Reference Material - Provisional & Limit Scope Crane Operator On-Line Exam

Contents:

- Common Rigging Equipment
- Common Rigging Hitches
- Rigging Slings Capacity Charts
- Sling Tension Formula
- Gross & Net Crane Capacity
- Tables & Formulas for Determining Load Weight
- Centre of Gravity Estimates and Calculations
- Tag Lines

May 2025

This document is designed to provide a reference for the content covered in the 15 sections of the on-line exam for Provisional and Limited Scope Crane Operators that is not contained in these publicly available resources:

WorkSafe BC - Occupational Health and Safety Regulations

Suspended Work Platform OHS Regulations & Standards

OHS Regulations Part 14: Cranes & Hoists

OHS Guideline 14: Cranes & Hoists

OHS Regulations Part 15: Rigging

OHS Regulations Part 19: Electrical Safety

WorkSafe BC Guide: Working Safely Around Electricity

WorkSafe BC Hand Signals for Cranes and Hoists

BC Crane Safety Association

BC Crane Safety Glossary of Crane & Rigging Terms

COMMON RIGGING EQUIPMENT

Hooks

Grab Hooks

Masterlink

Shackle

Swivel Host Ring

Eye Bolts (non-shouldered & shouldered)

Turnbuckle

Connecting Link

Plate Clamp

Spreader Bar

Chain Sling

Wire Rope Sling

Synthetic Web Sling

Round Sling

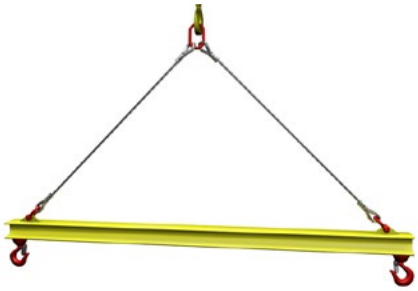
Metal Mesh Sling

Softeners

Common Rigging Hitches

Single Vertical Hitch

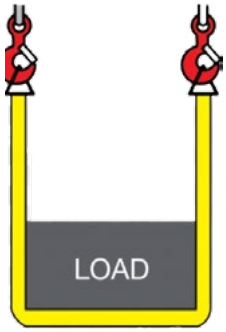
Double Wrap Basket Hitch



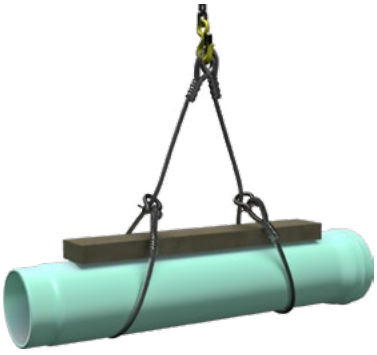
Bridle Hitch - 2 Leg

Single Choker Hitch

Single Basket Hitch
(Inclined legs)



Single Basket Hitch
(vertical legs)



Double Choker Hitch

Double Basket Hitch

Double Wrap Choker Hitch

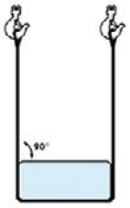
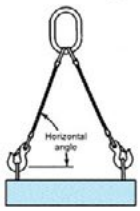
RIGGING SLINGS CAPACITY CHARTS

