

M_004 Basic Rigging Safety Lecture



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Safety is everyone's business and compliance with safety procedures is **MANDATORY**




- **If an activity or practice seems unsafe, “Stop Work” and take the time to address concerns**
- **Only designated or qualified personnel may attach loads to an overhead hoist**
- **No LLE personnel are qualified or permitted to repair rigging equipment**
- **Only approved/rated rigging gear shall be attached to a load hook**
- **Load ratings shall never be exceeded**
- **It is the riggers responsibility to ensure all components used in a rigging operation meet the required load ratings**
 - **If a rigger is unable to determine a proper rigging configuration contact ME or an Advanced Rigger for support**

There are two specific roles in moving materials overhead, hoist operators and riggers

- The definitions for hoist operators and riggers are as follows;
 - ***hoist operator:*** an employee who generally uses an overhead hoist as a tool to assist in the performance of their regular job
 - ***rigger:*** At LLE a rigger is responsible for safely attaching payloads to the load hook of a hoist.



There are two specific roles in moving material overhead, hoist operators and riggers

- There are 2 classes of training for Hoist operators
 - Hoist operator – for overhead vertical lifting with unpowered horizontal motion
 - Overhead Crane operator – for overhead vertical lifting with powered horizontal motion
- There are 3 classes of training for riggers
 - No training is required for rigging payloads <120 lbs
 -  — Basic rigger – for personnel attaching any loads from 120-500 lbs to any hoist for a pure vertical lift
 - Advanced rigger – for personnel attaching any load >500 lbs to any hoist or any load using multiple load hooks

Overhead rigging of material or equipment is to be performed only by designated personnel

Basic rigging scope of qualification



- **Basic rigging training qualifies the individuals to use the following equipment;**
 - **Slings: Synthetic web slings, round and flat**
 - **Hardware: Hoist rings, eye bolts, shackles, hooks**
- **Basic rigging training qualifies the individuals to perform the following activities for payloads up to 500 lbs;**
 - **Conduct rigging operations**
 - **Rig payloads for overhead lifts using the equipment listed above**
 - **Attach payloads to any load hook**

OSHA Department of Labor (DOL) establishes the rules for overhead hoists



- **The rules for rigging equipment are established in 29 CFR 1910.184 Slings and 29 CFR 1926.251 Rigging equipment for material handling**
- **The DOL incorporates additional rules by reference by citing additional standards within the regulations**
- **ASME B30 pertains to lifting and material-handling related equipment**
 - **There are 28 subparts to ASME B30**

Purpose of the ASME B30 standard



- **The B30 Standard is intended to**
 - (a) prevent or minimize injury to workers, and otherwise provide for the protection of life, limb, and property by prescribing safety requirements**
 - (b) provide direction to manufacturers, owners, employers, users, and others concerned with, or responsible for, its application**
 - (c) guide governments and other regulatory bodies in the development, promulgation, and enforcement of appropriate safety directives**

Numerous portions of the ASME B30 standard apply to rigging equipment



- **Each of the B30 sections listed below contain requirements on the selection, use, maintenance, and inspection**
 - **B30.1 Jacks**
 - **B30.9 Slings**
 - **B30.10 Hooks**
 - **B30.20 Below-the-Hook Lifting Devices**
 - **B30.26 Rigging Hardware**
- **This lecture distills the ASME requirements into the policies and practices used at LLE**

The basic steps for moving a payload

- 1) Prep work**
 - a. Understand the payload**
 - b. Select the rigging gear**
 - c. Inspect all rigging gear**
 - d. Assign responsibilities**
- 2) Attach the rigging gear to the payload**
- 3) Attach payload to a load hook**
- 4) Move the payload**
- 5) Secure the payload**
- 6) Detach the payload from a hook**
- 7) Remove the rigging gear**

A vital part of your Prep Work is knowing the payload and path of travel



- **Weight**
 - Can often be found in “notes” section of a part drawing
 - Calculations (volume x density)
 - Talk to Mechanical Engineering
- **Center of Gravity**
 - Drawings will sometimes denote CG
 - Test lift to determine CG
- **Path of travel**
 - Know that destination is clear and ready to accept the payload
 - Insure the path is clear of any obstructions and personnel that will hinder movement

Select rated rigging equipment based upon the payload and how it is used



- Know the load capacity of the overhead hoists and support structures
 - This includes hoist(s), bridges, jibs, or gantries
- Know the load capacity of rigging hardware used in the rigging operation
 - This includes the shackles, hoist rings, straps, etc.
- Know how use of the equipment affects the load rating
- Use only load rated products
- **NEVER** exceed the rated load capacity of any piece of rigging equipment

Rigging equipment must be inspected prior to each use to ensure that it is safe



- **Hardware**
 - Visually inspect all hardware for damage including but not limited to screws, lifting shackles, hoist rings/lifting eyes, etc.
 - Look for thread damage, bent or fractured pieces, intentional or unintentional modifications
- **Slings**
 - Visually inspect for damage or fraying
 - Insure load rating tag is on the sling and legible
 - Inspect sewn threads

Any rigging equipment that is found to be unsafe must removed from service immediately

During Prep activities, personnel assignments and responsibilities are reviewed



- **Hard hat and safety glasses must be worn during all rigging operations**
- **Make sure all personnel involved understand the purpose and the nature of the operation**
- **Designate specific tasks to individuals as needed**
- **Use a ground spotter when lifting loads to upper level areas**
- **Post a sentry or barricade to prevent personnel from walking under the payload**
- **Insure communication between all parties involved is clear and concise**
 - **Example**
 - **Crane operator “Moving the load North”**
 - **Rigger “ Moving the load North aye”**
- **NEVER** leave a suspended load unattended

Rated versus non-rated rigging hardware



- **The terms “rated” and “non-rated” have specific meaning in the rigging field**
- **“Load Rated” products are engineered with special considerations important to lifting loads with cranes and hoists**
- **“Non-rated” products often look the same, but are not engineered to provide the same design factors and safety features as the load rated versions**
- **Never** use non-rated products for rigging

Definitions

- ***angle of loading***: the acute angle between horizontal and the leg of the rigging, often referred to as the horizontal angle.
- ***designated person***: a person selected or assigned by the employer or the employer's representative as being competent to perform specific duties
- ***hoist operator***: an employee who generally uses an overhead hoist as a tool to assist in the performance of their regular job
- ***line pull***: the tension load in a rope entering a rigging block. The term “pull” is commonly used to describe line pull.
- ***qualified person***: a person who, by possession of a recognized degree in an applicable field, or certificate of professional standing, or who, by extensive knowledge, training, and experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter and work.

Definitions



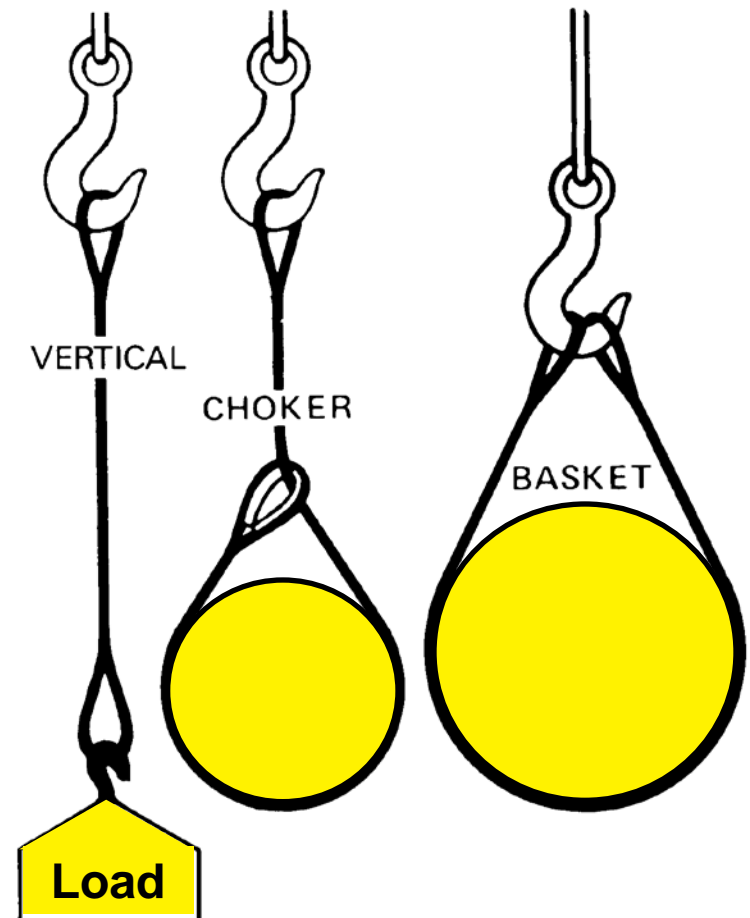
- ***rated load:*** the maximum allowable working load established by the rigging hardware manufacturer. The terms "rated capacity" and "working load limit (WLL)" are commonly used to describe rated load.
- ***rigger:*** At LLE a rigger is responsible for safely attaching payloads to the load hook of a hoist.

Synthetic slings



Synthetic slings are used with three basic hitch styles

- Sling ratings are specified for each of three basic styles; vertical, choker, and basket
- For the basket style hitch, the load rating is specified for a 90° sling angle



Synthetic slings come in two basic Styles

- **Endless Loop (EN)**



- **Eye and Eye (EE)**

- **Type 3 Flat eye is the most popular for all three hitch styles**



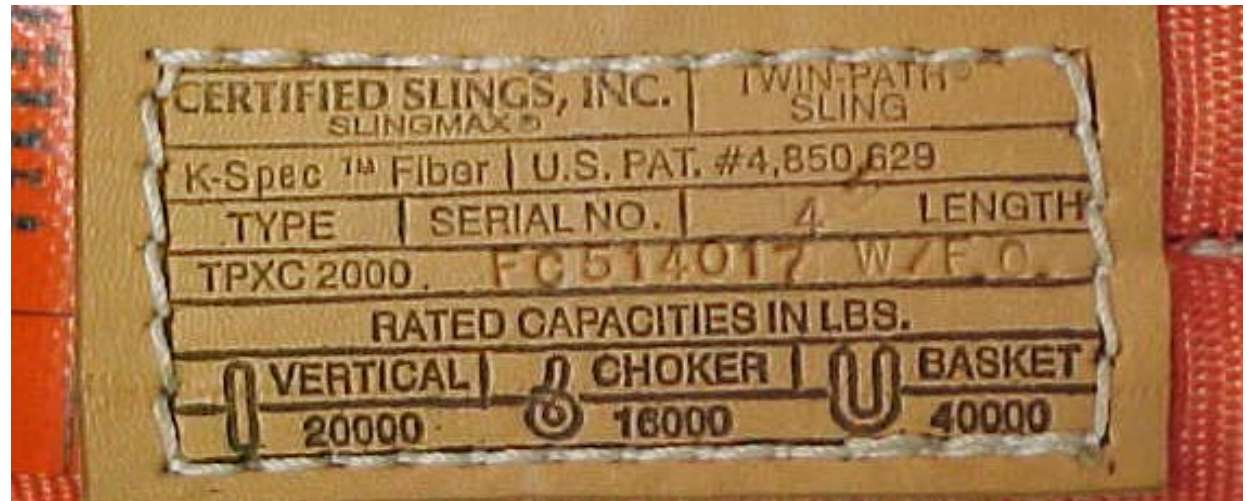
- **Type 4 Twisted eye is more commonly used for choker hitch**



Only synthetic slings are to be used at LLE

- Slings are made of either Polyester or Nylon
- Various widths are available – at LLE most are from 1” to 3” wide
- Information sewn into the sling label includes;

- Manufacturers' name
- Serial number
- Load ratings (per hitch style)
- Material
- Length
- Sling Type
- Material



Synthetic web slings shall be immediately removed from service if any of the following conditions exist

- **Burn Damage from either heat or chemical sources**
 - **Heat damage may not be obvious**
 - **Any synthetic sling exposed to temperatures above 150 °F must be removed from service**



Synthetic web slings shall be immediately removed from service if any of the following conditions exist

- Snags, punctures, tears or cuts



The red thread (tattletale) exposed in this example mean the sling must be removed from service. Simply remember “Red is dead”

- Broken or worn stitches



Synthetic web slings shall be immediately removed from service if any of the following conditions exist

Acid Damage



Heat Damage



Cuts



Cut & Tensile Damage



Abrasion Damage



Face Cuts



Punctures & Snags



Tensile Break



Illegible or Missing Tag



In a bridle hitch, two, three, or four single hitches are used together to hoist objects that have lifting lugs or other attachments

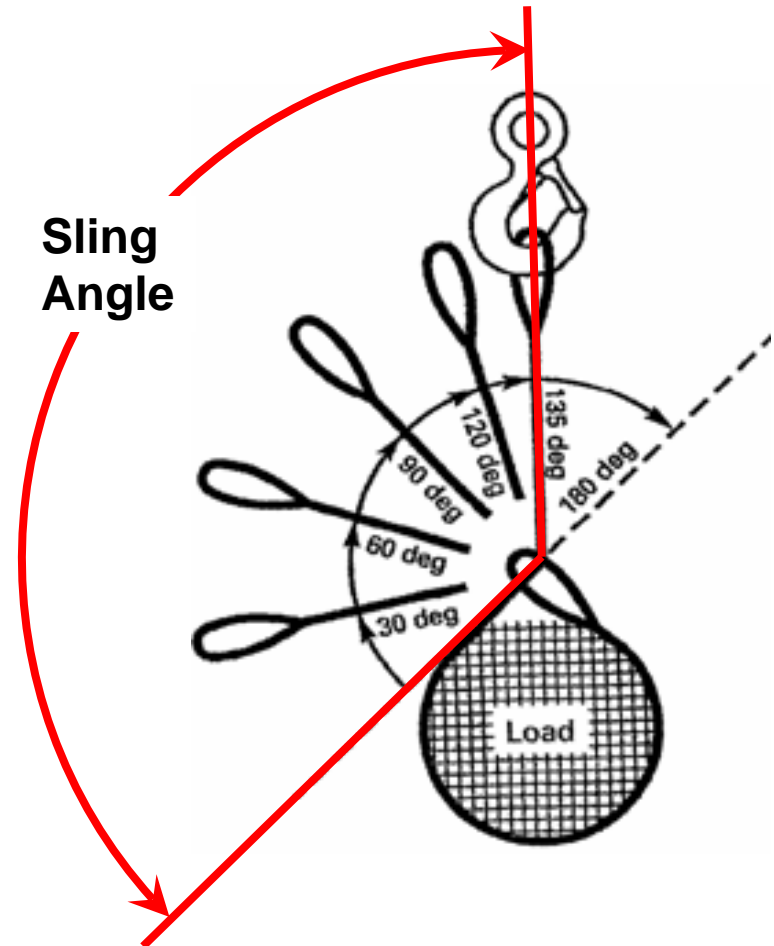
- Bridle hitches can be assembled from individual components (slings, shackles, hooks, etc.)
- Bridle synthetic slings are permanently assembled units consisting of a number web slings grouped together on a master link
- Bridle slings typically have 1-4 legs
- Sling ends can be either eyes or various types of hooks



