



Standard Specification for Utility Segmental Concrete Paving Slabs¹

This standard is issued under the fixed designation C1782/C1782M; 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 specification covers the requirements for segmental concrete paving slabs manufactured for construction of pedestrian and roof applications for commercial and municipal projects where close dimensional tolerances for thickness, and/or length and width are not required. These slabs can be manufactured with a dry-cast, wet-cast, or hydraulically pressed process.

1.2 Concrete units covered by this specification shall be made with lightweight or normal weight aggregates or both.

NOTE 1—If particular features are desired, such as weight classification, higher modulus of rupture, surface textures, finish, color, or other special features, such properties should be specified by the purchaser. Local sellers, however, should be consulted as to availability of units having the desired features.

1.3 The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

2. Referenced Documents

2.1 ASTM Standards:

- C33/C33M Specification for Concrete Aggregates
- C150/C150M Specification for Portland Cement
- C207 Specification for Hydrated Lime for Masonry Purposes
- C260/C260M Specification for Air-Entraining Admixtures for Concrete
- C331/C331M Specification for Lightweight Aggregates for Concrete Masonry Units
- C494/C494M Specification for Chemical Admixtures for Concrete
- C595/C595M Specification for Blended Hydraulic Cements
- C618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

- C979/C979M Specification for Pigments for Integrally Colored Concrete
- C989/C989M Specification for Slag Cement for Use in Concrete and Mortars
- C1157/C1157M Performance Specification for Hydraulic Cement
- C1232 Terminology of Masonry
- C1240 Specification for Silica Fume Used in Cementitious Mixtures
- C1645 Test Method for Freeze-thaw and De-icing Salt Durability of Solid Concrete Interlocking Paving Units
- D1056 Specification for Flexible Cellular Materials—Sponge or Expanded Rubber

3. Terminology

3.1 Terminology defined in C1232 shall apply for this specification.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *warpage, n*—the maximum vertical deviation from a straightedge placed across the full length, width or diagonal dimension of the paving slab surface.

4. Materials

4.1 *Cementitious Materials* shall conform to the following applicable ASTM specifications:

- 4.1.1 *Portland Cements*—Specification C150/C150M.
- 4.1.2 *Hydraulic Cements*—Specification C1157/C1157M.
- 4.1.3 *Blended Hydraulic Cements*—Specification C595/C595M.
- 4.1.4 *Hydrated Lime, Type S*—Specification C207.
- 4.1.5 *Fly Ash*—Specification C618.
- 4.1.6 *Ground Slag*—Specification C989/C989M.
- 4.1.7 *Silica Fume*—Specification C1240.

4.2 *Aggregates* shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:

- 4.2.1 *Normal Weight*—Specification C33/C33M.
- 4.2.2 *Lightweight*—Specification C331/C331M.

4.3 *Chemical Admixtures* shall conform to the following applicable ASTM specifications:

- 4.3.1 *Air-entraining Admixtures*—Specification C260/C260M.

¹ This test method is under the jurisdiction of ASTM Committee C15 on Manufactured Masonry Units and is the direct responsibility of Subcommittee C15.03 on Concrete Masonry Units and Related Units.

Current edition approved July 1, 2016. Published July 2016. DOI: 10.1520/C1782_C1782M-16.

4.3.2 *Water-reducing, Retarding, and Accelerating Admixtures*—Specification C494/C494M.

4.3.3 *Pigments for Integrally Colored Concrete*—Specification C979/C979M.

4.4 *Other Constituents*—Integral water repellents, fibers, and other materials for which no ASTM standards exist shall be previously established as suitable for use in concrete or shall be shown by test or experience not to be detrimental to the concrete paving slab.

5. Physical Requirements

5.1 Units shall have a finished face area greater than 101 in.² [0.065 m²] and their length (L) divided by thickness (T) shall be greater than 4. The minimum thickness shall be 1.2 in. [30 mm]. The maximum length and width dimensions shall be 48 in. [1220 mm]. See Fig. 1.

5.2 *Modulus of Rupture*—At the time of delivery to the job site, the average modulus of rupture of the test specimens shall be 725 psi [5.0 MPa] with no individual unit less than 650 psi [4.5 MPa] as determined in A1.3.

