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

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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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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

- \( A_1, A_2, \text{ and } A_n \) = 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.\(^2\)
- \( A_d \) = cross-sectional area of the steel column, in.\(^2\)
- \( a \) = depth of equivalent rectangular concrete compressive stress block at nominal flexural strength, in.
- \( a_0 \) = 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.
- \( b_t \) = width of flange, in.
- \( C \) = compressive force due to unfactored dead load and live load, kip
- \( c_e \) = 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\(^3\)