [mm].

d_{fix} = diameter of hole in shear sleeve, ≥d, in. [mm].

d_{hole} = diameter of drilled borehole in test specimen, in. [mm].

d_m = diameter of carbide-tipped drill bit with diameter on low end of tolerance range for new bit, representing moderately used bit, in. [mm].

d_{max} = diameter of carbide-tipped drill bit with diameter on high end of tolerance range for new bit, representing bit as large as would be expected in use, in. [mm].

d_{min} = diameter of carbide-tipped drill bit with diameter below low end of tolerance range for new bit representing a well-used bit, in. [mm].

d_o = outside diameter of post-installed anchor, in. [mm].

$d_{opening}$ = diameter of hole in confining plate for confined tension tests, in. [mm].

F_{cr} = crack-inducing force, applied to reinforcing bars, lb [N].

f'_c = specified concrete compressive strength, psi [MPa].

$f'_{c,ref}$ = specified compressive strength of reference concrete test member, psi [MPa].

$f'_{c,test}$ = specified compressive strength of concrete test member, psi [MPa].

h_{ef} = effective embedment depth, measured from the concrete surface to the deepest point at which the anchor tension load is transferred to the concrete, in. [mm].

h_{min} = minimum member thickness, in. [mm].

h_{nom} = distance between embedded end of concrete screw and concrete surface, in. [mm].

n_{ct} = number of test cycles.

n_{pt} = number of permitted pretest crack cycles.

$N_{p,cr}$ = characteristic pullout resistance in cracked concrete for the minimum specified concrete strength of 2500 psi [17 MPa], as determined from tests in cracked concrete, lb [N].

$N_{st,mean}$ = mean ultimate steel capacity determined from tensile tests on full-sized anchor specimens, lb [N].

$N_{sust,l}$ = sustained load, lb [N].

$N_{sust,con}$ = sustained load used for confined reference tests, lb [N].

$N_{sust,ft}$ = specified constant tension load, lb [N].

$N_{u,con,mean}$ = mean ultimate load determined from confined reference tests, lb [N].

$N_{u,mean}$ = mean ultimate load determined from tests, lb [N].

N_w = tensile load in tests of anchors located in cracks whose opening width is cycled, lb [N].

s_{min} = minimum anchor spacing, determined from test, in. [mm].

t_{fix} = effective thickness of shear sleeves (see d), in. [mm].

t_{pl} = thickness of confining plate for tension tests, ≥d, in. [mm].

T_{inst} = specified or maximum setting torque for expansion or prestressing of an anchor, ft·lb [N·m].

T_{screw} = specified maximum setting torque to prevent anchor failure during installation, ft-lb [N-m].

W_1 = largest crack width during test, in. [mm].

W_2 = smallest crack width during test, in. [mm].

W_3 = largest crack width at beginning of test, in. [mm].

ℓ_{side} = side length of test cube, in. [mm].

4. Significance and Use

4.1 These test methods are intended to provide reproducible data from which acceptance criteria, design data, and specifications can be developed for anchors intended to be installed in concrete.

5. Apparatus

5.1 *Testing Equipment:*

5.1.1 *General*—Use calibrated electronic load and displacement measuring devices meeting the specified sampling rate. Use load-measuring equipment with an accuracy of ±1 % of the anticipated ultimate load and calibrated in accordance with Practices E4. Use displacement measuring devices with an

[3] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.