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Standard Practice for Measuring Indent Geometrical Parameters of Indented Wires for Prestressed Concrete[1]

This standard is issued under the fixed designation A1129/A1129M; 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 practice covers the procedures to measure geometrical features of indented wires.

1.2 This practice applies to steel wires with discrete indents at a reoccurring pitch, including, but not limited to, patterns of the "chevron" and "elliptical" shape (5.2).

1.3 Quantitative limits are not addressed and are established in the general requirements or in individual product specifications, or both; or when applicable, as agreed to between supplier and user.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the inch-pound units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

A881/A881M Specification for Steel Wire, Indented, Low-Relaxation for Prestressed Concrete

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *average indent depth, d_{avg}, n*—the average depth of an indent, based on a minimum of three independent profile depth assessments for each indent.

3.1.2 *average indent distance, e, n*—the average arc length distance for the undeformed space located between each set of indented rows.

3.1.3 *average indent width, w_{avg}, n*—the average of the indent widths for the number of indents over which width was assessed.

3.1.4 *average wire cross-sectional area, A_{wire}, n*—the ratio between the mass per linear mm [in.] of a wire specimen in kg [lb] by 7.850×10^{-6} kg/mm^3 (mass of 1 mm^3 of steel) [0.2836 lb/in.^{3} (weight of 1 in.^{3} of steel)].

3.1.5 *bite per length per row, $BPLR_i$, n*—the product of the average indent width and average indent depth divided by the average pitch for a given (i^{th}) row of indents.

3.1.6 *center position line, m, n*—a sloped line representing the indent orientation relative to the axis of the row containing the indent.

3.1.7 *effective average indent sidewall length, l_{eff}, n*—an effective sidewall length evaluated in terms of the plateau and basin lengths for a given trapezoidal indent profile.

3.1.8 *effective wire diameter, D, n*—the diameter of a circle having an area equal to the average wire cross-sectional area.

3.1.9 *indent, n*—an intentionally depressed region of the wire surface having measurable geometrical characteristics (including depth, width, and pitch).

3.1.10 *indent basin length, l_{basin}, n*—the length of the basin region for a given trapezoidal indent centerline profile.

3.1.11 *indent distance, e_i, n*—the arc length of the undeformed space located between each set of indented rows.

3.1.12 *indent length, l_{indent}, n*—the length of the open plateau region for a given trapezoidal indent centerline profile.

3.1.13 *indent pitch, P, n*—the axial distance between corresponding features on two adjacent centerline indent trapezoidal profiles in a given row.

[1] This practice is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement.

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

3.1.14 *indent planform area, S, n*—the two-dimensional plateau level surface area of an indent.

3.1.15 *indent plateau length, $l_{plateau}$, n*—the distance between indents measured at the plateau level for a given trapezoidal indent centerline profile.

3.1.16 *indent profile, n*—the radial (*y*-direction) surface profile of an indent along a scan line parallel to the axis of the row containing the indent.

3.1.17 *indent profile area, $A_{profile}$, n*—area of the trapezoidal profile for a given indent; also designated as A_i.

3.1.18 *indent profile depth, d_i, n*—the depth of a given indent profile measured at multiple points.

3.1.19 *indent sidewall angle, θ, n*—the angle complementary to the basin of a given trapezoidal indent profile and the sidewall slope.

3.1.19.1 *Discussion*—There is an angle for each sloped face of the trapezoidal indent profile shape which is referred to as the left and right sidewall angles.

3.1.20 *indent sidewall area, A_{sw}, n*—the surface area of the sidewall of an indent.

3.1.20.1 *Discussion*—There is a sidewall area for each sloped face of an indent, referred to as the left and right sidewall areas.

3.1.21 *indent sidewall length, l_{sw}, n*—the length of a sidewall of the trapezoidal indent profile shape.

3.1.21.1 *Discussion*—There is a sidewall length for each sloped face of the trapezoidal indent profile shape which is referred to as the left and right sidewall lengths.

3.1.22 *indent trapezoidal profile, n*—a trapezoidal fit to the shape of a given indent profile.

3.1.22.1 *Discussion*—It is comprised of a minimum of nine discrete sample points along each axial profile. These points define the parallel upper plateau and lower basin levels, as well as the sloped sidewalls.

3.1.23 *indent volume, V, n*—the product of the average indent profile area and the indent width.

3.1.23.1 *Discussion*—A minimum of three independent profiles are required across each indent for this average, including a centerline profile.

3.1.24 *indent width, w_i, n*—the arc length between the edges where the indent intersects with the undeformed space between indent rows.

3.1.25 *orientation angle, φ, n*—the acute tilt angle of the center position line for each indent relative to the axis of the row containing the indent.

3.1.26 *row-averaged pitch, n*—the average of the pitch from one or more rows of centerline indent profiles, using at least two indents from each row.

3.1.27 *sidewall, n*—sloped faces of an indent that bound the indented region on each side.

3.1.28 *total (or overall) bite per length, BPL, n*—the sum of the bite per length per row for all indent rows.

4. Significance and Use

4.1 The definitions and procedures for measuring geometrical characteristics of indented wire are provided so that purchasers and suppliers have common definitions and measuring procedures for indent characteristics. The intention of these definitions and measuring methods is not to provide a dimensional specification for indent characteristics, but rather common measurement procedure(s) for quantifying indent geometry.

4.2 This practice was developed to characterize indents from Specification A881/A881M wire; however it could be applied to other indented wire products.

5. Indent Characteristics

5.1 *Indents*—This practice applies to indents that are formed in discrete rows, typically three rows with each row aligned parallel to the wire axis, with indents in fixed orientation in each row, and with the rows spaced uniformly around the wire. For the case of a three-row wire, the orientation for one row of indents is typically inclined in the opposite direction to the other two rows (Note 1).

NOTE 1—Indents are typically formed by drawing smooth wire through three indenting rollers oriented 120° apart. There is a periodic cycle (or repeat) in the indent patterns associated with each row of indents, corresponding to the number of teeth on the associated roller.

5.2 *Type*—Two examples of indented wire are shown in Fig. 1(*a*) and Fig. 1(*b*). Fig. 1(*a*) is a chevron pattern while Fig. 1(*b*) is an elliptical pattern.

5.3 *Two-Dimensional (2-D) Wire Indent Parameters*—Two-dimensional indent features are shown in Fig. 2.

5.4 *Three-Dimensional (3-D) Wire Indent Parameters*—Three-dimensional indent features are shown in Fig. 3.

6. Indent Measurement Requirements

6.1 Indent parameters shall be measured along the centerline axis for each indent, and along a minimum of two additional axial lines parallel to the *x*-axis of the wire, as shown in Fig. 4.

6.2 A minimum of two indents along each of the indent rows shall be measured.

6.3 Indents selected for measurements shall be free of damage via visual inspection and shall represent complete indents. Indents formed with chipped or otherwise damaged roller teeth shall be avoided.

6.4 A minimum magnification of 5× shall be used to visually determine measurement point locations.

6.5 To maintain consistent axial direction orientation of the indented wire for repeated measurements, an identifying mark shall be affixed to one end of the wire specimen.

6.6 To uniquely identify circumferential row orientation, an identifying mark shall also be affixed to one of the indented rows (Note 2).