



Designation: D 3953 – 06

## Standard Specification for Strapping, Flat Steel and Seals<sup>1</sup>

This standard is issued under the fixed designation D 3953; 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 approval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope

1.1 This specification covers flat steel strapping and seals intended for use in closing, reinforcing, bundling articles for shipment, unitizing, palletizing, and bracing for carloading and truckloading.

1.2 This specification includes strapping and seals made from carbon steel and applies only to the types and sizes as cataloged by strapping suppliers to be a standard, commercially available product. It does not include “specialty”-type strapping as developed for special applications or strapping produced from alloy metals.

1.3 The values stated in inch-pound units are to be regarded as standard.

1.4 The following safety hazards caveat applies only to the test method portion, Sections 11, 12, and 13, of this specification: *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:*<sup>2</sup>
- A 90/A 90M Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
  - A 109/A 109M Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled
  - A 239 Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles
  - B 504 Test Method for Measurement of Thickness of Metallic Coatings by the Coulometric Method
  - D 996 Terminology of Packaging and Distribution Environments
  - D 3951 Practice for Commercial Packaging

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.25 on Palletizing and Unitizing of Loads.

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<sup>2</sup> 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.

D 4332 Practice for Conditioning Containers, Packages, or Packaging Components for Testing

D 4675 Guide for Selection and Use of Flat Strapping Materials

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E 691 Practice for Conducting an Interlaboratory Study to Determine the Precision of a Test Method

2.2 *Military Standard:*

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes<sup>3</sup>

2.3 *AAR Open Top Loading Rules Manual, Section No. 1, General Rules for Loading All Commodities, Part 2, Rule 17*

AAR Rule Governing the Loading of Commodities on Open Top Cars<sup>4</sup>

### 3. Terminology

3.1 General definitions for packaging and distribution environments are found in Terminology D 996.

### 4. Strapping Classifications

4.1 Strapping shall be of the following types, finish and sizes:

*Type 1, Flat Strapping: Power Machine and Hand Application:*

Regular-duty

Regular-duty high-strength

Heavy-duty

*Type 2: Nail-On*

4.1.1 *Strapping Finish, Lubricated or Dry* (see 8.3):

4.1.1.1 *Finish A—Organic (Pigmented or Unpigmented Paint)*

4.1.1.2 *Finish B—Galvanized (Hot Dipped or Electro-Deposit Galvanized)* (see 8.10):

*Grade 1—Heavy Coating*

*Grade 2—Moderate Coating*

*Grade 3—Commercial Coating*

4.1.1.3 *Finish C—Organic Painted Metallic Filled (Aluminum or Zinc)*

<sup>3</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

<sup>4</sup> Available from the Association of American Railroads (AAR), Safety and Operations, 50 F St., NW, Washington, DC 20001-1564.

4.1.1.4 *Finish D—Uncoated*

4.1.2 *Strapping Sizes*— Strapping shall have the widths and thicknesses in accordance with sizes shown in **Table 1**, **Table 2**, and **Table 3**.

**5. Seal Classifications**

5.1 Seals shall be of the following classes, finishes, types, and styles:

5.1.1 *Seal Classes:*

R—Regular duty

H—Heavy duty

5.1.2 *Seal Finishes:*

*Finish A*—Organic (painted)

*Finish B*—Galvanized (hot dipped or electro-deposit galvanized)

*Grade 1*—Heavy coating

*Grade 2*—Moderate coating

*Grade 3*—Manufacturer’s standard commercial practice

*Finish C*—Uncoated

5.1.3 *Seal Styles:*

I—Snap-on or open

II—Thread-on or closed

III—Push-type or overlap

IV—Magazine-feed

V—Intersectional or cross-tie

5.2 *Seal Sizes*—Seals shall have widths in accordance with strapping width shown in **Table 1**, **Table 2**, and **Table 3**.

**6. Ordering Information**

6.1 The inquiry and order shall indicate the following:

6.1.1 Strapping type, duty, finish, grade, lubrication (when applicable), dimension required, and quantity of each size (see Section 4).

6.1.2 Coil of strapping dimensions, weight and feet per pound, oscillated, ribbon wound, or cut-to-length (see Section 9, **Table 4** and **Table 5**, and **Fig. 1** and **Fig. 2**).