Sling rigging practices using a choker hitch

- Set the sling angle to $>120^\circ$ for a full load rating
- Improperly setting the choke can reduce the load rating by as much as 50%

Angle of choke, deg	Rated Capacity, %
Over 120	100
90-120	87
60-89	74
30-59	62
0-29	49



Sling rigging practices using a basket hitch

- Remember that basket hitch ratings are for slings at 90°
- The legs of a basket hitch are typically collected on a single hook
- A sling angle less than 90° increases the tension (load) in the sling



Synthetic Sling Do's and Don'ts



Do's

- Visually inspect slings for any damage and remove from service if necessary
- Insure the safety tag is attached, legible, and has all pertinent information
- Verify load ratings per hitch style
- Use “softeners” on sharp corners as necessary

Don'ts

- Do not use if any part of sling is damaged
- Do not use if the safety information is missing or not legible
- Do not tie slings together
- Do not use a sling that has been shock loaded (remove it from service)
- **Never** exceed the load rating

Is this sling safe to use? No the red tattletale is showing



The three primary pieces of rigging hardware used at LLE

- Swivel Hoist rings



- Eyebolts



- Shackles

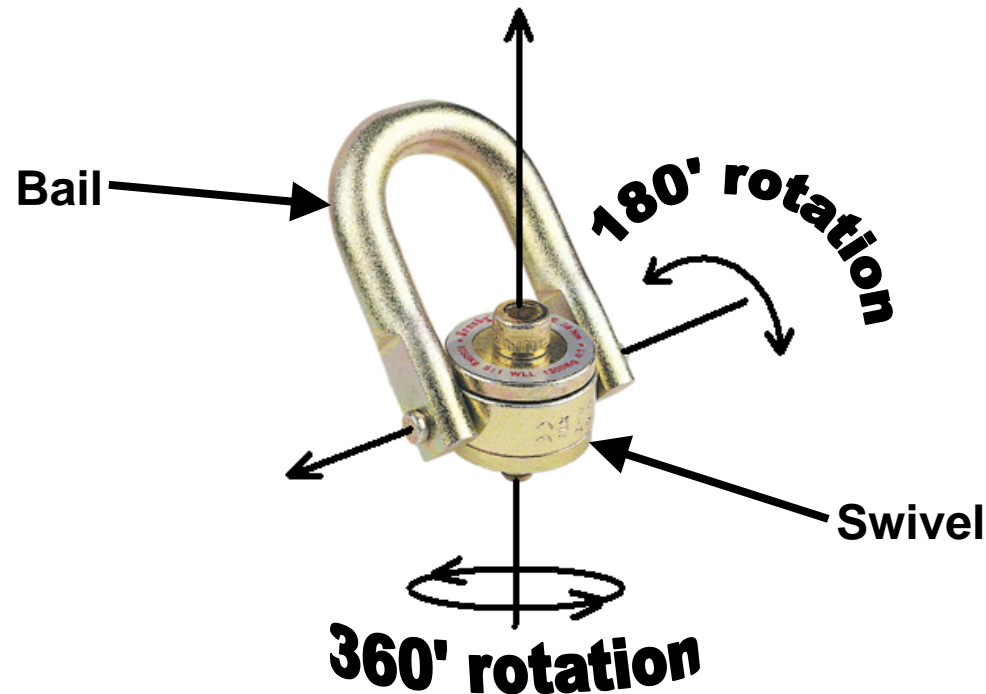


Hoist rings



Hoist rings have free movement about 2 axes or Degrees of Freedom (DOF)

- This motion allows the hoist ring to always be aligned with the sling



Never use a hoist ring if the swivel or bail bind, this is an indication of damage

Swivel hoist rings are able to accommodate various use angles

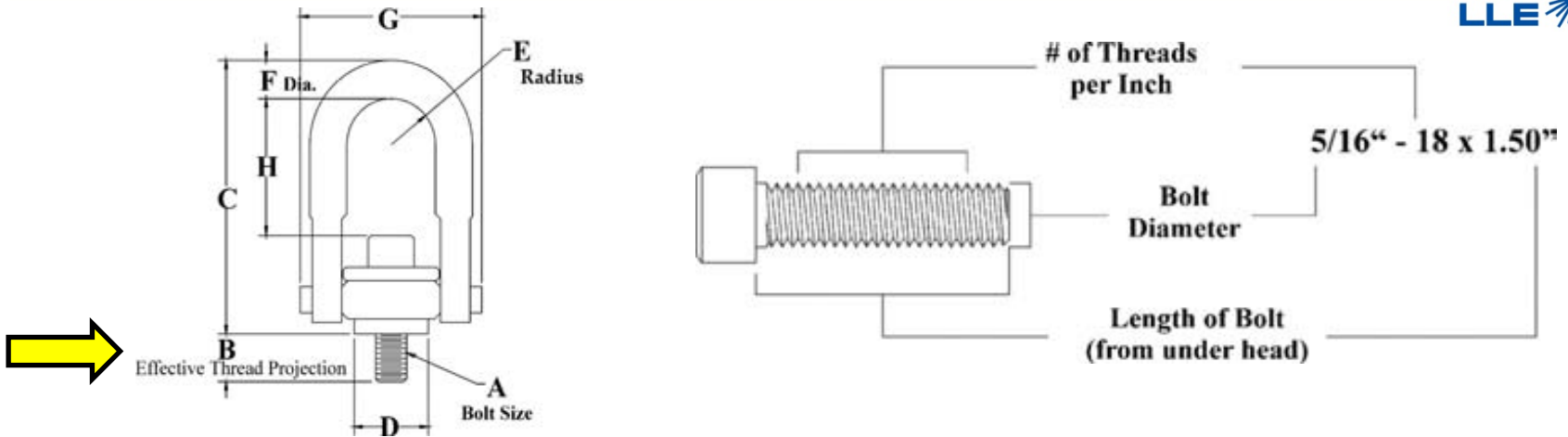


- **Load ratings based on:**
 - **Size**
 - **Ring size and thread size**
 - **Material**
 - **Commonly alloy steel or stainless steel**
 - **Thread length**
 - **Longer length usually designed for soft metals (aluminum)**
 - **Shorter lengths can be used in ferrous metals (steel)**

- **Each hoist ring is load tested and comes with a factory certificate**

- **Many different types and sizes are available**

The longer “Effective Thread Projection” that is approximately twice the thread diameter must be used for a hoist ring threaded into aluminum



Frame Size	HR-125 Stock No.	Working Load Limit (lbs.)	Torque in Ft-Lbs	Dimensions								Weight Each (lbs.)
				Bolt Size	Effective Thread Projection Length	C	D	Radius	Diameter	G	H	
No.				A	B	C	D	E	F	G	H	
2	1016909	2500	28	1/2 - 13 x 2.00	0.7	4.85	1.96	0.87	0.69	3.35	2.29	2.33
2	1016912	2500	28	1/2 - 13 x 2.50	1.2	4.85	1.96	0.87	0.69	3.35	2.29	2.36
2	1016920	4000	60	5/8 - 11 x 2.00	0.7	4.85	1.96	0.87	0.69	3.35	2.16	2.41
2	1016924	4000	60	5/8 - 11 x 2.75	1.45	4.85	1.96	0.87	0.69	3.35	2.16	2.47
2	1016931	5000	100	3/4 - 10 x 2.25	0.95	4.85	1.96	0.87	0.69	3.35	2.04	2.52
2	1016935	5000	100	3/4 - 10 x 2.75	1.45	4.85	1.96	0.87	0.69	3.35	2.04	2.59
3	1016942	7000	100	3/4 - 10 x 2.75	0.89	6.57	2.96	1.36	0.94	4.87	2.98	6.72
3	1016946	7000	100	3/4 - 10 x 3.50	1.64	6.57	2.96	1.36	0.94	4.87	2.98	6.81

Hoist ring load ratings and installation torque values are stamped or etched on an installation placard located on top of the hoist ring



- Use an allen wrench for initial installation of the hoist ring
- A torque wrench must always be used for proper installation of the hoist ring
- **Never** exceed the load rating



Hoist ring Do's



- **Visually inspect hoist rings for any damage or corrosion on threads and body**
- **Insure the installation placard is attached, if not remove the hoist ring from service**
- **Use an allen wrench for initial installation and then a torque wrench for final tightening**
- **Make sure the thread engagement is appropriate for the base metal the bolt is being threaded into**
 - **Approximately 1 times the diameter when threading into steel**
 - **Approximately 2 times the diameter when threading into aluminum**
- **Verify swivel and bail functionality after installation**

Hoist ring Don'ts



- Do not use if any part of hoist ring is damaged
- Do not use if placard information is missing or not legible
- Do not use a hoist ring if it is not tightened to the recommended torque
- Do not use if the hoist ring does not swivel
- Do not use washers in between the hoist ring and mounting surface
- Do not repair, replace, or modify any piece of a hoist ring
- Do not use if a gap exists between the part being lifted and the hoist ring
- Do not use a hook larger than the diameter of the hoist ring bail opening
- **Never** exceed the load rating of the hoist ring

What is the WLL of this hoist ring? Zero, the threaded rod, nut, and washers are clearly not an original bolt



Eye bolts



Machinery eye bolts are not as versatile as hoist rings



- **Fixed position based upon thread engagement makes them alignment sensitive when pulling at an angle**
- **Can accommodate thru hole applications**
- **Load ratings are based upon a number of factors**
 - **Size**
 - **Ring size and thread size**
 - **Material**
 - **Commonly forged from carbon steel or stainless steel (carbon steel and stainless steel have different load ratings for the same size)**
 - **Use angle**
 - **Can only be used up to 45°**
- **Two different styles and numerous sizes available**

There are two styles of eye bolts

- Plain pattern
 - straight vertical pulls only



- Shoulder pattern
 - angular pulls up to 45° from vertical



Machinery eye bolts must be used with great care



- **Working load limits for eye bolts are based on a straight vertical pull “in a gradually increasing manner”**
- **Angular pulls will significantly lower working load limits (see Shoulder Pattern) and should be avoided whenever possible**
- **If an angular pull is required, a properly seated Shoulder Pattern eye bolt must be used**
- **Loads should always be applied to eye bolts in the plane of the eye, not at an angle to this plane**
- **Angular pulls must never be more than a 45° pull**

Diameter and Thread	Working Load Limit	
	Straight Pull (X)	45° Pull (Y) Shoulder Only
1/4"-20	500	125
5/16"-18	900	225
3/8"-16	1400	350
7/16"-14	2000	500
1/2"-13	2600	650
9/16"-12	3200	750
5/8"-11	4000	1000
3/4"-10	6000	1500
7/8"-9	7000	1750
1"-8	9000	2250
1-1/8"-7	12000	2500
1-1/4"-7	15000	3750
1-1/2"-6	21000	4900

Loads must always be applied to eye bolts in the plane of the eye

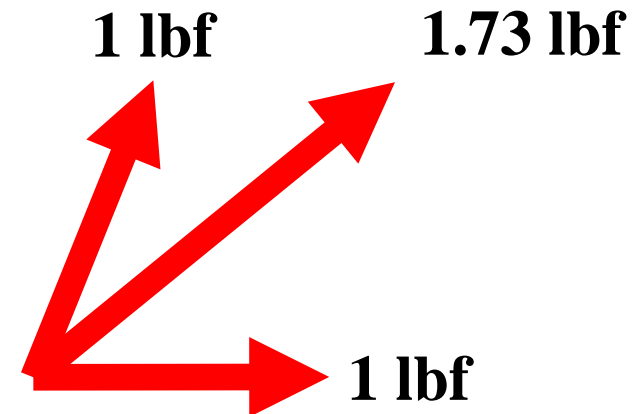
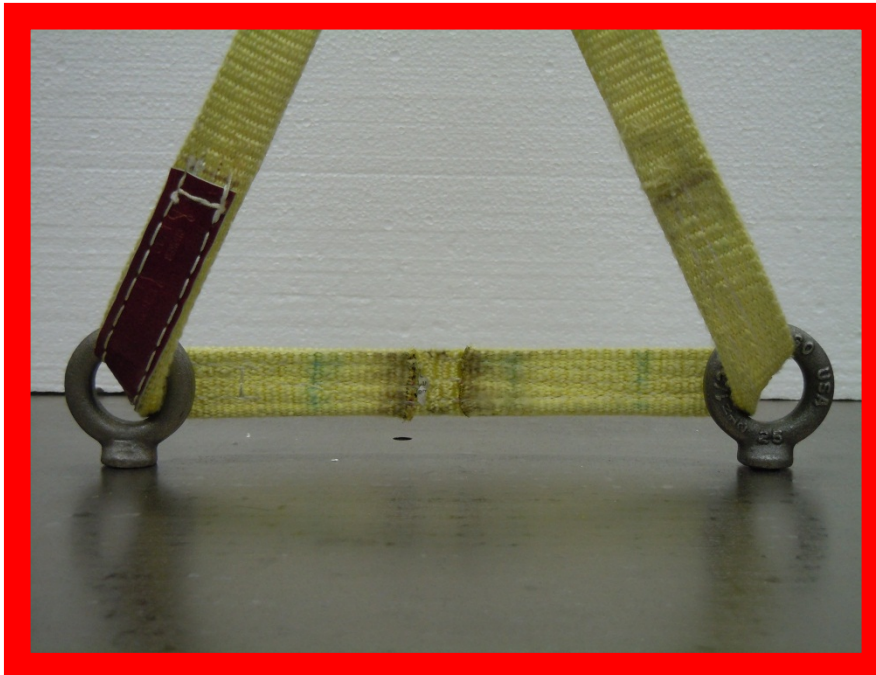
- Side pull in the plane of the eye
- Sling angle must not exceed 45 °
- Side pull out of the plane of the eye. This configuration must not be used



