CRANE SAFETY OPERATION

1. Risk
2. Inspection
3. Hydraulic
4. Outrigger
5. Steel rope
6. Operation
7. Tandem lift
8. Lifting Calculation
9. Crane Selection
10. Rigging

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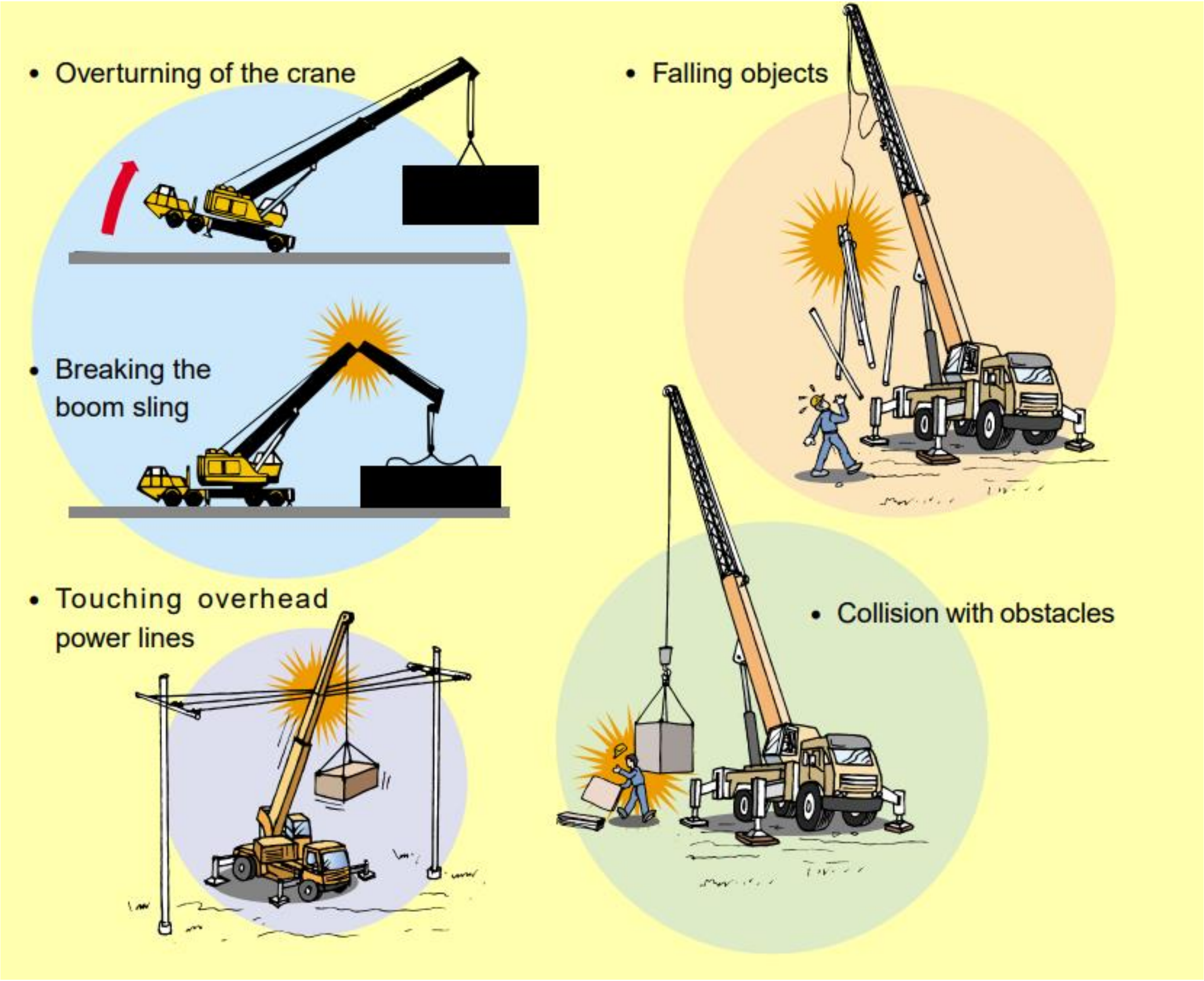
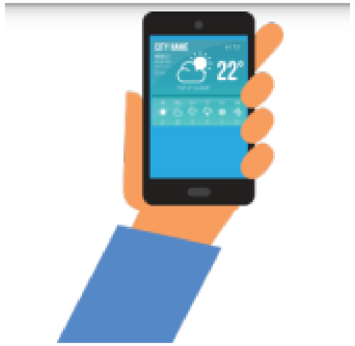
Crane – Risk



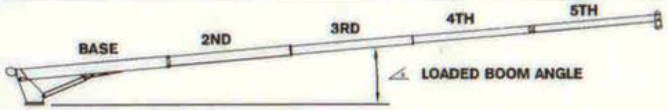
operate crane in adverse weather conditions



Load Chart- Function

- Crane must have its own Load chart for reference

BOOM LOAD CAPACITIES IN LBS. WITH FULL SPAN OUTRIGGERS (24 FT)

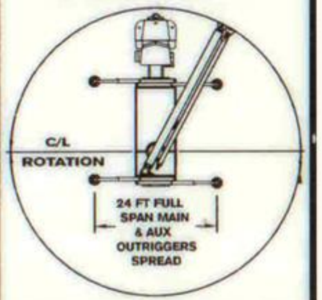


LOAD RADIUS (FT)	31 FT BOOM		51 FT BOOM		70 FT BOOM		89 FT BOOM		108 FT BOOM		127 FT BOOM	
	∠	LBS	∠	LBS	∠	LBS	∠	LBS	∠	LBS	∠	LBS
6	73	70000										
8	69	60700										
10	65	52300	76	35000								
12	60	46100	74	33000								
15	56	38000	70	31000	76	30000						
20	45	28000	64	24500	72	23000	77	17000				
25	28	21000	57	19500	68	19000	73	16500	77	14000		
30			50	16000	63	14500	70	14000	75	12000	77	8400
35			42	13200	58	12700	66	11000	72	10000	75	7900
40			33	10600	53	10200	62	9100	69	8500	73	7400
45			20	8500	47	8850	59	7500	66	7100	71	6800
50					41	7500	55	6700	63	6100	69	6000
55					34	6200	51	6200	60	5100	66	5100
60					26	5100	47	5300	56	4650	63	4500
65					14	4100	43	4400	53	4300	60	3850
70							37	3500	49	3600	58	3300
75							30	2850	46	3000	55	2850
80							23	2250	41	2400	52	2450
85							9	1750	37	1900	49	2000
90									32	1450	46	1600
95									26	1050	42	1150
100									22	750	37	750
0° BOOM CAPACITIES	0	15500	0	6000	0	2700	0	1350	SEE NOTE 9			
STOWED JIB LOAD DEDUCTIONS		500		350		250		200		150		150

NOTE: RATINGS ABOVE THE HEAVY LINE ARE BASED ON STRUCTURAL COMPETENCE AND NOT ON MACHINE STABILITY

AREA OF OPERATION

360° CAPACITY WORKING AREA WITH FULL SPAN AND FRONT BUMPER OUTRIGGERS



DEDUCTIONS FROM RATED LOADS FOR HANDLING DEVICES

OVERHAUL BALL: 230 LBS

1-SHEAVE LOADBLOCK: 360 LBS

2-SHEAVE LOADBLOCK: 500 LBS

3-SHEAVE LOADBLOCK: 600 LBS

JIB LOAD CAPACITIES (LBS) FOR ALL BOOM LENGTHS
JIB CAPACITIES FOR FULL SPAN OUTRIGGERS (24 FT)

LOADED BOOM ANGLE	50° *	55°	60°	65°	70°	75°	80°
1 STAGE 31 FT JIB	700	1250	1900	2600	3100	3400	3900

* DO NOT OPERATE JIB BELOW THIS ANGLE UNLESS BOOM IS FULLY RETRACTED. SEE NOTE 6.

791-00632 E (SHEET 1)

TYPICAL MAIN BOOM LIFTING CAPACITY RATING CHART

OUTRIGGERS FULLY EXTENDED WITH FRONT JACK (360° FULL RANGE)
OUTRIGGERS FULLY EXTENDED WITH FRONT JACK (OVER SIDE & OVER REAR)

Structural Area

Stability Area

WORKING RADIUS (m)	10.5m BOOM	14.2m BOOM	18.0m BOOM	21.7m BOOM	25.6m BOOM	29.2m BOOM	33.0m BOOM
2.5	25.00	20.00	16.00	[illegible]			
3.0	25.00	20.00	16.00	[illegible]			
3.5	25.00	20.00	16.00	12.00			
4.0	22.90	20.00	16.00	12.00	11.50		
4.5	21.00	20.00	[illegible]	12.00	11.50		
5.0	19.40	18.40	16.00	[illegible]	11.50	9.00	
6.0	16.20	15.30	13.73	12.00	11.50	9.00	
7.0	13.70	12.65	11.95	11.00	10.00	9.00	7.00
8.0	11.43	10.56	10.39	10.20	8.90	8.20	7.00
8.8	9.40	9.18	9.07	9.40	8.25	7.60	6.40
9.0		8.88	8.67	9.10	8.05	7.45	6.25
10.0		7.20	7.04	7.58	7.30	6.75	5.70
12.0		4.87	4.76	5.29	5.61	5.65	4.80
12.5		4.41	4.35	4.83	5.16	5.32	4.55
13.0			3.99	4.43	4.80	4.92	4.45
14.0			3.33	3.82	4.09	4.31	4.10
16.0			[illegible]	[illegible]	3.02	3.29	3.35
16.3			[illegible]	[illegible]	2.92	3.19	3.25
18.0				2.09	2.31	2.53	2.64
20.0				1.48	1.70	1.92	2.03
22.0					1.24	1.41	1.52
23.8					0.94	1.06	1.22
26.0						0.75	0.86
27.5						0.50	0.71
29.0							0.46
31.3							0.25
STANDARD HOOK	for 25 tonne						
HOOK WT.	280 kgs						
PARTS OF LINE	8			4			
CRITICAL BOOM ANGLE	–	–	–	–	–	–	–

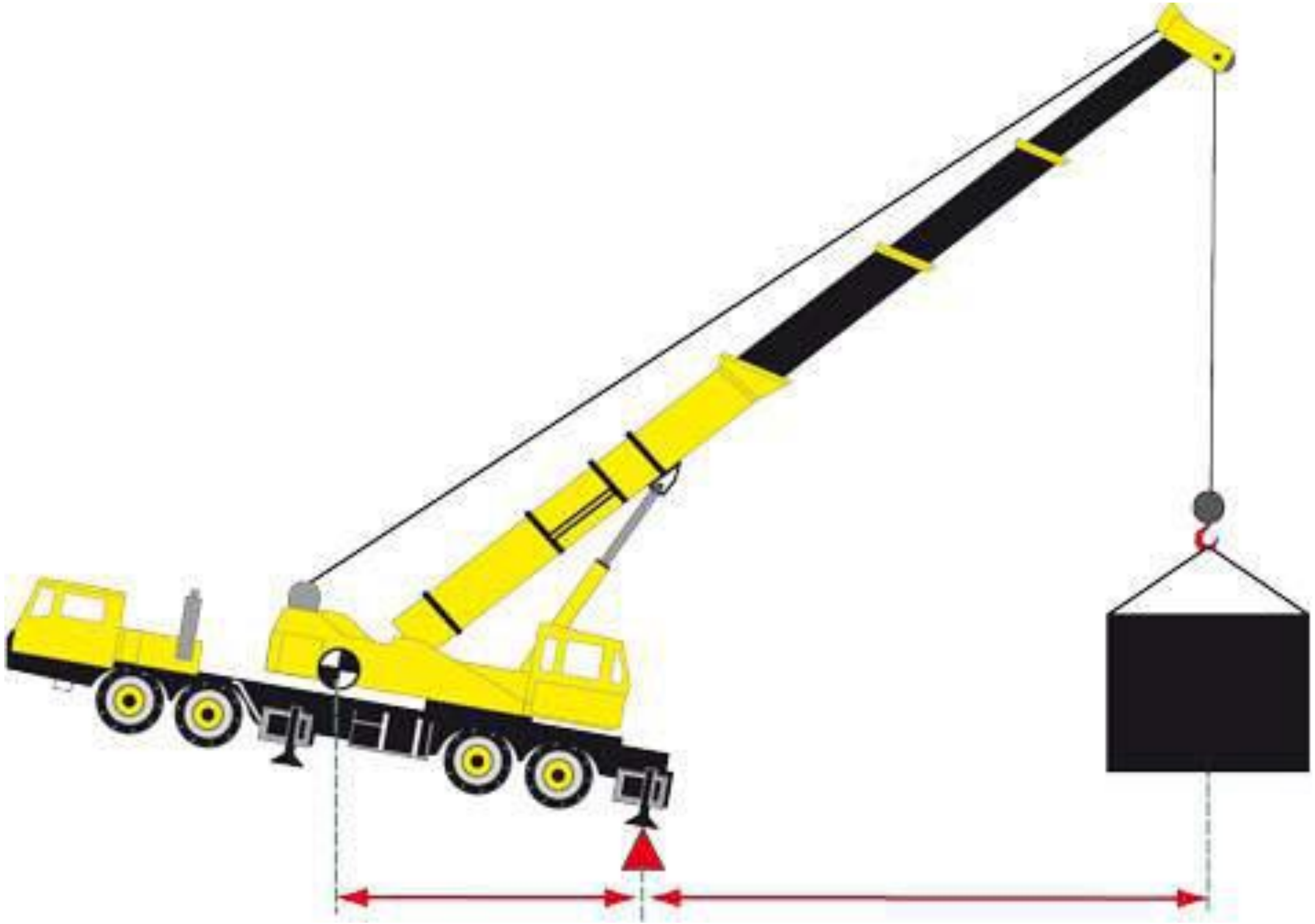
Load Chart- Information

1. Radius working
2. Length boom
3. Gross Weight or Net Weight
4. Number of lines
5. Counter weight

ALL LOADS IN lb x 1000

MAIN BOOM with TRACKS FULLY EXTENDED - 360° UP to 1.5° SLOPE								
17,400 lb COUNTERWEIGHT								
Radius (ft)	MAIN BOOM LENGTH (ft)							Radius (ft)
	36.1	49.0	62.0	75.0	87.9	100.9	113.8	
10	101.4	97.1	82.1	55.1				10
12	91.4	87.3	75.0	40.0	40.0			12
15	78.9	74.0	66.1	40.0	36.5	36.5		15
20	50.1	47.1	44.8	40.0	36.4	34.6	29.7	20
25	35.5	35.7	35.5	32.1	32.3	31.7	25.9	25
30		27.2	27.2	27.1	24.5	24.6	23.0	30
35		21.5	21.6	21.7	19.4	19.5	19.5	35
40		17.7	17.8	17.9	15.7	16.8	16.0	40
45			14.9	15.0	13.8	14.1	13.2	45
50			12.7	12.8	12.5	11.9	11.1	50
55				11.0	11.1	10.2	9.3	55
60				9.6	9.7	8.7	7.8	60
65				8.4	8.5	7.4	6.5	65
70					7.4	6.3	5.5	70
75					6.5	5.4	4.6	75
80					5.8	4.7	3.8	80
85						4.0	3.1	85
90						3.4	2.5	90
95							2.0	95
100							1.5	100
105							*	105
Parts of Line	12	10	8	6	4	4	4	Parts of Line

Load Chart- Crane Topple



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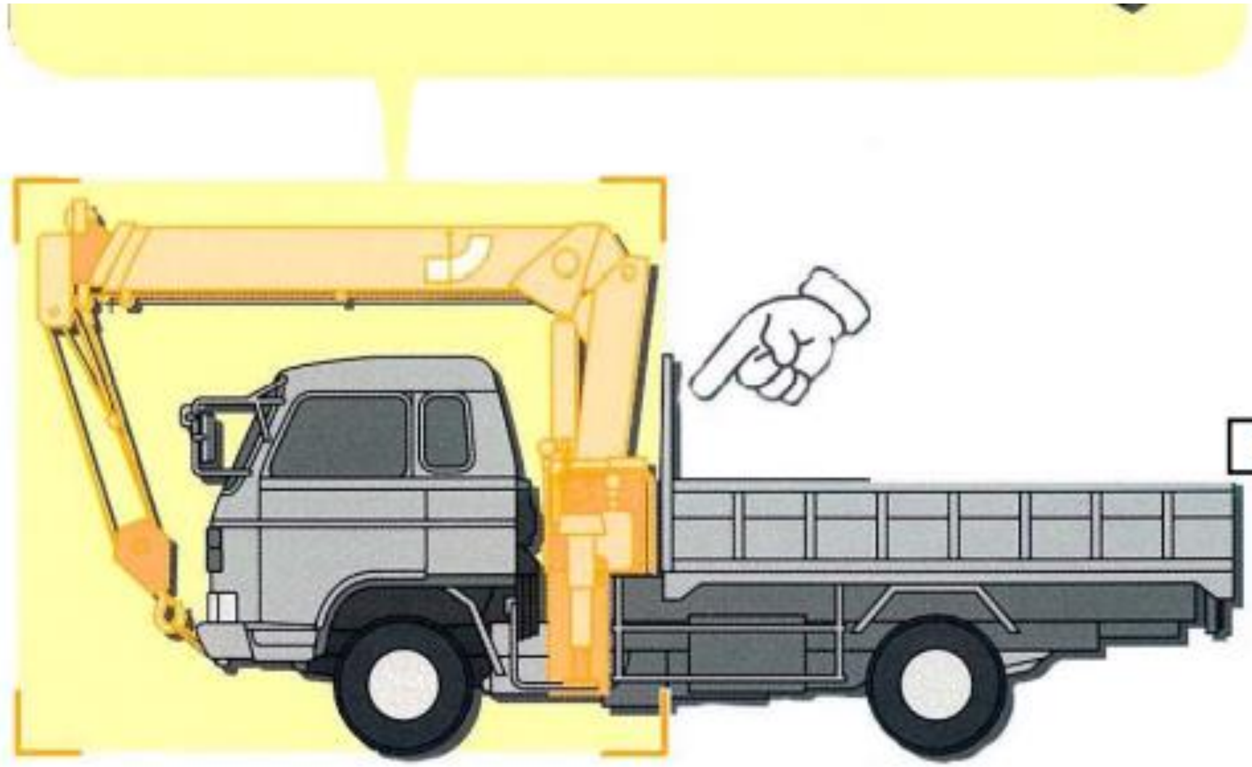
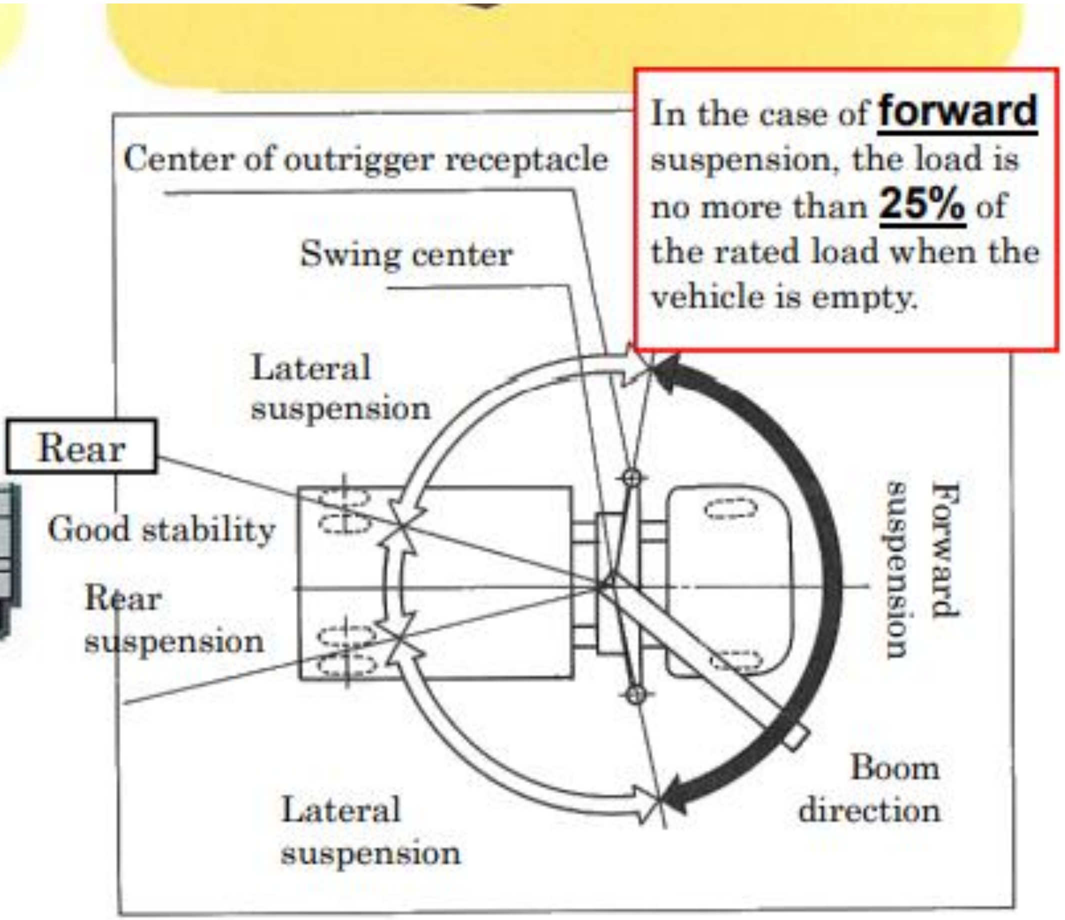
UNIC CRANE





In the case of forward suspension, the load is no more than 25% of the rated load when the vehicle is empty.
Center of outrigger receptacle
Swing center
Lateral suspension
Rear
Good stability
Rear suspension
Forward suspension
Boom direction
Lateral suspension

Crane Inspection

Crane Inspection- Outrigger

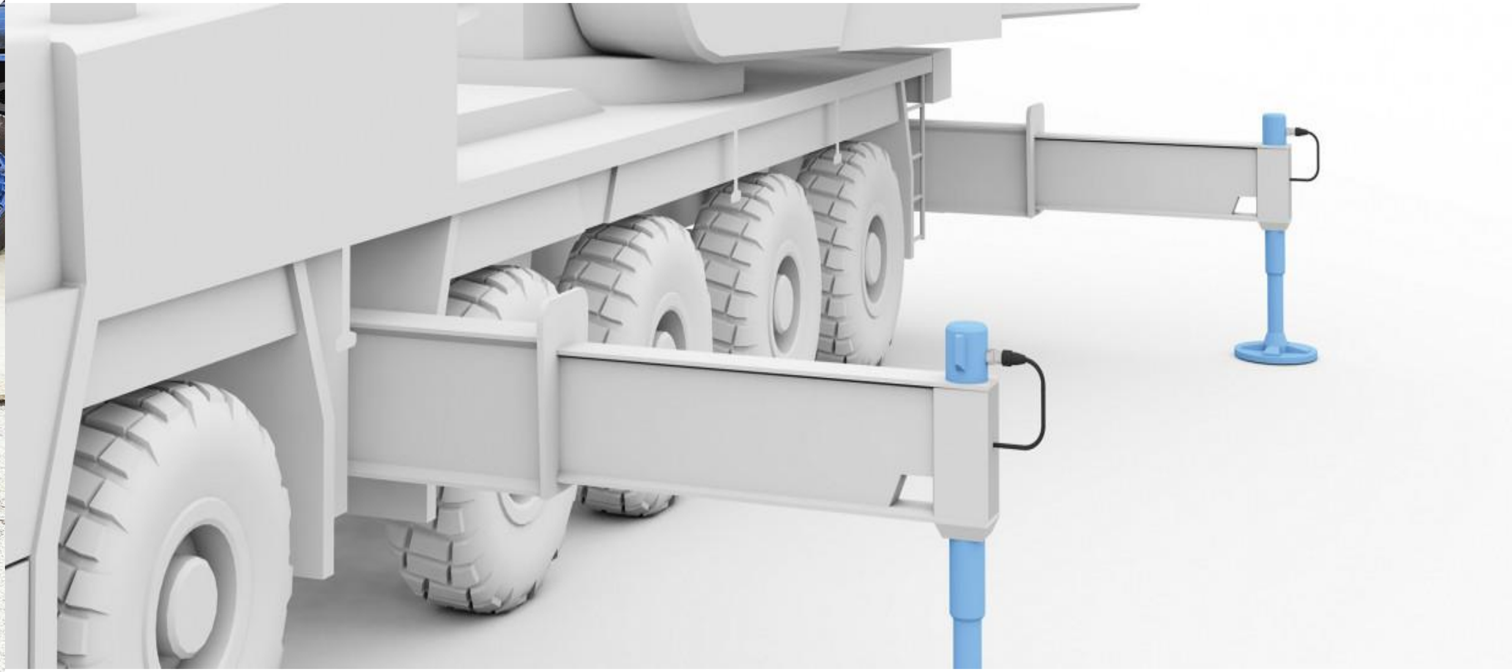
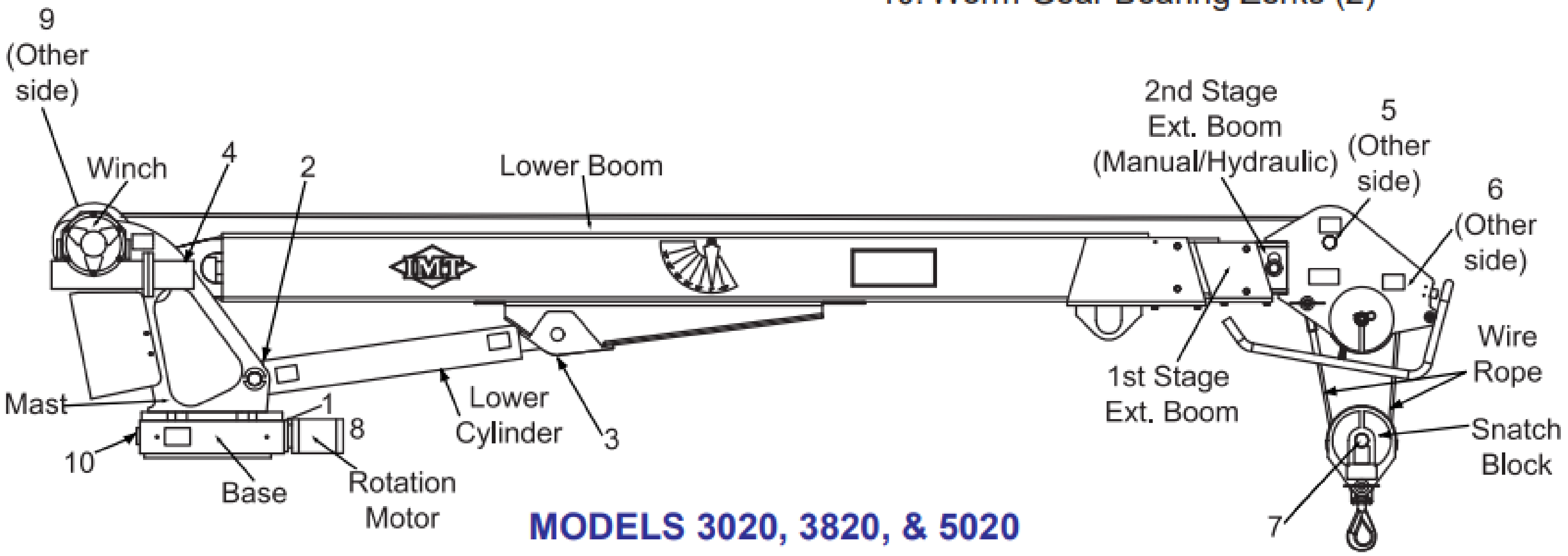


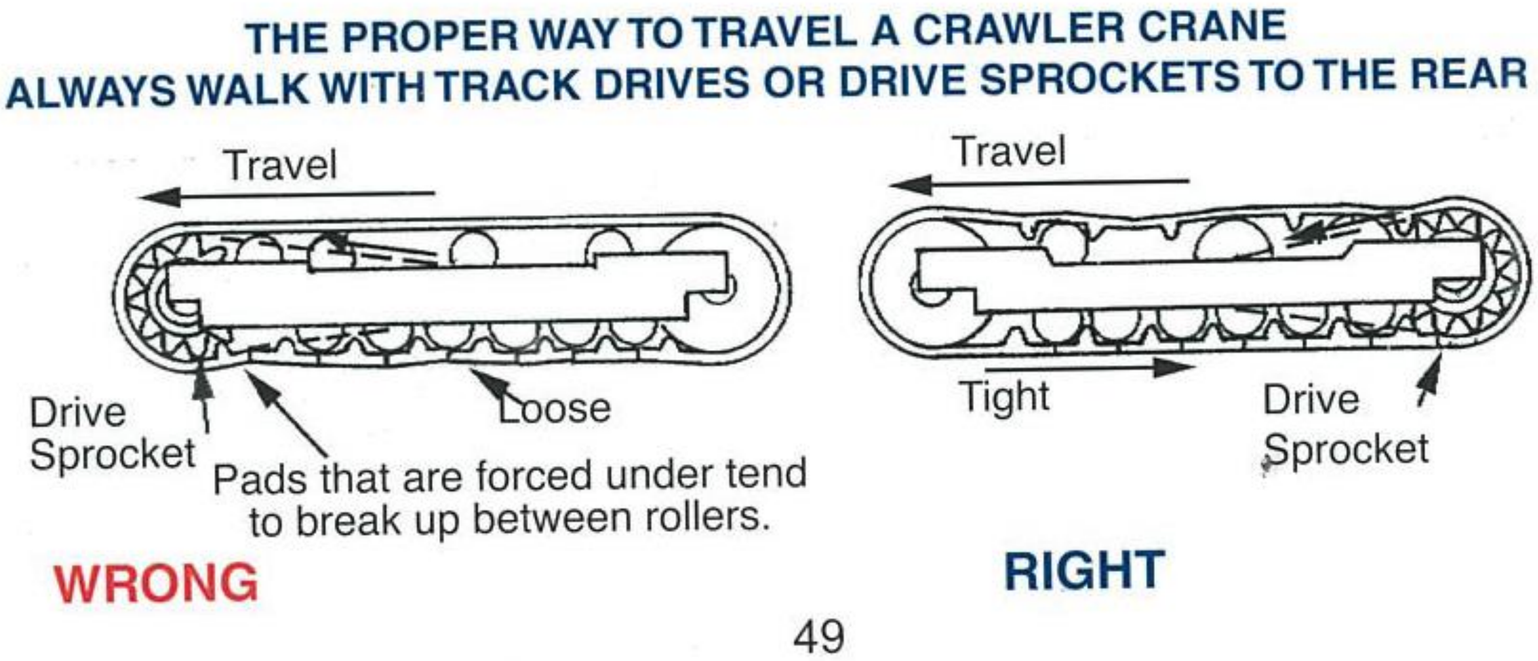
Figure B-5: Component & Grease Zerk Locations - Models 3020, 3820 & 5020

1. Gear Rotator Grease Extension (Rotate crane while greasing)
2. Lower Cylinder Base
3. Lower Cylinder Rod
4. Mast/Lower Boom Hinge Pin
5. Upper Sheave Pin
6. Lower Sheave Pin
7. Snatch Block Sheave Pin
8. Worm Drive Bearings (3 pumps, then rotate fully) (Model 5020 only)
9. Winch Outboard Bearings
10. Worm Gear Bearing Zerks (2)

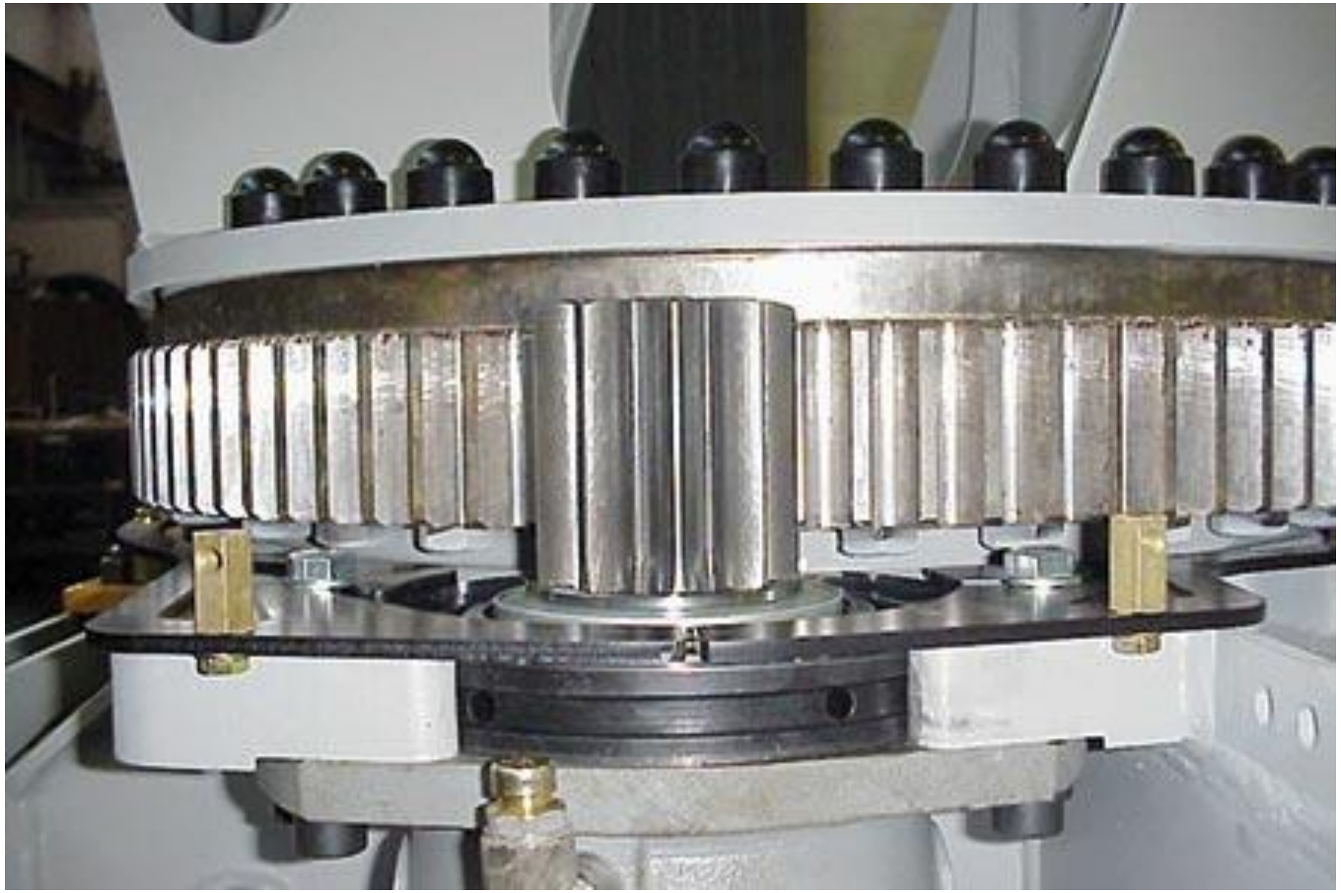


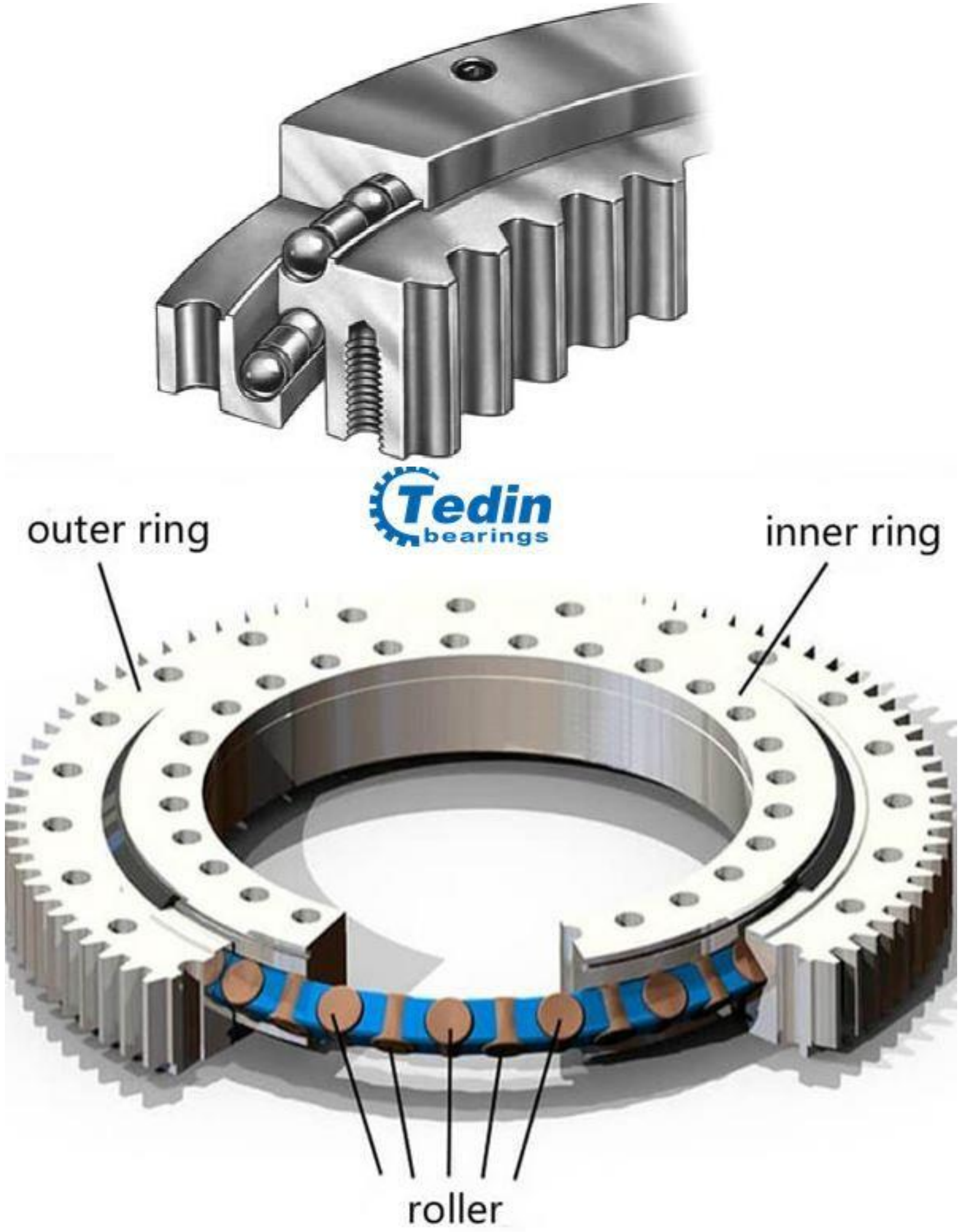
MODELS 3020, 3820, & 5020

Crane accessory – Foundation



Crane Accessory – Slewing Ring Bearing





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Crane Accessory – Slewing Ring Bearing

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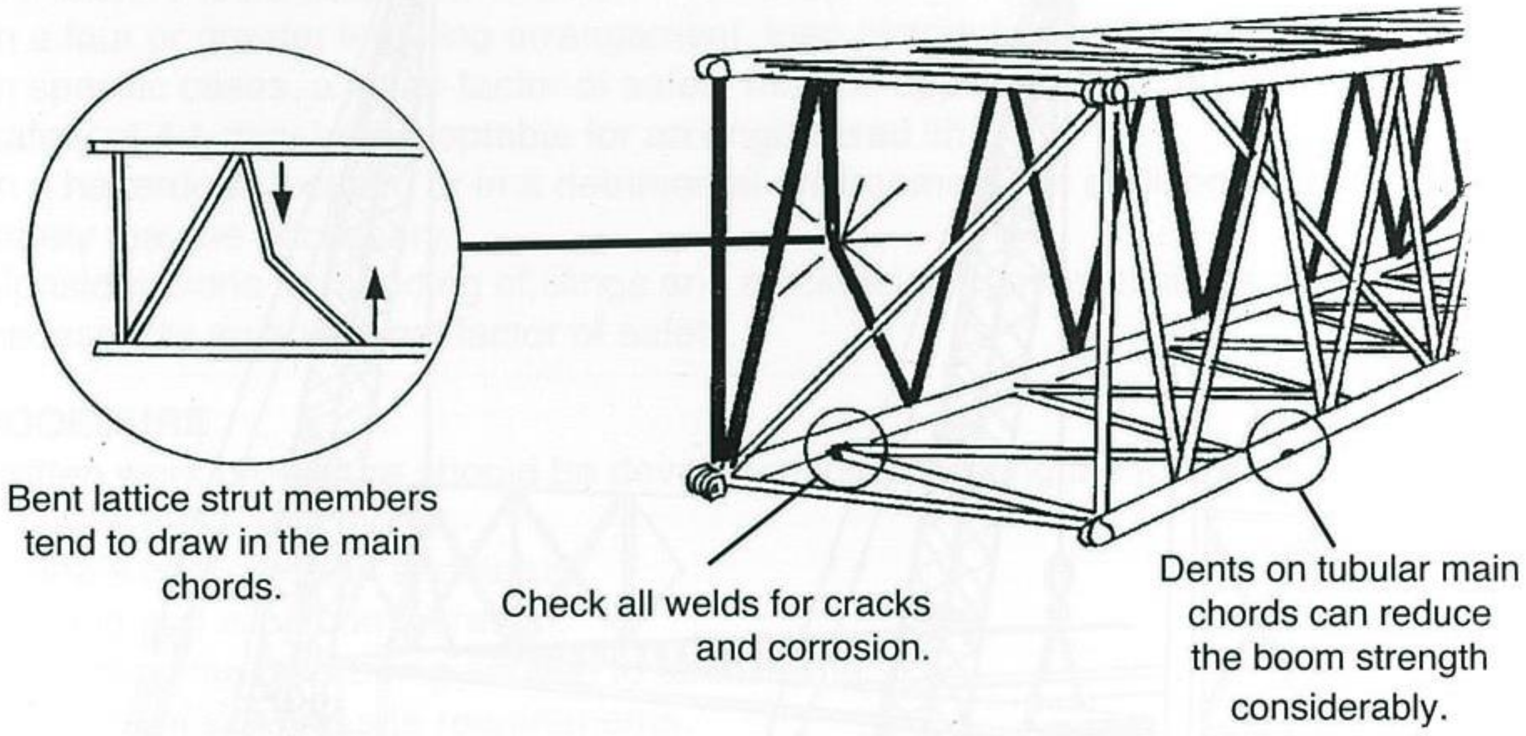
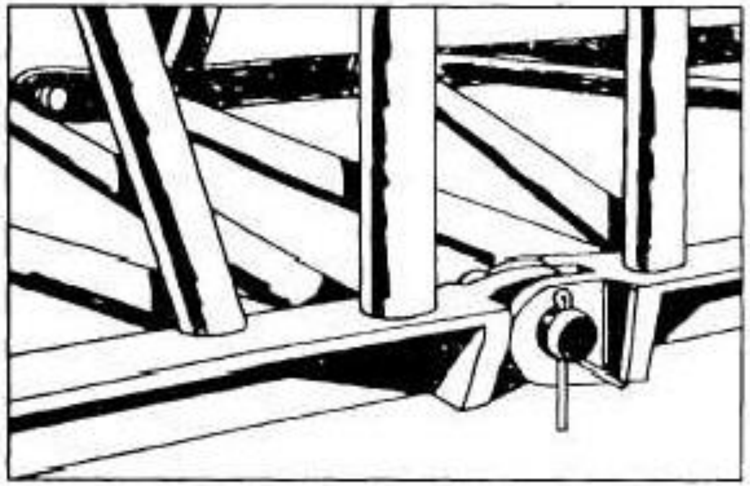
Crane accessory – Lattice Boom



Lattice type booms and jibs are weakened by damaged main chords, bent or missing lacings or cracked welds. Telescopic booms are weakened by distorted bottom or side plates. In either case the loss of strength is difficult to determine.

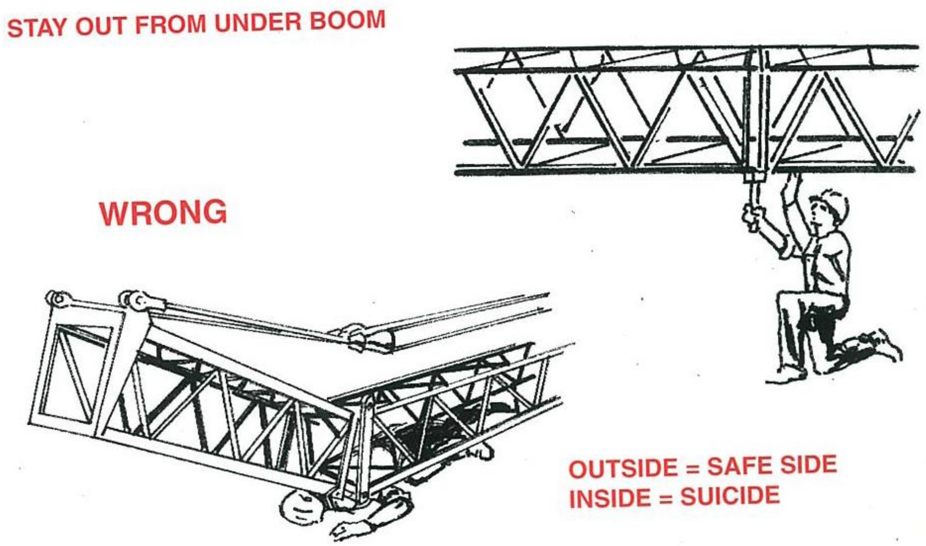
Crane accessory – Connecting pins/ cotter pins

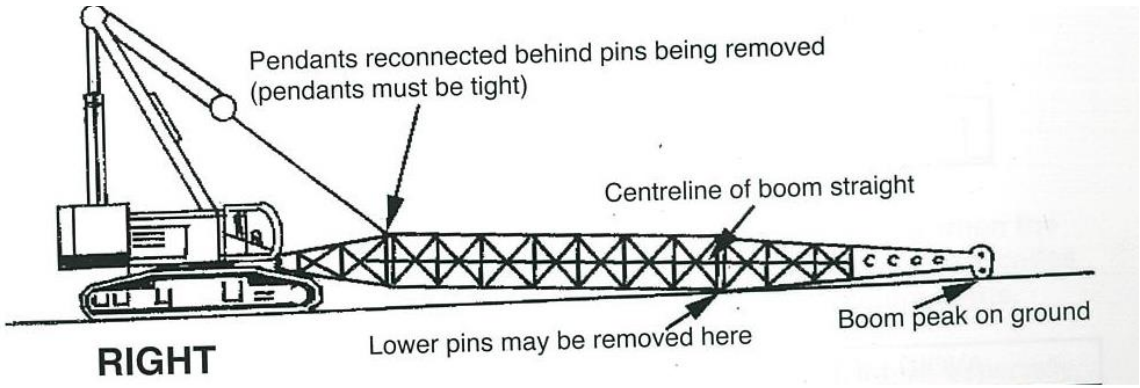


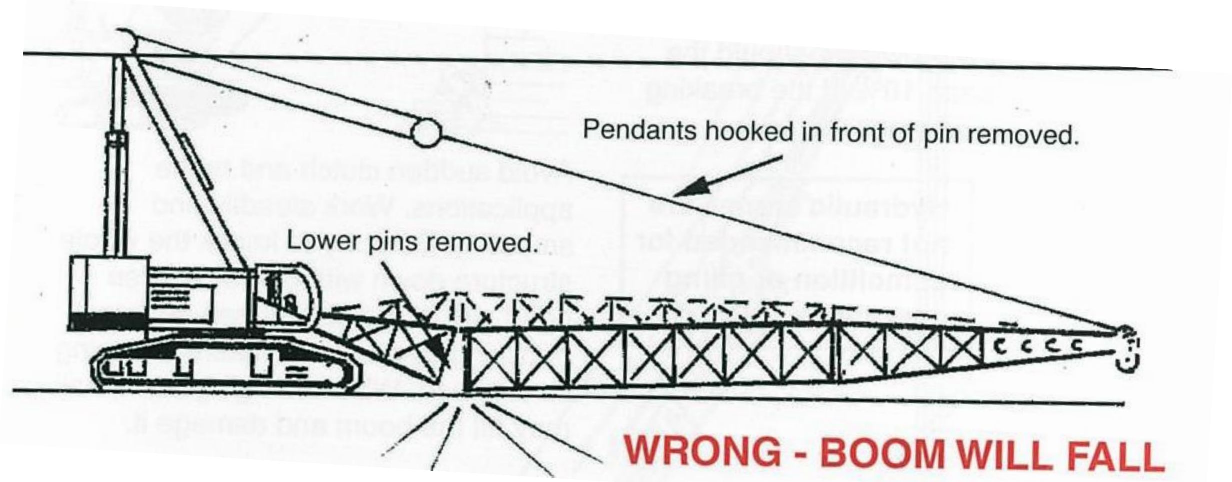
VIEW B
PIN CONNECTION

- Using welding sticks instead of proper cotter pins is not allowed.

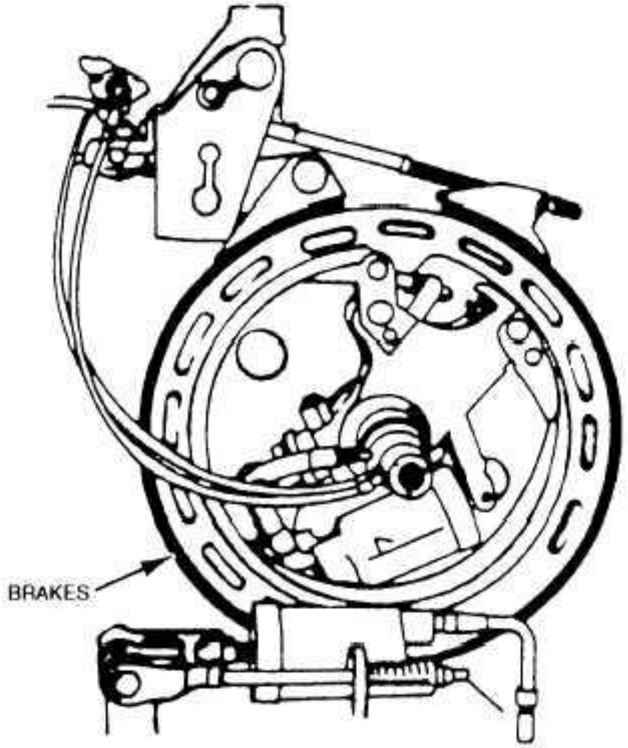
Crane accessory – Connecting pins/cotter pins



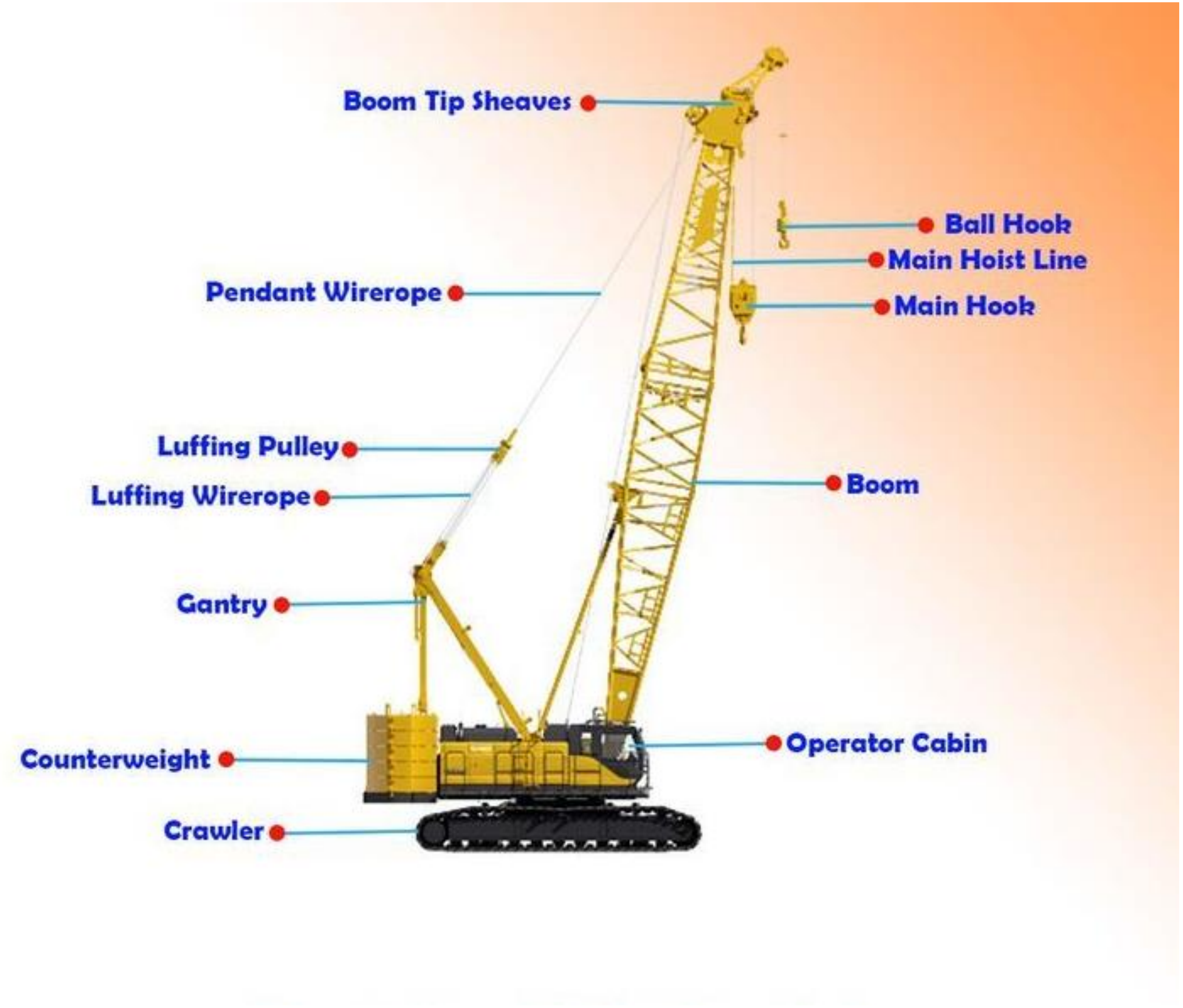




BRAKE OF ROPE DRUM



LATTICE CRANE PARTS



Crane inspection at site

- Booms;
- Lattice boom + connecting pins/cotter pins;
- Outriggers/ footing floats;
- Wire ropes;
- Wire rope on drums;
- Load blocks;
- Hooks;
- Anti-two-block device;
- Wedge sockets;
- Hydraulic systems;
- Man basket;
- Lifting gears;
- Lifting lugs/eyes.

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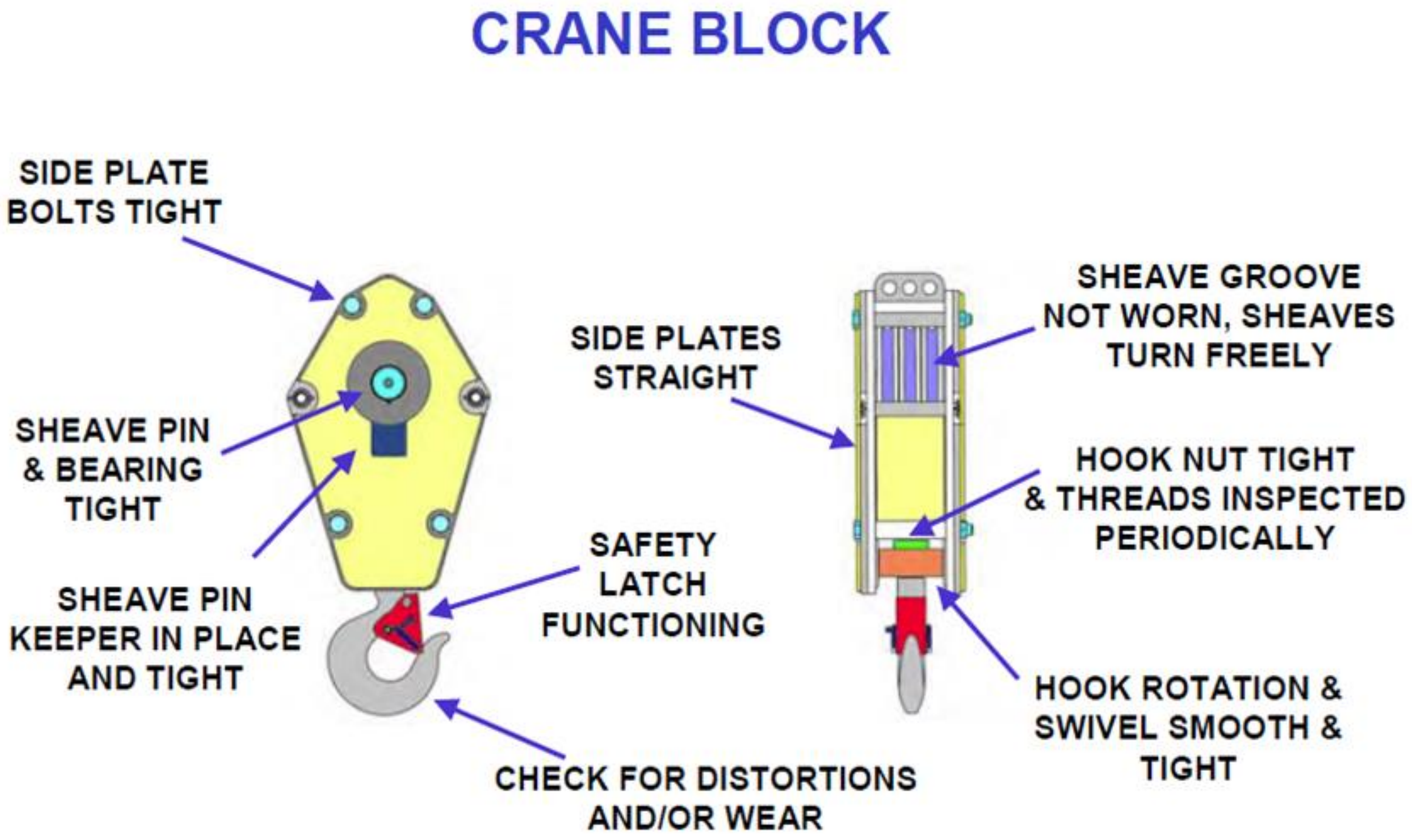
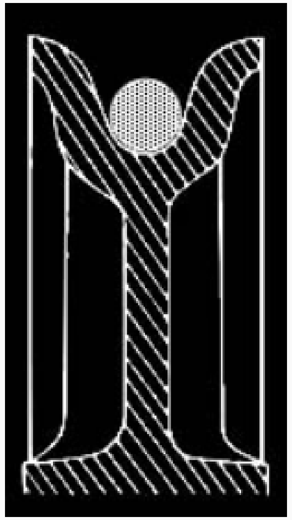
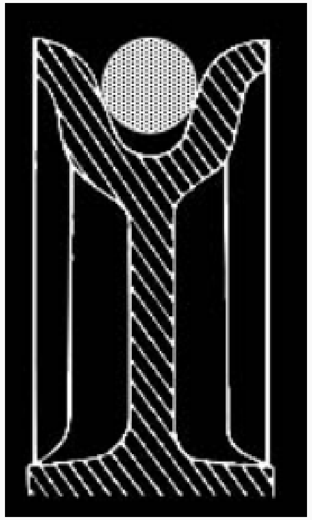
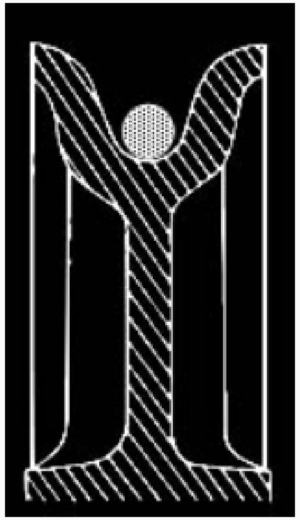
Crane accessory – Load Block/Hook

Load block must have safety latch and all bolts/nuts are in place and secured.



SHEAVE & ROPE SIZE

- Matching the load line with sheaves.

