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METAL BUILDINGS INSTITUTE"

Instructor Introduction

Course Objectives:

- Become familiar with rigging terms throughout this course
- Recognize basic types of rigging, hardware, and their applications
- Understand OSHA requirements for training and inspections
- Recognize safety hazards as they relate to rigging and cranes
- Understand hitch and sling angle modifiers to capacity
- Know how to use tag lines
- Demonstrate knowledge gained through written and practical tests.

Will I be a qualified rigger after this course? According to OSHA:

- A <u>qualified rigger</u> must meet the criteria for a <u>qualified person</u>.
- This means that a qualified rigger must possess a degree, certificate or professional standing as such, or have extensive knowledge, training and experience.
- OSHA does not require independent 3rd party evaluation for a qualified rigger, but leaves it up to the employer to determine and/or demonstrate who is a qualified rigger.
- This training a good start, but it is the responsibility of every individual company to determine if an employee is qualified based on the complexity of an individual rigging task.

What causes rigging and crane accidents?

- Most rigging and crane accidents are caused by human error.
- Selecting the proper rigging and hitches, and inspecting all rigging equipment is the first step in preventing accidents.
- Proper PPE such as steel toes, gloves, and hard hat should always be worn when working around a crane or handling rigging.
- Constant awareness and proper training are essential to keeping yourself and co-workers safe during all lifting activities. Never forget that steel erection is serious business, and one false move or bad decision can seriously injure or kill someone.

Name three basic types of rigging slings.

Wire Rope Slings:



Wire Rope slings are common, flexible, and have the advantage of "biting" into steel when used in a choker hitch. They are durable, available in many configurations, and are not easily affected by temperature or chemicals.



Chain Slings:

Chain slings have the advantage of being easily adjustable. They are also durable and available in many configurations, however careful inspections can be more time-consuming.

Synthetic Slings:





Synthetic slings come in different forms such as the Eye and Eye Web Sling or Endless Round. They are typically made of Polyester or Nylon They are lightweight and easy to use, but extra care must be taken to prevent synthetic slings from being damaged on sharp edges.

Sling Labeling Requirements:



All slings used for lifting *must* have a label with the following information,

or they may not be used:

Chain Slings:

Grade

Size

WLL

Manufacturer

Number of Legs

Serial Number

Wire Rope:

Manufacturer WLL Diameter/Size Serial Number

Synthetic Slings

Manufacturer Type of Material Rated Capacities for Vertical, Choker, Vertical Basket Length Serial Number or Stock Number

Rigging Components: Size alone DOES NOT determine rating!

WHICH HOOK HAS A HIGHER WORKING LOAD LIMIT? (LIFTING CAPACITY)

5t CROSBY ALLOY HOOK 10,000 LB

CROSBY CARBON HOOK 6000 LB

Rigging Components: <u>Hooks</u> <u>Turnbuckles</u>

Hooks for rigging must have a safety latch if connectors are expected to work below the load. Safety latches or keepers may not be removed or disengaged in most circumstances.

Turnbuckles can be used to adjust the length of some rigging connections. They can have an Eye, Jaw, or Hook on each end, in any combination. Manufacturer's name and turnbuckle size/diameter must be listed.

Rigging Components: Inspecting Hooks



Remove hooks from service if:

- a. Safe working capacity is unknown
- b. Cracks, bends, stretch or visible distortion
- c. Excessive nicks, gouges or wear (more than 5-10%)
- d. Excessive hook throat opening
- e. Twisting or distortion
- f. Safety latch or other components missing or damaged
- g. Attempt to repair by heating, welding or bending
- h. Weld splatter or discoloration from excessive temperature
- . Makeshift hooks, components or repairs
- Corrosion, pitting, or chemical damage
- k. Visible damage that casts doubt as to safe continued use.

Rigging components: Shackles

Shackles are the most common method of connecting rigging components. At right three variations are shown.
They must be marked with Manufacturer, Size, and Rated Capacity.



Round Pin shackles are for use when the load is applied directly in-line. They should not be used for gathering multiple slings or where side-loading is a possibility. Bolt-Type shackles are for use in any situation, but particularly for permanent or long-term installations, or

where there is side-loading or the risk of pin rotation involved.

Screw Pin shackles are commonly used for picking and placing loads. They have a reduced side-loading capacity. Screw pin shackles must also be secured against loosening if used in long-term applications.