Flat washers may be used under the shoulder to position the plane of the eye

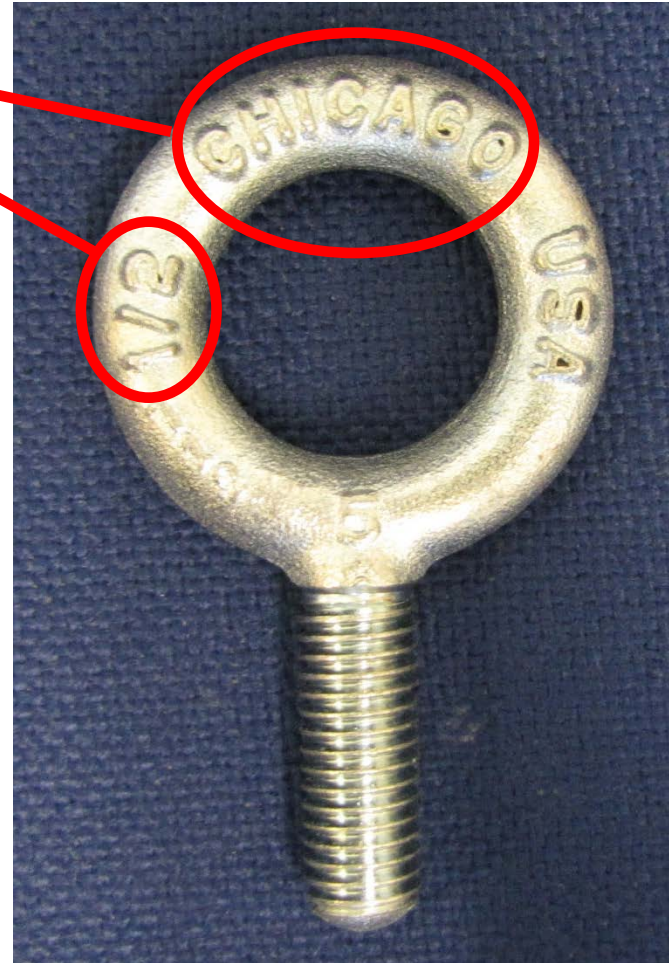
Do not reeve slings between attachment points

- Reeving introduces side pull
- Although the upper sling angle is 60° , the resultant sling angle is 30°
- For 1 lbf at 60° there is also a 1 lbf lateral load. The resultant load on the eye bolt is 1.73 lbf at 30° .



Eye bolt identification markings

- **Manufacturer and Size**
- **Eyebolts are not required to be marked with the WLL or required installation torque. The user must look up this information prior to use**
- **Do not use any eye bolt for rigging unless there are clearly legible identification marks**



All machinery eye bolts are not created equal, they vary between manufacturers



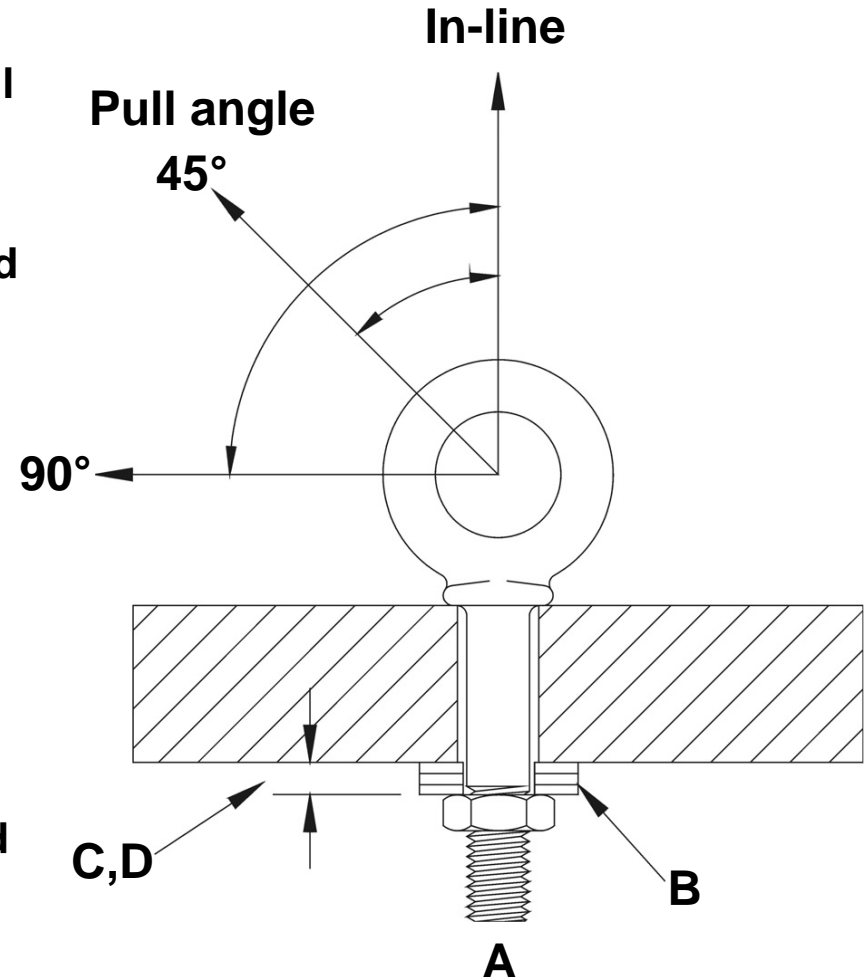
- A comparison of the same size shouldered eye bolts from two manufacturers shows different WLL
- Chicago rates the shouldered eye bolt for a side pull up to 45°
- Although Crosby rates the shouldered eye bolt for a side pull up to 90° (25% of in-line WLL), a maximum of 45° is permitted at LLE
- The user must look up WLL information prior to use

Diameter and Thread	Working Load Limit	
	Chicago Straight Pull	Crosby Straight Pull
1/4"-20	500	650
5/16"-18	900	1200
3/8"-16	1400	1550
7/16"-14	2000	-
1/2"-13	2600	2600
9/16"-12	3200	-
5/8"-11	4000	5200
3/4"-10	6000	7200
7/8"-9	7000	10600
1"-8	9000	13300
1-1/8"-7	12000	15000
1-1/4"-7	15000	21000
1-1/2"-6	21000	24000

Shoulder Nut Eye Bolt – Installation for In-Line and Angular Loading

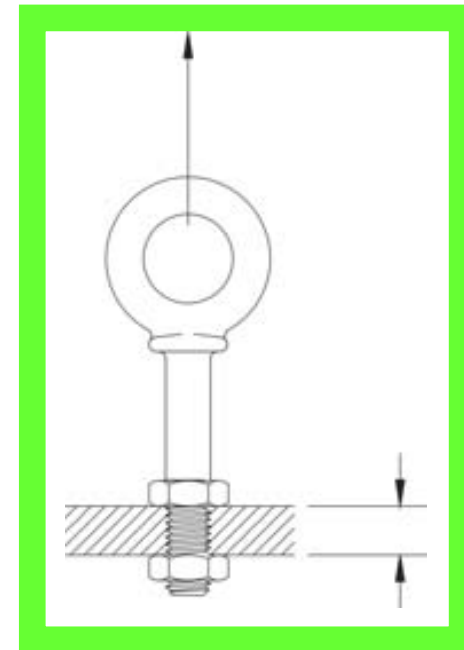
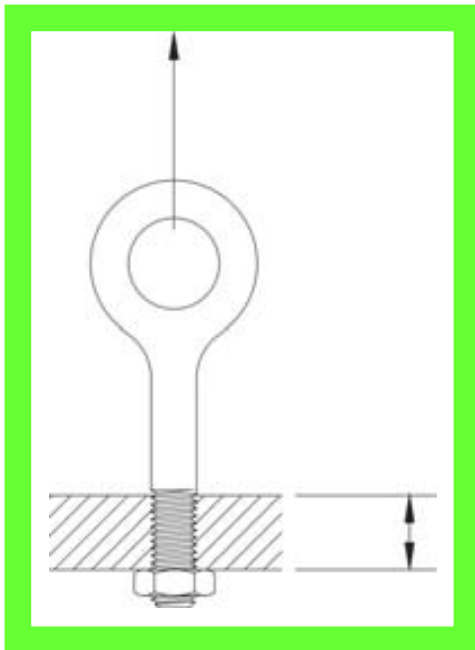


- A. The threaded shank must protrude through the load sufficiently to allow full engagement of the nut
- B. If the eye bolt protrudes so far through the load that the nut cannot be tightened securely against the load, use properly sized washers to take up the excess space **BETWEEN THE NUT AND THE LOAD**
- C. Place washers or spacers between nut and load so that when the nut is tightened securely, the shoulder is secured flush against the load surface
- D. Thickness of spacers must exceed this distance between the bottom of the load and the last thread of the eye bolt



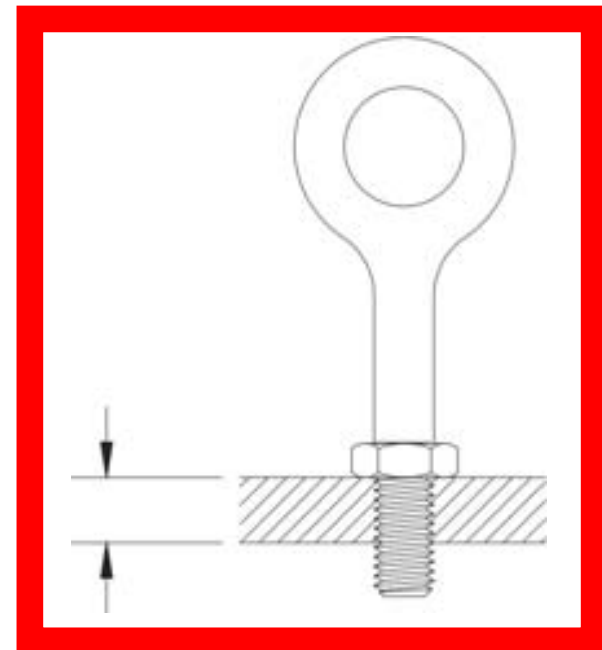
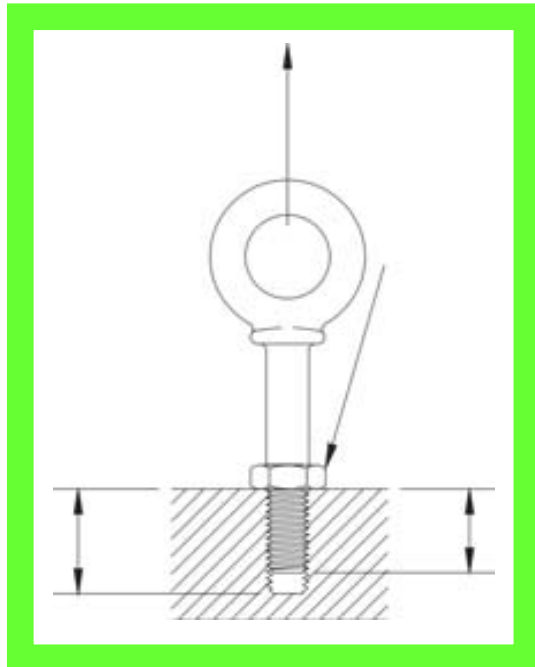
Regular Nut & Shoulder Nut Eye Bolt - Installation for In-line Loading with a tapped hole

- More than one eye bolt diameter of threads, only (1) nut is required
- Tighten hex nut securely against load
- One eye bolt diameter of threads or less, use two (2) nuts
- Tighten hex nut securely against load



Regular Nut & Shoulder Nut Eye Bolt - Installation for In-line Loading with a tapped hole

- **Minimum engagement depth is 2 x Diameter**
- **One eye bolt diameter of threads or less is not allowed**



Examples of non-load rated eyebolts that should never be used for rigging



welded eye bolt



open eye bolt



bent eye bolt

Machinery eye bolt Do's



- **Visually inspect eyebolts for any damage or corrosion on threads and body**
- **Always be sure threads on the shank and receiving holes are clean**
- **Insure the eyebolt has proper identification markings**
- **Always countersink receiving hole or use washers to seat the shoulder properly**
- **Always screw the eye bolt down completely for proper seating**
- **Always tighten nuts securely against the load**
- **When using blind tapped holes, make sure thread engagement is more than 1.5 times the diameter of the thread in steel and 2.5 times in aluminum**

Machinery eye bolt Don'ts



- Do not use the eyebolt if it is bent, damaged, or has been modified
- Do not use if the eyebolt if it does not have proper identification markings
- Do not use shouldered eyebolts at angles between 45 and 90 degrees to bolt axis
- Do not repair, replace, or modify an eyebolt
- Do not use if a gap exists between the part and eyebolt
- Do not use a hook larger than the diameter of the eyebolt opening
- Do not use a plain pattern eye bolt for angular pulls
- Shock loading must be avoided
- **Never** machine, grind, or cut an eye bolt
- **Never** use eye bolt that shows signs of wear or damage
- **Never** use eye bolt if eye or shank is bent or elongated
- **Never** exceed the load rating