5.3 *Resistance to Freezing and Thawing*—If the units are exposed to freezing and thawing during service, the manufacturer shall satisfy the purchaser either by proven field performance or a laboratory freezing-and-thawing test that the units have adequate resistance to freezing and thawing. If a laboratory test is used, test in accordance with 7.4. Specimens sampled from units that will not be exposed to deicing salts in service shall be tested in tap water. Specimens sampled from units that will be exposed to deicing materials in service shall be tested in 3 % saline solution. The average mass loss of all the specimens tested shall not be greater than: (a) 225 g/m² when subject to 28 freeze-thaw cycles, or (b) 500 g/m² when subject to 49 freeze-thaw cycles. This test shall be conducted not more than 12 months prior to delivery of units.

5.4 *Dimensional Tolerances*—At the time of delivery to the job site, the length, width and thickness dimensions, and concave or convex warpage measured across the full length, width and diagonal dimensions, as determined in A1.2, shall not differ from the amounts for the specified dimensions by more than the tolerances in Table 1. Length, width and thickness dimensions are based on manufacturer's drawings for the particular shape identified.

6. Visual Inspection

6.1 All units shall be sound and free of defects that would interfere with the proper placing of the units or impair the strength or performance of the construction. Cracks or surface chipping resulting from customary methods of manufacturing or handling in shipment and delivery shall not be deemed grounds for rejection.

7. Sampling and Testing

7.1 The purchaser or the purchaser's authorized representative shall be accorded proper facilities to inspect and sample the units at the place of manufacture from the lots ready for delivery. Prior to delivery of units, the supplier and purchaser shall decide on the lot size from which to sample test specimens for resistance to freezing and thawing, modulus of rupture, and dimensional tolerances.

7.2 Sample paving slabs that are representative of the lot and label with the date of manufacture.

7.3 Three units shall be checked for dimensional variations in accordance with A1.2. Measure the length, width, and thickness for conformance to manufacturer's specified dimensions and for warpage across the full length, width and diagonal dimensions to the nearest 0.02 in. [0.5 mm]. These units shall be used for modulus of rupture testing and, if applicable, three additional units shall be tested for resistance to freezing and thawing as described 7.4 and 7.4.1.

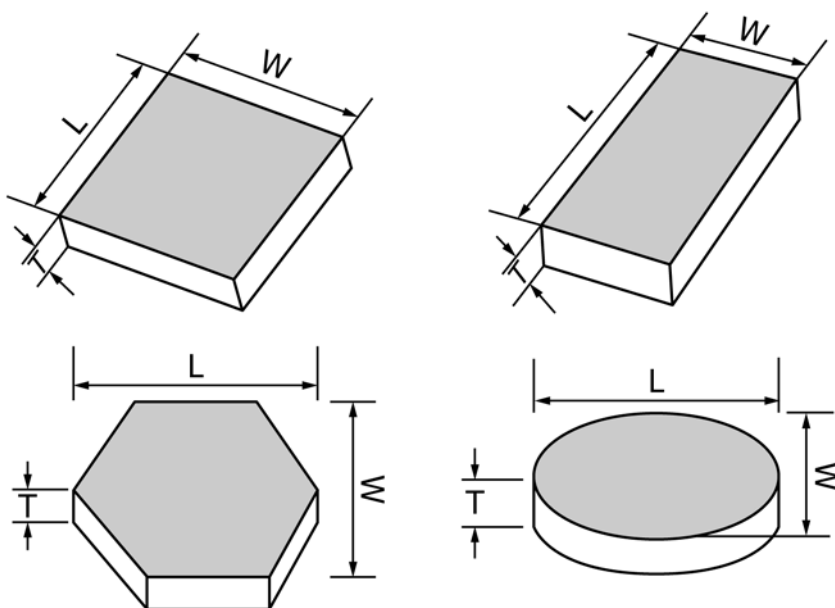


FIG. 1 L = Length, W = Width, T = Thickness



TABLE 1 Dimensional Tolerances

Length and Width, in. [mm]	Thickness, in. [mm]	Concave or Convex Warpage in One Dimension, in. [mm]
Units up to and including 24 in. [610 mm]		Up to and including 17.75 in. [450 mm]:
−0.04 [1.0] and +0.08 [2.0]	±0.12 [3.0]	±0.08 [2.0]
Units over 24 in. [610 mm]		Over 17.75 in. [450 mm]
−0.06 [1.5] and +0.12 [3.0]	±0.12 [3.0]	±0.12 [3.0]

7.4 Three units shall be tested for modulus of rupture according to A1.3 and, when required, three units shall be tested for resistance to freezing and thawing in accordance with Test Method C1645.

