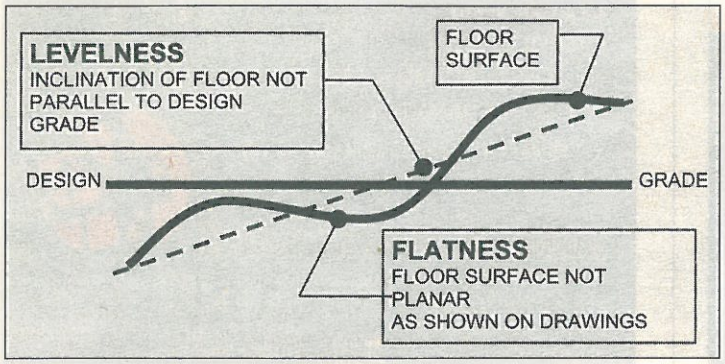
ACI Tolerances for Concrete Construction

The American Concrete Institute has released a new version of its standard tolerances for construction and materials. The publication includes the standard itself, written in such a way that it can be directly incorporated into contract documents, and a commentary which clearly explains what the standard means and provides guidance into meeting the standard.

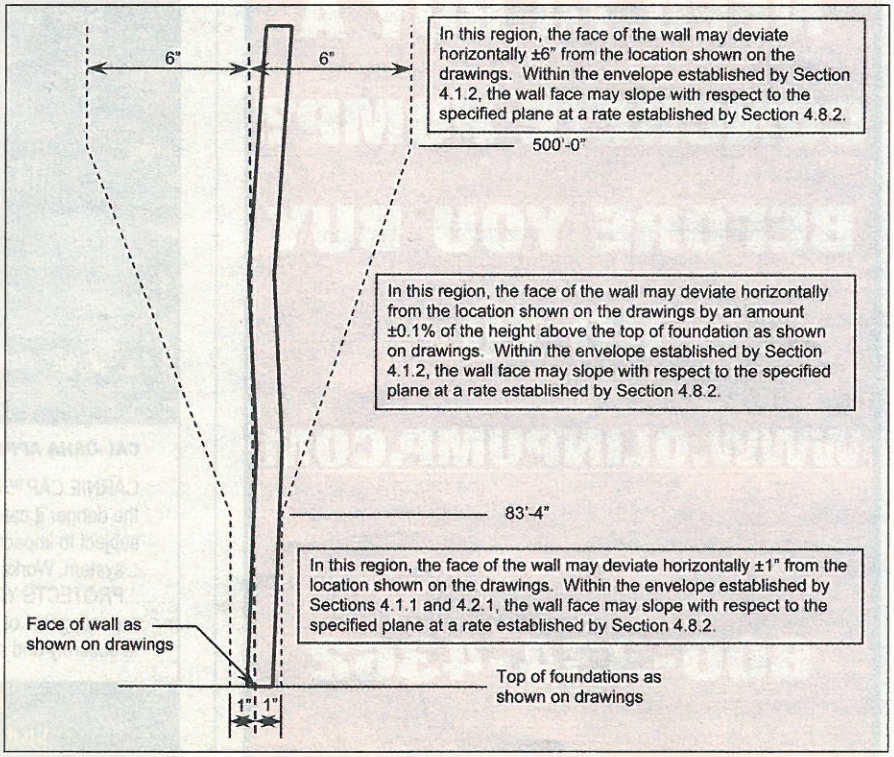


Problems with flatness and levelness shown.

Tolerances, according to the commentary to ACI 117 are "a means to establish permissible variation in dimension and location, giving both the designer and the contractor limits within which the work is to be performed." Tolerances provide a way for the structure's designer to let the contractor know what is expected—to define the acceptable level of imperfection—since it is understood that "No structure is exactly level, plumb, straight, and true." ACI's tolerances, however, can only govern concrete construction, and ACI 117 notes that "Materials that interface with or connect to concrete elements may have tolerance requirements that are not compatible with those contained in this document."

ACI 117 begins by defining what the tolerances mean in terms of such things as bowing, deviation, flatness, and levelness, and provides drawings to help explain these terms. Material tolerances are in Section 2, including the location tolerance for reinforcing bars, which varies depending on the thickness of the concrete member. For example, for members where the concrete is 4 to 12 inches thick, the tolerance for rebar location is ±⅜ inch. That is, the centerline of the bar must be within ⅜ inch in any direction from the location indicated on the plans or else it is out of tolerance and therefore violates the specification. Tolerances are also provided in Section 2 for the embedment length of rebars and for the location of dowels and anchor bolts (±¼ inch for ¾-inch bolts).

In Section 3, ACI 117-06 covers tolerances for foundations. For example, an unreinforced pier in soil must be plumb to within 1.5% of the length of the shaft. So, for a 6-foot-long pier, the distance between the shaft centerline at the top of the pier and a perfectly plumb line drawn from the shaft's center at the bottom of the pier can be no greater than 6x12x0.015 = 1.08 inches. How one would go about measuring that distance is, I'm afraid, a subject for a different article. Other tolerances in this section dictate the maximum deviation from the planned location of the top surface elevation and the cross-sectional dimensions of piers and footings.



Use of multiple toleranced items to yield toleranced result.

Section 4 is the longest part of ACI 117, covering tolerances for cast-in-place concrete for buildings, including walls, floors, and slabs. The maximum deviation is defined for the plumbness of walls, columns, and openings. Maximum deviation is defined for horizontal and vertical faces. The tolerance, for example, on the distance between different structural elements, for example, a wall and a column, is ±¼ inch.

Also in Section 4, the allowable deviation from the specified cross-sectional dimension is defined for concrete elements, including suspended slabs and slabs-on-ground. For suspended slabs, there is only a minus tolerance—the slab can be no more than ¼ inch thinner than specified, to ensure that the desired fire rating of the floor is achieved. Although there is no tolerance for a suspended slab that is too thick, the commentary does note that "Care should be taken to ensure that providing additional concrete in local areas does not overload the supporting framework or metal deck."

For slabs-on-ground, again, there is only a minus tolerance, meaning that thicker slabs are not prohibited by code, although every good contractor knows that thicker slabs mean more concrete and thus, more cost. For slabs, no sample may be more than ¾ inch thinner than specified and the average of all samples can't be more than ⅜ inch thinner than specified.

Section 4.8 may contain the most important tolerances in the standard for floor slab contractors—the flatness and levelness requirements for various classes of floors, including F_F and F_L values. Any contractor who is subjected to F-number requirements should study this section in detail.

Other sections in ACI 117-06 provide tolerances for special kinds of construction: slipformed elements (Section 7), mass concrete (Section 8), canal linings (Section 9), water-conveying structures (Section 10), cast-in-place bridges (Section 11), pavement and sidewalks (Section 12), chimneys and cooling towers (Section 13), and cast-in-place pipe (Section 14). For sidewalks, note that the horizontal positioning of dowels must be within 1¼ inches of where they were specified to be, and that the gap below a 10-foot straightedge cannot be greater than ¼ inch.

In many, perhaps most, plans and specifications, ACI 117 will be referenced. This document is also referenced in ACI 318, and therefore ends up by reference in the International Building Code. Every contractor who builds with concrete and does so under a specification would be wise to have a copy of ACI 117. If it comes around to a dispute, you can be sure that the owner who is saying the concrete is out of tolerance will have a copy.