# ASME B30.9-2010

(Revision of ASME B30.9-2006)

# Slings

## Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings



AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

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AN AMERICAN NATIONAL STANDARD

The American Society of Mechanical Engineers

Three Park Avenue • New York, NY • 10016 USA

Date of Issuance: January 18, 2011

The next edition of this Standard is scheduled for publication in 2013. This Standard will become effective 1 year after the Date of Issuance. There will be no addenda issued to this edition.

ASME issues written replies to inquiries concerning interpretations of technical aspects of this Standard. Interpretations are published on the ASME Web site under the Committee Pages at http://cstools.asme.org as they are issued. Interpretations will also be included with each edition.



The American Society of Mechanical Engineers
Three Park Avenue, New York, NY 10016-5990

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# FOREWORD

This American National Standard, Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings, has been developed under the procedures accredited by the American National Standards Institute (formerly the United States of America Standards Institute). This Standard had its beginning in December 1916 when an eight-page Code of Safety Standards for Cranes, prepared by an ASME Committee on the Protection of Industrial Workers, was presented to the annual meeting of the ASME.

Meetings and discussions regarding safety on cranes, derricks, and hoists were held from 1920 to 1925, involving the ASME Safety Code Correlating Committee, the Association of Iron and Steel Electrical Engineers, the American Museum of Safety, the American Engineering Standards Committee (later changed to American Standards Association and subsequently to the USA Standards Institute), Department of Labor — State of New Jersey, Department of Labor and Industry — State of Pennsylvania, and the Locomotive Crane Manufacturers Association. On June 11, 1925, the American Engineering Standards Committee approved the ASME Safety Code Correlating Committee's recommendation and authorized the project with the U.S. Department of the Navy, Bureau of Yards and Docks, and ASME as sponsors.

In March 1926, invitations were issued to 50 organizations to appoint representatives to a Sectional Committee. The call for organization of this Sectional Committee was sent out October 2, 1926, and the committee organized on November 4, 1926 with 57 members representing 29 national organizations. The Safety Code for Cranes, Derricks, and Hoists, ASA B30.2-1943, was created from the eight-page document referred to in the first paragraph. This document was reaffirmed in 1952 and widely accepted as a safety standard.

Due to changes in design, advancement in techniques, and general interest of labor and industry in safety, the Sectional Committee, under the joint sponsorship of ASME and the Naval Facilities Engineering Command, U.S. Department of the Navy, was reorganized as an American National Standards Committee on January 31, 1962, with 39 members representing 27 national organizations.

The format of the previous code was changed so that separate volumes (each complete as to construction and installation; inspection, testing, and maintenance; and operation) would cover the different types of equipment included in the scope of B30.

In 1982, the Committee was reorganized as an Accredited Organization Committee, operating under procedures developed by ASME and accredited by the American National Standards Institute.

This Standard presents a coordinated set of rules that may serve as a guide to government and other regulatory bodies and municipal authorities responsible for the guarding and inspection of the equipment falling within its scope. The suggestions leading to accident prevention are given both as mandatory and advisory provisions; compliance with both types may be required by employers of their employees.

In case of practical difficulties, new developments, or unnecessary hardship, the administrative or regulatory authority may grant variances from the literal requirements or permit the use of other devices or methods, but only when it is clearly evident that an equivalent degree of protection is thereby secured. To secure uniform application and interpretation of this Standard, administrative or regulatory authorities are urged to consult the B30 Committee, in accordance with the format described in Section IX, before rendering decisions on disputed points.

Operation and maintenance instructions in this safety Standard are intended for general applications.

Safety codes and standards are intended to enhance public safety. Revisions result from committee consideration of factors such as technological advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were inadequate. The 2010 edition of this Volume contains minor revisions throughout.

Following approval by the B30 Standards Committee and the ASME Board, ASME B30.9-2010 was approved as an American National Standard by ANSI on November 16, 2010.

# ASME B30 COMMITTEE
# Safety Standard for Cableways, Cranes, Derricks, Hoists, Hooks, Jacks, and Slings

(The following is the roster of the Committee at the time of approval of this Standard.)

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# SAFETY STANDARD FOR CABLEWAYS, CRANES, DERRICKS, HOISTS, HOOKS, JACKS, AND SLINGS

# B30 STANDARD INTRODUCTION

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## SECTION I: SCOPE

The ASME B30 Standard contains provisions that apply to the construction, installation, operation, inspection, testing, maintenance, and use of cranes and other lifting and material-handling related equipment. For the convenience of the reader, the Standard has been divided into separate volumes. Each volume has been written under the direction of the ASME B30 Standards Committee and has successfully completed a consensus approval process under the general auspices of the American National Standards Institute (ANSI).

As of the date of issuance of this Volume, the B30 Standard comprises the following volumes:

B30.1 Jacks, Industrial Rollers, Air Casters, and Hydraulic Gantries
B30.2 Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist)
B30.3 Tower Cranes
B30.4 Portal and Pedestal Cranes
B30.5 Mobile and Locomotive Cranes
B30.6 Derricks
B30.7 Base-Mounted Drum Hoists
B30.8 Floating Cranes and Floating Derricks
B30.9 Slings
B30.10 Hooks
B30.11 Monorails and Underhung Cranes
B30.12 Handling Loads Suspended From Rotorcraft
B30.13 Storage/Retrieval (S/R) Machines and Associated Equipment
B30.14 Side Boom Tractors
B30.15 Mobile Hydraulic Cranes (withdrawn 1982 — requirements found in latest revision of B30.5)
B30.16 Overhead Hoists (Underhung)
B30.17 Overhead and Gantry Cranes (Top Running Bridge, Single Girder, Underhung Hoist)
B30.18 Stacker Cranes (Top or Under Running Bridge, Multiple Girder With Top or Under Running Trolley Hoist)
B30.19 Cableways
B30.20 Below-the-Hook Lifting Devices
B30.21 Manually Lever-Operated Hoists
B30.22 Articulating Boom Cranes
B30.23 Personnel Lifting Systems
B30.24 Container Cranes
B30.25 Scrap and Material Handlers
B30.26 Rigging Hardware
B30.27 Material Placement Systems
B30.28 Balance Lifting Units
B30.29 Self-Erecting Tower Cranes[1]

## SECTION II: SCOPE EXCLUSIONS

The B30 Standard does not apply to track and automotive jacks, railway or automobile wrecking cranes, shipboard cranes, shipboard cargo-handling equipment, well-drilling derricks, skip hoists, mine hoists, truck body hoists, car or barge pullers, conveyors, excavating equipment, or equipment covered under the scope of the following standards: A10, A17, A90, A92, A120, B20, B56, and B77.

## SECTION III: PURPOSE

The B30 Standard is intended to

*(a)* prevent or minimize injury to workers, and otherwise provide for the protection of life, limb, and property by prescribing safety requirements

*(b)* provide direction to manufacturers, owners, employers, users, and others concerned with, or responsible for, its application

*(c)* guide governments and other regulatory bodies in the development, promulgation, and enforcement of appropriate safety directives

## SECTION IV: USE BY REGULATORY AGENCIES

These Volumes may be adopted in whole or in part for governmental or regulatory use. If adopted for governmental use, the references to other national codes and standards in the specific volumes may be changed to refer to the corresponding regulations of the governmental authorities.

[1] This Volume is currently in the development process.

## SECTION V: EFFECTIVE DATE

*(a) Effective Date.* The effective date of this Volume of the B30 Standard shall be 1 yr after its date of issuance. Construction, installation, inspection, testing, maintenance, and operation of equipment manufactured and facilities constructed after the effective date of this Volume shall conform to the mandatory requirements of this Volume.

*(b) Existing Installations.* Equipment manufactured and facilities constructed prior to the effective date of this Volume of the B30 Standard shall be subject to the inspection, testing, maintenance, and operation requirements of this Standard after the effective date.

It is not the intent of this Volume of the B30 Standard to require retrofitting of existing equipment. However, when an item is being modified, its performance requirements shall be reviewed relative to the requirements within the current volume. The need to meet the current requirements shall be evaluated by a qualified person selected by the owner (user). Recommended changes shall be made by the owner (user) within 1 yr.

## SECTION VI: REQUIREMENTS AND RECOMMENDATIONS

Requirements of this Standard are characterized by use of the word *shall*. Recommendations of this Standard are characterized by the word *should*.

## SECTION VII: USE OF MEASUREMENT UNITS

This Standard contains SI (metric) units as well as U.S. Customary units. The values stated in U.S. Customary units are to be regarded as the standard. The SI units are a direct (soft) conversion from the U.S. Customary units.

## SECTION VIII: REQUESTS FOR REVISION

The B30 Standards Committee will consider requests for revision of any of the volumes within the B30 Standard. Such requests should be directed to

Secretary, B30 Standards Committee
ASME Codes and Standards
Three Park Avenue
New York, NY 10016-5990

Requests should be in the following format:

Volume: Cite the designation and title of the volume.
Edition: Cite the applicable edition of the volume.
Subject: Cite the applicable paragraph number(s) and the relevant heading(s).
Request: Indicate the suggested revision.
Rationale: State the rationale for the suggested revision.

Upon receipt by the Secretary, the request will be forwarded to the relevant B30 Subcommittee for consideration and action. Correspondence will be provided to the requester defining the actions undertaken by the B30 Standards Committee.

## SECTION IX: REQUESTS FOR INTERPRETATION

The B30 Standards Committee will render an interpretation of the provisions of the B30 Standard. Such requests should be directed to

Secretary, B30 Standards Committee
ASME Codes and Standards
Three Park Avenue
New York, NY 10016-5990

Requests should be in the following format:

Volume: Cite the designation and title of the volume.
Edition: Cite the applicable edition of the volume.
Subject: Cite the applicable paragraph number(s) and the relevant heading(s).
Question: Phrase the question as a request for an interpretation of a specific provision suitable for general understanding and use, not as a request for approval of a proprietary design or situation. Plans or drawings that explain the question may be submitted to clarify the question. However, they should not contain any proprietary names or information.

Upon receipt by the Secretary, the request will be forwarded to the relevant B30 Subcommittee for a draft response, which will then be subject to approval by the B30 Standards Committee prior to its formal issuance.

Interpretations to the B30 Standard will be published in the subsequent edition of the respective volume, and will be available online at http://cstools.asme.org.

## SECTION X: ADDITIONAL GUIDANCE

The equipment covered by the B30 Standard is subject to hazards that cannot be abated by mechanical means, but only by the exercise of intelligence, care, and common sense. It is therefore essential to have personnel involved in the use and operation of equipment who are competent, careful, physically and mentally qualified, and trained in the proper operation of the equipment and the handling of loads. Serious hazards include, but are not limited to, improper or inadequate maintenance, overloading, dropping or slipping of the load,

obstructing the free passage of the load, and using equipment for a purpose for which it was not intended or designed.

The B30 Standards Committee fully realizes the importance of proper design factors, minimum or maximum dimensions, and other limiting criteria of wire rope or chain and their fastenings, sheaves, sprockets, drums, and similar equipment covered by the standard, all of which are closely connected with safety. Sizes, strengths, and similar criteria are dependent on many different factors, often varying with the installation and uses. These factors depend on

*(a)* the condition of the equipment or material

*(b)* the loads

*(c)* the acceleration or speed of the ropes, chains, sheaves, sprockets, or drums

*(d)* the type of attachments

*(e)* the number, size, and arrangement of sheaves or other parts

*(f)* environmental conditions causing corrosion or wear

*(g)* many variables that must be considered in each individual case

The requirements and recommendations provided in the volumes must be interpreted accordingly, and judgment used in determining their application.

# ASME B30.9-2010
# SUMMARY OF CHANGES

Following approval by the ASME B30 Committee and ASME, and after public review, ASME B30.9-2010 was approved by the American National Standards Institute on November 16, 2010.

ASME B30.9-2010 includes editorial changes, revisions, and corrections identified by a margin note, **(10)**.

| *Page* | *Location* | *Change* |
|---|---|---|
| vi | Foreword | Revised |
| ix–xi | Introduction | Revised |
| 1–3 | Section 9-0.2 | (1) Definition of *splice, hand tucked (wire rope and synthetic rope)* and *splice, turnback (return loop)* revised<br>(2) Definition of *splice (web sling)* and *assembly splice (web sling)* deleted |
| | Section 9-0.3 | Updated |
| 4 | 9-1.5.1 | Revised |
| | 9-1.5.3 | Revised |
| 7 | 9-1.5.4 | Revised |
| | 9-1.7.1 | Subparagraph (e) revised |
| 9, 10 | 9-1.9.5 | Subparagraph (d) revised |
| 12 | 9-2.3.1 | Revised |
| 13, 14 | 9-2.5.1 | Revised |
| | 9-2.5.3 | Revised |
| | 9-2.5.4 | Revised |
| | 9-2.6.1 | Subparagraph (a) revised |
| 15 | Table 9-2.5.2-1 | Table and Note (d) revised |
| 16 | Table 9-2.5.2-2 | Table and Note (c) revised |
| 17 | Table 9-2.5.2-3 | Table and Note (d) revised |
| 18 | Table 9-2.5.2-4 | Note (c) revised |
| 19 | Table 9-2.5.2-5 | Note (d) revised |
| 20 | Table 9-2.5.2-6 | Note (c) revised |
| 24, 25 | 9-2.7.1 | Subparagraph (b) revised |
| | 9-2.9.3 | (1) Subparagraph (d) revised<br>(2) Subparagraph (e) added |
| | 9-2.9.4 | Subparagraphs (b)(3) and (b)(4) revised |
| | 9-2.9.5 | Subparagraphs (d) and (g) revised |

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|---|---|---|
| 27 | 9-3.5.4 | Revised |
| 30 | 9-3.7.1 | Subparagraph (b) revised |
| 32 | 9-4.2.1 | Subparagraph (a) revised |
| 33 | 9-4.5.1 | Revised |
| | 9-4.5.3 | Revised |
| 39 | 9-4.5.4 | Revised |
| | 9-4.7.1 | Subparagraph (c) revised |
| 40 | 9-4.9.3 | (1) Subparagraph (d) revised<br>(2) Subparagraph (e) added |
| 41 | 9-4.9.5 | (1) Subparagraph (f) revised<br>(2) Subparagraph (g) added |
| 43 | 9-5.2.5 | Revised |
| | 9-5.5.1 | Revised |
| 44 | Fig. 17 | Revised |
| 46 | Table 9-5.5.2-1 | General Notes revised |
| | 9-5.5.3 | Revised |
| | 9-5.5.4 | Revised |
| 47 | Table 9-5.5.2-2 | General Notes revised |
| | Table 9-5.5.2-3 | Table and General Notes revised |
| 48 | Table 9-5.5.2-4 | Table and General Notes revised |
| | Table 9-5.5.2-5 | Table and General Notes revised |
| 49 | 9-5.7.1 | Subparagraph (c) revised |
| 50 | 9-5.9.3 | (1) Subparagraph (d) revised<br>(2) Subparagraph (e) added |
| | 9-5.9.5 | Subparasgraph (e) and (g) revised |
| | 9-5.10.1 | Subparagraph (f) revised |
| 51 | 9-5.10.4 | Subparagraph (m) revised |
| 52 | 9-6.5.1 | Revised |
| 55 | 9-6.5.3 | Revised |
| | 9-6.5.4 | Revised |
| | 9-6.7.1 | Subparagraph (c) revised |
| 56 | Table 9-6.5.2-1 | General Notes revised |

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|---|---|---|
| 57, 58 | Fig. 9-6.5.4-1 | Revised |
| | 9-6.9.3 | (1) Subparagraph (d) revised<br>(2) Subparagraph (e) added |
| | 9-6.9.5 | Subparagraphs (e) and (g) revised |
| | 9-6.10.1 | Subparagraph (f) revised |
| | 9-6.10.4 | Subparagraphs (b) through (p) redesignated |

**SPECIAL NOTE:**

The interpretations to ASME B30.9 are included in this edition as a separate section for the user's convenience.

# SLINGS

# Chapter 9-0
# Scope, Definitions, and References

## SECTION 9-0.1: SCOPE OF ASME B30.9

Volume B30.9 includes provisions that apply to the fabrication, attachment, use, inspection, and maintenance of slings used for lifting purposes, used in conjunction with equipment described in other volumes of the B30 Standard, except as restricted in B30.12 and B30.23. Slings fabricated from alloy steel chain, wire rope, metal mesh, synthetic fiber rope, synthetic webbing, and synthetic fiber yarns in a protective cover(s) are addressed. Slings fabricated from other materials or constructions other than those detailed in this Volume shall be used only in accordance with the recommendations of the sling manufacturer or a qualified person.

## (10) SECTION 9-0.2: DEFINITIONS

*abnormal operating conditions:* environmental conditions that are unfavorable, harmful, or detrimental to or for the operation of a sling, such as excessively high or low ambient temperatures; exposure to weather; corrosive fumes; dust-laden or moisture-laden atmospheres; and hazardous locations.

*abrasion:* the mechanical wearing of a surface resulting from frictional contact with other materials or objects.

*angle of choke:* angle formed in a sling body as it passes through the choking eye or fittings.

*angle of loading:* the acute angle between horizontal and the leg of the rigging, often referred to as horizontal angle.

*assembly:* a synonym for sling. See *sling.*

*authorized:* approved by a duly constituted administrative or regulatory authority.

*body (sling):* that part of a sling between the eyes, end fittings, or loop eyes.

*braided wire rope:* a rope formed by plaiting component wire ropes.

*braided wire rope sling:* a sling made from braided rope.

*bridle sling:* a sling composed of multiple legs with the top ends gathered in a fitting that goes over the lifting hook.

*cable-laid rope:* a cable composed of six wire ropes laid as strands around a wire rope core.

*cable-laid rope sling, mechanical joint:* a wire rope sling made from a cable-laid wire rope with eyes fabricated by swaging one of more metal sleeves over the rope junction.

*component:* see *fitting.*

*cross rod:* a wire used to join spirals of metal mesh to form the complete fabric.

*D/d ratio:* the ratio between the curvature taken by the sling, *D*, and the diameter of the component rope, *d*.

*design factor:* ratio between nominal or minimum breaking strength and rated load of the sling.

*designated person:* selected or assigned by the employer or employer's representative as being competent to perform specific duties.

*end fitting:* terminal hardware on the end of a sling. See *sling*.

*endless and grommet wire rope slings*

*cable-laid endless sling, mechanical joint:* a wire rope sling made endless from one continuous length of cable laid rope with the ends joined by one or more metallic fittings.

*cable-laid grommet, hand-tucked:* an endless wire rope sling made from one continuous length of rope formed to make a body composed of six ropes around a rope core. The rope ends are tucked into the body, thus forming the core. No sleeves are used.

*strand-laid endless sling, mechanical joint:* a wire rope sling from one continuous length of wire rope with the ends joined by one or more metallic fittings.

*strand-laid grommet, hand-tucked:* an endless wire rope sling made from one continuous length of strand formed to make a six-strand rope with a strand core. The strand ends are hand tucked into the body. No sleeves are used.

*eye opening:* the opening in the end of a sling for the attachment of the hook, shackle, or other lifting device or the load itself.

*fabric (metal mesh):* the flexible portion of the sling exclusive of end fittings consisting of a series of transverse spirals and cross rods.

*fabric length (metal mesh):* the distance of metal mesh between the end fittings.

*fabric thickness (metal mesh):* the nominal overall thickness of the spirals.

*fabrication efficiency:* the sling assembly strength, as a percentage of the material strength prior to fabrication.

*fitting:* hardware on the end of a sling.

*grommet sling:* a variety of an endless sling.

*hitch, basket:* a method of rigging a sling in which the sling is passed around the load and both loop eyes or end fittings are attached to the lifting device.

*hitch, choker:* a method of rigging a sling in which the sling is passed around the load, then through one loop eye, end fitting, or other device, with the other loop eye or end fitting attached to the lifting device. This hitch can be done with a sliding choker hook or similar device.

*hitch (hitched):* a method of rigging (attaching) a sling temporarily to a load or object for the purpose of lifting.

*hitch, vertical:* a method of rigging a sling in which the load is attached to the loop eye or end fitting at one end of the sling and the loop eye or end fitting at the other end is attached to the lifting device. Any hitch less than 5 deg from the vertical may be considered a vertical hitch.

*horizontal angle:* the acute angle between the horizontal plane and the leg of the rigging, also known as the angle of loading.

*length, sling:* the distance between the extreme bearing points of the sling.

*multiple-leg wire rope slings:* same as sling length above, except the gathering ring, master link, or similar fitting is not included in the length dimension.

*single-leg slings with end fittings:* measured from pull to pull of end fittings or eyes.

*single-leg slings without end fittings:* measured from pull to pull or from bearing to bearing of eyes.

*link, master:* forged or welded steel link used to support all members (legs) of an alloy steel chain or wire rope sling.

*link, master coupling:* alloy steel welded coupling link used as an intermediate link to join alloy steel chain to master links.

*link, mechanical coupling (alloy steel chain):* a nonwelded, mechanically closed link used primarily to attach fittings to alloy steel chain.

*loop eye (web sling):* a length of webbing that has been folded back upon itself, forming an opening, and joined to the sling body to form a bearing surface.

*ply:* a layer of load bearing webbing used in a web sling assembly.

*proof load:* the specific load applied in performance of the proof tests.

*proof test:* a nondestructive load test made to a specific multiple of the rated load of the sling.

*qualified person:* a person who, by possession of a recognized degree or certificate of professional standing in an applicable field, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

*rated load:* the maximum allowable working load established by the sling manufacturer. The terms "rated capacity" and "working load limit" are commonly used to describe rated load.

*reach (alloy steel chain):* see *length, sling.*

*selvage edge:* the woven or knitted edge of synthetic webbing so formed as to prevent raveling.

*shock load:* any condition of rapid lift, sudden shifting of load, or arrest of a falling load.

*sling:* an assembly to be used for lifting when connected to a lifting mechanism. The upper portion of the sling is connected to the lifting mechanism and the lower supports the load, as described in this Volume.

*sling body:* see *body (sling).*

*sling manufacturer (fabricator):* a person or company assembling or fabricating sling components into their final form. The sling manufacturer and the manufacturer of the sling material may or may not be identical.

*sling service*

*normal:* service that involves use of loads within the rated load.

*severe:* service that involves normal service coupled with abnormal operating conditions.

*special or infrequent:* service that involves operation, other than normal or severe, which is approved by a qualified person.

*socket, poured:* fitting into which a wire rope can be inserted and then permanently attached by filling the cavity into which the wire rope was inserted with special molten metal or resin materials. This method requires special fittings, materials, techniques, and equipment to produce an end termination to meet the requirements of this Volume.

*socket, swaged:* fitting into which a wire rope can be inserted and then permanently attached by mechanical compression applied to the shank that enclosed the rope. This method requires special fittings and equipment to produce an end termination to meet the requirements of this Volume.

*spiral:* a single transverse coil that is the basic element from which metal mesh is fabricated.

*splice, flemish eye (wire rope):* mechanical splice formed by opening the rope up in a specific manner and reforming it to create a loop or eye. A metal sleeve is slipped over the ends of the splice and mechanically compressed to secure the ends. This method requires special fittings, techniques, and equipment to produce an end termination to meet the requirements of this Volume.

*splice, hand tucked (wire rope and synthetic rope):* a loop or eye formed in the end of a rope by tucking the ends of the strands back into the main body of the rope in a prescribed manner.

*splice load bearing (web sling):* that part of a sling that is lapped and secured to become an integral load bearing part of the sling.

*splice, mechanical (wire rope):* swaging one or more metal sleeves over the wire rope to form a loop or eye.

*splice, turnback (return loop):* mechanical splice in which the rope is looped back on itself and secured with one or more metal sleeves. This method requires special fittings, techniques, and equipment to produce an end termination to meet the requirements of this Volume.