- Chain Slings
- Wire Rope Slings
- Nylon Web Slings

CHAIN SLINGS

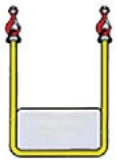
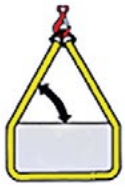
CHAIN SLINGS	**Grade 80 (8) Alloy Steel**					
Chain Size (inches)	**Working Load Limit (in pounds)**					
	Vertical Hitch 	Choker Hitch 	Basket Hitch (vertical legs) 	2-Leg Bridle Hitch & Basket Hitch with Legs Inclined  		
				60°	**45°**	**30°**
9/32	3,500	2,800	7,000	6,100	4,900	3,500
3/8	7,100	5,680	14,200	12,300	10,000	7,100
1/2	12,000	9,600	24,000	20,800	17,000	12,000
5/8	18,100	14,480	36,200	31,300	25,600	18,100
3/4	28,300	22,640	56,600	49,000	40,000	28,300
7/8	34,200	27,360	68,400	59,200	48,400	34,200
1	47,700	38,160	95,400	82,600	67,400	47,700
1 1/4	72,300	57,840	144,600	125,200	102,200	72,300
				When using **2-leg bridle with choker hitch**, multiply above values by .75 When using a **double basket hitch**, multiply the above values by 2.		

WIRE ROPE SLINGS

WIRE ROPE SLINGS 6x19 Improved Plow Steel, IWRC						
Wire Rope Diameter (inches)	**Working Load Limit (in pounds)**					
	Single Vertical Hitch 	Single Choker Hitch 	Basket Hitch (vertical legs) 	2-Leg Bridle Hitch & Basket Hitch with Legs Inclined  		
				60°	**45°**	**30°**
3/16	650	480	1,300	1,100	900	650
1/4	1,150	860	2,300	2,000	1,600	1,150
5/16	1,750	1,300	3,500	3,000	2,500	1,750
3/8	2,550	1,900	5,100	4,400	3,600	2,550
7/16	3,450	2,600	6,900	6,000	4,900	3,450
1/2	4,700	3,500	9,400	8,150	6,650	4,700
9/16	5,700	4,200	11,400	9,900	8,050	5,700
5/8	7,100	5,300	14,200	12,300	10,000	7,100
3/4	10,200	7,650	20,400	17,700	14,400	10,200
7/8	13,750	10,300	27,500	23,800	19,400	13,750
1	17,950	13,450	35,900	31,100	25,400	17,950
1 1/8	22,750	17,000	45,500	39,400	32,200	22,750
1 1/4	28,200	21,200	56,400	48,800	39,900	28,200
1 3/8	34,800	26,100	69,600	60,300	49,200	34,800
1 1/2	41,300	31,000	82,600	71,500	58,400	41,300
				When using **2-leg bridle with choker hitch**, multiply above values by .75 When using a **double basket hitch**, multiply the above values by 2.		

NYLON WEB SLINGS

NYLON WEB SLINGS single ply

Web	Working Load Limit (in pounds)					
	Single 	Single Choker Hitch 	Basket Hitch (vertical legs) 	2-Leg Bridle Hitch & Single Basket Hitch with Legs Inclined  		
				60°	**45°**	**30°**
1	1,200	960	2,400	2,000	1,700	1,200
2	2,400	1,900	4,800	4,100	3,400	2,400
3	3,600	2,900	7,200	6,200	5,100	3,600
4	4,800	3,800	9,600	8,300	6,800	4,800
5	6,000	4,800	12,000	10,400	8,500	6,000
6	7,200	5,700	14,400	12,500	10,200	7,200

When using **2-leg bridle with choker hitch**, multiply above values by .75

When using a **double basket hitch**, multiply the above values by 2.

Example rigging situation - 2 Leg Bridle Choked

Load: 10,000 lb. beam

Rigging: Chain sling, 2-leg bridle hitch choked at a 50° sling angle

What size chain sling is required?

Step 1:

Locate hitch configuration (2 leg bridle hitch) at 50° - next lowest column is 45°

Note that it is choked and a capacity reduction needs to be made by multiplying the values by .75.

Step 2:

Multiply the values by .75 and read down to find a value greater than 10,000 lbs

Step 3:

Read across from the weight to the associated chain size (1/2" chain).

