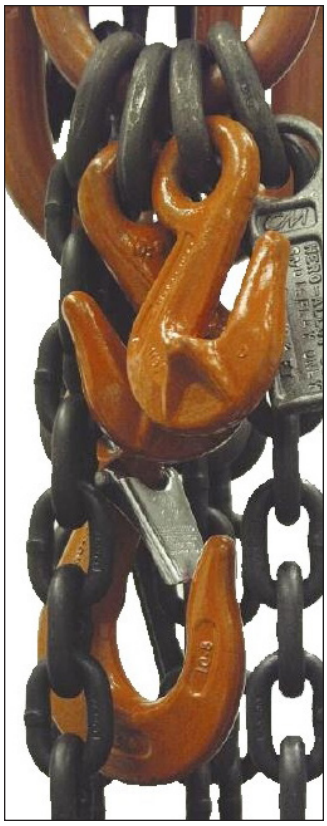


Overview

Chain Slings, Loading Angles and Choking

All chain manufacturers publish working load limits for single-chain slings in straight tension and for multiple-legged slings when used at various angles. For example:

Working Load Limits of CM Herc-Alloy 800 Chain Slings in Pounds

Chain Size	Single Types S or C – 90°	Double Branch Type D					
		60°	45°	30°	60°	45°	30°
	Herc-Alloy 800				Triple Quad		
7/32" (5.5mm)	2,100	3,600	3,000	2,100	5,500	4,400	3,200
9/32" (7.0mm)	3,500	8,100	4,900	3,500	9,100	7,400	5,200
3/8" (10.0mm)	7,100	12,300	10,000	7,100	18,400	15,100	10,600
1/2" (13.0mm)	12,000	20,800	17,000	12,000	31,200	25,500	18,000
5/8" (16.0mm)	18,100	31,300	25,600	18,100	47,000	38,400	27,100
3/4" (20.0mm)	28,300	49,000	40,000	28,300	73,500	60,000	42,400
7/8" (22.0mm)	34,200	59,200	48,400	34,200	88,900	72,500	51,300
1" (26.0mm)	47,700	82,800	67,400	47,700	123,900	101,200	71,500
1-1/4" (32.0mm)	72,300	125,200	102,200	72,300	187,800	153,400	108,400

The diagrams of a 9-ton (18,000 lb.) weight (Figs. 1 and 2) show how a 5/8" dia. Grade 80 Chain Sling is safely rated for both a straight 90° pull and a double-branch sling at 30°.

Fig. 3 shows an arrangement where a single chain sling is wrapped around the workpiece and used in a choke hitch similar to double branch sling. In a tight choke hitch, the branch angles can be too low and the resulting tension load in each leg can exceed the capacity of the chain. The chain used in the choking example is too small for the job and can be overloaded.

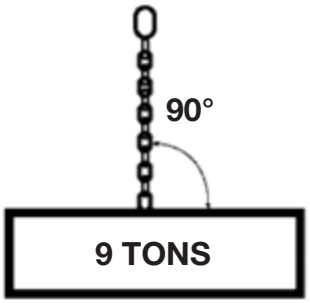


Fig. 1

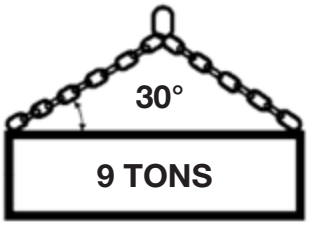


Fig. 2

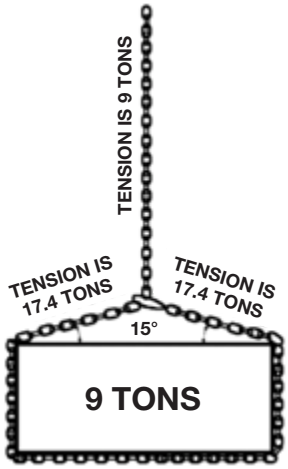
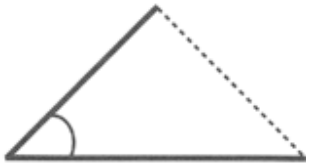


Fig. 3

Variations in Sling Angle Tables

Be sure you understand how a table is referring to the sling angle.