Is this eyebolt safe to use? No, because the shoulder has been damaged



Shackles



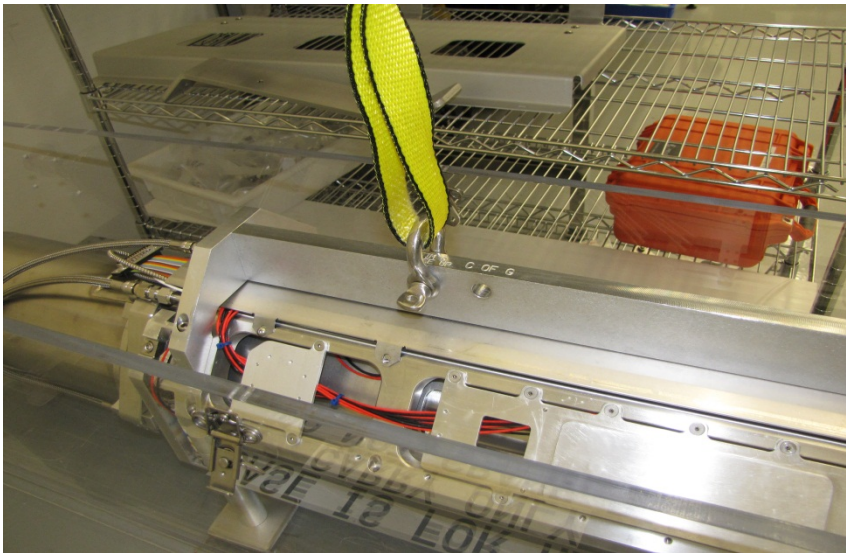
Shackles are used for connecting various pieces of rigging equipment together

- **Used as a connecting link between items**
 - **Strap to hoist ring or eyebolt**
 - **Strap to strap**
 - **Used as single attach point for multiple straps**
- **Load rating based on:**
 - **Size**
 - **Material**
- **Many different types and sizes**

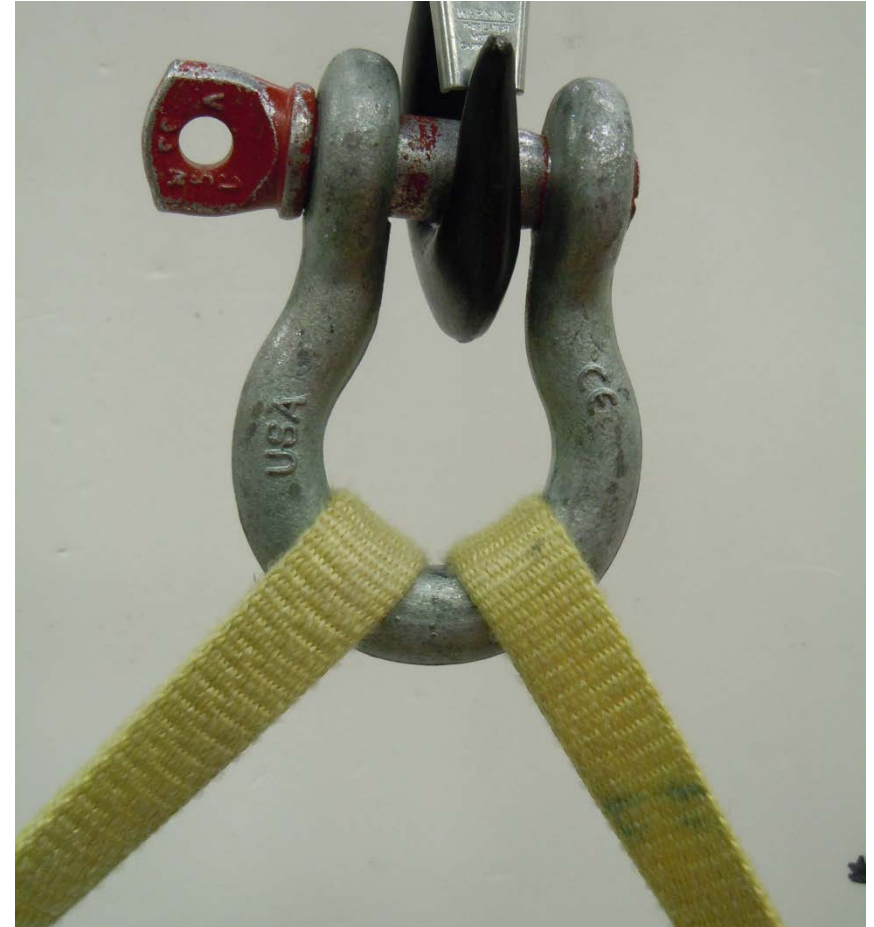


Examples of shackle usage

- Strap to diagnostic



- With multiple straps



Round pin shackle

- **Round Pin Shackles can be used in tie down, towing, suspension or lifting applications where the load is strictly applied in-line**
- **Round pin shackles should never be used in rigging applications to gather multiple sling legs, or where side loading conditions may occur**



Round pin shackles are not approved for use at LLE

Screw pin shackle

- **Screw Pin Shackles are used in Pick and Place applications.**
- **For permanent or long-term installations, Crosby recommends the use of bolt type shackles. Alternatively, the screw pin shall be secured from rotation or loosening.**
- **Screw pin shackles can be used for applications involving side-loading circumstances**
- **Reduced working load limits are required for side-loading applications**
- **While in service, do not allow the screw pin to be rotated by a live line, such as a choker application**



Screw pin shackles are preferred for use at LLE

Bolt-type shackle

- **Bolt-Type Shackles can be used in any application where round pin or screw pin shackles are used**
- **In addition, they are recommended for permanent or long term installations and where the load may slide on the shackle pin causing the pin to rotate**
- **The bolt-type shackle's secondary securement system, utilizing a nut and cotter, eliminates the requirement to tighten pin before each lift or movement of load**



Bolt-type shackles must have the cotter pin installed

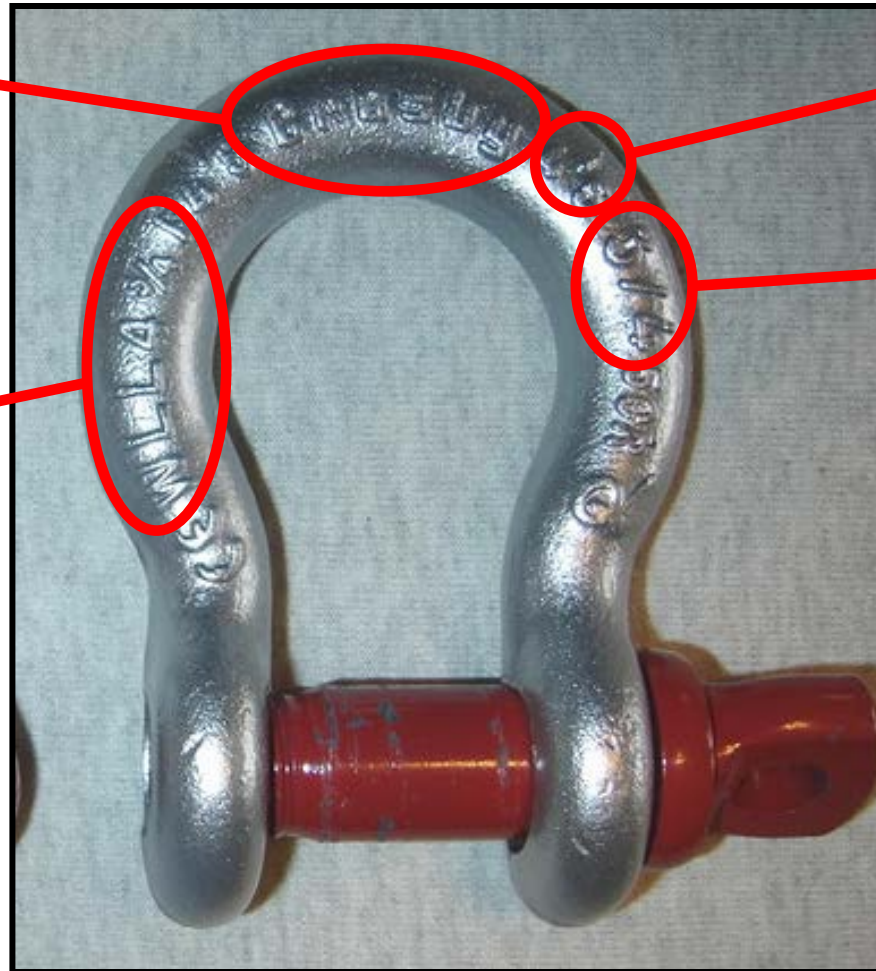
Shackle identification markings

Manufacturer
(Crosby)

45° mark

Working Load Limit
(4 ³/₄ T)

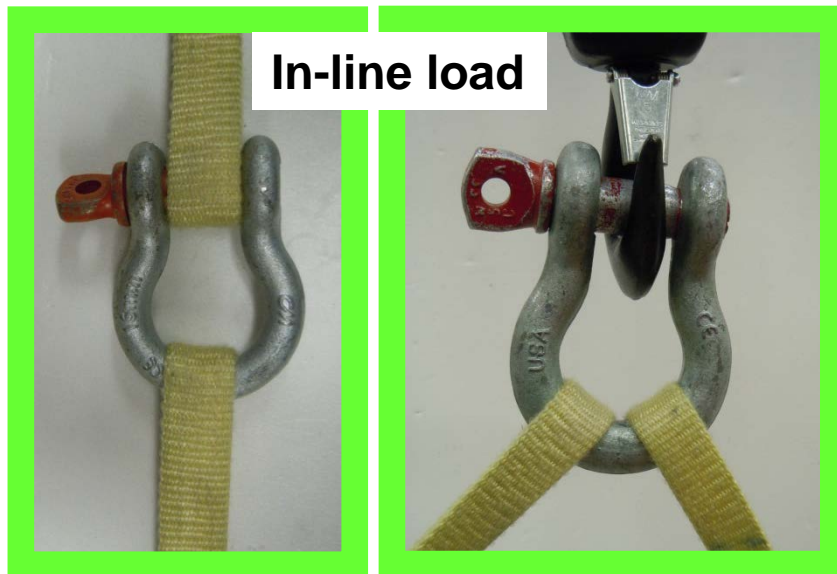
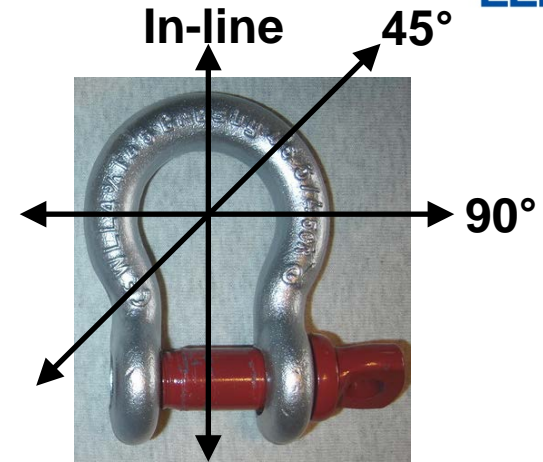
Size
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Side loading of screw pin and bolt type shackles results in a reduction of the working load limit



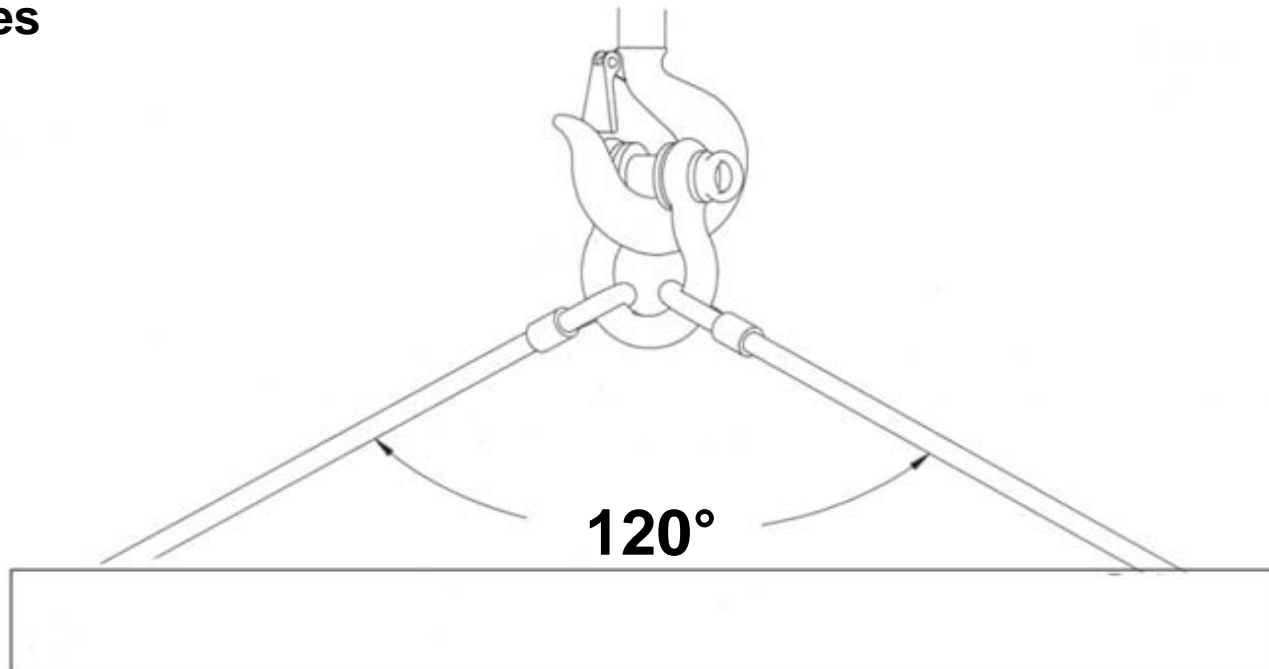
Angle of Side Load from Vertical In-Line of shackle	Adjusted WLL
0° In-Line	100% of Rated WLL
45° from In-Line	70% of Rated WLL
90° from In-Line	50% of Rated WLL



