Section 9
Wire Rope / Hooks/ Chains
Drop Lugs/Drums / Sheaves

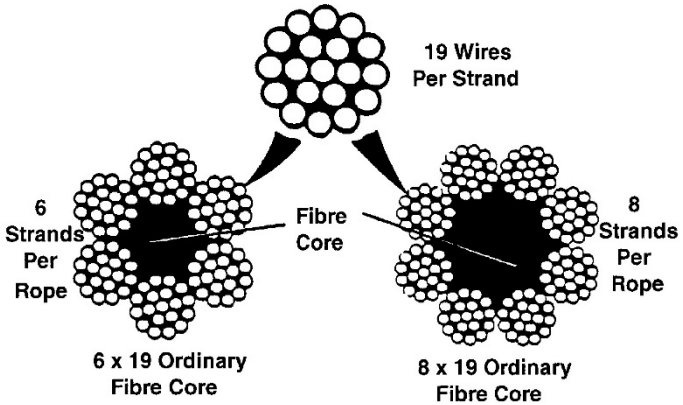
Training Objective

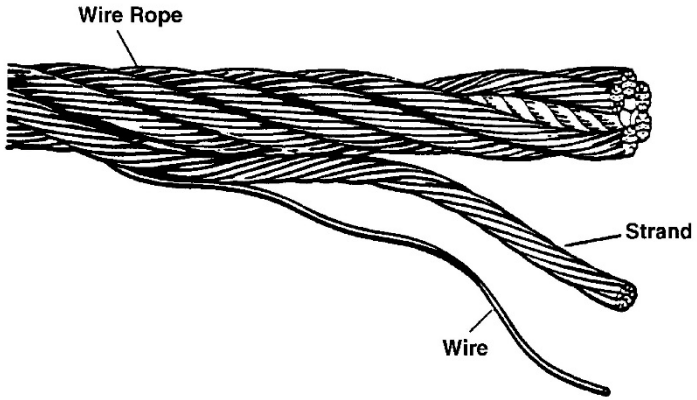
At the completion of this section, students should have a thorough understanding of:

- the inspection requirements and rejection criteria associated with wire rope, hooks, chain, hoist drums, drop lugs and sheaves.

- This understanding should be based on a working knowledge of:
  - ASME B30 standards
  - OSHA regulations
  - Guidelines set forth in Wire Rope Users Manual.

Wire Rope Terminology

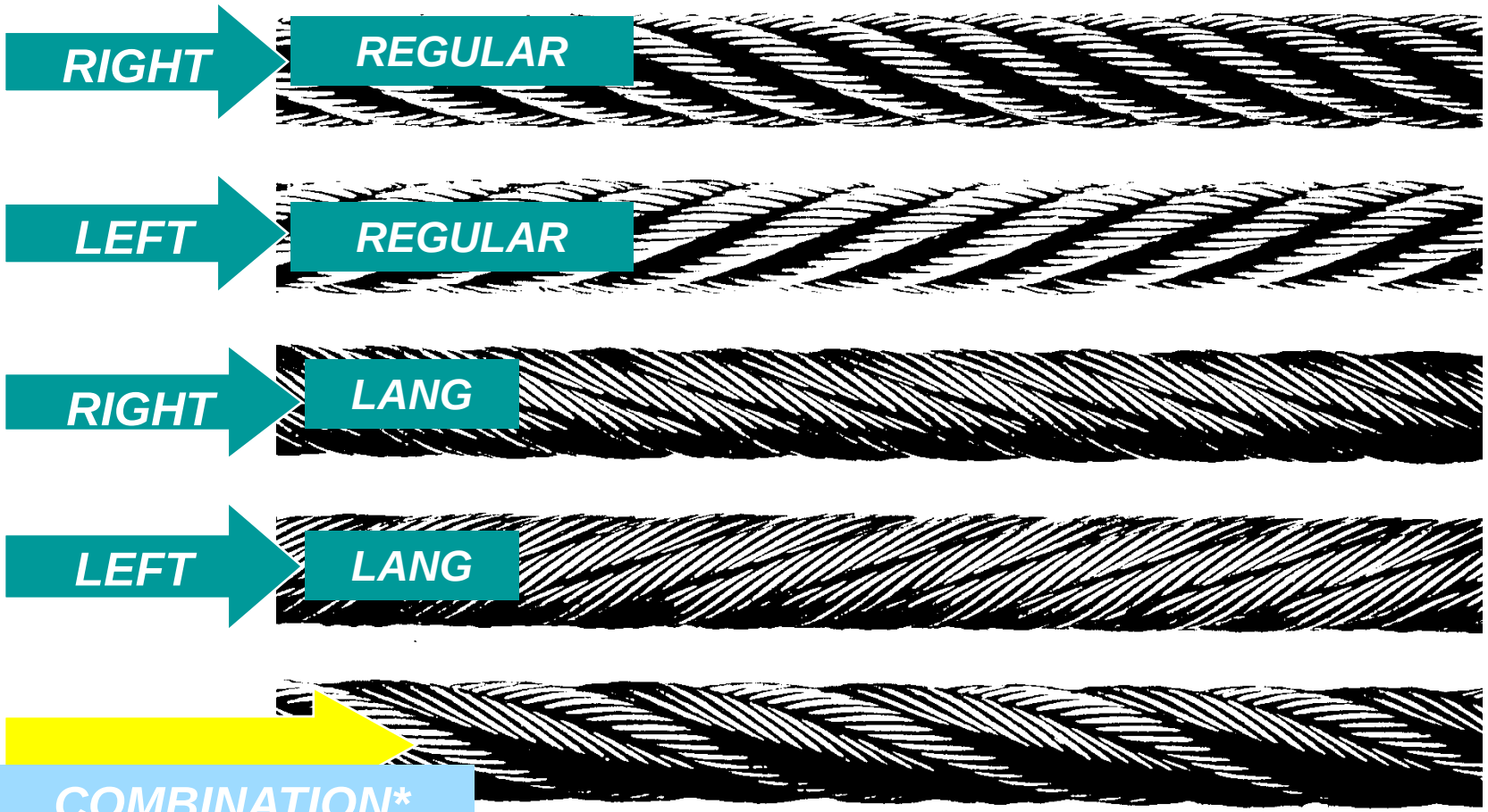




The term **lay,** when used to describe wire rope, has 3 different applications. What are they?

1. Right or left lay
2. Regular or lang lay
3. Length of 1 strand making a complete rotation around the wire rope

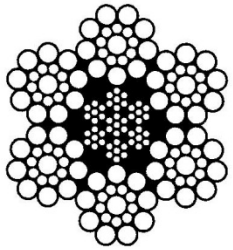
Wire Rope



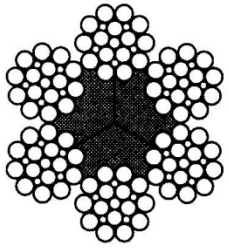
*** not for use on Overhead Cranes**

COLUMBUS McKINNON
CORPORATION

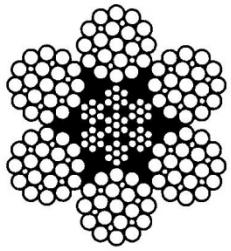
6 x 19 Classification



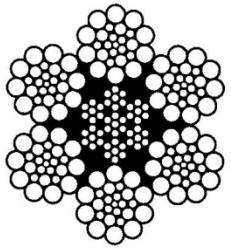
6 x 19 Seale
IWRC



6 x 21 Filler Wire
FC

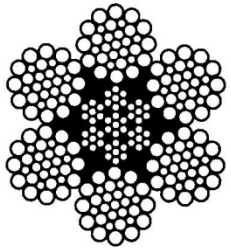


6 x 25 Filler Wire
IWRC

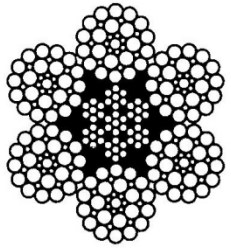


6 x 26 Warrington Seale
IWRC

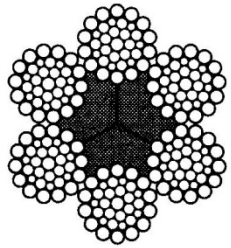
6 x 37 Classification



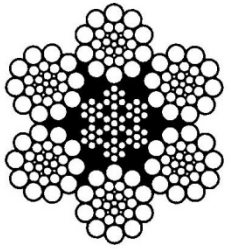
6 x 31 Warrington Seale
IWRC



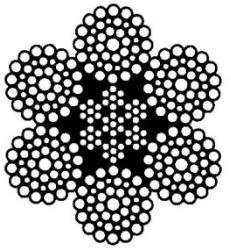
6 x 36 Seale Filler Wire
IWRC



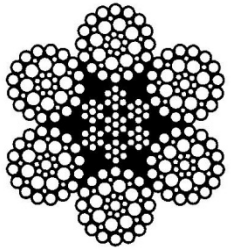
6 x 36 Warrington Seale
FC



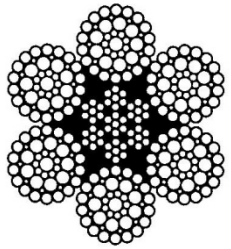
6 x 31 Filler Wire Seale
IWRC



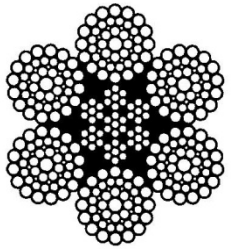
6 x 41 Warrington Seale
IWRC



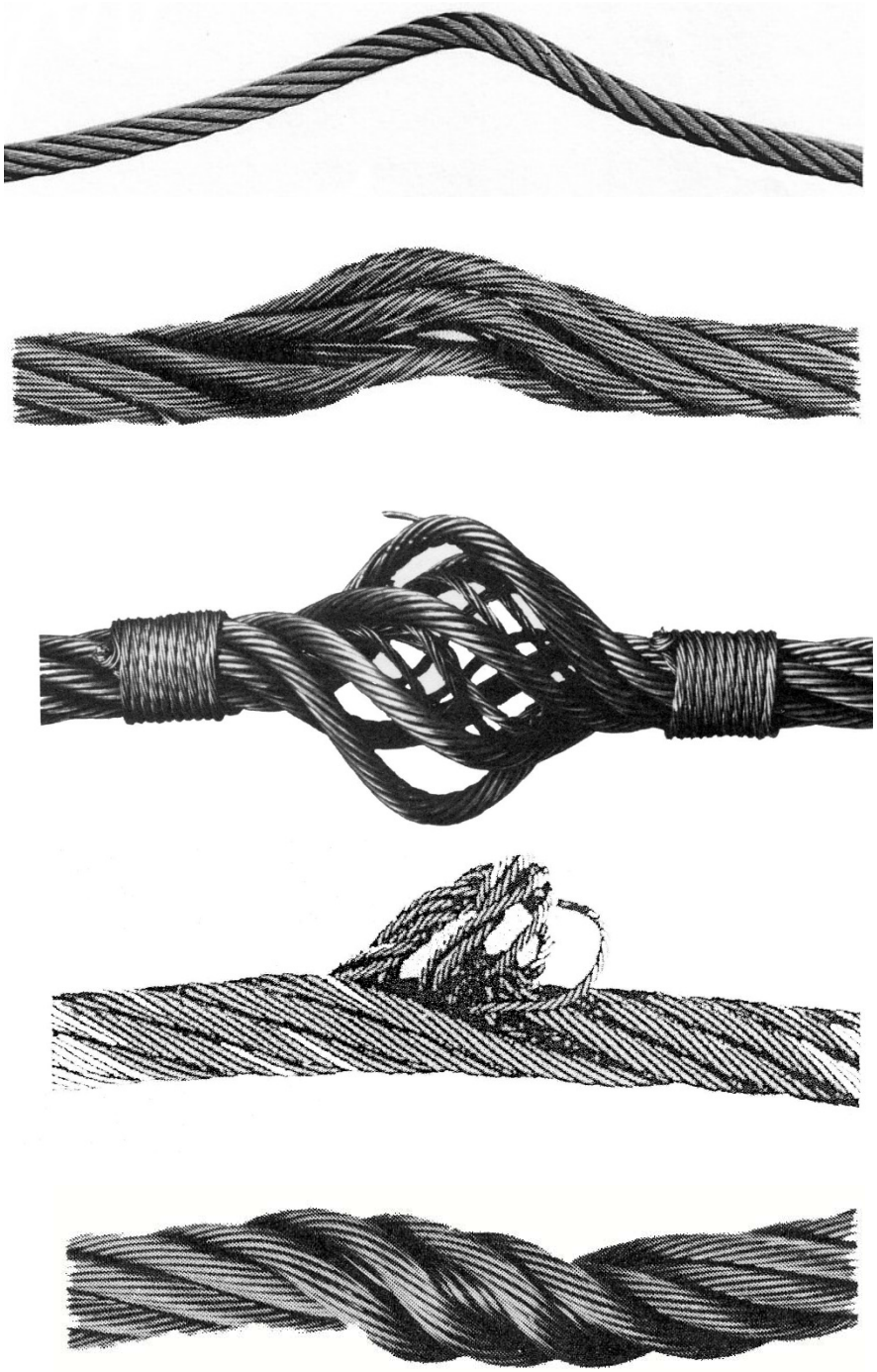
6 x 41 Seale Filler Wire
IWRC



6 x 46 Seale Filler Wire
IWRC



6 x 49 Filler Wire Seale
IWRC



Wire Rope Inspection

REFERENCE:

- **OSHA 1910.179(m)**
- **ASME B30.2-2.2.2**
- **ASME B30.16-2.1.5(c)(11) & (12)**
- **Wire Rope Users Manual**

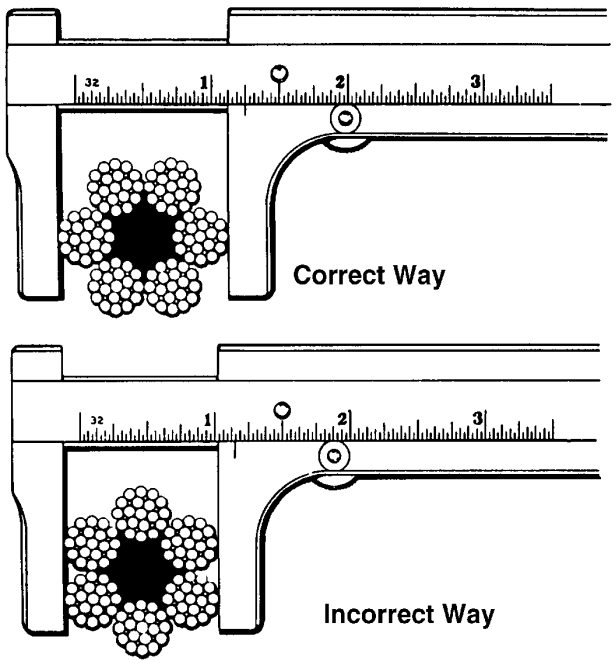
INSPECT:

