Birdbaths Underfoot

Avoiding disputes about concrete specification requirements

by Bev Garnant and Bruce A. Suprenant, Ph.D., PE, FACI

Perhaps the worst time to discuss whether a construction project will be considered satisfactorily completed is punchlist time—the period when participants conduct a walk-through of the nearly completed job. This is often when people who have not previously discussed specification requirements start reading those requirements a little more closely. It is also the time when owners want a structure that meets their expectations, design professionals want assurance the structure performs as anticipated, and contractors want to be paid. In other words, it is a time when disagreements are quite likely.

For concrete construction, arguments can be minimized through good communication between the contractor and design professional. People are much more likely to agree on what constitutes conformance with a specification at project-end when the work began with accord in three general areas:

1. Understanding of the specification requirements.
2. Achievability of the specification requirements.
3. Means for measuring conformance to specification requirements—especially those related to tolerances.

To address these areas, the Technical Review Committee of the American Society of Concrete Contractors (ASCC) has produced a series of position statements to help members of the construction team reach agreement before disputes get costly (see “ASCC Position Statements,” page 66). Examples of some of the job-site issues that resulted in these position statements are described in this article.

The need for understanding

Specifications sometimes require concrete contractors to produce floor surfaces free of trowel marks. However, most specifications do not explain what is meant by “trowel marks” and there is no commonly accepted definition of the term. In one case, a contractor bid a job in which the specifications required surfaces be “essentially free of trowel marks.” The contractor assumed these marks referred to small irregularities that could be seen and felt, such as chatter marks or the ridges produced at the end of the
trowel blades. As such, he used power trowels to produce a surface that met specified flatness tolerances and was free of ripples, bumps, or chatter marks.

During the walk-through, the owner objected to the semi-circular pattern left by the power trowel. The resulting dispute delayed the project while the owner and contractor tried to agree on the definition, and on a way to solve the problem.\textsuperscript{1} The familiar ‘failure-to-communicate’ phrase is certainly evident here. The owner wanted a floor that looked uniform, and the contractor thought the owner wanted a floor that ‘felt’ uniform. The owner’s expectations differed from the contractor’s understanding, which means the resulting cost—time and money—could have been avoided if one term had been defined before construction documents were issued.

ASCC Position Statement 4, \textit{Trowel Marks on Concrete Floors}, addresses this problem. It defines two terms—“trowel pattern” and “trowel marks”—as illustrated in Figure 1, and states contractors should remove trowel marks by rubbing, grinding, or other appropriate methods. When visual trowel patterns are unacceptable, the specifier should make a specific statement of this requirement in the documents. This way, the contractor can choose the best method for economically meeting the requirement, and show the owner the finished surface’s final appearance. Neither the owner nor the contractor would then have to deal with a costly, after-the-fact fix.

\textbf{Avoiding unachievable requirements}

Many specifications require contractors to build concrete slabs that contain no ‘birdbaths’—small puddles of water that remain on a horizontal or sloped concrete surface after rain has fallen or the slab has been washed (Figure 2, page 66). These specifications often require a final water washing of the slab as a means of locating birdbaths that...
must then be corrected by patching or grinding. The problem with this specification requirement is it is simply unachievable, as demonstrated by the sketch in Figure 3.

Flatness of concrete slabs can be addressed by specifying the permissible gap under a 3-m (10-ft) straightedge. The preferable method is measuring flatness F-number (FF) in accordance with the standard method for making this measurement—ASTM International E 1155, Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers. Nevertheless, straightedge measurements are commonly used for slabs with relatively small areas. There is a rough correlation between gaps under a straightedge and FF—a bigger gap corresponds with a lower value for FF.

Tolerances for the gap range from ±3 mm (±0.125 in.) for very flat floors to ±13 mm (±0.5 in.) for slabs that are bullfloated, then floated and troweled without using a scraping straightedge. Nevertheless, birdbaths are inevitable regardless of tolerance tightness. Specifying a relatively large permissible gap under a straightedge (i.e. low FF) results in numerous deep birdbaths, while calling for a small permissible gap under a straightedge (i.e. high FF) results in a few shallow birdbaths. Either way, these puddles are an unavoidable consequence of a flatness tolerance, and eliminating them would require construction of a perfectly plane slab.

Sloped surfaces present their own considerations. Should one tilt the slab shown in Figure 3 to produce a 20 mm per 1 m (0.25 in. per 1 ft) slope, the surface will still have humps and valleys that collect water. The FF number is determined by the number of humps and valleys, and their height and depth. Since the same finishing methods are employed for horizontal or sloped surfaces, one should expect about the same number and size of humps and valleys for a given FF. Thus, a sloped surface is just as likely to have birdbaths as its level counterpart.

