

Cracks, Cracks, Cracks... What is a Reasonable Level of Cracking?

We have all heard the Owner, Construction Manager, Architect, or Engineer say “I know concrete cracks, but this is more than I expected.” Of course, what they expected is not perfection, but so close it scares us! ACI 302.1R-04, “Guide to Concrete Floor and Slab Construction,” states that even with the best design and construction, random cracking should be expected. The document quantifies this by stating for unreinforced plain concrete slabs with joint spacing of 24 to 36 times the slab thickness “a reasonable level might be random visible cracks to occur in 0 to 3% of the surface area floor slab panels formed by saw-cutting, construction joints, or a combination of both.”

When cracking occurs, someone inevitably creates a crack map that shows the location, length and width of crack. How does this crack map correlate with the ACI 302 “reasonable level of cracking”? Consider a 100,000 ft² floor with joint spacing at 15 ft intervals on-center, each way. There would be a total of 445 panels formed by saw-cutting or construction joints of which ACI 302 states that a reasonable level of cracking is up to 3% of the panels or 14 cracked panels. If each panel contained one crack that was full-panel length—about 15 ft—the total crack length for the 100,000 ft² floor would be 210 lineal ft. This is equal to about 0.002 lineal ft or crack per square foot of floor area.

The ACI 302 provision setting “a reasonable level of cracking” first appeared in the 1996 revision of ACI 302.1R. There was no indication of how the maximum value of 3% was determined. Contractors often ask if the ACI 302 is a reasonable value and if it applies to their project. The answer to that question is difficult to answer without some frame of reference. So let’s consider another crack prediction source—this time for post-tensioned slabs.

Post-tensioned concrete slabs are typically expected to crack less than other slabs because post-tensioning produces a compressive stress that must be exceeded before enough tensile stress develops to cause cracking. However, as the slab shortens due to shrinkage, creep, elastic shortening, and cooling, it is restrained by supporting elements. Slab cracks occur around these restraints, i.e., walls and columns, and the cracks are referred to as “restraining cracks.” What is a typical restraining crack quantity for post-tensioned slabs?

Aalami and Barth (see reference) reported on the design, review, and observation of over 300 post-tensioned structures built in California between 1982 and 1987. They give a conservative estimate of the total length of anticipated cracks requiring repair as 0.009 lineal ft of crack per ft² of slab area. For a 100,000 ft² post-tensioned slab, this would result in an estimated 900 lineal ft of cracks.

If we compare the crack provision in ACI 302 for plain jointed unreinforced slabs to the Aalami and Barth provision for post-tensioned slabs, we see that ACI 302 expects less cracking, and by a factor greater than 4. Does this make sense?

Although Aalami and Barth were conservative in estimating the lineal ft of restraining cracks requiring repair, it seems difficult to believe that there are 4 times more lineal feet of cracking in a post-tensioned slab than in a jointed slab-on-ground. Also, because ACI 302 says a reasonable level of cracking is from 0% to 3%, it implies that no cracking, 0%, is a possible, reasonable level.

What makes sense to you? Should ACI Committee 302 change the percentages given? **Fortunately, ACI Committee 302 is currently preparing a revision of ACI 302.1R and the Chair of ACI 302 will be attending the ASCC Annual Conference on September 11 to answer questions from contractors. Don’t miss this opportunity to provide input to a document with content critical to contractors. Join me. I’ll be there asking for an explanation of how ACI 302 determined “a reasonable level of cracking!”**

Reference:

“Cracking in Prestressed Concrete Structures” ACI SP113-7, pages 157-202, April 1989.