- Proper rope type
- ***Kinks / dog legs***
- ***Crushing***
- ***Bird caging***
- ***Core protrusion***
- ***Strand separation***
- Diameter reduction
- Wear on outer wires
- Heat / Weld discoloration
- Lubrication

COLUMBUS McKINNON CORPORATION

Rope Measurement

Periodic Inspection
ASME B16-2.1.5(c)(11)(-c) reduction of nominal diameter of more than 5%



Rope Diameter	Maximum Reduction
Up to 5/16”	1/64”
3/8-1/2”	1/32”
9/16-3/4”	3/64”
7/8-1 1/8”	1/16”
1 1/4 - 1 1/2”	3/32”

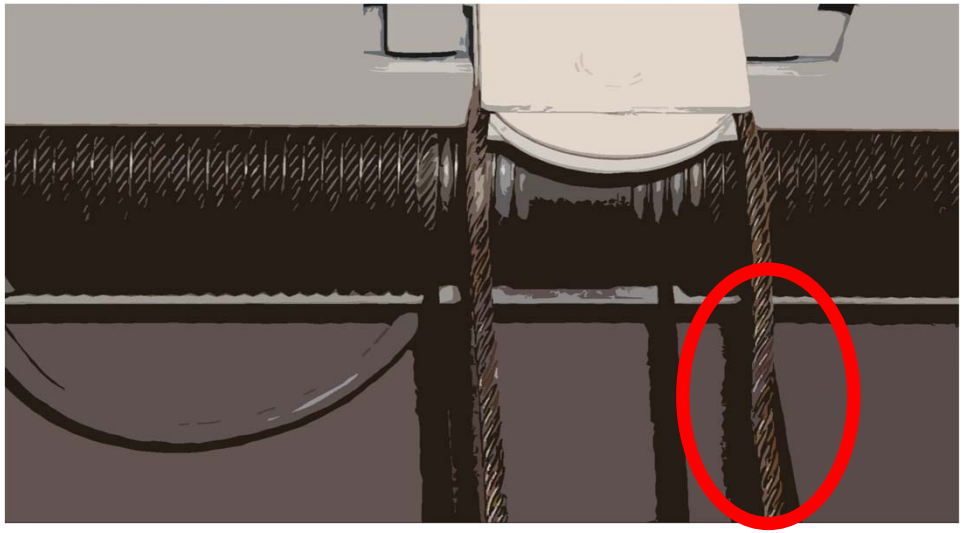
COLUMBUS McKINNON CORPORATION

New Rope Tolerance

Nominal Diameter of Rope in Inches	Undersize Inch	Oversize Inch
0 to ¾”	0	1/32
13/16 to 1 1/8	0	3/64
13/16 to 1 ½	0	1/16
1 9/16 to 2 ¼	0	3/32
2 5/16 and larger	0	1/8

COLUMBUS McKINNON
CORPORATION

Key Areas To Inspect

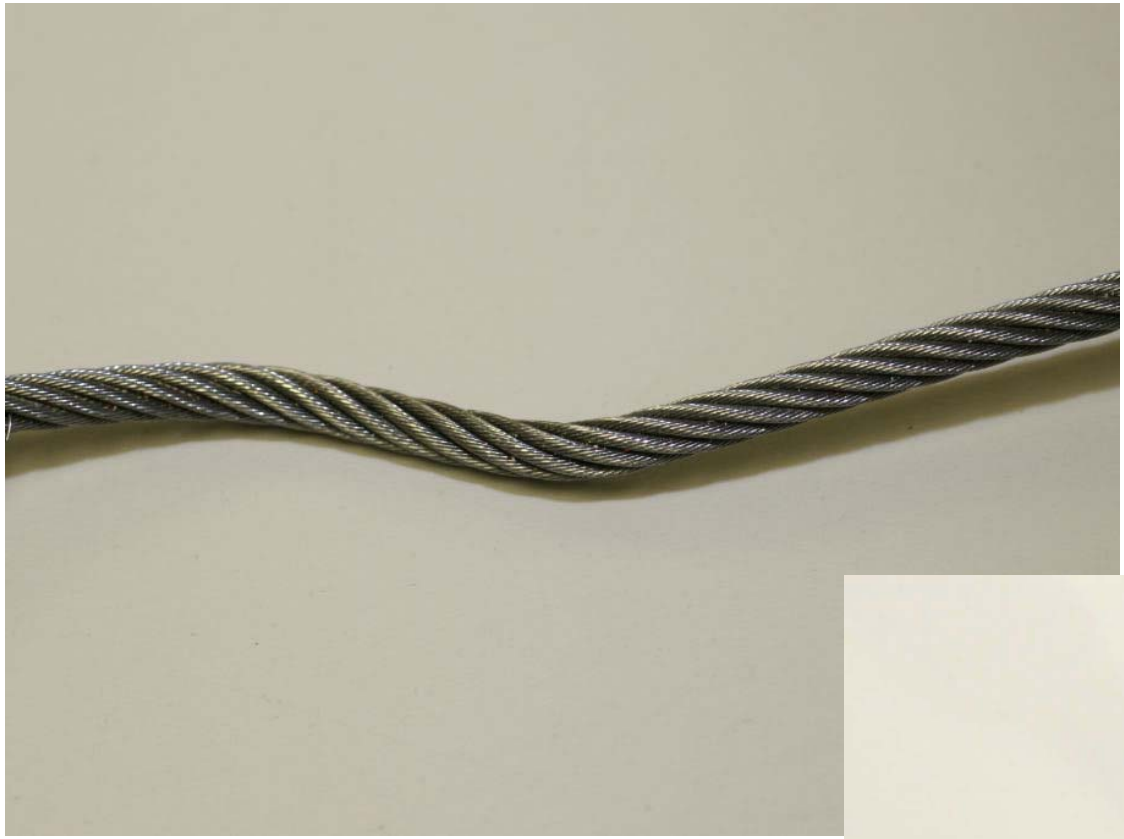


ASME B30.2-2.2.2 Frequent Rope Inspection
(a) All ropes should be visually inspected at the start of each shift. These visual observations should be concerned with discovering gross damage, such as the sample listed below, they may be a hazard.

INSPECT:

- Proper rope type
- *Kinks / dog legs*
- *Crushing*
- *Bird caging*
- *Core protrusion*
- *Strand separation*
- Diameter reduction
- Wear on outer wires
- Heat / Weld discoloration
- Lubrication

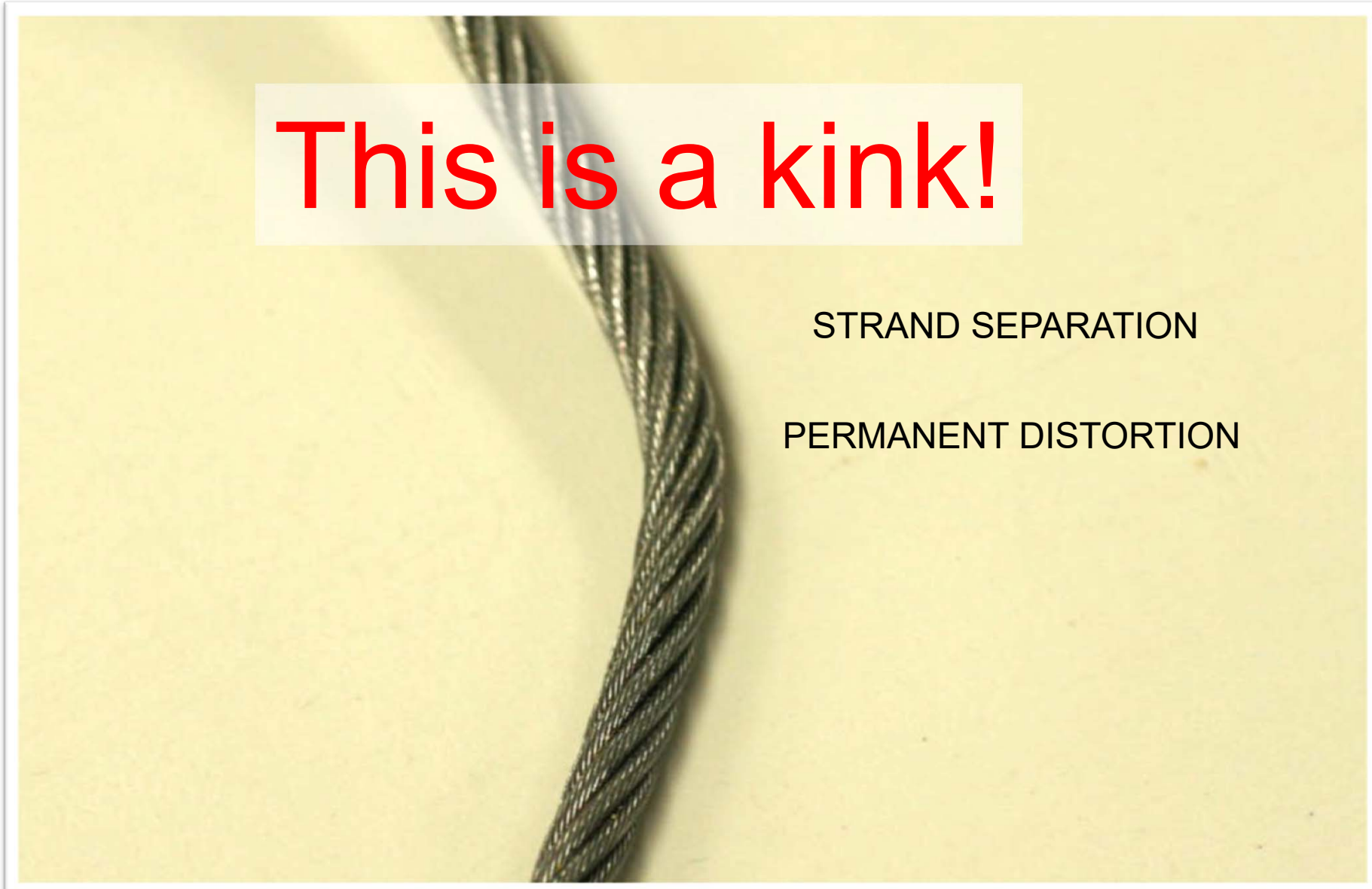
COLUMBUS McKINNON CORPORATION



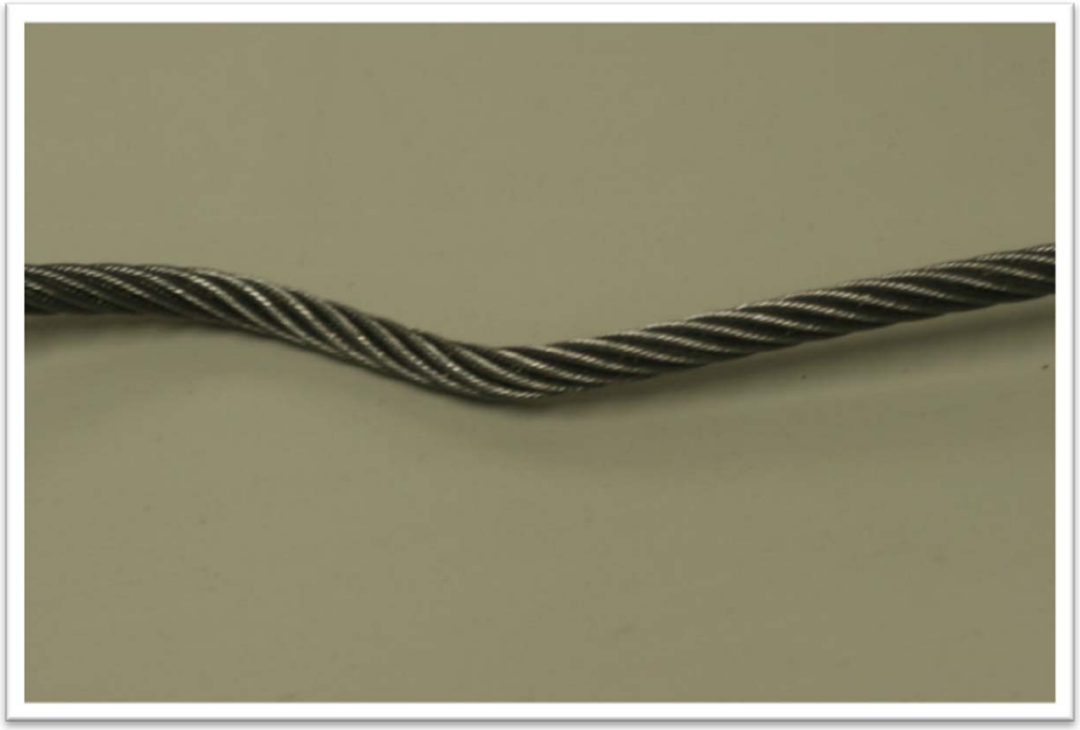
This is a kink!

1910.179(n)(3)(ii)(a)
HOIST ROPES SHALL NOT BE KINKED

ASME B30.2-2.2.2(a)(1)



ASME B30.2-2.2.2



This is a kink!

1910.179(n)(3)(ii)(a)
HOIST ROPES SHALL NOT BE KINKED

COLUMBUS McKINNON CORPORATION


Shiny surface – may indicate
wear to the outside wires

ASME B30.2-2.2.2

2-2.2.2 Frequent Rope Inspection

(a) All ropes should be visually inspected at the start of each shift. These visual observations should be concerned with discovering gross damage, such as listed below, that may be a hazard.

(1) distortion of the rope, such as kinking, crushing, unstranding, birdcaging, main strand displacement, or core protrusion

(2) general corrosion

(3) broken or cut strands

(4) number, distribution, and type of visible broken wires [see paras. 2-4.3.1(b)(1) and (2) for further guidance]

(b) When damage as described in paras. 2-2.2.2(a)(1) through (a)(4) is discovered, the rope shall either be removed from service or given an inspection as detailed in para. 2-2.2.3(b).

COLUMBUS McKINNON CORPORATION

ASME B30.2-4.3 Top Running Bridge & Trolley Hoist

SECTION 2-4.3: ROPE REPLACEMENT AND MAINTENANCE

2-4.3.1 Rope Replacement

(a) No precise rules can be given for determination of the exact time for rope replacement, since many variable factors are involved. Once a rope reaches any one of the specified removal criteria, it may be allowed to operate to the end of the work shift, based on the judgment of a qualified person. The rope shall be replaced after the work shift, at the end of the day, or at the latest time prior to the equipment being used by the next work shift.

