ACI/TMS 216.1-14

An ACI/TMS Standard

Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies

Reported by ACI/TMS Committee 216

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Reported by ACI Committee 216 joint with TMS

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Fire resistance of building elements is an important consideration in building design. While structural design considerations for concrete and masonry at ambient temperature conditions are addressed by ACI 318 and TMS 402/ACI 530/ASCE 5, respectively, these codes do not consider the impact of fire on concrete and masonry construction. This standard contains design and analytical procedures for determining the fire resistance of concrete and masonry members and building assemblies. Where differences occur in specific design requirements between this standard and ACI 318 and TMS 402/ACI 530/ASCE 5, as in the case of cover protection of steel reinforcement, the more stringent of the requirements shall apply.

Keywords: beams; columns; compressive strength; concrete slabs; fire endurance; fire ratings; fire resistance; fire tests; masonry walls; modulus of elasticity; prestressed concrete; prestressing steels; reinforced concrete; reinforcing steel; structural design; temperature distribution; thermal properties; walls.

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PREFACE

This standard provides requirements for determining fire resistance of concrete and masonry elements and assemblies. Calculation procedures for determining fire resistance are provided for concrete walls, floors, roofs, and columns and masonry walls, lintels, and columns. Procedures are also included for determining requirements for concrete cover, protection of structural steel columns using concrete or masonry, and for hollow structural steel columns filled with concrete. Procedures for determining the contribution of additional fire resistance provided by finish materials on concrete or masonry assemblies are also included.

CHAPTER 1—GENERAL

1.1—Scope

This standard describes acceptable methods for determining the fire resistance of concrete and masonry building assemblies and structural elements, including walls, floor and roof slabs, beams, columns, lintels, and masonry fire protection for structural steel columns. These methods shall be used for design and analysis purposes and shall be based on the fire exposure and applicable end-point criteria of ASTM E119. This standard does not apply to composite metal deck floor or roof assemblies.

The primary intended use of this standard is for determining the design requirements for concrete and masonry elements to resist fire and provide fire protection. Tolerance compliance to the provisions for concrete shall be based on information provided in ACI 117. Masonry construction shall comply with TMS 402/ACI 530.1/ASCE 6.

The provisions of this standard establish fire resistance based on calculations. The fire resistance associated with an element or assembly shall be deemed acceptable when established by the calculation procedures in this standard or when established in accordance with 1.2.

1.2—Alternative methods

Methods other than those presented in this standard shall be permitted for use in assessing the fire resistance of concrete and masonry building assemblies and structural elements if the methods are based on the fire exposure and applicable end-point criteria specified in ASTM E119. Computer models, when used, shall be validated and supported by published literature to substantiate their accuracy. Alternative methods include:

Qualification by testing—Materials and assemblies of materials of construction tested in accordance with the requirements set forth in ASTM E119 shall be classified for fire resistance in accordance with the results and conditions of such tests.

Approval through past performance—The application of fire resistance ratings to elements and assemblies that have been applied in the past and have been proven through performance shall be permitted.

Other methods—The provisions of this standard are not intended to prevent the application of new and emerging technology for predicting the life safety and property protection implications of buildings and structures.

CHAPTER 2—NOTATION AND DEFINITIONS

2.1—Notation

A_1, A_2, and A_n = air factor for each continuous air space having a distance of 1/2 to 3-1/2 in. between wythes
A_{ps} = cross-sectional area of prestressing tendons, in.^{2}
A_s = cross-sectional area of nonprestressed longitudinal tension reinforcement, in.^{2}
A_{st} = cross-sectional area of the steel column, in.^{2}
a = depth of equivalent rectangular concrete compressive stress block at nominal flexural strength, in.
a_θ = depth of equivalent concrete rectangular stress block at elevated temperature, in.
B = least dimension of rectangular concrete column, in.
b = width of concrete slab or beam, in.
b_f = width of flange, in.
C = compressive force due to unfactored dead load and live load, kip
c_c = ambient temperature specific heat of concrete, Btu/(lb-°F)
d = effective depth, distance from centroid of tension reinforcement to extreme compressive fiber or depth of steel column, in.
D = for hollow structural steel columns, outside diameter for circular columns, in.; outside dimension for square columns, in.; and least outside dimension for rectangular columns, in.
D_c = oven-dried density of concrete, lb/ft^3