NCMT

LIFTING SUPERVISOR

COURSE MATERIAL

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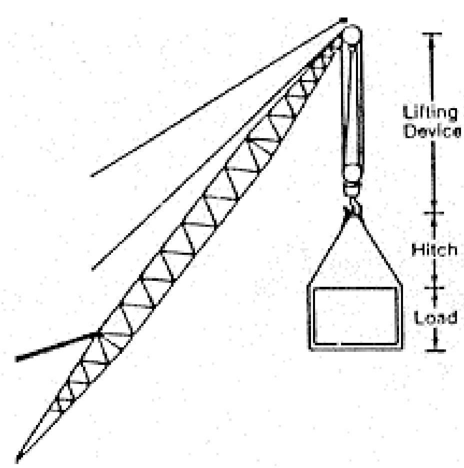
Lifting Supervisor TRAINING

The Users Responsibilities



Operator

Rigger

The Users Responsibilities

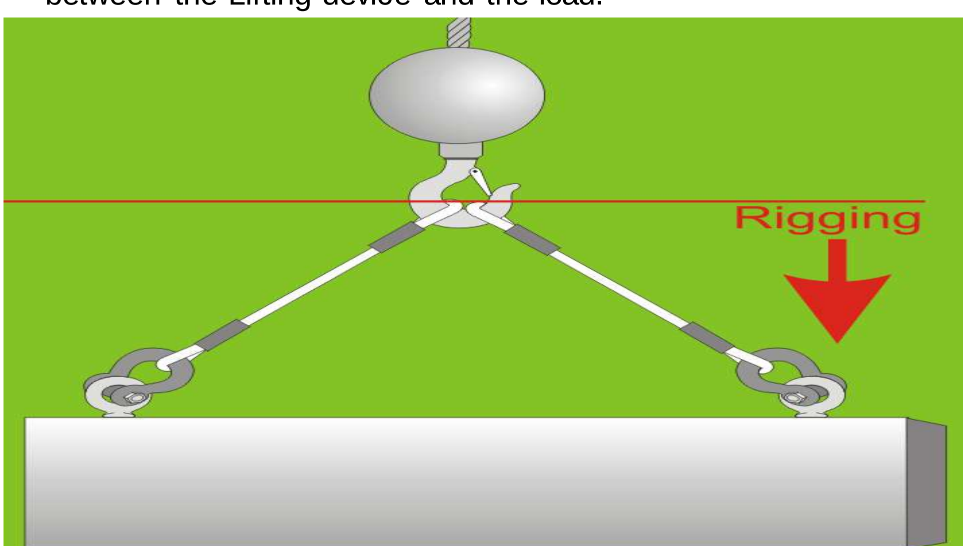
Utilize Appropriate Rigging Gear Suitable For Overhead Lifting.

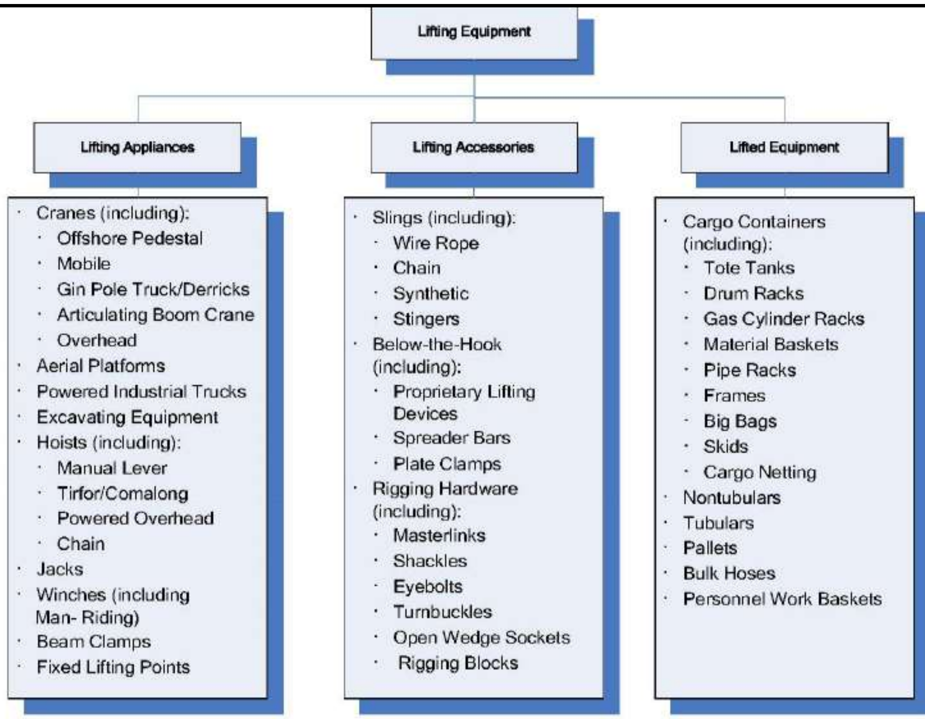
Utilize The Rigging Gear Within Industry Standards And The Manufacturers Recommendations.

Conduct Regular Inspection And Maintenance Of The Rigging Gear.

Definition of Rigging

Rigging is part of the lifting operation which forms the link between the Lifting device and the load.





Lifting Equipments

Any Devices Which is used for Lift the load, Which human can't.

- Hydra's
- CRANES: limit switches
- Fork lifts
- Magnetic lift crane
- Mobile cranes: wheel ,crawler
- EOT
- Gantry
- Chain pully: spur gear, worm wheel
- Winch machine

All the lifting equipments must be certified by third party annually.

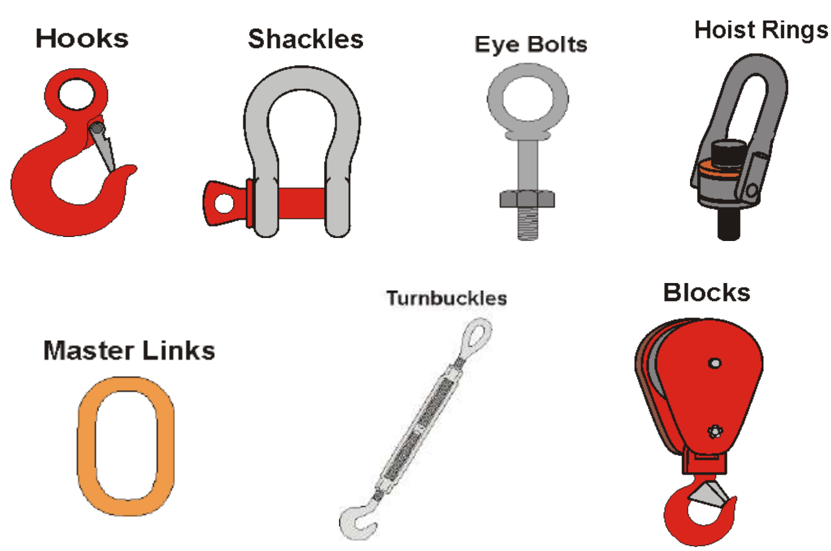
Lifting Gear

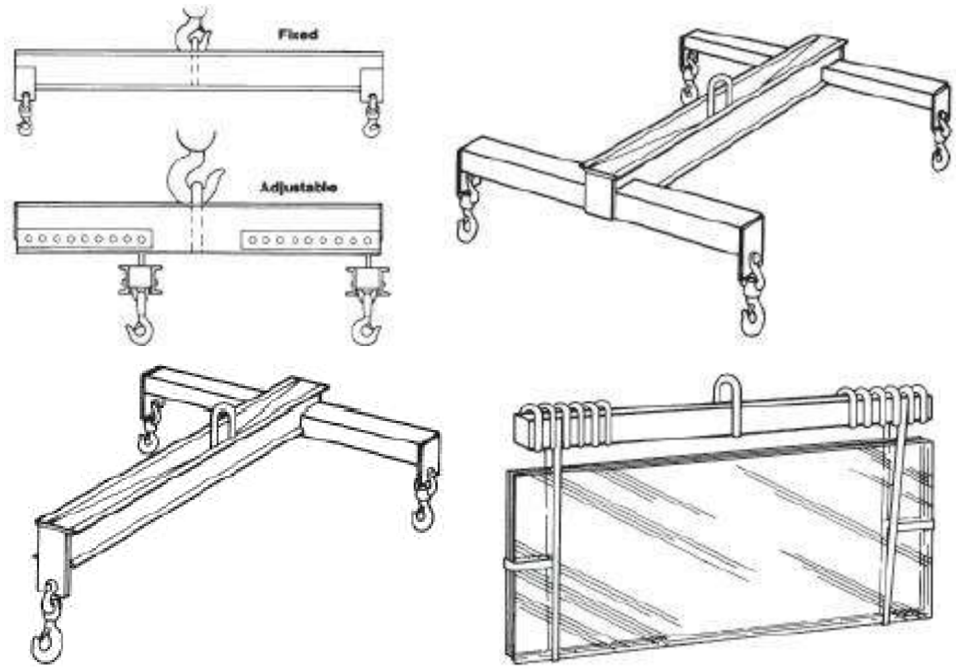
The Connector used to link between the lifting device and the load.

- Slings
- Ropes
- Shackles
- Swivel
- Rings
- Couplers
- Sockets, Eyebolts.
- Frames & spreaders
- Plate lifting clamps
- Tailor-made tackles

These must be inspected every six months by THIRD Party.

Rigging Types - Hardware



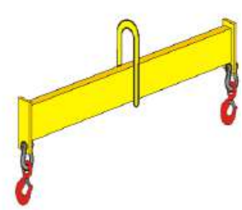


Hardware - Lifting beams

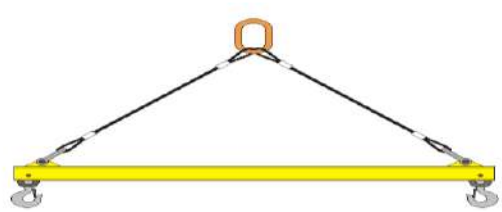
All spreader beams must have:

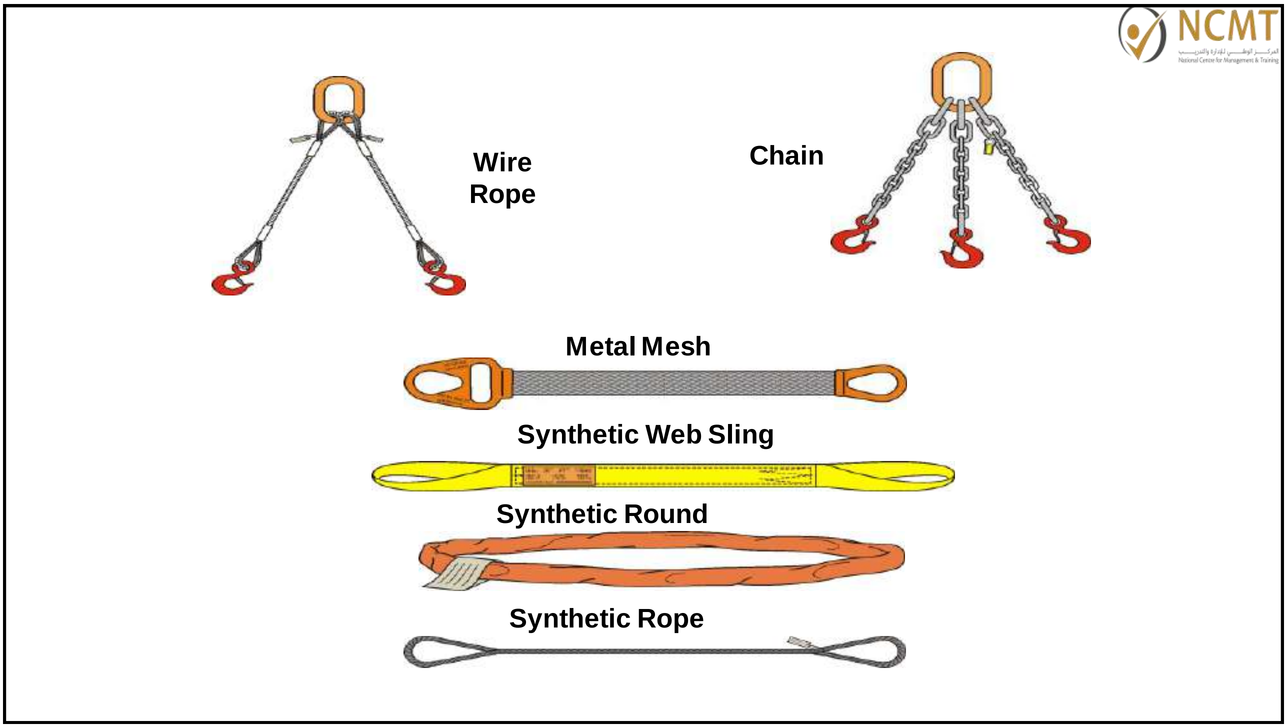
- Engineers certificate
- SWL mark
- Signed inspection sticker (colour code)

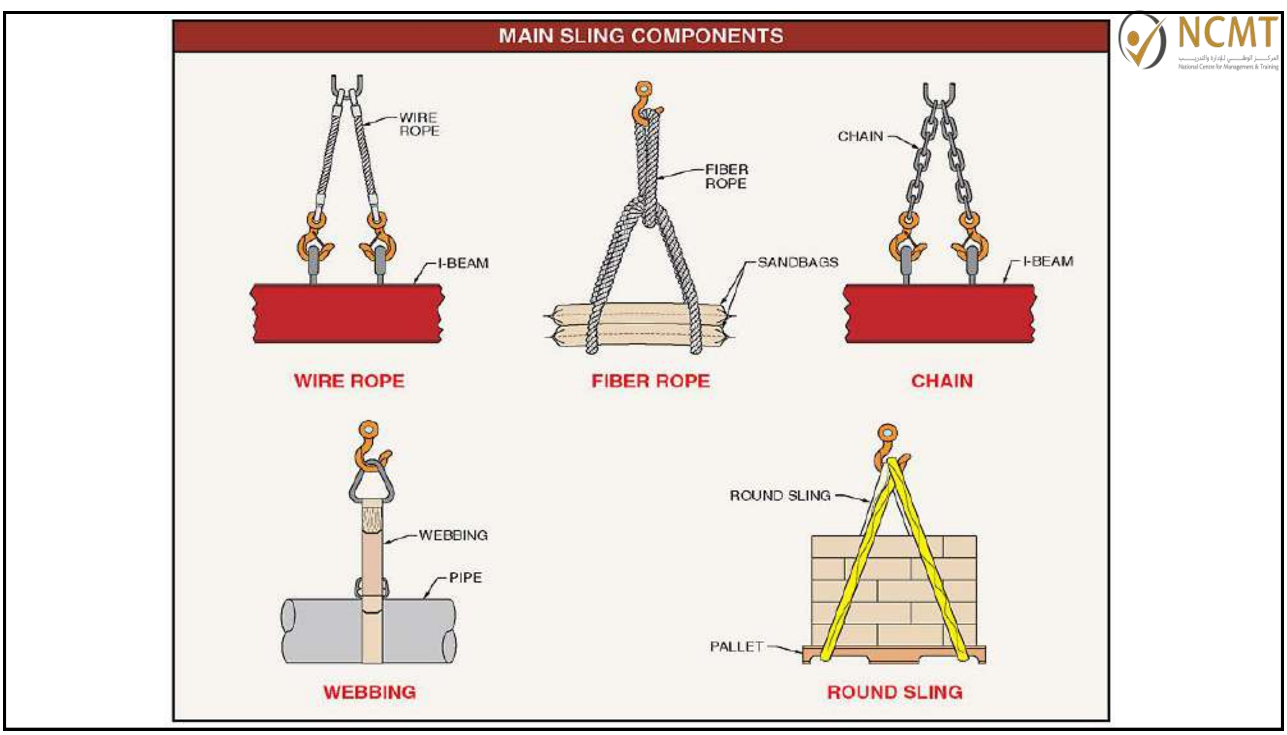
Rigid Beam



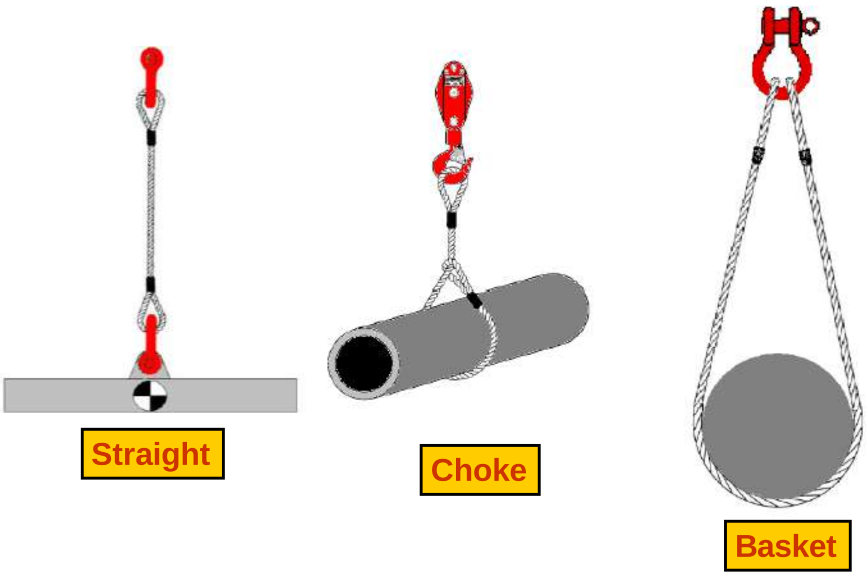
Spreader Beam



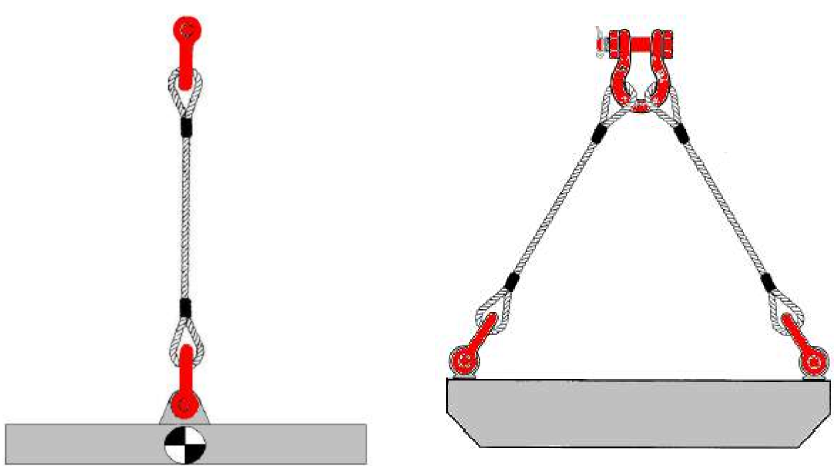

NCMT
Wire
Rope
Chain
Metal Mesh
Synthetic Web Sling
Synthetic Round
Synthetic Rope


MAIN SLING COMPONENTS
NCMT
WIRE
ROPE
I-BEAM
WIRE ROPE
FIBER
ROPE
SANDBAGS
FIBER ROPE
CHAIN
I-BEAM
CHAIN
WEBBING
PIPE
WEBBING
ROUND SLING
PALLET
ROUND SLING

Basic Rigging Hitches



Types of Hitches

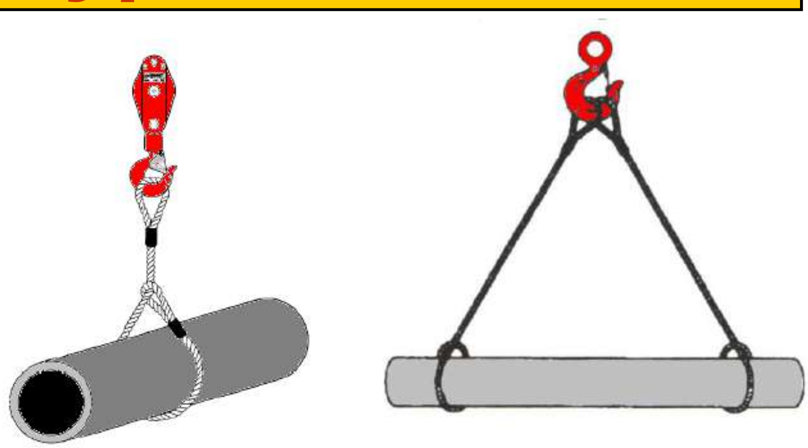


Straight – loading with the load suspended vertically on a single part or leg of the sling

Rigging Basics - Hitches

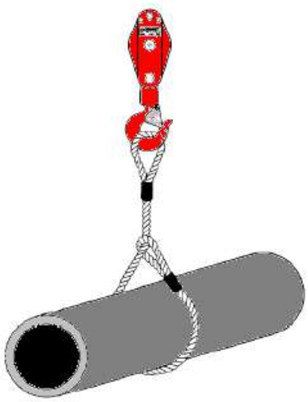
Characteristics:
- Load capacity is 100 % that of a single part
- Taglines should be used if the load tends to rotate as rotation can damage the sling.
- Use on items with lifting eye bolts or shackles or when a second sling is used in a spreader bar application
- Do **NOT** use when lifting loose or lengthy material, anything difficult to balance

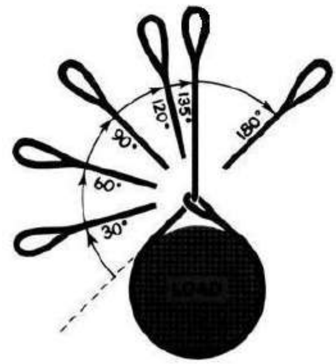
Types of Hitches



Choke – loading with the sling passed through one eye and suspended by the other

Choke



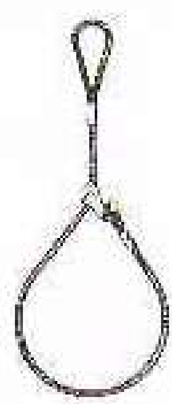


Angle of Choke in Degrees	Rated Capacity Percent
Over 120	100
90-120	87
60-89	74
30-59	62
0-29	49

Rigging Basics - Hitches

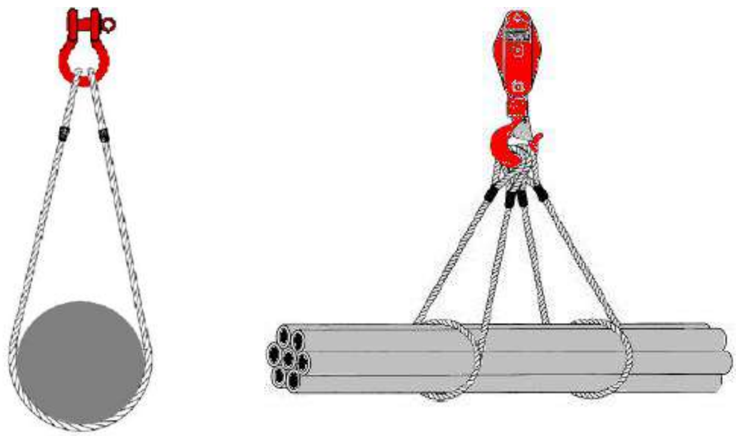
Characteristics:

- Choker hitch is easy to attach & forms a noose that tightens as the load is lifted
- Rated capacity is 80% of the single part*.
- Use to turn a load (if possible use a double choker hitch) or when handling bundles of bars or pipes
- Do **NOT** use on loads difficult to balance or which may slip out the choke



* *based on wire rope and chain slings, 120 degree angle of choke*

Types of Hitches



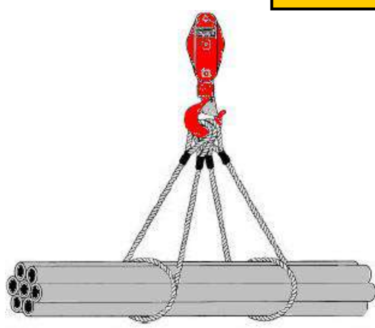
Basket - loading with the sling passed under the load and both ends on the hook or a single master link.

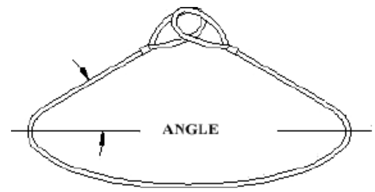
Rigging Basics - Hitches

Characteristics:

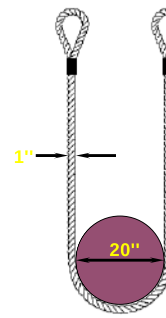
- Effectively doubles the capacity of a single vertical sling
- Stress on each leg tends to be equalized
- Use on straight lifts when the load is shaped so that the sling (or slings) will not slide over the surface.
- Do NOT use on loads that are difficult to balance and could tilt or slip out of the sling(s).
- When terminating to a common point (like a hook), sling angle can reduce sling capacity.

Basket



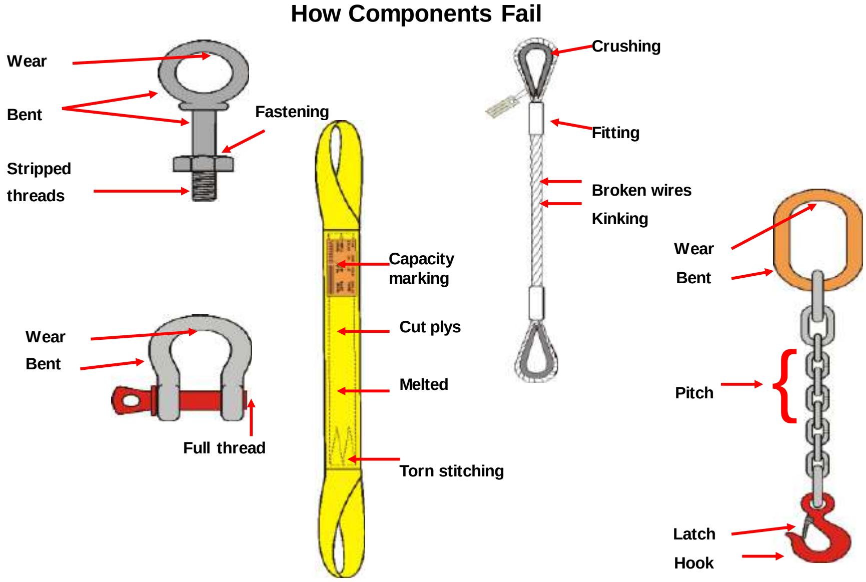


Angle	Capacity % of Single Leg
90º	200%
60º	170%
45º	140%
30º	100%



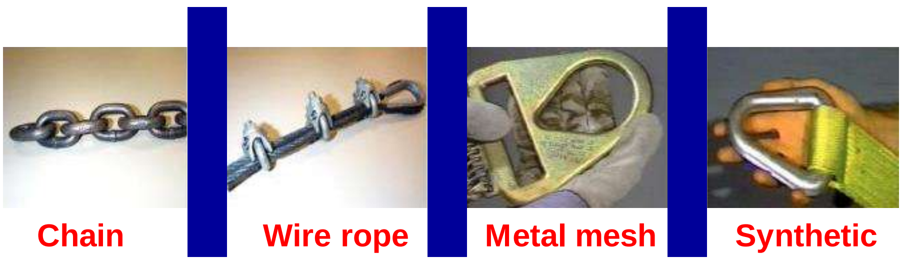
Rigging Rating Based on Breaking Strength

How Components Fail



Rigging Equipment Slings

Types of slings include alloy steel chain, wire rope, metal mesh, natural or synthetic fiber rope, and synthetic web.



Chain | **Wire rope** | **Metal mesh** | **Synthetic**

Hooks

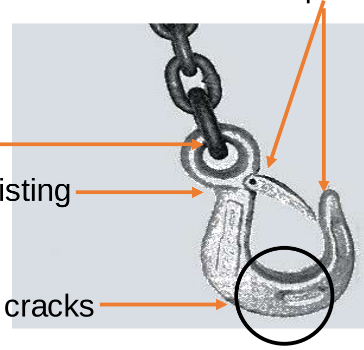
- Hooks are used for lifting, towing, pulling and securing.
- Two general classifications:
  - Sling Hooks: to which load or force is applied to the base (bowl saddle)
  - Grab Hooks: contain a throat or slot of uniform width for securing on the link of a chain, usually to form a chain loop for securing the load

Hooks

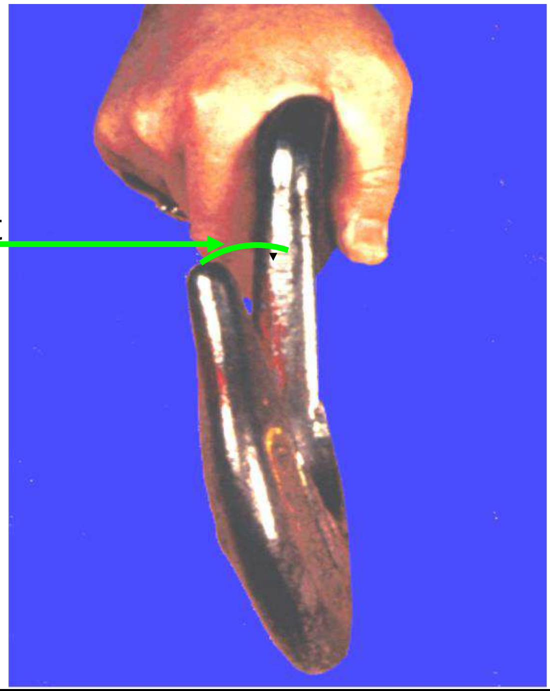
- Do not exceed the working load limit
- Only use alloy heat treated hooks for over-head lifting
- Do not tip load or use the hook in any manner for which it was not intended
- Do not shock load or dynamic load
- Never apply load to hook latches, latches are only to retain slack chains and slings

Basics of Hook Inspections

- Wear
- Deformation
- Cracks
- Sharp Nicks



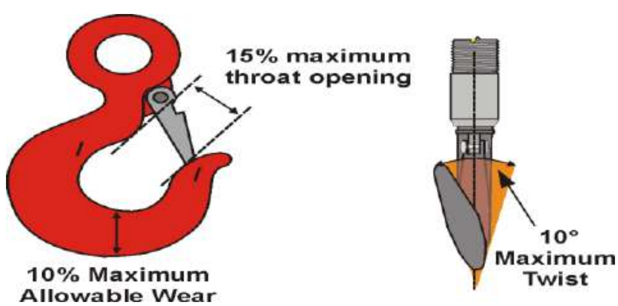
Max twist
10°



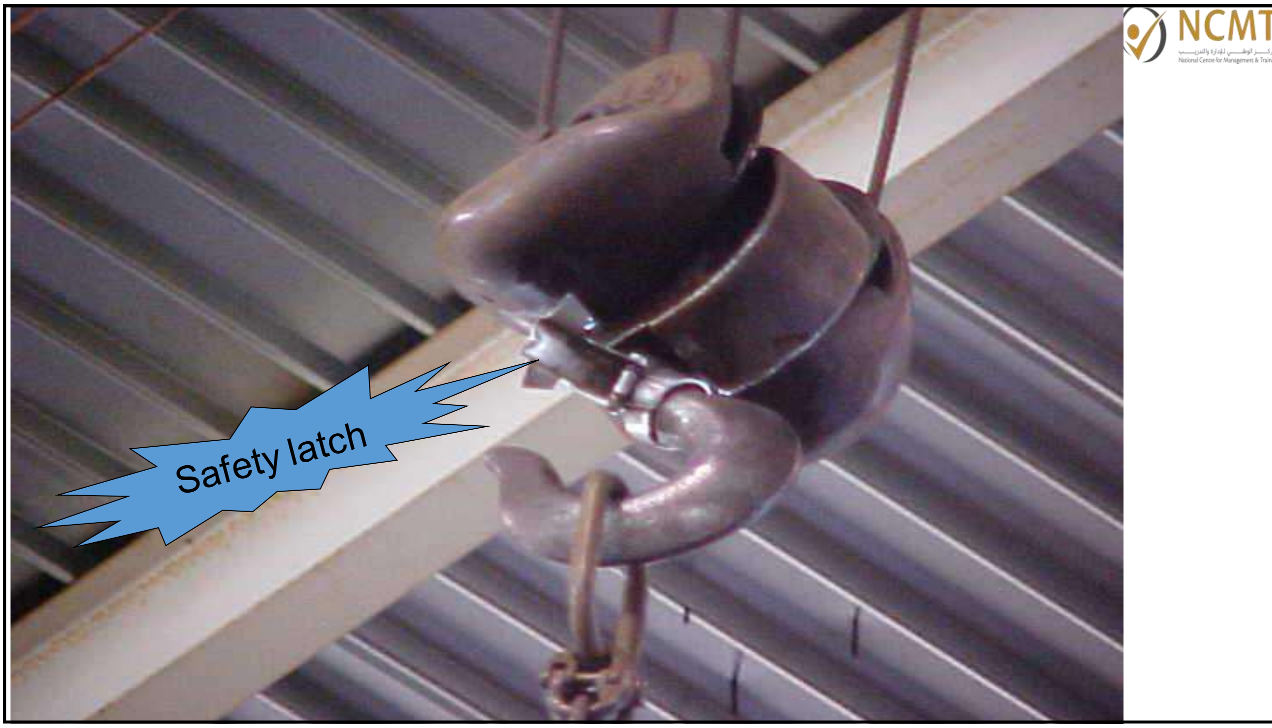
Avoid:
- **Side load**
- **Back load**
- **Tip load**

Hook Inspection

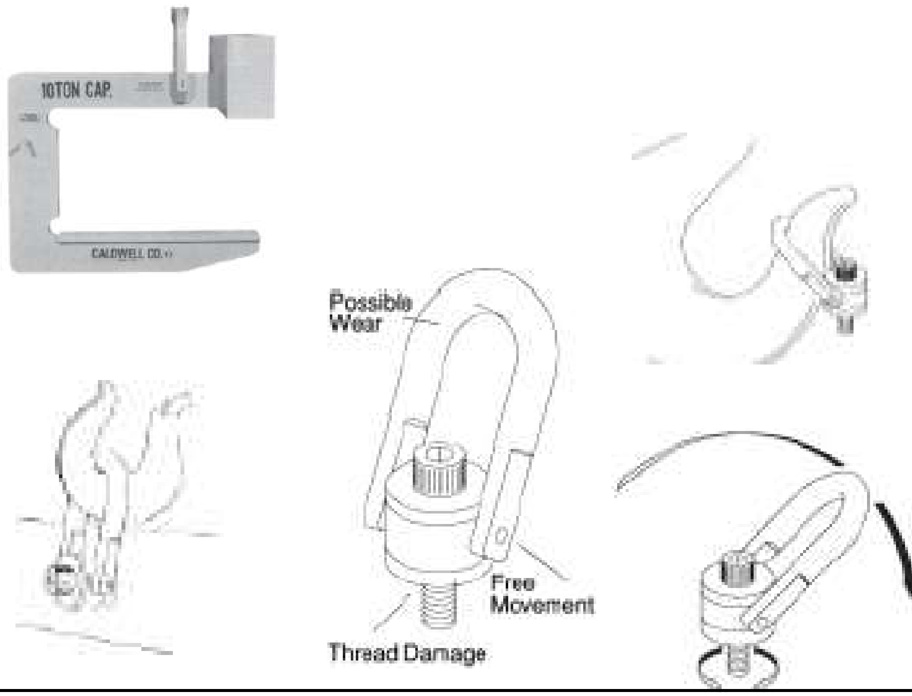
Hooks must be removed from service when any of the following conditions exist:

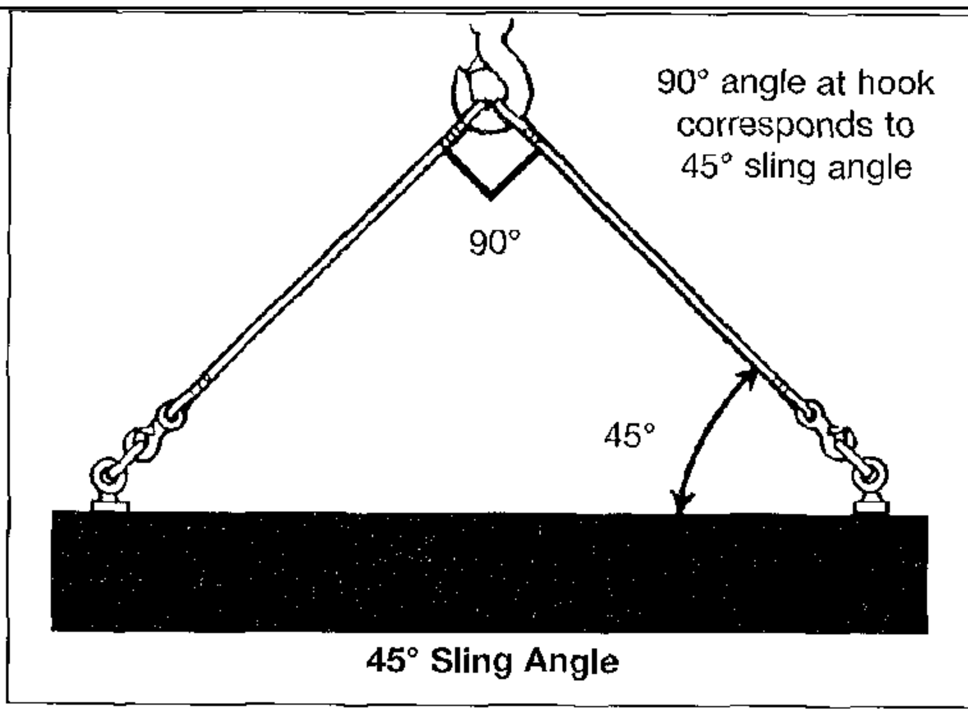


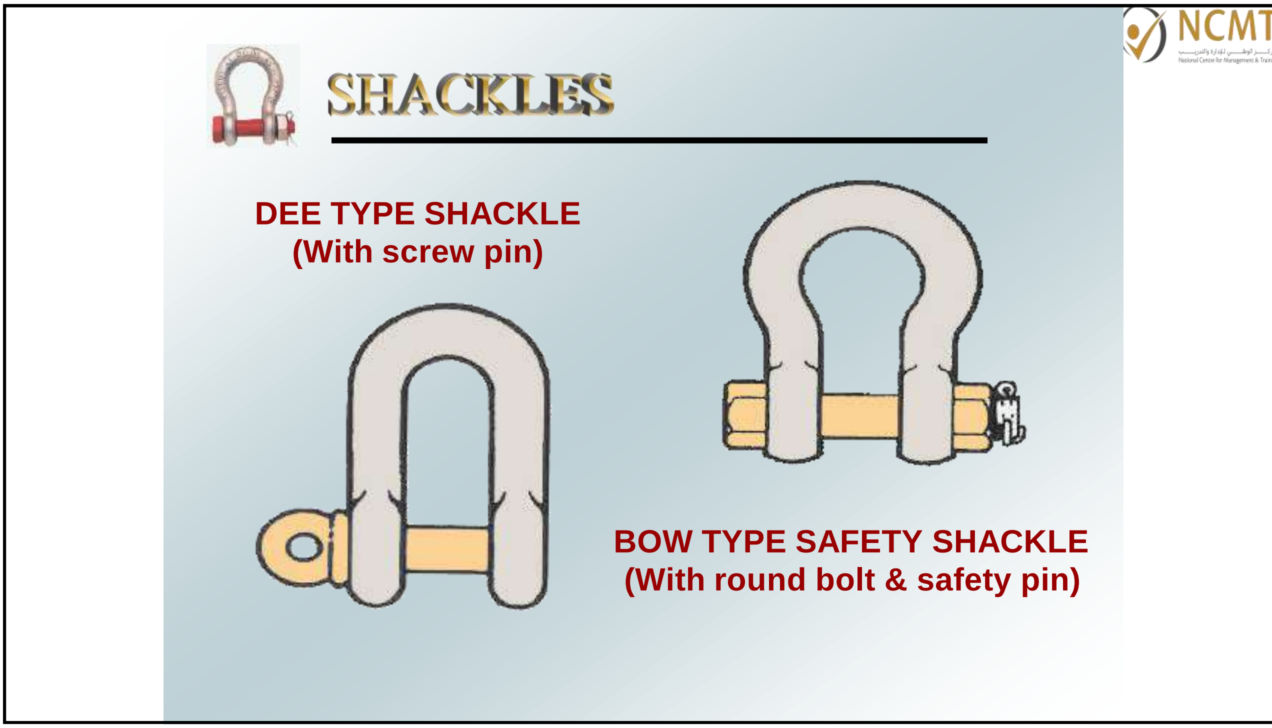
- **Cracks, nicks or gouges.**
- **Twist exceeding 10° from plane of unbent hook.**
- **Latch engagement, damage or malfunction.**
- **Throat opening exceeding 15%.**
- **Wear exceeding 10% of original dimension.**
- **Damage from heat.**
- **Unauthorized repairs.**

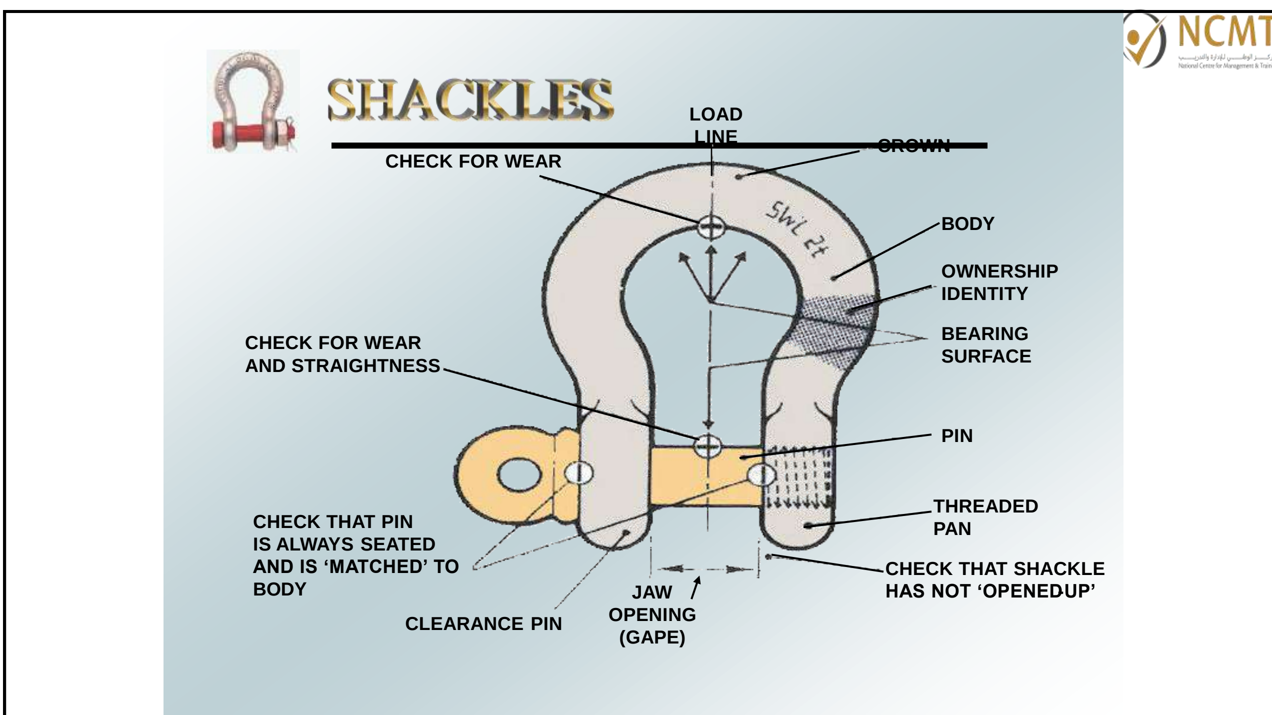

NCMT
Safety latch


NCMT


10TON CAP.
CALDWELL CO.
Possible Wear
Free Movement
Thread Damage


90° angle at hook corresponds to 45° sling angle
90°
45°
45° Sling Angle


NCMT
SHACKLES
DEE TYPE SHACKLE
(With screw pin)
BOW TYPE SAFETY SHACKLE
(With round bolt & safety pin)


NCMT
SHACKLES
LOAD LINE
CROWN
CHECK FOR WEAR
SWL 2t
BODY
OWNERSHIP IDENTITY
BEARING SURFACE
CHECK FOR WEAR AND STRAIGHTNESS
PIN
THREADED PAN
CHECK THAT PIN IS ALWAYS SEATED AND IS 'MATCHED' TO BODY
CHECK THAT SHACKLE HAS NOT 'OPENEDUP'
JAW OPENING (GAPE)
CLEARANCE PIN

SHACKLES
PRE - USE INSPECTION

- **Select correct type shackle for the job in hand.**
- **Ensure the shackle is correctly colour coded.**
- **Check the safe working load of the shackle before use - no SWL - quarantine .**
- **Check shackle pin for excessive wear-if wear is 1/10th or more of original diameter quarantine.**
- **Make sure the pin is free-but not loose in the tapped hole(s) of the shackle.**
- **Threads on pin and shackle should be undamaged and without appreciable wear.**

SHACKLES PRE - USE INSPECTION (CONT`D)

- Check alignment of pin holes - the untapped hole should not be worn or oversized.
- Only properly fitted pins shall be used in shackles.
- Home made or modified shackles must never be used.
- Check jaws and pin of shackle for distortion. Check body of shackle for pitting,cracks or corrosion.
- To test shackle suspend and tap lightly with a hammer or the shackle pin - "SOUND" shackles should have a "clear" ring or "ping"

SHACKLE INSPECTION

The working load limit (WLL) must be printed on the shackle or it must be taken out of service. This WLL is for vertical lifts.

Only two types of shackles are to be used in rigging for lifts. The screw pin type and the bolt type shackle.