At LLE shackles are only permitted to be loaded in-line

Shackle load ratings are based upon the use angle with multiple straps

- Shackles symmetrically loaded with two leg slings having a maximum included angle of 120° and can be utilized to full working load limit of the shackle
- **Never** exceed a 120° included angle and only use bolt-type or screw-pin shackles



Shackle rigging practices for Crosby shackles

- Point loading of shackle bows is acceptable

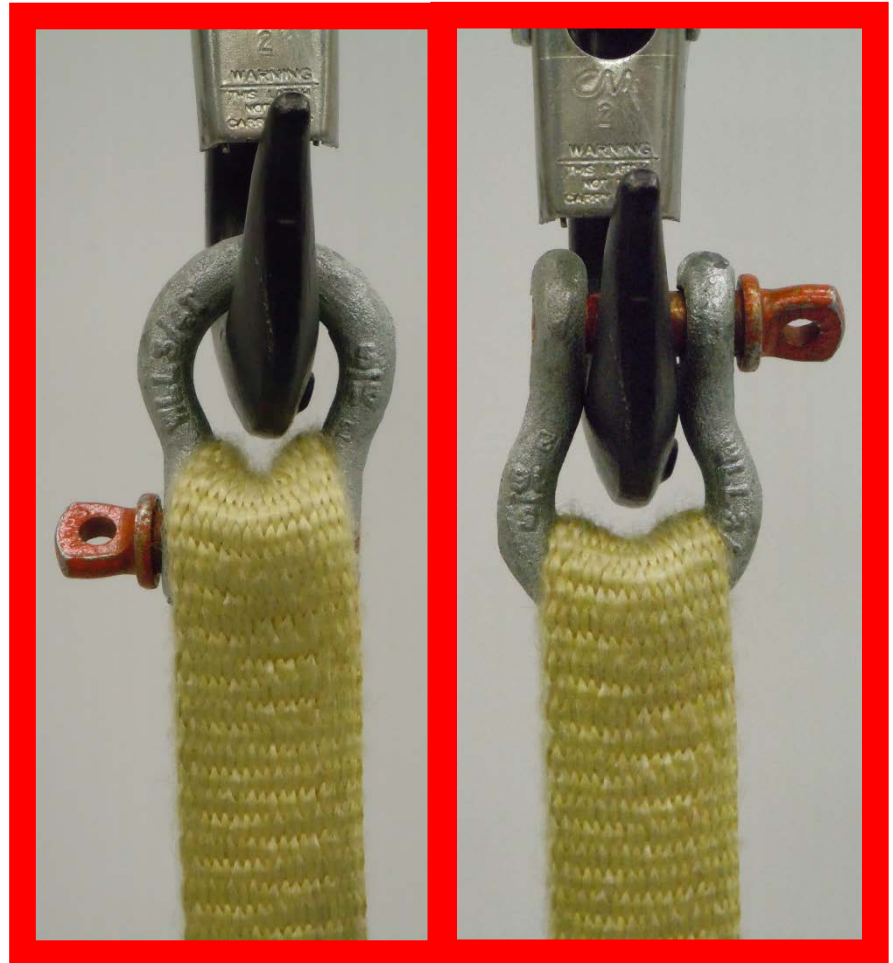


- Point loading of shackle pins is acceptable when the load is reasonably centered on the pin



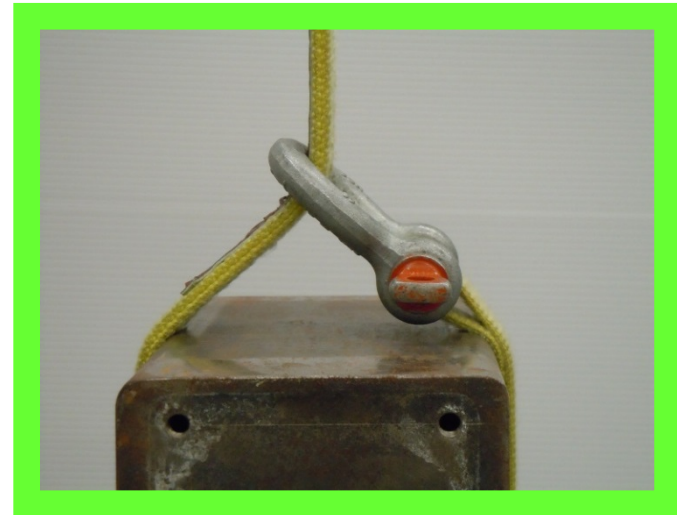
Shackle rigging practices with synthetic slings

- Folding, bunching, or pinching of synthetic slings can occur when used with shackles
- Folding, bunching, and pinching of synthetic slings reduces the sling load rating and must be avoided



Shackle rigging practices

- Screw pins shall be fully engaged
- If designed for a cotter pin, it shall be used and maintained
- Applied load should be centered in the bow to prevent side loading
- Multiple sling legs must not be applied to the pin
- If the shackle is side loaded, the rated load shall be reduced
- **Never** have the pin against the live line in a choker. The pin must go through the bow of the sling.



Shackle Do's



- **Visually inspect shackles for any damage or wear on ring and pin**
- **Insure shackles have proper identification markings**
- **Finger tighten the pin into ring of shackle**
- **Check for proper fit of the pin into ring**
- **Check the load ratings and use according to manufacturer recommendations**

Shackle Don'ts



- Do not use a shackle if it is bent, damaged, or has been modified
- Do not use if the shackle does not have proper identification markings
- Do not use a tool to tighten a shackle pin
- Do not repair, replace, or modify a shackle
- Do not use a shackle if the pin has been replaced with a bolt
- Do not use a hook larger than the diameter of the shackle opening
- **Never** exceed the load rating

What is the WLL of this shackle? Zero, because the screw pin has been replaced with a bolt



What is the WLL of this shackle? Zero, welding changes the strength of the shackle material



Never use counterfeit or unknown hardware

- Rigging hardware must be identifiable with all information clearly legible



Hooks

- **Shank hook**
- **Swivel hook**
- **Eye hook**
- **Grab hook**
- **Slip hook**
- **Sorting hook**
- **Sliding choker hook**



Of the wide variety of hooks that are available, only a few types are used at LLE

- In general, the only hooks used at LLE are the load hooks attached to hoists
 - The overhead cranes use shank hooks with latches
 - The electric chain hoists use clevis hooks with latches
- Most rigging situations at LLE do not require any additional hooks. Contact ME for situations where additional hooks may be required
- Of all of the hooks shown, only the sorting hook may be point loaded. All other types of hooks must not be point loaded.

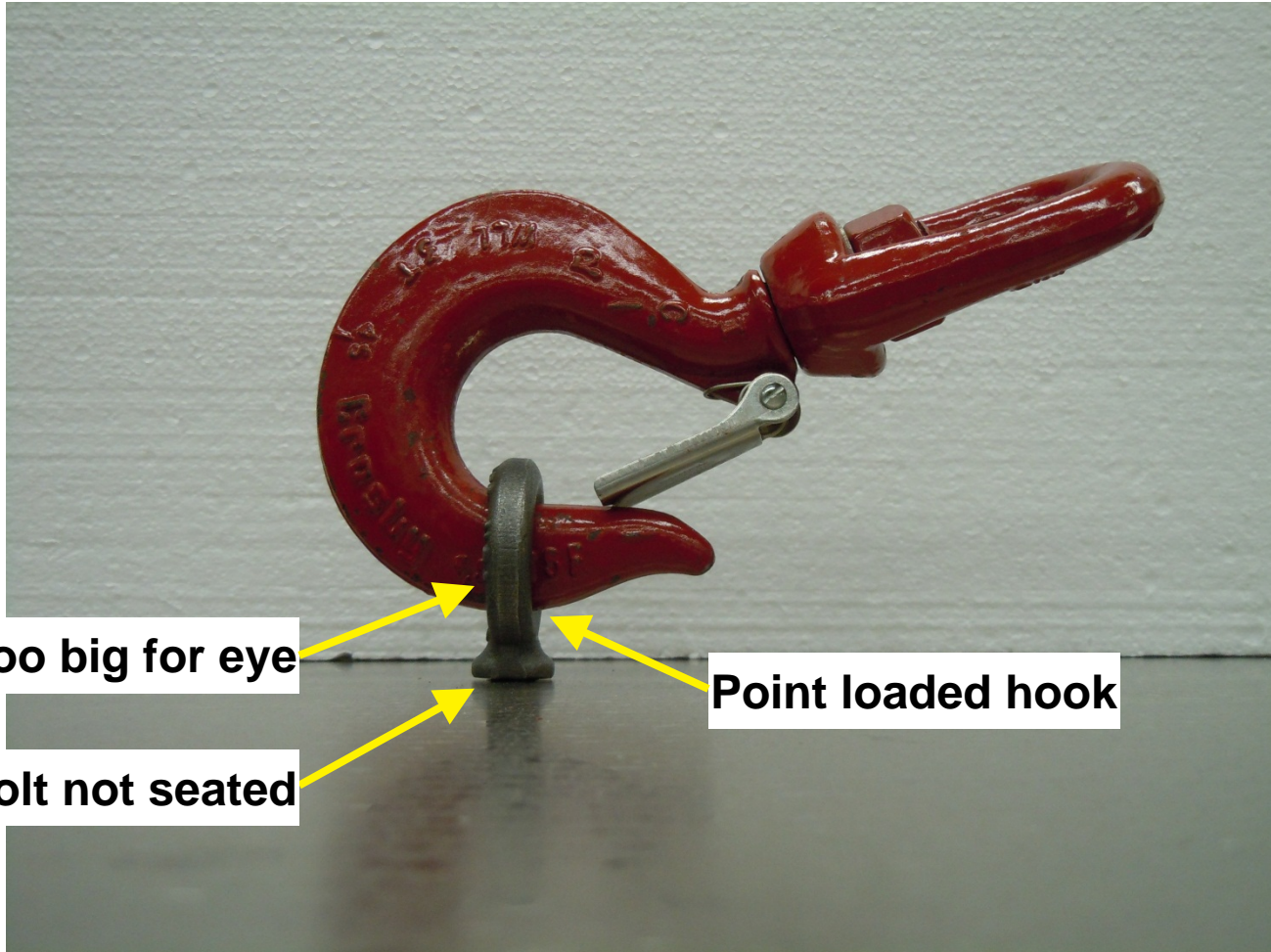


The load hook

- Always inspect the hook and latch before use
- Never use a latch that is distorted or bent
- Always make sure spring will force the latch against the tip of the hook
- Insure there is no excessive wear in the saddle of the hook
- Always make sure the hook supports the load. The latch must never support the load
- Latches are intended to retain loose sling or devices under slack conditions
- Latches are not intended to be an anti-fouling device
- Only load the hook in the “saddle” or “bowl” within $\pm 45^\circ$ of vertical
- Hooks are only to be loaded In-line



What is wrong with this picture?



Hook too big for eye

Point loaded hook

Eye bolt not seated

Loading the load hook

- When placing two sling legs in a hook, make sure the angle between the legs is less than 90° and if the hook or load is tilted, nothing bears against the bottom of this latch
- For two legged slings with angles greater than 90°, use an intermediate link such as a master link or bolt type shackle to collect the legs of the slings. The intermediate link can be placed over the hook to provide an in-line load on the hook. This approach must also be used when using slings with three or more legs.
- Make sure all rigging materials are secured inside the latch area and the latch closes
- **Never** point load a hook



Hook latches must be closed



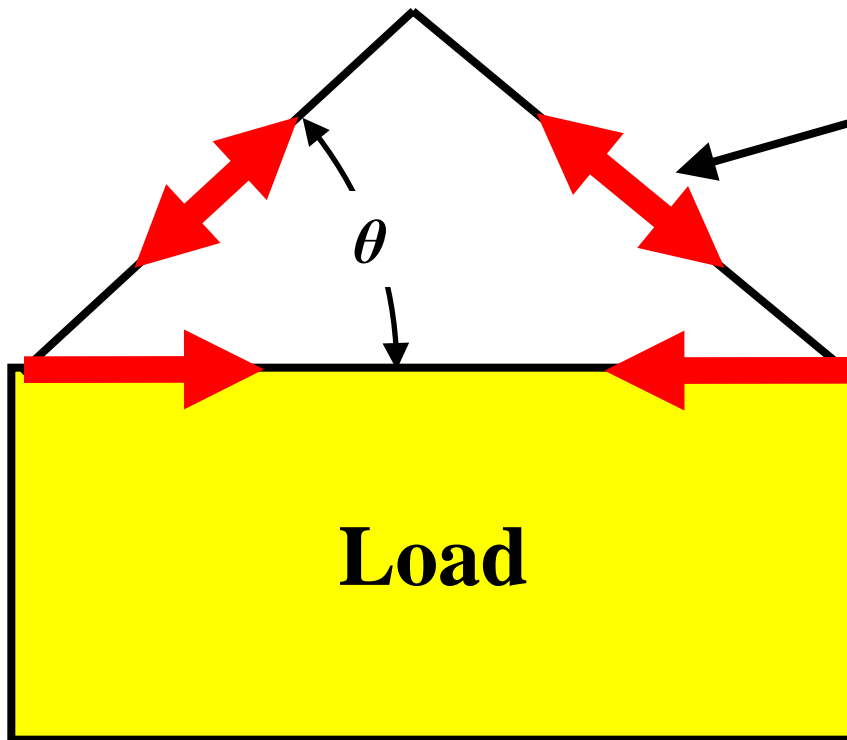
Are these hooks acceptable for use?



No!
No!!
and
No!!!