		
Properly matched rope and sheave	Rope is too large, will pinch	Rope is too small, will flatten

SMALL BLOCK HOOK

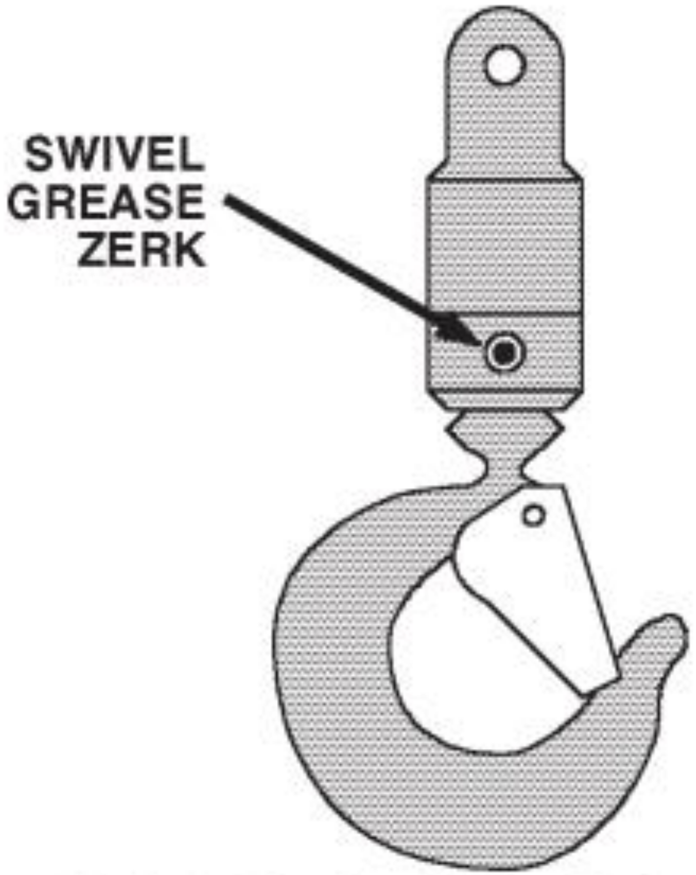


Figure B-14: Swivel Hook Grease Zerk

ANTILOCK DEVICE

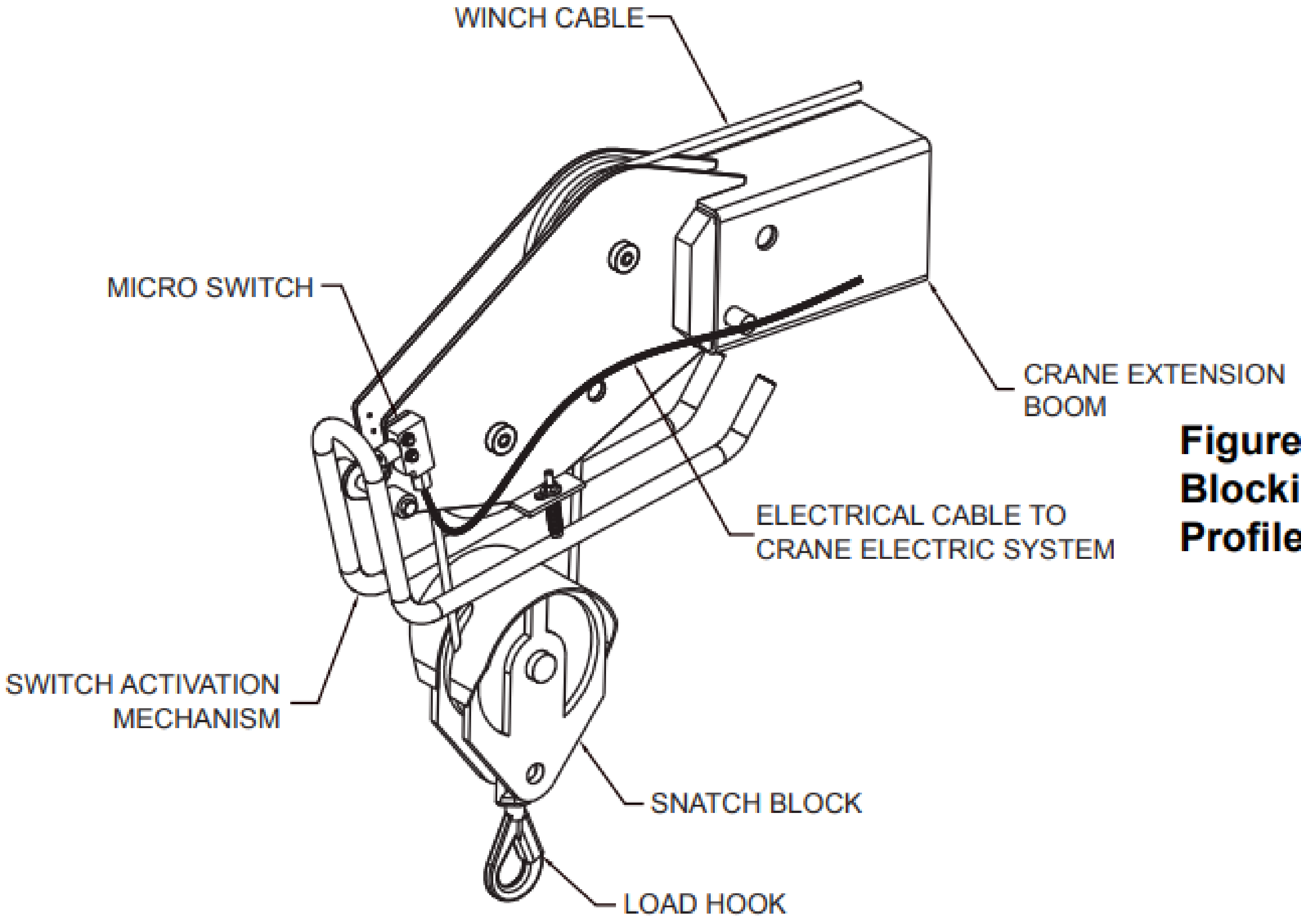


Figure A-13: Anti Two-Blocking System - Low Profile Boom Tip Cranes

ANTILOCK DEVICE

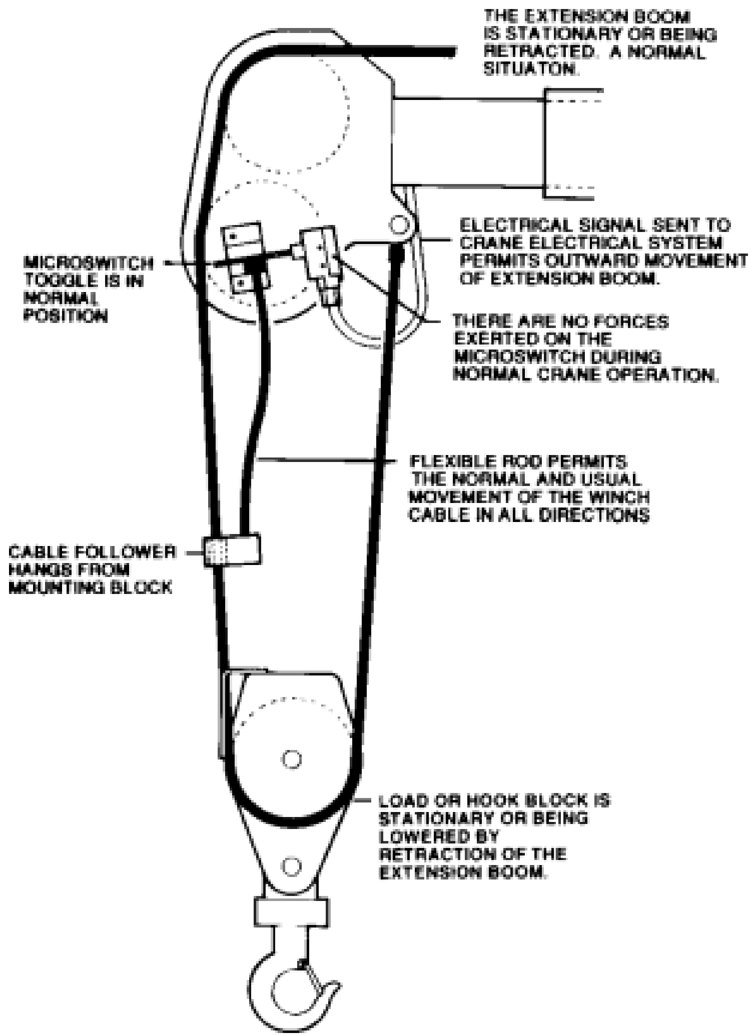


Figure A-14: Normal Work Position

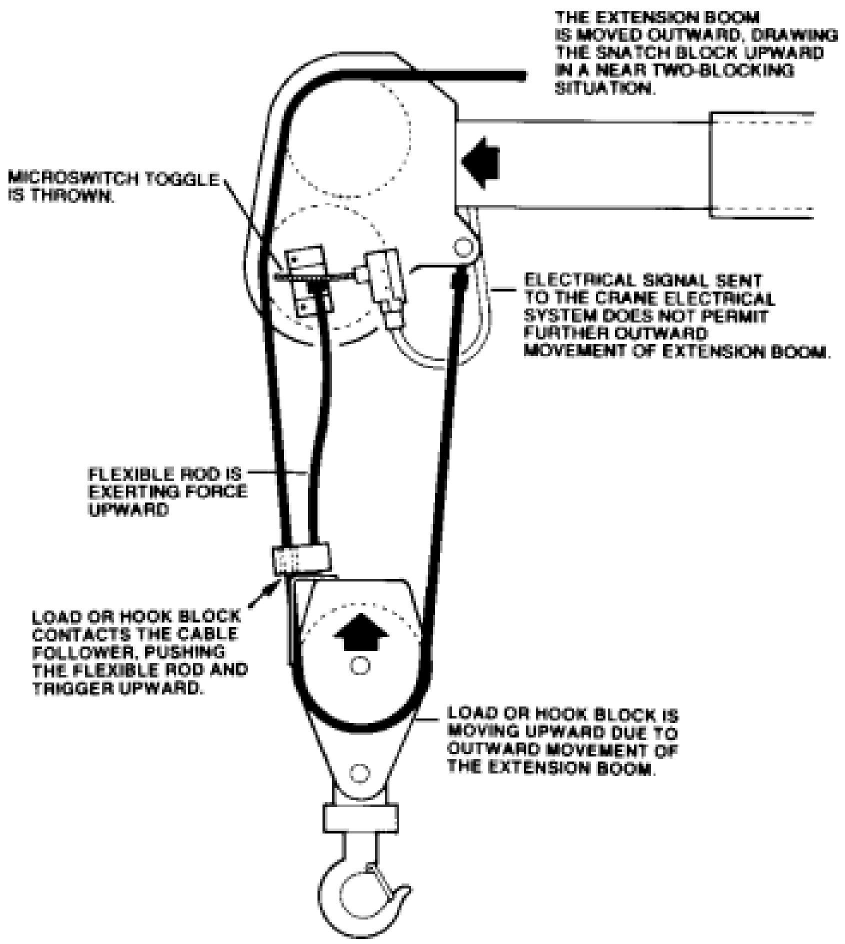


Figure A-15: Approaching Two-Blocking Situation

Crane accessory – Anti two block device

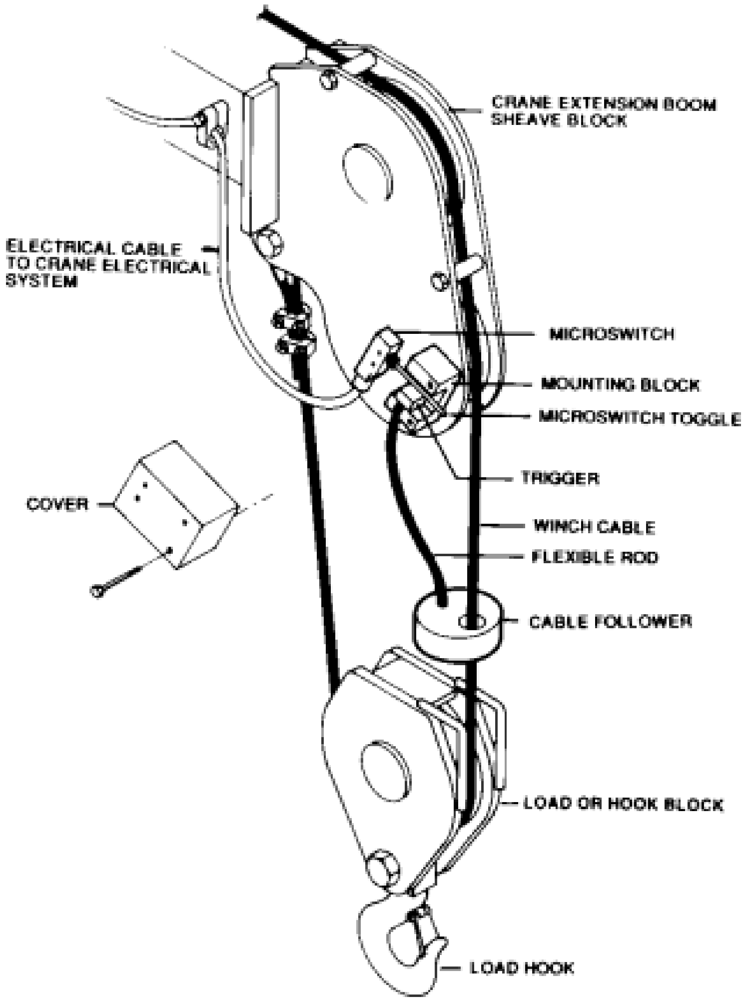
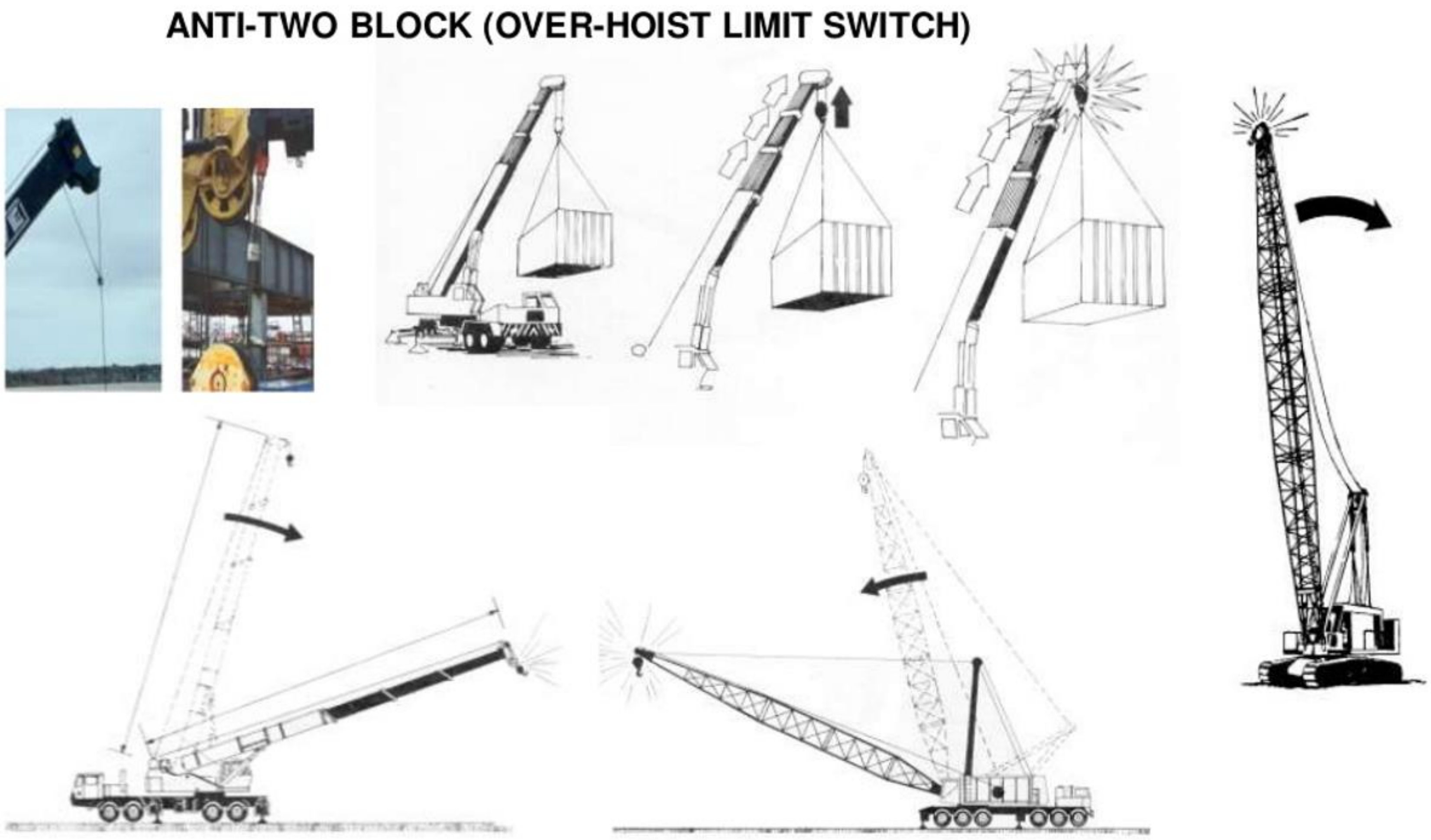


Figure A-16: Anti Two-Blocking Device Components

Crane accessory – Anti two block device



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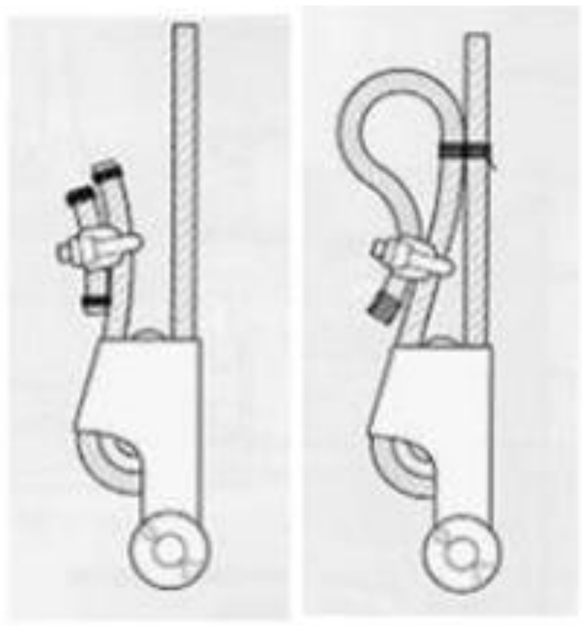
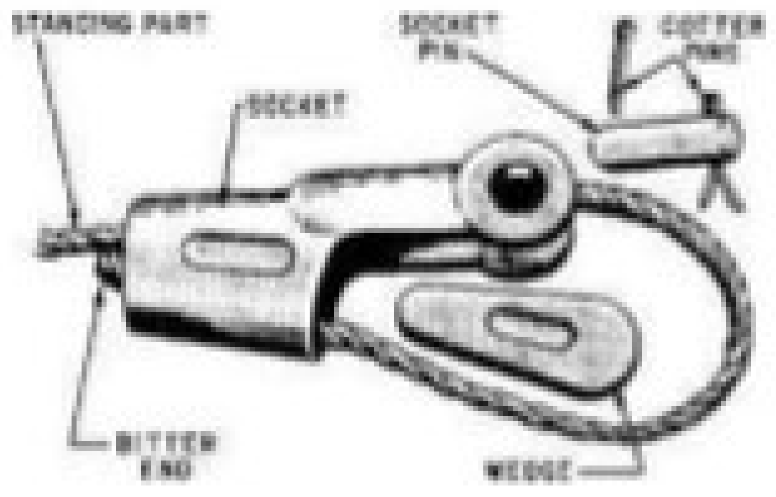
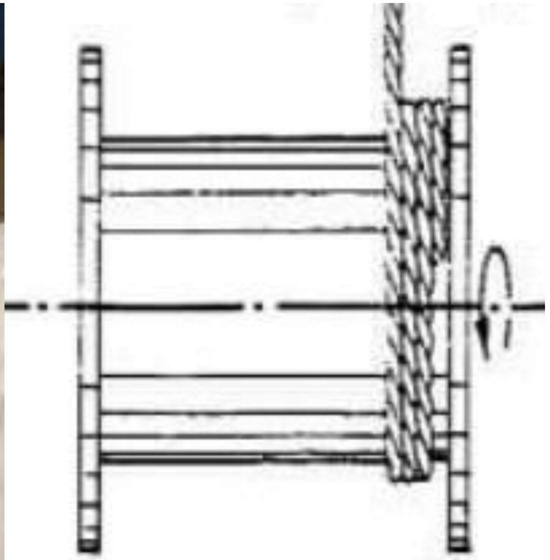
Crane Accessory - Wedge Socket



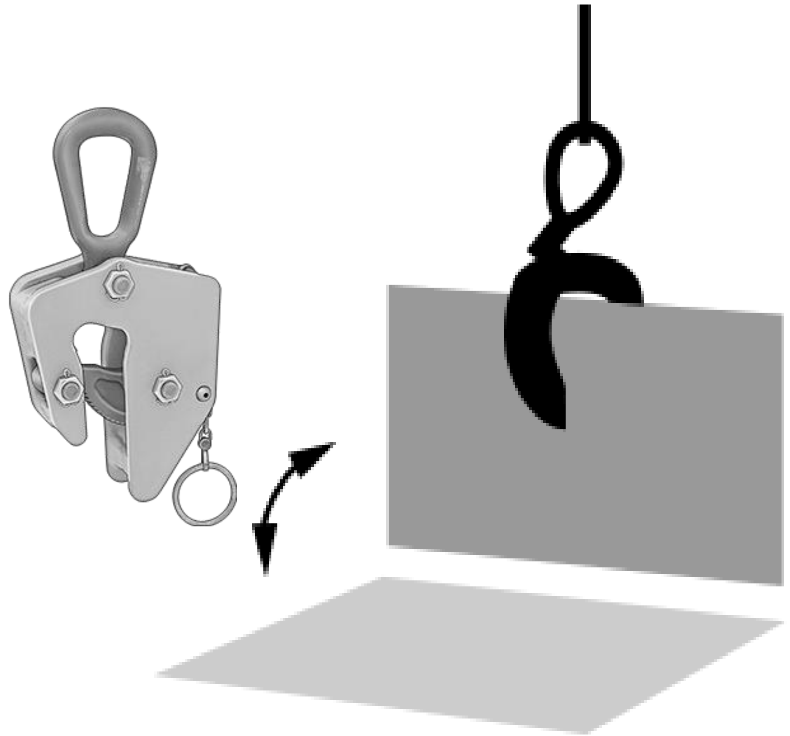


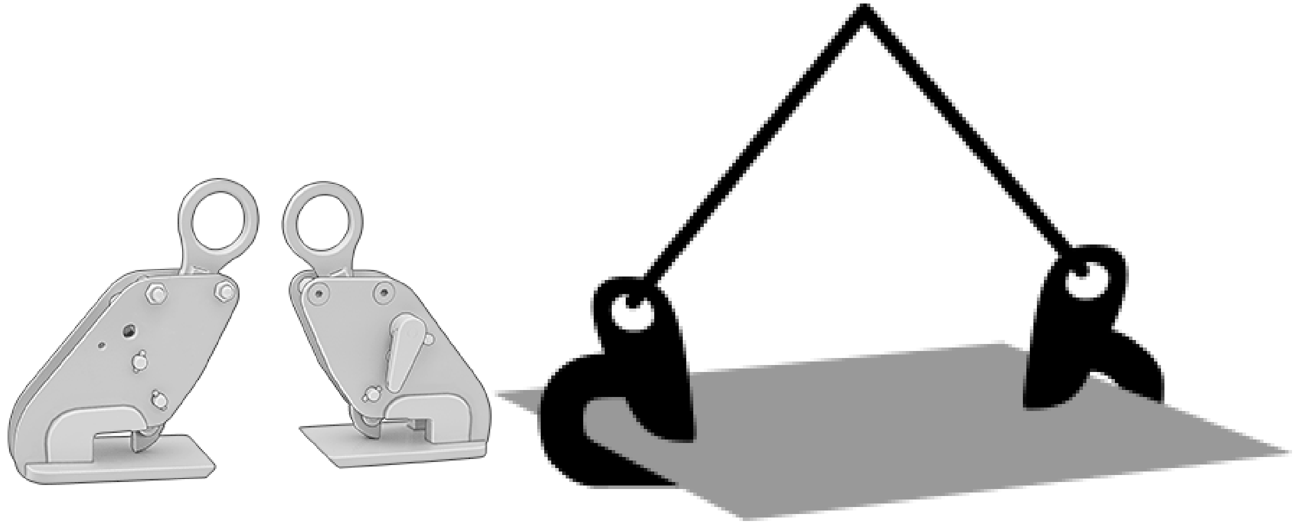
The wedge socket must be properly installed with clamp/shackle

Crane Accessory - Wire Rope On Drums



Crane Accessory - Lifting with Screw Clamps





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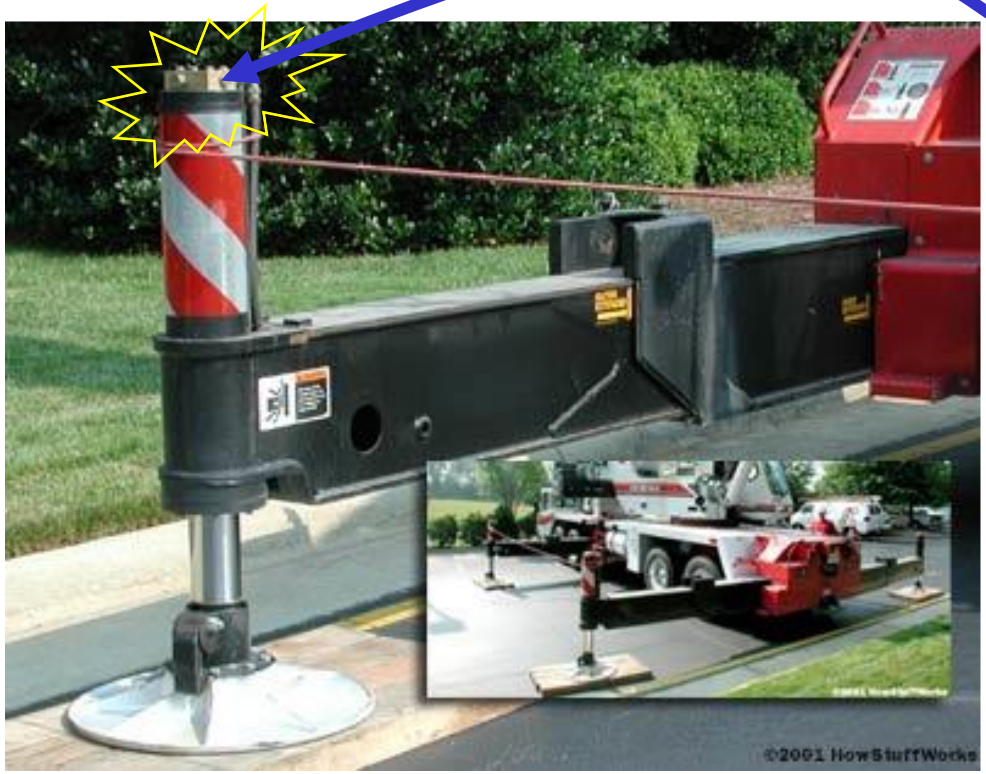
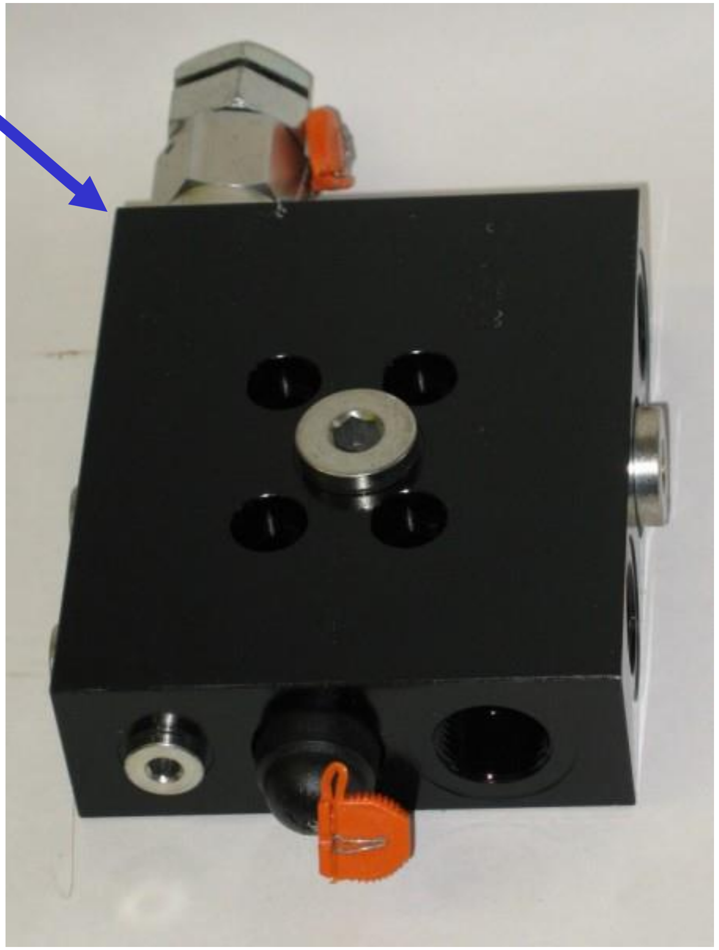
Crane Accessory - Load Holding Valve





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Crane Accessory -Lifting Gears

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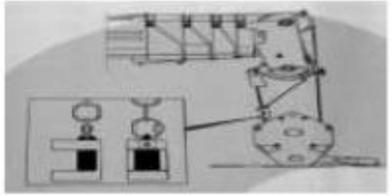
Moment Limiter

SECURITY SYSTEMS:

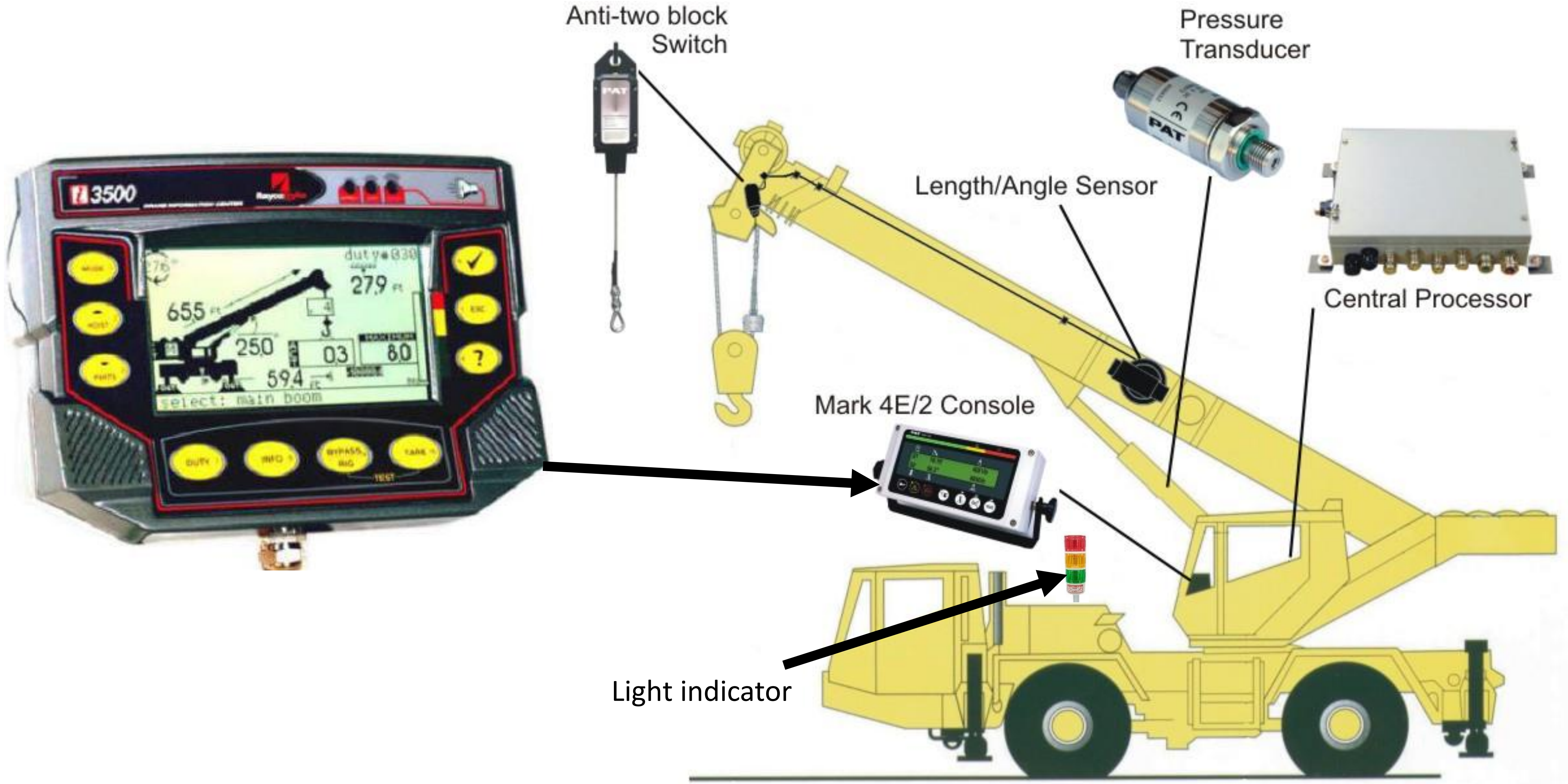
- Indicator/limiter (RCI/L) –(MAX. LIFTING OF LOAD WHIT THIS CONFIGURATION)
- Anti-two Block (Over-hoist Limit switch)
- Safety catch(es)



RCI

Anti-two Block

Crane Accessory -Moment Limiter



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Crane Accessory -Moment Limiter

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Load Chart- Crane Structural Damaged

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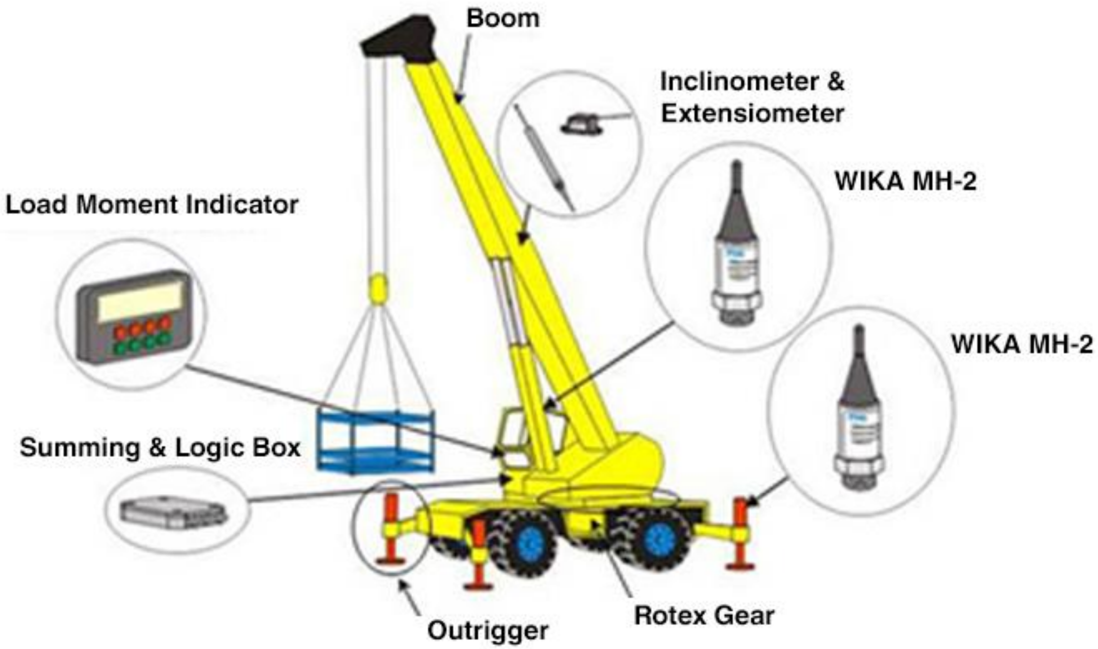
Hydraulic System



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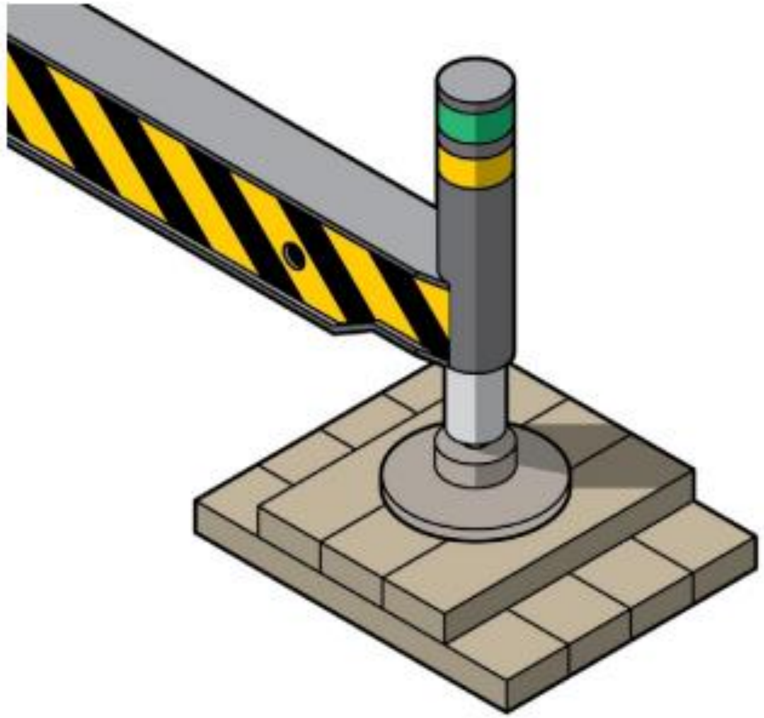


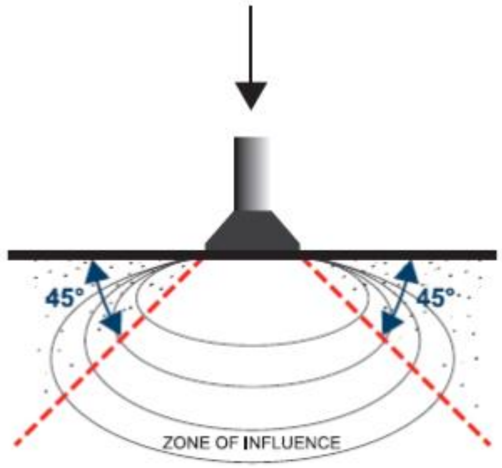


Figure 3 Zone of Influence

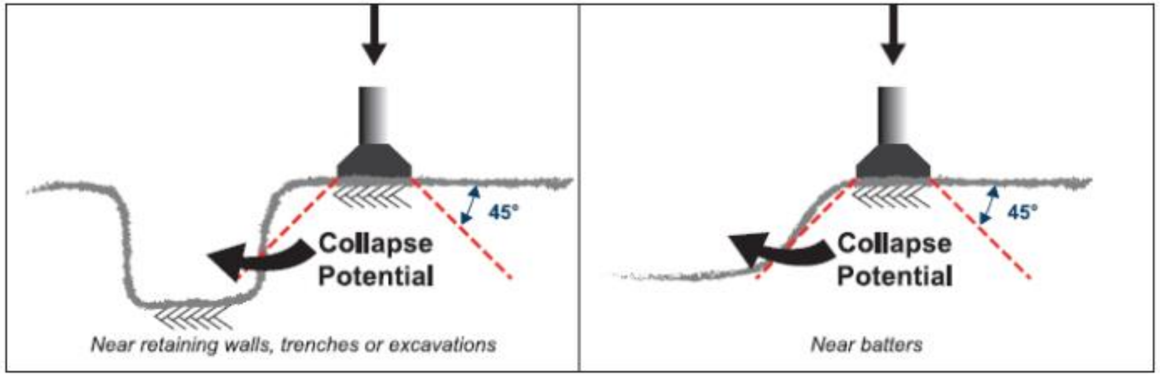
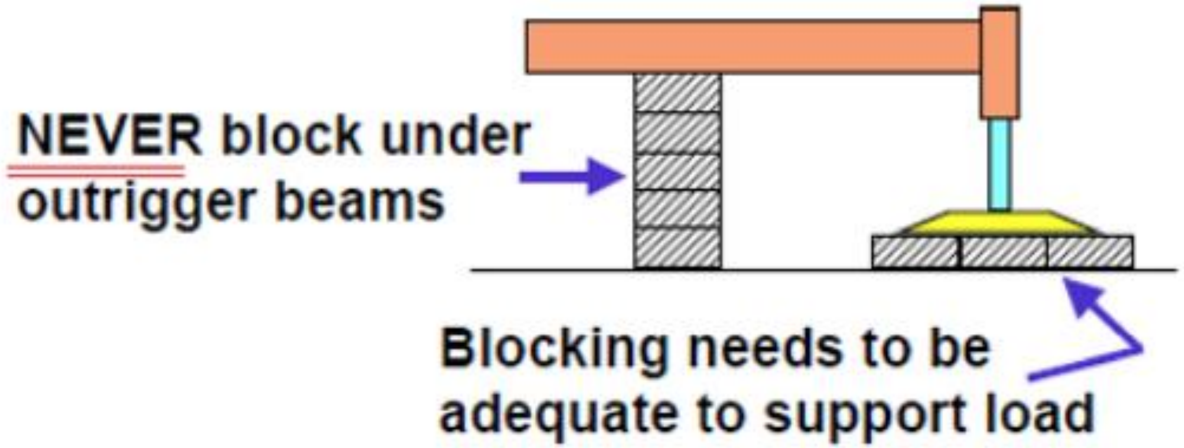
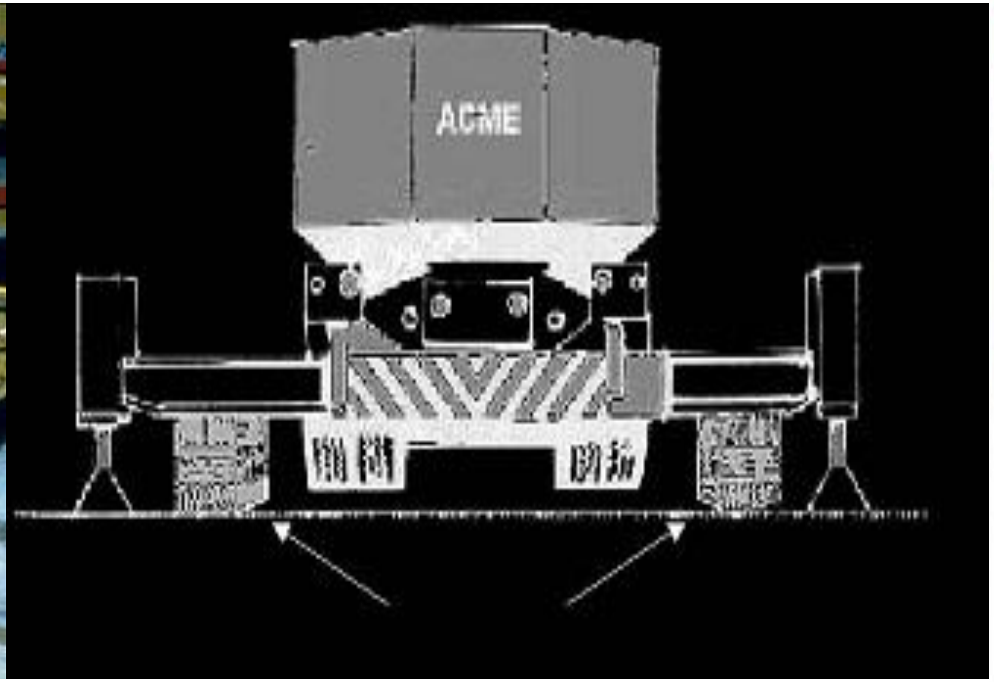


Figure 4 Trench Diagram

OUTRIGGER SETTING



Do not block beneath outrigger beam



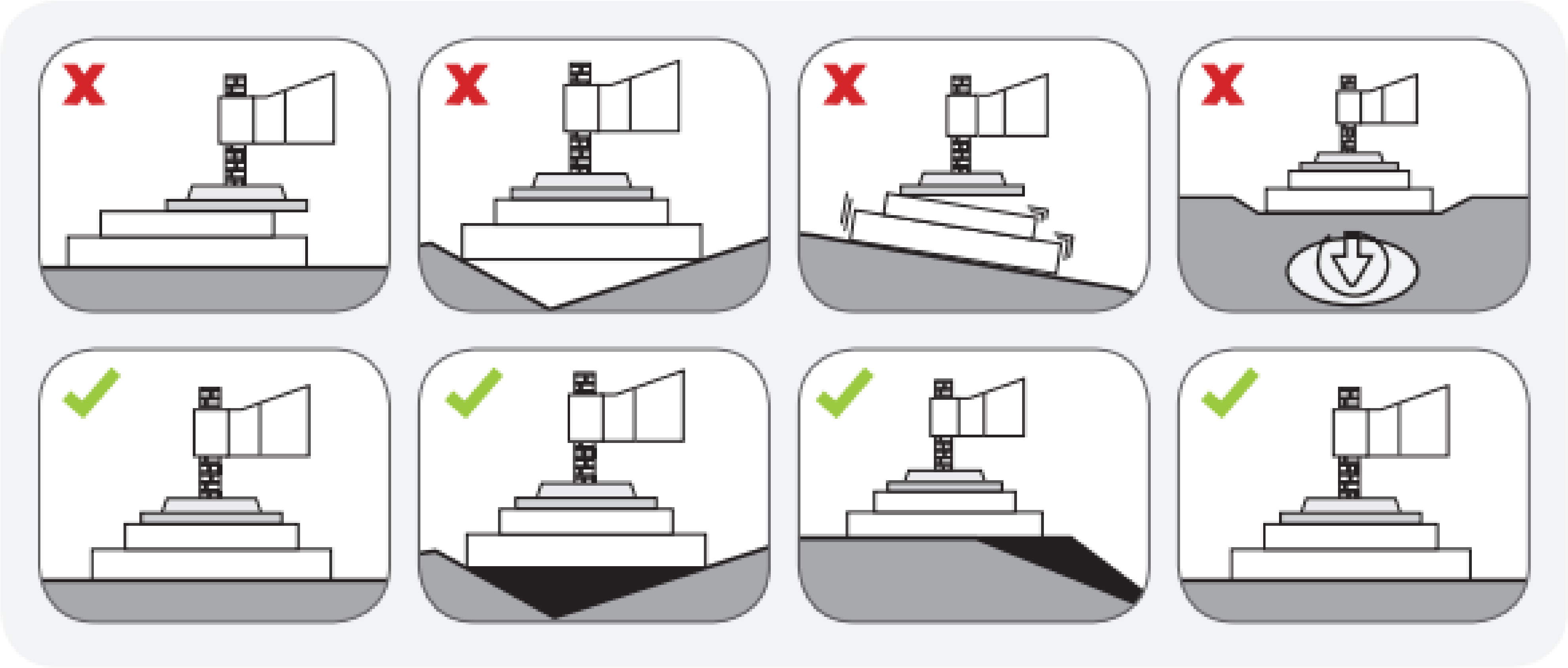
OUTRIGGER SETTING

OUTRIGGER SETTING

OUTRIGGER SETTING

OUTRIGGER SETTING

Some do's and don'ts of setting up outriggers are shown in Figure 4.



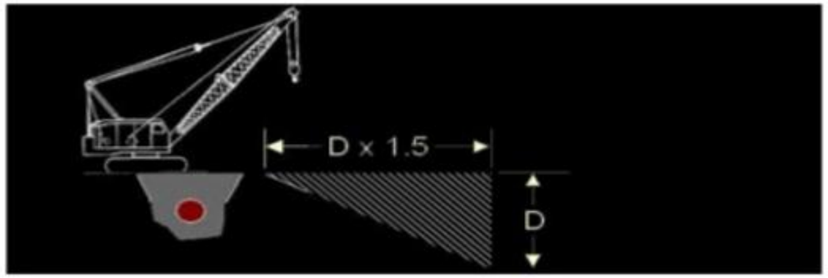
COUNTER WEIGHT

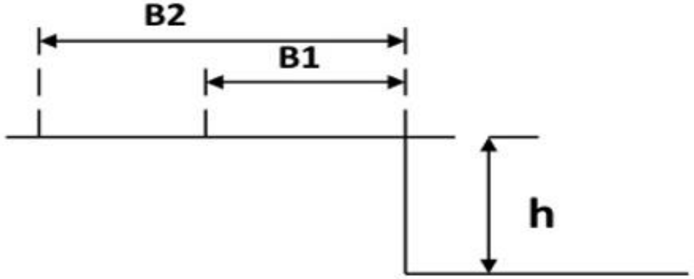
Do not apply extra counter weight

Outrigger Set Up

Beams and housings of the outrigger, floats and pads MUST be free of distortions, defects or cracks.
Mat must be of solid and strong material and large enough to spread the load.

Outrigger Set Up



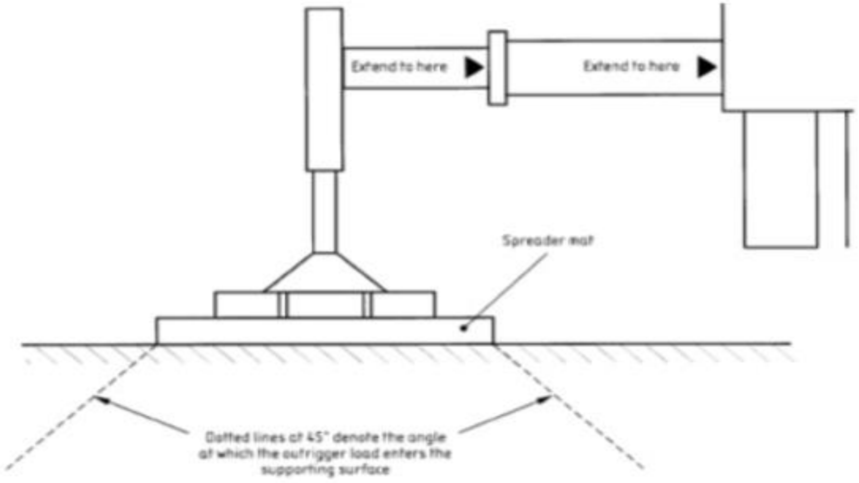


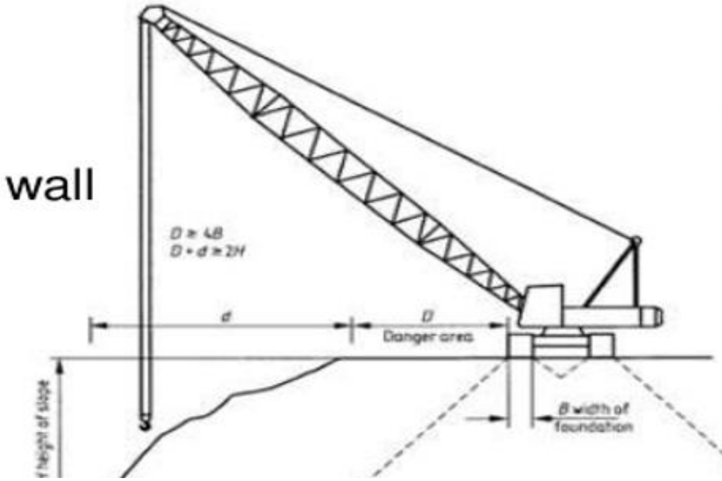
Uneven ground or soft: 2 x depth of wall

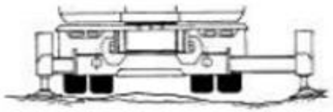
B2 = 2 x h

Hard ground : 1 x depth of wall

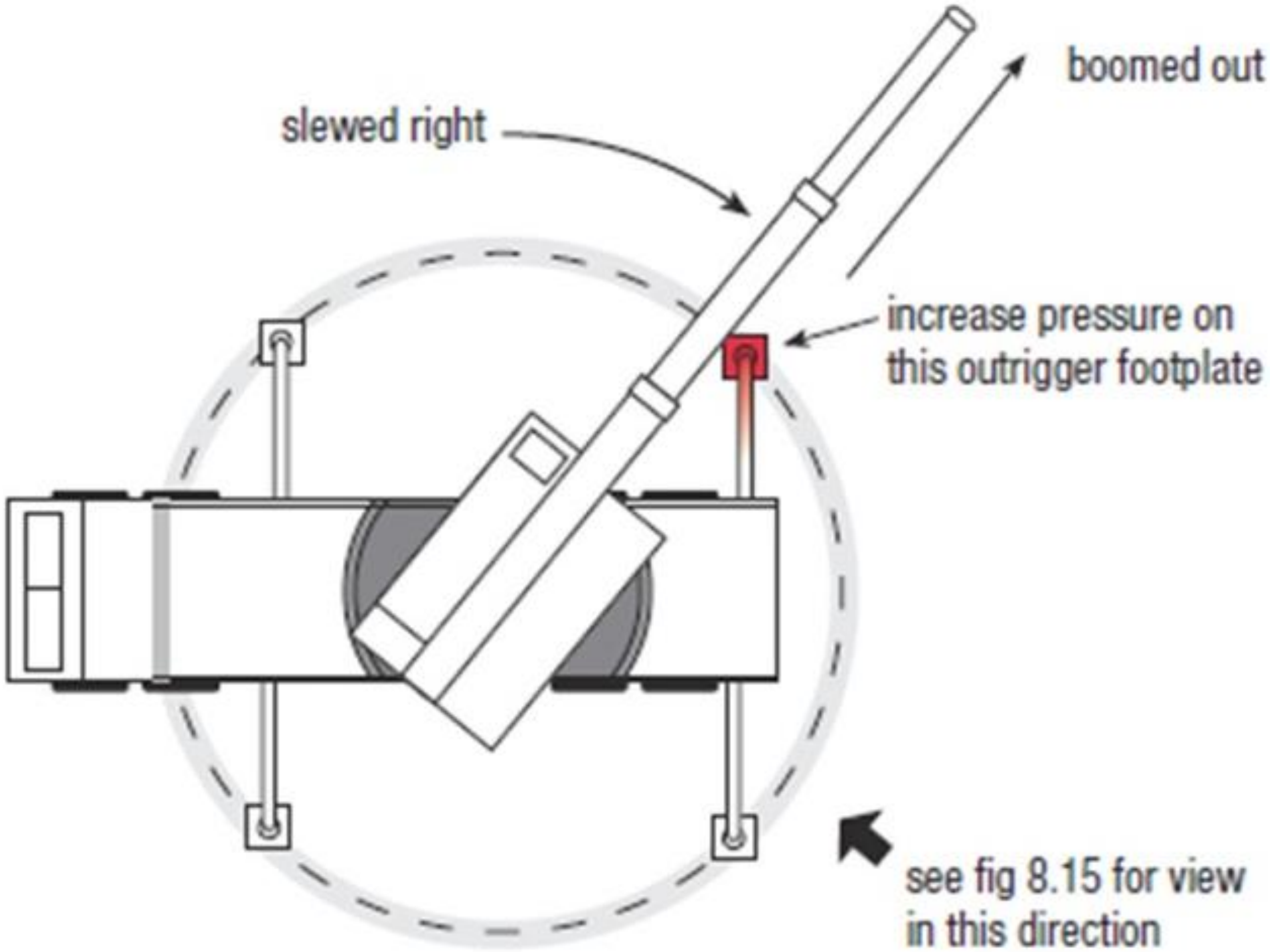
B1 = 1 x h





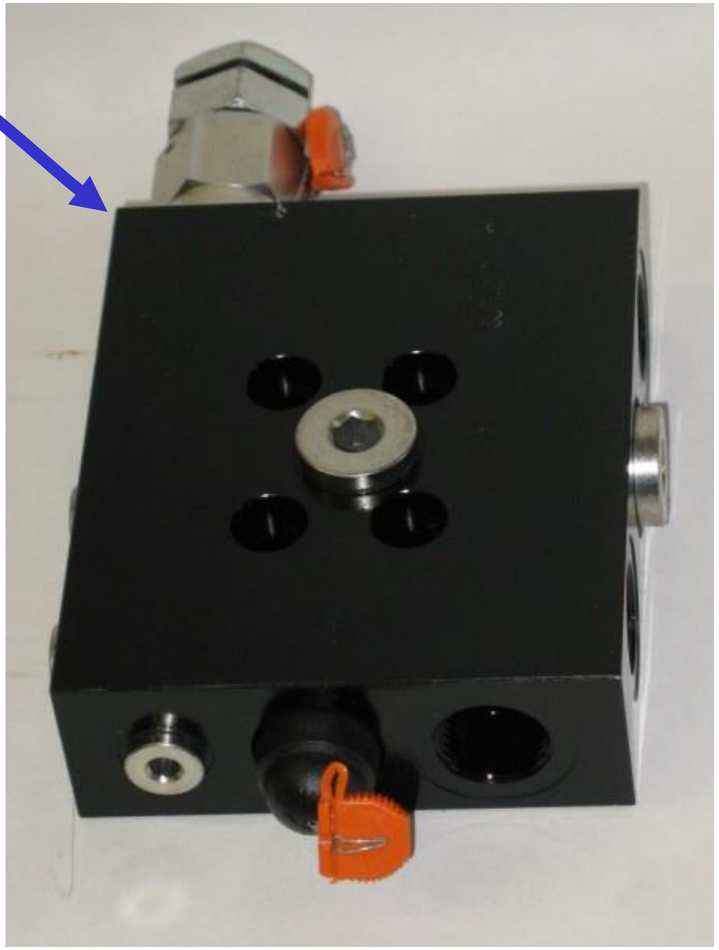


Outrigger Set Up



As the crane boom out, the bearing pressure in these outrigger foot plates would increase due to the increase moment, generated by the extended radius. This would give you a higher set of values

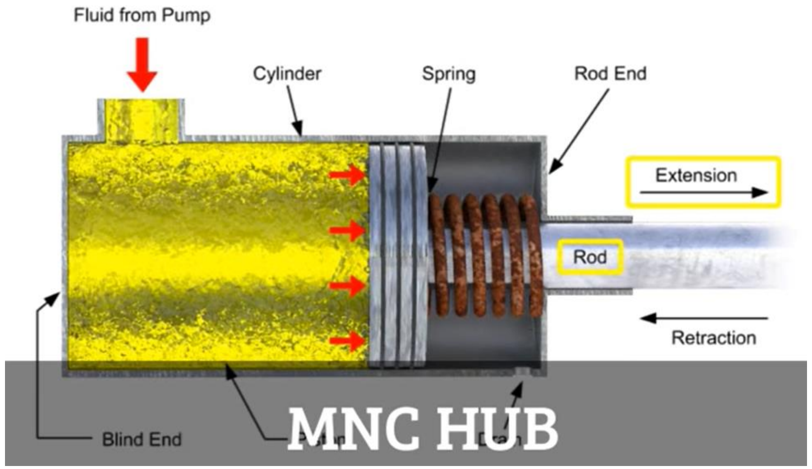
Outrigger Set up- Load Holding Valve



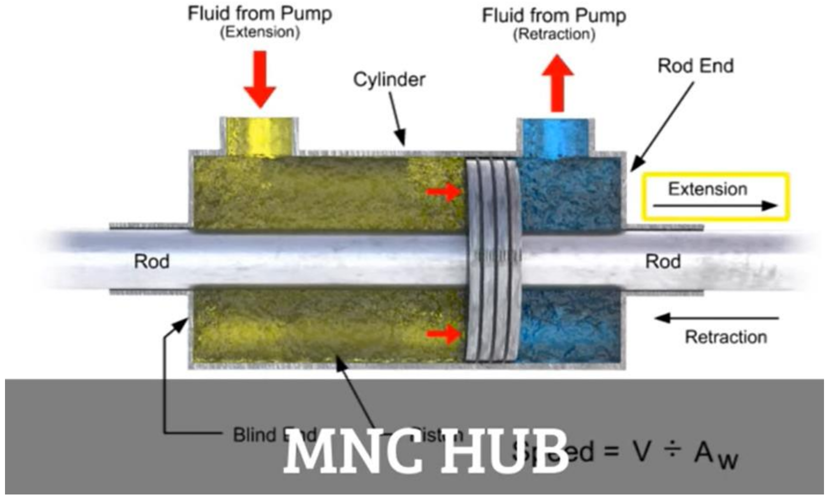
Presenter: Nguyen Si Khang

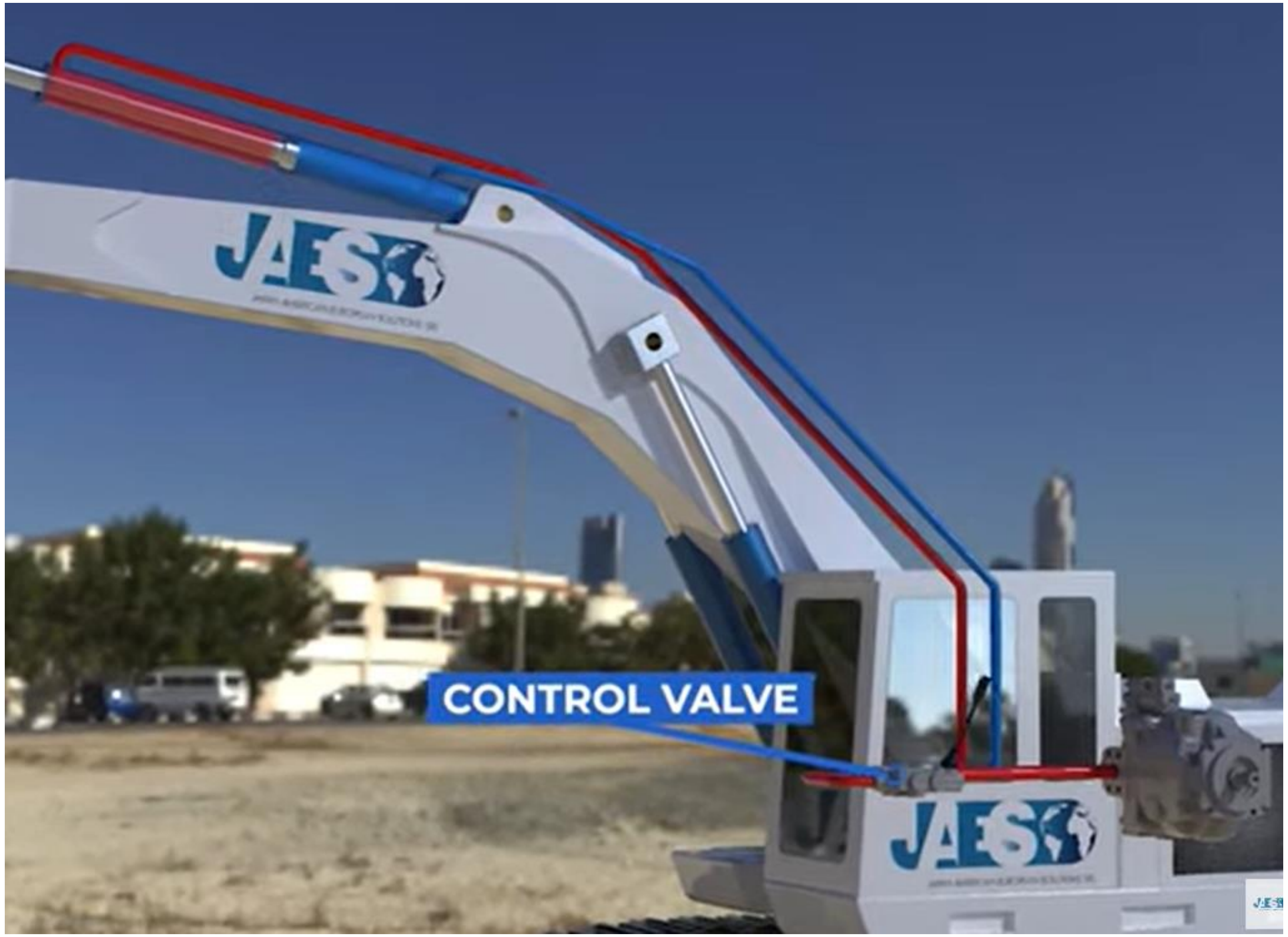
Outrigger Set up- Load Holding Valve

Single Acting, Single ended Cylinder



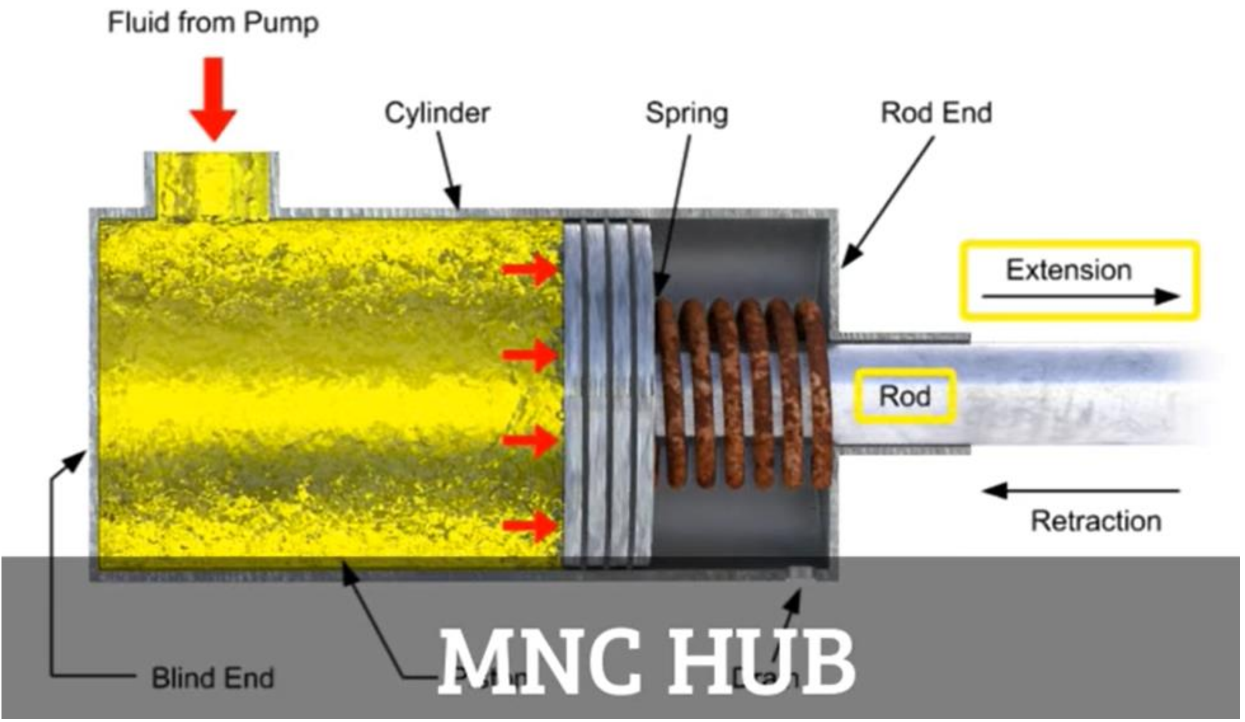
Double Acting, Double Ended Cylinder



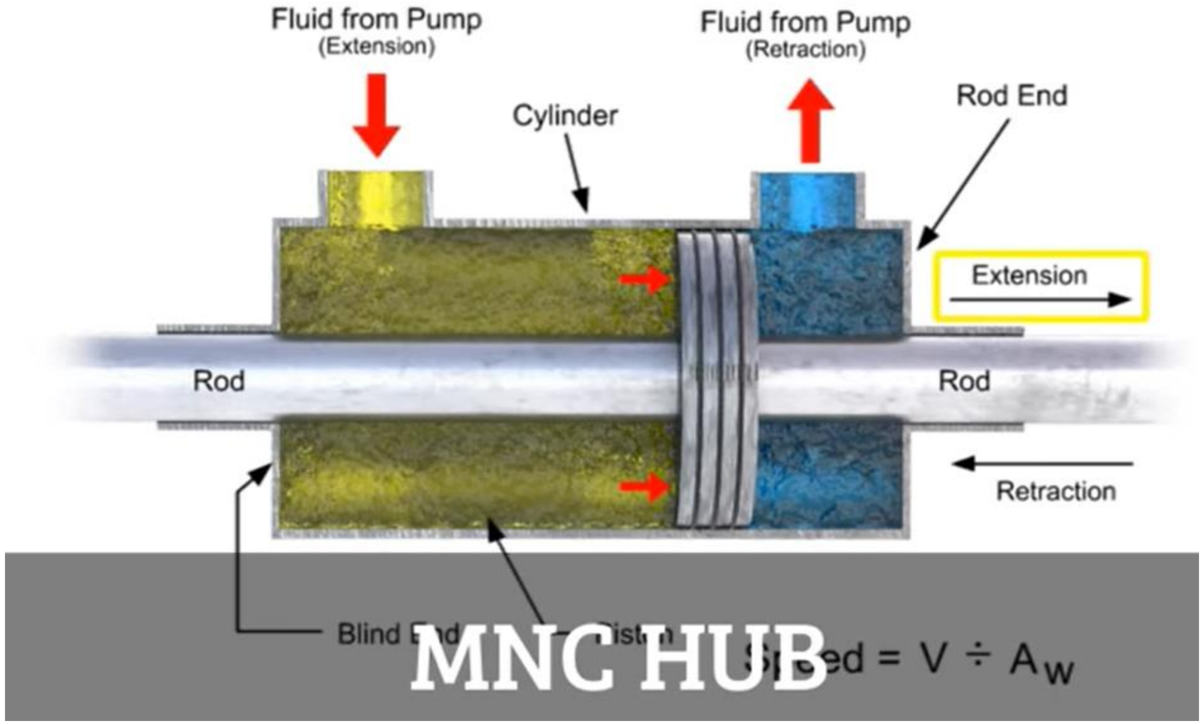


HYDRAULIC CYLINDER

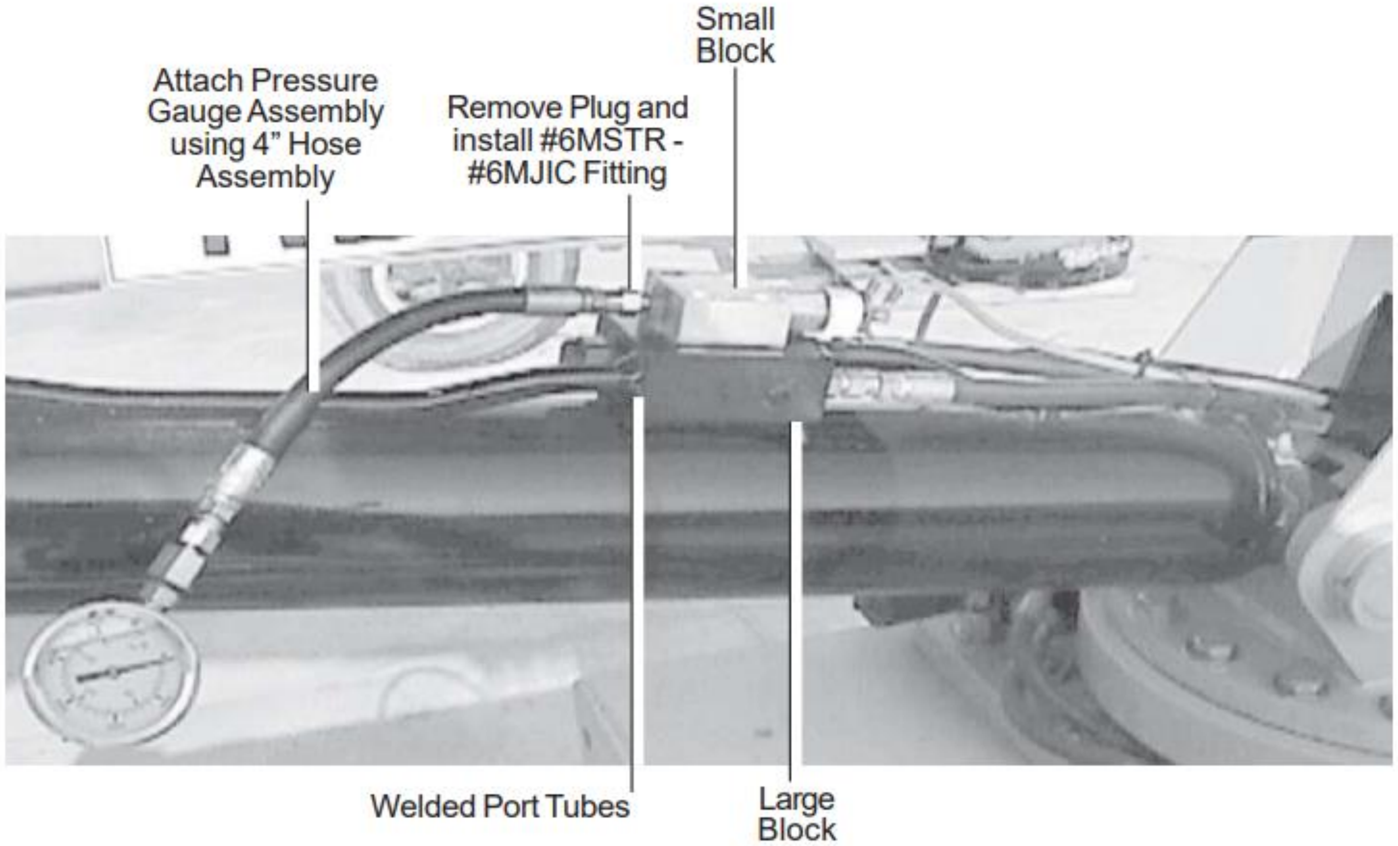
Single Acting, Single ended Cylinder



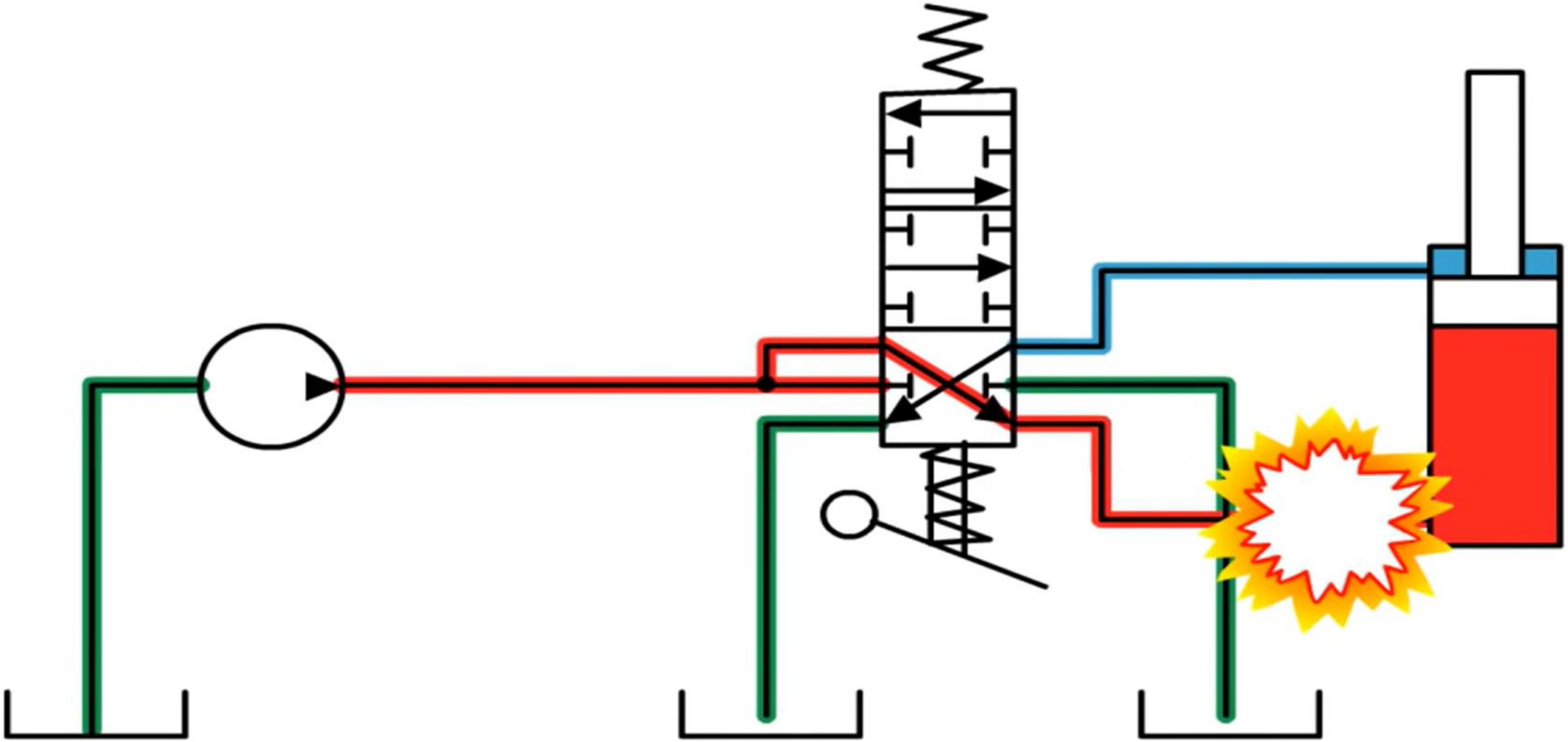
Double Acting, Double Ended Cylinder



PRESSURE GAGE ASSEMBLY & 4" HOSE ASSEMBLY

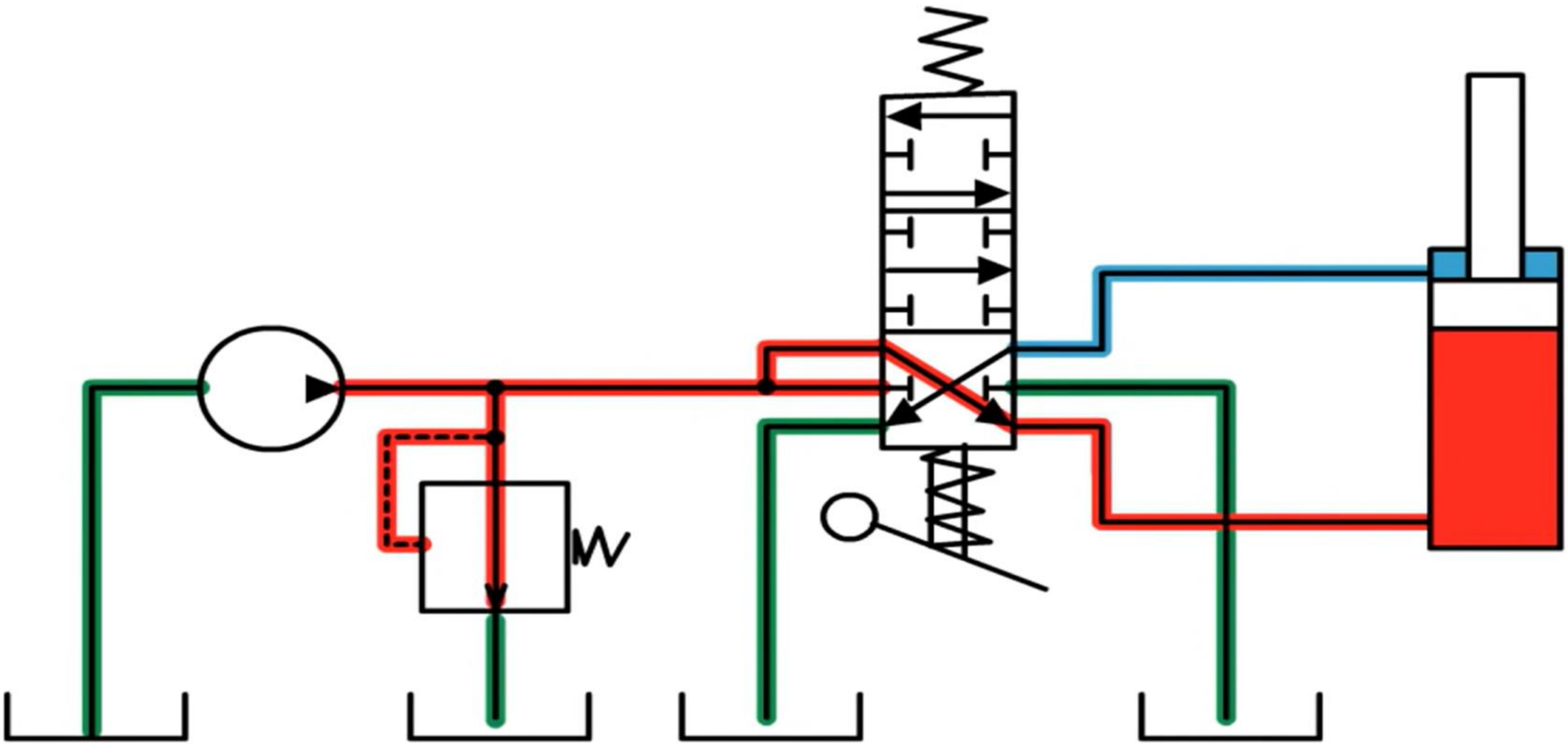


HYDRAULIC VALVES



Speaker No Speaker

HYDRAULIC VALVES



Speaker

No Speaker

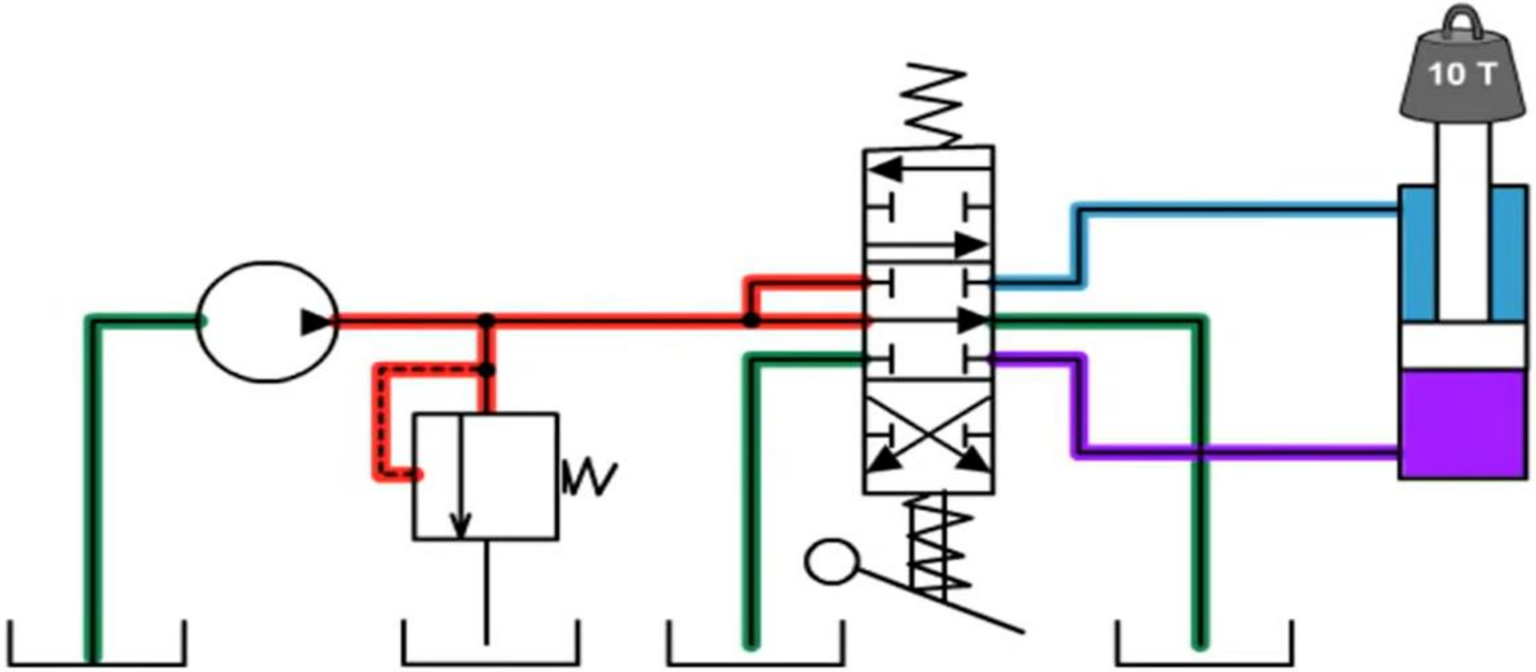
HYDRAULIC VALVES

Load holding valve

If we now have a load on the piston rod of the cylinder while the directional valve spool stands is in its neutral position?