Shackles that are deformed or damaged must be removed from service

Diameter of material in shackle body (inch)	Size of mark (inch)
Up to and including ½	1/8
Over 1/2, up to and including 1	3/16
Over 1	1/4

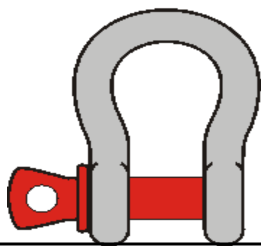
SELF INSPECTION

Lifting gear---shackles

- **All shackles shall be subjected to a semi-annually inspection by a authorized <u>third party</u>.**
- **Lifeboat shackles shall be subjected to an annual load test inspection.**
- **Minimum information marked (stamp) shall include: "SWL", SH No,**
- **Shackles shall be inspected prior to use and shall be immediately removed from service if any of the following condition is present:**

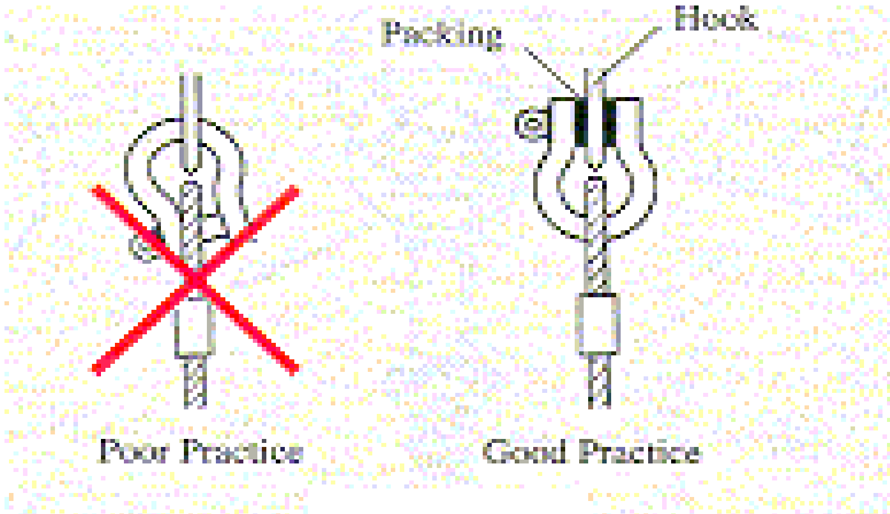
---broken
---distortion
---twisting
---excessive wear
---the pin shall be easy to screw in and out
---corrosion

Shackles



Unsuitable Alloy Steel Chain Attachments

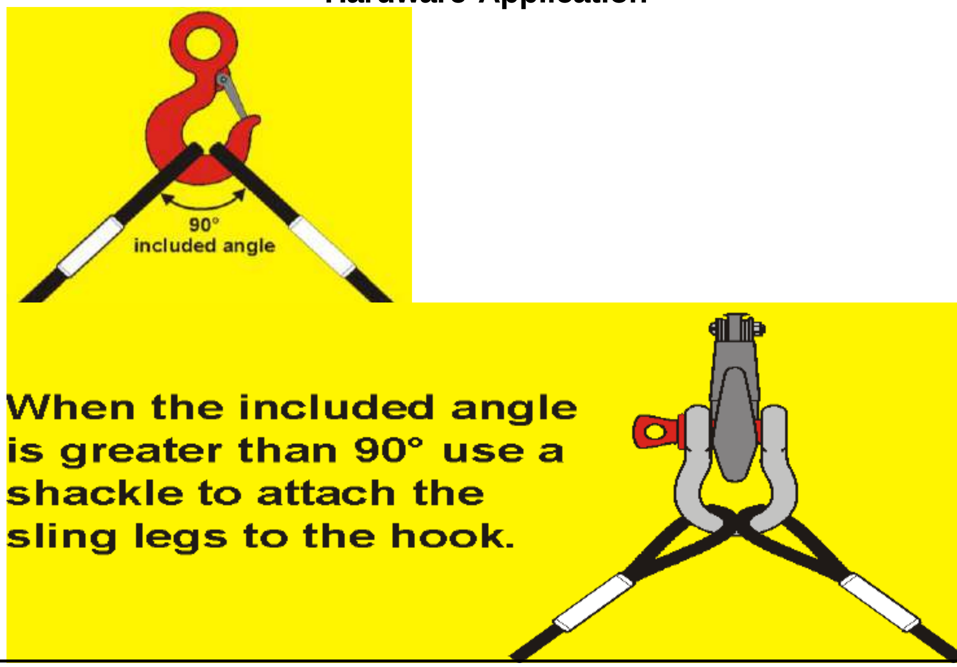
- **ALWAYS ensure that the load is clear before the lift**



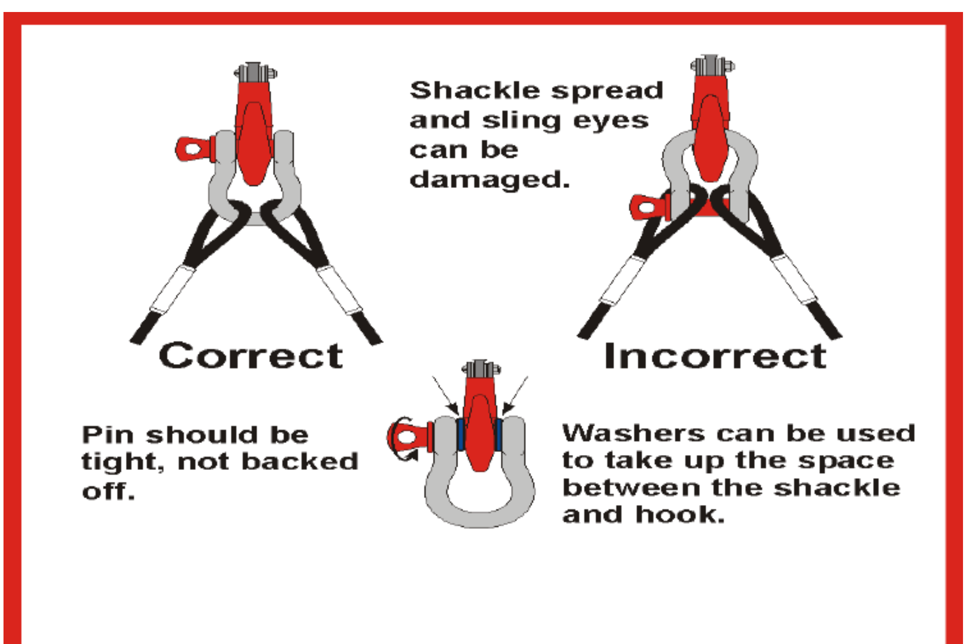
Wrong

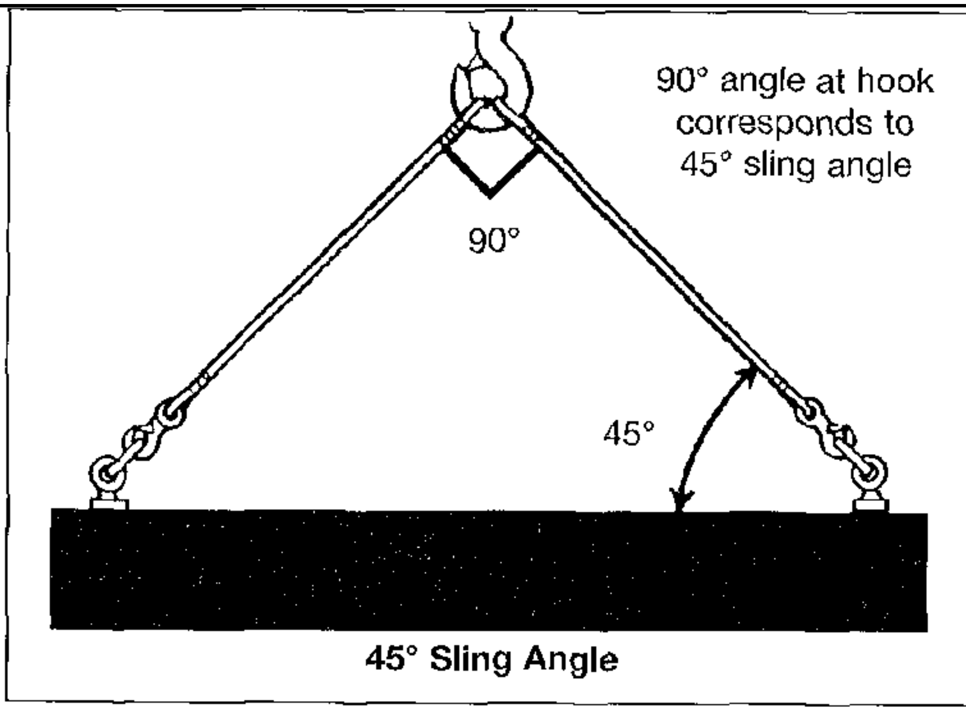
Correct

Hardware Application



Shackle Application

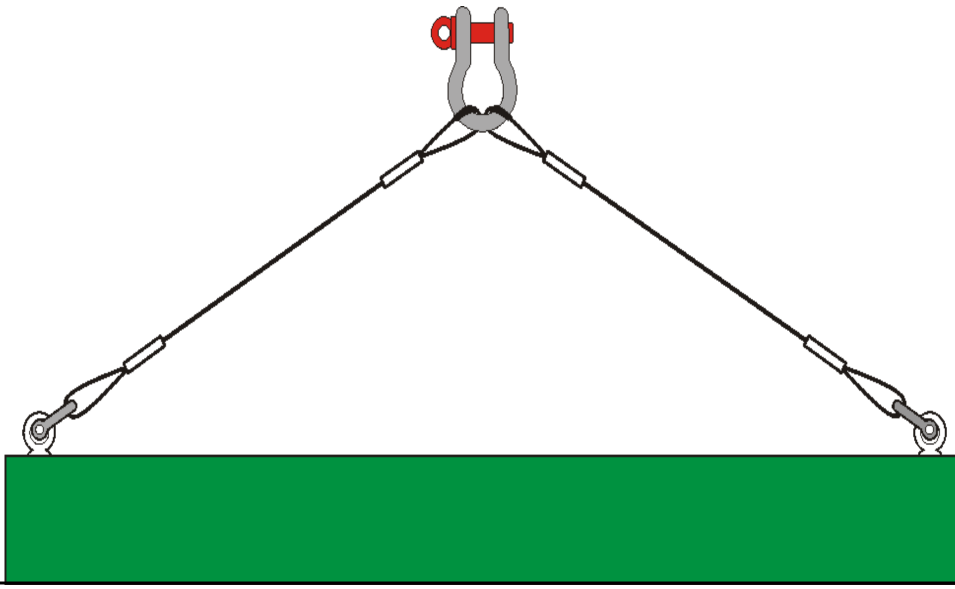




45° Sling Angle

Hardware

Shackle Application

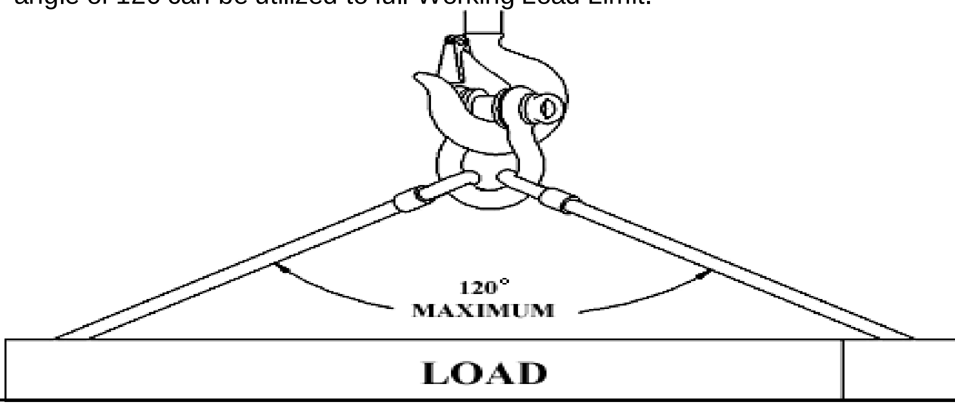


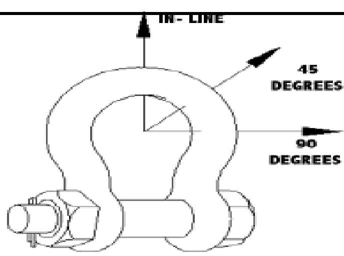
ON RIGHT: Angle loads must be applied in the plane of the bow.

Never Exceed 120 included angle.

Use Bolt Type and Screw Pin Shackles ONLY.

Shackles symmetrically loaded with two leg slings having a maximum included angle of 120 can be utilized to full Working Load Limit.





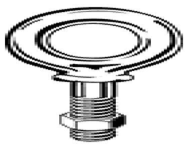
Side Loading Reduction Chart
For Screw Pin and Bolt Type Shackles Only

Angle of Side Load from Vertical In-Line of shackle	Adjusted Working Load Limit
0¡ In-Line *	100% of Rated Working Load Limit
45¡ from In-Line *	70% of Rated Working Load Limit
90¡ from In-Line *	50% of Rated Working Load Limit

Wire eye bolts (also referred to as bent or turned eye bolts) are used for light duty applications, and should not be used for angular loads.
Note: Each wire eye is supplied with one nut.

Drop forged eye bolts. Forged eye bolts are significantly stronger than wire eyes and are available in larger sizes. These bolts should not be used for angular loads.
Note: Each eye is supplied with one nut.

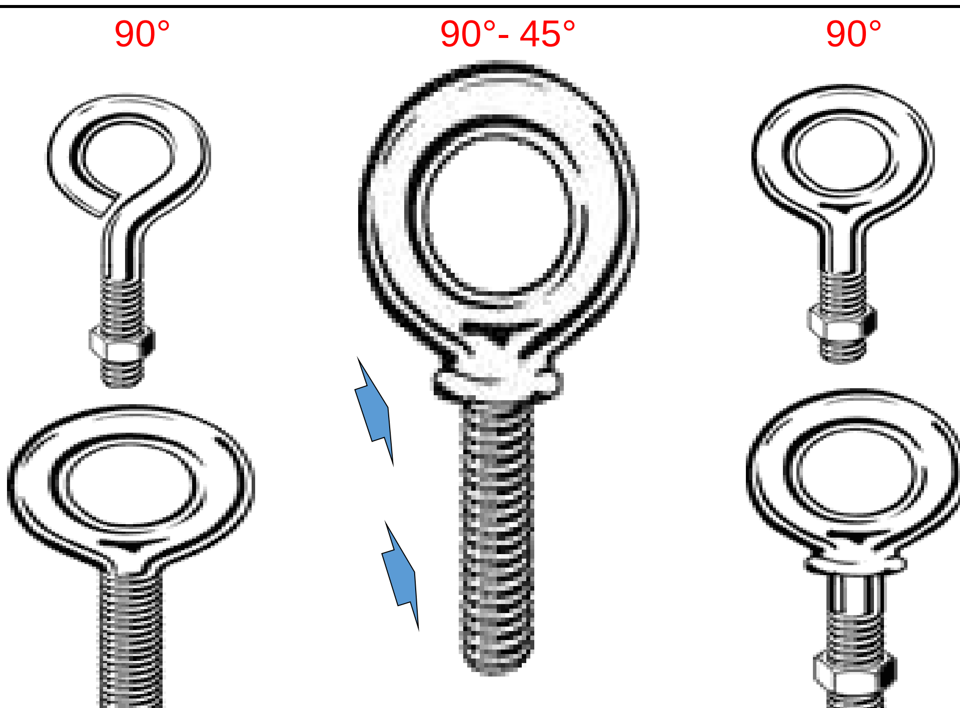
Drop forged machinery eye bolts. Machinery eyes are fully threaded. Machinery eye bolts without a shoulder should not be used for angular loads.

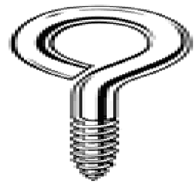


Drop forged eye bolts with a shoulder. Forged eye bolts are significantly stronger than wire eyes and are available in larger sizes. These bolts should not be used for angular loads

Note: Each eye is supplied with one nut.

Drop forged machinery eye bolts with shoulder. Machinery shoulder eyes are fully threaded. These are the only eye bolts rated for an angular load.



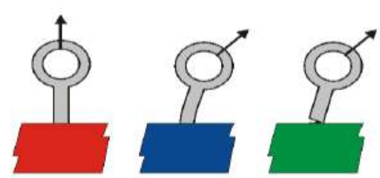


Wire eye lags (also referred to as screw thread eye bolts, eye screws, or turned/bent eye lags) have a wood screw thread for use in wood or lag anchors.

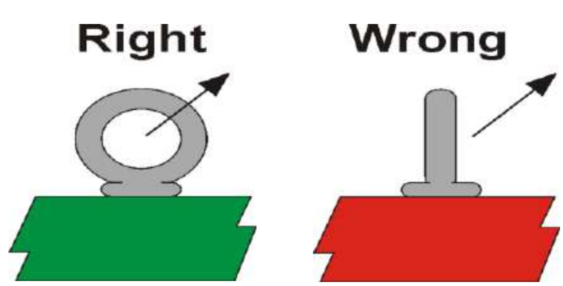
Like wire eye bolts, wire eye lags are intended for light duty applications and should not be used for angular loads.

Rigging Types
Eye Bolts

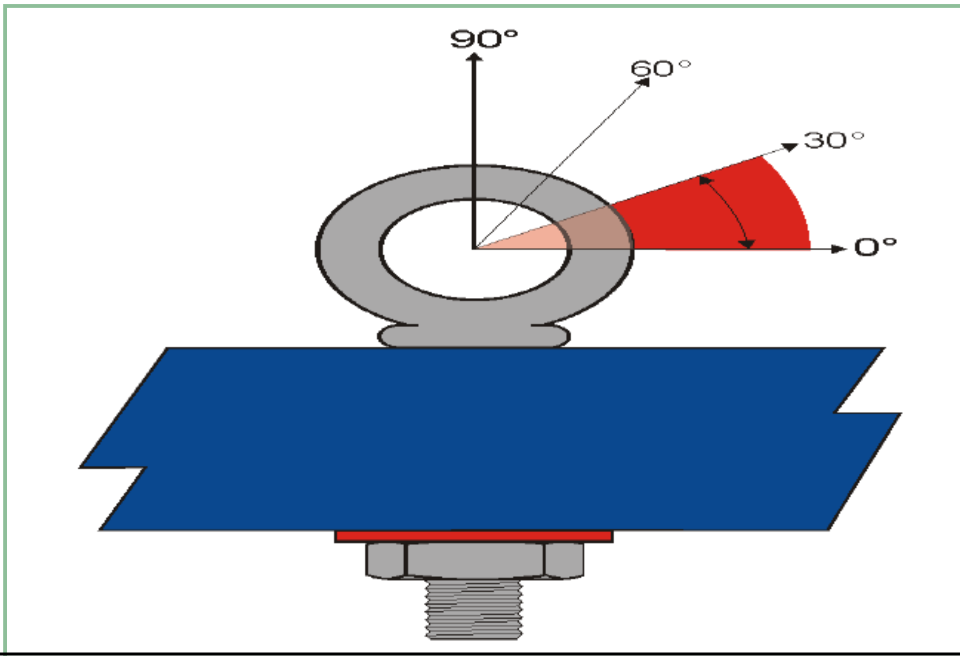
Non-shouldered eye bolts are only designed for vertical loads.

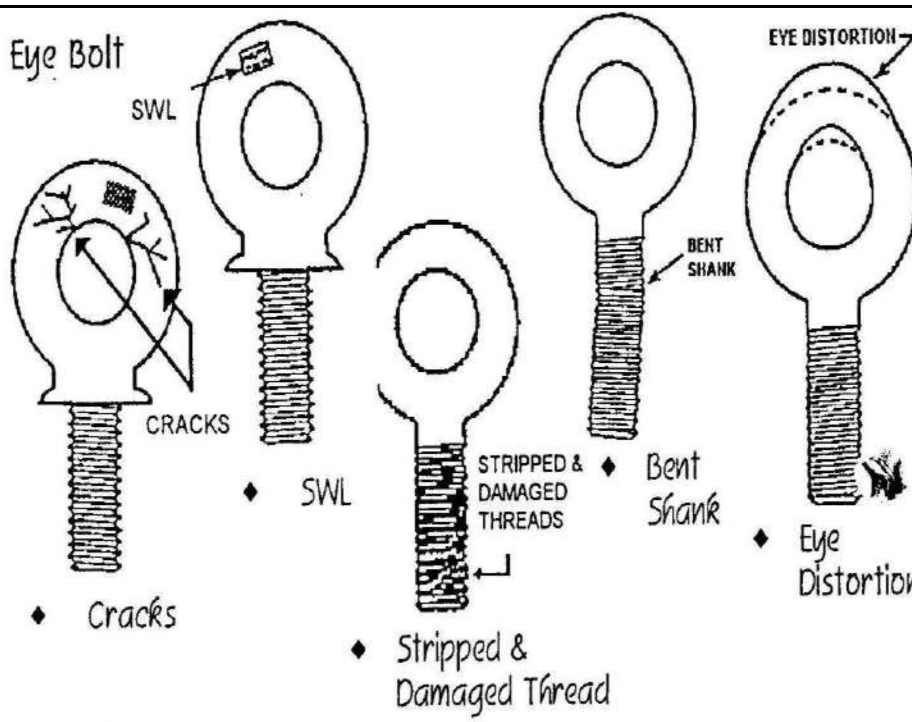


Angular loading must be in the plane of the eye

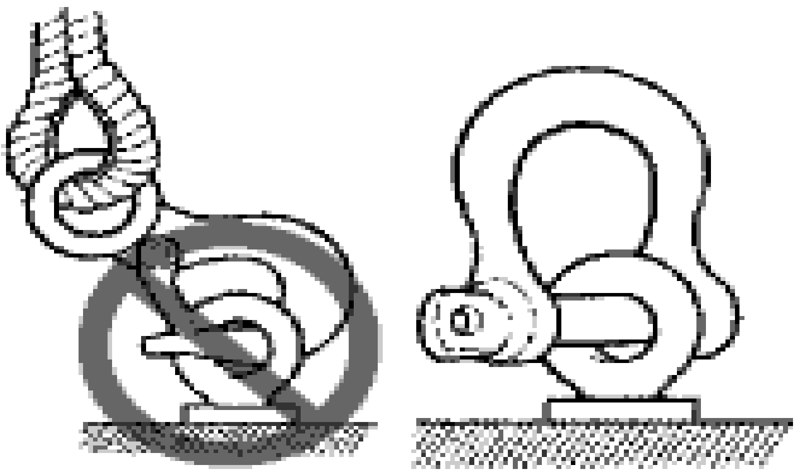


Eye Bolt Application

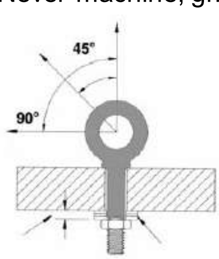


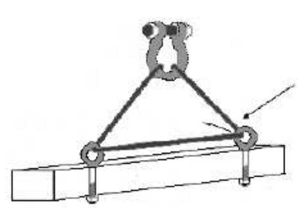


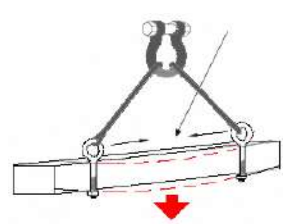
1. Do not use eye bolts that have worn threads or other flaws.
2. Do not insert the point of a hook in an eye bolt. Use a shackle.



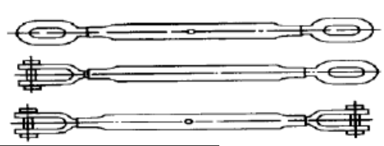
- Always use Shouldered Eye Bolts for angular lifts.
- For angular lifts, reduce working load according to chart.
- Never exceed load limits.
- Always screw eye bolt down completely for proper seating.
- Always tighten nuts securely against the load.
- Always stand clear of load when lifting.
- Always lift load with steady, even pull do not jerk.
- Do not reeve slings from one eye bolt to another.
- Never machine, grind or cut the eye bolt.





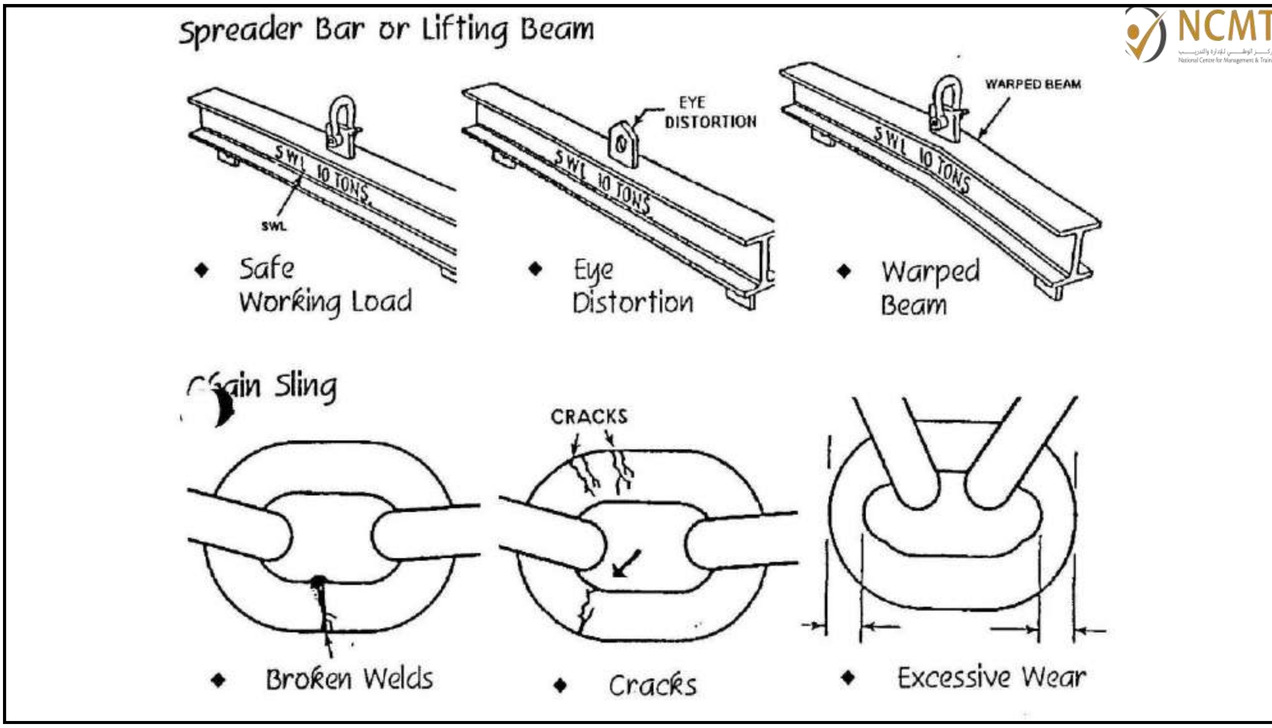


SWL OF TURNBUCKLES/ RIGGING SCREWS



BS 4429	
DIA (mm)	SWL
10	300KG
12	500KG
16	750KG
20	1.25t
22	2.0t
27	3.0t
30	4.0t
33	5.0t
39	6.0t
42	7.5t
48	10.0t
56	15.0t
64	20.0t
72	25.0t
76	30.0t
85	40.0t
100	50.0t

U.S. FED. SPEC	
DIA (ins)	WLL
3/8	545KG
1/2	1.00t
5/8	1.59t
3/4	2.36t
7/8	3.27t
1	4.55t
1 1/4	6.90t
1 1/2	9.73t
1 3/4	12.13t
2	16.82t
2 1/2	27.27t
2 3/4	34.09t


Spreader Bar or Lifting Beam
SWL 10 TONS
SWL
EYE DISTORTION
WARPED BEAM
Safe Working Load
Eye Distortion
Warped Beam
Chain Sling
CRACKS
Broken Welds
Cracks
Excessive Wear

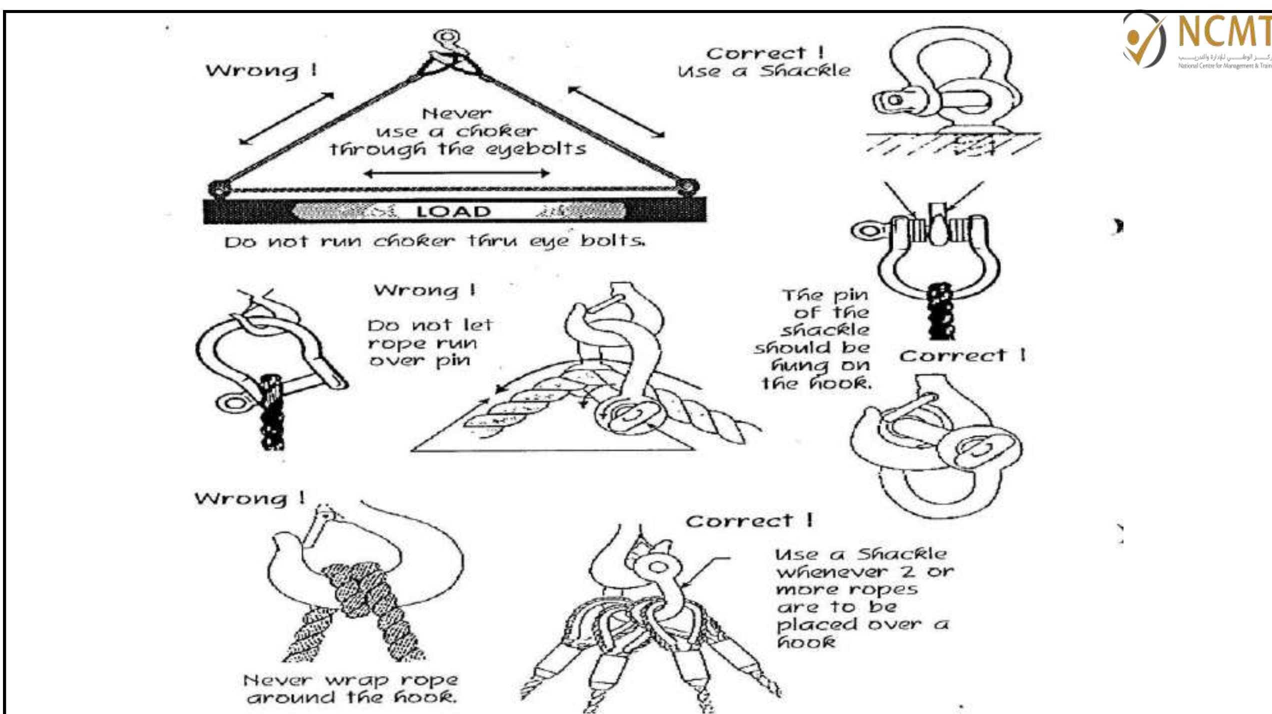

Wrong !
Never use a choker through the eyebolts
LOAD
Do not run choker thru eye bolts.
Correct ! Use a Shackle
Wrong !
Do not let rope run over pin
The pin of the shackle should be hung on the hook.
Correct !
Wrong !
Never wrap rope around the hook.
Correct !
Use a Shackle whenever 2 or more ropes are to be placed over a hook

Plate Clamps

Horizontal clamps

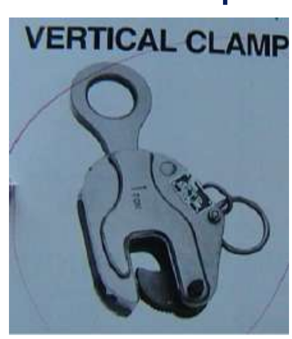
- **Uses**
- **Hazards**
  - **Incorrect clamp for task**
  - **Overloads**
  - **Personal Injury**
  - **Faulty Equipment**
  - **Load(s) Falling**

Only for lifting plate horizontally

Plate Clamps

- **Uses**
- **Hazards**
  - **Incorrect clamp for task.**
  - **Overloads**
  - **Faulty Equipment**
  - **Loads Falling**
  - **Personal Injury**

Vertical clamp



Handling Steel Plate

Steel plate can be lifted with:

Plate clamps that are designed to increase the pressure on the plate as the plate is lifted.

Hooks or shackles where there are lifting holes in the plate.

Do not use home made type plate clamps or plate dogs.

Use a spreader beam if the angle between the legs of a sling is likely to be more than 60'

Steel plate can be lifted vertically or horizontally.

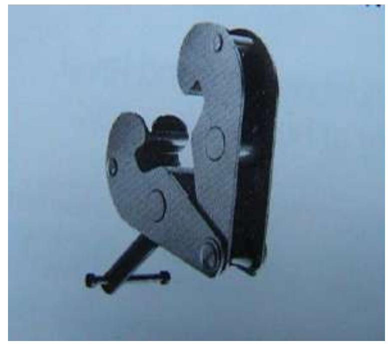
Inspection of Alligator Clamps

1) Wear pads.
2) Jaw locking mechanism whether spring action, or pull chain must be functional.
3) Pins on the alligator.
4) Attachment ring.
5) Quick-alloys.

Remove alligators from service if the teeth are worn even with wear indicator teeth!

Girder Clamp / Beam Clamp

- Uses
- Hazards
  - Side loading
  - Not secured correctly
  - Damaged Equipment
  - Exceeding S.W.L
  - Anchorage incapable of withstanding load
  - Loads Falling
  - Personal Injury



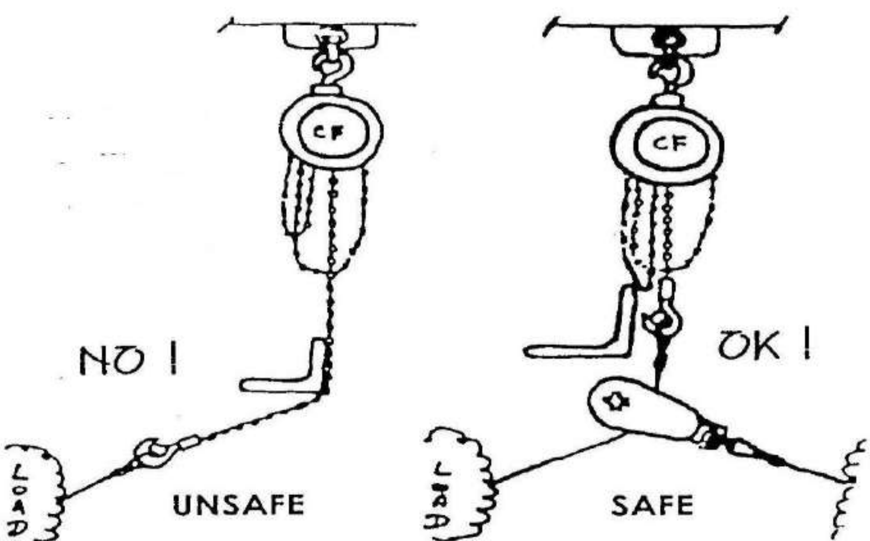
Lever Hoist / Come-a-long

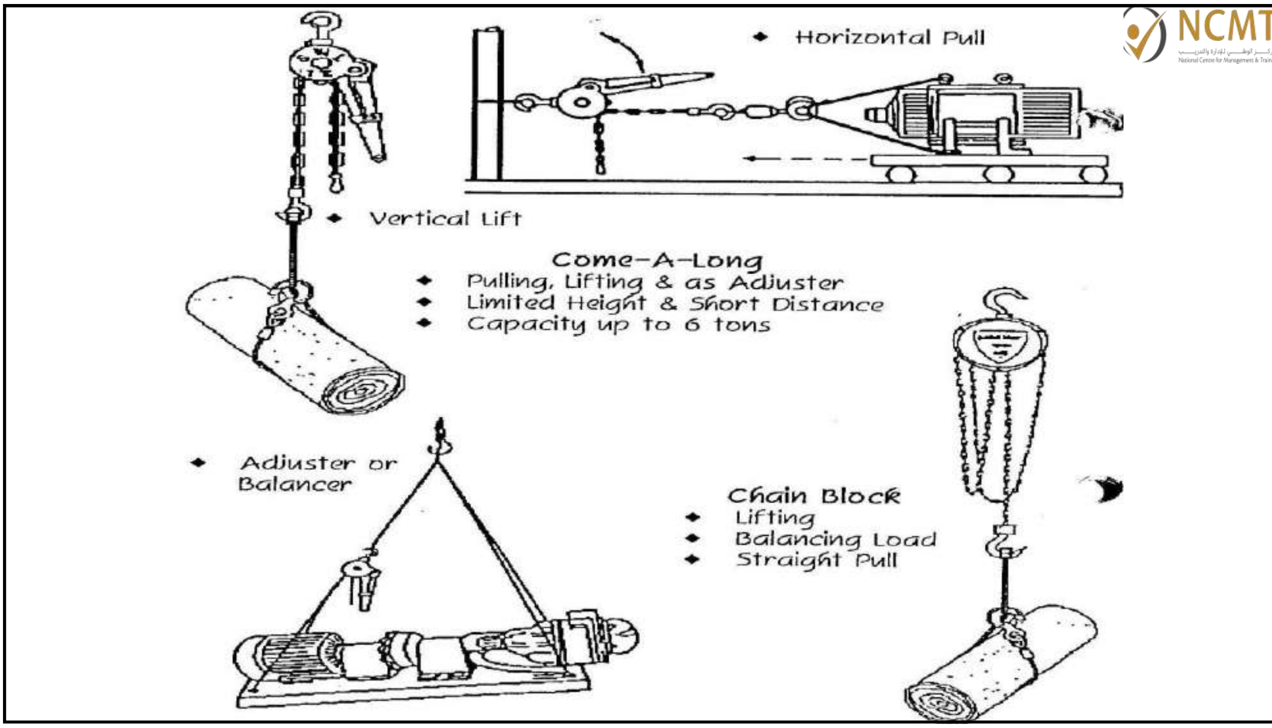
- Uses
- Hazards
  - Exceeding S.W.L
  - Damaged Equipment
  - Incorrect attachment(s)
  - Loads Falling
  - Personal injury

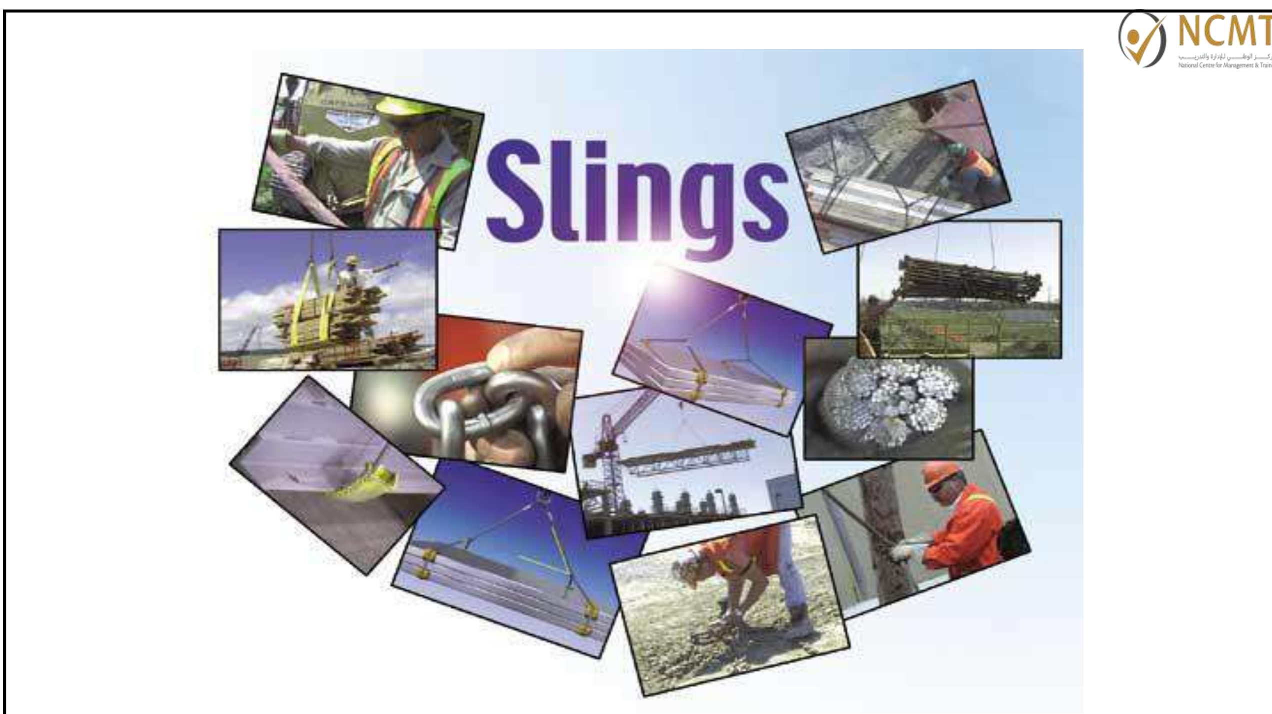
Chain Blocks

- **Uses**
- **Hazards**
  - **Exceeding S.W.L**
  - **Faulty Equipment**
  - **Incorrect attachment(s)**
  - **Loads Falling**
  - **Personal Injury**

Chain Block



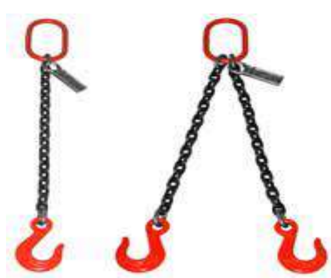

Horizontal Pull
Vertical Lift
Come-A-Long
Pulling, Lifting & as Adjuster
Limited Height & Short Distance
Capacity up to 6 tons
Adjuster or
Balancer
Chain Block
Lifting
Balancing Load
Straight Pull
NCMT


NCMT
Slings

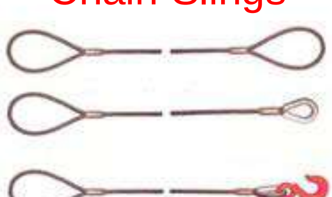
Sling Components

- Hooks
- Coupling Links
- Fittings
- Sling Legs
- Can be assembled at the job site but must use recommended components and assembly procedures
  - May also require some sort of weight test

Three Types of Slings



Chain Slings



Wire Rope Slings

Synthetic Web Slings

Chain
- Wear resistant, best durability.
- Flexible.
- A wide range of components to choose from.
- Heat resistant.
- Shortening possibility
-easy to store

Steel wire rope

- Lighter and often less expensive than chain.
- Usually hot-dip galvanised for best rust protection.
-Suitable for extremely heavy loads.

Soft lifting slings
Simple and inexpensive.
- Suitable for fragile goods.
- Flexible, suitable for choke-hitching load.
- Easy identification of max. Load by colour.
- easy to store

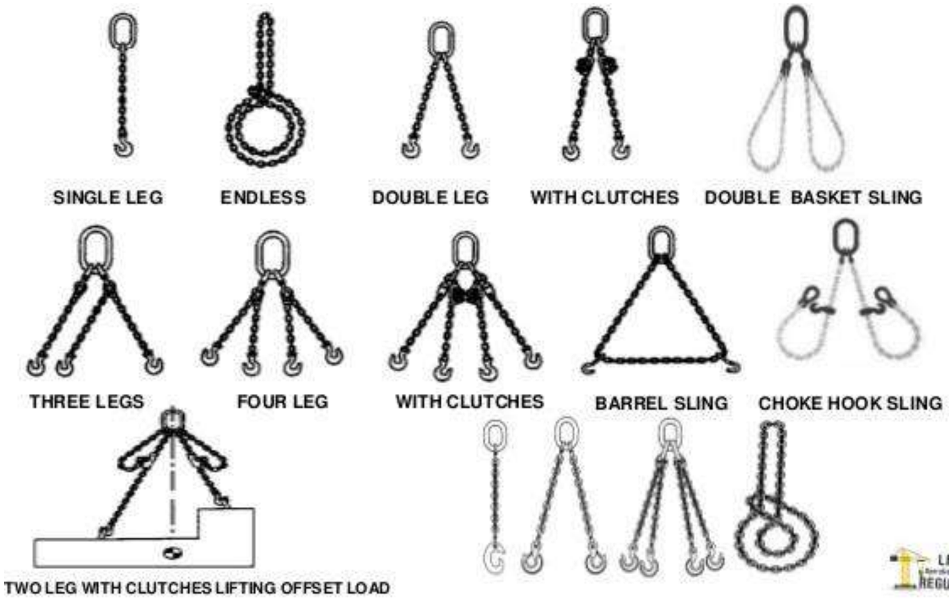
Sling Inspection

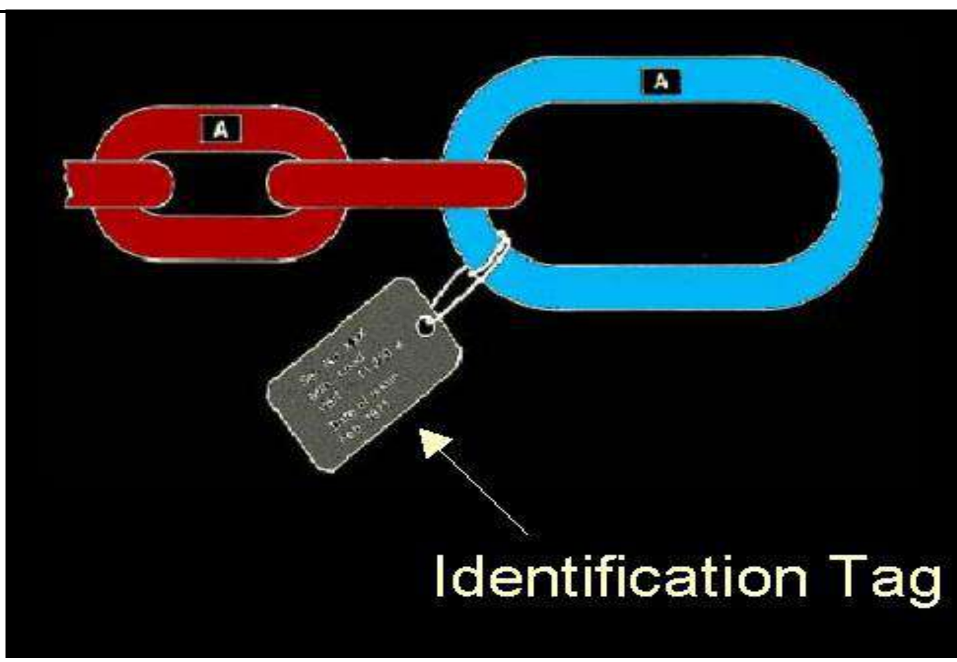
- **Each day before use**
- **Where service conditions**

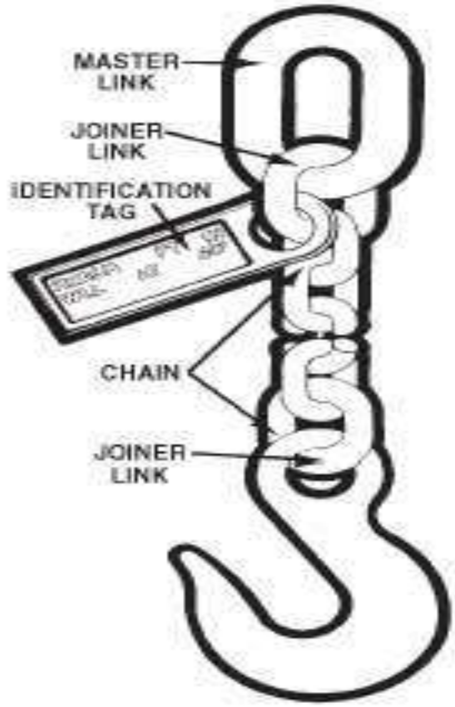
Alloy Steel Chains

- Adapts to shape of the load
- Can damage by sudden shocks
- Best choice for hoisting very hot materials
- When one link in a chain fails, the load will come down.
- Must have an affixed tag stating size, grade, rated capacity, and sling

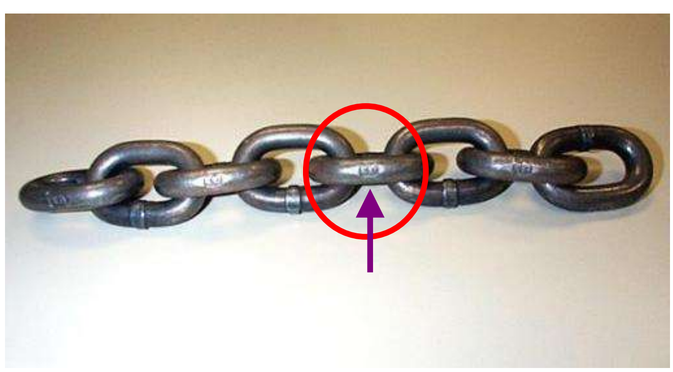
Chain configuration







Markings
Alloy Steel Chain



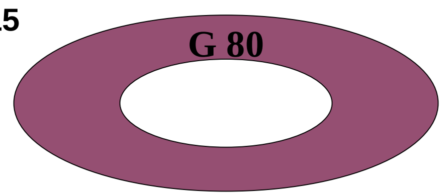
Hoist Chains

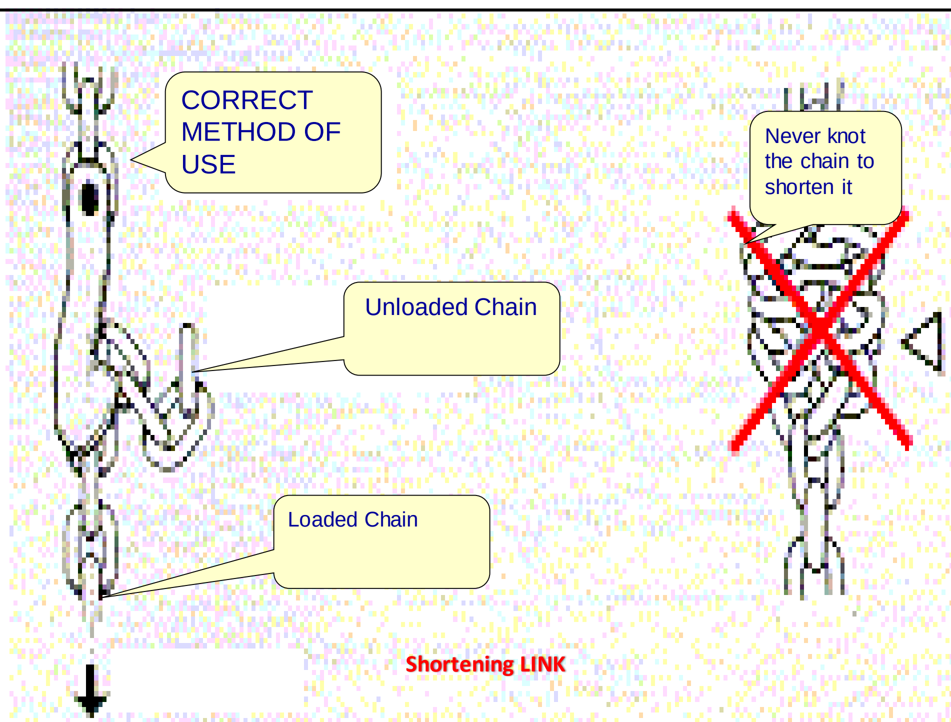
- Four grades:
  - Grade 28 General Utility Chain
  - Grade 43 High Test Chain
  - Grade 70 Binding Chain
  - Grade 80 Alloy Steel Chain: The only one used for overhead lifting!

- Ranges in size from 7/32 to 11/4 link diameter.
- Check for wear, gouges, stretch, shearing
- Inspection is LINK by LINK
- Twisted link extremely unsafe
- Use with grab hooks
- Tags: should be on every chain: Size, Grade, Capacity

Hoist Chains

- Hoist load chains do not stretch (they wear)
- Sling chains chain stretch 10 - 15 % before failure
- Grades are indicated on side of link




CORRECT METHOD OF USE
Unloaded Chain
Loaded Chain
Shortening LINK
Never knot the chain to shorten it

Pre-use inspection

Lifting gear---chain slings

- **All chain slings shall be subjected to a semi-annually inspection by a authorized third party.**

- **Chain slings shall be pre-use checked including:**
  ---SWL
  ---stretch or deformation
  ---wear between chain links and load pin
  ---heat damage or chemical effect
  ---safety catches

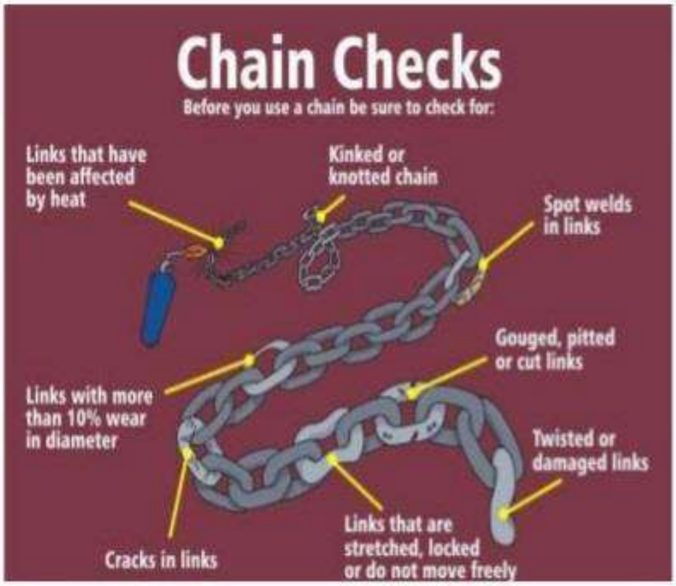
Inspection of Chain

- **Must be visually inspected prior to use.**

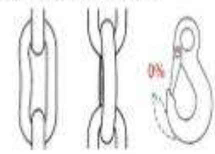
- **Pay special attention to any stretching (any elongation from the original length)**

- **The diameter of the worn chain link should be measured at the point of the greatest wear and compare with minimum allowable diameters in tables.**

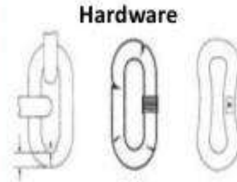
Inspection of Chain



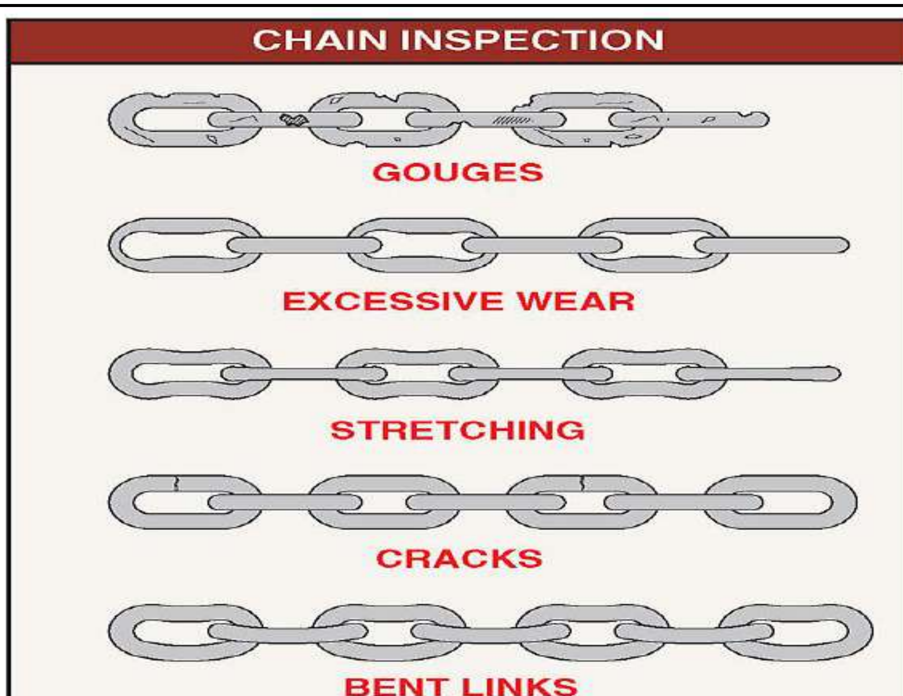
Look for streched, gouged, bent or worn links and componets, including hooks, with open throats, cracks or distorsion. If damaged, remove from service.



Twisted Links, Deformed Hardware



Wear Nicks, Cracks Stretch

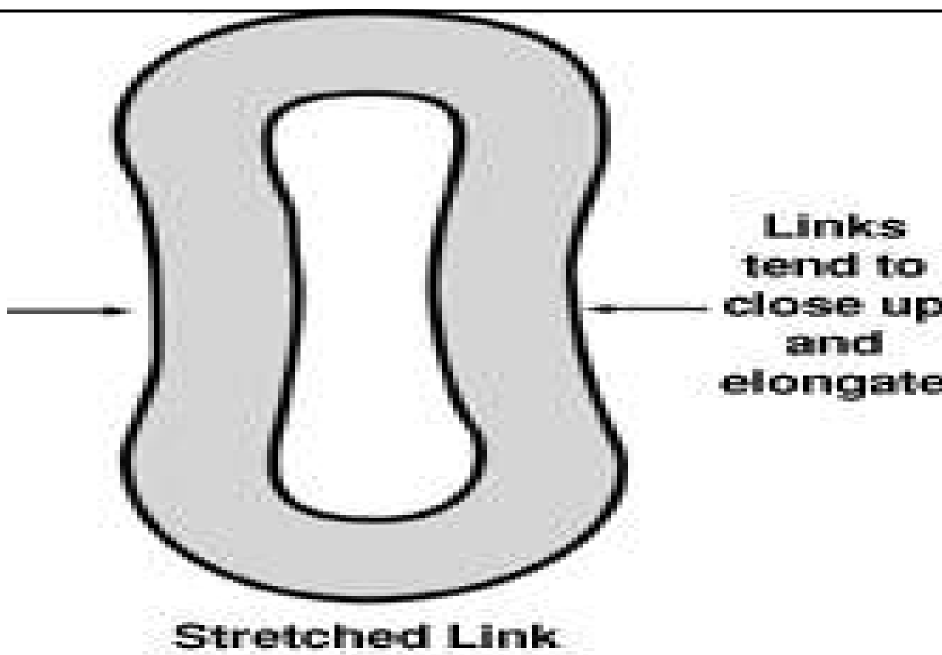


- Chains must only be repaired under qualified supervision.
- Repaired chains must be proof load tested before returning to service.
- Tests must be performed by mfg. or accredited agency.
- Test certificates must be available.