6.1.3 Seals (see Section 5) class, finish, grade (when applicable), type, style, and quantity by width (or nomenclature).

6.1.4 Make or model of strapping equipment that the strapping and seals must work in, if applicable.

6.1.5 Title, designation, and date of this specification.

6.1.6 For Department of Defense, indicate selection of preservation, packing, marking, and palletization, if applicable (see Section 16).

6.2 Sizes or physical properties, or both, other than those covered by this specification shall be as specified in the contract or order.

**7. Materials and Manufacture**

7.1 Materials shall be cold-rolled carbon steel of the quality normally used for this purpose in commercial practice, and the physical mechanical property requirements, as determined by tests, shall be within the allowable limits.

7.1.1 *Type 1 Regular-Duty Strapping*—Regular-duty strapping in **Table 1** shall be low-carbon cold-rolled steel (see 6.1.1).

7.1.2 *Type 1 Regular-Duty High-Strength Strapping*—Regular-duty high strength strapping in **Table 2** shall be low to medium carbon cold-rolled steel.

7.1.3 *Type 1 Heavy-Duty Strapping*—Heavy-duty strapping in **Table 3** shall be cold-rolled, high carbon, or medium carbon high-manganese steel which has been fully heat-treated; for example, austenitized and quenched.

7.1.4 *Type 2 Nail-On Strapping*—Unless otherwise specified, Type 2 nail-on strapping shall be strapping made from Type 1 regular-duty, regular-duty high-strength or Type 1 heavy-duty strapping, available in sizes 5/8 in. (15.87 mm) in width or greater with punched nail holes. Hole diameters and hole spacing can vary depending upon strap size and duty, which shall be in accordance with manufacturer’s standard practice. However, nail holes shall be spaced at intervals no more than 3 in. (76 mm) apart.

7.1.5 *Seals for Type 1 Strapping*—Unless otherwise specified, seals for Type 1 strapping shall be made of steel in accordance with the manufacturer’s commercial practice.

**8. Physical and Mechanical Properties**

8.1 *Breaking Strength and Elongation, Type 1 Regular-Duty, Regular-Duty High-Strength and Heavy-Duty Strapping:*

8.1.1 *Breaking Strength*—The breaking strength of the strapping shall be as shown in **Table 1**, **Table 2**, and **Table 3** when tested as specified in 13.3.

8.1.2 *Elongation*—The elongation in 6 in. (152 mm) for Type 1 strapping, when tested as specified in 13.4, shall be as follows:

Regular-duty (see 7.1.1)	0.5 to 4.0 %
Regular-duty high-strength (see 7.1.2)	0.5 to 8.0 %
Heavy-duty (see 7.1.3)	
Thickness less than 0.031 in. (0.79 mm)	5.0 to 12 %
Thickness 0.031 in. (0.79 mm) and greater	6.5 to 12 %

8.2 *Tolerances, Type 1 Strapping, Widths*—The widths of the strapping shall not vary from that shown in **Table 1**, **Table 2**, and **Table 3** by more than ±0.005 in. (0.13 mm) for all cold-rolled strapping.

**TABLE 1 Type 1 Regular-Duty Strapping Widths, Thickness, and Breaking Strengths**

Width, in. (mm)	0.015 (0.38)	0.018 (0.46)	0.020 (0.51)	0.023 (0.58)	0.028 (0.71)	0.035 (0.89)
3/8 (9.52)	450 (2000)	540 (2400)	600 (2670)	690 (3070)	...	...
1/2 (12.70)	600 (2670)	720 (3200)	800 (3560)	920 (4090)	...	...
5/8 (15.87)	750 (3335)	900 (4000)	1000 (4450)	1150 (5115)	...	...
3/4 (19.05)	900 (4000)	...	1200 (5340)	1380 (6140)	1680 (7470)	2100 (9340)