The piston rod will be pressed down until the pressure in the system exceeds the pressure caused by the force on the piston rod.

This can be prevented with a load holding valve.

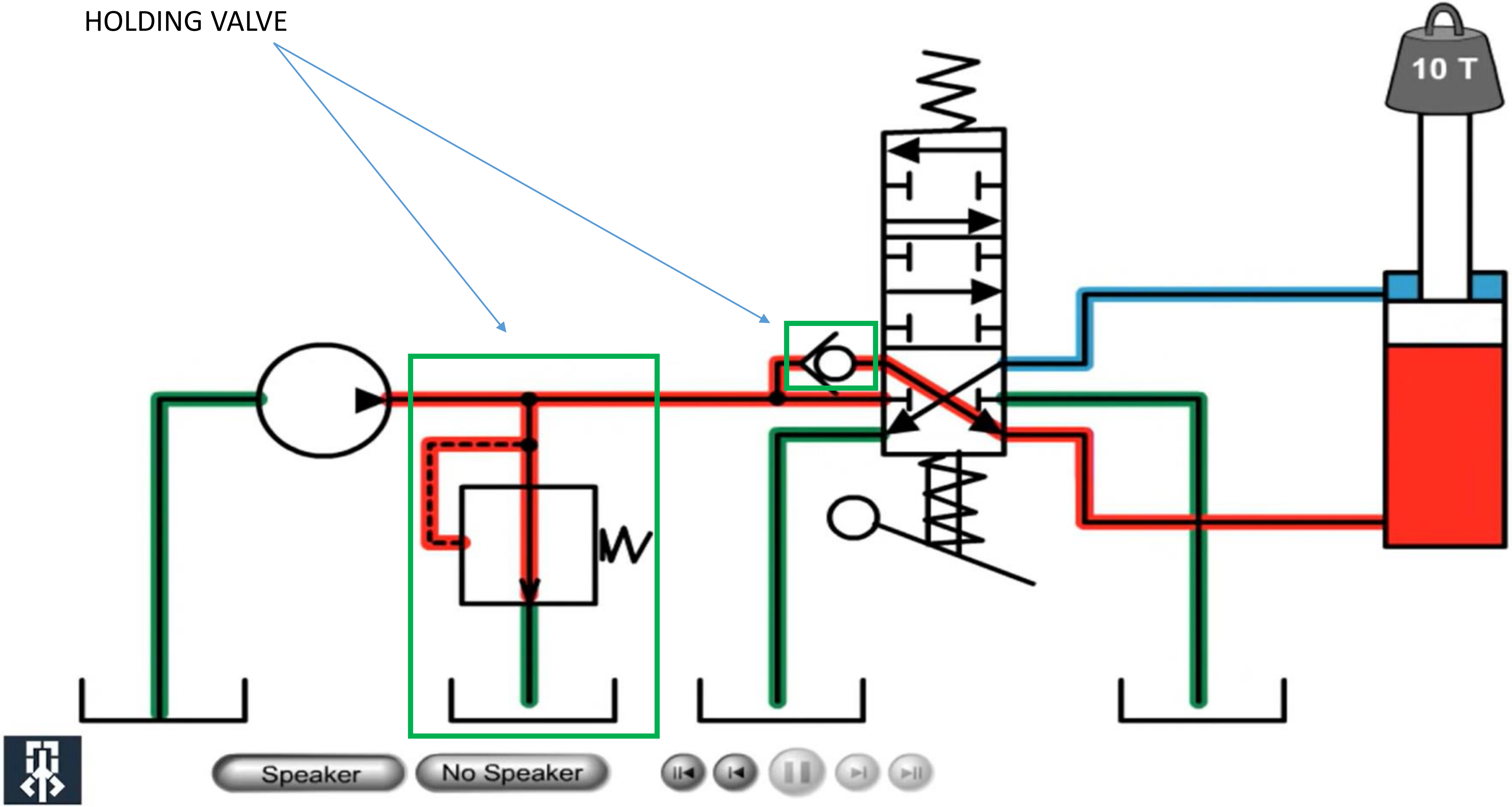


Speaker No Speaker

Enlarge media and remove the text

HYDRAULIC VALVES

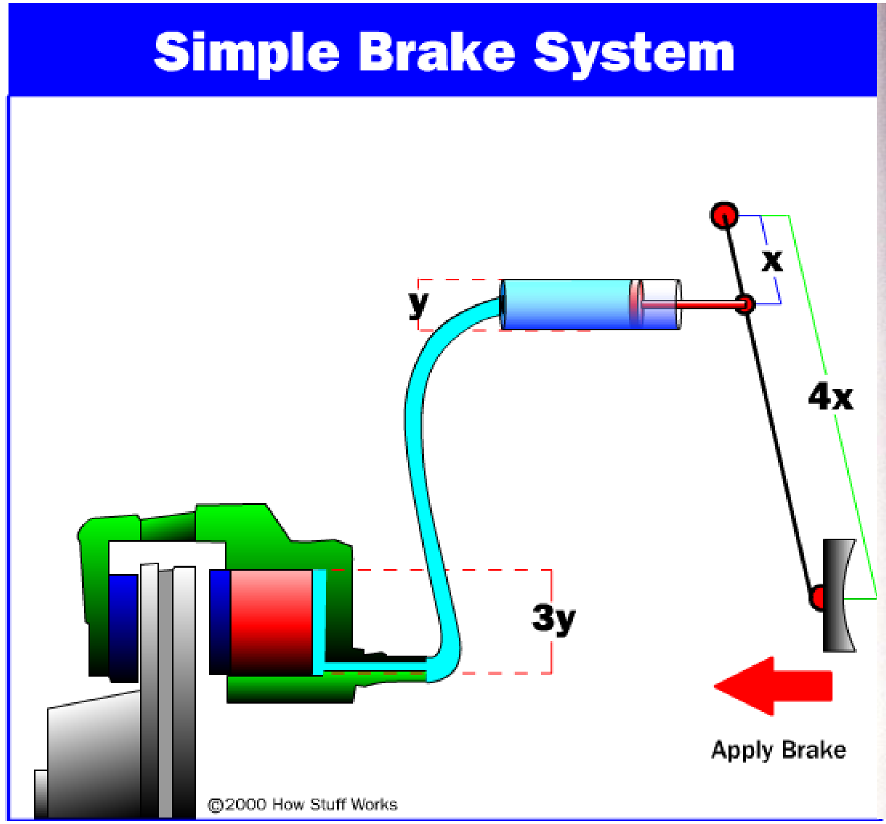
HOLDING VALVE

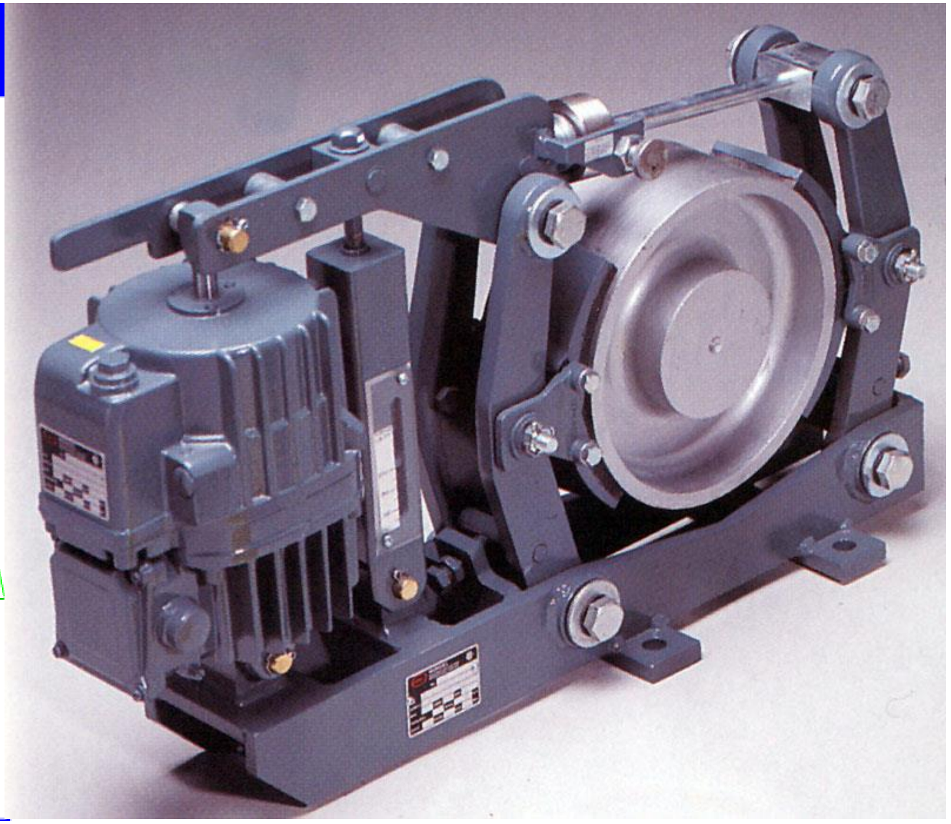


Hydraulic

Presenter: Nguyen Si Khang

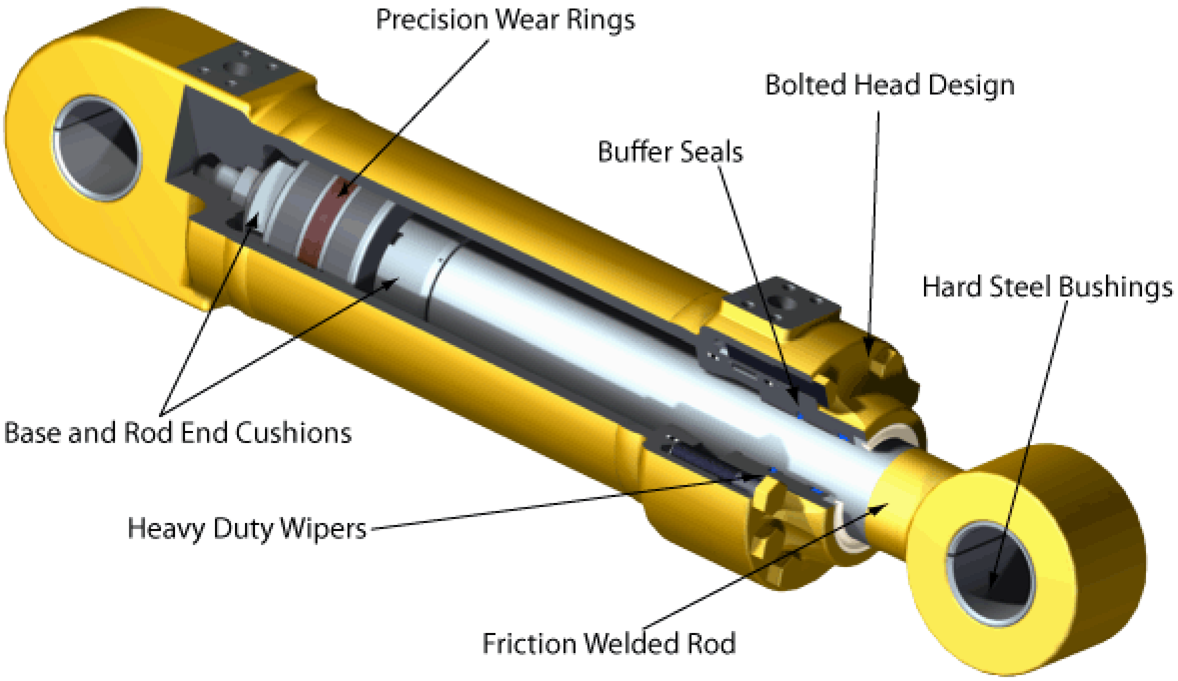
Hydraulic System- Brake Testing is Required





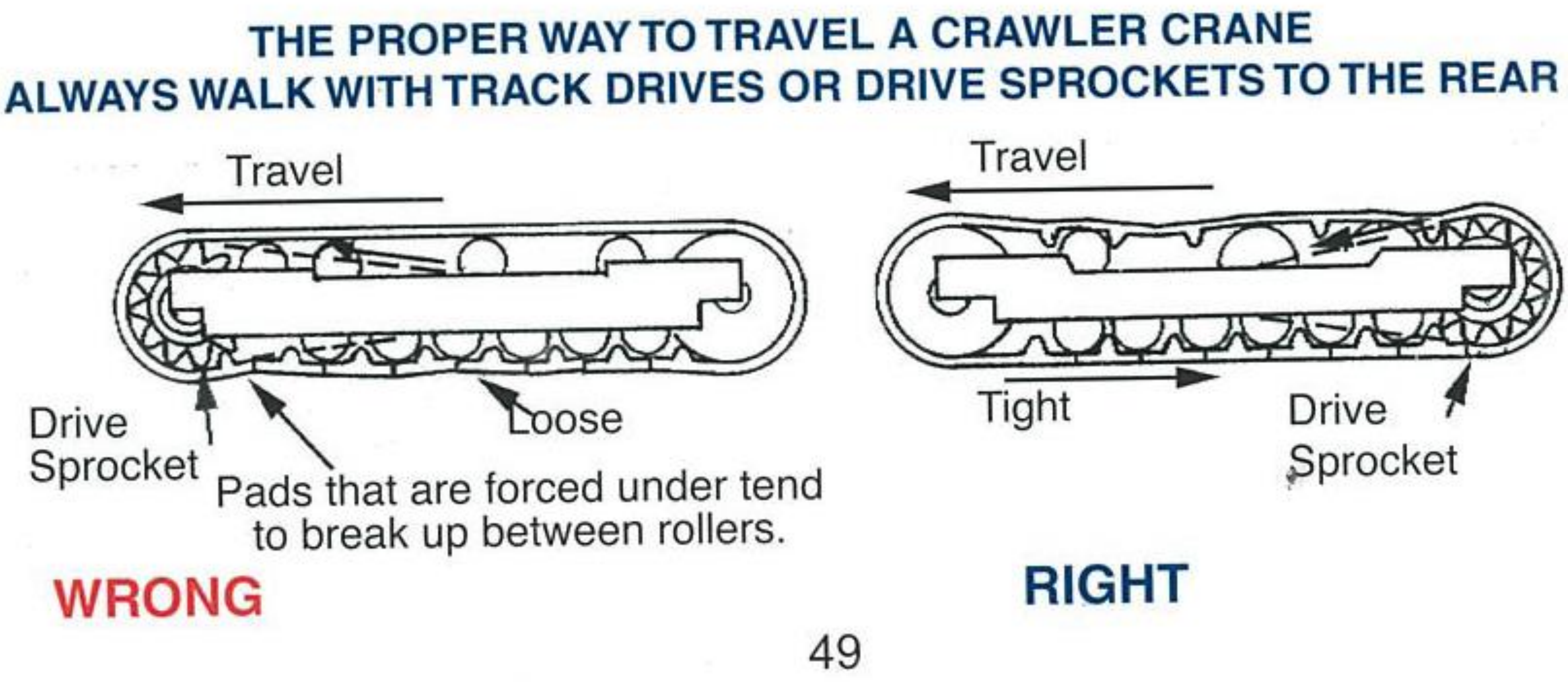
Presenter: Nguyen Si Khang

Hydraulic Cylinder



Presenter: Nguyen Si Khang

Crane Set Up



Presenter: Nguyen Si Khang

Outrigger Set Up- Timber Pad

Timbers, pads and bog mats should be of dimensions and materials as specified by the crane manufacturer. If the manufacturer has not provided this information, a competent person should specify the minimum size of the material to be used.

Generally, the following principles should be applied to timbers, pads, steel plates and bog mats:

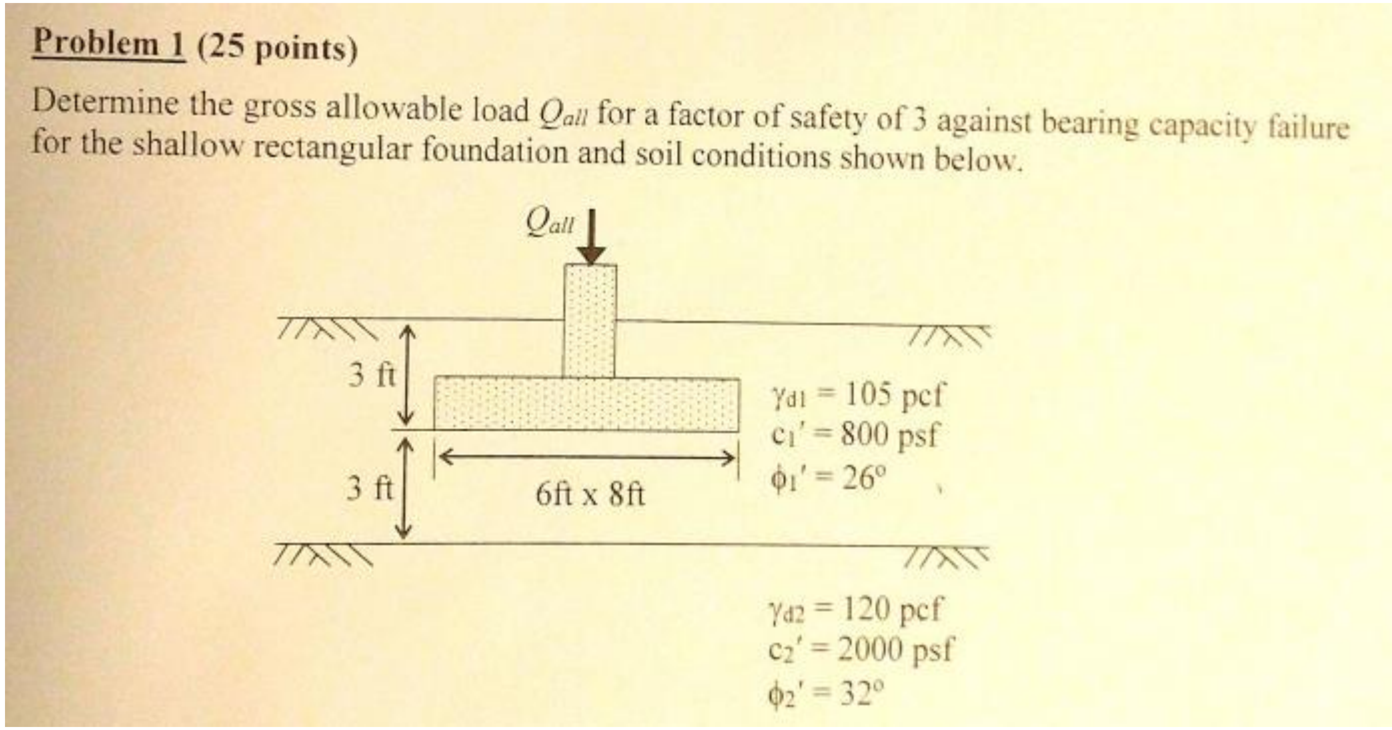
(a) Timbers should have a minimum width of 200 mm and minimum thickness of 75 mm.

(b) Timbers should be laid together so that the width of the timber pad is wider than the outrigger foot with no gaps between timbers.

(c) Pads should have a minimum thickness of 75 mm.

(d) The dimensions of steel plates and bog mats should be determined by a competent person, based on the type of mobile crane.

Outrigger Set Up- Soil Bearing Capacity



Problem 1 (25 points)

Determine the gross allowable load Q_{all} for a factor of safety of 3 against bearing capacity failure for the shallow rectangular foundation and soil conditions shown below.

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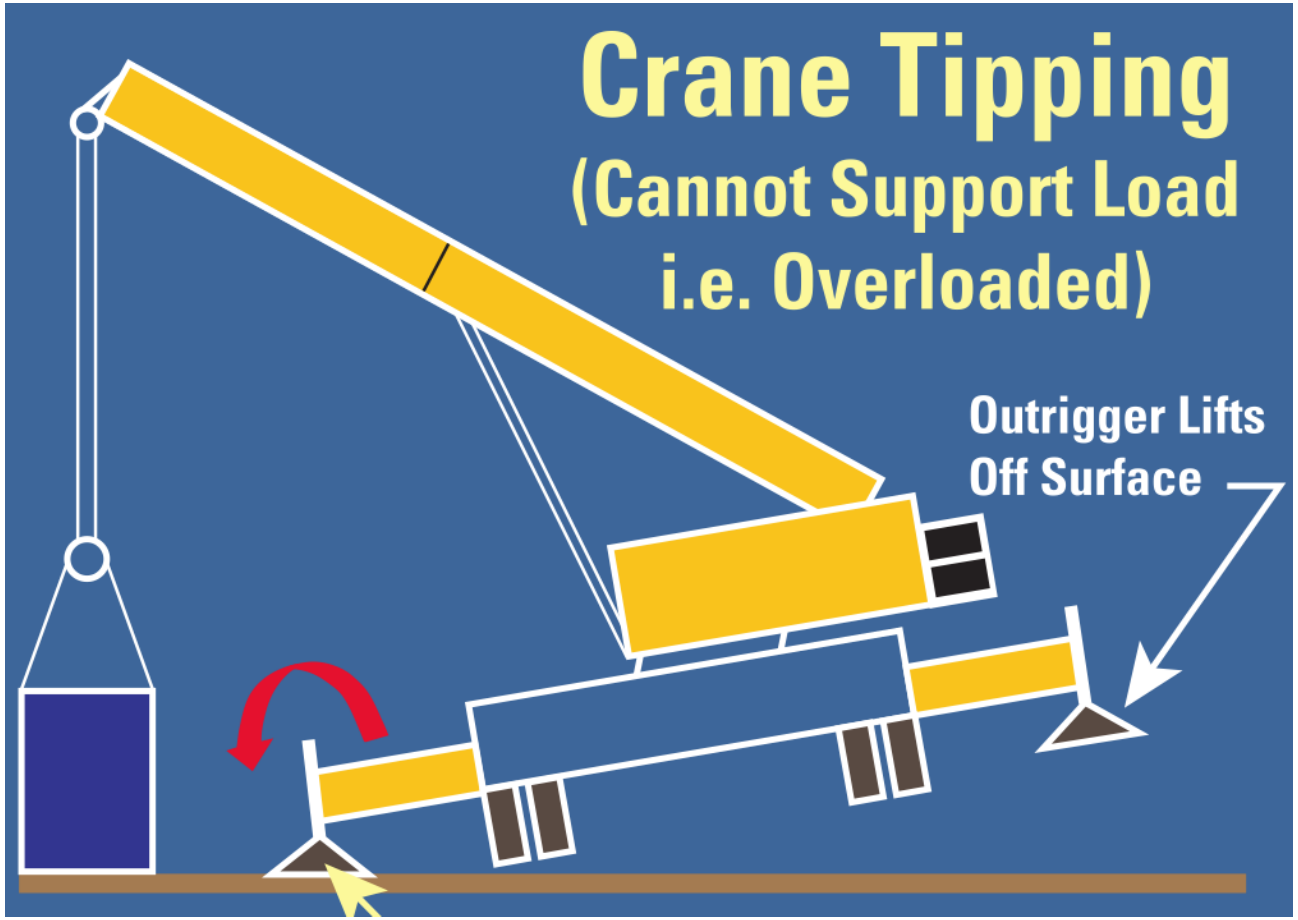
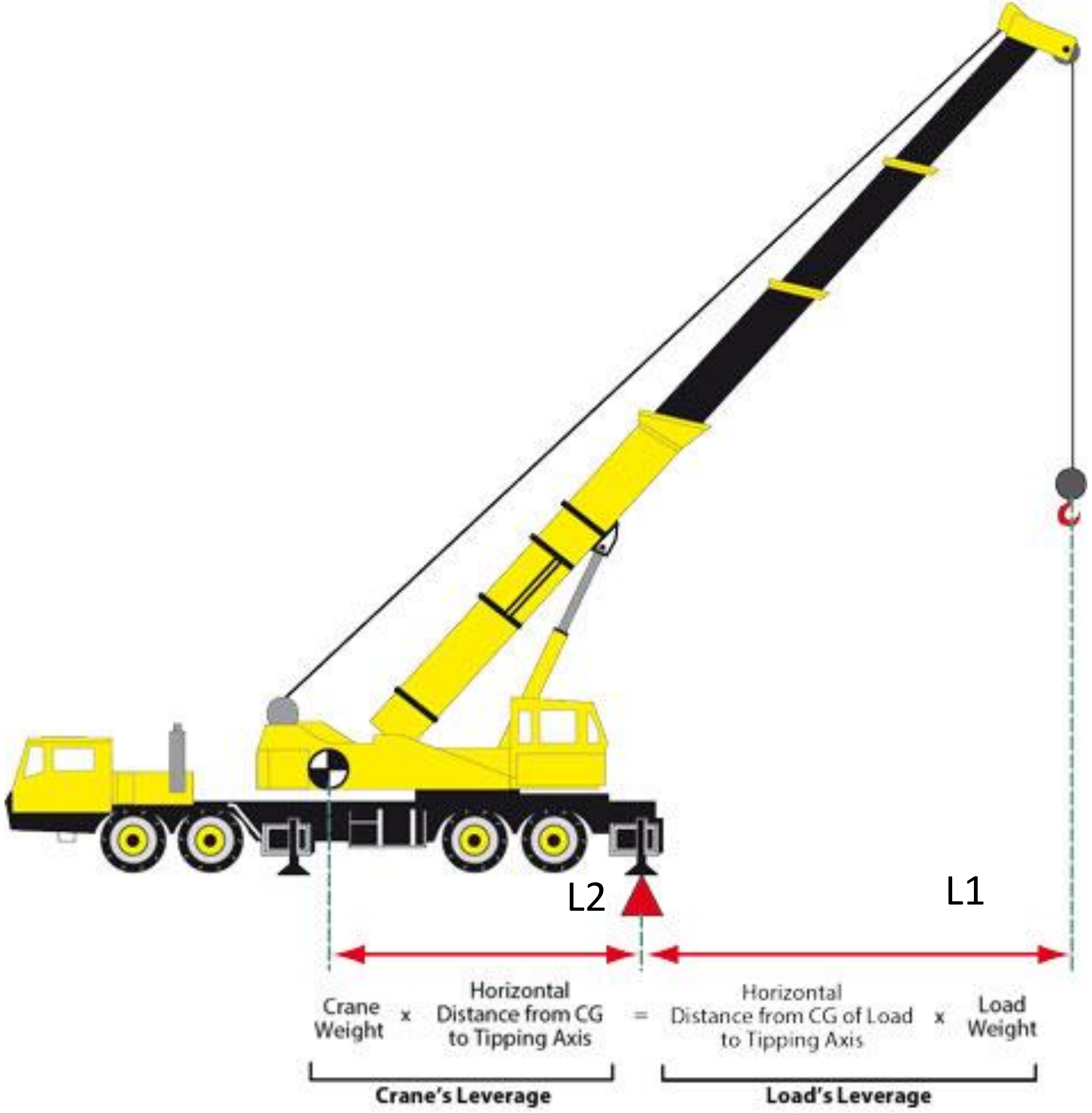
OUTRIGGER SETUP



Outrigger Set Up- Stabilizer Float Square Meter

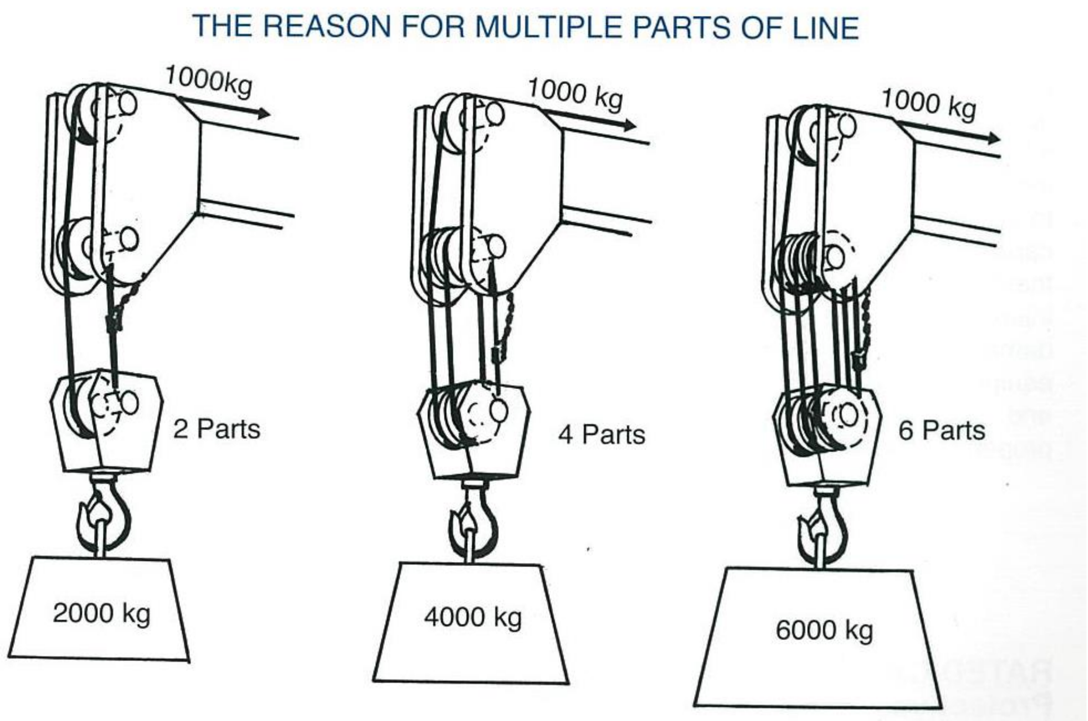


Load's Leverage= Weight A * L1 Crane's Leverage = Load's Leverage

Weight B = Load's Leverage/ L2

$$S=\frac{(Weight\ A+Weight\ B)+\frac{Weight\ Crane}{4}}{SOIL\ BEARING\ CAPACITY}$$

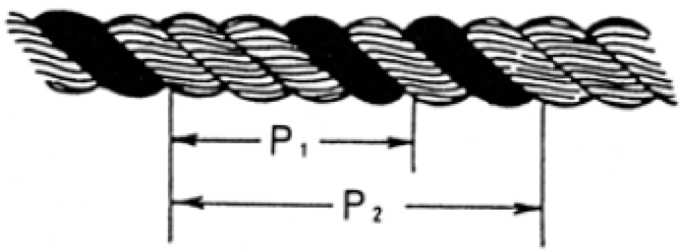
Wire rope



○ When using a wire rope

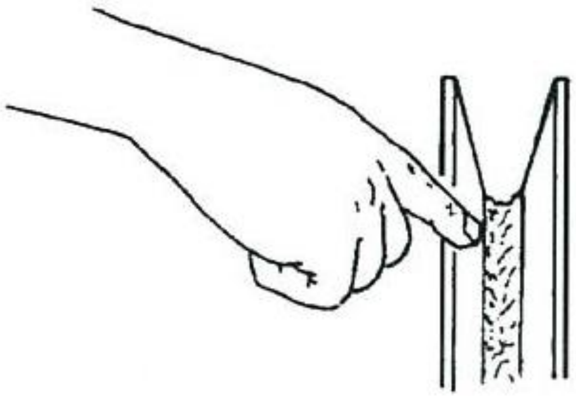
- The wires must not break.
  (The number of broken wires in one strand must be less than 10% of the total number of wires. See figure at right.)
- The reduction of diameter must be no more than 7% of the nominal diameter.
- The wire rope must not be kinked.
- The wire rope must not be markedly misshapen or corroded

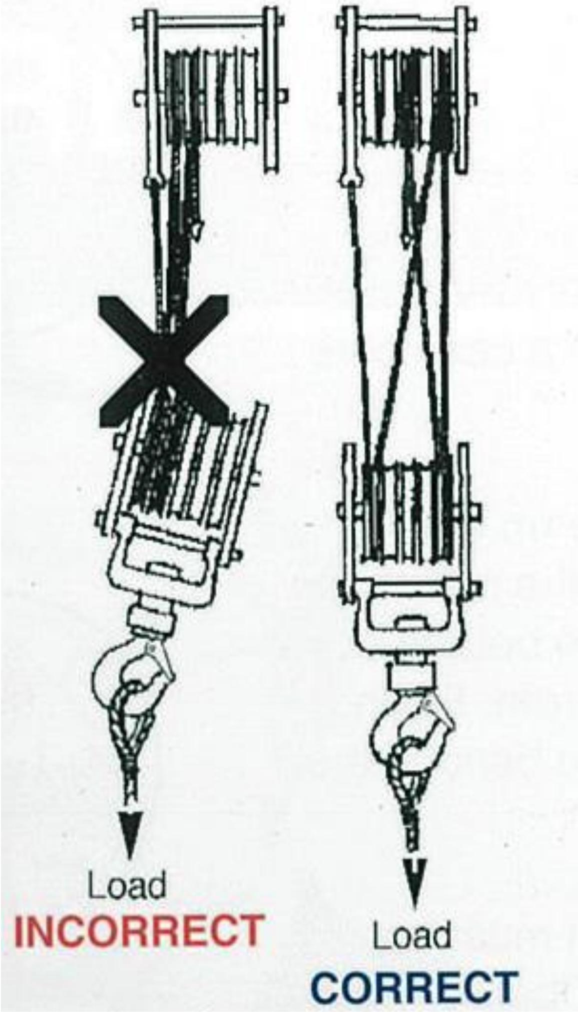
One strand of wire rope



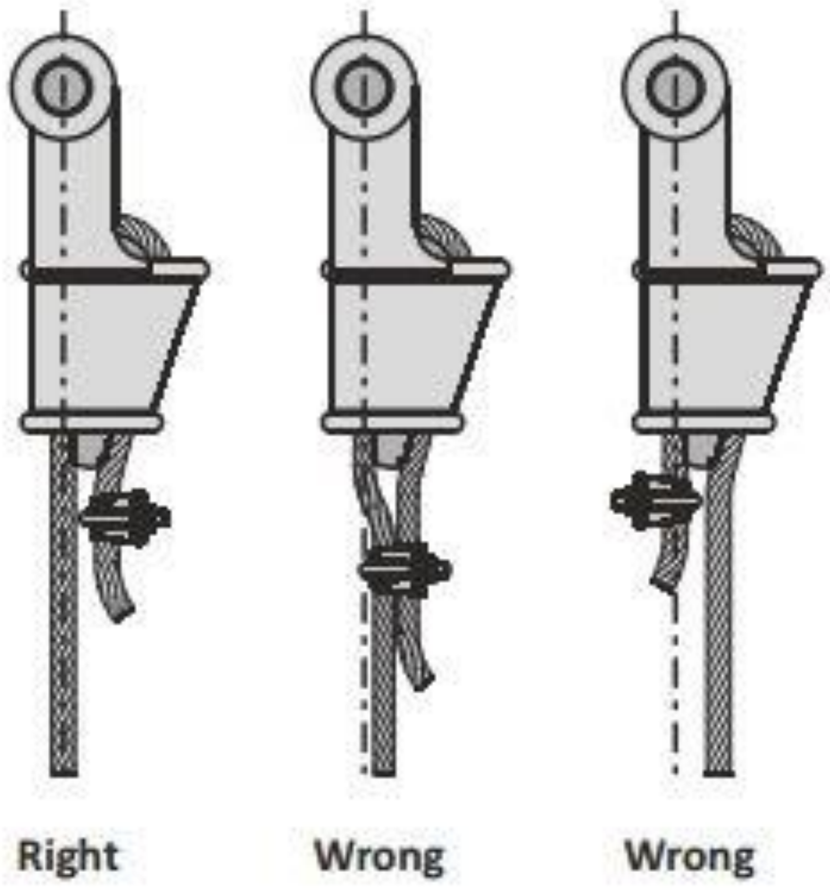
P_1… For 4-strand wire
P_2… For 6-strand wire

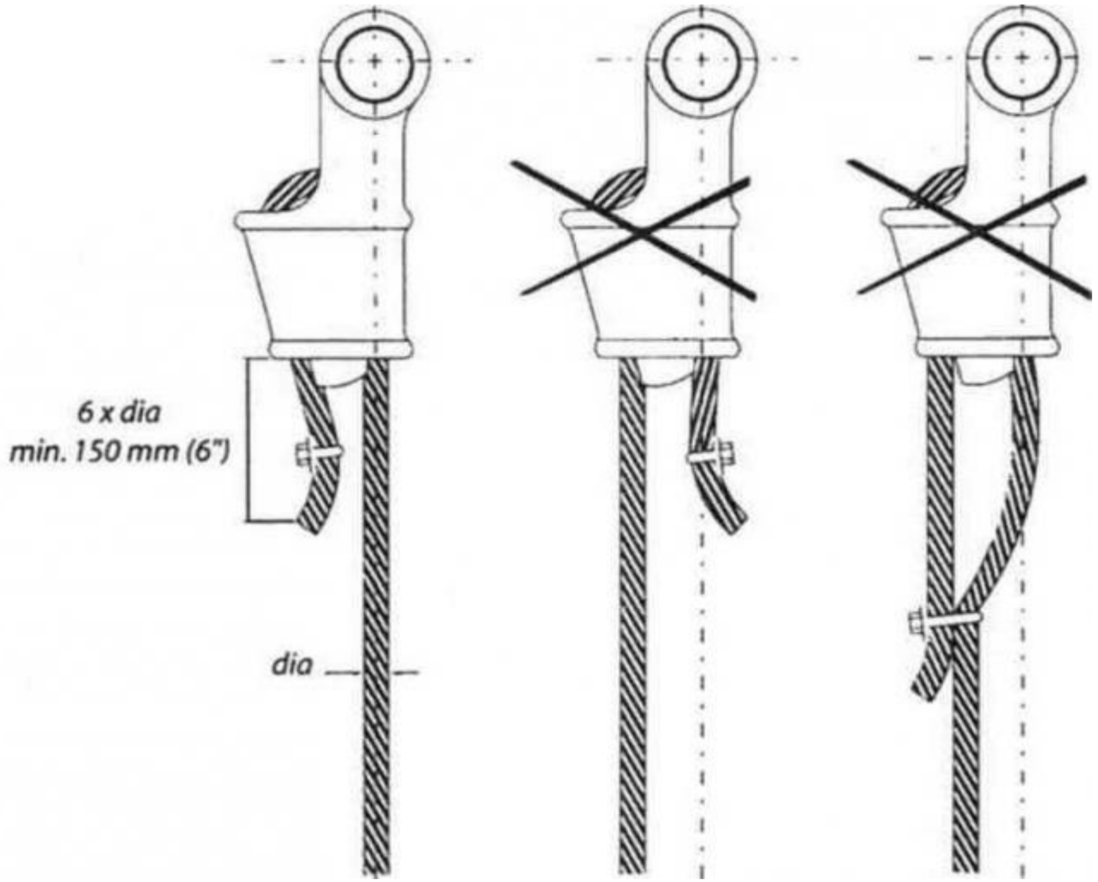
Wire Rope – Block Hook





Fitting Wedge Rope

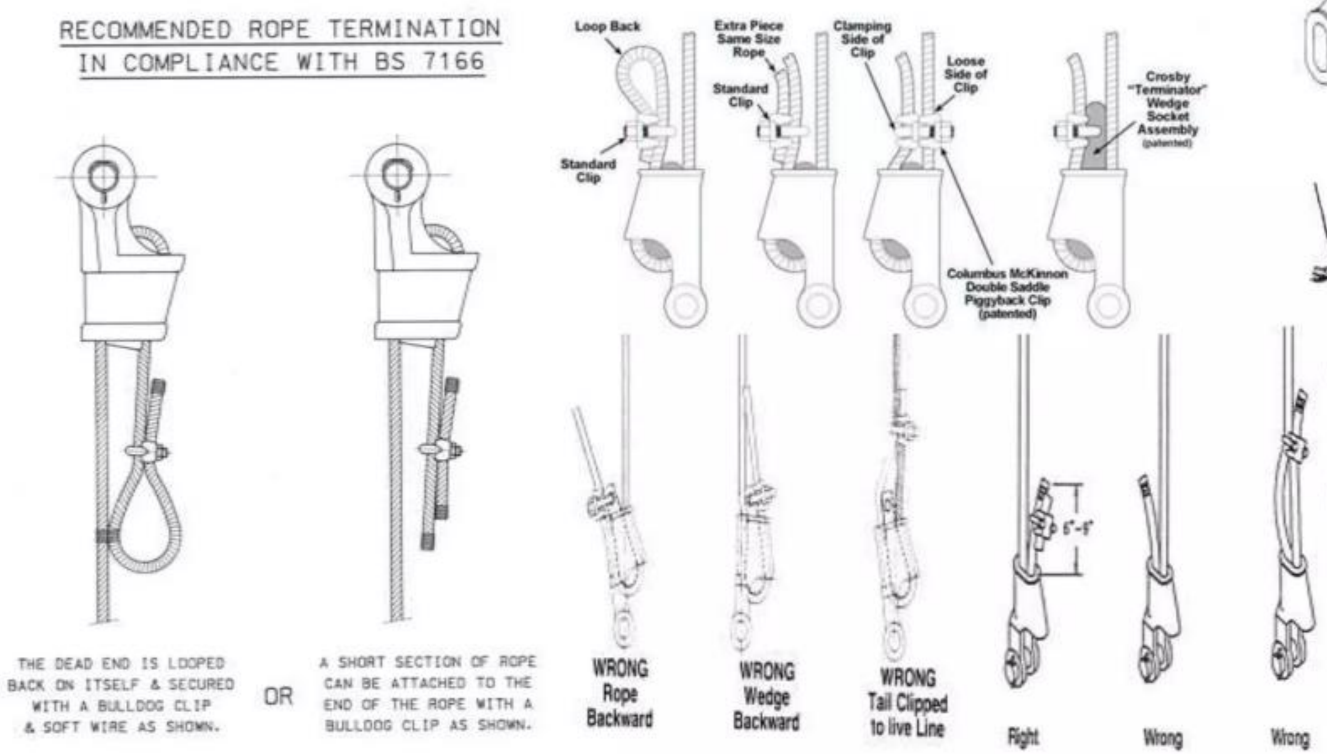


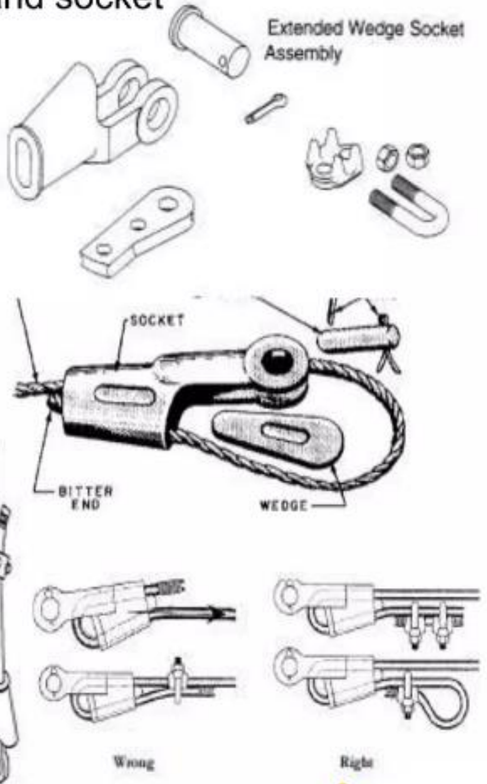


Presenter: Nguyen Si Khang

SAFE USE OF SLINGS- WEDGE SOCKET

Wedge sockets are among the simplest devices for anchoring a wire rope for any purpose. They are intented for on-the-job attachment and for quick rope replacement. However, the efficiency of a wedge socket is low- only 70 percent of the strength of the rope
The wedge socket must be properly set up as per the relevant Standard BS 7166, or equivalent
Protruding rope shall be a length of 6xdiameter of the rope
Wedge-type rope sockets should be inspected for damage to rope, wedge and socket
The wedge should be removed with a punch
Correct methods of fitting rope to wedge and use rope grips.

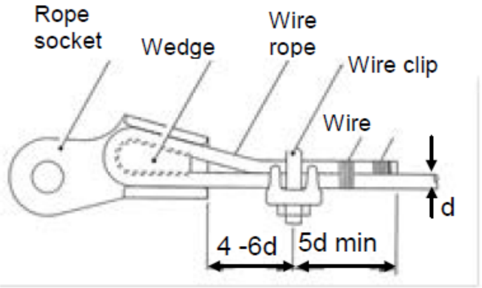




Wire Rope

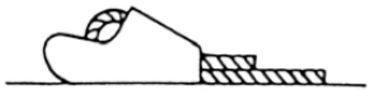
Method of fixing a wire rope

Wedge type fixing

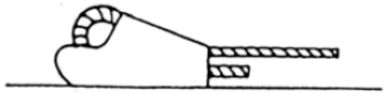


* Based on the manufacturer's instruction manual

In the case of a wedge type rope socket



○ Correct method



× Incorrect method

* In case of using in combination with clips, the proper method for fixing clips shall be studied.

Method of fixing clips

(a) Correct method

(b) Incorrect method

© Incorrect method

Clip utilization standard

Rope diameter (mm)	Number of clips	Interval between clips (mm)
9 -16	4	80
18	5	110
22.4	5	130
25	5	150
28	5	180
31.5	6	200
35.5	7	230
37.5	8	250

BASIC HITCHES

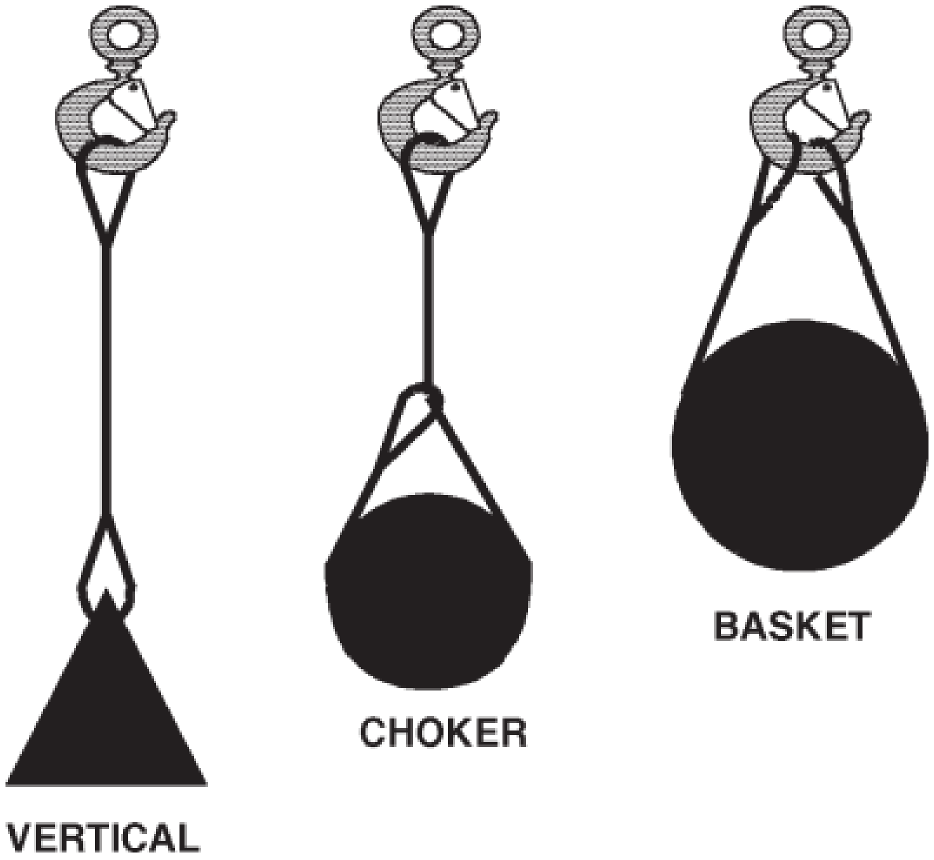
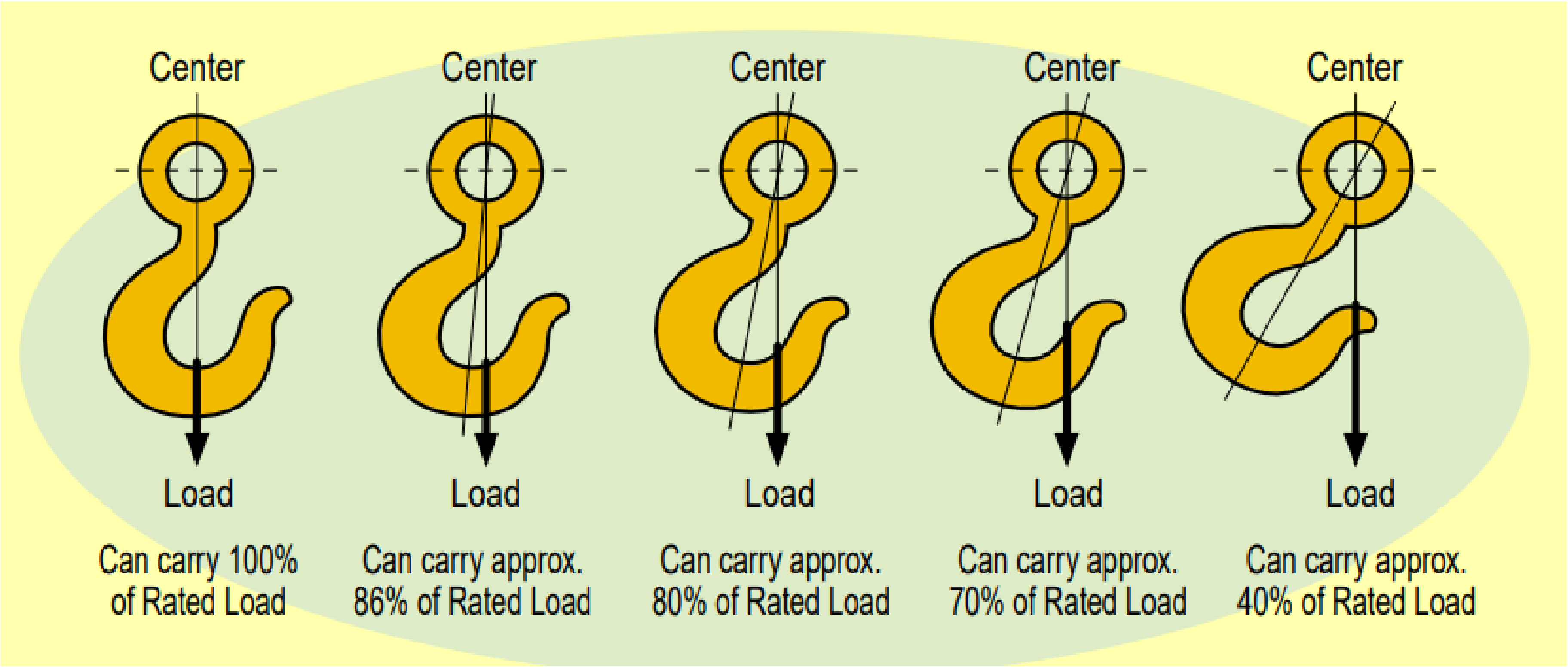


Figure B-11: Basic Hitches

BASIC HITCHES



Masterlink- Functional

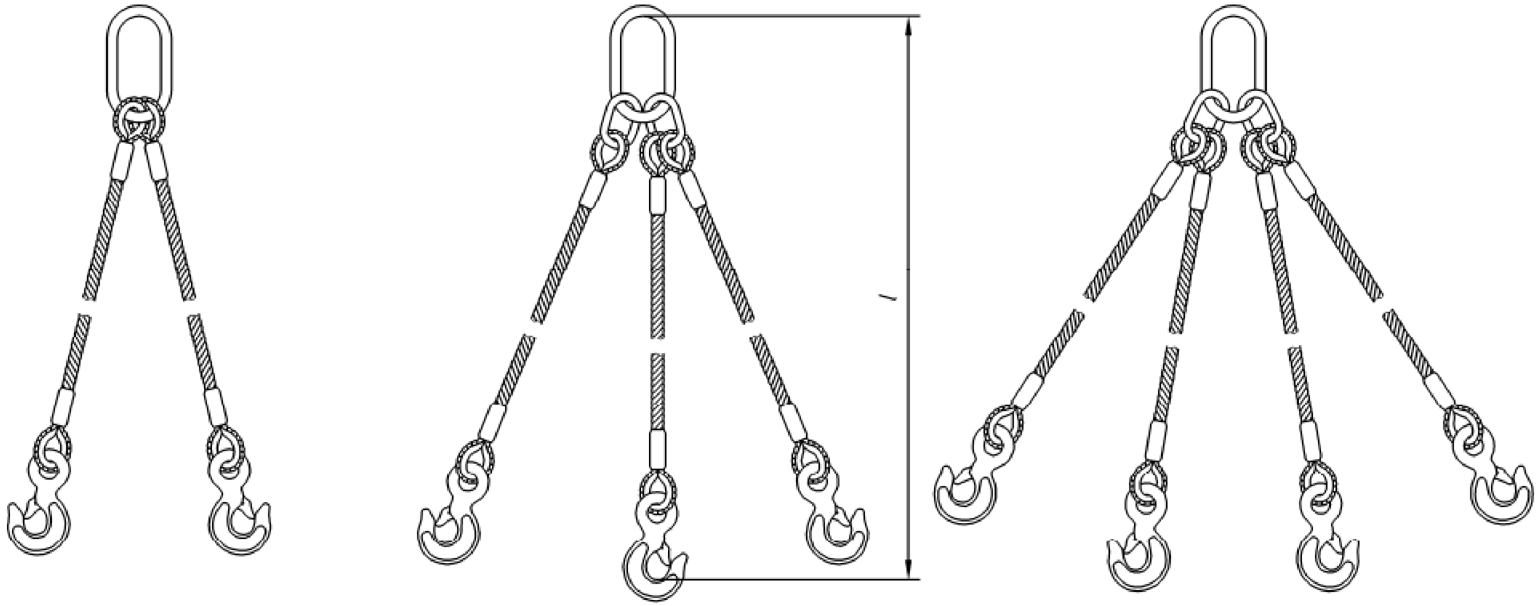
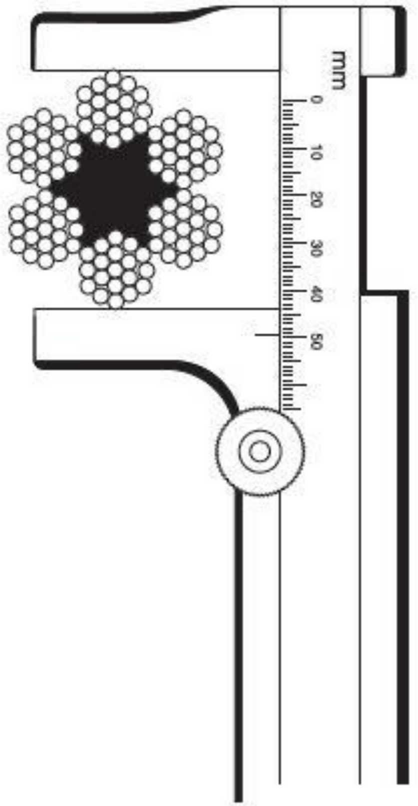


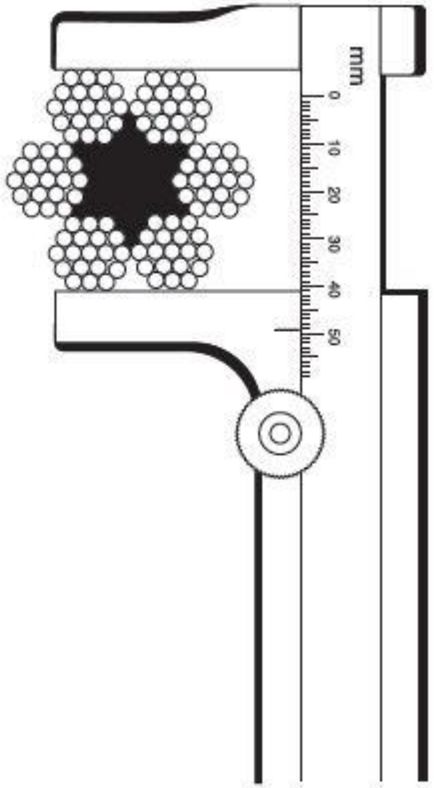
Figure 1 — Multi-leg slings

Wire Rope

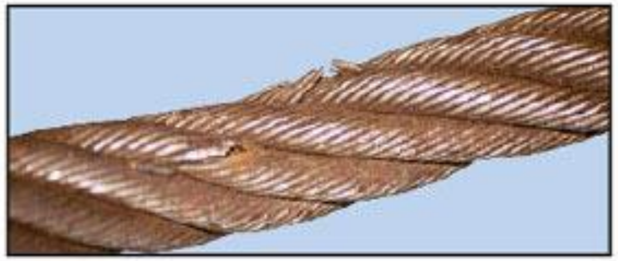
Correct Way
This gives correct Diameter



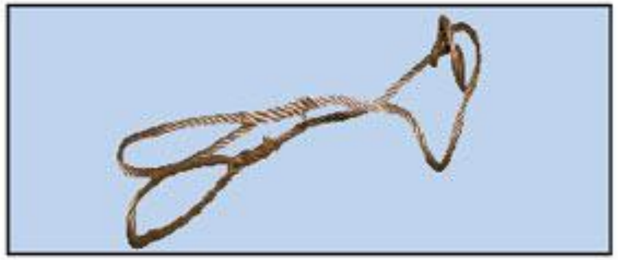
Incorrect Way
This does not give correct Diameter



Broken Wires



Kinked Wire

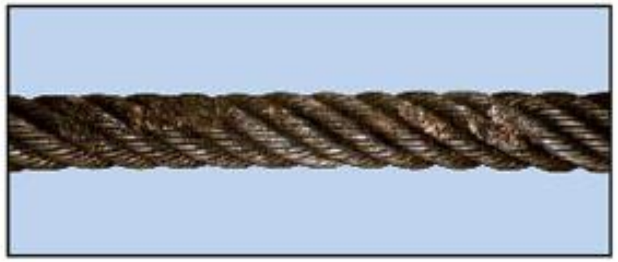


Abraded/Worn Wire

Popped Core

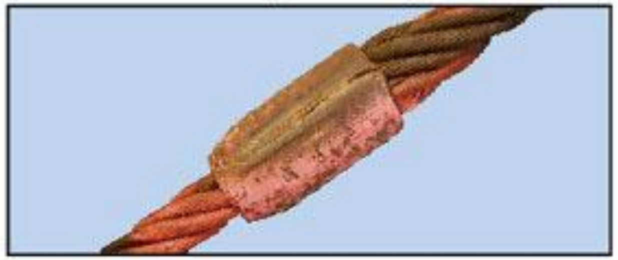
Corrosion

Heat Damage

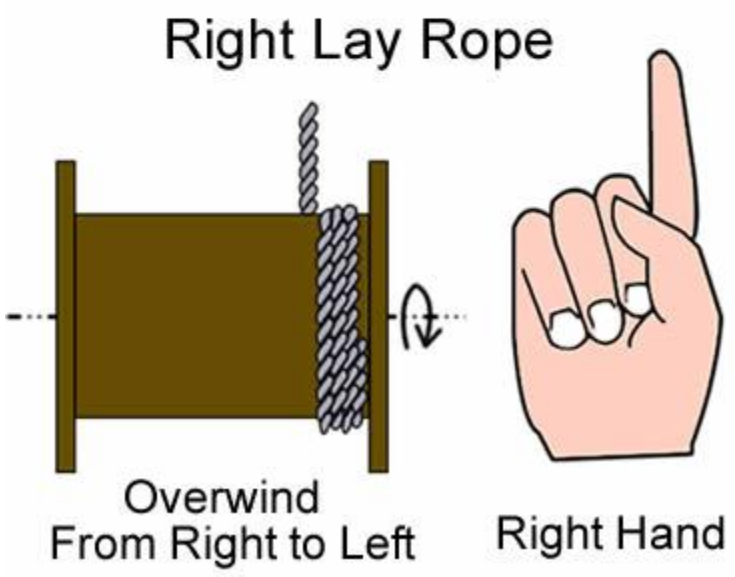


Bird Caging

Damaged Fittings

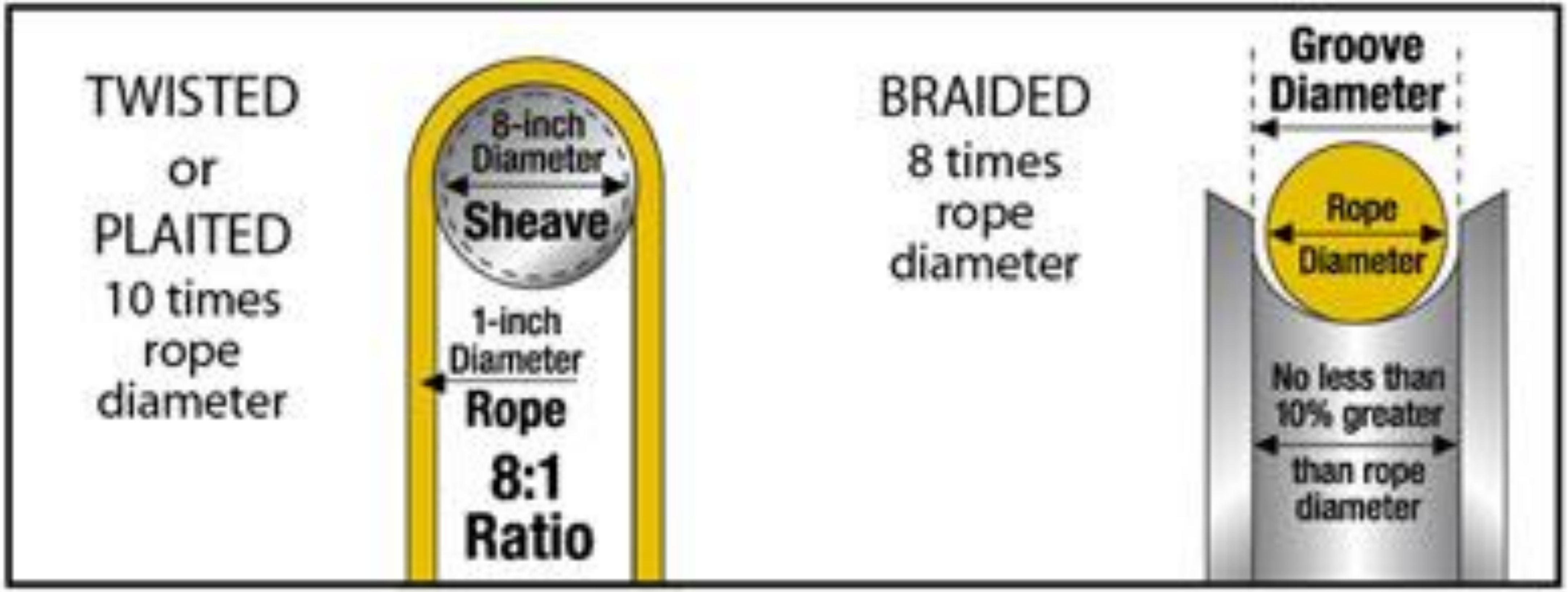


REMANING WRAP ON THE DRUM



Background: The American Society of Mechanical Engineers (ASME) B30 Standards Committee stated in a September 26, 2005 interpretation letter the following:

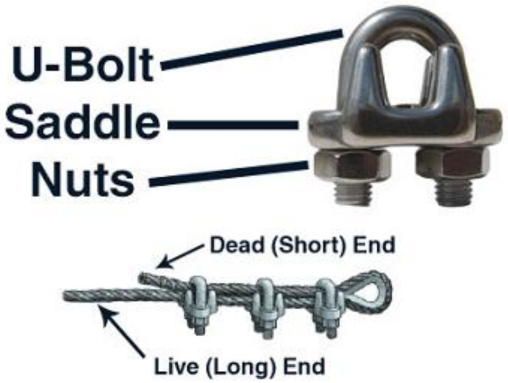
> Background: The following statement appears in Para. 2-1.14.3 of ASME B30.2, Para. 11-3.2.3 of ASME B30.11, and Para. 16-1.2.6 of ASME B30.16:
>
> No less than two wraps of rope shall remain on the drum at each anchorage of the hoist(ing) drum when the hook is in its extreme low position unless a lower-limit device is provided, in which case no less than one wrap shall remain.
>
> Question 1: When the hook is in its "extreme low position," does this mean that the hook is at its lowest point of travel when all of the rope has been unwound, except for the required wraps?
>
> Reply 1: Yes.
>
> Question 2: When the hook is in its "extreme low position," does this mean that the hook must be capable of traveling all the way to the ground with no load?
>
> Reply 2: No.