ASCC Position Statement 7, Birdbaths on Concrete Slabs, addresses the achievability problem. It states concrete contractors should meet specification flatness requirements, but cannot eliminate birdbaths because the two requirements are mutually exclusive. This explanation aids in matching expectations with reality.
Tolerance selection and measurement

The following excerpt from the American Concrete Institute (ACI) 117R-90, Commentary on Standard Specifications for Tolerances for Concrete Construction and Materials, summarizes the need for construction tolerances, and some principles that should be applied in their selection:

No structure is exactly level, plumb, straight, and true. Fortunately, such perfection is not necessary. Tolerances are a means to establish permissible variations in dimensions and location, giving both the designer and the contractor parameters within which the work is to be performed. They are the means by which the designer conveys to the contractor the performance expectations upon which the design is based or the use of the project requires. Such specified tolerances should reflect design assumptions and project needs, being neither overly restrictive nor lenient. Necessity rather than desirability should be the basis of selecting tolerances.

While this statement deals with the need for tolerances, it fails to address another important issue—how these tolerances will be measured. Without such a protocol, two people checking for compliance with specification requirements could reach different conclusions. As an example, one can consider the tolerance requirement for riser height and tread width for stairs. ACI 117-90 permits a ±3-mm (±0.125-in.) difference in height between adjacent risers and a ±6.4-mm (±0.25-in.) difference in width between adjacent treads. However, the specification is silent on how these differences are to be measured. Does one measure riser height to the low point on the step, the high point, or average several measurements? This problem has yet to be solved, but ACI Committee 117 will consider it when the document is revised.

A related problem occurs when tolerance measurement methods are prescribed, but conflicting techniques are used by different building trades. Dissimilar tolerances at the interfaces between different materials can cause construction disputes when building components cannot fit. One example of such an interface is flooring installed on concrete slabs.

Figure 3

Birdbaths are an unavoidable consequence of a flatness tolerance, and eliminating them would require construction of a perfectly plane slab (i.e., no gap under a straightedge).
Division 03 specifications for concrete floor flatness typically include FF requirements. The specifications also require floor tolerance measurements be taken in accordance with ASTM E 1155.

Division 09 specifications for concrete floors to receive a floor covering typically provide flatness requirements in terms of an allowable gap under an unlevelled straightedge. There is no ASTM procedure for this measurement. Division 03 and Division 09 floor-flatness tolerances are incompatible. There is only a rough correlation between FF numbers and the gap under a straightedge. F-number measurements do not include flatness variations indicated by straightedges placed across construction joints and column blockouts. Additionally, floor flatness changes over time (due to curling) make it impossible to predict the flatness when floor coverings are installed, based on FF measurements made soon after concrete placement.

Although F-numbers are a precise approach to specifying floor flatness, the F-number measuring method fails to meet the needs of the floor covering industry. For instance, according to ASTM E 1155 and ACI 117 the measurement should not be taken:

- across construction joints;
- within 0.6 m (2 ft) of a penetration; and
- after 72 hours.

Nevertheless, to provide the owner with a satisfactory floor finish, the floor covering must be placed over construction joints and near penetrations on a floor certainly older than 72 hours. Figure 4 shows a straightedge being used to measure the flatness directly across a construction joint and at the intersection of a column blockout and the floor slab. F-number measurements do not reflect the flatness variations indicated by the straightedge at these locations.

Despite this incompatibility of tolerance-measuring methods, some specifiers believe concrete contractors should be responsible for taking corrective action when Division 09 floor flatness requirements are not met. Further complicating this issue, concrete contractors seldom receive Division 09 specification requirements when bidding. The floor covering is frequently not chosen—and Division 09 not written—until after the concrete contract is signed, and sometimes until after the concrete is placed. Resulting disputes often lead to claims, counterclaims, and litigation.

ASCC Position Statement 6, Division 03 versus Division 09 Floor Flatness Tolerances, addresses the tolerance measurement problem. It suggests the engineer consider using reinforcing steel to minimize the adverse effect of
Authors
Bev Garnant is executive director of the American Society of Concrete Contractors (ASCC), which comprises concrete contractors, manufacturers, suppliers, architects, and specifiers. She can be contacted via e-mail at bgarnant@ascconline.org. Bruce A. Suprenant, Ph.D., PE, FACI, is president of the Boulder, Colorado-based Concrete Engineering Specialists. He is the chair of the ASCC Technical Review Committee. Suprenant can be contacted via e-mail at bsuprenant@ConcreteES.com.

Additional Information

Abstract
The relationship between design professionals and concrete contractors can be tenuous. To make things worse, a lack of understanding can lead to confusion over what is expected—and problems at punch-out time. For helping installers and specifiers get on the same page, the American Society of Concrete Contractors (ASCC) has devised position statements clarifying contract language and highlighting impossible requests.

Notes
1 “Concrete Specifications: Read and Write Them Carefully,” Concrete Technology Today vol. 15, no. 2 (Portland Cement Association, July 1994).
3 Suprenant, Bruce. “The Concrete Floor Tolerance/Floor Covering Conundrum,” Concrete International (July 2003).