Most chain tables reference the angle the sling leg to the horizontal plane of the load.



Horizontal Angle

Most wire rope tables reference the angle of the sling leg to the vertical plane of the load.

Vertical Angle

Some tables are based on the angle between the two legs of the sling.

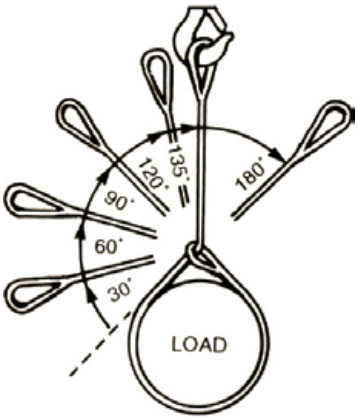
Included Vertical Angle

How Angle of Lift Affects Sling Rated Capacity

Using slings at an angle can become deadly if that angle is not taken into consideration when selecting the sling. The tension on each leg of the sling is increased as the angle of lift, from horizontal, decreases.

It is preferable that a sling have a larger angle of lift, approaching 90°. Lifts with angles of less than 30° from horizontal are not recommended.

If you can measure the angle of lift or the length and height of the sling as rigged, you can determine the properly rated sling for your lift.



Choker Hitch Angle

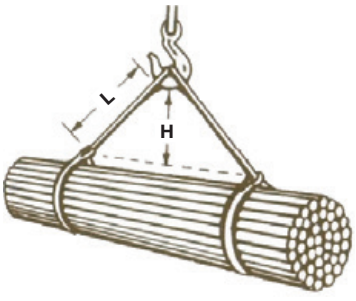
Sling capacity decreases as the choke angle decreases. When lifting and turning a load using a choker hitch, it is not uncommon to bend the body of the sling around the choker loop and have a severe bend occur around the body at this point.

For choker angles of 120° or less, the choker rating must be reduced by multiplying the corresponding factor times the slings standard choker rating.

For example, if you have a pull angle of 90° and a sling with a choker rating of 1,250 lbs., you would need to multiply 1,250 lbs. by the factor of 0.87 (see table at right).

Therefore: 1,250 lbs. x 0.87 = 1,087 lbs. maximum choker capacity.

Angle of Choke	Factor
Over 120°	1.00
90° – 120°	0.87
60° – 89°	0.75
30° – 59°	0.62
0° – 29°	0.49



Calculating Reduced Capacity

What would be the rating of each sling rigged at a known angle?

1. Calculate the Reduction Factor (RF) (see Effect of Angle Table at right).
   a. Using the angle from horizontal, read across the angle chart to the corresponding number of the Reduction Factor column.

   OR

   b. Divide the sling height* (H) by sling length (L)*.
2. Reduction Factor (RF) x the sling's rated capacity for the type hitch that will be used = Sling's Reduced Rating.

*Measured from a common horizontal plane to the hoisting hook.

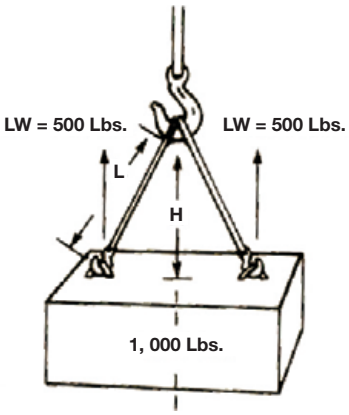
Example:

Vertical Choker Rating of each sling = 6,000 lbs.
Measured Length (L) = 6 ft.
Measured Height (H) = 4 ft.
Reduction Factor (RF) = 4 (H) ÷ 6 (L) = 0.667
Reduced sling rating in this configuration = 0.667 (RF) x 6,000 lbs.
= 4,000 lbs. of lifting capacity per sling

Effect of Angle

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

How Angle of Lift Affects Sling Rated Capacity (cont.)