TWISTED
or
PLAITED
10 times
rope
diameter
8-inch
Diameter
Sheave
1-inch
Diameter
Rope
8:1
Ratio
BRAIDED
8 times
rope
diameter
Groove
Diameter
Rope
Diameter
No less than
10% greater
than rope
diameter

Wire Rope Sling Eyes

Hand Tucked Eye Splice

Eye splices must be tucked at least three times for each strand.



Mechanical Eye Splice

Wire Rope – Working Load Limited

WLL= (Square meter* Minimum Breaking Load)/Safety Factor.

FACTORS CAUSING ROPE DETERIORATION

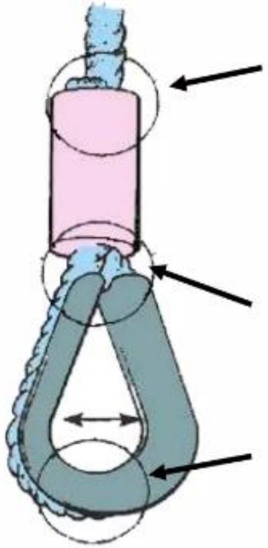
TERMINATION FAILURES

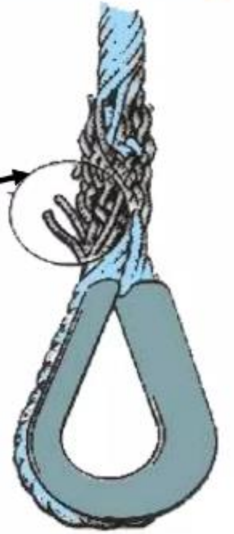
Rope Terminations

- •Spliced eye
- •Ferrule-secured eye
- •Metal or Resin filled socket
- •Wedge socket
- •Pressed/Swaged
- •Wire rope grips

Termination Failures

- •Incorrect selection of termination
- •Incorrect fitting of termination
- •Inadequate inspection/examination
- •Failure to maintain in service



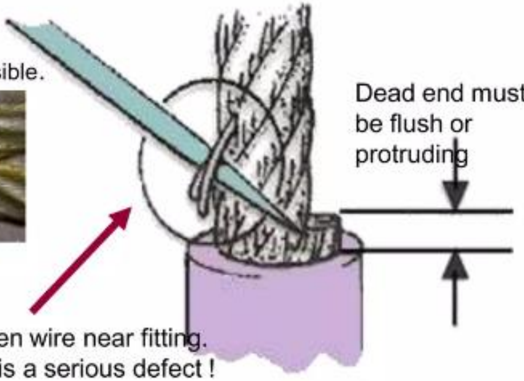


What to look for at a rope termination (CHECK):

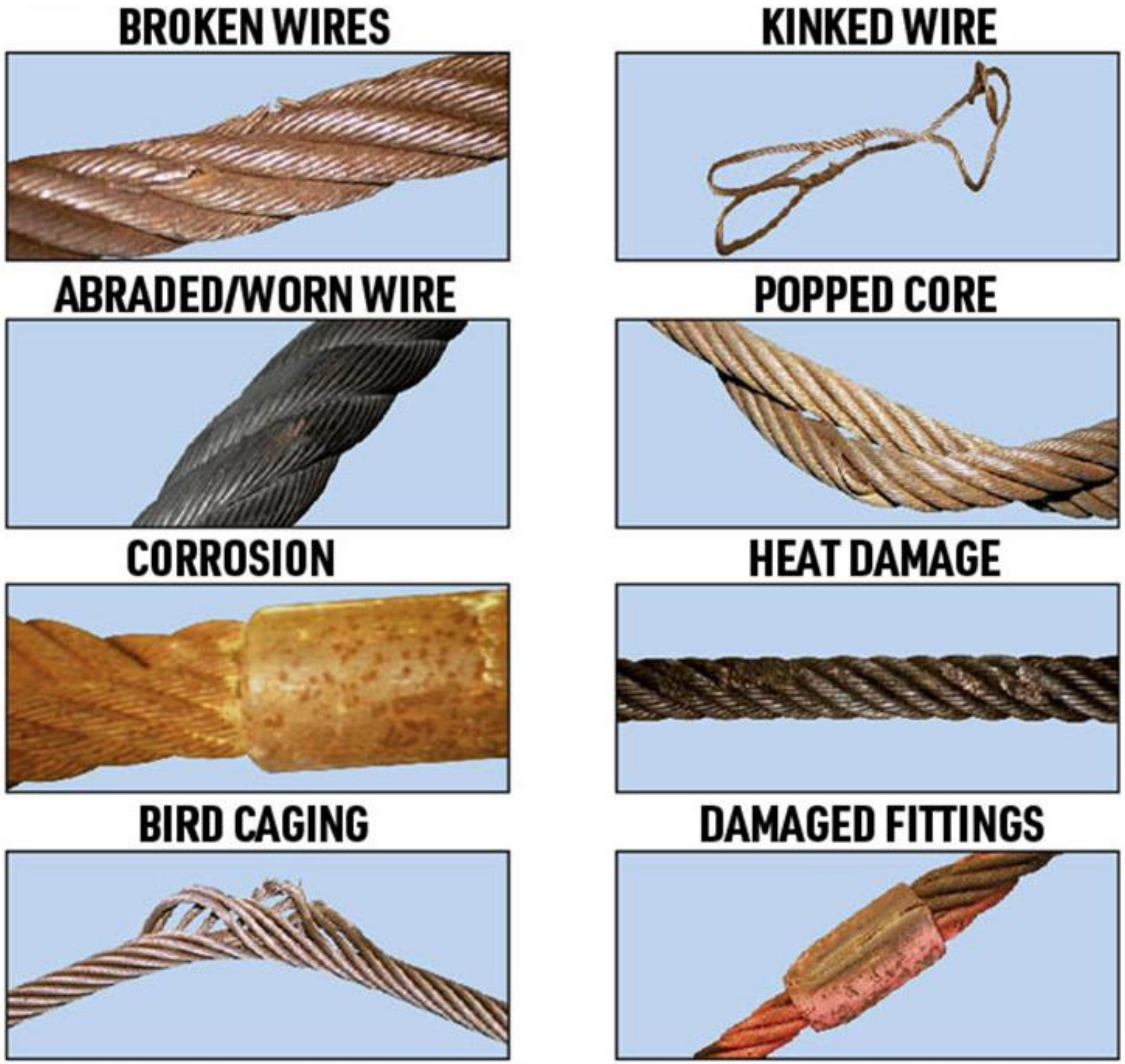
- ✓ Wire breaks
- ✓ Corrosion
- ✓ Reduction in rope diameter
- ✓ Unusual rope movement
- ✓ Evidence of rope end
- ✓ Evidence of any incorrect fitting
- ✓ Evidence of any component wear
- ✓ Presence of any interwire pressure/friction marks
- ✓ State of internal lubrication

Inspect termination, ensure wire rope end is visible.

Dead end tail = Rope dia. (+/-)



Wire Rope – Damaged



Chain Sling

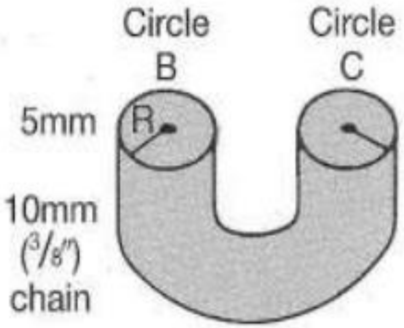
GRADE 30- industrial and agriculture applications including guard rail chain, logging and load securement. Not to be used for overhead lifting.
GRADE 40- is a high-test chain, approximately 50% stronger than Grade 30 chain. Typical uses are load binding, tie downs, and towing.
GRADE 60- may be used in rigging and lifting applications.
GRADE 70— Links are heat treated. Ideal for transport, load binding, logging and towing. This chain is 20% stronger than grade 40 chain and about 60% stronger than Grade 30 chain.
Typically used by truckers, loggers and highway crews. . Not to be used for overhead lifting.

RECOMMENDED FOR LIFTING

Grade 80— **The most common chain for lifting**. Maximum temperature is 400 F. Recommended for overhead lifting.
Widely used for slings, magnets, heavy duty dragging and pulling.
Grade 100— This chain is approximately 25% stronger than Grade 80 chain Maximum temperature is 400 F. Used in a variety of sling and tie down applications. Approved for lifting.

Chain Sling Calculation

The grade refers to the tensile strength of the chain. This is expressed in newtons per square millimeter (a newton is approximately 0.224805 lbs).
The tensile strength is calculated by multiplying the grade times the area of the two cross sections of a link by the mean stress



Example: 3/8" Grade 80

Area= πR^2

Area of B=3.1416 x 5^2 (or 78.54 mm^2)

Area of B+C=78.54+78.54 (or 157.08 mm^2)

AREA x GRADE = BREAKING STRENGTH

157.08 mm^2 x 800 N=125,664 Newtons

125,664 N x 0.224805 lbs/1N=28,250 lbs

125,664 N 1000=125.66 kN (Kilonewtons)

10.000 N = 1 Tonne

125.66 kN = 12 ,56 Tn

Presenter: Nguyen Si Khang

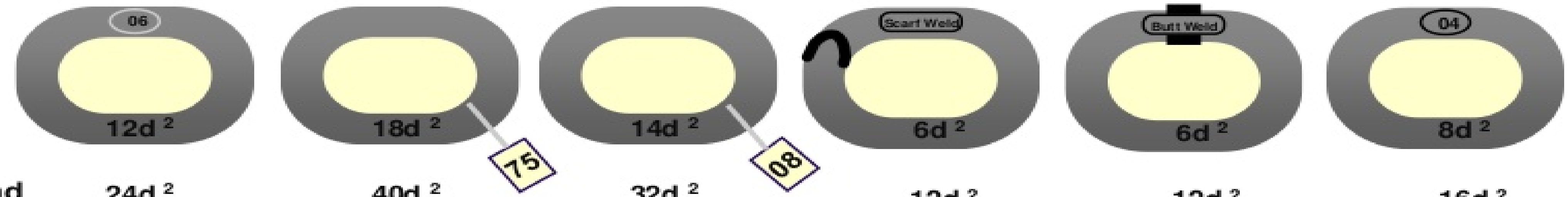
Safety Factor Of Chain Sling

THESE ARE THE MOSTLY GRADE USE ON LIFTING CHAIN FACTOR OF SAFETY 4:1

- GRADE (T) OR 80 — (T), 800, 80, 8, HA PWB or CM
- GRADE (P) — (P), 40, 4 OR 04
- GRADE (L) OR 30 — (L), 30, OR 3

Grade numbers must not be confused with tensile strengths of the steels - they bear no direct relation to the tensile strength of the material.

Chain - Alloy Steel



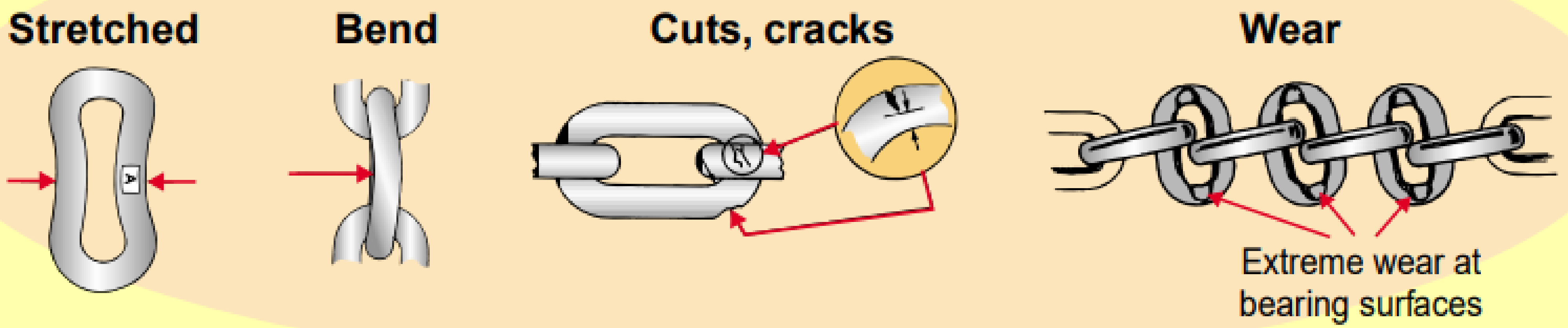
	Grade 60	Grade 75	Grade 80	Wrought Iron	Mild Steel	HTS
SWL	$12d^2$	$18d^2$	$14d^2$	$6d^2$	$6d^2$	$8d^2$
Proof Load	$24d^2$	$40d^2$	$32d^2$	$12d^2$	$12d^2$	$16d^2$
Breaking Load	$60d^2$	$75d^2$	$80d^2$	$27d^2$	$30d^2$	$40d^2$ Marked 4 when normalised

d = diameter of the bar from which the chain is made

Safety Factor Of Chain Sling

Inspection points:

- The chain sling shall be not be used under the following conditions:



WEBSLING

COLOUR & LOAD LIMITS - WEBBING & ROUND SLINGS

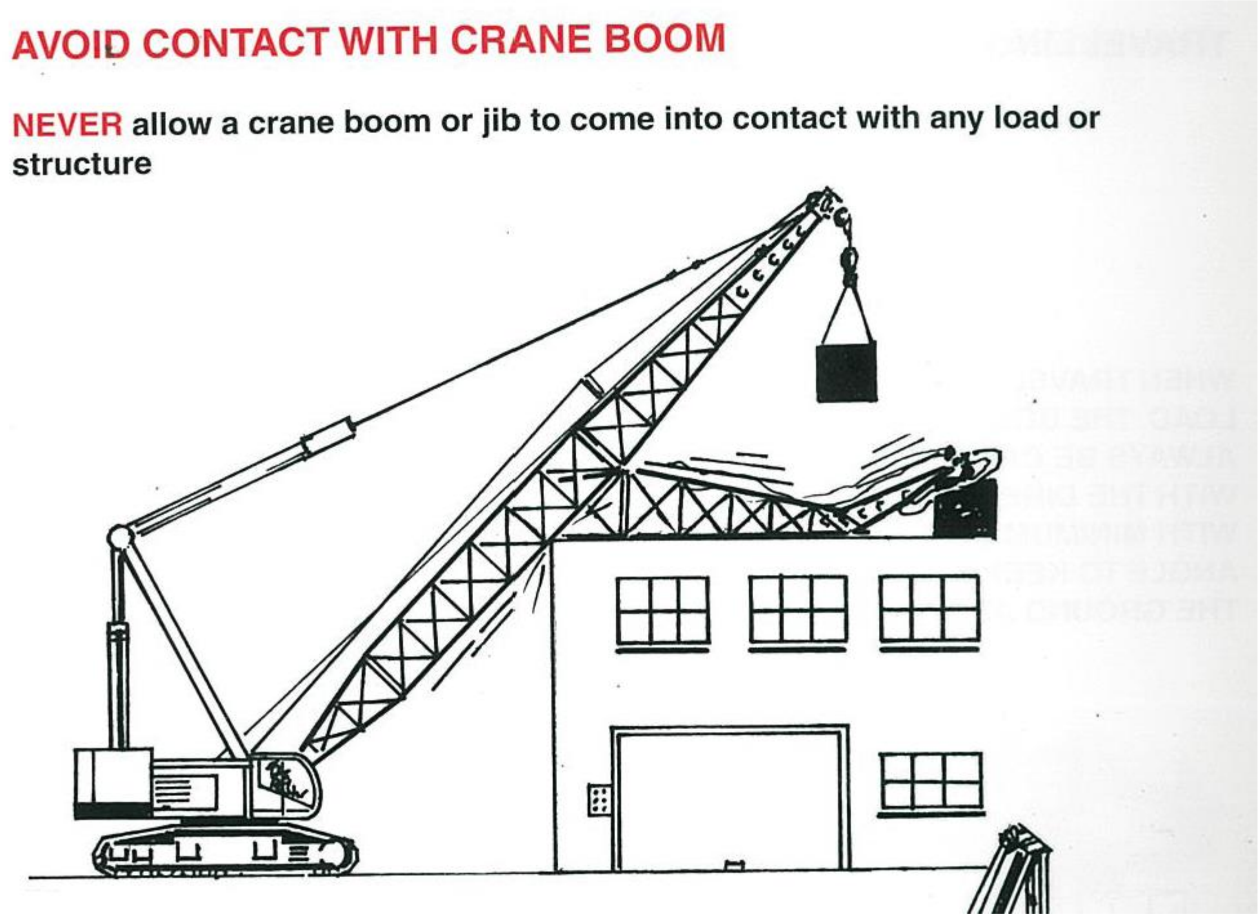
ROUND SLINGS AV. DIA MM	SIMPLEX SLING WIDTH MM	ENDLESS & DUPLEX SLING WIDTH MM	COLOUR	VERTICAL X 1	CHOKE X 0.8	STRAIGHT BASKET X 2	BASKET @ 90° X 1.4	BASKET @ 120° X 1
				WORKING LOAD LIMITS - TONNES				
18	50	25	VIOLET	1.0	0.8	2.0	1.4	1.0
20	100	60	GREEN	2.0	1.6	4.0	2.8	2.0
22	150	75	YELLOW	3.0	2.4	6.0	4.2	3.0
25	200	100	GREY	4.0	3.2	8.0	5.6	4.0
27	250	125	RED	5.0	4.0	10.0	7.0	5.0
32	300	150	BROWN	6.0	4.8	12.0	8.4	6.0
38	*	200	BLUE	8.0	6.4	16.0	11.2	8.0
46	*	250	ORANGE	10.0	8.0	20.0	14.0	10.0
58	*	300	ORANGE	12.0	9.6	24.0	16.8	12.0
70	*	*	ORANGE	15.0	12.0	30.0	21.0	15.0
78	*	*	ORANGE	20.0	16.0	40.0	28.0	20.0
98	*	*	ORANGE	25.0	20.0	50.0	35.0	25.0
118	*	*	ORANGE	30.0	24.0	60.0	42.0	30.0
143	*	*	ORANGE	36.0	28.8	72.0	50.4	36.0

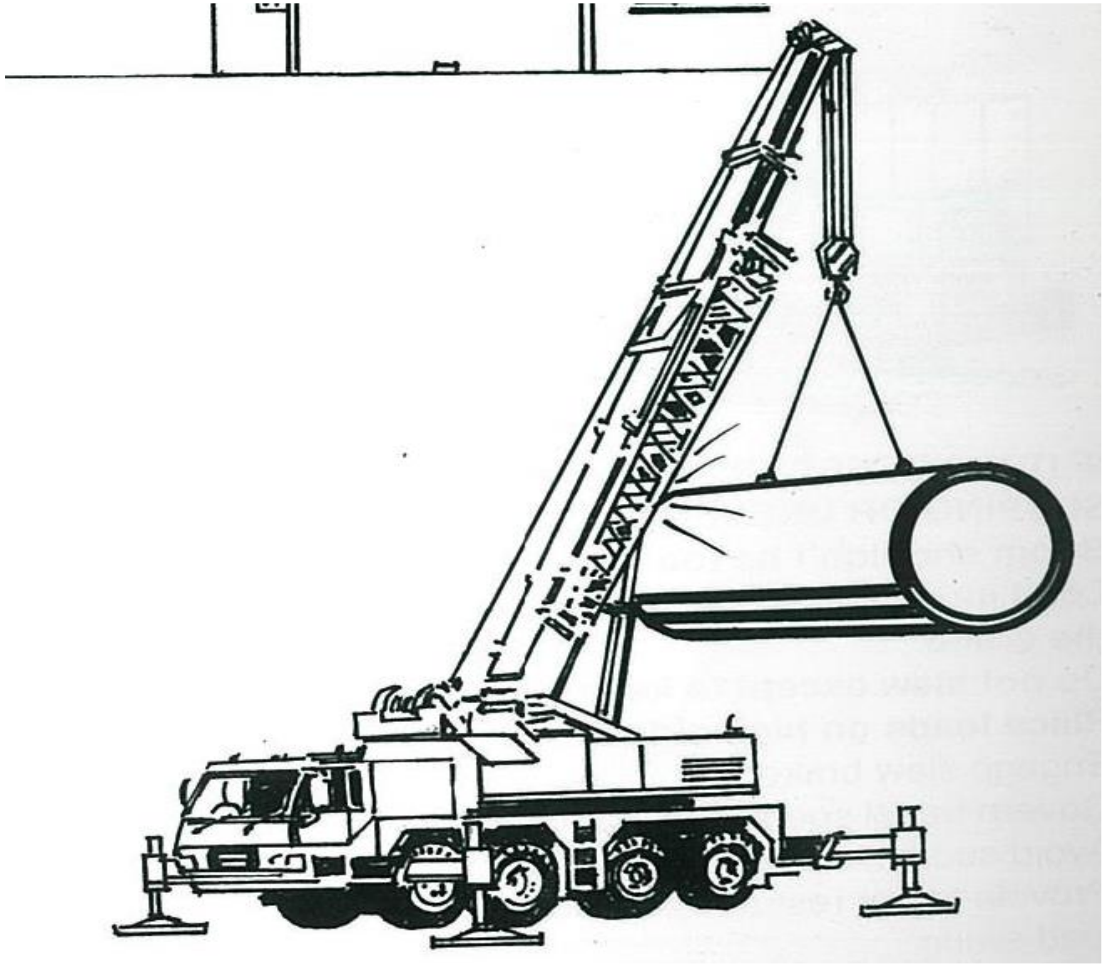
Manufacture & Testing in Accordance with BS6668, Part 2 / BS3481, Part 2

Rules of the thumb : 1inch= 1 ton(width)

Do not knot or damaged the synethic sling

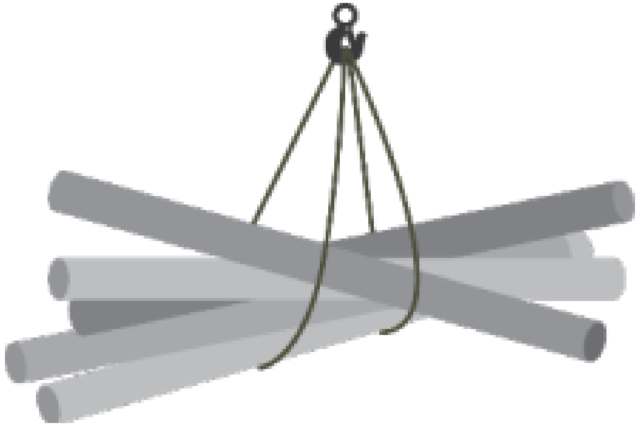
Operation


AVOID CONTACT WITH CRANE BOOM
NEVER allow a crane boom or jib to come into contact with any load or structure



OPERATION

carry loads over areas where workers are below the load



carry split or unstable loads

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Operation- Stucked by Counter Weight

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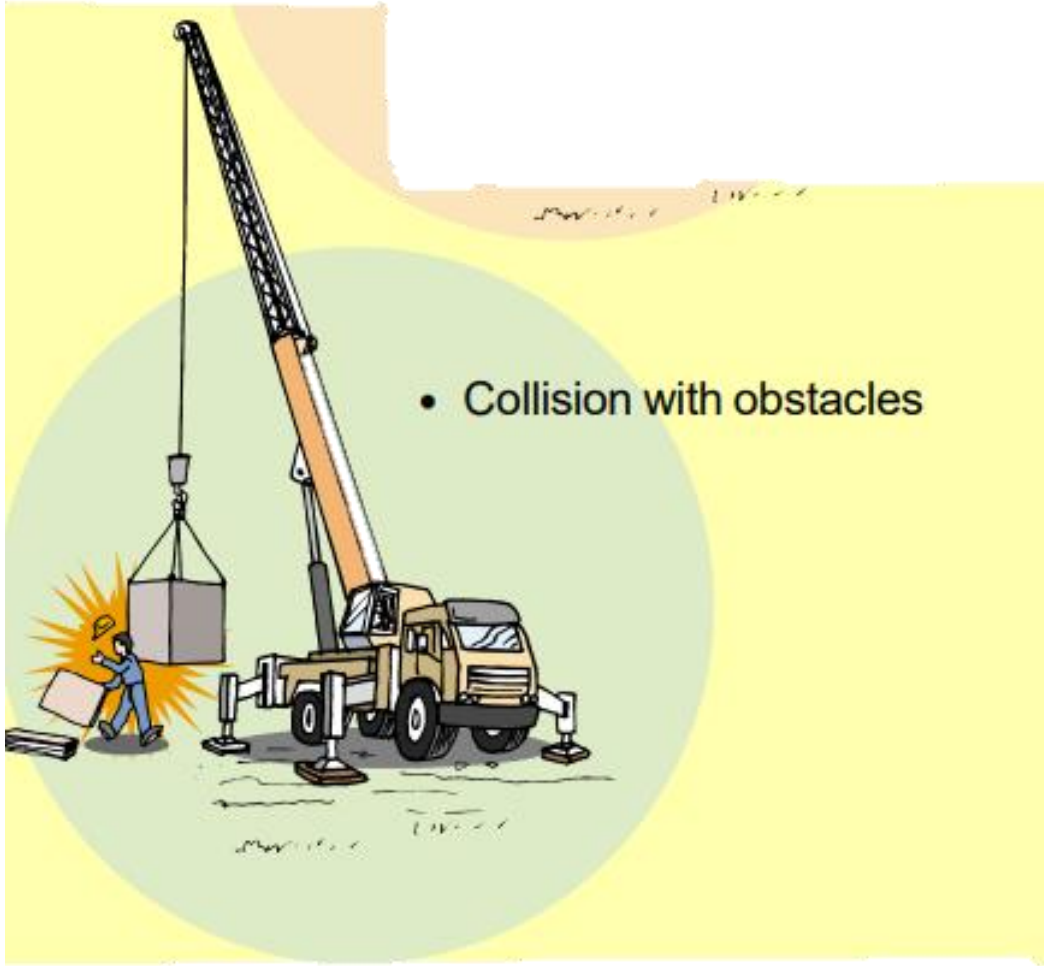
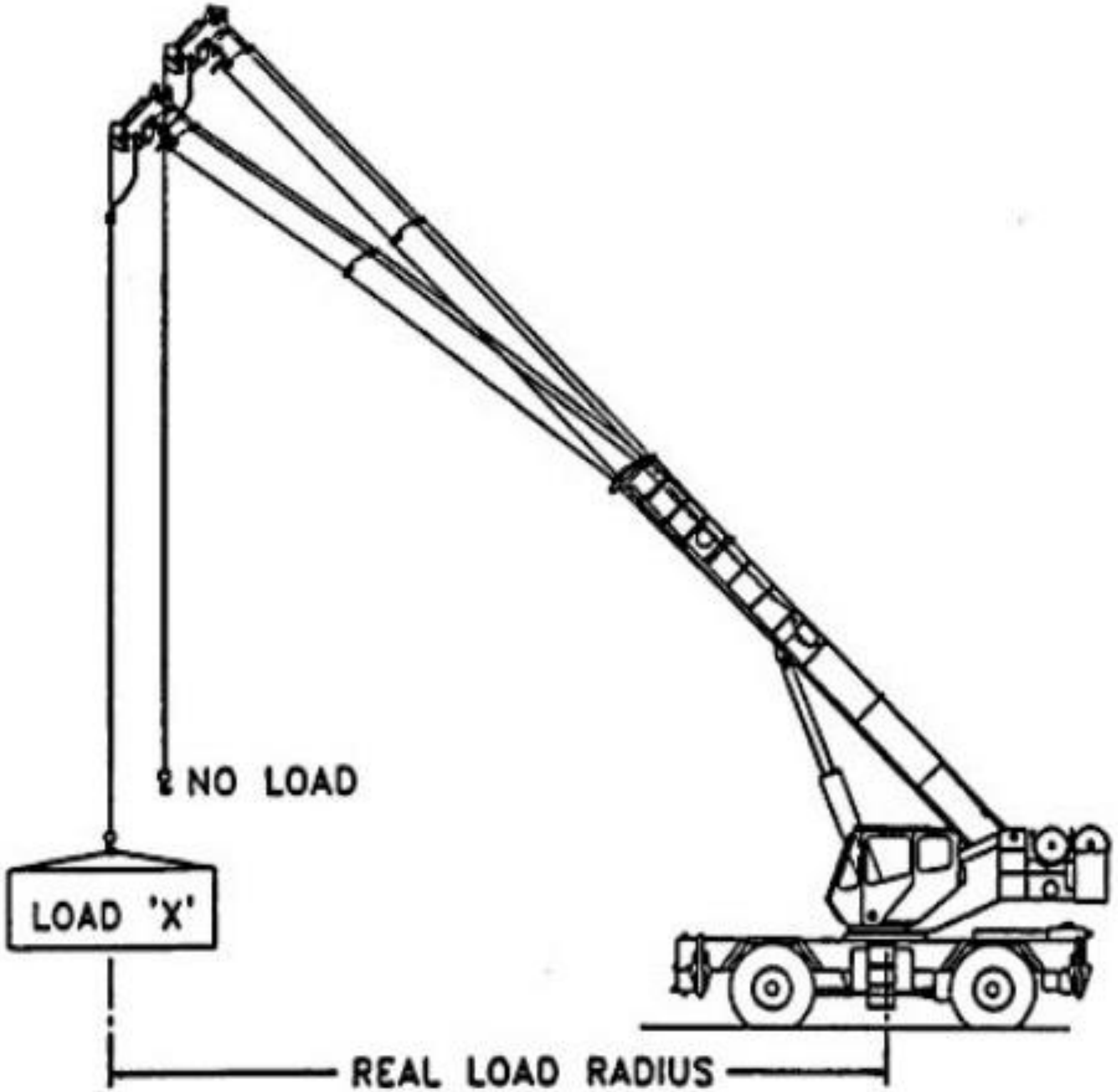
Operation- Collision



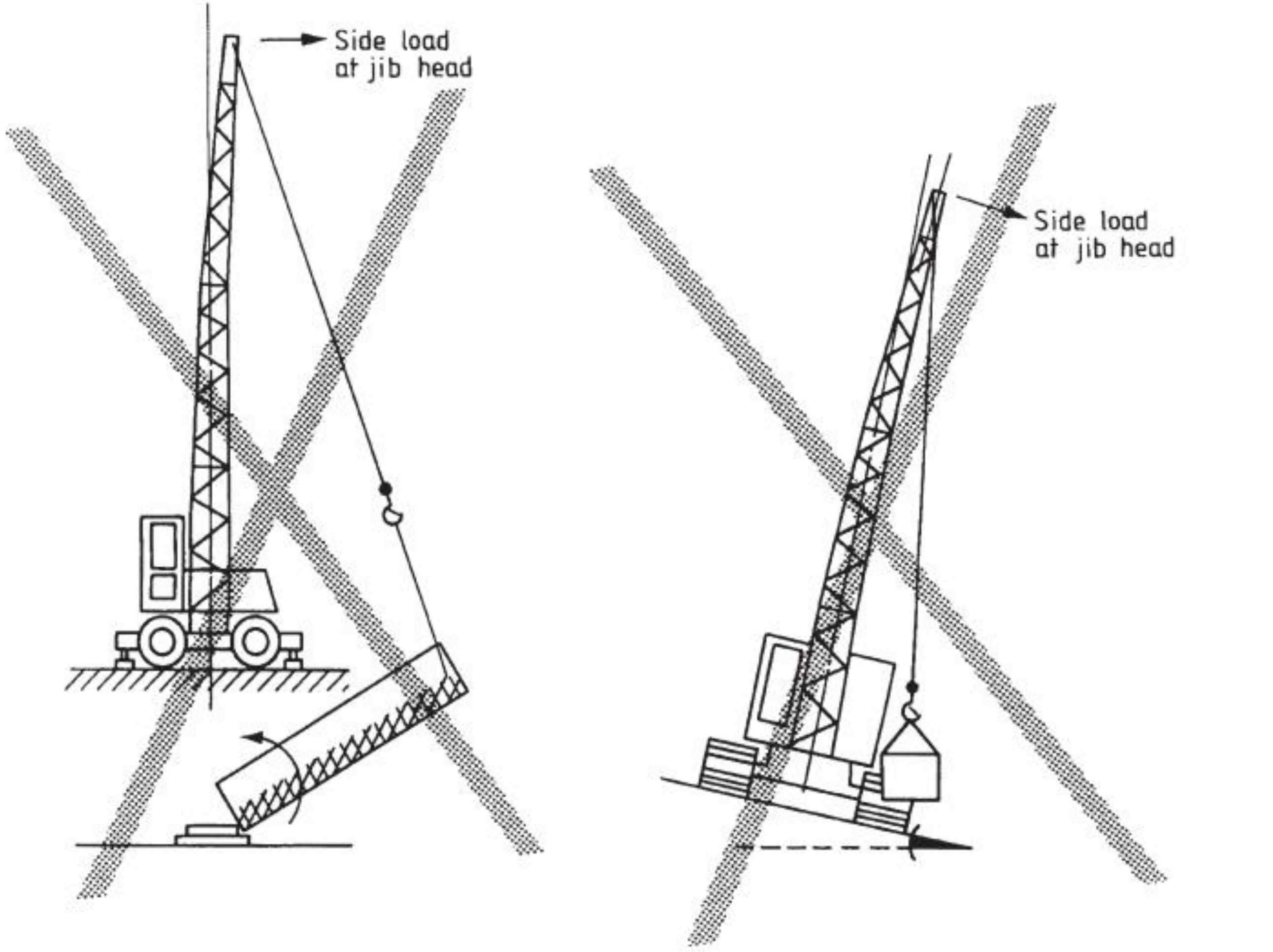


FREE FALL FUNCTION OF BLOK HOOK MUST BE LOCKED OUT

Background
A worker was fatally injured by a falling load while erecting a transmission tower west of Dalby in Queensland in March 2012. A 20 tonne rough terrain mobile crane was being used to lift part of the tower when it appears the auxiliary winch inadvertently went into free fall and the load fell, striking the worker.
Hoist winches on some mobile cranes are fitted with a free fall feature that allows the hook and load to fall under gravity in an uncontrolled manner. This feature has been traditionally provided on cranes for activities such as clam-shell dredging and dynamic compaction. However, the risk associated with an inadvertent activation of the free fall feature can be high and the provision is rarely needed. Most mobile crane manufacturers do not provide this feature on new cranes. The risk to workers from falling loads and potential damage to the crane and crane operator is too great to continue to allow free fall on cranes as standard industry practice.

https://www.worksafe.qld.gov.au/news-and-events/alerts/workplace-health-and-safety-alerts/2012/mobile-cranes-with-a-free-fall-feature#:~:text=Hoist%20winches%20on%20some%20mobile,shell%20dredging%20and%20dynamic%20compaction.

SIDE LOADING



(a) Pulling a load sideways

(b) Travelling across a slope

NOTE. The figure shows typical operational conditions imposing a side loading on the jib of a crane. Jibs are not designed for high side loads in crane service. Loads should not be pulled or dragged sideways using either the slewing motion or hoist line. The hoist line should always be in the plane of the jib and hanging plumb. Side loading of the jib should be avoided.

AVOID SIDE LOADING THE JIB

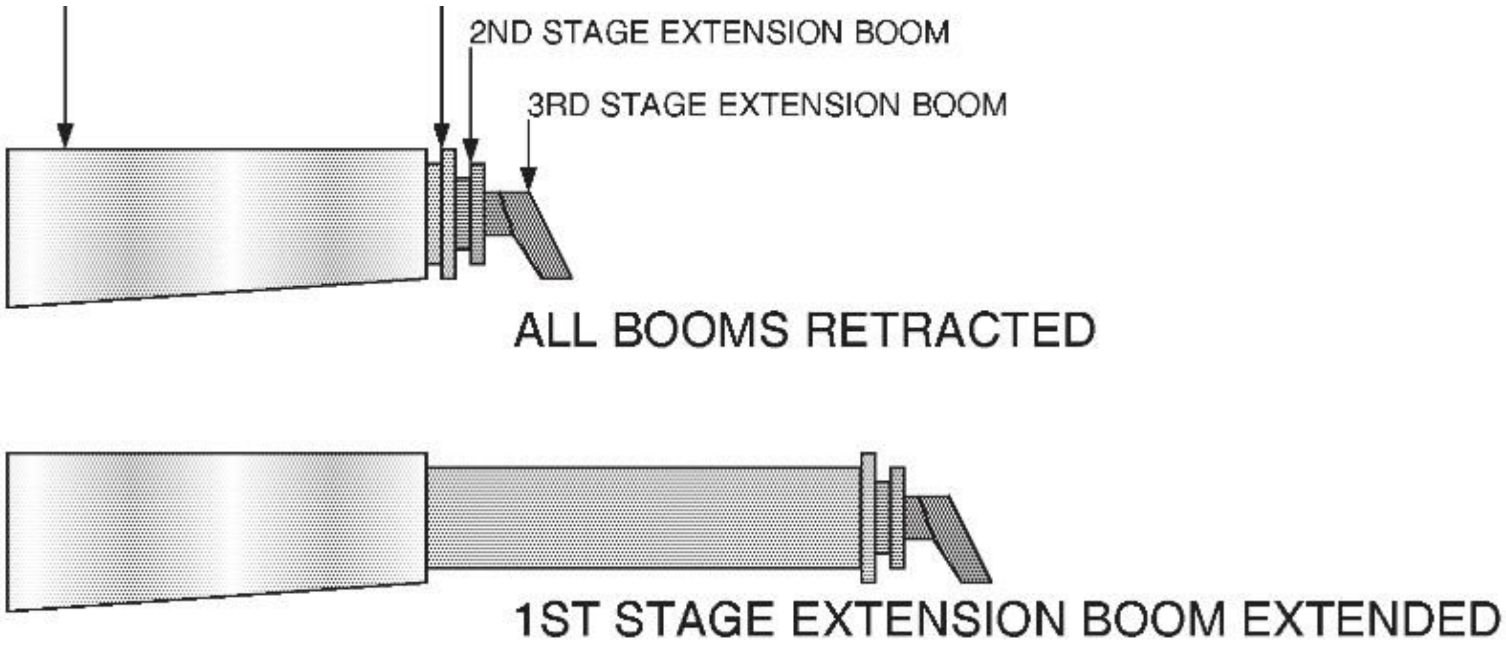
Operation- Extension Boom Consequence

Section 10. OPERATIONAL REFERENCE

EXTENSION BOOM SEQUENCE

Extension booms are to always be extended in their proper sequence, largest to smallest. NEVER extend booms out of sequence.

Extension booms are to always be retracted in their proper sequence, smallest to largest. NEVER retract booms out of sequence.



Operation- Extension Boom Consequence

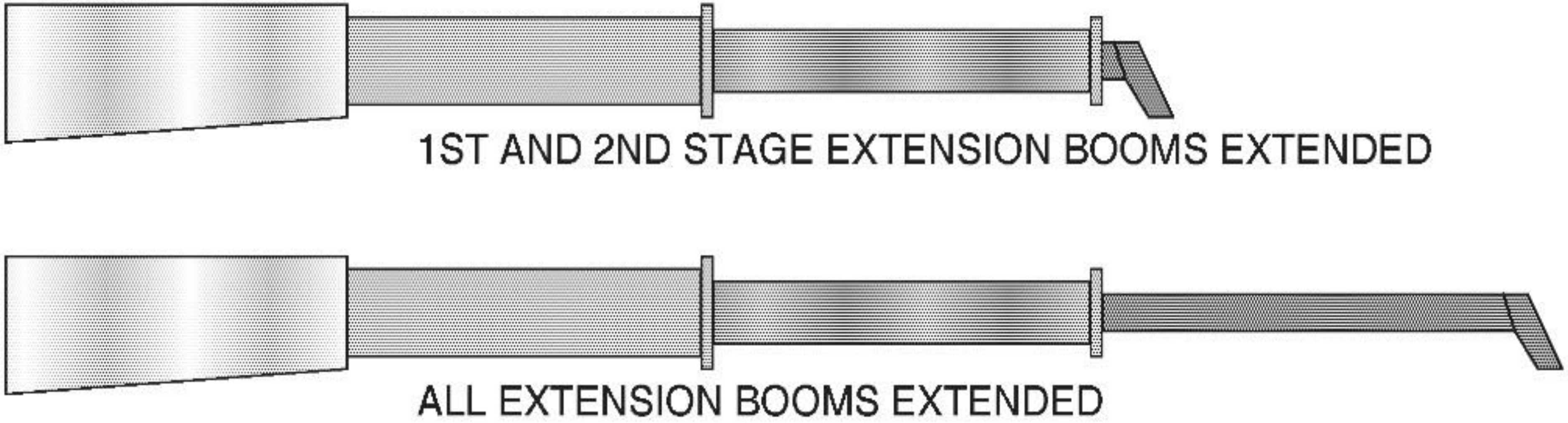


FIGURE J-1. PROPER EXTENSION BOOM DEPLOYMENT

Operation- Extension Boom Consequence

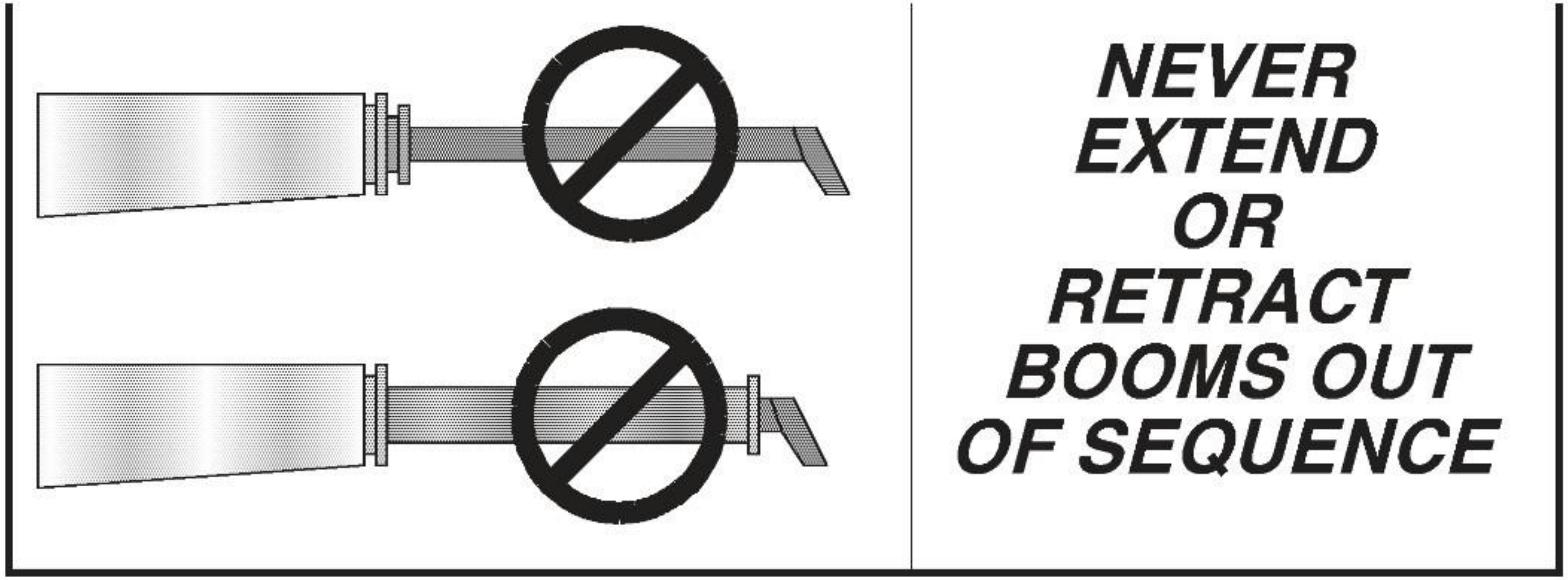
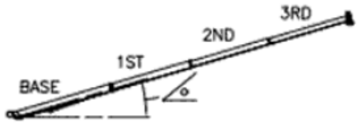


FIGURE J-2. IMPROPER EXTENSION BOOM DEPLOYMENT

Operation- Extension Boom Consequence

- INTERMEDIATE OUTRIGGER CONFIGURATION -



LOAD RATINGS IN LBS WITH ALL OUTRIGGERS IN THE INTERMEDIATE POSITION LMI CODE #9											JIB LOAD RATINGS IN LBS WITH ALL OUTRIGGERS IN THE INTERMEDIATE POSITION						
	LOADED BOOM ANGLE	BOOM LENGTH AND MARKER	A		B		C		D			FIXED JIB		TELESCOPIC JIB			
												LMI CODE #10		LMI CODE #11		LMI CODE #12	
OPERATING RADIUS FT	∠	30.5 FT	∠	52 FT	∠	68 FT	∠	84 FT	∠	100 FT	OPERATING RADIUS FT	LOADED BOOM ANG ∠	JIB LENGTH FOR ALL BOOM LENGTHS SEE WARNING NOTE 4 30.5 FT	LOADED BOOM ANG ∠	JIB LENGTH FOR ALL BOOM LENGTHS SEE WARNING NOTE 4 30.5 FT	LOADED BOOM ANG ∠	JIB LENGTH FOR ALL BOOM LENGTHS SEE WARNING NOTE 4 55 FT
5	74	80000															
8	68	61000															
10	64	52860	76	31500							10						
12	60	43730	73	31500	78	31500					12						
15	53	26300	70	27320	76	27650	79	23700			15						
20	40	14620	64	15460	71	15730	76	15890	79	14000	20						
25	20	9240	58	10060	67	10290	72	10430	76	10530	25						
30			51	6960	62	7180	69	7310	73	7400	30	77	7300	77	7000		
35			43	4950	57	5170	65	5290	70	5370	35	75	5710	75	5290	78	4000
40			34	3530	52	3750	61	3870	67	3950	40	73	4250	73	3830	76	3850
45			22	2470	46	2700	57	2820	64	2900	45	71	3180	71	2760	74	3540
50					39	1890	52	2010	60	2090	50	69	2360	69	1930	73	2690
55					32	1250	48	1370	57	1440	55	66	1700	66	1270	71	2020
60					22	720	43	850	53	920	60	64	1170	64	740	69	1470
65											65					67	1020
70											70					65	640
	590 LBS		350 LBS		270 LBS		220 LBS		180 LBS		FIXED			DEDUCTIONS FOR STOWED JIBS			
	890 LBS		530 LBS		400 LBS		330 LBS		280 LBS		TELESCOPIC						

Presenter: Nguyen Si Khang

Operation- Extension Boom Consequence

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Operation- Extension Boom Consequence

Presenter: Nguyen Si Khang

Prerequisites
① Boom operating conditions(fully extended boom length),min. length is 11.5m and max.length is 43m
② The span of outriggers is 6m×7.2m
③ 360°rotation is applied
④ Counterweight is 3.5T

			1	2								
Working range(m)	Main boom											Working range(m)
	11.5	15.44	19.38	19.38	27.25	27.25	35.15	35.15	39	39	43	
3	50000	40000	32000	21500								3
3.5	50000	40000	32000	21500								3.5
4	44600	40000	32000	21500								4
4.5	40000	36000	31000	21500	21000	15000						4.5
5	36200	33200	29000	20000	21000	15000						5
5.5	32000	30000	27500	19000	21000	14500						5.5
6	28000	27500	25700	18100	21000	13700	14000	9000				6
6.5	25800	25500	23900	17500	19500	12800	14000	9000				6.5
7	23500	23200	21500	17000	18000	12100	14000	9000	11500	9000		7
7.5	21400	21200	18600	16200	16800	11500	13500	8500	11500	9000		7.5
8	19500	19300	17000	15600	15800	11000	12700	8500	11000	9000	9000	8
9	15300	15000	13700	13800	14000	10000	11700	7800	10500	8500	8500	9
10		11700	10900	12000	12000	9000	10700	7100	10000	8000	8100	10
11		9600	9000	10600	9900	8200	9400	6400	9000	7500	7800	11
12		8000	8000	8700	9000	7500	8500	5800	8000	7000	7000	12
14			5300	6400	6300	6100	6600	5000	6300	5900	6000	14
16			3500	4600	4700	5000	5000	4400	5000	5000	5200	16
18					3500	4100	4000	3800	4000	4000	4200	18
20					2500	3000	3100	3200	3200	3500	3300	20
22					1900	2300	2200	2700	2400	2800	2600	22
24					1300	1800	1700	2400	1800	2100	2000	24
26							1200	1900	1300	1650	1500	26
28							800	1500	900	1300	1150	28
30							500	1000	600	900	900	30
32								800		600	600	32
34										400		34
Number of lines	12	10	8	8	6	6	4	4	4	4	3	Number of lines
Telescoping condition(%)												
Modes	I,II	I	I	II	I	II	I	II	I	II	I,II	Modes
2nd boom	0	50	100	0	100	0	100	0	100	50	100	2nd boom
3rd boom	0	0	0	33	33	66	66	100	83.3	100	100	3rd boom
4th boom	0	0	0	33	33	66	66	100	83.3	100	100	4th boom
Top boom	0	0	0	33	33	66	66	100	83.3	100	100	Top boom

Values listed in the table refer to rated lifting capacity measured at flat and solid gound under the lever state of the crane.
Value above heavy line shall be determined by strength of the crane and under this line shall be determined by stability of the crane.
Rated load values determined by stability shall comply with ISO 4305.
Rated lifting capacity listed in the table included weights of lifting hooks (610kg of main hook and 90kg of auxiliary hook)and hangers.
Rated lifting capacity with pulley at boom tip shall not exceed 4000kg and then substracts(230kg)to gain rated lifting capacity if the boom is used to lift after the installation of jib.
If actual boom length and range are between two values specified in the table, larger value will determine the lifting capacity.

At the same working radius, why longer boom can carry heavier load?

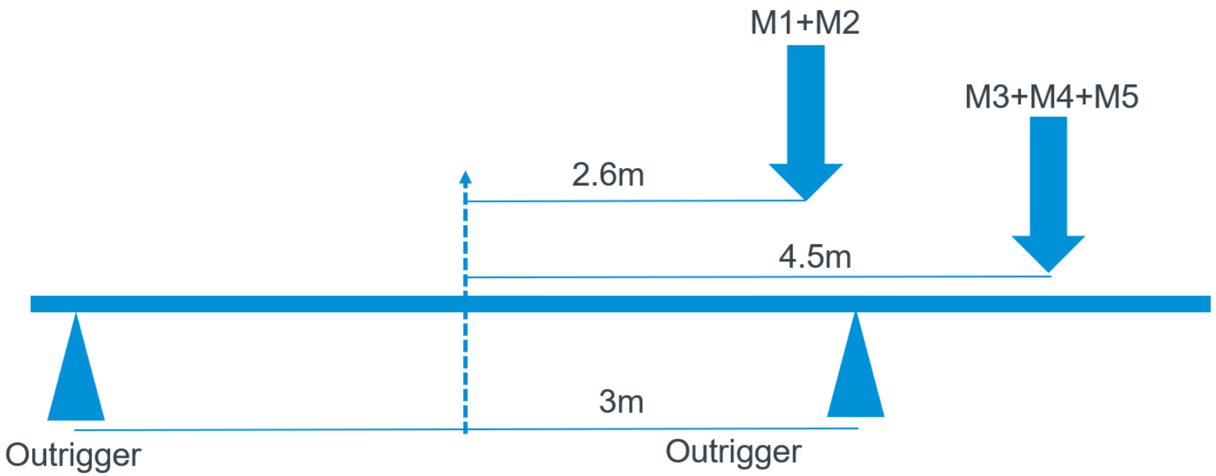
Prerequisites
① Boom operating conditions(fully extended boom length),min. length is 11.5m and max.length is 43m
② The span of outriggers is 6m×7.2m
③ 360°rotation is applied
④ Counterweight is 3.5T

Working range(m)	11.5	15.44	19.38 (1)	19.38 (2)	27.25	27.25	35.15	35.15	39	39	43	Working range(m)
	Main boom											
3	50000	40000	32000	21500								3
3.5	50000	40000	32000	21500								3.5
4	44600	40000	32000	21500								4
4.5	40000	36000	31000	21500	21000	15000						4.5
5	36200	33200	29000	20000	21000	15000						5
5.5	32000	30000	27500	19000	21000	14500						5.5
6	28000	27500	25700	18100	21000	13700	14000	9000				6
6.5	25800	25500	23900	17500	19500	12800	14000	9000				6.5
7	23500	23200	21500	17000	18000	12100	14000	9000	11500	9000		7
7.5	21400	21200	18600	16200	16800	11500	13500	8500	11500	9000		7.5
8	19500	19300	17000	15600	15800	11000	12700	8500	11000	9000	9000	8
9	15300	15000	13700	13800	14000	10000	11700	7800	10500	8500	8500	9
10		11700	10900	12000	12000	9000	10700	7100	10000	8000	8100	10
11		9600	9000	10600	9900	8200	9400	6400	9000	7500	7800	11
12		8000	8000	8700	9000	7500	8500	5800	8000	7000	7000	12
14			5300	6400	6300	6100	6600	5000	6300	5900	6000	14
16			3500	4600	4700	5000	5000	4400	5000	5000	5200	16
18					3500	4100	4000	3800	4000	4000	4200	18
20					2500	3000	3100	3200	3200	3500	3300	20
22					1900	2300	2200	2700	2400	2800	2600	22
24					1300	1800	1700	2400	1800	2100	2000	24
26							1200	1900	1300	1650	1500	26
28							800	1500	900	1300	1150	28
30							500	1000	600	900	900	30
32								800		600	600	32
34										400		34
Number of lines	12	10	8	8	6	6	4	4	4	4	3	Number of lines
	Telescoping condition(%)											
Modes	I,II	I	I	II	I	II	I	II	I	II	I,II	Modes
2nd boom	0	50	100	0	100	0	100	0	100	50	100	2nd boom
3rd boom	0	0	0	33	33	66	66	100	83.3	100	100	3rd boom
4th boom	0	0	0	33	33	66	66	100	83.3	100	100	4th boom
Top boom	0	0	0	33	33	66	66	100	83.3	100	100	Top boom

Values listed in the table refer to rated lifting capacity measured at flat and solid gound under the lever state of the crane.
Value above heavy line shall be determined by strength of the crane and under this line shall be determined by stability of the crane.
Rated load values determined by stability shall comply with ISO 4305.
Rated lifting capacity listed in the table included weights of lifting hooks (610kg of main hook and 90kg of auxiliary hook)and hangers.
Rated lifting capacity with pulley at boom tip shall not exceed 4000kg and then substracts(230kg)to gain rated lifting capacity if the boom is used to lift after the installation of jib.
If actual boom length and range are between two values specified in the table, larger value will determine the lifting capacity.

(d) : y=ax+b
O(0:0)
A(9:19.38)
⇒ y= 2.15

With Radius working R= 9m, Length boom L_B = 19.38m, first boom section L_{S1} = 11.5m



Case01:

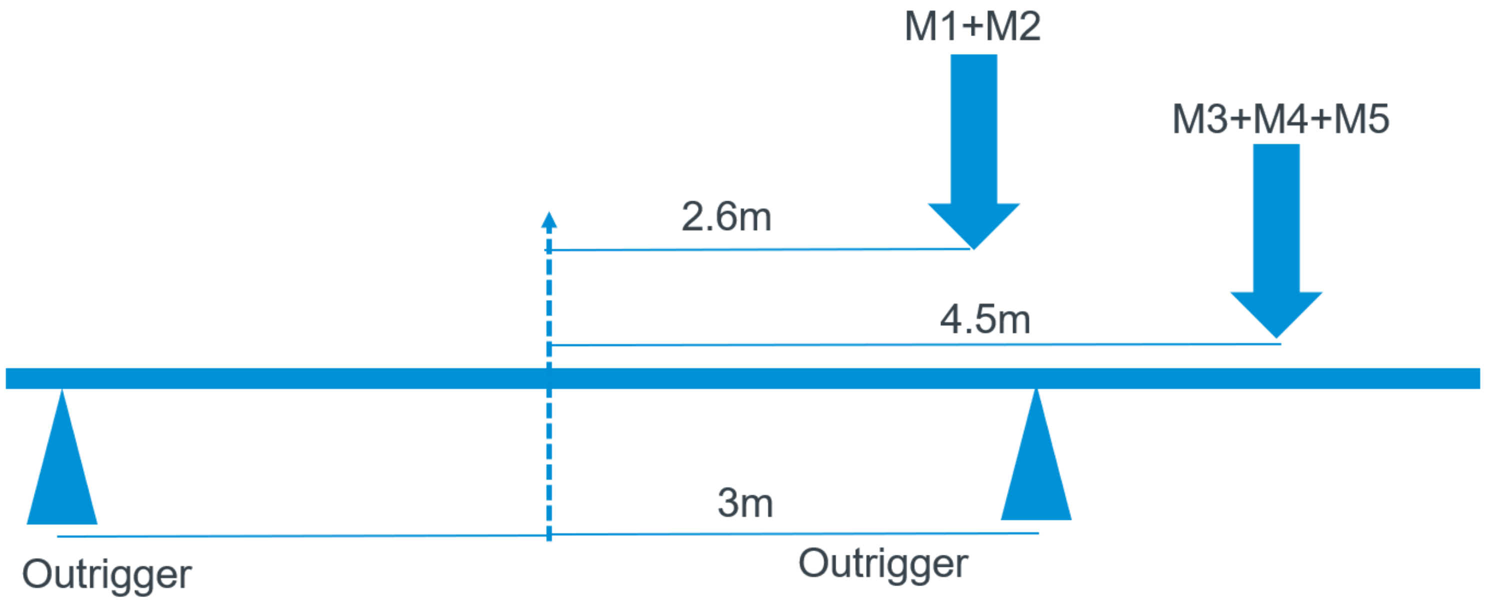
L_{S1} = 11.5m, L_{S2} = 7.88m

With L_{S1} = 11.5m, L_{S1} = 11.5m

$\Rightarrow$ M1= W_{s1} , Right Arm RA_1 = 2.67442m

$\Rightarrow$ M2= W_{s2} +W_{s3}+W_{s4} W_{s5}, Right Arm RA_2 =4.50698m

With Radius working R= 9m, Length boom L_B = 19.38m, first boom section L_{S1} = 11.5m



Case 02:

$\Rightarrow L_{S3} = L_{S4} = L_{S5} = 2{,}62667m$

$\Rightarrow M1 = W_{s1}+W_{s2}$

$\Rightarrow M2 = W_{s3}+W_{s4}\ W_{s5}$

With L_{S1} = 11.5m, L_{S1} = 11.5m

$\Rightarrow M1 = W_{s1} + W_{s2}$, Right Arm RA_1 = 2.67442m

$\Rightarrow M2 = W_{s3}+W_{s4}\ W_{s5}$, Right Arm RA_2 =4.50698m

Crane Checking/ Inspection

MOBILE CRANE - Daily Inspection Checklist

Company/Site ____________

Machine Hour Meter ____________ / /

Week Starting ____ / ____ / ____

Machine Type ____________

Machine Number ____________

CHECK DAILY BEFORE EACH SHIFT: [✓] = OK [✗] = Action needed [N/A] = Not applicable	Mon	Tue	Wed	Thur	Frid	Sat	Sun
STRUCTURE: Frame, damage, wear, unclean, leaks, slew ring							
ATTACHMENTS: Hooks, block, sheaves, winch, pulleys, hoist, rope drums, stabilisers/outriggers, counterweight							
BOOM: Angle, length indicator, welds, fly extension, mounting							
WHEELS & TYRES: Nuts, pressure, damage, wear, tracks							
HYDRAULICS: Steering rams, luffing rams, hoses, leaks, wear							
GUARDS: In place, secure, alarms, warning signs, warning lights							
LOAD CAPACITY PLATE: Present, legible, clean, correct							
ENGINE: Engine oil, coolant, hydraulic oil, brake fluid, fuel, belts, air filter, power steering, wiper water, grease, battery, leaks, hoses							
CABIN: Access, seat belt, seat, loose objects							
LIGHTS: Indicators, headlights, brake lights, warning devices							
VISIBILITY: Windscreen, wipers, washer, demister, mirrors, windows							
COMPUTER: Angle, length indicator, radius indicator							
CRANE FUNCTIONS & CONTROLS: Slew, boom raising & lowering, boom extension & retraction, steering, limit switch or cut outs, brakes, park brake, slew brake, horn, beeper, outrigger extension & retraction							
MISCELLANEOUS: Fire extinguisher, radio, door locks, decals, operators manual, warning signs, load chart, gauges							
Operator doing check to clearly write/sign their name at the bottom of each column.							

FAULT REPORTED BY ____________ Date: / /

DANGER DO NOT OPERATE

Description of fault ____________

NOTE: Operator to TAG OUT machine if needed.

