Concrete
Q&A

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Tolerances for Concrete Openings

Q. *We recently completed a mid-rise concrete building. During construction, the owner's testing agency conducted independent F-number and survey checks at all floor levels. The results indicated compliance with ACI 117-10(15)[1] tolerances for floor flatness and top-of-slab elevations stated in the construction documents. We have just been advised that the window wall installer has complained that the full-height windows don't fit between the slabs. Arguing that the separation between two slabs is considered an opening and therefore has a tighter tolerance than the slab elevation tolerances, the window installer is pressuring the owner to backcharge us to cover the cost of rework. We don't think the space between two slabs constitutes an opening. Does ACI provide guidance on this tolerance issue?*

A. Tolerance values for openings through concrete elements are provided in ACI 117-10(15) and listed in Table 1. They include tolerances for the size of the specified opening at –1/2 in. (13 mm) and +1 in. (25 mm), and tolerances for the specified edge location of ±1/2 in.

On occasion, there is confusion about the definition of "opening" and what tolerances might apply. Typically, openings are created to install a premanufactured component by one of several construction trades, most of which are addressed in ACI 117.1R-14.[2] This document states in Section 5.3.1.1.2 that ACI 117-10(15) opening tolerances "are for openings that are enclosed in a wall or slab (openings in an element)" as shown in Fig. 1. The key point is the opening must be within a single element. Thus, space between two slabs (or two columns) is not considered an opening. ACI 117.1R-14, Section 5.3.1.1.2, makes that clear by stating: "Clear space between floors has an elevation tolerance of ±3/4 in. (±20 mm) on each floor. This space is not considered an opening."

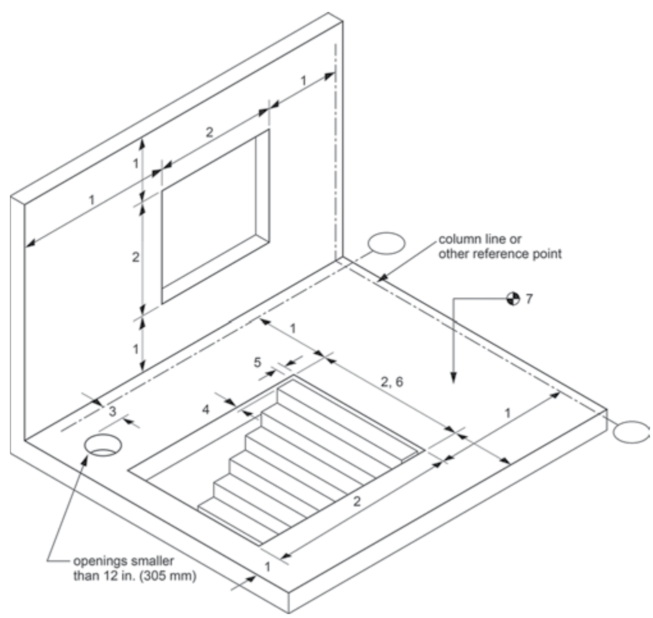

Fig. 1: Tolerances for concrete openings (Fig. 5.3.1.1.1 in ACI 117.1R-14[2])

ACI 117.1R-14, Section 4.3.3, provides clarification as

Table 1:
Tolerances for concrete openings provided in ACI 117-10(15)[1]

Section	Tolerance	Tolerance value	Application
4.1.3	Plumb	±1/2 in.	Vertical edge
4.2.1	Horizontal deviation	±1/2 in.	Vertical edge of floor opening and vertical edges of openings in walls, beams, or columns
4.2.2	Vertical deviation	±1/2 in.	Horizontal edge of openings in walls, beams, or columns
4.6.1	Formed opening	–1/2 in. and +1 in.	All openings

Table 2:
Clear height estimates based on properties of normal distribution (Table 4.3.3 in ACI 117.1R-14[2])

Shortest clear height	Largest clear height	Probability
7 ft 10-1/2 in. (2400 mm)	8 ft 1-1/2 in. (2480 mm)	Overestimates
7 ft 10-7/8 in. (2412 mm)	8 ft 1-1/8 in. (2468 mm)	99.7% (3 standard deviation)
7 ft 11-1/4 in. (2420 mm)	8 ft 3/4 in. (2460 mm)	95% (2 standard deviation)
7 ft 11-5/8 in. (2430 mm)	8 ft 3/8 in. (2450 mm)	68% (1 standard deviation)

follows: "ACI 117 provides position, location, and plan dimension tolerances, making it necessary to combine them for a length dimension tolerance. For example, if the nominal plan clear dimension between the top concrete floor surface of Level 5 and bottom elevation of Level 6 slab is 8 ft 0 in. (2440 mm), the ACI elevation tolerance of the top surface of a shored concrete slab is ±3/4 in. (±20 mm). The elevation tolerance of the ceiling of the upper concrete floor is ±3/4 in. (±20 mm)." Table 2 provides the height estimates based on these slab elevation tolerances.

To obtain the constructed clear dimension, the extreme values of the tolerances are added in each direction: +3/4 + 3/4 = +1-1/2 in. and –3/4 – 3/4 = –1-1/2 in., and then these combined tolerances are added/subtracted to/from the nominal plan height dimension. Thus, the constructed clear dimension could be 8 ft 0 in. ± 1-1/2 in. (2438 ± 38 mm). In other words, the clear dimension could range from 7 ft 10-1/2 in. to 8 ft 1-1/2 in. (2400 to 2480 mm).

The tolerances can be combined to provide a more realistic and smaller estimate. Adding the tolerances together provides the largest tolerance estimate and likely overestimates the combined tolerance. For example, if a floor were to be at the extreme tolerance value of +3/4 in., the ceiling above it should be at the extreme tolerance value of –3/4 in. However, it is unlikely that both extremes would occur at the same location. Therefore, adding the two tolerances together overestimates the probable combined tolerance. Table 2 provides a probability-based estimate of the combination of the two tolerances with the assumption that the ceiling and floor tolerances are independent and governed by a normal (bell-shape) distribution.

In conclusion, the window wall manufacturer/installer should have anticipated the clear height dimension between the two slabs in accordance with ACI 117 and designed the curtain wall to fit.

References

1. ACI Committee 117, "Specification for Tolerances for Concrete Construction and Materials (ACI 117-10) (Reapproved 2015)," American Concrete Institute, Farmington Hills, MI, 2010, 76 pp.

2. ACI Committee 117, "Guide for Tolerance Compatibility in Concrete Construction (ACI 117.1R-14)," American Concrete Institute, Farmington Hills, MI, 2014, 47 pp.

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