Rigging math

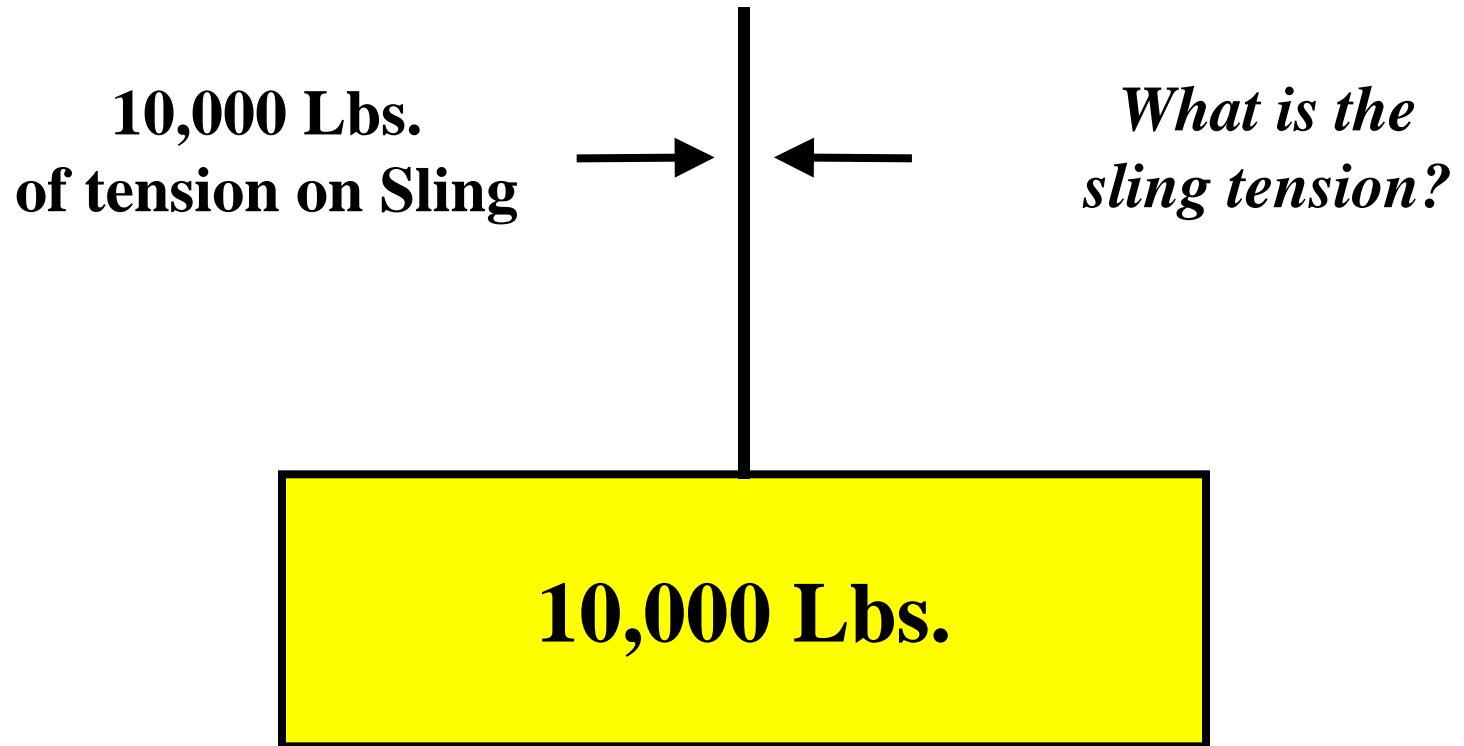


$$\text{SlingTension} = \frac{\text{Load}}{\#legs \cdot \sin \theta}$$

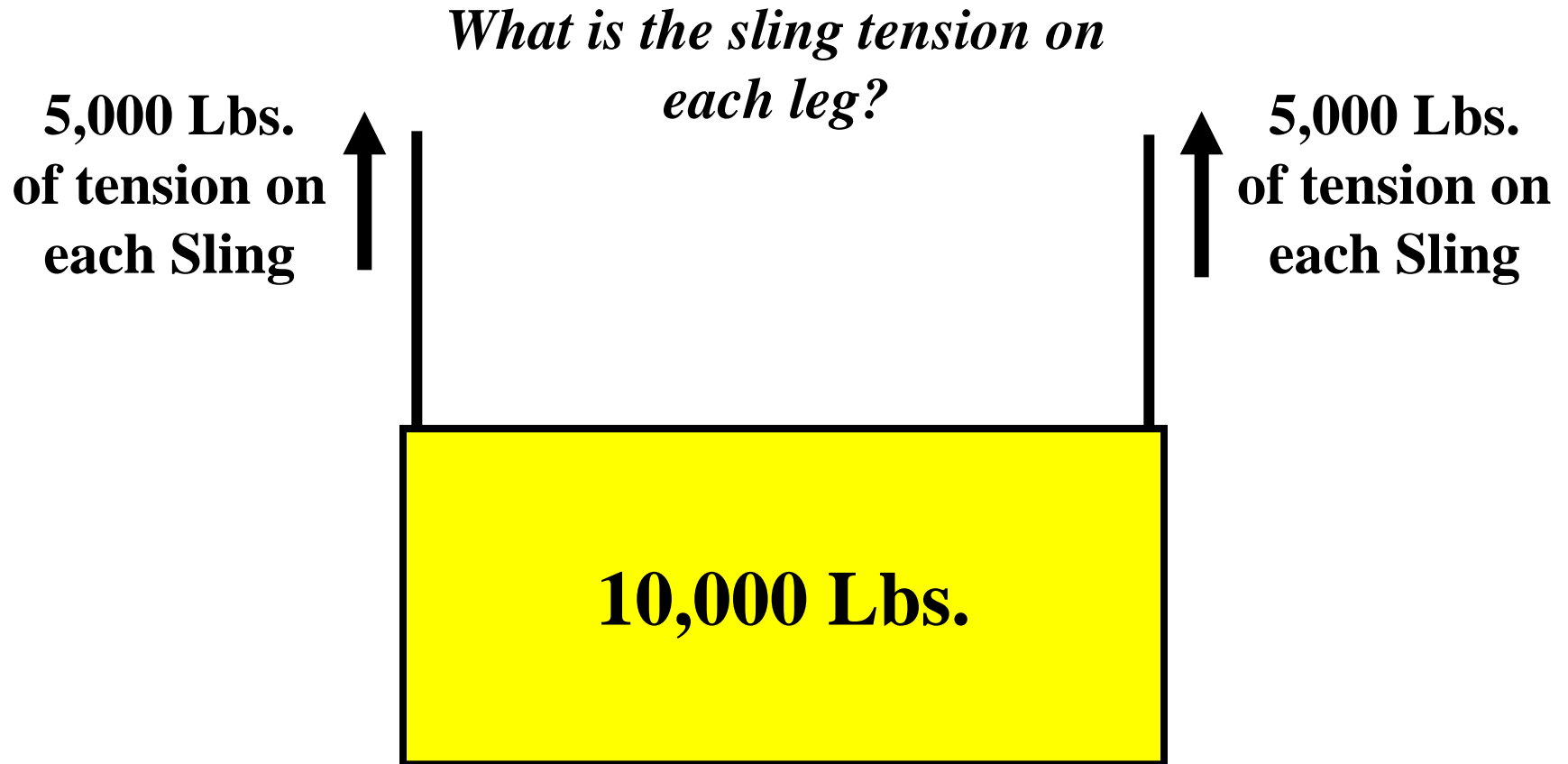
$$\text{CollapseForce} = \frac{\text{Load}}{\#legs \cdot \tan \theta}$$

The sling angle θ is always measured from the horizontal

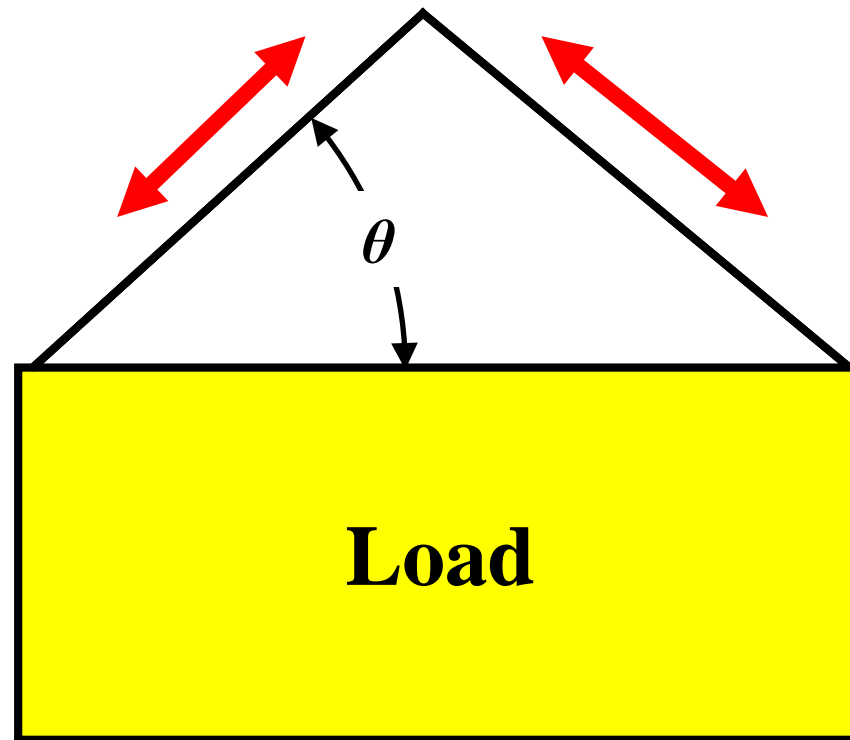
Sling tension in a vertical hitch



Sling tension in a two leg vertical hitch (basket hitch)