Answer:

Minimum sized chain sling required is 1/2"

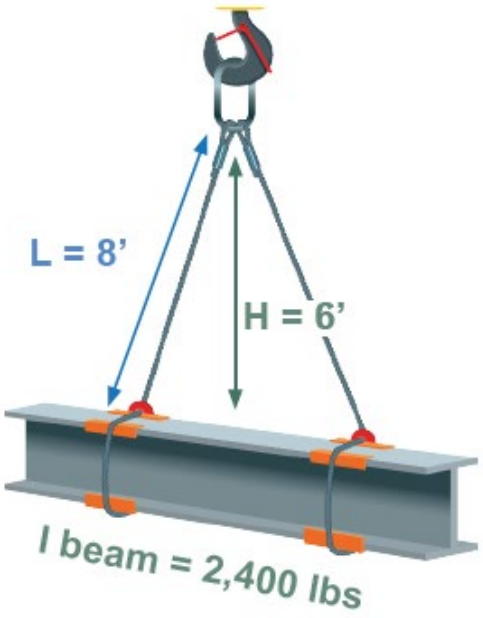
CHAIN SLINGS	**Grade 80 (8) Alloy Steel**					
Chain Size (inches)	**Working Load Limit (in pounds)**					
	Vertical Hitch 	Choker Hitch 	Basket Hitch (vertical legs) 	2-Leg Bridle Hitch & Basket Hitch with Legs Inclined  		
				60°	**45°**	**30°**
9/32	3,500	2,800	7,000	6,100	4,900	3,500
3/8	7,100	5,680	14,200	12,300	10,000/7,500	7,100
1/2	12,000	9,600	24,000	20,800	17,000/12,750	12,000
5/8	18,100	14,480	36,200	31,300	25,600	18,100
3/4	28,300	22,640	56,600	49,000	40,000	28,300
7/8	34,200	27,360	68,400	59,200	48,400	34,200
1	47,700	38,160	95,400	82,600	67,400	47,700
1 1/4	72,300	57,840	144,600	125,200	102,200	72,300
				When using **2-leg bridle with choker hitch**, multiply above values by .75 When using a **double basket hitch**, multiply the above values by 2.		
Note: Use only alloy steel chain grades 8 (80) or 10 (100).						

HOW TO CALCULATE SLING TENSION (Symmetrical rigging)

Sling tension = (Load weight ÷ Number of slings) x (Sling **L**ength ÷ **H**eight to the hook)

Example 1: Lifting 2,400 lb Beam

- 2-leg choker hitch
- 3/8" 6x19, IPS, IWRC wire rope slings



Step 1: Load weight ÷ number of slings

2,400 lbs ÷ 2 slings = 1,200 lbs per sling

Step 2: Length of sling ÷ Height to hook

8' ÷ 6' = 1.33

Step 3: Sling tension = 1,200 x 1.3 = 1,596 lbs

CRANE CAPACITY - GROSS & NET

Load Charts give the GROSS Lifting Capacity of the crane for a specific configuration

NET Load Capacity = GROSS Load Capacity – Weight of Non-Load Items

Non-Load Items include the weight of items such as:

- Hook block
- Hook ball
- Jib
- Rigging

TABLES & FORMULAS TO ESTIMATE LOAD WEIGHTS

Weights of Common Materials

Aluminum	171 lb / cubic foot
Brick (common red)	120 lb / cubic foot
Cast Iron	450 lb / cubic foot
Concrete	150 lb / cubic foot
Glass	170 lb / cubic foot
Gravel (loose/dry)	95 lb / cubic foot
Gypsum board / Drywall	
3/8 inch	1.56 lb / square foot
1/2 inch	2.08 lb / square foot
5/8 inch	2.6 lb / square foot
Lumber (Douglas fir)	**35 lb / cubic foot**
2X4	1.28 lb / linear foot
2X6	2.00 lb / linear foot
2X8	2.64 lb / linear foot
2X10	3.37 lb / linear foot
2X12	4.10 lb / linear foot
4X4	2.98 lb / linear foot
6X6	7.35 lb / linear foot

