Designation: F2754/F2754M – 21

Standard Test Method for Measurement of Camber, Cast, Helix, and Direction of Helix of Coiled Wire[1]

This standard is issued under the fixed designation F2754/F2754M; 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 the various standard methods that are used for measuring camber, cast, helix, and helix direction. The wire may be coiled with or without a spool.

1.2 This test method applies to round wire that has a diameter between 0.0127 to 4.78 mm [0.0005 to 0.188 in.]. It also applies to flat or shaped wire.

1.3 This test method does not apply to superelastic nitinol wire. It does apply to the as-drawn condition of nitinol wire.

1.4 This test method does not apply to the measurement of the straightness of straightened to length wire and tubing.

1.5 The values stated in either SI units or inch-pound 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 nonconformance with the standard.

1.6 *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.*

1.7 *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. Terminology

2.1 Fig. 1(a) through Fig. 1(e) illustrate the physical meaning of cast, helix, direction of helix, and camber.

2.2 *Definitions:*

2.2.1 *camber*—the deflection in the width direction of a flat or shaped wire, Fig. 1(e).

2.2.2 *cast*—the maximum diameter of coiled wire when one complete circumference rests completely on a flat surface such as a table, workbench, or floor, Fig. 1(a).

2.2.3 *helix*—there are two common methods for measuring helix—free end lift and hanging helix. These definitions are defined by Fig. 1(b) and Fig. 1(c), respectively.

2.2.3.1 *helix (free end lift)*—the maximum lift of the free end of the wire when laid on a flat surface, Fig. 1(b).

2.2.3.2 *helix (hanging helix)*—the maximum distance between two adjacent coils of wire, Fig. 1(c). A hanging helix can also be measured by suspending the coils.

2.2.4 *helix direction*—can be left or right-handed depending upon how the wire was coiled, Fig. 1(d).

2.2.4.1 *left-handed helix*—the wire is coiled in a counterclockwise direction, Fig. 2(a).

2.2.4.2 *right-handed helix*—the wire is coiled in a clockwise direction, Fig. 2(b).

3. Summary of Test Method

3.1 The maximum diameter of at least one complete circumference is measured using a linear scale while it is resting completely flat on a flat surface such as a table, workbench, or floor (cast measurement). The maximum lift of the free end of the wire when laid on a flat surface is the free end lift helix and is measured using a linear scale. A hanging helix can be measured using a linear scale while the wire is being suspended (hanging helix free end lift). Camber is the offset in the width dimension of a flat or shaped wire and can also be measured using a linear scale while the wire is resting on a flat surface. Alternatively, a coordinate measurement machine or optical comparator may be used. Helix direction is the direction in which the wire has been coiled.

4. Significance and Use

4.1 The process of coiling wire causes the wire to take on a curvature from the process of being mechanically deformed into a coiled geometry. The curvature in the wire is permanent unless the wire is straightened. It will affect how the coiled wire will react when it is subjected to additional wire forming

[1] This test method is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.15 on Material Test Methods.