*strand laid rope:* a wire rope made with strands (usually six to eight) formed around a fiber core, wire strand core, or independent wire rope core (IWRC).

*strength (wire rope and structural strand), minimum breaking:* load at which a new and unused wire rope or structural strand could be expected to break when loaded to destruction in direct tension.

*triangle choker fitting:* an end fitting for metal mesh or synthetic web slings; similar to the *triangle fitting*, except that it also has a transverse slot through which a triangle fitting can be passed to facilitate a choker hitch on the load.

*triangle fitting:* an end fitting for metal mesh or synthetic web slings, containing a single eye opening for connecting the sling to the lifting device.

*yarn:* a generic term for a continuous strand of fibers.

## (10) SECTION 9-0.3: REFERENCES

Within the text, references are made to the following publications, copies of which may be obtained from the publishers indicated.

ASME B30.10-1999, Hooks
ASME B30.12-1992, Handling Loads Suspended From Rotorcraft
ASME B30.20-2010, Below-the-Hook Lifting Devices
ASME B30.23-2005, Personnel Lifting Systems
ASME B30.26-2004, Rigging Hardware

Publisher: The American Society of Mechanical Engineers (ASME), Three Park Avenue, New York, NY 10016-5990; Order Department: 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900 (www.asme.org)

ASTM A 391/A 391M-01, Standard Specification for Grade 80 Alloy Steel Chain
ASTM A 586-98, Standard Specification for Zinc-Coated Parallel and Helical Steel Wire Structural Strand and Zinc-Coated Wire for Spun-in-Place Structural Strand
ASTM A 906/A 906M-02, Standard Specification for Grade 80 and Grade 100 Alloy Steel Chain Slings for Overhead Lifting
ASTM A 952/A 952M-02, Standard Specification for Forged Grade 80 and Grade 100 Steel Lifting Components and Welded Attached Links
ASTM A 973/A 973M-01, Standard Specification for Grade 100 Alloy Steel Chain
ASTM A 1023/A 1023M-02, Standard Specification for Stranded Carbon Steel Wire Ropes for General Purposes

Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

CI 1303-96, Nylon (Polyamide) Fiber Rope, 3-Strand and 8-Strand Construction
CI 1304-96, Polyester (PET) Fiber Rope, 3-Strand and 8-Strand Construction
CI 1305-96, Single Braided Polyester Fiber Rope, 12-Strand Braid Construction
CI 1306-96, Nylon (Polyamide) Fiber Rope, Double Braid Construction
CI 1307-96, Polyester (PET) Fiber Rope, Double Braid Construction

Publisher: The Cordage Institute (CI), 994 Old Eagle School Road, Wayne, PA 19087 (www.ropecord.com)

WRTB Wire Rope Sling Users Manual, 3rd Edition

Publisher: Wire Rope Technical Board (WRTB), 44 South Carriage Drive, St. Joseph, MO 64506-1233 (www.domesticwirerope.org/wrtb/index.html)

WSTDA-RS-1, Recommended Standard Specification for Synthetic Polyester Roundslings
WSTDA-TH-1, Recommended Standard Specification for Synthetic Thread
WSTDA-UV-Sling-2003, Summary Report UV Degradation
WSTDA-WB-1, Recommended Standard Specification for Synthetic Webbing for Slings
WSTDA-WS-1, Recommended Standard Specification for Synthetic Web Slings

Publisher: Web Sling & Tie Down Association (WSTDA), 2105 Laurel Bush Road, Bel Air, MD 21015 (www.wstda.com/index.shtml)

# Chapter 9-1
# Alloy Steel Chain Slings: Selection, Use, and Maintenance

## SECTION 9-1.0: SCOPE

Chapter 9-1 includes provisions that apply to alloy steel chain slings (see Fig. 9-1.0-1).

## SECTION 9-1.1: TRAINING

Alloy steel chain sling users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

## SECTION 9-1.2: MATERIALS AND COMPONENTS

### 9-1.2.1 Alloy Chain

The alloy steel chain shall be manufactured and tested in accordance with ASTM A 391/A 391M for Grade 80 chain and ASTM A 973/A 973M for Grade 100 chain.

### 9-1.2.2 Components

*(a)* Components for alloy steel chain slings shall be manufactured and tested in accordance with ASTM A 952/A 952M.

*(b)* Makeshift fasteners, hooks, or links formed from bolts, rods, or other such components shall not be used.

*(c)* Where used, handles shall be welded to the master link or hook prior to heat treating according to the recommendations of the sling manufacturer or a qualified person.

*(d)* Hooks, when employed, shall meet the requirements of ASME B30.10.

*(e)* Rigging hardware, when employed, shall meet the requirements of ASME B30.26.

### 9-1.2.3 Other Materials and Components

Chain or components other than those listed in paras. 9-1.2.1 and 9-1.2.2 may be employed. When such materials are employed, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-1.3: FABRICATION AND CONFIGURATIONS

### 9-1.3.1 Fabrication

*(a)* Grade 80 and Grade 100 alloy steel chain slings shall be fabricated in accordance with ASTM A 906/A 906M.

*(b)* Mechanical coupling links shall not be used within the body of an alloy chain sling to connect two pieces of chain.

### 9-1.3.2 Configurations

*(a)* Single-leg slings and two-leg, three-leg, and four-leg bridle slings used in vertical, choker, and basket hitches are covered in this Chapter.

*(b)* Single- and double-basket slings used in basket hitches are covered in this Chapter.

*(c)* Other configurations may be used. When used, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-1.4: DESIGN FACTOR

The design factor for alloy steel chain slings shall be a minimum of 4.

## SECTION 9-1.5: RATED LOADS

The term *working load limit* is commonly used to describe rated load.

### 9-1.5.1 (10)

These rated loads are based on the following factors:

*(a)* material strength(s)

*(b)* design factor

*(c)* type of hitch (see Fig. 9-1.0-1)

*(d)* angle of loading (see Fig. 9-1.0-1)

NOTE: Rated loads for basket hitches and bridle slings are based on symmetrical loading. See para. 9-1.10.1(d) for nonsymmetrical loading.

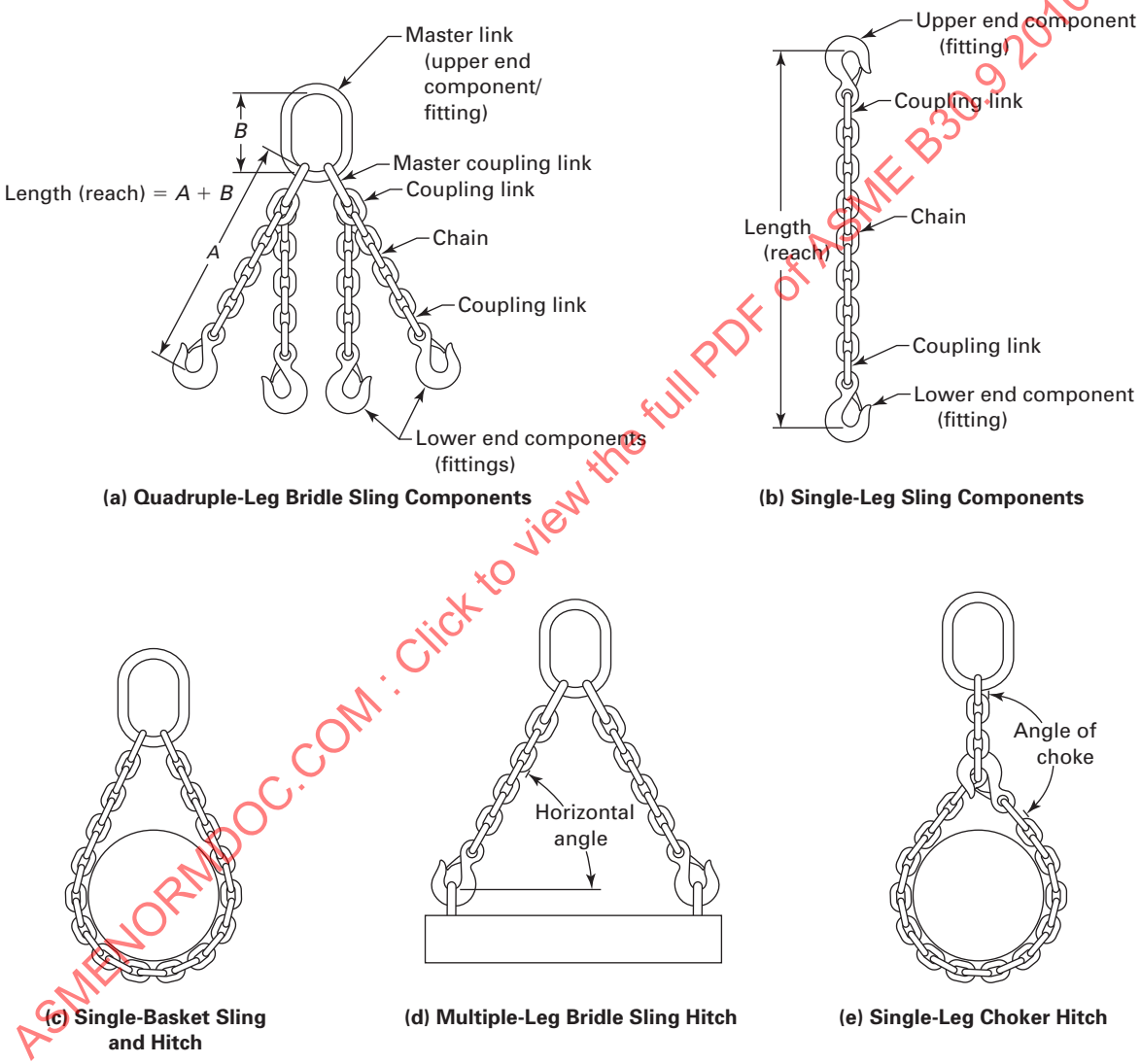
### 9-1.5.2

Tables 9-1.5.2-1 and 9-1.5.2-2 show rated loads for single-leg vertical, basket hitches, and bridle slings for specific grades of chain. For angles other than those shown in these tables, use the rated load for the next lower angle, or a qualified person shall calculate the rated load.

### 9-1.5.3 (10)

Horizontal sling angles less than 30 deg shall not be used except as recommended by the sling manufacturer or a qualified person (see Fig. 9-1.0-1).

**Fig. 9-1.0-1 Alloy Steel Chain Slings: Configurations, Components, and Hitches**




(a) Quadruple-Leg Bridle Sling Components

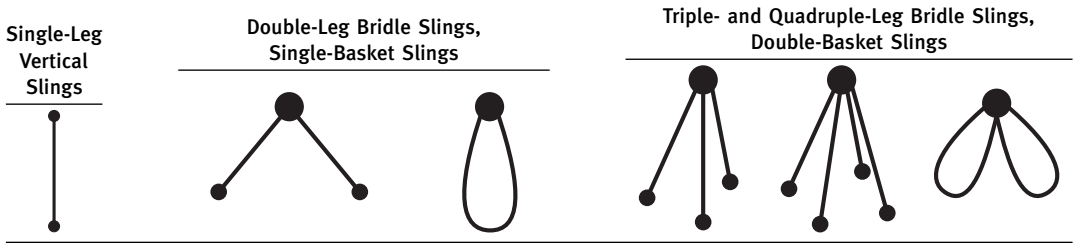
(b) Single-Leg Sling Components

(c) Single-Basket Sling and Hitch

(d) Multiple-Leg Bridle Sling Hitch

(e) Single-Leg Choker Hitch

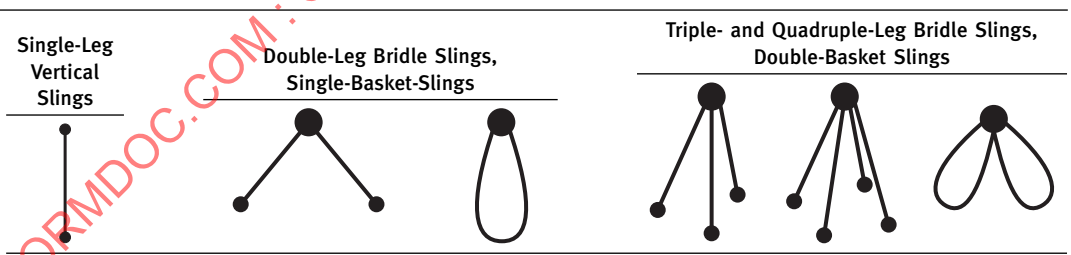
## Table 9-1.5.2-1 Rated Load for Grade 80 Alloy Steel Chain Slings — Vertical, Basket, and Bridle Hitches




| Nominal Chain Size | | Horizontal Angle, deg [Note (1)] | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 90 | 60 | 45 | 30 | 60 | 45 | 30 |
| in. | mm | lb | lb | lb | lb | lb | lb | lb |
| 7/32 | 5.5 | 2,100 | 3,600 | 3,000 | 2,100 | 5,500 | 4,400 | 3,200 |
| 9/32 | 7 | 3,500 | 6,100 | 4,900 | 3,500 | 9,100 | 7,400 | 5,200 |
| 5/16 | 8 | 4,500 | 7,800 | 6,400 | 4,500 | 11,700 | 9,500 | 6,800 |
| 3/8 | 10 | 7,100 | 12,300 | 10,000 | 7,100 | 18,400 | 15,100 | 10,600 |
| 1/2 | 13 | 12,000 | 20,800 | 17,000 | 12,000 | 31,200 | 25,500 | 18,000 |
| 5/8 | 16 | 18,100 | 31,300 | 25,600 | 18,100 | 47,000 | 38,400 | 27,100 |
| 3/4 | 20 | 28,300 | 49,000 | 40,000 | 28,300 | 73,500 | 60,000 | 42,400 |
| 7/8 | 22 | 34,200 | 59,200 | 48,400 | 34,200 | 88,900 | 72,500 | 51,300 |
| 1 | 26 | 47,700 | 82,600 | 67,400 | 47,700 | 123,900 | 101,200 | 71,500 |
| 1 1/4 | 32 | 72,300 | 125,200 | 102,200 | 72,300 | 187,800 | 153,400 | 108,400 |

NOTE:
(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane of the load [see Fig. 9-1.0-1, illustration (d)].

## Table 9-1.5.2-2 Rated Load for Grade 100 Alloy Steel Chain Slings — Vertical, Basket, and Bridle Hitches




| Nominal Chain Size | | Horizontal Angle, deg [Note (1)] | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 90 | 60 | 45 | 30 | 60 | 45 | 30 |
| in. | mm | lb | lb | lb | lb | lb | lb | lb |
| 7/32 | 5.5 | 2,700 | 4,700 | 3,800 | 2,700 | 7,000 | 5,700 | 4,000 |
| 9/32 | 7 | 4,300 | 7,400 | 6,100 | 4,300 | 11,200 | 9,100 | 6,400 |
| 5/16 | 8 | 5,700 | 9,900 | 8,100 | 5,700 | 14,800 | 12,100 | 8,500 |
| 3/8 | 10 | 8,800 | 15,200 | 12,400 | 8,800 | 22,900 | 18,700 | 13,200 |
| 1/2 | 13 | 15,000 | 26,000 | 21,200 | 15,000 | 39,000 | 31,800 | 22,500 |
| 5/8 | 16 | 22,600 | 39,100 | 32,000 | 22,600 | 58,700 | 47,900 | 33,900 |
| 3/4 | 20 | 35,300 | 61,100 | 49,900 | 35,300 | 91,700 | 74,900 | 53,000 |
| 7/8 | 22 | 42,700 | 74,000 | 60,400 | 42,700 | 110,900 | 90,600 | 64,000 |

NOTE:
(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane of the load [see Fig. 9-1.0-1, illustration (d)].

(10) **9-1.5.4**

Tables 9-1.5.4-1 and 9-1.5.4-2 show rated loads for choker hitches for specific grades of chain, provided that the angle of choke is 120 deg or greater [see Fig. 9-1.0-1, illustration (e)].For angles other than those shown in these tables, use the rated load for the next lower angle, or a qualified person shall calculate the rated load.

**9-1.5.5**

Rated loads for angles of choke less than 120 deg shall be determined by the sling manufacturer, or a qualified person.

**9-1.5.6**

Other materials and configurations not covered by this Chapter shall be rated in accordance with the recommendation of the sling manufacturer or a qualified person, and shall conform to all other provisions of this Chapter.

**9-1.5.7**

When components of the sling have a lower rated load than the alloy chain with which it is being used, the sling shall be identified with a rated load consistent with the lowest load rating of any of the components.

## SECTION 9-1.6: PROOF TEST REQUIREMENTS

### 9-1.6.1 General

Prior to initial use, all new and repaired chain and components of an alloy steel chain sling, either individually or as an assembly, shall be proof tested by the sling manufacturer or a qualified person.

### 9-1.6.2 Proof Load Requirements

*(a)* For single- or multiple-leg slings, each leg shall be proof loaded to a minimum of 2 times the single leg vertical hitch rated load.

*(b)* The proof load for components attached to single legs shall be a minimum of 2 times the single-leg vertical hitch rated load.

*(c)* Master links for double-leg bridle slings, single-basket slings, and master coupling links connected to two legs shall be proof loaded to a minimum of 4 times the single-leg vertical hitch rated load.

*(d)* Master links for triple- and quadruple-leg bridle slings and double basket bridle slings shall be proof loaded to a minimum of 6 times the single leg vertical hitch rated load.

## SECTION 9-1.7: SLING IDENTIFICATION

### (10) 9-1.7.1 Identification Requirements

Each sling shall be marked to show

*(a)* name or trademark of manufacturer

*(b)* grade

*(c)* nominal chain size

*(d)* number of legs

*(e)* rated loads for at least one hitch type and the angle upon which it is based

*(f)* length (reach)

*(g)* individual sling identification (e.g., serial numbers)

### 9-1.7.2 Initial Sling Identification

Sling identification shall be done by the sling manufacturer.

### 9-1.7.3 Maintenance of Sling Identification

Sling identification should be maintained by the user so as to be legible during the life of the sling.

### 9-1.7.4 Replacement of Sling Identification

Replacement of the sling identification shall be considered a repair as specified in paras. 9-1.9.5(a) and (b). Additional proof testing is not required.

## SECTION 9-1.8: EFFECTS OF ENVIRONMENT

### 9-1.8.1 Temperature

Extreme temperatures will reduce the performance of alloy steel chain slings. The sling manufacturer should be consulted when the slings are to be used in temperatures of −40°F (−40°C) or below. Guidance for rated load reductions for Grade 80 and Grade 100 alloy chain slings used at or after exposure to temperatures above 400°F (205°C) is given in Table 9-1.8.1-1.

### 9-1.8.2 Chemically Active Environments

The strength of alloy steel chain slings can be degraded by chemically active environments. This includes exposure to chemicals in the form of solids, liquids, gases, vapors, or fumes. The sling manufacturer or qualified person should be consulted before slings are used in chemically active environments.

## SECTION 9-1.9: INSPECTION, REMOVAL, AND REPAIR

### 9-1.9.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired slings shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter.

### 9-1.9.2 Frequent Inspection

*(a)* A visual inspection for damage shall be performed by the user or other designated person each day or shift the sling is used.

## Table 9-1.5.4-1 Rated Load for Grade 80 Alloy Steel Chain Slings — Choker Hitches

| Nominal Chain Size | | Single-Leg Vertical Slings | Double-Leg Bridle Slings | | | Triple- and Quadruple-Leg Bridle Slings | | |
|---|---|---|---|---|---|---|---|---|
| | | Horizontal Angle, deg [Note (1)] | | | | | | |
| | | 90 | 60 | 45 | 30 | 60 | 45 | 30 |
| in. | mm | lb | lb | lb | lb | lb | lb | lb |
| 7/32 | 5.5 | 1,700 | 2,900 | 2,400 | 1,700 | 4,400 | 3,500 | 2,600 |
| 9/32 | 7 | 2,800 | 5,000 | 3,900 | 2,800 | 7,300 | 5,900 | 4,200 |
| 5/16 | 8 | 3,600 | 6,200 | 5,100 | 3,600 | 9,300 | 7,600 | 5,400 |
| 3/8 | 10 | 5,700 | 9,800 | 8,000 | 5,700 | 14,700 | 12,100 | 8,500 |
| 1/2 | 13 | 9,600 | 16,600 | 13,600 | 9,600 | 25,000 | 20,400 | 14,400 |
| 5/8 | 16 | 14,500 | 25,000 | 20,500 | 14,500 | 37,600 | 30,700 | 21,700 |
| 3/4 | 20 | 22,600 | 39,200 | 32,000 | 22,600 | 58,800 | 48,000 | 33,900 |
| 7/8 | 22 | 27,400 | 47,400 | 38,700 | 27,400 | 71,100 | 58,000 | 41,000 |
| 1 | 26 | 38,200 | 66,100 | 53,900 | 38,200 | 99,100 | 81,000 | 57,200 |
| 1 1/4 | 32 | 57,800 | 100,200 | 81,800 | 57,800 | 150,200 | 122,700 | 86,700 |

GENERAL NOTE: Rated loads are for angles of choke greater than 120 deg [see Fig. 9-1.0-1, illustration (e) and para. 9-1.5.5].

NOTE:

(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane of the load [see Fig. 9-1.0-1, illustration (d)].

## Table 9-1.5.4-2 Rated Load for Grade 100 Alloy Steel Chain Slings — Choker Hitches

| Nominal Chain Size | | Single-Leg Vertical Slings | Double-Leg Bridle Slings | | | Triple- and Quadruple-Leg Bridle Slings | | |
|---|---|---|---|---|---|---|---|---|
| | | Horizontal Angle, deg [Note (1)] | | | | | | |
| | | 90 | 60 | 45 | 30 | 60 | 45 | 30 |
| in. | mm | lb | lb | lb | lb | lb | lb | lb |
| 7/32 | 5.5 | 2,100 | 3,600 | 3,000 | 2,100 | 5,500 | 4,400 | 3,200 |
| 9/32 | 7 | 3,500 | 6,100 | 4,900 | 3,500 | 9,100 | 7,400 | 5,200 |
| 5/16 | 8 | 4,500 | 7,800 | 6,400 | 4,500 | 11,700 | 9,500 | 6,800 |
| 3/8 | 10 | 7,100 | 12,300 | 10,000 | 7,100 | 18,400 | 15,100 | 10,600 |
| 1/2 | 13 | 12,000 | 20,800 | 17,000 | 12,000 | 31,200 | 25,500 | 18,000 |
| 5/8 | 16 | 18,100 | 31,300 | 25,600 | 18,100 | 47,000 | 38,400 | 27,100 |
| 3/4 | 20 | 28,300 | 49,000 | 40,000 | 28,300 | 73,500 | 60,000 | 42,400 |
| 7/8 | 22 | 34,200 | 59,200 | 48,400 | 34,200 | 88,900 | 72,500 | 51,300 |

GENERAL NOTE: Rated loads are for angles of choke greater than 120 deg [see Fig. 9-1.0-1, illustration (e) and para. 9-1.5.5].

NOTE:

(1) The horizontal angle is the angle formed between the inclined leg and the horizontal plane of the load [see Fig. 9-1.0-1, illustration (d)].

**Table 9-1.8.1-1 Effect of Elevated Temperature on Rated Load of Alloy Steel Chain**

| Temperature | | Grade of Chain | | | |
|---|---|---|---|---|---|
| | | Grade 80 | | Grade 100 | |
| °F | °C | Temporary Reduction of Rated Load While at Temperature | Permanent Reduction of Rated Load After Exposure to Temperature | Temporary Reduction of Rated Load While at Temperature | Permanent Reduction of Rated Load After Exposure to Temperature |
| Below 400 | Below 204 | None | None | None | None |
| 400 | 204 | 10% | None | 15% | None |
| 500 | 260 | 15% | None | 25% | 5% |
| 600 | 316 | 20% | 5% | 30% | 15% |
| 700 | 371 | 30% | 10% | 40% | 20% |
| 800 | 427 | 40% | 15% | 50% | 25% |
| 900 | 482 | 50% | 20% | 60% | 30% |
| 1000 | 538 | 60% | 25% | 70% | 35% |
| Over 1000 | Over 538 | Note (1) | Note (1) | Note (1) | Note (1) |

NOTE:
(1) Remove from service.

*(b)* Conditions such as those listed in para. 9-1.9.4 or any other condition that may result in a hazard shall cause the sling to be removed from service. Slings shall not be returned to service until approved by a qualified person.

*(c)* Written records are not required for frequent inspections.

### 9-1.9.3 Periodic Inspection

*(a)* A complete inspection for damage of the sling shall be periodically performed by a designated person. Each link and component shall be examined individually, taking care to expose and examine all surfaces including the inner link surfaces. The sling shall be examined for conditions such as those listed in para. 9-1.9.4 and a determination made as to whether they constitute a hazard.

*(b) Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed 1 yr. The frequency of periodic inspections should be based on

*(1)* frequency of sling use

*(2)* severity of service conditions

*(3)* nature of lifts being made

*(4)* experience gained on the service life of slings used in similar circumstances

*(c)* Guidelines for the time intervals are

*(1)* normal service — yearly

*(2)* severe service — monthly to quarterly

*(3)* special service — as recommended by a qualified person

*(d)* A written record of the most recent periodic inspection shall be maintained and shall include the condition of the sling.

### 9-1.9.4 Removal Criteria

An alloy steel chain sling shall be removed from service if conditions such as the following are present:

*(a)* missing or illegible sling identification (see Section 9-1.7).

*(b)* cracks or breaks.

*(c)* excessive wear, nicks, or gouges. Minimum thickness on chain links shall not be below the values listed in Table 9-1.9.4-1.

*(d)* stretched chain links or components.

*(e)* bent, twisted, or deformed chain links or components.

*(f)* evidence of heat damage.

*(g)* excessive pitting or corrosion.

*(h)* lack of ability of chain or components to hinge (articulate) freely.

*(i)* weld splatter.

*(j)* for hooks, removal criteria as stated in ASME B30.10.

*(k)* for rigging hardware, removal criteria as stated in ASME B30.26.

*(l)* other conditions, including visible damage, that cause doubt as to the continued use of the sling.

### 9-1.9.5 Repair (10)

*(a)* Slings shall be repaired only by the sling manufacturer or a qualified person.

*(b)* A repaired sling shall be marked to identify the repairing agency per Section 9-1.7.

*(c)* Chain and components used for sling repair shall comply with the provisions of this Chapter.

**Table 9-1.9.4-1 Minimum Allowable Thickness at Any Point on a Link**

| Nominal Chain or Coupling Link Size | | Minimum Allowable Thickness at Any Point on the Link | |
|---|---|---|---|
| in. | mm | in. | mm |
| 7/32 | 5.5 | 0.189 | 4.80 |
| 9/32 | 7 | 0.239 | 6.07 |
| 5/16 | 8 | 0.273 | 6.93 |
| 3/8 | 10 | 0.342 | 8.69 |
| 1/2 | 13 | 0.443 | 11.26 |
| 5/8 | 16 | 0.546 | 13.87 |
| 3/4 | 20 | 0.687 | 17.45 |
| 7/8 | 22 | 0.750 | 19.05 |
| 1 | 26 | 0.887 | 22.53 |
| 1 1/4 | 32 | 1.091 | 27.71 |

*(d)* Repair of hooks (ASME B30.10), rigging hardware (ASME B30.26), below-the-hook lifting devices (ASME B30.20), or other special devices shall comply with the repair instructions in the applicable volumes.

*(e)* Cracked, broken, or bent chain links or components other than hooks shall not be repaired; they shall be replaced.

*(f)* Mechanical coupling links shall not be used within the body of an alloy chain sling to connect two pieces of chain.

*(g)* Modifications or alterations to the sling or components shall be considered as repairs and shall conform to all other provisions of this Chapter.

*(h)* All repairs shall comply with the proof test requirements of Section 9-1.6.

## SECTION 9-1.10: OPERATING PRACTICES

### 9-1.10.1 Sling Selection

*(a)* Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-1.9.

*(b)* Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with the requirements of Sections 9-1.5 and 9-1.8.

*(c)* The rated load of the sling shall not be exceeded.

*(d)* For multiple-leg slings used with nonsymmetrical loads, an analysis by a qualified person should be performed to prevent overloading of any leg.

*(e)* Multiple-leg slings shall be selected according to Table 9-1.5.2-1 or 9-1.5.2-2 when used at the specific angles given in the tables. Operation at other angles shall be limited to rated load of the next lower angle given in the tables or calculated by a qualified person.

*(f)* The component shall be of the proper shape and size to ensure that it is properly seated in the hook or lifting device.

### 9-1.10.2 Cautions to Personnel

*(a)* All portions of the human body shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook.

*(b)* Personnel should never stand in line with or next to the leg(s) of a sling that is under tension.

*(c)* Personnel shall not stand or pass under a suspended load.

*(d)* Personnel shall not ride the sling.

### 9-1.10.3 Effects of Environment

*(a)* Slings should be stored in an area where they will not be subjected to mechanical damage, corrosive action, moisture, extreme temperatures, or kinking (see Section 9-1.8).

*(b)* When used at or in contact with extreme temperatures, the guidance provided in Section 9-1.8 shall be followed.

### 9-1.10.4 Rigging Practices

*(a)* Slings shall be shortened or adjusted only by methods approved by the sling manufacturer or a qualified person.

*(b)* Slings shall not be shortened or lengthened by knotting or twisting.

*(c)* The sling shall be hitched in a manner providing control of the load.

*(d)* Slings in contact with edges, corners, or protrusions should be protected with a material of sufficient strength, thickness, and construction to prevent damage to the sling.

*(e)* Shock loading should be avoided.

*(f)* Loads should not be rested on the sling.

*(g)* Slings should not be pulled from under a load when the load is resting on the sling.

*(h)* Twisting and kinking shall be avoided.

*(i)* During lifting, with or without load, personnel shall be alert for possible snagging.

*(j)* When using multiple basket or choker hitches, the load should be rigged to prevent the sling from slipping or sliding along the load.

*(k)* When using a basket hitch, the legs of the sling should contain or support the load from the sides, above the center of gravity, so that the load remains under control.

*(l)* Slings should not be dragged on the floor or over an abrasive surface.

*(m)* In a choker hitch, the choke point should only be on the sling body, never on a fitting.

*(n)* In a choker hitch, an angle of choke less than 120 deg should not be used without reducing the rated load (see para. 9-1.5.5).

*(o)* Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.

*(p)* The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook, unless the hook is designed for point loading.

# Chapter 9-2
# Wire Rope Slings: Selection, Use, and Maintenance

## SECTION 9-2.0: SCOPE

Chapter 9-2 includes provisions that apply to wire rope slings. (See Fig. 9-2.0-1.)

## SECTION 9-2.1: TRAINING

Wire rope sling users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered in this Chapter.

## SECTION 9-2.2: MATERIALS AND COMPONENTS

### 9-2.2.1 Wire Rope Material

The wire rope shall be manufactured and tested in accordance with ASTM A 1023/A 1023M and ASTM A 586.

*(a)* Only new or unused wire rope shall be used for fabricating slings covered in this Chapter.

*(b)* Only regular-lay wire rope shall be used for fabricating slings covered in this Chapter.

*(c)* Rotation-resistant wire rope shall not be used for fabricating slings covered in this Chapter.

### 9-2.2.2 Components

*(a)* Components such as sleeves and sockets shall be used in accordance with the component manufacturer's recommendations.

*(b)* Hooks, when employed, shall meet the requirements of ASME B30.10.

*(c)* Welding of handles or any other accessories to end attachments, except covers to thimbles, shall be performed prior to the assembly of the sling.

*(d)* Rigging hardware, when employed, shall meet the requirements of ASME B30.26.

### 9-2.2.3 Other Materials and Components

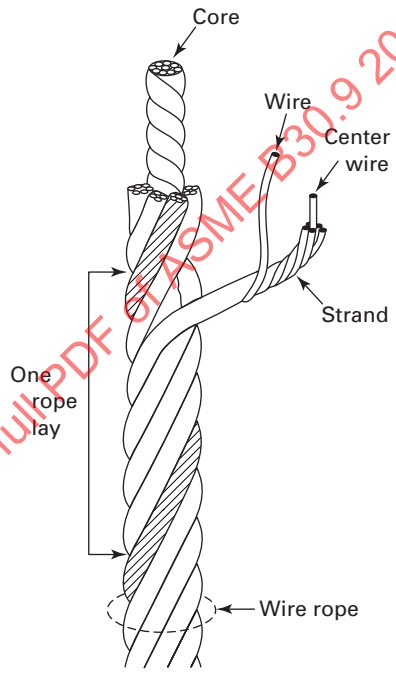
Wire ropes and components, other than those listed in paras. 9-2.2.1 and 9-2.2.2, may be employed. When such materials are employed, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-2.3: FABRICATION AND CONFIGURATIONS

(10) ### 9-2.3.1 Fabrication

Methods of fabrication include hand-tucked splicing, turnback eye (return loop), or flemish eye mechanical splicing, and poured or swaged socketing.

**Fig. 9-2.0-1 Wire Rope**




*(a)* Wire rope clips shall not be used to fabricate wire rope slings except where the application of slings prevents the use of prefabricated slings and where the specific application is designed by a qualified person.

*(1)* Wire rope clips, if employed, shall be installed and maintained in accordance with the recommendations of the clip manufacturer or a qualified person, or in accordane with the provisions of ASME B30.26.

*(2)* Malleable cast iron clips shall not be used to fabricate slings.

*(b)* Knots shall not be used to fabricate slings.

*(c)* The diameter and width of the bearing surface of the fitting can affect the strength of the sling. The sling manufacturer's recommendation should be followed when fittings are used with the sling.

*(d)* Other fabrication methods not covered by this Chapter shall be rated in accordance with the recommendation of the sling manufacturer or a qualified person, and shall conform to all other provisions of this Chapter.

**Fig. 9-2.3.2-1 Minimum Sling Length**

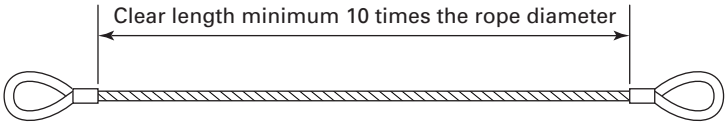
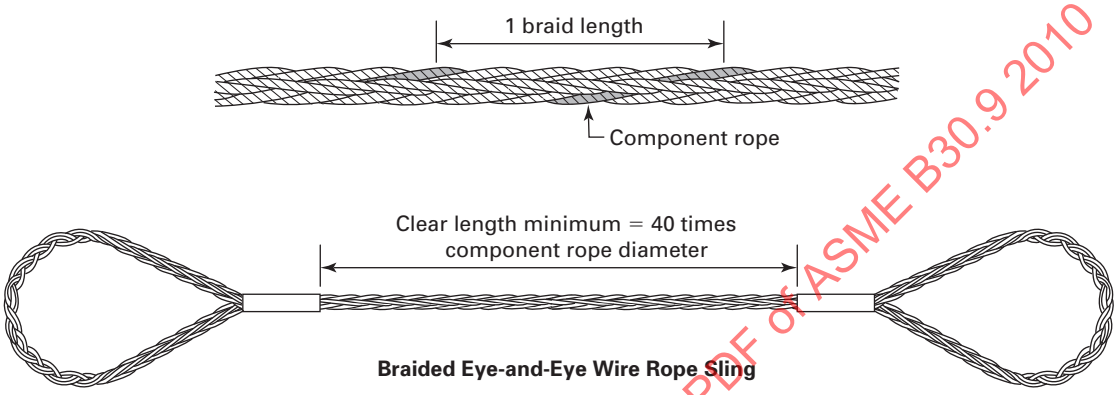



**Fig. 9-2.3.2-2 Minimum Braided Sling Length**




### 9-2.3.2 Configurations

*(a)* Single-leg slings and two-leg, three-leg, and four-leg bridle slings used in vertical, choker, and basket hitches are covered by this Chapter.

*(b)* Slings made of rope with 6 × 19 and 6 × 36 classification and cable laid slings shall have a minimum clear length of rope 10 times the rope diameter between splices, sleeves, or end fittings (see Fig. 9-2.3.2-1), unless approved by a qualified person.

*(c)* Braided slings shall have a minimum clear length of rope 40 times the component rope diameter between the loops or end fittings (see Fig. 9-2.3.2-2), unless approved by a qualified person.

*(d)* Grommets and endless slings shall have a minimum circumferential length of 96 times the body diameter of the grommet or endless sling unless approved by a qualified person.

*(e)* Other configurations may be used. When used, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-2.4: DESIGN FACTOR

The design factor for wire rope slings shall be a minimum of 5.

## SECTION 9-2.5: RATED LOAD

The term *rated capacity* is commonly used to describe rated load.

### 9-2.5.1 (10)

These rated loads are based on the following factors:

*(a)* material strength(s)

*(b)* design factor

*(c)* type of hitch

*(d)* angle of loading (see Fig. 9-2.5.1-1)

*(e)* diameter of curvature over which the sling is used ($D/d$) (see Fig. 9-2.5.1-2)

*(f)* fabrication efficiency

NOTE: Rated loads for basket hitches and bridle slings are based on symmetrical loading. See para. 9-2.10.1(d) for nonsymmetrical loading.

### 9-2.5.2

Tables 9-2.5.2-1 through 9-2.5.2-9 show rated loads for single leg vertical, choker, and basket hitches, and two-leg, three-leg, and four-leg bridle slings for specific grades of wire rope. For angles other than those shown in these tables, use the rated load for the next lower angle, or a qualified person shall calculate the rated load.

### 9-2.5.3 (10)

Horizontal sling angles less than 30 deg shall not be used except as recommended by the sling manufacturer or a qualified person (see Fig. 9-2.5.1-1).

### 9-2.5.4 (10)

Tables 9-2.5.2-1, 9-2.5.2-3, 9-2.5.2-5, 9-2.5.2-7, 9-2.5.2-8, and 9-2.5.2-9 show rated loads for choker hitches for specific grades of wire rope, provided that the angle of choke is 120 deg or greater (see Fig. 9-2.5.4-1). For angles

**Fig. 9-2.5.1-1 Angle of Loading**

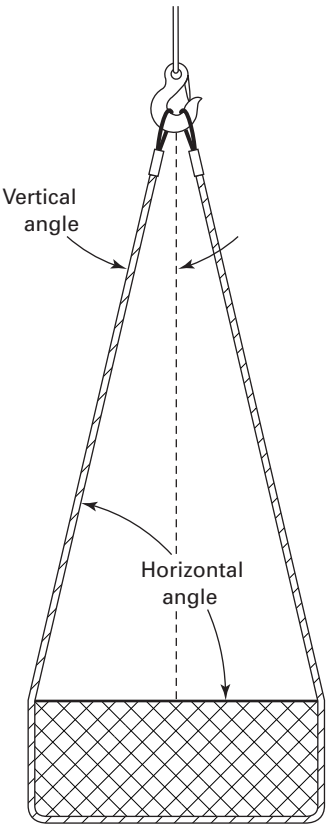
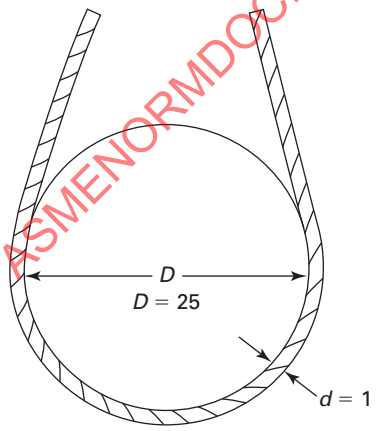



**Fig. 9-2.5.1-2 *D/d* Ratio**




GENERAL NOTE: When $D$ is 25 times the component rope diameter ($d$) the $D/d$ ratio is expressed as 25/1.

other than those shown in these tables, use the rated load for the next lower angle, or a qualified person shall calculate the rated load.

### 9-2.5.5

Rated loads for angles of choke less than 120 deg shall be determined by using the values in Fig. 9-2.5.4-1, the sling manufacturer, or a qualified person.

### 9-2.5.6

Other materials and configurations not covered by this Chapter shall be rated in accordance with the recommendation of the sling manufacturer or a qualified person and shall conform to all other provisions of this Chapter.

### 9-2.5.7

When components of the sling have a lower rated load than the wire rope with which it is being used, the sling shall be identified with a rated load consistent with the lowest load rating of any of the components.

## SECTION 9-2.6: PROOF TEST REQUIREMENTS

### 9-2.6.1 General (10)

*(a)* Prior to initial use, all new swaged sockets, poured sockets, turnback eyes, and mechanical joint endless wire rope slings shall be proof tested by the sling manufacturer or a qualified person.

*(b)* Prior to initial use, all wire rope slings incorporating previously used or welded fittings and all repaired slings shall be proof tested by the sling manufacturer or a qualified person.

*(c)* All other new wire rope slings are not required to be proof tested unless specified by the purchaser.

### 9-2.6.2 Proof Load Requirements

*(a)* For single- or multiple-leg slings and endless slings, each leg shall be proof loaded to the following load requirements based on fabrication method. In no case shall the proof load exceed 50% of the component ropes' or structural strands' minimum breaking strength.

*(1) Mechanical Splice Slings.* The proof load shall be a minimum of 2 times the single-leg vertical hitch rated load.

*(2) Swaged Socket and Poured Socket Slings.* The proof load shall be a minimum of 2 times and a maximum of 2.5 times the single-leg vertical hitch rated load.

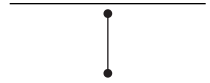
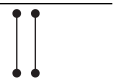
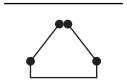
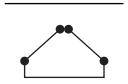
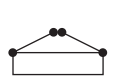
NOTE: The proof load should be that specified by the wire rope or fitting manufacturer's recommendation provided that it is within the above-specified proof load range.

*(3) Hand-Tucked Slings.* If proof tested, the proof load shall be a minimum of 1 time and a maximum of 1.25 times the single-leg vertical hitch rated load.

(10)

## Table 9-2.5.2-1 Rated Load for Single- and Two-Leg Slings 6×19 or 6×36 Classification Extra Improved Plow Steel (EIPS) Grade Fiber Core (FC) Wire Rope

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| | Single-Leg | | | | | | | Two-Leg Bridle or Basket | | | | | | | | | Choker | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Horizontal Angle | | | | | | | | | Horizontal Angle | |
| | Vertical | | | Choker | Vertical Basket | | | Vertical | | | 60 deg | | 45 deg | | 30 deg | | 60 deg | 30 deg |
| |  | | |  |  | | |  | | |  | |  | |  | |  |  |
| Hitch Type | | | | | | | | | | | | | | | | | | |
| Rope Diameter, in. | HT | MS | S | HT&MS | HT | MS | S | HT | MS | S | HT | MS | HT | MS | HT | MS | HT&MS | HT&MS |
| 1/4 | 0.54 | 0.56 | 0.60 | 0.42 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 1.1 | 0.94 | 0.97 | 0.77 | 0.79 | 0.54 | 0.56 | 0.73 | 0.42 |
| 5/16 | 0.83 | 0.87 | 0.94 | 0.66 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.4 | 1.5 | 1.2 | 1.2 | 0.83 | 0.87 | 1.1 | 0.66 |
| 3/8 | 1.2 | 1.2 | 1.3 | 0.94 | 2.4 | 2.5 | 2.5 | 2.4 | 2.5 | 2.5 | 2.0 | 2.2 | 1.7 | 1.8 | 1.2 | 1.2 | 1.6 | 0.94 |
| 7/16 | 1.6 | 1.7 | 1.8 | 1.3 | 3.2 | 3.4 | 3.4 | 3.2 | 3.4 | 3.4 | 2.7 | 2.9 | 2.2 | 2.4 | 1.6 | 1.7 | 2.2 | 1.3 |
| 1/2 | 2.0 | 2.2 | 2.4 | 1.6 | 4.0 | 4.4 | 4.4 | 4.0 | 4.5 | 4.4 | 3.5 | 3.8 | 2.9 | 3.1 | 2.0 | 2.2 | 2.9 | 1.6 |
| 9/16 | 2.5 | 2.7 | 3.0 | 2.1 | 5.0 | 5.5 | 5.5 | 5.0 | 5.5 | 5.5 | 4.4 | 4.8 | 3.6 | 3.9 | 2.5 | 2.7 | 3.6 | 2.1 |
| 5/8 | 3.1 | 3.4 | 3.7 | 2.6 | 6.2 | 6.8 | 6.8 | 6.2 | 6.8 | 6.8 | 5.3 | 5.9 | 4.4 | 4.8 | 3.1 | 3.4 | 4.5 | 2.6 |
| 3/4 | 4.3 | 4.8 | 5.2 | 3.7 | 8.6 | 9.7 | 9.7 | 8.6 | 9.7 | 9.7 | 7.4 | 8.4 | 6.1 | 6.8 | 4.3 | 4.8 | 6.3 | 3.7 |
| 7/8 | 5.7 | 6.6 | 7.1 | 5.0 | 11 | 13 | 13 | 11 | 13 | 13 | 9.8 | 11 | 8.0 | 9.3 | 5.7 | 6.6 | 8.6 | 5.0 |
| 1 | 7.4 | 8.3 | 9.2 | 6.4 | 15 | 17 | 17 | 15 | 17 | 17 | 13 | 14 | 10 | 12 | 7.4 | 8.3 | 11 | 6.4 |
| 1 1/8 | 9.3 | 10 | 12 | 8.1 | 19 | 21 | 21 | 19 | 21 | 21 | 16 | 18 | 13 | 15 | 9.3 | 10 | 14 | 8.1 |
| 1 1/4 | 11 | 13 | 14 | 9.9 | 23 | 26 | 26 | 23 | 26 | 26 | 20 | 22 | 16 | 18 | 11 | 13 | 17 | 9.9 |

GENERAL NOTES:

(a) HT = hand-tucked splice.

(b) MS = mechanical splice.

(c) S = swaged or poured socket.

(d) Rated loads for HT based on minimum $D/d$ ratio of 15/1; rated loads for MS and S based on $D/d$ ratio of 25/1

(e) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

(f) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-2.5.4).

(10)

## Table 9-2.5.2-2 Rated Load for Three- and Four-Leg Slings 6×19 or 6×36 Classification Extra Improved Plow Steel (EIPS) Grade Fiber Core (FC) Wire Rope

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| | Three-Leg | | | | | | | | Four-Leg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Horizontal Angle | | | | | | | | Horizontal Angle | | | | | | | |
| | Vertical | | 60 deg | | 45 deg | | 30 deg | | Vertical | | 60 deg | | 45 deg | | 30 deg | |
| Hitch Type / Rope Diameter, in. | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS |
| 1/4 | 1.6 | 1.7 | 1.4 | 1.4 | 1.2 | 1.2 | 0.81 | 0.84 | 2.2 | 2.2 | 1.9 | 1.9 | 1.5 | 1.6 | 1.1 | 1.1 |
| 5/16 | 2.5 | 2.6 | 2.2 | 2.3 | 1.8 | 1.8 | 1.3 | 1.3 | 3.3 | 3.5 | 2.9 | 3.0 | 2.4 | 2.5 | 1.7 | 1.7 |
| 3/8 | 3.5 | 3.7 | 3.1 | 3.2 | 2.5 | 2.6 | 1.8 | 1.9 | 4.7 | 5.0 | 4.1 | 4.3 | 3.3 | 3.5 | 2.4 | 2.5 |
| 7/16 | 4.7 | 5.0 | 4.1 | 4.4 | 3.4 | 3.6 | 2.4 | 2.5 | 6.3 | 6.7 | 5.5 | 5.8 | 4.5 | 4.8 | 3.2 | 3.4 |
| 1/2 | 6.1 | 6.5 | 5.3 | 5.7 | 4.3 | 4.6 | 3.0 | 3.3 | 8.1 | 8.7 | 7.0 | 7.5 | 5.7 | 6.2 | 4.0 | 4.4 |
| 9/16 | 7.6 | 8.2 | 6.6 | 7.1 | 5.4 | 5.8 | 3.8 | 4.1 | 10 | 11 | 8.7 | 9.5 | 7.1 | 7.8 | 5.0 | 5.5 |
| 5/8 | 9.3 | 10 | 8.0 | 8.8 | 6.5 | 7.2 | 4.6 | 5.1 | 12 | 14 | 11 | 12 | 8.7 | 9.6 | 6.2 | 6.8 |
| 3/4 | 13 | 15 | 11 | 13 | 9.1 | 10 | 6.4 | 7.3 | 17 | 19 | 15 | 17 | 12 | 14 | 8.6 | 9.7 |
| 7/8 | 17 | 20 | 15 | 17 | 12 | 14 | 8.5 | 9.8 | 23 | 26 | 20 | 23 | 16 | 19 | 11 | 13 |
| 1 | 22 | 25 | 19 | 22 | 16 | 18 | 11 | 12 | 29 | 33 | 25 | 29 | 21 | 23 | 15 | 17 |
| 1 1/8 | 28 | 31 | 24 | 27 | 20 | 22 | 14 | 16 | 37 | 42 | 32 | 36 | 26 | 29 | 19 | 21 |
| 1 1/4 | 34 | 38 | 30 | 33 | 24 | 27 | 17 | 19 | 45 | 51 | 39 | 44 | 32 | 36 | 23 | 26 |

GENERAL NOTES:

(a) HT = hand-tucked splice.

(b) MS = mechanical splice.

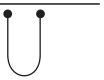
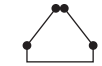
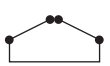
(c) Rated loads for HT based on minimum $D/d$ ratio of 15/1; rated loads for MS and S based on $D/d$ ratio of 25/1.

(d) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

(10)

## Table 9-2.5.2-3 Rated Load for Single- and Two-Leg Slings 6×19 or 6×36 Classification Extra Improved Plow Steel (EIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| | Single-Leg | | | | | | | | Two-Leg Bridle or Basket | | | | | | | | Choker | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Horizontal Angle | | | | | | | | Horizontal Angle | | | |
| | Vertical | | | Choker | | Vertical Basket | | | Vertical | | | 60 deg | | 45 deg | | 30 deg | 60 deg | | 30 deg | |
| Hitch Type |  | | |  | |  | | |  | | |  | |  | |  |  | |  | |
| Rope Diameter, in. | HT | MS | S | HT | MS | HT | MS | S | HT | MS | S | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS |
| 1/4 | 0.54 | 0.65 | 0.68 | 0.42 | 0.48 | 1.1 | 1.3 | 1.3 | 1.1 | 1.3 | 1.3 | 0.94 | 1.1 | 0.77 | 0.91 | 0.54 | 0.65 | 0.73 | 0.82 | 0.42 | 0.48 |
| 5/16 | 0.83 | 1.0 | 1.1 | 0.66 | 0.74 | 1.7 | 2.0 | 1.9 | 1.7 | 2.0 | 1.9 | 1.4 | 1.7 | 1.2 | 1.4 | 0.83 | 1.0 | 1.1 | 1.3 | 0.66 | 0.74 |
| 3/8 | 1.2 | 1.4 | 1.5 | 0.94 | 1.1 | 2.4 | 2.9 | 2.8 | 2.4 | 2.9 | 2.8 | 2.0 | 2.5 | 1.7 | 2.0 | 1.2 | 1.4 | 1.6 | 1.8 | 0.94 | 1.1 |
| 7/16 | 1.6 | 1.9 | 2.0 | 1.3 | 1.4 | 3.2 | 3.9 | 3.8 | 3.2 | 3.9 | 3.8 | 2.7 | 3.4 | 2.2 | 2.7 | 1.6 | 1.9 | 2.2 | 2.5 | 1.3 | 1.4 |
| 1/2 | 2.0 | 2.5 | 2.7 | 1.6 | 1.9 | 4.0 | 5.1 | 4.9 | 4.0 | 5.1 | 4.9 | 3.5 | 4.4 | 2.9 | 3.6 | 2.0 | 2.5 | 2.9 | 3.2 | 1.6 | 1.9 |
| 9/16 | 2.5 | 3.2 | 3.4 | 2.1 | 2.4 | 5.0 | 6.4 | 6.2 | 5.0 | 6.4 | 6.2 | 4.4 | 5.5 | 3.6 | 4.5 | 2.5 | 3.2 | 3.6 | 4.1 | 2.1 | 2.4 |
| 5/8 | 3.1 | 3.9 | 4.1 | 2.6 | 2.9 | 6.2 | 7.8 | 7.6 | 6.2 | 7.8 | 7.6 | 5.3 | 6.8 | 4.4 | 5.5 | 3.1 | 3.9 | 4.5 | 5.0 | 2.6 | 2.9 |
| 3/4 | 4.3 | 5.6 | 5.9 | 3.7 | 4.1 | 8.6 | 11 | 11 | 8.6 | 11 | 11 | 7.4 | 9.7 | 6.1 | 7.9 | 4.3 | 5.6 | 6.3 | 7.1 | 3.7 | 4.1 |
| 7/8 | 5.7 | 7.6 | 8.0 | 5.0 | 5.6 | 11 | 15 | 15 | 11 | 15 | 15 | 9.8 | 13 | 8.0 | 11 | 5.7 | 7.6 | 8.6 | 9.7 | 5.0 | 5.6 |
| 1 | 7.4 | 9.8 | 10 | 6.4 | 7.2 | 15 | 20 | 19 | 15 | 20 | 19 | 13 | 17 | 10 | 14 | 7.4 | 9.8 | 11 | 13 | 6.4 | 7.2 |
| 1 1/8 | 9.3 | 12 | 13 | 8.1 | 9.1 | 19 | 24 | 24 | 19 | 24 | 24 | 16 | 21 | 13 | 17 | 9.3 | 12 | 14 | 16 | 8.1 | 9.1 |
| 1 1/4 | 11 | 15 | 16 | 9.9 | 11 | 23 | 30 | 30 | 23 | 30 | 30 | 20 | 26 | 16 | 21 | 11 | 15 | 17 | 19 | 9.9 | 11 |
| 1 3/8 | 14 | 18 | 19 | 12 | 13 | 27 | 36 | 36 | 27 | 36 | 36 | 24 | 31 | 19 | 25 | 14 | 18 | 21 | 23 | 12 | 13 |
| 1 1/2 | 16 | 21 | 23 | 14 | 16 | 32 | 42 | 42 | 32 | 42 | 42 | 28 | 37 | 23 | 30 | 16 | 21 | 25 | 28 | 14 | 16 |
| 1 5/8 | 19 | 24 | 26 | 16 | 18 | 38 | 49 | 49 | 38 | 49 | 49 | 33 | 42 | 27 | 35 | 19 | 24 | 29 | 32 | 16 | 18 |
| 1 3/4 | 22 | 28 | 31 | 19 | 21 | 44 | 57 | 57 | 44 | 57 | 57 | 38 | 49 | 31 | 40 | 22 | 28 | 33 | 37 | 19 | 21 |
| 1 7/8 | 25 | 32 | 35 | 22 | 24 | 50 | 64 | 64 | 50 | 64 | 64 | 43 | 56 | 35 | 46 | 25 | 32 | 38 | 42 | 22 | 24 |
| 2 | 28 | 37 | 40 | 25 | 28 | 56 | 73 | 73 | 56 | 73 | 73 | 49 | 63 | 40 | 52 | 28 | 37 | 43 | 48 | 25 | 28 |

GENERAL NOTES:

(a) HT = hand-tucked splice.

(b) MS = mechanical splice.

(c) S = swaged or poured socket.

(d) Rated loads for HT based on minimum $D/d$ ratio of 15/1; rated loads for MS and S based on $D/d$ ratio of 25/1.

(e) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

(f) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-2.5.4).

(10)

## Table 9-2.5.2-4 Rated Load for Three- and Four-Leg Slings 6×19 or 6×36 Classification, Extra Improved Plow Steel (EIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| | Three-Leg | | | | | | | | Four-Leg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Horizontal Angle | | | | | | | | Horizontal Angle | | | | | | | |
| | Vertical | | 60 deg | | 45 deg | | 30 deg | | Vertical | | 60 deg | | 45 deg | | 30 deg | |
| Hitch Type / Rope Diameter, in. | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS |
| 1/4 | 1.6 | 1.9 | 1.4 | 1.7 | 1.2 | 1.4 | 0.81 | 0.97 | 2.2 | 2.6 | 1.9 | 2.2 | 1.5 | 1.8 | 1.1 | 1.3 |
| 5/16 | 2.5 | 3.0 | 2.2 | 2.6 | 1.8 | 2.1 | 1.3 | 1.5 | 3.3 | 4.0 | 2.9 | 3.5 | 2.4 | 2.8 | 1.7 | 2.0 |
| 3/8 | 3.5 | 4.3 | 3.1 | 3.7 | 2.5 | 3.0 | 1.8 | 2.2 | 4.7 | 5.7 | 4.1 | 5.0 | 3.3 | 4.1 | 2.4 | 2.9 |
| 7/16 | 4.7 | 5.8 | 4.1 | 5.0 | 3.4 | 4.1 | 2.4 | 2.9 | 6.3 | 7.8 | 5.5 | 6.7 | 4.5 | 5.5 | 3.2 | 3.9 |
| 1/2 | 6.1 | 7.6 | 5.3 | 6.6 | 4.3 | 5.4 | 3.0 | 3.8 | 8.1 | 10 | 7.0 | 8.8 | 5.7 | 7.1 | 4.0 | 5.1 |
| 9/16 | 7.6 | 9.6 | 6.6 | 8.3 | 5.4 | 6.8 | 3.8 | 4.8 | 10 | 13 | 8.7 | 11 | 7.1 | 9.0 | 5.0 | 6.4 |
| 5/8 | 9.3 | 12 | 8.0 | 10 | 6.5 | 8.3 | 4.6 | 5.9 | 12 | 16 | 11 | 14 | 8.7 | 11 | 6.2 | 7.8 |
| 3/4 | 13 | 17 | 11 | 15 | 9.1 | 12 | 6.4 | 8.4 | 17 | 22 | 15 | 19 | 12 | 16 | 8.6 | 11 |
| 7/8 | 17 | 23 | 15 | 20 | 12 | 16 | 8.5 | 11 | 23 | 30 | 20 | 26 | 16 | 21 | 11 | 15 |
| 1 | 22 | 29 | 19 | 26 | 16 | 21 | 11 | 15 | 29 | 39 | 25 | 34 | 21 | 28 | 15 | 20 |
| 1 1/8 | 28 | 36 | 24 | 31 | 20 | 26 | 14 | 18 | 37 | 48 | 32 | 42 | 26 | 34 | 19 | 24 |
| 1 1/4 | 34 | 44 | 30 | 38 | 24 | 31 | 17 | 22 | 45 | 59 | 39 | 51 | 32 | 42 | 23 | 30 |
| 1 3/8 | 41 | 53 | 36 | 46 | 29 | 38 | 21 | 27 | 55 | 71 | 47 | 62 | 39 | 50 | 27 | 36 |
| 1 1/2 | 49 | 63 | 42 | 55 | 34 | 45 | 24 | 32 | 65 | 84 | 56 | 73 | 46 | 60 | 32 | 42 |
| 1 5/8 | 56 | 73 | 49 | 63 | 40 | 52 | 28 | 37 | 75 | 98 | 65 | 85 | 53 | 69 | 38 | 49 |
| 1 3/4 | 65 | 85 | 57 | 74 | 46 | 60 | 33 | 42 | 87 | 113 | 76 | 98 | 62 | 80 | 44 | 57 |
| 1 7/8 | 74 | 97 | 64 | 84 | 53 | 68 | 37 | 48 | 99 | 129 | 86 | 112 | 70 | 91 | 50 | 64 |
| 2 | 84 | 110 | 73 | 95 | 60 | 78 | 42 | 55 | 113 | 147 | 98 | 127 | 80 | 104 | 56 | 73 |

GENERAL NOTES:

(a) HT = hand-tucked splice.

(b) MS = mechanical splice.

(c) Rated loads for HT based on minimum $D/d$ ratio of 15/1; rated loads for MS and S based on $D/d$ ratio of 25/1.

(d) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

(10)

## Table 9-2.5.2-5 Rated Load for Single- and Two-Leg Slings 6×19 or 6×36 Classification Extra Extra Improved Plow Steel (EEIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| Hitch Type | Single-Leg | | | | | | | | Two-Leg Bridle or Basket | | | | | | | | Choker | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Vertical | | | Choker | | Vertical Basket | | | Horizontal Angle | | | | | | | | Horizontal Angle | | | |
| | | | | | | | | | Vertical | | 60 deg | | 45 deg | | 30 deg | | 60 deg | | 30 deg | |
| Rope Diameter, in. | HT | MS | S | HT | MS | HT | MS | S | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS |
| 1/4 | 0.60 | 0.71 | 0.74 | 0.46 | 0.52 | 1.2 | 1.4 | 1.4 | 1.2 | 1.4 | 1.0 | 1.2 | 0.84 | 1.0 | 0.60 | 0.71 | 0.80 | 0.90 | 0.46 | 0.52 |
| 5/16 | 0.92 | 1.1 | 1.2 | 0.72 | 0.81 | 1.8 | 2.2 | 2.1 | 1.8 | 2.2 | 1.6 | 1.9 | 1.3 | 1.6 | 0.92 | 1.1 | 1.2 | 1.4 | 0.72 | 0.81 |
| 3/8 | 1.3 | 1.6 | 1.7 | 1.0 | 1.2 | 2.6 | 3.2 | 3.1 | 2.6 | 3.2 | 2.3 | 2.7 | 1.8 | 2.2 | 1.3 | 1.6 | 1.8 | 2.0 | 1.0 | 1.2 |
| 7/16 | 1.7 | 2.1 | 2.2 | 1.4 | 1.6 | 3.5 | 4.3 | 4.1 | 3.5 | 4.3 | 3.0 | 3.7 | 2.5 | 3.0 | 1.7 | 2.1 | 2.4 | 2.7 | 1.4 | 1.6 |
| 1/2 | 2.2 | 2.8 | 2.9 | 1.8 | 2.0 | 4.5 | 5.5 | 5.4 | 4.5 | 5.5 | 3.9 | 4.8 | 3.1 | 3.9 | 2.2 | 2.8 | 3.1 | 3.5 | 1.8 | 2.0 |
| 9/16 | 2.8 | 3.5 | 3.7 | 2.3 | 2.6 | 5.6 | 7.0 | 6.8 | 5.6 | 7.0 | 4.8 | 6.1 | 3.9 | 5.0 | 2.8 | 3.5 | 4.0 | 4.5 | 2.3 | 2.6 |
| 5/8 | 3.4 | 4.3 | 4.5 | 2.8 | 3.2 | 6.8 | 8.6 | 8.4 | 6.8 | 8.6 | 5.9 | 7.5 | 4.8 | 6.1 | 3.4 | 4.3 | 4.9 | 5.5 | 2.8 | 3.2 |
| 3/4 | 4.7 | 6.2 | 6.5 | 4.0 | 4.5 | 9.4 | 12 | 12 | 9.4 | 12 | 8.2 | 11 | 6.7 | 8.7 | 4.7 | 6.2 | 7.0 | 7.9 | 4.0 | 4.5 |
| 7/8 | 6.2 | 8.3 | 8.8 | 5.5 | 6.1 | 12 | 17 | 16 | 12 | 17 | 11 | 14 | 8.8 | 12 | 6.2 | 8.3 | 9.4 | 11 | 5.5 | 6.1 |
| 1 | 8.1 | 11 | 11 | 7.1 | 8.0 | 16 | 22 | 21 | 16 | 22 | 14 | 19 | 11 | 15 | 8.1 | 11 | 12 | 14 | 7.1 | 8.0 |
| 1 1/8 | 10 | ... | 14 | 8.9 | ... | 20 | ... | 26 | 20 | ... | 18 | ... | 14 | ... | 10 | ... | 15 | ... | 8.9 | ... |
| 1 1/4 | 13 | ... | 18 | 11 | ... | 25 | ... | 33 | 25 | ... | 22 | ... | 18 | ... | 13 | ... | 19 | ... | 11 | ... |
| 1 3/8 | 15 | ... | 21 | 13 | ... | 30 | ... | 39 | 30 | ... | 26 | ... | 21 | ... | 15 | ... | 23 | ... | 13 | ... |
| 1 1/2 | 18 | ... | 25 | 16 | ... | 36 | ... | 46 | 36 | ... | 31 | ... | 25 | ... | 18 | ... | 27 | ... | 16 | ... |
| 1 5/8 | 21 | ... | 29 | 18 | ... | 41 | ... | 54 | 41 | ... | 36 | ... | 29 | ... | 21 | ... | 31 | ... | 18 | ... |
| 1 3/4 | 24 | ... | 34 | 21 | ... | 48 | ... | 63 | 48 | ... | 42 | ... | 34 | ... | 24 | ... | 36 | ... | 21 | ... |
| 1 7/8 | 27 | ... | 38 | 24 | ... | 55 | ... | 71 | 55 | ... | 47 | ... | 39 | ... | 27 | ... | 41 | ... | 24 | ... |
| 2 | 31 | ... | 43 | 27 | ... | 62 | ... | 80 | 62 | ... | 54 | ... | 44 | ... | 31 | ... | 47 | ... | 27 | ... |

GENERAL NOTES:

(a) HT = hand-tucked splice.

(b) MS = mechanical splice.

(c) S = swaged or poured socket.

(d) Rated loads for HT based on minimum $D/d$ ratio of 15/1; rated loads for MS and S based on $D/d$ ratio of 25/1.

(e) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

(f) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-2.5.4).

(10)

## Table 9-2.5.2-6 Rated Load for Three- and Four-Leg Slings 6×19 or 6×36 Classification Extra Extra Improved Plow Steel (EEIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| Hitch Type | Three-Leg | | | | | | | | Four-Leg | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Horizontal Angle | | | | | | | | Horizontal Angle | | | | | | | |
| | Vertical | | 60 deg | | 45 deg | | 30 deg | | Vertical | | 60 deg | | 45 deg | | 30 deg | |
| Rope Diameter, in. | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS | HT | MS |
| 1/4 | 1.8 | 2.1 | 1.6 | 1.8 | 1.3 | 1.5 | 0.90 | 1.1 | 2.4 | 2.8 | 2.1 | 2.4 | 1.7 | 2.0 | 1.2 | 1.4 |
| 5/16 | 2.8 | 3.3 | 2.4 | 2.9 | 1.9 | 2.3 | 1.4 | 1.7 | 3.7 | 4.4 | 3.2 | 3.8 | 2.6 | 3.1 | 1.8 | 2.2 |
| 3/8 | 3.9 | 4.7 | 3.4 | 4.1 | 2.8 | 3.3 | 1.9 | 2.4 | 5.2 | 6.3 | 4.5 | 5.5 | 3.7 | 4.5 | 2.6 | 3.2 |
| 7/16 | 5.2 | 6.4 | 4.5 | 5.5 | 3.7 | 4.5 | 2.6 | 3.2 | 7.0 | 8.5 | 6.0 | 7.4 | 4.9 | 6.0 | 3.5 | 4.3 |
| 1/2 | 6.7 | 8.3 | 5.8 | 7.2 | 4.7 | 5.9 | 3.3 | 4.2 | 8.9 | 11 | 7.7 | 9.6 | 6.3 | 7.8 | 4.5 | 5.5 |
| 9/16 | 8.3 | 11 | 7.2 | 9.1 | 5.9 | 7.5 | 4.2 | 5.3 | 11 | 14 | 9.6 | 12 | 7.9 | 9.9 | 5.6 | 7.0 |
| 5/8 | 10 | 13 | 8.8 | 11 | 7.2 | 9.1 | 5.1 | 6.5 | 14 | 17 | 12 | 15 | 9.6 | 12 | 6.8 | 8.6 |
| 3/4 | 14 | 18 | 12 | 16 | 10 | 13 | 7.1 | 9.2 | 19 | 25 | 16 | 21 | 13 | 17 | 9.4 | 12 |
| 7/8 | 19 | 25 | 16 | 22 | 13 | 18 | 9.4 | 12 | 25 | 33 | 22 | 29 | 18 | 24 | 12 | 17 |
| 1 | 24 | 32 | 21 | 28 | 17 | 23 | 12 | 16 | 32 | 43 | 28 | 37 | 23 | 31 | 16 | 22 |
| 1 1/8 | 31 | ... | 26 | ... | 22 | ... | 15 | ... | 41 | ... | 35 | ... | 29 | ... | 20 | ... |
| 1 1/4 | 38 | ... | 32 | ... | 27 | ... | 19 | ... | 50 | ... | 43 | ... | 35 | ... | 25 | ... |
| 1 3/8 | 45 | ... | 39 | ... | 32 | ... | 23 | ... | 60 | ... | 52 | ... | 43 | ... | 30 | ... |
| 1 1/2 | 53 | ... | 46 | ... | 38 | ... | 27 | ... | 71 | ... | 62 | ... | 50 | ... | 36 | ... |
| 1 5/8 | 62 | ... | 54 | ... | 44 | ... | 31 | ... | 83 | ... | 72 | ... | 59 | ... | 41 | ... |
| 1 3/4 | 72 | ... | 62 | ... | 51 | ... | 36 | ... | 96 | ... | 83 | ... | 68 | ... | 48 | ... |
| 1 7/8 | 82 | ... | 71 | ... | 58 | ... | 41 | ... | 109 | ... | 95 | ... | 77 | ... | 55 | ... |
| 2 | 93 | ... | 80 | ... | 66 | ... | 46 | ... | 124 | ... | 107 | ... | 88 | ... | 62 | ... |

GENERAL NOTES:

(a) HT = hand-tucked splice.

(b) MS = mechanical splice.

(c) Rated loads for HT based on minimum $D/d$ ratio of 15/1; rated loads for MS and S based on $D/d$ ratio of 25/1.

(d) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

**Table 9-2.5.2-7 Rated Load for Cable-Laid Wire Rope Single- and Two-Leg Slings Mechanical Splice Only**
Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| Hitch Type / Rope Diameter, in. | Single-Leg Hitch Type: Vertical | Single-Leg Hitch Type: Choker | Single-Leg Hitch Type: Vertical Basket | Two-Leg Bridle or Basket Horizontal Angle — Hitch Type: Vertical | 60 deg | 45 deg | 30 deg | Choker Horizontal Angle — Hitch Type: 60 deg | 30 deg |
|---|---|---|---|---|---|---|---|---|---|
| **7×7×7 Construction** | | | | | | | | | |
| 1/4 | 0.50 | 0.35 | 1.0 | 1.0 | 0.87 | 0.71 | 0.50 | 0.61 | 0.35 |
| 3/8 | 1.1 | 0.8 | 2.2 | 2.2 | 1.9 | 1.5 | 1.1 | 1.3 | 0.76 |
| 1/2 | 1.9 | 1.3 | 3.7 | 3.7 | 3.2 | 2.6 | 1.9 | 2.2 | 1.3 |
| 5/8 | 2.8 | 1.9 | 5.5 | 5.5 | 4.8 | 3.9 | 2.8 | 3.4 | 1.9 |
| 3/4 | 3.8 | 2.7 | 7.6 | 7.6 | 6.6 | 5.4 | 3.8 | 4.6 | 2.7 |
| 7/8 | 5.0 | 3.5 | 10 | 10 | 8.7 | 7.1 | 5.0 | 6.1 | 3.5 |
| 1 | 6.4 | 4.5 | 13 | 13 | 11 | 9.1 | 6.4 | 7.8 | 4.5 |
| **7×7×19 Construction** | | | | | | | | | |
| 1/2 | 1.9 | 1.3 | 3.8 | 3.8 | 3.3 | 2.7 | 1.9 | 2.3 | 1.3 |
| 5/8 | 2.9 | 2.0 | 5.8 | 5.8 | 5.0 | 4.1 | 2.9 | 3.5 | 2.0 |
| 3/4 | 4.1 | 2.8 | 8.1 | 8.1 | 7.0 | 5.8 | 4.1 | 4.9 | 2.8 |
| 7/8 | 5.4 | 3.8 | 11 | 11 | 9.3 | 7.6 | 5.4 | 6.5 | 3.8 |
| 1 | 6.9 | 4.8 | 14 | 14 | 12 | 9.7 | 6.9 | 8.3 | 4.8 |
| 1 1/8 | 8.3 | 5.8 | 17 | 17 | 14 | 12 | 8.3 | 10 | 5.8 |
| 1 1/4 | 9.9 | 6.9 | 20 | 20 | 17 | 14 | 9.9 | 12 | 6.9 |
| **7×6×19 or 7×6×36 IWRC Classification** | | | | | | | | | |
| 3/4 | 3.8 | 2.7 | 7.6 | 7.6 | 6.6 | 5.4 | 3.8 | 4.6 | 2.7 |
| 7/8 | 5.0 | 3.5 | 10 | 10 | 8.7 | 7.1 | 5.0 | 6.1 | 3.5 |
| 1 | 6.4 | 4.5 | 13 | 13 | 11 | 9.1 | 6.4 | 7.8 | 4.5 |
| 1 1/8 | 7.7 | 5.4 | 15 | 15 | 13 | 11 | 7.7 | 9.3 | 5.4 |
| 1 1/4 | 9.3 | 6.5 | 19 | 19 | 16 | 13 | 9.3 | 11 | 6.5 |
| 1 3/8 | 11 | 7.6 | 22 | 22 | 19 | 15 | 11 | 13 | 7.6 |
| 1 1/2 | 13 | 9.0 | 26 | 26 | 22 | 18 | 13 | 16 | 9.0 |
| 1 5/8 | 15 | 10 | 30 | 30 | 26 | 21 | 15 | 18 | 10 |

GENERAL NOTES:
(a) 7×7×7 = galvanized specialty cable.
(b) 7×7×19 = galvanized specialty cable.
(c) Rated loads based on minimum $D/d$ ratio of 10/1.
(d) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.
(e) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-2.5.4).

**Table 9-2.5.2-8 Rated Load for Six-Part Braided Single- and Two-Leg Slings 6×19 or 6×36 Classification Extra Improved Plow Steel (EIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope**

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| | Single-Leg | | | Two-Leg Bridle or Basket | | | | Choker | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Horizontal Angle | | | | Horizontal Angle | |
| Hitch Type | Vertical | Choker | Vertical Basket | Vertical | 60 deg | 45 deg | 30 deg | 60 deg | 30 deg |
| Rope Diameter, in. | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS |
| 3/16 | 1.6 | 1.4 | 3.2 | 3.2 | 2.8 | 2.3 | 1.6 | 2.4 | 1.4 |
| 1/4 | 2.9 | 2.5 | 5.7 | 5.7 | 4.9 | 4.0 | 2.9 | 4.3 | 2.5 |
| 5/16 | 4.4 | 3.9 | 8.9 | 8.9 | 7.7 | 6.3 | 4.4 | 6.7 | 3.9 |
| 3/8 | 6.3 | 5.5 | 13 | 13 | 11 | 9.0 | 6.3 | 9.6 | 5.5 |
| 7/16 | 8.6 | 7.5 | 17 | 17 | 15 | 12 | 8.6 | 13 | 7.5 |
| 1/2 | 11 | 9.8 | 22 | 22 | 19 | 16 | 11 | 17 | 9.8 |
| 9/16 | 14 | 12 | 28 | 28 | 24 | 20 | 14 | 21 | 12 |
| 5/8 | 17 | 15 | 35 | 35 | 30 | 24 | 17 | 26 | 15 |
| 3/4 | 25 | 22 | 49 | 49 | 43 | 35 | 25 | 37 | 22 |
| 7/8 | 33 | 29 | 67 | 67 | 58 | 47 | 33 | 51 | 29 |
| 1 | 43 | 38 | 87 | 87 | 75 | 61 | 43 | 66 | 38 |
| 1 1/8 | 55 | 48 | 109 | 109 | 95 | 77 | 55 | 83 | 48 |
| 1 1/4 | 67 | 59 | 134 | 134 | 116 | 95 | 67 | 102 | 59 |
| 1 3/8 | 87 | 71 | 161 | 161 | 140 | 114 | 81 | 122 | 71 |
| 1 1/2 | 96 | 84 | 192 | 192 | 166 | 135 | 96 | 145 | 84 |
| 1 5/8 | 111 | 97 | 222 | 222 | 192 | 157 | 111 | 168 | 97 |
| 1 3/4 | 129 | 112 | 257 | 257 | 223 | 182 | 129 | 195 | 112 |
| 1 7/8 | 146 | 128 | 292 | 292 | 253 | 207 | 146 | 222 | 128 |
| 2 | 166 | 146 | 333 | 333 | 288 | 235 | 166 | 252 | 146 |

GENERAL NOTES:

(a) HT = hand-tucked splice.

(b) MS = mechanical splice.

(c) Rated loads based on minimum $D/d$ ratio of 25 times the component rope diameter.

(d) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

(e) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-2.5.4).

**Table 9-2.5.2-9 Rated Load for Eight-Part Braided Single- and Two-Leg Slings 6×19 or 6×36 Classification Extra Improved Plow Steel (EIPS) Grade Independent Wire Rope Core (IWRC) Wire Rope**

Based on Design Factor = 5 and Rated Loads Expressed in Tons (2,000 lb)

| | Single-Leg | | | Two-Leg Bridle or Basket | | | | Choker | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Horizontal Angle | | | | Horizontal Angle | |
| Hitch Type | Vertical | Choker | Vertical Basket | Vertical | 60 deg | 45 deg | 30 deg | 60 deg | 30 deg |
| Rope Diameter, in. | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS | HT&MS |
| 3/16 | 2.2 | 1.9 | 4.3 | 4.3 | 3.7 | 3.0 | 2.2 | 3.3 | 1.9 |
| 1/4 | 3.8 | 3.3 | 7.6 | 7.6 | 6.6 | 5.4 | 3.8 | 5.8 | 3.3 |
| 5/16 | 5.9 | 5.2 | 12 | 12 | 10 | 8.3 | 5.9 | 8.9 | 5.2 |
| 3/8 | 8.5 | 7.4 | 17 | 17 | 15 | 12 | 8.5 | 13 | 7.4 |
| 7/16 | 11 | 10 | 23 | 23 | 20 | 16 | 11 | 17 | 10 |
| 1/2 | 15 | 13 | 30 | 30 | 26 | 21 | 15 | 23 | 13 |
| 9/16 | 19 | 16 | 38 | 38 | 33 | 27 | 19 | 29 | 16 |
| 5/8 | 23 | 20 | 46 | 46 | 40 | 33 | 23 | 35 | 20 |
| 3/4 | 33 | 29 | 66 | 66 | 57 | 47 | 33 | 50 | 29 |
| 7/8 | 45 | 39 | 89 | 89 | 77 | 63 | 45 | 68 | 39 |
| 1 | 58 | 51 | 116 | 116 | 100 | 82 | 58 | 88 | 51 |
| 1 1/8 | 73 | 64 | 146 | 146 | 126 | 103 | 73 | 110 | 64 |
| 1 1/4 | 89 | 78 | 179 | 179 | 155 | 127 | 89 | 136 | 78 |
| 1 3/8 | 108 | 94 | 215 | 215 | 186 | 152 | 108 | 163 | 94 |
| 1 1/2 | 128 | 112 | 255 | 255 | 221 | 181 | 128 | 194 | 112 |
| 1 5/8 | 148 | 129 | 296 | 296 | 256 | 209 | 148 | 224 | 129 |
| 1 3/4 | 171 | 150 | 343 | 343 | 297 | 242 | 171 | 260 | 150 |
| 1 7/8 | 195 | 171 | 390 | 390 | 338 | 276 | 195 | 295 | 171 |
| 2 | 222 | 194 | 444 | 444 | 384 | 314 | 222 | 336 | 194 |

GENERAL NOTES:

(a) HT = hand-tucked splice.

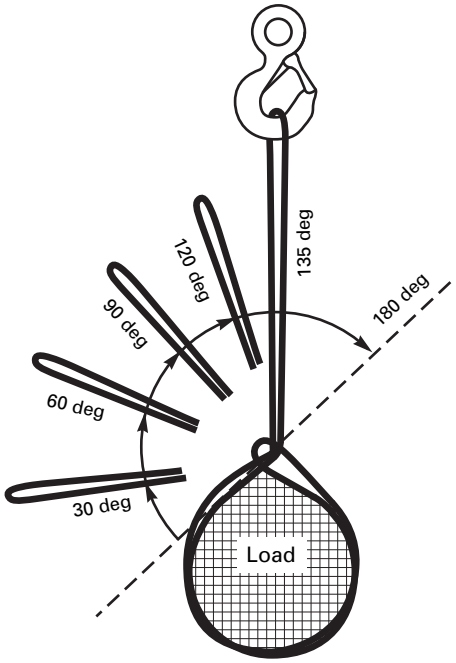
(b) MS = mechanical splice.

(c) Rated loads based on minimum $D/d$ ratio of 25 times the component rope diameter.

(d) Rated load based on pin diameter not larger than natural eye width or less than the nominal sling diameter.

(e) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-2.5.4).

**Fig. 9-2.5.4-1 Angle of Choke**




| Angle of Choke, deg | Rated Capacity, % [Note (1)] |
|---|---|
| Over 120 | 100 |
| 90–120 | 87 |
| 60–89 | 74 |
| 30–59 | 62 |
| 0–29 | 49 |

NOTE:
(1) Percent of sling rated capacity in a choker hitch.

*(b)* The proof load for components (fittings) attached to single legs shall be the same as the requirement for single-leg slings in para. 9-2.6.2(a).

*(c)* Master links for two-leg bridle slings shall be proof loaded to a minimum of 4 times the single-leg vertical hitch rated load.

*(d)* Master links for three-leg bridle slings shall be proof loaded to a minimum of 6 times the single-leg vertical hitch rated load.

*(e)* Master links for four-leg bridle slings shall be proof loaded to a minimum of 8 times the single-leg vertical hitch rated load.

## SECTION 9-2.7: SLING IDENTIFICATION

### 9-2.7.1 Identification Requirements

(10)

Each sling shall be marked to show

*(a)* name or trademark of manufacturer

*(b)* rated load for at least one hitch type and the angle upon which it is based

*(c)* diameter or size

*(d)* number of legs, if more than one

### 9-2.7.2 Initial Sling Identification

Sling identification shall be done by the sling manufacturer.

### 9-2.7.3 Maintenance of Sling Identification

Sling identification should be maintained by the user so as to be legible during the life of the sling.

### 9-2.7.4 Replacement of Sling Identification

Replacement of the sling identification shall be considered a repair as specified in paras. 9-2.9.5(a) and (b). Additional proof testing is not required.

## SECTION 9-2.8: EFFECTS OF ENVIRONMENT

### 9-2.8.1 Temperature

*(a)* Fiber core wire rope slings of all grades shall not be exposed to temperatures in excess of 180°F (82°C).

*(b)* When IWRC wire rope slings are to be used at temperatures above 400°F (204°C) or below −40°F (−40°C), the sling manufacturer should be consulted.

### 9-2.8.2 Chemically Active Environments

The strength of wire rope slings can be degraded by chemically active environments. This includes exposure to chemicals in the form of solids, liquids, gases, vapors, or fumes. The sling manufacturer or qualified person should be consulted before slings are used in chemically active environments.

## SECTION 9-2.9: INSPECTION, REMOVAL, AND REPAIR

### 9-2.9.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired slings shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter.

### 9-2.9.2 Frequent Inspection

*(a)* A visual inspection for damage shall be performed by the user or other designated person each day or shift the sling is used.

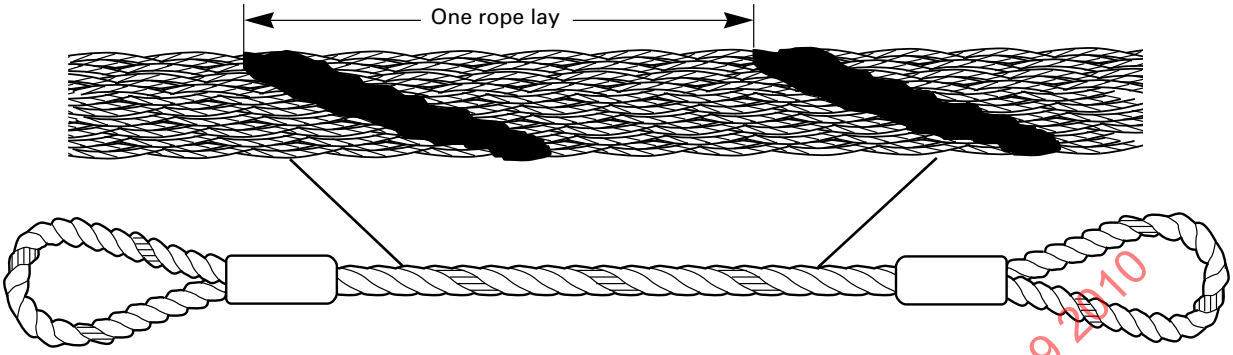
*(b)* Conditions such as those listed in para. 9-2.9.4 or any other condition that may result in a hazard shall cause the sling to be removed from service. Slings shall not be returned to service until approved by a qualified person.

*(c)* Written records are not required for frequent inspections.

### 9-2.9.3 Periodic Inspection (10)

*(a)* A complete inspection for damage to the sling shall be periodically performed by a designated person. Inspection shall be conducted on the entire length

**Fig. 9-2.9.4-1 Cable-Laid Wire Rope Sling**




including splices, end attachments, and fittings. The sling shall be examined for conditions such as those listed in para. 9-2.9.4 and a determination made as to whether they constitute a hazard.

*(b) Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed 1 yr. The frequency of periodic inspections should be based on

*(1)* frequency of sling use

*(2)* severity of service conditions

*(3)* nature of lifts being made

*(4)* experience gained on the service life of slings used in similar circumstances

*(c)* Guidelines for the time intervals are

*(1)* normal service — yearly

*(2)* severe service — monthly to quarterly

*(3)* special service — as recommended by a qualified person

*(d)* Documentation that the most recent periodic inspection was performed and shall be maintained.

*(e)* Inspection records of individual slings are not required.

(10) **9-2.9.4 Removal Criteria**

A wire rope sling shall be removed from service if conditions such as the following are present:

*(a)* missing or illegible sling identification (see Section 9-2.7)

*(b)* broken wires

*(1)* for strand-laid and single-part slings, ten randomly distributed broken wires in one rope lay, or five broken wires in one strand in one rope lay (see Fig. 9-2.0-1)

*(2)* for cable-laid slings, 20 broken wires per lay (see Fig. 9-2.9.4-1)

*(3)* for less than eight-part braided slings, 20 broken wires per braid (see Fig. 9-2.3.2-2)

*(4)* for eight-part or more than eight part braided slings, 40 broken wires per braid (see Fig. 9-2.3.2-2)

*(c)* severe localized abrasion or scraping

*(d)* kinking, crushing, birdcaging, or any other damage resulting in damage to the rope structure

*(e)* evidence of heat damage

*(f)* end attachments that are cracked, deformed, or worn to the extent that the strength of the sling is substantially affected

*(g)* severe corrosion of the rope, end attachments, or fittings

*(h)* for hooks, removal criteria as stated in ASME B30.10

*(i)* for rigging hardware, removal criteria as stated in ASME B30.26

*(j)* other conditions, including visible damage, that cause doubt as to the continued use of the sling

**9-2.9.5 Repair** (10)

*(a)* Slings shall be repaired only by the sling manufacturer or a qualified person.

*(b)* A repaired sling shall be marked to identify the repairing agency per Section 9-2.7.

*(c)* End attachments and fittings used for sling repair shall comply with the provisions of this Chapter.

*(d)* Repair of hooks (ASME B30.10), rigging hardware (ASME B30.26), below-the-hook lifting devices (ASME B30.20), or other special devices shall comply with the repair instructions in the applicable volumes.

*(e)* The wire rope used in the sling shall not be repaired.

*(f)* Repairs to wire rope slings shall be restricted to end attachments and fittings.

*(g)* Modifications, alterations, or repairs to end attachments or fittings shall be approved by the sling manufacturer, fitting or component manufacturer, or a qualified person and shall conform to all other provisions of the Chapter.

*(h)* All repairs shall comply with the proof test requirements of Section 9-2.6.

## SECTION 9-2.10: OPERATING PRACTICES

### 9-2.10.1 Sling Selection

*(a)* Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-2.9.

*(b)* Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with the requirements of Sections 9-2.5 and 9-2.8.

*(c)* The rated load of the sling shall not be exceeded.

*(d)* For multiple-leg slings used with nonsymmetrical loads, an analysis by a qualified person should be performed to prevent overloading of any leg.

*(e)* Multiple-leg slings shall be selected according to Tables 9-2.5.2-1 through 9-2.5.2-9 when used at the specific angles given in the table. Operation at other angles shall be limited to rated loads of the next lower angle given in the table or calculated by a qualified person.

*(f)* When using a multiple-leg sling, the rating shown for the single-leg sling shall not be exceeded in any leg of the multiple-leg sling.

*(g)* When $D/d$ ratios (see Fig. 9-2.5.1-2) smaller than those cited in the tables are necessary, the rated load of the sling shall be decreased. Consult the sling manufacturer for specific data or refer to the WRTB Wire Rope Sling User's Manual.

*(h)* The fitting shall be of the proper shape and size to ensure that it seats properly in the hook or lifting device.

### 9-2.10.2 Cautions to Personnel

*(a)* All portions of the human body shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook.

*(b)* Personnel should never stand in line with or next to the leg(s) of a sling that is under tension.

*(c)* Personnel shall not stand or pass under a suspended load.

*(d)* Personnel shall not ride the sling.

*(e)* Do not inspect a sling by passing bare hands over the wire rope body. Broken wires, if present, may puncture the hands.

### 9-2.10.3 Effects of Environment

*(a)* Slings should be stored in an area where they will not be subjected to mechanical damage, corrosive action, moisture, extreme temperatures, or kinking (see Section 9-2.8).

*(b)* When used at or in contact with extreme temperatures, the guidance provided in Section 9-2.8 shall be followed.

*(c)* Fiber core wire rope slings should not be subjected to degreasing or a solvent because of possible damage to the core.

### 9-2.10.4 Rigging Practices

*(a)* Slings shall be shortened or adjusted only by methods approved by the sling manufacturer or a qualified person.

*(b)* Slings shall not be shortened or lengthened by knotting, twisting, or by wire rope clips.

*(c)* The sling shall be hitched in a manner providing control of the load.

*(d)* Slings in contact with edges, corners, or protrusions should be protected with a material of sufficient strength, thickness, and construction to prevent damage to the sling.

*(e)* Shock loading should be avoided.

*(f)* Loads should not be rested on the sling.

*(g)* Slings should not be pulled from under a load when the load is resting on the sling.

*(h)* Twisting and kinking shall be avoided.

*(i)* During lifting, with or without load, personnel shall be alert for possible snagging.

*(j)* When using multiple basket or choker hitches, the load should be rigged to prevent the sling from slipping or sliding along the load.

*(k)* When using a basket hitch, the legs of the sling should contain or support the load from the sides, above the center of gravity, so that the load remains under control.

*(l)* Slings should not be dragged on the floor or over an abrasive surface.

*(m)* In a choker hitch, the choke point should only be on the sling body, not on a splice or fitting.

*(n)* In a choker hitch, an angle of choke less than 120 deg should not be used without reducing the rated load (see para. 9-2.5.5).

*(o)* Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.

*(p)* The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook, unless the hook is designed for point loading.

*(q)* An object in the eye of a sling should not be wider than one half the length of the eye.

*(r)* Sling and load shall not be allowed to rotate when hand tucked slings are used in a single leg vertical lift application. Care shall be taken to minimize sling rotation.

*(s)* Slings made with wire rope clips shall not be used as a choker hitch.

# Chapter 9-3
# Metal Mesh Slings: Selection, Use, and Maintenance

## SECTION 9-3.0: SCOPE

Chapter 9-3 includes provisions that apply to metal mesh slings (see Fig. 9-3.0-1).

## SECTION 9-3.1: TRAINING

Metal mesh sling users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

## SECTION 9-3.2: MATERIALS AND COMPONENTS

### 9-3.2.1 Metal Mesh

The carbon steel metal mesh shall be manufactured in accordance with the specifications in Table 9-3.2.1-1.

### 9-3.2.2 Coatings

Finishes and coatings shall be compatible with the other components and not impair the performance of the sling.

### 9-3.2.3 Components

*(a)* End fittings shall be manufactured to ensure that the rated load shall be at least the same as the metal mesh sling.

*(b)* End fittings shall have sufficient strength to sustain twice the rated load of the sling without visible permanent deformation.

*(c)* All surfaces of end fittings shall be cleanly finished and sharp edges removed.

### 9-3.2.4 Other Materials

Metal mesh and components other than those listed in paras. 9-3.2.1 and 9-3.2.3 may be employed. When such materials are employed, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-3.3: FABRICATION AND CONFIGURATIONS

### 9-3.3.1 Fabrication

Methods of fabrication include welding or brazing.

### 9-3.3.2 Configurations

Single-leg slings used in vertical, choker, and basket hitches are covered in this Chapter.

## SECTION 9-3.4: DESIGN FACTOR

The design factor for metal mesh slings shall be a minimum of 5.

## SECTION 9-3.5: RATED LOAD

The term *rated capacity* is commonly used to describe rated load.

### 9-3.5.1

These rated loads are based on the following factors:
*(a)* material strength(s)
*(b)* design factor
*(c)* type of hitch
*(d)* angle of loading

### 9-3.5.2

Table 9-3.5.2-1 shows rated loads for single-leg vertical, choker, and basket hitches. For angles other than those shown in these tables, use the rated load for the next lower angle, or a qualified person shall calculate the rated load.

### 9-3.5.3

Horizontal sling angles less than 30 deg shall not be used except as recommended by the sling manufacturer or a qualified person (see Table 9-3.5.2-1).

### 9-3.5.4 (10)

Table 9-3.5.2-1 shows rated loads for choker hitches for specific grades of metal mesh, provided that the angle of choke is 120 deg or greater.

### 9-3.5.5

Rated loads for angles of choke less than 120 deg shall be determined by the sling manufacturer or a qualified person.

### 9-3.5.6

Other metal mesh materials and configurations not covered by this Chapter shall be rated in accordance with the recommendation of the sling manufacturer or a qualified person, and shall conform to all other provisions of this Chapter.

### 9-3.5.7

When components of the sling have a lower rated load than the metal mesh with which it is being used, the sling shall be identified with a rated load consistent with the lowest load rating of any of the components.

**Fig. 9-3.0-1 Metal Mesh Sling**

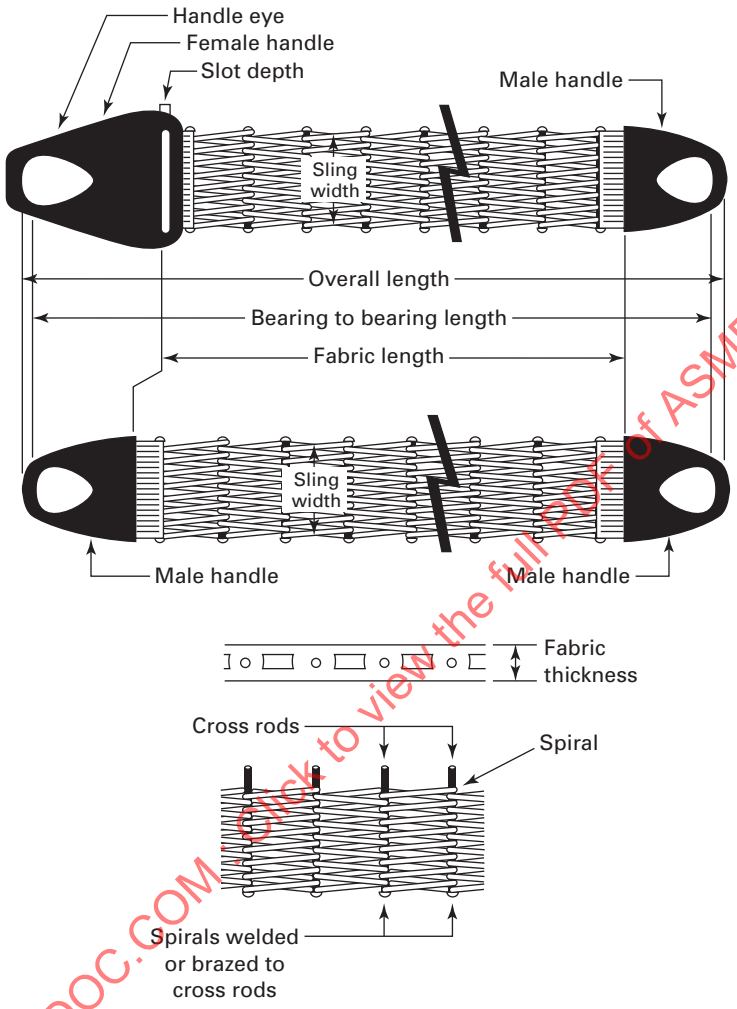



**Table 9-3.2.1-1 Fabric Construction (Metal Mesh Slings)**

| | Heavy Duty | Medium Duty | Light Duty |
|---|---|---|---|
| Nominal spiral turns per foot mesh width | 35 | 43 | 59 |
| Approx. spiral wire size | 10 gage | 12 gage | 14 gage |
| Equivalent decimal size | 0.135 in. | 0.105 in. | 0.080 in. |
| Nominal cross rods per foot of fabric length | 21 | 30 | 38 |
| Approximate size of cross rods | 8 gage | 10 gage | 14 gage |
| Equivalent decimal size | 0.162 in. | 0.135 in. | 0.080 in. |
| Nominal fabric thickness | $\frac{1}{2}$ in. | $\frac{3}{8}$ in. | $\frac{5}{16}$ in. |

## Table 9-3.5.2-1 Rated Load for Metal Mesh Slings

Based on Design Factor = 5

| Hitch Type / Width, in. | Vertical or Choker  | Vertical Basket  | Effect of Angle on Rated Capacities in Basket Hitch | | |
|---|---|---|---|---|---|
| | | | 60 deg  | 45 deg  | 30 deg  |
| **Heavy Duty — 10 gage [Rated Loads in Pounds (lb)]** | | | | | |
| 2 | 1,600 | 3,200 | 2,770 | 2,260 | 1,600 |
| 3 | 3,000 | 6,000 | 5,200 | 4,240 | 3,000 |
| 4 | 4,400 | 8,800 | 7,620 | 6,220 | 4,400 |
| 6 | 6,600 | 13,200 | 11,430 | 9,330 | 6,600 |
| 8 | 8,800 | 17,600 | 15,240 | 12,440 | 8,800 |
| 10 | 11,000 | 22,000 | 19,050 | 15,550 | 11,000 |
| 12 | 13,200 | 26,400 | 22,860 | 18,660 | 13,200 |
| 14 | 15,400 | 30,800 | 26,670 | 21,770 | 15,400 |
| 16 | 17,600 | 35,200 | 30,480 | 24,880 | 17,600 |
| 18 | 19,800 | 39,600 | 34,290 | 28,000 | 19,800 |
| 20 | 22,000 | 44,000 | 38,100 | 31,100 | 22,000 |
| **Medium Duty — 12 gage [Rated Loads in Pounds (lb)]** | | | | | |
| 2 | 1,450 | 2,900 | 2,510 | 2,050 | 1,450 |
| 3 | 2,170 | 4,350 | 3,770 | 3,070 | 2,170 |
| 4 | 2,900 | 5,800 | 5,020 | 4,100 | 2,900 |
| 6 | 4,800 | 9,600 | 8,310 | 6,780 | 4,800 |
| 8 | 6,400 | 12,800 | 11,080 | 9,050 | 6,400 |
| 10 | 8,000 | 16,000 | 13,850 | 11,310 | 8,000 |
| 12 | 9,600 | 19,200 | 16,620 | 13,570 | 9,600 |
| 14 | 11,200 | 22,400 | 19,400 | 15,830 | 11,200 |
| 16 | 12,800 | 25,600 | 22,170 | 18,100 | 12,800 |
| 18 | 13,500 | 27,000 | 23,380 | 19,090 | 13,500 |
| 20 | 15,000 | 30,000 | 25,980 | 21,210 | 15,000 |
| **Light Duty — 14 gage [Rated Loads in Pounds (lb)]** | | | | | |
| 2 | 900 | 1,800 | 1,560 | 1,270 | 900 |
| 3 | 1,400 | 2,800 | 2,420 | 1,980 | 1,400 |
| 4 | 2,000 | 4,800 | 4,150 | 3,390 | 2,000 |
| 6 | 3,000 | 6,000 | 5,190 | 4,240 | 3,000 |
| 8 | 4,000 | 8,000 | 6,920 | 5,650 | 4,000 |
| 10 | 5,000 | 10,000 | 8,660 | 7,070 | 5,000 |
| 12 | 6,000 | 12,000 | 10,390 | 8,480 | 6,000 |
| 14 | 7,000 | 14,000 | 12,120 | 9,890 | 7,000 |
| 16 | 8,000 | 16,000 | 13,850 | 11,310 | 8,000 |
| 18 | 9,000 | 18,000 | 15,580 | 12,720 | 9,000 |
| 20 | 10,000 | 20,000 | 17,320 | 14,140 | 10,000 |

GENERAL NOTE: For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-3.5.4).

## SECTION 9-3.6: PROOF TEST REQUIREMENTS

### 9-3.6.1 General

*(a)* Prior to initial use, all new and repaired metal mesh slings shall be proof tested by the sling manufacturer or a qualified person.

*(b)* Coated slings shall be proof tested prior to coating.

### 9-3.6.2 Proof Load Requirements

The proof load shall be a minimum of 2 times the vertical hitch rated load.

## SECTION 9-3.7: SLING IDENTIFICATION

(10)

### 9-3.7.1 Identification Requirements

Each sling shall be marked to show

*(a)* name or trademark of manufacturer

*(b)* rated load for at least one hitch type and the angle upon which it is based

*(c)* width and gauge

*(d)* number of legs, if more than one

*(e)* individual sling identification (e.g., serial numbers)

### 9-3.7.2 Initial Sling Identification

Sling identification shall be done by the sling manufacturer.

### 9-3.7.3 Maintenance of Sling Identification

Sling identification should be maintained by the user so as to be legible during the life of the sling.

### 9-3.7.4 Replacement of Sling Identification

Replacement of the sling identification shall be considered a repair as specified in paras. 9-3.9.5(a) and (b). Additional proof testing is not required.

## SECTION 9-3.8: EFFECTS OF ENVIRONMENT

### 9-3.8.1 Temperature

*(a)* Metal mesh slings covered by this Chapter shall not be subjected to a reduction in rated load if used in temperatures below −20°F (−29°C) and above 550°F (288°C).

*(b)* All slings covered by this Chapter that are elastometer coated should be used only in a temperature range from 0°F (−18°C) to 200°F (93°C).

*(c)* For operation at temperatures outside these ranges or for other coatings, the sling manufacturer should be consulted for specific data.

### 9-3.8.2 Chemically Active Environments

The strength of metal mesh slings can be degraded by chemically active environments. This includes exposure to chemicals in the form of solids, liquids, gases, vapors, or fumes. The sling manufacturer or qualified person should be consulted before slings are used in chemically active environments.

## SECTION 9-3.9: INSPECTION, REMOVAL, AND REPAIR

### 9-3.9.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired slings shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter.

### 9-3.9.2 Frequent Inspection

*(a)* A visual inspection for damage shall be performed by the user or other designated person each day or shift the sling is used.

*(b)* Conditions such as those listed in para. 9-3.9.4 or any other condition that may result in a hazard shall cause the sling to be removed from service. Slings shall not be returned to service until approved by a qualified person.

*(c)* Written records are not required for frequent inspections.

### 9-3.9.3 Periodic Inspection

*(a)* A complete inspection for damage to the sling shall be periodically performed by a designated person. Inspection shall be conducted on the entire length including splices, end attachments, and fittings. The sling shall be examined for conditions such as those listed in para. 9-3.9.4 and a determination made as to whether they constitute a hazard.

*(b) Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed 1 yr. The frequency of periodic inspections should be based on

*(1)* frequency of sling use

*(2)* severity of service conditions

*(3)* nature of lifts being made

*(4)* experience gained on the service life of slings used in similar circumstances

*(c)* Guidelines for the time intervals are

*(1)* normal service — yearly

*(2)* severe service — monthly to quarterly

*(3)* special service — as recommended by a qualified person

*(d)* A written record of the most recent periodic inspection shall be maintained and shall include the condition of the sling.

### 9-3.9.4 Removal Criteria

A metal mesh sling shall be removed from service if conditions such as the following are present:

*(a)* missing or illegible sling identification (see Section 9-3.7)

*(b)* broken weld or a broken brazed joint along the sling edge

(c) broken wire in any part of the mesh

(d) reduction in wire diameter of 25% due to abrasion or 15% due to corrosion

(e) lack of flexibility due to distortion of the mesh

(f) distortion of the choker fitting so the depth of the slot is increased by more than 10%

(g) distortion of either end fitting so the width of the eye opening is decreased by more than 10%

(h) a 15% reduction of the original cross-sectional area of any point around the hook opening of the end fitting

(i) visible distortion of either end fitting out of its plane

(j) cracked end fitting

(k) slings in which the spirals are locked or without free articulation shall not be used

(l) fittings that are pitted, corroded, cracked, bent, twisted, gouged, or broken

(m) other conditions, including visible damage, that cause doubt as to the continued use of the sling

#### 9-3.9.5 Repair

(a) Slings shall be repaired only by the sling manufacturer or a qualified person.

(b) A repaired sling shall be marked to identify the repairing agency per Section 9-3.7.

(c) Metal mesh and fittings used for sling repair shall comply with the provisions of this Chapter.

(d) Cracked, broken, bent, or damaged metal mesh or components shall not be repaired; they shall be replaced.

(e) All repairs shall comply with the proof test requirements of Section 9-3.6.

(f) Modifications or alterations to the sling or components shall be considered as repairs and shall conform to all other provisions of this Chapter.

## SECTION 9-3.10: OPERATING PRACTICES

### 9-3.10.1 Sling Selection

(a) Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-3.9.

(b) Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with the requirements of Sections 9-3.5 and 9-3.8.

(c) The rated load of the sling shall not be exceeded.

(d) The end fitting shall be of the proper shape and size to ensure that it is properly seated in the hook or lifting device.

### 9-3.10.2 Cautions to Personnel

(a) All portions of the human body shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook.

(b) Personnel should never stand in line with or next to the leg(s) of a sling that is under tension.

(c) Personnel shall not stand or pass under a suspended load.

(d) Personnel shall not ride the sling.

(e) Metal mesh slings shall not be used as bridles on suspended personnel platforms.

### 9-3.10.3 Effects of Environment

(a) Slings should be stored in an area where they will not be subjected to mechanical damage, corrosive action, moisture, extreme temperatures, or kinking (see Section 9-3.8).

(b) When used at or in contact with extreme temperatures, the guidance provided in Section 9-3.8 shall be followed.

### 9-3.10.4 Rigging Practices

(a) Slings shall be shortened or adjusted only by methods approved by the sling manufacturer or a qualified person.

(b) The load should be evenly distributed across the width of the metal mesh.

(c) The sling shall be hitched in a manner providing control of the load.

(d) Slings in contact with edges, corners, or protrusions should be protected with a material of sufficient strength, thickness, and construction to prevent damage.

(e) Shock loading should be avoided.

(f) Loads should not be rested on the sling.

(g) Slings should not be pulled from under a load when the load is resting on the sling.

(h) Twisting and kinking shall be avoided.

(i) During lifting, with or without load, personnel shall be alert for possible snagging.

(j) In a basket hitch, the load should be balanced to prevent slippage.

(k) When using a basket hitch, the sling should contain or support the load from the sides, above the center of gravity, so that the load remains under control.

(l) Slings should not be dragged on the floor or over an abrasive surface.

(m) In a choker hitch, the choke point should only be on the sling body, not on a weld, braze, or end fitting.

(n) In a choker hitch, an angle of choke less than 120 deg should not be used without reducing the rated load (see para. 9-3.5.5).

(o) Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.

(p) In a choker hitch, the load should be balanced to prevent edge overload.

(q) Straightening a spiral or cross rod or forcing a spiral into position shall not be done.

(r) Slings used in pairs should be attached to a spreader beam.

# Chapter 9-4
# Synthetic Rope Slings: Selection, Use, and Maintenance

## SECTION 9-4.0: SCOPE

Chapter 9-4 includes provisions that apply to synthetic rope slings (see Fig. 9-4.0-1).

## SECTION 9-4.1: TRAINING

Synthetic rope sling users shall be trained in the selection, inspection, cautions to personnel, effects of environment, and rigging practices as covered by this Chapter.

## SECTION 9-4.2: MATERIALS AND COMPONENTS

(10)

### 9-4.2.1 Synthetic Ropes

*(a)* Synthetic fiber materials covered for use in synthetic ropes are nylon and polyester. Rope constructions covered are three-strand laid, eight-strand plaited, single braided, and double braided. The rope constructions shall be manufactured and tested in accordance with one of the following applicable Cordage Institute specifications:

| Rope Type | Designation |
|---|---|
| Nylon three-strand laid | CI 1303 |
| Nylon eight-strand plaited | CI 1303 |
| Nylon double braid | CI 1306 |
| Polyester three-strand laid | CI 1304 |
| Polyester eight-strand plaited | CI 1304 |
| Polyester double braid | CI 1307 |
| Polyester single braid | CI 1305 |

*(b)* Slings made of nylon or polyester rope shall be made of fibers that have been produced with an appropriate ultraviolet inhibitor.

### 9-4.2.2 Coatings

Finishes and coatings shall be compatible with the other components and not impair the performance of the sling.

### 9-4.2.3 Components

Mechanical components used as part of a synthetic rope sling should be selected to meet the following requirements:

*(a)* Suitability of mechanical or socketed fittings shall be verified by a qualified person.

*(b)* The material shall be compatible with the mechanical and environmental requirements imposed on the sling.

*(c)* Components shall have sufficient strength to sustain twice the rated load of the sling without visible permanent deformation.

*(d)* All surfaces shall be cleanly finished and sharp edges removed so as not to cause damage to the rope.

*(e)* Slings incorporating reused, repaired, or welded fittings shall undergo proof load in accordance with Section 9-4.6.

*(f)* Slings incorporating aluminum fittings shall not be used where fumes, vapors, sprays, mists, or liquids of alkalis or acids are present.

*(g)* Thimbles shall have a minimum diameter at the bearing surface of at least two times the rope diameter.

*(h)* Hooks, when employed, shall meet the requirements of ASME B30.10.

*(i)* Rigging hardware, when employed, shall meet the requirements of ASME B30.26.

### 9-4.2.4 Other Materials

Synthetic ropes and components other than those listed in paras. 9-4.2.1 and 9-4.2.3 may be employed. When such materials are employed, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-4.3: FABRICATION AND CONFIGURATIONS

### 9-4.3.1 Fabrication

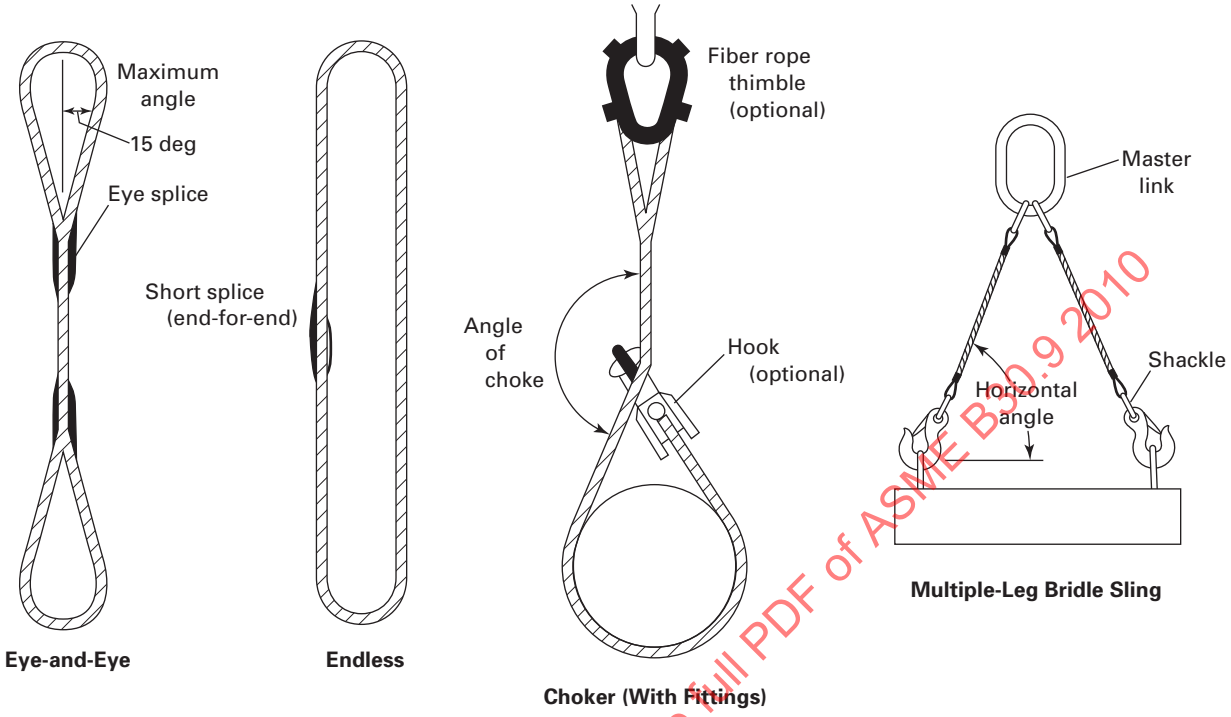
Splicing is the preferred method of fabricating eye-and-eye or endless rope components for slings. All splices shall be made in accordance with splicing instructions provided by the rope manufacturer or a qualified person. In addition, the following shall be observed:

*(a)* With tuck splices in three-strand and eight-strand synthetic ropes, no less than four full tucks shall be used. Short splices shall contain at least six full tucks, three on each side of the center of the splice.

*(b)* Strand end tails in all tuck splices shall not be trimmed short (cut flush with the body of the rope). In cases where the projecting tails may be objectionable, the tails shall be tapered and buried into the body of the rope using two additional tucks.

*(c)* Synthetic rope slings shall have a minimum undisturbed length of rope of 10 times the rope diameter between the last tuck of tuck splices or between the ends of the buried tails or strands of other types of splices.

**Fig. 9-4.0-1 Synthetic Fiber Rope Slings**




GENERAL NOTE: Fittings designed for synthetic slings should be used.

*(d)* The diameter and width of the bearing surface of the fitting can affect the strength of the sling. The sling manufacturer's recommendation should be followed when fittings are used with the sling.

*(e)* Knots, clips, or clamps shall not be used to fabricate slings.

*(f)* If thimbles do not have ears to prevent rotation, they should be lashed to the rope. Thimbles should be used in the sling whenever possible, and installed in a manner that will prevent the thimble from rotating inside the eye or falling out of the eye.

### 9-4.3.2 Configurations

*(a)* Single-leg slings and two-leg, three-leg, and four-leg bridle slings used in vertical, choker, and basket hitches are covered by this Chapter.

*(b)* Synthetic rope leg(s) shall be either eye-and-eye or endless.

## SECTION 9-4.4: DESIGN FACTOR

The design factor for synthetic rope slings shall be a minimum of 5.

## SECTION 9-4.5: RATED LOAD

The term *rated capacity* is commonly used to describe rated load.

### 9-4.5.1 (10)

These rated loads are based on the following factors:

*(a)* material strength(s)

*(b)* design factor

*(c)* type of hitch (see Fig. 9-4.5.1-1)

*(d)* angle of loading (see Fig. 9-4.5.1-2)

*(e)* diameter of curvature over which the sling is used ($D/d$) (see Fig. 9-4.5.1-3)

NOTE: Rated loads for basket hitches and bridle slings are based on symmetrical loading. See para. 9-4.10.1(d) for nonsymmetrical loading.

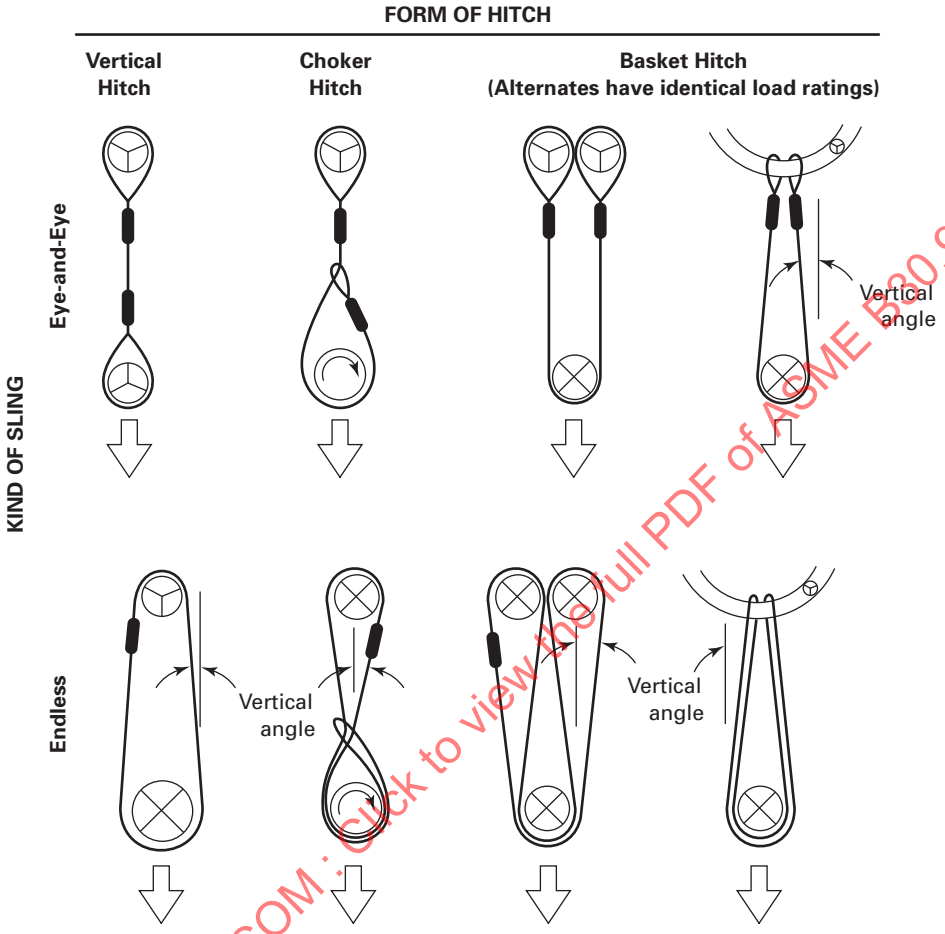
### 9-4.5.2

Tables 9-4.5.2-1 and 9-4.5.2-2 show rated loads for vertical, choker, and basket hitches. For angles other than those shown in these tables, use the rated load for the next lower angle, or a qualified person shall calculate the rated load.

### 9-4.5.3 (10)

Horizontal sling angles less than 30 deg shall not be used except as recommended by the sling manufacturer or a qualified person (see Fig. 9-4.5.1-2).

**Fig. 9-4.5.1-1 Hitch Types for Synthetic Rope Slings**




The symbols below represent load or support surfaces in contact with the rope sling. The contact surface diameter divided by the rope diameter is designated *D/d* ratio as described in Fig. 9-4.5.1-3. Tables 9-4.5.2-1 and 9-4.5.2-2 are based on the *D/d* ratios indicated below.

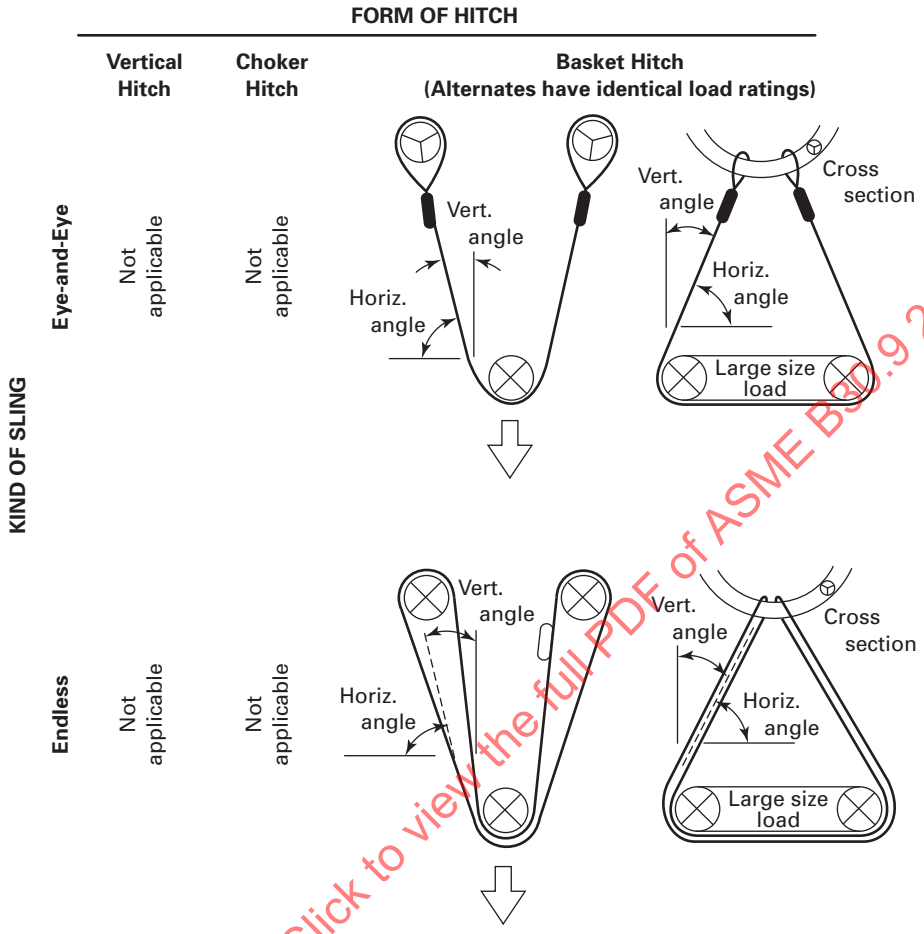
Represents a contact surface which shall have a diameter of curvature at least double the diameter of the rope from which the sling is made.

Represents a contact surface which shall have a diameter of curvature at least 8 times the diameter of the rope.

Represents a load in choker hitch and illustrates the rotary force on the load and/or the slippage of the rope in contact with the load. Diameter of curvature of load surface shall be at least double the diameter of the rope.

GENERAL NOTE: Legs 5 deg or less from vertical may be considered vertical. For slings more than 5 deg vertical, the actual angle shall be used. See para. 9-4.5.2.

**Fig. 9-4.5.1-1 Hitch Types for Synthetic Rope Slings (Cont'd)**




GENERAL NOTE: Legs 5 deg or less from vertical may be considered vertical. Slings with horizontal angles less than 30 deg should not be used. See paras. 9-4.5.2 and 9-4.5.3.

**Fig. 9-4.5.1-2 Angle of Loading**

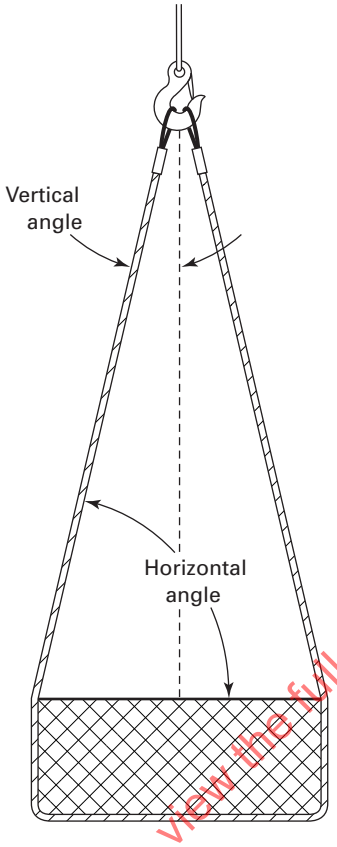
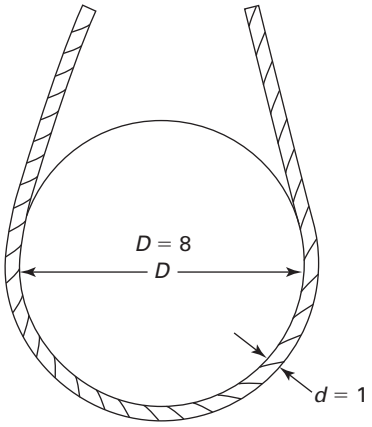


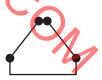
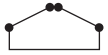

**Fig. 9-4.5.1-3 *D/d* Ratio**




GENERAL NOTE: When $D$ is 8 times the component rope diameter ($d$), the $D/d$ is expressed as 8/1.

## Table 9-4.5.2-1 Nylon Rope Slings

Based on Design Factor = 5 and Rated Loads Expressed in Pounds (lb)

| Hitch Type / Rope Diameter, in. | Eye-and-Eye Slings | | | | | | Endless Slings | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Two-Leg Bridle or Basket | | | | | | Basket | | | |
| | | | Horizontal Angle, deg | | | | | | Horizontal Angle, deg | | | |
| | Vertical | Choker | 90 | 60 | 45 | 30 | Vertical | Choker | 90 | 60 | 45 | 30 |
| |  |  |  |  |  |  |  |  |  |  |  |  |
| 1/2 | 1,100 | 830 | 2,200 | 1,900 | 1,600 | 1,100 | 2,000 | 1,500 | 4,000 | 3,500 | 2,800 | 2,000 |
| 9/16 | 1,400 | 1,100 | 2,800 | 2,400 | 2,000 | 1,400 | 2,600 | 2,000 | 5,200 | 4,500 | 3,700 | 2,600 |
| 5/8 | 1,800 | 1,400 | 3,600 | 3,100 | 2,500 | 1,800 | 3,200 | 2,400 | 6,400 | 5,500 | 4,500 | 3,200 |
| 3/4 | 2,600 | 2,000 | 5,200 | 4,500 | 3,700 | 2,600 | 4,600 | 3,500 | 9,200 | 8,000 | 6,500 | 4,600 |
| 7/8 | 3,500 | 2,600 | 7,000 | 6,100 | 4,900 | 3,500 | 6,200 | 4,700 | 12,400 | 10,700 | 8,800 | 6,200 |
| 1 | 4,400 | 3,300 | 8,800 | 7,600 | 6,200 | 4,400 | 7,900 | 5,900 | 15,800 | 13,700 | 11,200 | 7,900 |
| 1 1/8 | 5,700 | 4,300 | 11,400 | 9,900 | 8,100 | 5,700 | 10,100 | 7,600 | 20,200 | 17,500 | 14,300 | 10,100 |
| 1 1/4 | 7,000 | 5,300 | 14,000 | 12,100 | 9,900 | 7,000 | 12,400 | 9,300 | 24,800 | 21,500 | 17,500 | 12,400 |
| 1 5/16 | 7,700 | 5,800 | 15,400 | 13,300 | 10,900 | 7,700 | 13,700 | 10,300 | 27,400 | 23,700 | 19,400 | 13,700 |
| 1 1/2 | 9,700 | 7,300 | 19,400 | 16,800 | 13,700 | 9,700 | 17,400 | 13,100 | 34,800 | 30,100 | 24,600 | 17,400 |
| 1 5/8 | 11,500 | 8,600 | 23,000 | 19,900 | 16,300 | 11,500 | 20,500 | 15,400 | 41,000 | 35,500 | 29,000 | 20,500 |
| 1 3/4 | 13,200 | 9,900 | 26,400 | 22,900 | 18,700 | 13,200 | 23,600 | 17,700 | 47,200 | 40,900 | 33,400 | 23,600 |
| 2 | 16,900 | 12,700 | 33,800 | 29,300 | 23,900 | 16,900 | 30,200 | 22,700 | 60,400 | 52,300 | 42,700 | 30,200 |
| 2 1/8 | 19,100 | 14,300 | 38,200 | 33,100 | 27,000 | 19,100 | 34,100 | 25,600 | 68,200 | 59,100 | 48,200 | 34,100 |
| 2 1/4 | 21,400 | 16,100 | 42,800 | 37,100 | 30,300 | 21,400 | 38,300 | 28,700 | 76,600 | 66,300 | 54,200 | 38,300 |
| 2 1/2 | 26,300 | 19,700 | 52,600 | 45,600 | 37,200 | 26,300 | 46,900 | 35,200 | 93,800 | 81,200 | 66,300 | 46,900 |
| 2 5/8 | 28,800 | 21,600 | 57,600 | 49,900 | 40,700 | 28,800 | 51,400 | 38,600 | 102,800 | 89,000 | 72,700 | 51,400 |
| 3 | 37,100 | 27,800 | 74,200 | 64,300 | 52,500 | 37,100 | 66,200 | 49,700 | 132,400 | 114,700 | 93,600 | 66,200 |

GENERAL NOTES:

(a) See Fig. 9-4.0-1 for sling types, Fig. 9-4.5.1-1 for hitch types, and Fig. 9-4.5.1-2 for sling angle descriptions. For $D/d$ considerations, see note in Fig. 9-4.5.1-1 and para. 9-4.10.1(f).

(b) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-4.5.4).

## Table 9-4.5.2-2 Polyester Rope Slings

Based on Design Factor = 5 and Rated Loads Expressed in Pounds (lb)

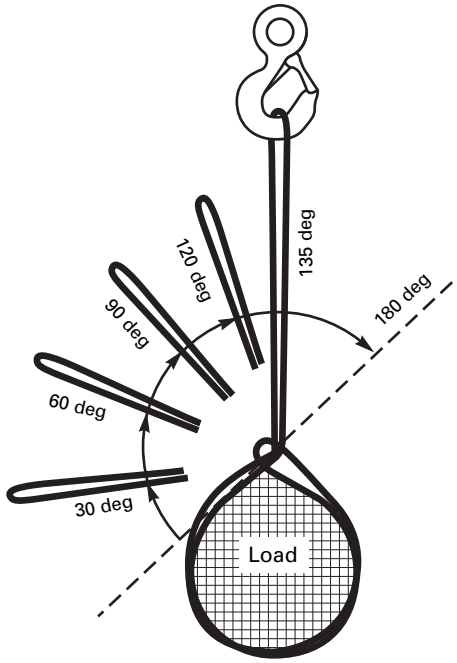
| | Eye-and-Eye Slings | | | | | | Endless Slings | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Basket | | | | | | Basket | | | |
| | | | Horizontal Angle, deg | | | | | | Horizontal Angle, deg | | | |
| Hitch Type | Vertical | Choker | 90 | 60 | 45 | 30 | Vertical | Choker | 90 | 60 | 45 | 30 |
| Rope Diameter, in. |  |  |  |  |  |  |  |  |  |  |  |  |
| 1/2 | 1,000 | 750 | 2,000 | 1,700 | 1,400 | 1,000 | 1,800 | 1,400 | 3,600 | 3,100 | 2,500 | 1,800 |
| 9/16 | 1,300 | 980 | 2,600 | 2,300 | 1,800 | 1,300 | 2,300 | 1,700 | 4,600 | 4,000 | 3,300 | 2,300 |
| 5/8 | 1,600 | 1,200 | 3,200 | 2,800 | 2,300 | 1,600 | 2,800 | 2,100 | 5,600 | 4,800 | 4,000 | 2,800 |
| 3/4 | 2,200 | 1,700 | 4,400 | 3,800 | 3,100 | 2,200 | 4,000 | 3,000 | 8,000 | 6,900 | 5,700 | 4,000 |
| 7/8 | 3,000 | 2,300 | 6,000 | 5,200 | 4,200 | 3,000 | 5,400 | 4,100 | 10,800 | 9,400 | 7,600 | 5,400 |
| 1 | 4,000 | 3,000 | 8,000 | 6,900 | 5,700 | 4,000 | 7,100 | 5,300 | 14,200 | 12,300 | 10,000 | 7,100 |
| 1 1/8 | 5,000 | 3,800 | 10,000 | 8,700 | 7,100 | 5,000 | 8,900 | 6,700 | 17,800 | 15,400 | 12,600 | 8,900 |
| 1 1/4 | 6,000 | 4,500 | 12,000 | 10,400 | 8,500 | 6,000 | 10,600 | 8,000 | 21,200 | 18,400 | 15,000 | 10,600 |
| 1 5/16 | 6,500 | 4,900 | 13,000 | 11,300 | 9,200 | 6,500 | 11,600 | 8,700 | 23,200 | 20,100 | 16,400 | 11,600 |
| 1 1/2 | 8,400 | 6,300 | 16,800 | 14,500 | 11,900 | 8,400 | 15,100 | 11,300 | 30,200 | 26,200 | 21,400 | 15,100 |
| 1 5/8 | 9,900 | 7,400 | 19,800 | 17,100 | 14,000 | 9,900 | 17,600 | 13,200 | 35,200 | 30,500 | 24,900 | 17,600 |
| 1 3/4 | 11,400 | 8,600 | 22,800 | 19,700 | 16,100 | 11,400 | 20,400 | 15,300 | 40,800 | 35,300 | 28,800 | 20,400 |
| 2 | 14,400 | 10,800 | 28,800 | 24,900 | 20,400 | 14,400 | 25,700 | 19,300 | 51,400 | 44,500 | 36,300 | 25,700 |
| 2 1/8 | 16,200 | 12,200 | 32,400 | 28,100 | 22,900 | 16,200 | 28,900 | 21,700 | 57,800 | 50,100 | 40,900 | 28,900 |
| 2 1/4 | 18,100 | 13,600 | 36,200 | 31,300 | 25,600 | 18,100 | 32,300 | 24,200 | 64,600 | 55,900 | 45,700 | 32,300 |
| 2 1/2 | 22,000 | 16,500 | 44,000 | 38,100 | 31,100 | 22,000 | 39,300 | 29,500 | 78,600 | 68,100 | 55,600 | 39,300 |
| 2 5/8 | 24,200 | 18,200 | 48,400 | 41,900 | 34,200 | 24,200 | 43,200 | 32,400 | 86,400 | 74,800 | 61,100 | 43,200 |
| 3 | 31,200 | 23,400 | 62,400 | 54,000 | 44,100 | 31,200 | 55,700 | 41,800 | 111,400 | 96,500 | 78,800 | 55,700 |

GENERAL NOTES:

(a) See Fig. 9-4.0-1 for sling types, Fig. 9-4.5.1-1 for hitch types, and Fig. 9-4.5.1-2 for sling angle descriptions. For $D/d$ considerations, see note in Fig. 9-4.5.1-1 and para. 9-4.10.1(f).

(b) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-4.5.4).

**Fig. 9-4.5.4-1 Angle of Choke**




| Angle of Choke, deg | Rated Capacity, % [Note (1)] |
|---|---|
| Over 120 | 100 |
| 90–120 | 87 |
| 60–89 | 74 |
| 30–59 | 62 |
| 0–29 | 49 |

NOTE:
(1) Percent of sling rated capacity in a choker hitch.

(10) **9-4.5.4**

Tables 9-4.5.2-1 and 9-4.5.2-2 show rated loads for choker hitches for specific grades of synthetic fiber rope, provided that the angle of choke is 120 deg or greater (see Fig. 9-4.5.4-1).

**9-4.5.5**

Rated loads for angles of choke less than 120 deg shall be determined by using the values in Fig. 9-4.5.4-1, the sling manufacturer, or a qualified person.

**9-4.5.6**

Other synthetic rope materials and configurations not covered by this Chapter shall be rated in accordance with the recommendation of the sling manufacturer or a qualified person, and shall conform to all other provisions of this Chapter.

**9-4.5.7**

When components of the sling have a lower rated load than the synthetic rope with which it is being used, the sling shall be identified with a rated load consistent with the lowest load rating of any of the components.

## SECTION 9-4.6: PROOF TEST REQUIREMENTS

### 9-4.6.1 General

*(a)* Prior to initial use, all synthetic fiber rope slings incorporating previously used or welded fittings and all repaired slings shall be proof tested by the sling manufacturer or a qualified person.

*(b)* All other new synthetic fiber rope slings and fittings are not required to be proof tested unless specified by the purchaser.

### 9-4.6.2 Proof Load Requirements

*(a)* For single- or multiple-leg slings and endless slings, each leg shall be proof loaded to a minimum of 2 times the single-leg vertical hitch rated load.

*(b)* The proof load for fittings attached to single legs shall be a minimum of 2 times the single-leg vertical hitch rated load.

*(c)* Master links for two-leg bridle slings shall be proof loaded to a minimum of 4 times the single-leg vertical hitch rated load.

*(d)* Master links for three-leg bridle slings shall be proof loaded to a minimum of 6 times the single-leg vertical hitch rated load.

*(e)* Master links for four-leg bridle slings shall be proof loaded to a minimum of 8 times the single-leg vertical hitch rated load.

## SECTION 9-4.7: SLING IDENTIFICATION

### 9-4.7.1 Identification Requirements (10)

Each sling shall be marked to show
*(a)* name or trademark of manufacturer
*(b)* manufacturer's code or stock number
*(c)* rated load for at least one hitch type and the angle upon which it is based
*(d)* type of fiber material
*(e)* number of legs, if more than one

### 9-4.7.2 Initial Sling Identification

Sling identification shall be done by the sling manufacturer.

### 9-4.7.3 Maintenance of Sling Identification

Sling identification should be maintained by the user so as to be legible during the life of the sling.

### 9-4.7.4 Replacement of Sling Identification

Replacement of the sling identification shall be considered a repair as specified in paras. 9-4.9.5(a) and (b). Additional proof testing is not required.

## SECTION 9-4.8: EFFECTS OF ENVIRONMENT

### 9-4.8.1 Temperature

*(a)* Polyester and nylon rope slings shall not be used in contact with objects or at temperatures in excess of 194°F (90°C) or at temperatures below −40°F (−40°C).

*(b)* Some synthetic yarns do not retain their published breaking strength during long-term exposure above 140°F (60°C). The rope sling manufacturer should be consulted for the effects of long-term heat exposure.

### 9-4.8.2 Chemically Active Environments

The strength of synthetic rope slings can be degraded by chemically active environments. This includes exposure to chemicals in the form of solids, liquids, gases, vapors, or fumes. The sling manufacturer or qualified person should be consulted before slings are used in chemically active environments.

### 9-4.8.3 Sunlight and Ultraviolet Light

The strength of synthetic rope slings is degraded by exposure to sunlight or ultraviolet light. The sling manufacturer or qualified person should be consulted for additional retirement or inspection requirements. For additional degradation information, see CI 2001-04.

## SECTION 9-4.9: INSPECTION, REMOVAL, AND REPAIR

### 9-4.9.1 Initial Inspection

Prior to use, all new, altered, modified, or repaired slings shall be inspected by a designated person to verify compliance with the applicable provisions of this Chapter.

### 9-4.9.2 Frequent Inspection

*(a)* A visual inspection for damage shall be performed by the user or other designated person each day or shift the sling is used.

*(b)* Conditions such as those listed in para. 9-4.9.4 or any other condition that may result in a hazard shall cause the sling to be removed from service. Slings shall not be returned to service until approved by a qualified person.

*(c)* Written records are not required for frequent inspections.

(10) ### 9-4.9.3 Periodic Inspection

*(a)* A complete inspection for damage to the sling shall be periodically performed by a designated person. Each sling and component shall be examined individually, taking care to expose and examine all surfaces. Inspection shall be conducted on the entire length including splices, end attachments, and fittings. The sling shall be examined for conditions such as those listed in para. 9-4.9.4 and a determination made as to whether they constitute a hazard.

*(b) Periodic Inspection Frequency.* Periodic inspection intervals shall not exceed 1 yr. The frequency of periodic inspections should be based on

*(1)* frequency of sling use

*(2)* severity of service conditions

*(3)* nature of lifts being made

*(4)* experience gained on the service life of slings used in similar circumstances

*(c)* Guidelines for the time intervals are

*(1)* normal service — yearly

*(2)* severe service — monthly to quarterly

*(3)* special service — as recommended by a qualified person

*(d)* Documentation that the most recent periodic inspection was performed shall be maintained.

*(e)* Inspection records of individual slings are not required.

### 9-4.9.4 Removal Criteria

A synthetic rope sling shall be removed from service if conditions such as the following are present:

*(a)* missing or illegible sling identification (see Section 9-4.7)

*(b)* cuts, gouges, areas of extensive fiber breakage along the length, and abraded areas on the rope

*(c)* damage that is estimated to have reduced the effective diameter of the rope by more than 10%

*(d)* uniform fiber breakage along the major part of the length of the rope in the sling such that the entire rope appears covered with fuzz or whiskers

*(e)* inside the rope, fiber breakage, fused or melted fiber (observed by prying or twisting to open the strands) involving damage estimated at 10% of the fiber in any strand or the rope as a whole

*(f)* discoloration, brittle fibers, and hard or stiff areas that may indicate chemical damage, ultraviolet damage, or heat damage

*(g)* dirt and grit in the interior of the rope structure that is deemed excessive

*(h)* foreign matter that has permeated the rope and makes it difficult to handle and may attract and hold grit

*(i)* kinks or distortion in the rope structure, particularly if caused by forcibly pulling on loops (known as hockles)

*(j)* melted, hard, or charred areas that affect more than 10% of the diameter of the rope or affect several adjacent strands along the length that affect more than 10% of strand diameters

*(k)* poor condition of thimbles or other components manifested by corrosion, cracks, distortion, sharp edges, or localized wear

*(l)* for hooks, removal criteria as stated in ASME B30.10

*(m)* for rigging hardware, removal criteria as stated in ASME B30.26

*(n)* other visible damage that causes doubt as to the strength of the sling

(10) **9-4.9.5 Repair**

*(a)* Slings shall be repaired only by the sling manufacturer or a qualified person.

*(b)* A repaired sling shall be marked to identify the repairing agency per Section 9-4.7.

*(c)* Components used for sling repair shall comply with the provisions of this Chapter.

*(d)* The ropes that make up the sling shall not be respliced or knotted to effect repairs.

*(e)* All repairs shall comply with the proof test requirements of Section 9-4.6.

*(f)* Modifications, alterations, or repairs to end attachments or fittings shall be approved by the sling manufacturer, fitting or component manufacturer, or a qualified person and shall conform to all other provisions of the Chapter.

*(g)* Repair of hooks (ASME B30.10), rigging hardware (ASME B30.26), below-the-hook lifting devices (ASME B30.20), or other special devices shall comply with the repair instructions in the applicable volumes.

## SECTION 9-4.10: OPERATING PRACTICES

### 9-4.10.1 Sling Selection

*(a)* Slings that appear to be damaged shall not be used unless inspected and accepted as usable under Section 9-4.9.

*(b)* Slings having suitable characteristics for the type of load, hitch, and environment shall be selected in accordance with the requirements of Sections 9-4.5 and 9-4.8.

*(c)* The rated load of the sling shall not be exceeded.

*(d)* For multiple-leg slings used with nonsymmetrical loads, an analysis by a qualified person should be performed to prevent overloading of any leg.

*(e)* Multiple-leg slings shall be selected according to Tables 9-4.5.2-1 and 9-4.5.2-2 when used at the specific angles given in the table. Operation at other angles shall be limited to rated loads of the next lower angle given in the table or calculated by a qualified person.

*(f)* When $D/d$ ratios (see Fig. 9-4.5.1-3) smaller than those cited in Fig. 9-4.5.1-1 are necessary, the rated load of the sling shall be decreased. Consult the sling manufacturer or a qualified person.

*(g)* The component shall be of the proper shape and size to ensure that it is properly seated in the hook or lifting device.

### 9-4.10.2 Cautions to Personnel

*(a)* All portions of the human body shall be kept from between the sling and the load, and from between the sling and the crane hook or hoist hook.

*(b)* Personnel should never stand in line with or next to the leg(s) of a sling that is under tension.

*(c)* Personnel shall not stand or pass under a suspended load.

*(d)* Personnel shall not ride the sling.

*(e)* Synthetic rope slings shall not be used as bridles on suspended personnel platforms.

### 9-4.10.3 Effects of Environment

*(a)* Slings should be stored in an area where they will not be subjected to mechanical, chemical, or ultraviolet damage or extreme temperatures (see Section 9-4.8).

*(b)* When used at or in contact with extreme temperatures, the guidance provided in Section 9-4.8 shall be followed.

*(c)* Do not store nylon ropes in areas where they may become impregnated with rust.

*(d)* Slings exposed to salt water should be thoroughly rinsed with fresh water to prevent mechanical damage from salt crystals when the rope dries.

### 9-4.10.4 Rigging Practices

*(a)* Slings shall be shortened or adjusted only by methods approved by the sling manufacturer or a qualified person.

*(b)* Slings shall not be shortened or lengthened by knotting or twisting.

*(c)* The sling shall be hitched in a manner providing control of the load.

*(d)* Slings in contact with edges, corners, protrusions, or abrasive surfaces shall be protected with a material of sufficient strength, thickness, and construction to prevent damage.

*(e)* Shock loading should be avoided.

*(f)* Loads should not be rested on the sling.

*(g)* Slings should not be pulled from under a load when the load is resting on the sling.

*(h)* Twisting and kinking shall be avoided.

*(i)* During lifting, with or without load, personnel shall be alert for possible snagging.

*(j)* When using multiple basket or choker hitches, the load should be rigged to prevent the sling from slipping or sliding along the load.

*(k)* When using a basket hitch, the legs of the sling should contain or support the load from the sides, above the center of gravity, so that the load remains under control.

*(l)* Slings should not be dragged on the floor or over an abrasive surface.

*(m)* In a choker hitch, the choke point should only be on the sling body, not on a splice or fitting.

*(n)* In a choker hitch, an angle of choke less than 120 deg should not be used without reducing the rated load (see para. 9-4.5.5).

*(o)* Slings should not be constricted, bunched, or pinched by the load, hook, or any fitting.

*(p)* The load applied to the hook should be centered in the base (bowl) of the hook to prevent point loading on the hook, unless the hook is designed for point loading.

*(q)* An object in the eye of a sling should not be wider than one-third the length of the eye.

*(r)* Sling and load shall not be allowed to rotate when hand-tucked slings are used in a single-leg vertical lift application. Care shall be taken to minimize sling rotation.

# Chapter 9-5
# Synthetic Webbing Slings: Selection, Use, and Maintenance

## SECTION 9-5.0: SCOPE

Chapter 9-5 includes provisions that apply to synthetic webbing slings (see Figs. 9-5.0-1 and 9-5.0-2).

## SECTION 9-5.1: TRAINING

Synthetic webbing sling users shall be trained in the selection, inspection, cautions to personnel, effects of the environment, and rigging practices as covered by this Chapter.

## SECTION 9-5.2: MATERIALS AND COMPONENTS

### 9-5.2.1 Webbing

The synthetic webbing shall be manufactured and tested in accordance with WSTDA-WB-1.

### 9-5.2.2 Thread

The thread used in the fabrication of synthetic webbing slings shall be manufactured and tested in accordance with WSTDA-TH-1.

### 9-5.2.3 Coatings

Finishes and coatings shall be compatible with the other components and not impair the performance of the sling.

### 9-5.2.4 Components

*(a)* Fittings shall be manufactured to ensure that the rated load shall be at least the same as the synthetic webbing sling.

*(b)* Fittings shall have sufficient strength to sustain twice the rated load of the sling without visible permanent deformation.

*(c)* All surfaces of fittings shall be cleanly finished and sharp edges removed.

*(d)* Hooks, when employed, shall meet the requirements of ASME B30.10.

*(e)* Rigging hardware, when employed, shall meet the requirements of ASME B30.26.

(10) ### 9-5.2.5 Other Materials

Synthetic webbings or components other than those listed in paras. 9-5.2.1 and 9-5.2.4 may be employed. When such materials are employed, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-5.3: FABRICATION AND CONFIGURATIONS

### 9-5.3.1 Fabrication

*(a)* Stitching shall be the method for fabricating synthetic webbing slings.

*(b)* The thread shall be the same yarn type as the sling webbing.

*(c)* The diameter and width of the bearing surface of the fitting can affect the strength of the sling. The sling manufacturer's recommendation should be followed when fittings are used with the sling.

### 9-5.3.2 Configurations

*(a)* Single-leg slings and two-leg, three-leg, and four-leg bridle slings used in vertical, choker, and basket hitches are covered by this Chapter.

*(b)* One-ply, two-ply, and four-ply slings are covered by this Chapter.

*(c)* Other configurations may be used. When used, the sling manufacturer or a qualified person shall provide specific data. These slings shall comply with all other requirements of this Chapter.

## SECTION 9-5.4: DESIGN FACTOR

The design factor for synthetic webbing slings shall be a minimum of 5.

## SECTION 9-5.5: RATED LOAD

The term *rated capacity* is commonly used to describe rated load.

### 9-5.5.1 (10)

These rated loads are based on the following factors:

*(a)* material strength(s)

*(b)* design factor

*(c)* type of hitch

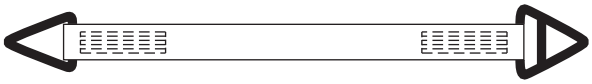
*(d)* angle of loading (see Fig. 9-5.5.1-1)

*(e)* diameter of curvature over which the sling is used

*(f)* fabrication efficiency

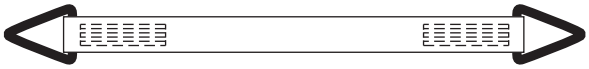
NOTE: Rated loads for basket hitches and bridle slings are based on symmetrical loading. See para. 9-5.10.1(d) for nonsymmetrical loading.

**Fig. 9-5.0-1 Synthetic Webbing Slings**



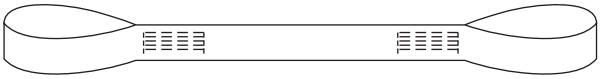
Sling made with a triangle fitting on one end and a slotted triangle choker fitting on the other end. It can be used in a vertical, basket, or choker hitch.

**Type I**



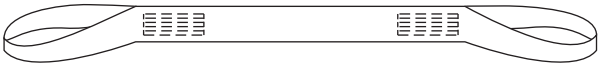
Sling made with a triangle fitting on both ends. It can be used in a vertical or basket hitch only.

**Type II**



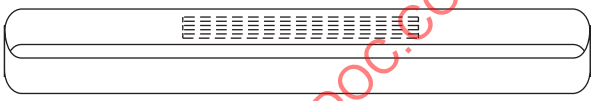
Sling made with a flat loop eye on each end with loop eye opening on same plane as sling body. This type of sling is sometimes called a flat eye-and-eye, eye-and-eye, or double-eye sling.

**Type III**



Sling made with both loop eyes formed as in Type III, except that the loop eyes are turned to form a loop eye which is at a right angle to the plane of the sling body. This type of sling is commonly referred to as a twisted-eye sling.

**Type IV**



Endless sling, sometimes referred to as a grommet. It is a continuous loop formed by joining the ends of the webbing together.

**Type V**

Return-eye (reversed-eye) sling is formed by using multiple widths of webbing held edge-to-edge. A wear pad is attached on one or both sides of the sling body and on one or both sides of the loop eyes to form a loop eye at each end which is at a right angle to the plane of the sling body.

**Type VI**

**Fig. 9-5.0-2 Synthetic Webbing Sling Nomenclature (10)**

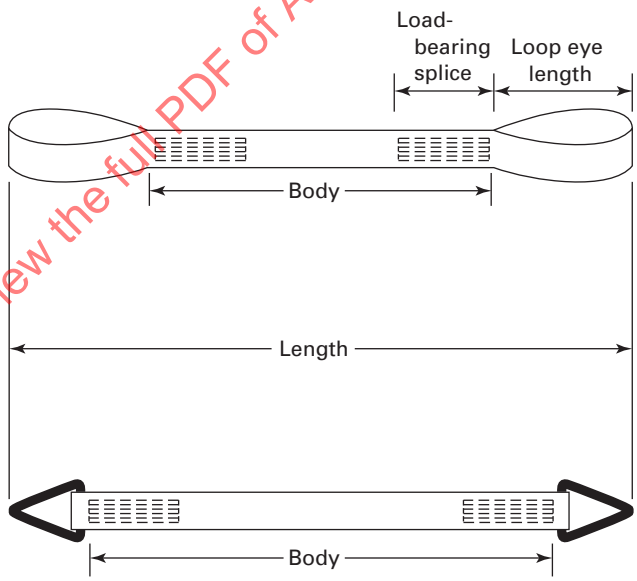
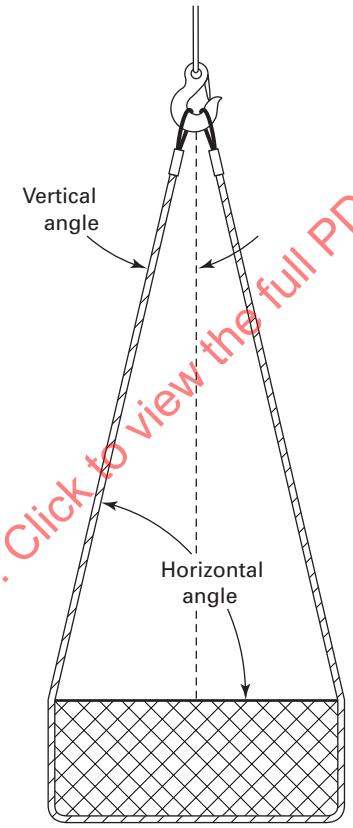


**Fig. 9-5.5.1-1 Angle of Loading**



(10) **Table 9-5.5.2-1 Rated Load for One-Ply, Class 5 Synthetic Webbing Slings**

| Hitch Type / Width, in. | Types I, II, III, and IV: Single-Leg: Vertical | Choker | Vertical Basket | Two-Leg or Single Basket: Horizontal Angle: Vertical | 60 deg | 45 deg | 30 deg | Type V: Endless Vertical |
|---|---|---|---|---|---|---|---|---|
| 1 | 1,100 | 880 | 2,200 | 2,200 | 1,900 | 1,600 | 1,100 | 2,200 |
| 1½ | 1,600 | 1,280 | 3,200 | 3,200 | 2,800 | 2,300 | 1,600 | 3,200 |
| 1¾ | 1,900 | 1,520 | 3,800 | 3,800 | 3,300 | 2,700 | 1,900 | 3,800 |
| 2 | 2,200 | 1,760 | 4,400 | 4,400 | 3,800 | 3,100 | 2,200 | 4,400 |
| 3 | 3,300 | 2,640 | 6,600 | 6,600 | 5,700 | 4,700 | 3,300 | 6,600 |
| 4 | 4,400 | 3,520 | 8,800 | 8,800 | 7,600 | 6,200 | 4,400 | 8,800 |
| 5 | 5,500 | 4,400 | 11,000 | 11,000 | 9,500 | 7,800 | 5,500 | 11,000 |
| 6 | 6,600 | 5,280 | 13,200 | 13,200 | 11,400 | 9,300 | 6,600 | 13,200 |

GENERAL NOTES:

(a) Rated loads cited in this Chapter are based on pin diameters shown in WSTDA-WS-I. Pin diameters smaller than these may reduce the rated load of the sling.

(b) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 6,800 lb/in. of width of the webbing.

(c) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.

(d) For Type VI slings, consult the manufacturer for rated loads.

(e) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-5.5.4).



### 9-5.5.2

Tables 9-5.5.2-1 through 9-5.5.2-5 show rated loads for single-leg vertical, choker, and basket hitches, and two-leg bridle slings. For angles other than those shown in these tables, use the rated load for the next lower angle, or a qualified person shall calculate the rated load.

(10) ### 9-5.5.3

Horizontal sling angles less than 30 deg shall not be used except as recommended by the sling manufacturer or a qualified person (see Fig. 9-5.5.1-1).

(10) ### 9-5.5.4

Tables 9-5.5.2-1 through 9-5.5.2-5 show rated loads for choker hitches for specific types of synthetic webbing slings, provided that the angle of choke is 120 deg or greater (see Fig. 9-5.5.4-1).

### 9-5.5.5

Rated loads for angles of choke less than 120 deg shall be determined by using the values in Fig. 9-5.5.4-1, the sling manufacturer, or a qualified person.

### 9-5.5.6

Other synthetic webbing materials and configurations not covered by this Chapter shall be rated in accordance with the recommendation of the sling manufacturer or a qualified person, and shall conform to all other provisions of this Chapter.

### 9-5.5.7

When components of the sling have a lower rated load than the synthetic webbing with which it is being used, the sling shall be identified with a rated load consistent with the lowest load rating of any of the components.

## SECTION 9-5.6: PROOF TEST REQUIREMENTS

### 9-5.6.1 General (10)

*(a)* Prior to initial use, all synthetic webbing slings incorporating previously used or welded fittings and all repaired slings shall be proof tested by the sling manufacturer or a qualified person.

*(b)* All other new synthetic webbing slings and fittings are not required to be proof tested unless specified by the purchaser.

### 9-5.6.2 Proof Load Requirements

*(a)* For single- or multiple-leg slings and endless slings, each leg shall be proof loaded to 2 times the single-leg vertical hitch rated load.

*(b)* The proof load for fittings attached to single legs shall be a minimum of 2 times the single-leg vertical hitch rated load.

## Table 9-5.5.2-2 Rated Load for Two-Ply, Class 5 Synthetic Webbing Slings (10)

| Hitch Type / Width, in. | Types I, II, III, and IV: Single-Leg: Vertical | Choker | Vertical Basket | Two-Leg or Single Basket: Horizontal Angle: Vertical | 60 deg | 45 deg | 30 deg | Type V: Endless Vertical |
|---|---|---|---|---|---|---|---|---|
| 1 | 2,200 | 1,760 | 4,400 | 4,400 | 3,800 | 3,100 | 2,200 | 4,400 |
| 1½ | 3,300 | 2,640 | 6,600 | 6,600 | 5,700 | 4,700 | 3,300 | 6,600 |
| 1¾ | 3,800 | 3,040 | 7,600 | 7,600 | 6,600 | 5,400 | 3,800 | 7,600 |
| 2 | 4,400 | 3,520 | 8,800 | 8,800 | 7,600 | 6,200 | 4,400 | 8,800 |
| 3 | 6,600 | 5,280 | 13,200 | 13,200 | 11,400 | 9,300 | 6,600 | 13,200 |
| 4 | 8,200 | 6,560 | 16,400 | 16,400 | 14,200 | 11,600 | 8,200 | 16,400 |
| 5 | 10,200 | 8,160 | 20,400 | 20,400 | 17,700 | 14,400 | 10,200 | 20,400 |
| 6 | 12,300 | 9,840 | 24,600 | 24,600 | 21,300 | 17,400 | 12,300 | 24,600 |

GENERAL NOTES:

(a) Rated loads cited in this Chapter are based on pin diameters shown in WSTDA-WS-I. Pin diameters smaller than these may reduce the rated load of the sling.

(b) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 6,800 lb/in. of width of the webbing.

(c) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.

(d) For Type VI slings, consult the manufacturer for rated loads.

(e) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-5.5.4).

## Table 9-5.5.2-3 Rated Load for One-Ply, Class 7 Synthetic Webbing Slings (10)

| Hitch Type / Width, in. | Types I, II, III, and IV: Single-Leg: Vertical | Choker | Vertical Basket | Two-Leg or Single-Basket: Horizontal Angle: Vertical | 60 deg | 45 deg | 30 deg | Type V: Endless Vertical |
|---|---|---|---|---|---|---|---|---|
| 1 | 1,600 | 1,280 | 3,200 | 3,200 | 2,800 | 2,300 | 1,600 | 3,200 |
| 1½ | 2,300 | 1,840 | 4,600 | 4,600 | 4,000 | 3,300 | 2,300 | 4,600 |
| 1¾ | 2,700 | 2,160 | 5,400 | 5,400 | 4,700 | 3,800 | 2,700 | 5,400 |
| 2 | 3,100 | 2,480 | 6,200 | 6,200 | 5,400 | 4,400 | 3,100 | 6,200 |
| 3 | 4,700 | 3,760 | 9,400 | 9,400 | 8,100 | 6,600 | 4,700 | 9,400 |
| 4 | 6,200 | 4,960 | 12,400 | 12,400 | 10,700 | 8,800 | 6,200 | 12,400 |
| 5 | 7,800 | 6,240 | 15,600 | 15,600 | 13,500 | 11,000 | 7,800 | 15,600 |
| 6 | 9,300 | 7,440 | 18,600 | 18,600 | 16,100 | 13,200 | 9,300 | 18,600 |
| 8 | 11,800 | 9,440 | 23,600 | 23,600 | 20,400 | 16,700 | 11,800 | 23,600 |
| 10 | 14,700 | 11,760 | 29,400 | 29,400 | 25,500 | 20,800 | 14,700 | 29,400 |
| 12 | 17,600 | 14,080 | 35,200 | 35,200 | 30,500 | 24,900 | 17,600 | 35,200 |

GENERAL NOTES:

(a) Rated loads cited in this Chapter are based on pin diameters shown in WSTDA-WS-I. Pin diameters smaller than these may reduce the rated load of the sling.

(b) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 9,800 lb/in. of width of the webbing.

(c) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.

(d) For Type VI slings, consult the manufacturer for rated loads.

(e) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-5.5.4).

(10)

## Table 9-5.5.2-4 Rated Load for Two-Ply, Class 7 Synthetic Webbing Slings

| | Types I, II, III, and IV | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Single-Leg | | | Two-Leg or Single-Basket | | | | Type V |
| | | | | Horizontal Angle | | | | |
| Hitch Type / Width, in. | Vertical | Choker | Vertical Basket | Vertical | 60 deg | 45 deg | 30 deg | Endless Vertical |
| 1 | 3,100 | 2,480 | 6,200 | 6,200 | 5,400 | 4,400 | 3,100 | 6,200 |
| 1½ | 4,700 | 3,760 | 9,400 | 9,400 | 8,100 | 6,600 | 4,700 | 9,400 |
| 1¾ | 5,400 | 4,320 | 10,800 | 10,800 | 9,400 | 7,600 | 5,400 | 10,800 |
| 2 | 6,200 | 4,960 | 12,400 | 12,400 | 10,700 | 8,800 | 6,200 | 12,400 |
| 3 | 8,800 | 7,040 | 17,600 | 17,600 | 15,200 | 12,400 | 8,800 | 17,600 |
| 4 | 11,000 | 8,800 | 22,000 | 22,000 | 19,100 | 15,600 | 11,000 | 22,000 |
| 5 | 13,700 | 10,960 | 27,400 | 27,400 | 23,700 | 19,400 | 13,700 | 27,400 |
| 6 | 16,500 | 13,200 | 33,000 | 33,000 | 28,600 | 23,000 | 16,500 | 33,000 |
| 8 | 22,700 | 18,160 | 45,400 | 45,400 | 39,300 | 32,100 | 22,700 | 45,400 |
| 10 | 28,400 | 22,720 | 56,800 | 56,800 | 49,200 | 40,200 | 28,400 | 56,800 |
| 12 | 34,100 | 27,280 | 68,200 | 68,200 | 59,100 | 48,200 | 34,100 | 68,200 |

GENERAL NOTES:

(a) Rated loads cited in this Chapter are based on pin diameters shown in WSTDA-WS-I. Pin diameters smaller than these may reduce the rated load of the sling.

(b) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 9,800 lb/in. of width of the webbing.

(c) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.

(d) For Type VI slings, consult the manufacturer for rated loads.

(e) For choker hitch, the angle of choke shall be 120 deg or greater (see para. 9-5.5.4).

(10)

## Table 9-5.5.2-5 Rated Load for Four-Ply, Class 7 Synthetic Webbing Slings

| | Single-Leg | | | Types I, II, III, and IV | | | |
|---|---|---|---|---|---|---|---|
| | | | | Two-Leg or Single Basket | | | |
| | | | | Horizontal Angle | | | |
| Hitch Type / Width, in. | Vertical | Choker | Vertical Basket | Vertical | 60 deg | 45 deg | 30 deg |
| 1 | 5,500 | 4,400 | 11,000 | 11,000 | 9,500 | 7,800 | 5,500 |
| 2 | 11,000 | 8,800 | 22,000 | 22,000 | 19,100 | 15,600 | 11,000 |
| 3 | 16,400 | 13,120 | 32,800 | 32,800 | 28,400 | 23,200 | 16,400 |
| 4 | 20,400 | 16,320 | 40,800 | 40,800 | 35,300 | 28,800 | 20,400 |
| 5 | 25,500 | 20,400 | 51,000 | 51,000 | 44,200 | 36,100 | 25,500 |
| 6 | 30,600 | 24,480 | 61,200 | 61,200 | 53,000 | 43,300 | 30,600 |

GENERAL NOTES:

(a) Rated loads cited in this Chapter are based on pin diameters shown in WSTDA-WS-I. Pin diameters smaller than these may reduce the rated load of the sling.

(b) The rated loads are based on stuffer weave construction webbing with a minimum certified tensile strength of 9,800 lb/in. of width of the webbing.

(c) Rated loads for Types III and IV slings apply to both tapered and nontapered eye constructions. Rated loads for Type V slings are based on nontapered webbing.

(d) For Types VI and V slings, consult the manufacturer for rated loads.

(e) For choker hitch, the angle of choke shall be 120 deg greater (see para. 9-5.5.4).