6X8	10.03 lb / linear foot
Plywood	
1/4 inch	0.71 lb / square foot
3/8 inch	1.06 lb / square foot
1/2 inch	1.42 lb / square foot
5/8 inch	1.77 lb / square foot
3/4 inch	2.13 lb / square foot
Rebar	
10M	.53 lb / linear foot
15M	1.06 lb / linear foot
20M	1.58 lb / linear foot
Roofing	
Asphalt Shingles	3.0 lb / square foot
Aluminum 26 gauge	0.3 lb / square foot
Sand (Dry)	100 lb / cubic foot
Sand (Wet)	120 lb / cubic foot
Steel	490 lb / cubic foot
Water	63 lb / cubic foot

Weight of Concrete Pipe

Pipe Size	Metric Equivalent	Wall Thickness	Weight
15"	375mm	2.25"	140 lb / foot
18"	450mm	2.5"	180 lb / foot
24"	600mm	3"	286 lb / foot
30"	750mm	3.5"	402 lb / foot
36"	900mm	4.75"	654 lb / foot

Pipe Size	Metric Equivalent	Wall Thickness	Weight
42"	1,050mm	5.25"	810 lb / foot
48"	1,200mm	5.75"	1,010 lb / foot
54"	1,350mm	6.25"	1,208 lb / foot
60"	1,500mm	6.75"	1,475 lb / foot
72"	1,800mm	7"	1,810 lb / foot

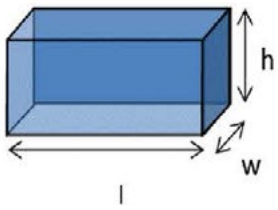
Weight of Steel Pipe - pounds per foot

Outside Diameter OD (in)	Wall Thickness (in)													
	0.050	0.095	0.150	0.200	0.250	0.300	0.360	0.400	0.460	0.500	0.625	0.750	0.875	1.000
1/2	0.2403	0.4109	0.5607											
3/4	0.3738	0.6646	0.9612	1.175	1.335									
1	0.5073	0.9182	1.362	1.709	2.003	2.243	2.461							
1 1/4	0.6408	1.172	1.762	2.243	2.670	3.044	3.422	3.631						
1 1/2	0.7743	1.426	2.163	2.777	3.338	3.845	4.383	4.699	5.109	5.340				
2	1.041	1.933	2.964	3.845	4.673	5.447	6.305	6.835	7.566	8.010	9.178	10.01		
2 1/2	1.308	2.440	3.765	4.913	6.008	7.049	8.228	8.971	10.02	10.68	12.52	14.02	15.19	
3	1.575	2.947	4.566	5.981	7.343	8.651	10.15	11.11	12.48	13.35	15.85	18.02	19.86	21.36
4	2.109	3.962	6.168	8.117	10.01	11.85	14.00	15.38	17.39	18.69	22.53	26.03	29.20	32.04
5	2.643	4.977	7.770	10.25	12.68	15.06	17.84	19.65	22.30	24.03	29.20	34.04	38.55	42.72
6		5.991	9.372	12.39	15.35	18.26	21.68	23.92	27.22	29.37	35.88	42.05	47.89	53.40
8				16.66	20.69	24.67	29.37	32.47	37.04	40.05	49.23	58.07	66.58	74.76
10					26.03	31.08	37.06	41.01	46.87	50.73	62.58	74.09	85.27	96.12