(b) Removal criteria for rope replacement shall be as follows:

(1) in running ropes, twelve randomly distributed broken wires in one lay or four broken wires in one strand in one lay

COLUMBUS McKINNON CORPORATION

ASME B30.16-4.4 Overhead Hoist Underhung

SECTION 16-4.4: ROPE REPLACEMENT AND MAINTENANCE

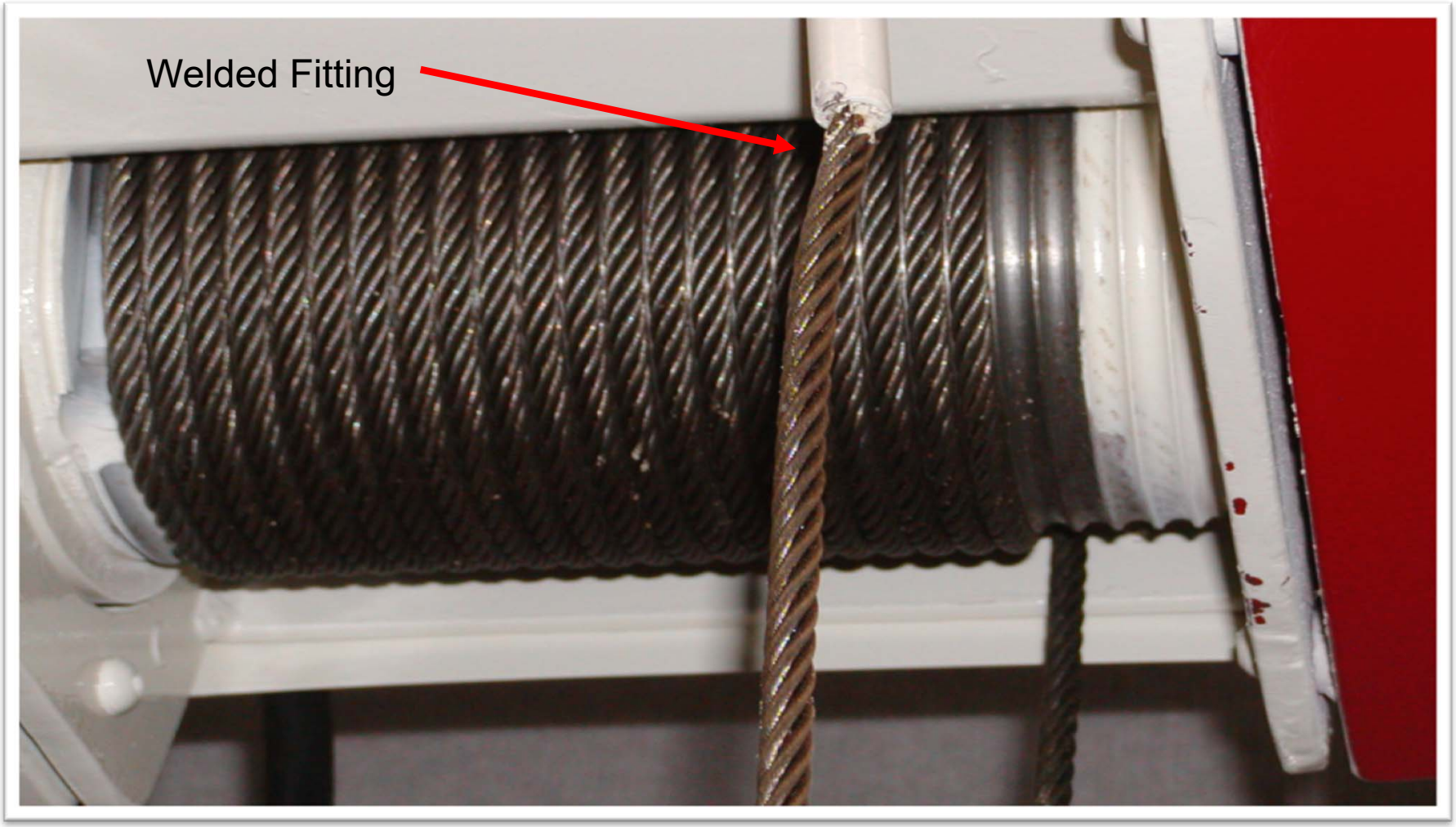
16-4.4.1 Rope Replacement

(a) No precise rules can be given for determination of the exact time for rope replacement since many variable factors are involved. Once a rope reaches any one of the specified removal criteria, it may be allowed to operate to the end of the work shift, based on the judgment of a qualified person. The rope shall be replaced after that work shift, at the end of the day, or at the latest time prior to the equipment being used by the next work shift.

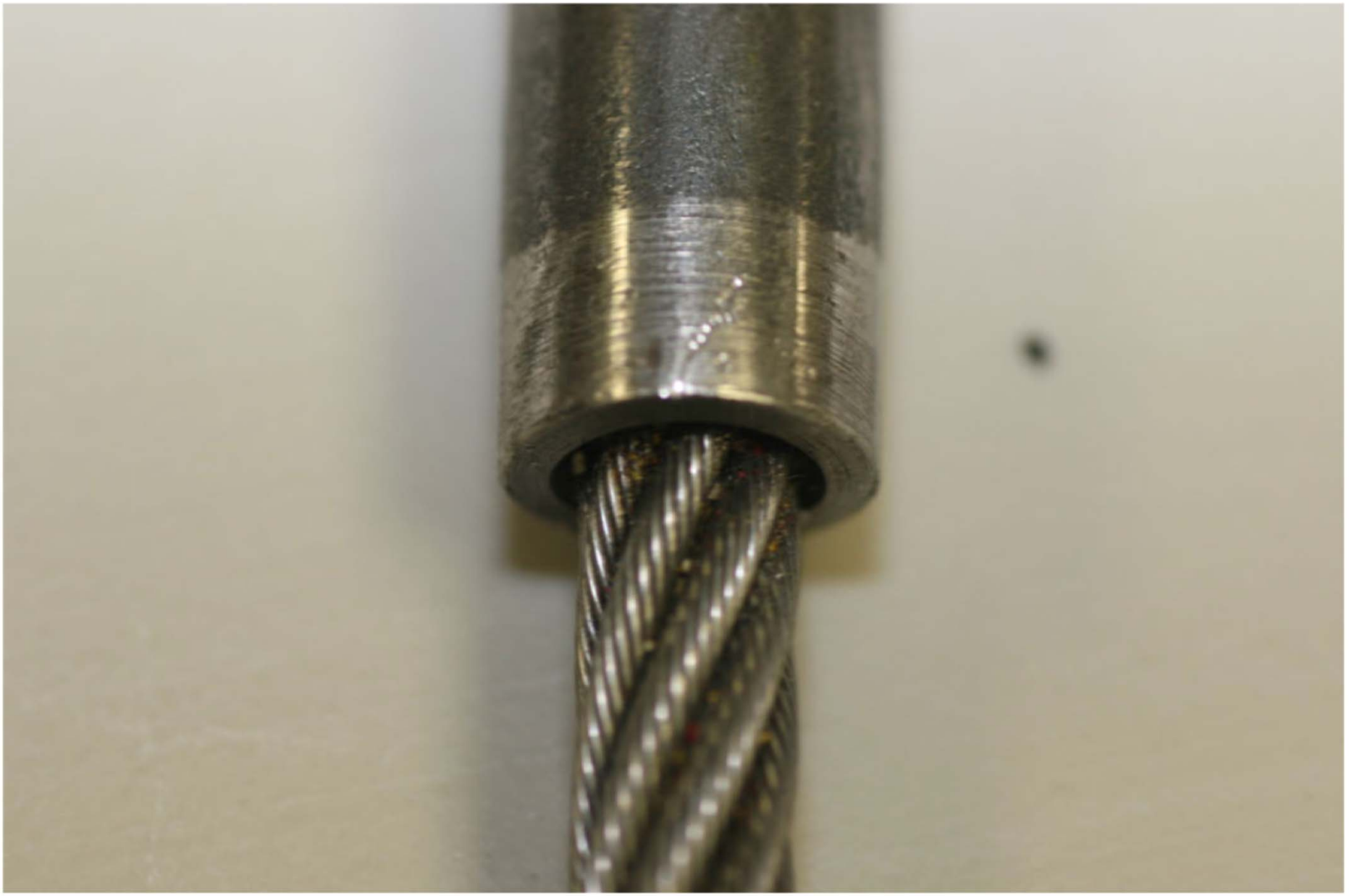
(b) Removal criteria for the rope replacement shall be as follows:

(1) in running ropes, six randomly distributed broken wires in six rope diameters, or three broken wires in one strand in six rope diameters, except as noted in (b)(2)

Fixed End Fittings



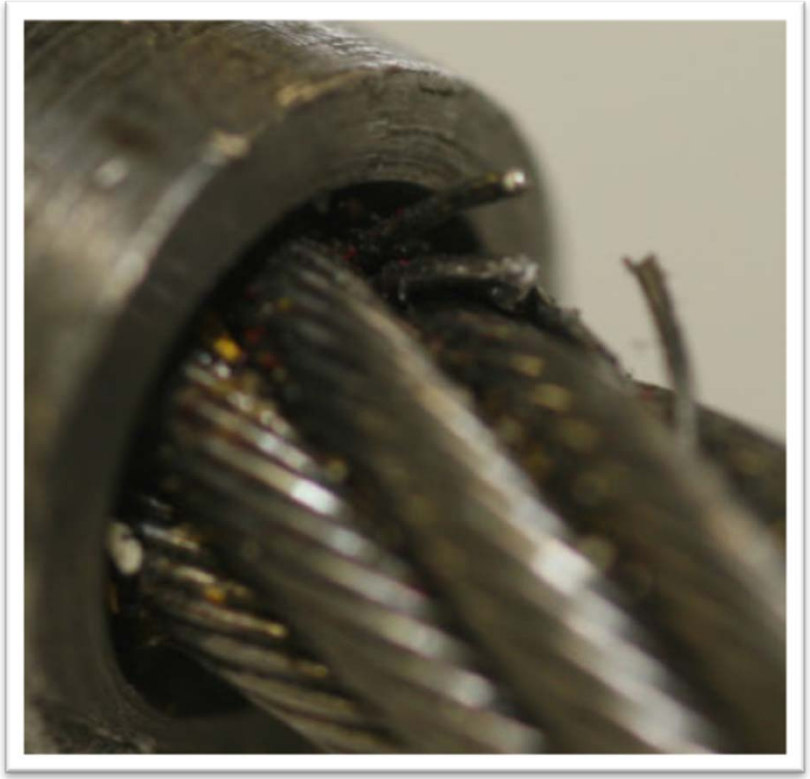
COLUMBUS McKINNON
CORPORATION



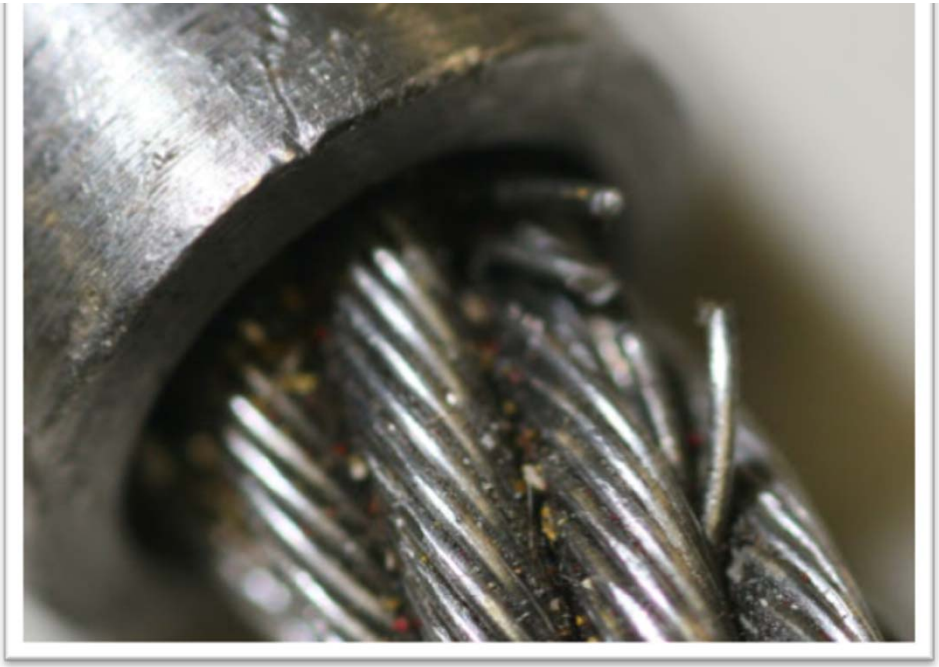
ASME B30.2-4.3.1

(b)(2) One outer wire broken at the contact point with the core of the rope, which has worked its way out of the rope structure & protrudes or loops out from the rope structure.

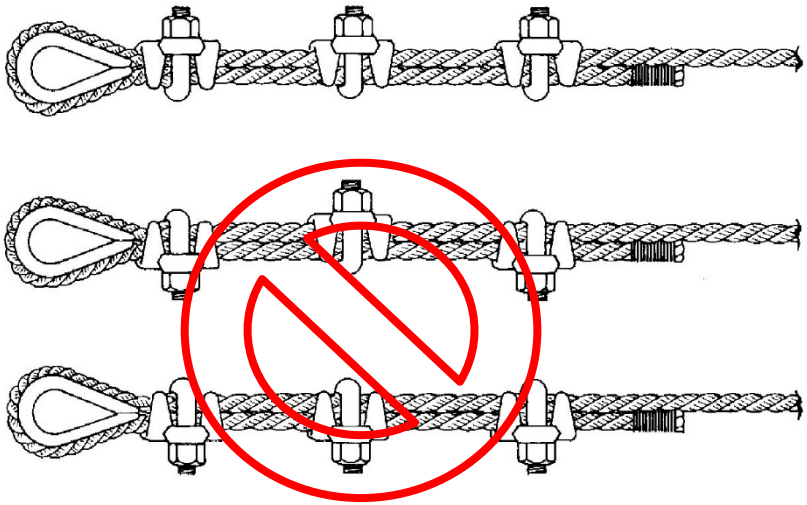
(d)Attention shall be given to end connections. Upon development of two broken wires adjacent to a socketed end connection, the rope should be re-socketed or replaced. Re-socketing shall not be attempted if the resulting rope length will be insufficient for proper operation.