- Chains must be removed from service when maximum allowable wear is reached at any point of link.
  - As indicated in Table

Chain Sling Wear Chart

Chain Size (inches)	Minimum Allowable Chain Size (Inches)	Chain Size (inches)	Minimum Allowable Chain Size (Inches)
¼	15/64	1	13/16
3/8	19/64	1 1/8	29/32
½	25/64	1 ¼	1
5/8	31/64	1 3/8	1 3/32
¾	19/32	1 ½	1 3/16
7/8	45/64	1 ¾	1 13/32



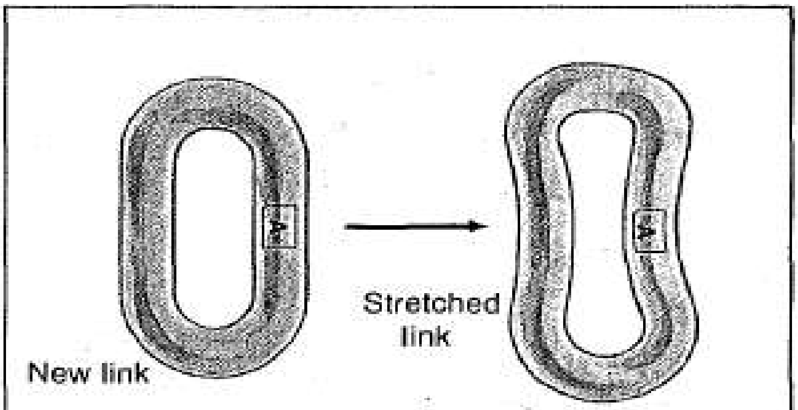
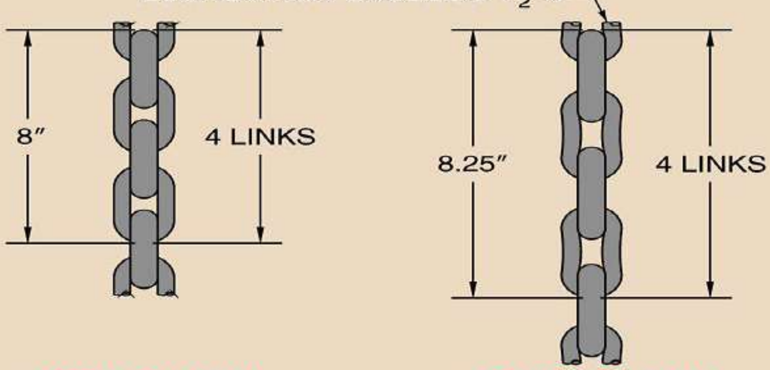


Figure 32

15

REMOVE FROM SERVICE IF
ELONGATION EXCEEDS $1\frac{1}{2}$%



NEW CHAIN **USED CHAIN**

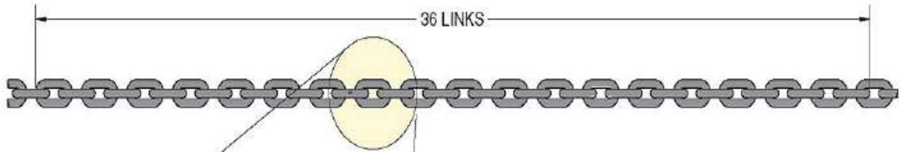
Four links of a new chain measure 8″. After use, four links measure 8.25″. Should chain be removed from service?

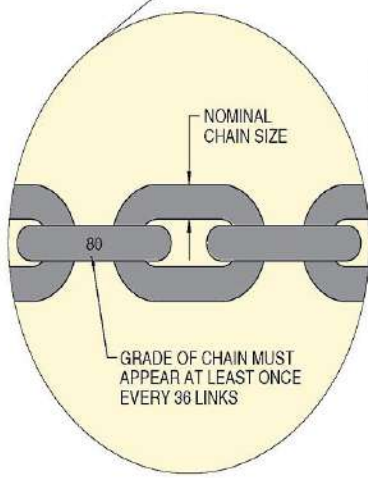
8″ x .015 = .12″

8″ + .12 = 8.12″

8.25″ > 8.12″

Yes, remove used chain from service.





CHAIN CLASSIFICATION

Diameter*	Grade	Working Load Limit†
$\frac{1}{2}$	43	9200
$\frac{1}{2}$	70	11,300
$\frac{1}{2}$	80	12,000

* in in.
† in lb

Columbus McKinnon Corporation Industrial Products Division

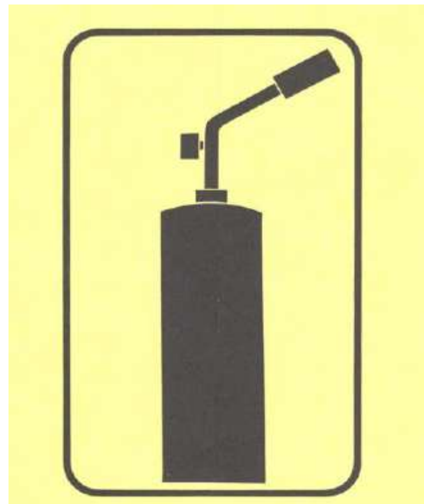
Chain Wear

When a chain shows excessive wear, or is cracked or pitted, remove it from service

Non-alloy repair links can not be used

- **Kinked or knotted chains must not be used for lifting.**
- **Chains must not be shortened by bolting, wiring or knotting.**

- Wrought iron chains in use must be annealed or normalized at least every six months.
- Heat treatment certificates must be available.
- Alloy chains must not be annealed.

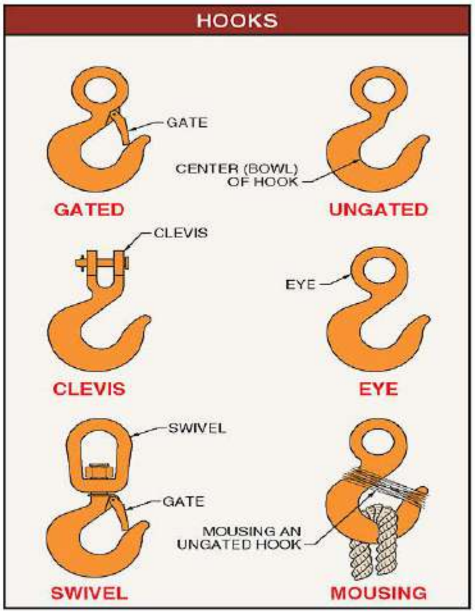


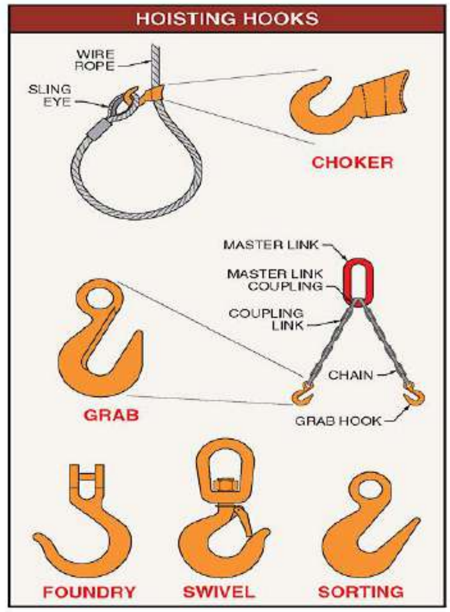
Alloy Steel Chain Attachments

Rated Capacity

Hooks, rings, oblong links, or other attachments, when used with alloy steel chains, must have a rated capacity at least equal to that of the chain

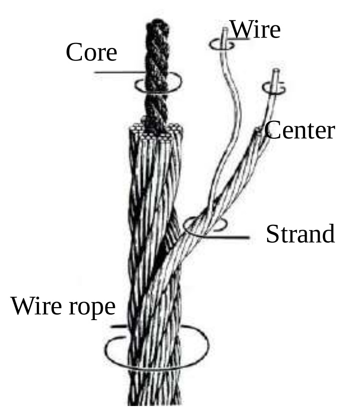
Types of Hooks for lifting





Wire Rope Slings

- Used to hoist materials
- Selection considerations:
  - strength
  - ability to bend without cracking
  - ability to withstand abrasive wear
  - ability to withstand abuse



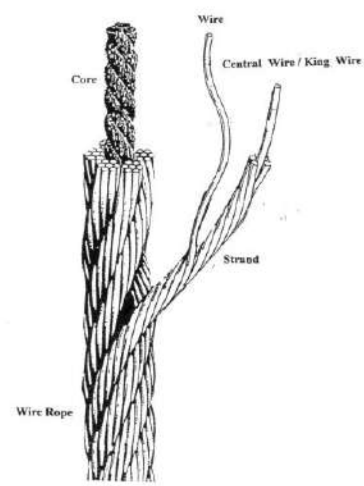
Wire Rope Construction

- There are three main things to observe when examining the construction:
  - (a) Number of wires in each strand
  - (b) Number of strands in the rope
  - (c) Direction in which wires and strands lay (spiral) in the rope

- CORE
  The core of a wire rope can be
  - Fibre (FC),
  - Wire Steel (WSC),
  - or an Independent Wire Rope Core (IWRC)

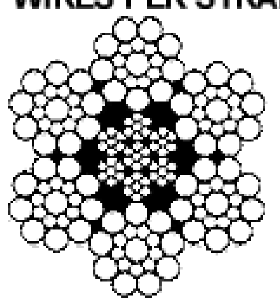
- STRANDS Depend on classification of Rope but usually consists of Wires spiralling around a Central Core Wire

COMPONENTS OF A WIRE ROPE



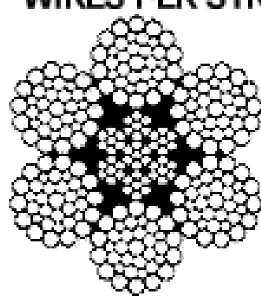
Wire Rope Construction

BENEFIT OF FEWER OUTSIDE WIRES PER STRAND



ABRASION RESISTANCE
Increases with larger wires
Dearea ses with smaller wires

BENEFIT OF MORE OUTSIDE WIRES PER STRAND



FATIGUE RESISTANCE
Decreases with larger wires
Increases with smaller wires

Wire Rope Cores

Fiber IWRC Strand

WIRE ROPE

- Shall be capable of supporting without failure at least 6 times the maximum intended load applied or transmitted to the rope
- Larger outer wire provide greater resistance to abrasion and crushing.
- Rate at which a wire rope weakens depends on where and how often it is used, how it is cared for, condition of hoist.
- Regular inspection is needed to determine whether the wire rope has enough life left to support until the next inspection

WIRE ROPE

- Do not expose steel wire rope to excessive heat or cold.
- Rope with fibre core: max. 100ºC.
- Rope with steel core and aluminium ferrule: max. 150ºC.
- Rope with steel core and steel ferrule/or hand spliced:

  max. 150ºC = 100%,

  max. 200ºC = 90% of WLL,

  max. 400ºC = 60% of WLL.
- Do not use at temperatures below –40ºC without consulting the manufacturer

STEEL WIRE ROPE

The most common designs of steel wire rope used in lifting equipment are: **114-wire rope (6 x 19)** with a fibre core (diameter: approx. **3 to 8** mm)

216-wire rope (6 x 36) with a fibre core (diameter: approx. **6 to 60** mm)

133-wire rope (7 x 19)with a steel core, intended for hot environments.

265-wire rope (6 x 36) with a steel core, intended for hot environments.

144-wire rope (6 x 24) for use in shipping and disposable slings.

The nominal breaking strain of individual wires in ropes must be **1770 N/mm2.** The minimum wire fill-factor of ropes must be 0.40.

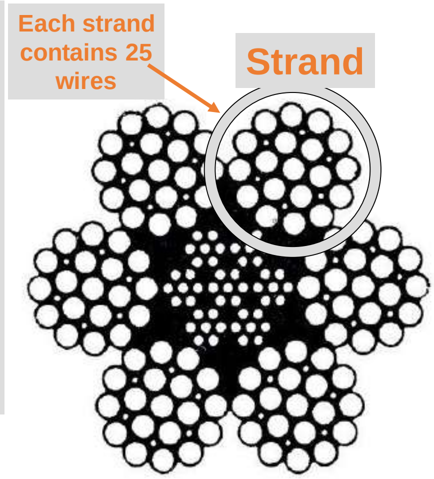
How to describe any wire rope

A typical wire rope may be designated 6X25 FW PRF RLL XIP IWRC. This translates to:

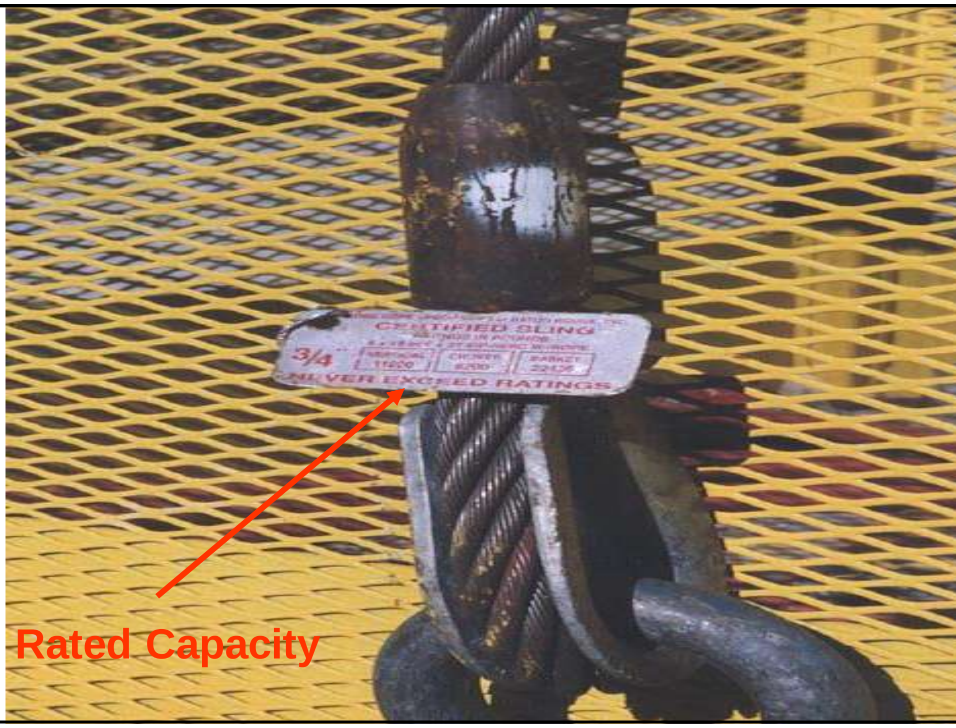
A 6 strand (6X25) of filler wire construction (FW).

The grade of wire used is Extra Improved Plow Steel (XIP).

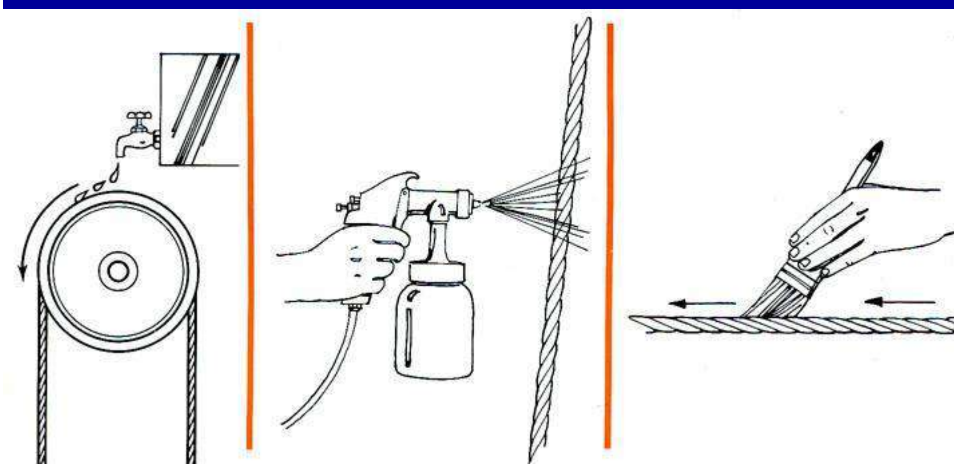
The strands are preformed (PRF) in helical pattern before being laid Right lang (RLL) around an Independent Wire Rope Core (IWRC).



Rope Dia mm	7 x 7 Wire Strand Core 1570 Grade	6 x 19 Fibre Core 1570 Grade	7 x 19 Wire Strand Core 2070 Grade	6 x 24 Fibre Core 1570 Grade	Rope Dia mm	6 x 36 Wire Strand Core 1770 Grade
1.5	140					
2	234				32	65820
2.5	376					
3	530		700		36	83250
3.5		570			40	102910
4	930	780	1140		44	124310
5	1450	1220	1770		48	147750
6	2100	1790	2590	1610	52	174240
7		2380	3460		56	201760
8	3670	3140	6x19 I.W.R.C. 4790	2870	60	231310
9		3980		3620	64	241000
10	5720	4910		4480	70	285000
11			6x25 I.W.R.C. 9600	5420	76	336000
12	8250	7080		6450		
13				7570		
14		9630		8780		
16		12630	6x25 I.W.R.C. 19180	11510		
18				14570		
20				17930		
22				21700		
24	33010			25780		
26				30260		
28	45040			35150		
32				45850		



Lubrication



Wire Rope Slings

Lifting gear---<u>Wire rope slings</u> (safety factor: 3-5)

All wire ropes shall be subjected to a semi-annually inspection by a authorized **<u>third party</u>**.

Minimum information marked (stamp/tag) shall include: “SWL”, “Sling Number” and “manufacture date”

Wire rope slings shall be inspected before and after each use according to the list below: --self-inspection
---broken wire
---distortion of the rope (kinking)
---excessive wear
---heat damage
---distortion of ferrules, splicing or fittings, etc.

Wire rope sling having any of the above mentioned characteristics shall be immediately removed from service and destroyed.

General Requirements

✓Slings used in a basket hitch must have the loads balanced to prevent slippage.

✓Slings must be securely attached to their loads.

General Requirements

✓Slings must be padded or protected from the sharp edges of their loads.

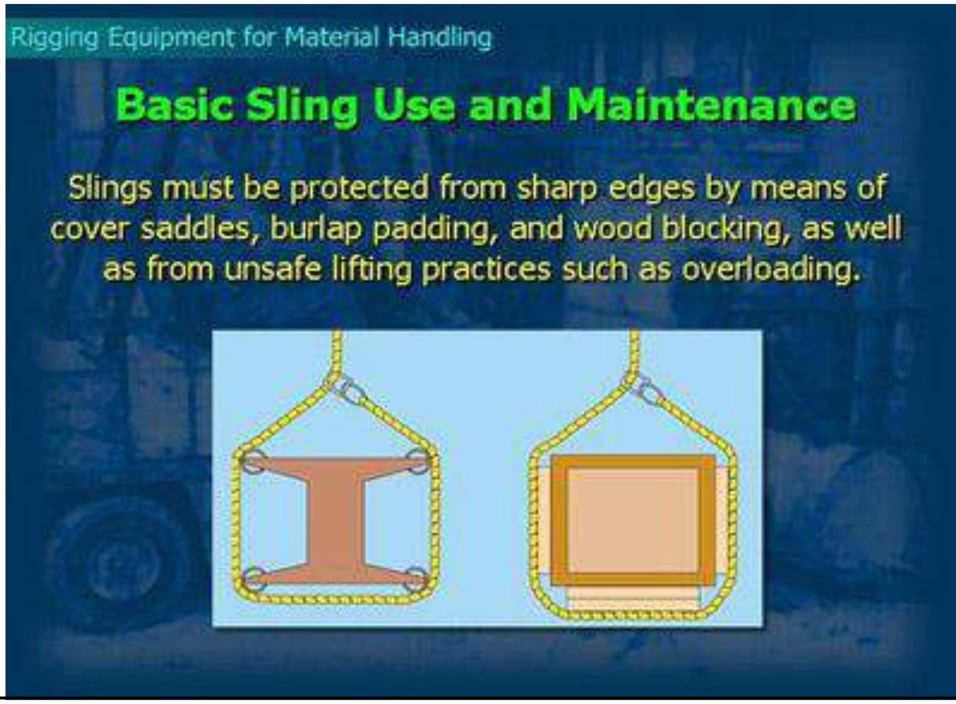
✓Suspended loads must be kept clear of all obstructions.

General Requirements

- ✓All employees must keep clear of loads to be lifted and suspended loads.
- ✓Hands or fingers must not be placed between the sling and its load while the sling is being tightened.

Inspections

- ✓Each day before use, the sling, all fastenings and attachments must be inspected by a competent person
- ✓Additional inspections performed during use, where conditions warrant
- ✓Damaged slings must be removed from service



Wire Rope Slings

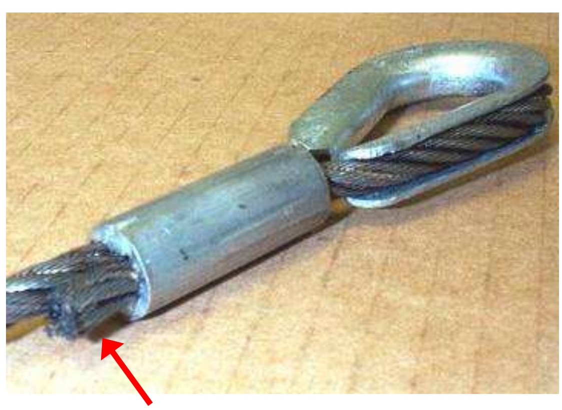
Eye Splices

- Eye splices made in any wire rope
- must have at least three full tucks

Rigging equipment for material handling

Mechanical Splice

Protruding Ends

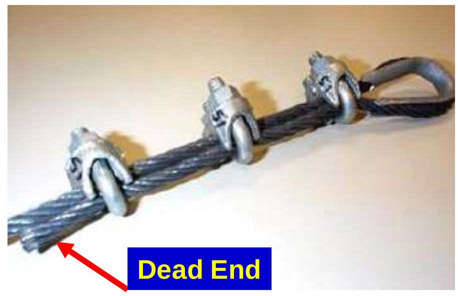



22 14:41


Wire Rope Clips

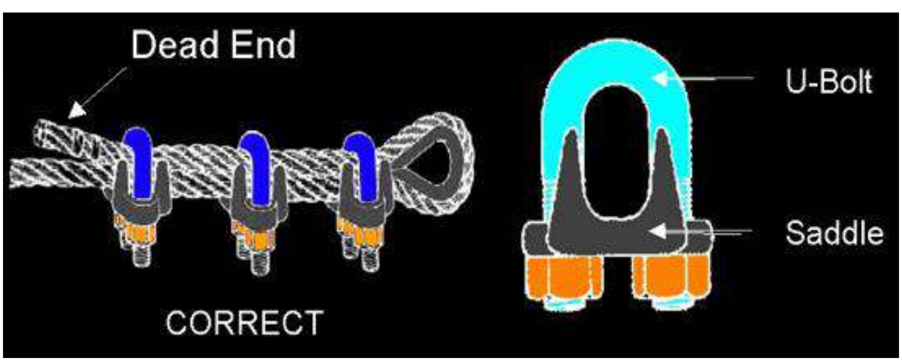
Wire Rope Clips

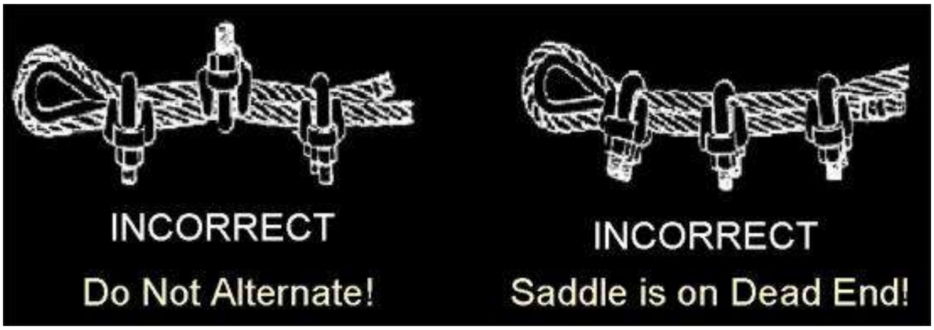
When using U-bolt wire rope clips to form eyes, ensure the "U" section is in contact with the dead end of the rope



This is the correct method

U must always in shorter side

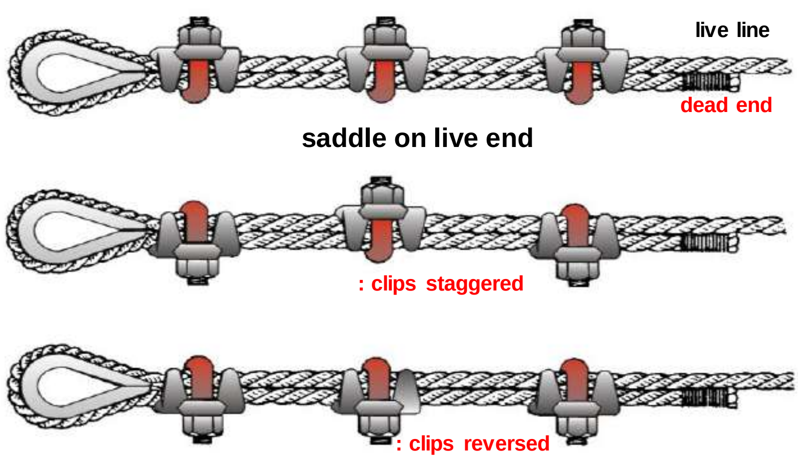


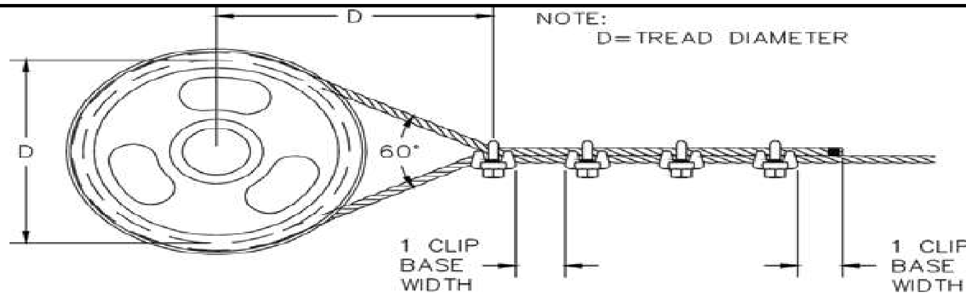


WIRE ROPE

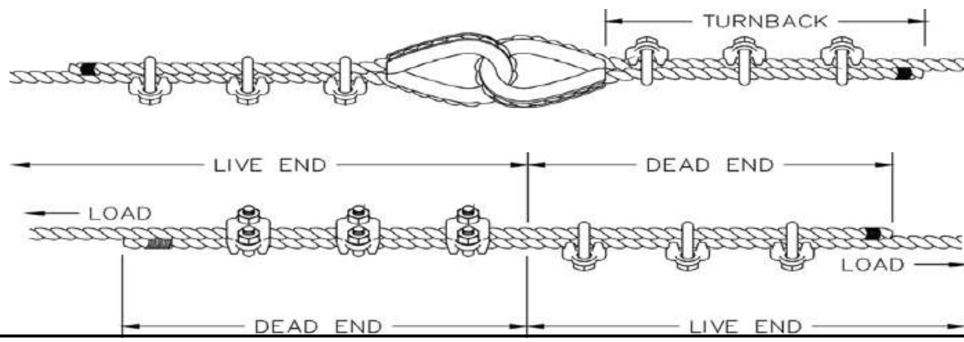
Clips

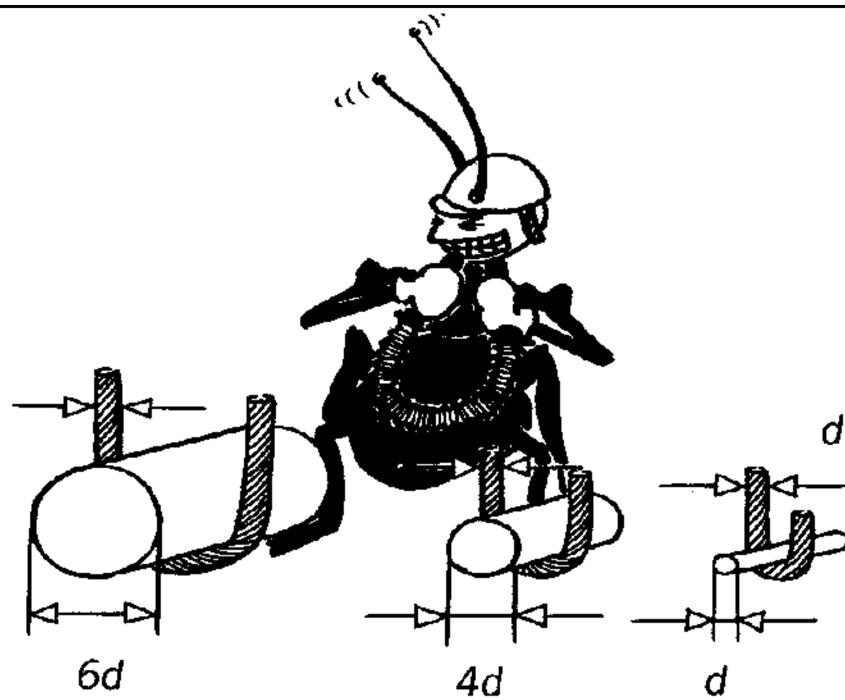
Never saddle a dead horse





4. **If a pulley (sheave)** is used in place of a thimble, add one additional clip. Clip spacing should be as shown.





The strength of steel wire rope is reduced by bending. The derating is related to the diameter of the bend as follows
(d = diameter of the steel rope)

6d = 100%
5d = 85%
4d = 80%
3d = 70%
2d = 65%
1d = 50%

Mirdif Security & Safety Consultants
Quality & Standardization Consultants
Vocational Training Services

مردف لاستشارات الأمن والسلامة
واستشارات الجودة والمعايير والتقييم
خدمات التدريب الفني

Table 1

Rope Diameter (mm)	Number of Clips	Min. Spacing (mm)	Tightening Torque Newton/meter
5 mm	3	30 mm	2
6.5 mm	3	39 mm	3.5
8 mm	4	48 mm	6
10 mm	4	60 mm	9
13 mm	4	78 mm	33
16 mm	4	96 mm	49
19 mm	4	114 mm	68
22 mm	5	132 mm	107
26 mm	5	156 mm	147
30 mm	6	180 mm	212
34 mm	6	204 mm	296
40 mm	6	240 mm	363

Clip size	Rope size	Minimum No. of clips	Amount of Rope to TURN BACK in inches	* Torque in Ft.Lbs.
1/8	1/8	2	3-3/4	7.5
1/4	1/4	2	4-3/4	15
5/16	5/16	2	5-1/4	30
3/8	3/8	2	6-1/2	45
7/16	7/16	2	7	65
1/2	9/16	3	12	95
5/8	5/8	3	12	95
3/4	3/4	4	18	130
7/8	7/8	4	19	225
1	1	5	26	225
1-1/8	1-1/8	6	34	225
1-1/4	1-1/4	7	44	360

Clip size	Rope size	Minimum No. of clips	Amount of Rope to Turn Back in inches	* Torque in Ft.Lbs.
1-3/8	1-3/8	7	44	360
1-1/2	1-1/2	8	54	360
1-5/8	1-5/8	8	58	430
1-3/4	1-3/4	8	61	590
2	2	8	71	750
2-1/4	2-1/4	8	73	750
2-1/2	2-1/2	9	84	750
2-3/4	2-3/4	10	100	750
3	3	10	106	1200
3-1/2	3-1/2	12	149	1200

If a pulley (sheave) is used for turning back the wire rope, add one additional clip.

Rope diameter	Required number of wire rope grips	Tightening torque required
19 mm	4	68 n/m
22 mm	5	107 n/m
26 mm	5	147 n/m
30 mm	6	212 n/m
34 mm	6	296 n/m
40 mm	6	363 n/m

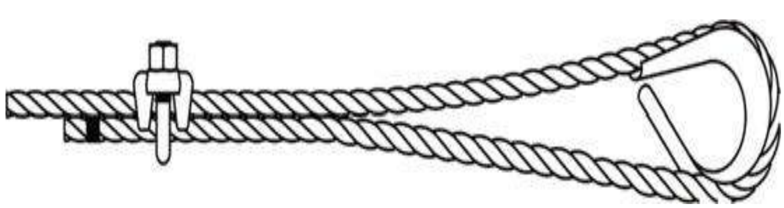
Safe Working Load= d^2x8

1.Turn back specified amount of rope from thimble or loop.

Apply first clip one base width from dead end of rope.

Apply U-Bolt over dead end of wire rope – live end rests in saddle (Never saddle a dead horse!).

Use torque wrench to tighten evenly, alternate from one nut to the other until reaching the recommended torque.



2. When two clips are required, apply the second clip as near the loop or thimble as possible.

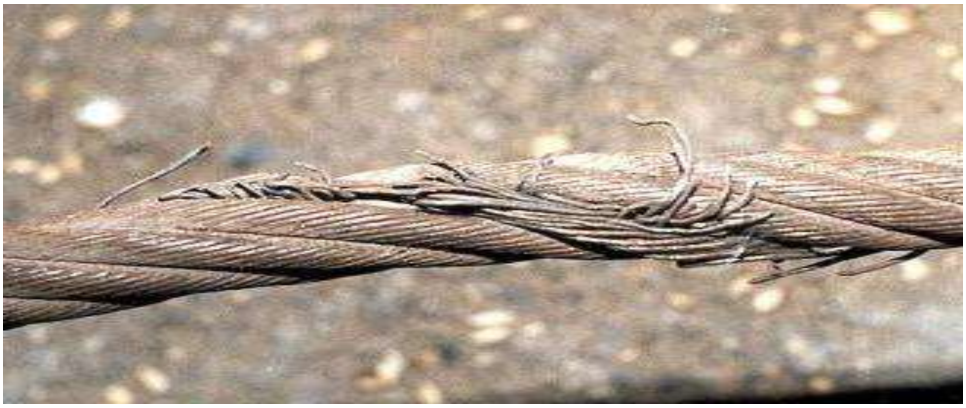
Use torque wrench to tighten evenly, alternating until reaching the recommended torque.

When more than two clips are required, apply the second clip as near the loop or thimble as possible, turn nuts on second clip firmly, but do not tighten.

3. When three or more clips are required, space additional clips equally between first two - take up rope slack - use torque wrench to tighten on each U-Bolt evenly, alternating from one nut to the other until reaching recommended torque.

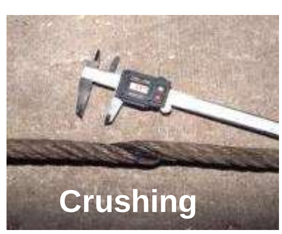
- **Eyes in wire rope bridles, slings, bull wires, or in single parts used for hoisting must not be formed by wire rope clips or knots.**

Remove From Service



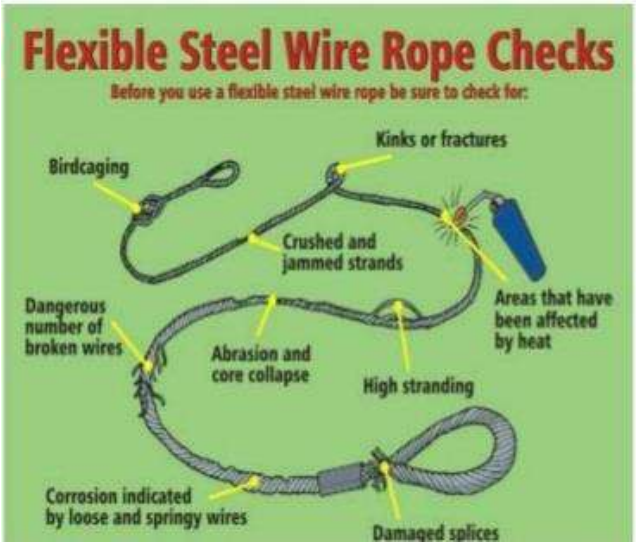
Wire Rope Slings
Remove From Service

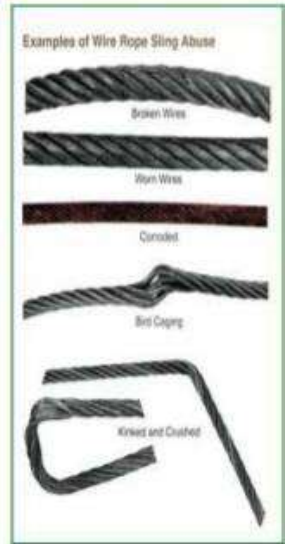
Bird Caging



Crushing

Wire Rope Slings
Remove From Service



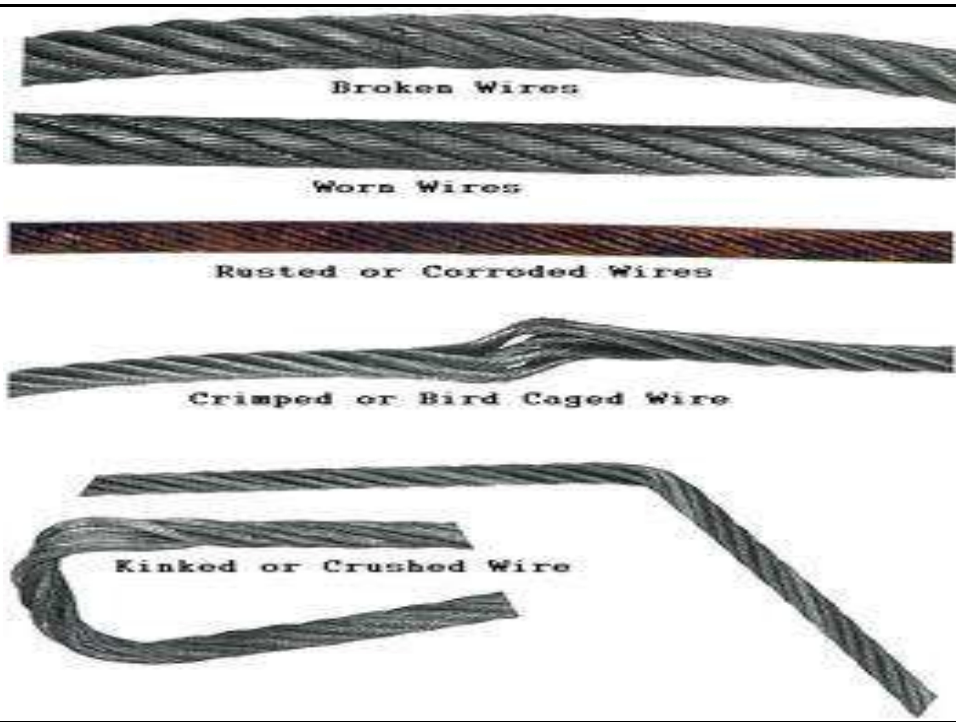


WIRE ROPE REJECTION CRITERIA

- **Consider which regulations apply to your work location and apply the relevant criteria as applicable.**
- **Recognise the removal criteria. - 9 points to consider**

(BRITISH STANDARDS)

1. **Number, nature, type and position of visible broken wires in a length equal to 10 times the rope diameter a maximum 5% of total number of wires in the rope.**
2. **Local groups of visible broken wires-a maximum of 3 in one or adjacent strand.**
3. **Deterioration in the vicinity of the termination or terminal damage any wire breaks within 6mm of the termination.**
4. **Core deterioration-abrupt loss in diameter.**
5. **Wear-Maximum reduction in diameter-10% from nominal diameter. (6&8 strand) (3%from nominal -Multistrand).**
6. **Internal corrosion - reject rope if internal corrosion is confirmed.**
7. **External corrosion - corrosion causes very high losses in rope breaking load. Reject rope if corrosion causes wire slackness.**
8. **Deformations.**
9. **Thermal damage.**



Wire Rope Slings

Remove From Service

ABRASION

KINKED

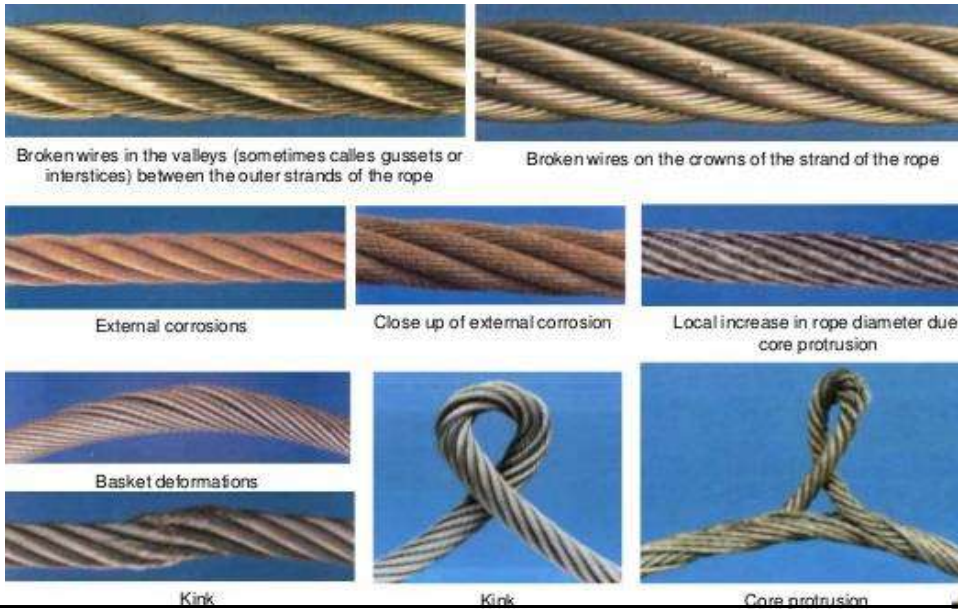
KINKED

BROKEN WIRES

BROKEN STRAND

CORRODED

Wire Rope Slings
Remove From Service

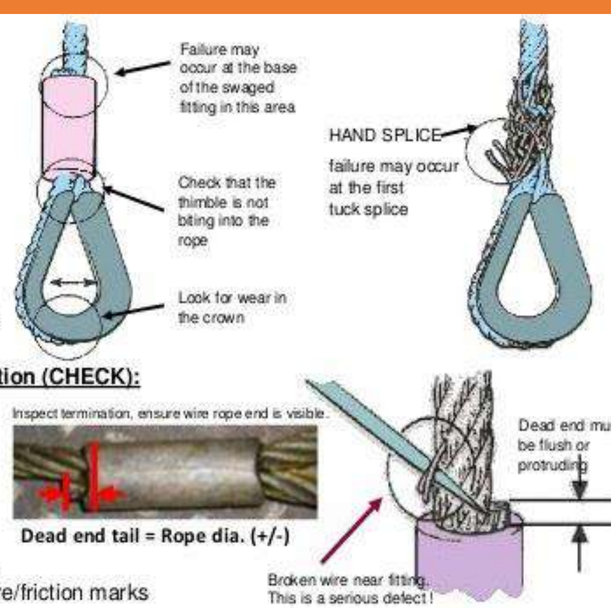


Termination Failure

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

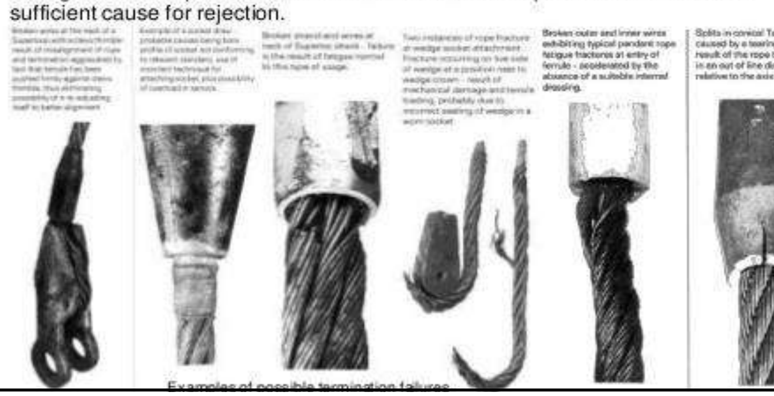
What to look for at a rope termination (CHECK):
- ✓ Wire breaks
- ✓ Corrosion
- ✓ Reduction in rope diameter
- ✓ Unusual rope movement
- ✓ Evidence of rope end
- ✓ Evidence of any incorrect fitting
- ✓ Evidence of any component wear
- ✓ Presence of any interwire pressure/friction marks
- ✓ State of internal lubrication

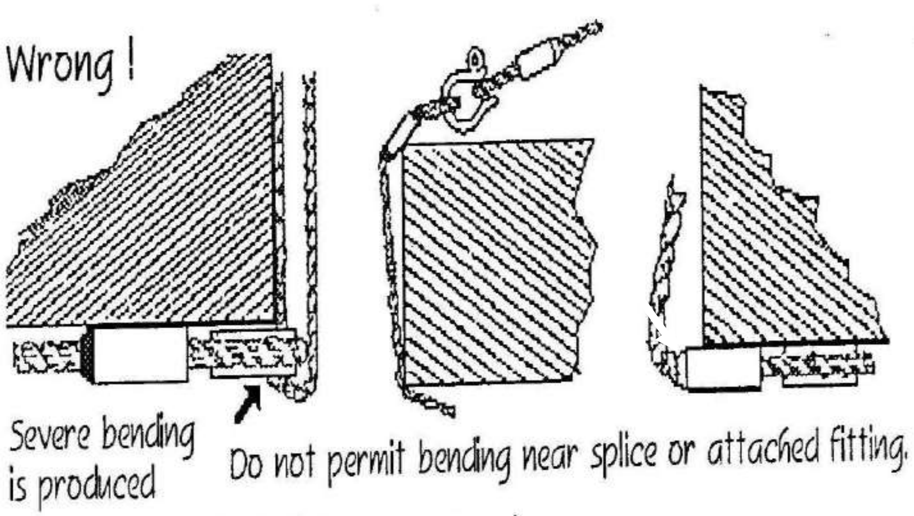


Termination Failure

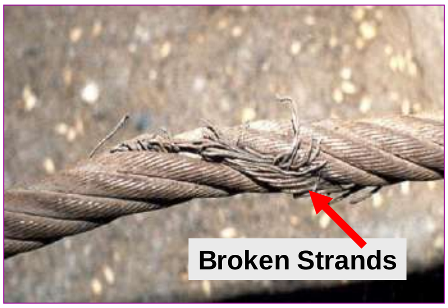
END TERMINATION DAMAGE

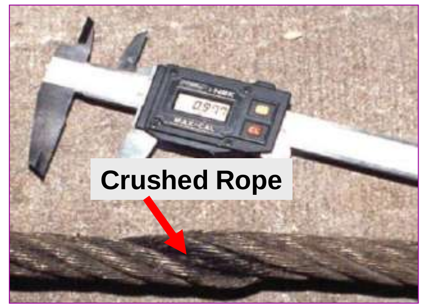
End termination's to some degree restrict the available movement of the wire rope at the attachment point.
This inevitably can cause the breakage of wires where the restriction is occurs.
Therefore it is important to ensure that a close inspection of the end termination is carried out prior to use.
A single broken wire within close proximity to the termination is generally enough cause to question continued use of the wire rope and more then one sufficient cause for rejection.





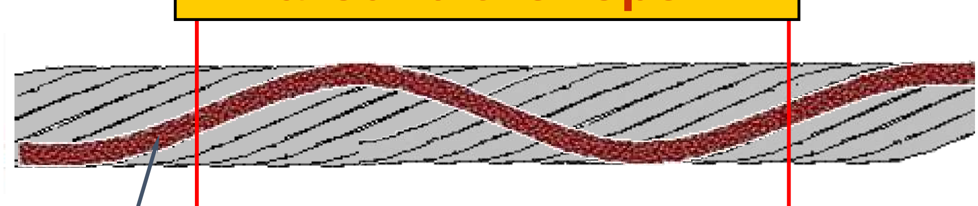
Damaged wire rope





Damaged wire rope must be taken out of service

ROPE LAY : the distance it takes a strand to fully spiral around the rope.