Increasing Tension

What capacity sling do I need?

1. Determine the weight that the sling will be lifting (LW).
2. Calculate the Tension Factor (TF) using the "Effect of Angle" table on the previous page.
   a. Using the angle from horizontal, read across the angle chart to the corresponding number of the Tension Factor column.

   –OR–

   b. Divide sling length* (L) by sling height (H)*.
3. Lifting Weight (LW) x the Tension Factor (TF) = Minimum Sling Rating for the type of hitch that will be used.

*Measured from a common horizontal plane to the hoisting hook.

Example:

Load weight = 1,000 lbs.
Rigging - 2 slings in vertical hitch
Lifting Weight (LW) per sling = 500 lbs.
Measured Length (L) = 10 ft.
Measured Height (H) = 5 ft.
Tension Factor (TF) = 10 (L) ÷ 5 (H) = 2.0
Minimum Vertical Rated Capacity required for this lift = 500 (LW) x 2.0 (TF) = 1000 lbs. per sling

Types of Hitching

Although it is difficult to list safe practices for all loads, sizes and sling-angle combinations, the following rules of thumb work well as safe guidelines.

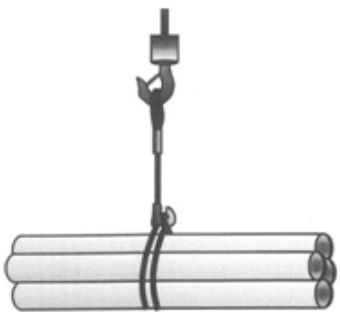
There are basically four common ways to hitch a load. No matter which method is used, always be certain the load is balanced because shifting and rotation can be problematic. If lifting at any angle other than 90°, refer to the tables of load-angle factors to calculate the sling capacity.

Single Vertical Hitch

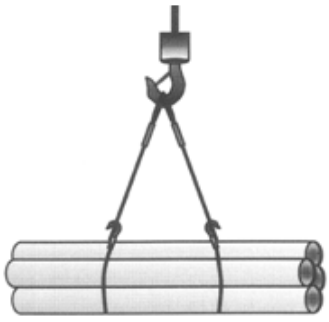
Used primarily when the load has a single attachment point. There is a tendency for the load to rotate so a tag line may be necessary.

Choker Hitch

The sling is wrapped around the load and one end is looped through the other end or attached to a sliding choker hook. The load should be large enough to prevent the sling or fittings from kinking or crimping.



If the load is a loose bundle that may have a tendency to slip, a double-wrapped choker hitch may be used.



When using two choker hitches, the hook openings should face out from the center of the load.

Types of Hitching (cont.)

Single Choker Hitch

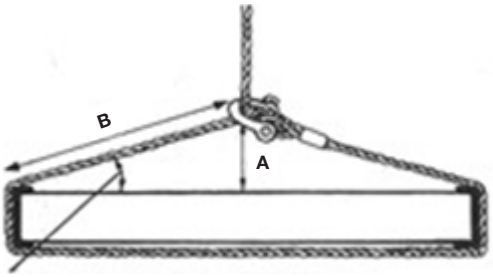
Angle of choke is greater than 45°

The rule of thumb is the capacity of the sling should be reduced by one-quarter less than the safe working load for a single vertical hitch rating.

When this angle is greater than 45°, SWL = SWL (of single vertical hitch) × 3/4

Angle of choke is less than 45°

As the choking angle decreases, the sling capacity decreases. A sling angle of less than 45° is not recommended. However, a reduction factor table, or height to length ratio, must be considered in this formula.