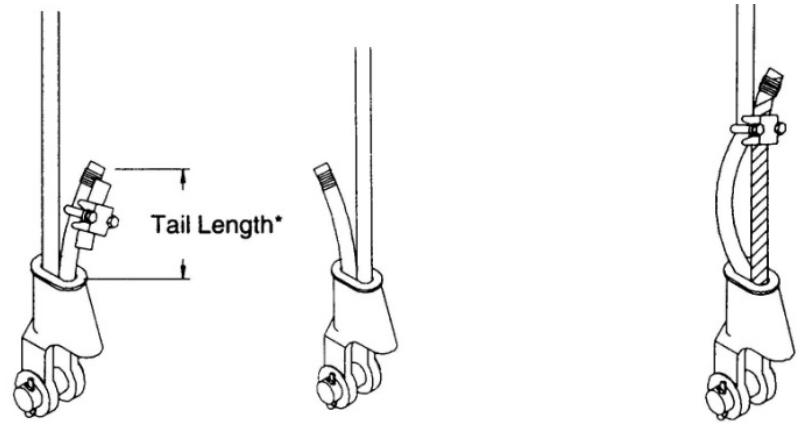


Must be replaced or re-socketed
If possible

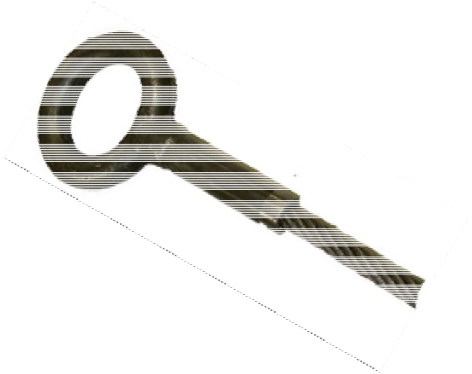


End Fittings





Right **Wrong** **Wrong**



* Tail Length
Standard 6 to 8 strand wire rope
A minimum or 6 rope diameters, but not less than 6".
(i.e. - For 1" rope: Tail Length = 1"x6=6")

Rotation Resistant Wire Rope
A minimum of 20 rope diameters, but not less than 6".
(i.d. - For 1" rope: Tail Length = 1"x20=20")

COLUMBUS McKINNON CORPORATION

Chains

REFERENCE:

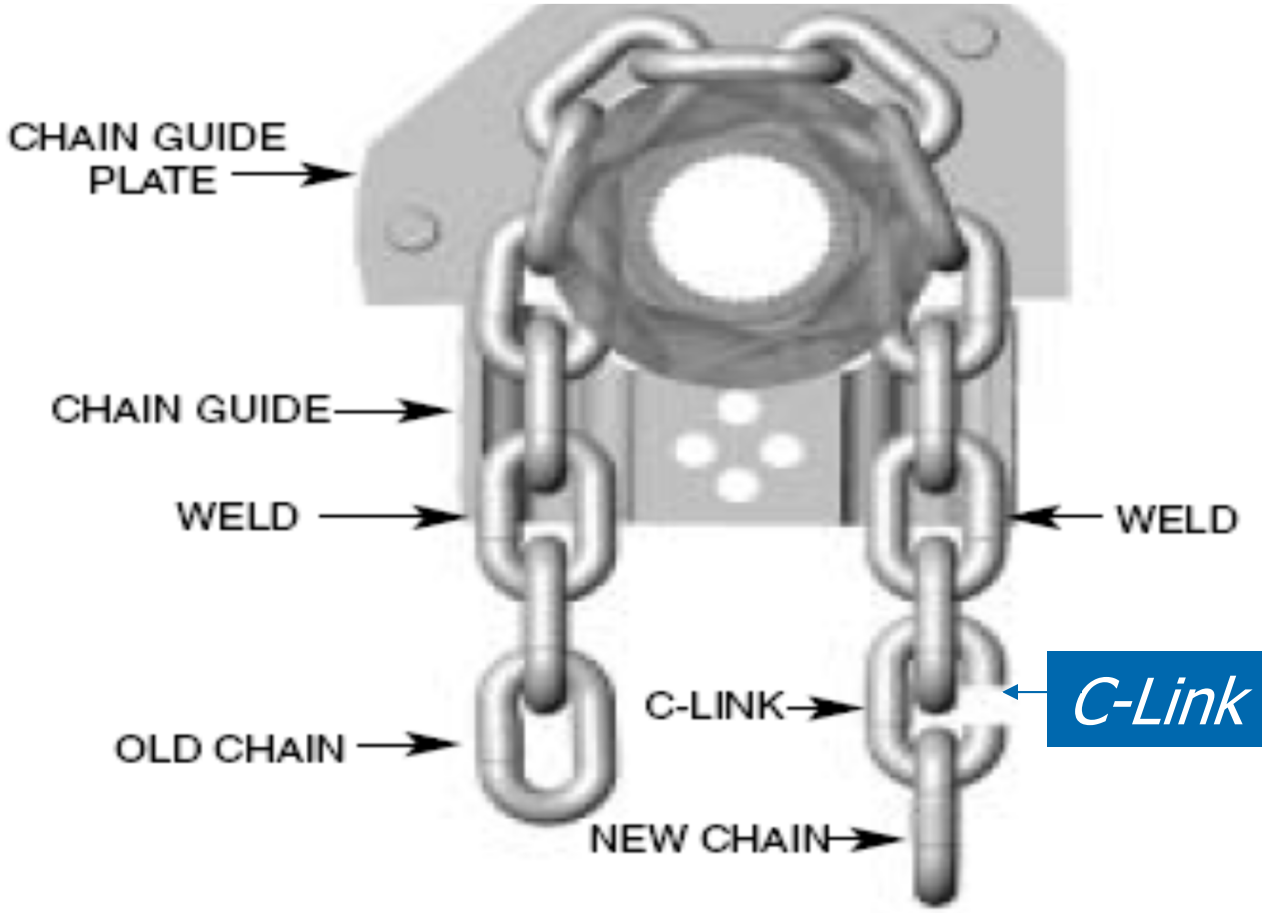
- OSHA 1910.179(j)(2)(iv)
- ASME B30.16-2.1.5
- ASME B30.20-1.2.1
- ASME B30.21-2.1.2

INSPECT:

- Twist
- Chain stop
- Welds
- Distorted links
- Nicks
- Gouges
- Contact point wear
- Stretch (Hand chain hoist different than powered hoist)
- Cracks
- Heat discoloration
- Shoulder wear
- Corrosion

COLUMBUS McKINNON CORPORATION

Chain parts of an Electric Hoist
Replacing the Chain on Existing Hoists



COLUMBUS McKINNON
CORPORATION

Chain parts of an Electric Hoist
Replacing the Chain on Existing Hoists

ASME B30.16-2.2.2(a)(2)(-d), (b)(2)(-d) Load Test

(-d) The replacement of load chain is specifically excluded from this load test; however, an operational test of the hoist should be made in accordance with para. 16-2.2.1(a)(2) prior to putting the hoist back in service.

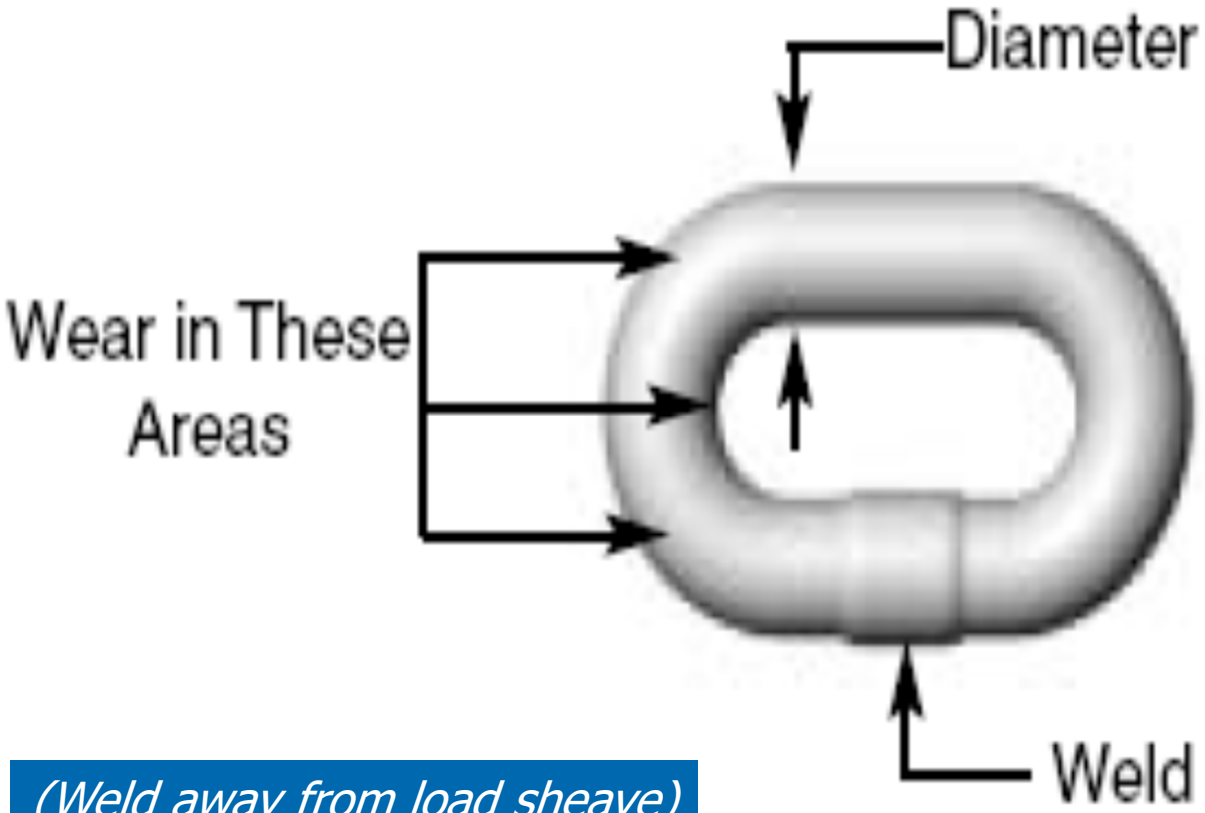
ASME B30.16-4.5.1(f)(g) Welded Link Chain Replacement

(f) When chain is replaced, the mating parts (sprockets, guides, stripper) shall be disassembled and inspected for wear and replaced if necessary.

(g) Discarded load chains shall not be used for slings.

COLUMBUS McKINNON CORPORATION

Chain Wear



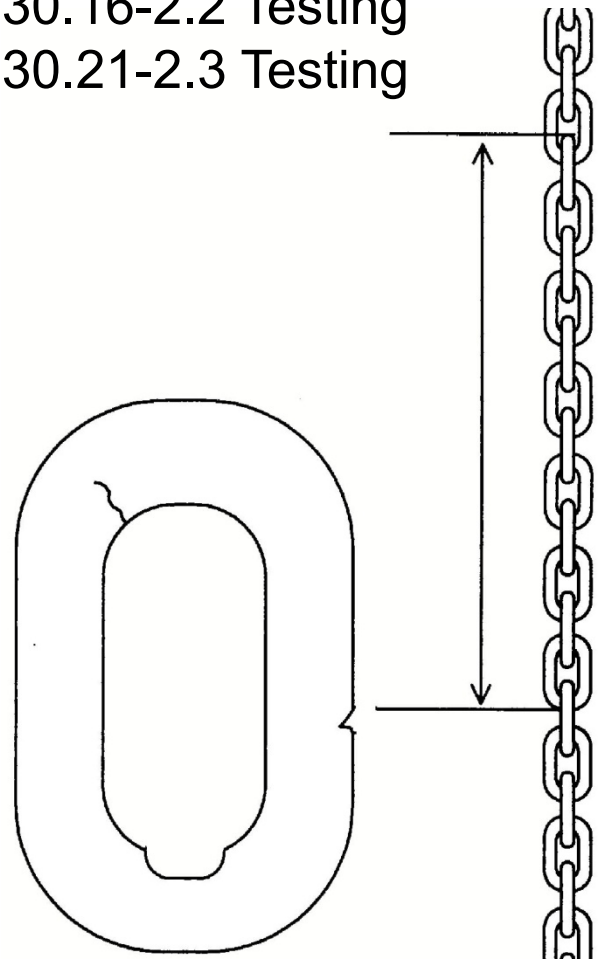
(Weld away from load sheave)

COLUMBUS McKINNON CORPORATION

Chain Inspection

REFERENCE:

- OSHA 1910.179(j)(2)(iv)
- ASME B30.16-2.2 Testing
- ASME B30.21-2.3 Testing

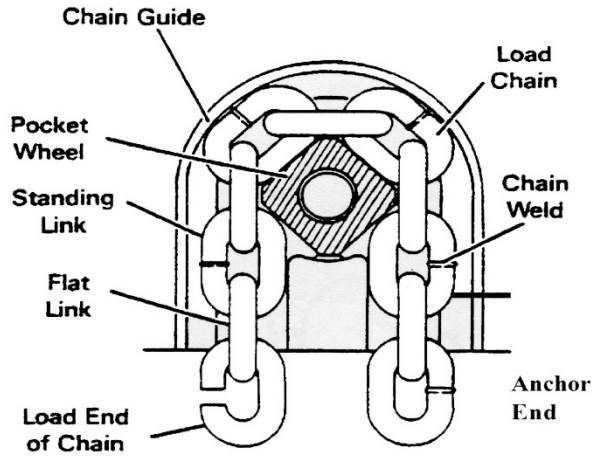


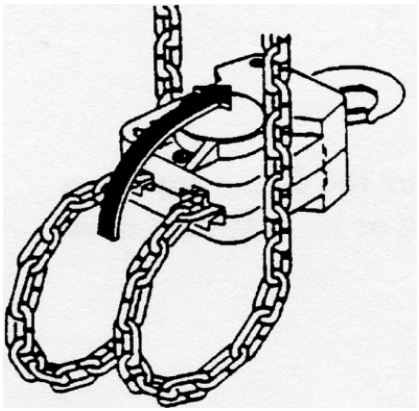
INSPECT:

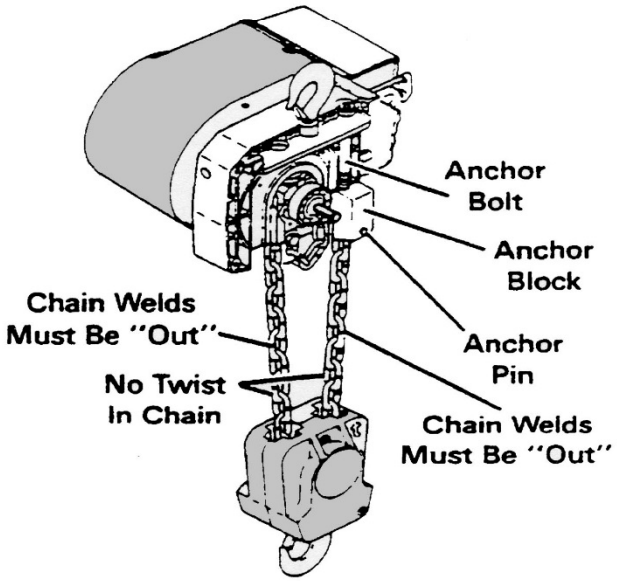
- Twist
- Chain stop
- Welds
- Distorted links
- Nicks
- Gouges
- Contact point wear
- Stretch (hand chain hoist different than powered hoist)
- Cracks
- Heat discoloration
- Shoulder wear
- Corrosion