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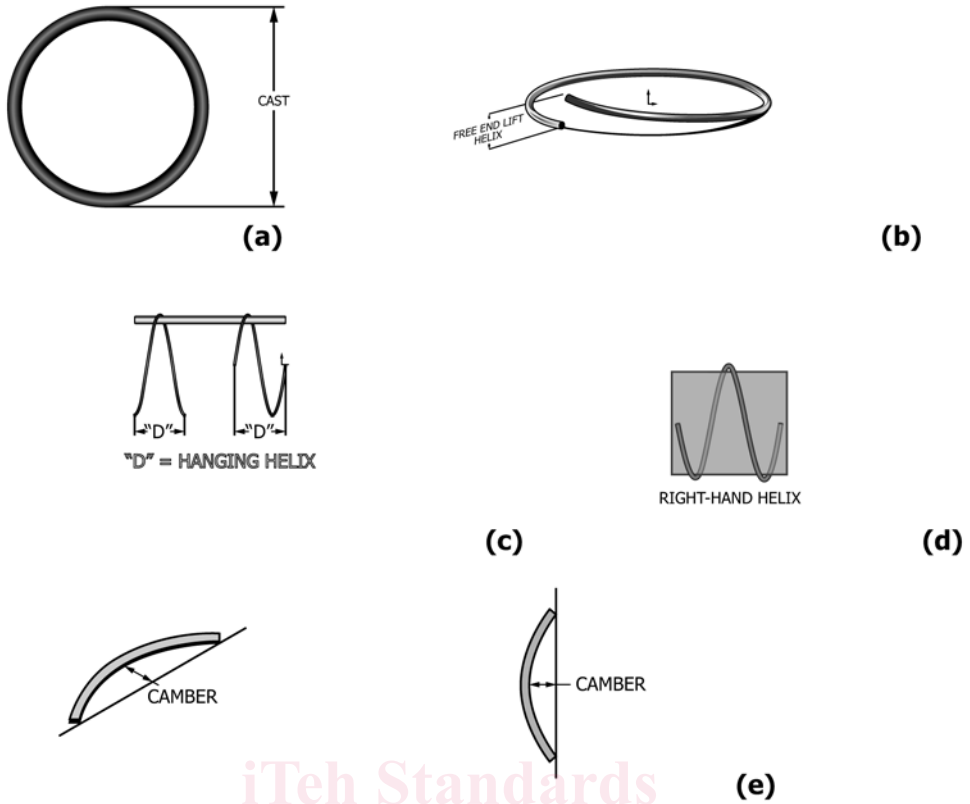
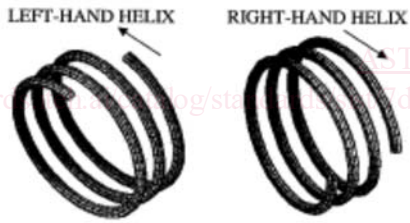
*A Summary of Changes section appears at the end of this standard



NOTE 1—(a) Definition of cast; (b) definition of helix as measured by lift method; (c) definition of helix as measured by hanging method; (d) definition of helix direction; (e) definition of camber.

FIG. 1 Standard Definitions for Cast, Helix, and Camber of Spooled Wire



NOTE 1—(a) Definition of left-handed helix direction; (b) definition of right-handed helix direction.

FIG. 2 Standard Definition for Direction of Helix

operations. In addition, residual stresses induced from the coiling operation can cause elastic recoil or spring back in subsequent wire forming operations unless the material is straightened and stress relieved prior to forming. These residual stresses can create wide variations in the dimensions of components and/or parts that have been built using the coiled wire (cast).

4.2 The direction that the wire has been coiled affects how the wire will be taken off of the coil for subsequent wire forming operations (helix direction).

4.3 Lift or spacing between adjacent coils also affects how the wire will be taken off of the coil and can also affect the dimensions of components and/or parts that have been built using the coiled wire due to residual stresses (helix).

5. Apparatus

5.1 A linear scale is required for measurement of the cast of coiled wire. An alternate approach is to use a profilometer or coordinate measurement machine.

5.2 A template is useful for measuring the cast of coiled wire that is greater than 0.6 m [24 in.], Fig. 3. An alternative approach is to use a coordinate measurement machine or optical comparator.

5.3 Special equipment is not required for measurement of camber, helix, or the direction of helix.

6. Test Specimen

6.1 *Test Specimen for Measuring Cast:*

6.1.1 It is preferred to fixture the spool or coil in a suitable manner so it does not move as the wire is removed. It is important to keep a firm tension on the wire to prevent tangling which could alter the measurement.

6.1.2 Scrap the first 1.5 to 3 m [5 to 10 ft] of wire in order to eliminate any possible end effects and wire damage from being tied off. Ensure that the wire is easily coming off of the spool or coil without any crossing over of the wire.

6.1.3 Allow the uncoiled wire to naturally form at least one complete circle that rests completely flat on a level surface such as a smooth table, bench, or the floor.