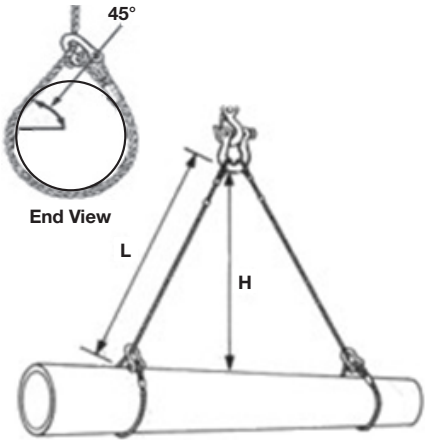


When this angle is less than 45°,
SWL = SWL (of single vertical hitch) × A/B

Double Choker Hitch

Angle of choke is greater than 45°

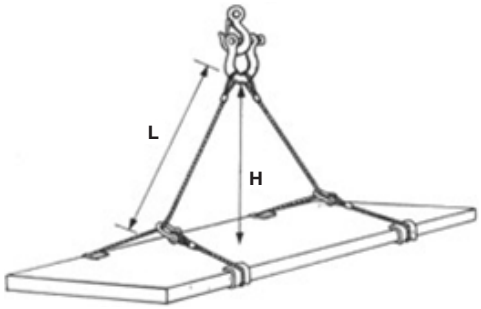
The rule of thumb is the capacity of the sling should be reduced by one-quarter less than the safe working load for a single vertical hitch rating.



SWL = SWL (for vertical hitch) × 3/4 × H/L × 2

Angle of choke is less than 45°

As the choking angle decreases, the sling capacity decreases. A sling angle of less than 45° is not recommended. However, a reduction factor table, or height to length ratio, must be considered in this formula.

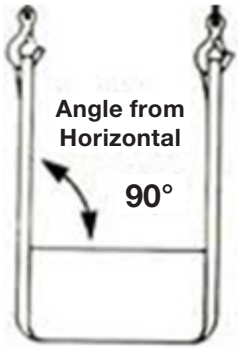


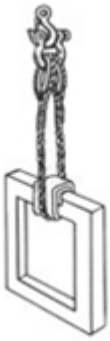
SWL = SWL (for vertical hitch) × A/B × H/L × 2

Types of Hitching (cont.)

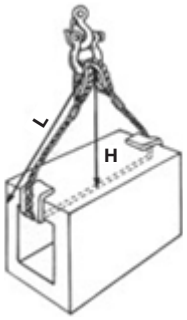
Basket Hitch

Used when loads have an opening for the sling to be passed through and the load is well balanced or not likely to slip. A basket hitch with two vertical legs has double the rated capacity of a single vertical sling. If the two legs form an angle to the load, the sling capacity must be reduced accordingly.





Vertical legs:
SWL = 2× vertical rating



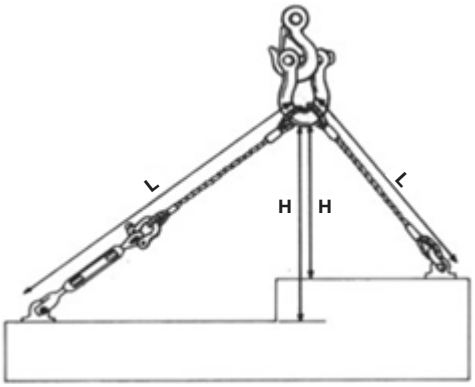
For inclined legs:
SWL = vertical rating × H/L × 2

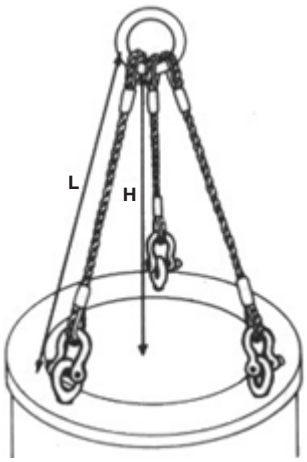
Bridle Hitches

Used when there are two or more attachment points on the load. Whether using a three-leg or four-leg bridle hitch, only two of the legs primarily carry the load. The remaining legs are basically for balance. Measure the length of the sling legs (L) and measure the headroom between the hook and the load (H).