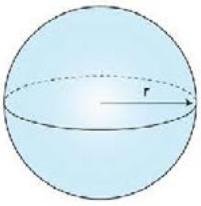
Volume & Area Formulas

Volume Formulas

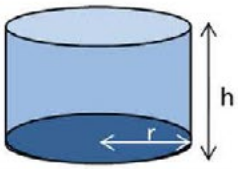
$V = h \times w \times l$



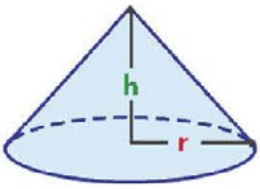
$V = 4.2 \times r^3$



$V = 3.14 \times r^2 \times h$

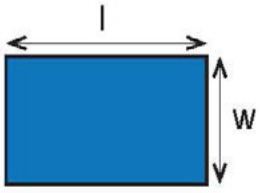


$V = 1/3\ (3.14 \times r^2) \times h$

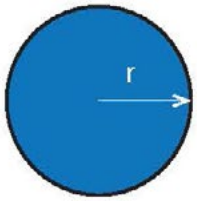


Area Formulas

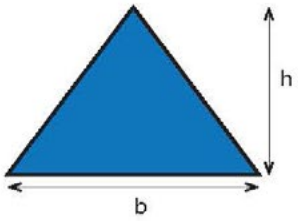
$A = w \times l$



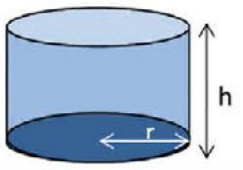
$A = 3.14 \times r^2$



$A = 1/2b \times h$



$A = 6.28 \times r^2 + (6.28 \times r \times h)$

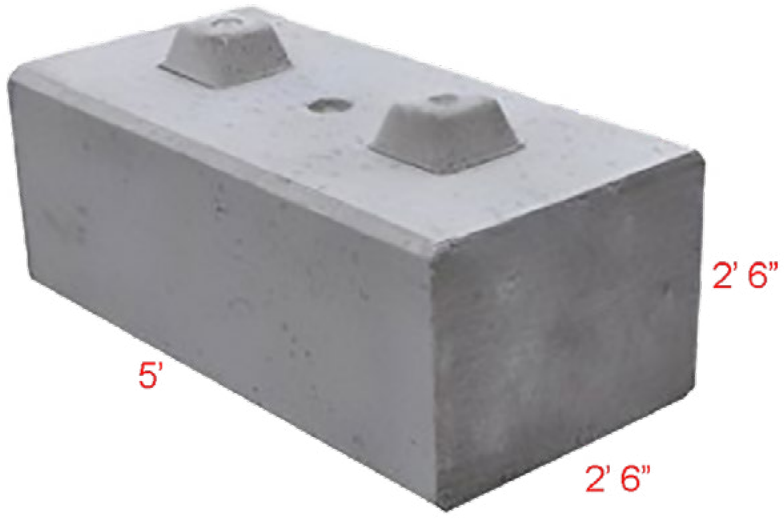


Example: Determine Weight of Concrete Lock Block

This concrete lock block is 5' long, 2' 6" tall and 2' 6" wide.

By consulting the table for weights of common materials we know that concrete weighs:

150 lbs per cubic foot.



To calculate how many cubic feet are in the lock block, we first need to convert all the measurements to feet, ie. **2' 6" = 2.5'**

Formula for volume of a rectangular solid is: Length X Width X Height

So the lock block volume is: 5' X 2.5' X 2.5' = 31.25 cubic feet

And the weight is: 31.25 cubic feet X 150 lb = 4,687.5 lbs

Aluminum	171 lb / cubic foot
Brick (common red)	120 lb / cubic foot
Cast Iron	450 lb / cubic foot
Concrete	150 lb / cubic foot
Glass	170 lb / cubic foot
Gravel (loose/dry)	95 lb / cubic foot
Gypsum board / Drywall	
3/8 inch	1.56 lb / square foot
1/2 inch	2.08 lb / square foot
5/8 inch	2.6 lb / square foot
Lumber (Douglas fir)	**35 lb / cubic foot**
2X4	1.28 lb / linear foot
2X6	2.00 lb / linear foot
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4X4	2.98 lb / linear foot
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Asphalt Shingles	3.0 lb / square foot
Aluminum 26 gauge	0.3 lb / square foot
Sand (Dry)	100 lb / cubic foot
Sand (Wet)	120 lb / cubic foot
Steel	490 lb / cubic foot
Water	63 lb / cubic foot

Centre of Gravity (COG)

It is important to know where the centre of gravity (COG) of a load is because this is where the load is perfectly balanced.

