



**LESSONS LEARNED:
 Construction Materials**
 OBSERVATIONS AND LESSONS FROM THE SCHOOL OF EXPERIENCE

Floor Flatness and Levelness

For many retailers, the exposed concrete floor is what the public sees. Building owners want flat and level floors to minimize fit up costs and to eliminate an uneven appearance. Developers know that many future tenants will have floor flatness and levelness requirements for space they lease. This edition of "Lessons Learned" will help you understand floor flatness and the ASTM "F-Number" system, which is routinely specified in construction documents for measuring floor flatness and floor levelness.

In years past, the gap below a 10-foot straight edge placed on a concrete floor surface was commonly used to measure floor flatness. This method had many shortcomings. To overcome these shortcomings, the "F-Number" method was developed. This method provides a superior method to the 10-foot straight edge method since it allows a broader evaluation of the floor slab, is less subject to human error, and allows a statistical evaluation of the entire slab.

F-Number - The F-Number test method is defined in ASTM E-1155. This standard includes the definitions of flatness and levelness (F_F and F_L), and the procedures for measuring these values in the field.

Floor Flatness (F_F) - Flatness refers to the relative smoothness of a floor slab. Although the F_F number cannot be converted directly to the traditional 10-foot straight edge method, it is conceptually similar to this method for defining the suitability of a slab.

Floor Levelness (F_L) - Levelness of a slab relates to the overall slope of the slab with respect to a horizontal plane. For example, a pool table may be perfectly flat, but it is not level if it has been turned on its side. The straight edge method has no corresponding levelness value.

Using the F-Number

There is no direct method to convert the 10-foot straight edge measurement to F_F and F_L numbers. However, the following chart provides an approximation of the relative values of the F_F and F_L numbers as they apply to various situations for slabs on ground. These values are taken from ACI 302.1R.

F_F	F_L	Approx. Gap Below a 10 Foot Straight Edge Equivalent for F_F	Slab Type
20	15	5/16 in.	Non-critical areas such as mechanical rooms and surfaces to have thick set tile
25	20	1/4 in.	Carpeted areas of commercial office buildings
35	25	1/8 in.	Thin-set flooring or warehouse floors with moderate or heavy traffic

Where it is necessary to have a relatively flat and level floor, F_F and F_L numbers appropriate to the utilization of the slab should be specified. Specifying higher than needed F_F/F_L requirements should be considered carefully. Higher F-Numbers will require specialized equipment and more intense concrete finishing efforts; both can lead to higher construction costs.

Good concrete mix designs, proper formwork, finishing procedures and equipment, and preconstruction coordination will help achieve the specified F_F and F_L numbers at the lowest cost.

Floor surveys are performed with a floor profiler with the most commonly used device called a "Dipstick." It measures and records relative change in elevation between the two adjacent points along a straight line. Important points to remember in floor profile evaluations include:

- Areas to be tested must be clean and not obstructed by construction materials
- Floor profile surveys should be conducted as soon as possible after concrete placement, and within 72 hours of concrete placement
- Levelness measurements for elevated slabs must be performed prior to formwork removal
- Test results should be provided to the contractor promptly so modifications to concrete finishing methods can be made if necessary
- The F-Number method cannot be used to measure the levelness of a cambered elevated slab
- For industrial projects, practice pours made in future office space or other non-critical areas can help eliminate problems in areas where flatness and levelness requirements are mandatory

A preconstruction meeting regarding floor slab construction and finishing is highly recommended to make sure that all participants understand the use and implications of floor flatness and levelness testing. The purpose of the meeting is to clarify requirements, to agree to a testing plan, timing of measurements and reporting, and evaluation of test results. If remedies for out-of-spec results are not spelled out in the contract specifications, this meeting can also be used to address actions to be taken if the slab does not meet flatness or levelness specifications. Discussions can address the range of remedial actions to possibly include grinding, topping coats, and financial credits.

We hope this "Lessons Learned" will be helpful to you in planning for your next "flat and level" concrete floor.

Respectfully,
 ECS Corporate Services, LLC