7.4.1 If applicable, each of the three test specimens for resistance to freezing and thawing shall be cut from three separate units. The freeze-thaw test specimens shall have a surface area of at least 29.5 in.² [0.019 m²] and not exceeding 101 in.² [0.065 m²], and have at least two edges that are uncut.

8. Compliance

8.1 If a sample fails to conform to the specified requirements, the manufacturer shall be permitted to remove paving slabs from the shipment. A new sample shall be selected by the purchaser from remaining slabs from the shipment with a similar configuration and dimension and tested. If the second

sample meets the specified requirements, the remaining portion of the shipment represented by the sample meets the specified requirements. If the second sample fails to meet the specified requirements, the remaining portion of the shipment represented by the sample fails to meet the specified requirements.

NOTE 2—Unless otherwise specified in the purchase order, the cost of tests is typically borne as follows: (1) if the results of the tests show that the slabs do not conform to the requirements of this specification, the cost is typically borne by the seller; (2) if the results of the tests show that the units conform to the specification requirements, the cost is typically borne by the purchaser.

9. Keywords

9.1 concrete; concrete paving unit; segmental concrete paving slab

ANNEX

(Mandatory Information)

A1. TEST METHODS FOR PAVING SLABS

A1.1 Scope

A1.1.1 This annex includes testing requirements for concrete paving slabs manufactured for compliance with the unit specifications in this standard.

A1.2 Measurement for Dimensional Accuracy

A1.2.1 Apparatus:

A1.2.1.1 *Measurement Devices*—Devices used to measure specimen dimensions shall have divisions not greater than 0.01 in. [0.25 mm].

A1.2.1.2 Measuring devices shall be readable and accurate to the division required to be reported. Accuracy shall be verified at least once annually. Verification record shall include date of verification, person or agency performing verification, identification of reference standard used, test points used during verification, and readings at test points.

A1.2.1.3 *Flat Surface*, of steel or glass, at least 1 in. [25 mm] larger than the specimen and plane to within 0.01 in. [0.025 mm].

A1.2.1.4 *Straightedge* made of steel at least 1 in. [25 mm] longer than the specimen and straightness within 0.01 in. [0.025 mm].

A1.2.2 *Length and Width Measurements*—Length and width measurements shall be measured across the top and bottom

surfaces at the mid-point. Spacer bars, if applicable, shall not be measured, but a measurement adjacent to the spacer bars may be taken.

A1.2.3 *Thickness Measurement*—The thickness of the specimen shall be taken at four points equidistant along the perimeter. Each measurement shall be taken 0.2 in. [5 mm] from any edge of the specimen, excluding all chamfered areas. Thickness measurements shall be measured as the distance between the flat surface and the top of the specimen to the nearest 0.01 in. [0.25 mm]. The thickness of the product shall be calculated as the average of the four values.

NOTE A1.1—The paving unit can be measured while inverted on a flat surface or while resting on its edge.

A1.2.4 Warpage shall be measured as follows:

A1.2.4.1 *Concave Warpage*—Place the unit with the concave surface to be measured facing upwards so the opposite side is in contact with a plane surface. Place the straightedge lengthwise or diagonally along the surface to be measured, selecting the location that gives the greatest departure from straightness. Select the greatest distance from the unit surface to the straightedge. Using the measuring device, measure this distance to the nearest 0.01 in. [0.25 mm], and record as the deviation from flat as shown in Fig. A1.1.