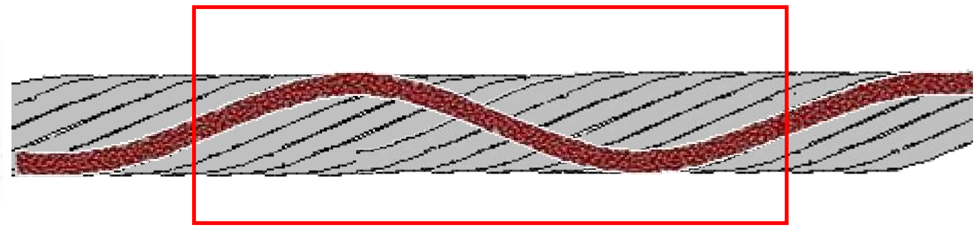


STRAND

Rule of Thumb:
6 to 7 times the rope diameter

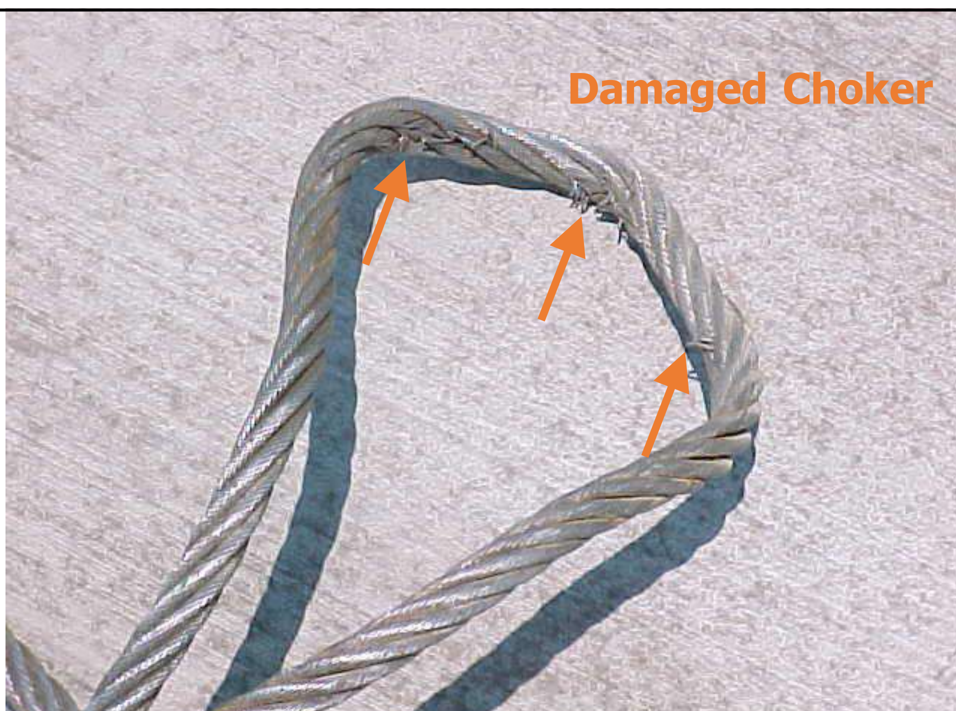
SLING Replacement Criteria

6 RANDOMLY DISTRIBUTED broken wires in 1 rope lay



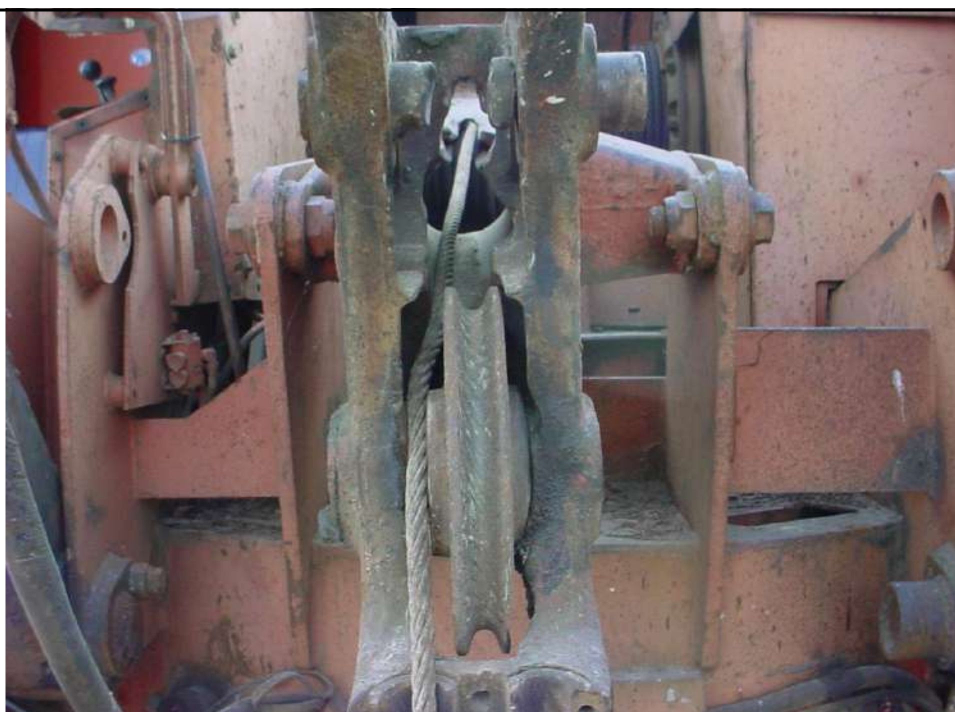
3 broken wire in 1 rope strand in 1 rope lay

ANSI B30.9



Remove From Service When

- **6 broken wires in 1 lay**
- **3 in one strand**
- **Outer wire diameter worn 1/3 original diameter**
- **Bird caged , crushed, kinked**
- **Rope that cannot safely support 6 times the hoist capacity should be replaced**



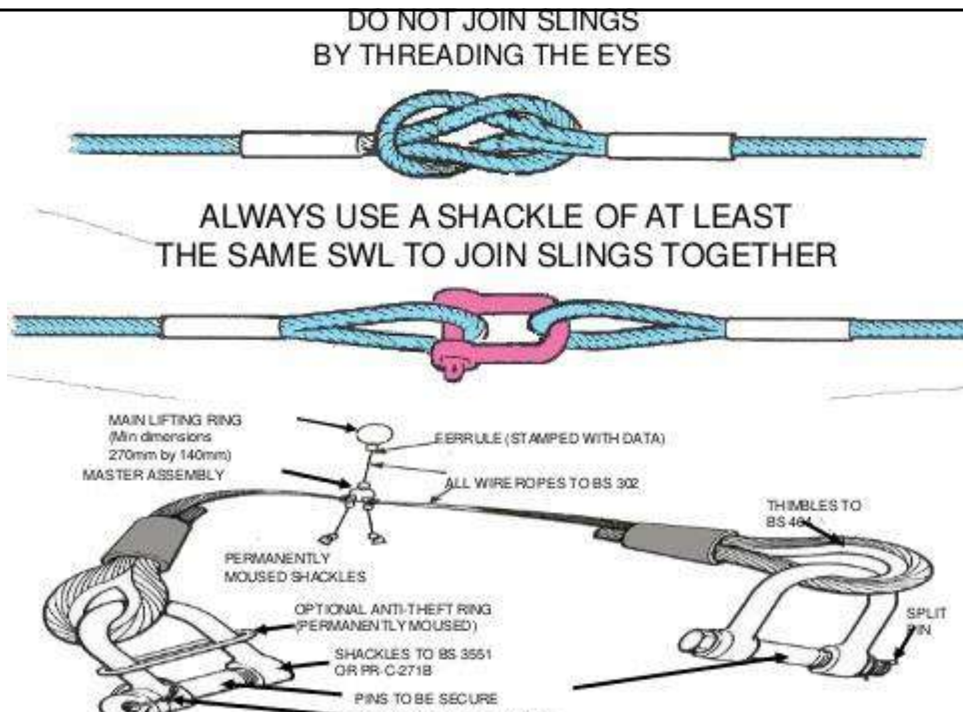
Wire rope slings, like chain slings, must be cleaned prior to each inspection because they are also subject to damage hidden by dirt or oil.

In addition, they must be lubricated according to manufacturer's instructions.

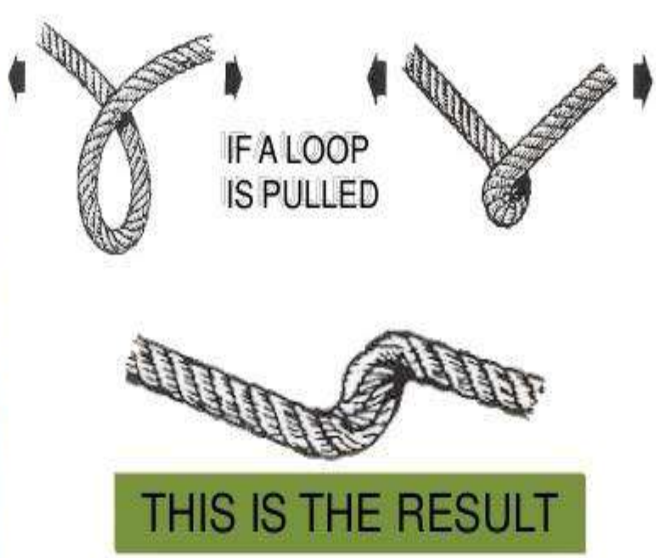
Lubrication prevents or reduces corrosion and wear due to friction and abrasion.

Before applying any lubricant, however, the sling user should make certain that the sling is dry.

Applying lubricant to a wet or damp sling traps moisture against the metal and hastens corrosion.



POOR HOUSEKEEPING



Lifting gear---Webbing slings (safety factor: 5-10)

- All webbing slings shall be subjected to a semi-annually inspection by a authorized third party.
- Minimum information marked (stamp/tag) shall include: "SWL", "Sling Number", "manufacture date" and manufacturer's tag.
- Webbing slings shall be inspected prior to use and shall be immediately removed from service if any of the following condition is present:

---Acid or caustic burn
---melting or charring of any part of the sling
---holes, tears, cuts or snags
---excessive abrasive wears
---knots in any part of the sling
---other visible damage that cause doubt as to strength of the sling

WLL of sewn webbing component t	Colour of webbing
1.0	Violet
2.0	Green
3.0	Yellow
4.0	Grey
5.0	Red
6.0	Brown
8.0	Blue
10.0 and over	Orange

Polyester Round Slings

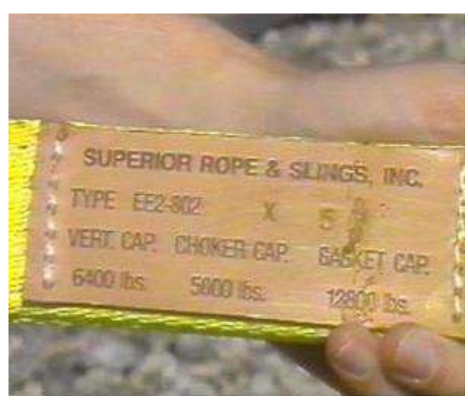
Codes and Capacities

Color		Vertical	Choker	Basket	Minimum Length
	Purple	2,650	2,120	5,300	3 ft.
	Green	5,300	4,240	10,600	3 ft.
	Yellow	8,400	6,720	16,800	3 ft.
	Tan	10,600	8,500	21,200	3 ft.
	Red	13,200	10,560	26,400	3 ft.
	Orange	16,800	13,440	33,600	3 ft.
	Blue	21,200	17,000	42,400	3 ft.
	Orange	25,000	20,000	50,000	3 ft.
	Gray	31,700	25,300	63,400	3 ft.
	Orange	40,000	32,000	80,000	3 ft.
	Brown	52,900	42,300	105,800	3 ft.
	Olive	66,100	52,880	132,200	3 ft.
	Black	90,000	72,000	180,000	3 ft.

Synthetic Web Sling

Markings

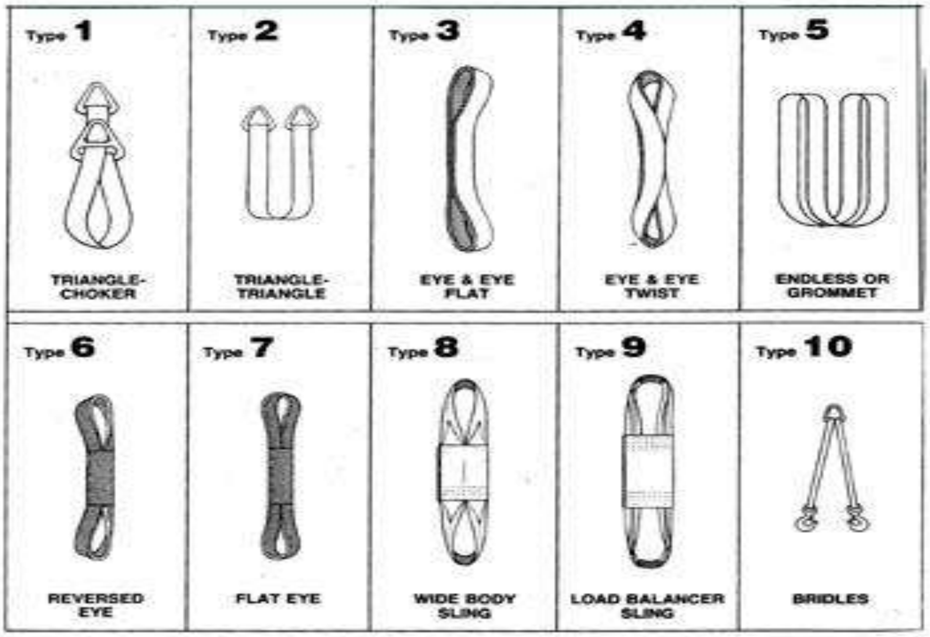
- Mark or code to show:
  - Name or trademark of manufacturer
  - Rated capacities for the type of hitch
  - Type of material



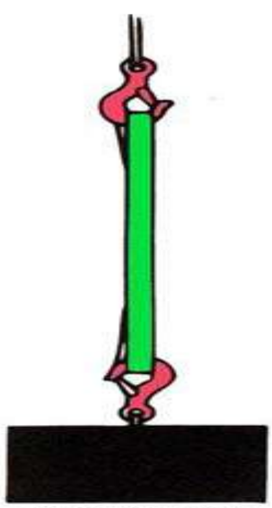

ALLSAFE
ACC.TO EN 1492-1
LENGTH 2 M
SWL 2000 KG
4000
MATERIAL:100% POLYESTER
SAFETY FACTOR 7 : 1
DATE 06/2008
IDENT. 41493 — 4610
FRENCH COLLABORATION
NCMT


NCMT

Web slings



Synthetic Slings



VERTICAL HITCH

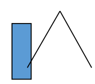
CHOKER HITCH

SYNTHETIC WEB SLINGS

- Available in 2 material

  1.nylon 2.polyester

- Polyester stretch only half as much as nylon slings.
- Less tendency to crush fragile objects than fiber , wire and chain slings.
- Do not rust and thus will not stain.



SYNTHETIC WEB SLINGS

- They are elastic and stretch under load more than either wire or chain and thus absorb heavy shock.
- Light weight permits ease of rigging
- Nylon and polyester slings must not be used at temperature above 90°c
- At low sling angles one edge of the web will be overloaded and the sling will tend to tear.

Material properties Polyester is resistant to acids but not to alkalis, e.g. ammonia and caustic soda.

- The melting point is 260oC, but polyester lifting equipment must not be used with loads or ambient temperatures hotter than 100oC.
- The strength is not affected by water. Water absorption is negligible.
- Note that friction and sharp edges can quickly wear and cut polyester.
- Lifting equipment in polyester has a blue identification tag.

Polypropylene

- The melting point is 165oC.
- Polypropylene must not be used with loads hotter than 80oC.
- Lifting equipment in polyproplene has a brown identification tag.

Safety factor

Roundslings and webbing slings = 7:1 according
to EN-standards.

Rigging Equipment for Material Handling

Synthetic Webbing

Safe Operating Temperatures:

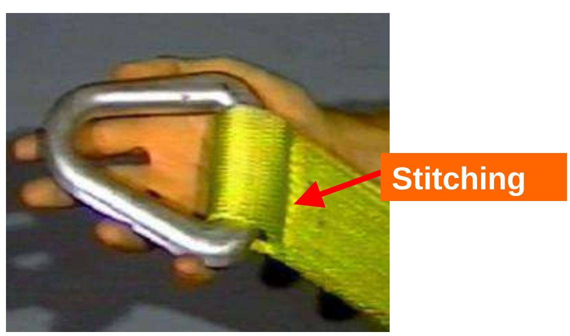
Synthetic web slings of polyester and nylon shall not be used at temperatures in excess of 180 deg F.

Polypropylene web slings shall not be used at temperatures exceeding 200 deg F.

Synthetic Web Slings
Fittings

- Fittings must be:
  - At least as strong as that of the sling
  - Free of sharp edges that could damage the webbing

Synthetic Web Sling
Stitching



- Stitching is the only method allowed to attach end fittings to webbing, or to form eyes


Synthetic Sling Checks
Before you use a synthetic sling be sure to check for:
Internal wear or abrasions
Areas that have been affected by heat
Damage caused by chemical contact
Damage to sleeve
Cuts, tears or contusions
Destroyed or unreadable labelling
Damage to eyes, terminal attachments or end fittings
External wear or abrasions
Damage to stitching
8 lines per 25 mm
NCMT


WEBBING AND ROUND SLING INSPECTION
ACID DAMAGE
MELTING/CHARRING
CUTS ON WEB FACE
EXCESSIVE WEAR
EDGE TEAR
PUNCTURE
Lift-All Company, Inc.
NCMT

Synthetic Web Slings -

Remove from Service

ABRASION

Localised abrasions is the result of movement of the sling over sharp edges, this will significantly reduce the strength of the sling and justify removal from Service.

FRICTION BURNS

✓A webbing sling that has been *'heated'* will display hard, brittle, shiny patches at the points where the high temperatures occurred and fused the fibres together.

✓Damage usually occurs across the whole width of the sling and can be detected by folding the sling during inspection. These hard patches are sling weak points and are sufficient evidence to withdraw the slings from service.

✓*Friction* is the most common cause of 'heat' damage to webbing slings.

✓Ensure that a sling under tension is not allowed to 'skid' along load surfaces.

✓Ensure that the sling is not subjected to 'point' loading such as pulling onto a sharp corner. This produces very high pressure at the 'point' and can result in heat fusion in the sling material.

Synthetic Web Slings -

Remove from Service

CUTS

✓ Cuts in webbing slings usually result from contact with unprotected sharp edges.

✓ Cut damage is similar to that of 'friction burns' except that the cut may be clean, or matted and soft in appearance.

✓ Inspect for cut damage in the same way as for friction burns.

✓ Any cuts in the edge of the webbing will significantly reduce sling strength and justify removal from service.

WEAR

Damage from wear arises only in local areas of the sling. It is caused by:

✓ Dragging along the ground / deck.

✓ The 'bight' being made in the same place for too many lifts.

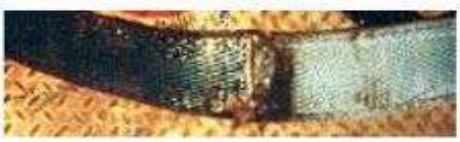
✓ Wear damage from a scuffed surface will appear in patches. If scuffing is severe whole threads may be broken.

CHAFFING

The degree of chaffing will vary. Even minor chaffing will result in some loss of strength. Substantial chaffing, especially when it is localised, will be justification for removal from service

Synthetic Web Slings -
Remove from Service

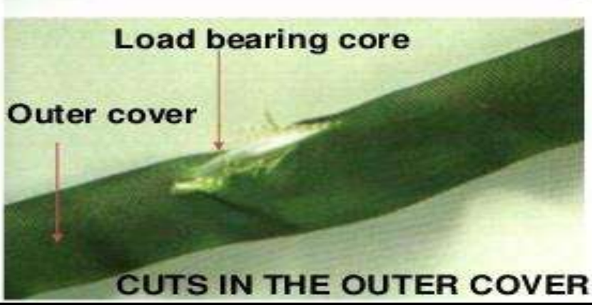
- Web slings should be examined along their length for surface chafe, cuts in the webbing, cuts or chafe damage to the selvedges and any damage to the stitching, eyes or end fittings.
- The effect of chafe on the surface is variable. Any substantial chafe, particularly localised, should be viewed critically.
- Local abrasion, as distinct from general wear may be caused by the sling passing over sharp edges and will result in a serious loss of strength.
- Heat damage may show as hard spots and could be generated byfriction, particularly at the bight when choke hitch is used.



Sewing thread abrasion

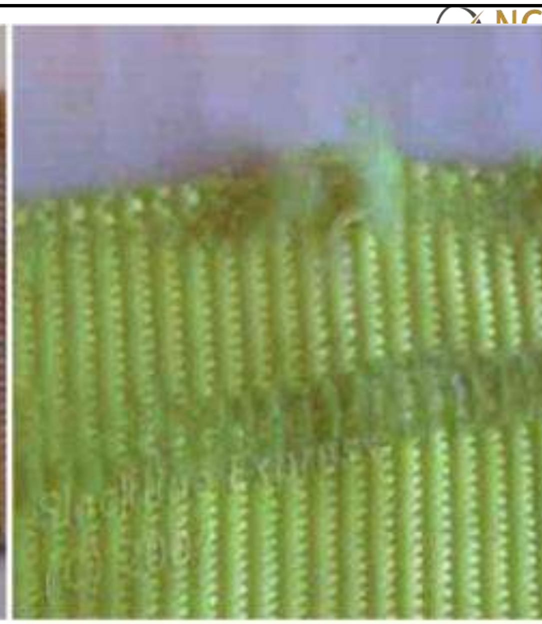
Abrasive Damage

Synthetic Web Slings -
Remove from Service



Cuts, particularly at the selvedge will result in a serious loss of strength.

A sling so affected should be taken out of service immediately.



Synthetic Web Slings -
Remove from Service

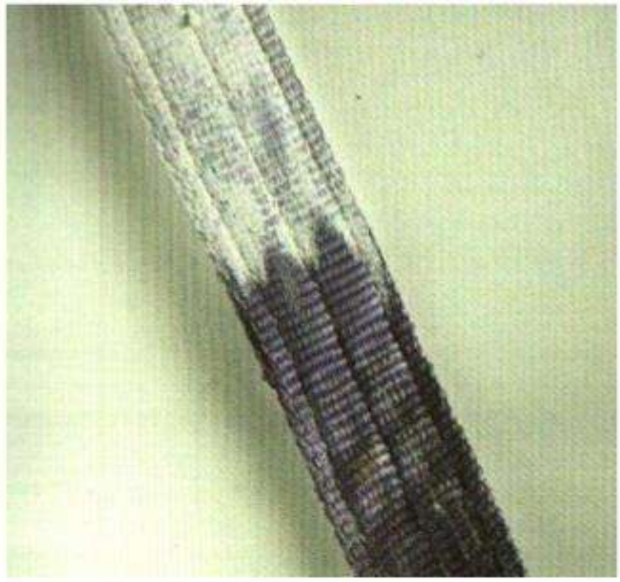
Damage at the triangle

Synthetic Web Slings -
Remove from Service

CHEMICAL ATTACK

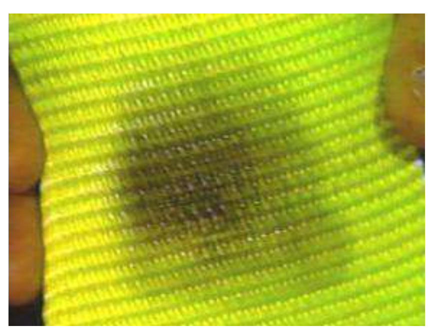
- Chemical attack is indicated by local weakening or softening of the material in the webbing so that surface fibres can be rubbed off, as a powder in extreme cases.

- Chemical attack/contamination may show as discolouration and is a clear indication of damage to the sling.



Synthetic Web Slings -
Remove from Service

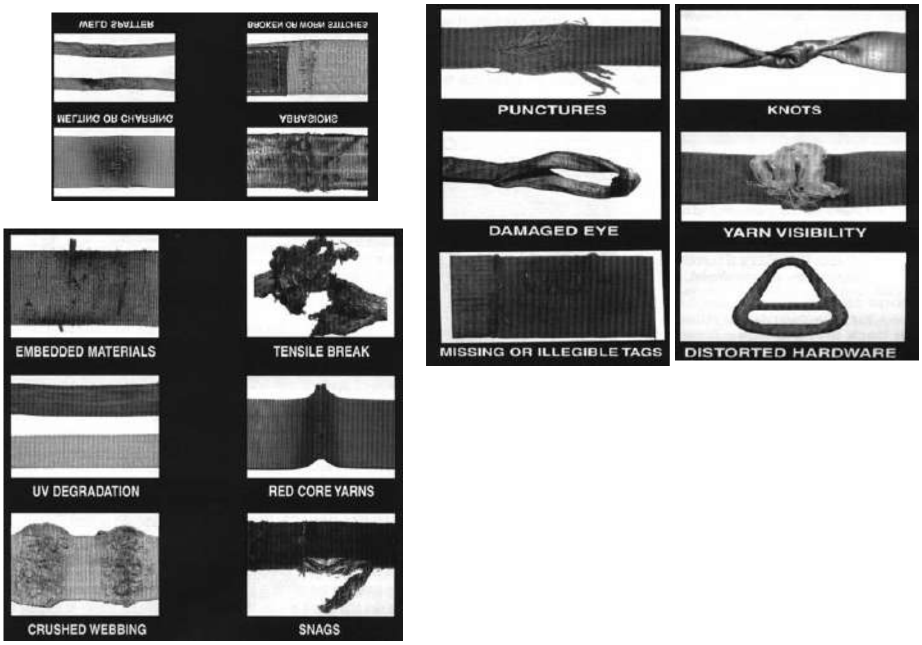
- Remove from service if any of these are present:
  - Acid or caustic burns
  - Melting or charring of any part
  - Snags, punctures, tears or cuts
  - Broken or worn stitches
  - Distortion of fittings



Heat Damage


Rigging Equipment for Material Handling
NCMT
Synthetic Webbing
Webbing must be removed from service immediately if any of the following conditions exist on the rope:
acid or caustic burns
melting of charring on any part of the sling surface
snags, punctures, tears and cuts
broken or worn stitches
distortion of fittings
VIOLATION!
Crucible Media
Materials Handling


NCMT



STORAGE

Always inspect slings prior to use.

STORAGE

PROTECTIVE GUARD

- EDGE GUARD

Consists of strips of webbing or leather sewn around each end of the sling. This is necessary whenever sling edges are subjected to damage.

- SLEEVE OR SLIDING TUBE WEAR PADS

are available for slings used to handle material with sharp edge. The pads are positioned on the sling where required. Will not move when the sling stretches.

- BUFFER STRIPS

of leather , nylon or other material sewn on the body of the sling protect against wear.

Leather pads are more resistant to wear.

Not recommended in length over six feet because of their strength characteristics differ from those of webbings.

Lifting gear---personnel working basket

- Personnel working basket shall be subjected to a annual load test and inspection-------Third party
- Personnel working basket shall be visually examined by the person in charge of the lift before each use including:

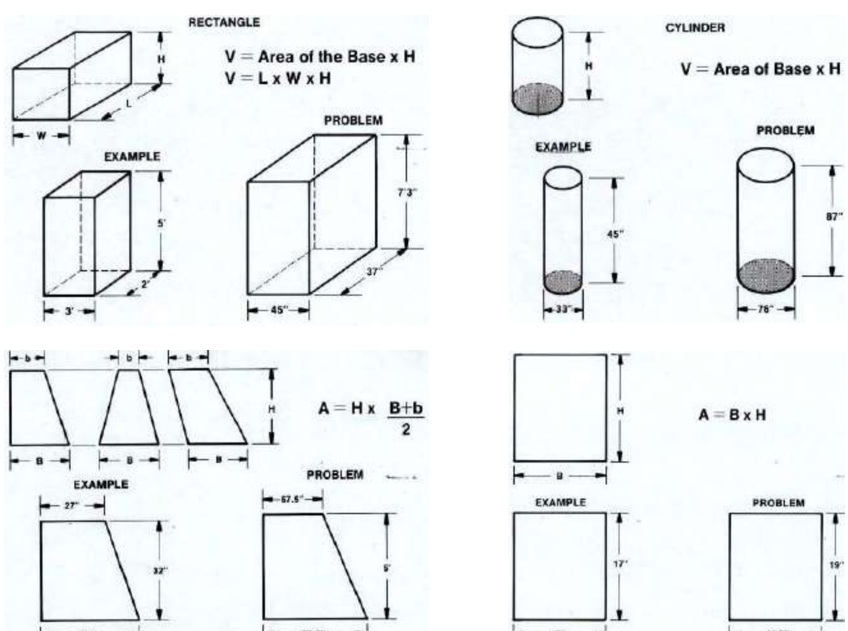
---structure defects
---excessive wear
---corrosion
---other unsafe condition

Determining the weight of the load

- Shipping paper
- Manufacturers information attached to the load
- Catalogs or blueprints
- Tables of weights from manufacturers or handbooks
- Make sure the weight has not changed

Name of metal	Weight lb/ft³	Name of material	Weight lb/ft³
Aluminum	166	Bluestone	160
Antimony	418	Brick, pressed	150
Bismuth	613	Brick, common	125
Brass, cast	504	Cement, Portland (packed)	100-120
Brass, rolled	523	Cement, Portland (loose)	70-90
Copper, cast	550	Cement, slag (packed)	80-100
Copper, rolled	555	Cement, slag (loose)	55-75
Gold, 24-carat	1204	Chalk	156
Iron, cast	450	Charcoal	15-34
Iron, wrought	480	Cinder concrete	110
Lead, commercial	712	Clay, ordinary	120-150
Mercury, 60°F	846	Coal, hard, solid	93.5
Silver	655	Coal, hard, broken	54
Steel	490	Coal, soft, solid	84
Tin, cast	458	Coal, soft, broken	54
Zinc	437	Coke, loose	23-32
Name of wood	**Weight lb/ft³**	Concrete, or stone	140-155
		Earth, rammed	90-100
Ash	35	Granite	165-170
Beech	37	Gravel	117-125
Birch	40	Lime, quick (ground loose)	53
Cedar	22	Limestone	170
Cherry	30	Marble	164
Chestnut	26	Plaster of paris (cast)	80
Cork	15	Sand	90-106
Cypress	27	Sandstone	151
Ebony	71	Shale	162
Elm	30	Slate	160-180
Fir, Balsam	22	Terra-cotta	110
Hemlock	31	Trap rock	170

Volume & Area Formulas



Calculating an allowable load

- Determine the breaking strength of the rope
  - Load which will cause the rope to break
  - Refer to standard tables in rigging handbooks
  - Listed according to the diameter and kind of rope
  - Design or safety factor usually 5

Calculating an allowable load

- Find the load limit by dividing the breaking strength of the rope by the design factor
- Example-
  - If the table indicates that the breaking strength of the rope you are using is 27,000 pounds. Dividing this figure by the design factor of 5 gives you a 5400 pound maximum allowable load.

Determine the center of gravity

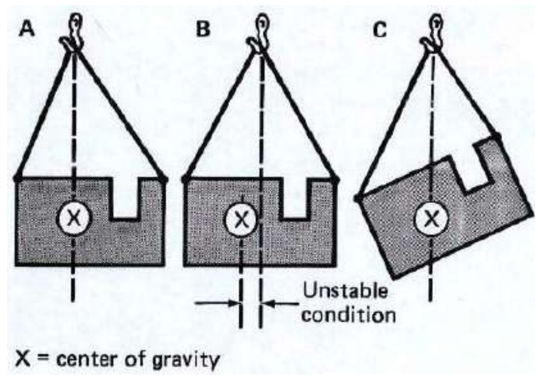
- The point at which the load will balance
- Whole weight of the load is considered concentrated at this balance point
- When suspended from a point, the load tends to move so that the center of gravity is directly below the point of support.
- Make sure the center of gravity is located directly below the hoisting hook

Determine the center of gravity

- Stable load
  - Balanced about its center of gravity
  - Directly below the hoisting hook
- Unstable load
  - has a tendency to tip or topple
  - Creates a hazard to personnel and equipment

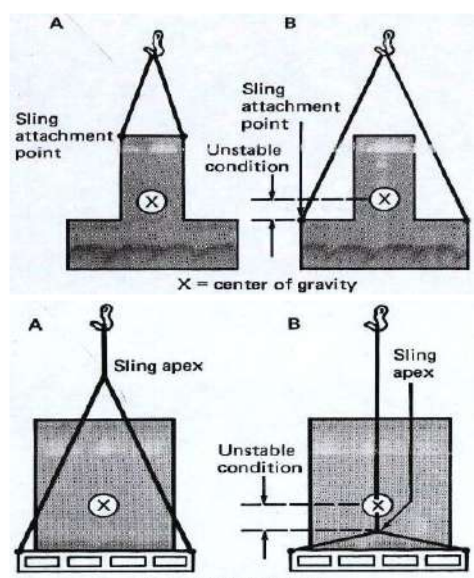
Before Lifting any load check for hazards

- If not directly below the hook the load is unstable
- If the sling is free to slide across the hook the center of gravity will shift directly below the hook
- If two slings are used one will assume the greater share of the load



Before Lifting any load check for hazards

- The sling must not be attached to the load at a point lower than the loads center of gravity
  - Exception to this rule when lifting loads on pallets or skids
  - Then apex of sling must be above the center of gravity



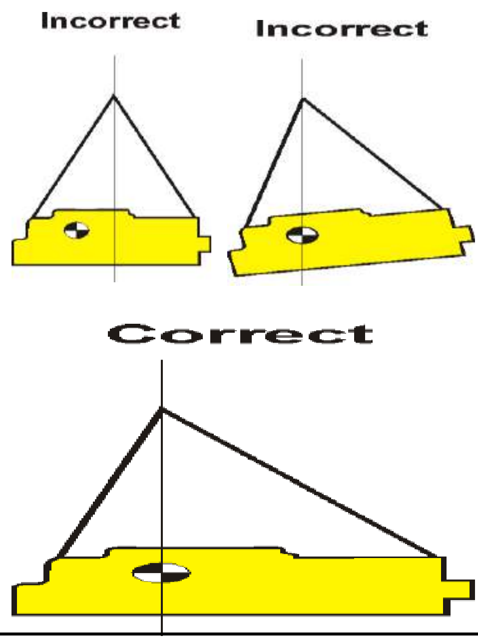
Determining the center of gravity

- Marked on the load by manufacturer
- Located in catalogs or blueprints
- Some objects have lifting lugs
- Calculate or estimate it
  - Make an educated guess and correct through trial and error before making the lift

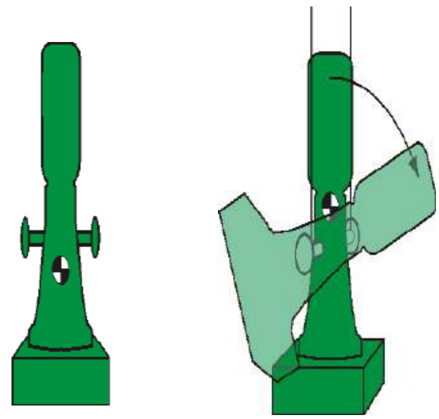
Procedures to determine center of gravity

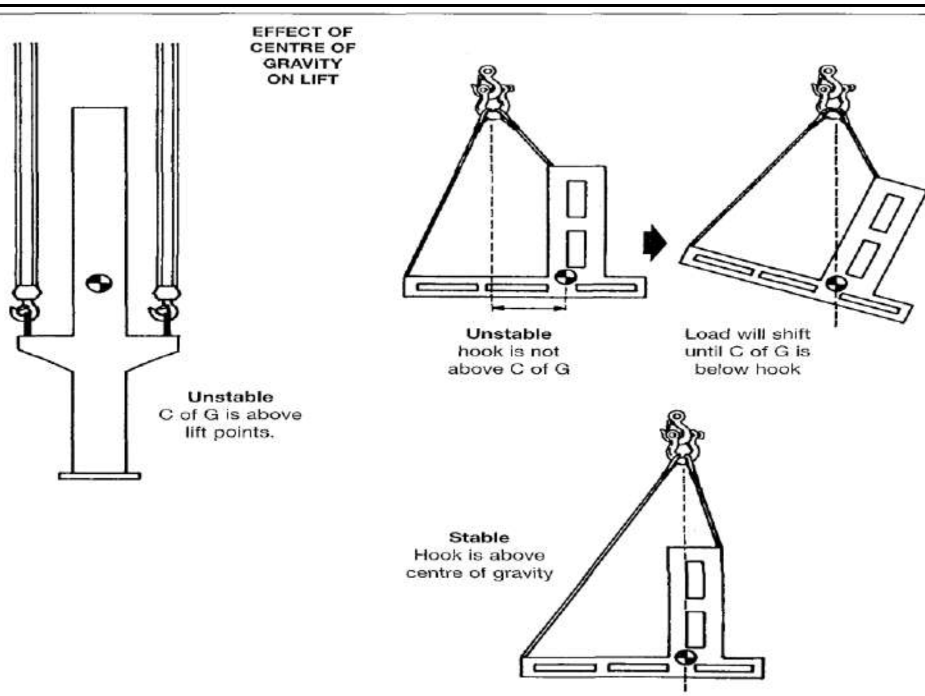
- Connect slings and hoist based on estimate of object's center of gravity
- Take up slack in slings or hoist
- Lift the load just enough to check stability
- If stable, continue to lift
- If unstable, lower load and adjust the rigging
  - Lift point should be moved closer to end that dips
- Repeat until load is stable

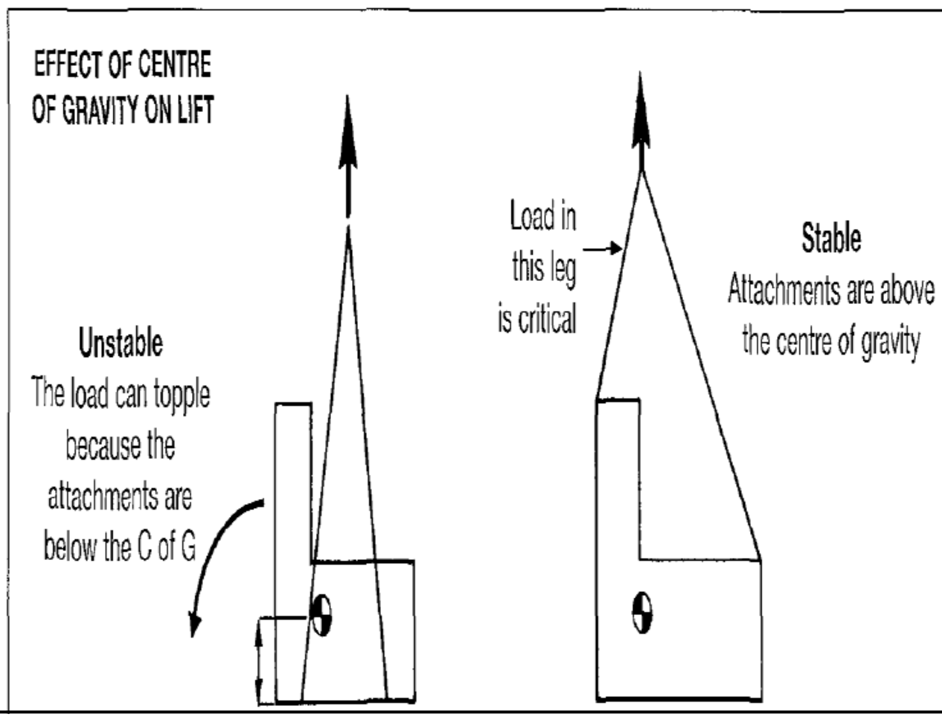
Center of Gravity



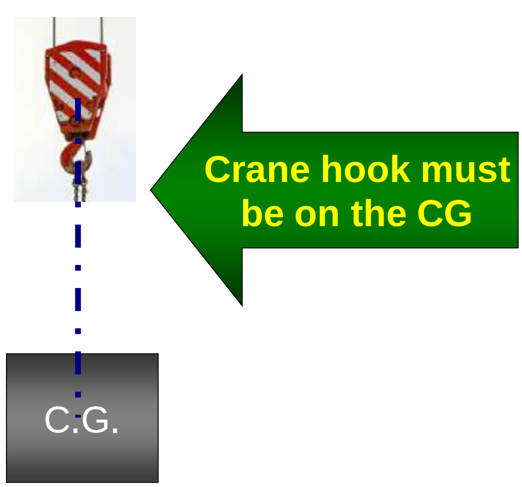
For the load to remain stable, rigging should be attached above the center of gravity.







Safe Slinging Practice



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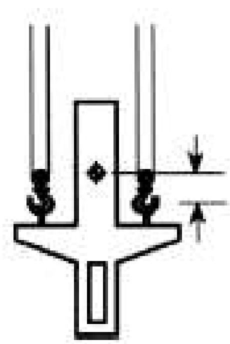
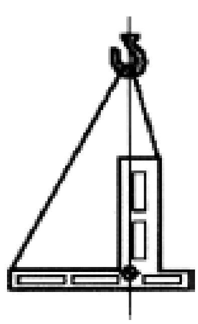
Safe Slinging Practice



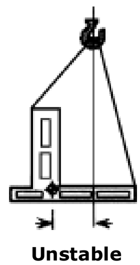
This load is not stable. The hook is over the CG, but the CG is above the lifting hook.
This load is top heavy, and could overturn while being lifted

Safe Slinging Practice

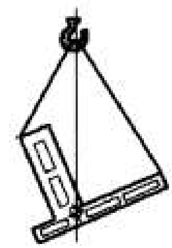


This load is stable
The hook is right over the CG.

Safe Slinging Practice



The hook is not over the centre of gravity



The load will shift until the CG is under the hook.

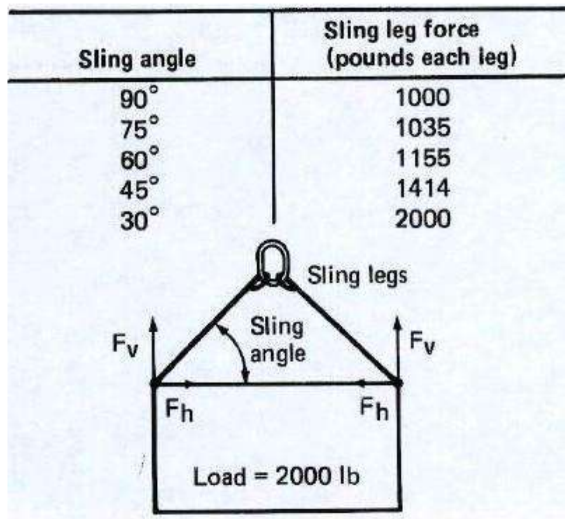
This will make landing the load very difficult, and could cause major problems in carnage

Horizontal Force

- Very often sling legs are attached at an angle less than 90^0
- Then a horizontal force is added to the vertical force
- Resulting Combined force is greater than the weight of the load
- Horizontal force increases as the angle becomes smaller

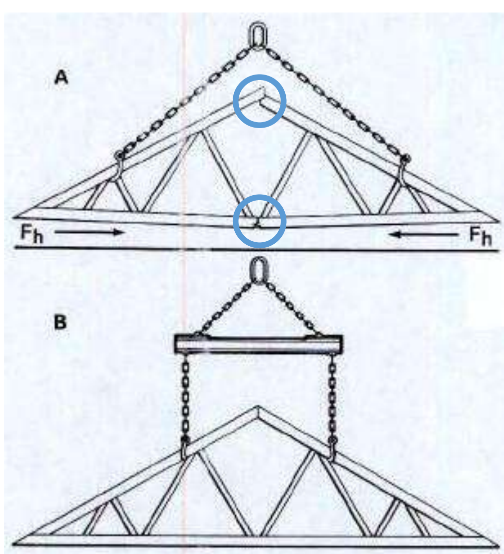
Horizontal Force

- When a sling angle is 30^0 the total force is twice that of the load
- Sling Angles of 45^0 are not recommended



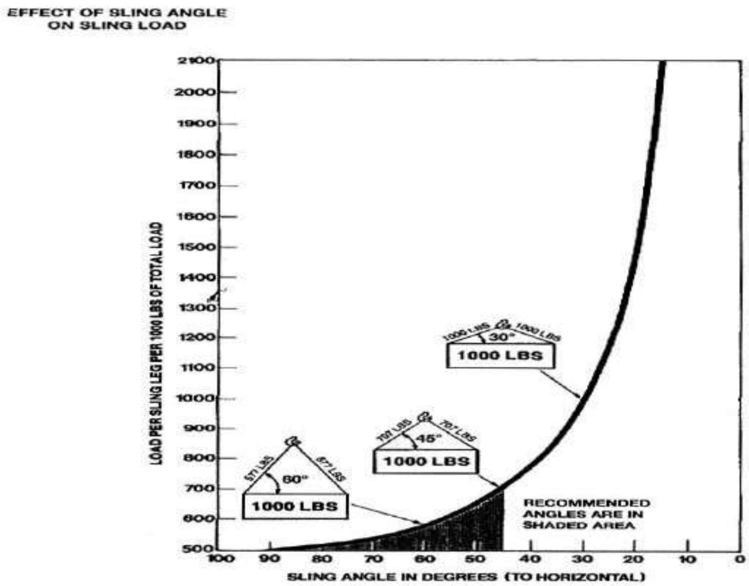
Sling angle	Sling leg force (pounds each leg)
90°	1000
75°	1035
60°	1155
45°	1414
30°	2000

Horizontal Force

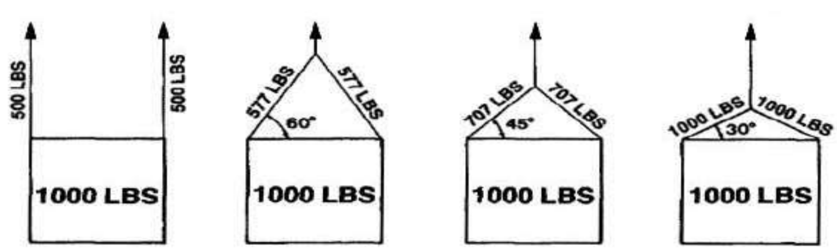


- Horizontal forces act on the load causing damage by compression or buckling
- Horizontal forces are absorbed by using a spreader beam making the sling legs between beam and load vertical

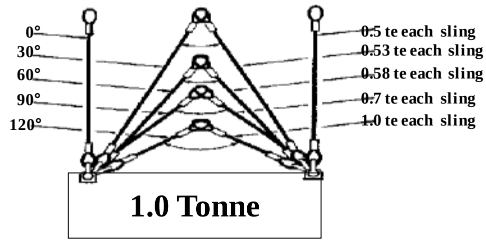
Sling Angles



EFFECT OF SLING ANGLE MEASUREMENT ERROR ON LOADS				
Assumed Sling Angle	Assumed Load (Pounds per Leg)	Actual Angle (is 5° less than Assumed Angle)	Actual Load (Pounds per Leg)	Error %
90°	500	85°	502	0.4
75°	518	70°	532	2.8
60°	577	55°	610	5.7
45°	707	40°	778	9.1
30°	1,000	25°	1,183	18.3
15°	1,932	10°	2,880	49.0



SLING ANGLES

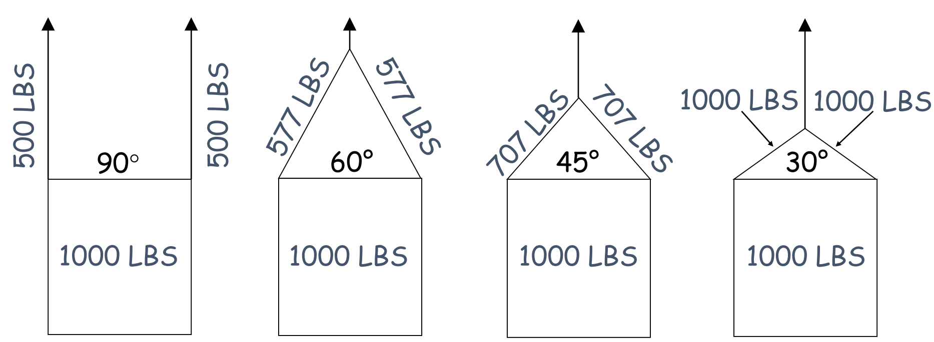


The SWL of a pair of single slings decreases as the angle between them increases.

0°-SWL=SWL of one sling x 2
30°-SWL=SWL of one sling x 2 x 0.966
60°-SWL=SWL of one sling x 2 x 0.866
90°-SWL=SWL of one sling x 2 x 0.707
120°-SWL=SWL of one sling x 2 x 0.5

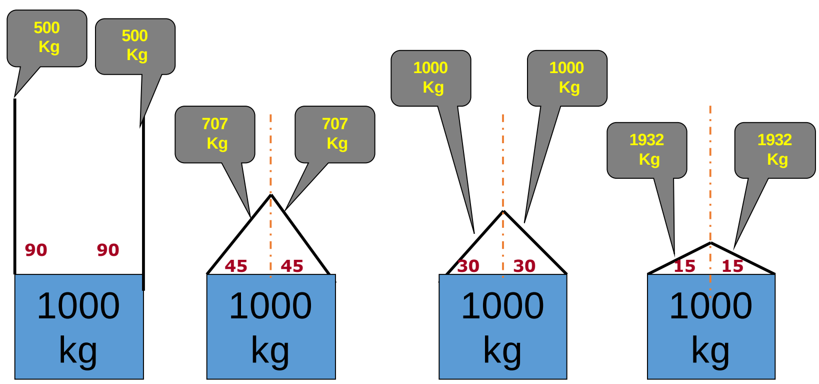
0°-SWL=SWL of one sling x 2
30°-SWL=SWL of one sling x 1.93
60°-SWL=SWL of one sling x 1.73
90°-SWL=SWL of one sling x 1.414
120°-SWL=SWL of one sling only.

How Horizontal Angle Affects Sling Capacity

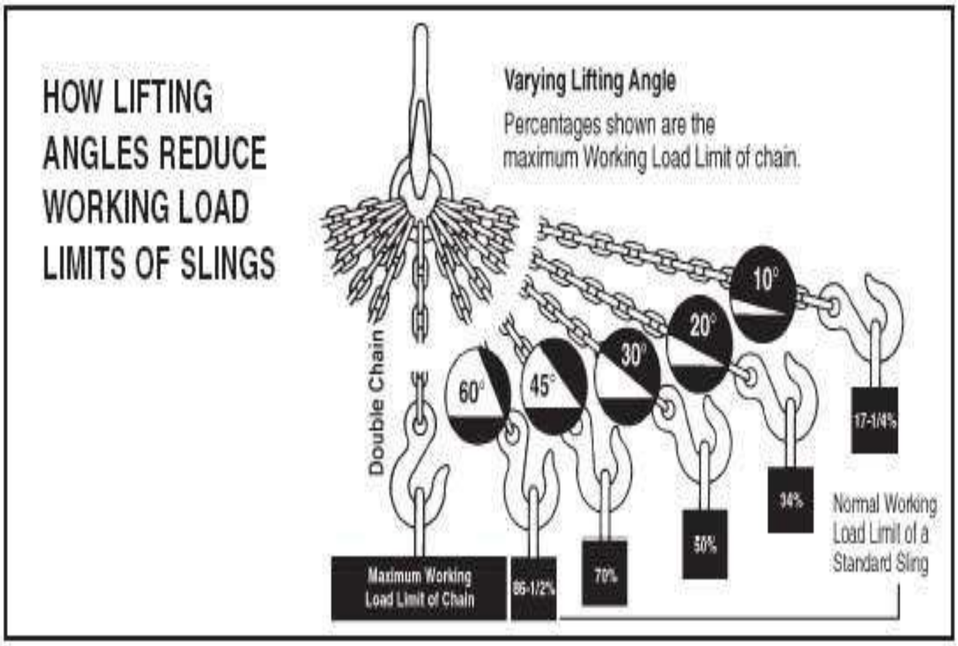


Note: *A good operating practice is to keep sling angles from going below 60 degrees*

Safe Slinging Practice



Wire Rope Capacities



SLING ANGLES

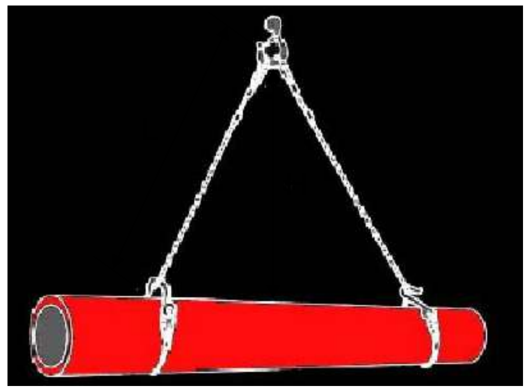
- Loading in any type of sling is affected by the angle of the legs.
- Possible keep leg angles greater than 45° from horizontal
- Angles approaching 30° are extremely hazardous and must be avoided at all costs.
- Low sling angles create large horizontal compressive forces in the load ,which may be sufficient to cause buckling, especially in long, flexible load.
- Error in measurement as little as 5° can affect the load in the sling drastically (hugely).

Sling Angle Factor

Sling Angle Factor = L/H

Where:

L = Length of the sling.
H = Height of the connection point from the horizontal plane of the load.

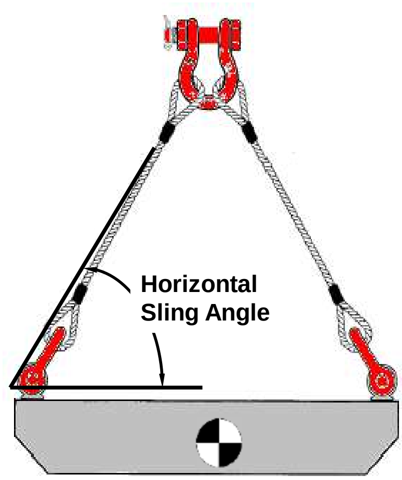


Sling Angles

Sling tension is multiplied when slings are gathered and an angle is formed.