When a load is suspended, the centre of gravity will move directly beneath the hook. If the load's COG isn't under the hook at the beginning of the lift, it will move there during the lift.

How to Estimate the Centre of Gravity

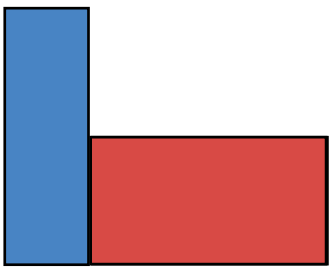
Estimating the COG of regularly shaped uniform loads such as rectangular solids, cubes and spheres is easily done by measuring into the centre of the object from all sides.

It is trickier to estimate the COG of irregularly shaped objects but, the three step process below can help you make a good guess. Once you make your COG estimate, rig the load with your hook over the COG and make a controlled test lift just off the ground to check if your estimate is good and the load is balanced.

Load with unknown COG

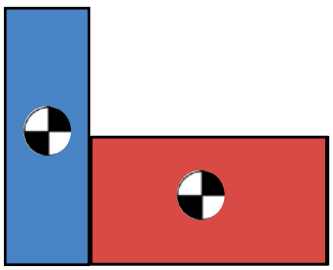
Step 1

Divide the object into regular shapes (rectangles, circles, triangles)



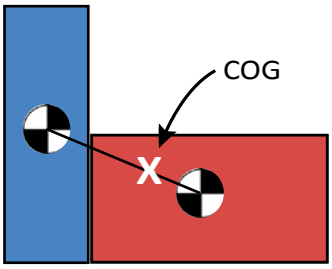
Step 2

Mark the COG in the regular shapes (which is in the centre of the shape)

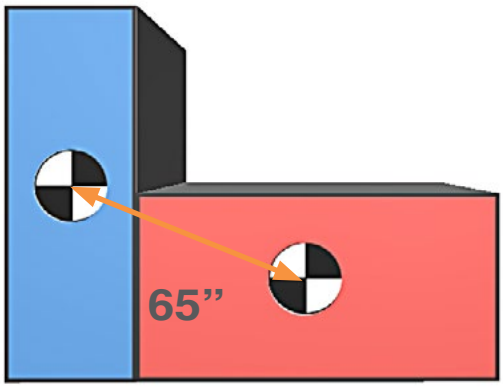


Step 3

Draw a line between the two COGs. The combined COG will be along the line, closer to the bigger object



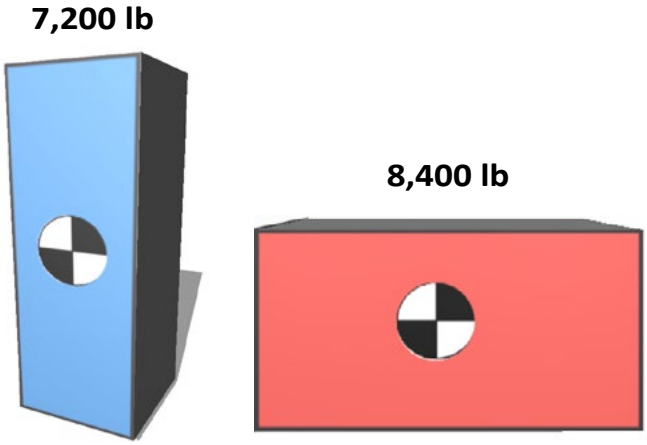
How to Calculate the Centre of Gravity



Measure the regular shaped parts to locate the COGs. Measure the distance between the two COGs.