**TABLE 2 Type 1 Regular Duty High-Strength Strapping Widths, Thickness and Break Strengths**

Width, in. (mm)	Thickness, in. (mm)							
	0.016 (0.41)	0.017 (0.43)	0.018 (0.46)	0.020 (0.51)	0.023 (0.58)	0.025 (0.64)	0.031 (0.79)	0.035 (0.89)
Breaking Strength, min, lbf (N)								
3/8 (9.52)	...	640 (2849)	...	750 (3366)	...	...	...	...
1/2 (12.70)	800 (3559)	850 (3781)	900 (4003)	1000 (4448)	1150 (5115)	...	...	...
5/8 (15.87)	1000 (4448)	1050 (4671)	1125 (5004)	1250 (5560)	1440 (6405)	...	...	...
3/4 (19.05)	1200 (5339)	1275 (5671)	1350 (6005)	1500 (6672)	1725 (7673)	1875 (8340)	2325 (10342)	...
1 1/4 (31.75)	...	...	...	...	...	3125 (13901)	3875 (17237)	4375 (19461)

**TABLE 3 Type 1 Heavy-Duty Strapping Widths, Thickness, and Breaking Strengths**

Width, in. (mm)	Thickness, in. (mm)									
	0.020 (0.51)	0.022 (0.56)	0.023 (0.58)	0.025 (0.64)	0.028 (0.71)	0.029 (0.75)	0.031 (0.79)	0.035 (0.89)	0.044 (1.12)	0.050 (1.27)
Breaking Strength, min, lbf (N)										
1/2 (12.70)	1 280 (5 690)	...	1 470 (6 540)	...	...	...	1 950 (8 675)	...	...	...
5/8 (15.87)	1 600 (7 120)	...	1 840 (8 185)	...	...	...	...	...	...	...
3/4 (19.05)	2 000 (8 896)	2 280 (10 140)	2 280 (10140)	2 280 (10 140)	2 280 (10 140)	2 850 (12 675)	2 850 (12 675)	2 850 (12 675)	4 050 (18 015)	...
1 (25.4)	...	...	...	...	...	3 700 (16 455)	3 700 (16 455)	...	...	...
1 1/4 (31.75)	3 200 (14 240)	...	...	3 680 (16 370)	...	4 750 (21 130)	4 750 (21 130)	4 750 <sup>A</sup> (21 130)	6 750 (30 025)	6 750 (30 025)
2 (50.80)	...	...	...	...	...	...	...	...	10 600 (47 150)	10 600 (47 150)

<sup>A</sup> Heavy-duty, or heavy-duty/high elongation.

**TABLE 4 Number of Feet Per Pound (Metres per Kilogram) of Type 1 Strapping<sup>A</sup>**

NOTE 1—Number of feet per pound (metres per kilogram) is based on nominal dimensions and will vary slightly with the width and thickness of the strapping within the tolerances as described in 8.2.

Width, in. (mm)	Thickness, in. (mm)													
	0.010 (0.25)	0.012 (0.311)	0.015 (0.38)	0.018 (0.46)	0.020 (0.51)	0.022 (0.56)	0.023 (0.58)	0.025 (0.64)	0.028 (0.71)	0.029 (0.75)	0.031 (0.79)	0.035 (0.89)	0.044 (1.12)	0.050 (1.27)
Length per Unit Mass, ft/lb (m/kg), approximate														
3/8 (9.52)	78.5 (52.7)	65.4 (43.9)	52.4 (35.2)	43.6 (29.3)	39.3 (26.4)	...	34.1 (22.9)	...	...	...	...	...	...	...
1/2 (12.70)	58.9 (39.6)	49.1 (33.0)	39.3 (26.4)	32.7 (22.0)	29.4 (19.7)	...	25.6 (17.2)	...	...	...	19.0 (12.7)	...	...	...
5/8 (15.87)	47.1 (31.6)	39.3 (26.4)	31.4 (21.1)	26.2 (17.6)	23.6 (15.8)	...	20.5 (13.7)	...	...	...	...	...	...	...
3/4 (19.05)	...	...	26.2 (17.6)	...	19.6 (13.1)	17.8 (11.9)	17.1 (11.5)	15.7 (10.5)	14.0 (9.4)	13.5 (8.95)	12.7 (8.5)	11.2 (7.5)	...	...
1 (25.4)	...	...	...	...	...	...	...	...	...	10.1 (6.7)	9.5 (6.3)	...	...	...
1 1/4 (31.75)	...	...	...	11.8 (7.9)	...	...	9.4 (6.3)	...	8.1 (5.5)	7.6 (5.1)	6.6 (4.4)	5.3 (3.5)	4.7 (3.1)	...
2 (50.80)	...	...	...	...	...	...	...	...	...	...	...	3.3 (2.2)	2.9 (1.9)	...