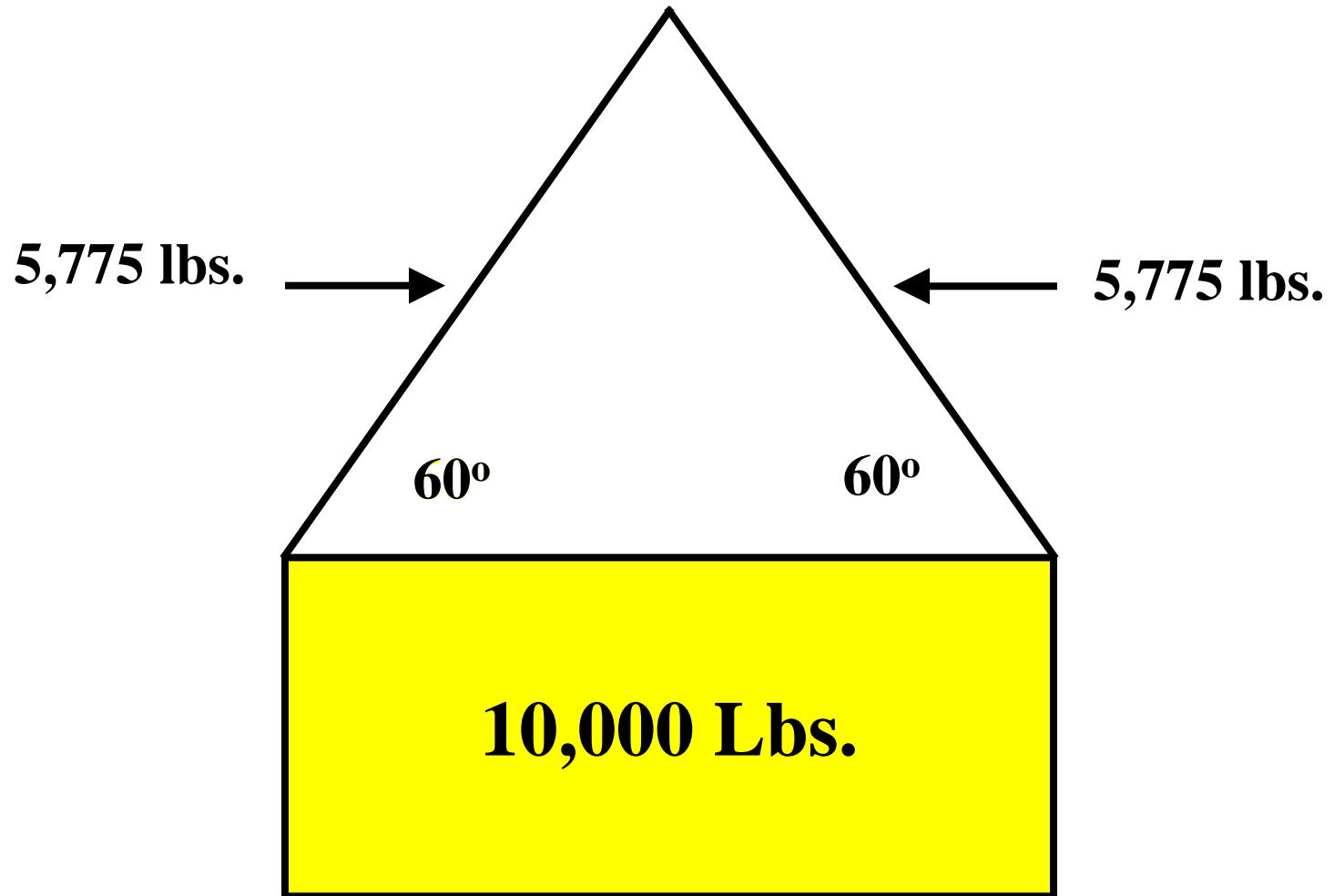


Sling tension in a two leg bridle hitch

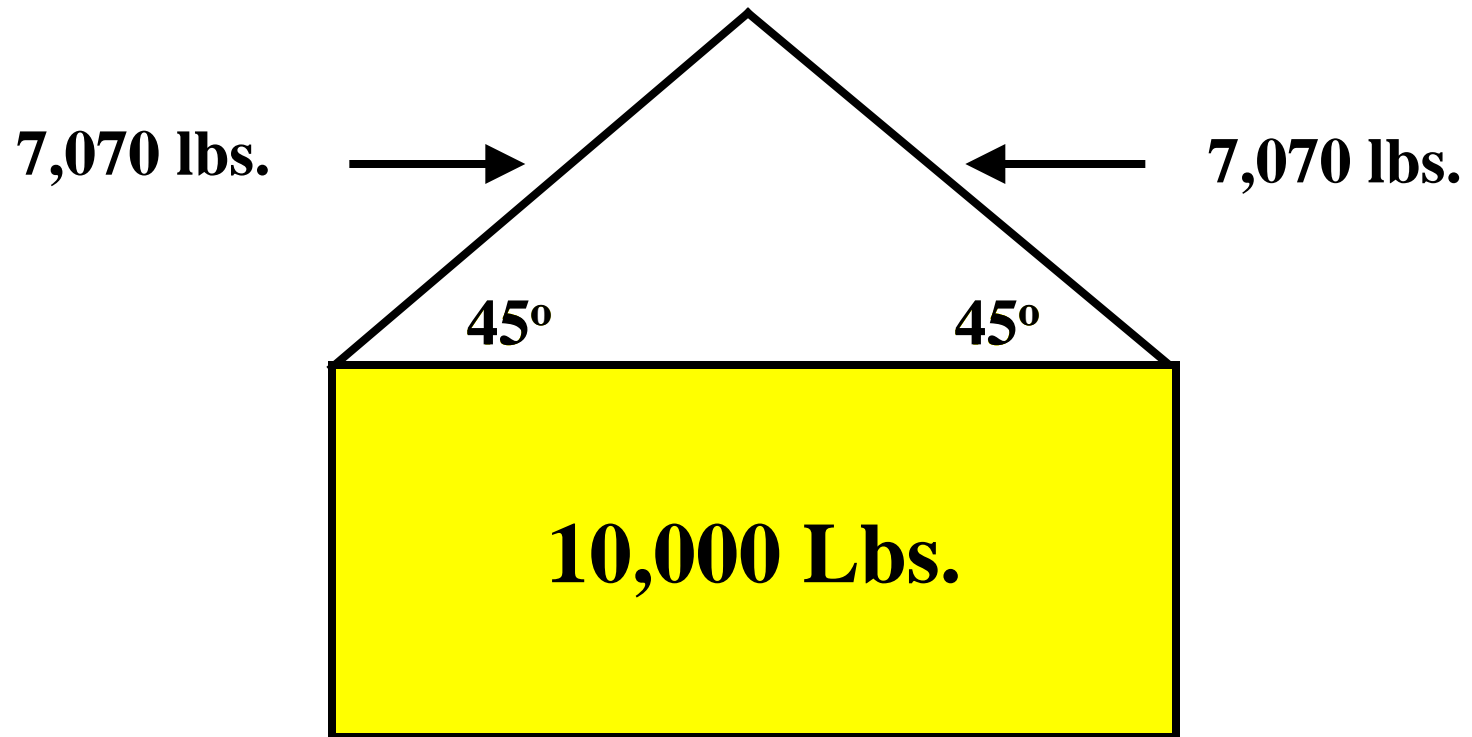


Sling tension will increase as the sling angle θ gets smaller

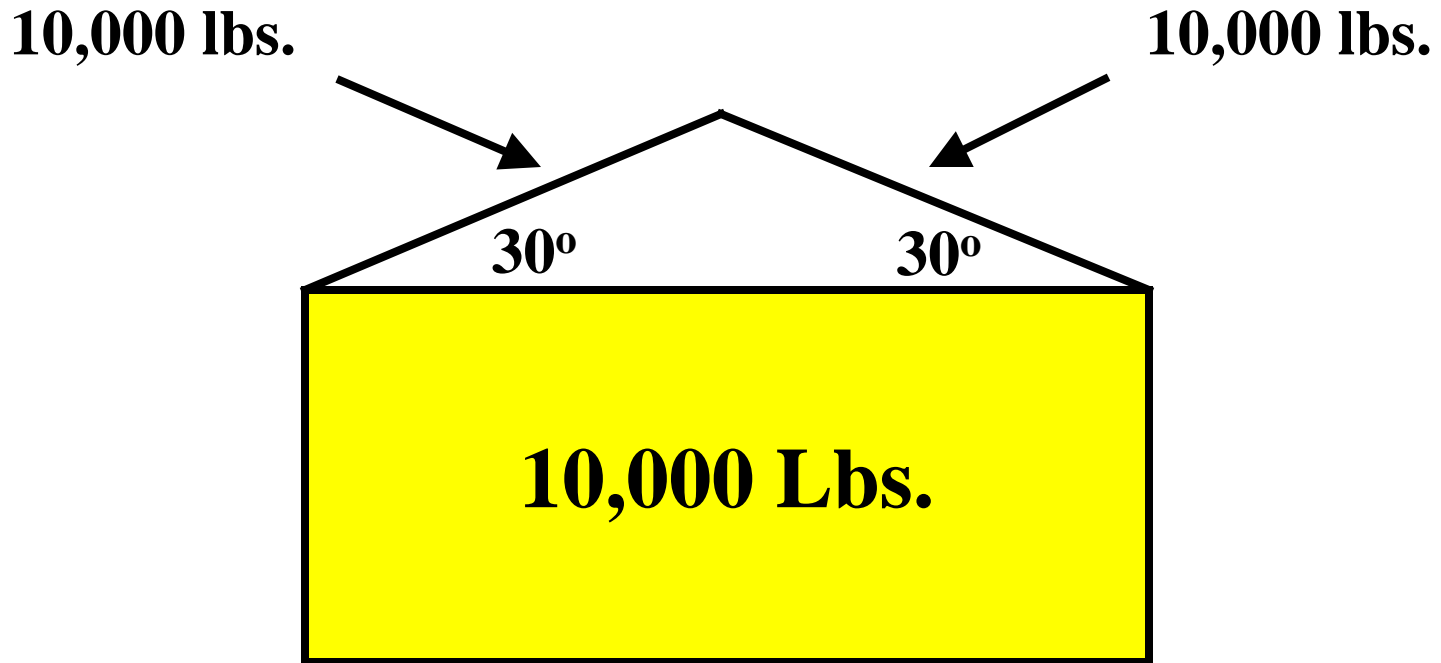
Sling tension in a two leg bridle hitch at 60°



Sling tension in a two leg bridle hitch at 45°

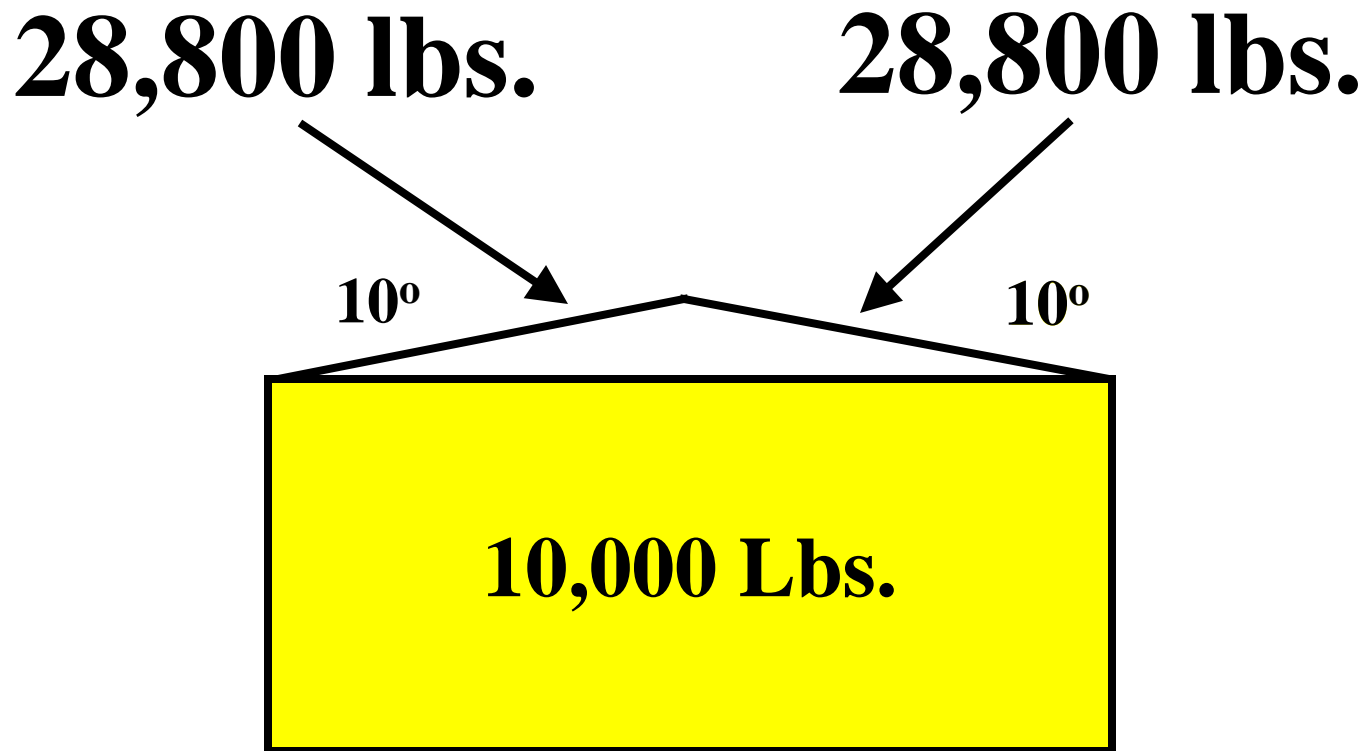


Sling tension in a two leg bridle hitch at 30°



Notice that at 30° the tension in the sling is equal to the Load

Sling tension in a two leg bridle hitch at 10°



Notice that at below 30° the tension in the sling is greater than Load

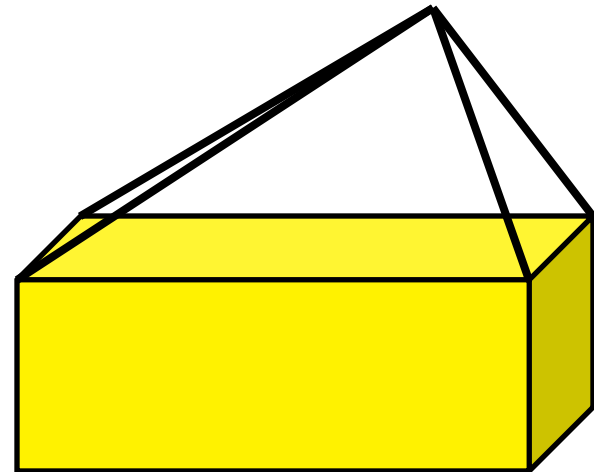
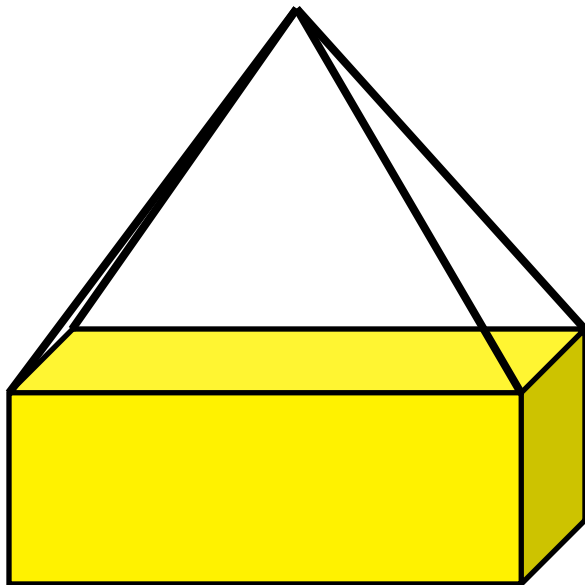
Using a sling at any angle other than vertical applies a collapsing force on the load

- High collapsing forces can lead to
 - load buckling
 - exceeding the pad eye strength of where the hoist attaches to the load

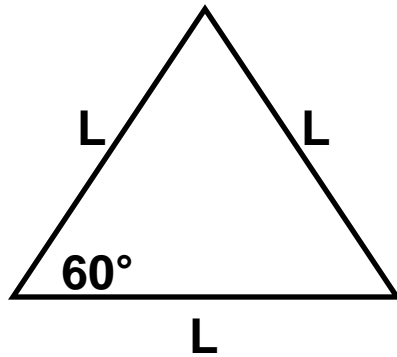


Rigging with a 3 or 4 sling bridle hitches

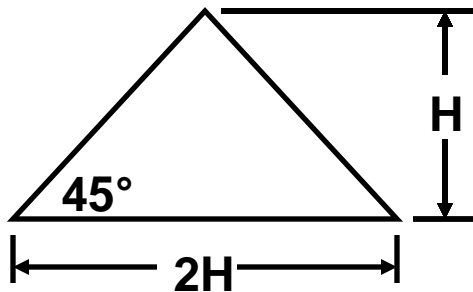
- With 3 and 4 leg sling bridle hitches, only 2 legs will likely carry the load while the other two steady (balance) the load
- Use only 2 legs when calculating the required load rating for rigging equipment
- Use the smallest sling angle when calculating load rating



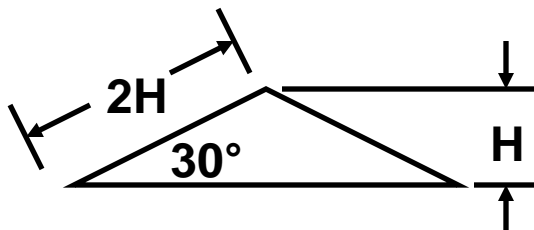
Checking sling angles with simple geometry