This angle is referred to as the "Horizontal Sling Angle"

The tension induced into the slings must be considered the same as load when sizing slings and hardware.

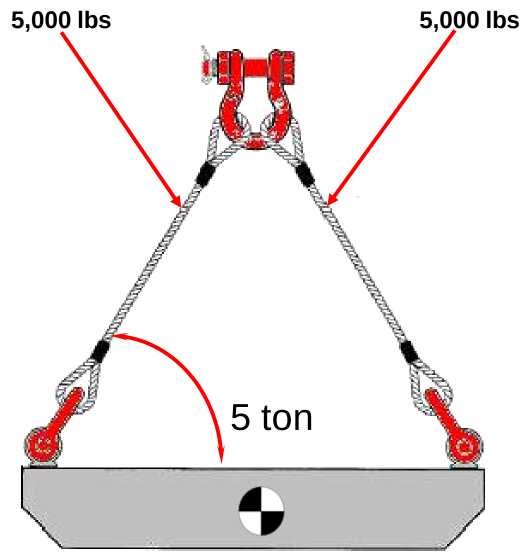


Sling Angles

Sling tension can be calculated as follows:

In this example, each sling supports ½ of the load or 5,000 lbs in the true vertical position.

When the sling angle is changed, a load factor is applied to account for tension induced into each sling due to mechanical force.

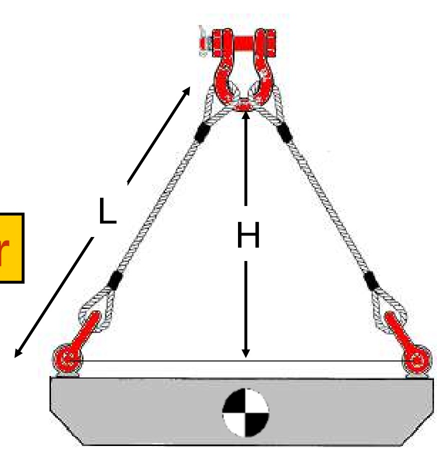


Load Angle Factor

Load factor is calculated as follows

L/H =Load Factor

L = 12’
H= 10’5”
144 / 125 = 1.152

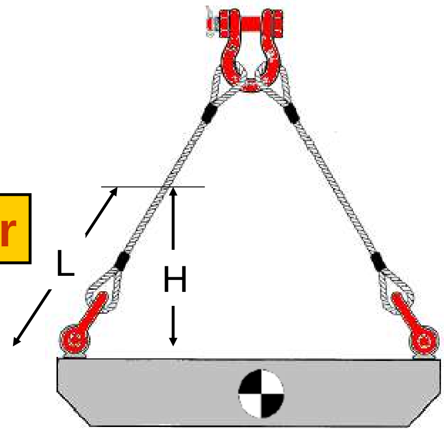


Load Angle Factor

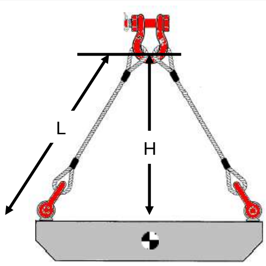
Load factor:Measure at midpoint if necessary.

L/H =Load Factor

L = 6'
H= 5'2"
72" / 62" = 1.152



Sling Angles



L/H =Load Factor

L = 144''
H= 125''
144''/ 125'' = 1.152

Angle near 60°

Sling Angle	Load Angle Factor
90°	1.000
85°	1.004
80°	1.015
75°	1.035
70°	1.064
65°	1.104
60°	1.155
55°	1.221
50°	1.305
45°	1.414
40°	1.555
35°	1.742
30°	2.000
25°	2.364
20°	2.924
15°	3.861
10°	5.747
5°	11.490

Sling Angles

60º provides excellent load control with minimal mechanical force applied to slings. Use caution over 60º as the load can become unstable with multiple slings depending on load and hitch.

Most Desirable Angles

Use Caution With These Angles

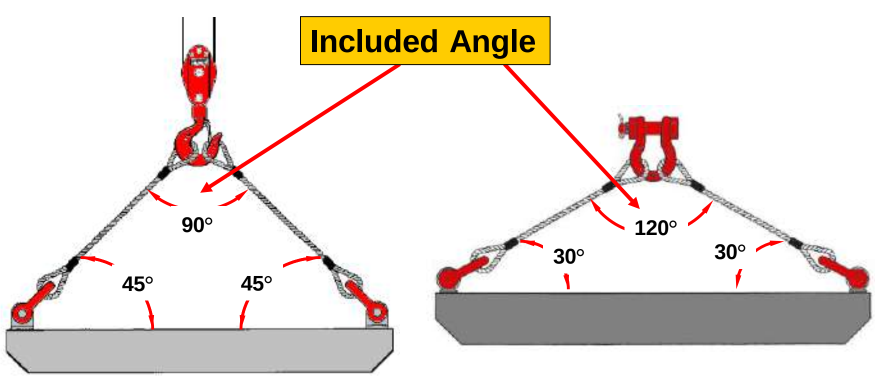
Avoid These Angles

Rigging to angles less than 30° is not recommended.

Sling Angle	Load Angle Factor
90º	1.000
85º	1.004
80º	1.015
75º	1.035
70º	1.064
65º	1.104
60º	1.155
55º	1.221
50º	1.305
45º	1.414
40º	1.555
35º	1.742
30º	2.000
25º	2.364
20º	2.924
15º	3.861
10º	5.747
5º	11.490

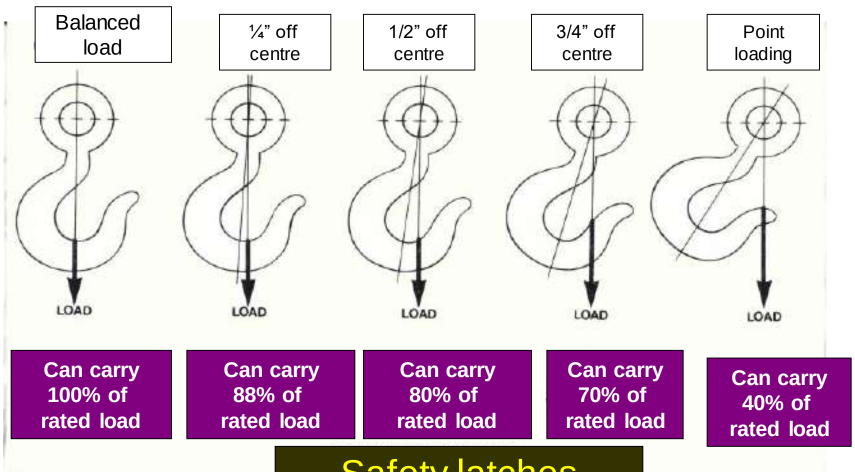
Included Angle

All triangles have 180°



The reason that you can’t rig below a 30° angle is that there is no hardware designed to take it.

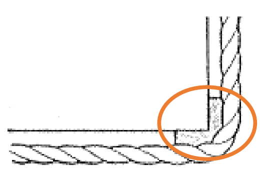
Safe Slinging Practice

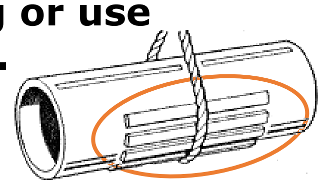


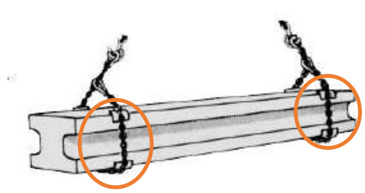
Safety latches omitted

Safe Slinging Practice

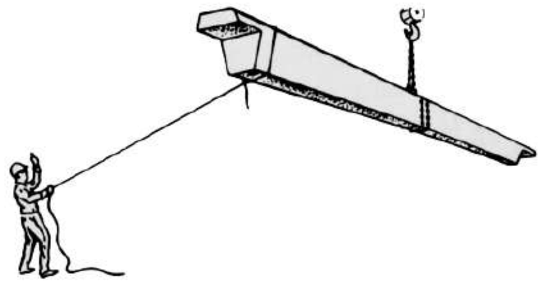
Softeners, padding or use of blocking..







Safe Slinging Practice



Tag line should be attached to the load swinging and to help it landing in the right place.

Unsafe Slinging

Lift and lower the load smoothly, do not jerk

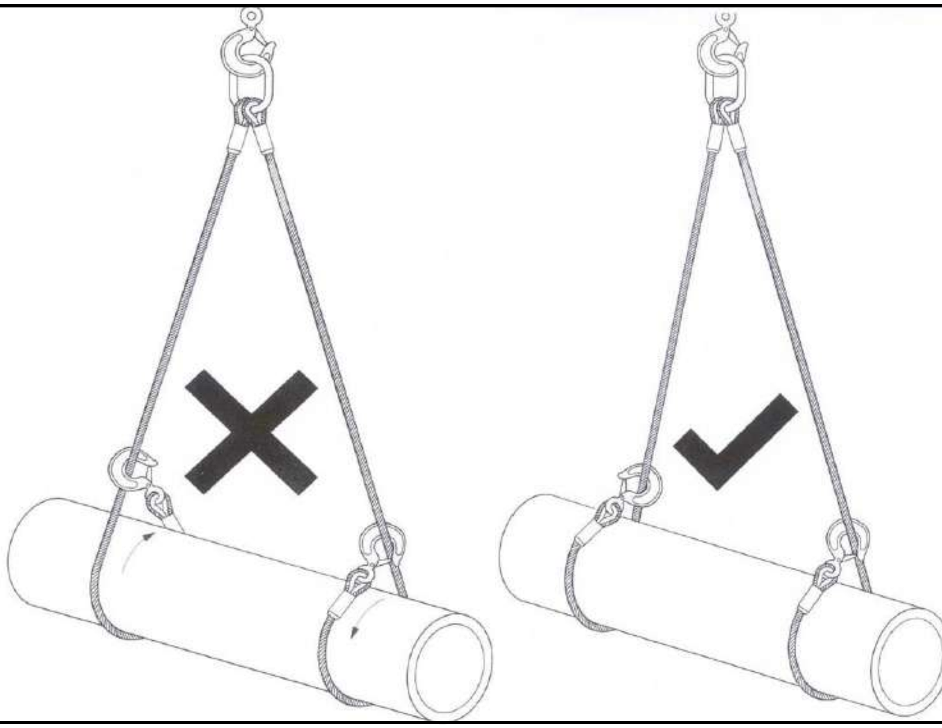
Unsafe Slinging

Unsafe Slinging

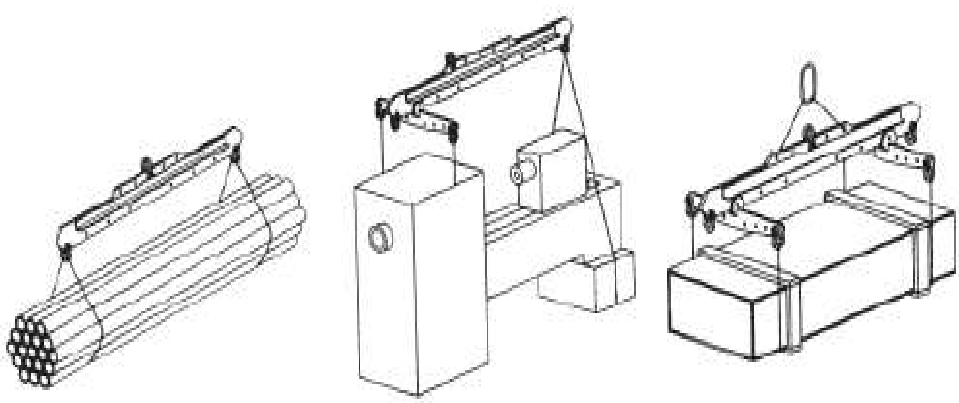
Unsafe Slinging

Is it right method to extend a chain sling?

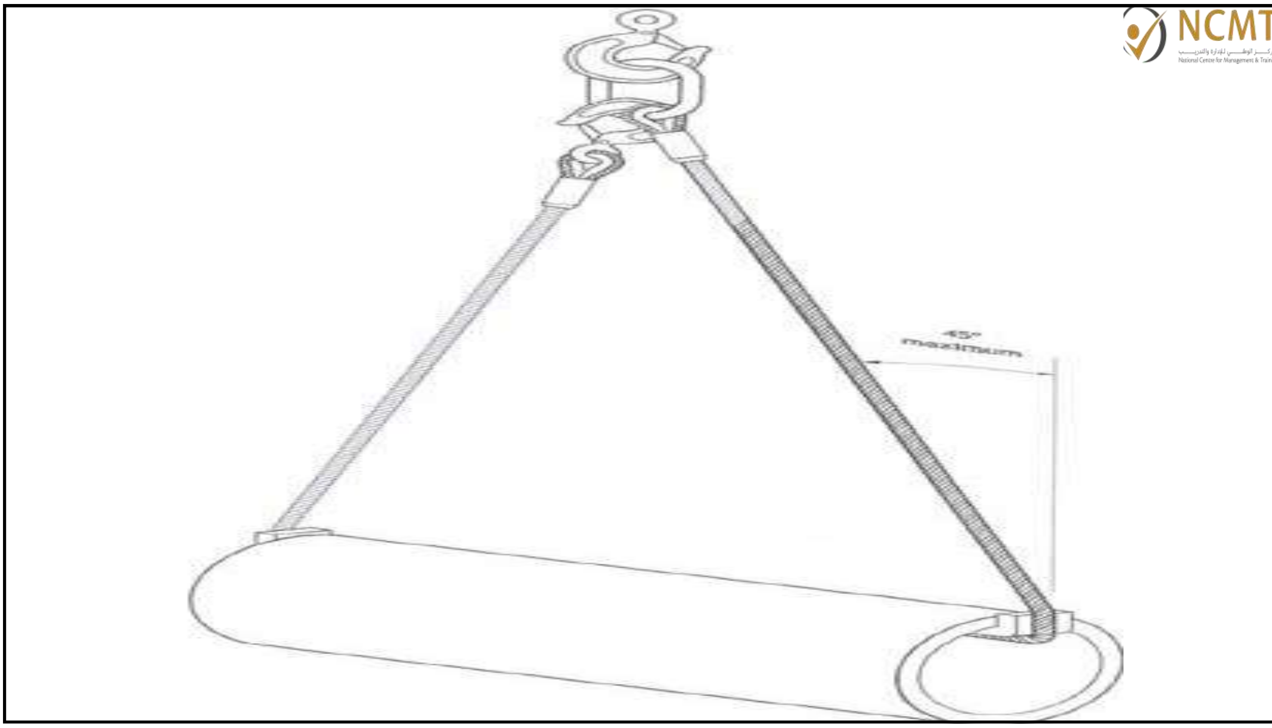
Unsafe Slinging



Point Lifting



Two Point Three Point Four Point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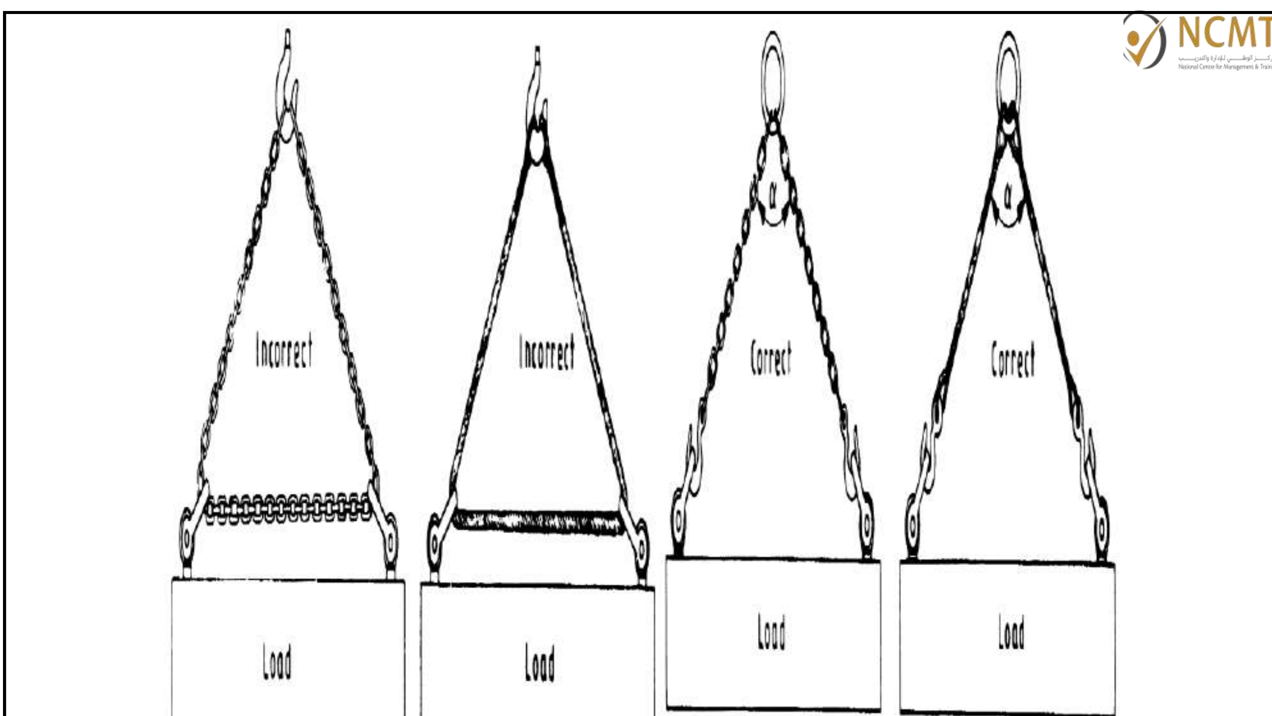
45°
maximum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Incorrect
Incorrect
Correct
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Load
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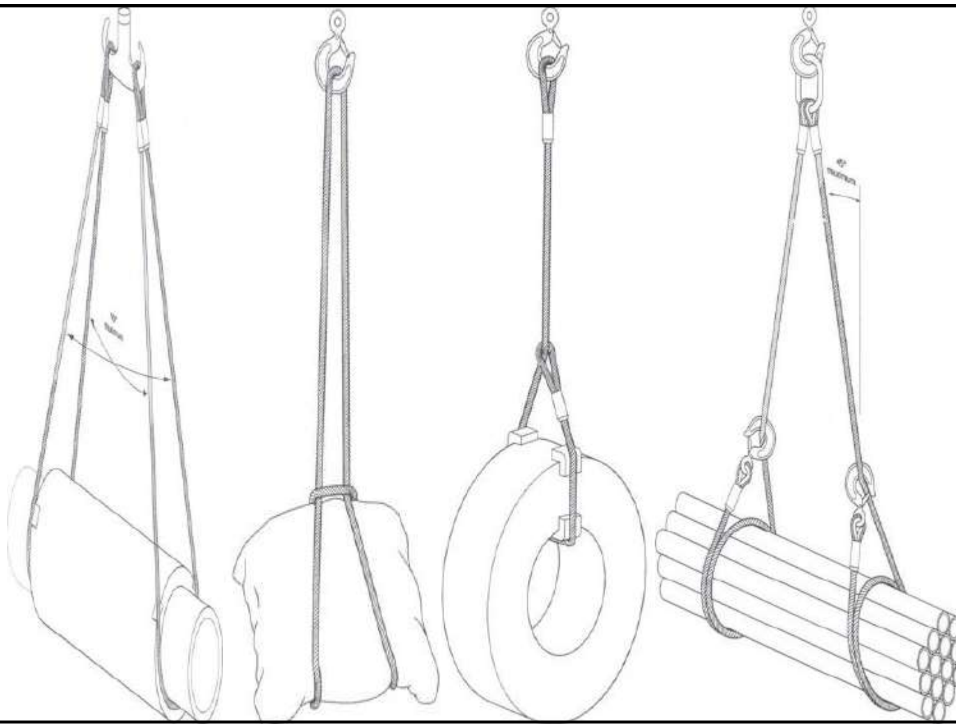


Scaffold tubes

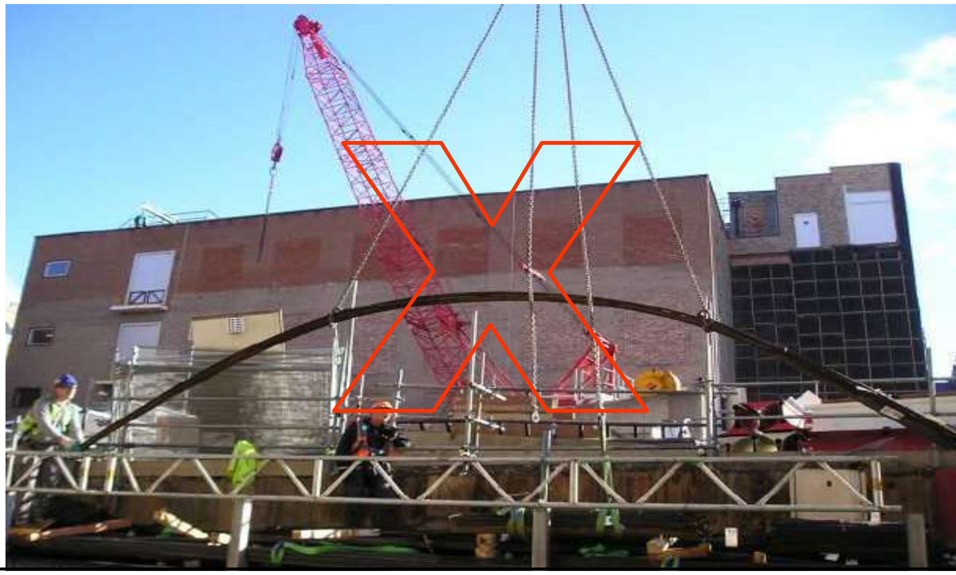
Slings wrapped in opposite directions

Loose scaffold tube – unacceptable?

Loose re-bar

Acceptable…

Unacceptable – excessive deformation



Use chain clutches to level load…

Re-bar lifting beam – (walls)

Unacceptable – Wall Re-bar

Re-bar lifting beam – (columns)

Wall/column shutters

Method:

- Lift by the designed lifting points only
- Use the manufacturers supplied & certified lifting eyes/accessories only

Precautions:

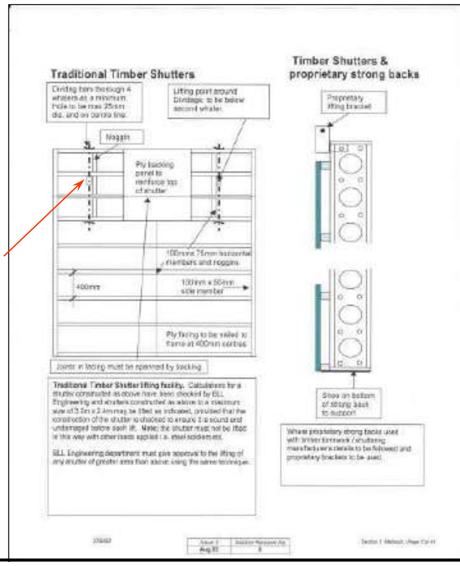
- Avoid lifting over others wherever possible
- Tag lines are to be used for all lifts wherever practicable
- Shutters are to be visually inspected before any lift
- Loose materials are to be removed from all shutters

Wall shutters

Unacceptable…

Lifting Shutters

Extract from RC Code

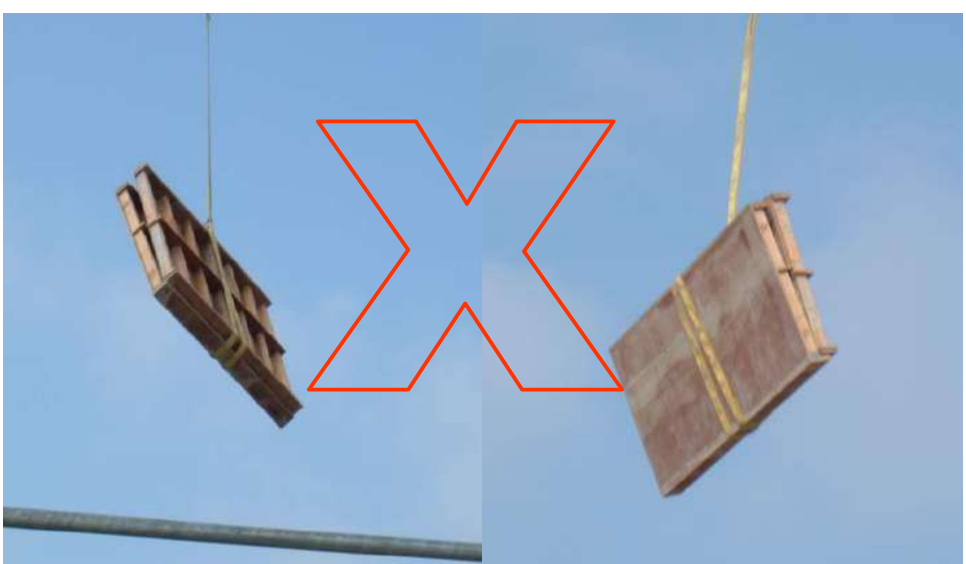


Use of tested lifting cleats as per previous slide is a better option than wrapping chains around dividags

Acceptable…

Unacceptable…

Unacceptable…



System column shutters

Column Shutters

Tableforms

Method:

- Tables are to be lifted at the designed lifting points only
- Properly designed, tested lifting equipment to be used
- Method statement/risk assessment to be rigidly adhered to when lifting these shutters

Precautions:

- Exclusion zones to be established below all areas where these shutters are being removed from the building
- Additional training may be required for slinger/signallers

Tableforms lifting hook

Tableforms

Acceptable…

Unacceptable…

Both on same load…

Acceptable…

Acceptable…

Rigid Sheet Materials

Method:

- Typical load, rigid sheets such as Plywood, scaffold boards
- Double wrapped with webbing slings or chains unless banded

Precautions:

- Webbing slings to be less than 6 months from 1st issue
- Webbing slings must be protected from sharp edges, not be worn, have cuts or any damage
- The load must be level for uniform loading
- Sleeves or secure packing should be used at corners to avoid damaging materials or slings.

Acceptable…

Unacceptable…

Scaffold boards

Unacceptable…

Loose timber

- Timber to be double wrapped
- Slings or chains may be used
- Beware of damage to timber if using chains
- Bulky loads may require a combination of slings & chains

Loose timber

Four point lifting

Palletised loads

- Ensure that slings or chains are passed below or through the pallet
- Loads to be double wrapped wherever practicable – check with coordinator if in doubt

Palletised lift

Unacceptable…

Stillage Bins

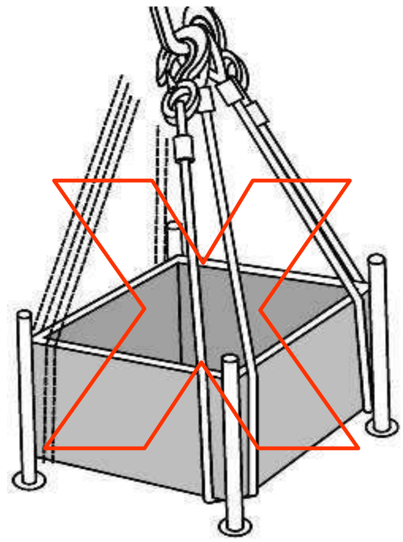
Method:

- Chains or slings double wrapped & choked
- or Lifting forks with debris netting

Precautions:

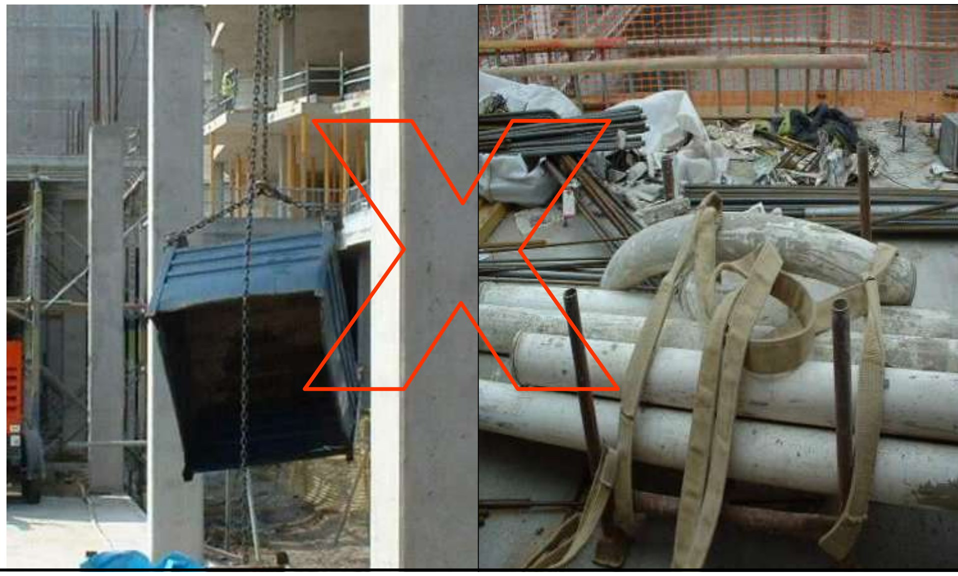
- Ensure stillage is loaded within capacity
- Check stillage for impact damage
- Beware of rusted bases

Stillage Bins



Acceptable

Unacceptable



Open Stillages

Method:

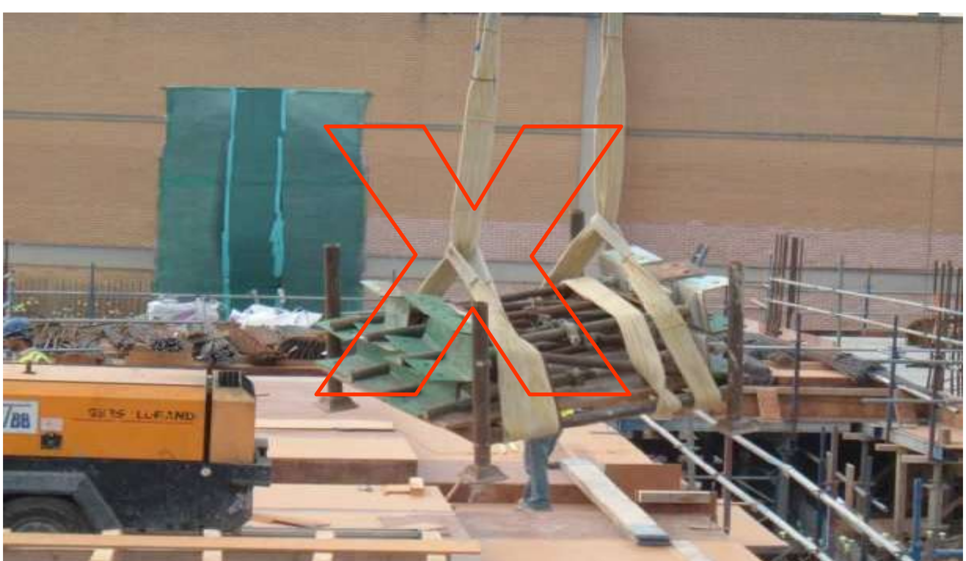
- Where possible, lift load and stillage separately
- Where lifting together, two leg chains or slings double wrapped around both load & stillage

Precautions:

- Ensure bite to avoid risk of tube slippage
- Avoid risk of compression to structure of stillage
- Essential that load is level

Acceptable

Unacceptable



Pallet / brick forks & net

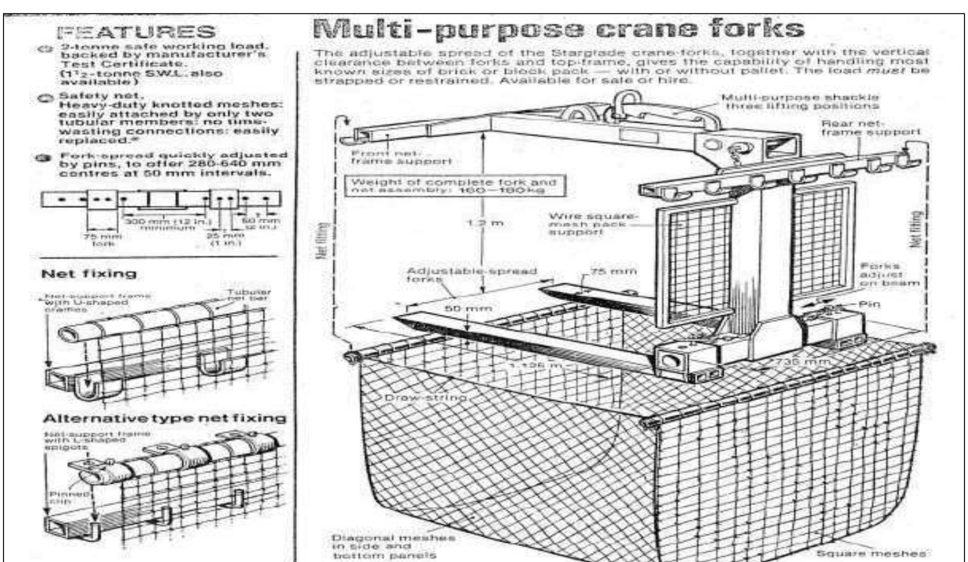
Method:

- Pallet Forks (netted) are frequently used for palletised or banded materials e.g. bricks, blocks

Precautions:

- Check the load is within the capacity of the forks
- The SWL of the forks is sufficient for the load
- Ensure the net is secured and mesh size is smaller than the smallest item to be lifted

Brick forks & net



Brick forks & net

Concrete or Muck Skip

Method:

- Use only single leg drop chain of correct capacity

Precautions:

- Skips approved for lifting & identified in Lifting Plan
- Never lift directly with the crane hook
- Beware of overloaded skips - If in doubt, don't lift
- Beware of rusted floors or loosely fitting traps
- Tremmie pipe with chain attached to skip frame to avoid fall
- Tremmie pipe to have discharge end secured to upper edge of skip
- Tremmie pipe connecting pin must be locked in place before concrete skip is moved/loaded.

Concrete skip or drop chain

Muck-skip or drop chain

Tremmie pipe & pin location

Rubbish Skips

Method:

- Skips must be marked as tested & certified for lifting
- Otherwise use skip cradle for all skips EXCEPT as noted above & with specific agreement with the EHS department
- Use appropriately rated & sized 4 leg chain slings attached to tested lifting lugs

Precautions:

- Never lift waste skips which are not approved for lifting
- Skips that can be lifted are identified in Lifting Plan & uniquely coloured
- Beware of overloaded skips - If in doubt, don't lift
- Skips should be netted or lids closed during lift
- Beware of rusted floors - If in doubt, don't lift.

Rubbish Skips with lifting cradle

Designated lifting skip

Steelwork

Lifting Connections

- Generally all beams and columns will be lifted using positive lifting points, i.e. Dawson shackles, LBG shackles and / or bolted on lifting plates etc.
- Wrapped chains may be used where there is no possibility of them slipping. In practice this probably means that only where chains are wrapped through holes in Metsec or castellated beams, will this technique be acceptable
- In certain exceptional circumstances traditional lifting techniques may be required, but these will be planned out where possible, and must be agreed in writing by the EHS department before any lift takes place

Steelwork

Steelwork positive lifting

Steelwork positive lifting

- Chains wrapped through holes

Precast concrete

<u>Method:</u>

- Lift using ALL manufacturers cast-in <u>lifting</u> points provided
- Use correct Lifting Accessories (check if provided by manufacturer)

<u>Precautions:</u>

- Ensure lifting eyes fully inserted & lifted at correct angle
- Ensure multiple legs slings are evenly loaded
- Consider required angle of unit to allow safe positioning
- Consider supplier constraints such as limitations on orientation or intermediate support requirements etc

Precast concrete

Gas bottles

- Bottles to be lifted in a specifically designed & fabricated lifting cage, tested etc as other lifting accessories
- Any shackle used to connect to hook etc is subject to a separate test inspection
- BOTTLES ARE NOT TO BE LIFTED HORIZONTALLY, OR IN BOAT-SKIPS OR IN ANY GENERAL BUILDERS SKIPS

Gas bottles

- Bottles are to be physically secured into lifting cradle

Gas bottles

- Bottle banks to be lifted via the supplied lifting point only

Site plant

Method:

- Only lift using integral lifting points (or refer to manufacturer instructions)

Precautions:

- Only lift from manufacturer's approved & rated lifting points (Some lugs are for transportation restraint only)
- Secure any loose equipment, including jockey/dolly wheels
- Check correct lifting shackles are used
- Visually check condition of item to be lifted. Does it look well maintained? Address any concerns to the Crane Supervisor
- Check loads & centre gravity – are fuel/oil/water tanks filled?
- Do not lift MEWPS with boom/scissor elevated.

Site plant

Site plant

Portable buildings

Method:

- 4 leg chain slings attached to designated lifting points with D Shackles or safety hooks
- Chains to be minimum 45 degrees to horizontal

Precautions:

- Remove all heavy items or hazards inside, before lifting
- Only lift high enough to place on trailer and under no circumstances to lift over anything or anybody
- Do not walk the roof to remove chains. Use ladders safely to access chains or shackles
- Connect fall prevention lanyard to crane hook via inertia reel if necessary

Portable buildings

Portable buildings

Forklift Lifting Suspended Loads

Forklifts used in this manner are regarded as Cranes

Method:

- An approved certificated Lifting Attachment must be used, centred between the forks
- Assess accessories for individual requirements
- Safe working load is as marked

Precautions:

- Forklifts lifting suspended loads must be controlled by a Slinger / Signaller

Forklifts

Forklifts attachment

Multiple lifts

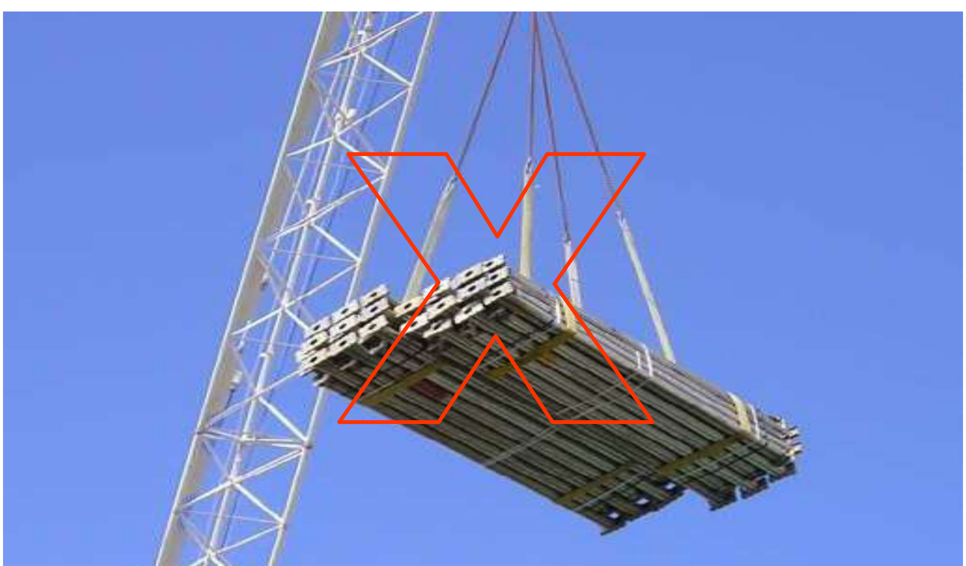
Method:

- Multiple items can be slung & lifted together provided there is no risk of loss of load (or part load), both are level with one another, & there is a safe method of removing the lifting gear once landed
- Both must be treated as individual loads & slung accordingly

Precautions:

- Multiple lifts are to be agreed with the Lifting Coordinator
- Beware when removing slings / chains etc – load may shift

Acceptable?



Acceptable?

Chandelier lift

Where 2 or more loads are lifted simultaneously, one being slung directly above the other, on a common hook

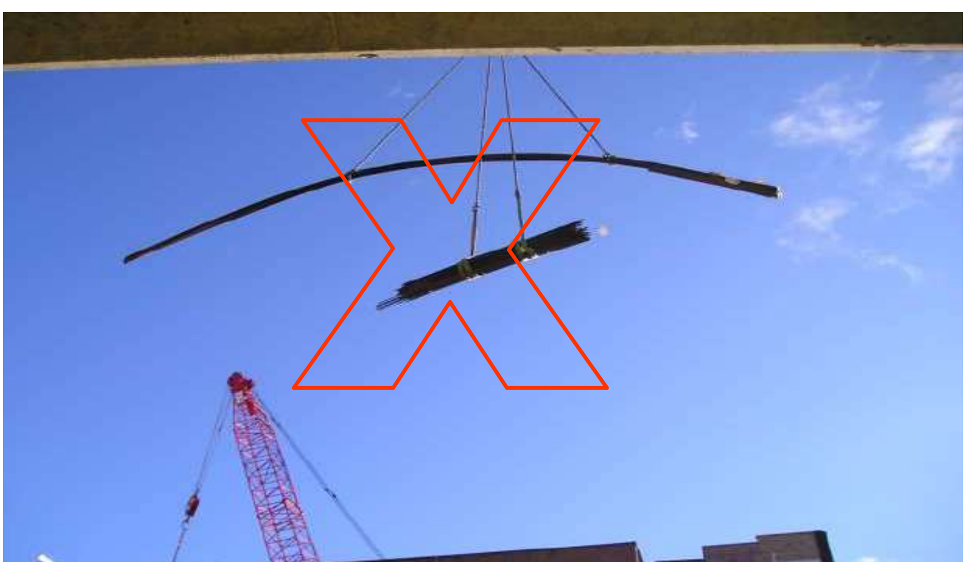
Method:

- Each load is to be treated as an individual load & slung accordingly

Precautions:

- Where loads are of unequal lengths, the longer load must be slung as the LOWEST load, & the lengths reduced progressively upwards
- Tag lines are essential
- There is a safe method of removing the lifting gear once landed

Unacceptable…Why?



Tandem lifting

- Tandem lifts are NOT to be carried out by Tower Cranes
- Any tandem lift is to be the subject of a separate Method Statement & full Risk Assessment process

Specialised lifts – Glass stillage

- Stillages should be used when lifting glass
- Glass to be secured to the stillage
- Stillage should be thoroughly examined & tested

Specialised lifts – Glass stillage

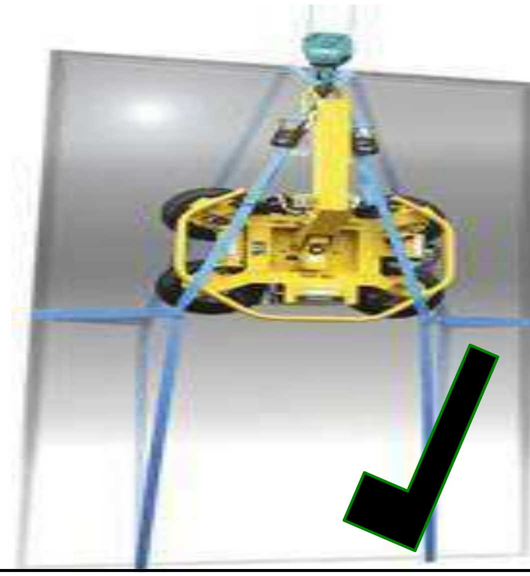
- Plate showing SWL on glass stillage and date of thorough examination
- Lifts should be planned by a competent person

Specialised lifts – vacuum lifters

- Subject to thorough examination
- Trained and competent operators only to use
- Secondary means of support required

Specialised lifts – vacuum lifters

- A secondary mechanical device must be used when using vacuum lifters
- These may need removal for FINAL locating



Specialised lifts – vacuum lifters

- SWL is shown, lifter is to be checked daily prior to use for serviceability
- Battery power must be at least 25%

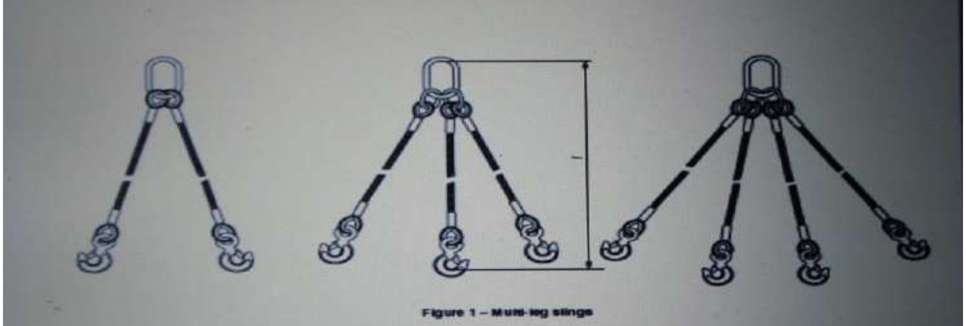
Specialised lifts – vacuum lifters

- The SWL of this machine is 8 tonnes, with each of the vacuum pads rated at 2t.

Specialised lifts – vacuum lifters

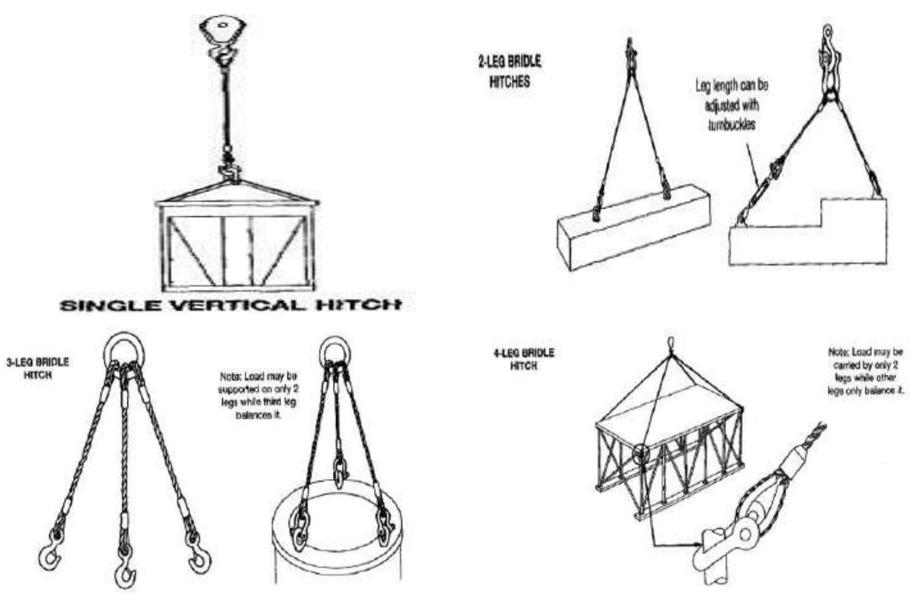
- Each pad has a non-return valve to maintain vacuum, giving a maximum stated time of 20 minutes to lower the load safely

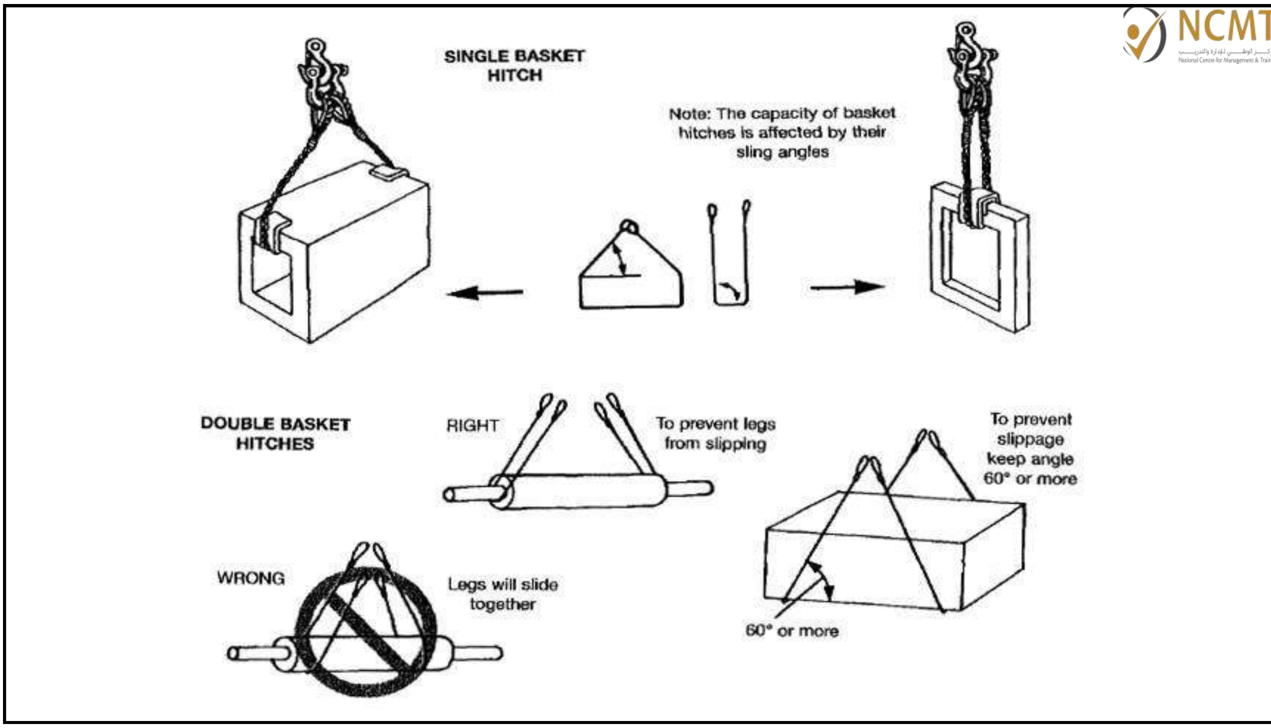
MULTI LEG SLINGS

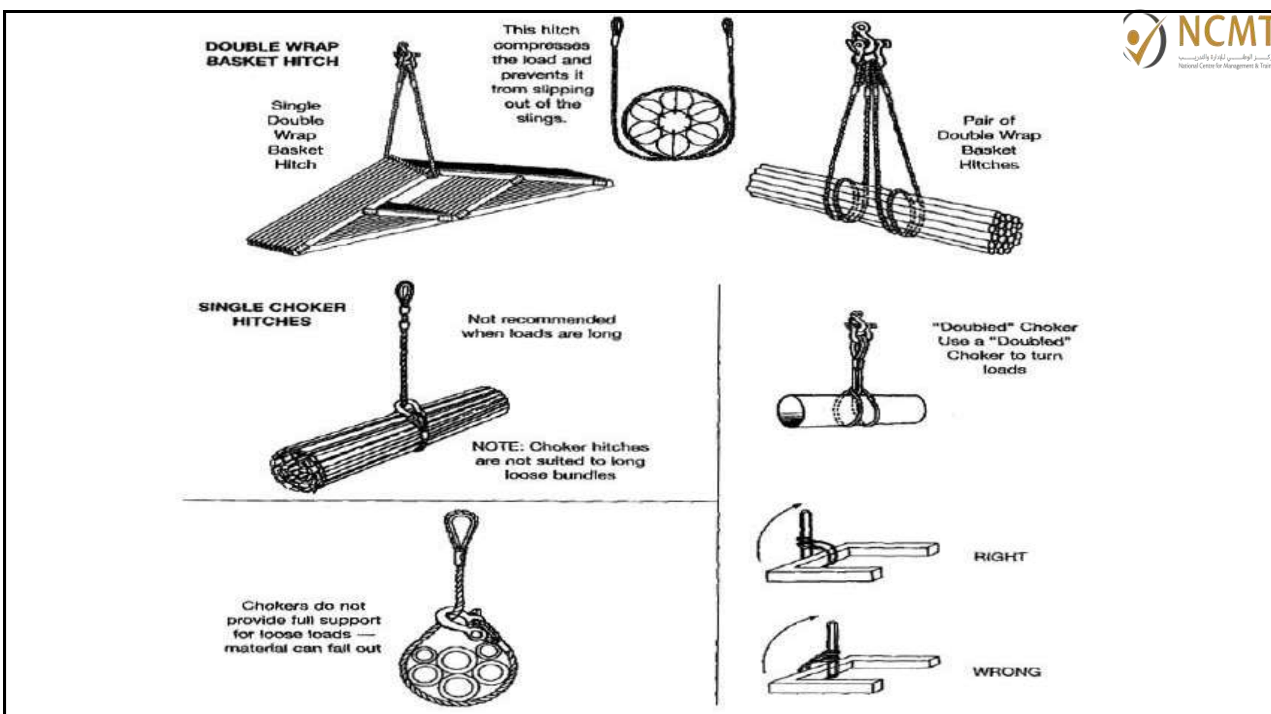


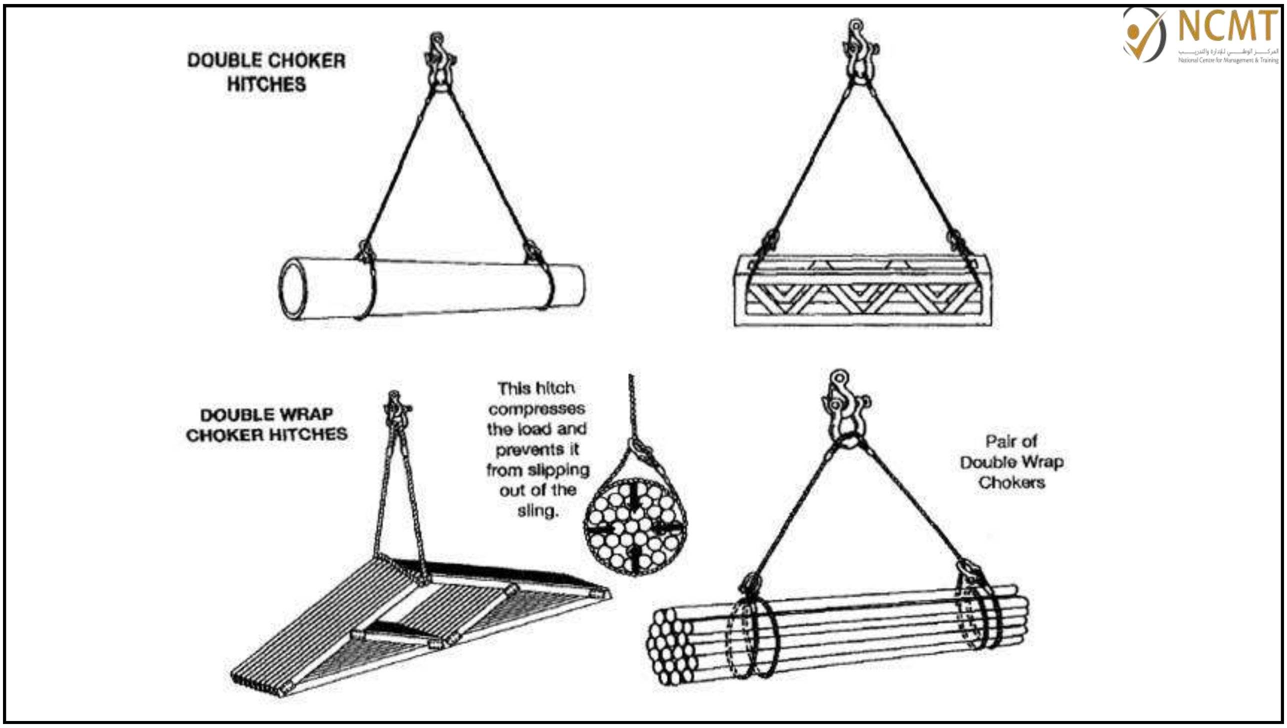
If the lengths of the legs of a multilegged chain sling are unequal, overload should be suspected.