<sup>A</sup> Commercial tolerances apply.

8.2.1 *Type 1 Strapping, Thickness*—The thickness of strapping sizes listed in Table 1, Table 2, Table 3, and Table 4 shall not vary from nominal thickness by more than the following: Cold-rolled steel strapping +0.002 in. (0.05 mm), -0.002 (0.05 mm) thickness.

8.3 *Lubrication*— Unless otherwise specified, Type 1 strapping shall have a coating of wax or wax-like lubricant applied to the surfaces that will render the strapping suitable for application with tension tools of the feed wheel (friction) type (see 4.1.2 and 6.1.4). The lubrication of the strapping is

**TABLE 5 Size of Coils and Package**

Type Coils	Size of Strapping, in. (mm)	Inside Diameter, in (mm) (Commercial Tolerance)	Outside Diameter, max, in. (mm)	Coils Per Package, max	Coil Face Width	Coil Weight
Oscillated	3/8 by 0.015 (9.52 by 0.38) through 3/4 by 0.035 (19.05 by 0.89)	16 (406)	23 1/2 (597)	1		
Ribbon	3/4 by 0.022 (19.05 by 0.56) through 3/4 by 0.035 (19.05 by 0.89)	16 (406)	27 (686)	1		
Ribbon	1 by 0.029 (25.4 by 0.75) through 1 by 0.031 (25.4 by 0.79)	16 (406)	27 (686)	1		
	1 1/4 by 0.020 (31.75 by 0.51) through 1 1/4 by 0.057 (31.75 by 1.45)	16 (406)	27 (686)	1		
	2 by 0.044 (50.80 by 1.12) through 2 by 0.050 (50.80 by 1.27)	16 (406)	25 7/8 (657)	1		
	3/8 by 0.015 (9.52 by 0.38) through 1 1/4 by 0.044 (31.75 by 1.12)	16 (406)	in accordance with manufacturers commercial practice	1	3 in. to 16 in.	350 lb. to 4000 lb.

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intended to facilitate the use of strapping tools in which the two bands of the strapping are held in contact with each other under pressure by frictional grips, and sliding of the faces of the strapping is necessary during the tensioning operation. Test in accordance with 13.9.

8.4 *Type 1 Strapping, Coils*—Each coil shall consist of one continuous piece of strapping. Coils with lengths of strapping welded together shall be considered as one-piece coil.

8.4.1 *Dimensional Requirements at the Weld*—The thickness at the weld shall be no more than one and one half the thickness of the strap. The width of strapping at the weld shall be subject to the same dimensional requirements as the remainder of the strapping. Metal splattering or extruded points causing increased thickness are not permissible. Only machine welds shall be acceptable.

8.4.2 *Weld Efficiency*—Strength of manufacturer's process welded joints in coils of strapping shall have a joint efficiency of not less than 75 % based on the breaking strength shown in Table 1, Table 2, and Table 3 when tested as specified in 13.6.

8.5 *Identification Marking*—Each coil of AAR approved Type 1 heavy-duty, 1 1/4-in. (31.75-mm) by 0.029 in. (0.75 mm) in thickness and greater and 2-in. wide (50.8-mm) strapping

shall be marked in accordance with the Association of American Railroads General Rule 17.

8.6 *Type 2 Strapping:*

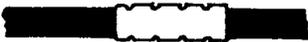
8.6.1 *Breaking Strength*—The breaking strength for Type 2 strapping shall be the same as shown in Table 1, Table 2 or Table 3 for the applicable strapping size and type, but shall be based on the cross-sectional metal area of the strapping taken across the hole. Breaking strength will be reduced proportionally in accordance with nail hole diameter.

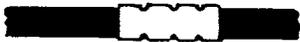
8.6.2 *Tolerances*—The tolerances on width and thickness for Type 2 strapping shall be the same as for Type 1 strapping (see 8.2).