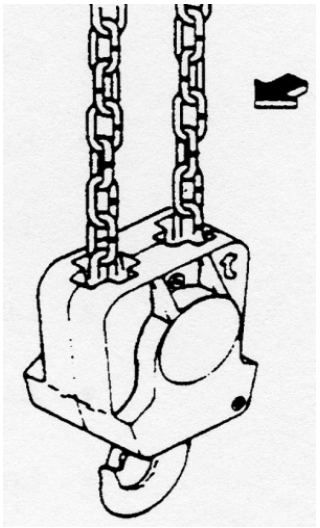
COLUMBUS McKINNON CORPORATION

Chain Twist









COLUMBUS McKINNON CORPORATION

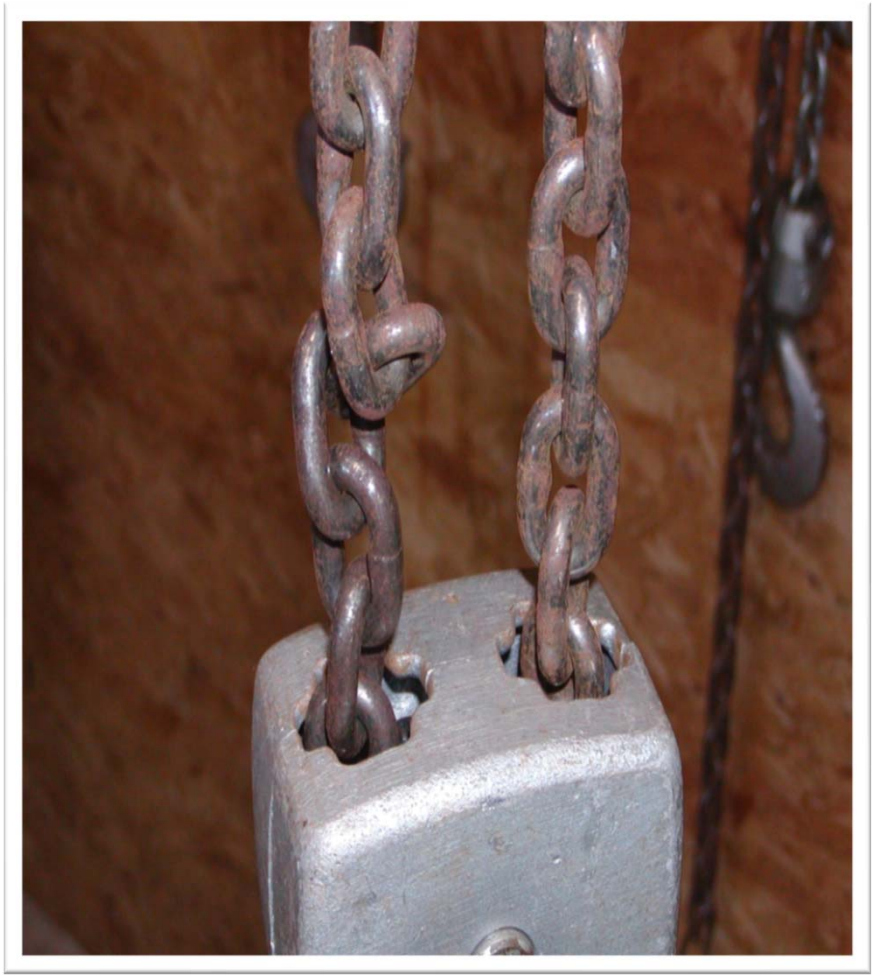
Capsized Lower Load Block

Problem:

- Flipped lower load block.
- Can only occur with a double chained hoist.

Solution:

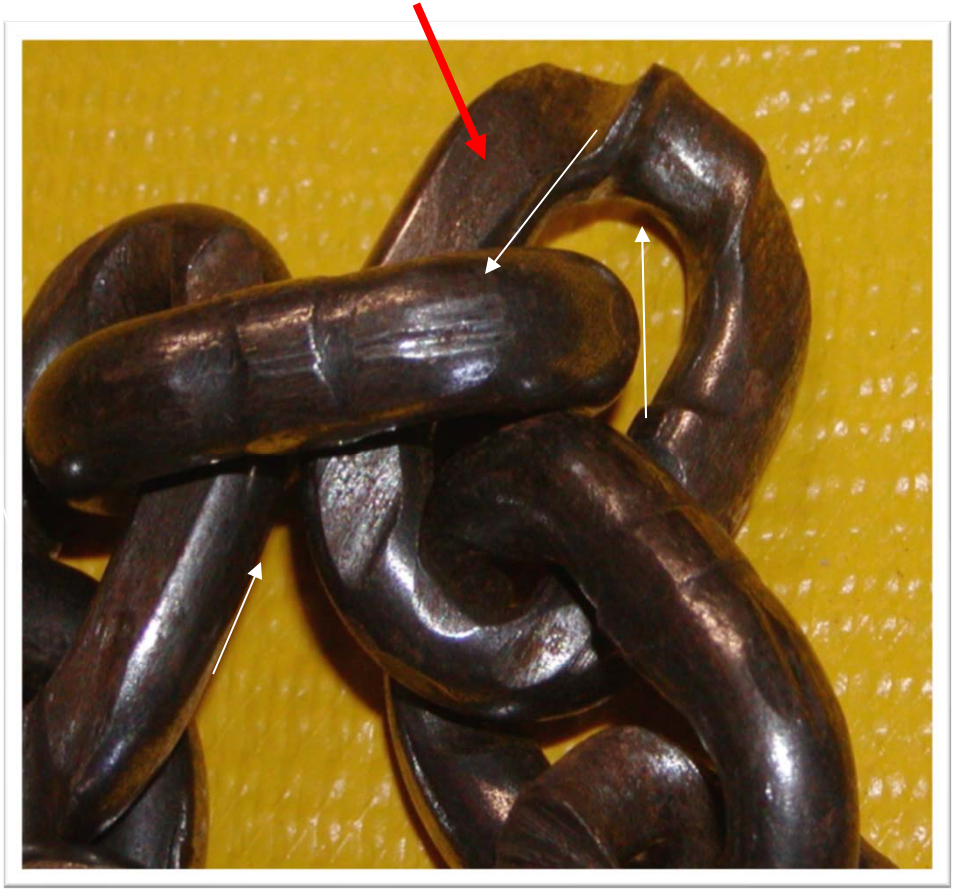
- Use a single chained hoist whenever possible.



COLUMBUS McKINNON CORPORATION

Worn Chain

What causes this type of wear?



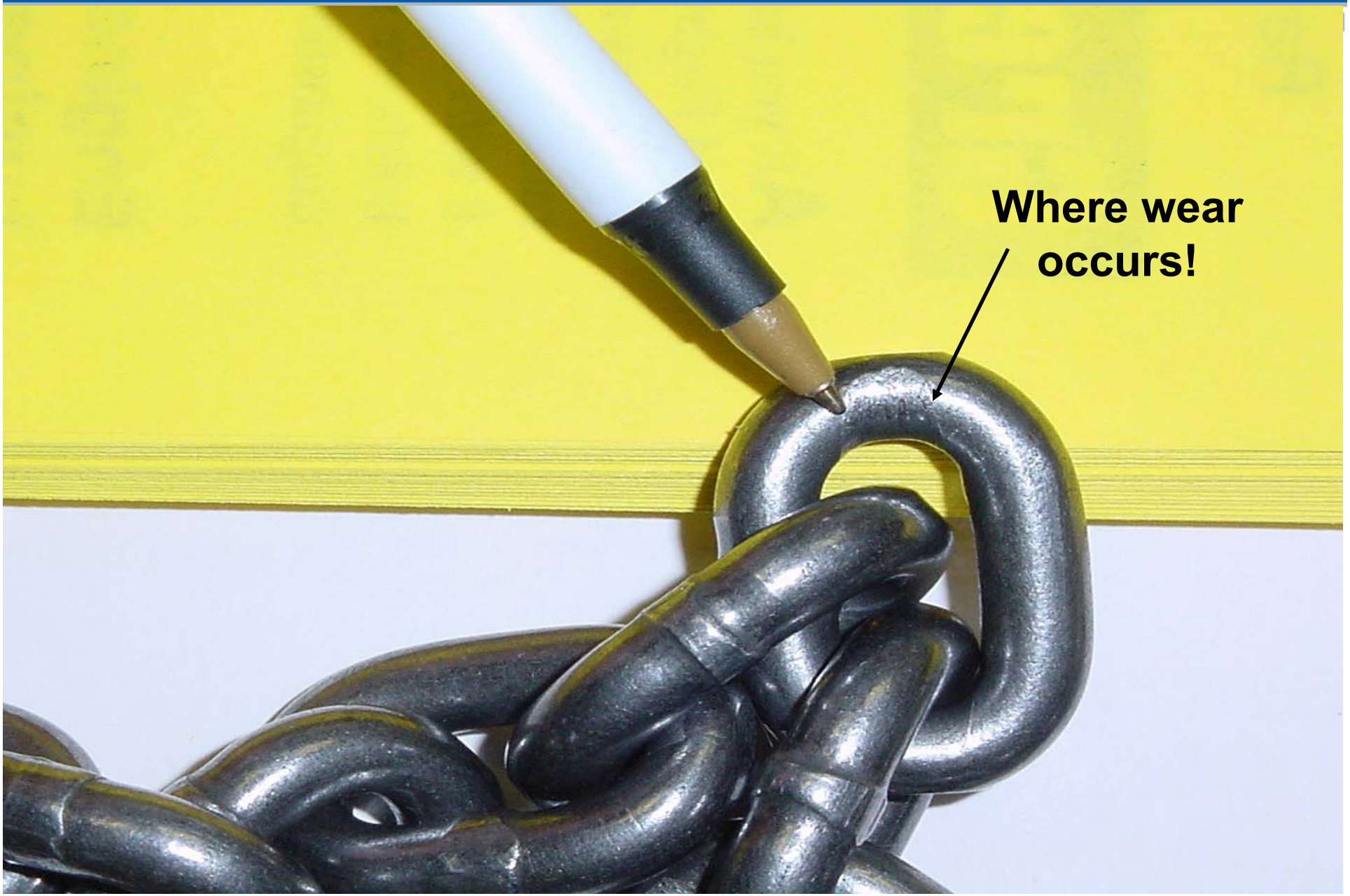
COLUMBUS McKINNON
CORPORATION

And this?

Extreme Wear

COLUMBUS McKINNON
CORPORATION

Worn Chain



And this?

Chain Stop


Keeps chain from running out of the hoist if the limit switch fails.

ROLLER CHAIN

REFERENCE

- ASME B30.16-2.1.7
- ASME B30.21-2.1.5-1

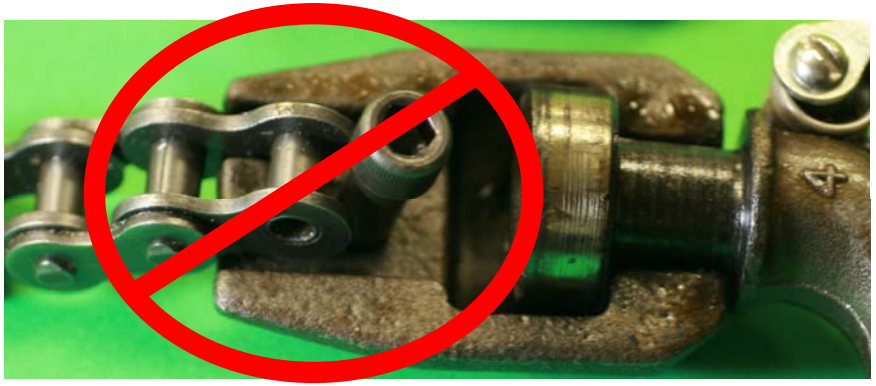
  Tables 16-2.14-1 & 16-2.1.4-2

ANNUAL INSPECTION RECORDS

INSPECT:

- Binding
- Elongation
- Twist
- Side bow
- Pins
- Joints
- Side plates
- Corrosion
- Over travel restraints

COLUMBUS McKINNON CORPORATION



Sheave Inspection

REFERENCE:

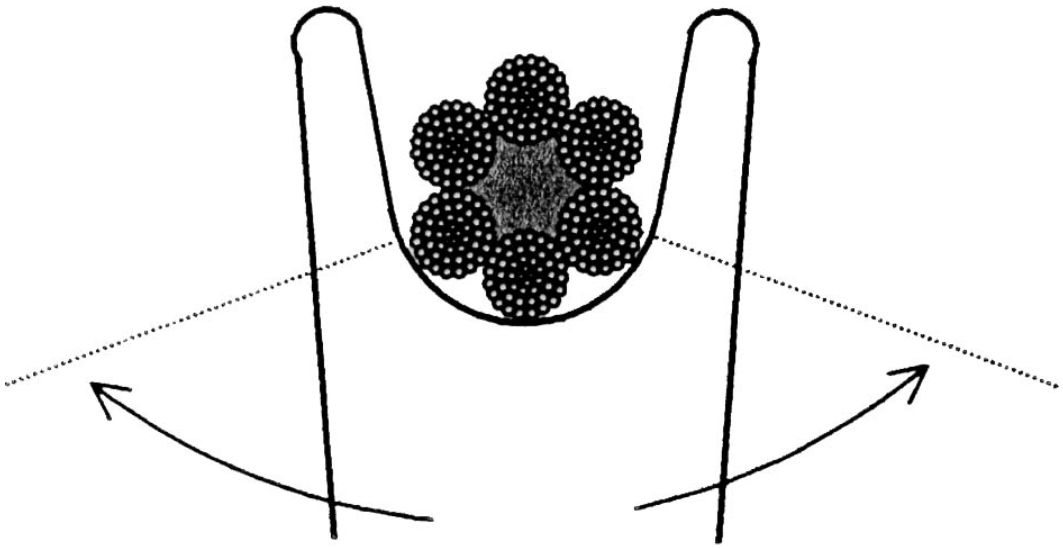
- OSHA 1910.179(h)(1)
- OSHA 1910.179(j)(3)(iii)
- OSHA 1910.179(j)(3)(viii)
- ASME B30-2.2.1.5
- ASME B30.16-2.1.5
- ASME B30.21-1.2.2
- CMAA Spec #70-4.5

INSPECT:

- **Groove wear**
- **Wire rope print**
- Guards
- Lubrication
- **Sharpening**
- Fleet angle
- Sheave pitch diameter

COLUMBUS McKINNON CORPORATION

Sheave Machining



SHEAVE GUAGE SHOULD CONTACT
120° - 150 °

Sheave Machining

CMAA #70-4.5.1

The sheave shall be made of steel or minimum ASTM A48-latest edition, Class 40 cast iron or other suitable materials as specified by the crane manufacturer.