- For 60° sling angle
 - All sides of the triangle are equal length



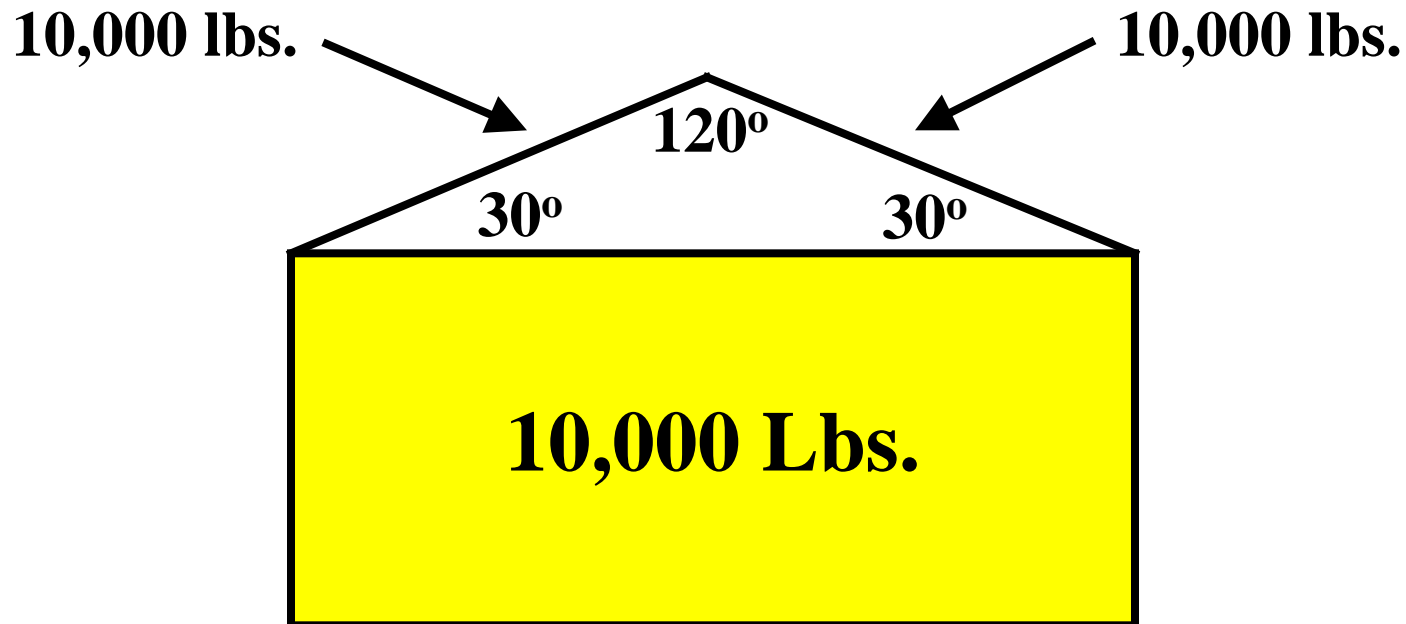
- For 45° sling angle
 - The base of the triangle is twice the height



- For 30° sling angle
 - The height is one-half of the sling length

For a two leg bridle hitch the basic rigger should size rigging hardware based on a two leg bridle hitch at 30°

- Recall – Shackles symmetrically loaded with two leg slings having a maximum included angle of 120° can be utilized to the full working load limit of the shackle



- Select the sling load rating to be equal or greater than the payload and use a sling angle greater than 30°

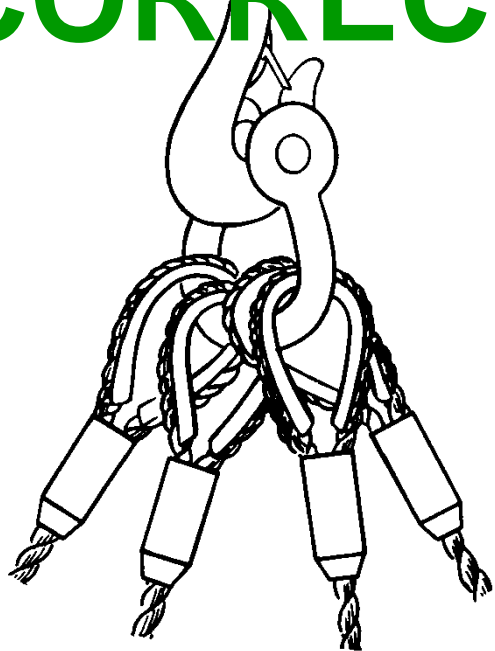
Basic rigging practices

- **When multiple slings are used on a common hook or bridle;**
 - **Always use sling angles greater than 30°**
 - **For sling load calculations use *Sling Tension = Load***
- **All rigging hardware must satisfy the load rating requirements of the lift to be performed**
 - **It either meets the load requirements or not (there is no such thing as just over the load capacity)**
- **Use single slings between hooks and attachment points on the payload**
 - **do not reeve slings between attachment points**
- **All slings must be straight and free of knots**

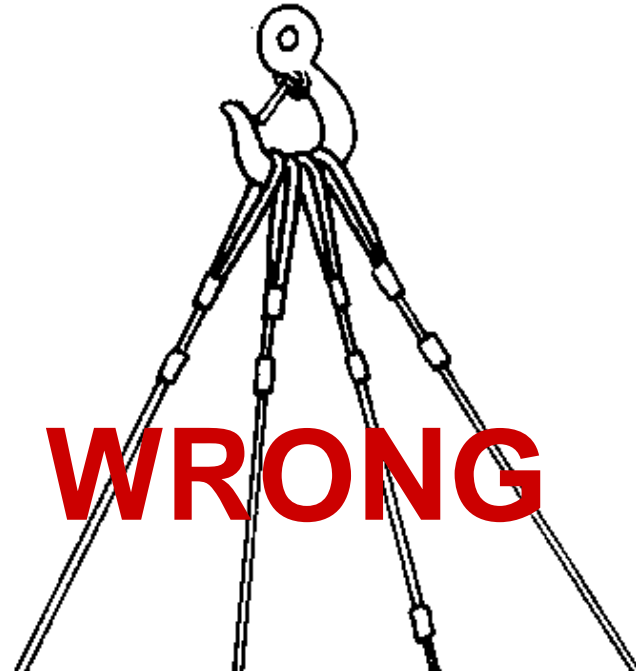
Basic rigging practices – continued

- When more than one wide sling (>1”) or two narrow slings (1”) are required, they shall be placed in a shackle or bridle which is then placed on the crane hook

CORRECT



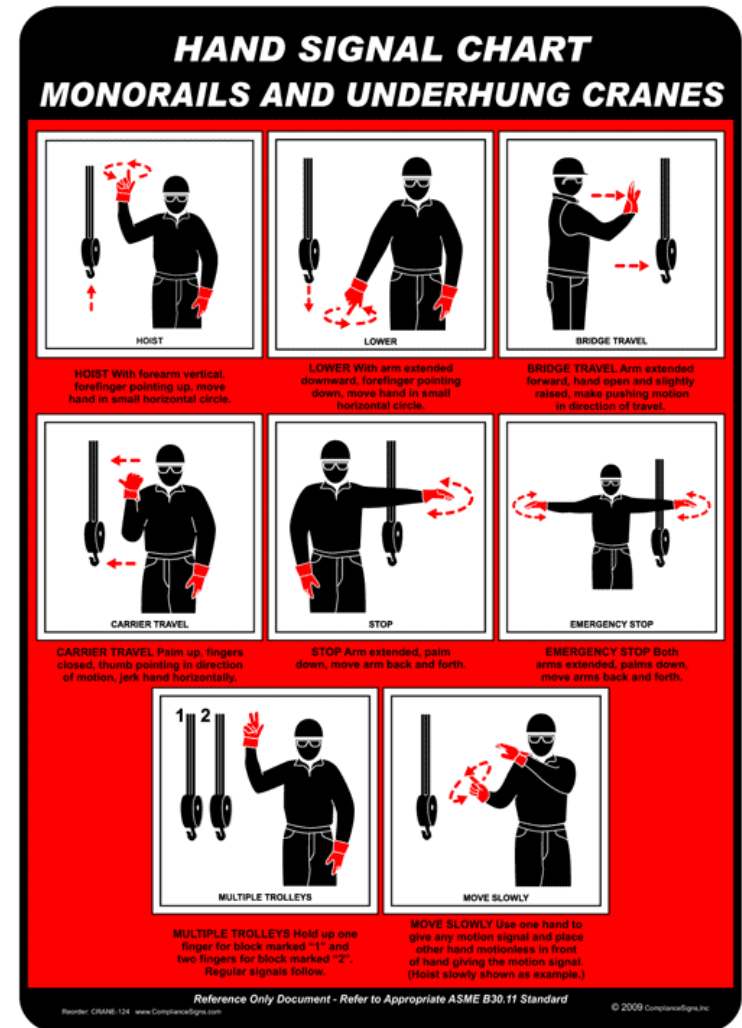
WRONG



Hand signals



- Posters containing complete hand signal information are posted near the overhead bridge cranes
- Complete knowledge of the hand signals is required for operation of the overhead cranes
- Complete knowledge of the hand signals is required for all riggers

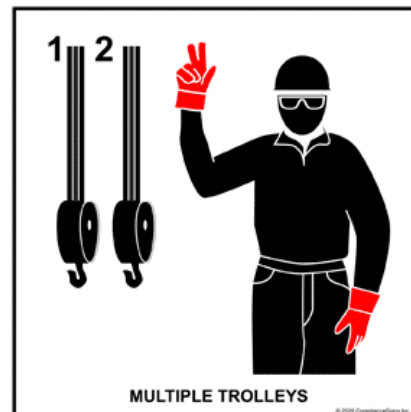
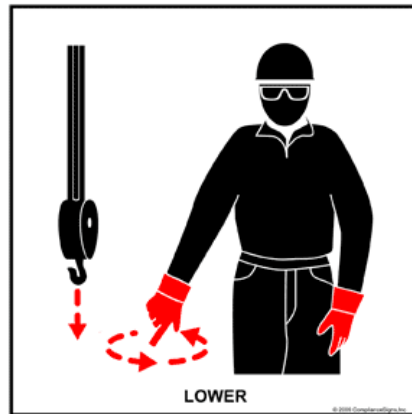


Knowledge of hand signals is required

- Hand signals are not likely to be needed in most spaces because of close proximity and the use of radios
- However, all operators must know all of the listed/posted hand signals
- The hoist operator will only follow hand signals from a designated signalman (usually a rigger)
- Anyone may call for a stop or an emergency stop and it must be obeyed by the hoist operator



Knowledge of these eight hand signals is required



Qualified Advanced Riggers



- **Advanced Riggers are available to support Basic Riggers to ensure safe lifting conditions**
 - **Dan Neyland, Omega XOPS**
 - **Jeff Rodas, EP XOPS**
 - **Mark Romanofsky, ME**
 - **Milt Shoup, ME**

Safety is everyone's business and compliance with safety procedures is **MANDATORY**



- **If an activity or practice seems unsafe, “Stop Work” and take the time to address concerns**
- **Only designated or qualified personnel may attach loads to an overhead hoist**
- **No LLE personnel are qualified or permitted to repair rigging equipment**
- **Only approved/rated rigging gear shall be attached to a load hook**
- **Load ratings shall never be exceeded**
- **It is the riggers responsibility to ensure all components used in a rigging operation meet the required load ratings**
 - **If a rigger is unable to determine a proper rigging configuration contact ME or an Advanced Rigger for support**

Example test questions

- A payload is being lifted using a vertical hitch with the following components; Plain machinery eye bolt (WLL 2600 lb), synthetic sling (vertical WLL 10000 lb), Hoist (1T). What is the maximum payload?



- 1300 lb
 - 2000 lb
 - 2600 lb
 - 10000 lb
 - Not enough information or not safe
- 2000 lb – limited by the hoist

Example test questions

- A payload is being lifted with a sling in basket hitch configuration with the following components; synthetic sling (basket WLL 10000 lb), and Hoist (4T). What is the maximum payload?

- 4000 lb

- 8000 lb


- 10000 lb



- Not enough information or not safe

- Not enough information – What is the sling angle?

Example test questions

- **A payload is being lifted using a 2 leg bridle hitch assembled with the following individual components; Plain machinery eye bolts (WLL 2600 lb), synthetic slings (vertical WLL 1000 lb), Shackles (WLL 4T), and Hoist (5T). What is the maximum payload?**
 - 1000 lb
 - 1300 lb
 - 2600 lb
 - 8000 lb
 - 10000 lb
 -  Not enough information or not safe
- **Not safe – Plain eye bolts can ONLY be used for vertical lifts, no sling angle provided**

Example test questions

- A payload is being lifted using a 2 leg bridle hitch assembled with the following individual components; Plain machinery eye bolts (WLL 2600 lb), synthetic slings (vertical WLL 1000 lb), Shackles (WLL 4T), and Hoist (5T). The sling angle is 30°. What is the maximum payload?
 - 1000 lb
 - 1300 lb
 - 2600 lb
 - 8000 lb
 - 10000 lb
 - Not enough information or not safe
- Not safe – Plain eye bolts can ONLY be used for vertical lifts




Example test questions

- A payload is being lifted using a 2 leg bridle hitch assembled with the following individual components; hoist rings (WLL 5000 lb), synthetic slings (vertical WLL 10000 lb), Shackles (WLL 4T), and Hoist (5T). The sling angle is 30°. What is the maximum payload?



- 2500 lb
 - 5000 lb
 - 7500 lb
 - 8000 lb
 - 10000 lb
 - Not enough information or not safe
-
- Remember that in a 2 leg configuration at 30° the tension in the sling tension is equal to the load

Example test questions

- A payload is being lifted using a 4 leg bridle hitch assembled with the following individual components; hoist rings (WLL 5000 lb), synthetic slings (vertical WLL 10000 lb), Shackles (WLL 4T), and Hoist (5T). The sling angle is 30°. What is the maximum payload?
 - 2500 lb
 -  — 5000 lb
 - 7500 lb
 - 8000 lb
 - 10000 lb
 - Not enough information or not safe
- Remember that with a 4 leg bridle hitch the load must be assumed to be only on 2 legs