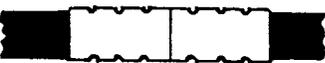
8.7 *Seals, Type 1 Strapping*—Seals intended for Type 1 strapping shall be made of steel to manufacturer's commercial practice. Seal lengths shall be adequate for a single-notch joint (one pair of cut notches), a double-notch joint (two pairs of cut notches), a double-crimp joint (two pairs of crimps), a triple-crimp joint (three pairs of crimps), or a quadruple-crimp joint (four pairs of crimps). Unless otherwise specified, seals shall be suitable in size or design to satisfy the requirements of 8.9.2 and 8.9.3.

TYPICAL  
RECOMMENDED  
CRIMP TYPE JOINTS

  
2 SEALS - 4 PAIRS OF CRIMPS

  
1 SEAL - 4 PAIRS OF CRIMPS

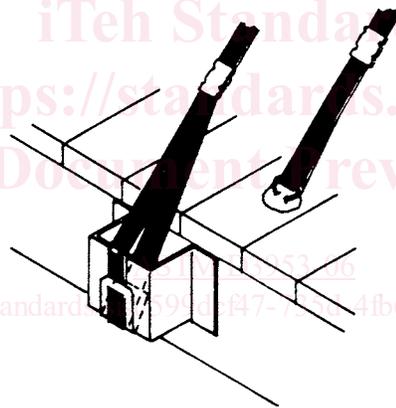
  
1 SEAL - 3 PAIRS OF CRIMPS

  
2 SEALS - 6 PAIRS OF CRIMPS

TYPICAL  
RECOMMENDED  
NOTCH TYPE JOINTS

  
1 SEAL - 2 PAIRS OF NOTCHES

  
2 SEALS - 4 PAIRS OF NOTCHES



LOOP TYPE SECUREMENT, AS ILLUSTRATED,  
REQUIRES ONLY ONE SEAL PROPERLY SEALED,  
TO PROVIDE ACCEPTABLE JOINT EFFICIENCY.

FIG. 1 Recommended Seal Joints

8.7.1 *Seal Width*—Seal width shall be adequate to allow the seal to slip on the applicable strapping and shall be compatible with the sealing tool used to provide the required joint strength.

8.7.2 *Seals, Regular-Duty High Strength and Heavy-Duty*, Seals shall be in thickness and hardness suitable for use with regular-duty high strength or heavy-duty strapping. Regular-duty seals shall be used with regular-duty high strength strapping and heavy-duty seals with heavy-duty strapping.

8.8 *Application of Seals:*

8.8.1 *Style I*—Style I seals shall have one or both sides open so that the seal shall slip in the overlapping bands of strapping either during or after tensioning the strapping.

8.8.2 *Style II*—Style II seals shall have sides partially closed at the bottom of the seal so that this seal shall be pre-threaded with the overlapping bands of strapping before the tensioning tool is applied.

8.8.3 *Style III*—Style III seals shall have the sides completely closed by overlapping at the bottom of the seal so that pre-threading with the overlapping bands of strapping and bending of the bottom strap under the seal can be accomplished. The seal shall permit the tensioning tool to tension the strapping as the tool butts against the seal.

8.8.4 *Style IV*—Style IV seals shall have sides opened to allow nesting and stacking of the seals for hand or power tools