SWL = SWL (of chain) × H/L × 2

This formula is for a two-leg bridle hitch, but it should also be used for the three- and four-leg hitches.





When sling legs are not of equal length, use smallest H/L ratio.

Safety Considerations

Avoid Shock Loading

A falling or jerking load can apply dynamic forces that exceed the static weight being lifted. Falling or jerking loads can result in overload conditions even though the safe working load of the sling is proper.

Extra precaution should always be exercised to position the sling so the slack is taken up slowly to prevent abrupt movement, jerking and shock.

Avoid Pulling the Sling from Under the Load

To avoid excessive wear and potential recoil, it is not good practice to drop the load on the sling or pull the sling out from under a load if the load is resting on the sling.

Protect from Sharp Corners

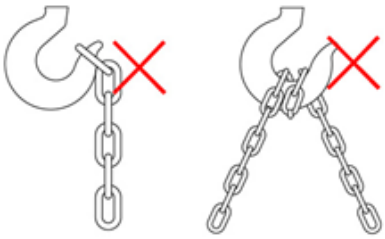
Slings should be padded or protected from the sharp edges of the load.

Do not Shorten by Twisting or Knotting

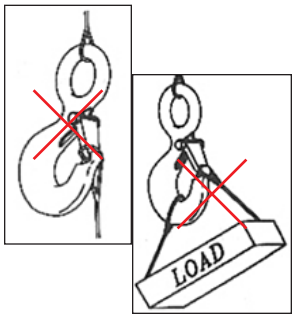
Make sure the sling is not twisted, knotted or kinked before or during the lifting of the load. Slings should not be shortened with knots, bolts, other makeshift devices, or by twisting.

Hooks

Avoid point-loading the hook by ensuring the load is applied to the base or saddle of the hook. Do not apply load to safety-hook latches.



Wrong



Wrong

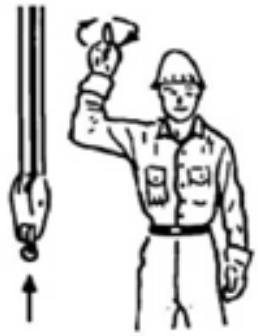
Safety Latches

- Do not use if latch is distorted or bent
- Ensure the spring forces the latch against the tip of the hook
- The latch is intended to facilitate rigging by retaining the sling leg under slack conditions
- Always ensure the bearing against the bottom of the latch

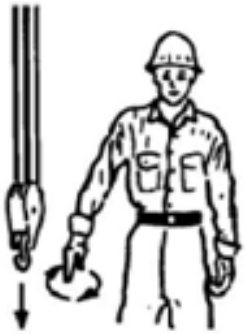
Storage

- Store slings in a cool, dry place and protect them from exposure to moisture and corrosion.
- Store slings on an A-frame rack to keep them off the ground or floor.
- Slings should not be subjected to corrosive media and steel slings should be oiled if stored for long periods of time.
- Do not expose steel chain slings to temperatures of 400°F or higher.

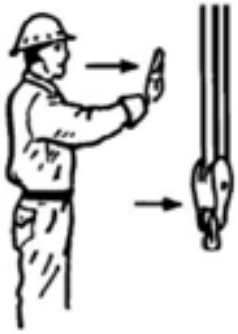
Standard hand signals for controlling overhead crane operation



HOIST With forearm vertical, forefinger pointing up, move hand in small horizontal circles.



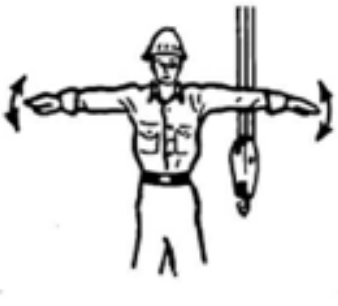
LOWER Extend arm downward, forefinger pointing down, and move hand in small horizontal circles.



