

Concrete Slab Profile Quality

Introduction

All finishes, equipment, partitions, and furniture in a facility rest on the floor slab, either directly or indirectly, so the slab must provide a flat and level bearing surface. If a slab surface is not flat and level, full contact cannot be achieved and shims, leveling legs, scribed trim pieces, and other methods of installation must be used. An uneven surface profile will also pond water and negatively impact the aesthetics and detailing of flooring. To avoid these issues slabs must be appropriately flat and level, especially in high performance facilities.

The surface profile of a slab is generally the result of workmanship and is under the control of the concrete contractor. It is incumbent of the designer to determine the required characteristics of the slab and include them in the construction documents.

In older specifications the maximum allowable surface unevenness was defined as a 1/8" deviation in 10 feet. This metric is problematic because it is not reliably replicable; it depends on where on a slab a 10-foot straight-edge is placed. However, with the advent of computerized profile measurement instruments, the quality of a slab surface can be determined more objectively and specified using F-numbers.

F-Numbers

A slab surface can vary in either flatness or levelness, and the values of each are quantified as F-numbers (Figure 1). F-numbers range from low (bad) to high (good) and should be specified appropriately for the use of the space.

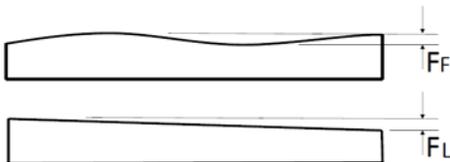


Figure 1: F_F and F_L Numbers

Very high F-numbers are costly to achieve and should only be specified where necessary in critical facilities. All slabs

should have a specified F-number so that appropriate surface profiles are defined and achieved.

After the installation of a slab, profiling instruments take measurements in multiple perpendicular directions (figure 2). The F-number values for that slab are determined based on an analysis of the resulting measurements.

Flatness is a measure of waves or roughness in the concrete surface. The F-number measure of flatness is F_F . F_F range from 10 to 150. As a point of reference, F_F 50 is roughly equivalent to the traditional 1/8" deviation in 10 feet.

Levelness is the degree to which a slab tilts or pitches and varies from true level. The F-number measure of levelness is F_L . F_L also range from 10 to 150.



Figure 2: Slab profiling instrument

Concrete slabs on grade are uniformly supported and so have both F_F and F_L characteristics. Elevated slabs are subject to deflection over time and under loading, so F_L characteristics are not applicable. Elevated slabs and their support framing system should be designed with sufficient camber and stiffness to result in a surface that is appropriately level when fully loaded.

The American Concrete Institute publication ACI-302.1 provides recommended minimum F_F and F_L values for a number of facility types. The requirements of critical facilities and the technical specifications of equipment should be reviewed with users to confirm whether they exceed recommended minimums.

Corrective Actions

If a slab is not specified and built to acceptable F_F and F_L characteristics, corrective actions may be required. All corrective options are expensive, time consuming, and disruptive.

The remove and replace method involves removing sections of slab and replacing with a slab of acceptable surface quality.

Leveling compound involves scarifying portions of the existing slab and installing a self-leveling filling material. This only addresses low areas on the slab.

Grinding involves abrasively grinding or chipping material from the surface of the slab. This only addresses raised areas on the slab.

A topping slab, which provides a new surface over an entire slab, may be required if other corrective actions are not sufficient.

Resources

ASTM E1155: *Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers* - This test covers a quantitative method of measuring floor surface profiles to obtain estimates of the floor's characteristic F_F Flatness and F_L Levelness.

American Concrete Institute ACI 117: *Specification for Tolerances for Concrete Construction and Materials* - This specification provides tolerances for concrete installations including slab surfaces.