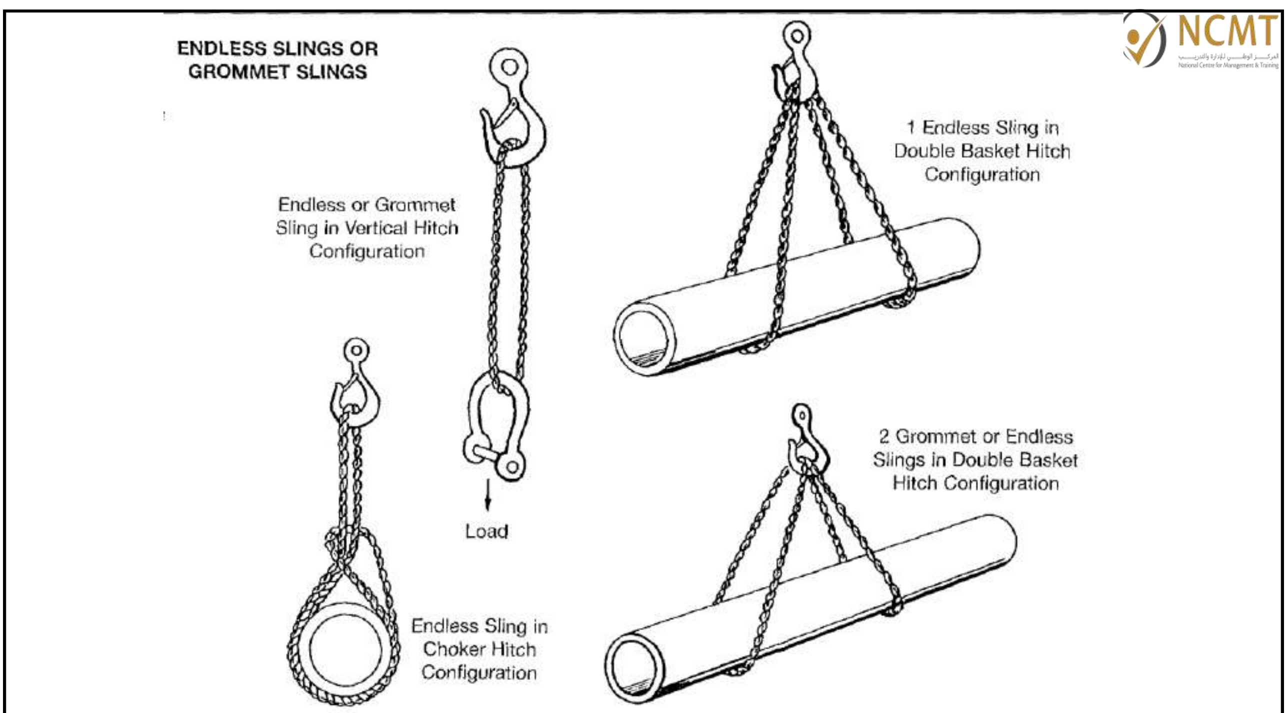
Sling Configurations




NCMT
SINGLE BASKET HITCH
Note: The capacity of basket hitches is affected by their sling angles
DOUBLE BASKET HITCHES
RIGHT
To prevent legs from slipping
To prevent slippage keep angle 60° or more
WRONG
Legs will slide together
60° or more


NCMT
DOUBLE WRAP BASKET HITCH
Single Double Wrap Basket Hitch
This hitch compresses the load and prevents it from slipping out of the slings.
Pair of Double Wrap Basket Hitches
SINGLE CHOKER HITCHES
Not recommended when loads are long
NOTE: Choker hitches are not suited to long loose bundles
"Doubled" Choker Use a "Doubled" Choker to turn loads
Chokers do not provide full support for loose loads — material can fall out
RIGHT
WRONG


DOUBLE CHOKER HITCHES
DOUBLE WRAP CHOKER HITCHES
This hitch compresses the load and prevents it from slipping out of the sling.
Pair of Double Wrap Chokers


ENDLESS SLINGS OR GROMMET SLINGS
Endless or Grommet Sling in Vertical Hitch Configuration
Load
1 Endless Sling in Double Basket Hitch Configuration
2 Grommet or Endless Slings in Double Basket Hitch Configuration
Endless Sling in Choker Hitch Configuration

Factor of Safety

- A factor of safety is applied to a rigging system after all known loads and strengths have been considered.
- It is intended to allow for unknown variability of material, deterioration of equipment over time, acceleration and other unforeseeable loads, and the like.
- The usual factor of safety is 5 (1 : 5)

$$\text{Factor of safety} = \frac{\text{The Breaking Strength}}{\text{Force to be applied}}$$

SAFE WORKING LOAD

$$\text{MAX. S.W.L.} = \frac{\text{CATALOGUE BREAKING STRENGTH OF ROPE}}{\text{FACTOR OF SAFETY}} = \frac{\text{CATALOGUE BREAKING STRENGTH OF ROPE}}{5}$$

EXAMPLE: If the wire rope catalogue gives the breaking strength of the rope as 10 tons, the maximum safe working load is'

$$\text{Max. S.W.L.} = \frac{10 \text{ tons}}{5} = 2 \text{ tons}$$

SAFE WORKING LOAD

Rule of Thumb of Computing Rope S.W.L.

S.W.L. = Rope Diameter x Rope Diameter x 8

EXAMPLE:

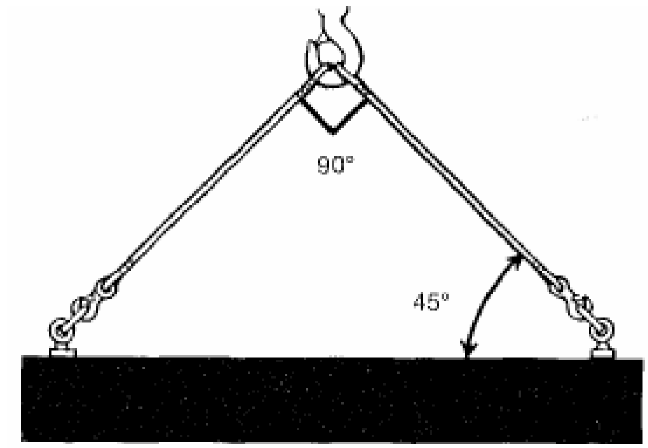
(a) 1/2 inch diameter rope
SWL = 1/2 x 1/2 x 8 = 2 tons
(b) 5/8 inch diameter rope
SWL = 5/8 x 5/8 x 8 = 3.125 tons
(c) I inch diameter rope
SWL = 1 x 1 x 8 = 8 tons

SWL OF SLINGS

SAFE WORKING LOAD OF SLING	INCLUDED ANGLE θ	SAFE WORKING LOAD WITH ANGLEθ
G = 10 TON at 90	90	10 TON
	160	3.45 TON
	140	6.80 TON
	120	7.07 TON
	60	12.25 TON
P = G / Cos 45	0	14.14 TON
SWL at angle =P X Cosθ /2		

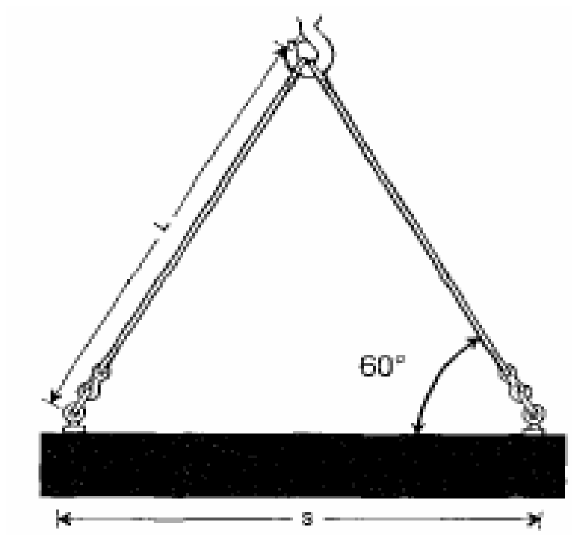
SLING ANGLES AND SAFE WORKING LOADS

90˚ angle at hook corresponds
to 45˚ sling angle



SLING ANGLES AND SAFE WORKING LOADS

When L = S
Sling angle is 60˚



SLING ANGLES AND SAFE WORKING LOADS

Calculating SWL

H is the vertical distance from the saddle

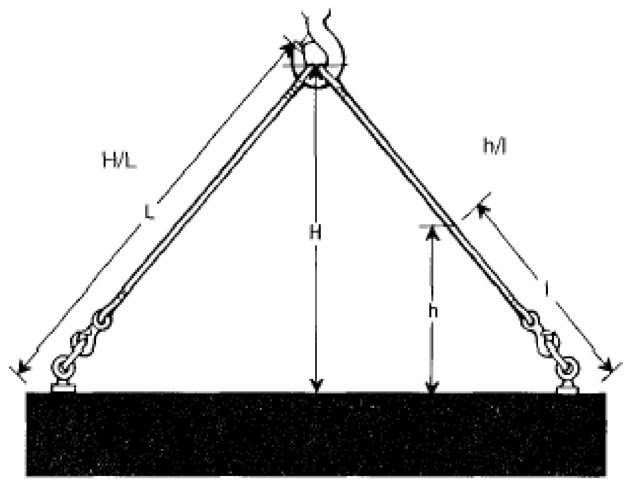
of the hook to the top of the load.

L is the distance measured along the

sling from the saddle of the hook to the

top of the load.

The ratio H/L will be same as the ratio h/l



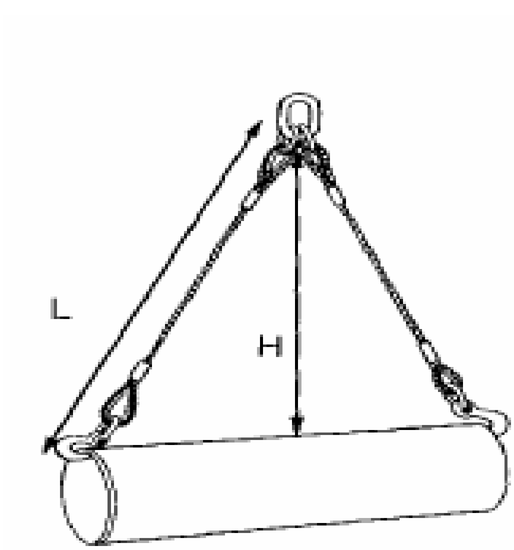
SLING ANGLES AND SAFE WORKING LOADS

Determining capacity of 2-Leg Bridle

Hitch

SWL

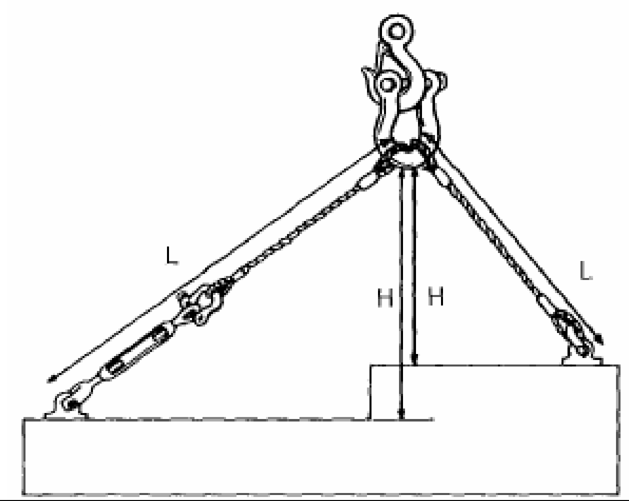
= SWL (of single vertical hitch) X H/L X 2



SLING ANGLES AND SAFE WORKING LOADS

When sling legs are not of equal length

use smallest H/L ratio.



SLING ANGLES AND SAFE WORKING LOADS

Determining capacity of 3-Leg Bridle

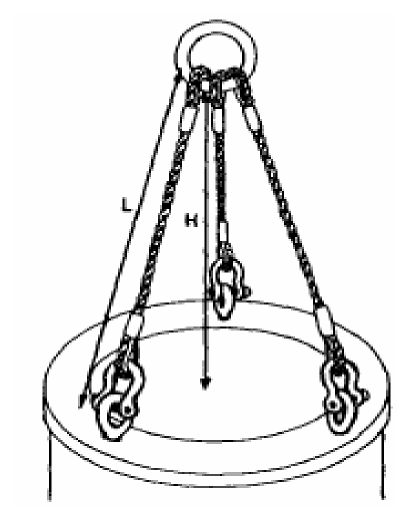
Hitch

SWL

= SWL (of single vertical hitch) X H/L X 3

When sling legs are not of equal length

use smallest H/L ratio.



SLING ANGLES AND SAFE WORKING LOADS

Determining capacity of 4-Leg Bridle

Hitch

Load may be carried by only 3 legs while

the fourth merely balances it. Therefore

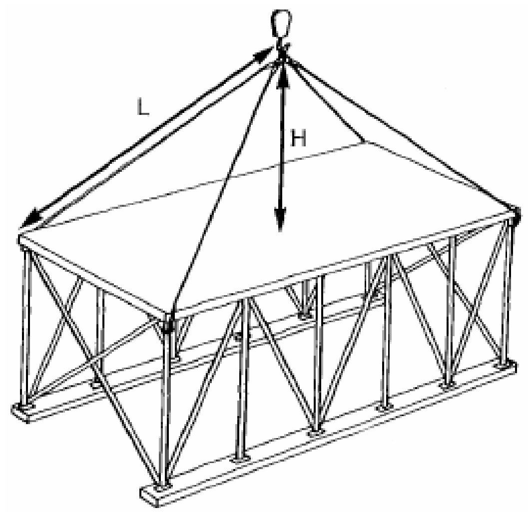
the recommended SWL is:

SWL

= SWL (of single vertical hitch) X H/L X 3

When sling legs are not of equal length

use smallest H/L ratio.



SLING ANGLES AND SAFE WORKING LOADS

Determining capacity of Single Basket

Hitch

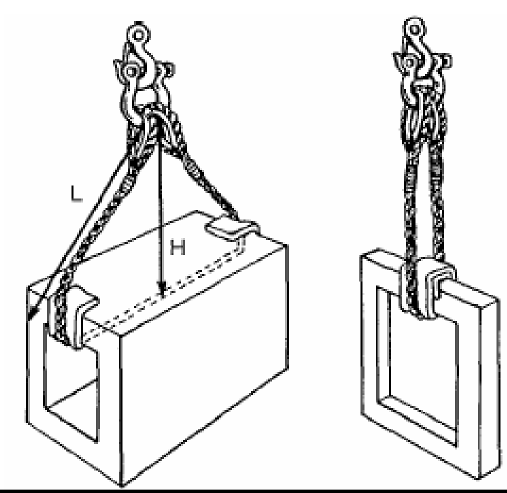
For Vertical legs (fig A):

SWL = SWL (of single vertical hitch) X 2

For inclined legs (fig B):

SWL

= SWL (of single vertical hitch) X H/L X 2



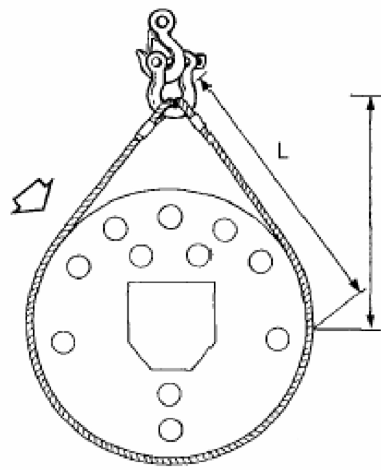
SLING ANGLES AND SAFE WORKING LOADS

Determining capacity of Double Basket

Hitch with inclined angles

SWL

= SWL (of single vertical hitch) X H/L X 4



SLING ANGLES AND SAFE WORKING LOADS

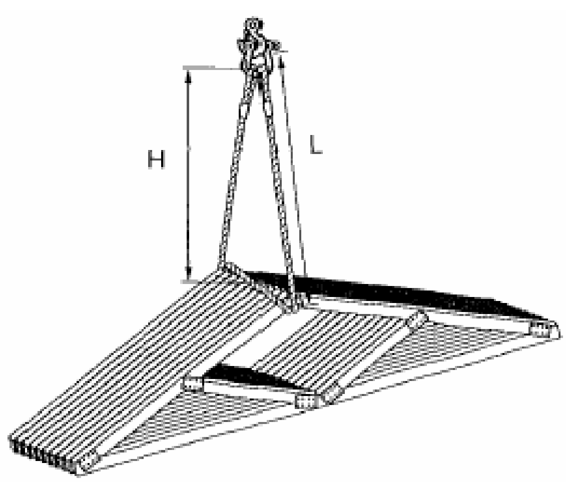
Determining capacity of Double Wrap

Basket Hitch

Depending on the configuration, SWLs

are the same for the Single Basket Hitch

or the Double Basket Hitch.



SLING ANGLES AND SAFE WORKING LOADS

Sling angles less than 45˚ (formed by the

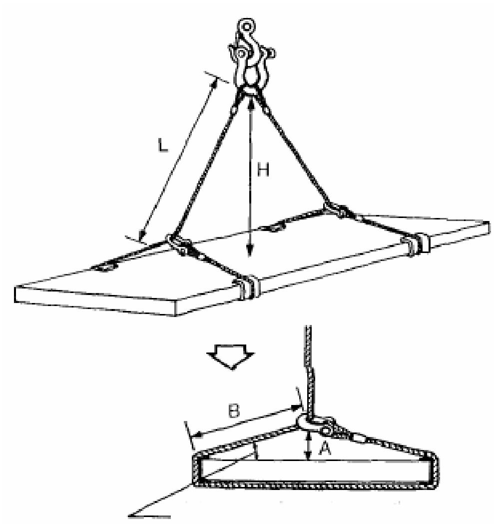
choker) are not recommended. If they

must be used the formula is:

SWL

= SWL (of single vertical hitch) X H/L X

A/B X 2



SLING ANGLES AND SAFE WORKING LOADS

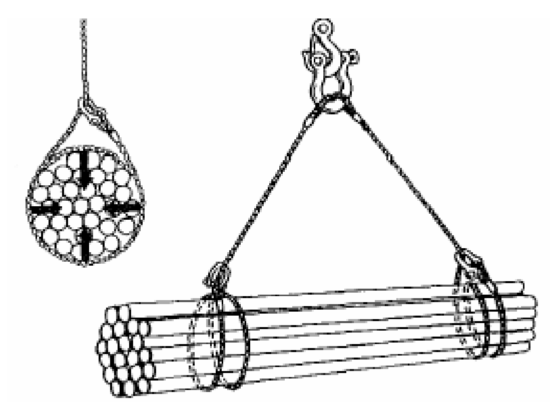
Determining capacity of Double Wrap

Choker Hitch

Depending on the configuration, SWLs

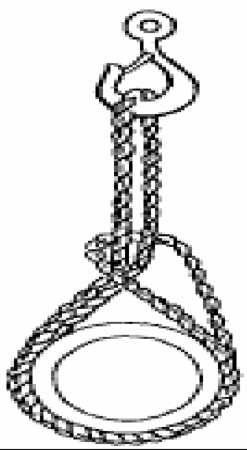
are the same for the Single Choker Hitch

or the Double Choker Hitch.

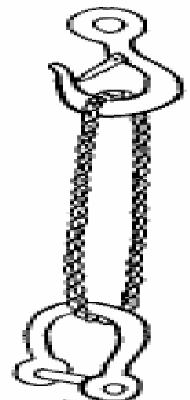


SLING ANGLES AND SAFE WORKING LOADS

Endless Sling choker Hitch Configuration



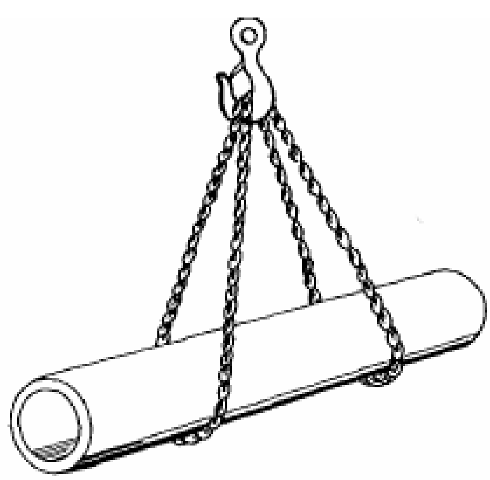
Endless or Grommet Sling in Vertical Hitch



SLING ANGLES AND SAFE WORKING LOADS

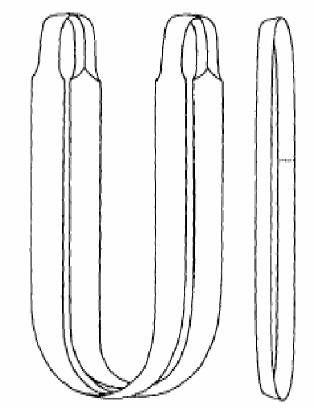
Endless Sling in Double Basket Hitch

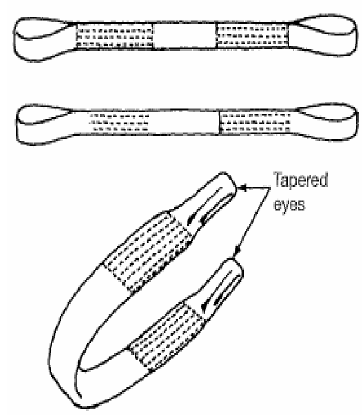
Configuration



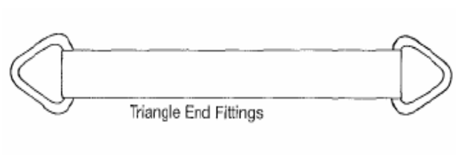
SLING ANGLES AND SAFE WORKING LOADS

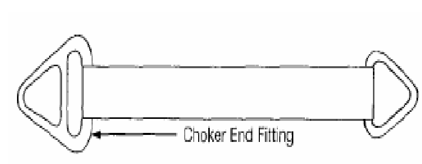
Endless or Grommet Slings   Standard Eye-to Eye slings

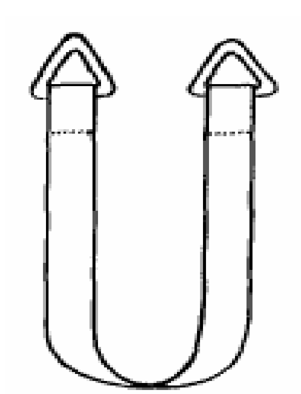


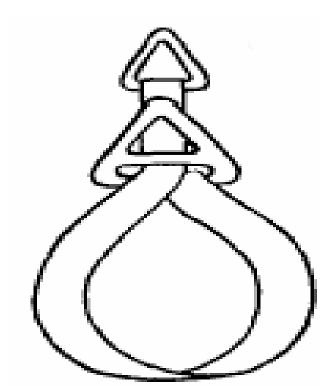


SLING ANGLES AND SAFE WORKING LOADS

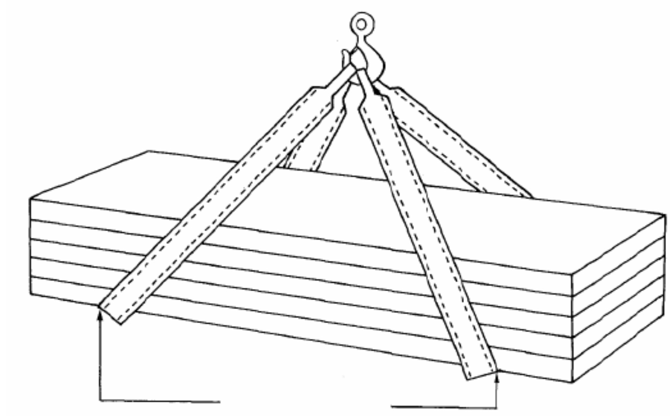




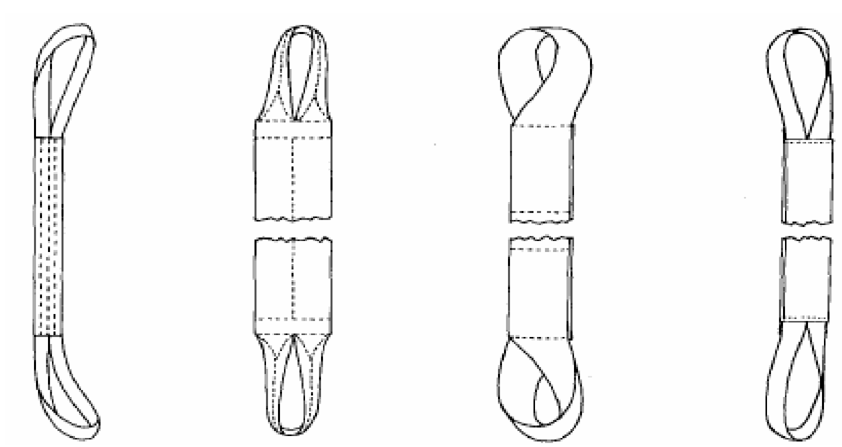




Effect of sling angle on Webbing



Twisted Eye Slings



Basic Sling Operating Practices (ANSI B30.9)

<u>Whenever any sling is used, the following practices shall be observed!</u>

1. Slings that are damaged or defective shall not be used.
2. Slings shall not be shortened with knots or bolts or other makeshift devices.

Basic Sling Operating Practices (ANSI B30.9)

3. Sling legs shall not be kinked.
4. Slings shall not be loaded in excess of their rated capacity.
5. Slings used in a Basket Hitch shall have the load balanced to prevent slippage.
6. Slings shall be securely attached to the load.

Basic Sling Operating Practices (ANSI B30.9)

7. Slings shall be padded or protected from the sharp edges of their loads.
8. Suspended loads shall be kept free of obstructions.
9. All employees shall be kept clear of loads about to be lifted and of suspended loads.

Basic Sling Operating Practices (ANSI B30.9)

10. Hands or fingers shall not be placed between the sling and it's load while the sling is being tightened around the load.
11. Shock loading is prohibited.
12. A sling shall not be pulled from under a load when the load is resting on the sling.

Basic Sling Operating Practices (ANSI B30.9)

INSPECTION

Each day before being used, the sling and all fastenings and attachments shall be inspected for damage and defects by a ***competent person designated by the employer***. Additional inspections shall be performed during sling use as ***often as necessary*** to assure the safety of the operation.

Basic Sling Operating Practices (ANSI B30.9)

REPLACEMENT

Severe localized Abrasion or Scraping.

Ten Randomly Distributed Broken Wires in one Rope Lay, or Five Broken Wires in One Rope Strand in One Rope Lay.

Evidence of Heat Damage. (Cut with a Torch)

Basic Sling Operating Practices (ANSI B30.9)

REPLACEMENT

Kinking, Crushing, Birdcaging, or Any Damage Resulting in Distortion of the Rope Structure.

Damaged, Distorted or Field Welded Hooks.

Damaged or Worn End Attachments.

If In Doubt*, *Don't Use It!

GUIDELINES FOR SLINGER/BANKSMAN

1. Do everything possible to ensure the safety of personnel and equipment.
2. Be familiar with the crane working range,load radius and boom angle.
3. Know and understand appropriate safe slinging principles.
4. Inspect lifting accessories each time before use.
5. Know the weight of the load and the slinging methodology.
6. Be able to select the correct equipment for the job in hand.
7. Be aware of obstructions and hazards within operating range.
8. Know and understand the method of banksman hand signals.
9. Give clear and precise hand signals.
10. Use correct protocol during radio communication.

GUIDELINES FOR SLINGER/BANKSMAN

11. Warn personnel in the area of the movement of the load.
12. Never lift a load over personnel.
13. Never stand beneath a load or allow other personnel to do so.
14. Ensure hands are clear from lifting gear prior to lifting loads.
15. Always ensure an escape route is available prior to lifting loads.
16. Always use tag lines especially for awkward loads.
17. Ensure a minimum of **3** personnel is deployed for each lifting operation. I.E. Crane operator, Banksman and slinger.
18. If anything out of the ordinary occurs - **STOP and CHECK.**
19. Be aware of potential snagging points in the vicinity of the load whilst hoisting/lowering in restricted areas.
20. Be aware of wind speed and direction which could affect the lifting operation.

RIGGER TRAINING

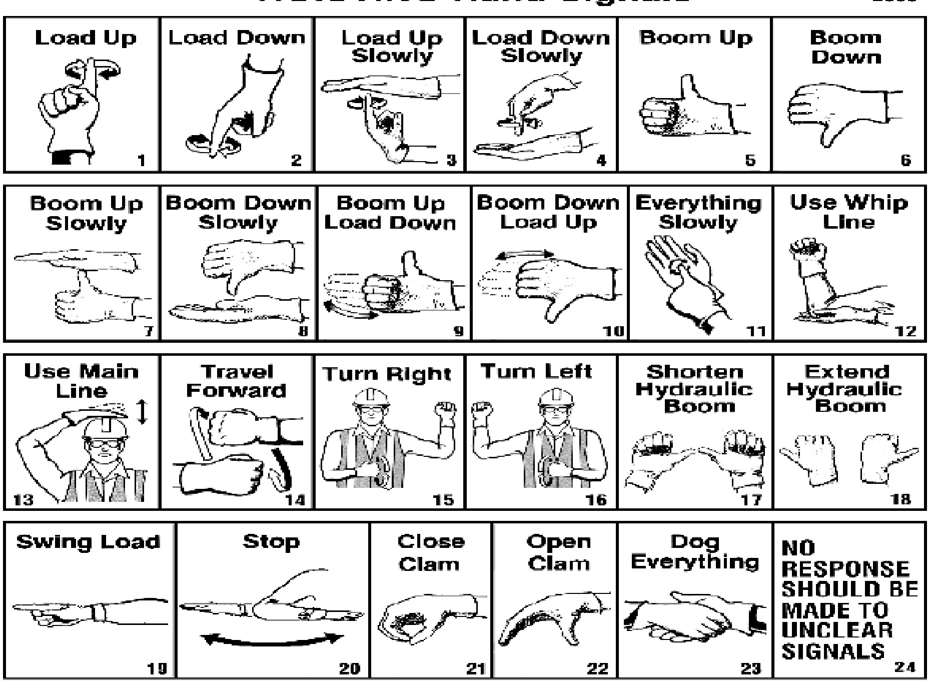
SIGNAL SAFETY

Two-Way Radio Communication

- It is strongly recommended that 2-way radios be used on all craning operations where the signaling is required. There are far too many accidents that result from misunderstood or misinterpreted hand signals and all could have been avoided by using voice communication.
- The signalperson must constantly talk to the operator at all times during loading operations. If for any reason the signalperson stops talking the operator must stop the operation.
- Adequate lighting arrangements and radio communications must be provided for all night operations.

HOISTING Hand Signals

2008

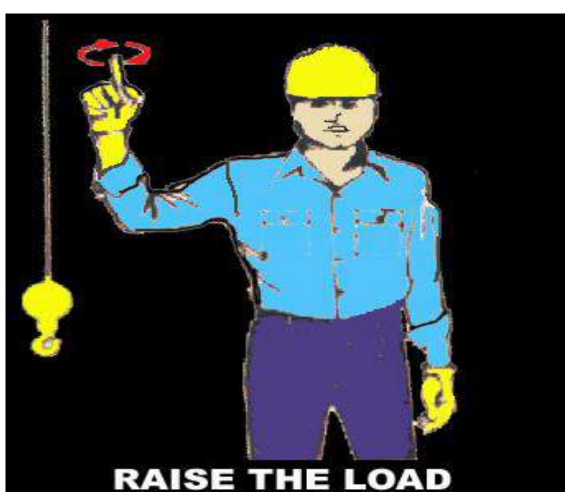


Hand Signals

Signalperson: **Signals shall be Discernible or audible at all times. No response shall be made unless signals are clearly understood.**

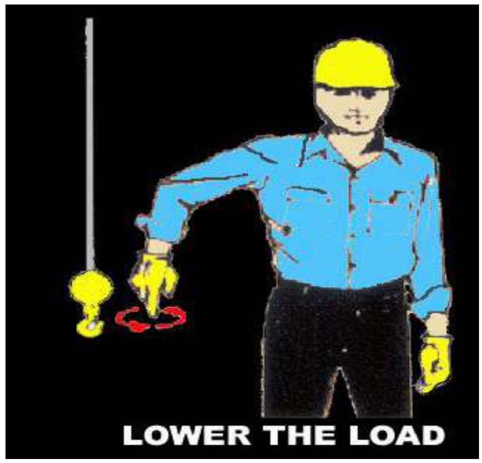
Hand Signals - Hoist

Hoist: **With the forearm vertical, forefinger pointing up, move hand in small horizontal circle.**



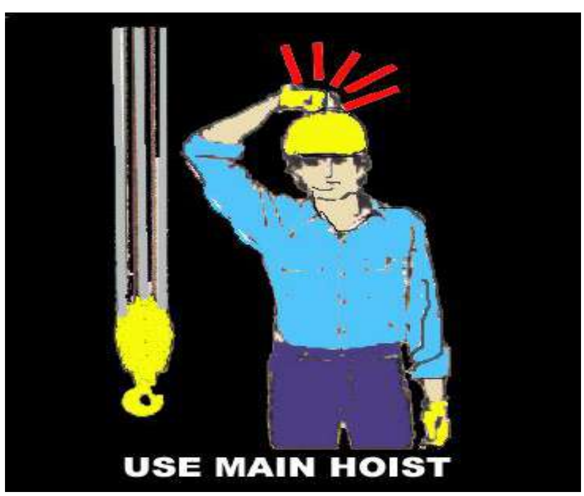
Hand Signals - Lower

Lower: With the arm extended downward, forefinger pointing down move hand in small horizontal circle



Hand Signals – Main Hoist

Use Main Hoist: Tap fist on top of head then use regular signals.

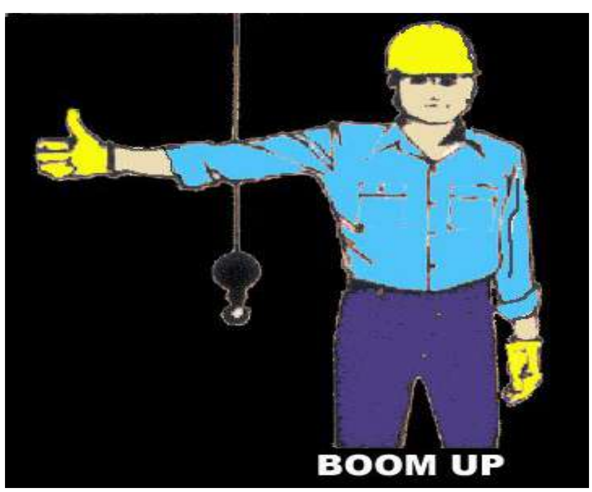


Hand Signals – Whip-line

Use Whip-Line: **(Auxiliary Hoist) Tap elbow with one hand, then use regular signals.**

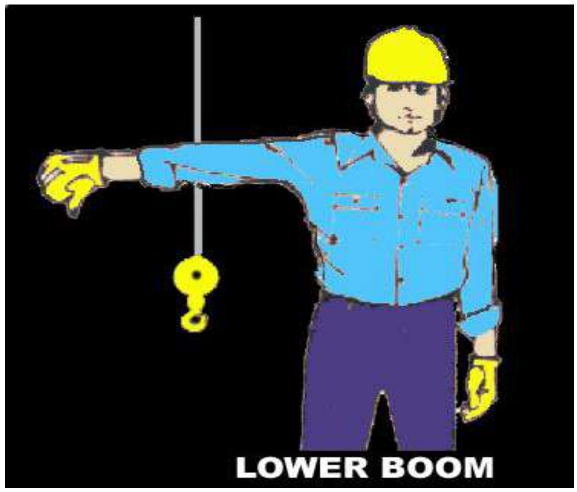
Hand Signals – Raise Boom

Raise Boom: **Arm extended fingers closed with thumb pointing upward.**



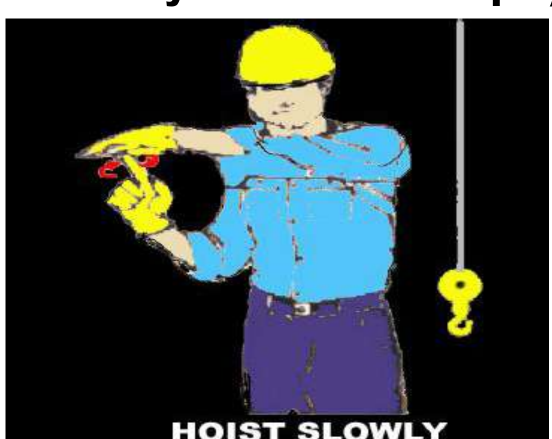
Hand Signals – Lower Boom

Lower Boom: **Arm extended fingers closed with thumb pointing downward.**



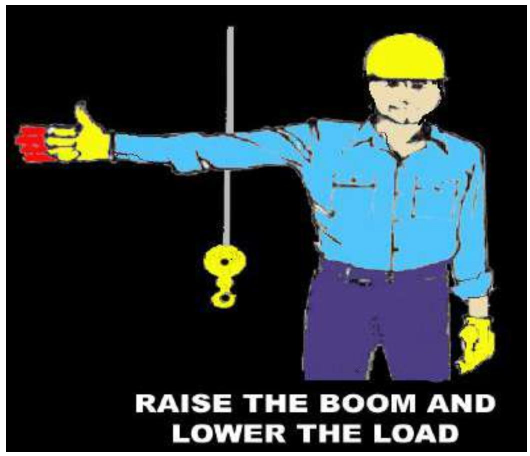
Hand Signals – Move Slowly

Move Slowly: **Use one hand to give any motion signal and place the other hand motionless in front of hand giving the motion signal (Hoist slowly shown as example).**



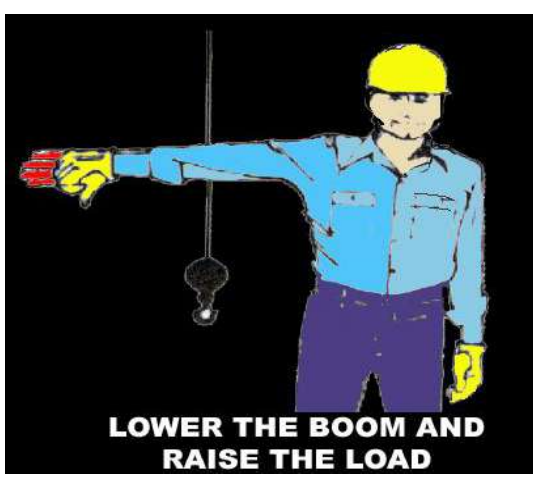
Hand Signals – Raise Boom & Lower the Load

Raise the Boom & Lower the Load: With arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired.



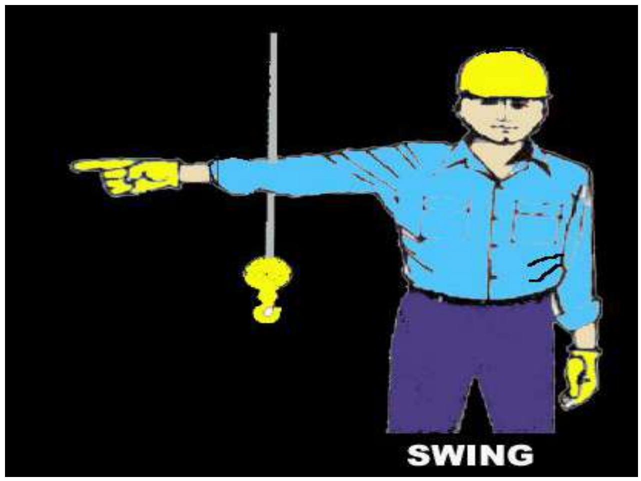
Hand Signals – Lower the Boom & Raise the Load

Lower the Boom & Raise the Load: With arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired.



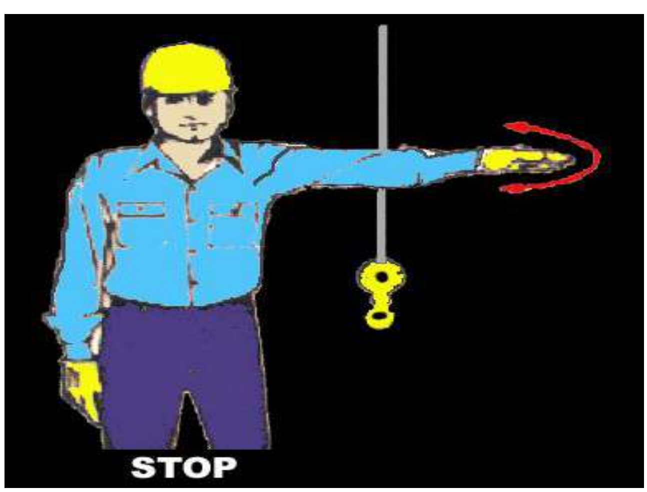
Hand Signals - Swing

Swing: **Arm extended, point with finger in direction of swing of boom.**



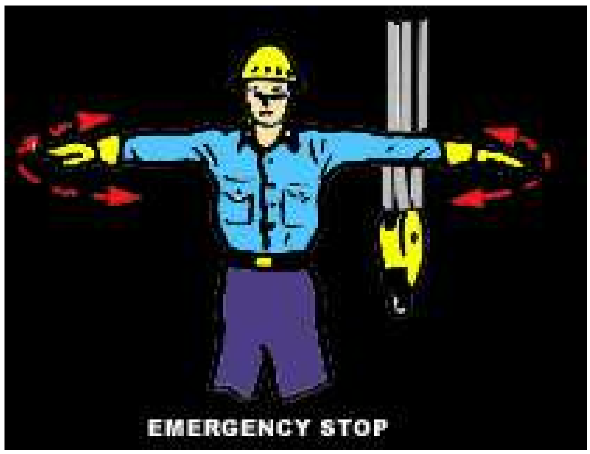
Hand Signals - Stop

Stop: **Arm extended, palm down, move arm back and forth horizontally.**



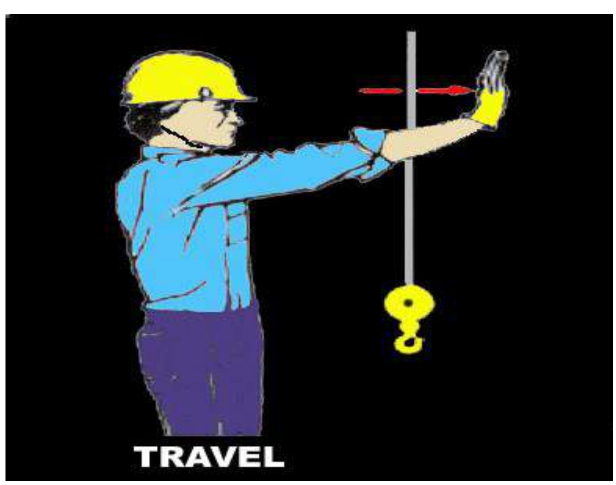
Hand Signals – Emergency Stop

Emergency Stop: **Both arms extended, palms down, move arms back and forth horizontally.**



Hand Signals - Travel

Travel: **Arm extended forward hand open and slightly raised make a pushing motion in direction of travel**



Hand Signals Dog Everything

Dog Everything: **Clasp hands in front of body.**

Hand Signals – Travel Both Tracks

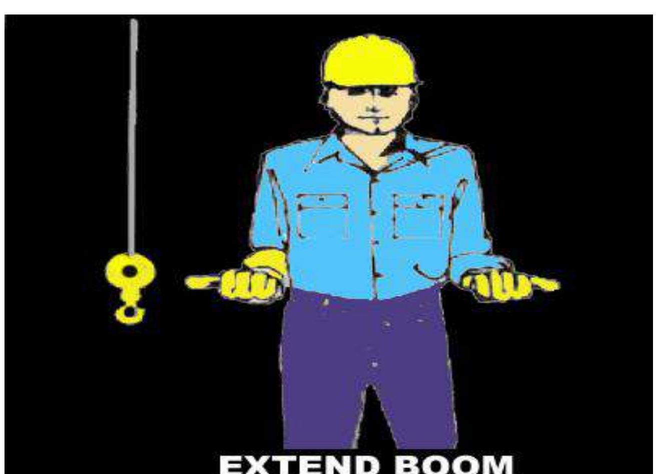
Travel Both Tracks: Use both fists in front of body, making a circular motion about each other, indicating direction of travel, forward or backward. (For land cranes only)

Hand Signals – Travel One Track

Travel One Track: Lock the track on side indicated by raising fist. Travel opposite direction indicated by circular motion of other fist, rotated vertically in front of body. (For land cranes only)

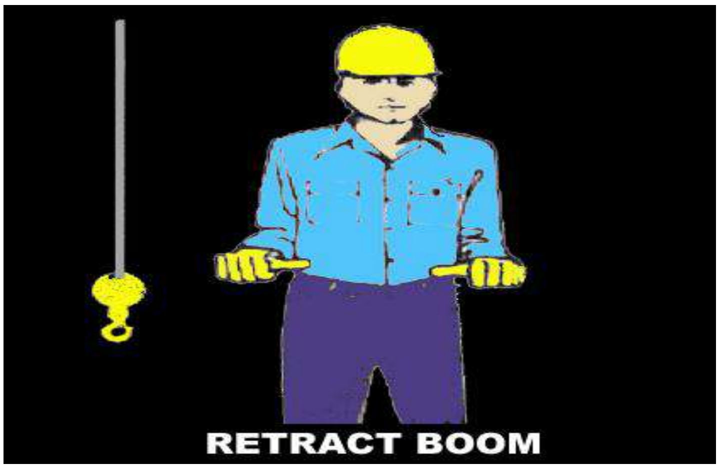
Hand Signals – Extend Boom

Extend Boom: (Hydraulic cranes) Both fists in front of body with thumbs pointing outward.



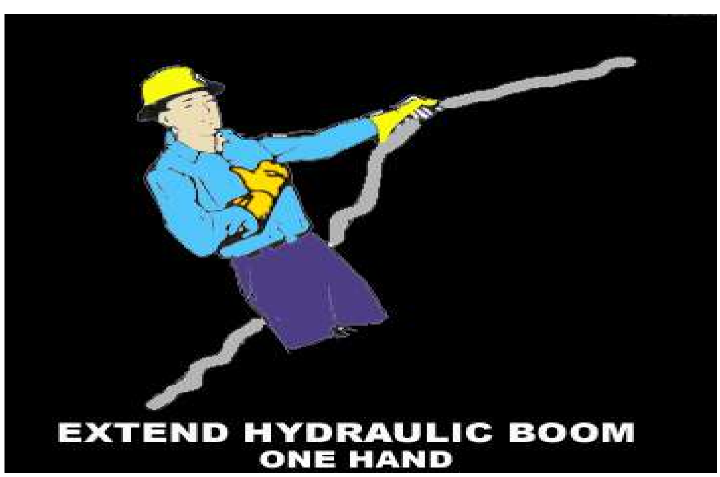
Hand Signals – Retract Boom

Retract Boom: (Hydraulic cranes) Both fists in front of body with thumbs pointing towards each other.



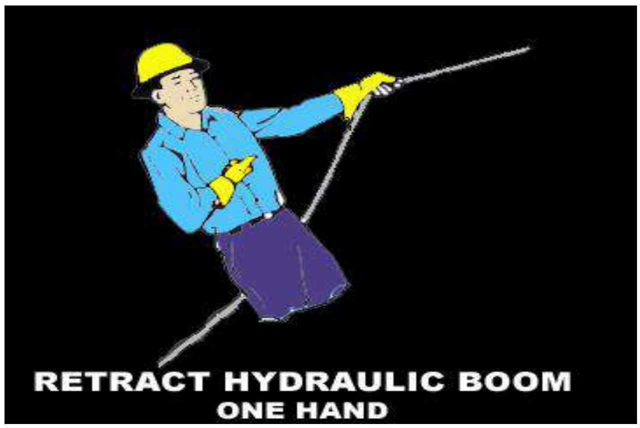
Hand Signals – Extend Boom One Hand

Extend Boom – One Hand Signal: (Hydraulic cranes) One fist in front of chest with thumb tapping on chest.