A1.2.5 *Convex Warpage*—Place the convex surface facing upwards so the opposite side is in contact with a plane surface,

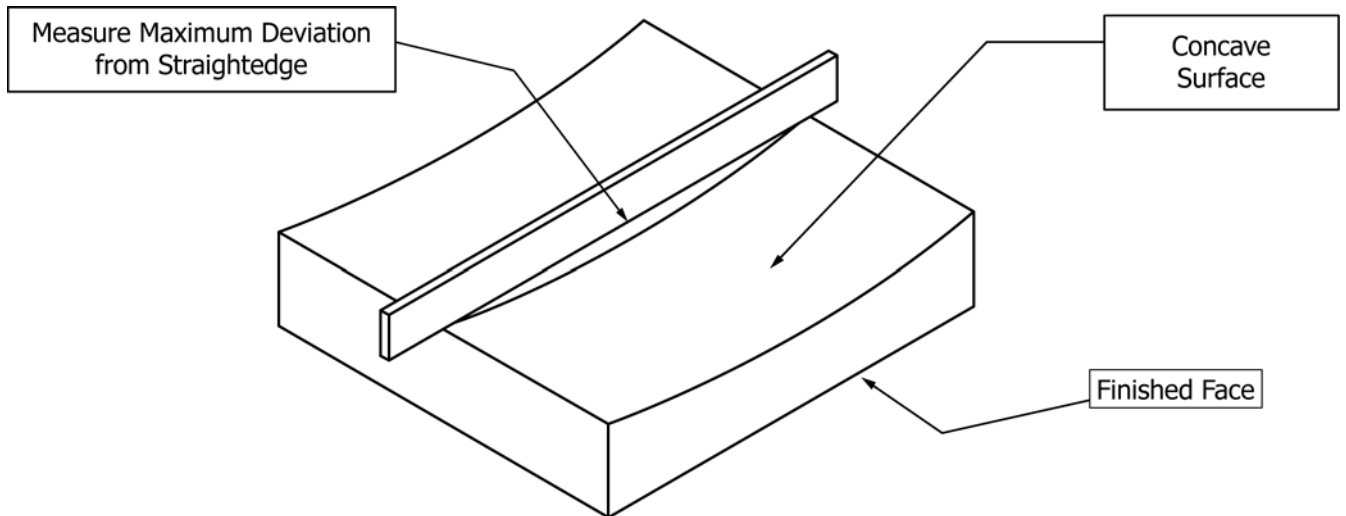


FIG. A1.1 Concave Warpage Measurement

and with the corners approximately equidistant from the plane surface. Place and level the straightedge on steel blocks having equal heights within 0.001 in. [0.025 mm]. Place the straightedge lengthwise or diagonally along the surface to be measured, selecting the location that gives the greatest departure from the straightedge. See Fig. A1.2. The straightedge shall be above the slab surface at least 0.4 in. [10 mm] and extend at least 1 in. [25 mm] beyond each side of the unit while resting on the steel blocks. Measure the vertical distance from the bottom of the straightedge to the unit surface at each end of the unit and record the greater of the two measurements. Measure the smallest vertical distance between the bottom of the straightedge and the unit surface. Subtract the smallest vertical distance measured from the greater of the two end measurements to obtain the convex warpage measurement. All vertical measurements from the bottom of the straightedge to the unit edge and surface shall be measured and recorded to the nearest 0.01 in. [0.25 mm].

A1.3 Modulus of Rupture

A1.3.1 Cure and condition test specimens as follows: cure all specimens in a moist chamber, or submerge for 28 ± 1 days as specified in A1.3.1.1. Moist curing shall be followed by air curing for a minimum of three to a maximum of seven days at $73 \pm 3^\circ\text{F}$ [$23 \pm 2^\circ\text{C}$] at a minimum 40 % relative humidity before start of the test procedures.

A1.3.1.1 Moist curing shall be carried out in a moist chamber (cabinet or room) which shall maintain a controlled air temperature of $73 \pm 3^\circ\text{F}$ [$23 \pm 2^\circ\text{C}$] and a relative humidity of at least 90 %. Alternatively, the units shall be stored, submerged in a saturated lime solution which shall be maintained at a temperature of $73 \pm 3^\circ\text{F}$ [$23 \pm 2^\circ\text{C}$].

A1.3.2 The producer shall have the option to waive curing and conditioning for the modulus of rupture tests.