ACTION TAKEN TO RETURN TO SERVICE

Print Name ____________

Date / / Signature ____________

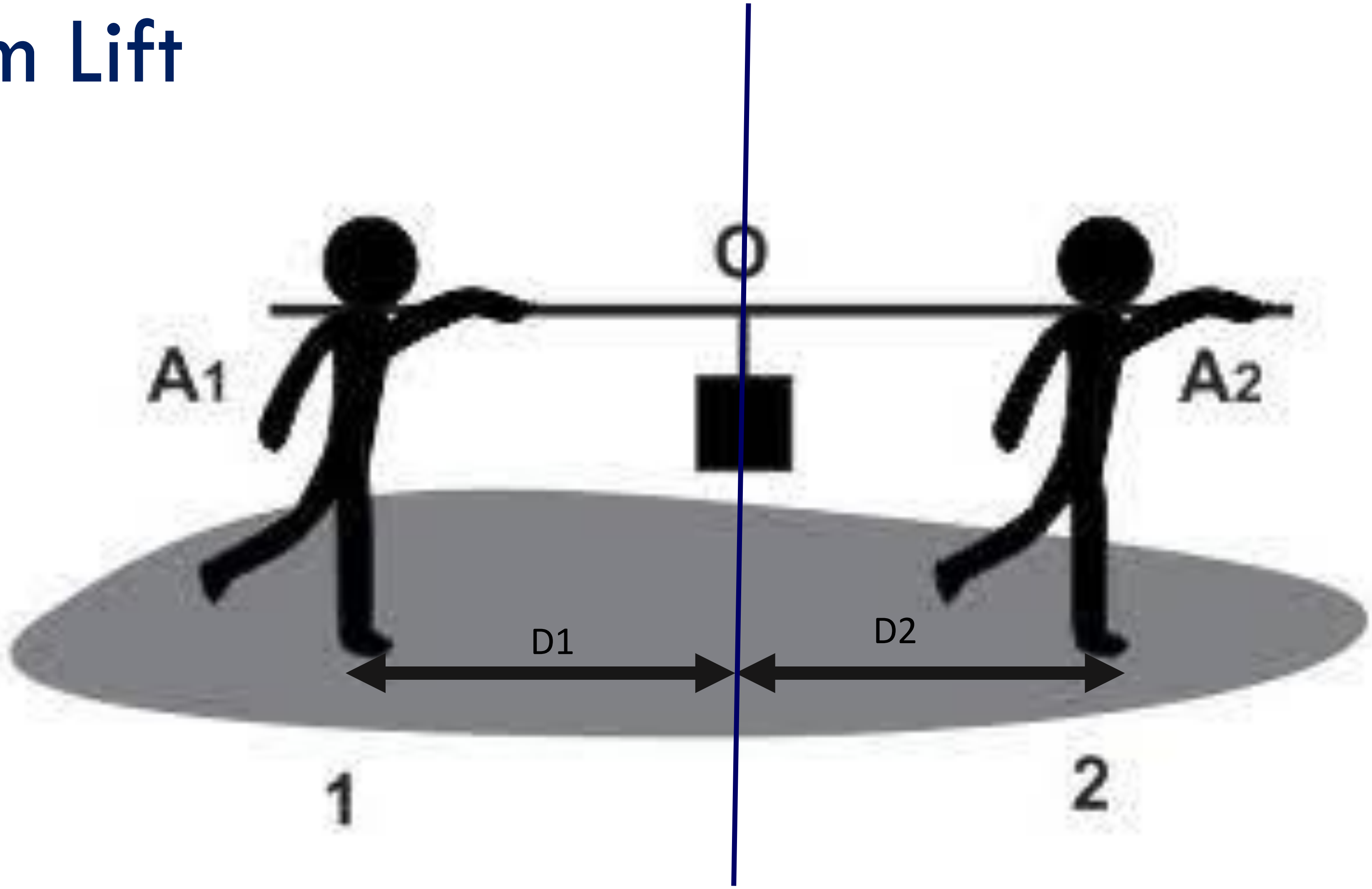
SAMPLE

Presenter: Nguyen Si Khang

Tandem Lift

Presenter: Nguyen Si Khang

Tandem Lift



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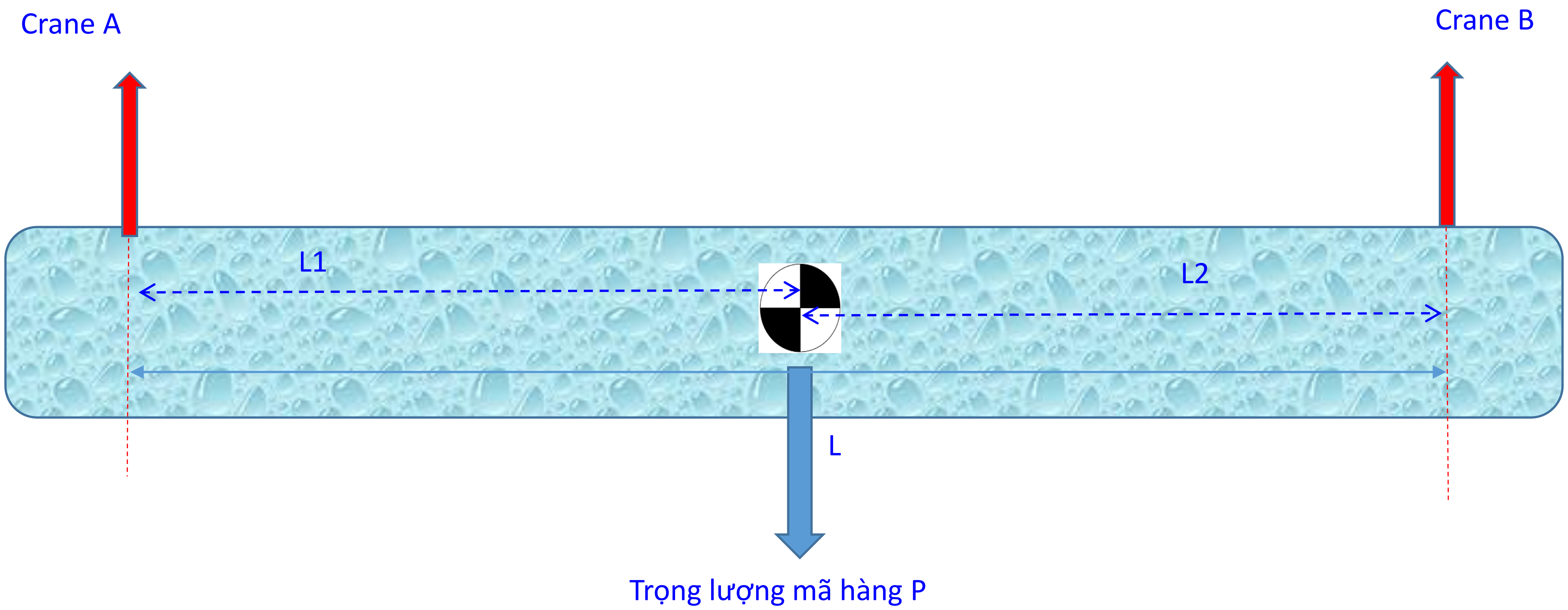
Tandem Lift



Crane A= L_2.P/L

Crane B= L_1.P/L

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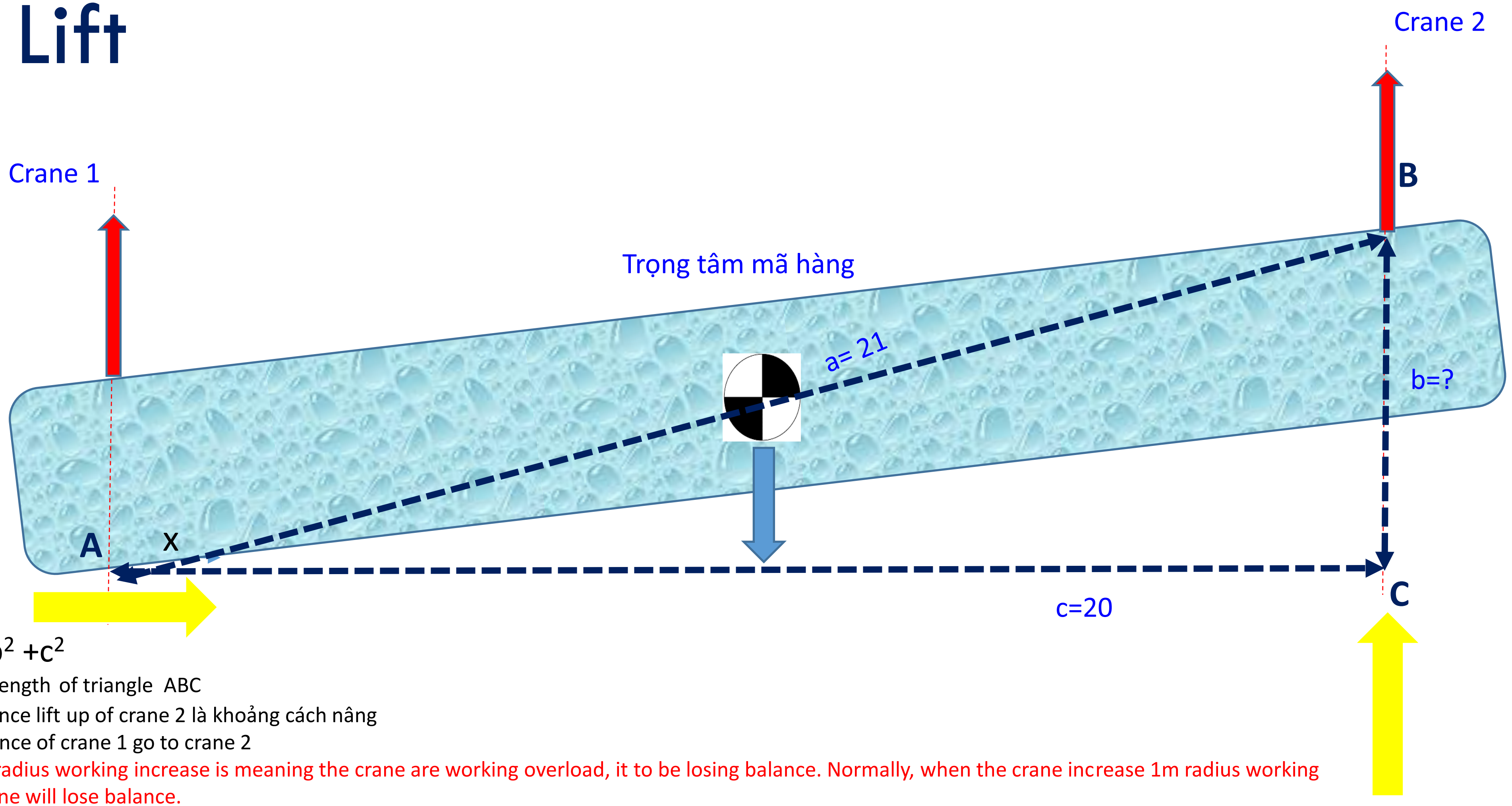
Tandem Lift



$a^2= b^2 +c^2$

a,b,c : length of triangle ABC

x: distance lift up of crane 2 là khoảng cách nâng

y: distance of crane 1 go to crane 2

When radius working increase is meaning the crane are working overload, it to be losing balance. Normally, when the crane increase 1m radius working the crane will lose balance.

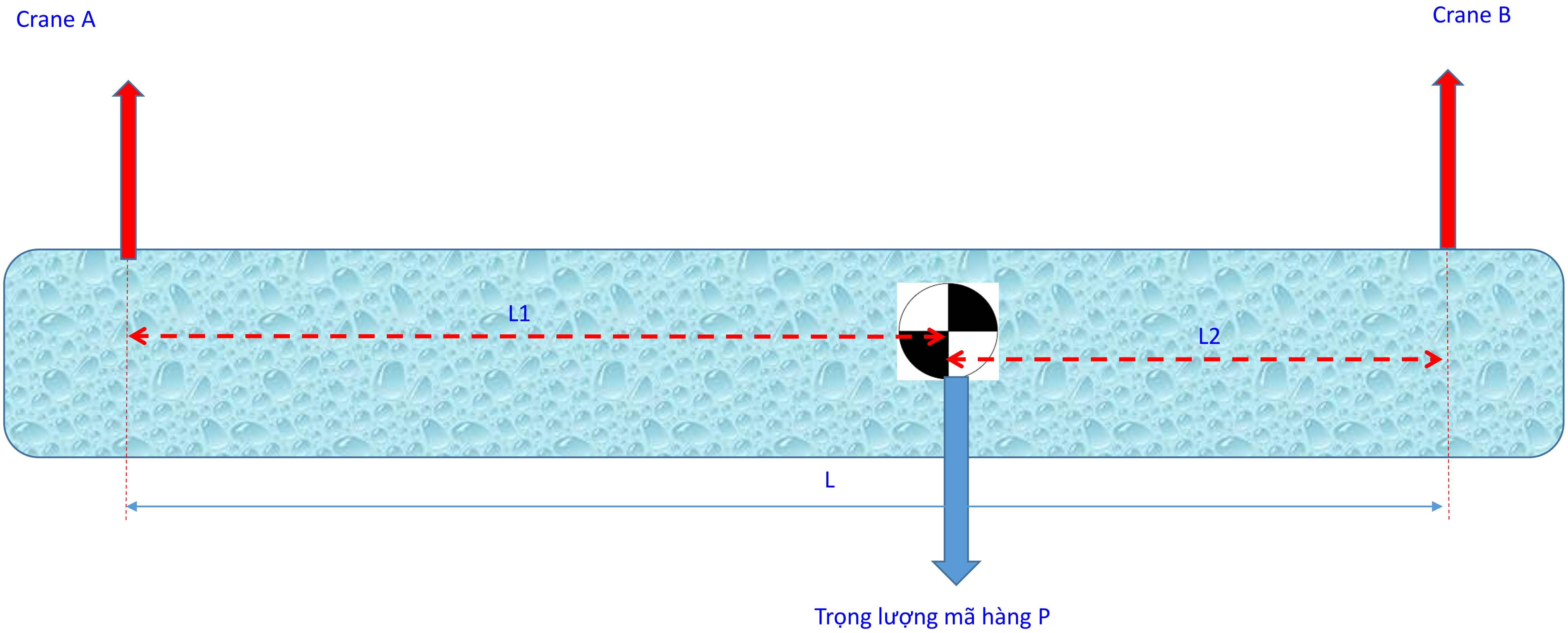
Apply the Pitago regulation,we will have the distance increase “b” of crane 2

$a^2= (b+x)^2 +(c-1)^2)$

a=	21
b=	6.4031
c=	20

Presenter: Nguyen Si Khang

Tandem Lift

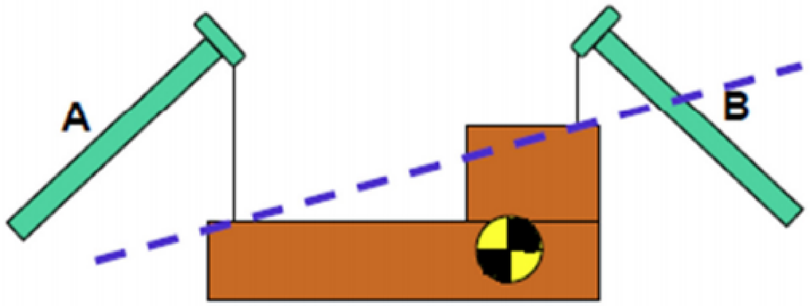


Crane A= L_2.P/L

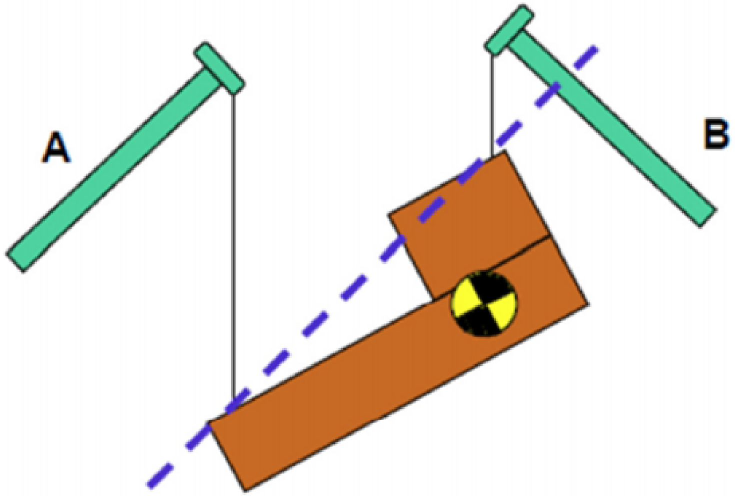
Crane B= L_1.P/L

Presenter: Nguyen Si Khang

Tandem Lift



The load on crane B is more than the load on crane A because the Center of Gravity of the load is closer to B.



If the load is tilted as shown, stress on crane B increases.

Tandem Lift

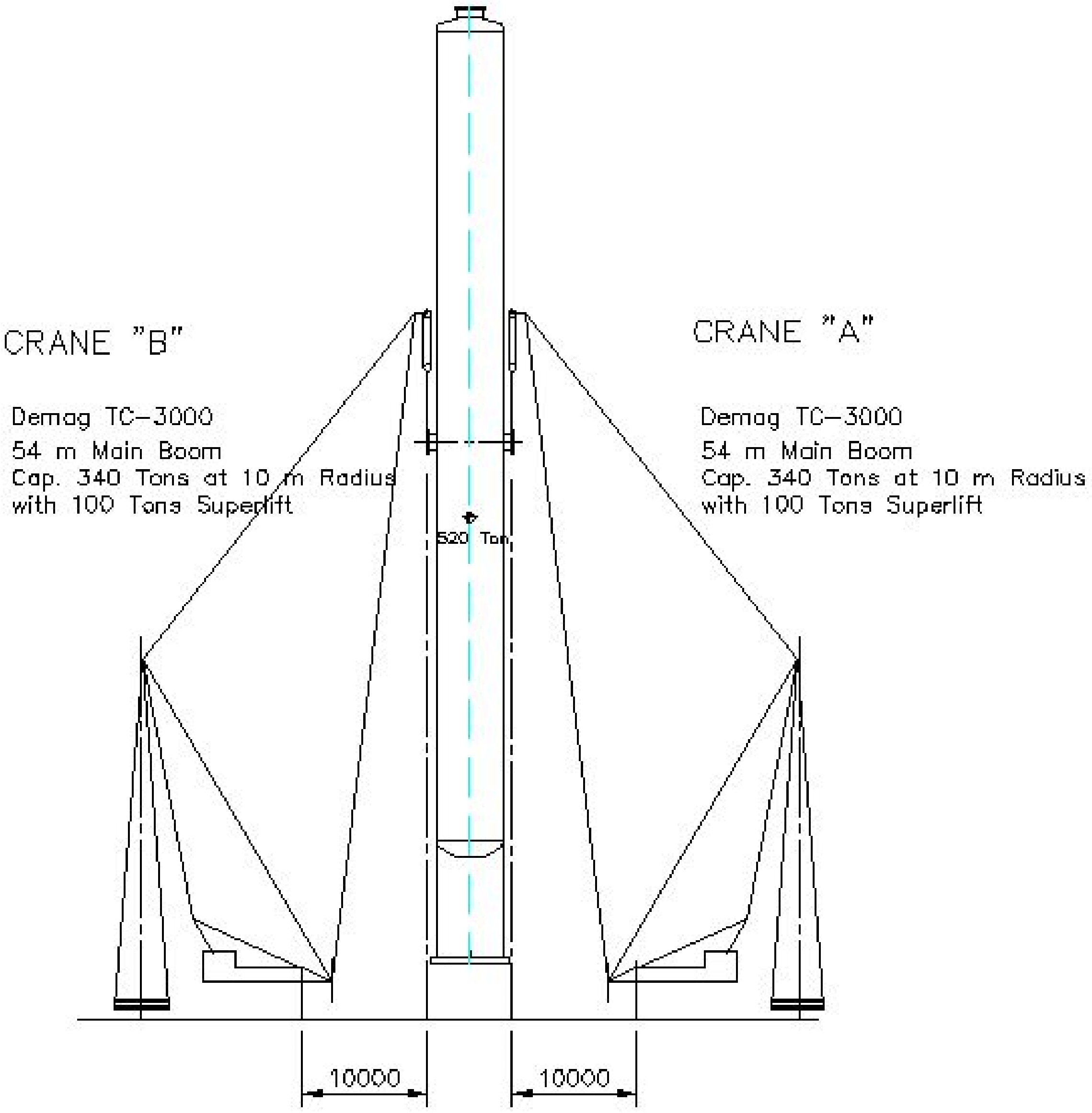


Figure 3

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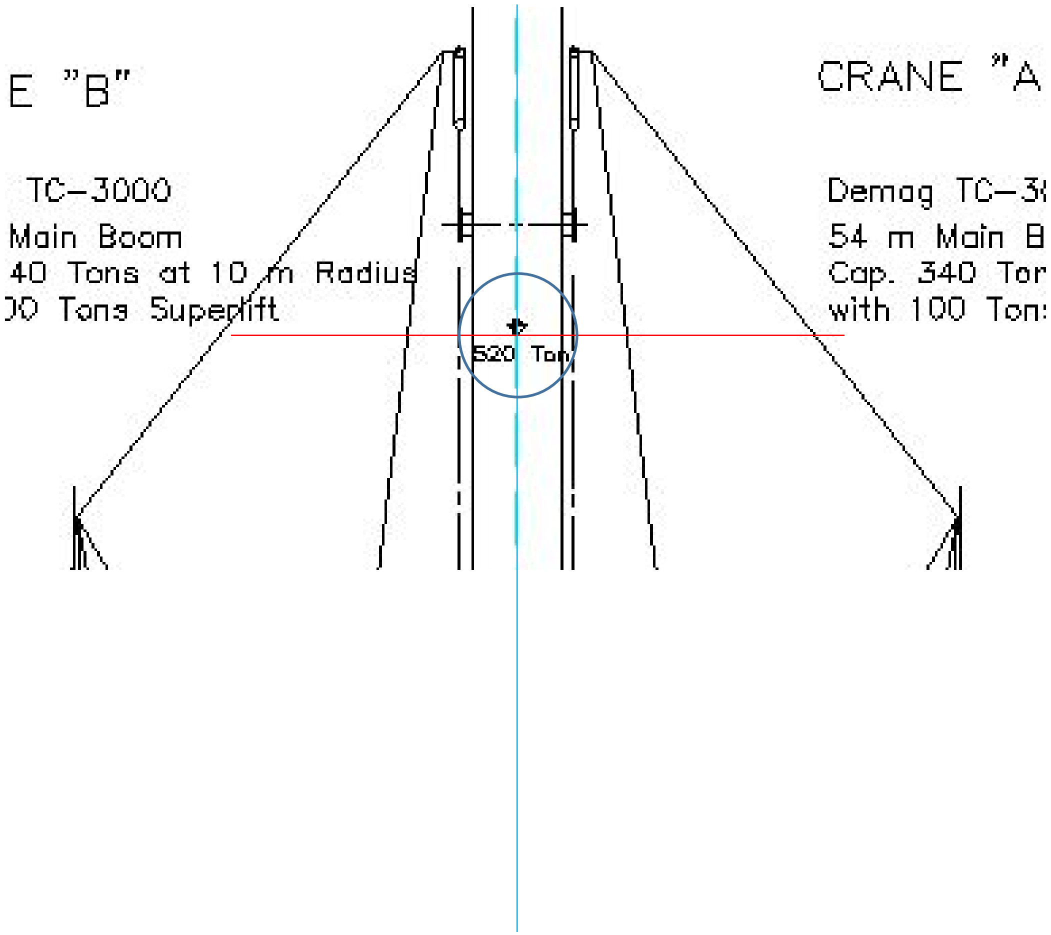
Tandem Lift



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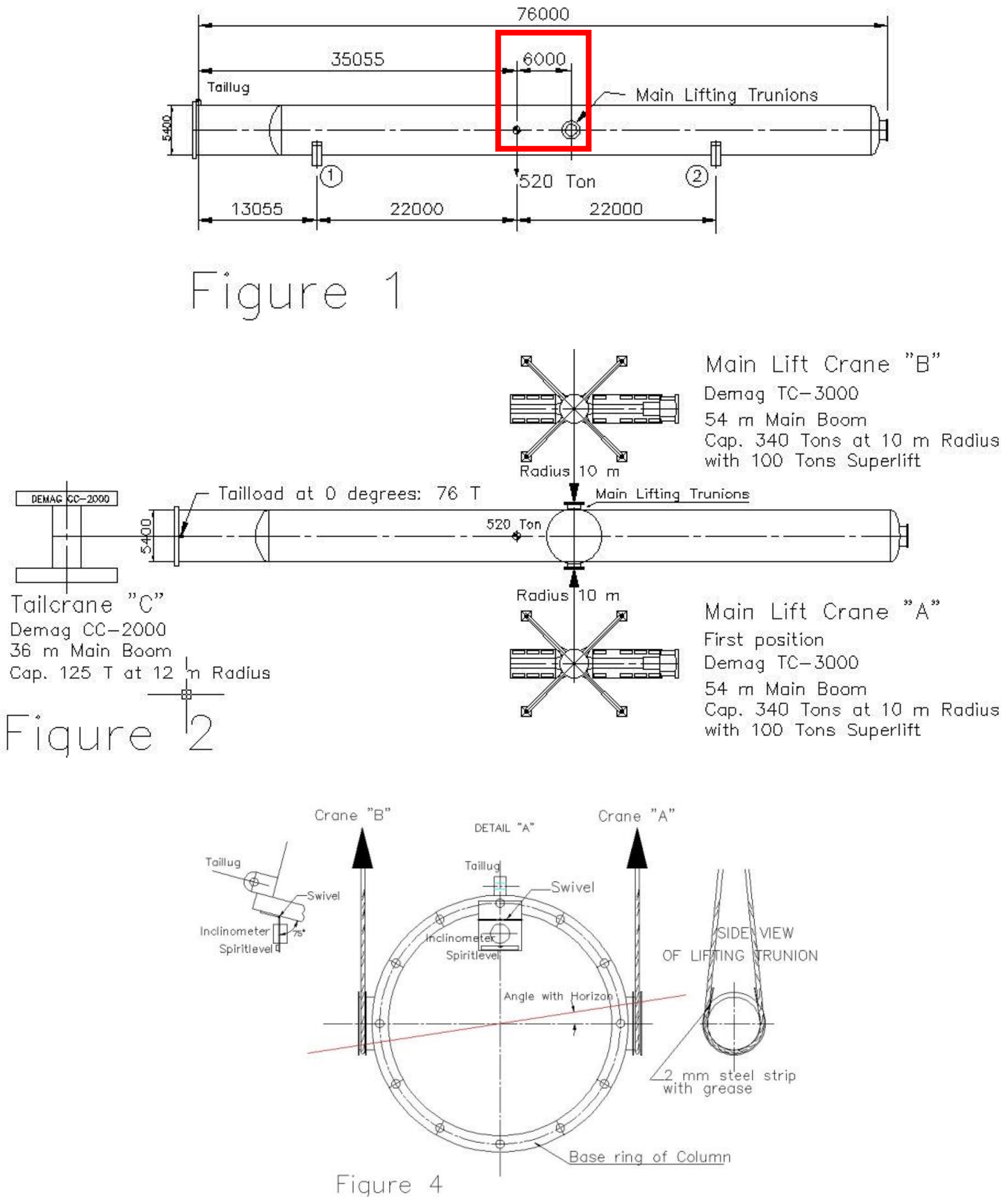
Tandem Lift



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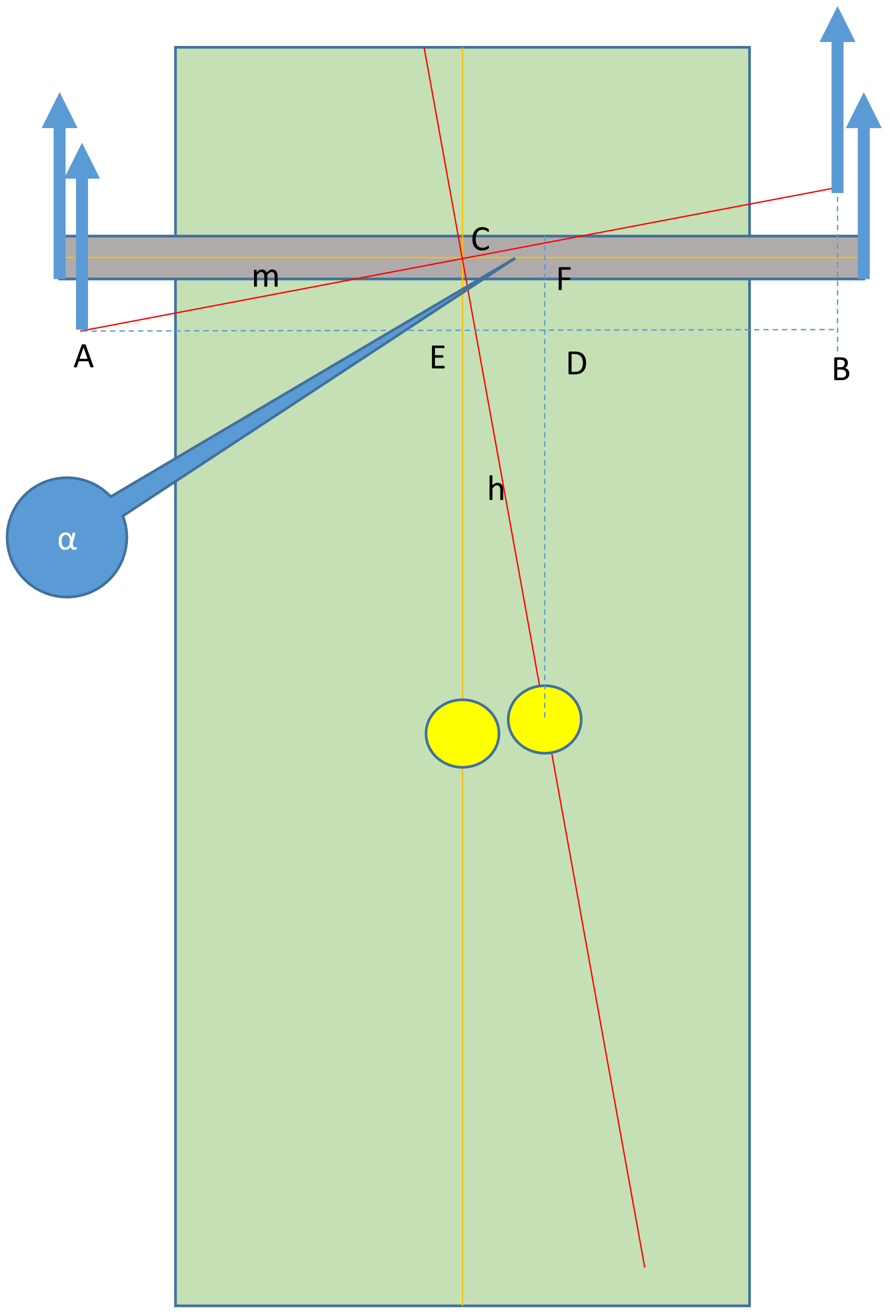
Tandem Lift



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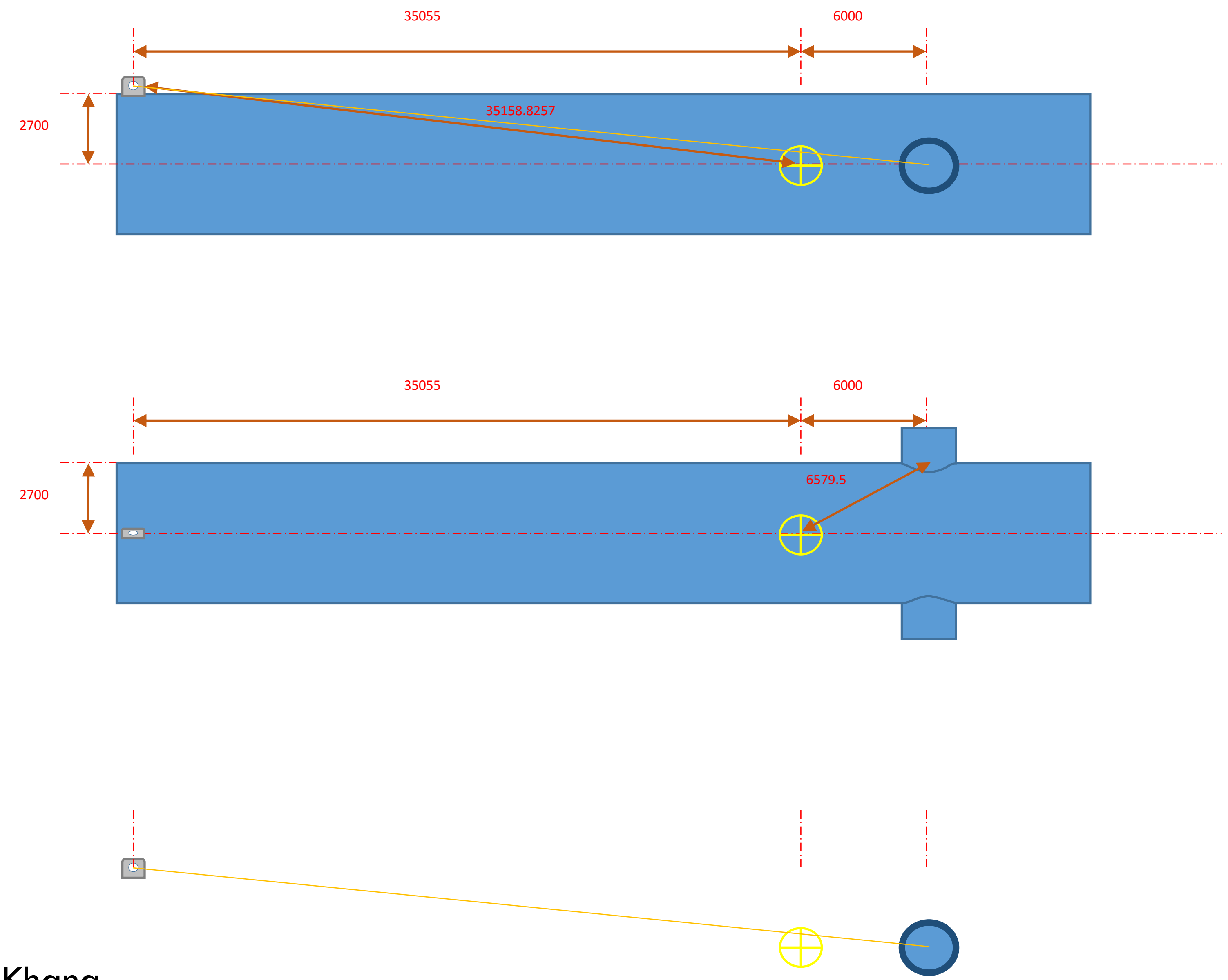
Tandem Lift



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Tandem Lift

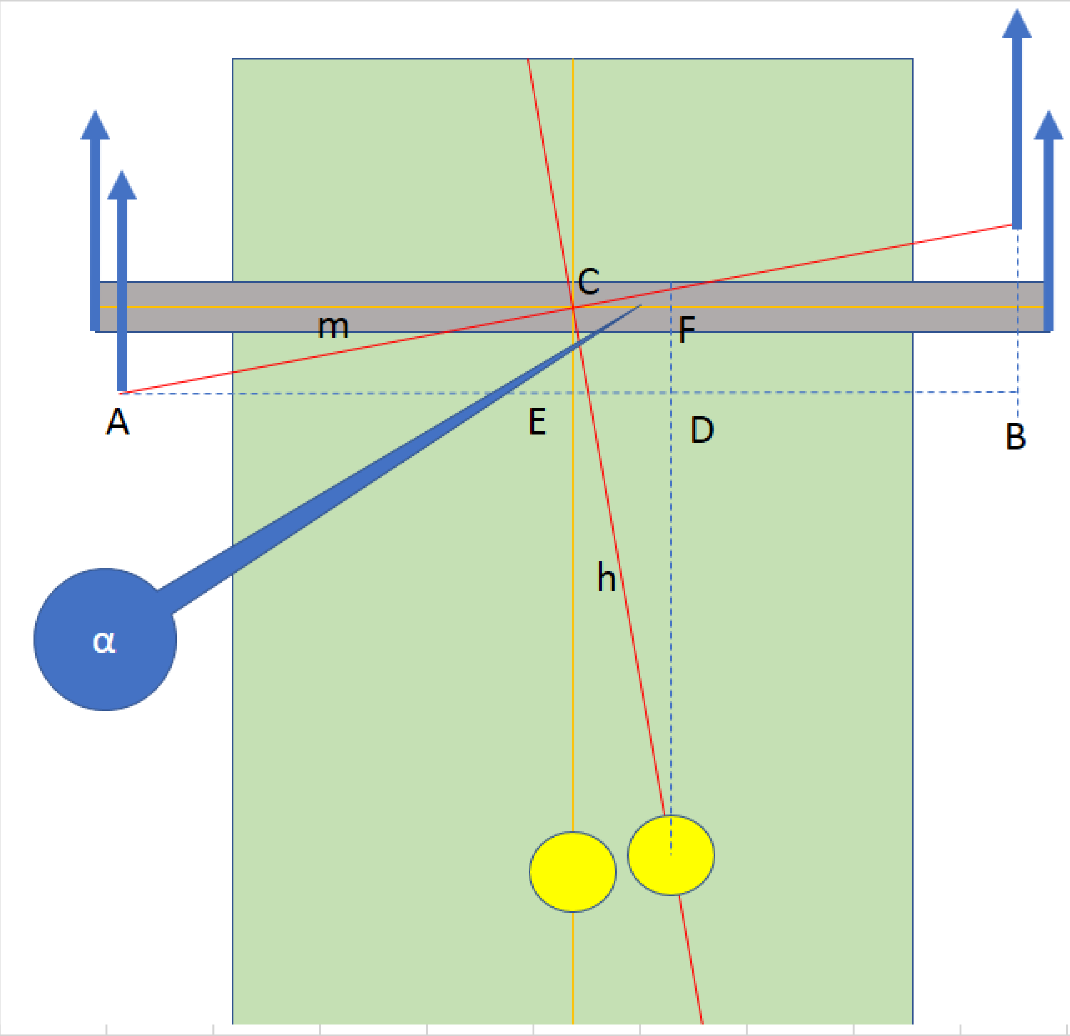
TABLE 1

Distance to C.of G.: 6 m					
Angle with horizon	**0°**	**1°**	**2°**	**3°**	**4°**
Load in crane "A"	260.0 t	270.09t	280.18 t	290.28 t	300.40 t
Load in crane "B"	260.0 t	249.91 t	239.82 t	229.72 t	219.60 t
Height difference between "A" & "B"	0 cm	9 cm	19 cm	28 cm	38 cm

TABLE 2

Distance to C.of G.: 12 m					
Angle with horizon	**0°**	**1°**	**2°**	**3°**	**4°**
Load in crane "A"	260.0 t	280.17t	300.35 t	320.56 t	340.80 t
Load in crane "B"	260.0 t	239.83 t	219.65 t	199.44 t	179.20 t
Height difference between "A" & "B"	0 cm	9 cm	19 cm	28 cm	38 cm

Tandem Lift



α=	4	degrees
m=	5.4	m
h=	6	m
AB=	5.386846	(=m*cos α)
CF=	0.418539	(=h*sin α)
AE=EB=	2.693423	(=AB/2)
DB=	2.274884	AE-CF
Load	520	Tons
Load on A	219.5978	Tons
Load on B	300.4022	Tons

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Tandem Lift

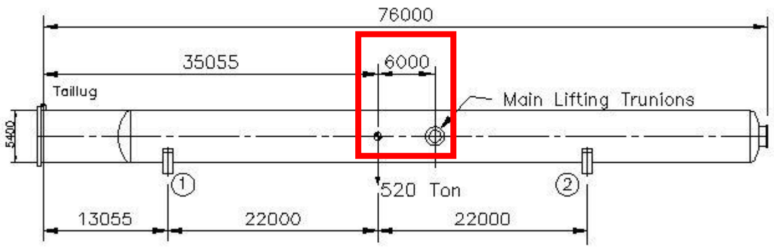

Figure 1

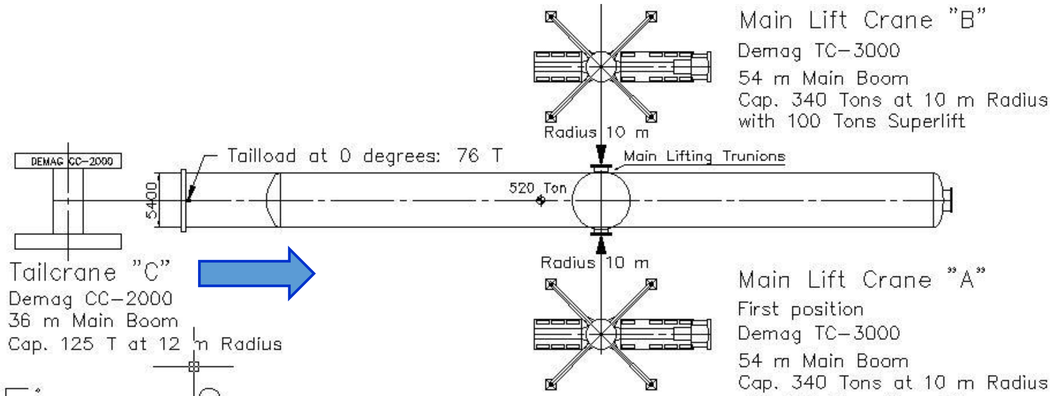

Figure 2

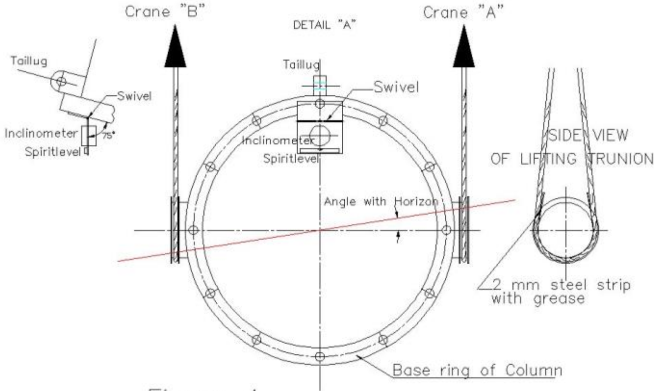

Figure 4

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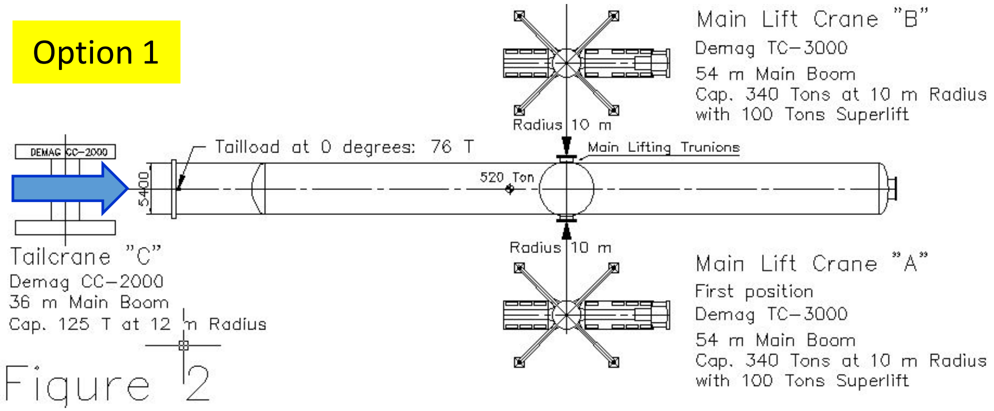
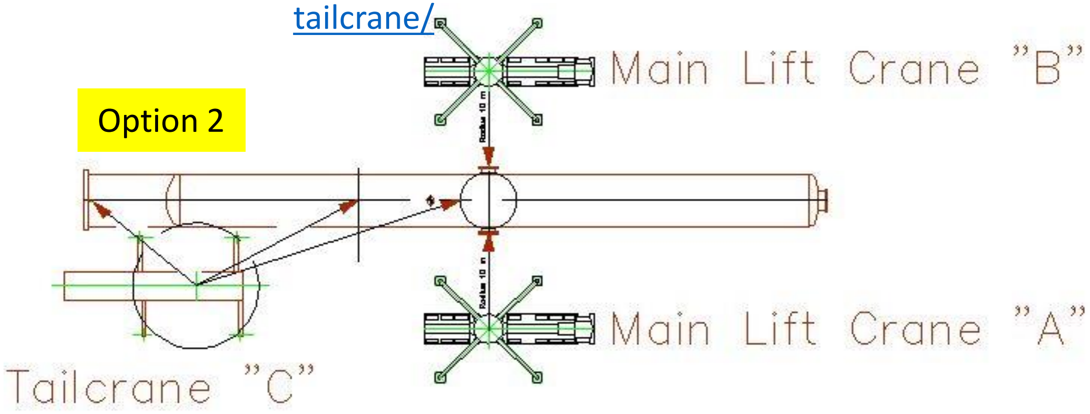
Tandem Lift

Option 1



http://www.heavyliftspecialist.com/heavy-lift-articles/lifting-pressure-vessel-main-lift-cranes-tailcrane/

Option 2



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Tandem Lift

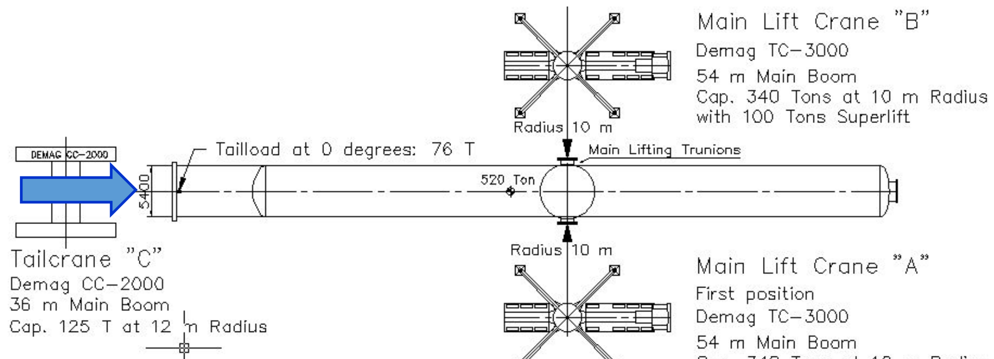
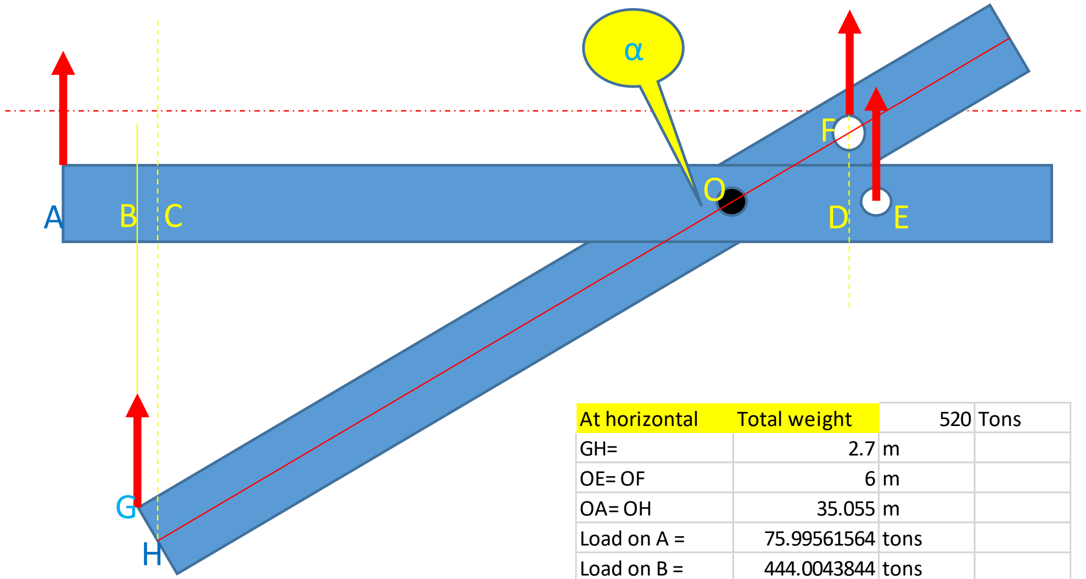


Figure 2



At horizontal	Total weight		520 Tons
GH=	2.7	m	
OE= OF	6	m	
OA= OH	35.055	m	
Load on A =	75.99561564	tons	
Load on B =	444.0043844	tons	
α=	85	degrees	
OD=	0.522934456	m	
OB=OC +CB	5.744970247	m	
OC=	3.055244562	m	
CB=	2.689725685	m	
Load on A =	43.38386275	tons	
Load on B =	476.6161373	tons	

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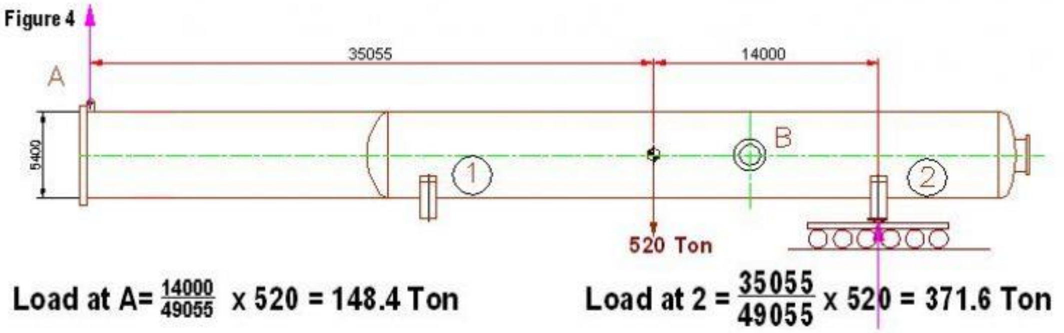
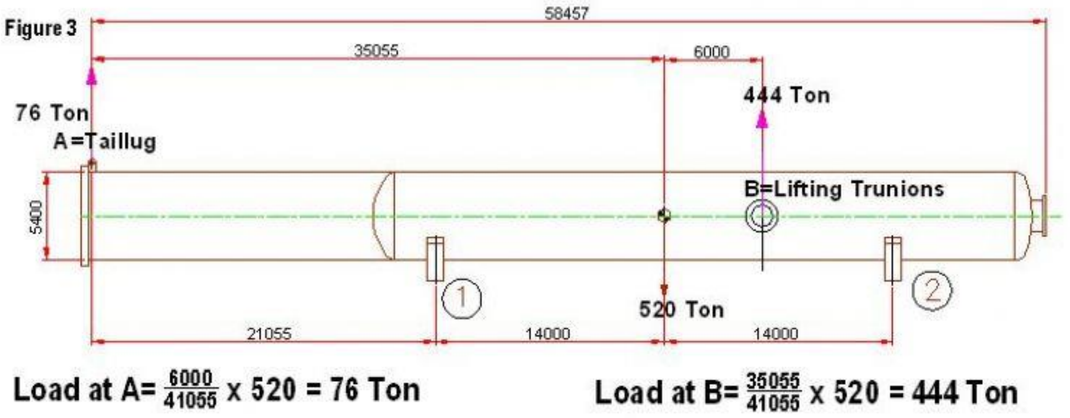
Tandem Lift





http://www.heavyliftnews.com/heavy-lift-articles/5415

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Tandem Lift

TABLE 3 ANGLE TO THE VERTICAL

Load variation	0°	15°	30°	45°	60°	75°	80°	85°	90°
Tailcrane "A"+"B"	444.0t	445.3t	446.8t	448.7t	451.8t	458.0t	454.7t	476.6t	520.0t
Tailcrane "C"	76.0t	74.7t	73.2t	71.3t	68.2t	61.0t	55.3t	43.4t	0.0t

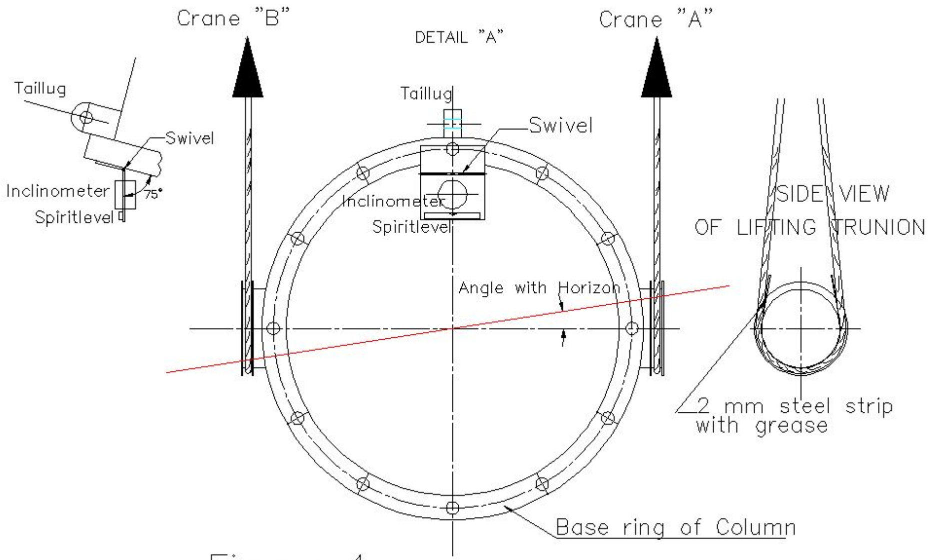

Figure 4

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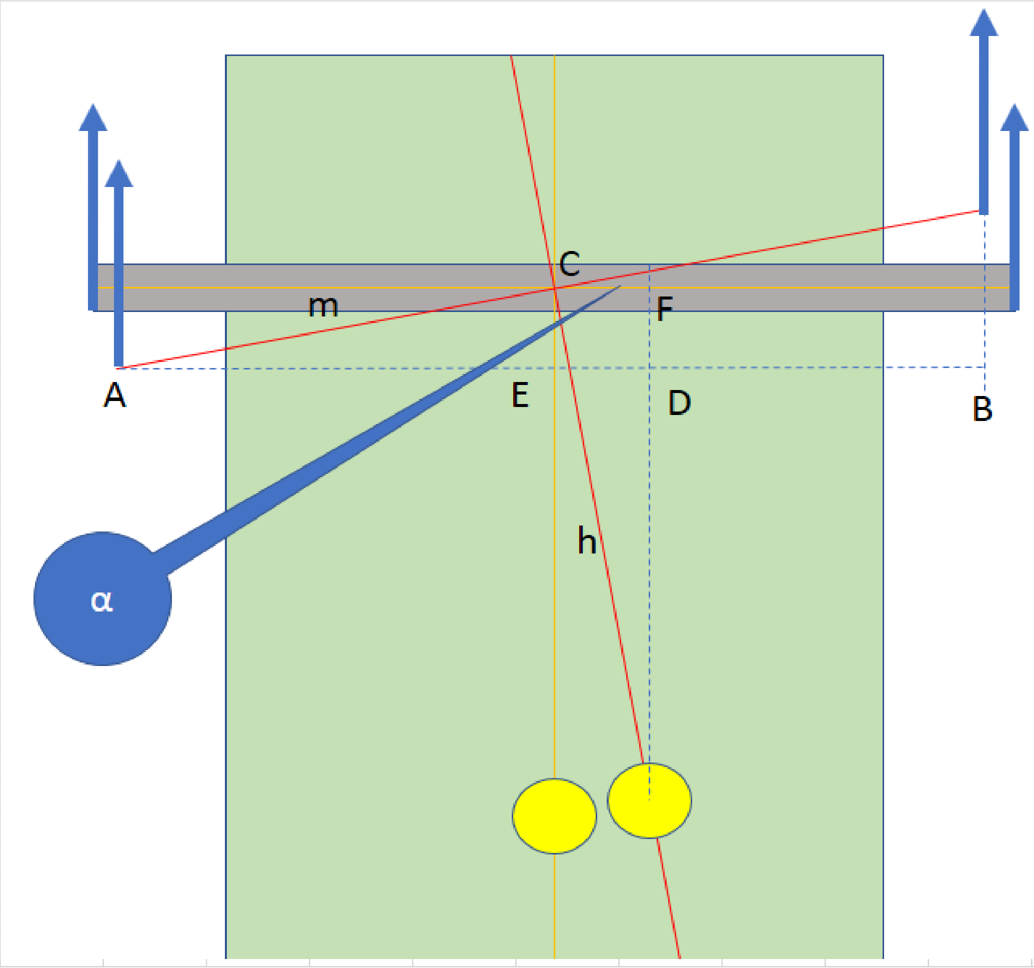
Tandem Lift - Backups



α=	6	degrees
m=	5.4	m
h=	6	m
AB=	5.370418	(=m*cos α
CF=	0.627171	(=h*sin α)
AE=EB=	2.685209	(=AB/2)
DB=	2.058038	AE-CF
Load	520	Tons
Load on A	199.2731	Tons
Load on B	320.7269	Tons

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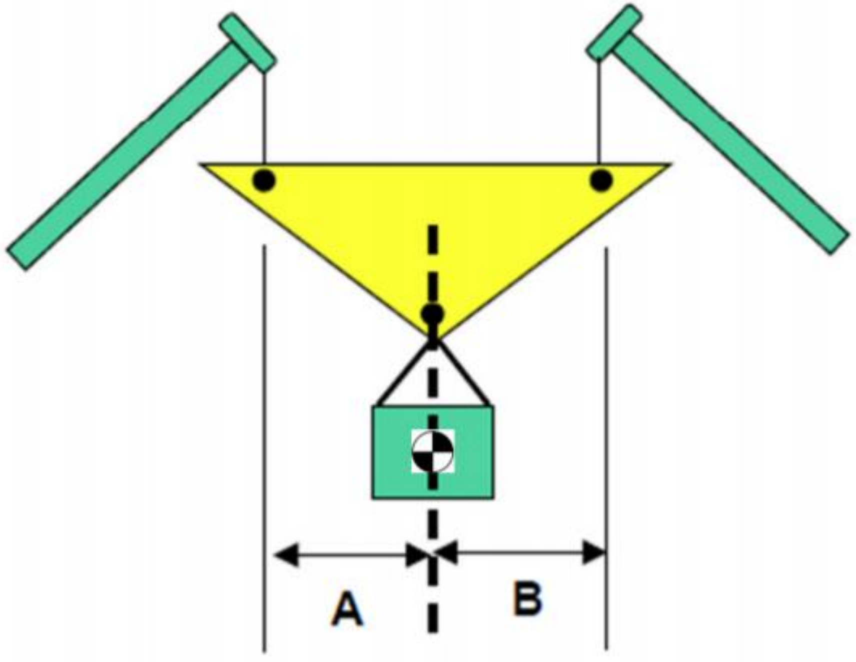
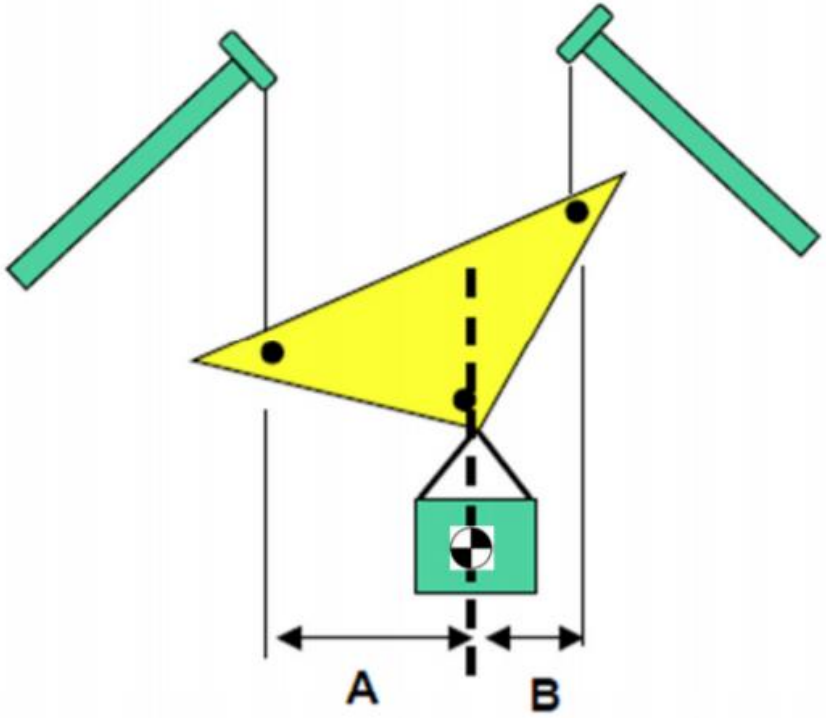
Tandem Lift



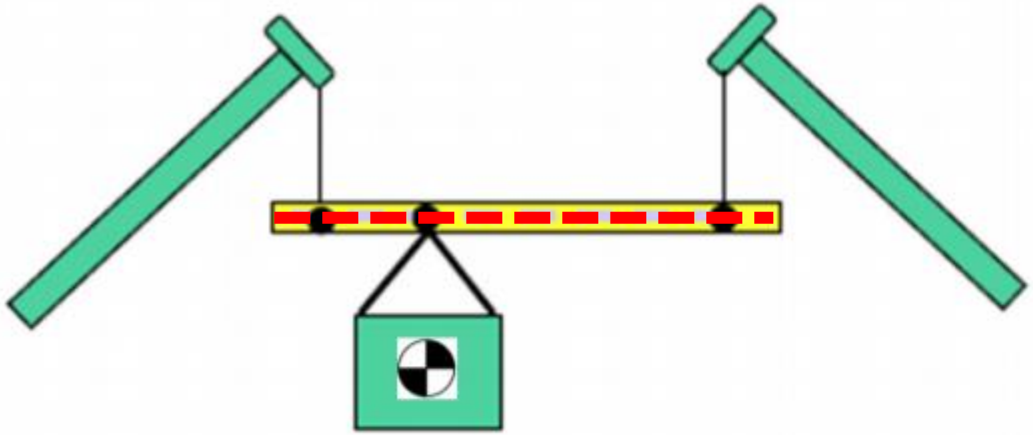
A=B

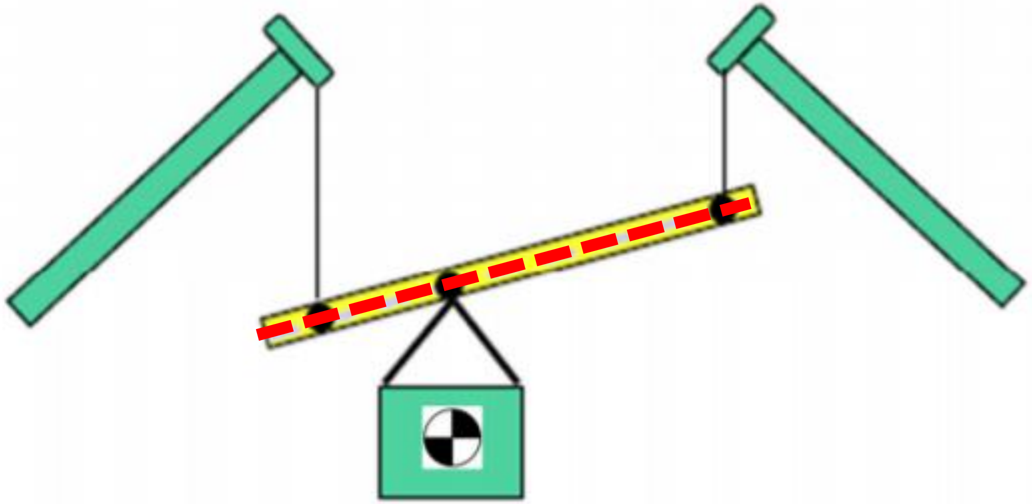
When the load is lifted by a beam and all the load attachment points ARE NOT in a straight line, if crane A lowers its end and the beam tilts to the right, the loading on crane B increases.



A Greater than B

Tandem Lift

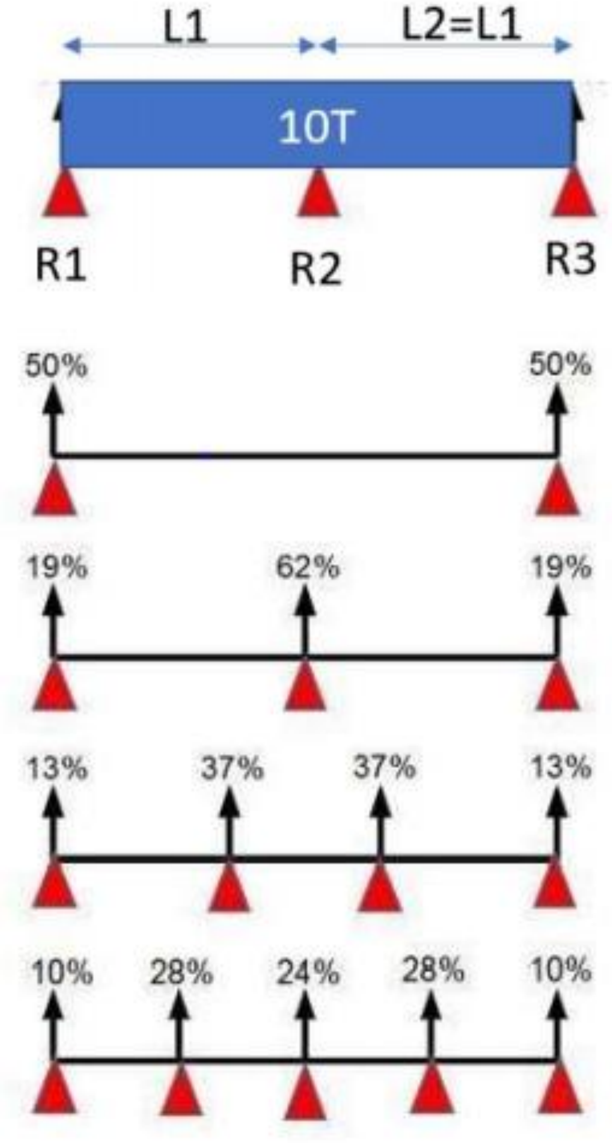




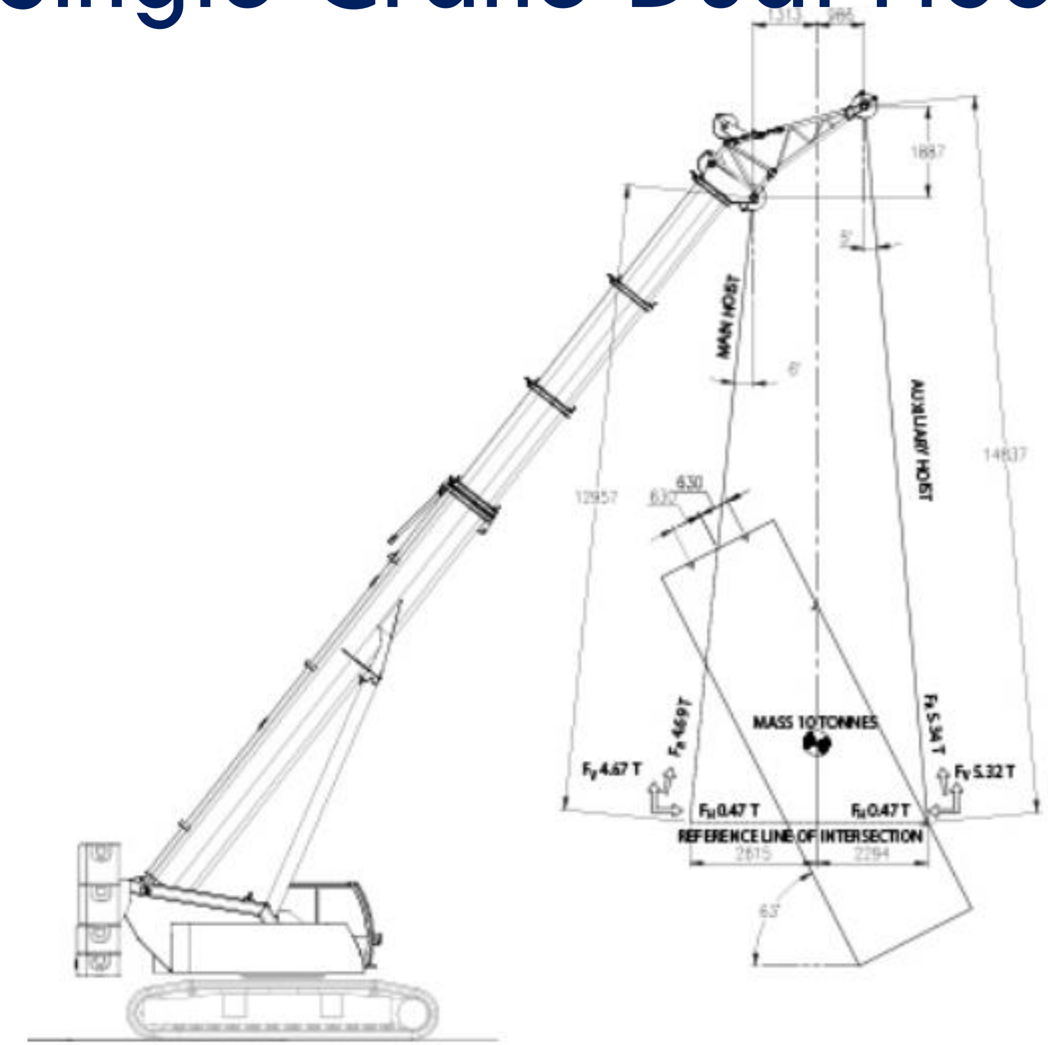
When a load is lifted with a beam and all the load attachment points remain in a straight line as the beam is tilted, the loading on each crane stays the same.

