Designation: E1155M – 14

Standard Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers (Metric)[1]

This standard is issued under the fixed designation E1155M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a quantitative method of measuring floor surface profiles to obtain estimates of the floor's characteristic F_F Flatness and F_L Levelness Face Floor Profile Numbers (*F*-Numbers) using the metric (SI) system of units.

NOTE 1—This is the metric companion to Test Method E1155.

1.2 The text of this test method references notes and footnotes that provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of this test method.

1.3 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E1155 Test Method for Determining F_F Floor Flatness and F_L Floor Levelness Numbers

2.2 *ACI Standard:*[3]

ACI 117-90 Standard Specifications for Tolerances for Concrete Construction and Materials

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *elevation*—height, altitude, vertical location in space. Elevation measurements are always made parallel to the direction of gravity.

3.1.2 *flat*—even, plane, homoloidal, free of undulation.

3.1.2.1 *Discussion*—For the purposes of this test method, flatness will be measured by calculating curvature value, *q*, between all 300-mm. reading points separated by 600 mm. The curvature value is the difference between successive elevation differences. The mean and standard deviation of all the curvature values for a given test section are then converted according to the equations in this test method to get the dimensionless F_F Flatness Number.

3.1.3 *floor profilometer*—a Type I device (see 6.1.1) that produces a continuous record of the elevation of a single point moving along a line on the floor's surface.

3.1.4 *horizontal*—level, normal to the direction of gravity.

3.1.5 *inclinometer*—a Type II device (see 6.1.2) that measures the angle between horizontal and the line joining the two points of contact with the floor's surface.

3.1.6 *level*—horizontal, normal to the direction of gravity.

3.1.6.1 *Discussion*—For the purposes of this test method, levelness will be measured by collecting elevation differences at points spaced 3 m apart and that will be described by the F_L Levelness number (dimensionless).

3.1.7 *longitudinal differential floor profilometer, n*—a Type II device (see 6.1.2) that produces a continuous record of the elevation difference between two points moving along a line on the floor's surface, which two points remain separated by a fixed distance.

3.1.8 *sample measurement line*—a sample measurement line shall consist of any straight line on the test surface along which measurements are taken, with the limitations listed in 7.3.

3.1.9 *sign convention*—where up is the positive direction; down is the negative direction. Consequently, the higher the reading point, the more positive its h_i value, and the lower the reading point, the more negative its h_i value. Similarly, the elevation difference from a low point to a high point (that is, an *uphill* difference) is positive, while the elevation difference from a high point to a low point (that is, a *downhill* difference) is negative.

[1] This test method is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.21 on Serviceability.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.

3.1.10 *test section*—a test section consists of any subdivision of the test surface with the limitations listed in 7.2.

3.1.11 *test surface*—on any one building level, the entire floor area of interest constitutes the test surface, with the limitations listed in 7.1.

3.1.12 *vertical*—parallel to the direction of gravity.

3.2 *Symbols:*

3.2.1 A_i—area of Test Section i.

3.2.2 d_i—difference in elevation (in millimetres) between reading points P_i and P_{i-1} ($i \geq 1$).

3.2.3 F_f—Face F_F Flatness Number (dimensionless).

3.2.4 F_{f_i}—composite F_F Flatness Number for Test Section i.

3.2.5 F_l—Face F_L Levelness Number (dimensionless).

3.2.6 F_{l_i}—composite F_L Levelness Number for Test Section i.

3.2.7 h_i—elevation (in millimetres) of Reading Point P_i ($i \geq 0$).

3.2.8 n_j—number of reading points in Test Sample j ($n_j \geq 12$).

3.2.9 N_{min}—minimum number of 3-m elevation difference readings required per the test section.

3.2.10 q_i—arithmetic difference (in millimetres) between elevation differences d_i and d_{i-1} ($i \geq 2$).

3.2.11 r_{x_j}—number of readings of Variable $x$obtained from Sample j.

3.2.12 s_{x_j}—standard deviation of Variable x in Sample j.