A1.3.3 Test specimens shall be full size units unless the units do not fit in the testing machine or do not comply with the

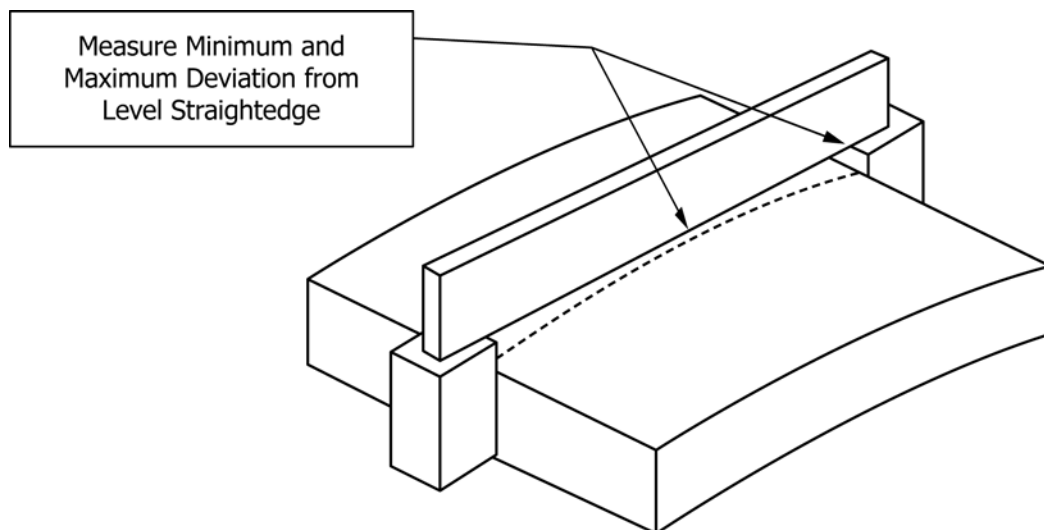


FIG. A1.2 Convex Warpage Measurement

configuration requirements of A1.3.3.1. If full size units cannot be tested, cut a rectangular specimen from the units by reducing the width or length or both to meet all the requirements of A1.3.3.1.

A1.3.3.1 Specimens shall:

(1) have a cross section about any principal axis that is a rectangle;

(2) have a minimum length, and width of 10 in. [250 mm].

A1.3.4 Tests shall be conducted on full-size specimens when possible in accordance with following procedure:

A1.3.4.1 Each specimen shall span two steel supporting rollers each 1.5 ± 0.12 in. [38 ± 3 mm] in diameter. See Fig. A1.3. The span length (spacing of the rollers) shall be:

(1) 8 in. [200 mm] for units having a maximum length of 12 in. [300 mm],

(2) 10 in. [250 mm] for units having a length between 12 in. [300 mm] and 20 in. [500 mm],

(3) 12 in. [300 mm] for units having a length of greater than 20 in. [500 mm].

A1.3.4.2 A pivot shall be required at the center of one of the rollers to counteract any twisting in the slab during the test.

A1.3.4.3 The rollers shall be level in all directions and shall support the slab throughout its entire width during testing.

A1.3.4.4 Cover the rollers with leather or similar compressible material of uniform thickness, not less than $\frac{1}{4}$ in. [6 mm] thick and 1 to 2 in. [25 to 50 mm] in width. This material shall be placed between the rollers and specimen.

A1.3.4.5 The load shall be applied axially through a spherical seated bearing block in the testing machine without inducing torsion on the specimen. The load shall be applied axially through a spherical seated bearing block in the testing machine without inducing torsion on the specimen.

A1.3.4.6 A 2 in. [50 mm] wide by a minimum 2 in. [50 mm] thick steel platen and a hardwood fillet 2 in. [50 mm] wide shall be placed under the spherical seating and parallel to the rollers. Place a 2 in. [50 mm] wide by nominal 0.5 in. [13 mm] thick strip of flexible expanded (closed cell) rubber between the hardwood fillet and the slab. The rubber shall meet the classification 2A1 requirements of Specification D1056.

A1.3.4.7 The steel platen, hardwood fillet and flexible expanded rubber strip all shall be centered in the span of the slab and shall extend the entire width of the slab.