Hand Signals – Retract Boom One Hand

Retract Boom – One Hand Signal:
(Hydraulic cranes) One fist in front of chest with thumb pointing outward and heel of fist tapping on chest.



Hand Signals – Special Hand Signals

ANSI B30.5-3.3.3 Special Signals:

- **For operations not covered by ANSI B30.5-3.3.2, or for special conditions that occur from time to time, additions to or modifications of the standard signals may be required. In all such cases, these special signals shall be agreed upon in advance by both the operator and the signalperson, and should not be in conflict with the standard signals.**

Audible Travel Signals

ANSI B30.5-3.3.4 Audible Travel Signals:

1. **When moving the vehicle, the following signals shall be used;**

   A. **STOP**
   One Audible Signal

   B. **GO AHEAD**
   Two Audible Signals

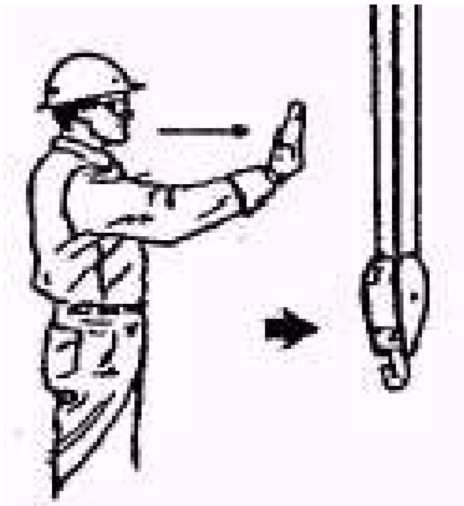
   C. **BACK-UP**
   Three Audible Signals

Hand Signals – Special Hand Signals

ANSI B30.5-3.3.5 Instructions:

➔ **If it is desired to give instructions to the crane operator, other than those provided by the established signal system, the crane motions shall be stopped.**

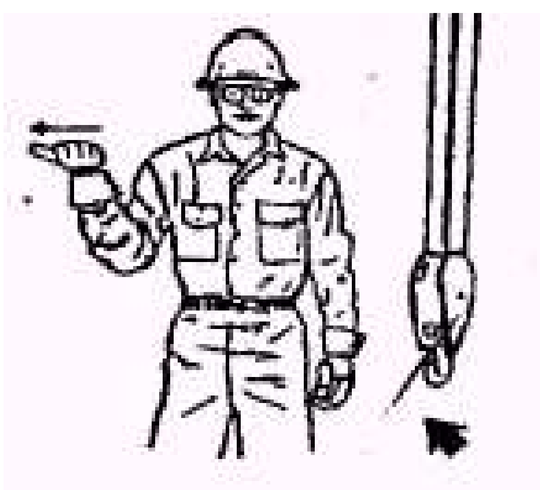
Standard Hand Signals For Controlling Overhead Cranes



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

BRIDGE TRAVEL

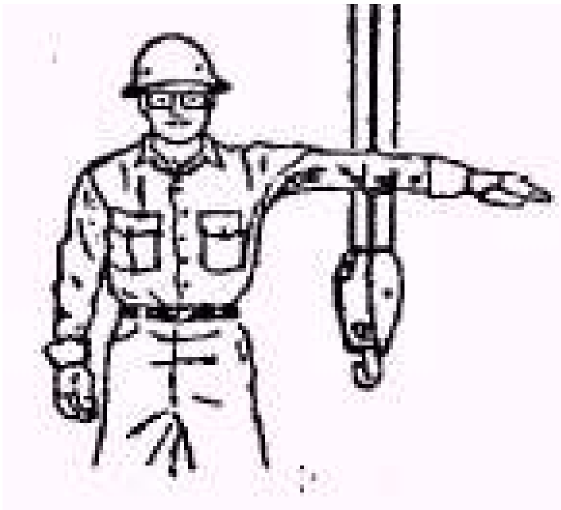
Standard Hand Signals For Controlling Overhead Cranes



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

TROLLEY TRAVEL

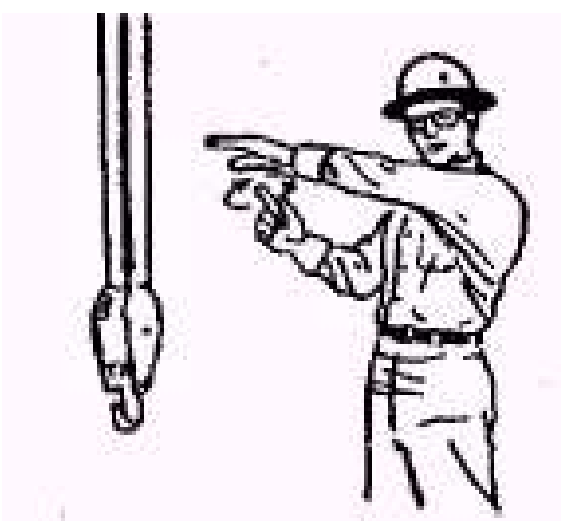
Standard Hand Signals For Controlling Overhead Cranes



Arm extended, palm down, hold position rigidly.

STOP

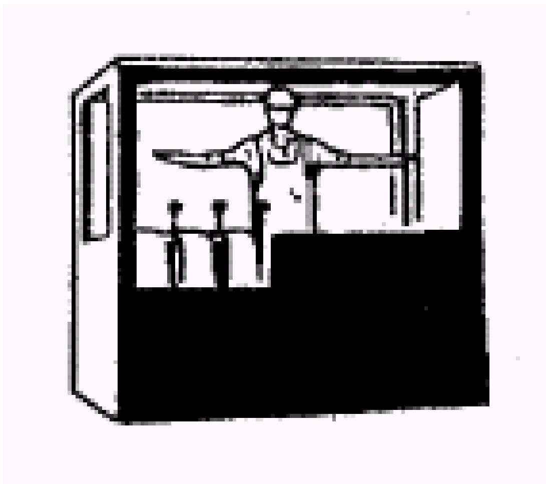
Standard Hand Signals For Controlling Overhead Cranes



Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal. (Hoist Slowly shown as an example.)

MOVE SLOWLY

Standard Hand Signals For Controlling Overhead Cranes



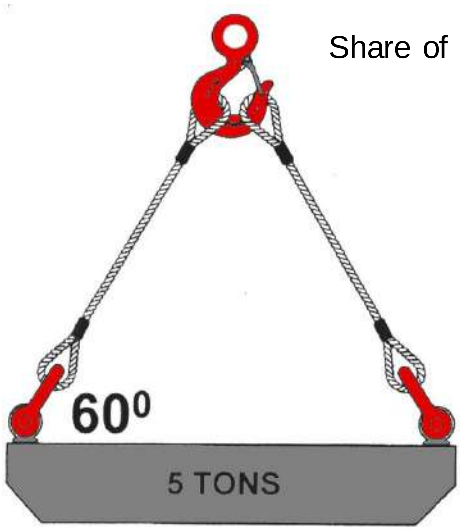
Crane operator spreads both hands apart – palms up.

MAGNET DISCONNECTED

Eleven questions for safe hoisting (work permit)

- Are all those involved familiar with the rules and procedures for the hoisting assignment?
- Have all those involved visited the Toolbox?
- Have the necessary hoisting/lifting equipment and materials been inspected and given a:
  - Safe hoisting weight
  - Unique identification number
  - Valid inspection date?
- Are all the safety provisions operating correctly?
- Is everyone aware of who the responsible supervisor is for these hoisting activities?
- Is everyone properly qualified and aware of their assigned tasks?
- Is there a plan to carry out a task risk analysis and/or risk inventory & evaluation for the job and does everyone understand the hoisting assignment and the precautionary measures?
- Do we know under what weather conditions the hoisting work needs to be suspended (e.g. high winds)?
- Has the hoisting area been checked and is everyone positioned at a safe distance in the event that the load swings or falls?
- Have the communication methods been agreed and are they clear?
- Is the hoisting equipment being used in the correct way?

Sling Angles



Load Angle Factor **1.155**

Share of Load In Each Sling **5,000#**

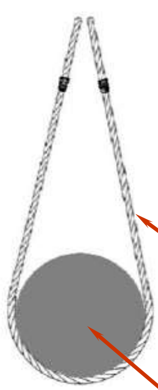
Load Per Sling **5,775#**

Sling Size **5/8”**

Shackle Size **3/4”**

Never use a D to d ratio of 1:1 or less. Always use at least one size larger shackle than wire rope size.

D to d IS EXTREMELY IMPORTANT IN RUNNING ROPES ON A CRANE. THE LARGER THE SHEAVES, THE LESS BENDING FATIGUE IN THE ROPE.



SAME AS BENDING A PAPER CLIP

D to d

Sling Angles

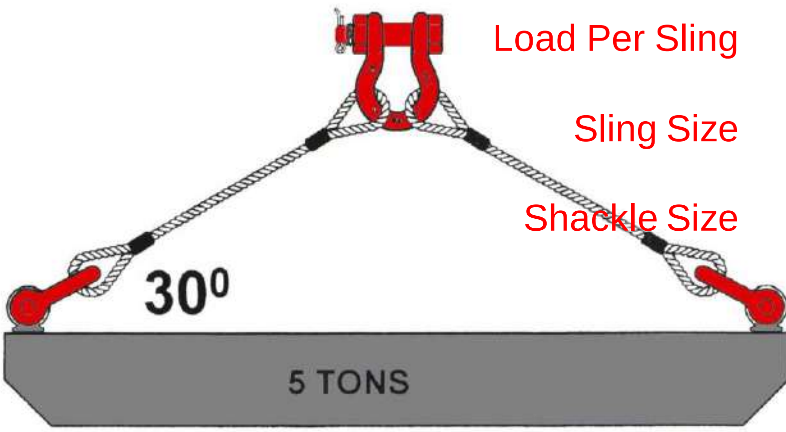
Load Angle Factor 2

Share of Load In Each Sling 5,000#

Load Per Sling 10,000#

Sling Size 7/8”

Shackle Size 1”



Sling Angles

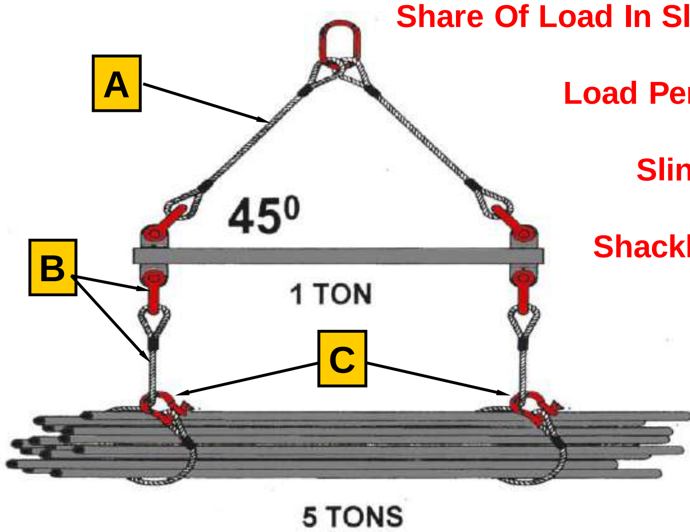
Load Angle Factor 1.414

Share Of Load In Slings A 6,000#

Load Per Sling A 8,484#
B 5,000#

Sling Size A 3/4”
B 3/4”

Shackle Size A 7/8”
B 7/8”
C 7/8”



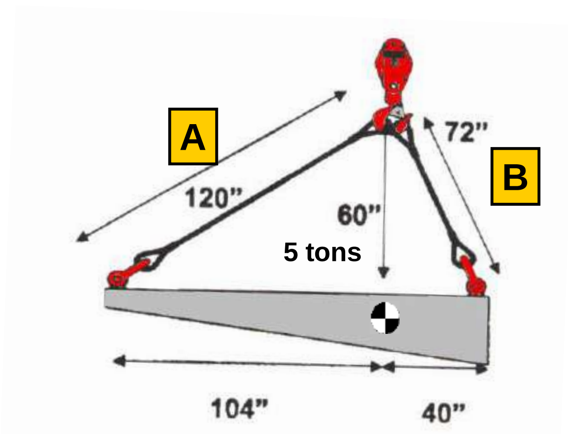
Center Of Gravity

Load Angle Factor A________

Load Angle Factor B________

Share Of Load Sling A________

Share Of Load Sling B________



Load Sling A________

Load Sling B________

Sling A Size________

Sling B Size________

Shackle A Size________

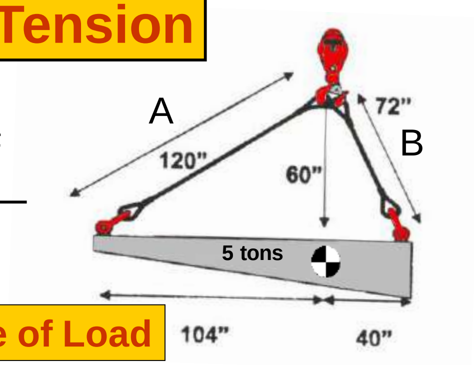
Shackle B Size________

Sling Tension

LF

2

60/120



LF

1.2

60/72

Share of Load

104 + 40 = **144"**

.72 or 72%

144 ⟌ 104

.28 or 28 %

144 ⟌ 40

10,000 X .72 = **7200#**

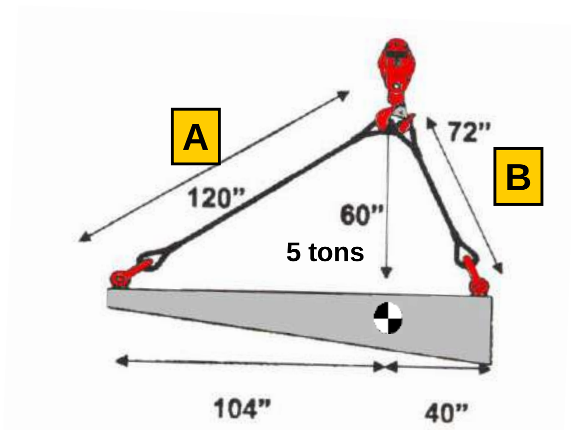
10,000 X .28 = **2800#**

Which sling is which?

Center Of Gravity

Load Angle Factor A___2___
Load Angle Factor B___1.2___

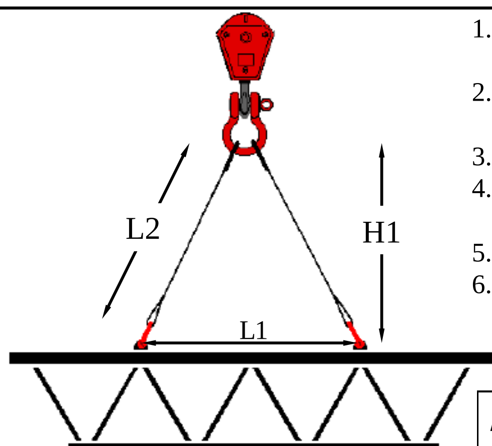
Share Of Load Sling A 2,800#
Share Of Load Sling B 7,200#



Load Sling A___5,600#
Load Sling B___8,640#

Sling A Size___5/8"___
Sling B Size___3/4''___

Shackle A Size___3/4"___
Shackle B Size___7/8"___



The weight of the object above is 15,000#. The lifting lugs are 17' apart. Answer the following.

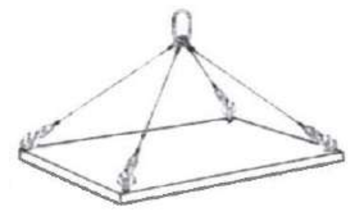
1. What length of sling is needed to produce a 60° sling angle? ___17'___
2. At 60° what is the tension in the slings? ___8,700#___
3. What is the rigging height? ___176 5/8"___
4. To keep rigging height under 6', what is the max sling length? ___124"___
5. What is the sling angle? ___35°___
6. What is the tension in each sling? ___13,050#___

SLING LENGTHS AND LOADINGS

Sling Angle (deg)	Sling Length (L2)	Rigging Height (H1)	Tension in Each Sling (T)
30	=L1 * 0.577	=L1 * 0.289	=W * 1.00
35	=L1 * 0.610	=L1 * 0.350	=W * 0.87
40	=L1 * 0.653	=L1 * 0.420	=W * 0.78
45	=L1 * 0.707	=L1 * 0.500	=W * 0.71
50	=L1 * 0.778	=L1 * 0.596	=W * 0.65
55	=L1 * 0.872	=L1 * 0.714	=W * 0.61
60	=L1 * 1.000	=L1 * 0.866	=W * 0.58
65	=L1 * 1.183	=L1 * 1.072	=W * 0.55
70	=L1 * 1.462	=L1 * 1.374	=W * 0.53
75	=L1 * 1.932	=L1 * 1.866	=W * 0.52
80	=L1 * 2.879	=L1 * 2.836	=W * 0.51

Multi Leg Slings

When all legs of the sling will be equally spaced around the center of gravity, the sling sizes should be based on only two legs as the load can teeter from corner to corner thus loading only two slings.



Rigging Selection

The rigging capacity and the material to be lifted must match. Using too small capacity rigging or components is just asking for an accident to happen.

1. **Who is responsible (competent/qualified) for the rigging?**
   a. Communications Established?

Rigging Selection

2. **Is the Equipment in Acceptable Condition?**
   a. Appropriate Type?
   b. Proper Identification?
   C. Properly Inspected?

Rigging Selection

3. **Are the Working Load Limits Adequate?**
   a. What is the weight of the load?
   b. Where is the center of gravity?
   c. What is the sling angle?
   d. Will there be side loading?
   e. Capacity of the gear?

Rigging Selection

4. Will the Load be Under Control?

a. Tag Line available?

b. Is there any possibility of fouling?

c. Clear of Personnel?

Rigging Selection

5. Are there any Unusual Loading or Environmental Conditions?

a. Wind?

b. Temperature?

c. Surfaces?(Ice, Suction, Water)

d. Unstable Object(s)?

BANKSMAN

5 SIMPLE RULES FOR A BANKSMAN

1. Know the weight of the load.
2. Use the right Lifting equipment for the job.
3. Attach it correctly to the load, ensuring that the hook is over the C of G of the load.
4. Before lifting ensure that hands are clear of the slings.
5. Lift slowly and carefully. Ensure all personnel are clear of the load.

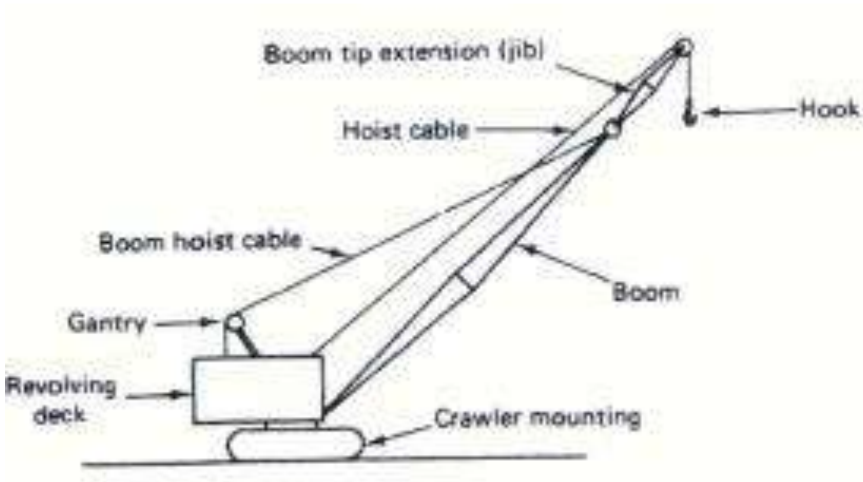
Lifting Supervisor TRAINING

Lifting Equipment SAFETY

Cranes

- A crane is a type of machine, generally equipped to lift and lower materials and to move them horizontally. It is mainly used for lifting heavy things and transporting them to other places. It uses one or more simple machine to create mechanical advantage and thus move loads beyond the normal capability of a man

Components of Crane



TYPES OF CRANE

- CRANES
  - MOBILE CRANE
    - CRAWLER MAUNTED
    - WHEEL MOUNTED
    - FORK LIFTS
  - TOWER CRANE
  - GANTRY CRANE
    - SEMI GANTRY CRANE
    - CANTILEVER GANTRY CRANE
  - OVERHEAD TRAVERSE CRANE
  - CRANE WITH HEAVY LIFT ATTACHMENT

Types of cranes

- Boom truck
- Jib crane
- Crawler Crane
- Ceiling Crane
- Tower Crane
- Gantry Crane
- Side Boom
- Hammer Crane
- …

Identification and Capacity

The manufacturer must issue a Test Certificate for every crane he produces, identifying it and specifying the Safe Working Load (SWL) which must be clearly marked on the Crane structure.

Safe Working Load

Booms

- A lattice boom resembles pipe pieces connected together. It is cable suspended and acts as a compression member. The structure is lightweight, which means extra lifting capacity. This boom is usually transported in sections that are assembled at the site. Crawler and tower cranes typically have lattice booms. Most heavy lifting is done with lattice booms.
- A telescoping boom works in the same manner as a retractable telescope. As lift height is needed, the boom is telescoped or extended. This boom acts a bending member when lifting. Typically, the boom comes ready for lifting when it arrives at the site. Mobile hydraulic cranes, sky track type lifters use telescoping booms. Moderate to medium lifting can be done with telescoping booms.

Type of Cranes

- Mobile cranes are widely used in construction since they are capable of moving freely around a job site. Rubber tired cranes are also capable of moving rapidly between construction projects. Crawler cranes have excellent local mobility but must be transported on equipment trailers between projects.
- Tower cranes are widely used on building construction sites as well as on other construction projects requiring large vertical clearances and having restricted space in the work area. Such cranes are able to move loads over a wide area and have an almost unlimited vertical range

Mobile Crane

Telescoping boom all-terrain

Crawler

Lattice-boom truck-mounted

Modified cranes for heavy lifting

Rough-terrain

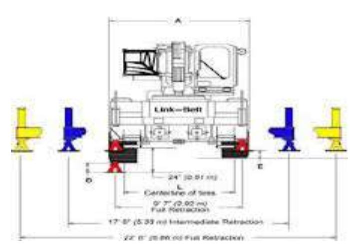
Crawler Cranes

- The *full revolving superstructure of this type of unit is mounted on a pair of* continuous, parallel crawler tracks.
- The crawlers provide the crane with good travel capability around the job site.
- Inclined lattice mast, which helps decrease compressive forces in the boom.
- Relocating a crawler crane between projects requires that it be transported by truck, rail, or barge. These machines usually have lower
- Initial cost per rated lift· capability, compared with other mobile crane types is low, but movement between jobs is more expensive.
- Therefore, crawler-type machines should be considered for projects requiring long duration usage at a single site.

Telescoping-Boom Truck-Mounted Cranes

- These truck-mounted cranes have a self-contained telescoping boom.
- Most of these units can travel on public highways between projects under their own power with a minimum of dismantling.
- These machines, however, have higher initial cost per rated lift capability.
- For small jobs requiring crane utilization for a few hours to a couple of days, a telescoping truck crane should be preferred.
- Telescoping-boom truck cranes have extendable outriggers for stability.

Outriggers



- *Movable beams that can be extended laterally from a mobile crane to stabilize and help support the unit.*
- Some models can operate on their tires when there is firm leveled ground, but their lifting capacity is markedly reduced

Latticed-Boom Truck-Mounted Cranes

- The lattice-boom truck crane has a fully revolving superstructure mounted on a multi axle truck/carrier.
- The advantage of this machine is the *lattice boom. The lattice-boom* structure is lightweight.
- This reduction in boom weight means additional lift capacity, as the machine predominately handles hoist load and less weight of boom.
- The lattice boom does take longer to assemble. The lightweight boom will give a less expensive lattice-boom machine the same hoisting capacity as a larger telescoping-boom unit.
- The disadvantage of these units is the time and effort required to disassemble them for transport. In the case of the larger units, it may be necessary to remove the entire Superstructure.

Rough-Terrain Cranes

- These cranes are mounted on two-axle carriers .
- These units have a lower cost.
- These units are equipped with unusually large wheels and closely spaced axles to Improve maneuverability at the job site.
- They further earn the right to their name by their high ground c1earence allowance, as well as the ability of some models to move on slopes of up to 70%.
- Most units can travel on the highway but have maximum speeds of only about 30 mph.
- In the case of long moves between projects, they should be transported on low-bed trailers.

All-Terrain Cranes

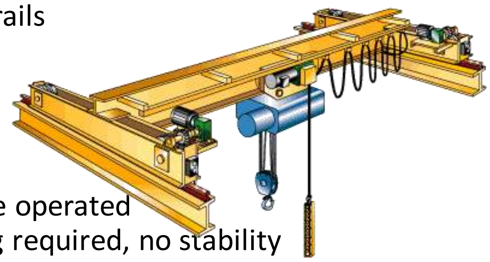
- Designed for long-distance highway travel.
- The carrier has all-axle drive and all-wheel steering, crab steering, large tires, and high ground clearance.
- All-terrain cranes have dual cabs, a lower cab for fast highway travel, and a superstructure cab that has both drive and crane controls.
- Most appropriate machine when multiple lifts are required at scattered project sites or at multiple work locations on a single project.
- It has a higher cost than an equivalent capacity telescoping truck crane or rough-terrain crane.
- All-terrain machine can be positioned on the project without the necessity of having other construction equipment prepare a smooth travel way as truck cranes would require.

Modified Cranes for Heavy Lifting

- These are basically systems that significantly increase the lift capacity of a crawler crane.
- A crane's capacity is limited by one of two factors: (1) structural strength or (2) tipping moment.
- Manufacturers have developed systems that provide the heavy lift capability while maintaining machine integrity.
- The three principal systems available are
  - Trailing counterweight
  - Extendable counterweight
  - Ring system

Industrial Cranes

- Overhead Cranes
  - Common in industrial facilities
  - Supported by overhead rails
  - Components
    - Bridge
    - Trolley
    - Hoist
  - Often pendant or remote operated
  - Easy to use, little training required, no stability problems



Industrial Cranes

- Gantry cranes
  - Similar to overhead cranes, but supported by a mobile frame which travels on the ground

Small (1000 – 10,000 pound capacity) gantry crane

Large (600 ton capacity) gantry crane

Industrial Cranes

- Jib cranes
  - Pivot mounted boom with trolley and hoist

Floor-mounted jib crane

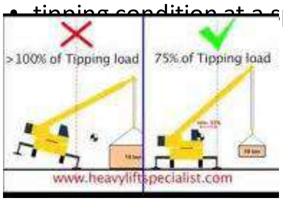
Wall-mounted jib crane

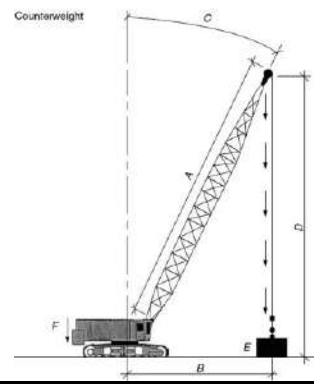
Industrial Cranes

- Power hoist
  - Usually electric or air operated
- Chain hoist (or "chain fall")
  - Hand operated

Lifting Capacity

- Lifting capacity depends upon:
  - Boom length A
  - Radius of load B
  - Counter weight F
  - Weight of crane
  - Boom angle C
- The tipping load is that load which produces
- tipping condition at a specified radius.





Rated Loads

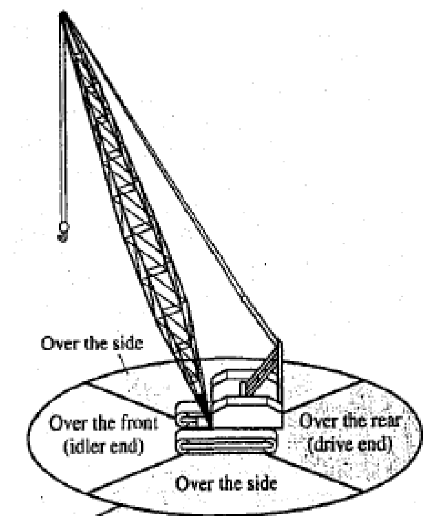
- The rated load for a crane are published by the manufacturer.
- A partial safety factor with respect to tipping are:
  - Crawler-mounted machines: 75%
  - Rubber-tire-mounted machines: 85%
  - Machines on outriggers: 85%

Radius (ft)	Capacity (lb)	Radius (ft)	Capacity (lb)	Radius (ft)	Capacity (lb)
32	146,300	80	39,200	130	17,900
36	122,900	85	35,800	135	16,700
40	105,500	90	32,800	140	15,500
45	89,200	95	30,200	145	14,500
50	76,900	100	27,900	150	13,600
55	67,200	105	25,800	155	12,700
60	59,400	110	23,900	160	11,800
65	53,000	115	22,200	165	11,100
70	47,600	120	20,600	170	10,300
75	43,100	125	19,200	175	9,600

*Specified capacities based on 75% of tipping loads.

Rated Loads

- Load capacity will vary depending on the quadrant position of the boom with respect to the machine's Undercarriage
  - Over the side
  - Over the drive end of the tracks
  - Over the idler end of the tracks



Rated Loads

- The important point is that the rated load should be based on the direction of minimum stability for the mounting, unless otherwise specified.
- The minimum stability condition restricts the rated load because the crane must both raise and swing loads.
- The swinging motion will cause the boom to move through various quadrants, changing the load's effect on the machine.
- Further, it should be remembered that the rating is based on the fact that the outriggers are fully extended.
- Rated loads are based on the assumption that the crane is in a level position (for the full 3600 of swing)

Rated Loads

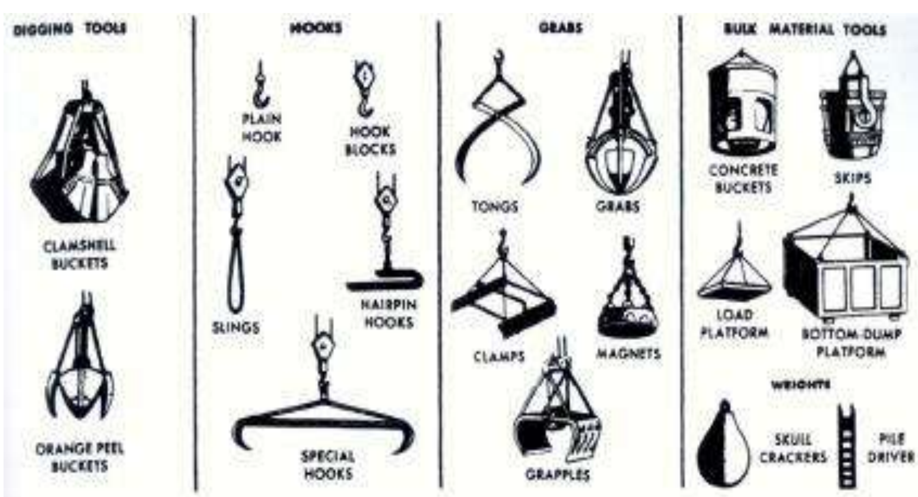
- Another important consideration with modern cranes is that tipping is not always the critical capacity factor.
- At short radii, capacity may be dependent on boom or outrigger strength and structural capacity, and at long radii, pendant tension can be the controlling element.
- Manufacturers' load charts will limit the rated capacity to values below the minimum critical condition taking into account all possible factors.

Load radius (ft)	Lifting capacity (lb)† Boom length (ft) 31.5	40	48	56	64	72	80
12	50,000	45,000	38,700				
15	41,500	39,000	34,400	30,000			
20	29,500	29,500	27,000	24,800	22,700	21,100	
25	19,600	19,900	20,100	20,100	19,100	17,700	17,100
30		14,500	14,700	14,700	14,800	14,800	14,200
35			11,200	11,300	11,400	11,400	11,400
40			8,800	8,900	9,000	9,000	9,000
45				7,200*	7,300	7,300	7,300
50				5,800	5,900	6,000	6,000
55					4,800	4,900	4,900
60					4,000	4,000	4,000
65						3,100	3,300
70							2,700
75							2,200

*Specified crane capacities based on 85% of tipping loads.

†The loads appearing below the solid line are limited by machine stability. The values appearing above the solid line are limited by factors other than machine stability.

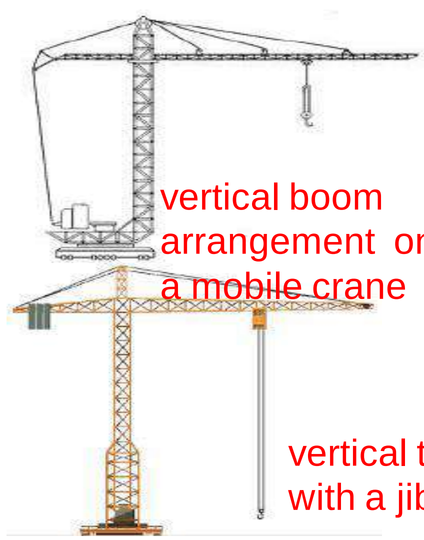
Lifting Attachments



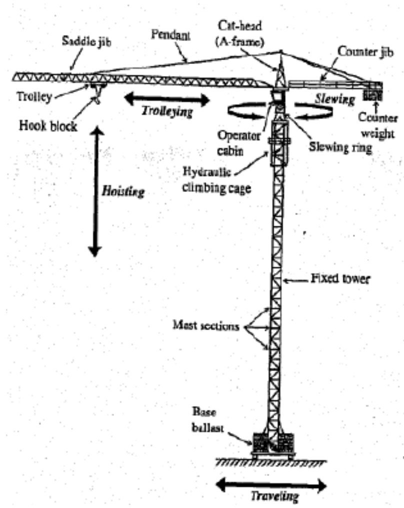
Tower Cranes

- Tower cranes provide high lifting height and good working radius, while taking up a very limited area.
- These advantages are achieved at the expense of low lifting capacity and limited mobility, as compared to mobile cranes.
- The three common tower crane configurations are
  - a special 'vertical boom arrangement ("tower attachment") on a mobile crane
  - a mobile crane superstructure mounted atop a tower
  - a vertical tower with a jib.

Tower Cranes



Tower Crane Parts



Mobile Cranes Rigged with Vertical Towers

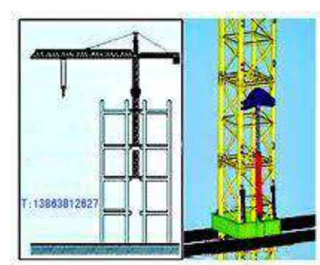
- Crawler- and truck-mounted tower cranes use pinned jibs extending from special booms that are set vertically.
- A crawler-mounted tower crane can travel over firm, level ground after the tower is erected, but it has only limited ability to handle loads while moving.
- A truck mounted tower crane must have its out rigers extended and down before the tower is raised.
- Therefore, it cannot travel with a load, and the tower must be dismantled before the crane can be relocated.
- Recent models of truck-mounted tower cranes merge a bottom-slewing
- tower crane with a mobile truck crane.
- The resulting crane provides excellent lifting height and outreach, as would a normal tower crane, and yet it is possible
- to erect and dismantle the crane in less than 15 min.

Fixed-Base Tower Crane

- The fixed-base-type crane, commonly of the top-slewing configuration.
- The tower is mounted on an engineered concrete mass foundation, either on fixing angles or bolted to the concrete base
- A large crawler or mobile crane is used to erect the tower crane to its full height; however, many of these tower cranes have the capability to independently increase their tower height by means of a climbing mechanism.
- There is a vertical limit known as the *maximum free-standing height to* which fixed-base cranes can safely rise above a base, typically 200 ft for average-size top-slewing cranes, and up to 400 ft for the larger-size cranes.
- To raise the tower above this limiting height, lateral bracing must be provided. Guy ropes may be used to brace tower cranes, but in the majority of cases the towers are tied to the structure being constructed using engineered steel brackets.

Climbing Tower Crane

- Along with the externally braced tower crane, the climbing tower crane is a common choice of crane for high rise building construction; and is a lifting mechanism solution for buildings exceeding the maximum-braced height tower crane limit.
- Structurally supported by the floors of the building that is being constructed, the crane climbs on special climbing collars that are fitted to the building's completed structural floors .
- The weight of both the crane and the loads lifted is transmitted to the structure of the host building.
- The crane will have only a relatively short mast because it moves upward with vertical construction progress .
- The taller the mast, the less frequent the climbing procedure.



Selection of Tower Cranes

- Weight, dimension, and lift radii of the heaviest loads
- Maximum free-standing height of the crane
- Maximum braced height of the crane
- Crane-climbing arrangement
- Weight of crane supported by the structure.
- Available headroom
- Area that must be reached
- Hoist speeds of the crane
- Length of cable the hoist drum can carry

Rated Loads for Cranes

Jib model	L1	L2	L3	L4	L5	L6	L7	
Maximum hook reach	104′ 0″	123′ 0″	142′ 0″	161′ 0″	180′ 0″	199′ 0″	218′ 0″	Hook reach
	27,600	27,600	27,600	27,600	27,600	27,600	27,600	10′ 3″
	27,600	27,600	27,600	27,600	27,600	27,600	27,600	88′ 2″
	27,600	27,600	27,600	27,600	27,600	27,600	25,800	94′ 6″
	27,600	27,600	27,600	27,600	27,600	25,800	24,200	101′ 0″
	27,600	27,600	27,600	27,600	26,800	24,900	23,400	104′ 0″
		27,600	27,600	27,600	25,200	23,600	22,200	109′ 8″
		27,600	27,600	25,600	23,300	21,800	20,500	117′ 8″
		27,000	27,000	25,100	22,800	21,300	20,100	120′ 0″
Lifting capacities in pounds, two-part line		26,300	26,300	24,300	22,200	20,700	19,500	123′ 0″
			24,800	22,800	20,800	19,300	18,300	130′ 0″
			22,400	20,700	18,700	17,400	16,400	142′ 0″
				19,500	17,600	16,300	15,400	150′ 0″
				18,800	16,800	15,700	14,800	155′ 0″
				17,900	16,200	15,100	14,200	161′ 0″
					15,200	14,200	13,300	170′ 0″
					14,200	13,200	12,400	180′ 0″
						12,300	11,600	190′ 0″
						11,700	10,800	199′ 0″
							10,200	210′ 0″
							9,700	218′ 0″

Rated Loads for Tower Cranes

Jib model	L1	L2	L3	L4	L5	L6	L7	
Maximum hook reach	100' 9"	119' 9"	138' 9"	157' 9"	176' 9"	195' 9"	214' 9"	Hook reach
	55,200	55,200	55,200	55,200	55,200	55,200	55,200	13' 6"
	55,200	55,200	55,200	55,200	55,200	55,200	55,200	48' 9"
	55,200	55,200	55,200	55,200	55,200	55,200	51,400	51' 0"
	55,200	55,200	55,200	55,200	55,200	51,500	48,500	53' 6"
	55,200	55,200	55,200	55,200	51,300	48,300	45,600	56' 6"
	55,200	55,200	55,200	50,700	47,100	44,600	42,100	60' 6"
	46,200	46,200	46,200	42,800	39,700	37,400	35,200	70' 0"
	39,400	39,400	39,400	36,500	34,100	31,900	29,900	80' 0"
	34,600	34,600	34,600	31,900	29,700	27,700	26,100	90' 0"
	30,700	30,700	30,700	28,200	26,100	24,100	22,600	100' 9"
Lifting capacities		27,800	27,800	25,600	23,600	21,700	20,300	110' 0"
in pounds		25,400	25,400	23,200	21,300	19,600	18,300	119' 9"
four-part line			23,100	21,100	19,300	17,700	16,400	130' 0"
			21,300	19,400	17,800	16,300	15,100	138' 9"
				17,600	16,200	14,700	13,600	150' 0"
				16,400	15,100	13,800	12,700	157' 9"
					13,600	12,400	11,400	170' 0"
					12,900	11,800	10,800	176' 9"
						11,500	10,600	180' 0"
						10,700	9,800	190' 0"
						10,200	9,300	195' 9"
							9,100	200' 0"
							8,300	210' 0"
							8,100	214' 9"

Example

- Can the tower crane, whose load chart is shown in Table , lift a 15,000-lb load at a radius of 142 ft? The crane has an L7 jib and a two-part hoist line, The slings that will be used for the pick weigh 400 Ib.
- Weight of load 15,0001b
- Weight of rigging 400 Ib (slings)
- Total weight =15,4001b
- Required capacity =15400x 1.05 working margin =16,170lb.
- From Table 17.3 the maximum lifting capacity at a 142-ft hook reach is 16,400 lb.
- 16,400 Ib > 16,170 Ib Therefore, the crane can safely make the lift.

Example

- Can the tower crane, whose load chart is shown in Table , lift a 15,OOO-lb load at a radius of 138 ft? The crane has an L7 jib and a four-part hoist line. The slings that will be used for the pick weigh 400 lb.
- Weight of load 15,000lb
- Weight of rigging 400lb (slings)
- Total weight = 15,400lb
- Required capacity=15400 x 1.05 working margin=16,170lb
- From Table the maximum lifting capacity at a 138-ft hook reach is 15,100 lb.
- 15,100 Ib < 16,170 Ib Therefore, the crane cannot make the lift.

HELPFUL HINTS FOR EFFECTIVE CRANE OPERATION

- When repetitive lifting is involved the crane should be positioned for shortest possible swing cycle to reduce cycle time. For heavy lifts, crane should be positioned to lift over end of mounting where it has maximum lift capacity.
- Crane footing should be checked carefully before lifting capacity or near-capacity loads. Ratings are based on firm, level footings.
- All overhead obstructions should be inspected carefully before moving a crane or starting lifting operations. Machine should be located so as to avoid any contact with power lines.
- In attaching loads, a secure hitch must be made and lift started when all helpers a re in the clear.
- Operator should swing crane slowly enough to avoid excessive outward throw of load and over swinging when machine stops. Crane work is similar to moving a long pendulum, which can be controlled only in slow motion. Fast swinging of crane loads will lose more time than it gains through loss of control, and is very dangerous. A tagline device, similar to that used for clamshell buckets, can be attached to loads to control outward swing.

HELPFUL HINTS FOR EFFECTIVE CRANE OPERATION

- Loads should be placed on solid footings so they have no tendency to overbalance when hitch is released.
- In figuring height of lift, the block, hook, and any sling-slack between hook and load must be included. When making capacity lifts, the entire lifting cycle should be calculated and planned before picking up load. It takes less time and is much safer to check clearance and position than to lift and try, then reposition and try again. With repetitive lifting, a planned cycle is the best way to high production at low costs.
- Organize work for minimum travel time. All needed lifts possible in one area should be completed before moving to another location.
- Booming up and down lengthens the cycle and should be avoided as much as possible on repetitive lifting.
- With rubber-mounted cranes, outriggers should be securely set before undertaking any near capacity loads. Footing under jacks must be level and solid.

HELPFUL HINTS FOR EFFECTIVE CRANE OPERATION

- Jerky operations on crane work should be avoided. It is hard on cable and dangerous.
- Adding a jib to the boom increases the working range both horizontally and vertically, but can reduce lifting capacity.
- With a given boom length, the steeper the working angle the shorter the working radius. With each degree of boom movement to a more vertical position, there is a corresponding degree of reduction in boom radius-and a corresponding increase in lifting capacity.
- Level footing avoids swing "up or down hill," requires less power, is faster and safer.
- When a heavy load is to be lowered from a high position (Example: into a basement or hold of a ship), it is of prime importance that adequate length of hoist cable is assured to facilitate full travel of the block to the lowest point required

Major Causes of Crane Accidents

- Contact with power lines

  10 feet away from power lines

- Overturns

Major Causes of Crane Accidents

- Fall

- Mechanical failure

Major Causes of Crane Accidents

- Lack of training

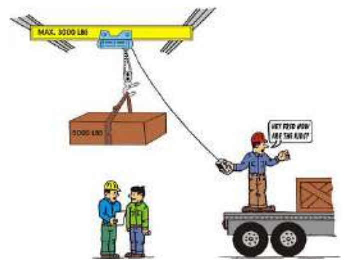
- Inadequate maintenance or inspection

How do Accidents Occur

- Instability - unsecured load, load capacity exceeded, or ground not level or too soft

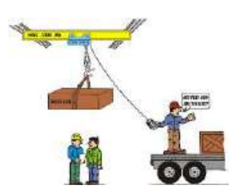
How do Accidents Occur

- Lack of communication - the point of operation is a distance from the crane operator that may not be in full view of the operator



Who is at Risk?

Operator



Persons at crane sites

Banksman

Crane Hazards

Improper load rating

No hand signals

Unguarded parts

Inadequate inspection and maintenance

Crane Hazards

Working too close to power lines (minimum 10 feet)

Shattered windows

Unguarded swing radius

No boom angle indicator

Competent Person

- **Must inspect all machinery and equipment prior to each use, and during use.**

Competent Person

- Must always
  - Carry your certificate or licence
  - Check your vehicle at every shift and report any faults
  - Check the load and load rating
  - Daily check:
    Review last shift's checklist
    Brakes
    Tyres
    Hoses and couplings
    Steering
    Slings, chains or web harnesses if used
    Lights
    Warning devices
    Out riggers or limits if fitted
    Sign off checklist
    Report defects to supervisor

What to Inspect?

Loose or missing hardware, nuts, or bolts

Wire rope wear

Correct air pressure and no leaks

Tires properly inflated

Crane Inspection

- Daily inspections include:
  - Operating mechanisms to ensure proper working order
  - Air or hydraulic systems for leaks
  - Hoist chains/ropes for wear, twisting, distortion

Crane Inspection

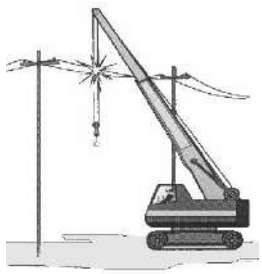
- Periodic Inspections
  - Deformed, cracked or corroded components
  - Loose bolts or rivets
  - Wear on brakes, chain drives or sockets

Planning before Start-up

Level the crane and ensure support surface

Know the basic crane capacities, limitations, and job site restrictions

Planning before Start-up



Know the location and voltage of overhead power lines

Determine safe areas to store materials and place machinery

Planning before Start-up

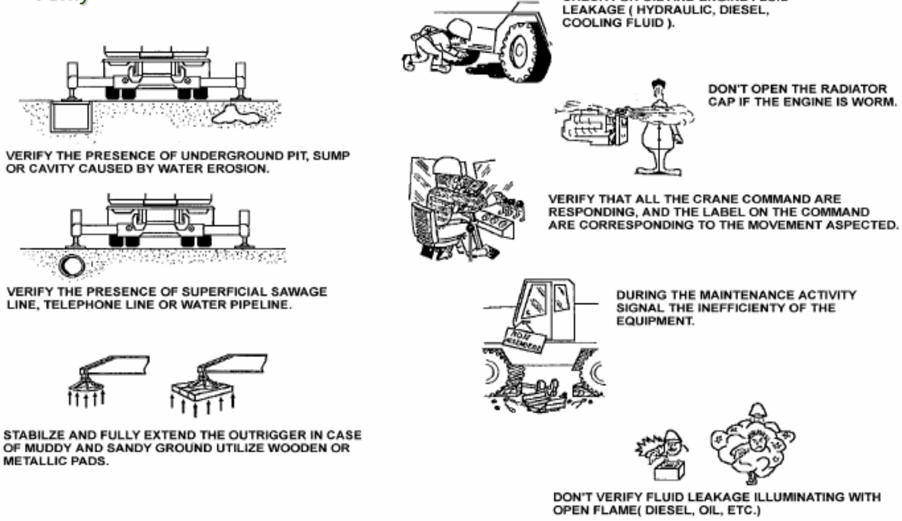
Ensure proper maintenance and inspections

Barricade areas within swing radius

Make other personnel aware of hoisting activities

Planning Before Start-up

- Verify



Preliminary checks

- Before Lifting

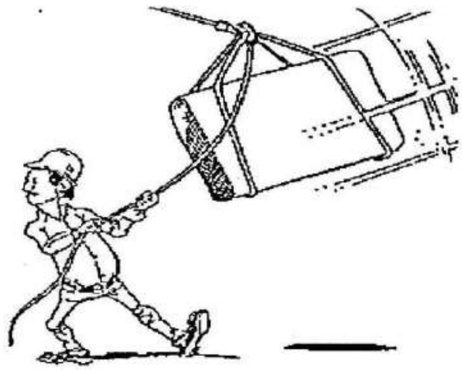
Crane stability

Estimation of load

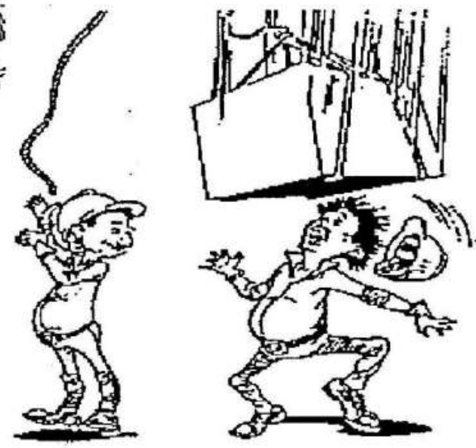
Lifting gear capacity

Load stability

CRANE SAFETY

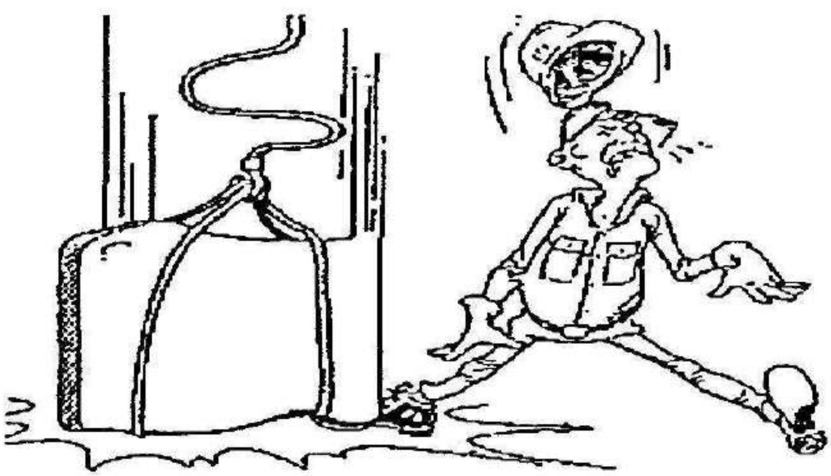


Keep an eye on the load



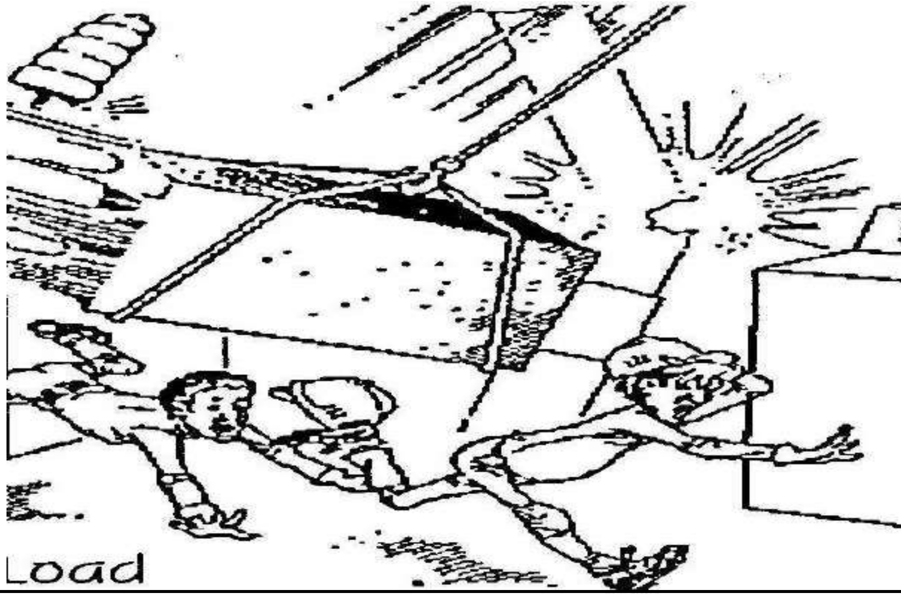
Horseplay & practical jokes can lead to accident.