Cùng hệ treo và điểm treo thẳng hàng

Multiple crane



Single Crane Dual Hook Operation



Simultaneous use of both main and aux hooks should only be done in accordance with instructions provided by the crane manufacturer

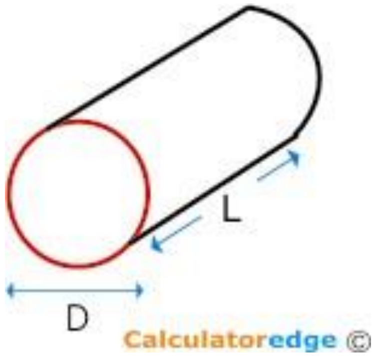
Do not lift up" If the entire weight of the load to be lifted exceeds either the minimum rated capacity of the main or the auxiliary hook(holding brake) "

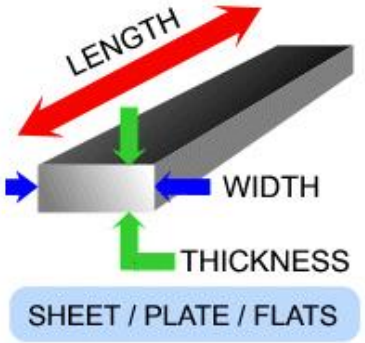
http://www.cranesandlifting.com.au/cica-guidance-note-single-crane-dual-hook-operation/

LOADING

Weight of load = ?

WEIGHT OF MATERIALS		
	Kg/m3	T/m3
Aluminium	2643.046	2.643
Copper	8970.339	
iron	7688.862	7.6889
lead	11373.11	11.3731
steel	7849.047	7.849
concrete, slag	2082.4	2.0824
tone	2306.659	2.3067
concrete reinforced	2402.77	2.4028
glass	2562.954	2.563
paper	961.1078	0.9611
oil	929.0709	0.9291
water	993.1447	0.9931
earth wet	1601.846	1.6018
earth dry	1201.385	1.2014
sand gravel wet	1922.216	1.9222
sand gravel dry	1681.939	1.6819
cement	2931.379	2.9314
crushed rock	1762.031	1.762





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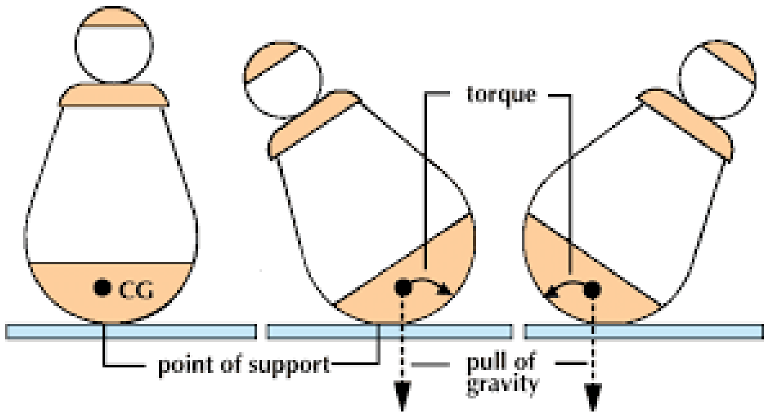
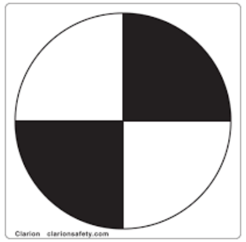
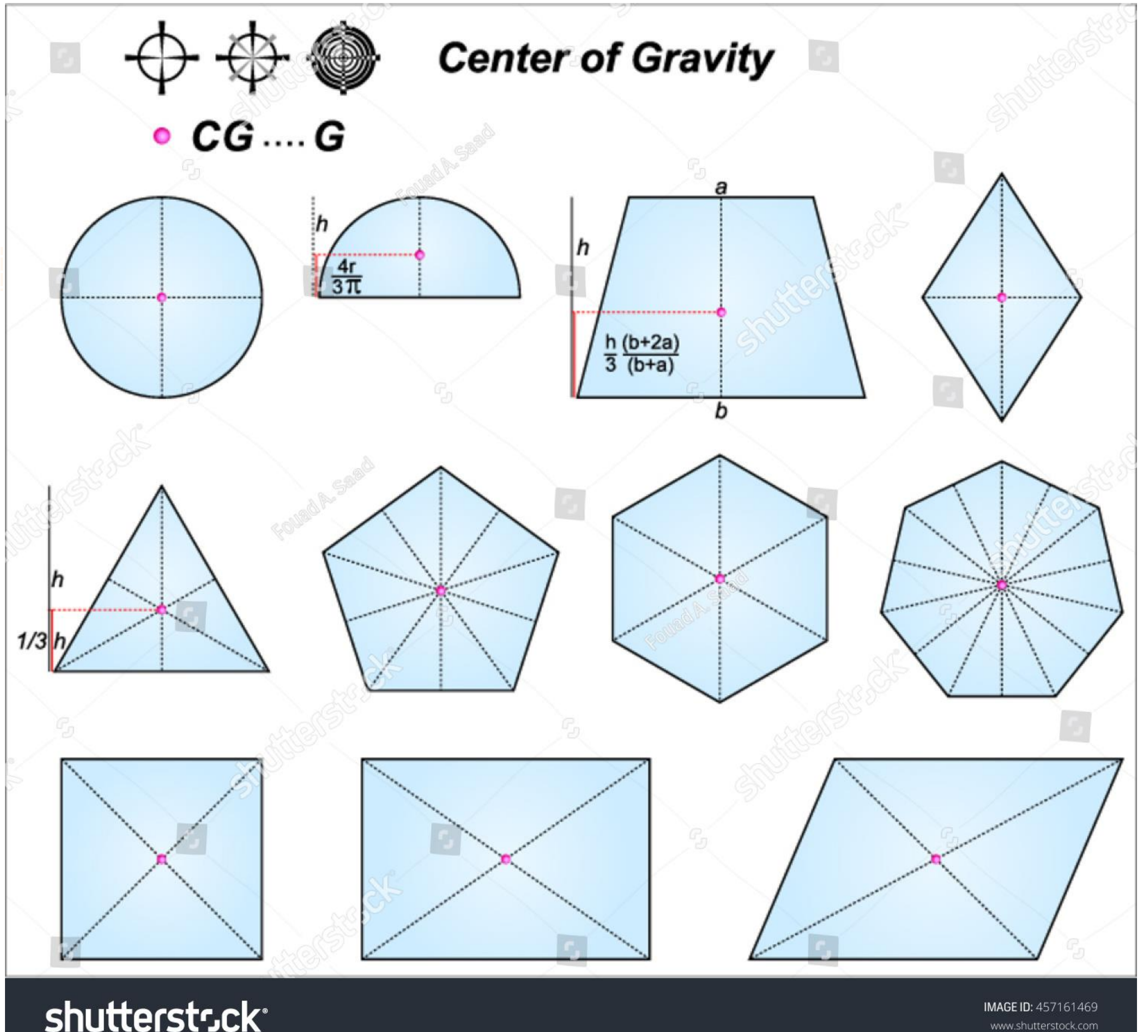
CENTER OF GRAVITY







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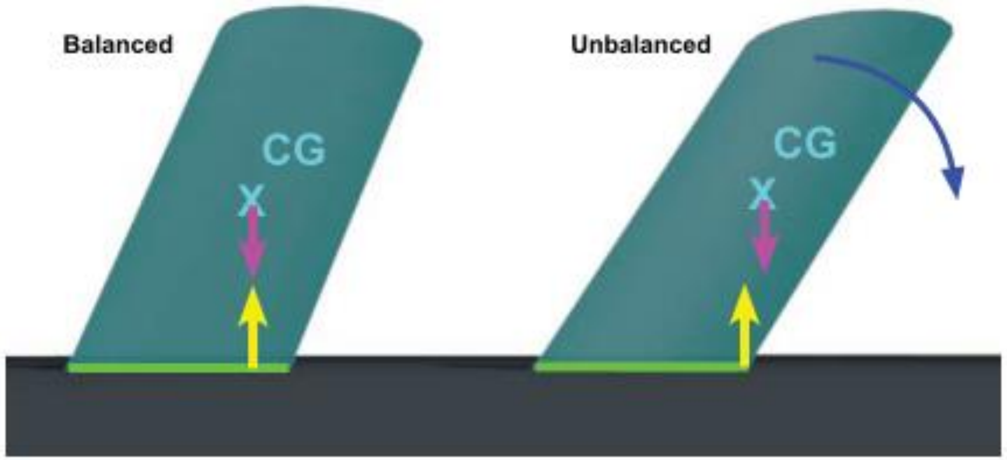
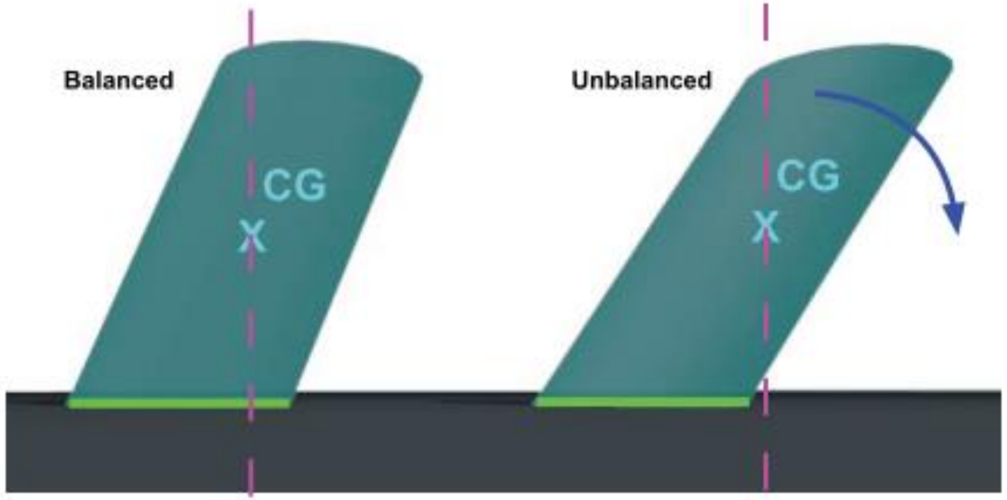
CENTER OF GRAVITY



For the cylinder on the right the CG is not above the base of support so these two forces cannot align and instead create a torque that rotates the object, tipping it over.



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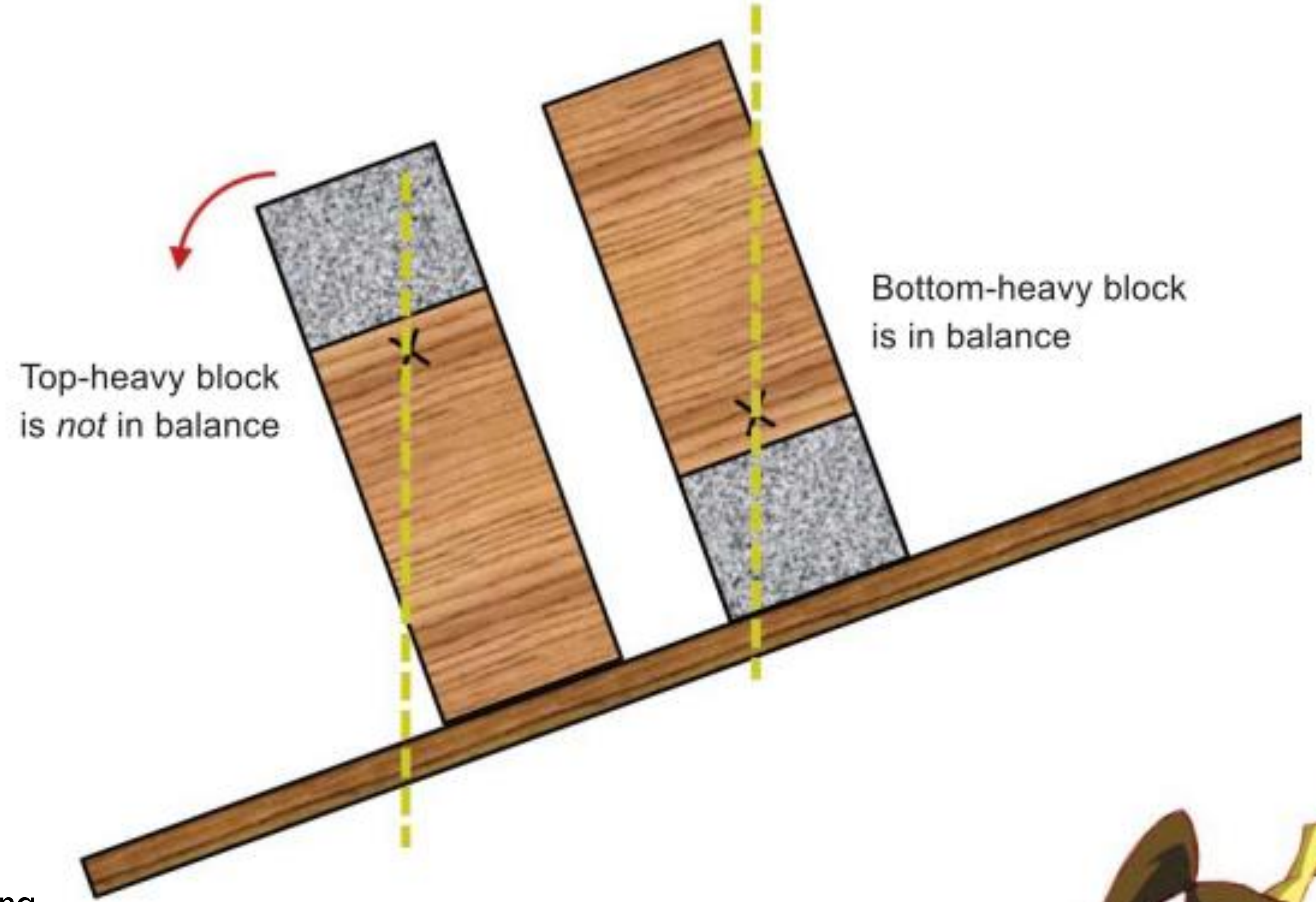

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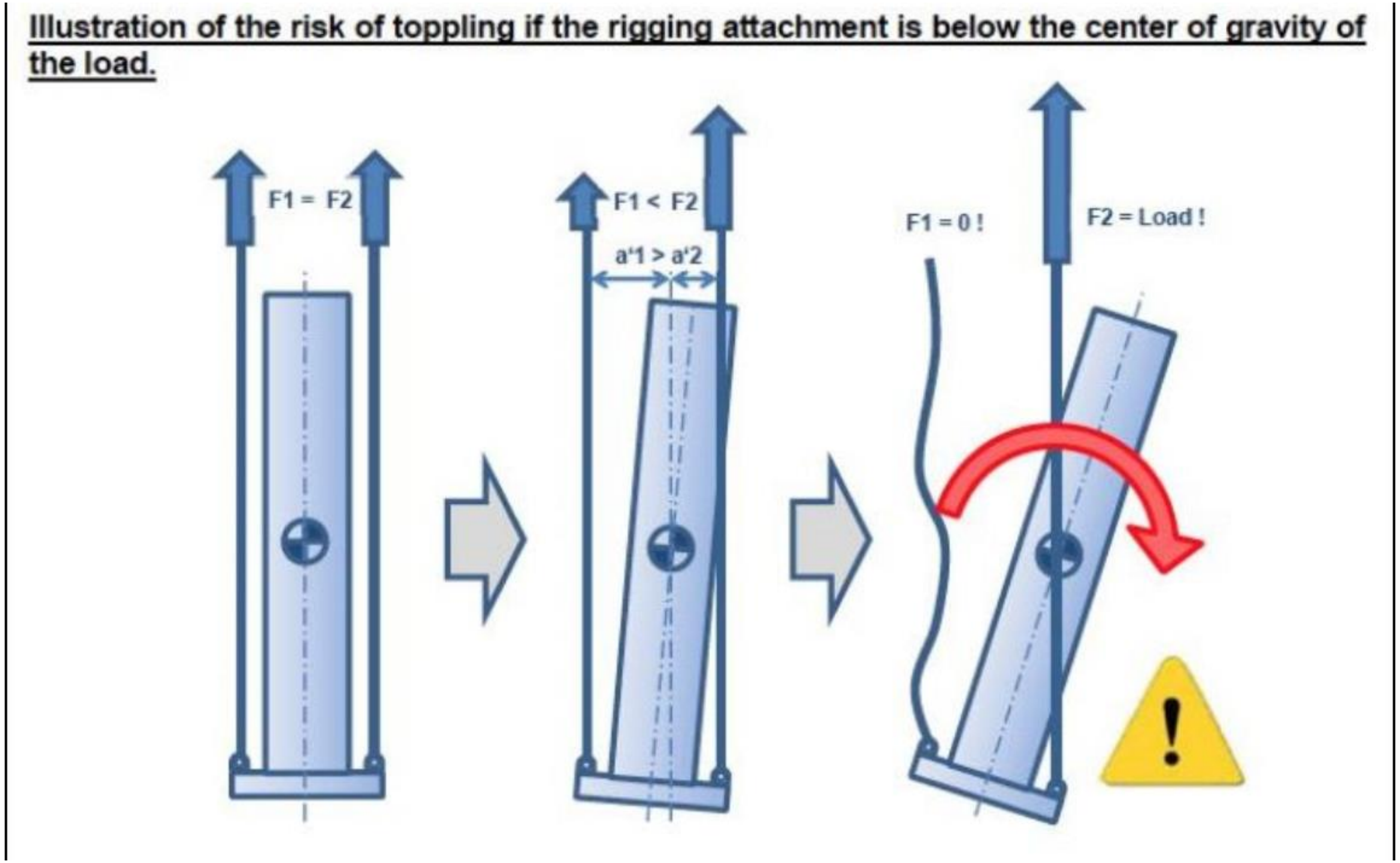
CENTER OF GRAVITY



http://www.heavyliftnews.com/news/video---guidance---lifting-a-load-with-several-mobile-cranes--multiple-lifting--?cu=58

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CENTER OF GRAVITY

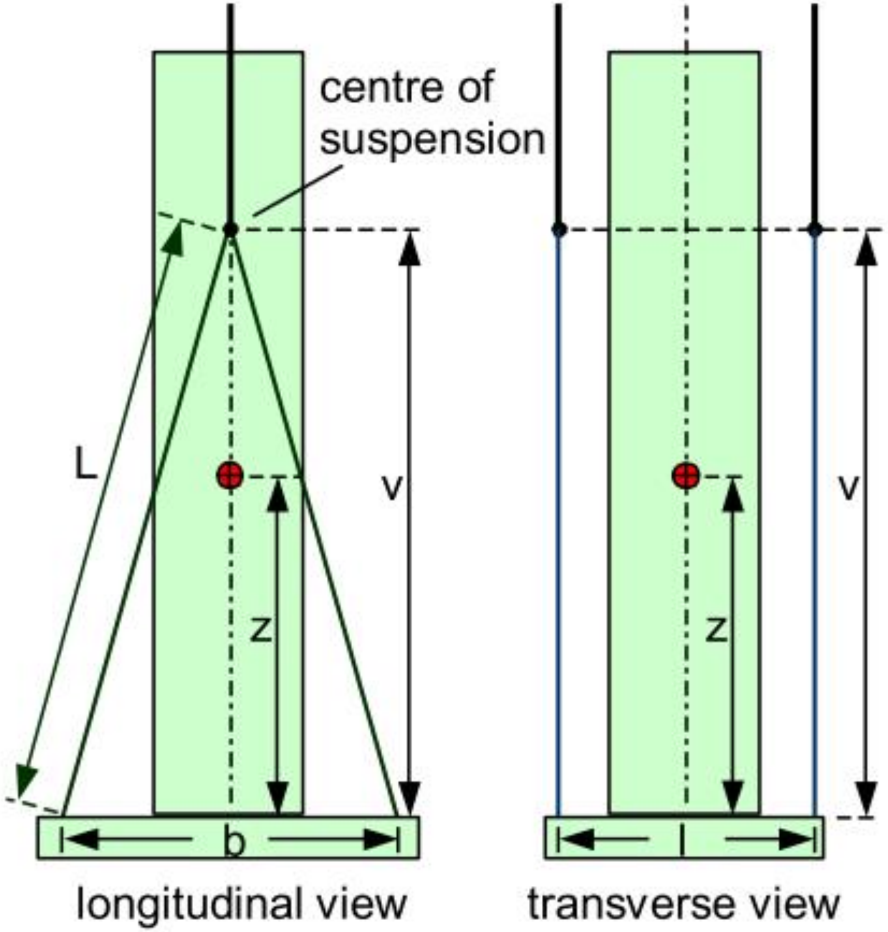

Figure 1.8: Dual crane lift with primary suspension, essential parameters

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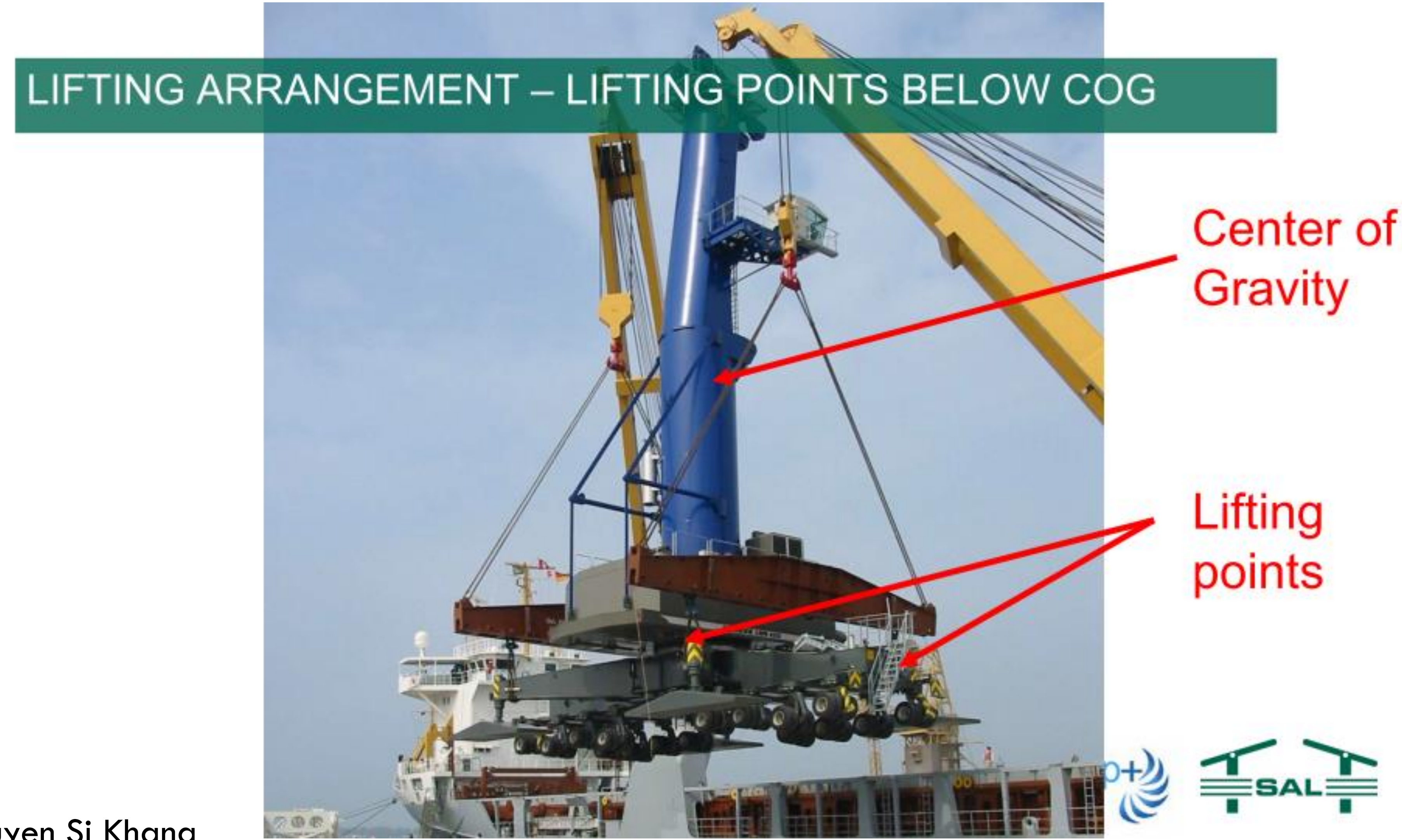
CENTER OF GRAVITY



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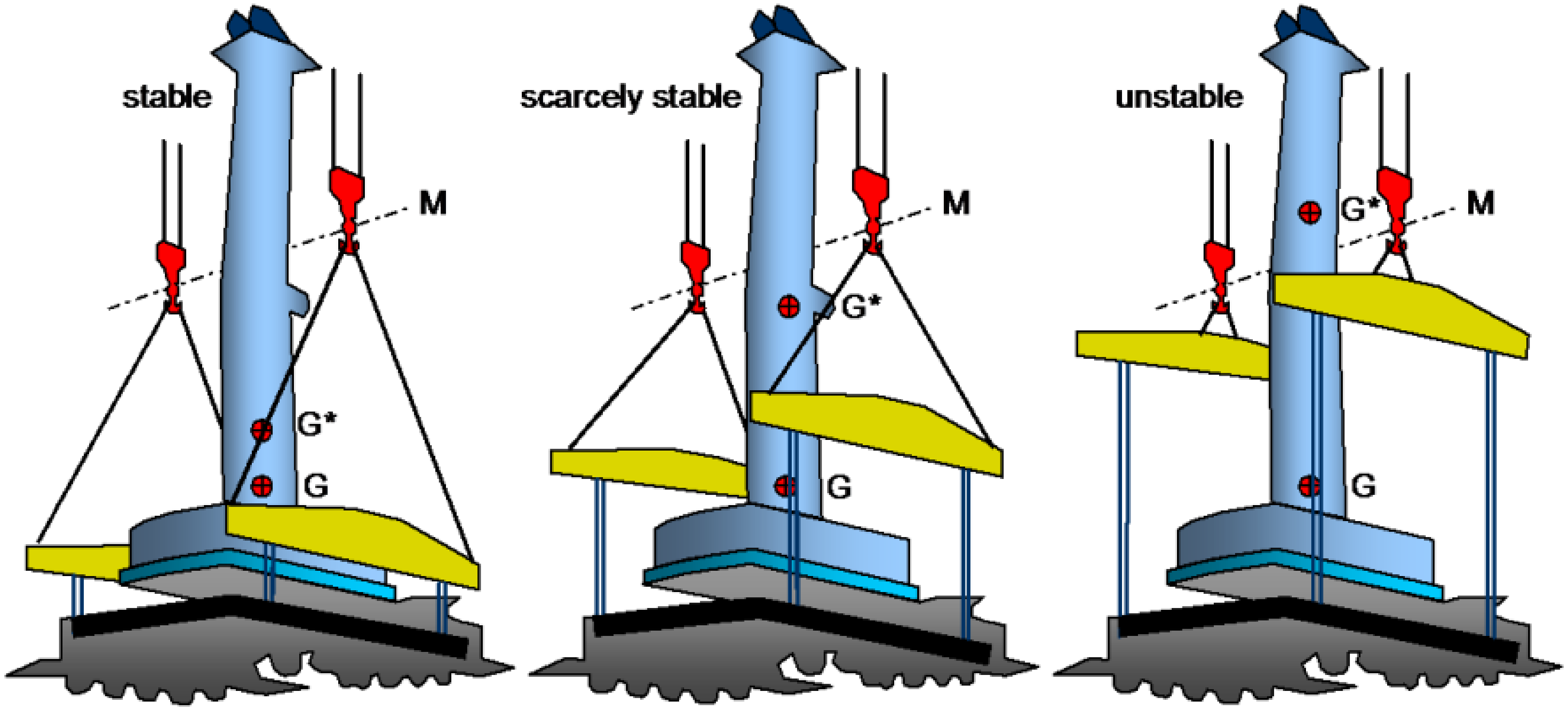

Figure 1.9: Different shares of primary and secondary suspension

CENTER OF GRAVITY

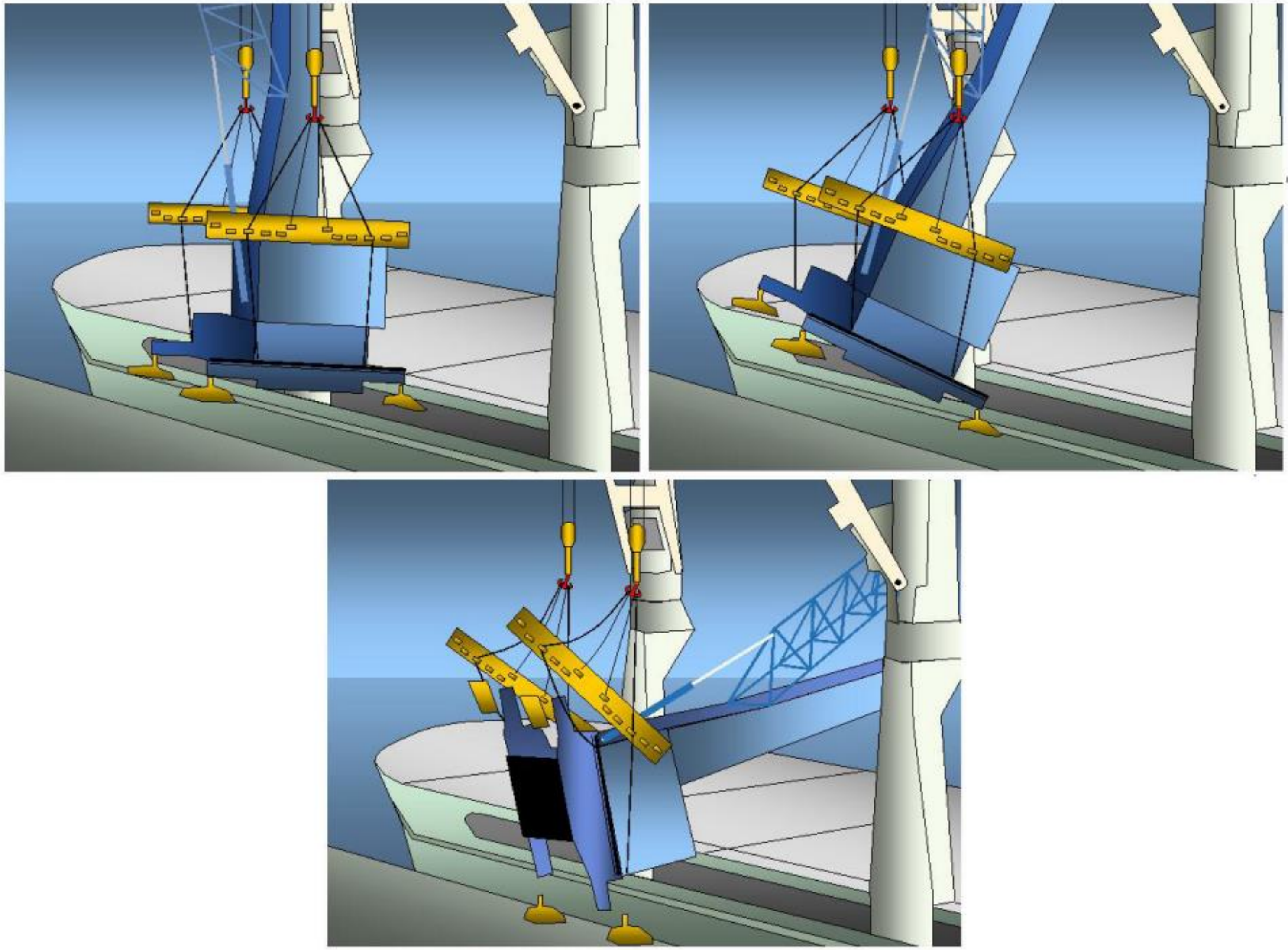

Figure 1.10: Capsize due to insufficient metacentric height of suspension arrangement

CENTER OF GRAVITY

Ontario, Canada, 29 May 2013
A rotor was dropped last week as it was unloaded at new power generation facility in Durham Ontario, Canada

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CENTER OF GRAVITY

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CENTER OF GRAVITY

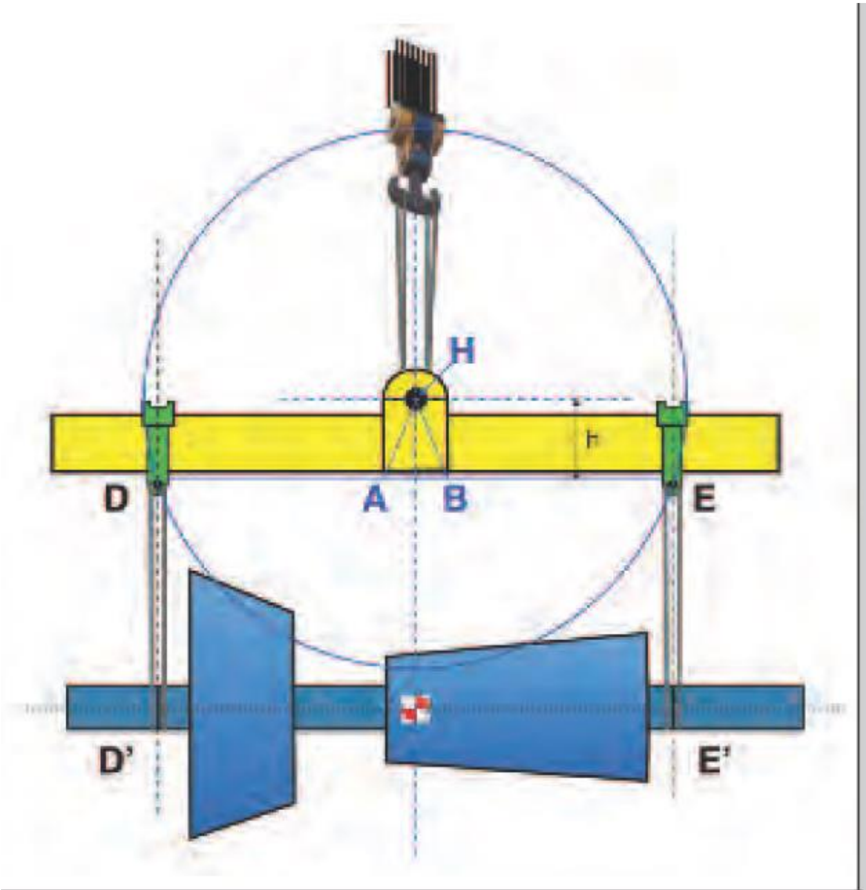

Figure 6: Stability rotor 1.

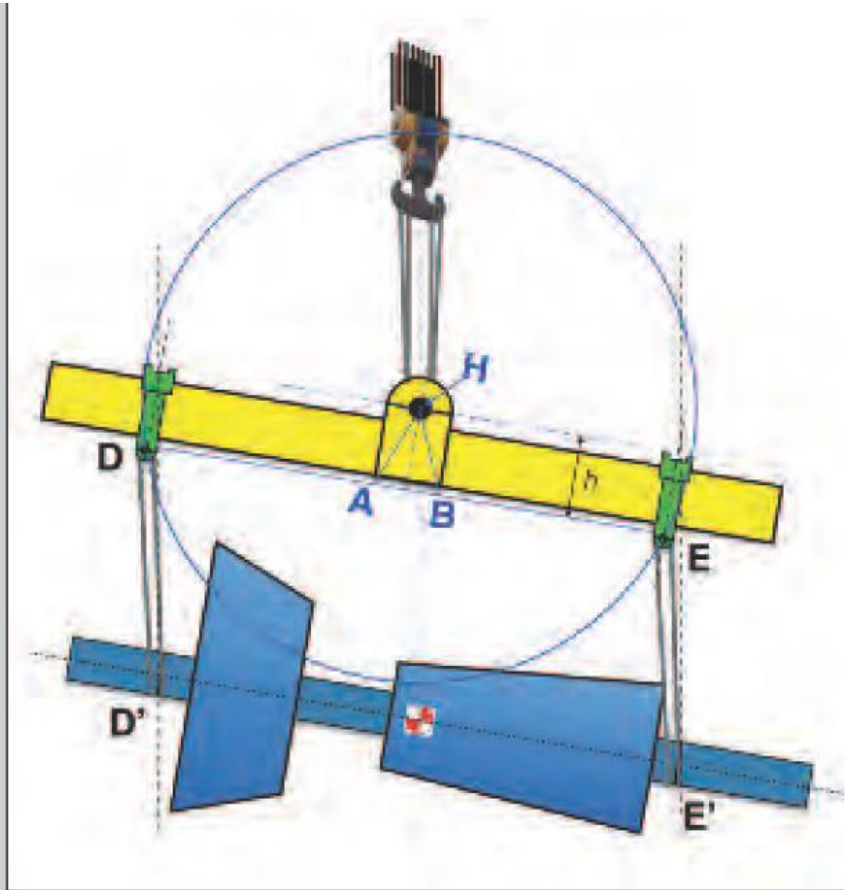

Figure 7: Stability rotor 2.

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CENTER OF GRAVITY

To allow Crane users to easily determine the necessary de-rating of the cranes, FEM provides a method and a simplified formula that covers both effects described above:

$$\%RC = \frac{100}{1 + \frac{h}{\min(a_1; a_2)} . \tan\alpha}$$

%RC: Percentage/Utilization of the crane's capacity chart for each crane

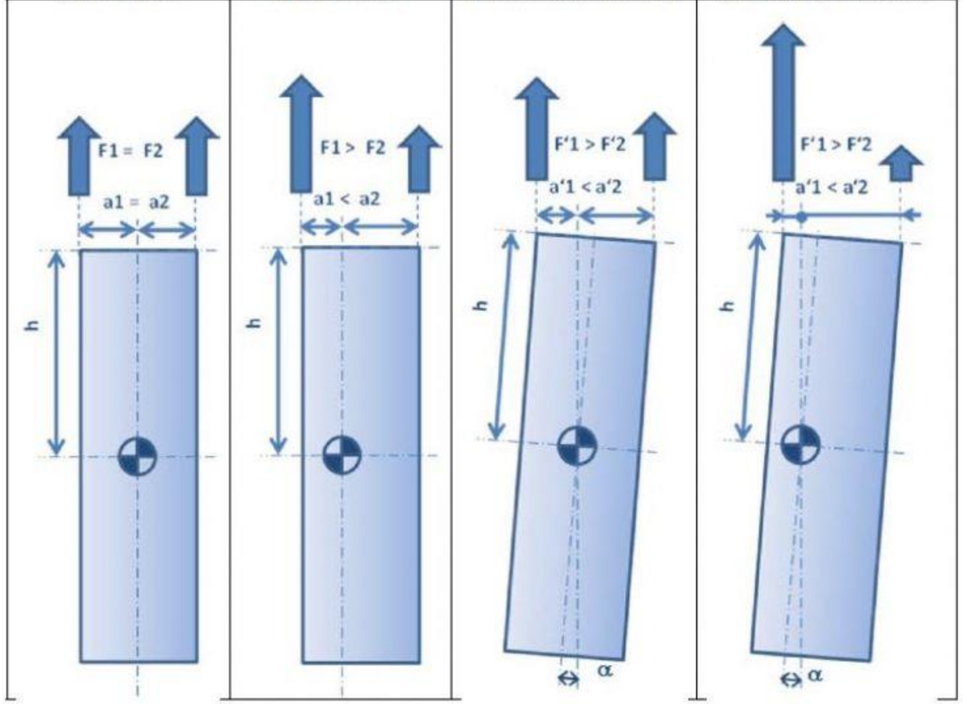
h: distance between lift points and center of gravity measured parallel to the lifting direction. **NOTE: in these examples, the Center of Gravity is shown underneath the lifting points; if the Center of Gravity is higher than the lifting points, the load distribution between the cranes is inverted (refer also to Page 6).**

a_1, a_2: distance between lift points and center of gravity measured perpendicular to the lifting direction

α: Potential inclination of the load

Typical cases:

Case			
I	II	III	IV
Symmetrical	Non-symmetrical	Symmetrical	Non-symmetrical
$\alpha = 0$ (vertical load)	$\alpha = 0$ (vertical load)	$\alpha \neq 0$ (inclination from vertical)	$\alpha \neq 0$ (inclination from vertical)



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CENTER OF GRAVITY

Due to the smal lift triangle from swivel point of the hook to the lift beam sling connections, which projected down through the lift points and not enclosing the CoG, the load tilts as shown above.
As long as the lift points are above the CoG, there is no problem, or ensure the lift triangle encloses the CoG.

http://www.heavyliftnews.com/news/scf-is-changing-the-future-of-the-spreader-bar-industry-and-setting-new-standards

I would recommend not to use a Super Bar™ design, when lifting loads from lift points below the CoG.

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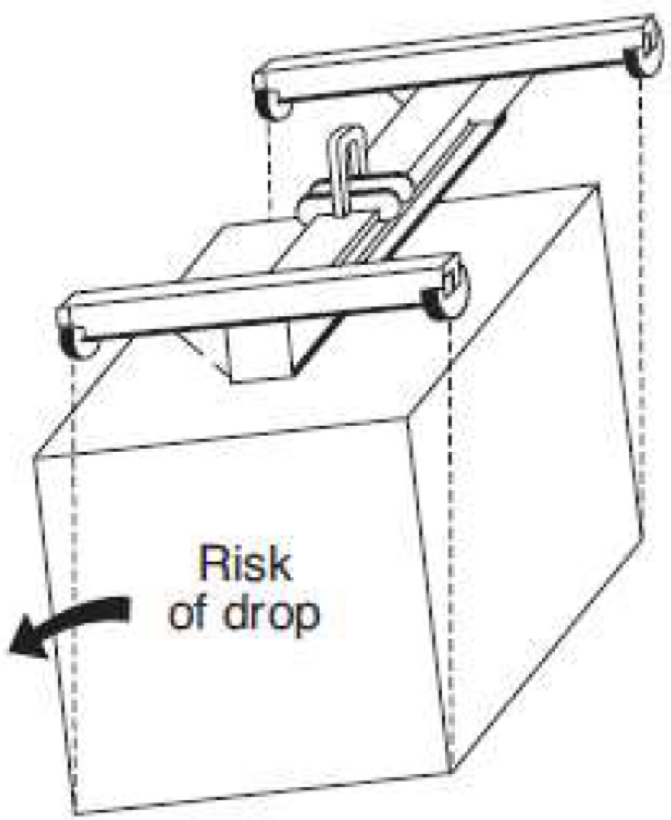
CENTER OF GRAVITY



A typical application of this kind might be a container lifted from the base. The lifting beam is connected to the container base by four vertical single leg slings.

When viewed from the side, the lifting beam, container and slings form the four sides of a rectangle.

Without triangulation the four sides form a mechanism which can deform into the shape of a parallelogram. That is what happens if the load is unstable and starts to topple.

CENTER OF GRAVITY

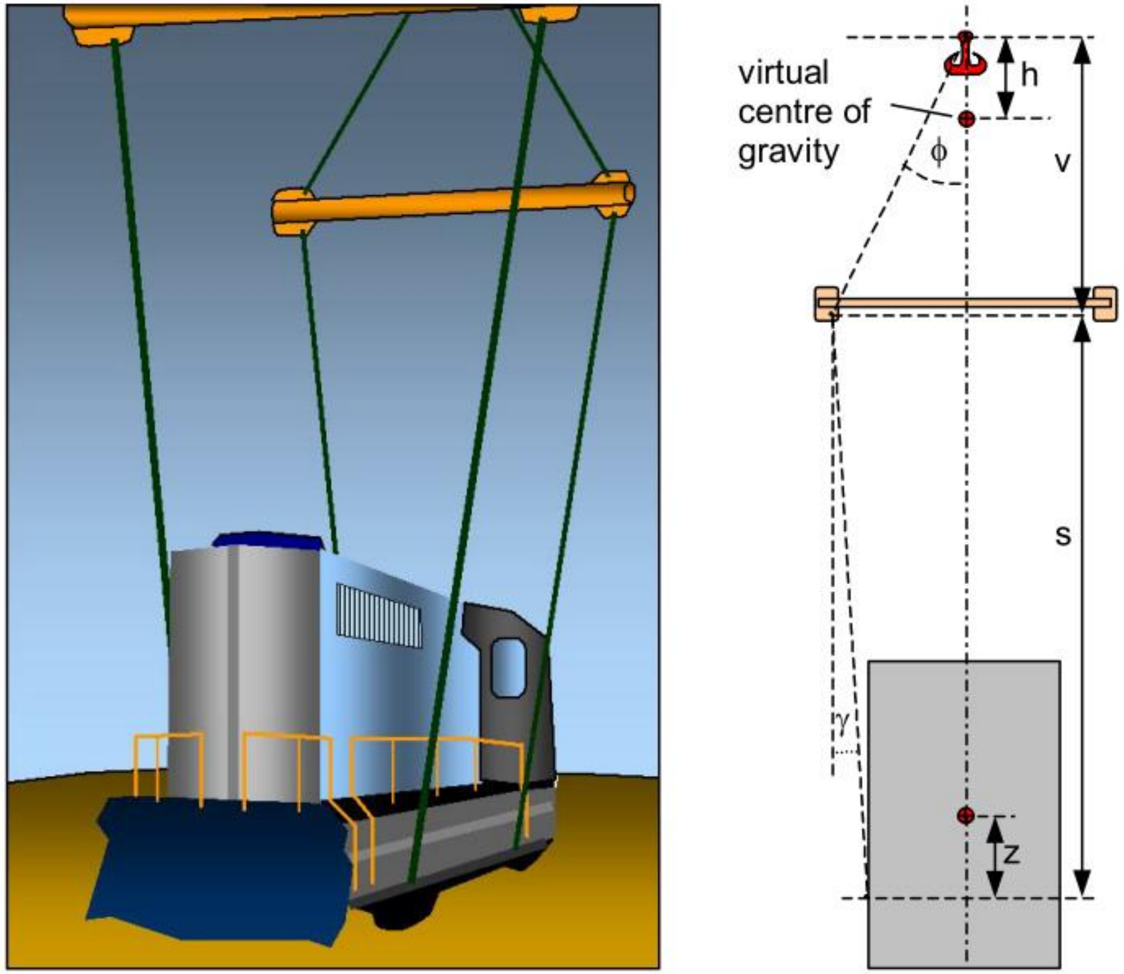


Figure 1.7: Arrangement with inward inclined secondary slings, estimated parameters

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CENTER OF GRAVITY

30

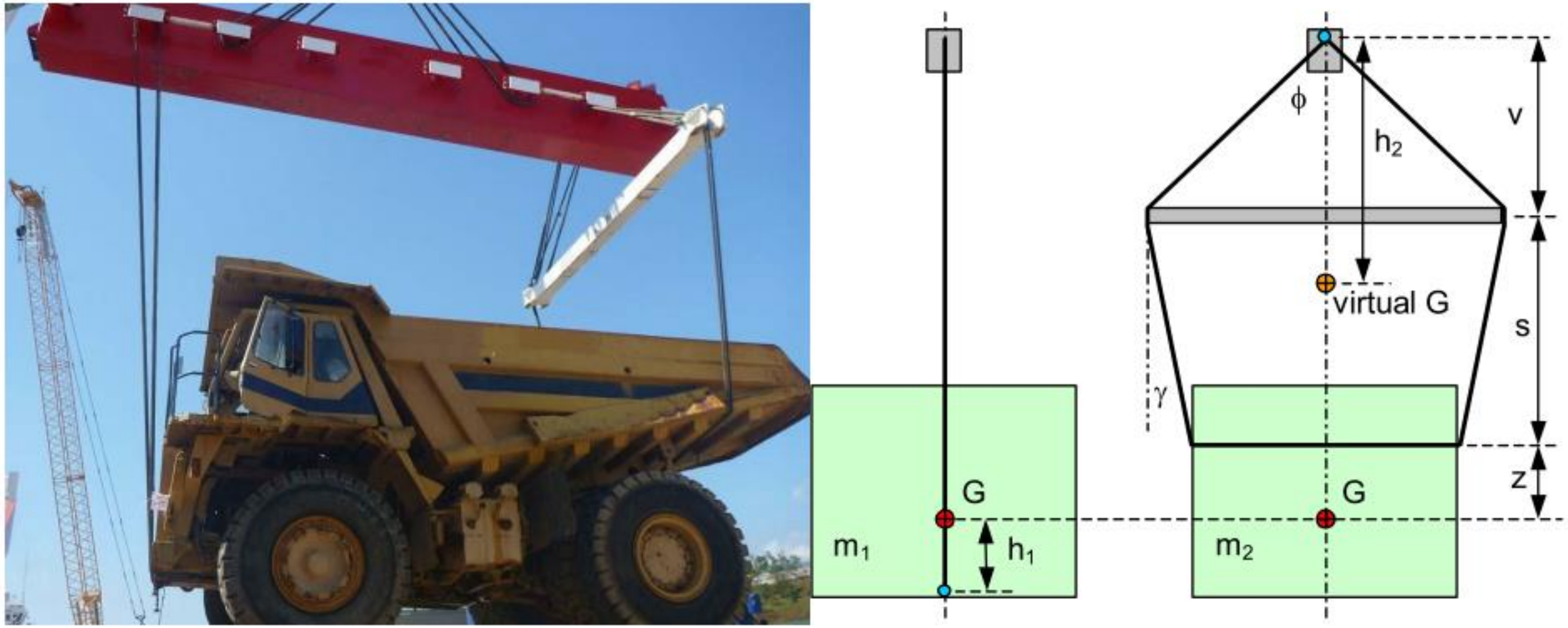
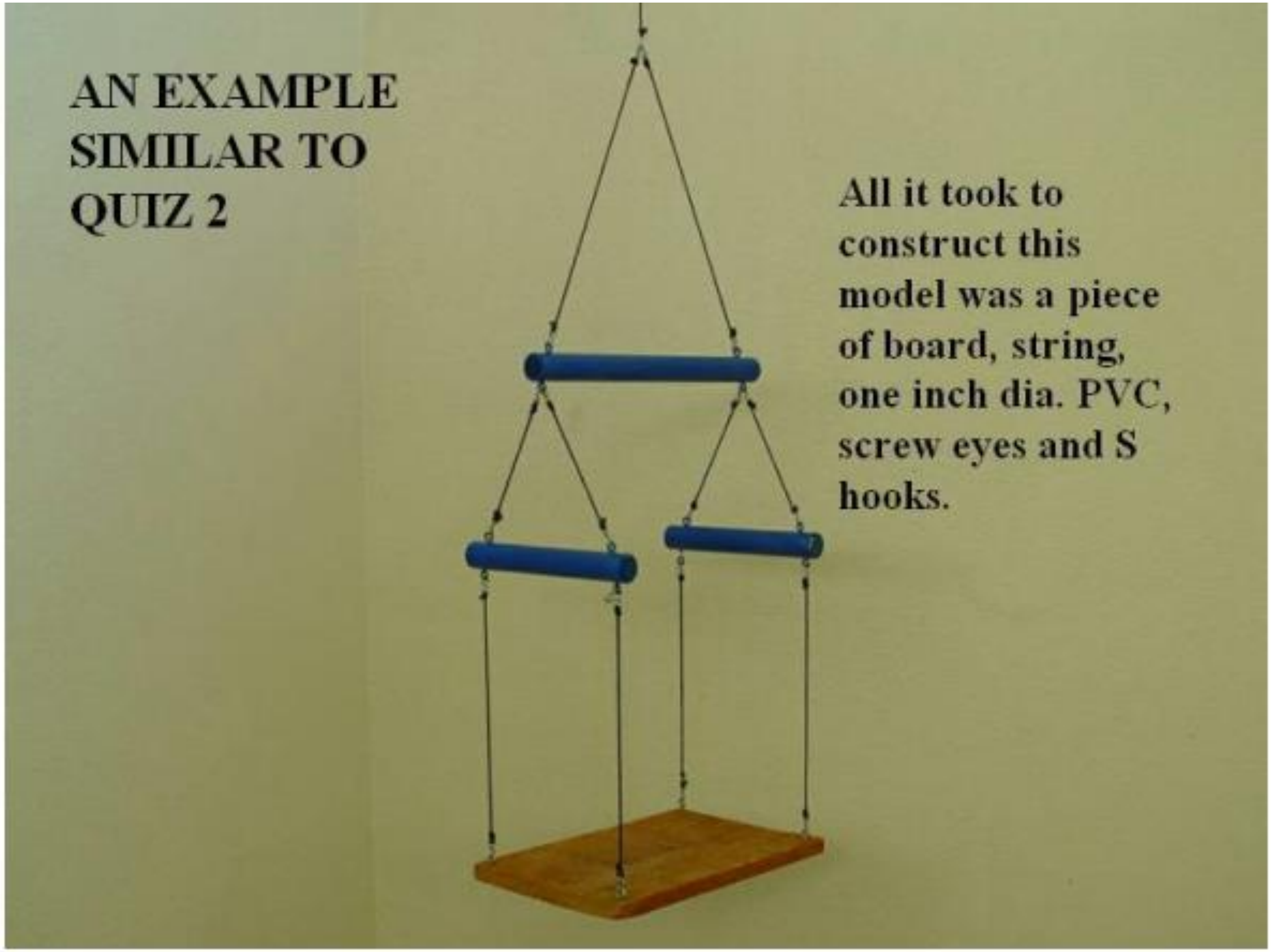


Figure 1.11: Asymmetric suspension arrangement

CENTER OF GRAVITY



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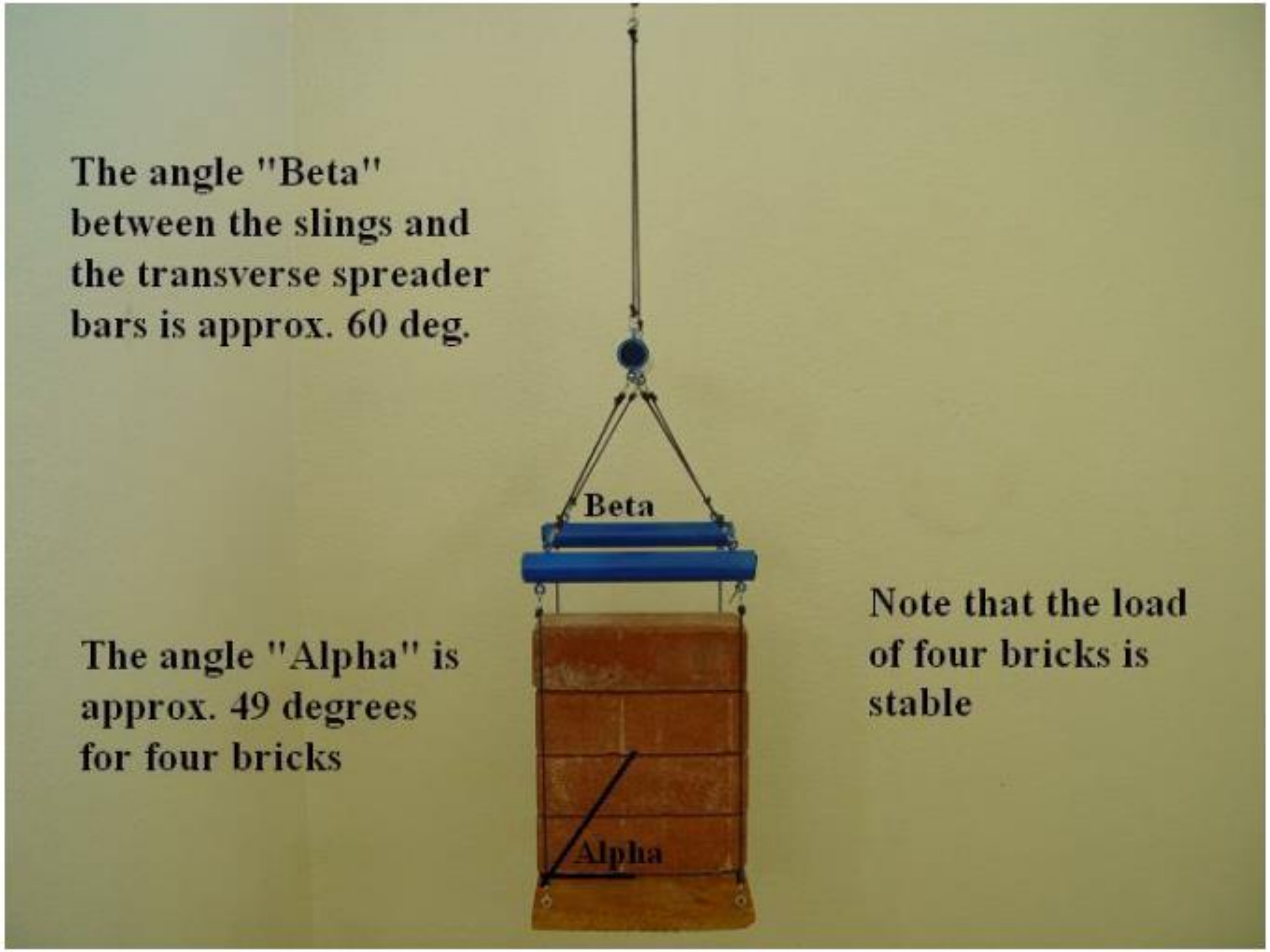
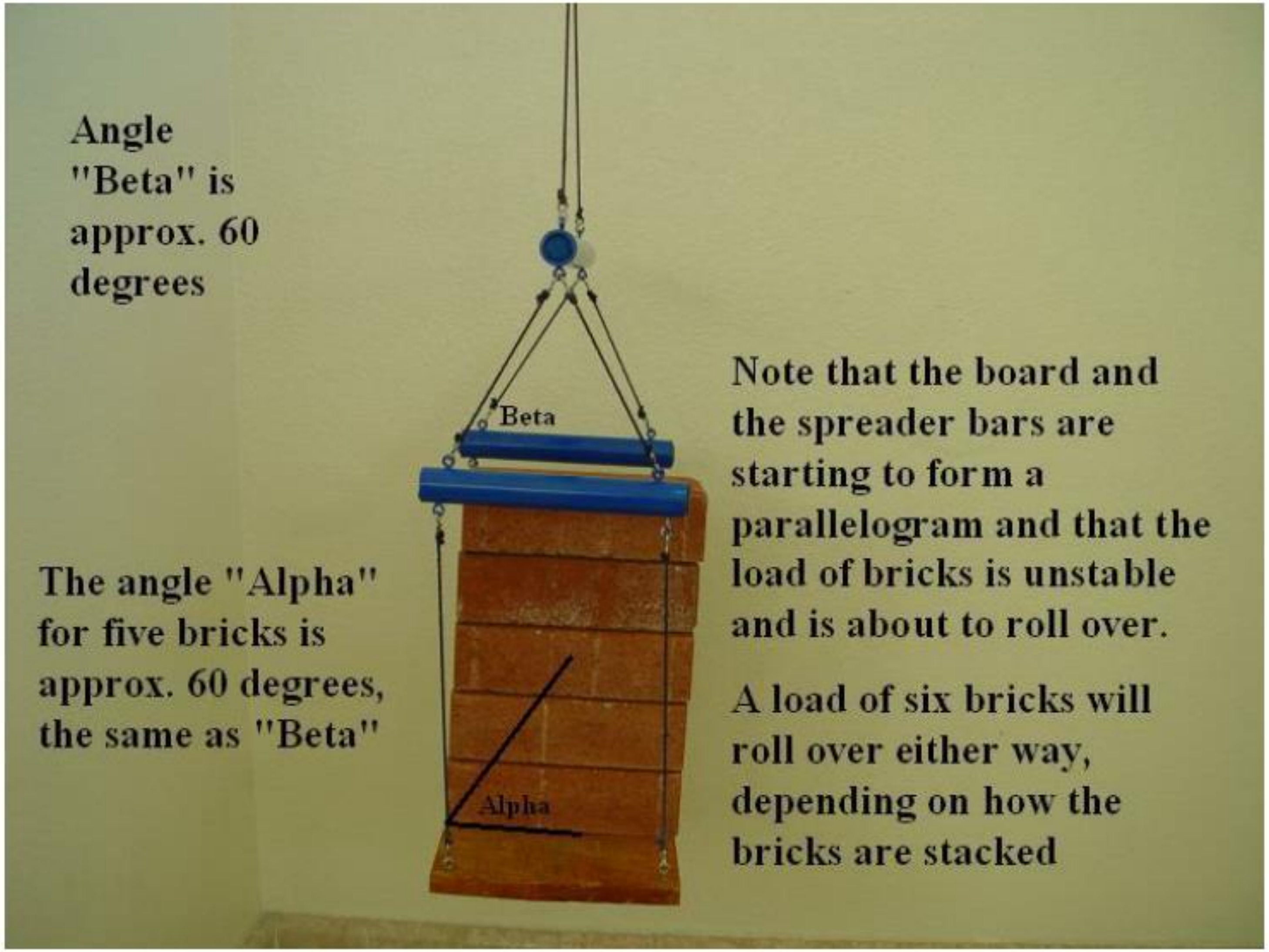
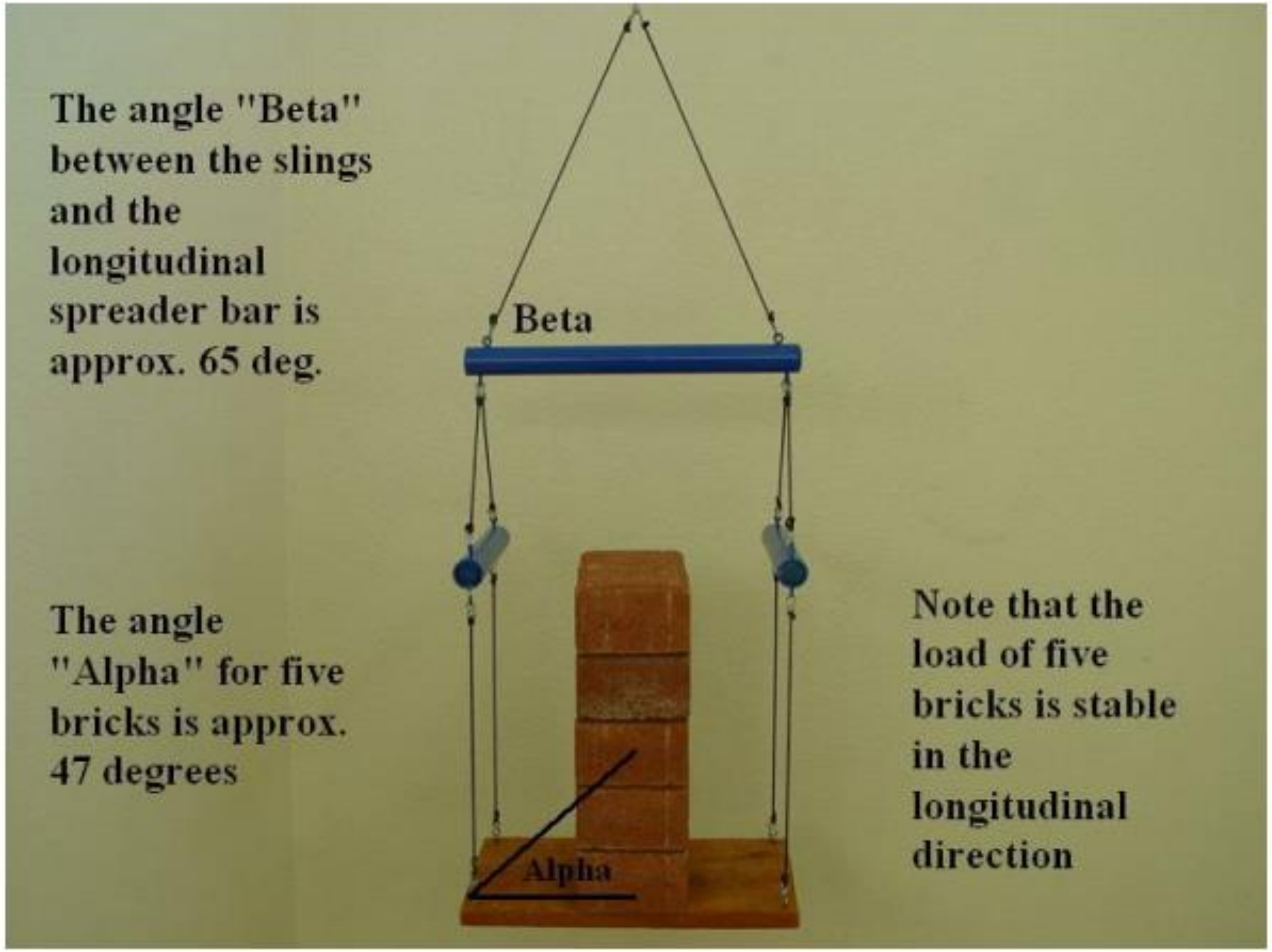
CENTER OF GRAVITY



CENTER OF GRAVITY



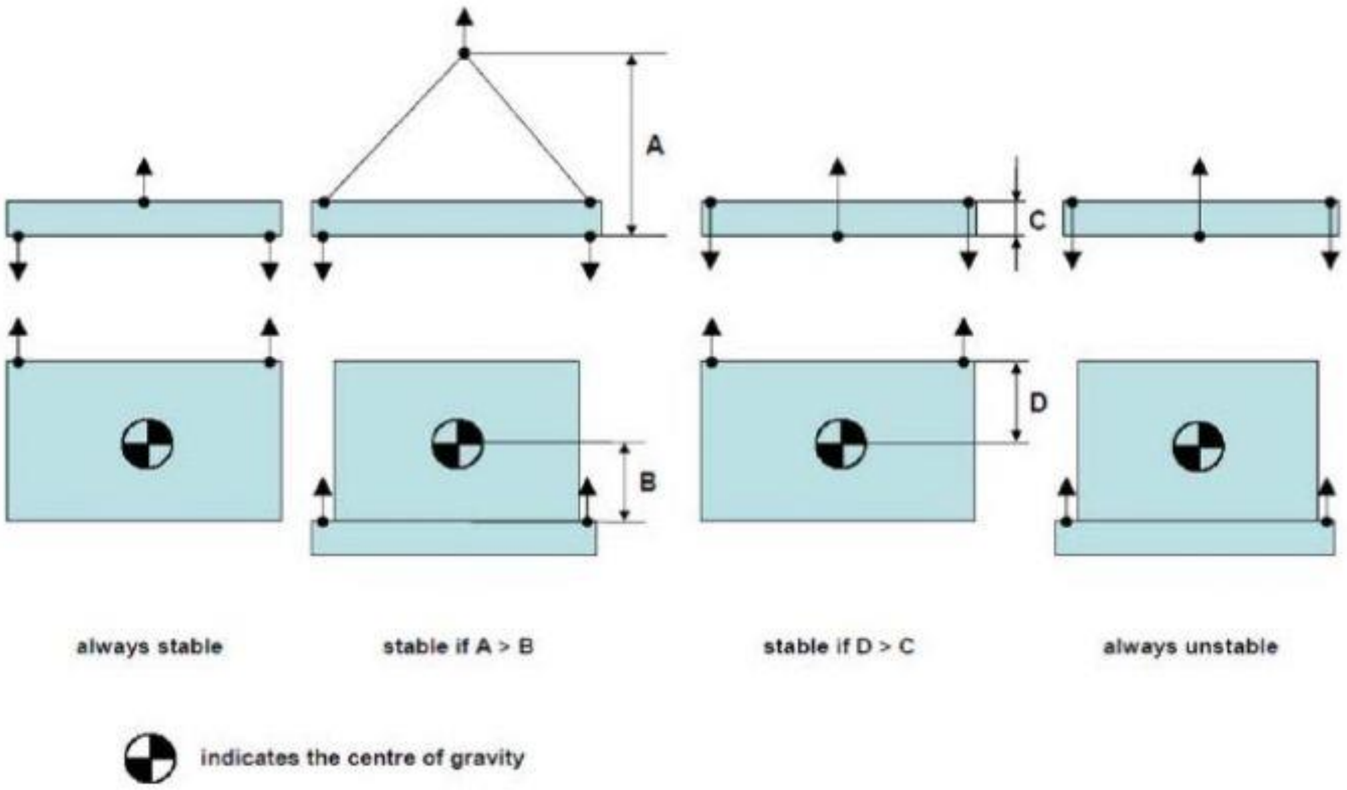
CENTER OF GRAVITY



CENTER OF GRAVITY

ANNEX 4 Positioning of Lifting Lugs

The figure explains the effects of stable and unstable arrangements of lifting beams and support points (lifting points) on the load (compare EN13155 Chapter 7.1.2.5 Lifting beams). Forces which will try to topple the load will always be present (wind load, acceleration and deceleration of slewing, etc.).