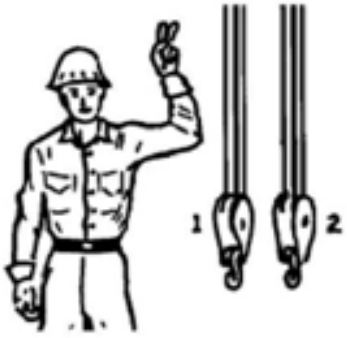
BRIDGE Arm extended forward, hand open and slightly raised, make pushing motion in direction of travel.

TROLLEY TRAVEL Palm up, finger closed, thumb pointing in direction of motion, jerk hand horizontally.

STOP Extend arm, palm down, hold position rigidly.



EMERGENCY STOP Extend arm, palm down, moving hand rapidly right and left.



MULTIPLE TROLLEYS Hold up one finger for block marked "1" and two fingers for block marked "2." Regular signals follow.

MOVE SLOWLY Use one hand to give any motion signal and place other hand motionless above hand giving the motion signal. (Hoist slowly shown as example.)

MAGNET IS DISCONNECTED Crane operator spreads both hands apart, palms up.

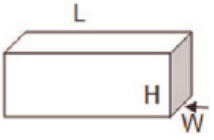
Weights of Common Materials

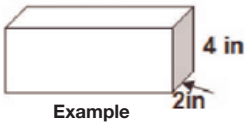
Metal	Weight (lb./ft³)
Aluminum	166
Antimony	418
Bismuth	613
Brass, cast	504
Brass, rolled	523
Copper, cast	550
Copper, rolled	555
Gold, 24K	1,204
Iron, cast	450
Iron, wrought	480
Lead, commercial	712
Mercury, 60°F	846
Silver	655
Steel	490
Tin, cast	458
Uranium	1,163
Zinc	437

Wood	Weight (lb./ft³)
Ash	35
Beech	37
Birch	40
Cedar	22
Cherry	30
Chestnut	26
Cork	15
Cypress	27
Ebony	71
Elm	30
Fir, Balsam	22
Hemlock	31
Maple, Oak	62
Pine, Poplar	30

Other Materials	Weight (lb./ft³)
Bluestone	160
Brick, pressed	50
Brick, common	125
Cement, Portland (packed)	100 – 120
Cement, Portland (loose)	70 – 90
Cement, slag (packed)	80 – 100
Cement, slag (loose)	55 – 75
Chalk	156
Charcoal	15 – 34
Cinder concrete	110
Clay, ordinary	120 – 150
Coal, hard, solid	93.5
Coal, hard, broken	54
Coal, soft, solid	84
Coal, soft, broken	54
Coke, loose	23 – 32
Concrete or stone	140 – 155
Earth, rammed	90 – 100
Granite	165 – 170
Gravel	117 – 125
Lime, quick (ground loose)	53
Limestone	170
Marble	154
Plaster of Paris (cast)	80
Sand	90 – 106
Sandstone	151
Shale	162
Slate	160 – 180
Terracotta	110
Traprock	170
Water	65

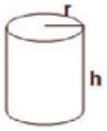
Volume Calculations

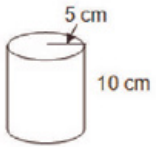




Example

Volume = Length (L) x Width (W) x Height (H)
13" x 2" x 4" = 104 in.³

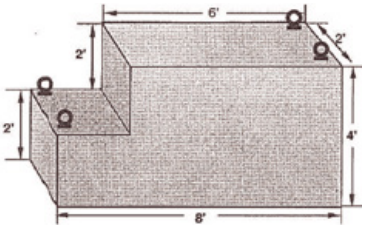




Example

Volume = Area of Base* x Height = πr^2 x H
3.14 x 5cm² x 10 cm = 785cm³
*The base is a circle, so the area of a circle is πr^2

Example: Calculate the Weight of this Concrete Block



8' x 2' x 2' = 32 ft.³
6' x 2' x 2' = 24 ft.³
32 ft.³ + 24 ft.³ = 56 ft.³
Concrete weighs 150 lb./ft.³ (from table above)
Therefore
56 x 150 = 8,400 lbs.