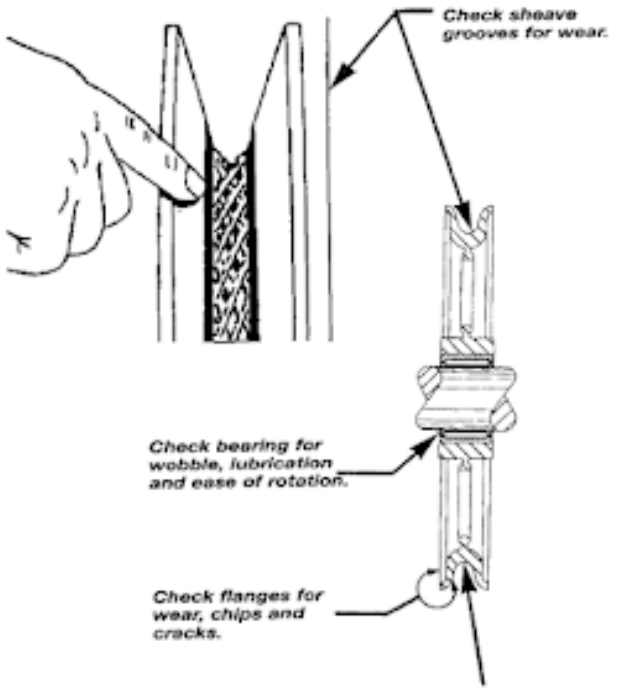
COLUMBUS McKINNON CORPORATION

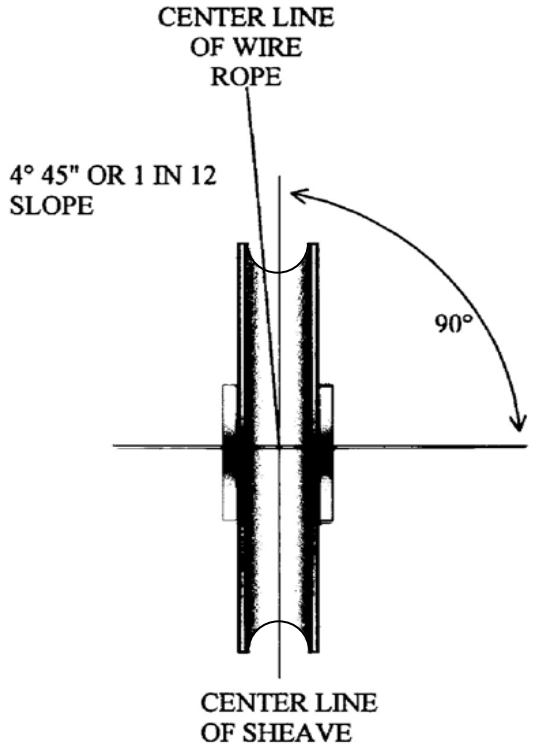
Guide for Minimum Sheave Pitch Diameter

CMAA Class	6 x 37 Class Rope (dia. mm)	6 x 19 Class Rope (dia. mm)
A & B	16	20
C	18	24
D	20	24
E	24	30
F	30	30

CMAA 70-4.5.3
The pitch dia. of equalizer sheaves should not be less than ½ of the dia. of the running sheaves, & also shall not be less than 12 times the rope dia. When using 6x37 class rope or 15 times the rope dia. For 6x19 class rope.

COLUMBUS McKINNON CORPORATION





CMAA 70 – 4.4.3.2

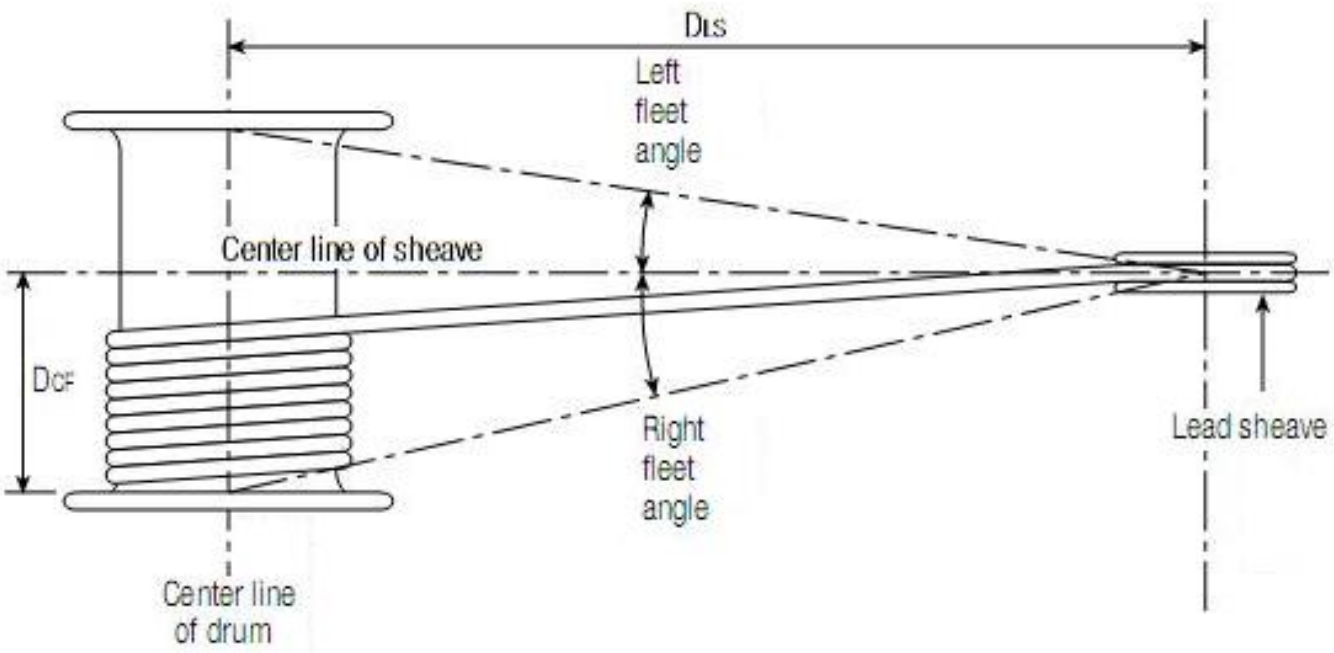
Rope fleet angle for sheaves. The fleet angle of the rope should be limited to 1 in 12 slope (4^{o} – 45 mins.)

Load Sheaves

Sheave grooves shall be free of surface defects which could cause wire rope wear and damage

COLUMBUS McKINNON CORPORATION

Fleet Angle for a Drum



CMAA 70 - 4.4.3.1
Rope fleet angle for drums. The fleet angle of the rope should be limited to 1 in 14 slope (4°)

COLUMBUS McKINNON
CORPORATION

ASME B30.16-2.1.5 Periodic Inspection

(a)Periodic inspections shall be preformed at intervals based on the units application, & may be preformed with the hoist at its normal location. Periodic inspections do not require the hoist to be disassembled.

(c)(5)load sprockets, idler sprockets, drums, & sheaves for evidence of damage & wear.

Hook Inspection

REFERENCE:

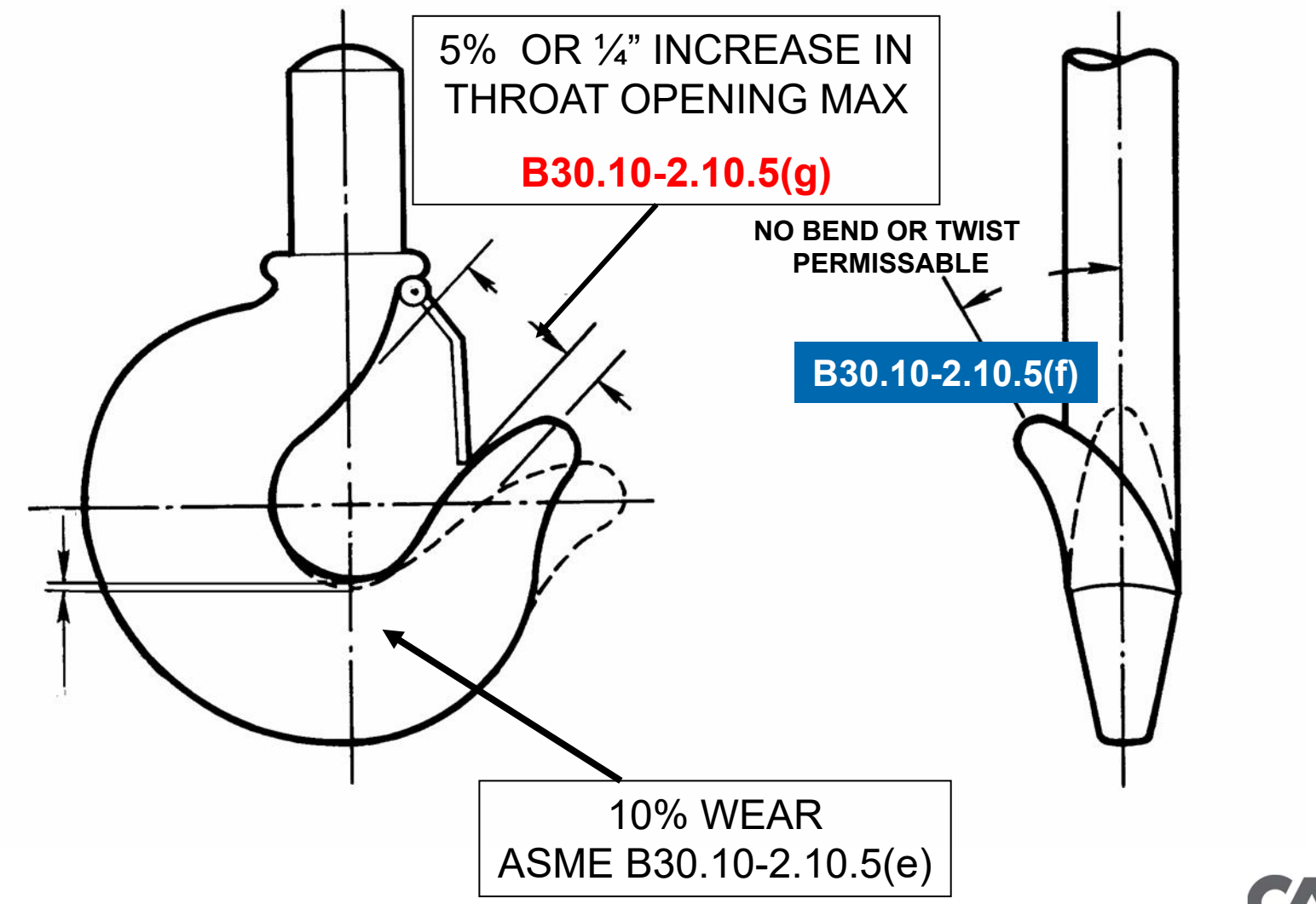
- OSHA 1910.179(j)(2)(iii)
- OSHA 1910.179(j)(2)(iii)(a)
- ASME B30.2-1.14.5
- ASME B30.2-2.1.2
- ASME B30.10-1.2.1.3
- ASME B30.10-2.2.3
- ASME B30.16-1.2.9
- ASME B30.16-2.1.2
- CMAA Spec #70-4.2.2.1
- CMAA Spec #70-4.2.2.2

INSPECT:

- Hook body
- Hook shank
- Hook shank nut & retaining device
- Throat latch
- Cracks, Nicks, Gouges
- Saddle and Shoulder wear
- Evidence of Repairs**
- Bottom block condition
- Side plates (distortion, bends, capacity)
- Shoulder running clearance
- Lubrication