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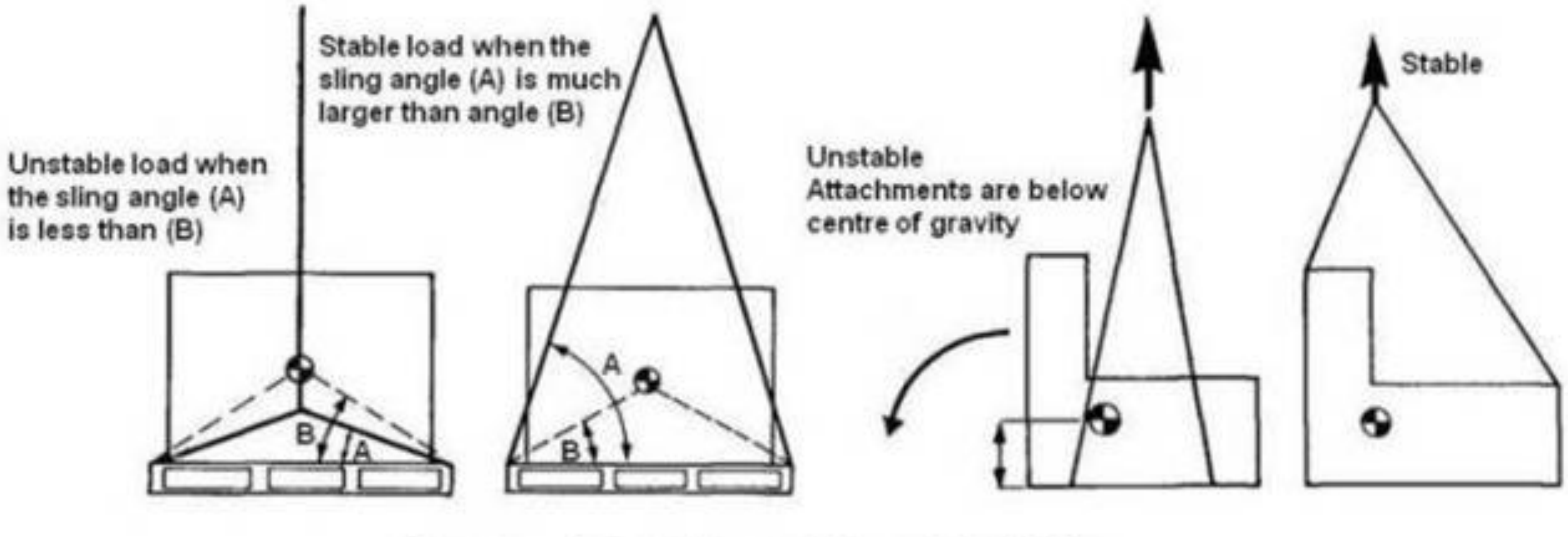
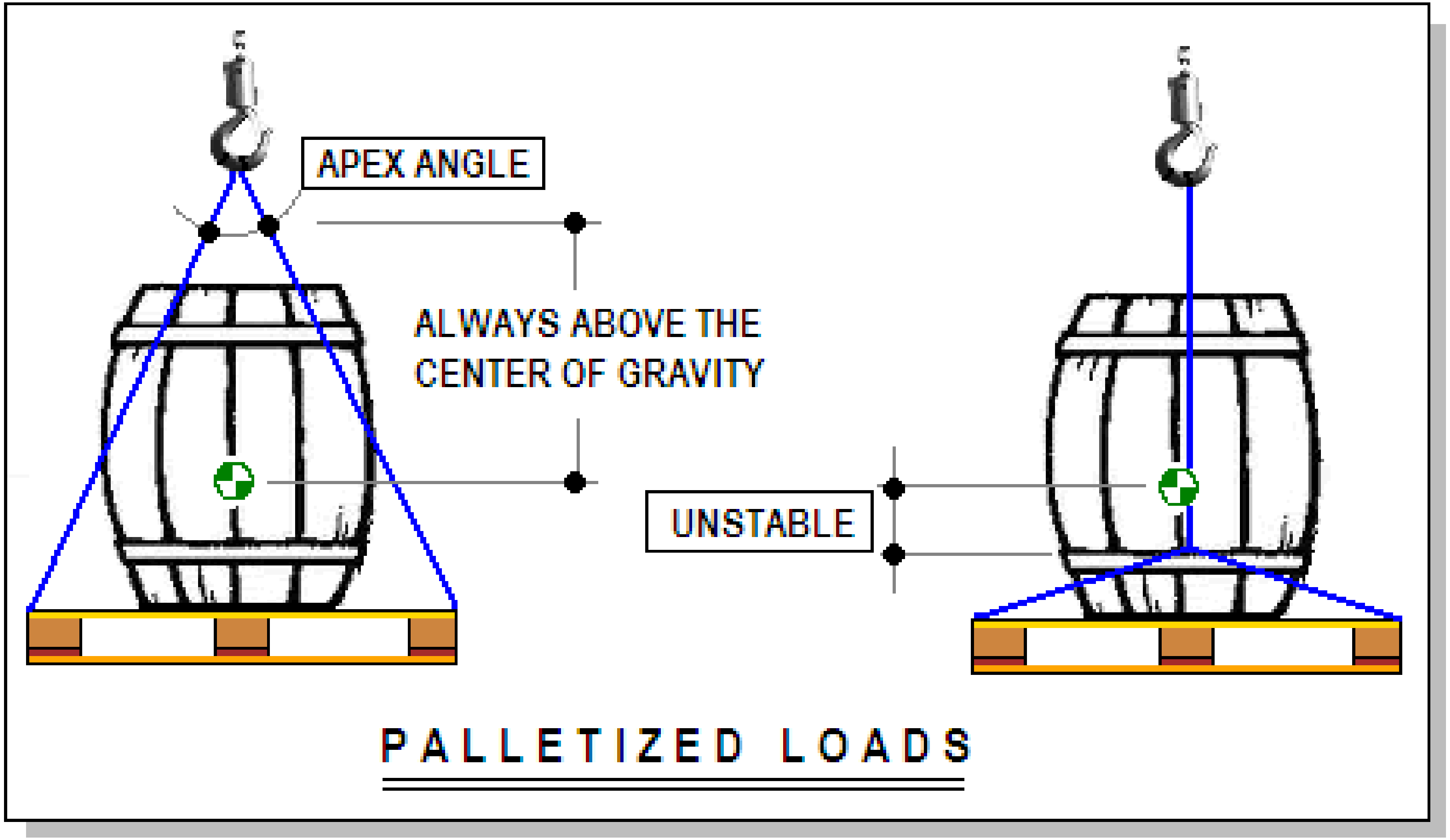
CENTER OF GRAVITY



Centre of Gravity and Load Stability

CENTER OF GRAVITY



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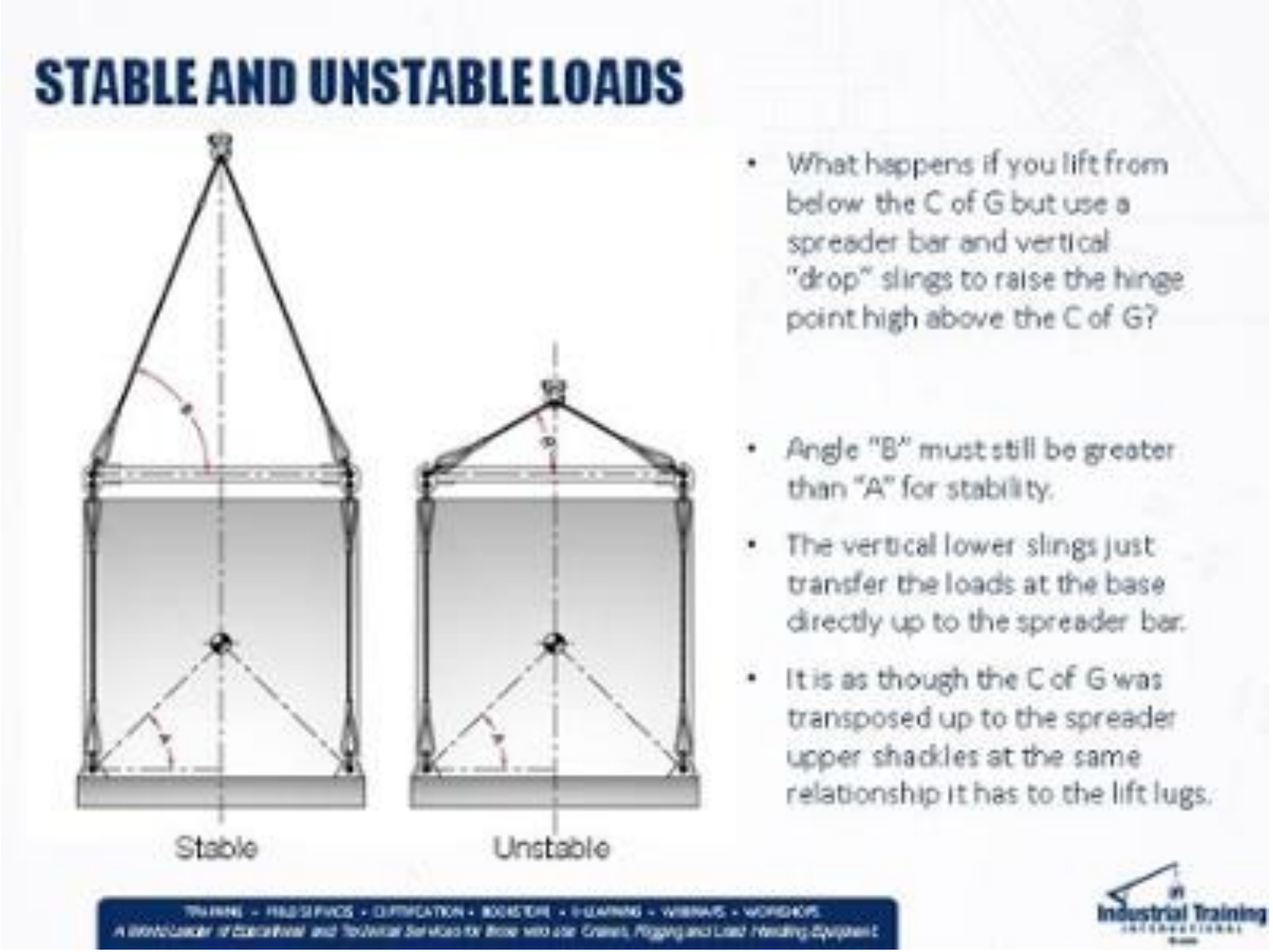
CENTER OF GRAVITY



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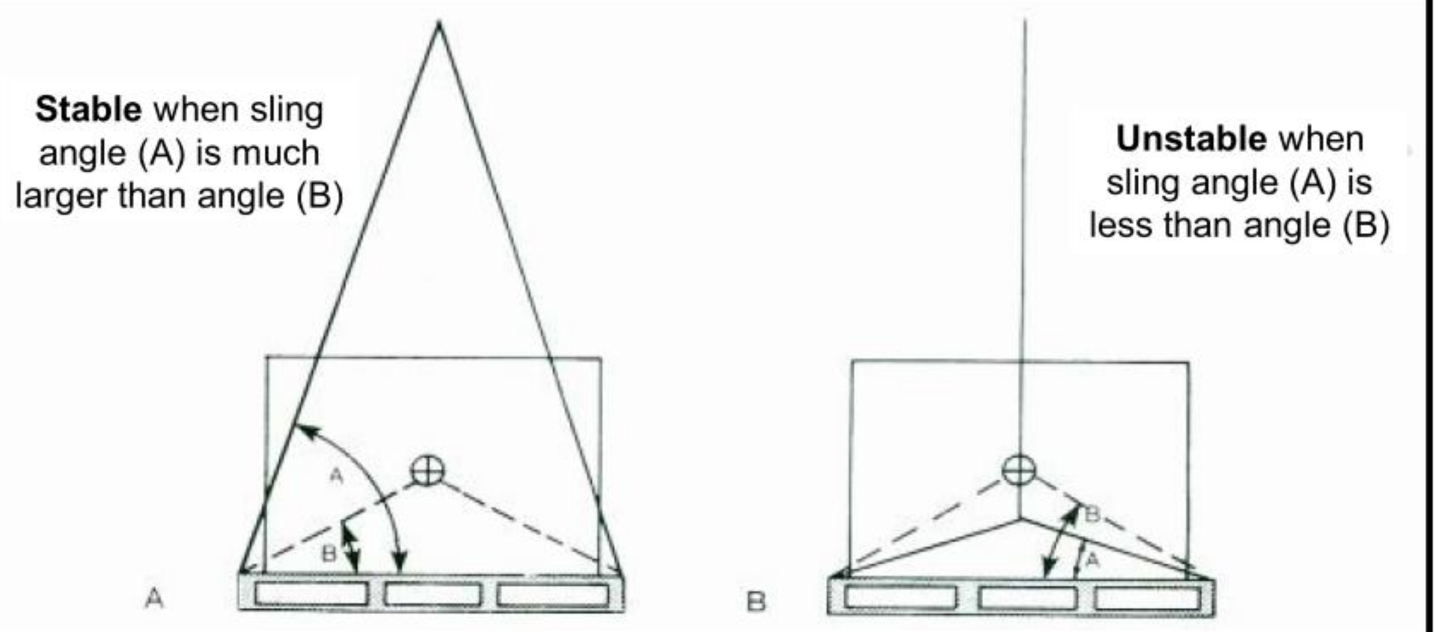
CENTER OF GRAVITY

Why Locating the CG Is Important?

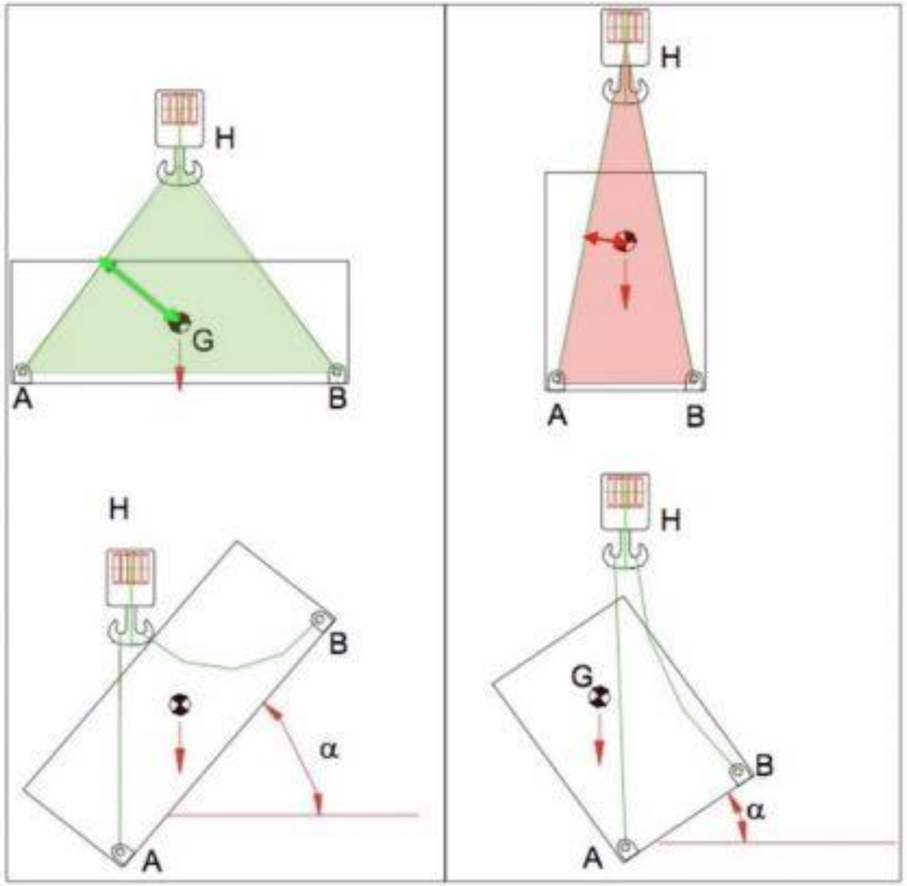
3- The CG must reside between the sling cables



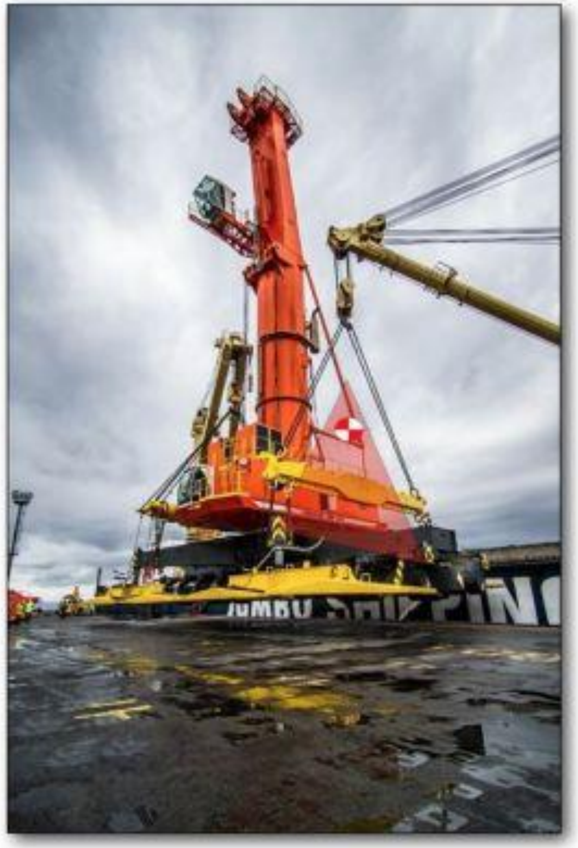
CENTER OF GRAVITY

4.The Stability Range (Video)

KRABBENDAM ADVIES SERVICE



1. Only a **small force** is needed to disturb the stability of a load when the **stability range is small.**

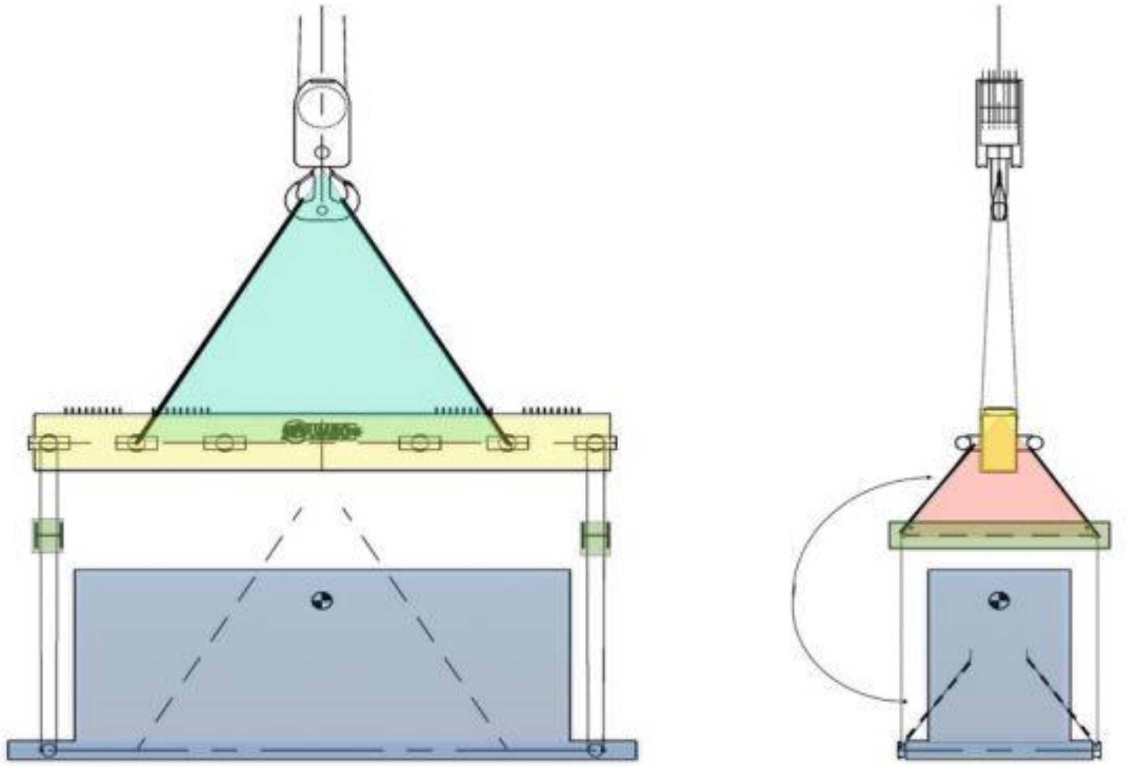


CENTER OF GRAVITY

4.The Stability of the load to be lifted (video)

In this plane the load **IS** stable

In this plane the load **IS NOT** stable

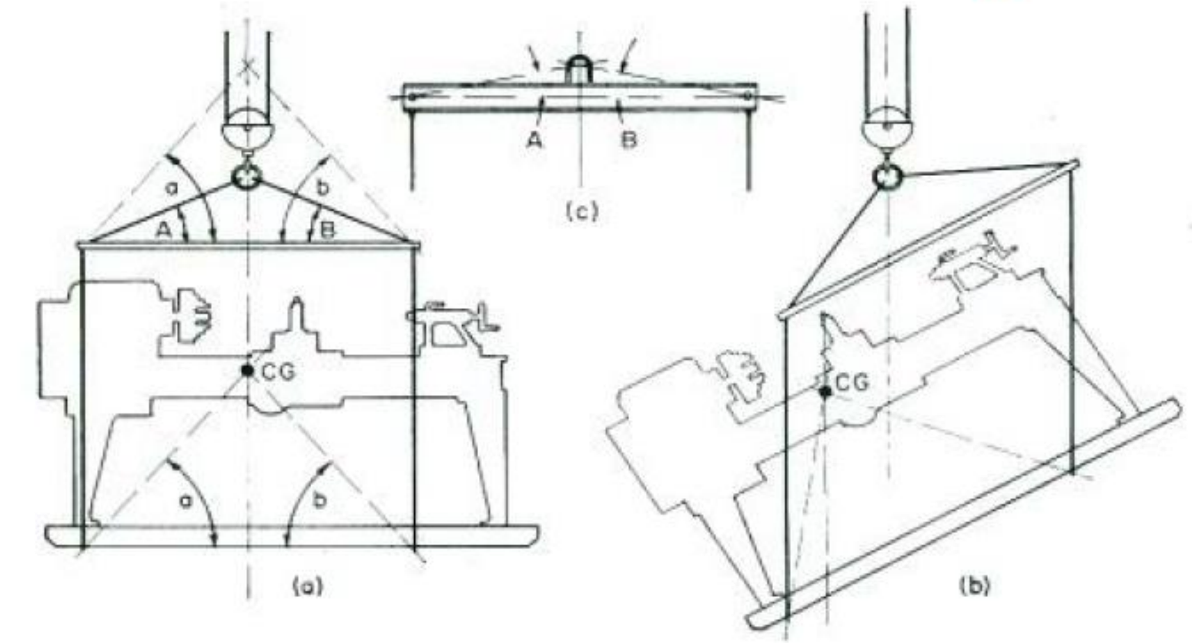


1. We will demonstrate this with a small model

CENTER OF GRAVITY

Why Locating the CG Is Important?

3- The CG must reside between the sling cables



Increasing cable angle will increase stability

W.E. Rossnagel, Handbook of Rigging © 1964, McGraw-Hill

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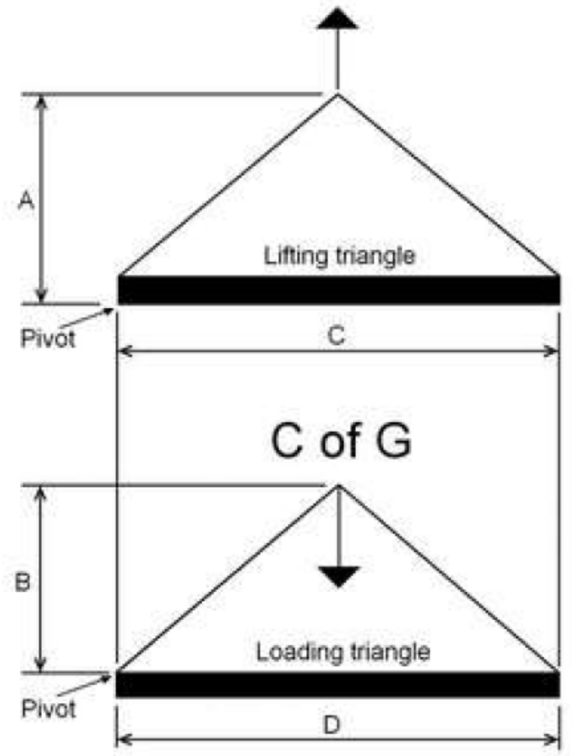
CENTER OF GRAVITY



Looked at from the side, the figure left illustrates the situation.

The forces which prevent or cause toppling come from the vertical distance from the seat of the lifting machine hook to the sling attachment points on the lifting beam (A) and the distance of the centre of gravity above the attachment points on the skid (B).

The centre of gravity will always try to be as far from the hook as possible. If (A) is greater than (B) the arrangement will be stable. The larger the difference, the more stable the arrangement will be. However if (B) is greater than (A), the arrangement will be unstable and will topple. The relationship between dimensions (C) and (D) also affect stability. If (C) is greater than (D) the arrangement will be less stable.

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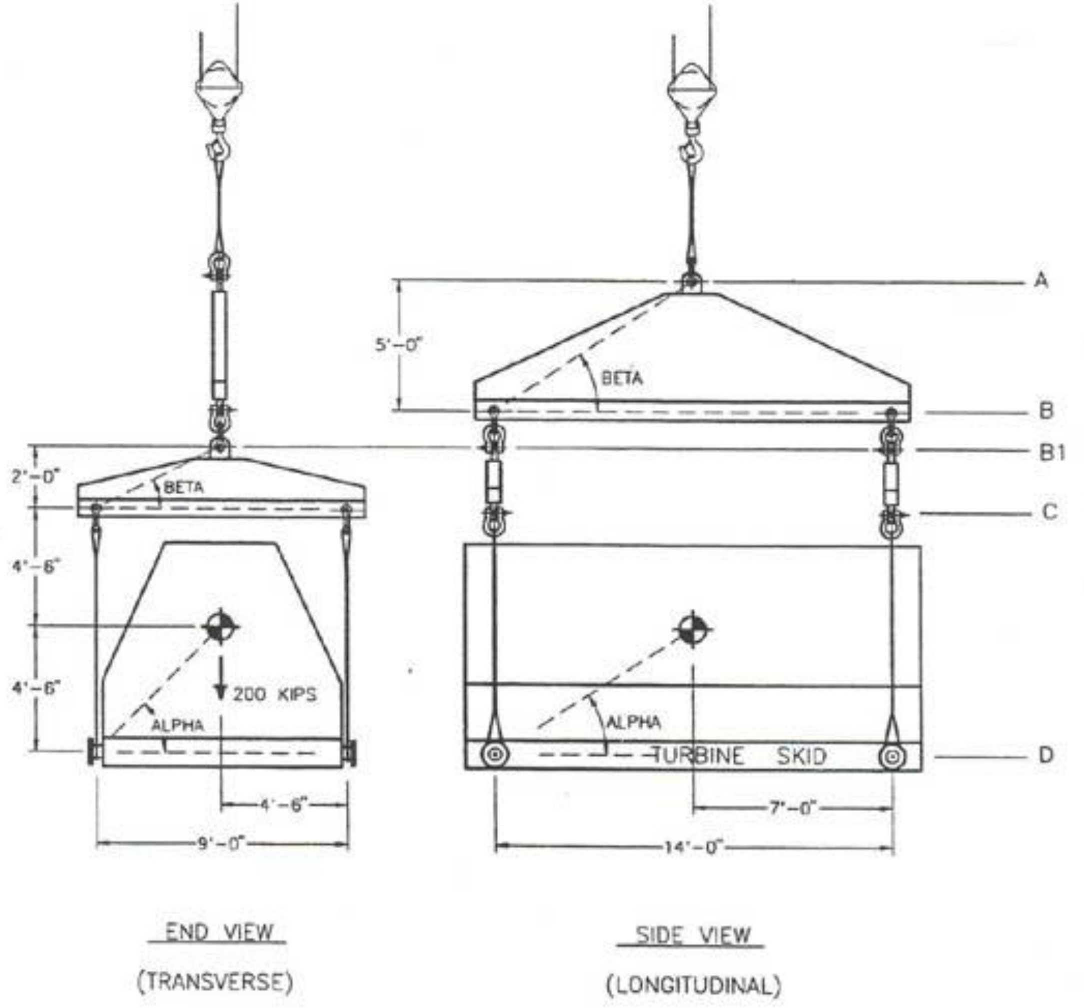
CENTER OF GRAVITY



If there is adequate crane capacity, crane stability, boom clearance & rigging capacity, is this a safe lift? YES or NO

http://maximumreach.com/Quiz6Ans.htm

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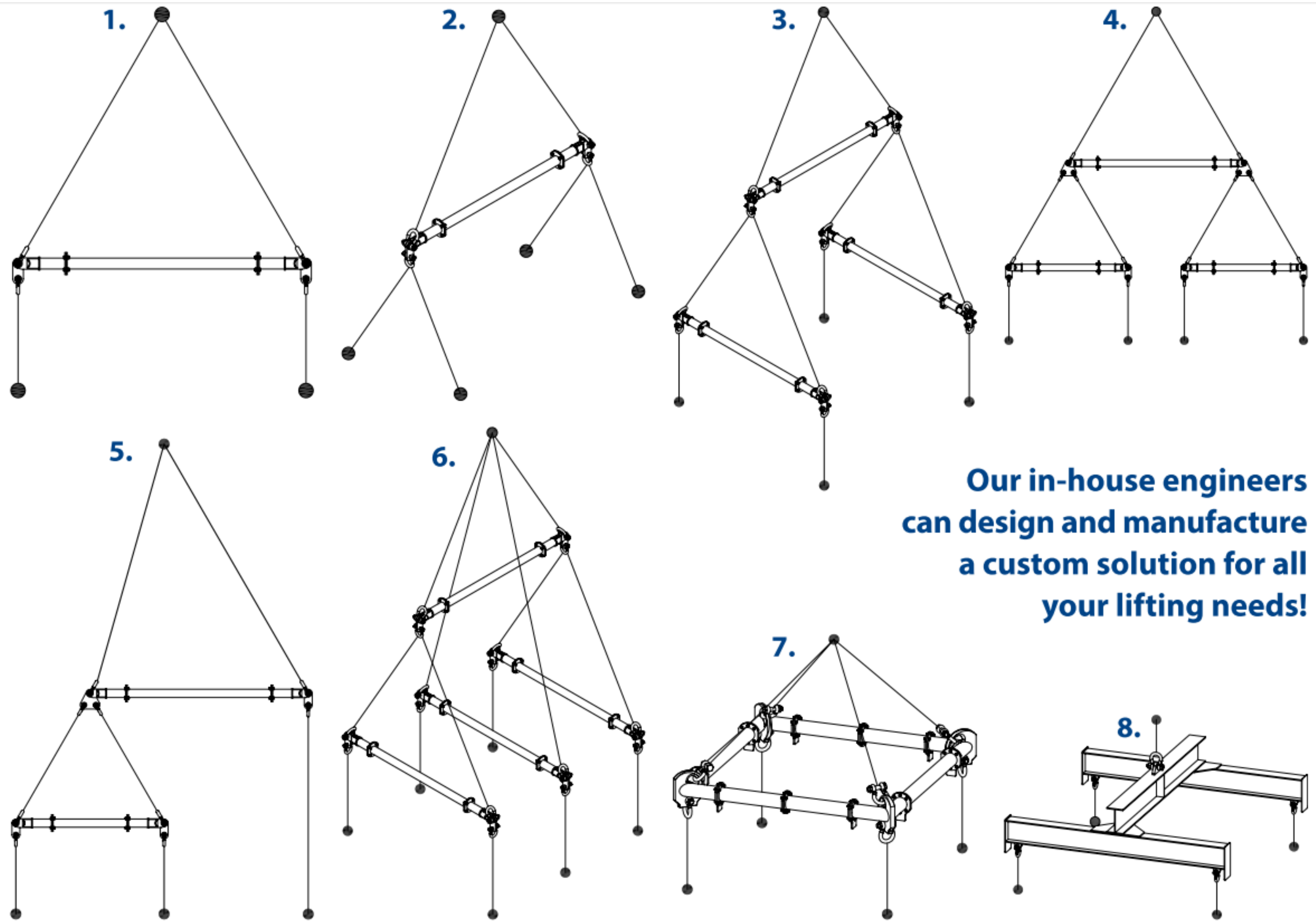
CENTER OF GRAVITY



Our in-house engineers
can design and manufacture
a custom solution for all
your lifting needs!

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CENTER OF GRAVITY

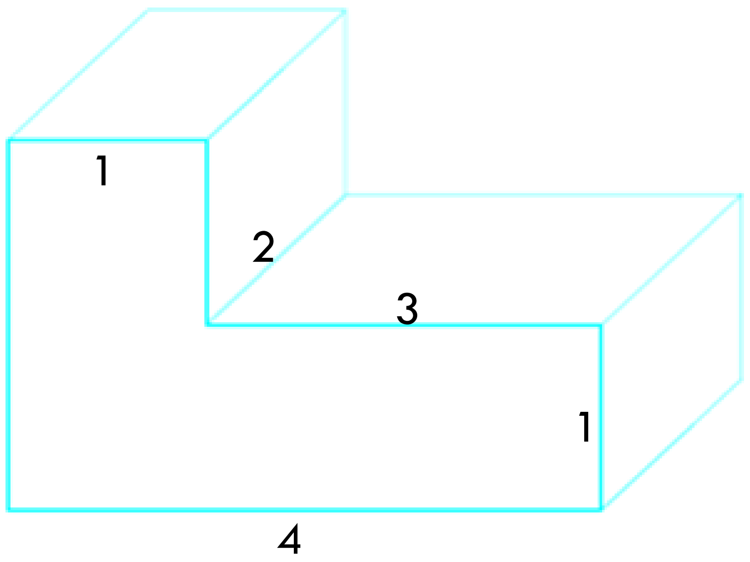
The answer is no, this is not a safe lift. It is unstable against tipping in the transverse direction and borderline stable against tipping in the longitudinal direction.

This is because the angle Alpha below the center of gravity (CG) in the transverse direction is 45 degrees, and the angle Beta at the spreader bar is approximately 24 degrees. In order to be stable, Beta must be greater than Alpha.

For the longitudinal direction, angle Alpha is 32.75 degrees and angle Beta at the spreader bar is approximately 35 degrees. As Beta is greater than Alpha, theoretically, it is stable.

Now the most often asked question is how much greater must angle Beta be than angle Alpha. Theoretically and on paper, if Beta is as great as say one degree larger than Alpha, the lift should be stable. But due to the dynamics of lifting, the CG location not always being know accurately, the slings not always matched for length, etc, it is recommended that Beta be at least 20 degrees larger than Alpha. In most cases this will be conservative but safe.

CENTER OF GRAVITY



- How do you identify the center of gravity for this precast concrete?

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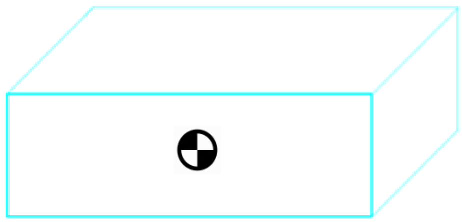
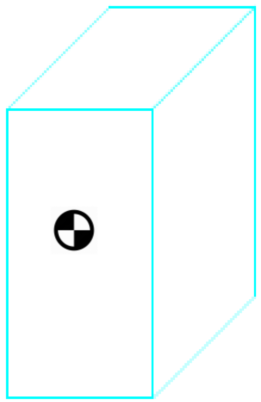
CENTER OF GRAVITY

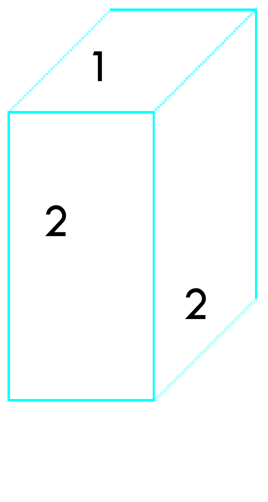




- Identify the center of gravity of each small part

Identify the center of gravity of each small part

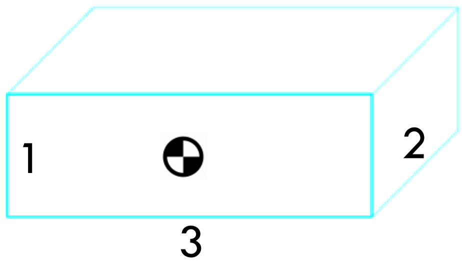
CENTER OF GRAVITY



- Identify the weight of each small part

- M1 = 1x2x2x2.5=10 tons

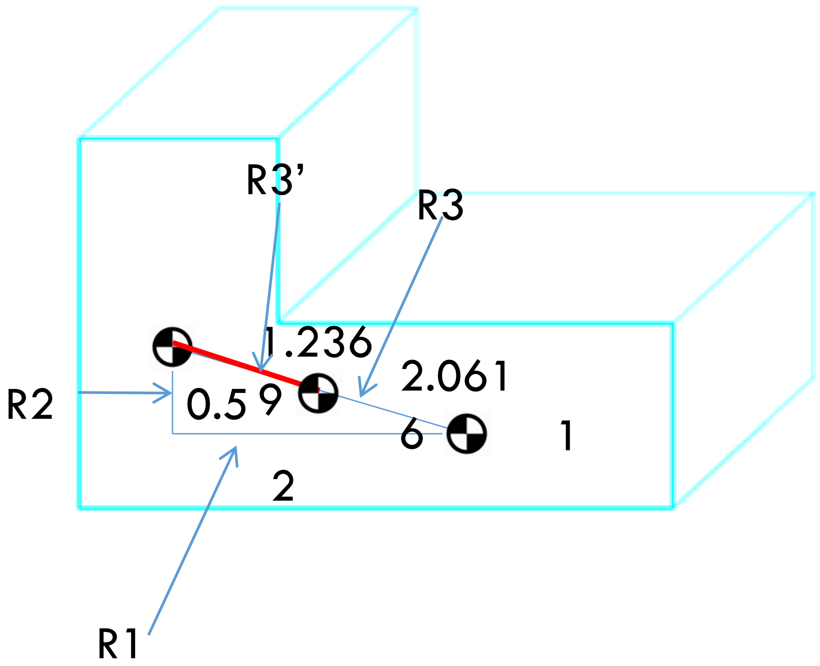
CENTER OF GRAVITY



- M1 = 1x2x3x2.5=15 tons
- M= M1+M2= 25 Tons
- % M1= 15/25*100= 60%
- %M2=10/25*100= 40%

- Identify the weight of each small part and weight percent of each small part

CENTER OF GRAVITY



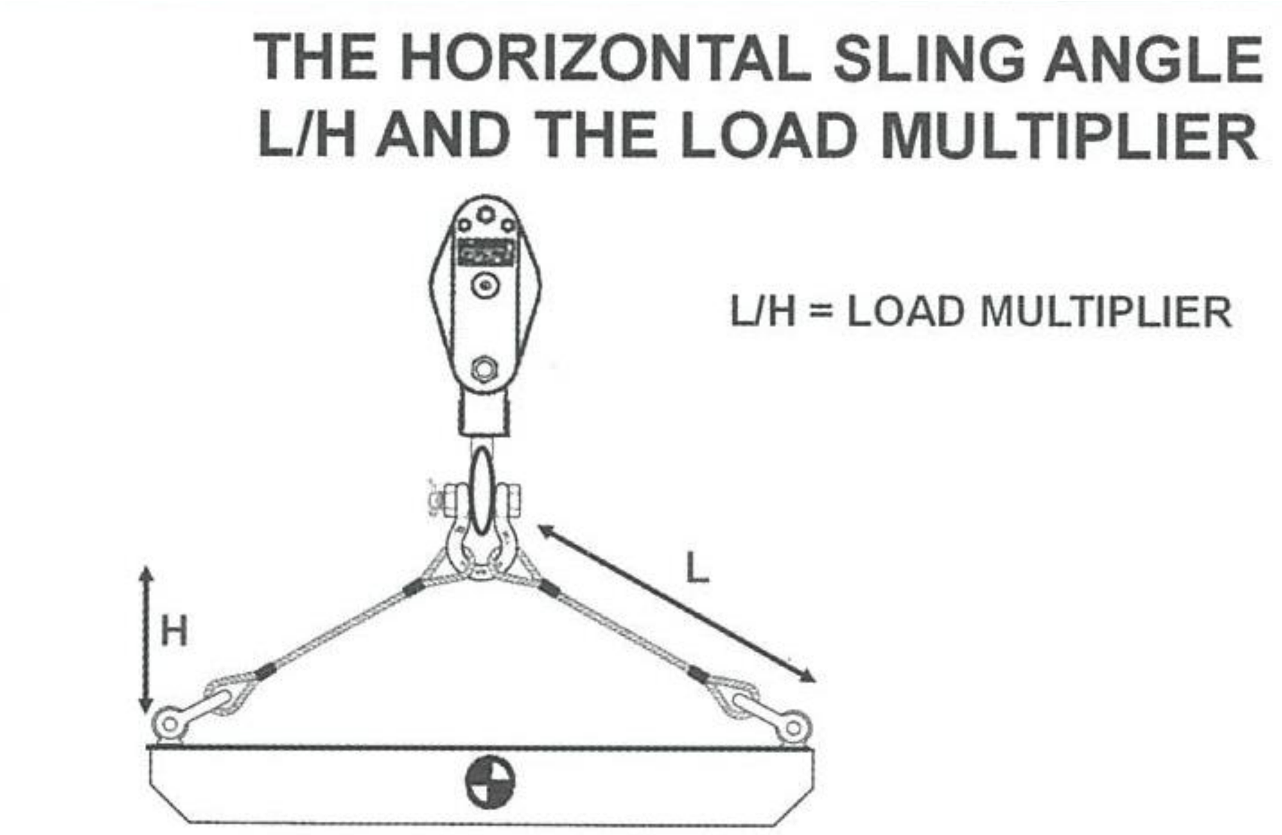
R3= $\sqrt{R1^2 + R2^2} = \sqrt{2^2 + 0.5^2}$ =2.0616

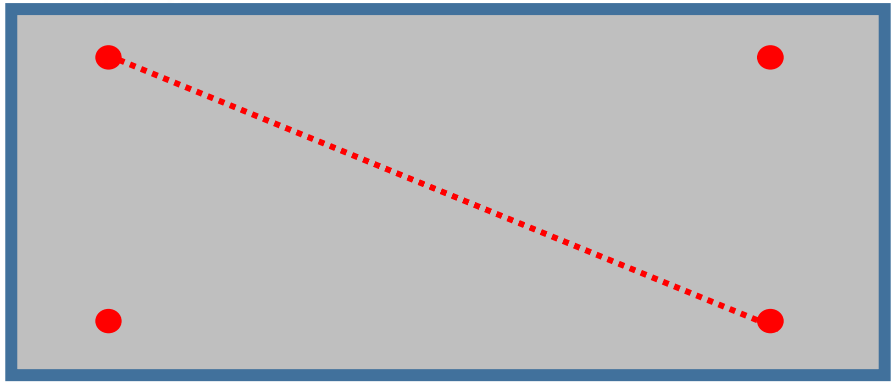
R3'= R3x %M2= 60%x 2.0616= 1.2369

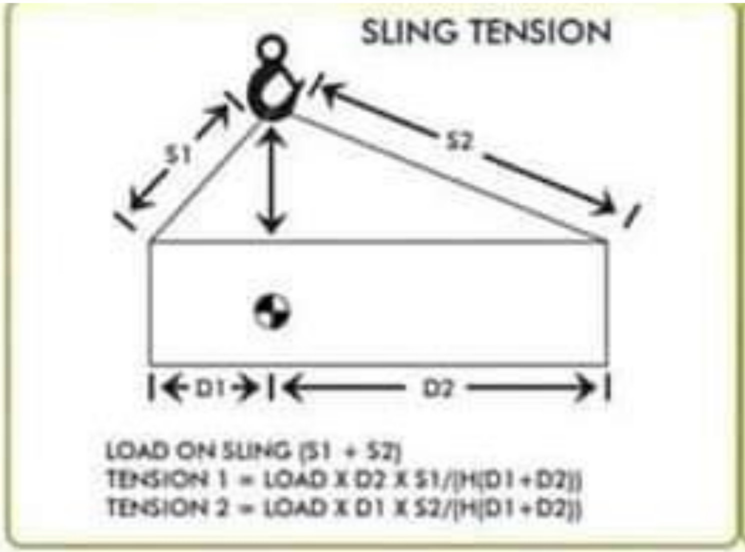
Sling Tension

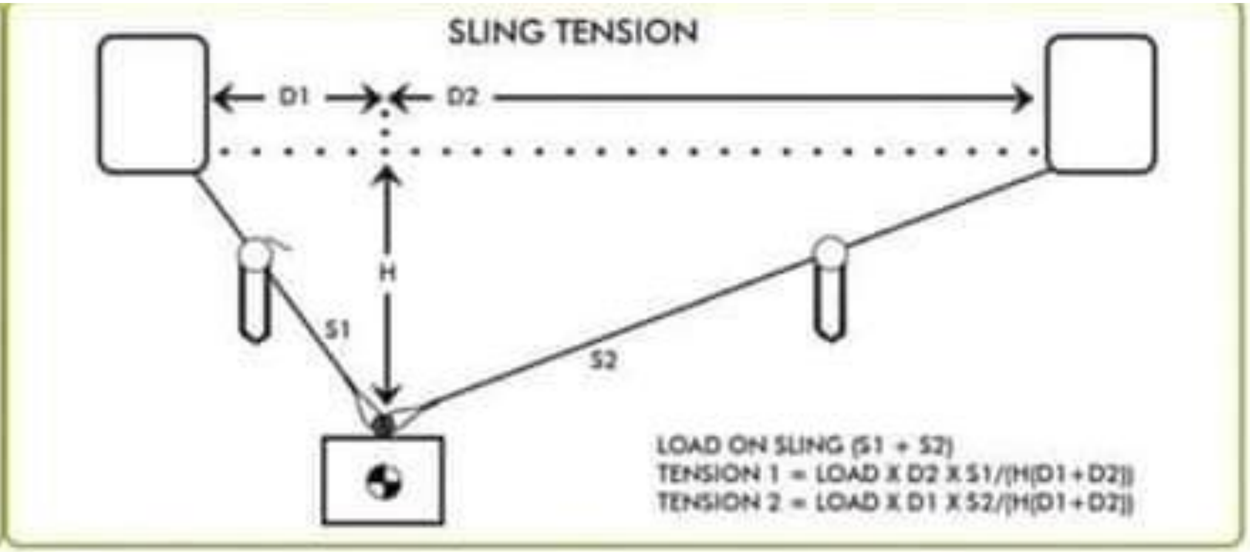
$$F = \frac{Loading.L}{2H}$$

- H: Height
- L: Length
- F: Sling tension






SLING TENSION
S1
S2
D1
D2
LOAD ON SLING (S1 + S2)
TENSION 1 = LOAD X D2 X S1/(H(D1+D2))
TENSION 2 = LOAD X D1 X S2/(H(D1+D2))


SLING TENSION
D1
D2
H
S1
S2
LOAD ON SLING (S1 + S2)
TENSION 1 = LOAD X D2 X S1/(H(D1+D2))
TENSION 2 = LOAD X D1 X S2/(H(D1+D2))

SLING TENSION-PROPORTIONAL SHARE OF THE LOAD

6 FT. LEG

Proportional Share of the Load $\frac{3}{12}$ = .25 Distance from CG
.75 Share of the Load

.75 x 55,000 = 41,250 Lbs.

x x

Load Angle Factor $\frac{L1}{H} = \frac{6}{5} = 1.20$

Sling Tension 49,500 Lbs.

10.5 FT. LEG

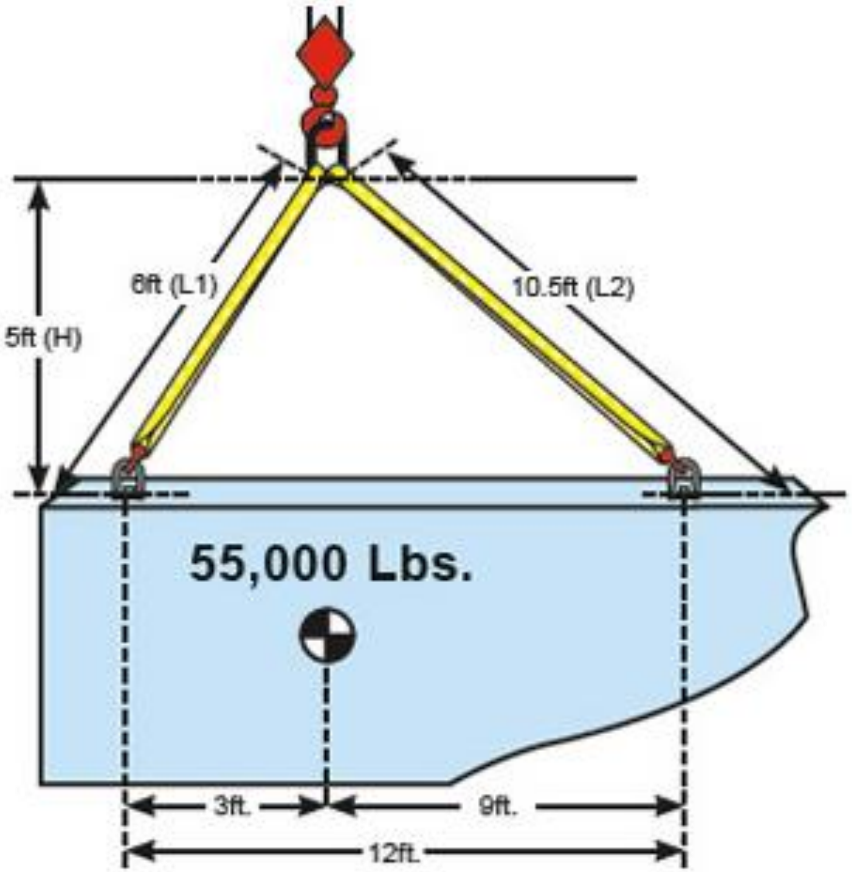
Proportional Share of the Load $\frac{9}{12}$ = .75 Distance from CG
.25 Share of the Load

.25 x 55,000 = 13,750 Lbs.

x x

Load Angle Factor $\frac{L2}{H} = \frac{10.5}{5} = 2.10$

Sling Tension 28,875 Lbs.



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SLING TENSION- DIFFERENT HORIZONTAL PLANES

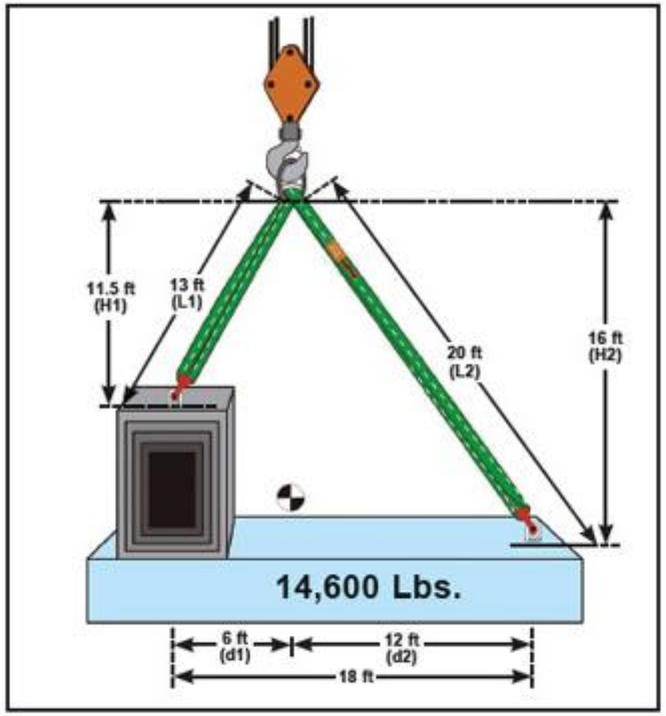
20 FT. LEG (L2) SLING TENSION

$$\frac{W \times d1 \times L2}{(d2 \times H1) + (d1 \times H2)}$$

$$\frac{14{,}600 \times 6 \times 20}{(12 \times 11.5) + (6 \times 16)}$$

$$\frac{1{,}752{,}000}{234}$$

7,487 Lbs. TENSION



13 FT. LEG (L1) SLING TENSION

$$\frac{W \times d2 \times L1}{(d2 \times H1) + (d1 \times H2)}$$

$$\frac{14{,}600 \times 12 \times 13}{(12 \times 11.5) + (6 \times 16)}$$

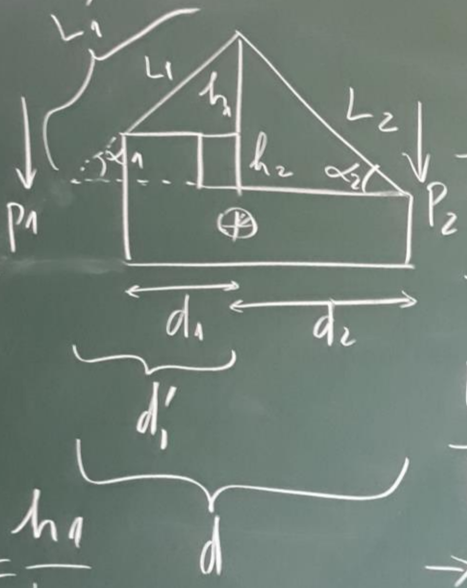
$$\frac{2{,}277{,}600}{234}$$

9,733 Lbs. TENSION

$$P_1 = \frac{P \cdot h_1}{(d_2 h_1 + d_1 h_2)} \times d_2 \rightarrow T_1 = \frac{P \cdot \cancel{h_1}\, d_2}{d_2 h_1 + d_1 h_2} \times \frac{L_1}{\cancel{h_1}}$$

$$P_2 = \frac{P \cdot \cancel{h_1}}{d_2 h_1 + d_1 h_2} \times \frac{h_2 \cdot d_1}{\cancel{h_1}} \rightarrow T_2 = \frac{P \cdot \cancel{h_2}\, d_1}{d_2 h_1 + d_1 h_2} \times \frac{L_2}{\cancel{h_2}}$$

$$d = d_2 + \frac{h_2}{h_1} \cdot d_1 = \frac{d_2 h_1 + d_1 h_2}{h_1}$$



$$\frac{h_1}{h_2} = \frac{d_1}{d_1'} \rightarrow d_1' = \frac{h_2 \cdot d_1}{h_1}$$

$$\frac{L_1}{L_1'} = \frac{h_1}{h_2} \rightarrow L_1' = \frac{L_1 \cdot h_2}{h_1}$$

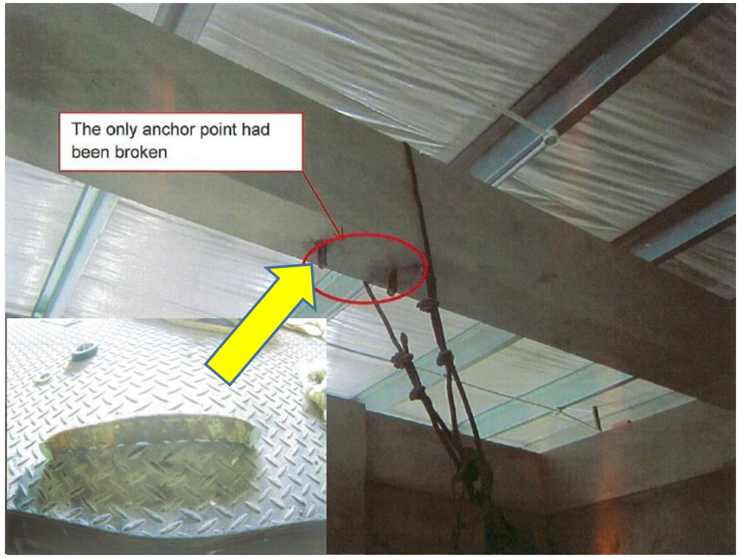
$$\sin \alpha_1 = \frac{h_1}{L_1}$$

$$\sin \alpha_2 = \frac{h_2}{L_2} \rightarrow T_1 =$$

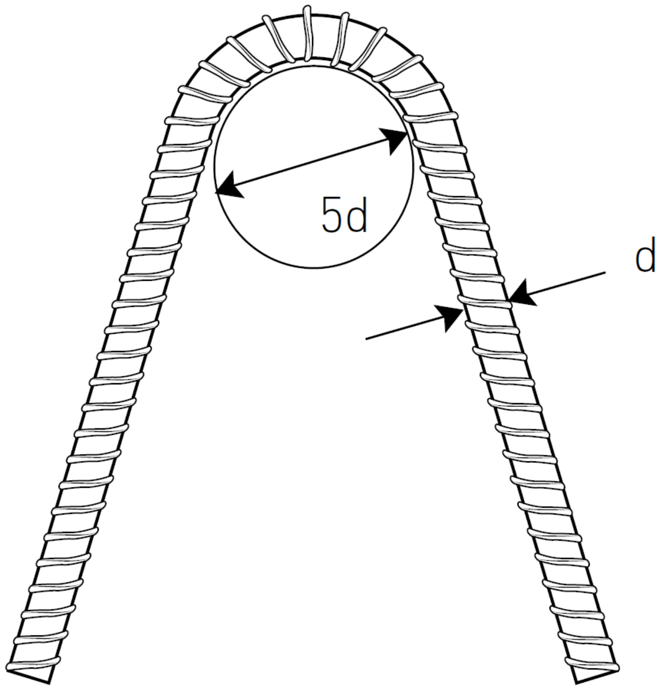
LIFT LUG

1. Moment uốn
2. Lực kéo

PRECAST CONCRETE LIFT LUG



MINIMUM BENDING REQUIRED



Rebar size	Norminal diameter (d)	Min. bend diameter
#3	10mm	6d
#4	12mm	6d
#5	16mm	6d
#6	20mm	6d
#7	22mm	6d
#8	25mm	6d
#9	28mm	8d
#10	32mm	8d
#11	35mm	8d
#14	43mm	10d
#18	57mm	10d

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MINIMUM BENDING REQUIRED

http://rebar.ecn.purdue.edu/wwr/resDesign_codeStand.htm

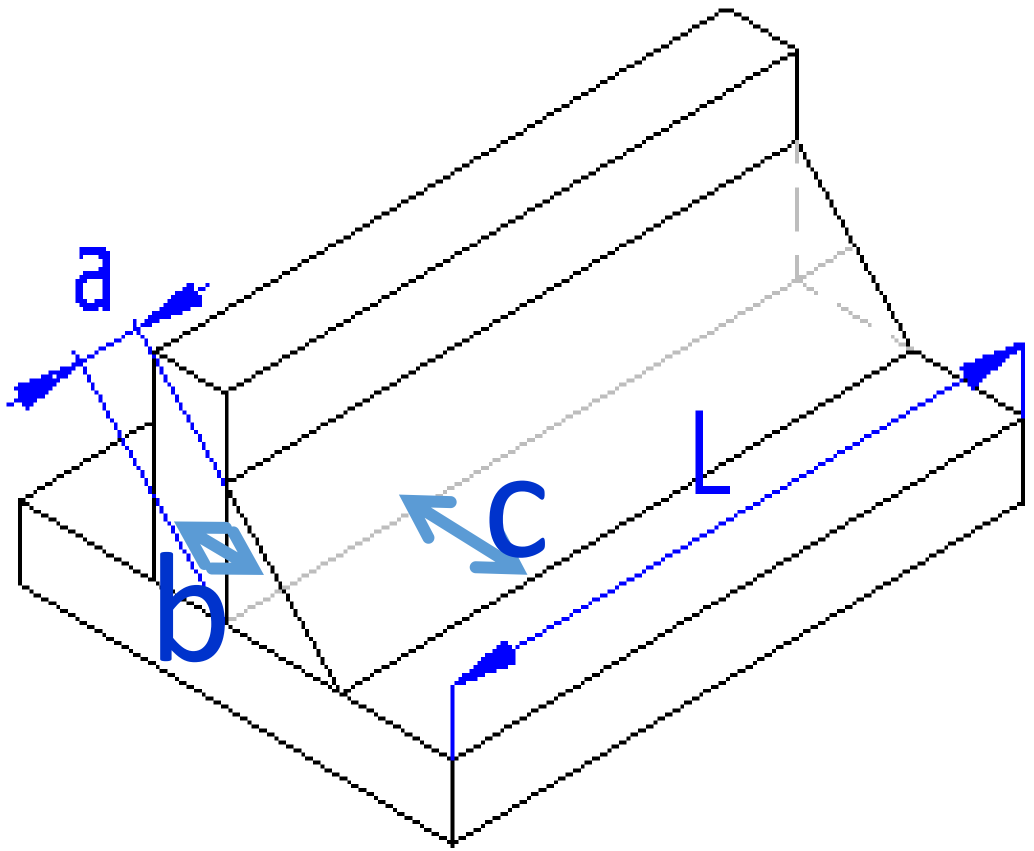
- 7.2- Minimum bend diameters
- 7.2.1- Diameter of bend measured on the inside of the bar, other than for stirrups and ties in sizes No.3 through No.5, shall not be less than the values in Table7.2.
- 7.2.2 - Inside diameter of bend for stirrups and ties shall not be less than 4db for No.5 bar and smaller. For bars larger than No.5, diameter of bend shall be in accordance with Table 7.2.
- 7.2.3 - Inside diameter of bend in welded wire fabric (plain or deformed) for stirrups and ties shall not be less than 4db for deformed wire larger than 06 and 2db for all other wires. Bends with inside diameter of less than 8db sh[illegible]elded intersection.

TABLE 7.2—MINIMUM DIAMETERS OF BEND

Bar size	Minimum diameter
No. 3 through No. 8	$6d_b$
No. 9, No. 10, and No. 11	$8d_b$
No. 14 and No. 18	$10d_b$

LIFT LUG

LIFT LUG CAPACITY



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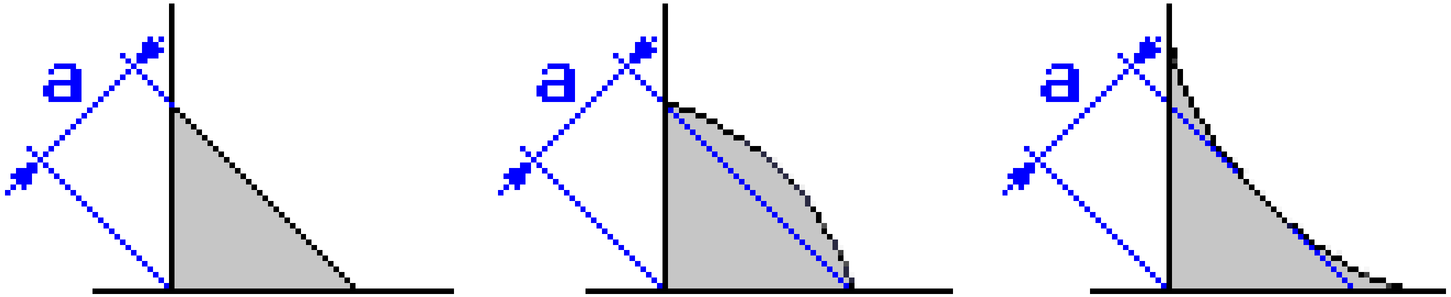
LIFT LUG CAPACITY



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Example

a= $\frac{\sqrt{2c^2}}{2}$

If c = 5mm => a = 3.53 (mm)

Total perimeter of welding is

L= 100mm ; b=10mm

E= 2 x (L+b) = 2 X(100+10)= 220 (mm)

⇒Area welding :

S1 = a X E = 3.53 X 220 = 776 (mm^2)

Welding capacity is :

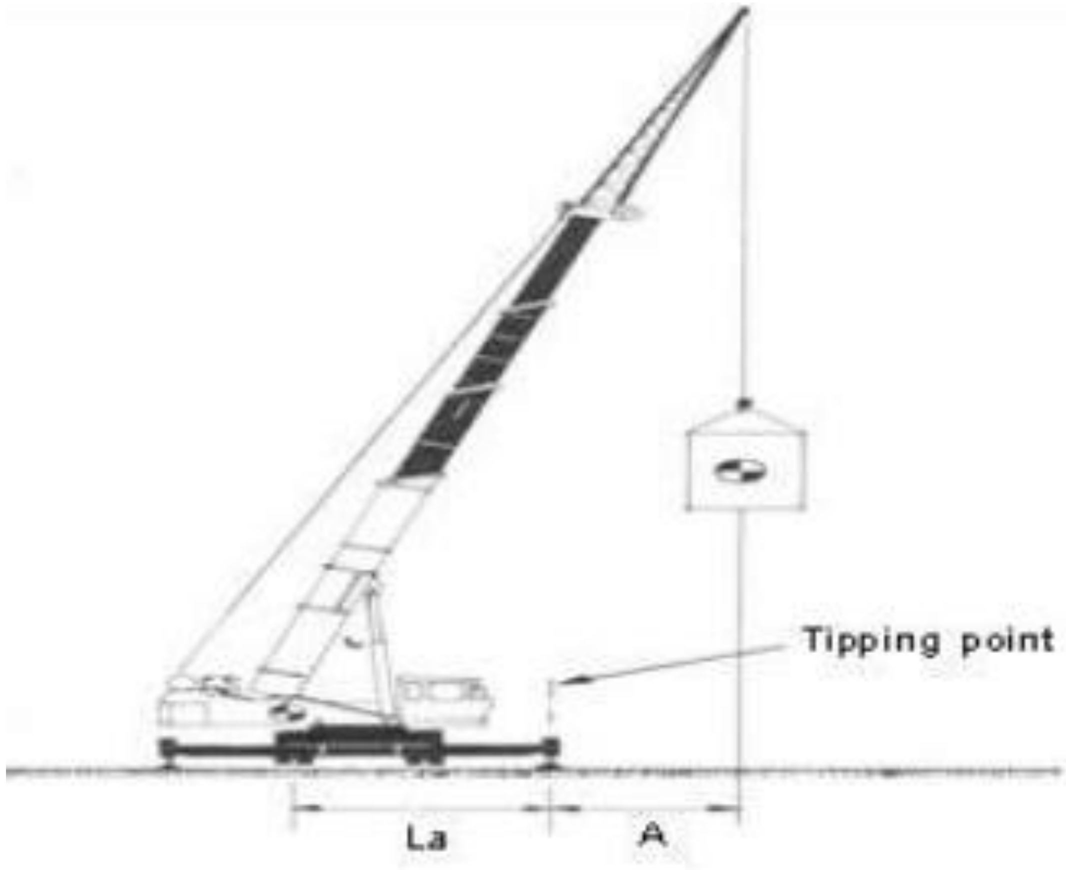
F1 = S X 30(Kg/mm^2) = 776 X 30 = 23.280 Kgs

= 23 tons.