Rigging components: Proper Use



Right



Wrong



Right

Wrong

Rigging components: Eye Bolts and Lugs

Eye bolts and lifting lugs may be used in some situations for rigging steel members. They are made from forged carbon or alloy steel and must bear the manufacturer's name or trademark. An raised "A" denotes an alloy steel eyebolt.

Shouldered Eye Bolts provide a limited amount of strength for picking steel through bolt holes.
Machine Eye Bolts are attached directly to threaded holes in equipment designed to be picked. However, all strength comes from the threads.

Lifting Lugs are preferred because they are designed to pivot and swivel as necessary to pick from an angle.

Rigging components: Proper Use

ALWAYS PULL LOAD IN THE PLANE OF THE EYE Never go below 45° side pull



Rigging Components: Beam Clamps Plate Clamps

Beam clamps are typically used on the flange of I-beams and column top plates where the width is less than 15".

CALDWELL

5 TON CAP.

F Plate clamps come either with a serrated jaw which relies on friction, or a screw clamp for moving plate steel.

Rigging Components: Spreader Bars

Spreader bars come in a great variety of sizes and forms. Their purpose is usually to minimize the effect of sling angle on long or wide loads by letting slings hang more vertically.

WLL 12T

BRUD

Rigging Components:

Bridles

A bridle consists of a "master link" or shackle connected to two or more "legs" of rigging. Two, Three, and Four-legged bridles are common.

Rigging Inspections:

All rigging must be inspected daily before each use by a qualified rigger. (A rigger who is also a qualified person)

All rigging must be inspected at least annually and the event must be documented. Only alloy chain slings must be individually documented along with the sling condition.

Rigging Inspections: Wire Rope



Abraded/Worn Wire



Corrosion



Bird Caging





Popped Core



Heat Damage



Damaged Fittings



The qualified person must determine if wire rope damage is such that it should be removed from service. Remove any wire rope sling with: * 10 randomly distributed broken wires in one lay, or * 5 broken wires in one strand in one lay. A strand is made up of individual wires. Strands are wound around each other to form a rope

Rigging Inspections: What is a wire rope lay?



A lay is one full rotation of a strand around the wire rope core.

Rigging Inspections: Chain Slings

The qualified person will determine if chain damage is such that it should be removed from service. Periodic inspections should be more frequent than annually if service conditions are severe.

Chain Slings that must be rejected:



Stretched Hook with damaged latch



Stretched hook



Stretched master link and sub-links



Bent clevis pin and stretched chain



Hook with stretched throat opening and missing latch

Rigging Inspections: Chain Slings

The qualified person will determine if chain damage is such that it should be removed from service. Periodic inspections should be more frequent than annually if service conditions are severe.

"CHAIN SLINGS"

Chain Sling Inspection

Chain Slings that must be rejected:



Chain with weld splatter



Chain with severe corrosion



Excessive wear



Bent links







Rigging Inspections: Web Slings

The qualified person will determine if sling damage is such that it should be removed from service. Periodic inspections should be more frequent than annually if service conditions are severe.

"WEBBING SLINGS"

Webbing Inspection

Webbing Slings that must be rejected, edge damage:



All slings have damaged edges, frayed, cut, or abraded

Rigging Inspections: Web Slings

The qualified person will determine if sling damage is such that it should be removed from service. Periodic inspections should be more frequent than annually if service conditions are severe.

"WEBBING SLINGS"

Webbing Inspection

Webbing Slings that must be rejected, body damage:



Abraded webbing Torn, snagged cover and load bearing fibers

Face cut of body



Punctured webbing

Rigging Inspections: Web Slings

"WEBBING SLINGS"

The qualified person will determine if sling damage is such that it should be removed from service. Periodic inspections should be more frequent than annually if service conditions are severe.

Webbing Inspection Webbing Slings that must be rejected, body damage:



Rigging Inspections: Round Slings



The qualified person will determine if sling damage is such that it should be removed from service. Periodic inspections should be more frequent than annually if service conditions are severe.

Roundsling Inspection Roundslings that must be rejected:



Chemical damage



Cut cover and load bearing fibers



Weld splatter damage



Cut and pulled cover

Rigging Inspections: Round Slings

Round slings may have External Warning Indicators which indicate that a sling has been overloaded. Those show below "retract" if a sling has been overloaded.







Basic Rigging Hitches: Vertical

Load and rigging calculations are based on a straight vertical hitch.

The WLL, or Working Load Limit, of all rigging components must be equal to or greater than the load you intend to pick.

Rigging is only as good as its weakest component. EVERY piece of rigging in the illustration at left must be capable of fully supporting the load.



Any deviation from a straight vertical hitch and vertical pick will introduce other variables that must be accounted for.