CRANE SAFETY

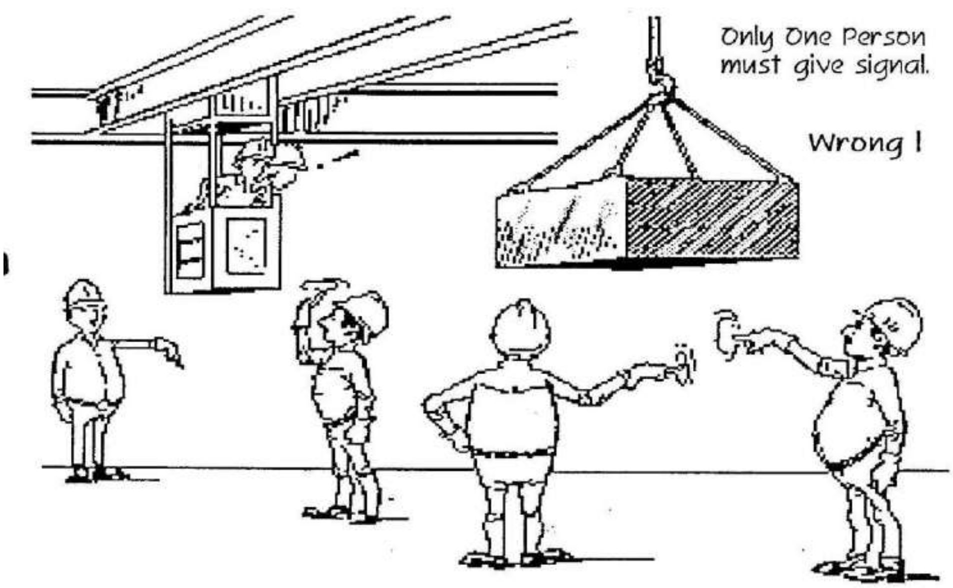


Keep all parts of your body out from under the load

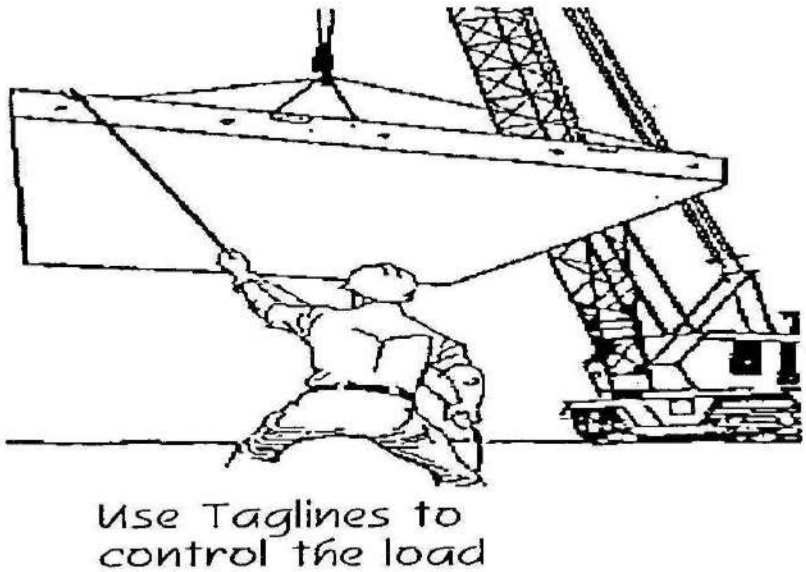
CRANE SAFETY



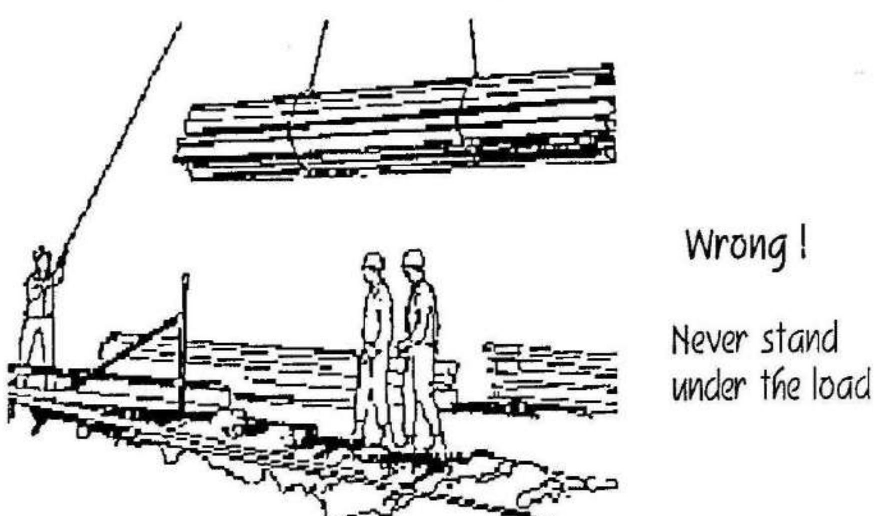
CRANE SAFETY



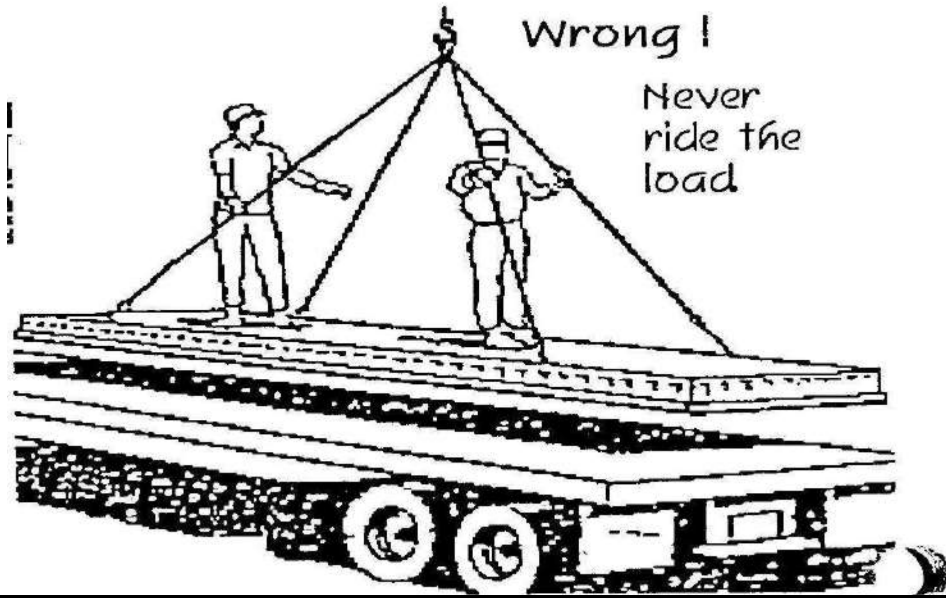
CRANE SAFETY



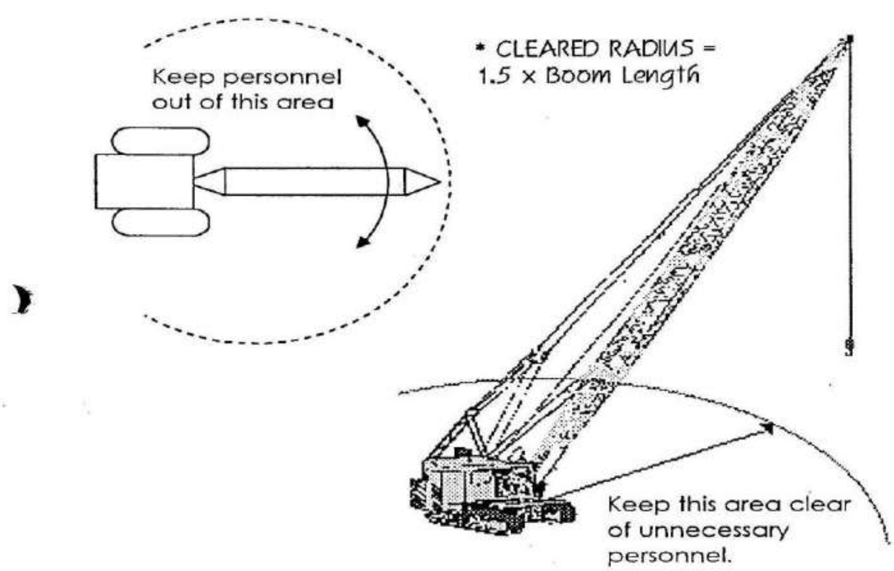
CRANE SAFETY



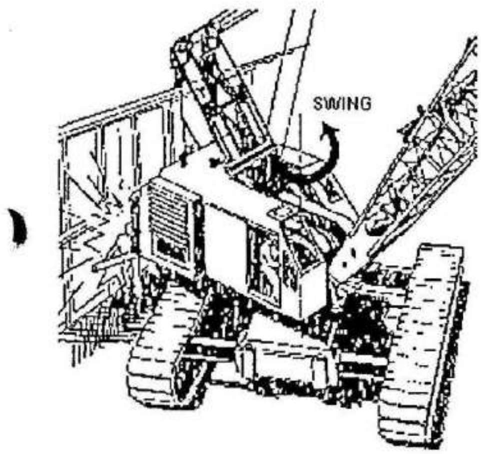
CRANE SAFETY



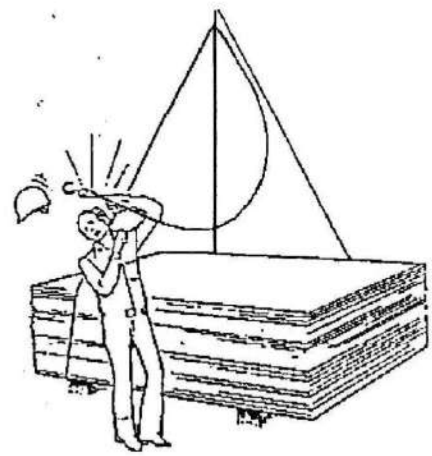
CRANE SAFETY



CRANE SAFETY

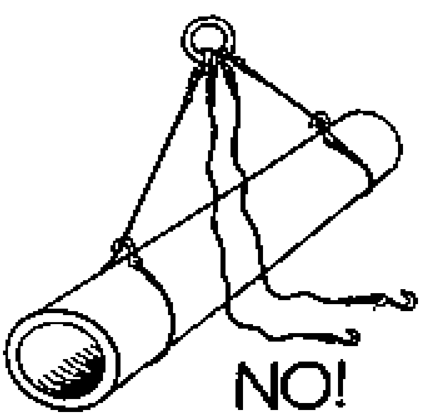


Barricade the areas in which person could be trapped or crushed

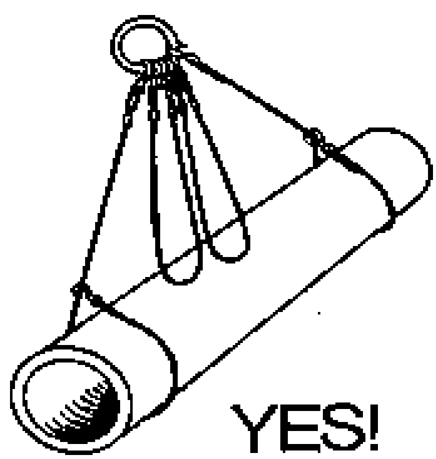


Keep away from the load while slings are being pulled out.

CRANE SAFETY



DO NOT MAKE LIFTS WHEN LOOSE EQUIPMENT IS NOT SECURED.



SECURE UN-USED SLING LEGS.

Lifting Supervisor TRAINING

Legislations & Code of Practice

LIFTING OPERATIONS APPLICABLE LEGISLATION

- **HEALTH & SAFETY AT WORK etc 1974.**
- **MANAGEMENT OF HEALTH&SAFETY AT WORK REGULATIONS 1992.**
- **LIFTING OPERATIONS AND LIFTING EQUIPMENT REGULATIONS 1998.**
- **PROVISION AND USE OF WORK EQUIPMENT REGULATIONS 1992 (AMENDED 1998).**
- **MANUAL HANDLING OPERATIONS REGULATIONS 1992.**

LIFTING OPERATIONS APPLICABLE LEGISLATION

HEALTH & SAFETY AT WORK etc ACT 1974

- EMPLOYERS RESPONSIBILITIES
- It shall be the duty of every employer to ensure,as far as is reasonably practicable, the health, safety and welfare at work of all his employees.
- EMPLOYEES RESPONSIBILITIES
- To take reasonable care for the health and safety of themselves and others who may be affected by their acts or omissions.
- They must co-operate with their employers as far as is necessary to enable that duty or requirement to be performed or complied with.
- No person shall intentionally or recklessly interfere with or misuse any equipment provided in the interest of health,safety or welfare.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Management Of Health & Safety At Work Regs 1992

- Requires employers and self employed persons to assess the risks to workers and any others who may be affected by their undertaking
- Employers with five or more employees must also record the significant findings of that assessment
- Assessment should be reviewed and if necessary modified when the nature of the work or the physical conditions of the work place changes.
- Suitable and sufficient risk assessments should -
- be carried out by a competent person
- ensure that all relevant risks or hazards are addressed
- determine the likelihood of injury or harm arising
- take into account any existing control measures.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Management Of Health & Safety At Work Regs 1992 cont`d

-Identify the measures that employers must take in order to comply with their duties under the applicable health and safety legislation.

-Generic or "model"risk assessments are acceptable where similar activities are being under taken in similar places of work.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Provision And Use Of Work Equipment Regs 1992

- **Every employer shall:-**
- Ensure that work equipment is so constructed or adapted as to be suitable for the purpose for which it is used or provided.
- The suitability of work equipment should be addressed from three aspects.
- it's initial integrity,- the place where it will be used,- the purpose for which it will be used.
- In selecting work equipment every employer shall have regard to the working conditions and to the risks to the health and safety of persons which exist in the premises or undertaking in which the work equipment is to be used.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Provision And Use Of Work Equipment Regs 1992 cont`d

- "suitable" means that it must be suitable by design, construction or adaptation for the work it is provided to do and suitable in every respect which it is reasonably foreseeable will affect the safety and health of any person.
- Risk assessments carried out under the MHSWR will help employers to select work equipment and assess it's suitability for particular tasks.

Every employer shall ensure:-

- That work equipment is maintained in an efficient state,in efficient working order and in good repair,and the where there is a maintenance log it is kept up to date.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Provision And Use Of Work Equipment Regs 1992 cont`d

- The use of work equipment is restricted to those persons given the task of using it.
- That all persons who use or supervise the work equipment have available to them adequate health and safety information and where appropriate written instructions pertaining to its use.
- That all persons who use work equipment have received adequate training in the methods which may be adopted when using the work equipment**,** any risks which are entailed and precautions to be taken
- That effective measures are taken to prevent contact with dangerous parts of machinery, this includes measures at four levels-fixed enclosing guards, other guards or protection devices, protection appliances and the provision of information.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Manual Handling Operations Regs 1992

- Manual handling operations-means any transporting or supporting of a load by hand or bodily force -I.e. lifting, pulling, pushing, carrying, putting down or moving thereof by hand or bodily force.
- They refer to the manual handling of loads by human effort as opposed to mechanical handling by a crane or other such equipment.
- A load in this context must be a discrete moveable object but does not include an implement, tool or machine while in use.
- The reg`s seek to prevent injury to any part of the body and as such account should be taken of physical properties which may effect grip or cause direct injury.
- Each employer shall so far as is reasonably practicable, avoid the need for his employee to undertake any manual handling at work.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Manual Handling Operations Regs 1992 cont`d

- Where it is not reasonably practicable to avoid the need for the employee to under take manual handling which involves the risk of injury,the employer shall make a suitable and sufficient assessment of all such manual handling operations.
- The assessment should be carried out by a competent person and shall take into account the task,load,and working environment.
- Properly based generic assessments are acceptable if they draw draw together common threads from a range of broadly similar manual handling operations.
- Manual handling assessment findings must be recorded.

L O L E R

Loler regulations

1. Came into effect 5th Dec 1998.
   From this date holders must comply with all the all duty requirements.
2. Defining the terms etc.
   I E. 1974 act means the Health and safety at work act 1974.
3. To whom and where.

- Ships Merchant Shipping.
- Slips Trips And Falls.
- Risk Assessment.

4. Calls upon the employer to ensure that the strength and stability are adequate.
5. Lifting equipment for lifting persons.

L O L E R

Reg`s Cont`d

6. Every employer shall reduce to as low as possible.

- The load from striking people.
- Load drifting.
- Falling.
- Being released unintentionally.

7. Every employer shall ensure that
   I.e. equipment for lifting people is clearly marked.

8. Properly planned
   Properly supervised
   Carried out in a safe manner

L O L E R

Reg`s Cont`d

9. **Thorough examination and inspection.**
- **Lifting persons every 6 months.**
- **Accessories lifting gear slings hooks shackles 6 months.**
- **Lifting equipment, mechanical device capable of raising or lowering a load 12 months.**

10. **Report and defects.**

11. **Keeping of information**.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Lifting Operations And Lifting Equipment Regulations 1998

- **Regulation.1-** Citation and commencement-lays out scope and timing.
- **Regulation.2-** Interpretation -Definitions
- **Regulation.3-** Application-Details where and to whom the regulations apply.
- **Regulation.4-** Strength and stability-Calls upon the employer to ensure that the strength and stability of lifting equipment is adequate for use.
- **Regulation.5-** Takes precedence over all other **LOLER** reg`s when lifting of persons is to be carried out.
- **Regulation.6-** Positioning and installation of equipment to minimise risk.

LIFTING OPERATIONS APPLICABLE LEGISLATION

Lifting Operations And Lifting Equipment Regulations 1998 cont`d

Regulation. 7-Marking of equipment to reflect SWL.
Regulation. 8-Organisation of lifting operations to reflect operational safety, adequate supervision and planning.
Regulation. 9-Thorough examination and inspection to ensure valid certification, proper manufacture and fitness for use.
Regulation.10-Reports and defects places a duty on the examiner to provide a report of examination to employer and HSE in certain circumstances.
Regulation.11-Keeping of information to ensure that initial conformity certificates and examination reports follow a piece of equipment.
Schedule.1- Information for report of thorough examination contains a list of key information which must be recorded.

CoP 34.0 Safe use of Lifting Equipments & Accessories

- New Regulation of frame work for construction industry introduced 2010.
- Revised version ADEHSMS V2.0 released on Feb 2012.
- Training & competency for all the persons in lifting operation.
- Records of evidences.
- Employers Responsibility Such as lifting plans, training, inspection, competence of employee & equipments.
- Slingers/ Signaler Responsibility such as SSoW, Reporting Hazards, Visual inspection & terminate unsuitable components, Communication.
- Appointed Person responsibility such as Planning & preparing lifting plans, Advise & monitoring of Operator & rigger, common lift & special lift

CoP 34.0 Safe use of Lifting Equipments & Accessories

Lifting plan Requirements

Contractor shall have the lifting plan which include

- Details of Appointed person.
- List of other operatives & responsibility.
- Overview procedure.
- Crane details & Spec.
- Diagrammatic representation.
- Copies of certificates of operator & slinger/ Signaler.
- Equipment & accessories certificates.
- Common lift elements & its attachment modes.
- Specific procedure for Special lift.
- Inspection & maintenance checks of the equipment & accessories.
- Risk assessment for the lifting operation.

CoP 34.0 Safe use of Lifting Equipments & Accessories

Planning & Assessment

- Competency requirements of operatives.
- Lifting equipments & accessories certification requirements.
- Unauthorized use of lifting equipments.
- Failure of lifting equipments & accessories.
- A load being dropped
- Unstable Ground condition.
- Collision of lifting equipment each other or more.
- Visibility.
- Lifting of people
- Communication
- Fatigue
- Struck by load or equipments.
- Striking Over head power cables.
- Falls during erection.
- Manual handling risks.
- Health risks form oils, solvent & greases.
- Contact with moving machinery parts

CoP 34.0 Safe use of Lifting Equipments & Accessories

Selection & Safe use of lifting equipments

- Weight of the load
- Frequency & duration of work.
- Mobility of the lifting equipments
- Lifting radius.
- Accessories requirements.
- SWL & other marking.
- Load radius indicators.
- Safe load indicators.
- Means of communications- more than 35 MTR radio must.
- Wind speed- Anemometer, Direction, reports daily, 38Km/h
- Lifting Operation- Protection, secure, trail lift, not over personal
- Collision of lifting equipment- Anti collision devices, radio
- Emergency procedure

CoP 34.0 Safe use of Lifting Equipments & Accessories

Emergency Procedure

- Recovery procedure of operatives.
- Suspended Employees during erection or dismantling
- Overturning of the crane
- Load being snagged
- Security of the load
- Any other foreseeable situations

CoP 34.0 Safe use of Lifting Equipments & Accessories

Crane Specific Requirements

Tower Crane

- Bases should be checked before erection by competent engineer
- Competent erectors shall do the erection.
- All electrical connections shall be checked by competent person
- Steel wire amour protected
- Erector should wear safety harness
- Temp platform should be removed prior to use the carne.
- Handover certificate shall available
- Manual shall available on site
- Anemometer shall be fixed.
- Resting platform shall be provided every 9 meter
- Self climbing section had to be lowered after erection

CoP 34.0 Safe use of Lifting Equipments & Accessories

Crane Specific Requirements

Truck Mounted Crane

- Ensure Ground level.
- Excavations & culverts
- Outer rigger & base plates
- Exclusion zones- swing radius
- Not allowed to move on wheels with load
- Safe access for the truck mounted crane.
- Shall be switched off before leaving the cabin
- Windows & wind screen should be in good conditions.

CoP 34.0 Safe use of Lifting Equipments & Accessories

Crane Specific Requirements

Crawler Crane

- Ensure Ground level.
- Excavations & culverts
- Exclusion zones- swing radius
- Shall be switched off before leaving the cabin
- Windows & wind screen should be in good conditions.
- Jib shall be reduced to the minimum radius.
- Jib shall be laid fat & works will be carried out.
- Crawler tracks shall maintain regularly.

CoP 34.0 Safe use of Lifting Equipments & Accessories

Crane Specific Requirements

Gantry Crane

- Anti collision should be installed if two or more on the same bay.
- Exceed load not allowed
- Legible marking of SWL direction of movement on all side
- Load should not pull.
- Ensure all the safety devices are in place, tested & activated.
- Licensed operator

Lifting Supervisor TRAINING

LIFT PLAN

LIFT PLAN

- Successful management of Lift Management System (LMS) is fostered by input and coordination of many groups within an organization
- The purpose of this guide is to define and detail key features of an Lift Plan
- Within this Lift Plan approach, expectations and minimum requirements should be specified with respect to the key factors influencing lifting operations namely:

LIFT PLAN

- Roles and Responsibilities
- Plan the Lift
  - Lift Categorization
    - Routine Lifts
    - Non-routing Lifts
  - Risk Assessment

LIFT PLAN

  - Training
  - Competent Personnel
  - Documentation
  - Approval of Lift Plans
  - Changes to Lift Plans
- Summary for a safe lift

ROLES & RESPONSIBILITIES

LIFT PLAN

Lift Team Responsibilities:

- All key personnel involved in planning and execution of a lift operation.

LIFT PLAN

- Typically includes a Qualified Crane Operator, one or more Qualified Riggers and the Appointed person.



LIFT PLAN

Key responsibilities of the Lift Team:

- Pre Operations
  - Prepare Lift Plan for all lift categorization

LIFT PLAN

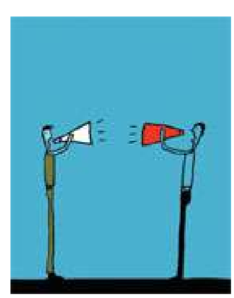
- Evaluate the lift operations to determine if additional personnel are needed to assist in loading or offloading operation

- **Conduct a pre-lift to review scope of work and execution of plan**

LIFT PLAN

- Review Lift Plan with all members of Lift Team

- **Ensure that a clear method of communication is established (e.g. radio or hand-signals)**



LIFT PLAN

- Assess site conditions to ensure that the lift operation can be conducted safely (e.g. sea state, currents, wind speed / direction, weather, size of vessel, position of cargo, etc.)

LIFT PLAN

- Review the Lift Plan and weight of loads to determine if specific simultaneous operations procedures are required to protect equipment from falling loads

LIFT PLAN

Key responsibilities of the Lift Team:

- <u>During Operations</u>
  - Maintain constant communication between Lift Team members

LIFT PLAN

- If site conditions change or if the lift operations change from the original plan, Stop Work Authority or Time Out is executed, conduct another pre-lift meeting / Lift Plan discussion

LIFT PLAN

Key responsibilities of the Lift Team:

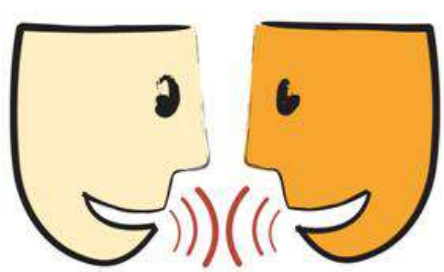
- Post Operations
  - Everyone on the Lift Team in the lift has the opportunity to discuss and make improvements to the lift plan

LIFT PLAN

- Any learning points noted on the plan will be reviewed by the Competent Person (e.g. this may include feedback or equipment effectiveness, lifting techniques, etc.)

LIFT PLAN

- Employees should ensure that the significant learning's and improvements identified from lifting operations are recorded and communicated to all relevant parties



LIFT PLAN

RESPONSIBILE PERSON

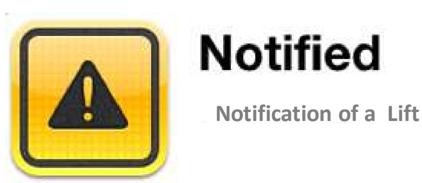
- The Responsible Person is someone who has overall responsibility for work activities.

LIFT PLAN

- This person may be the Supervisor, Manager, Project Engineer, Appointed person, etc.

LIFT PLAN

- The Responsible Person recognizes, or is advised of; the need for a lifting activity and either notifies the Competent Person or appoints a Competent Person to plan the lifting operations.



LIFT PLAN

COMPETENT PERSON

- The Competent Person is someone who has the required level of competency to plan and supervise lifting operations.

LIFT PLAN

- He must have the practical skill, theoretical knowledge and ability to carry out risk assessments, produce and assess lift plans and conduct Pre-lift meeting or Toolbox Talks.

- Example of a Competent Person & Responsibilities:
  - Crane Operator: is responsible for those operations under his or her direct control. Whenever there is any doubt as to safety, the crane operator should have the authority to stop and refuse to handle loads or continue operations as safety dictates.

COMPETENT LIFT TEAM MEMBER

- Each team member has the responsibility to know and work within their own competency

LIFT PLAN

- They are required to attend and participate in Pre-Lift meeting or Toolbox, carry out Pre-use inspections of lifting equipment and stop any operations when they are concerned about its safety.

LIFT PLAN

- Example of a Competent Lift Team Member & Responsibilities:
    - Rigger: the Qualified Rigger is an integral part of crane operations, shipping, material movement, and rigging. Qualified Riggers have certain responsibilities and duties that are critical to the safe load lifting and attaching activities as per this RP.
    - The Crane Operator and Rigger(s) must work as a team.

LIFT PLAN

- Communication among the Lift Team is one of the most important responsibilities.

LIFT PLAN

- ◆Only Qualified Riggers who participate in rigging operations will be used.

- ◆Rigger will always be a key member of the Lift Team.

LIFT PLAN

TECHNICAL SUPPORT

- Those providing technical support must be technically competent in the area of expertise upon which they are requested to give advice.

LIFT PLAN

- Example of a Technical Support Person & Responsibilities:
  - Engineer: shall understand their role and be competent to do it. Shall inform the Crane Operator if conditions changes and/or if there are safety concerns during lifts.

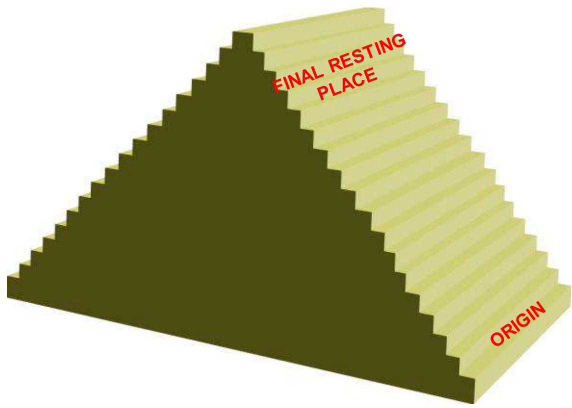
PLAN the LIFT

LIFT PLAN

- The lift plan is intended to clearly identify the Competent Person planning the lift, the lifting operation to which it relates, all lifting operations shall have a lift plan supported by and analysis of hazards and risks.

LIFT PLAN

- The plan should describe in detail the systematic steps or movements required to safely relocate the load from origin to its final resting place



LIFT PLAN

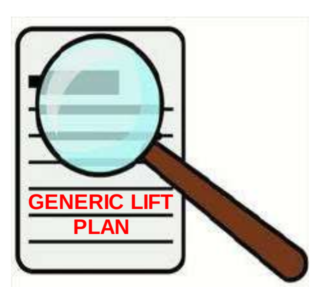
- The Lift Plan should be documented and identify the Lift Team members and shall include copies of current certificates and credentials.

LIFT PLAN

- The Lift Plan should include a copy of most recent crane inspections and pre-use inspection.

LIFT PLAN

- The Lift Plan may only require a generic in nature but will still be reviewed prior to each lift plan supported by and onsite risk assessment and team briefing whereas non-routine lifts, this may be further classified, for example in terms of Simple, Complicated, Complex/Critical, may need significant engineering design effort



LIFT PLAN

- The classification of lifting operations is designed to give the Responsible Person and Competent Person additional guidance.

The Following Items to Consider for Lift Planning

- The type & number of personnel required;
- Their specific roles and competences;
- How they will be briefed;
- The size/shape and weight of the load & lifting points;
- Pick up and set down points and constraints such as space and stacking;
- Rigging equipment required and lifting hardware inspection & certification checks;
- Step-by-Step instructions
- Communication methods to be used
- Where lift will originate
- Finale location of lift
- Identify lift is onboard or offboard
- Condition of crane performing lift
- Dropped object survey
- Lift over survey
- Center of Gravity
- Do you have a emergency plan and rescue plans
- Restrictions on the lift such as weather
- Access and egress for slinging and un-slinging the load in work area

LIFT CATEGORIZATION

LIFT PLAN

- To insure that suitable controls are applied, lifting operations should be categorized according to the level of risk and complexity

LIFT PLAN

- As an aid to identifying risks and suitable controls, lifting operations should be categorized to reflect increasing risk and increasing level of control

ROUTINE LIFT OPERATION GUIDE

- Within the normal operating parameters of the crane
- Lifting over non-sensitive areas
- Suitable environmental conditions
- Familiar, competent Qualified Crane Operators
- Single function or series of functions repeated manually or automatically
- Load has known and evaluated weight, shape and centre of gravity
- Standard rigging arrangements
- Repetitive lifting operations using the same equipment
- Order of function repeated

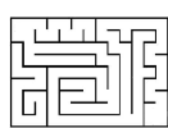
LIFT PLAN

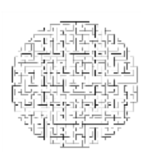
- A generic risk assessment and lift plan may be used for routine lift
- However, classifying a lifting operation as "routine" does not automatically make it a "safe" lifting operation.
- Most incidents associated with lifting occur during routine operations

LIFT PLAN

NON-ROUTINE LIFTS

- Non-routine lifting operations can be sub-divided into three categories to reflect increasing risk:
  - Simple
  - Complicated
  - Complex/critical





SIMPLE LIFT OPERATION GUIDE

- Equipment specifically installed by a crane operator
- Load has known and evaluated weight
- Centre of gravity below the lifting point
- Use of a certified lifting point directly above the load
- Ample headroom
- Not sensitive, difficult or in restricted areas
- Use of one crane
- Standard rigging arrangements
- Unlikely to be affected by changing environmental conditions
- Experienced and competent Crane Operator
- Standard Rigging arrangements
- Suitable working area available
- Relevant permits

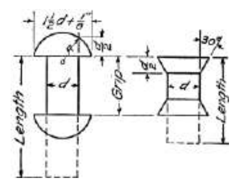
COMPLICATED LIFT OPERATION GUIDE

- Continuation of a lifting operation with different equipment (due to malfunction, inadequacy or unsuitability)
- Use of two crane (tandem lift)
- Within sensitive, difficult or in restricted areas
- Load has an offset centre of gravity
- The load is fragile
- The load has a large surface area which may act like a sail
- Load has to be rotated or overturned
- The signalman is out of site with the Crane Operator during the lift
- Lifts form one offshore vessel to another

LIFT PLAN

COMPLEX / CRITICAL LIFT

- A critical lift plan consist of as many drawings, specifications, and procedures as necessary to accurately assess all important load factors and site factors relating to a critical lift.



COMPLEX / CRITICAL LIFT OPERATION GUIDE

- Continuation of a lifting operation with different people (crew changeover)
- Over or in sensitive areas
- Transferring the load form one crane to another
- Environmental conditions likely to affect equipment performance
- Operator under training
- Load is special and/or expensive
- Non-standard rigging arrangements
- Load lowered into or lifted from a confined space
- Lift operations involves divers
- Plan view drawing of lifting operation

LIFT PLAN

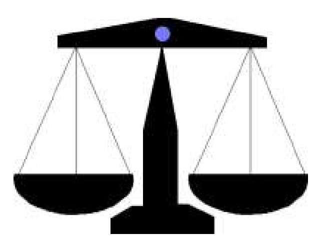
RISK ASSESSMENT

- Follow the risk assessment guidelines recommended by the JSA / JSEA committee.

LIFT PLAN

TRAINING & COMPETENT PERSONNEL

- The management system should define the standards required for critical roles and the process for assuring the competence of those involved in planning and executing lifting operations.



LIFT PLAN

- The system should allow the Person in Charge (PIC) to easily confirm personnel competence.

- **Records of competence should be available on site and if practicable on the person**

LIFT PLAN

- Only suitable Competent Personnel should be involved in lifting operations

- **Personnel should be trained, assessed and monitored as part of a Competency Scheme**

LIFT PLAN

DOCUMENTATION

- Written lift plan
- Safety checklist
- Drawings
- Risk Assessment
- JSA / JSEA
- Toolbox Talk
- Permit to work
- Heavy lift controls





LIFT PLAN

APPROVAL OF THE LIFT PLAN

- All lifts plan should be reviewed and approved by a Competent Person

LIFT PLAN

- The rigor of review should be determined by the category of lift, which may require a Engineer Specialist

LIFT PLAN

CHANGES

- Any changes to plan should be approved as if it were a new plan

LIFT PLAN

SUMMARY

- Questions for a safe lift:

1. Is there a new or existing lift plan which is adequate for the lifting operation?

LIFT PLAN

2. Has a risk assessment been undertaken and the risks managed through the control measures within the lift plan?

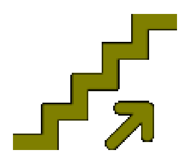
LIFT PLAN

3. Is the equipment selected fit for purpose and identified in the lift plan?

4. Do the personnel selected to undertake this lifting operation have the correct level of competence?

LIFT PLAN

5. Have the steps of the lift plan been communicated and understood by all involved?



6. What could go wrong? (Has this information been fed into the lift plan and risk assessment)

LIFT PLAN

7. Have all potentially affected parties been informed of the lifting activities. (that includes 3rd party)

Lifting Supervisor TRAINING

Alternative Lifting Methods

Multi-Crane Lifts

- Two cranes- horizontal load
- Two cranes- vertical load
- Tailing a vertical load
- More than two cranes- horizontal loads

Multi-Crane Lifts

May be preferred when:

- Handling long pieces
- When obstructions may restrict a single crane
- Utilization of equipment on site
- The extra capacity works well with the nature of the load
- Loads must be placed at an angle
- When dictated by center of gravity issues
- To offload from double-bolstered railcars or hauling equipment

Multi-Crane Lifts

Things to Consider:

- Nearly all crane and lifting safety plans mandate a reduction in chart capacity for multi-crane lifts (some exclude tail cranes)
- A greater chance of side loading either crane exists
- Load distribution can change if one crane gets noticeably higher than the other
- Swinging and hoisting at the same time are not recommended
- If one crane fails, the other will have all of the load
- A first rate signalman is required as well as good communications

Multi-Crane Lifts

Two Cranes – Horizontal Loads

- The two cranes used on this concrete beam allowed the beam to be landed first on one end
- The two cranes were probably on the jobsite, resulting in cost savings

Multi-Crane Lifts

Two Cranes – Horizontal Loads

- Here two matched cranes lift an asymmetrical load
- Careful CG calculation and load distribution is very important

Multi-Crane Lifts

Two Cranes – Horizontal Loads

- Two unequal cranes lifting a process module
- This lift was carefully planned, allowing the larger crane to lift at a greater radius and allowing for a proportional lift

Multi-Crane Lifts

Two Cranes – Horizontal Loads

- Connecting two similar cranes with a long lift beam enables the cranes to reduce their respective operating radii, thereby increasing their lifting capacities

Multi-Crane Lifts

Two Cranes – Horizontal Loads

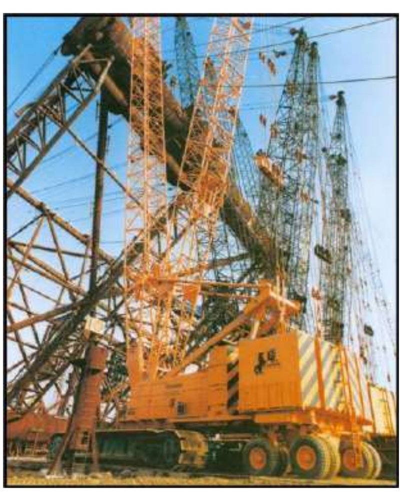
- This is an excellent use of two cranes
- The duct needs to be lifted at an angle for correct placement
- With a single crane lift, the rigging must be selected to provide the correct angle

Multi-Crane Lifts

More Than Two Cranes

- Lifts like this roof raising are normally restricted to lifting only
- Loadings must be carefully calculated
- Communication is most critical
- Chart deductions are essential
- Ground surface should be level, firm, and matted as deemed necessary

Multi-Crane Lifts



More Than Two Cranes: Roll Up

- Another possibility is this this roll-up of an offshore jacket section
- The many cranes will lift only and walk in tightly-controlled unison until the jacket section is rotated to the desired position

Multi-Crane Lifts

TWO CRANES: VERTICAL LIFTS

- Utilizing two cranes to make a vertical lift should require a high level of planning . It is essential to consider:
  - The orientation and the initial layout
  - Boom side clearance and two-blocking
  - The changing of loads on all cranes
  - Minimum and maximum radii
  - Method of safely unhooking the rigging
  - Insure one crane doesn't get ahead of the other
  - A lift of this nature should always be an engineered lift

Multi-Crane Lifts

Two Cranes: Tailing

- Most larger vertical loads require trailing with a crane or an equivalent tailing device
- Sometimes two tail cranes are used
- The crane or device must be able suspend (or support) the proportionate load- whether moving into the hook of the main erection crane or remaining at radius while the erection crane booms out to the tail crane

Multi-Crane Lifts

Two Cranes: Tailing

- Not all vertical loads require tailing with a second crane

Multi-Crane Lifts

Tailing to the Vertical

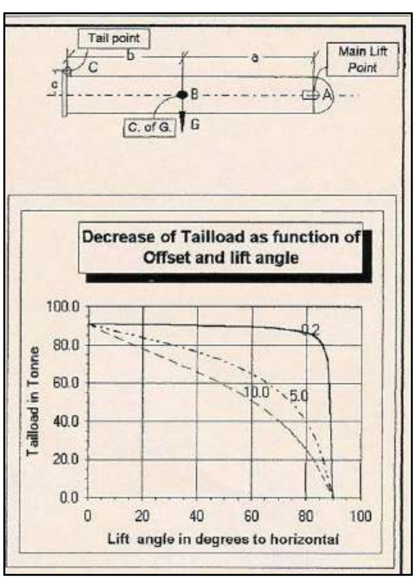
- Not all upendings require a tail crane
- This HRSG module uses a roll up skid attachment

Multi-Crane Lifts

Multiple Cranes: Tailing

- This is a typical erection of a pressure vessel using two erection cranes and a tail crane
- Note that the tail load should be relatively low due to the location of the lifting trunnions
- This slide is used to illustrate how tail loads vary throughout the lift

Tailing to the Vertical



- This is a graph of the tailing load in relation to the horizontal angle
- The solid line is the actual case for the previous slide
- The curve is variable and dependent upon the relationships between the dimensions between the center of gravity and the lift points
- The dotted lines show curves if the offset distance ”c” were greatly reduced

Tailing to the Vertical

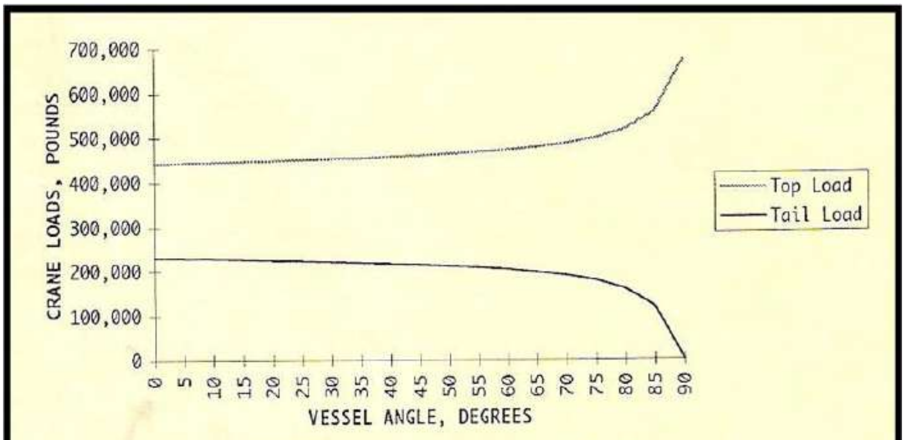
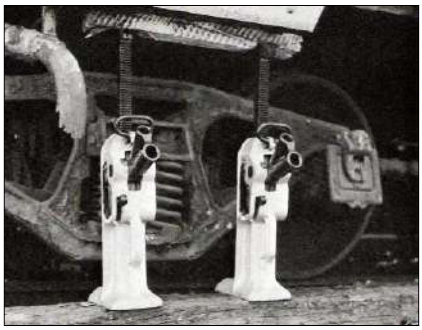


FIGURE 4: Crane loads during a tandem lift.

Alternate Lifting Methods

- Manual and hydraulic jacks
- Hydraulic gantries
- Jacking towers
- Helicopters

Alternate Lifting Methods: Jacks

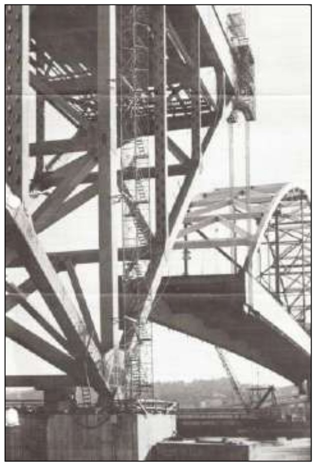


- For years, mechanical track jacks (and similar products) were the standard for much jacking, and are still used today

Alternate Lifting Methods: Hydraulic Jacks

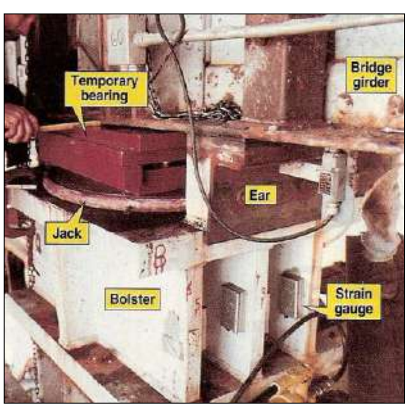
- Hydraulic jacks can be used in an endless number of applications
- From the small, as with the placement of these precast planter boxes

Alternate Lifting Methods: Jacks



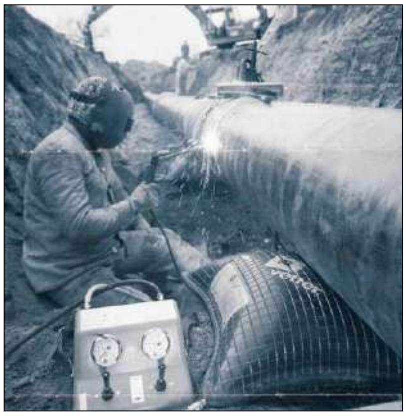
- To the large, as with lifting this large truss bridge with center hole strand jacks

Alternate Lifting Methods: Flat Jacks



- Flat jacks have proved effective in the raising of heavy structures, such as bridges, only a few inches for inspection, repairs, or other applications
- The jacks remain extended and can only be used once
- They can also be filled with grout and remain in place

Alternate Lifting Methods: Air Jacks



- Compressed air jacks have also found their niche in the construction world
- They are also effective jacks for some tasks in the maintenance of construction equipment

Alternate Lifting Methods: Hydraulic Gantries

- Hydraulic gantries can be utilized in open spaces or tight spots

Alternate Lifting Methods: Hydraulic Gantries

- Hydraulic gantries are highly versatile, portable and have high lifting capacities
- They can also translate a suspended load on tracks or even tail up certain loads to the vertical
- The use of these gantries requires good planning and engineering

Alternate Lifting Methods: Jacking Towers

- For very heavy and high loads, jacking towers are frequently used.
- Most, as with this system, utilize large multiple center hole jacks and bridge strand.
- Others may use chain or special links, while others use a push-up jacking system
- These lifts require extensive engineering

Alternate Lifting Methods: Forklifts

- Forklifts, especially with the increasing popularity of rough terrain forklifts, have taken over many jobsite lifting activities

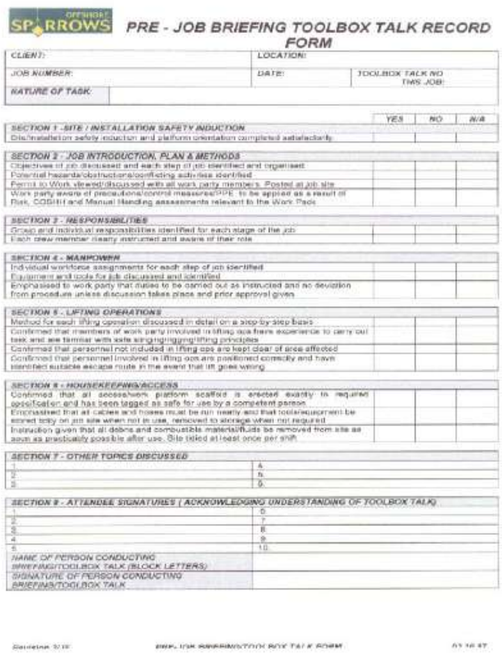
Lifting With Helicopters (Rotorcraft)

- Lifting with helicopters is most feasible when working in remote areas
- Risk factors include:
  - Near hurricane winds below the craft
  - A very limited amount of time that the craft can remain over the set point- only seconds
  - The inherent possibility of a crash

Lifting With Helicopters (Rotorcraft)

- When working around people or operating plants, such as at this truck plant, special care and planning must be implemented

QUESTIONS



SPARROWS OFFSHORE

PRE - JOB BRIEFING TOOLBOX TALK RECORD FORM

CLIENT:	LOCATION:	
JOB NUMBER:	DATE:	TOOLBOX TALK NO THIS JOB:
NATURE OF TASK:		

	YES	NO	N/A
SECTION 1 - SITE / INSTALLATION SAFETY INDUCTION			
Site/installation safety induction and platform orientation completed satisfactorily			
SECTION 2 - JOB INTRODUCTION, PLAN & METHODS			
Objectives of job discussed and each step of job identified and organised			
Potential hazards/obstructions/conflicting activities identified			
Permit to Work viewed/discussed with all work party members. Posted at job site			
Work party aware of precautions/control measures/PPE to be applied as a result of Risk, COSHH and Manual Handling assessments relevant to the Work Pack			
SECTION 3 - RESPONSIBILITIES			
Group and individual responsibilities identified for each stage of the job			
Each crew member clearly instructed and aware of their role			
SECTION 4 - MANPOWER			
Individual workforce assignments for each step of job identified			
Equipment and tools for job discussed and identified			
Emphasised to work party that duties to be carried out as instructed and no deviation from procedure unless discussion takes place and prior approval given			
SECTION 5 - LIFTING OPERATIONS			
Method for each lifting operation discussed in detail on a step-by-step basis			
Confirmed that members of work party involved in lifting ops have experience to carry out task and are familiar with safe slinging/rigging/lifting principles			
Confirmed that personnel not included in lifting ops are kept clear of area affected			
Confirmed that personnel involved in lifting ops are positioned correctly and have identified suitable escape route in the event that lift goes wrong			
SECTION 6 - HOUSEKEEPING/ACCESS			
Confirmed that all access/work platform scaffold is erected exactly to required specification and has been tagged as safe for use by a competent person			
Emphasised that all cables and hoses must be run neatly and that tools/equipment be stored tidily on job site when not in use, removed to storage when not required			
Instruction given that all debris and combustible materials/fluids be removed from site as soon as practicably possible after use. Site tidied at least once per shift			

SECTION 7 - OTHER TOPICS DISCUSSED	
1	4
2	5
3	6

SECTION 8 - ATTENDEE SIGNATURES (ACKNOWLEDGING UNDERSTANDING OF TOOLBOX TALK)	
1	6
2	7
3	8
4	9
5	10
NAME OF PERSON CONDUCTING BRIEFING/TOOLBOX TALK (BLOCK LETTERS)	
SIGNATURE OF PERSON CONDUCTING BRIEFING/TOOLBOX TALK	

Do's & Don'ts

Always

- Ensure that only authorized slingers/signalers attach or detach loads, or signal the crane operator.
- Discuss operations with the crane operator (special operations).
- Ensure that the capacity of the crane is sufficient.
- Seek expert advice when using eye bolts, plate clamp etc.
- Use tag line always

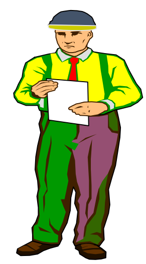
Never

- Wrap tag line around hand or body.
- Leave a suspended load unattended.
- Pass loads over people.
- Ride or climb on suspended loads.
- Stand or walk beneath the loads.
- Use pipes to support for landing the load

THANK YOU

FOR

YOUR KIND ATTENTION.



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