- Comparison:

SWL > 0.85 F approve for lifting .

Crane Selection - Parameter Of Load



Crane capacity:

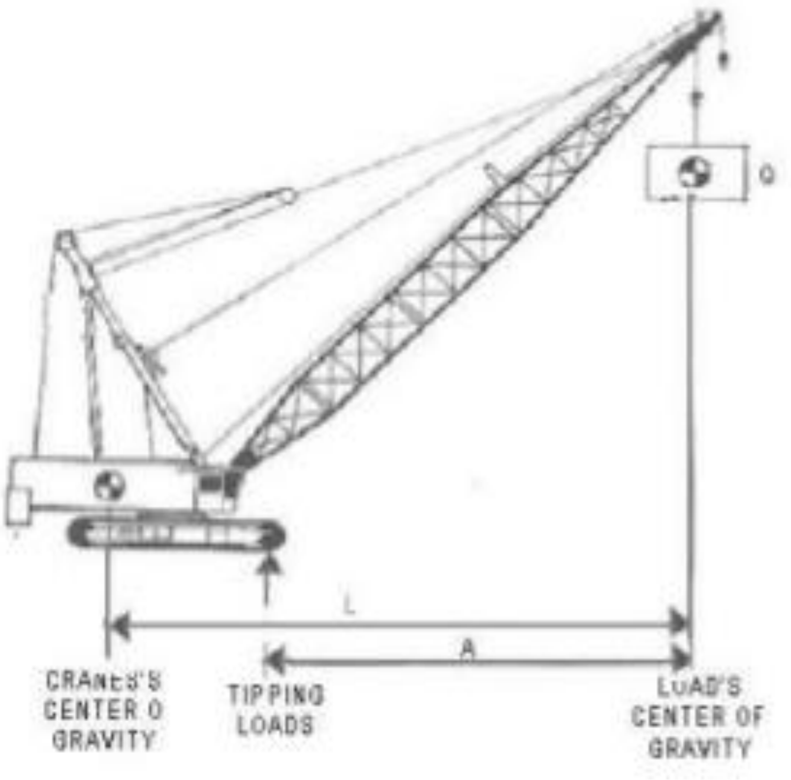
$Q_A = \frac{A.W}{La}$

A: maximum radius working have to stability.

W: Weight of loading

L_A: moment arm is distance from tipping point to Center of gravity of the counter weight.(Please refer catalog)

Crane Selection - Parameter Of Load



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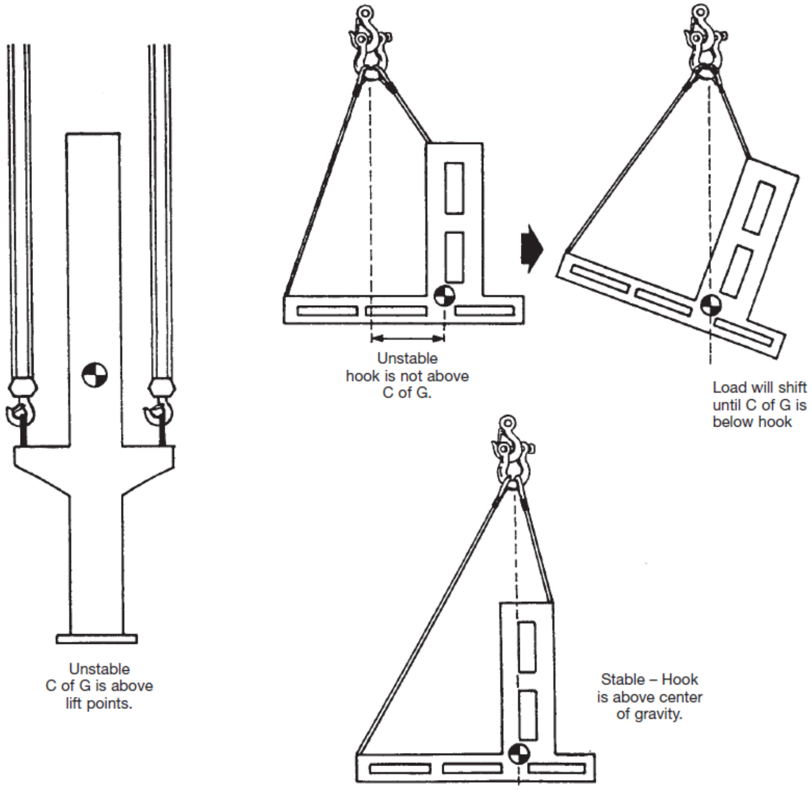
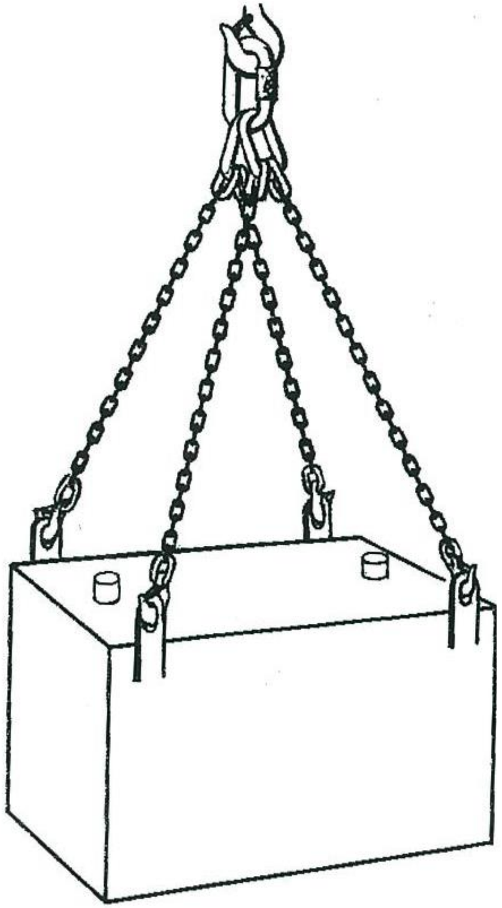
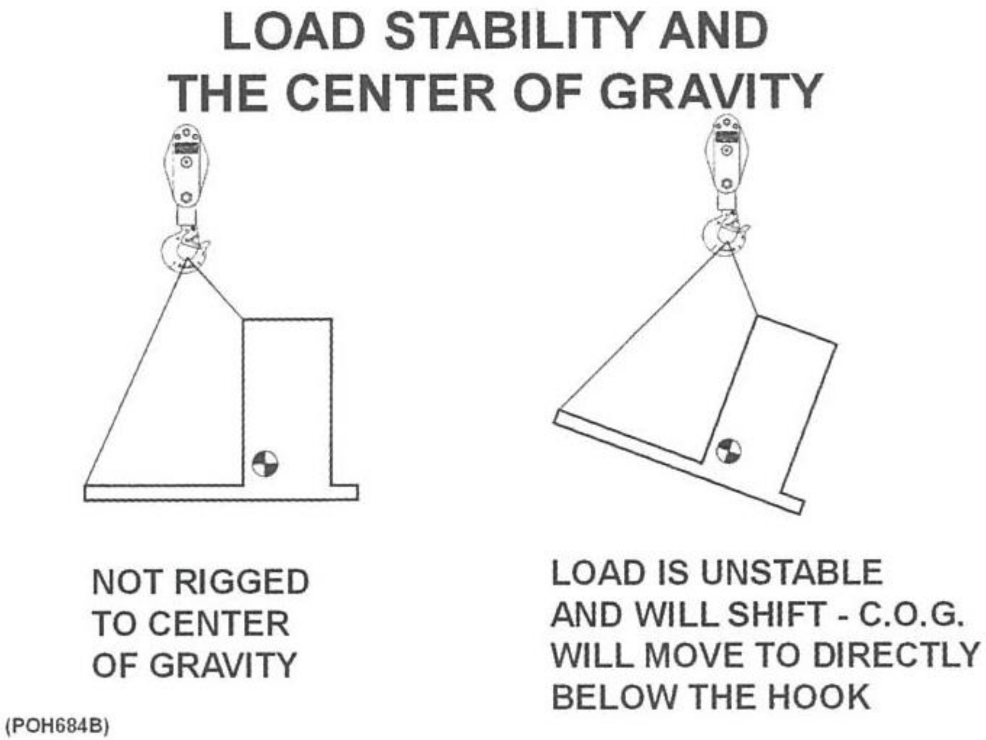
Operation- Rigging



EFFECT OF CENTRE OF GRAVITY ON LIFT





CENTER OF GRAVITY

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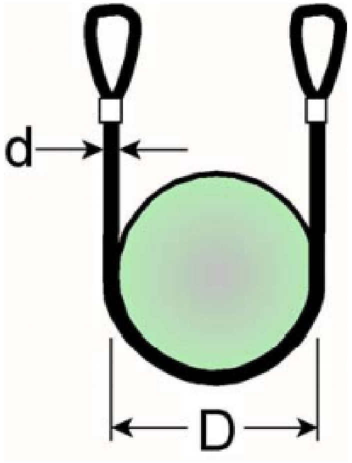
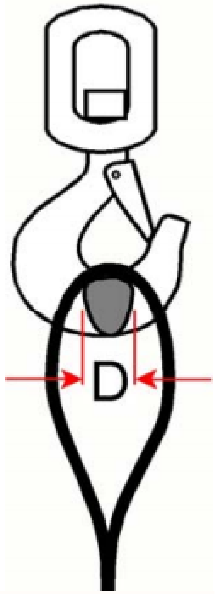
Rigging – D/d Ratio

D/d Ratio



When a wire rope sling is used in a basket hitch, the diameter of the load where the sling contacts the load can reduce sling capacity. The method used to determine the loss of strength or efficiency is referred to as the *D/d Ratio*.

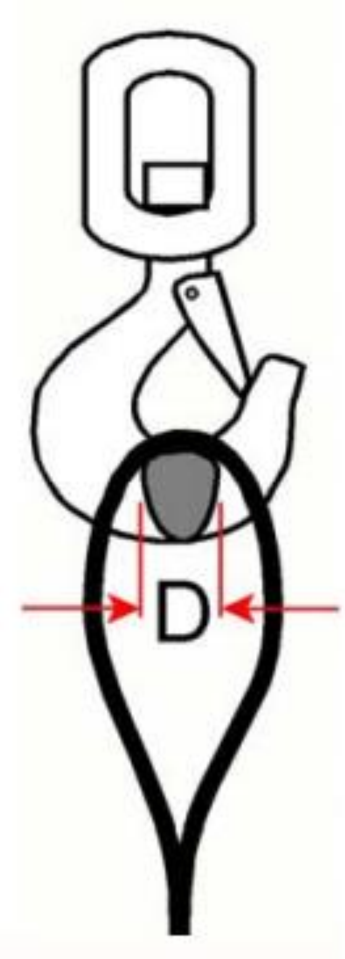
The "D" refers to the diameter of the object being lifted, while the "d" refers to the diameter of the wire rope sling, as shown in the figure at the upper right. For example, when a 1-inch wire rope sling is used to lift an object that measures 25 inches in diameter, the D/d Ratio is 25-to-1 (written 25/1).

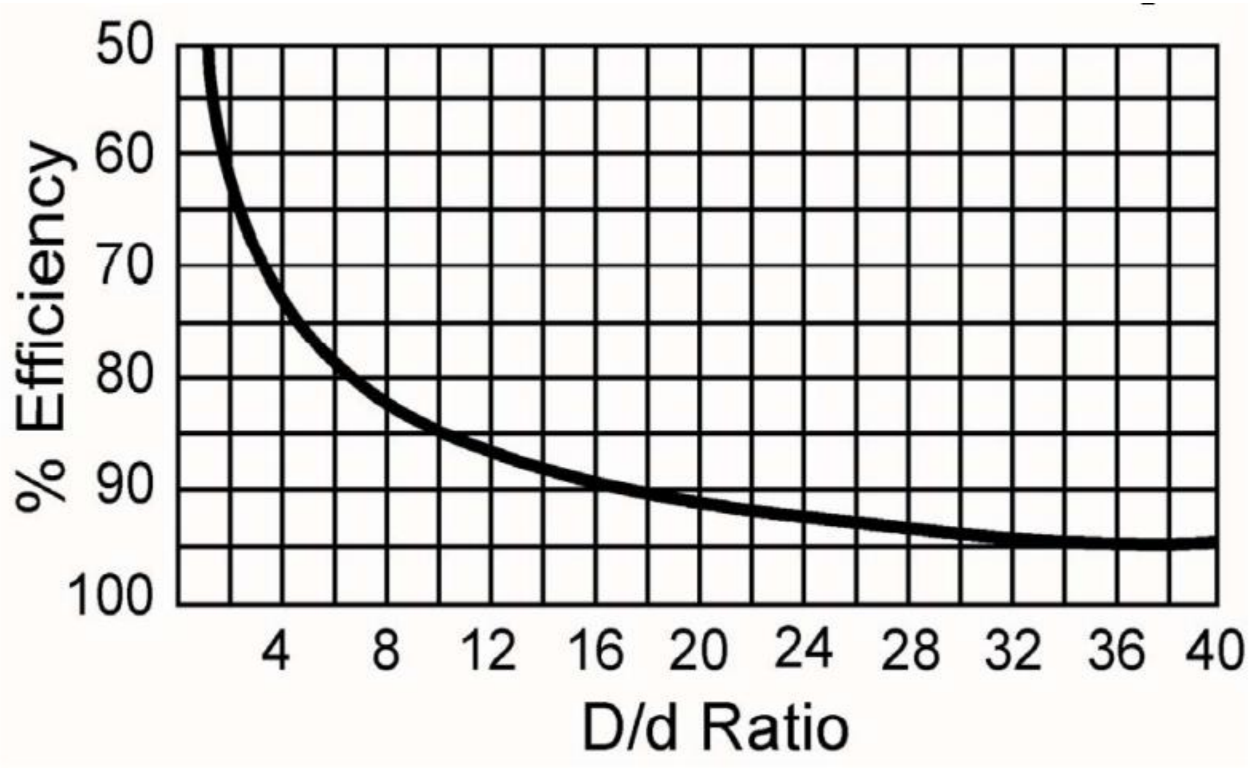


Alternatively, the "D" can refer to the cross-sectional diameter of the eye, hook, or other object being used to hoist the load, as shown in the figure at right.

In both cases, the effective strength of the sling results. The table below shows the D/d Ratio and corresponding efficiency percentage.

Rigging – D/d Ratio





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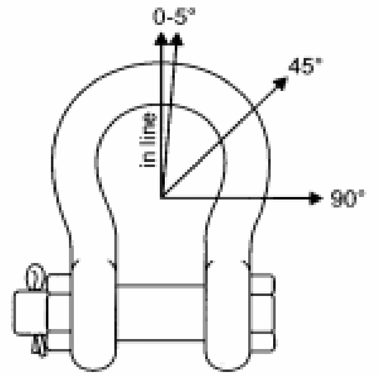
Rigging- Shackle

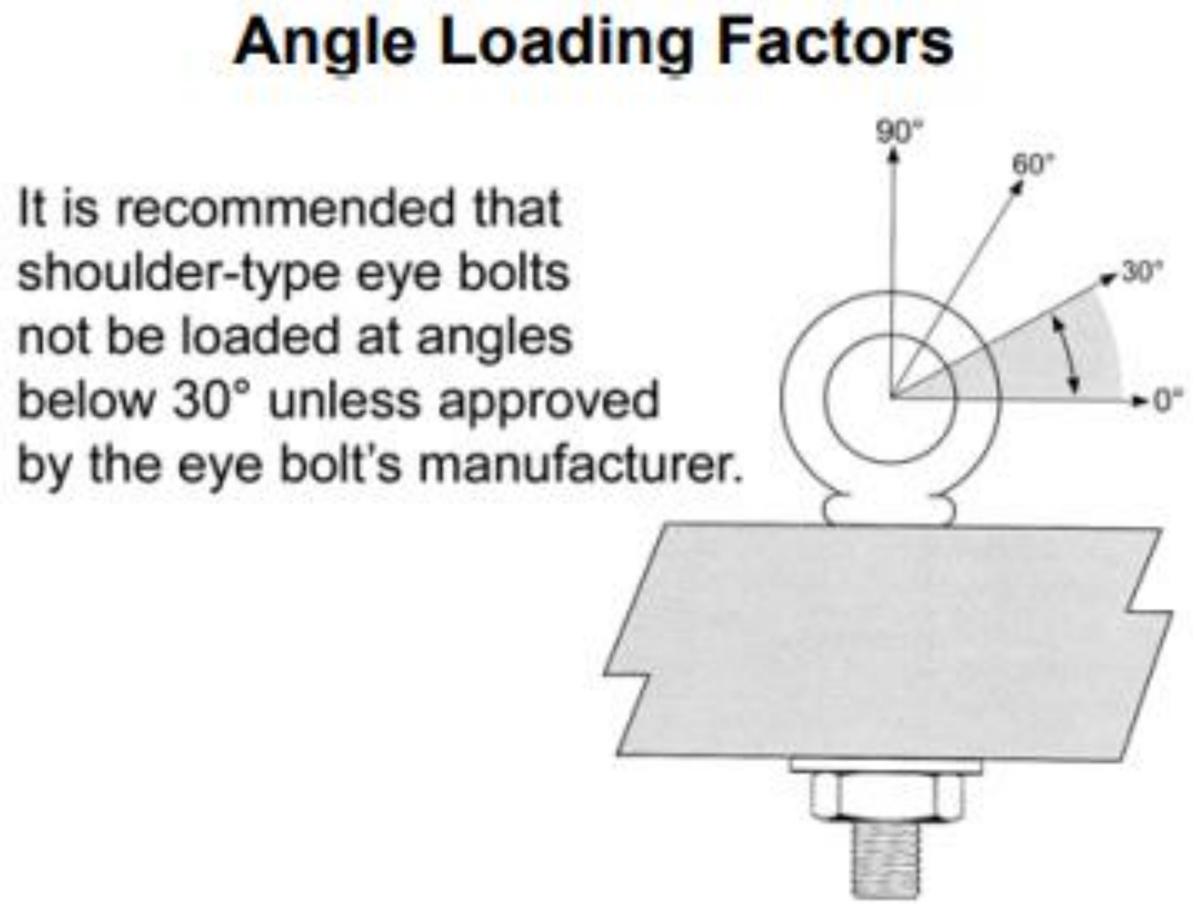
Side Loading Reduction Factors
Screw Pin and Bolt Type Shackles

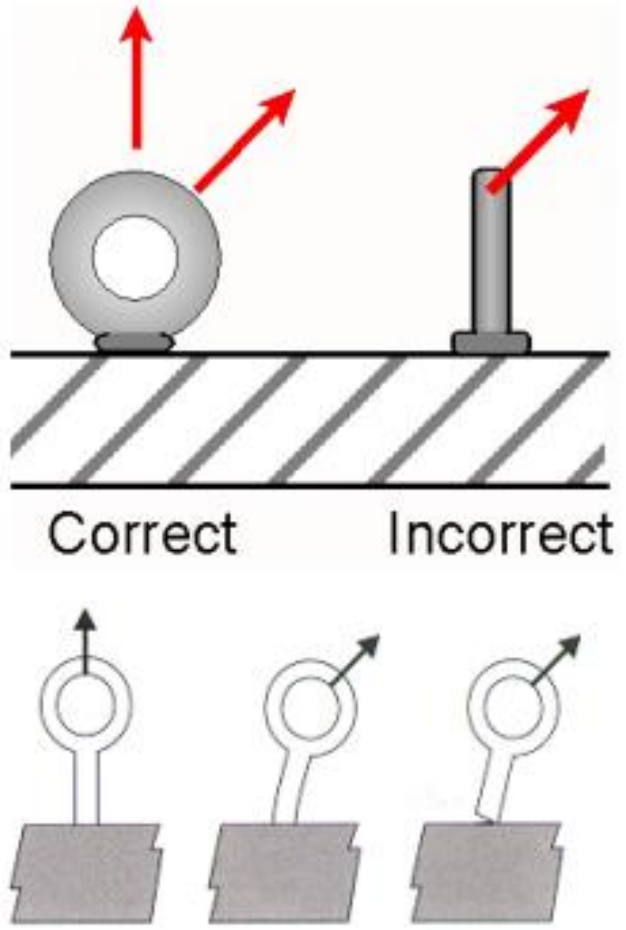


Angle of Side Load from Vertical In-Line of Shackle	Percent Rated Load Reduction
0° - 5°	0%
5°- 45°	30%
46°-90°	50%
Over 90°	Avoid

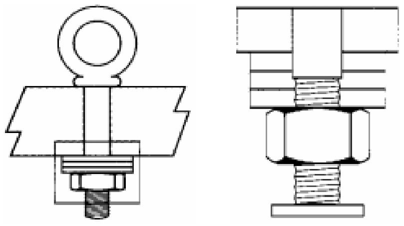
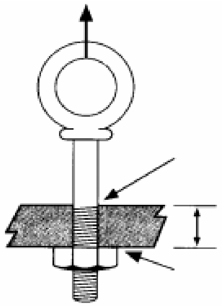
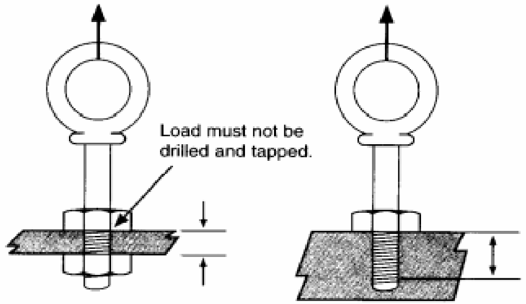
Incorrect Applications

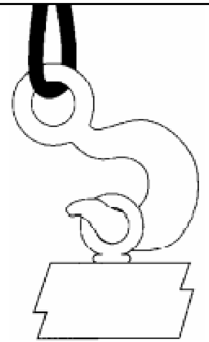
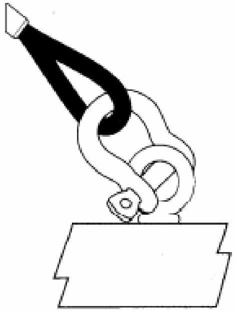
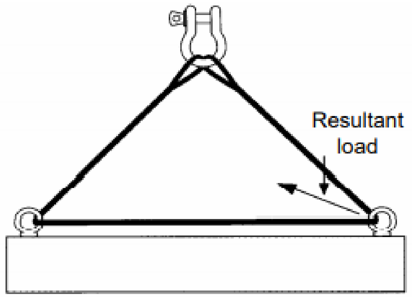
Rigging- Eye bolt





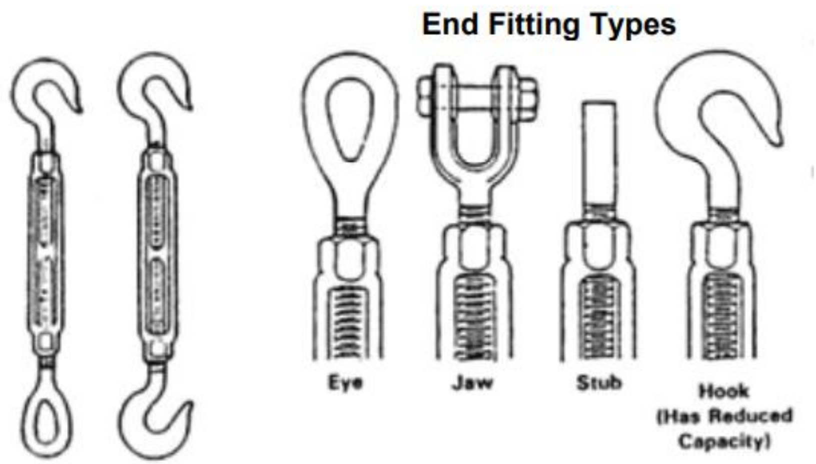
Rigging- Eye Bolt

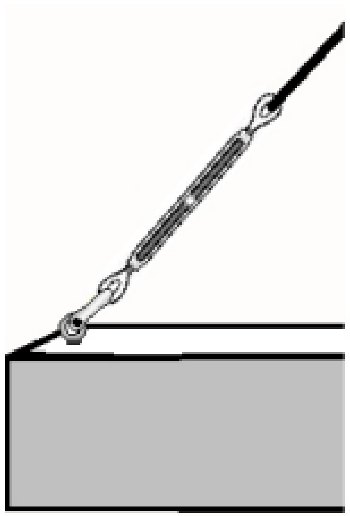
		
If the nut cannot be tightened securely against the load, washers can be used to take up excess space between the load and nut. To ensure that the nut tightens securely, spacers must extend beyond the threaded portion of the eye bolt.	Only one nut is required when there is more than one eye bolt diameter of threads engaging the load.	Two hex nuts must be used when one eye bolt diameter of threads or less engages the load. Only one hex nut is required when at least twice the eye bolt diameter of the threaded portion engages the load.

		
Do not use the point of a hook in an eye bolt.	Use a shackle instead to attach the sling to the eye bolt.	Do not lift or pull loads with slings reeved from one eye bolt to another. This will change the angle of loading on the eye bolts and create added tension.

Presenter: Nguyen Si Khang

Rigging- Turnbuckles





Applications

- Turnbuckles can be used to level and distribute the load among the sling.
- When used in hoisting and rigging applications, turnbuckles should be made from alloy steel or the equivalent, and not welded.
- Turnbuckles must be used in a straight or in-line pull only.

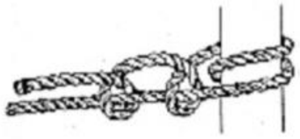
Rigging- Knots

Useful Knots

- Figure-Eight Knot
  - at end to prevent from passing through object

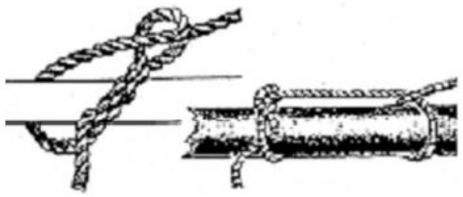
- Reef or Square Knot
  - join two ropes of same size

- Round turn and two half hitches
  - secure tag line to object



- Bowline
  - most widely used knot
  - will not slip, jam, or fail

- Timber Hitch
  - used for hoisting planks or pipe
  - holds without slipping or jamming

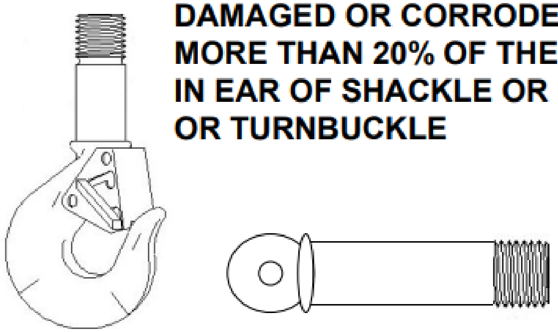


Rigging- Hook

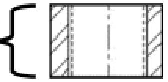
INSPECTION OF RIGGING HARDWARE REMOVAL CRITERIA FOR THREADS

EXCESSIVE THREAD DAMAGE OR WEAR OF SCREW PINS, SHANK HOOKS AND TURNBUCKLES:

REMOVE FROM SERVICE IF THREADS DAMAGED OR CORRODED FOR MORE THAN 20% OF THE LENGTH ENGAGED IN EAR OF SHACKLE OR NUT OF HOOK OR TURNBUCKLE



ENGAGED LENGTH



(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

INSPECTION OF HARDWARE HEAT DAMAGE

HEAT DAMAGE CAUSED BY EXPOSURE TO TEMPERATURES ABOVE 400°F

WELD SPLATTERS

ARC STRIKES

EXPOSURE TO EXCESSIVE TEMPERATURE WILL DAMAGE THE HEAT TREATMENT AND MATERIAL STRENGTH, SEVERE WELD SPLATTERS AND ARC STRIKES CAN CREATE STRESS CONCENTRATION AND ARE CAUSE FOR REMOVAL FROM SERVICE

(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

Rigging- Hook

INSPECTION OF HARDWARE
WEAR

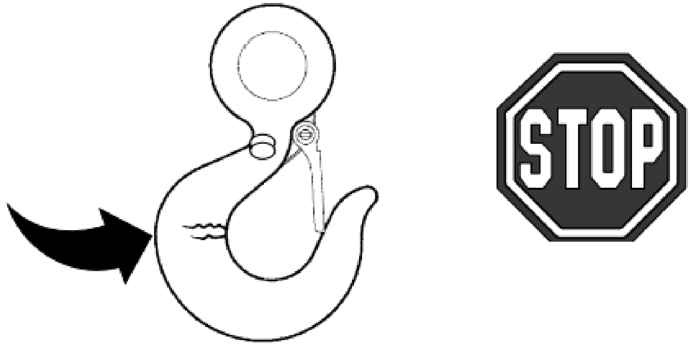
10% OR MORE REDUCTION IN OF ANY SECTIONAL DIMENSION INDICATES IT HAS EXCESSIVE WEAR, MEASURE BY COMPARING TO A SECTION OF FITTING THAT HAS NO WEAR, OR TO THE CATALOG DIMENSIONS

MAKE SURE IDENTIFICATION IS LEGIBLE

(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

INSPECTION OF HARDWARE
CRACKS AND SHARP NICKS



ANY CRACK, SHARP NICK OR GOUGE IN THE SURFACE OF ANY FITTING CAN CAUSE STRESS CONCENTRATION AND IS CAUSE FOR REMOVAL FROM SERVICE

(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

Rigging- Hook

INSPECTION OF HARDWARE PROPER FUNCTION

MISSING LATCHES WHEN REQUIRED

DAMAGED LATCHES WHEN PRESENT

SWIVEL BEARINGS THAT LACK THE ABILITY TO FREELY ROTATE WHEN NOT LOADED

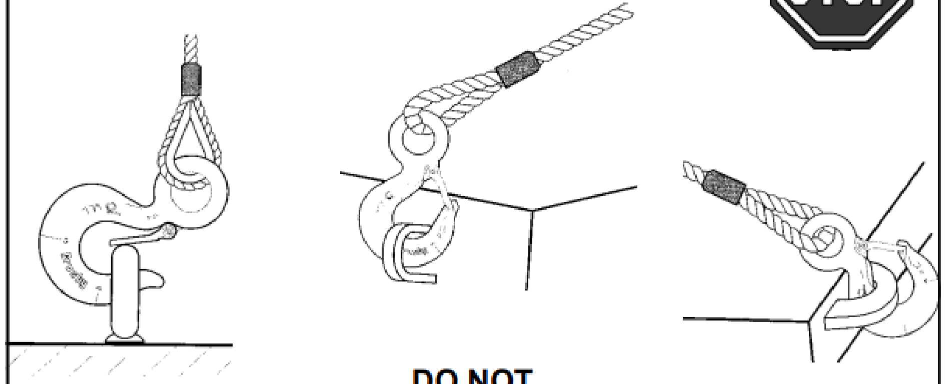
LOOSE OR MISSING NUTS, BOLTS, COTTER PINS, SNAP RINGS, OR OTHER FASTENERS AND RETAINING DEVICES

MALFUNCTION OR MISSING LOCKING DEVICES IS CAUSE FOR REMOVAL FROM SERVICE

(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

HOOKS IMPROPER LOADING



DO NOT
TIP LOAD, SIDE LOAD OR BACK LOAD
HOIST HOOKS

(MOM-01)

"THE FUNDAMENTALS OF PROPER USE"

Rigging- Hook

Correct way to balance a shackle load

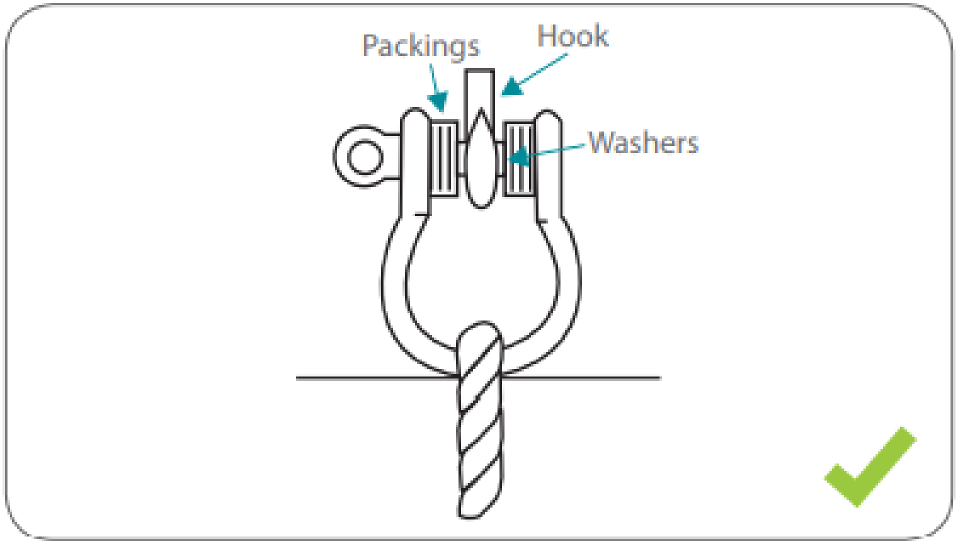


Figure 6: Insert sufficient washers to centralise the position of the shackle.

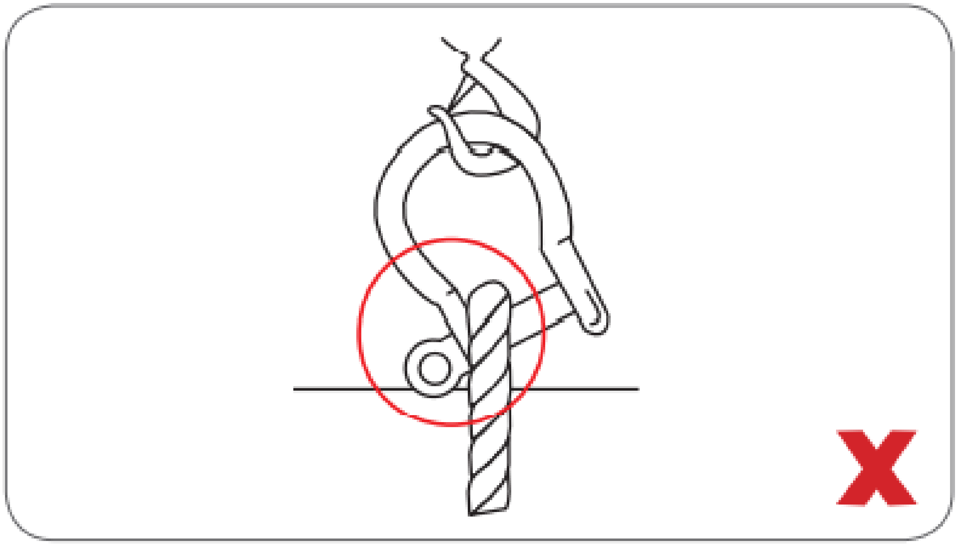
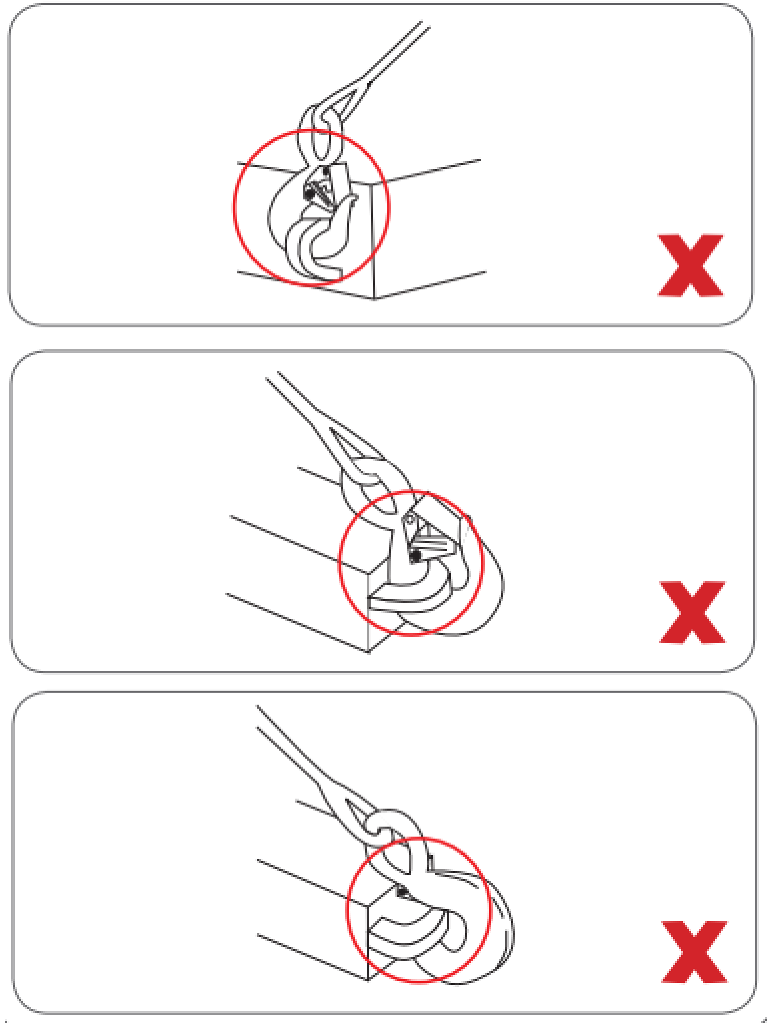


Figure 7: Make sure the shackle is not pulled down at an angle.

Presenter: Nguyen Si Khang

Rigging- Hook

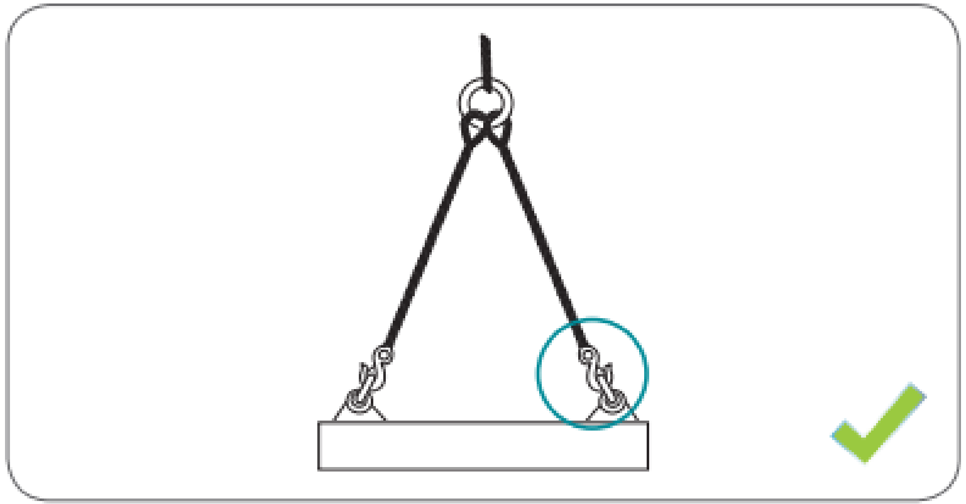


It's wrong hooked up method

Presenter: Nguyen Si Khang

Rigging- Hook

Correct rigging method



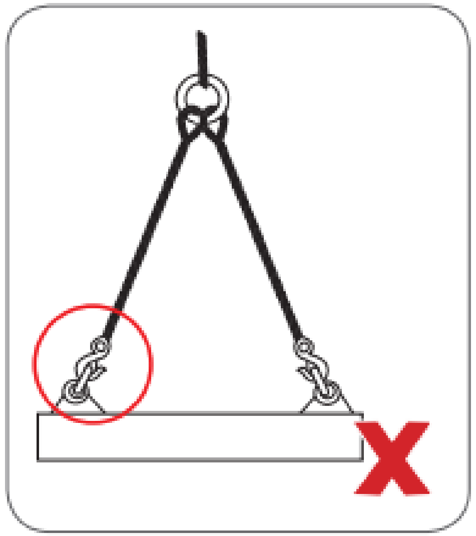


Figure 13: Do not secure the hooks facing in.

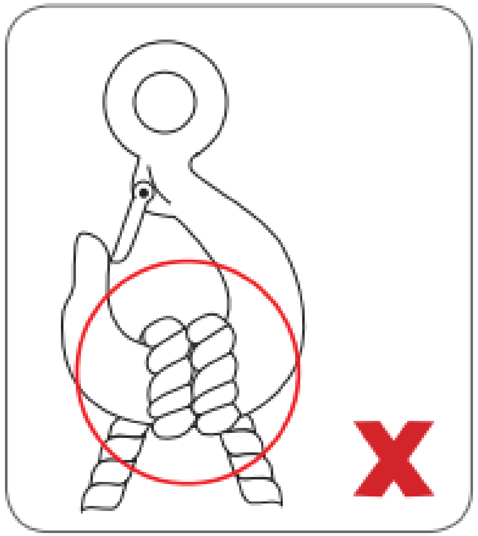


Figure 14: Do not wrap a rope around the hook.

Rigging- Hook

Correct rigging method

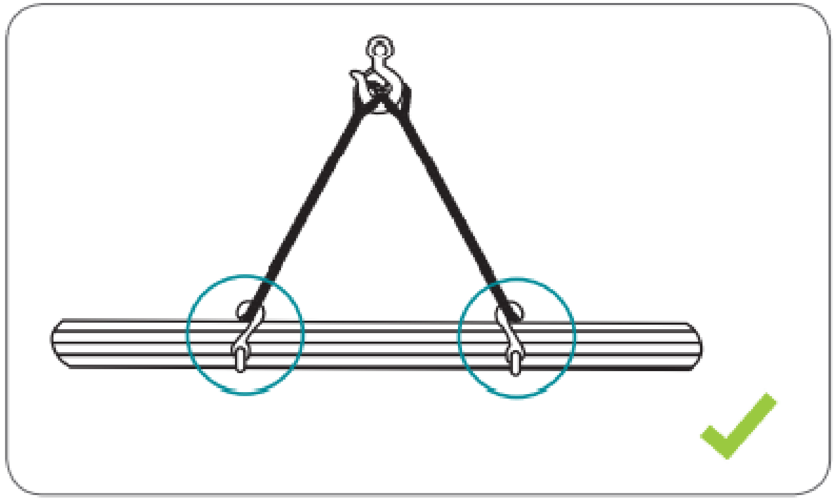


Figure 15: Make sure the load is rigged correctly before lifting.

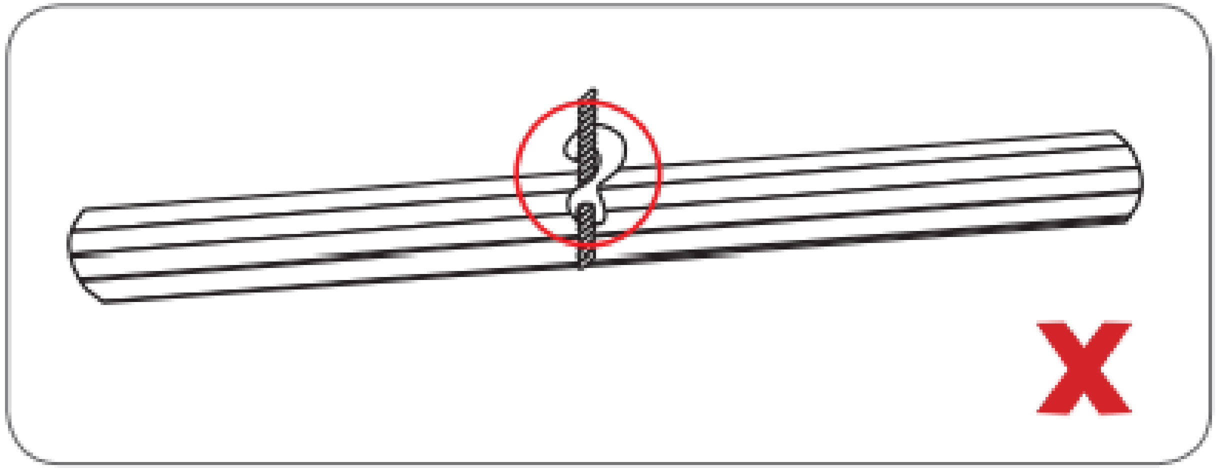


Figure 16: The load will tilt to one side during lifting if it is not rigged correctly.

Rigging- Hook

Use paddings during lifting

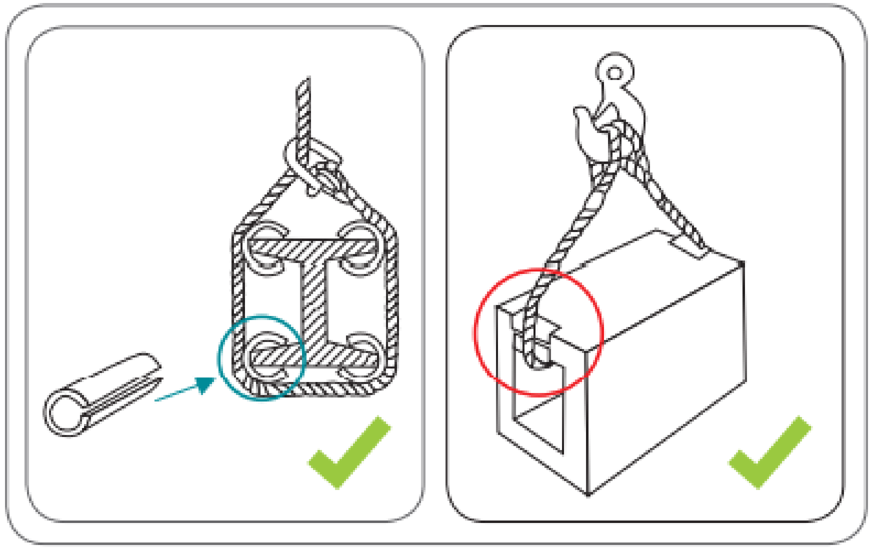


Figure 22: Correct ways of using paddings to prevent damage to the sling.

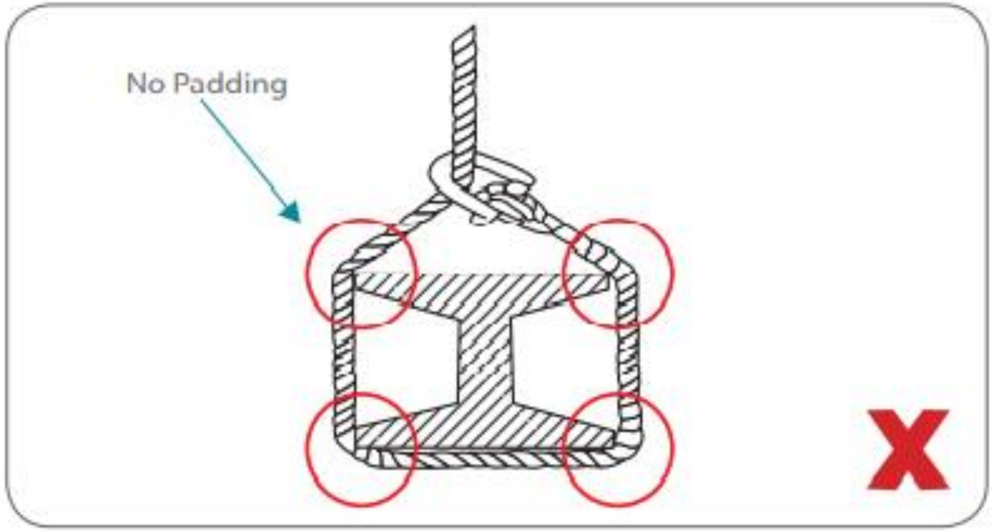


Figure 23: The sling will be damaged if paddings are not used on the load.

Presenter: Nguyen Si Khang

Rigging - Sling protection

Sling protection
required for sharp edges

Rigging- Hook

Correct method of unloading

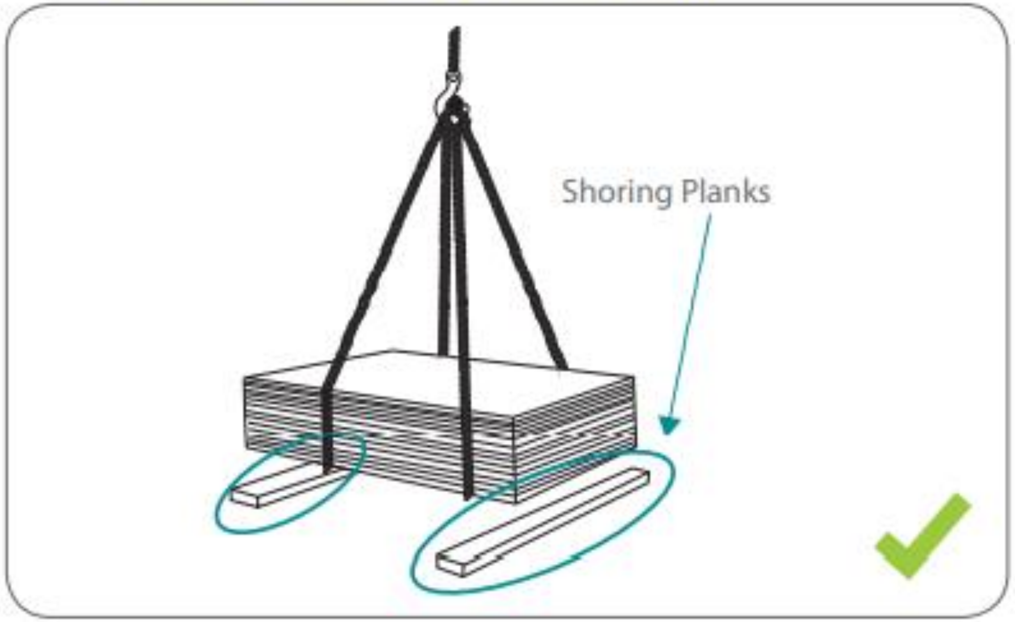


Figure 28: Place load on shoring planks during unloading.

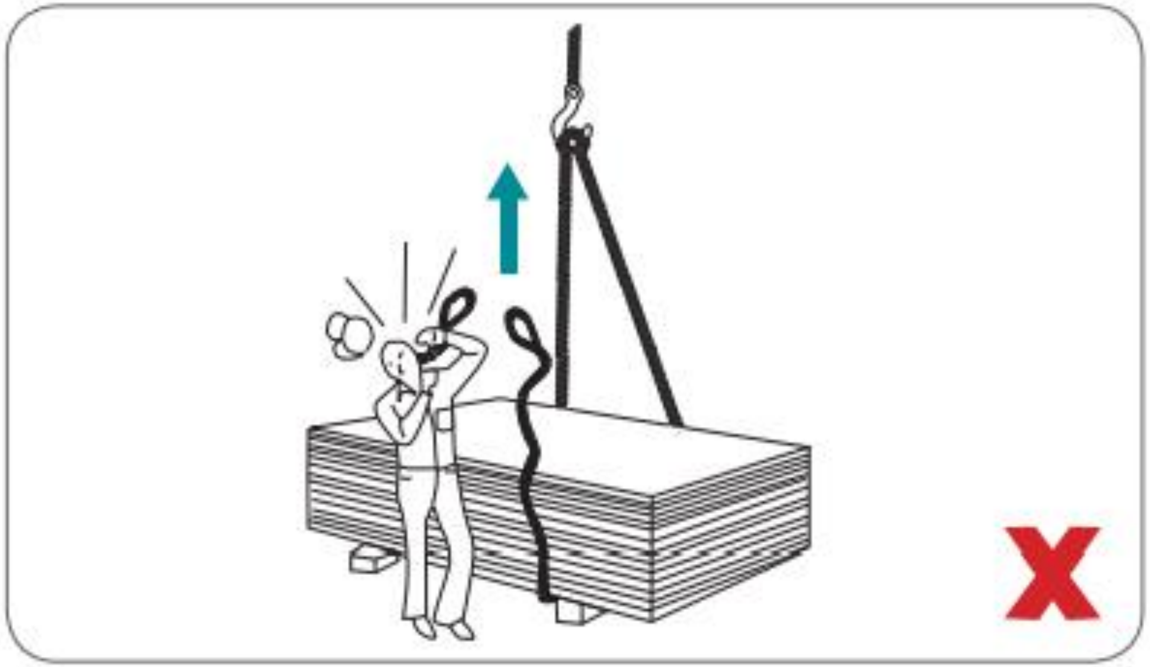
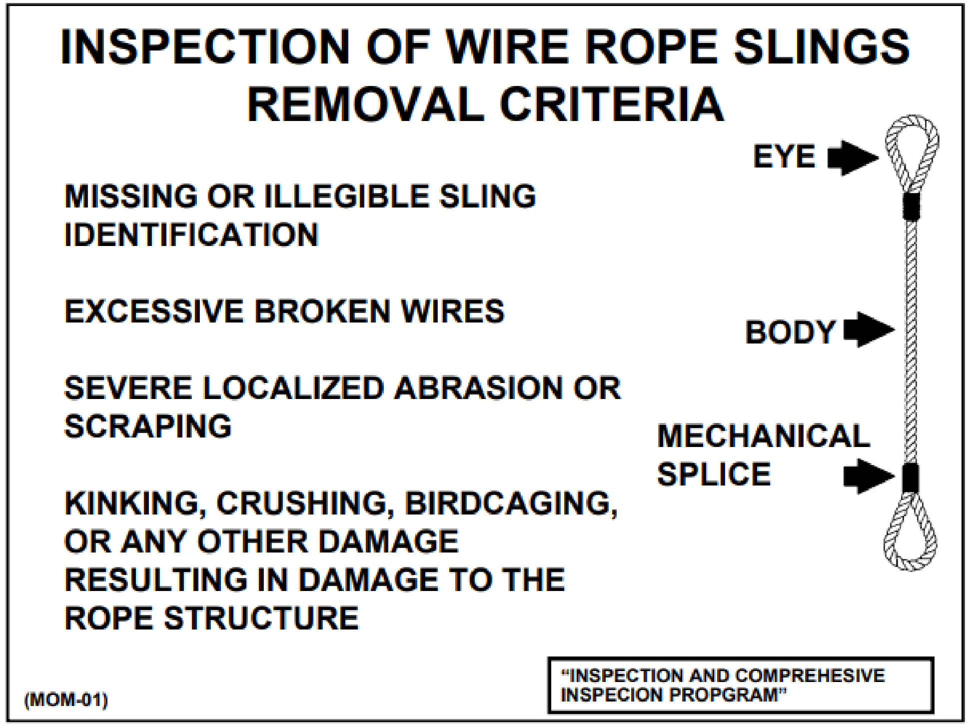
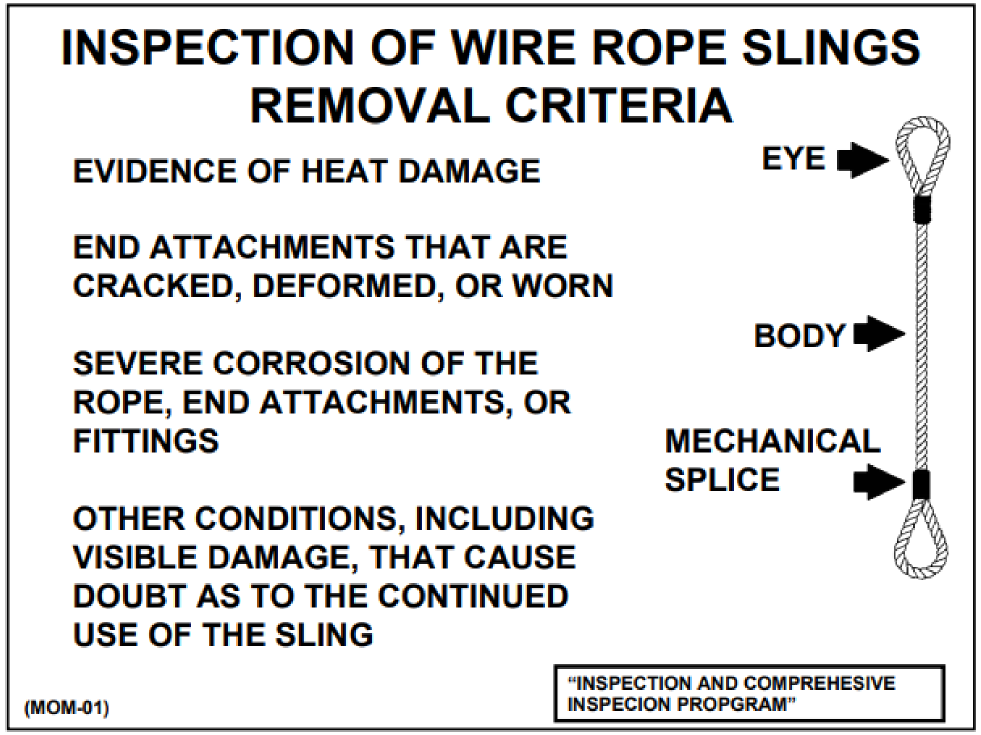


Figure 29: Do not use the crane to pull out the sling from under the load.

Rigging- Hook





Rigging- Hook

INSPECTION OF CHAIN SLINGS REMOVAL CRITERIA

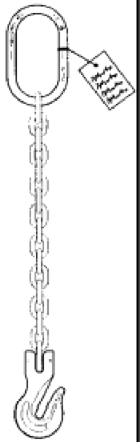
MISSING OR ILLEGIBLE SLING IDENTIFICATION

CRACKS OR BREAKS

EXCESSIVE WEAR, NICKS, OR GOUGES

STRETCHED CHAIN LINKS OR COMPONENTS

BENT, TWISTED, OR DEFORMED CHAIN LINKS OR COMPONENTS



(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

INSPECTION OF CHAIN SLINGS REMOVAL CRITERIA

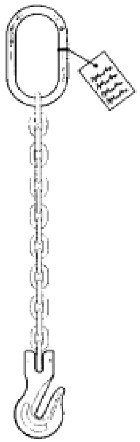
EVIDENCE OF HEAT DAMAGE

EXCESSIVE PITTING OR CORROSION

LACK OF ABILITY OF CHAIN OR COMPONENTS TO HINGE FREELY

WELD SPLATTER

OTHER CONDITIONS, INCLUDING VISIBLE DAMAGE, THAT CAUSE DOUBT AS TO THE CONTINUED USE OF THE SLING

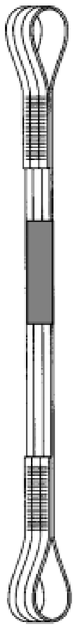


(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

Rigging- Hook

INSPECTION OF WEB SLINGS CAUSE FOR REMOVAL



MISSING OR ILLEGIBLE SLING IDENTIFICATION

ACID OR CAUSTIC BURNS

MELTING OR CHARRING OF ANY PART OF THE SLING

HOLES, TEARS, CUTS, OR SNAGS

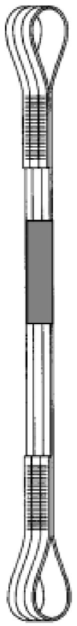
BROKEN OR WORN STITCHING IN BEARING SPLICES

EXCESSIVE ABRASIVE WEAR

(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

INSPECTION OF WEB SLINGS CAUSE FOR REMOVAL



KNOTS IN ANY PART OF SLING

DISCOLORATION AND BRITTLE OR STIFF AREAS ON ANY PART OF THE SLING, WHICH MAY MEAN CHEMICAL OR ULTRAVIOLET / SUNLIGHT DAMAGE

FITTINGS THAT ARE PITTED, CORRODED, CRACKED, BENT, TWISTED, GOUGED, OR BROKEN

OTHER CONDITIONS, INCLUDING VISIBLE DAMAGE, THAT CAUSE DOUBT AS TO THE CONTINUED USE OF THE SLINGS

(MOM-01)

"INSPECTION AND COMPREHESIVE INSPECION PROPGRAM"

Rigging- Hook

Correct use of choker hitches

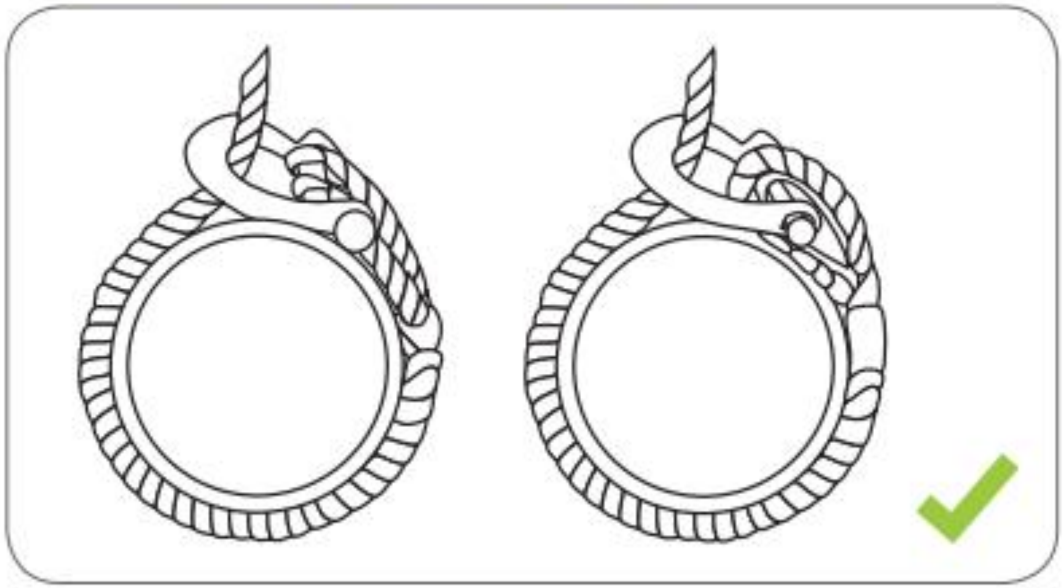


Figure 3: Make sure there is no cutting action on the running line.

Figure 4: Do not use shackle pin as it will become loose over time.

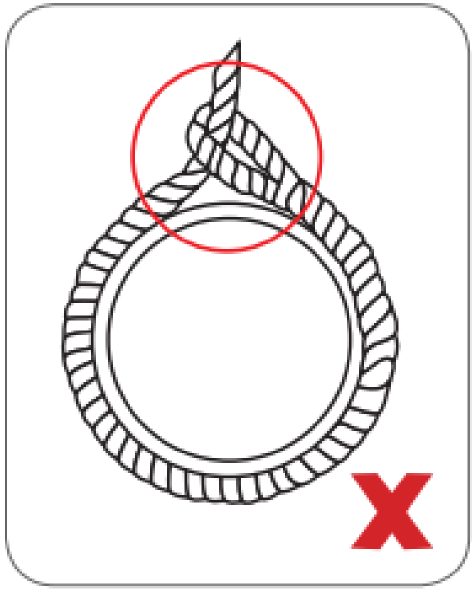
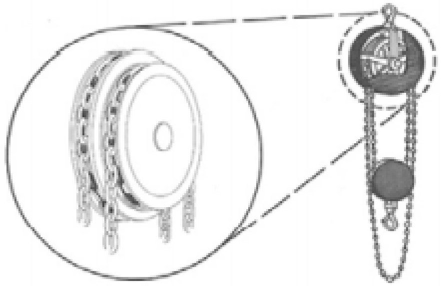


Figure 5: Make sure there is no cutting action of the wire rope sling eye on the running line.

Rigging- Hoist

Differential Hoist



Operating Principle

- Operates with multiple sheaves, each with pockets cut out to fit chain links. One sheave has more pockets than the other so as it rotates of the same shaft it take up chain faster.

Advantages

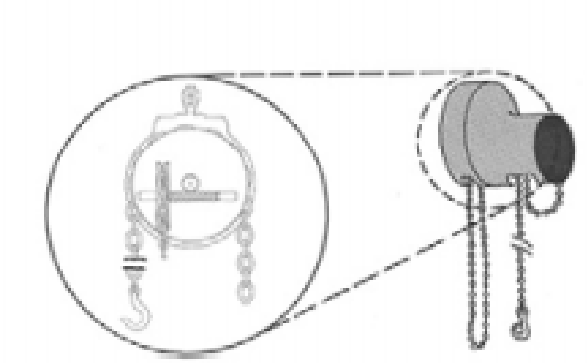
- Relatively inexpensive
- Simple to operate

Disadvantages

- Least efficient hand-operated chain hoist
- Will slip when hand loop is released
- If load/hoist are jarred the load may fall

Rigging- Hoist

Screw-Gear Hoist



Operating Principle

- The mechanism inside the block is a worm and pinion arrangement. The hand chain is an endless loop that rotates the mechanism. The load chain descends directly from the block.

Advantages

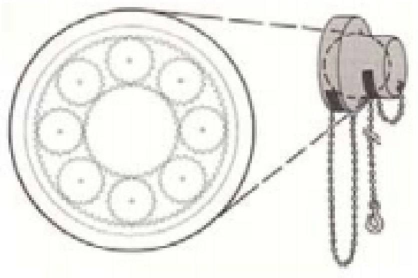
- More efficient than differential hoists
- Can safely suspend a load when the hand chain is released because the worm gear cannot be driven by its pinion.

Disadvantages

- Less efficient than a spur-gear hoist

Rigging- Hoist

Spur-Gear Hoist



Operating Principle

- Uses a gear arrangement called a sun and planetary gear set. The hand wheel is coupled to the sun gear. As the sun gear turns, the entire group of planetary gears slowly revolves. The load wheel rotates much more slowly than the sun gear, providing the reduction in speed necessary for the hoist to operate.

Advantages

- Most efficient hand-operated chain hoist
- Incorporates a clutch that slips if the hoist is overload beyond its safe lifting capacity to keep the load from being raised

Disadvantages

- Requires a friction brake (usually an automatic feature/some have a manual brake release) to hold a load aloft when the hand chain is released because of the reduced amount of friction.