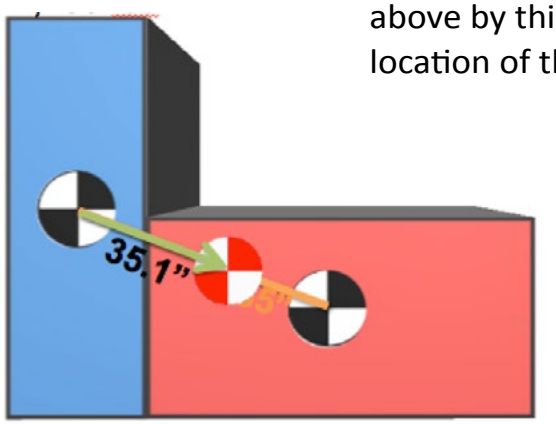
Distance: 5’5” or 65 inches

Add the weights of the two parts and determine the ratio of the larger part’s weight (the red box) to the total.



Add weights: **7,200 lb (blue box) + 8,400 lb (red box) = 15,600 lb total**

Ratio of larger piece to total: **8,400 lb ÷ 15,600 lb = 0.54**



Multiply the distance between the COG’s above by this ratio. The answer is the location of the combined COG along the line.

Combined COG:

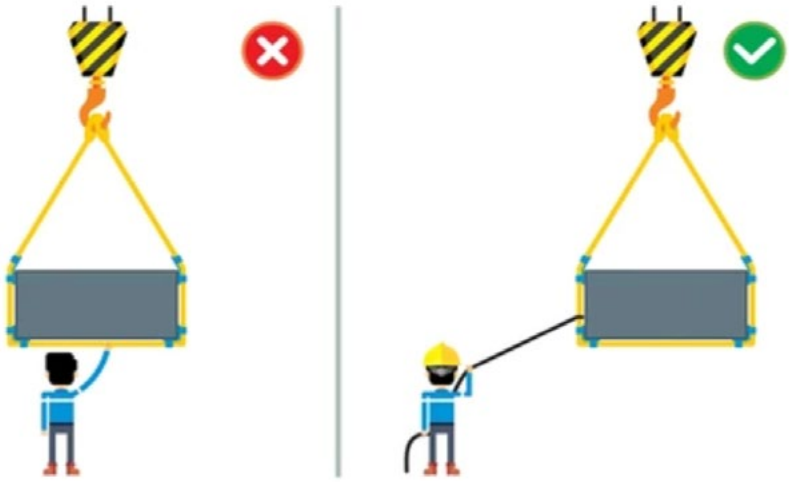
Ratio of red box to total weight times distance between the COGs:
0.54 x 65 inches = **35.1 inches** along the line towards the larger red part of the load.

Tag Lines

Tag lines are used to control the load while allowing personnel to remain a safe distance away. Tag lines should be tied to the load using a rope that is large enough to not break and long enough to keep personnel a safe distance away. A general rule is to stand back from the load at a distance at least as long as the height the load is being hoisted, e.g. load is being hoisted 10', then personnel should be at least 10' away from the area beneath the load.

It is a good idea to add extra tag line length for unexpected events such as wind or failure of any equipment. Tag lines should be clean and free of debris such as splinters and metal shavings that can penetrate gloves. Tag lines should also be clean and free of sand and mud that can loosen into the eyes of the person tending the line as the rope runs through his hands. Avoid using any tag line that is wet as it may conduct electricity.

When tending tag lines you should wear gloves to avoid rope burns. Never loop the line around your hand, arm, or body as this can cause you to be dragged along with the load. Also make sure that your travel path for walking with the load is clear and safe before the load is suspended to avoid a tripping injury as you focus on the load. You should never place yourself between an immovable object and a load. If the movement of the load is placing you in a dangerous position, you should release the tag line to avoid becoming trapped or pinched.



Two tag lines offer greater control for rotating the load. Wherever possible it is best to attach tag lines directly to the load versus to the rigging.