TILT-UP CONCRETE ASSOCIATION

FIRE RESISTANCE OF TILT-UP WALL SYSTEMS

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Tilt-Up Concrete Association

Promoting growth and achievement in innovative tilt-up design and construction for over twenty-five years.

Founded in 1986, the Tilt-Up Concrete Association was created by a dedicated group of construction professionals interested in improving the quality and acceptance of tilt-up concrete construction.

Our mission is to expand and improve the use of tilt-up as the preferred building system by providing education and resources that enhance quality and performance.

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INTRODUCTION

The building envelope is required to provide a minimum fire endurance for both the structure and the enclosing planes. Based on occupancy, size and proximity to adjacent structures or property lines, the applicable building code will set the value for the given construction type. Specifications may require the contractor to provide verification of the fire rating and many designers default to a request for UL Listing for all assemblies. During submittals, contractors must recognize that such a listing is not available for tilt-up wall assemblies and therefore information to support the fire performance must be obtained.

UL LISTING VS ASTM STANDARD

Underwriter's Laboratory (UL) is a good source, and perhaps the most recognized, for finding information pertaining to the fire safety of products, including those used in construction. However, UL does not provide numbers for concrete construction assemblies, components or elements. According to the listing service description, the products must be "manufactured" in order to request a listing. In other words, there must be a consistent product of a given assemblage with restrictive variations in order to submit for such a listing, with or without fire test research. Tilt-up construction, although a form of precast, is constructed on a job site as part of the building frame with each element having unique or custom configurations and production parameters. Tilt-up is also non-proprietary in that the components that are used to achieve each panel are generally available throughout the industry. Therefore, tilt-up is part of the exception from a UL perspective on concrete.

Fire ratings for such construction systems are determined from methodologies established in ASTM E 119, which sets the intensity of the fire, the size of the specimen and the criteria for determining the end point of the test. Using this standard, extensive testing over many years

provided support for procedures of calculating the fire ratings of concrete walls, slabs, beams and columns. Based on the unit density of the concrete (unit weight), aggregate type and the section thickness or clear cover requirements for steel reinforcement, the fire rating of a tilt-up wall panel can be determined. Additionally, based on this research, methods were developed for calculating the fire rating for multiple wythes such as an insulated sandwich panel. This information can be found in industry standards such as ACI 216.1 Standard Method for Determining Fire Resistance of Concrete and Masonry Construction Assemblies, available at www.concrete.org; and ASCE 29.

CODE REQUIREMENTS

Building codes recognize the difference between manufactured assemblies and construction systems. The International Building Code (IBC) provides designers, contractors and code officials with a reference calculation for fire resistance.

Paragraph 720.1 of the IBC states,

> *The provisions of this section contain procedures by which the fire resistance of specific materials or combinations of materials is established by calculations. These procedures apply only to the information contained in this section and shall not be otherwise used. The calculated fire resistance of concrete shall be permitted in accordance with ACI 216.1.*

ACI/TMS 216.1-14, Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies, lists the minimum equivalent thickness of single-layer concrete walls to meet fire resistance ratings ranging from 1 to 4 hours (see table on following page). These values are for solid walls or slabs. ACI 216.1-14 also provides methods for determining equivalent thickness based on variations to the section as well as multiple wythes or layers.

CONCRETE TYPE	MINIMUM SLAB THICKNESS (inches) FOR FIRE RESISTANCE RATING OF				
	1-hour	1.5-hour	2-hour	3-hour	4-hour
Siliceous	3.5	4.3	5.0	6.2	7.0
Carbonate	3.2	4.0	4.6	5.7	6.6
Sand-Lightweight	2.7	3.3	3.8	4.6	5.4
Lightweight	2.5	3.1	3.6	4.4	5.1

Reinforced concrete also must meet cover protection requirements to maintain structural fire resistance. The concrete cover requirements, provided in ACI 216.1-14, depend on the construction classification of the concrete member, the aggregate type and whether the member is restrained.

The IBC also provides a fire-resistance calculation based on the performance of individual material layers. This calculation is used when walls consist of two or more wythes of different types of concrete. This calculation is also used when foam plastic insulation is sandwiched between two wythes of concrete. Section 720.2.1.2 should be referenced when attempting to use the calculation.

$$R = (R_1^{0.59} + R_2^{0.59} + \ldots + R_n^{0.59})^{1.7}$$

SUMMARY

Tilt-up panels offer considerable fire-resistance protection and flexibility in achieving rating requirements. However, a tilt-up panel is only a portion of the wall assembly. Panel joints must be designed to the level of fire endurance specified and all openings or penetrations need to be configured to provide a total building envelope fire rating. For more information on tilt-up wall panels and their performance, contact the Tilt-Up Concrete Association or check with your local TCA contractor or design professional.