NOTE A1.2—The purpose of the flexible expanded (closed cell) rubber strip is to accommodate any texture on the surface of the slab and to distribute the load evenly across the slab while minimizing point loading. The flexible expanded (closed cell) rubber can be manufactured from a variety of synthetic rubbers and is commonly available in approximately 3 by 6 ft [1 by 2 m] rolls to be used as gasket, sealing or cushioning material. Classification 2A1 signifies Closed Cell (Type 2), no particular resistance to petroleum base oils required (Class A), with a compression-deflection range from 2 to 5 psi [15 to 35 kPa] (Grade 1). Classifications 2B1, 2C1 or 2D1 can also be used although these classifications have oil or temperature resistance that is not required in this application. The strip can be used for a number of tests but should be replaced if it shows excessive wear on the surface, tears greater than 0.375 in. [10 mm] in length, or if it does not return to at least 75 % of its original thickness.

A1.3.5 Each specimen shall be tested with the finished face upwards in the testing machine. The load shall be uniformly applied without shock starting from zero to a rate not exceeding 4 lbf [18 N] per second for each 4 in. [100 mm] of width tested until the specimen fails. The accuracy of the applied load shall be ± 2 %.

A1.3.6 *Calculation of Modulus of Rupture*—Modulus of rupture of a concrete paving slab shall be defined by the following formula:

$$R = \frac{3Pl}{2bd^2} \quad (\text{A1.1})$$

where:

R = modulus of rupture, psi [MPa],

P = failing load, lb [N],

l = span length between rollers, in. [mm],

b = width of the slab along the fracture, in. [mm], and

d = thickness of the slab, in. [mm].

A1.4 Precision and Bias

A1.4.1 Precision:

A1.4.1.1 Repeatability testing was performed by a single laboratory by making three replicate measurements on seven sets of paving slabs, three slabs per set. The single-operator coefficient of variation of the modulus of rupture was found to average 6.8 %. The coefficient of variation within each set of the seven sets ranged from 0.7 % to 11.2 %.

A1.4.1.2 The multi-operator variability data has not been developed.

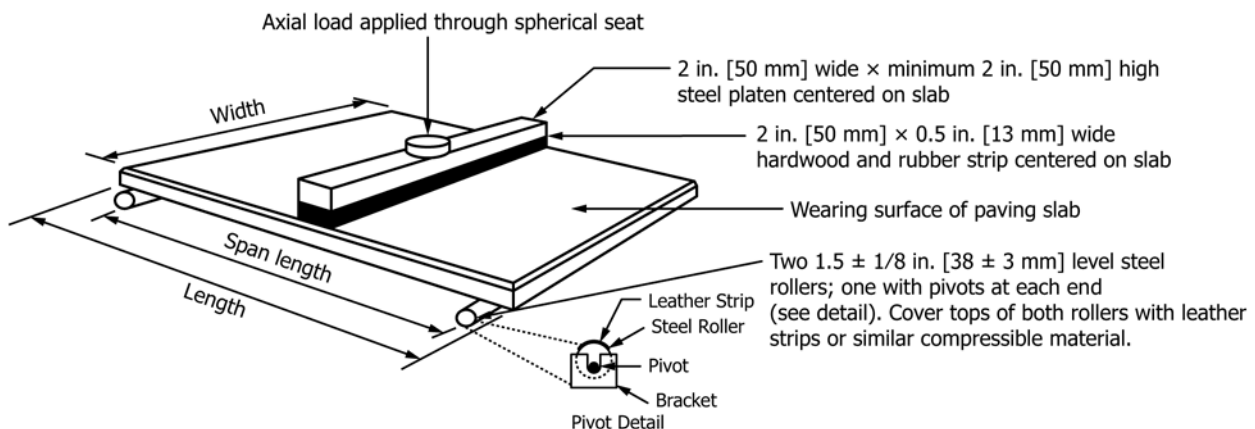


FIG. A1.3 Modulus of Rupture Test



A1.4.1.3 An interlaboratory study of this test method is being conducted and a complete precision statement is expected to be available on or before 2018.

A1.4.2 *Bias*—No information can be presented on the bias of the procedure for measuring modulus of rupture because no material having an accepted reference value is available.

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