Controlling curling and cracking in floors to receive coverings

Do you worry about excessive cracking or curling in concrete floor slabs placed directly on a vapor retarder? Here are some hints on using reinforcing steel to minimize these defects and avoid floor-covering failures.

BY JERRY A. HOLLAND AND WAYNE WALKER

Because of an increasing number of moisture-related floor-covering failures in the past several years, some designers now recommend eliminating the granular blotter layer that's often used between the concrete and the vapor retarder or vapor barrier. Though a blotter layer offers several advantages, it can hold water from many possible sources and cause problems if the floor will receive moisture-sensitive coverings such as sheet vinyl, rubber, wood or similar materials (see reference).

Many designers, however, are reluctant to place concrete directly on a vapor retarder because they fear the floor slab will curl or crack excessively. These defects also can cause floor-covering failures that, in some cases, require remedial work after the building is in service. However, with the correct positioning and amount of reinforcing steel, both curling and cracking can be controlled.

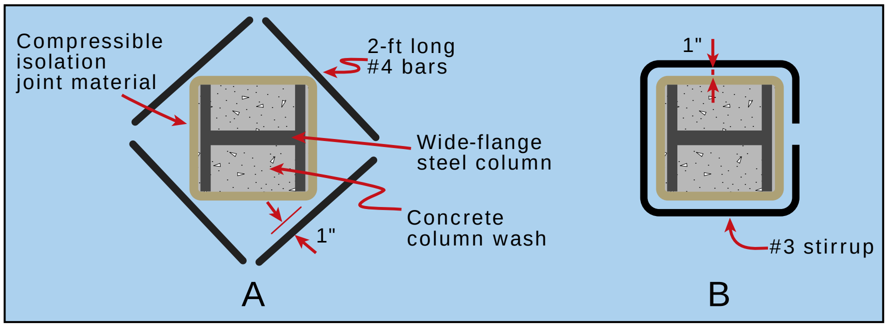
Rebar in concrete slabs placed directly on a vapor retarder help to control slab curling and cracking. Use supported deformed bars no smaller than #4, and space the bars far enough apart so workers can step between them.

Positioning is key

Cracks in a slab-on-grade floor surface are wider at the top than at the bottom. For the best crack control, then, you want the reinforcing steel to be as close to the surface as possible. And you must be able to control the location of the steel so it doesn't change during floor construction. Because of this, I prefer to use supported deformed bars no smaller than #4 instead of light-gauge mesh. Smaller-diameter bars are too limber, requiring too many bar supports, and light-gauge mesh is difficult to keep in the correct location.

For a 5-inch-thick floor slab, I prefer to use #4 bars near the top with 1 inch of clear cover, or #5 bars with 1½ inches of clear cover. For #5 bars, greater cover depth is needed to control plastic settlement cracking over the bar.

Typically, I specify #4 bars spaced 18 inches on center both ways. This amount of steel holds crack faces together tightly enough for nonrigid floor coverings by maintaining aggregate interlock and significantly reducing slab curling. In some instances, closer spacing or larger-diameter bars may be needed. Constructability becomes an issue when bar spacing is so close that workers



Eliminate the normal isolation-joint box outs at wide-flange steel columns by wrapping the column with compressible material and using 2-foot lengths of #4 bars (A) to control cracking at the reentrant corners. To speed up steel placement at the columns, have the rebar supplier fabricate continuous #3 stirrups that workers can easily bend open to fit around the column (B). In either case, the steel should be positioned with a top-and-side clear cover of 1 inch.

can't step into openings between bars. Then larger-diameter bars may be the better choice.

Eliminate joints

Because the reinforcing steel limits crack width, I prefer to eliminate contraction joints and the traditional diamond-shaped isolation joints at columns when floors will receive a covering. I suggest wrapping wide-flange steel columns for the full floor depth with ⅛- to ¼-inch-thick compressible isolation-joint material. For floors receiving coverings that won't tolerate wide cracks, such as ceramic tile, I also suggest placing four 2-foot-long #4 bars near the floor surface, with a top-and-side clear cover of 1 inch to control reentrant-corner cracking (Fig. A). As an alternative, the rebar supplier can fabricate #3 bars as a continuous stirrup that can easily be bent open so the ironworker can fit it around the column (Fig. B). This speeds placement of the steel when there are many columns to be treated. The stirrups also should have a 1-inch top-and-side clear cover.

Carpeting or other floor coverings can tolerate larger crack widths in the concrete subfloor without noticeable distress. When these coverings are used, crack-control measures at columns may not be needed. Simply wrap the columns to isolate them from the slab.

Construction considerations

Some designers use an upper and lower layer of reinforcing steel in the slab to control cracking at both the top and bottom. However, bottom-crack width doesn't affect floor-covering performance. And some of the advantages of these double layers of rebar are offset by placement difficulties; workers spreading the concrete have trouble stepping around the rebar and may displace it during concrete placement.

If the concrete is tailgated or struck off by a self-propelled laser-guided screed, ironworkers can lay out a single layer of steel on the vapor retarder and chair it up as concrete placement and strike-off proceeds. To prevent damage to the vapor retarder, workers can lay down thin sheets of plywood or several folds of plastic sheeting beneath the tires of the concrete truck or the screed. These materials are then moved back as the pour proceeds. The same procedure will help prevent damage to the vapor retarder if motorized buggies are used to place the concrete.

If the concrete is placed by pump or conveyor, all the steel can be chaired up before the pour begins, provided there's enough space between the rebar for workers' feet. If control of crack width requires rebar spacings of a foot or less both ways, I sometimes require placement of a heavy-gauge welded-wire fabric (4x4-inch spacing of 4-gauge wire) on top of the bars. Workers can easily walk on this mesh without sinking into the concrete or twisting their ankles. The closely spaced mesh wires improve crack control, and the material cost is about the same because you can reduce the rebar diameter and maintain about the same steel cross-sectional area.

Weighing the costs

Although controlling curling and cracking by using rebar in the way I've described increases project costs by requiring more than the normal amount of steel, part of this cost increase is offset by savings in other areas. You eliminate the costs associated with overexcavation to accommodate the blotter-layer thickness and for purchasing, placing and compacting the granular material used for the layer. You also save money because workers don't have to cut contraction joints and fill them with a sealant. Nor do they have to form and strip column box outs and place the in-fill concrete later.

Use of a blotter layer is still a viable alternative for controlling curling and cracking. But if the floor will receive a moisture-sensitive floor covering and the blotter layer picks up excessive moisture before, during or after floor construction, a flooring failure is likely. The cost of correcting the failure almost always will be much higher than the cost of using more reinforcing steel.

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Reference

Bruce A. Suprenant and Ward R. Malisch, "Where to Locate the Vapor Retarder," *Concrete Construction,* May 1998, pp. 427-433.