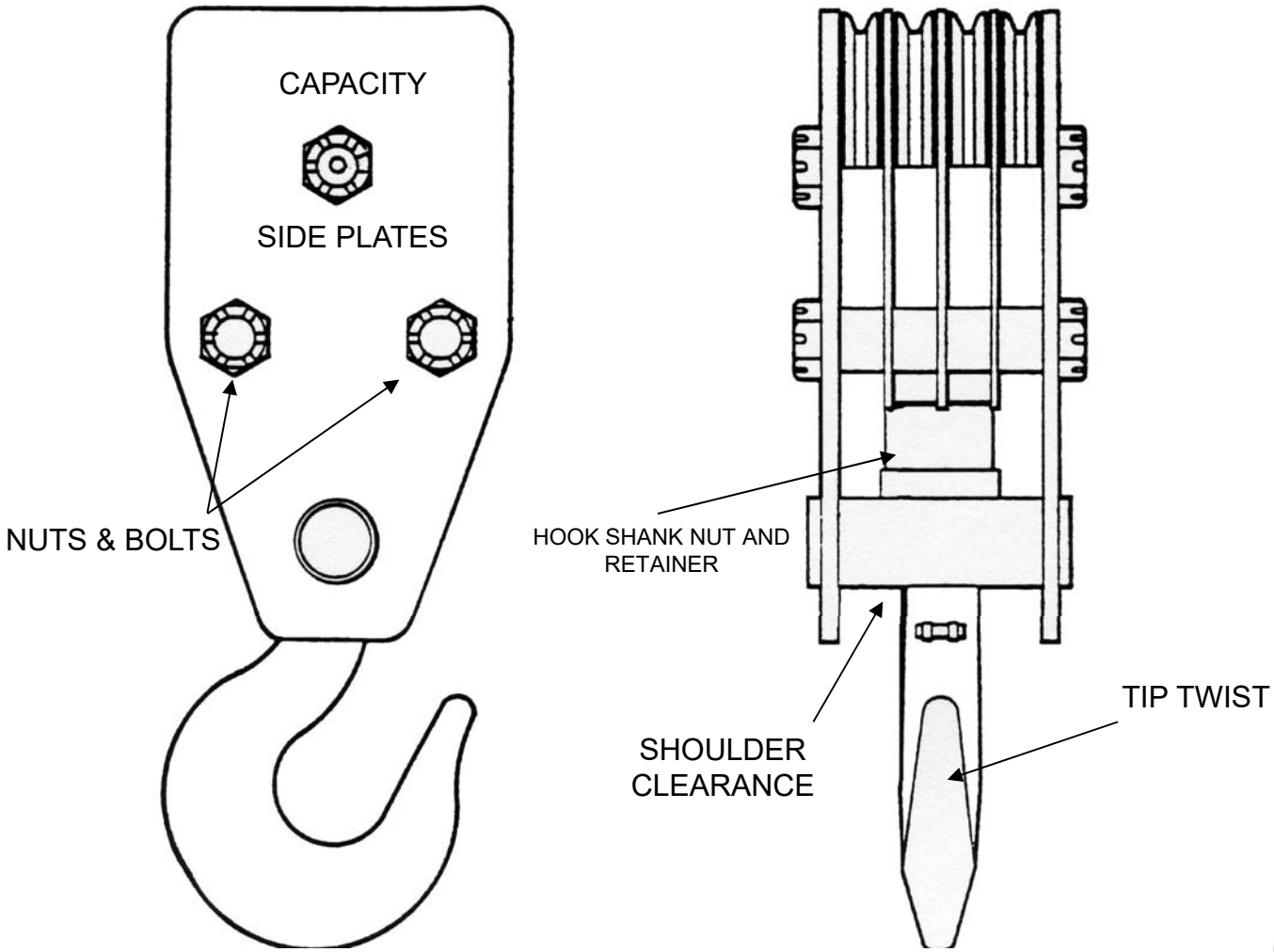
COLUMBUS McKINNON CORPORATION

Hook Inspection



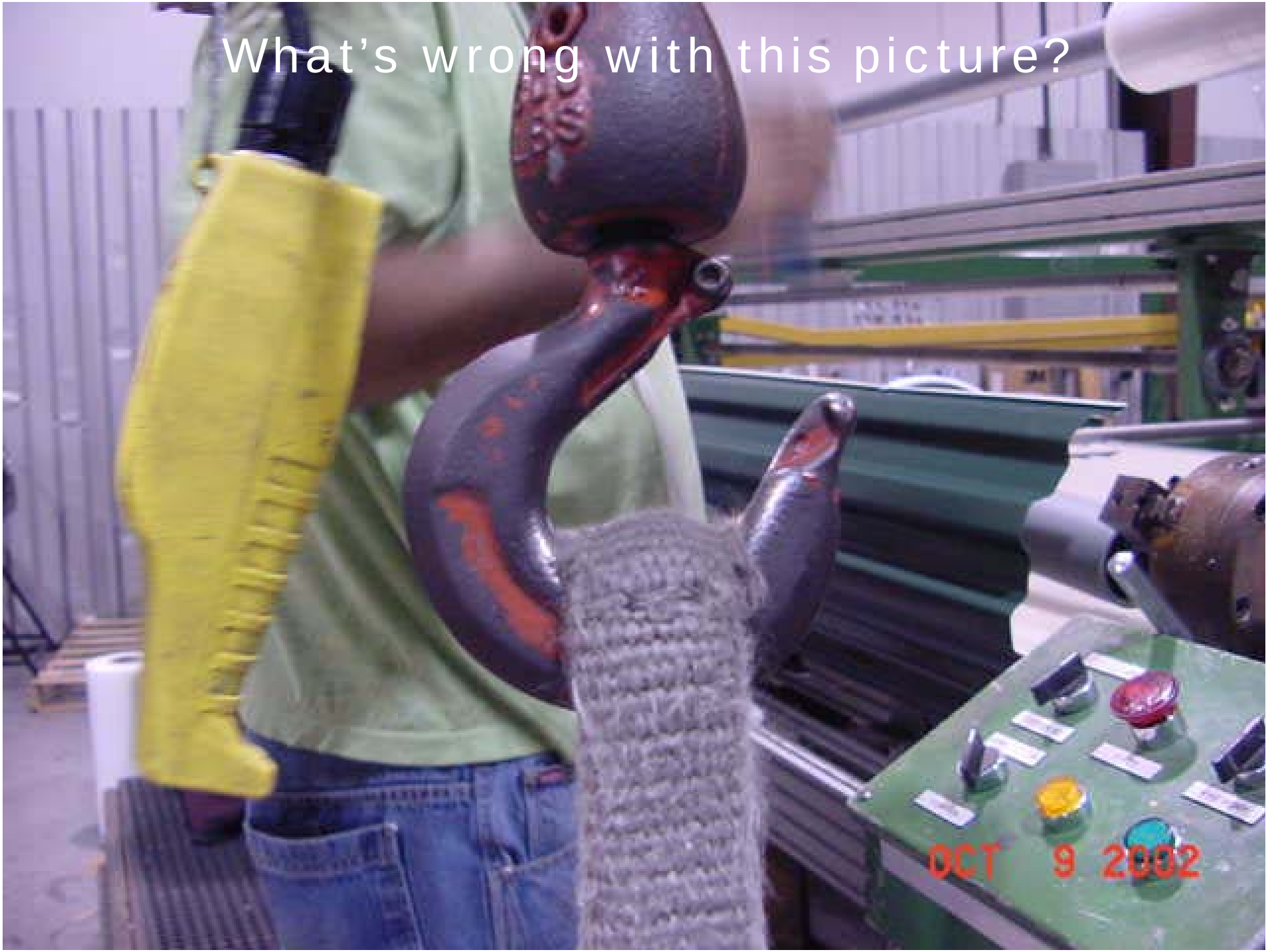
COLUMBUS McKINNON CORPORATION

Block Inspection



COLUMBUS McKINNON CORPORATION

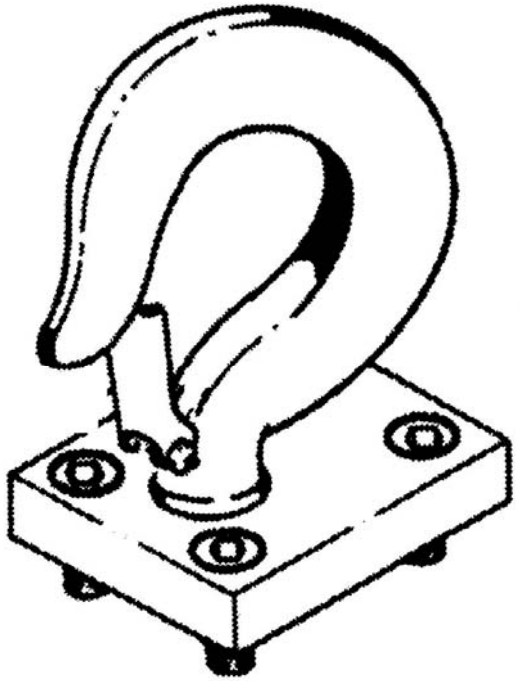
What's wrong with this picture?



Hook Mount

INSPECT:

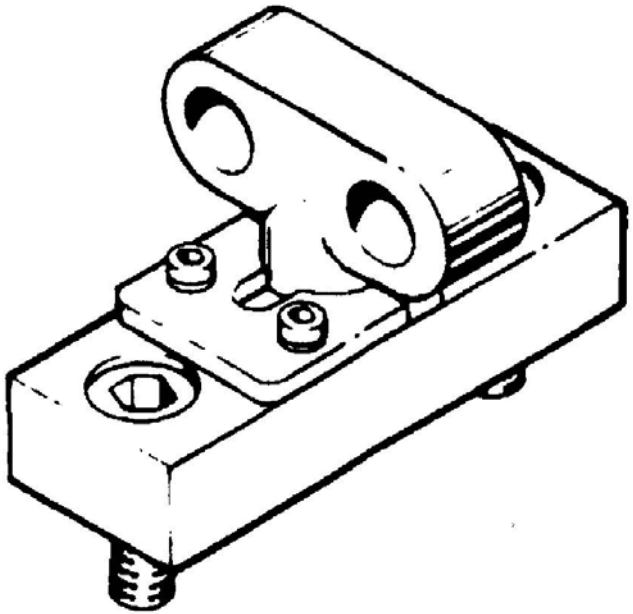
- Hook
- Screws
- Bolts (torque to manufacturer specification)
- Lug
- Load bar

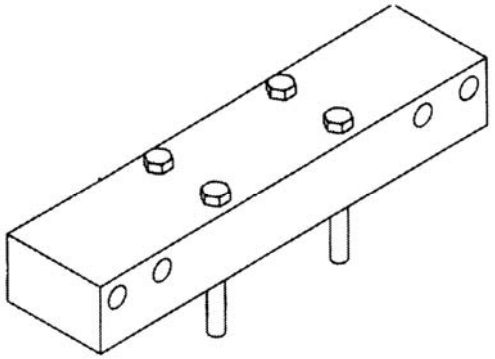


This hook is no less important than the load hook.

COLUMBUS McKINNON CORPORATION

Lug Mount



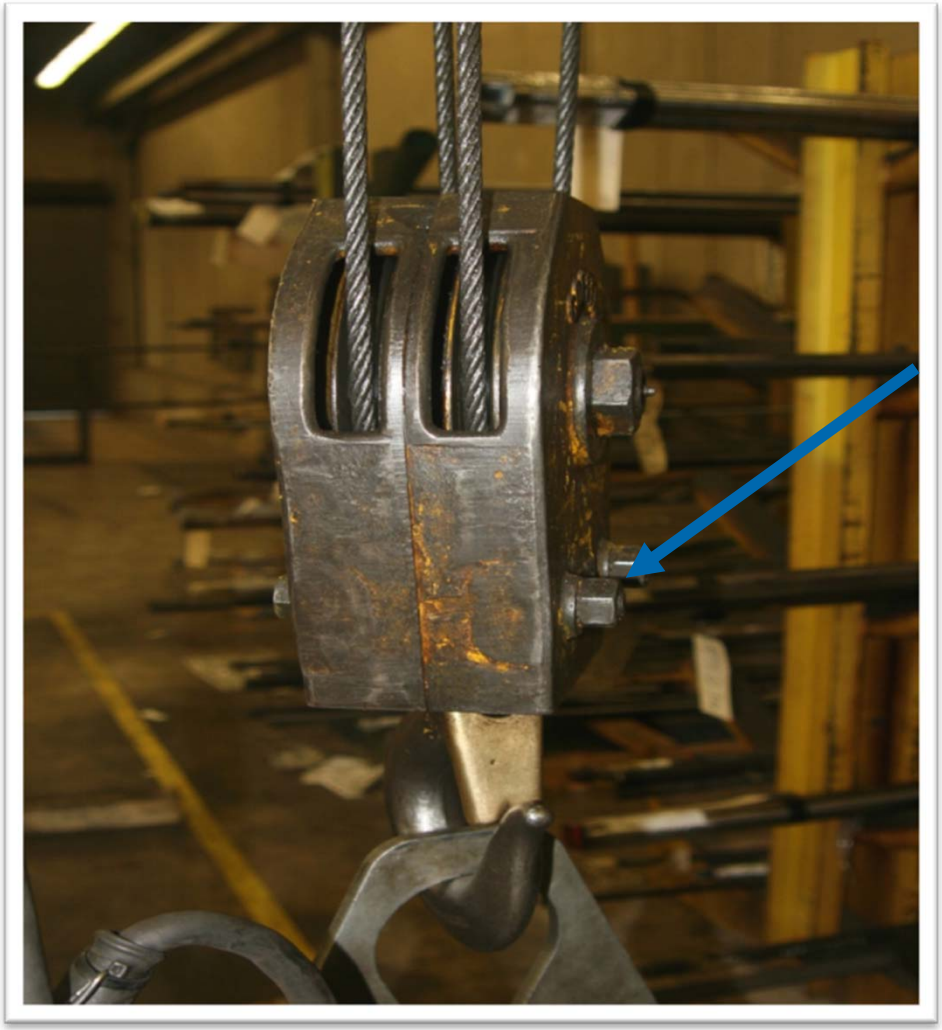


INSPECT:

- Screws
- Bolts (torque to manufacturer specification)
- Lug
- Load bar

COLUMBUS McKINNON CORPORATION

Load Block



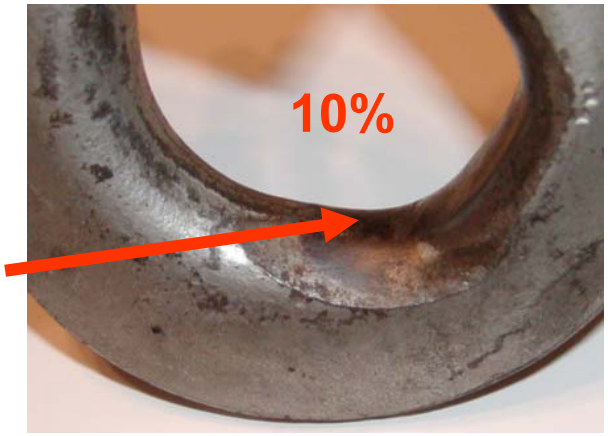
INSPECT:

- Capacity Markings *
- Side Plates (Distorted/Bent)
- Means for lubrication
- Sheave Guards
- Sheave Grooves

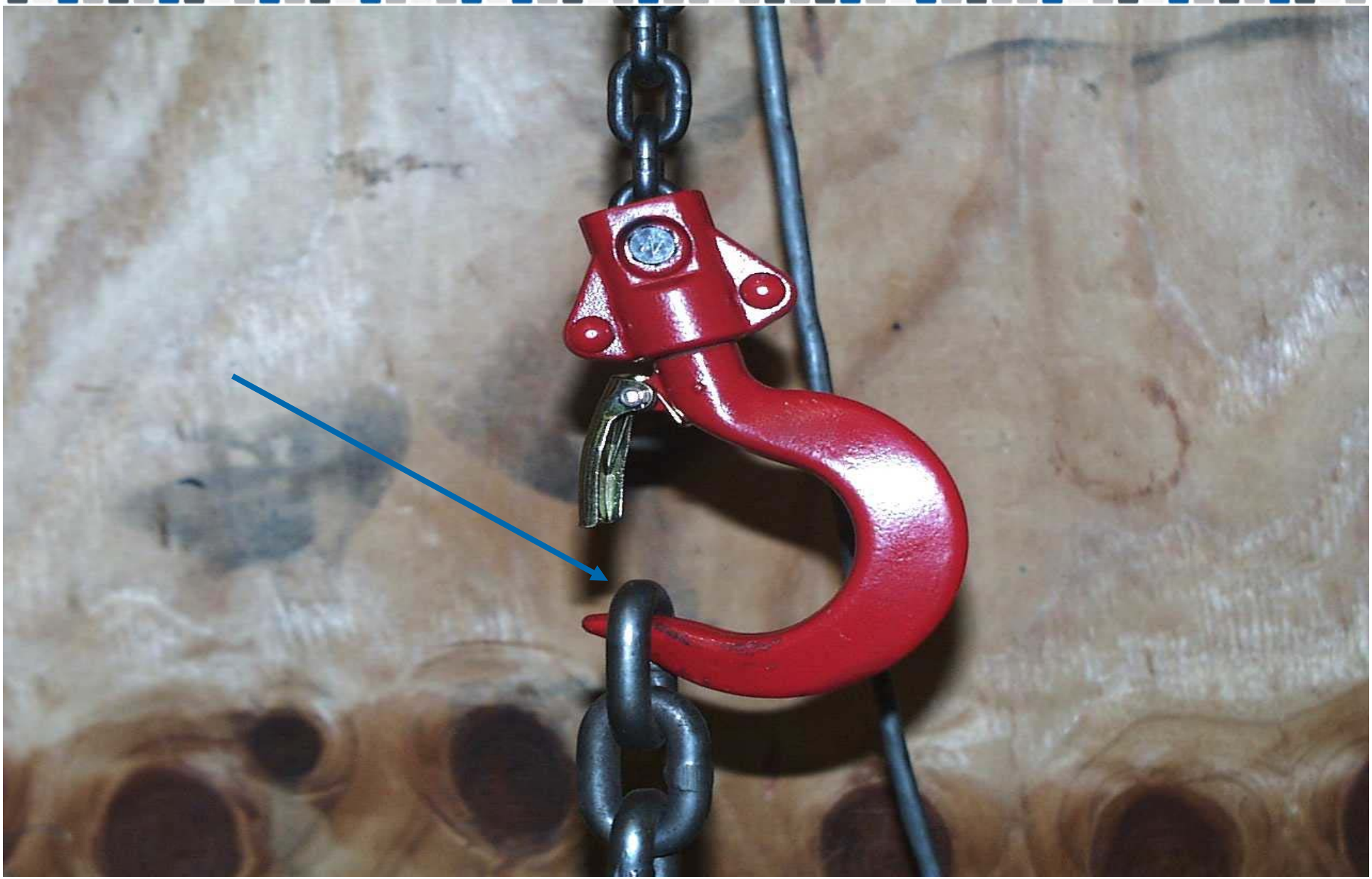
COLUMBUS McKINNON CORPORATION

WHAT CAUSED THIS?

