

# Responsibility for Slab Curling

## ASCC Position Statement #30

**C**urling is the distortion of a slab into a curved shape by bending of the edges due to differences in moisture between the top and bottom of a concrete slab. It is caused primarily by loss of moisture from the concrete surface as the concrete dries. The moisture loss occurs in all environments at less than 100% relative humidity and is typically more severe in areas of low relative humidity.

The effect of curling on floor serviceability varies depending on the intended use. A curled slab may be serviceable when covered by carpet but not by vinyl tile. A curled slab may also experience joint deterioration when subjected to forklift traffic. "A Checklist for Industrial Floor Design" published in *Concrete International*, November 2001 includes a "crack and curl management" checklist to aid the designer in minimizing curling to suit the Owner's intended use.

Concrete contractors are responsible for initial floor flatness and levelness that is measured within 72 hours of placement, as required by ACI 117-06 and ACI 301-05. But flatness can change with time due to curl. "The Concrete Floor Tolerance/Floor Covering Conundrum" *Concrete International*, July 2003, includes two examples of measured floor flatness and levelness that decrease by as much as 50% in a year due to curling. Both the Canadian Standards Association (CSA) and the American Concrete Institute (ACI) recognize that control of curling is a designer responsibility.

CSA A23.1-04 "Concrete materials and methods of concrete construction" states:

### 6.4.2.2.3 Curling or warping

Owners shall specify low-shrinkage concrete mixes, appropriate curing, or suitable reinforcing, or a combination of these, as necessary to minimize curling to suit their intended usage.

**Commentary:** Tolerance losses up to 50% may occur in jointed floors due to normal drying shrinkage curling. Curling may also create material handling problems or produce a surface profile that is unsuitable for the application of subsequent finishes.

ACI 360R-06 "Design of Slabs-on-Ground" states:

- "Designers of enclosed slabs-on-ground can reduce shrinkage cracking and shrinkage curling by considering the features that affect these phenomena and addressing them;" (Section 13.5)
- "Design methods are given for unreinforced concrete, reinforced concrete, shrinkage-compensating concrete, post-tensioned concrete, fiber reinforced concrete slabs-on-ground, and slabs-on-ground in refrigerated buildings, followed by information on

shrinkage and curling problems. Advantages and disadvantages of each of these slab designs are provided, including the ability of some slab designs to minimize cracking and curling more than others." (Foreword)

Unreinforced jointed slabs are the most common slab-on-ground designs. ACI 360R-06, Table 2.2, states that with this design "flatness and levelness may decrease with time." Owners should be advised of this disadvantage for this slab design.

Because design and specifications minimize curling to suit the Owner's use, concrete contractors will assist the designer in meeting the Owner's objectives by complying with Division 3 specifications and project drawings. For more information on curling see "Why Slabs Curl: Part I and II", *Concrete International*, March and April 2002. If you have any questions, contact your ASCC concrete contractor or the ASCC Technical Hotline at (800) 331-0668.

**Update:** Concrete contractors are responsible for initial floor flatness measured within 72 hours after completion of slab concrete finishing operations as required by ACI 117-10 and ACI 301-10.

ACI 360R-10, Design of Slabs-on-Ground states:

"Unique serviceability requirements distinguish slabs-on-ground from other structural elements. Some of these serviceability requirements can:"

- "Minimize cracking and curling;"
- "Increase surface durability;"

"The designer selects the factor of safety to minimize the likelihood of serviceability failure." (Section 5.9, Factor of Safety)

"Designers of enclosed slabs-on-ground can reduce shrinkage cracking and shrinkage curling by considering the feature that affect these phenomena and addressing them;" (Section 14.5)

The Foreword for ACI 360-10 is identical to the Foreword for ACI 360R-06.

ACI 360R-10, Table 3.1, states that one of the disadvantages of unreinforced slab types is "Flatness and levelness may decrease over time."

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