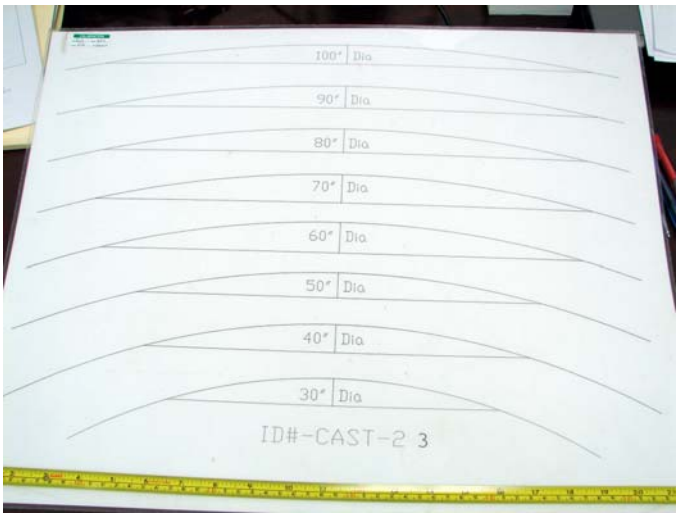


FIG. 3 Example of a Template Used for Measuring Large-Diameter Spooled Wire Cast

6.1.4 For wire with a cast 1 m or greater [or 36 in. or greater], cut a section of wire 0.5 m [18 in.] in length from the spool.

6.2 *Test Specimen for Determining the Direction of Helix*—Cut enough wire from the spool or coil for approximately two to four full diameters of the natural cast of wire. It is important to keep tension on the wire as it is unspooled in order to prevent tangling which could affect the measurement.

6.3 *Test Specimen for Measurement of Helix:*

6.3.1 *Free Lift Method*—Remove approximately two to four full diameters of the natural cast of the wire and allow them to rest on a flat surface. It is important to keep tension on the wire as it is unspooled in order to prevent tangling which could affect the measurement.

6.3.2 *Hanging Method*—Remove approximately two to four full diameters of the natural cast of the wire and suspend them using your index finger. It is important to keep tension on the wire as it is unspooled in order to prevent tangling which could affect the measurement.

6.4 *Test Specimen for Measurement of Camber in Flat or Shaped Wire*—A cut length, typically 30 cm [12.0 in.], or as agreed upon between the purchaser and supplier, should be removed from the spool or coil.

7. Procedure

7.1 *Measurement of Cast:*

7.1.1 Allow the test specimen to form at least one complete circle that rests completely flat on a level surface such as a smooth table, bench, or the floor.

7.1.1.1 For wire with a cast less than 2.5 cm [1 in.], measure the cast at the largest diameter of the circle using a linear scale, profilometer, or coordinate measurement machine. The cast should be rounded to the closest 5 mm [0.25 in.] measurement. For wire with a cast between 2.5 cm [1 in.] and less than 1 m [36 in.], measure the cast at the largest diameter of the circle using a linear scale, optical comparator, or coordinate measurement machine. The cast should be rounded to the closest 2.5 cm [1 in.] measurement or as is specified on the purchase order. If the cast is greater than 1 m [36 in.], use a sectioned piece of wire as is described in 6.1.4. The sectioned piece of wire should be slid on the template until the curvature matches as closely an arc on the template. This is the cast measurement and should be measured in 0.25 m [10 in.] increments or as is specified on the production order. An alternate approach is to use a optical comparator or coordinate measurement machine.

7.2 *Determination of the Direction of Helix:*

7.2.1 Suspend the wire specimen described in 6.2 by grasping it between a couple of fingers or by suspending it on a straight object such as an ink pen and observe the direction that it spirals away from you.

7.2.1.1 A right-handed helix spirals away from you in a clockwise direction, Fig. 2(a). A left-handed helix spirals away from you in a counterclockwise direction, Fig. 2(b).

7.3 *Measurement of Helix of Coiled Wire:*

7.3.1 *Measurement of Helix by Free End Lift Method*—Using the wire specimen described in 6.3.1, if the free end does not lift from the top of the flat surface, the wire has a zero lift by the free end lift method. If a lift is observed, use a linear scale to measure the amount of maximum spacing between the free end and adjacent coil. If the free end lift is between 0 to 25 mm [0 to 1 in.], the helix shall be reported to the nearest 10 mm [0.25 in.]. If the free end lift is greater than 25 mm [1 in.], the helix shall be reported to the nearest 15 mm [0.5 in.]. This procedure is to be used to measure and report the free end lift unless agreed upon otherwise between the purchaser and supplier. An optical comparator or coordinate measurement machine can be used alternatively to measure helix.

7.3.2 *Measurement of Helix by Suspension (Hanging) Method:*

7.3.2.1 Using the test specimen described in 6.3.2, the suspended or hanging helix is measured using a linear scale at the point of maximum separation at the bottom of the loop. One complete diameter of wire should be removed from the spool and suspended on a straight shaft. Hanging helix should