What is the maximum allowable wear in this area?



Tip Loaded Hook



Throat opening may not exceed 5%. Zero twist from plane.

ASME B30.10-1.10.5 Removal Criteria

(f) deformation — any visibly apparent bend or twist from the plane of the unbent hook

(g) throat opening — any distortion causing an increase in throat opening of 5% not to exceed ¼ in. (6 mm) (or as recommended by the manufacturer)

Extreme Tip Loading or Overloading

COLUMBUS McKINNON CORPORATION

Wire Rope Drums

Reference:

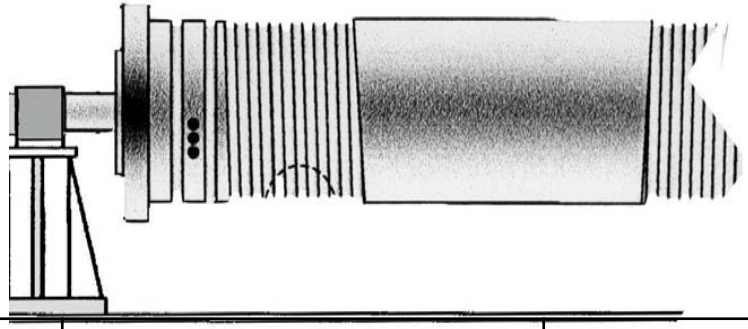
- OSHA 1910.179(h)(2)(i)
- OSHA 1910.179(h)(2)(iii)
- OSHA 1910.179(h)(2)(iii)(b)
- ASME B30.2-1.14.2
- ASME B30.2-.1.14.3
- CMAA Spec #70

INSPECT:

- Drum shafts
- Bearing pedestal
- Wire rope anchors
- Lands and Grooves

COLUMBUS McKINNON CORPORATION

Minimum Pitch Diameter

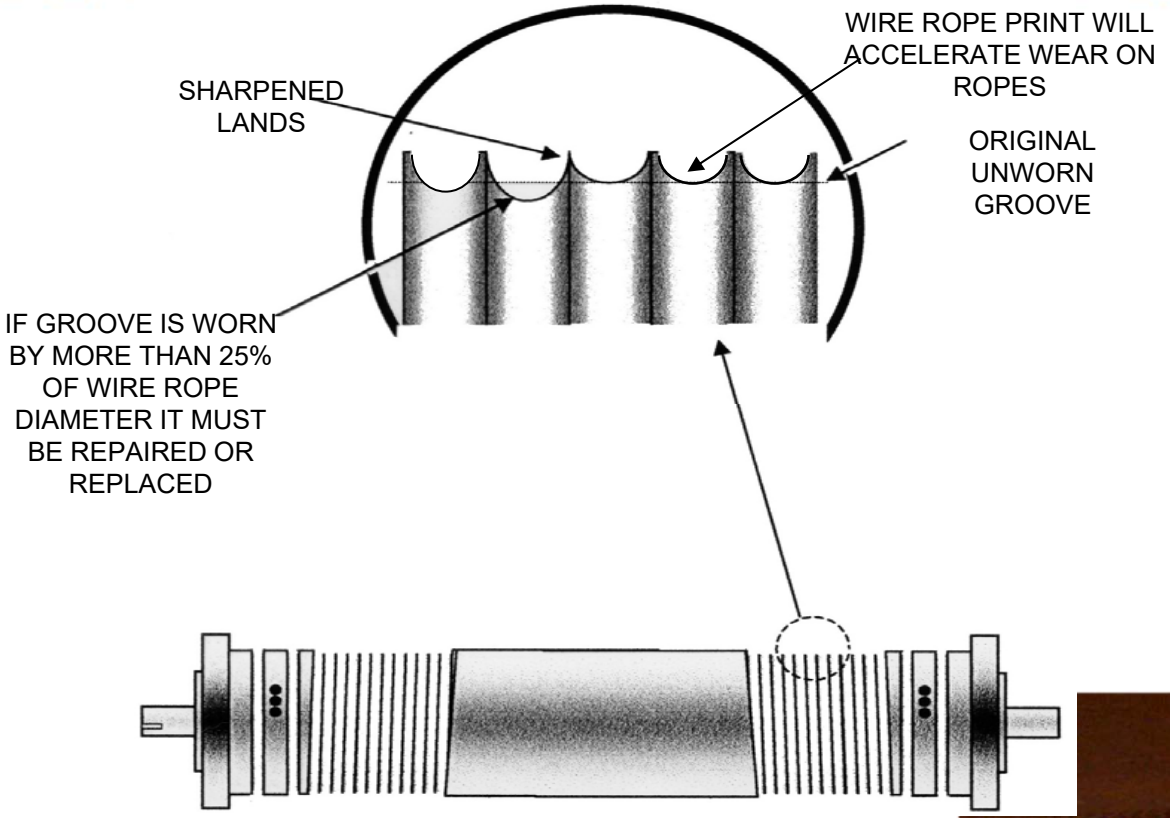


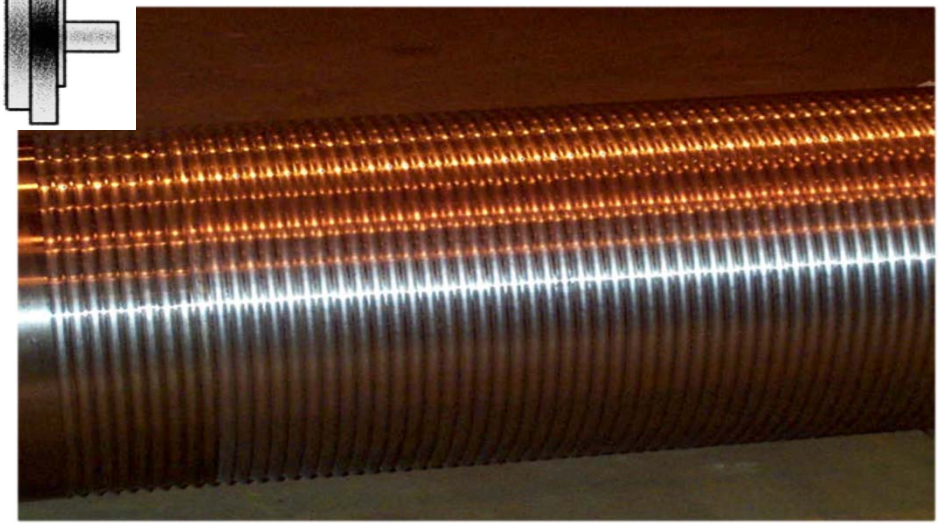
CMAA CLASS	6 x 37 Class Rope	6 X 19 Class Rope
A & B	16 x Diameter	20 x Diameter
C	16 x Diameter	24 x Diameter
D	20 x Diameter	24 x Diameter
E	24 x Diameter	30 x Diameter
F	30 x Diameter	30 x Diameter

CMAA 70-4.6.3.1
Recommended minimum drum groove depth is 0.375 x *Rope Dia.*
CMAA 70-4.6.3.2
Recommended minimum drum groove pitch is either 1.14 x *Rope Dia.* or *Rope Dia.* + 1/8 in. whichever is smaller.

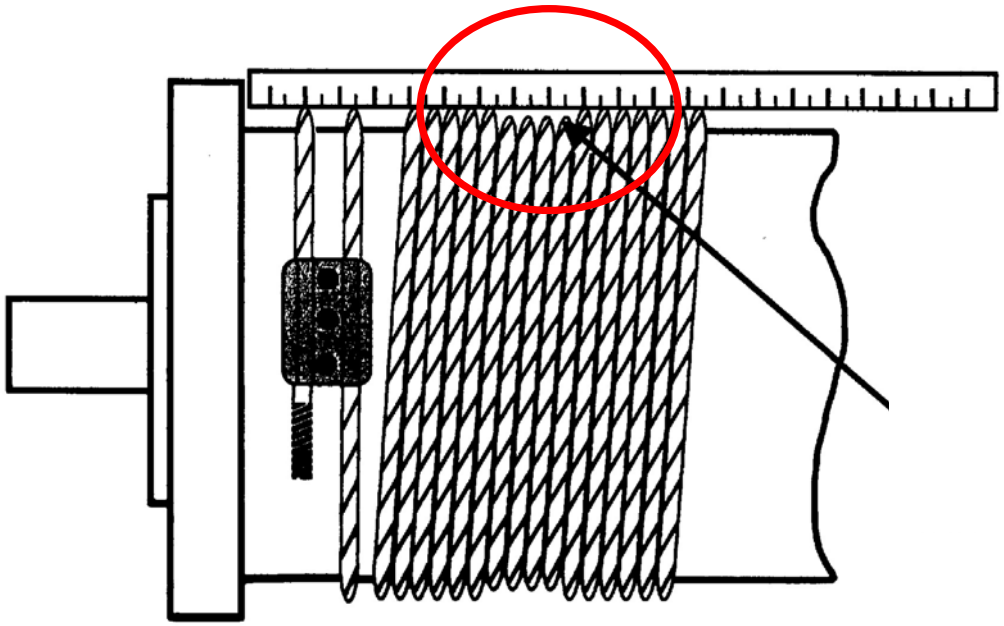
COLUMBUS McKINNON CORPORATION

Drum Grooves





DRUM GROOVE WEAR

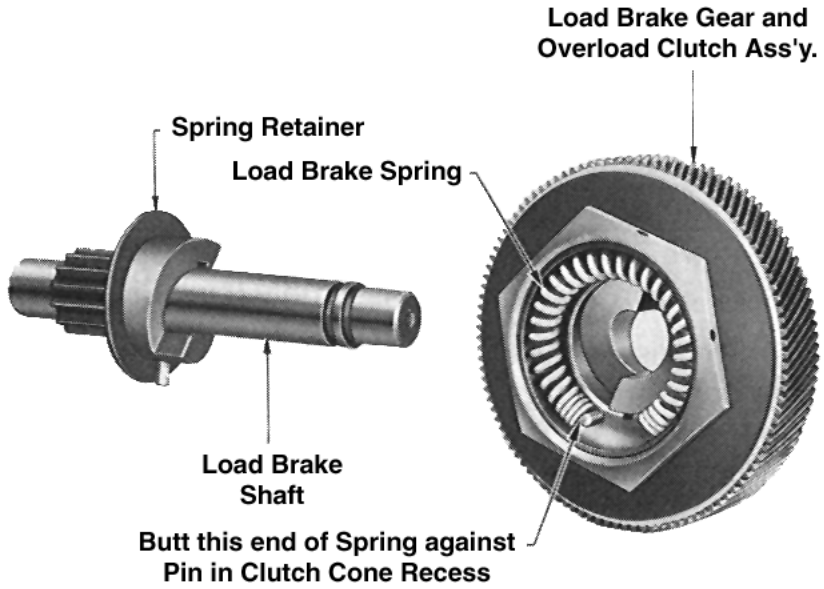


LIMITS OF WEAR

Compare the most worn grooves (typically toward the center of the drum) with the unworn grooves (closest to the drum clam or wire rope anchor). The standard for maximum drum wear is 25% of the wire rope diameter.

EXAMPLE: If your crane uses 3/4" wire rope, the maximum allowable wear would be 3/16". (Whiting Crane Handbook / pg 312, Fig. 240)

Load Limiters



COLUMBUS McKINNON
CORPORATION

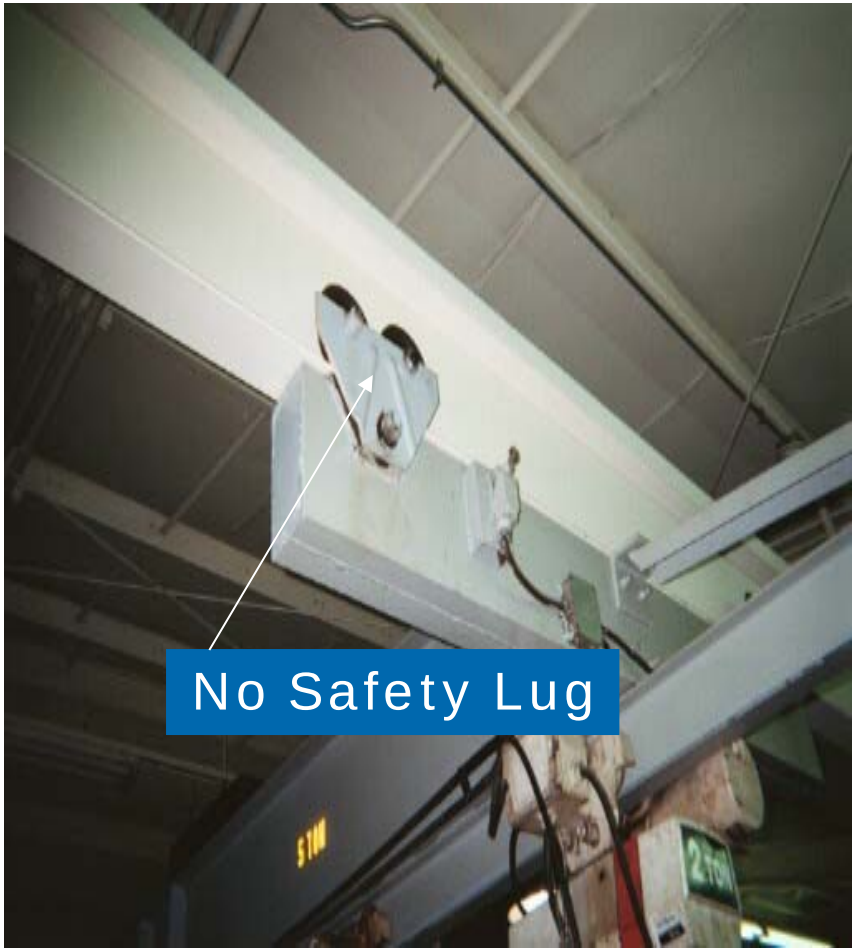
Safety Lug Violation

Required on end trucks…not technically required on trolleys

SECTION 17-1.12: DROP PROTECTION

(a) Means shall be provided to limit the drop of bridge end trucks to 1 in. (25.4 mm) in case of wheel, axle, or load bar failure. Drop protection for underhung bridge end trucks shall be located on both sides of the track to provide central loading of the track about the vertical axis if failure occurs.

(b) Means should be provided to limit the drop of a trolley in case of wheel, axle, or load bar failure. Drop protection, if provided, shall limit the drop of a trolley to 1 in. (25.4 mm) and shall be located on both sides of the track to provide central loading of the track about the vertical axis if failure occurs.



COLUMBUS McKINNON CORPORATION

Safety Lugs

COLUMBUS McKINNON
CORPORATION

Safety Lugs

CSA B167-16.5.4.3.2

Means shall be provided to prevent an uncontrolled drop in the event of wheel failure (e.g., drop stops).

Note: *Specific requirements and recommendations on drop stops can be found in CMAA Specification 70 and CMAA Specification 74.*

Questions??

Thanks for your attention,
let's take a break!

COLUMBUS McKINNON
CORPORATION