The Basket Hitch

A basket hitch will typically double the capacity of a sling if both legs are vertical.



Each leg of the sling in this illustration supports exactly ½ of the load's total weight.

In this exact configuration, a sling rated for 500lbs could safely lift a 1000lb load.

However, in practice, this perfect scenario rarely occurs. Usually, we must reduce the sling's rating based on other factors.

Sling Angle - Basket

As you can see in the illustration below, decreasing the angle of the sling legs from vertical down to 30° induces additional stress on the sling legs.

Rigging should never be attached so that the sling legs are less than 30°. We prefer to keep them no less than 60° from vertical whenever possible.



At 30° of sling leg angle, the force on each leg is effectively doubled.

We will discuss this math soon.



The Choker Hitch

A normal choker hitch reduces a sling's vertical capacity to 75% of it's rating.

A sling rated at 10,000lbs vertical should not be used to lift more than 7,500lbs in a choker hitch.

However, the exact angle of the choker itself can affect the modified rating of the sling.

The chart at right shows once again how decreasing sling angle reduces a sling's rated capacity.



For wire rope slings in choker hitch when angle of choke is less than 120°.

Angle of Choke (Degrees)	Rated Capacity Percent *
Over - 120	100
90 - 120	87
60 - 89	74
30 - 59	62
0 - 29	49

 Percent of sling rated capacity in a choker hitch.

Load

1-IAC **Sling Angle Reduces Capacity**

Sling Angle Reduction

Reduction Factor (RF)	Angle From Horizontal	Tension Factor (TF)
1.000	90°	1.000
0.996	85°	1.004
0.985	80°	1.015
0.966	75°	1.035
0.940	70°	1.064
0.906	65°	1.104
0.866	60°	1.155
0.819	55°	1.221
0.766	50°	1.305
0.707	45°	1.414
0.643	40°	1.555
0.574	35°	1.742
0.500	30°	2.000

For a lift with symmetrical legs, a sling's capacity reduction is calculated by the chart at left.

An individual sling rated at 10,000lbs vertical would be rated to pick how much weight at a 60° angle?

Load

How much could the same sling lift at 45°?

Multiple Lift Rigging



- Must use a *manufactured* multiple lift rigging assembly with 5-1 safety factor
- Maximum of 5 members lifted together
- Beams or similar structural members
- Rigged level, from top down, and 7' apart
- Must be installed from bottom up.
- All involved employees must be trained



Tag Lines

Tag lines should be used whenever practical to stabilize the load. Tag lines should be free of knots and securely fastened to one end of the load. Heavy or awkward loads may require a tag line on both ends or all corners. Tag lines should be untangled and stretched out so they do not snag or "bite" anyone on the ground as the load is raised. All personnel handling tag lines should stay out from under the load, and maintain tension until the connectors have control of the pick.

Rigging and Crane Hazards



Exceeding rigging capacity:

•All components must be able to support the load.

•The capacity of any rigging assembly is only as strong as its weakest link.



Cutting/damaging rigging during pick:

• Special care must be taken to pad synthetic slings and prevent them from sliding on sharp edges.

• Wire rope slings should not be attached to a hook, turnbuckle, or shackle that have a smaller diameter than the wire.

Rigging Hazards

Pins, latches, screws:

- All pins should be tightened before a pick. This includes hand-tightening shackle screw pins. The old standard of loosening the shackle screw to make it easier to remove is unsafe.
- Safety latches should never be defeated or removed.
- All clamp screws should be fully tightened.



Tangled or snagged rigging:

• From the time a piece of steel is picked until the time it is bolted into place, everyone involved should make sure that the rigging does not snag, is not tangled or twisted, and is never caught up on any part of the building or steel.

Rigging Hazards

Overhead hazards:

- No one is allowed under a raised load except when absolutely necessary to make a connection.
- Crane blocks and job balls can easily hit anyone who is not paying 100% attention at all times.
- Always wear proper PPE



Dynamic loading, shock loading:

- If steel snags on its way up or while being lowered into position, there is the danger of overloading the crane and/or the rigging involved.
- If the load moves suddenly, there is a real danger of injury, falling materials, or crane tip-over.
- Tag lines should always be used to stabilize the load.

Rigging Hazards

Not Inspecting the Entire Rigging Assembly Before Each Pick:

• It is the rigger's responsibility to make sure that every pin is tight, every latch is secure, every sling is rated and free of damage, and that everything is rigged properly.

• This must be checked each and every time before the load is flown.

Questions?