3.2.13 V_{x_j}—variance of Variable x in Sample j.

3.2.14 z_i—difference in elevation (in millimetres) between Reading Points P_i and P_{i-10} ($i \geq 10$).

4. Summary of Test Method

4.1 Straight lines are marked at various locations on the floor surface. Point elevations are then measured at regular 300-mm intervals along each line. The elevation differences between all adjacent reading points are calculated, and a straight line approximation to the surface profile along each measurement line is produced and evaluated for consistency with visual observation of the floor surface.

4.2 The arithmetic differences between all adjacent 300-mm elevation differences and the elevation differences between all points separated 3 m are then calculated. Estimates of each test section's floors F_F Flatness and F_L Levelness *F*-Numbers are obtained through statistical analyses of these calculated profile values. Finally, the *F*-Numbers for each test section are combined to arrive at a composite set of *F*-Numbers for each test surface.

5. Significance and Use

5.1 This test method provides statistical (and graphical) information concerning floor surface profiles.

5.2 Results of this test method are used primarily to:

5.2.1 Establish compliance of randomly trafficked floor surfaces with specified F_F Flatness and F_L Levelness tolerances,

5.2.2 Evaluate the effect of different construction methods on resulting floor surface flatness and levelness, and

5.2.3 Investigate the curling and deflection of floor surfaces.

5.3 Results of this test method shall not be used to enforce contract flatness and levelness tolerances on those floor installations primarily intended to support the operation of fixed-path vehicle systems (for example, narrow aisle warehouse floors).

NOTE 2—When the traffic patterns across a floor are random, (as is generally the case) evaluation of the floor's F_F Flatness and F_L Levelness will necessarily involve a random sampling of the surface, since all of the infinite potential profiles to be seen by the traffic can not possibly be measured. In those instances when the traffic across a floor will be confined to specific paths, however, the requirement for random sampling is eliminated, since the floor can indeed be inspected exactly as it will be seen by all of the traffic. In these special cases, rather than inferring the condition of the traffic paths from a random sample, it is far more useful to measure each of the traffic paths directly using continuous recording floor profilometer configured to run exactly in the traffic wheel paths. Such direct simulation measurements eliminate the inherent uncertainties of statistical sampling and provide profile information immediately applicable to the correction of the surface in way of the future traffic.

6. Apparatus

6.1 *Point Elevation Measurement Device:*

6.1.1 *Type I Apparatus*—If a Type II apparatus (see 6.1.2) is not used for this test, then an apparatus capable of measuring the elevations of a series of points spaced at regular 300-mm intervals along a straight line on the floor surface shall be used. Examples of satisfactory Type I point elevation measurement devices include, but are not limited to the following:

6.1.1.1 *Leveled Straightedge,* with gage (for example, tri-square, dial indicator, etc.) to measure vertical distance from the upper straightedge surface to floor.

6.1.1.2 *Leveled Straightedge,* with graduated wedges or shims to measure vertical distance from lower straightedge surface to floor.

6.1.1.3 *Optical Level,* with vernier or scaled target.

6.1.1.4 *Laser Level,* with vernier or scaled target.

6.1.1.5 *Taut Level Wire,* with gage to measure vertical distance from wire to floor.

6.1.1.6 *Floor Profilometer.*

6.1.1.7 *Laser Imaging Device.*

6.1.2 *Type II Apparatus*—If a Type I apparatus (see 6.1.1) is not used for this test, then an apparatus capable of measuring the elevations of a series of points spaced at regular 300-mm intervals along a straight line on the floor surface shall be used. Examples of satisfactory Type II point elevation measurement devices include, but are not limited to the following:

6.1.2.1 *Inclinometer,* having 300-mm contact point spacing.

6.1.2.2 *Longitudinal Differential Floor Profilometer,* having 300-mm sensor wheel spacing.

6.2 *Ancillary Equipment:*

6.2.1 *Measurement Tape,* graduated in millimetres.

6.2.2 *Chalk Line* (or other means for marking straight lines on the test surface).

6.2.3 *Data Recording Means*—This procedure requires the recording of both verbal and numeric information. Examples of satisfactory data recording means include, but are not limited to the following: