





INTRODUCTION

This manual is provided as a users' guide for the various lifting, pulling, and binding products available from Columbus McKinnon Corporation. It is not an all-encompassing guide to the broad and detailed subjects of lifting, rigging, and load binding; but is intended to educate users on general applications and uses of Columbus McKinnon's products. It will also serve to educate inspectors and maintenance personnel on inspection requirements and maintenance criteria for these products. This manual provides sufficient information which, when properly implemented, assures safe product use.

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#### NOTE:

Columbus McKinnon Corporation assumes no responsibility for the misuse or misapplication of any of its products. Products are provided with the express understanding that the purchaser and/or user are thoroughly familiar with the correct application and proper use of such products in rigging. Warnings and definitions are provided as an aid to the user in understanding the correct application and for proper use of the product.

**Working Load Limit**—refers to the maximum load (rated capacity) in pounds that shall be applied to the product. See Working Load Limits in Table II, Table IV, and Table V. The manufacturer does not accept any liability for damages which result from their products being used in excess of the working load limit or from abuse.

**<u>ASTM</u>**—American Society of Testing and Materials. Specifications published by ASTM, 100 Bar Harbor Drive, W. Conshohocken, PA, 19428-2959, (610) 832-9500.

**<u>ASME</u>**—The American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990, (212) 591-7722.

**<u>ANSI</u>**—American National Standards Institute. Specifications published by ANSI, 25 West 43rd St. New York, NY 10036, (212) 642-4900.

<u>CVSA</u>—Commercial Vehicle Safety Alliance, 1101 17th Street, N.W. • Suite 803 Washington, DC 20036 • (202) 775-1623

**NACM**—National Association of Chain Manufacturers. Specifications published by NACM, P.O. Box 22681, Lehigh Valley, PA 18002-2681, (610) 691-8708

**OSHA**—Occupational Safety & Health Administration, U.S. Department of Labor.

# **CM CHAIN SYSTEMS**

Because of its flexibility and ability to follow contours readily, chain is a versatile medium for lifting, towing, pulling, securing, or for any application where a tensile force is to be exerted. Its ability to elongate prior to rupture gives the user warning to remove it from service before bodily injury or property damage occurs.

Columbus McKinnon Corporation supplies a number of welded and weldless chains manufactured in accordance with the NACM Chain Specifications, Fed. Spec. RR-C-271 and ASTM Specifications for chain. In the welded category they include graded chains and non-graded chains. Graded chain is marked with the grade number approximately every 10 inches. Welded graded chains find applications in industry and construction, while welded non-graded chains are used primarily in non-technical applications where lower strength chain than graded chain is acceptable.

Columbus McKinnon Corporation also manufactures three sizes of welded stainless steel chain. Stainless steel chain is considered a specialty product and will not be covered in detail in this manual. For more information contact Columbus McKinnon Corporation. Information presented in this manual for chains and slings may also be used as a guide for stainless steel chain and slings.

# WELDED GRADED CHAIN

Welded graded chain is an industrial grade used extensively in rigging and towing. The welded alloy steel chain is used in overhead lifting applications. CM graded chains are manufactured in accordance with the NACM specification for chain, ASTM Standard A391, and ASTM Standard A413. The grade number equates to the strength level of the chain with the grade number increasing as the strength of the chain increases. The standardized grade designations are 30, 43 and 70 for carbon steel, and 63, 80 and 100 for alloy steel chain.

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#### **USE** Always observe the following when working with chain:

# MARNING Improper use or care of chain can result in loss of load and personal injury To avoid injury: Never exceed the working load limit Always inspect chain before use for wear, damage, and elongation Do not impact load or jerk chain. Apply load slowly. Protect chain from corrosion and high temperatures Use only alloy chain for overhead lifting Do not use twisted, knotted, or kinked chain

Table I (page 4) provides specification and application data for CM Grade 30, 43, 63, 70, 80 and 100 chains. Grades 63, 80, and 100 are alloy chains and due to their strength/toughness properties are the only chains recommended for overhead lifting by NACM, OSHA Standard 1910.184, ASTM Standard A391 and ANSI/ASME Standard B30.9. See Table II (page 5) for the "Working Load Limits" of CM Grade 30, 43, 70, 80 & 100 chains.

- 1. Inspect chain before each use as indicated in the "chain inspection" section.
- 2. Do not exceed the working load limit.
- 3. Free all twists, knots and kinks, and protect chain from sharp corners and objects.
- 4. Avoid sudden jerks or impacts when applying the load to the chain.
- 5. Select the proper grade and size chain for the application. Refer to Tables I and II.
- 6. Select attachments such as hooks to match the grade, size and working load limit of the chain.
- 7. Be aware of the environment the chain is being used in. Extreme temperatures and corrosive media can affect the working load limit of the chain.

#### CARE

Care should be exercised so that the chain is not abused in any way.

- 1. Links should not be subjected to or exposed to sharp objects that could cause nicks or gouges.
- 2. Avoid exposure to corrosive mediums or high temperatures that could affect thermal treatment and strength of the chain, refer to Table VI (page 15).

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# GRADES 30, 43, 63, 70, 80 and 100 INSPECTION

Visually inspect all chain before use. For a meaningful examination the chain should be cleaned to permit proper viewing of links. Examine each link for the following conditions:

- 1. Twists or bends
- 2. Nicks or gouges
- 3. Excessive wear at bearing points (Interlink Area)
- 4. Elongation (Link Elongation)
- 5. Corrosion or other obvious damage

Since any of the above noted conditions can affect chain performance and/or reduce the chain strength, chains containing any of the conditions should be removed from service. A qualified person should examine the chain, assess the damage, and make a decision on whether or not repair is necessary before returning it to service. Extensively damaged chain should be scrapped. Because of its use in critical lifting applications, repair of alloy steel chain is not recommended except that nicks and gouges must be removed from the chain by a qualified person as instructed in the "Nicks and Gouges" section of this document. A more thorough discussion of damage assessment can be found in the "Grade 63, 80, and 100 inspection" section of this document.

# GRADES 63, 80, AND 100 INSPECTION (IN DEPTH)

Since grade 63, 80, and 100 chains are used for overhead lifting, and used frequently as part of a sling component, the potential for bodily injury or property damage is greater than uses involving other graded chains. For this reason a more detailed and in depth inspection is necessary. These grades can also be used for pulling and binding when a higher strength chain system is required for these purposes. The following instructions and information address Grade 63, 80, and 100 chain, but are of value for all chain uses and chain systems.

# **OSHA CHAIN SLING INSPECTION**

Since first published in final form on July 27, 1975, the OSHA Chain Sling Inspection section remains little changed. Specifically, the applicable sections of Code of Federal Regulations (29 CFR 1910.184) are quoted as follows:

(d) INSPECTIONS — Each day before being used, the sling and all fastenings and attachments shall be inspected for damage or defects by a competent person designated by the employer. Additional inspections shall be performed during sling use, where service conditions warrant. Damaged or defective slings shall be immediately removed from service.

(e) ALLOY STEEL CHAIN SLINGS

(3) inspections (i) in addition to the inspection required by paragraph (d) of this section, a thorough periodic inspection of alloy steel chain steel slings in use shall be made on a regular basis, to be determined on the basis of (A) frequency of slings in use; (B) severity of service conditions; (C) nature of lifts being made; and (D) experience gained on the service life of slings used in similar circumstances. Such inspections shall in no event be at intervals greater than once every 12 months.

(ii) The employer shall make and maintain a record of the most recent month in which each alloy steel chain sling was thoroughly inspected, and shall make such record available for examination.

(iii) The thorough inspection of alloy steel chain slings shall be performed by a competent person designated by the employer, and shall include a thorough inspection for wear, defective welds, deformation and increase in length. Where such defects or deterioration are present, the sling shall be immediately removed from service."

Note that while the requirements under (d) for daily inspections are not explicit as to scope or maintenance of records, it is possible that individual OSHA inspectors may have different views on conformity. However, the minimum 12-month interval inspections required under (e) call for thorough inspection and written records. It is this thorough type inspection which the procedures recommended in this booklet and in CM Chain seminars are designed to satisfy. Of course, the fundamentals are equally applicable to the more cursory daily inspections made by the riggers, users, or inspectors (a competent person) and will enable them to fulfill their responsibility efficiently.

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# TABLE I

#### APPLICATIONS AND SPECIFICATION DATA FOR CM GRADED WELDED STEEL CHAIN

ASTM & NACM Grade	CM Chain Embossment	ASTM Specification	Name	Typical Uses
30	G30	A413	Proof Coil	General purpose low carbon chain with industrial and agriculture applications including guard rail chain, logging and load securement. <b>Not to be used for overhead lifting.</b>
43	G43	A413	High Test	A carbon steel chain with industrial, construction, and agricultural applications including towing, logging, and load secure- ment. Preferred over Grade 30 because of its higher strength to weight ratio. <b>Not to be used for overhead lifting.</b>
63	A	A413	Alloy	A special heat treated alloy steel chain used extensively by the steel manufacturing industry. May be used in rigging and lifting applications.
70	G70	A413 Binder	Transport	A higher strength heat treated carbon steel chain typically used by truckers, loggers and highway crews. Load ratings of grade 70 chain are approximately 20% higher than Grade 43. Uses include load securement, towing, lashing, and as trawler chain. <b>Not to be used for overhead lifting.</b>
80	HA 800	A391	Alloy	A higher strength heat treated alloy steel chain primarily used as a sling component for overhead lifting, but can be used in rigging and tie down applications where a lighter weight, higher strength chain is desirable. Recommended for overhead lifting by NACM, ASME, and OSHA.
100	HA 1000	A973	Alloy	Has approximately 25% higher strength than Grade 80 is also used primarily as a sling component for overhead lifting. Can also be used for any of the previously mentioned applications. Recommended for overhead lifting by NACM, ASME, and OSHA.

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# TABLE II

			SIZE								
NOM	INAL		AC	CTUAL (	IN.)		WC	ORKING	LOAD L	IMII (LE	3S.)
IN.	MM	GRADE 30	GRADE 43	GRADE 70	GRADE 80	GRADE 100	GRADE 30	GRADE 43	GRADE 70	GRADE 80	GRADE 100
3/16″	4.7	0.213					800				
7/32″	5.5				0.218	0.218				2,100	2,700
1/4″	6.0	0.270	0.270	0.281			1,300	2,600	3,150		
9/32″	7.0				0.281	0.281				3,500	4,300
5/16″	8.0	0.309	0.327	0.327	0.315		1,900	3,900	4,700	4,500	
3/8″	10.0	0.386	0.386	0.394	0.394	0.394	2,650	5,400	6,600	7,100	8,800
7/16″	11.0	0.468	0.468	0.468			3,700	7,200	8,750		
1/2″	13.0	0.512	0.512	0.531	0.512	0.512	4,500	9,200	11,300	12,000	15,000
5/8″	16.0	0.625	0.625	0.625	0.630	0.630	6,900	13,000	17,100	18,100	22,600
3/4″	20.0	0.750	0.750	0.750	0.787	0.787	10,600	20,200	24,700	28,300	35,300
7/8″	22.0		0.875		0.875		12,800	24,500		34,200	
1″	26.0	1.000	1.000		1.024		17,900	34,100		47,700	
<b>1</b> 1/4″	32.0				1.260					72,300	

#### WORKING LOAD LIMIT OF CM GRADES 30, 43, 70, 80, AND 100 CHAIN

# **INSPECTION (IN DEPTH) GRADES 63, 80 AND 100**

#### **TWISTING and BENDING**

Twisted and bent links are relatively easy to recognize and affect chain performance significantly. Twisting and bending of links results from use of slings around sharp corners without padding, use of links with grab hooks under certain adverse conditions, and from loading of chain that is twisted, knotted, or kinked. (Refer to hook section for a more detailed discussion of grab hooks.)

Consider that chain is evaluated by applying loads in a pure tensile link end to link end fashion and rated accordingly. Bent or twisted links alter this normal loading pattern significantly and thus alter inner link stresses accordingly. For this reason all chain containing twisted or bent links must be removed from service.

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#### **NICKSand GOUGES**

Outsides of the link barrels are exposed to contact with, and therefore damage from foreign objects. Most often, nicks and gouges occur on the ends. Therefore, they usually are located in surfaces under compressive stress and their potentially harmful effects fortunately are reduced. In this connection we might note that the unique geometry of a chain link tends to protect tensile stress areas against damage from external causes. **Figure 1** shows that these tensile stress areas are on the outside of the link body at the link ends where they are shielded against most damage by the presence of interconnected links. Tensile stress areas are located also on the insides of the straight barrels, but these surfaces are similarly sheltered by their location.

However, gouges cause localized increases in the link stress. They can be harmful if they are located in areas of tensile stress and particularly so if they are perpendicular to the direction of stress. refer to **Figure 1.** 

**Figure 2** shows nicks of varying degrees of seriousness. Reading clockwise, at three o'clock there is a longitudinal mark in a compressive stress area. Since it is longitudinal and located in a compressive stress area, its effect is mitigated, but good workmanship calls for it to be ground out. At about five o'clock there is a deep transverse nick in an area of high shear stress. A similar nick is located at six o'clock in the zone of maximum tensile stress. Both of these can create a potentially dangerous escalation of the local stress and must be filed out. A nick that was located at eight o'clock has been filed out properly. Although the final cross section is smaller, the link is stronger because the stress riser effect of the notch has been removed. The remaining cross section can now be evaluated for acceptability by measuring it and applying the criterion for worn chain. See Table III (page 7).

#### WEAR and CORROSION

Corrosion is included in this discussion because it results in a reduction of link cross-section and can be detected using the same criteria as that for wear. Wear can occur in any portion of a link that is subject to rubbing contact with another surface. A glance at a strand of chain will reveal that its natural shape confines wear, for practical considerations, to only two areas. These are, in order of importance, (a) at the bearing points of interlink contact, and (b) on the outsides of the straight side barrels which may be abraded from dragging chains along hard surfaces or from under loads.



Figure 1 – Pattern of tensile and compression stress shown by a link under load



Figure 2 – Location of nicks, gouges, and notches will dictate their seriousness.



**Figure 3** – Inspection for interlink wear can be detected easily by collapsing the chain.

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**Figure 3** (page 6) illustrates the condition of interlink wear and shows how to inspect for it. Notice how easily such wear cab be detected by collapsing the chain to separate each link from its neighbors.

When wear has been observed the question arises as to whether the amount is tolerable. This question can be resolved quickly by making a caliper measurement across the worn section and comparing this with the minimum allowable dimension. See Table III giving minimum section dimensions or wear allowances for Columbus McKinnon Grade 80 and 100 Chain.



Fortunately, the strength of welded link chain is relatively unaffected by a moderate degree of wear. The reason for this will be understood better if we take a brief look at the pattern of stress distribution in a chain link supporting an axial tension load.

**Figure 4** shows in exaggerated manner the change in shape that takes place under such loading conditions. Note that the ends move farther apart while the side barrels move closer together. If the link were in a neutral stress condition to start with, the loaded link shown in broken outline would contain stresses of compression and tension. This is clearly illustrated in **Figure 5** showing an inflated inner tube which is sustaining a load in the manner of a chain link. The wrinkled sections clearly indicate the areas of compression.



**Figure 4** — Changes in link shape that take place under axial tension loading.

Figure 1 (page 6) shows the location of these stresses in a chain link. Tensile stresses are represented by arrows pointing away from each other, and compression stresses are depicted by arrows pointing toward each other. Notice that the bending, which occurs when link elongation takes place, induces compressive stresses at the interlink bearing surfaces and on the outside surfaces of the side barrels. Hence, we see that these surfaces, which are the potential wear areas, play a lesser role in supporting the tensile load on the chain. For that reason some amount of interlink or side barrel wear can occur before chain tensile strength decreases significantly.

Corrosion will generally be exhibited in the form of rusting and pitting. Rusted chain with a smooth unpitted surface finish may be continued in service provided that the mini-



**Figure 5** — The tube "under load" shows by wrinkles the areas of compression.

mal section dimensions or wear allowances published by the chain manufacturer are complied with. Visually discernable pitting, however, should be carefully inspected using the technique outlined for "Nicks and Gouges", paying particular attention to areas of tensile stress.

Alloy steel sling chain typically exhibits well over 15% elongation before rupture. The combination of elongation and high strength provides energy absorption capacity. However, high elongation or stretch, by itself, is not an adequate indicator of shock resistance or general chain quality and should not be relied upon by riggers to provide advance warning of serious overloading and impending failure. Overloading must be prevented before it happens by selection of the proper type and size of slings.

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# A STRETCHED CHAIN INDICATES OVERLOADING

A visual link-by-link inspection is the best way to detect dangerously stretched links. The least sign of binding or loss of clearance at the juncture points of links indicates collapse in sides of links due to stretch. Any amount of stretch indicates overloading, and the chain should be removed from service.

Note that a significant degree of stretch in a few individual links may be hidden by the apparent acceptable length gage of the overall chain. This highlights the importance of link-by-link inspection.

There is no short-cut method that will disclose all types of chain damage. Safety can only be achieved through proper inspection procedures. There is no adequate substitute for careful link-by-link scrutiny.

#### WELDED NON-GRADED CHAINS

CM manufacturers a number of welded non-graded chains as shown in Figure 6. While not classified as industrial grade chain, they find use in a variety of light duty applications where bodily injury or property damage is not likely. Such applications include use with guard rails, as a security chain, to support signs and light suspended loads and as a curtain chain. These chains are not covered in detail in this manual since they are not considered towing, lifting, or pulling chains. Information under "Welded Graded Chains" "Use, Care, and Inspection," may be used as a guide in the use and inspection of these chains.

For complete specifications and code numbers refer to CM Bulletin IPC-10



Figure 6

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# Chain



#### WELDLESS CHAINS

CM markets a number of light duty weldless chains as shown in **Figure 7.** Some uses include plumbing applications, boats, gates, animal leashes, window sashes, support fixtures, and playground equipment. These chains are not covered in detail in this manual since they are not considered towing, pulling, or lifting chains.

Figure 7

# **CHAIN SLINGS**

Chain slings are used primarily for overhead lifting and are generally used in conjunction with a crane or some type of lifting device. Standard sling configurations consist of chain branches which are affixed on one end to a master link or ring with some type of attachment, usually a hook, affixed to the opposite end. **Figure 8** (page 12) shows a number of standard sling configurations manufactured by Columbus McKinnon Corporation.

American National Standard ANSI B30.9, the National Association of Chain Manufacturers, and the Occupational Safety & Health Administration recommend only the use of alloy steel chain for overhead lifting i.e. for sling chain. Slings may be constructed by the user using CM grades 63, 80 or 100 Chain, CM alloy attachments and CM mechanical coupling links (Hammerloks). Columbus McKinnon uses Grade 80 or 100 chain and alloy steel welded coupling links instead of Hammerloks for construction of welded slings. Refer to the sections in this manual entitled "Welded Graded Chain," "Hooks," "Mechanical Coupling Links," and "Rings and Links" for detailed information on components which may be used in the construction of slings.

CM Alloy steel chain slings are provided with a durable metal identification tag. This tag is typically affixed to a master coupling link and contains the following data.

- A) Size
- B) Reach Figure 8 (page 12)
- C) Working load limit at 90 degrees on single and 60 degrees from horizontal on multi-leg slings
- D) Serial number
- E) CM (manufacturer's name) and grade
- F) Number of branches (sling type)

#### USE

Always observe the following when working with Chain Slings:

	Improper use and care of chain slings can result in bodily injury or property damage.
To avoid injury	or damage:
Never exceed components	l the working load limit. Make certain all sling are matched in strength - Table IV (page 13)
<ul> <li>Always inspe OSHA regula</li> </ul>	ct slings before use for wear damage or elongation - refer to ANSI B30.9, tion,and this manual
<ul> <li>Do not impac</li> </ul>	t load or jerk the sling
<ul> <li>Protect slings</li> </ul>	from corrosion and high temperatures - Table VI (page 15)
<ul> <li>Use only allo</li> </ul>	/ chain for overhead lifting
<ul> <li>Do not use tv</li> </ul>	visted, knotted, or kinked chain





FIGURE 8-CM GRADE 80 AND 100 HERC ALLOY WELDED CHAIN SLINGS

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#### **USE (Continued)**

- 1. Inspect chain slings before each use as indicated in "GRADE 80 and 100 CHAIN INSPECTION" and sling "INSPECTION" sections.
- 2. Do not exceed working load limit as indicated on sling identification tag. Any of the following factors can lead to a reduction in the strength of the sling and possible pre mature failure:
  - Rapid load application can produce dangerous overloading.
  - Variation in the angle of the load of the sling. As the angle decreases, the working load of the sling will decrease. Refer to Table IV and Table V— Working Load Limit Chart.
  - Twisting, knotting, and kinking subjects links to undesirable loading which decreases the working limit of the sling.
  - Conditions other than that for which slings are intended can reduce the working load limit of the sling. For example, use at elevated temperatures will result in a reduction in working load limit. Refer to Table VI — "Use of Chain Under Heat Conditions." (page 15)
- 3. Free all twists, knots and kinks.
- 4. Center load in hook(s). Hook latches must not support load.
- 5. Avoid sudden jerks when lifting and lowering.
- 6. Balance all the loads; avoid tipping of loads.
- 7. Use pads around sharp corners.
- 8. Don't drop load on chains.
- 9. Select attachments such as hooks or rings for use with chain to match the size and working load limit of the chain.
- 10. Use only alloy steel chain for overhead lifting.

# TABLE IV

#### *WORKING LOAD LIMITS OF CM Herc-Alloy 800 CHAIN SLINGS IN POUNDS

СН		SINGLE TYPES	DOUBLE	EBRANCH	TYPE D	60°	<b>45</b> ⁰	30°
SIZ	E IN HES	90°	60° 8° -	450 455	30°	58	45	35
IN.	MM.	Herc-Alloy 800	Herc-Alloy 800	Herc-Alloy 800	Herc-Alloy 800	Triple/Quad	Triple Quad	Triple/Quad
7/32″	5.5	2,100	3,600	3,000	2,100	5,500	4,400	3,200
9 _{/32} ″	7.0	3,500	6,100	49,000	3,500	9,100	7,400	5,200
3 _{/8″}	10.0	7,100	12,300	10,000	7,100	18,400	15,100	10,600
1/2″	13.0	12,000	20,800	17,000	12,000	3,1200	25,500	18,000
5 _{/8″}	16.0	18,100	31,300	25,600	18,100	47,000	38,400	27,100
3 _{/4″}	20.0	28,300	49,000	40,000	28,300	73,500	60,000	42,400
7 _{/8″}	22.0	34,200	59,200	48,400	34,200	88,900	72,500	51,300
1″	26.0	47,700	82,600	67,400	47,700	123,900	101,200	71,500
<b>1</b> 1/4 ″	32.0	72,300	125,200	10,2200	72,300	187,800	153,400	108,400

Factory assembled HERC-ALLOY 800 chain slings have the "HERC - ALLOY 800" trademark on serial number tags and on the sling hooks. On chain sizes 9/32" thru — 11/4" links are embossed with with grade symbol "HA-800". This data applies to Herc-Alloy 800 Chain only. Ratings apply to both factory assembled slings and slings assembled with **Hammerlok** coupling links, **Clevlok** hooks, or Lodelok hooks

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## TABLE V

#### HERC-ALLOY 1000 CHAIN SLINGS

		*WORK	ING LOAD	LIMITS IN F	POUNDS		
	TYPES S OR C	DOUE	BLE BRANCH	TYPE D			
3	900.	605	455	35	60*	45%	***
Size of Chain In Inches	Pounds lift when USED single	POUNDS LIFT WHEN USED AT 60° ANGLE	Pounds lift when USED at 45° angle	POUNDS LIFT WHEN USED AT 30° ANGLE	TRIPLE/QUAD 60° ANGLE	TRIPLE/QUAD 45º ANGLE	TRIPLE/QUAD 30º ANGLE
7/32″	2,700	4,700	3,800	2,700	7,000	5,700	4,000
⁹ /32″	4,300	7,400	6,100	4,300	11,200	9,100	6,400
3 _{/8″}	8,800	15,200	12,400	8,800	22,900	18,700	13,200
1/2″	15,000	26,000	21,200	15,000	39,000	31,800	22,500
5 _{/8″}	22,600	39,100	32,000	22,600	58,700	47,900	33,900
3 _{/4} ″	35,300	61,100	49,900	35,300	91,700	74,900	53,000

Factory assembled HERC-ALLOY 1000 chain slings have the "HERC-ALLOY 1000" trademark on serial number tags and on the sling hooks. On chain sizes 9/32" thru -3/4" links are embossed with with grade symbol "HA-1000." This data applies to Herc-Alloy 1000 Chain only. Ratings apply to both factory assembled slings and slings assembled with **Hammerlok** coupling links, **Cleviok** hooks, or Lodelok hooks.

# HOW LIFTING ANGLES REDUCE WORKING LOAD LIMITS OF SLINGS.

Percentages shown represent the maximum working load limit of the sling when used at the designated angle.

For example, a  $3/8^{"}$  Herc-Alloy 800 double sling used at  $90^{\circ}$  would have a working load limit of 2 times the working load of a  $3/8^{"}$  Herc-Alloy 800 single or 2 x 7, 100 lbs. = 14,200 lbs.

The same double sling used at 35° would have a maximum working load limit of 57% of 14,200 lbs.or .57 x 14,200 lbs. = 8,094 lbs.



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# TABLE VI

EFFECT OF ELEVATED TEMPERATURES ON THE WORKING LOAD LIMIT OF ALLOY CHAIN

Tempe	erature	Grad	de 80	Grade 100						
(F)	(C)	REDUCTION OF WORKING LOAD LIMIT <b>WHILE AT</b> TEMPERATURE	REDUCTION OF WORKING LOAD LIMIT AFTER EXPOSURE TO TEMPERATURE	REDUCTION OF WORKING LOAD LIMIT <b>WHILE AT</b> TEMPERATURE	REDUCTION OF WORKING LOAD LIMIT <b>AFTER EXPOSURE</b> TO TEMPERATURE					
BELOW	BELOW									
400	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	OSHA 1910 .184 REQUI BE REMOVED FROM S	IRES ALL SLINGS EXPOSI ERVICE	ED TO TEMPERATURES C	VER 1000° F					

# SLING LOADING, ANGLES, AND CHOKING

A simple and necessary precaution is expressed in the phrase "Do not overload!" The use of slings of ample size pays off in longer service life and added safety.

All chain manufacturers publish working load ratings for single chain slings in straight tension, and for double, triple and quad-branch slings when used at various angles (Table VI). **Figure 9** illustrates how such tables would rate the capacity of a commercial Grade 80 sling made from 5/8 inch alloy chain. Working load limit tables are helpful and easily understood. - refer to Table IV, and Table V (pages 13 and 14).

However, the fact is often overlooked that a single strand sling may be rigged to be, in part, like a double branch sling and as such to involve sharp angles of loading. This is the reason that chain damage and overloading are usually localized in the lower portion of the sling near the load. **Figure 10** illustrates this important point. On the left we see a double branch sling used in the conventional manner. Unfortunately, such idealized rigging, where sling hooks are neatly seated in eyebolts or clevises and all portions of the chain are in straight tension, is not always possible.

A more typical and frequent arrangement is shown in the illustration on the right of **Figure 10.** Here a single sling equipped with a hook is being used in a choke hitch. Above the crotch the tension in the chain is 9 tons, the same tension as that in the illustration on the left. Let us assume the 9 tons to be an acceptable load for this size chain in straight tension. One could think that everything is in proper order. We can pick up our 9 ton load and safely move it away. Or can we? Take another look below the hook! Here, surprisingly, you see what looks like a little double branch sling. As a matter of fact, it is a double branch sling. Furthermore, typical of the flat branch angles in tight choke hitches, the legs are at angles of only 15 degrees from the horizontal. At those angles the tension load in each leg of our 9 ton capacity is 17.4 tons — an overload of nearly 100%.





#### Figure 9 - WORKING LOAD LIMITS FOR 5/8" CM HA 800 ALLOY STEEL CHAIN SLINGS

#### Figure 10 - 5/8" CM HA 800 ALLOY STEEL CHAIN

Obviously the chain used in this example is too small for the job. From a safe rigging standpoint, it is important that the worker be aware of the load that will be imposed on the sling in a given situation, and select the proper size chain for the job. From an inspection standpoint, it should be clear that most damage is likely to occur in the lower portion of a sling. The chain inspection must therefore give particular attention to this section. Since the sections most subject to damage are those with which the workers come into contact during the process of making hitches, it is advantageous to enlist the riggers' aid. By reporting promptly any damaged links they notice, caused by overloading or by contact with loads and grab hooks, riggers can make the job of chain inspection much more effective.

# SHOCK LOADING

It should be remembered that the dynamic load applied to a chain if a payload is raised with a jerk or permitted to fall and snubbed by a slack chain can vastly exceed the static weight being lifted.

For example, 1/2" Herc-Alloy 800 has a working load rating of 12,000 lbs. It will sustain this amount of total load many years in trouble-free service. However, a payload weighing considerably less than 12,000 lbs. can break the chain in a one-time situation if permitted to drop and produce high dynamic stresses.

Herc-Alloy 800  $1/2^{"}$  chain in this example has a rupture work (impact strength) capacity of about 9,000 ft.lbs./ft. this means that if a 9 foot long sling were being used to raise a 12,000 lb. payload and if the load some how snagged and then dropped onto the slack sling hook, a drop of about 7 feet would break the chain. Ex. 9,000 ft. lbs./ft x 9 ft. approximately equals 12,000 lbs. x 7 ft.

The amount of dynamic load imposed on a chain in such a situation can, of course, not be planned on and allowed for. Although the cited example is rather extreme, it can happen, and should serve to emphasize the warning, "**Do No Overload!**"

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#### CARE

Chain slings require proper care as follows:

- 1. Store slings on an "A" frame in a clean dry place.
- 2. Avoid exposure to corrosive mediums. Oil chain before prolonged storage.
- 3. Never alter the thermal treatment of CM Herc-Alloy 800 chain or components by heating.
- 4. Do not plate or change surface finish of chain or components. Contact Columbus McKinnon for special requirements.

#### INSPECTION

It is important to inspect chain slings regularly and to keep a record of each chain inspection. The following is a guide for such an inspection procedure. CM will supply sling record cards or sheets as requested.

Before inspection, clean the chain sling so that marks, nicks, wear and other defects can be seen. Use a non-acid/non-caustic solvent. Each chain link and sling component should be individually inspected for the conditions noted below. For a more detailed discussion of each of the following conditions listed in steps 1-4, refer to the section entitled "INSPECTION OF GRADES 63, 80, and 100 CHAINS".

- 1. Excessive wear and corrosion at chain and attachment bearing points. Refer to Table III, "Wear Allowance chart for HA 800 and HA 1000 chain." Table III should also be used as a guide when inspecting coupling links.
- 2. Nicks or gouges.
- 3. Stretch
- 4. Twists or bends
- Distorted or damaged master links, coupling links, or attachments, especially spread in throat opening of hooks. Each link or component having any condition listed above is to be marked with paint to clearly indicate rejection and elimination form service until properly repaired or replaced.
- 6. Refer to sections in this manual entitled "HOOKS," "MECHANICAL COUPLING LINKS," and "RINGS AND LINKS" for inspection guideline regarding distortion and wear of hooks, master links and Hammerloks. In general, any linear reduction in section of 10% or more is cause for removal of the attachment from use.

Slings exhibiting any of the above noted conditions should be removed from service for repair or replacement.

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# **CM ATTACHMENTS**

Attachments are load transmitting components frequently used in conjunction with other rigging equipment. Primarily used in the construction of slings, they also find use in tie down applications, temporary repair of low carbon chain, and joining other attachments such as hooks to chain. Attachments manufactured and marketed by Columbus McKinnon include hooks, mechanical coupling links, master links, and rings.

# HOOKS

Hooks may be used in a wide variety of applications for lifting, towing, pulling, and securing. In many of these applications hooks are frequently used in conjunction with chain. There are specialty tailored hooks to be used with the graded chains discussed earlier in this product m anual. Refer to American National Standard ANSI B30.10 for a discussion on hooks, inspection procedures, and operating practices.

There are two general classifications of hooks supplied by Columbus McKinnon Corporation. Sling hooks to which the load or force is applied to the base (bowl saddle) of the hook and grab hooks which contain a slot or throat of uniform width for securement on a link of the chain usually to form a chain loop for supporting the load.

In addition to the hooks discussed above there are a number of specialty and non-conventional hooks supplied by Columbus McKinnon Corporation. They include foundry hooks, claw hooks, "S" hooks, plate hooks, sorting hooks, trek hooks, tie-down hooks, "C" hooks, and tarp hooks.

All CM conventional style hooks are manufactured of drop forged steel.

#### USE

Always observe the following when using hooks:

# **A**WARNING

Improper use of hooks can result in bodily injury or property damage. To avoid injury or damage:

• Do not exceed the working load limit.

- Do not tip load or use in any manner for which th hook was not intended.
- Do not shock or dynamic load.
- Do not apply load to hook latches. Latches are to retain slack slings and chain only.

1. Inspect hooks before each use as indicated in the hook "Inspection" section.

- 2. Hooks attached to chain should be selected to match the size and working load limit of the chain.
- Do not exceed the working load limit or shock load the chain. Note: Loads less than the working load limit if applied rapidly or dropped freely can result in serious overloading of the hook.
- 4. Use proper size chain in the slot of the grab hook.

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# SLIP HOOKS

#### **CLEVIS SLIP HOOKS**

Clevis slip hooks must be matched to the chain size. Designed for use primarily with graded chains and affixed directly to the chain. Available in heat treated carbon and heat treated alloy steel (compatible with Grade 63 chain). Load must be applied in line with clevis, placed firmly in the base (bowl saddle) of the hook.



Clevis Slip Hook

#### **CLEVLOK SLING HOOKS**

Clevlok sling hooks must be matched to chain size and grade. Designed for sling use primarily with Grade 80 chain and affixed directly to the chain. Available in heat treated alloy steel only with optional latch. Load must be applied in line with clevis, placed firmly in the base (saddle-bowl) of the hook. **Note:** The latch is designed to retain such items as slings and chains under slack conditions only and is not intended to support the load.

#### **EYE SLIP/SLING HOOKS**

Eye slip hooks should be matched to the size and grade. Designed for use primarily with graded chains. Must be affixed to the chain either with a welded coupling link or with a mechanical coupling link. Load must be applied in line with eye placed firmly in the base (bowl-saddle) of the hook.

**TYPE I** — **EYE SLIP HOOKS** — Available in un-heat treated carbon, and heat treated carbon, and heat treated alloy steels. **Note:** The alloy steel version will not develop the strength of grade 80 chain, but meets alloy Grade 63 chain requirements.

**TYPE II** — **EYE SLING HOOKS** — Available only in heat treated alloy steel* — latch optional. Designed for sling use primarily with grade 80 chain. **Note:** The latch is designed to retain such items as slings and chains under slack conditions and is not intended to support the load.

*This hook is also available in stainless steel for use in stainless steel slings.





Clevlok Sling Hook



Eye Slip Hook



Eye Sling Hook

**TYPE III** — **LODELOK HOOKS** — Available in two types made of heat treated alloy steel only. Can be used with Grade 80/100 chain. Clevis type (under development)must be matched to the size of the chain. Rigging type has enlarged eye to accept larger couplers and thimbles used in rigging applications. Also ideal for use in slings. The latch is an integral part of the upperhook. Note: The latch is designed to retain such items as slings and chains under slack conditions and is not intended to support the load.

**TYPE IV** — **LATCH SLIP HOOK** — Available in un-heat treated carbon steel with latch designed for use on small winches, cable pullers, and towing assemblies. **Note:** Latch is designed to retain such items as slings and chain under slack conditions and is not intended to support the load.

# RIGGING HOOKS

Similar to eye slip hooks except with an enlarged eye for larger couplers such as thimbles, etc. Available in heat treated carbon or heat treated alloy steels. A general purpose rigging hook with optional latch. Load must be applied in line with eye firmly in the base (bowl-saddle) of the hook. **Note:** The latch is designed to retain such items as slings and chain under slack conditions and is not intended to support the load. See also "Type III - Latchlok Hooks."

# **GRAB HOOKS**

A conventional grab hook is designed to be hooked back onto the chain in a choker arrangement. The full working load limit can be achieved if the hitch angle is 30° or greater. See **Figure 10** (page 16) and Table IV (page 13) and Table V (page 14) — outlining derating for slings in section entitled "CHAIN SLINGS."

If used in other configurations such as direct tension, the working load limit of the assembly must be derated by 25%. **Figure 11** shows why the link in the slot of a conventional grab hook is stressed more than the adjacent links. In addition to carrying its share of the straight tension load, the link must also withstand an additional bending caused by contact with the hook saddle. The link usually fractures in this arrangement at about 75% of the chain's normal breaking load.

With the cradle style grab hook as shown in the illustration, the outrigger's cradle action reduced bending distortion of the link in the chain slot and the chain typically develops full strength.

Refer also to warning on page 21.





Latch Slip Hook



CM Rigging Hook



Figure 11 Comparison of conventional and cradle grab hooks

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# CONVENTIONAL CLEVIS GRAB HOOKS

Clevis grab hook must be matched to the chain size. Designed for use primarily with graded chains and affixed directly to the chain. Available in heat treated carbon and heat treated alloy steels.

# **CLEVLOK CRADLE GRAB HOOKS**

Clevlok Cradle Grab hooks must be matched to chain size. Designed for use primarily with grade 80 chain and affixed directly to the chain. Available in heated treated alloy steel only.

# **CONVENTIONAL EYE GRAB HOOKS**

Eye grab hooks must be matched to the chain size. Designed for use primarily with graded chains. Must be affixed to the chain with a welded coupling link or with a mechanical coupling link. Available in unheat treated carbon, and heat treated alloy steels.*

*This hook is also available in stainless steel for use in stainless steel slings.

# **EYE CRADLE GRAB HOOKS**

Cradle Grab hooks must be matched to the chain size. Designed for use primarily with Grade 80 chain. Must be affixed to chain with a welded link or with a mechanical coupling link. Available in heat treated alloy steel only.

# 

Improper use and care of grab hooks can result in bodily injury or property damage.

#### To avoid injury or damage:

When using grab hooks in a choker arrangement, derate working load limit of the assembly according to the angle of chains forming the choker. See also Figure 10 (page 16) Table IV (page 13) and Table V (page 14)– outlining derating information for slings shown in section entitled "CHAIN SLINGS".













# NON-CONVENTIONAL HOOKS

Foundry Hooks should be matched to the chain size. Available in heat treated alloy steel only. Designed for use primarily with Grade 80 chain. Must be affixed to the chain either with a welded coupling link or with a mechanical coupling link. Hook is suitable for sling use and in applications requiring a uniform throat opening or applications where the hook may be subjected to tip loading.

#### **CLAW HOOKS**

Claw hooks must be matched to the chain size. Available in heat treated carbon steel. Designed for easy hook up to loose or taught chain with a hand connection.

#### **"S" HOOKS**

A utility type hook made of heat treated alloy steel. Most popular in applications requiring speed and convenience of attachment such as conveyor systems. Also available in low carbon steel material.

#### **ALLOY SWIVEL HOOKS**

Alloy swivel hooks are primarily used in rigging applications where the swivel feature allows other rigging elements such as wire rope and chain to remain straight without twists.

#### SPECIALTY HOOKS PLATE HOOKS

Plate hooks should be matched to the chain size. Available in heat treated alloy steel only. Designed for use primarily with Grade 80 chain in a sling arrangement for the lifting of steel plates or flat planes. Optimum angle of the sling branches is 55-60 degrees. Sling capacity must be derated accordingly.

#### **SORTING HOOK**

Made of heat-treated alloy steel, available in one capacity. Sorting hooks may be loaded within 1" of the tip. The working load limit with the load sitting in the bowl (or saddle) of the hook is 7.5 tons whereas the working load limit is 2 tons if the hook is being loaded 1" from the tip. Do not load the last one inch of the tip. The working load limit of 2 tons is forged on the side of the hook. The hook is most useful for efficient handling of cylindrical shapes. The long tapered point is designed for easy grab in rings, pear links, and lifting holes.

















# **TRACTOR DRAWBAR GRAB HOOK**

Hook must be matched to the chain size. Made of heat treated carbon steel. Available in only one capacity. For use with 5/16''-1/2 inch graded chain. Fits all tractor draw bars up to  $1^{5}/8$  inch thick.

# TREK HOOKS

Made of heat treated carbon steel. Ref: Army ordinance drawing PN7336460.

# **AIRCRAFT TIE DOWN HOOKS/CHAIN TYPE**

Made of heat treated alloy steel. Available in only one size. Designed for use with 9/32 inch grade 80 chain.

# **AUTOMOTIVE TIE DOWN HOOKS**

Made of heat treated alloy steel. Conform to requirements set forth in American Association of Railroads Specifications. American Automotive manufacturers have standardized on these two styles. (R-Hook & T-Hook)

# **TARP HOOKS**

Made of carbon steel in one size only  $(3/8" \times 3^{1/2"})$ . A general purpose light duty hook with a variety of uses. Secured in place with bolts.

# **VEHICLE RECOVERY HOOKS**

These hooks include "R" and "T" hooks listed as Automobile Tie Down Hooks plus "J" hooks, which are forged and heat treated. "J" hooks are available in clevis style and eye style in lengths from 8 to 15 inches.

#### CARE

Care should be exercised during use so that the hook is not abused or damaged.

- 1. Hooks should not be subjected to bending, exposed to sharp objects, tip loaded (unless specified by the manufacturer) or loaded in a manner inconsistent with its design.
- 2. Avoid exposure to corrosive mediums or high temperatures that could effect the thermal treatment and strength of the hook.

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#### INSPECTION

#### Inspect hooks prior to each use. Observe the following:

- 1. Discard hooks that are worn more than 10% of the original dimension or are worn beyond a specific dimension or tolerance as provided in a wear allowance table, chart, or diagram.
- 2. Discard hooks that have an increase in throat or slot opening more than 15% of the original opening or in excess of that recommended in the appropriate CM bulletin.
- 3. Discard hooks that are bent or twisted more than 10 degrees from the plane of the unbent hook.
- 4. Replace load pins that are permanently distorted.
- 5. Replace damaged cotter pins.
- 6. Replace damaged hook latches.
- 7. Replacement load pins to be obtained from the manufacturer of the hook.

# **MECHANICAL COUPLING LINKS**

Columbus McKinnon Corporation supplies a number of coupling links, some of which are suitable in the construction of slings, others which afford quick repair or splicing of welded carbon steel chain,

Note that alloy steel chain Grade 80 and Grade 100 is not to be spliced or repaired using mechanical coupling links.

#### USE

Always observe the following when using Coupling Links.

# 

#### Improper use of coupling links can result in bodily injury or property damage.

#### To avoid injury or damage:

- Do not exceed the working load limit of the coupling link.
- Be certain that the working load limit of the coupling link matches the working load limit of the chain and the recommended chain size.
- Do not impact or shock load coupling links.
- Do not use excessively worn or damaged coupling links.
- Do not use coupling links to repair alloy chains used for over-head lifting.
- Inspect coupling links before each use.

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# HAMMERLOKS

Constructed of drop forged alloy steel and primarily used in the construction of overhead lifting slings. Specifically used for connecting the chain branches to the master link and to the hook attachments. Meets the strength of Grade 80 chain. Must be matched to the chain size. **Not to be used for repair or splicing of the chain.** 

# **MID-LINKS (DOUBLE CLEVIS)**

Used for quick temporary or permanent repair of chain and for attaching chain hooks, rings, swivels, etc. Must be sized to the chain. Available in a range of sizes to fit 1/4 inch through 5/8 inch chain. Will develop the strength of grade 70 chain. Not to be used for overhead lifting.

# LAP LINKS

A quick permanent way to repair the chain. Chain link and attachments are threaded onto the lap link and the link flattened. Made of low carbon steel, available in a variety of sizes with stock diameters ranging from 1/8 inch thru 5/8 inch chain. Must be matched to the working load limit of the chain. Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA.

# **CONNECTING LINKS**

A repair link intended for use with Grade 30 chain. Available in a range of sizes to fit 3/16 inch thru 1 inch stock diameter chain. Both halves are placed together and small protrusions are peened over. Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA.

# **COLD SHUTS**

A permanent repair link available for use with Grade 30 and Grade 43 chain. After threading link onto the chain, the plain end is inserted through the hole in the link and peened over. Working load limit of the cold shut must be matched to that of the chain. Typically this can be achieved by selecting a cold shut one size larger than the chain. Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA.

# QUICK LINKS

Afford quick and easy chain repair and/or attachment of fittings. Easy closing by threading nut onto threaded end. Reusable. Working Load limit of link must be matched to that of the chain. Available in stock diameters ranging from 1/8" to 1/2 inch. Not to be used for overhead lifting, and prohibited for all load securement applications by CVSA

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#### CARE

#### Care should be exercised so that the coupling link(s) is not abused in any way during use.

1. Links should not be subjected to bending or exposed to sharp corners or objects.

2. Avoid exposure to corrosive mediums or high temperatures.

#### INSPECTION

Visually inspect all coupling links before each use for the following conditions

- 1. Twists or bends.
- 2. Nicks or Gouges*
- 3. Excessive wear at bearing points (innerlink area)*
- 4. Elongation (link elongation)
- 5. Corrosion or other obvious damage

*The "Grades 30, 43, 63, 70, 80, and 100" Inspection section of this manual (page 3) may be used as a guide.

Since any of the above conditions can affect the coupling strength, a qualified person should conduct the inspection and determine whether replacement is necessary.

# **RINGS AND LINKS**

While alloy steel rings and links may be used individually for overhead lifting and rigging applications, they are used most frequently as a component of a sling. Figure 8 under the section entitled "Sling Systems" (page 12) which illustrates a number of sling configurations using a Master Link. They are sized for use with Grade 80 chain and enable the user to construct a balanced sling system for lifting and rigging. Shown below are various alloy steel rings and links manufactured and sold by Columbus McKinnon Corporation:



- Do not use on oversize crane hooks where link does not fit in saddle of the hook
- Protect from corrosion.
- •Use with alloy chain for overhead lifting.

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Inspect rings and links before each use as indicated in the "INSPECTION" section.

### **MASTER RINGS**

Because of their round configuration, they have a universal use in rigging applications

# **OBLONG MASTER LINKS**

Oblong master links are the optimum design for use in the construction of slings. The oval design is an optimum configuration for use with crane hooks since the depth of a hook is normally greater than the width. The link may be used in any rigging application including overhead lifting and may be used independent of chain. Oblong master links have a greater capacity size -for-size than master rings because of their smaller width.

# **OBLONG MASTER LINK SUB-ASSEMBLY**

Designed primarily for sling construction with multiple branches. They allow the user to construct a sling using mechanical couplers between the welded master couplers and the chain branches. Also available in stainless steel for use in construction of stainless steel slings.

# PEAR SHAPED MASTER LINKS

May be used for the same applications as oblong master links. The design is not optimum for multiple branch slings and in some cases may interfere with the crane hook.

# **GRAB LINKS**

Can be used to create a variable length loop type sling. A link of the chain is captured in the link slot similar to that of a grab hook.

#### CARE

Rings and links, because of their large size, are prone to bending and distortion. Care should be taken so that such abuse does not occur. They should not be used in extremely corrosive environments without protective coating such as galvanizing. Before galvanizing, to avoid altering metallurgy or heat treatment, contact CM for instructions. If subjected to high temperatures the load rating should be derated as indicated in Table VI in the Grade 80/100 chain inspection section (page 15).

#### INSPECTION

Before use, inspect the link or ring for wear, bending, distortion (elongation or collapse), cracks, corrosion damage, nicks and gouges.

- 1. Links or rings which are worn more than 10% of the original diameter should be discarded.
- 2. Corrosion will deteriorate link material. Unless corrosion is very granular, apply wear criterion in step 1 to determine if link must be discarded. Discard all components with granular corrosion.
- 3. Wear criterion in step 1 should be applied after nicks and gouges are ground out. See section entitled "Nicks and Gouges" under Grade 80 Chain Inspection (page 6).
- 4. Links bent more than 10 degrees in the plane of the link should be discarded.
- 5. Links visibly distorted or twisted should be discarded.

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# **CM SHACKLES & CLEVISES**

Shackles and clevises are mechanical couplers which consist of a U-shaped body closed by a "pin." Shackles are used for construction, rigging, and lifting applications while clevises are used for less demanding applications such as farming and towing. Shackles/clevises are made in two general styles and several special styles. The general styles are "Anchor" and "Chain" while special styles include "Twist" and "Web." The "Anchor" pattern has a more generous loop better suited to multiple connections. Various "Pin" styles are also available. They range from a round pin secured with a cotter pin or screw pin secured by tightening, to a bolt nut or cotter pin arrangement.

#### USE

Always observe the following when using shackles/clevises.

# WARNING Improper use or care of shackles/clevises can result in bodily injury or property damage. To avoid injury or damage: • Do not exceed the working load limit. • Do not shock or load. • Do not side load – center line of load must • Do not side load – center line of load must

- coincide with center line of shackle/clevis
- Do not replace pin or bolt with other than original equipment parts.
- Inspect before use for wear, deformation, and pin engagement.

Inspect shackles/clevises before each use as indicated in the "INSPECTION" section (page 3).

# SHACKLES

#### Screw Pin Anchor Shackles /

#### **Screw Pin Chain Shackles**

Screw pin shackles afford quick and easy removal of the screw pin which is secured by torque. Desirable in applications where the shackle is frequently removed. While the threaded pin can resist axial forces, it is vulnerable to backing out and the shackle is not reliable in applications where the pin is subjected to a torque or twisting action. Available in the following materials with capacities up to 43 tons:

- A) Forged, heat treated special bar quality steel body with forged heat treated alloy steel pin.
- B) Forged, heat treated alloy steel body with forged heat treated alloy steel pin.
- C) Stainless steel body and pin. Available only in anchor pattern.

#### Alloy steel shackles are acceptable for overhead lifting.

- 1. Meets or exceeds Fed. Spec. RR-C-271
- 2. Meets or exceeds Mil-S-24214
- 3. Meets or exceeds Mil-F-17280

#### Logging/Trawling Shackles

Similar to screw pin chain shackles except the pin has a hex head for convenience in wrench tightening and loosening. Shackle body is made of drop forged heat treated steel and the pin is made of heat treated alloy steel. Available in capacities up to 81/2 tons.

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# SHACKLES-SIDE LOADING

DO NOT SIDE LOAD ROUND PIN SHACKLES

# ANGLE OF SIDE LOAD

0°, VERTICAL OR IN LINE 100% WLL 45° ......70%

90°	 50%

# SHACKLE INSPECTION:

DISCARD CM SHACKLES IF:

- 1. Any parts worn more than 10% of original dimension.
- 2. Visibly distorted
- 3. Bent or twisted more than 10°
- 4. Load pins have bent or visibly damaged threads.

# SYMMETRICAL LOADING

Shackles symmetrically loaded with two legs at a maximum angle of 120° can be used to full working load limit.

SIDE AND SYMMETRICAL LOADING DATA APPLIES TO SCREW PIN AND BOLT, NUT, AND COTTER TYPE SHACKLES ONLY.



DO NOT EXCEED 120° INCLUDED ANGLE

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#### Round Pin Anchor Shackles Round Pin Chain Shackles

Round pin shackles afford easy removal of the pin which is secured by a cotter pin. Perform well where the pin is subjected to a torque or twisting action. Unsatisfactory in applications where the pin is subjected to an axial load. Available in capacities up to 35 ton. Forged, heat treated steel body with forged heat treated alloy steel pin.

#### Bolt, Nut, and Cotter Pin Anchor Shackles Bolt, Nut and Cotter Pin Chain Shackles

Bolt, nut, and cotter pin shackles provide the most secure pin(bolt) arrangement of all styles. Will resist axial loading and torsional loading. Should be used in applications where shackle is semi-permanent with infrequent removal. Available in the following materials with capacities up to 50 tons:

- A) Forged, heat treated special bar quality steel body with forged heat treated alloy steel pin (bolt).
- B) Forged, heat treated alloy steel body with forged heat treated alloy steel, pin (bolt). Available only in anchor pattern.

Alloy steel shackles are acceptable for overhead lifting.

Meets or exceeds Fed. Spec. RR-C-271 Meets or exceeds MIL -S-24214

#### **KILN SHACKLES**

Available in "anchor" pattern only, made of carbon steel, alloy steel, or stainless steel. The following shackle closures are available: Loose pin for welding, hex head screw pin, and full nut and bolt. Pin diameters available in 3 sizes for a given size shackle for match with type of service. Can be used in service at elevated temperatures. Heat treatment optional to customer specifications.

#### **WEB SLING SHACKLES**

Designed primarily for use with web slings up to 6 inches in width. Available in capacities up to 12 ton. Body is made of heat treated carbon steel and pin is made of heat treated alloy steel.











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# **CLEVISES**

Available in configurations depicted. Forged of steel components, designed principally for farm or towing applications. **Not to be used in construction or rigging applications.** 

# **A**WARNING

Improper use of/clevises can result in bodily injury or property damage.

**To avoid injury or damage:** Do not use for overhead lifting.



#### **STRAIGHT CLEVIS/TWIST CLEVIS**

Heavy duty tractor clevis with T-handle pins and hair-pin retainers for close hook ups. Steel pin heat treated. Available in capacities up to 12 tons.



**UTILITY CLEVIS** 

Loose pin harrow clevis. Heat treated steel body with heat treated alloy steel pin.



#### FARM CLEVIS

Screw pin "anchor" pattern body configuration for multiple hook up. Heat treated steel body with heat treated alloy steel pin. The threaded pin cast axial loads, but is vulnerable to backing out and the clevis is not reliable in applications where the pin is subjected to a torque or twisting action.

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#### CARE

#### Care should be exercised so that the shackle/clevis is not abused during use.

- 1. Spacers should be used if necessary on the shackle/clevis pin to assure that the shackle/clevis is not loaded at an angle. Load line of action should be through the center line of the shackle/clevis body and the middle of the shackle/clevis pin.
- 2. The shackle/clevis should be protective coated such as zinc plated or galvanized if exposed to a corrosive medium.
- 3. The shackle/clevis should not be subjected to high temperatures that could affect thermal treatment and the strength of the shackle/clevis.

#### INSPECTION

Visually inspect shackles/clevis before each use.

#### Discard CM shackles/clevis or shackle/clevis parts that:

- 1. Are worn more than 10% of the original dimension.
- 2. Are visibly distorted due to side loading.
- 3. Are bent or twisted more than 10 degrees in the plane of the unbent shackle/clevis.
- 4. Have load pins that are visibly bent or have damaged threads.
- 5. Have damaged cotter pins or hairpin retainers.

Replacement load pins to be obtained from the manufacturer of the shackle/clevis.

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# **CM ACCESSORIES**

Accessories offered by Columbus McKinnon Corporation include wire rope clips and thimbles. Used in conjunction with one another, their primary purpose is for wire rope turn back (loop formation).

#### WIRE ROPE CLIPS

Wire rope clips are used to secure the end of wire rope when forming a loop, i.e, for wire rope turn back. Available in two configurations, mid-grip (double saddle) and single saddle. Each is equally effective and strong; care does have to be exercised in the proper installation of single saddle clips. When installing single saddle clips, saddle must rest against live end of wire rope thimble.



Mid-grip clips are available in a drop forged carbon steel material and single saddle clips are available in malleable iron or drop forged carbon steel. Available in sizes up to 1-1/2 inches. Malleable iron clips are manufactured in accordance with Fed. Spec. RR-C-271 and ASTM Spec. A47, while forged clips are manufactured in accordance with Fed. Spec. FF-C-450.

#### USE:

Always observe the following when using wire rope clips:



When applying wire rope clips observe the following general instructions:

- 1. Refer to specific instructions which accompany clips for spacing, number of clips, and torque values.
- 2. Apply wire rope clips with the live rope in the clip in the saddle and the "U" bolt over the end of the rope.
- 3. Apply first clip as close as possible to thimble.
- 4. Tighten clips evenly to recommended torque.
- 5. After applying the initial load to the rope, retorque the clip nuts to the recommended torque to compensate for any decrease in rope diameter caused by load application.
- 6. Retorque rope clip nuts periodically to compensate for any further decrease in rope diameter.
- 7. Use only drop forged clips for lifting applications.

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#### CARE

Care should be exercised in the installation and use of wire rope clips so that the clip, wire rope, or thimble is not damaged.

- 1. Do not over torque or under torque the nuts. Too much torque can result in damage to the clip and/or the wire rope. Too little torque can result in the wire rope slipping. Torque nuts to the value specified in the accompanying instructions.
- 2. Clips should not be subjected to bending or come in contact with sharp object.
- 3. Avoid exposure to corrosive mediums.

#### INSPECTION

Visually inspect wire rope clips before each use.

- 1. Be certain threads are not stripped and that nuts are tight.
- 2. Check torque of nuts periodically.
- 3. Replace distorted thimbles.
- 4. Shorten wire rope and form new loop if damaged.
- 5. Replace distorted thimbles.

## THIMBLES-WIRE ROPE USE

Made specifically for wire rope turn back forming a cable loop. Used in conjunction with wire rope clips. Manufactured of hot rolled steel in accordance with FED. SPEC. FF-T-276. Available in sizes to fit a maximum of  $1^{-1/2}$  inch diameter wire rope.



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Improper use and care of wire rope thimbles can result in bodily injury or property damage.

#### To avoid injury or damage:

- During use be certain that crown of thimble is uniformly loaded by appropriate size crane hook.
- Do not point load crown of thimble.
- Inspect periodically for wear and distortion.



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# SHOULDER EYEBOLTS

#### USE

Shoulder eyebolts find numerous uses as "lifting rings" in large, usually metal objects, such as dies, to assist in moving and handling.

Do not exceed the working load limit — reduce the working load limit according to the adjacent table if loading other than true vertical.

S	Shoulder Eye Ang	<b>bolt Workin</b> le to Horizon	g Load Limit Ital	t	65° 75° 0° 35% of full rated load rated load No reduction
True Vertical	<b>75</b> °	<b>65</b> ⁰	45°	Less than 45°	45° 25% of full
Full working load limit (refer to full catalog page)	55% of full working load limit	35% of full working load limit	25% of full working load limit	Do not use	Less than 45° Do Not Use

#### If in doubt, consult a rigging handbook or discuss with a qualified person.

Install with shoulder at 90° to axis of hole to assure total contact of shoulder. Torque nut/eyebolt to assure proper seating. Check seating after initial loading.

If installing in tapped hole, make sure depth of thread engagement is at least 1¹/2 times bolt diameter. Thread fit must also be good-tight, not loose-sloppy.

Where eyebolts must be aligned, a washer or shim may be placed under the shoulder to permit alignment when tightened.

To minimize the bending moment, always apply load in the direction of the plane of the eye. Reduce working load limit according to table if loaded other than true vertical.

Never insert a hook tip in an eyebolt; always use a shackle to connect eyebolt to load.

Do not use a sling reeved through an eyebolt or a pair of eyebolts. Attach each single sling leg to an eyebolt using a shackle.

# **A**WARNING

Improper use and care of shoulder eyebolts can result in bodily injury or property damage.

- To avoid injury:
- Inspect eyebolt before use for distortion and wear.
- Make sure shoulder is at  $90^{\circ}$  to axis of hole and seated.
- Always apply load in the plane of the eye.
- Do not exceed working load limit; if loaded other than true vertical, de-rate according to values in table.

#### **CARE AND INSPECTION**

Inspect eyebolts before use.

- Do not use if bent more than 15°.
- Do not use if worn more than 10% from any original dimension.
- Do make sure eyebolt shoulder is seated.

# **HOIST RINGS**

Used in the same manner as shoulder eyebolts, hoist rings pivot or swivel to provide a steady lift and maintain higher working load limits than shoulder eyebolts when lifting at angles.



- 1. Never exceed the rated capacity of the hoist ring.
- 2. Mounting surface should be flat and smooth for full contact with the hoist ring.
- 3. Drill and tap the workpiece so that the hoist ring bolt is installed perpendicular to the surface of the workpiece.
- 4. Spacers should not be used between the hoist ring and the mounting surface.
- 5. Mounting screws should always be tightened to recommended torque.
- 6. After installation, check hoist ring to be sure it swivels and pivots freely in all directions.
- 7. When lifting, apply force gradually.



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# TURNBUCKLES



#### USE

Turnbuckles find many uses to apply tension to wire rope or cable. They are composed of a forged body and two end fittings. End fittings can be eyes, jaws, or hooks. They must, however, be applied only up to loads within their working load limit as specified for the particular end fitting being applied.

Apply turnbuckles in a straight in-line manner only. Do not allow anything to contact the turnbuckle body or end attachment threaded shanks.

Apply load to the center of end attachment eyes and bowl of hooks. Do not tip load hooks or side load eyes.

#### **CARE AND INSPECTION**

Inspect turnbuckles before use for bent components and worn threads. Do not use if body or end fitting is bent more than 10° from the axial center line. Do not use if threads are visibly worn or feel loose. If in doubt, consult a rigging handbook or discuss with a qualified person.

# WARNING

Improper use and care of turnbuckles can result in bodily injury or property damage.

#### To avoid injury:

- Inspect turnbuckles for distortion and wear.
- Do not use if anything is in contact with the turnbuckle body or an end fitting
- Do not apply load only to center of eyes and bowl of hooks.
- Do not exceed working load limit.

# PLATE CLAMPS

(refer also to ANSI/ASME B30.20)

#### USE

Plate clamps are used to lift and handle sheets (plates) of metal that are up to 300 Brinell in surface hardness. They tend to grip the metal and thus should not be used where marks may be injurious to the sheet being handled. Special jaws may be required to handle "soft" metals.

Plate Clamps are available in Universal, Hinged, and Horizontal styles.

Handle no more than one sheet at a time within the clamp's working load limit. Avoid sudden jerks and unbalanced loads.

Lift load a short distance to make sure clamp grips before making complete lift.

Use lifting clamps only if authorized and properly trained.

#### **CARE AND INSPECTION**

Inspect clamps before use. Do not use if components are bent, elongated, gouged, nicked excessively, worn, or damaged. Make sure that nuts, bolts, pins, and other fastners are tightened and secure. Make sure clamps are functional and will grip the load before use. Refer also to "CM Lifting Clamps Repair Parts" publication which contains operating instructions as well as care, use and inspection information.

# **A**WARNING

Improper use and care of lifting clamps may result in bodily injury or property damage.

#### To avoid injury:

- Do inspect clamps and equipment before use.
- Do not exceed clamp rated load.
- Use clamps only if authorized and properly trained.
- Do not move unbalanced load.
- Do pick up a minimum of 20% of rated load for proper tooth grip.

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# **CM LOAD SECUREMENT SYSTEM COMPONENTS**

Load securement (tie down or load binding) is a complex matter governed by state and federal regulations involving a number of factors. CM offers a number of components, including chain, that conforms with National Association of Chain Manufacturers (NACM) Welded Steel Chain Specifications and the American Society of Testing (ASTM) and Materials Specifications. The available load securement system components are discussed herein.

# **BINDER CHAIN ASSEMBLIES**

Binder chain assemblies are used most often to retain loads to trucks, rail cars, or truck trailers. They typically consist of a length of chain ranging from 6 to 26 feet in length with a grab hook at each end. The grab hook can be clevis style or eye style connected to the chain via a welded coupling link. Standard binder chain assemblies are available in G30, G43, and G70 with G80, and G100.



Binder Chain Assembly W/Welded Coupling Links



Binder Chain Assembly W/Clevis Style Hooks

# **BINDER CHAIN USE**

This chart indicates the minimum number of chains required to secure loads in the forward direction (0.8g deceleration)* per Federal Motor Carriers Safety Administration, DOT Regulations; per 49CFR, Part 393 – Paragraph 393.102.

*Refer to 49CFR, Parts 392 and 393, for North American Standard for Protection Against Falling and Shifting Cargo for complete regulations

CRADE		Wo	rking	Minimun	n number (	of chains r	equired to	secure loa	ds in forwa	rd direction	by Weight	of article in	lbs. (kg.)
OF CHAIN	Size	Load	Limit (ka)	5,000 (2 270)	10,000 (4 540)	15,000 (6 800)	20,000 (9.070)	25,000 (11 340)	30,000 (13,600)	35,000 (15,870)	40,000 (18 140)	45,000 (20 410)	50,000 (22,680)
CM Grade 30	5/16	1.900	862	3	5	7	9	11	13	15	17	19	22
Proof Coil	3/8	2,650	1,202	2	4	5	7	8	10	11	13	14	16
CM Grade 43	5/16	3,900	1,770	2	3	4	5	6	7	8	9	10	11
High Test	3/8	5,400	2,450	1	2	3	3	4	5	6	6	7	8
CM Grade 70	1/4	3,150	1,429	2	3	4	6	7	8	9	11	12	13
Transport	5/16	4,700	2,132	1	2	3	4	5	6	6	7	8	9
	3/8	6,600	2,994	1	2	2	3	4	4	5	5	6	7
CM Grada 90	7/32	2,100	953	2	4	6	8	10	12	14	16	18	20
Herc-Allov	9/32	3,500	1,588	2	3	4	5	6	7	9	10	11	12
HA800	5/16	4,500	2,041	1	2	3	4	5	6	7	8	9	10
	3/8	7,100	3,220	1	2	2	3	3	4	4	5	6	6
CM Grade 100	7/32	2,700	1,225	2	3	5	6	8	9	11	12	14	15
Herc-Alloy	9/32	4,300	1,950	1	2	3	4	5	6	7	8	9	10
I HATUUU	3/8	8,800	3,992	1	1	2	2	3	3	4	4	5	5

#### **TABLE VII**

# **CHAIN SPECIFICATIONS**

Chain Grade Identification Samples[†]



# TABLE VIII

**GRADES OF CHAIN** 

	Proof Co Grade 30	il D		High Tes Grade 43	it 3		Transpo Grade 7	rt '0		Herc Allo Grade 80	y )		Herc Allo Grade 10	y O
CM Other 3, G-3, Note: Ur trea	l Embossing embossing i M-3, P-30, marked cha ted as Proog	G30 ncludes CG3, L3 in is to be g Coil	CM Other 4, G4,	Embossing embossing i G40, M4, C P43, T4, H	G43 ncludes G4, L4, T	Cl Othe 7, G7 P	M Embossing r embossing 7, G40, M7, 0 70, W7, P70	g G70 includes CG7, L7, , TS7	CM E Other 8, A8A, V G8 PWA	Embossing H embossing i VB-80, CA8, 3, 8GJC, L8, A80, KWS-8,	IA 800 ncludes CG8, 8G, P8, W8A	CM E Other A10,	mbossing H embossing i C10, CG10 PWA100, VI	A 1000 ncludes I, P10, P,
Size(in)	Working L (Lbs.	oad Limits (Kg.)	Size(in)	Working I (Lbs.	Load Limits (Kg.)	Size(in)	Working L (Lbs.	.oad Limits (Kg.)	Size(in)	Working L (Lbs.	oad Limits (Kg.)	Size(in)	Working L (Lbs.	oad Limits (Kg.)
1/4 5/16 3/8 1/2	1/4         1300         580           5/16         1900         860           3/8         2650         1200           1/2         4500         2030		1/4 5/16 3/8 1/2	2600 3900 5400 9200	1180 1770 2450 4170	1/4 5/16 3/8 1/2	3150 4700 6600 11300	1430 2130 2990 5130	9/32 5/16 3/8 1/2	3500 4500 7100 12000	1570 2040 3200 5400	7/32 9/32 3/8 1/2	2700 4300 8800 15000	1225 1950 3990 6800

†Markings shown are for CM chain, samples of other markings are displayed in Chain Grade boxes depending on product and manufacturer, chain grade identification mark spacing varies from every link to one in every 3 feet (91.5 cm). Chain grade identification is accomplished using embossed (raised) numbers and letters. Embossing may be difficult to see on chain which has been in service and is rusty, dirty or worn. Typically, marked links contain only one marked area. Wire brushing and illumination will help improve visibility of markings.

# A WARNING

Death/injury can occur from improper use or maintenance of tie down equipment.

To avoid injury:

- •Inspect before use remove from
- service if cracked, worn, or deformed.
- •Do not overload.
- Do not use handle extender on load binders.
- Do not use binder components for overhead lifting.

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# **TIE DOWN HOOKS**



See page 18, 23, and 24 under CM ATTACHMENTS for detailed information on these hooks including "USE," "CARE" AND "INSPECTION."

# LOAD BINDERS

Load binders are typically used to take up slack and apply tension to a tie down system. They are designed primarily for use with graded chains. They are available in two general configurations, e.g. Lever Type (over the center) and Ratchet Configuration. They are rated by working load limit and are provided with hooks of various styles that will accept chain size and grade consistent with the load rating.

#### LOAD BINDER USE

To assure safe operation, operate binders only as outlined in the following steps:



- 1. Always follow safe work practices and take precautions in use of binders. Particular attention is called to the following sections of the Federal Motor Carrier Safety Regulations: S392.9(relating to safe loading) S393.100 (relating to protection against shifting or falling cargo); and S393.102 (relating to securement systems).
- 2. Visually inspect binder as detailed in "Load Binder Inspection" section.
- 3. Always position the load binder so the handle goes downward when securing or tightening the load.
- 4. Operate only by hand from a firm standing position.
- 5. Do not use a handle extension. Extensions can dangerously overload the binder system and may result in serious injury. Use a ratchet type binder if sufficient leverage is difficult to develop.

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- 6. Make certain that the lever of the lever type binder is over center and locked. Always secure the handle in locked position with a positive retaining method. The handle must be secured since there is a possibility of relaxation of the load which may result in the lever moving from the locked over center position to relaxed mode resulting in loss of tension in the system.
- 7. Be sure no one is in a position to be struck by the handle when releasing the lever type binder. Handle may whip suddenly.
- 8. Retighten binders periodically.

# LEVER TYPE BINDERS

Lever type (over the center) binders utilize the principle of mechanical advantage associated with a system of linkages. Tension can be applied quickly and also released quickly. Lever (handle) stores unobtrusively in line with load. This type binder is available with a variety of attachments.

# **RATCHET TYPE BINDERS**

Ratchet binders utilize the principle of the screw and are slower but easier to operate than lever type binders. They do not require locking of handle. Available in one style with grab hooks.

# **RIVER RATCHETS**

Similar in operation to ratchet type binders but with a substantially larger capacity. Used to gang barges. Double pawl construction gravity operated. Available in a variety of attachments. One version shown here.

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Meets or exceeds Fed. Spec. GGG-B-325

# LOAD BINDER CARE

Care should be exercised during use so that the binder is not abused or damaged. See "Care" section under Hooks (page 23).

- 1. The binder or hooks should not be subjected to bending or sharp objects. Loading should be in a straight line.
- 2. Avoid exposure to corrosive mediums. Rust or corrosion can increase operating forces and prevent ease of operation of the unit. Lubricate pivot swivel points and threads periodically.

# LOAD BINDER INSPECTION

Inspect binder prior to each use for damage, distortion, cracks, nicks, or wear. See "Inspection" section under hooks (page 24).

- 1. Bending of any feature in any plane of more than 10 degrees is cause for removal of the unit from service. Any distortion indicates overloading or misuse.
- 2. Distorted or elongated connecting links indicate overloading or misuse and is also cause for removal of the unit from service.
- 3. If wear of connecting link ends is more than 10% of the original stock, remove unit from service.
- 4. On lever type binders inspect yoke periodically for distortion and make certain it is seated on the pins.
- 5. Deep nicks and gouges should be smoothed out to relief stress concentrations providing that the material removed does not exceed 10% of the total material.
- 6. If distortion, cracks, nicks, or wear affect more than 10% of the stock, discard the unit.

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Improper use of load binders can result in bodily injury or property damage.

#### To avoid injury or damage:

- Never exceed working load limit.
- Always inspect binder before use for wear, damage, and elongation.
- Do not use cheater bar or handle extension.
- Do not operate load binder while anyone is on the load.
- Release load on lever type binders with extreme care. Make sure everyone is clear of the load. Handle may whip suddenly.

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