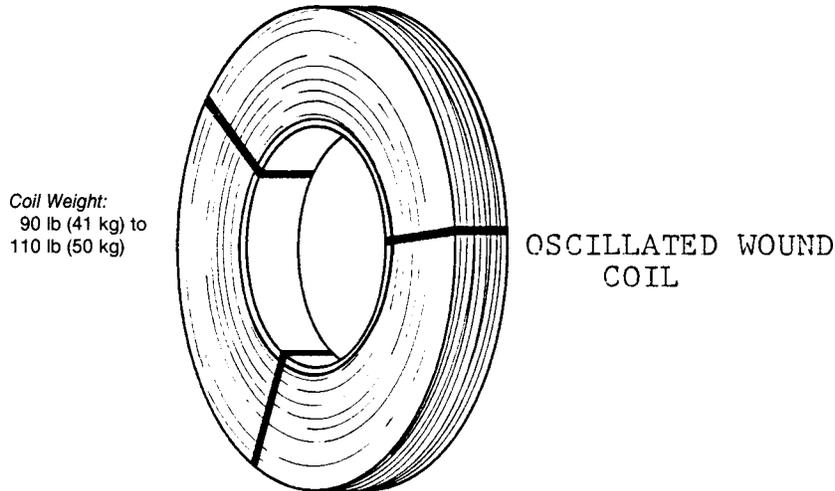


FIG. 2 Oscillated Wound Coil

with magazine feed. Seals shall fit and form joints with the seal manufacturer's tool model as specified (see 6.1.4). Means provided on Style IV seals to facilitate stacking are acceptable.

NOTE 1—Style IV seals are commonly designed for use with the seal manufacturer's tool and are not adaptable for other manufacturer's tools.

8.8.5 *Style V*—Style V seals shall have one or both sides open so that the seal shall slip on the crossing bands of strapping either during or after tensioning of the straps.

8.9 *Sealed Joints:*

8.9.1 *Fastening Flat Steel Strapping*—The various methods of fastening flat steel strapping in use commercially are notched seal joints, crimped seal joints, and sealless joints made by die cutting or spot welding the overlapping ends of the strapping. These methods are acceptable provided that the joint made meets the efficiency requirements, as follows:

8.9.2 *Notch Joints*, Notch-type seal joints made with hand tools, power hand tools, or power strapping machines recommended by the supplier, shall be made on applicable strapping, without cracking and tearing of the seal metal. Notched seal joints are usually intended for use with lubricated (waxed) strapping. Notched seal joints when used with Type 1 regular-duty strapping and regular-duty high-strength, or Type 1

heavy-duty strapping must have a minimum joint strength of 75 % for double-notch joints and 45 % for single-notch joints. Joint strength is based on the minimum breaking strength of the applicable strapping size as shown in Table 1, Table 2 and Table 3 when tested as specified in 13.5. Examples of notch-type seal joints are shown in Fig. 3.

8.9.3 *Crimp Joints*—Crimp-type seal joints, made with hand tools or power hand tools, shall be made on applicable strapping without cracking and tearing of the seal metal. Crimped seal joints are usually intended for use with dry Type 1 heavy-duty strapping, primarily where severe impact or heavy stresses on the strap and joint may be encountered. Crimp joints may also be used with lubricated (waxed) strapping, provided the loss in friction is compensated for by adding sufficient additional seals and crimps, or by using "Grit"-type friction seals. Crimp seal joints when used with Type 1 heavy-duty (high-tension) strapping in sizes 3/4 by 0.031 in. (19.05 by 0.79 mm) or greater must have a minimum joint efficiency of 75 % based on the minimum breaking strength of the applicable strapping size as shown in Table 3 when tested as specified in 13.5. Three or more crimps will be required to attain or exceed the 75 % joint efficiency as determined by seal,

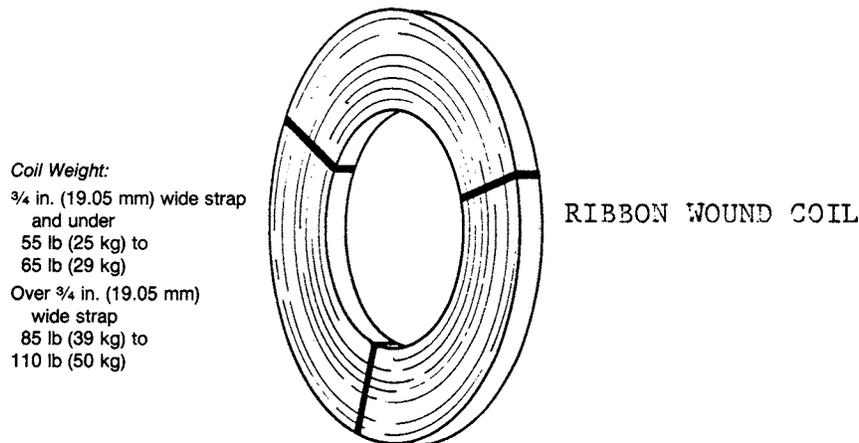


FIG. 3 Ribbon-wound Coil